BIDDING DOCUMENTS

for

Procurement of

Construction of Highway E 75 Section: Grdelica (Gornje Polje) – Caricina Dolina

LOT 1: Road and bridges Grdelica-Tunnel Predejane
LOT 2: Road and bridges Tunnel Predejane-Caricina Dolina

VOLUME 1 **Part 2** **Works Requirements**

ICB No: CORRX.E75.EIB.PACK1.ICB

Project: Corridor X Highway Project

Employer:
Koridori Srbije d.o.o. Beograd, Serbia

Section VI Works Requirements

Contents

Scope of Works

SCOPE OF WORKS

on the E75 Grabovnica – Levosoje highway, Section Gornje Polje – Predejane, LOT 1

1.0. GENERAL DATA

1.1. SUBJECT OF THE PROJECT

The E75 highway is a section of the European Highway Network that runs through the both Serbia and Montenegro from the Hungarian border (Horgos) via Novi Sad, Belgrade and Nis to the state border with the FYR of Macedonia (Presevo) and further on to Skopje and Athens. In Belgrade, the E75 highway is connected to both the E70 highway (from Croatian to the Romanian border) and the E763 highway running to Podgorica, while feeding roads in Nis enable the E75 highway to be connected to E80 highway toward Sophia.

The section of the studied highway running through Serbia is under different phases of construction. At the time of preparing this report, traffic operations from the state border with Hungary to Novi Sad are enabled on single carriageway that will be integrated into the future highway. The other carriageway is under construction fully in accordance with the plan and should be completed to the end of 2010. The highway has been completed from Beska (bridge over the Danube River) to Batajnica, while the bridge over the Danube River is under construction.

From Belgrade to Nis, the highway has been built in full profile during the 1980s and 1990s. On the already constructed section, from Belgrade to Nis, the existing pavement has been improved through rehabilitation works performed on either carriageway. The highway section from Leskovac to Grabovnica has been completed in 2006 and put into operation afterwards.

The subject of the Final design herein is Gornje Polje - Caricina Dolina section, which is considered to be the final phase in construction of the E75 highway considering its segment passing through Serbia, from Leskovac (Grabovnica) to the border with FYR of Macedonia (Cukarka village). The Preliminary design has been prepared for this section and approved by the Revision Commission for expert verification of technical documentation at the meeting hold on January 28, 2009, fully in accordance with the decision No. 350-01-00792/2003-03 dated February 17, 2009. Preparation of the Preliminary design was entrusted to the Institute of Transportation CIP, Belgrade. The Preliminary design was developed fully in accordance with the Enactment on Town Planning referring to construction of E75, Nis – Macedonian border highway, Grabovnica – Levosoje section, No. 350-01-01416/2007-10 dated August 17, 2008 issued by the Ministry of Environmental Protection and Spatial Planning. Pursuant to the Preliminary design, the Ministry of Environmental Protection and Spatial Planning has issued the Decision on Building Approval, No. 351-03-01149/2/2009-07 dated April 6, 2010.

1.2 OVERVIEW OF CONCLUSIONS MADE THROUGH EXPERT VERIFICATION OF THE PRELIMINARY DESIGN, GENERAL MEASURES AND SUGGESTIONS GIVEN BY THE REVISION COMMISSION TO BE APPLIED BY THE INVESTOR THROUGH THE DEVELOPMENT OF THE FINAL DESIGN

Terms of Reference for the purpose of Final design preparation requires design speed to be defined fully in accordance with provisions stated in the Law on Public Roads so as other elements integrating the highway can be properly sized. Widening of the typical cross section, from 10.70 m to 11.50 m per direction is proposed to be reconsidered in the ToR.

It should also be necessary to reconsider conceptual solution referring to toll payment system. Since state-of-the-art technologies enable more rational and effective solutions for toll payment, additional activities should be performed and design requirements defined adequately through the development of ToR for the purpose of Final design preparation.

Introduction of ITS along the whole highway section should be considered. However, this system should be harmonized with other models installed within the entire Serbian Highway Network.

1.3. RESULTS OF TRAFFIC, SURVEYING, HYDROLOGICAL AND GEOTECHNICAL INVESTIGATIONS

Technical characteristics of Grdelica (Gornje Polje) - Caricina Dolina section are shown in the Table below:

Technical characteristics of Grabovnica - Vladicin Han section

Technical characteristics	
Section length (km)	12,000
Number of traffic lanes	2
Traffic lane width (m)	3.50
Distance from side obstacles (m)	1.0
Gradient (%)	1.7
Minimum horizontal curve radius (m)	250
Average curvature (^{o}/1000m)	0.77
Sight for safe overtaking (%)	30
Height above sea level (m)	290
Section type	Suburban

The studied section as well as the entire M1 road was constructed more than 40 years ago. During that time, this road with single carriageway and two traffic lanes was officially named ’’highway’’ and was provided with the following cross section elements: carriageway (7.5 m wide); shoulder (0.90 m wide); verge (0.35 m wide); formation (10.00 m wide). According to modern criteria, M1 is suppose to be the road for motor vehicle operations since there is no separate carriageway with two traffic lanes minimum.

The original pavement structure was covered by asphalt-concrete/cement-concrete layer. In a meantime, the pavement structure was improved by placing the new asphalt-concrete layer over the entire length.

During the next period, forecast of traffic flows within the Serbian Road Network will include considerations referring to relation between economic indicator growth and growth of traffic flows within the network. Once the solid basis has been defined, it will be possible to make real forecasts of traffic flow based on plans referring to sustainable economic growth in the Republic of Serbia.

The forecast traffic load during the operation period (2002-2021) on the existing M1 road (E75) has been obtained as an average forecast traffic flow as shown in the Table below.

T.7.6: Forecast traffic load on the existing road

Year	Vehicle type				
	PC	BUS	FV	TT	**AADT** (vehicle/day)
2002.	3033	219	1597	564	**5413**
2005.	3928	283	2068	730	**7010**
2010.	5782	417	3044	1075	**10317**
2015.	8504	613	4476	1581	**15174**
2021.	11560	833	6086	2150	**20629**

Note: PC (passenger car), FV (freight vehicle), TT (truck trailer).

TRAFFIC FORECAST ON THE NEWLY-DESIGNED E75 HIGHWAY AND ALTERNATIVE ROAD

Traffic forecast for the newly-designed E75 highway, Gornje Polje - Caricina Dolina section, is shown in the Table T.8.1, while traffic load for the alternative variant is shown in the Table T.8.2.

The forecast traffic load on M1 arterial road is based on solution that will require "splitting the traffic" to the future highway and alternative roads network in relation 85% to 15%.

T.8.1: Forecast of traffic load on the planned highway

Table 01

Traffic section	Year	Vehicle type						
		PC	BUS	FV	TT	AADT (vehicle/day)		
						sum	national	internat.
Vlasotince interchange - Predejane interchange	2002	3550	44	678	708	**4980**	4332	648
	2005	4226	48	772	855	**5901**	5075	826
	2010	5268	55	923	1056	**7302**	6207	1095
	2015	6348	64	1091	1254	**8757**	7268	1489
	2021	7940	76	1332	1541	**10889**	8820	2069
Predejane interchange - Vladicin Han interchange	2002	3501	50	665	685	**4901**	4264	637
	2005	4170	54	756	827	**5807**	4994	813
	2010	5196	63	904	1021	**7184**	6106	1078
	2015	6261	73	1069	1213	**8616**	7151	1465
	2021	7832	86	1306	1491	**10715**	8679	2036
Vladicin Han interchange - Vranje interchange	2002	3313	48	586	630	**4577**	3982	595
	2005	3914	52	667	761	**5394**	4639	755
	2010	4916	61	797	939	**6713**	5706	1007
	2015	5924	70	943	1115	**8052**	6683	1369
	2021	7410	82	1151	1371	**10014**	8111	1903
Vranje interchange - Bujanovac interchange	2002	3171	38	449	585	**4243**	3691	552
	2005	3776	41	512	707	**5036**	4331	705
	2010	4705	49	613	872	**6239**	5303	936
	2015	5670	55	724	1036	**7485**	6213	1272
	2021	7092	65	883	1274	**9314**	7544	1770

T.8.2: Forecast of the traffic loading on alternative road

Year	Vehicle type				
	PC	BUS	FV	TT	**AADT** (vehicle/day)
2002	455	33	240	85	812
2005	589	42	310	110	1051
2010	867	63	457	161	1548
2015	1275	92	671	237	2276
2021	1734	125	913	322	3094

1.3.2. SURVEY INVESTIGATIONS

The area covered by surveying has been marked on the map, 1:1000 in scale. The survey works have covered the area by entire width and length for the purpose of Final design preparation, including all relevant enlargements so as the alternative road could be designed and the existing Nis-Skopje railway line relocated, if necessary.

Geodetic plans (layouts) required for preparation of the Final design for the studied highway have been developed by the Institute of Transportation CIP, Belgrade.

1.3.3. HYDROLOGICAL INVESTIGATIONS

1.3.3.1. Hydrological considerations and drainage concept

The subject of the design herein, which is considered to be an integral part of the design for the E75 highway alignment, is storm water drainage.

Regulation works of the roadside water streams are incorporated into the separate design (Book 6).

Corridor of this highway section is mostly stretching along the right valley of the Juzna Morava River. From km 874+225 (the existing bridge) the alignment goes by the right side of Juzna Morava River. The most important tributaries gravitating toward Juzna Morava are as follows: Predajanska River, Palojska River, Licindolska River, Bakarni brook and Caricina Dolina. Considering natural conditions, the following have been identified as the most unfavorable ones: watershed erosion (category 1 and 2) and torrents (category 1 and 2).

The standard drainage system will apply. The highway runoff will be intercepted in concrete gutters and channeled into the relevant recipient through drain trenches. The highway alignment will intersect smaller water streams and dry ravines. These water streams are tributaries of both Juzna Morava and Moravica Rivers. On sections not covered by the drainage system, the highway runoff will be taken to the watershed area gravitating toward Juzna Morava River.

On this highway section as well as on the entire length from Leskovac to the national border with FYR of Macedonia, treatment of surface water runoff prior to releasing into natural streams and brooks will not be performed. Water will be directly released into rivers and streams along the highway through the relevant drainage system.

There are two systems of protection against accumulation of storm water on the highway surface:

- Drainage system that in addition to gutters and trenches also includes sewage system provided with inspection manholes and outlets into embankment slope or roadside ditches/water streams and culverts. Stormwater sewage system will be installed in the embankment so as water cannot be spilled over (small embankment height, populated area). Due to small outflow profile of the gutter, runoff from the pavement will be discharged and taken away from the highway.
- On the segment where trenches are planned to be designed below the embankment, water runoff will be taken either by pipes passing along the central lane and released laterally or will be discharged in curbs and conveyed by special gutters alongside the embankment slope. On such sections, water will be taken along the embankment slope to trenches through the use of concrete flumes.

Drainage of capillary water is not planned due to several reasons. The entire highway alignment is positioned on the embankment and there are no possibilities for capillary water accumulation. Embankments will be constructed of high quality materials excavated on the studied area or taken from the relevant borrow pit (sandy-gravel material from Morava River). Since the top subgrade layer will be composed of crushed shales, capillary water will not be expected.

Structures, bridges, viaducts and culverts except concrete pipes not exceeding 1.6 m in diameter, are separately analyzed in the volume named ’’Structures’’. Pipe culverts positioned on water streams have been incorporated into the regulation works stated in the volume named ’’Hydroengineering structures’’. However, the design herein only includes concrete pipe culverts varying from 1.0 m to 1.6 m in diameter required for proper highway drainage. Concrete culverts having 1.6 m in diameter are easy for maintenance. On the segment of the alignment where the existing carriageway (M1 road) is in use, the already constructed culverts will be retained. These culverts mostly have opening of 1.0 m and some of them are provided with manholes placed on green areas to enable easy maintenance.

1.3.3.2. Hydraulic computation of drainage features

The hydraulic computation includes input parameters required for both hydrological and hydraulic analyses for storm water sewage and other related drainage features.

Roadside ditches

Main watersheds (analyzed in the design referring to water stream control (Volume 3.1) and subwatersheds with littoral waters gravitating toward the studied highway are marked on the general map, 1:25000 in scale. The biggest watershed (watershed 10) occupies 20 ha in area. Time of runoff concentration in the stated areas varies from 10 to 25 minutes. Hydraulic computation also includes hydraulic characteristics of roadside channels that will be constructed in accordance with all relevant criteria.

Sewage pipes

Hydraulic computation is obtained by applying the Rational Method (see Tabular attachments).

Input parameters for the purpose of estimation are as follows:

- Relevant rainfalls adopted for ’’Grdelica’’ rainfall gauging station
- Adopted recurrence interval of T = 10 years
- Rainfall duration as a function of concentration time for relevant roadside watershed areas with the time of concentration t_0 = 5 min
- Coefficient of runoff from the asphalt surfaces ψ_a= 0.9
- Coefficients of runoff from green areas ψ_z= 0.1 - 0.2

1.3.3.3. Design considerations

Drainage of both surface and riparian waters is suppose to be one of the most important tasks to be fulfilled in the course of road designing from the aspect of both structure stability and safe driving. For the studied section, relevant analyses have been performed and adequate drainage solutions proposed. The graphical part of documentation includes drainage plans together with drainage features.

For the purpose of drainage of both surface and riparian waters the following concept has been considered:

Median drainage is planned to be installed across the median area along the entire highway provided with uniform crossfalls. The drainage system will also cover the right side of the highway due to morphological ground properties.

On the segment of the roadway where installation of longitudinal drainage system is not possible to be performed, side inlets will be placed after each manhole.

Storm water runoff from the pavement provided with uniform crossfall will be collected in standard concrete gutter placed along the pavement edge;

Recipient structures are considered to be manholes provided with pipe gully grating (due to lack of space for placing of separate drainage system and pipe gully joints). They will be spaced at 40 to 50 m apart (at critical segments where the gutter is inclined at 0.3% maximum, manholes (gutters) will be spaced at 20 m apart) and further convey of water will be enabled through storm water sewage to the roadside channel.

Manholes are consisting of prefabricated conical top and pipe having 1.0 m in diameter cast in situ by concrete, class MB30. The conical top is of standard shape with standard grating and the pipe is of changeable length provided with 0.5 m deep separator.

Storm water sewage is consisting of HDPE pipes having 300-400 mm in diameter laid in trenches varying 0.90 - 1.10 m in width on minimum 0.10 m thick sandy-gravel layer.

The both layout and longitudinal profile show manholes marked as follows:

1. Manholes for acceptance of both storm and drainage waters are marked as "Kd"
2. Manholes for acceptance of only drained water are marked as "D"

Drainage system in the median area is not planned to be installed in a case of camber.

On sections having medians provided with segmented gutter characterized with twice as much capacity comparing to the standard gutter of triangular section, storm water will be collected in manholes provided with pipe gully grating. Drainage pipes are planned to be installed above the sewage pipes.

Roadside ditches of semi-round shape characterized with minimum depth of 30 cm that will collect water runoff from the pavement and embankment slopes are planned to be constructed along embankment and cut sections.

Certain single-sided sections will be provided with pipe storm water sewage system due to urban or spatial restrictions in a case that water cannot be released on the lower slope side.

Releasing of storm water into recipient will be enabled by manhole located at the most downstream position. Water shall enter the relevant structure (bridge, slab top or pipe culvert) or **"lateral outlets"** and released into natural depressions or roadside ditches, if conditions allow. The so-called "lateral outlets" are pipes that accept water from the storm water sewage and convey it to the roadside ditches through the substructure. In a case of significant change of level, drop manhole will be installed so as relevant requirements can be met.

Lateral outlets are HDPE pipes of adequate diameter (200 mm -400 mm) laid onto the 10 cm thick layer made of concrete, class MB 20 at the minimum depth of 1.20 m measured from the pavement surface. The stated parameters are in compliance with the allowable peak pressure of pipes and pavement dynamic load.

Embankment slope ends will be provided with prefabricated concrete flumes that will accept water from outlets and convey it to the roadside ditch or adjoining areas. At the inlet point, the drain trench will be lined with concrete, 2 m long, to prevent erosion as a result of water action. Water from drain trenches will be further conveyed into relevant structures (pipe and top slab culverts), brooks or natural depressed sections (road alignment design -Book 1).

Drainage system is mostly consisting of perforated PVC pipes laid onto the lean concrete layer. The drain trench filling is composed of aggregate, as designed.

Graphical presentation of storm water sewage features in this design is also stated in the road alignment design (Book 1), drainage chart.

Graphical part also includes standard profiles and typical drainage details.

Outlet points including outlet pipe shortcuts are shown in the Table below:

Watershed	**Mark**	**Position**	**Starting point**	**End / Recipient**	**DN**	**Length**
			Km	*Km*	*mm*	*m*
1	**D1**	Left				
		Central	874,028.65	874,221.99	300	193.3
		Right				
	ISP 1-1	Left	874,221.99	r. J. Morava	300	15.7
2	**D2'**	Left				
		Central	874,346.20	874,475.00	300	128.8
		Right				
	D2''	Left				
		Central	874,986.66	874,475.00	400	511.7
		Right				
	ISP 2-1	Right	874,475.00	r. J. Morava	400	15.9
3	**D3'**	Left				
		Central	875,026.80	875,147.08	300	120.3
		Right				
	D3''	Left				
		Central	875,266.90	875,147.08	300	119.8
		Right				
	ISP 3-1	Right	875,147.08	r. J. Morava	300	18.3
4	**D4**	Left				
		Central	875,698.50	875,538.14	300	160.4
		Right				
	ISP 4-1	Left	875,538.14	J. Morava River	300	20.3
5	**D5**	Left				
		Central	876,650.00	876,419.86	300	230.1
		Right				
	ISP 5-1	Left	876,419.86	Slope	300	12.7
6	**D6**	Left				
		Central	876,650.00	876,748.00	300	98.0
		Right				
	ISP 6-1	Left	876,748.00	Slope	300	14.5
7	**D7**	Left				
		Central	877,225.00	877,366.70	300	141.7
		Right				
	ISP 7-1	Right	877,366.70	Palojska River	300	28.2
8	**D8**	Left				
		Central	877,465.95	877,405.90	300	60.0
		Right				
	ISP 8-1	Right	877,405.90	Palojska River	300	32.7

Watershed	Mark	Position	Starting point	End / Recipient	DN	Length
			Km	*Km*	*mm*	*m*
9	D9	Left				
		Central	877,724.00	877,493.50	400	230.5
		Right				
	ISP 9-1	Right	877,493.50	Slope	400	14.6
10	D10	Left				
		Central	878,137.70	877,937.19	300	200.5
		Right				
	ISP 10-1	Right	877,937.19	J. Morava River	300	16.6
11	D11	Left				
		Central	878,295.35	878,157.20	300	138.2
		Right				
	ISP 11-1	Right	878,157.20	Slope	300	17.1
12	D12	Left				
		Central	878,635.05	878,484.95	300	150.1
		Right				
	ISP 12-1	Left	878,484.95	J. Morava River	300	15.0
13	D13'	Left				
		Central	878,715.10	879,075.00	500	359.9
		Right				
	D13''	Left				
		Central	879,275.00	879,075.00	300	200.0
		Right				
	ISP 13-1	Left	879,075.00	Slope	500	16.2

1.3.3.4. Works execution methodology, bill of quantities and cost estimate

Since the alignment of the studied highway is positioned in the embankment along the entire studied section, drainage and sewage systems will be carried out successively together with construction of bottom layers on the road embankment.

In the course of embankment compaction, minimum works on filled material will be required so as adequate thickness required for pipe lying can be obtained regardless of drainage/storm water sewage.

Material around the trench and formwork for drainage filling will be compacted by hand in 25 cm-30 cm thick layers.

Together with placing of material below the highway formation sewage and drainage manholes will be installed. Material in the manhole areas will be also compacted by hand.

In accordance with everything mentioned above, quantities of earth works will refer to fillings in the area of pipes, sewage and drainage trenches.

1.3.3.5. Protection and displacement of water supply system

1.3.3.5.1.Current situation and design considerations

Since the studied section of E75 highway is passing through the territory of ’’Grdelica’’ public utility company, conditions issued by this company has been obtained for the purpose of preparation of the design herein.

Concerning water supply installations, one collision with the designed alignment at the beginning of the section has been identified. Technical requirements and proposition referring to displacement of the existing PEHD F90 water supply system have been obtained. Through the contacts with representatives of the said company, it was concluded that the technical documentation for the water supply system herein is not available and that its position has been marked approximately.

In accordance with the stated requirements, the design herein will include displacement as well as applying of adequate protection measures.

For the purpose of design preparation, relevant solution plans referring to alignment, reference level and cross sections have been obtained.

1.3.3.5.2.Reference levels of the water supply system

Reference levels of the displaced water supply system have been defined so as gradients of the existing pipes can be maintained and placing of new outlets or air valves escaped. Gradient has been defined according to ground levels.

1.3.3.5.3. Pipe material

Regardless of materials used for the existing water supply pipes, all displaced pipelines will be made of PEHD material capable to support pressure of 10 bar. Pipes will be provided with adequate nominal diameters.
Pipes shall be backfilled with excavated material.

1.3.3.5.4. Water supply system and related facilities

Outfall manholes are planned to be installed at km 0+060 and km 0+394.11. The designed manholes of adequate volume will have 1.2 x 1.3 m and 1.4 x 1.4 m in size.

Pipeline turnouts and reinforcing bars in manholes will be secured by anchor blocks embedded in concrete base.

The pipeline shall be displaced in the course of preliminary works so as damages during the execution of works can be escaped, if any. Prior to commencement of works, test grooving shall be performed so as position of the pipeline could be precisely defined and connection between new and the existing water supply systems enabled once the route of the new pipeline has been defined.

1.3.3.6. Water flows control

The subject of the Final design herein is control of water flows in the area of the future highway section passing through Grdelicka Gorge. The chainage of the studied section is taken from the already approved General design. Kilometrage to be used in this design are those taken from the road alignment design.

In the course of design preparation, Study on climatic, hydrologic and hydrographic parameters (Institute for Spatial and Urban Planning - Nis - 1993) incorporated into the General design was studied as a baseline document for defining the input parameters required for hydrologic analysis.

For sizing the structures positioned at points where a water stream intersects the highway alignment (culverts and bridge opening) as well as for the purpose of analysis addressing to the potential threat the permanent/temporary water streams might have to the studied highway, the 100-year frequency storm event has been adopted. Storm events with the return period of 1000 years have also been considered.

Location and sizes of structures planned for intake and evacuation of permanent and temporary water streams alongside the highway at the section planned for reconstruction and extension have been retained, as designed, although on certain sections control works must be performed so as the structure could be aligned with the existing riverbed.

Hydrologic analysis has been performed for all locations planned for intersection of both regulated and unregulated water streams so as data on high waters and hydraulic calculation required for testing of function and capacities of the existing and newly-designed structures can be obtained.

In addition to design criteria and analysis specified in the design, the competent water management companies and the Republic Hydrometeorologic Service have been also asked for their opinion and their requirements were taken into account in the course of design preparation.

The alignment of the E75 highway in Grdelicka Gorge runs through morphologically unsuitable areas. The first segment is stretching along the right bank of Juzna Morava River and the second one that passes along the left bank of Juzna Morava River is in collision with numerous torrents.

This section of the studied highway starts at km 873+719.94. Its first segment runs along the valley of Juzna Morava River (right bank). The highway alignment crosses from one river bank to another and vice versa through seven bridges.
Water streams on both left and right banks are torrent in nature. At the points of intersection with the alignment of the newly-designed highway (valley variant), 3 and 4 m wide box culverts and pipe culverts having 1600 mm and 2000 mm in diameter have been planned.
The subject of the hydrotechnical segment of the design is stated below:

- Regulation of the Juzna Morava river bed,
- Regulations of tributary beds,
- Securing the Juzna Morava river bed in the bridge areas (upstream and downstream)
- Testing of hydraulic permeability of cross structures on the highway.

1.3.3.6.1. Basic documents for design preparation

Among all available documents, the design engineer has used data integrated into the previously prepared design documentation for the area concerned (preliminary designs from earlier period), geodetic maps, geological basic data as well as opinion of the Republic Hydrometeorological Service of Serbia and ’’VP Morava Nis’’ Water Management Company. Sensitive spots on the designed alignment have also been identified during site visits.

1.3.3.6.2. Design considerations

Through design considerations referring to high water events, adequate solution must be find so as transient flowing regimes could be escaped. At the beginning as well as at the end of every regulated section of the Juzna Morava River, adequate retaining structures are planned to be constructed.

The Juzna Morava River frequently collides with the alignment of the studied highway and planned intersections are enabled at unfavorable angles. Crossfalls of natural river bed vary from 0.22% to 0.35% and the river itself is characterized with rapid streams as a result of high water in the gorge area.

Characteristics of the regulated bed of Juzna Morava River are listed below:

- Bottom width of 25 m
- Slopes (banks) inclined at 1:1.5
- Height of 4.5 m after the bed was being provided with adequate support.

The highway alignment is in collision with the Juzna Morava River at six locations planned for execution of regulation works.

Beds of tributaries are planned to be made of concrete. Regulation works in the Juzna Morava riverbed will require using of stone embedded in cement mortar.

Small structures alongside the highway are pipe and slab top culverts.
Mean profile speed for relevant high water is shown below:

Mean profile speed [m^3/s]	Elevation of the structure bottom edge [m]
0.5	0.60
1.0	0.65
1.5	0.75
2.0	0.80
2.5	0.90
3.0	1.10
3.5	1.25
4.0	1.40
>4.0	1.50

This was performed due to ease maintenance and cleaning since torrents are temporary in nature and characterized with significant deposits.

The design herein also includes alternative highway route (regional highway) not included in toll payment system for the purpose of local traffic operations.

At the point of intersection with tributaries, the newly-designed alignment of the regional road will be provided with adequate structures of similar sections as those positioned along the highway.

Torrents will be provided with inflow structures and ramps to overcome the significant differences of levels and calming of the adjoining soil. On points where overcoming of significant grade-separation between water streams and the highway would require expensive regulation works, previously stilled side water streams will be taken to the drain channels. Side channels will be placed at the top of retaining walls parallel to the highway alignment provided with similar longitudinal grades (retaining walls are discussed in the separate book).

Water streams affected with regulation works are listed below:

No	CHAINAGE	WATER STREAM NAME	REGULATION LENGTH	STRUCTURE
1	874+115.48	Vasiljkovac Brook	154.63	Pipe ∅1600
2	874+266.12	Juzna Morava River	639.60	-
2'	0+570.00	Tributary of Juzna Morava (874+266.12)	73.55	-
3	874+903.62	Nameless stream	53.66	Pipe ∅1600
4	875+434.24	Juzna Morava River	569.43	-
5	877+386.56	Palojska River	60.00	-
6	877+483.95	Nameless stream	49.5	Pipe ∅1600
7	877+504.05 – 878+127.00	Juzna Morava	626.25	-
8	878+305.47	Licindolska River	128.37	-
9	878+411.02	Juzna Morava River	188.38	-

List of water streams intersecting the studied highway not planned to be affected with regulation works is given in the text below.

No	Structure	Water stream name	Chainage
1	Pipe	Cerje Brook	875+734
2	Pipe	Terzinci Brook	876+531.572
3	Pipe	Crnogorski Brook	878+596.482
4	Pipe	Graovska Valley	879+420.526
5	Culvert 3x2	Petkova Valley	879+770.542

1.3.3.6.3. Hydraulic calculation

Hydraulic calculation for the Juzna Morava River has been performed so as water table line and gravitation flow could be defined in the area of regulated sections. Water table lines have be calculated for two flows stated below:

- 100-year frequency storm event $Q_{1\%}$ and
- 1000-year frequency storm event $Q_{0.1\%}$.

Level lines for both flows and capacity of the newly-designed and existing bridges are attached to this section (graphs and tables included).

For lateral water streams planned to be affected with regulation works, testing of capacity of the newly-designed openings has been performed through the application of FLOW MASTER Program for the 100-year frequency storm event $Q_{1\%}$.

Pipe culverts having the minimum diameter of 2000 mm will be used fully in accordance with the mean profile speed for the relevant storm event computed according to the Table below:

Mean profile speed [m^3/s]	Elevation of the structure bottom edge [m]
0.5	0.60
1.0	0.65
1.5	0.75
2.0	0.80
2.5	0.90
3.0	1.10
3.5	1.25
4.0	1.40
>4.0	1.50

1.3.4. ENGINEERING – GEOLOGICAL INVESTIGATIONS

1.3.4.1. INTRODUCTION

In 1999 and 2002, Department of Geotechnical Engineering, Institute of Transportation CIP, Belgrade has performed field investigations and related tests fully in accordance with the relevant schedule of works for the purpose of preparation of Preliminary design for the E75 highway, Gornje Polje - Caricina Dolina section. Reports on geotechnical soil investigations for the purpose of the Preliminary design were prepared in 2000, 2003 and 2007. The Preliminary design for the E75 highway, Gornje Polje - Caricina Dolina section was adopted in 2007 after expert verification of technical documentation has been performed.

Pursuant to the Contract concluded with the ’’Roads of Serbia’’ PE, the Institute of Transportation CIP has undertaken the obligation to design and perform all relevant surveys, investigations and tests for Gornje Polje - Caricina Dolina section (E75 highway) for the Final design preparation fully in accordance with the alignment position developed through the Preliminary design. The Department of Geotechnical Engineering has performed field investigations in the period November-February (2009/2010) according to the both schedule of works and the offer.

In the phase of investigations performed for the purpose of Preliminary design, all engineering, geological and geotechnical conditions that may affect the construction of the future highway have been completely analyzed. Otherwise, geotechnical conditions for the purpose of construction of related structures and tunnels have been partly studied. According to the defined schedule, geotechnical soil investigations for the Final design level have been mostly performed on locations planned for construction of future structures and partially alongside the studied highway on locations where engineering structures are planned to be constructed, Juzna Morava riverbed and locations reserved for revetments and tunnel structures.

Geological and geotechnical documentation required for the Final design preparation includes results of investigations and tests performed for the purpose of Preliminary design as well as results of performed additional field investigations and tests.

Results of additional geotechnical investigations and tests performed for the purpose of development of the Final design for the E75 highway, Gornje Polje - Caricina Dolina section, from km 873+719.941 to km 879+775.00 (lot 1), are stated in the Book 2: "Report on geological and geotechnical investigations, tests and analyses". The book is consisting of the following Volumes:

Volume 1: "Report on geotechnical soil investigations for the highway alignment" (textual and graphical parts),

Volume 2: "Report on geotechnical investigations for structures" (textual and graphical parts and geostatic calculations),

Volume 3: "Report on geotechnical investigations for the tunnel" (textual and graphical parts),

Volume 4: "Report on soil investigations for engineering structures on the studied highway" (textual and graphical parts),

Volume 5: "Geotechnical field investigations for alignment, structures, tunnel and engineering structures on the studied highway" (documentation).

’’Design of aquifers and stockpiling area’’ has been integrated into the separate Book that contains information about all borrow pits for materials including locations planned for permanent stockpiling of surplus material.

1.3.4.2. RESULTS OF PREVIOUSLY PERFORMED ENGINEERING, GEOLOGICAL AND GEOTECHNICAL ANALYSES

Basic analyses and data on geological composition, stratigraphic relationships, engineering, geological, hydrogeological and seismic properties of the ground as well as basic engineering, geological and geotecnical conditions required for design considerations of the E75 highway have been stated in the ’’Study on engineering, geological and geotechnical conditions in the corridor for all highway variant solutions’’ as an integrating part of the General design prepared by the Highway Institute – Belgrade, 1991 (B. Jelisavac).

Considering content and extent as well as accuracy and level of site investigations, results of the stated Study have been used for optimization of both type and scope of investigations and tests required for the Preliminary design, fully in accordance with problems identified on the ground-structure relation.

In the course of preparation of Preliminary design for the studied highway, Gornje Polje-Caricina Dolina section, certain investigations have been performed. Investigations have included as follows:

- Lithological composition, structural-textural properties and spatial position of separated lithological members in the area of the designed highway,
- Watering and hydrogeological soil properties,
- Identification and classification, resistance and deformable properties of soil,
- Occurrences and possible occurrences of recent geodynamic processes and
- Geophysical, seismic and electric soil properties.

For the purpose of preparation of the report for the level of Final design, basic data stated in the Preliminary design for the E75 highway, Gornje Polje - Caricina Dolina section have been used. Phase V: Adopted variant, Book 4.1. "Engineering, geological and geotecnical conditions for establishing the highway alignment'. Field works have been performed in the period September-November, 1999 and September-November, 2002.

The following documents have been used:

- Engineering and geological maps,
- Boreholes (75 boreholes were drilled along the corridor of the adopted alignment),
- Test pits (11 test pits were excavated along the corridor of the adopted alignment),
- Laboratory and geomechanical testing of soil samples,
- Geophysical investigations and
- Geodetic survey.

Geotechnical categorization and soil classification have been performed fully in accordance with soil properties.

1.3.4.3. OVERVIEW OF THE PERFORMED ENGINEERING, GEOLOGICAL AND GEOTECHNICAL TESTS AND SOIL INVESTIGATIONS

Department of Geotechnical Engineering, Institute of Transportation CIP, has performed all field investigations and tests required fully in accordance with the applicable legislation.

Method applied in defining the alignment is stated in the Preliminary design. Design work and construction of the studied highway will require additional investigation works to be performed and related tests to be carried out.

1.3.4.3.1. FIELD INVESTIGATIONS AND TESTING

Field investigation works for the level of Final design have been performed fully in accordance with the defined schedule in the period November-February 2009/2010 in areas planned for construction of structures, engineering structures, revetments, displacement of riverbed and tunnel.

1.3.4.3.1.1. Detailed engineering-geological mapping

Detailed engineering-geological ground mapping has been performed in the course of Preliminary design preparation. The mapping has included 12 km long zone of changeable width. The studied zone occupies 7 km^2 in area, approximately.

According to engineering-geological mapping, surface boundaries between different lithological media have been defined, hydrological occurrences identified and spatial boundaries of present geodynamic process defined (alluvium, diluvium, proluvial and terrace sediments). Rock exposures have been measured through spatial orientation of structural members while degree of rock mass failure (RQD) has been performed in the area of portals and tunnel tubes. Mapping results have been modified and harmonized with data obtained during exploratory boring and therefore represent synthesis of all results obtained in previous investigations.

Engineering-geological ground mapping has been performed in the course of investigations required for the Final design level. Small modifications referring to positions of geological boundaries have been carried out according to the precisely performed surveying and data obtained from the additional exploratory boring.

In accordance with the results obtained through additional investigation works for the level of Final design, certain modifications of position of Quaternary lithological complexes and modification of results obtained through preliminary engineering-geological mapping have been obtained.

1.3.4.3.1.2. Exploratory boring and detailed engineering-geological core mapping

Exploratory boring for the level of Preliminary design has covered the area of both right and left banks of J. Morava River as well as segment of the terrain on the right bank in the area close to the river itself (at points where the alignment spans the one bank and goes to another) or in the zone of possible variant solutions. Exploratory boring was carried out so as areas along the alignment where tunnel and related structures will be constructed could be investigated. Since the exploratory boring has been performed in two different periods (1999 and 2002) and for different variant solutions, detailed analysis has shown results of all investigations. This report shows boreholes drilled along the corridor of the adopted variant (75 boreholes of the total length of 639.80 m). Boreholes drilled in 1999 were designated as MBt, MBol, MBod, MBk and MBv, and boreholes drilled in 2002 were designated as Bvt and Bvo.

Exploratory boring for the level of Final design has already been performed according to investigation design with insignificant modifications as a result of local ground properties. Drilling was carried out in the period November-February, 2009/2010 in the area of designed structures, engineering structures, revetments, river bed displacement and tunnel, considering the fact that geological composition and ground properties along the studied alignment have been precisely defined. Although 137 boreholes have been planned for drilling, only 90 boreholes were drilled as a result of conditions of local ground. Instead of boreholes, test pits have been excavated in difficult areas. Boreholes varied from 4.00 to 30.00 m in depth with the total length of 820.40 m. Although boreholes provided with designation V followed by the relevant number are not shown in the continuity, they are stated fully in accordance with the previous borehole arrangement developed through the investigation works.

Drilling has been performed by Bort Longer drill rig (DB 505, BG-1 and GDR-150). Continuous rotary core drilling has been applied and small quantity of water was used for tools cooling. So called ’’dry’’ drilling where no water was anticipated has been applied on slopes.

The drilled boreholes varied from 146 mm to 101 mm in diameter. Boreholes drilled in rock environment had diameters varying from 76 mm to 86 mm. Percentage of the obtained core varied dependent on type of material in which drilling was performed. In silty sand environments, this percentage varies between 90% and 100 % and in coarser alluvial and proluvial sediments the said percentage ranged between 60% and 70 %, or less. Percentage of core samples in eluvial zones obtained through drilling in hard rock mass varied from 40% to 60% while in less disturbed zones almost 100% of core sample was obtained.

Detail engineering-geological core mapping and selection of samples for laboratory geomechanical testing has been carried out during the field work upon completion of boreholes drilling. In the course of mapping, identification of lithological media, presence of water, moisture, plasticity, physical and chemical modification, type, shape and number of inclusions have been identified. Since drilling in hard rock mass was carried out in eluvial zone that suffered intensive physical, mechanical and chemical changes, degree and type of fissibility, failure, etc. could not be precisely defined.

1.3.4.3.1.3. Exploratory excavation and detail engineering-geological mapping of pits

In the course of investigations for the purpose of Preliminary design preparation, exploratory excavation has been performed in the subsurface that will support the construction of the future highway so as type of materials and their physical and mechanical properties can be precisely defined and depth of ground water identified as well as thickness of topsoil to be removed. The exploratory excavation has been performed on locations difficult for drilling rig approach. In the area of the studied alignment, 12 (twelve) trial pits designated as Jvt were excavated.

The exploratory excavation in the course of investigations for the purpose of Final design preparation has been also performed on difficult terrain through the use of drill rigs. Twenty five (25) test pits in total designated as JV were excavated in the area of the studied alignment.

Detail engineering and geological mapping of pits together with monitoring of change in lithological members and taking samples for laboratory geomechanical testing have been performed in the course of excavation.

1.3.4.3.1.4. Detail mapping of rock mass exposures

Detail mapping of rock mass exposures have been performed together with engineering geological ground mapping. Shale exposures have been analyzed so as fracture texture according to both RMR and Q classifications could be defined. Direction of fractures and spaces between them have been measured and failure state identified.

1.3.4.3.1.5. Sample selection for the purpose of laboratory geomechanical testing

In accordance with soil investigations stated above (exploratory boreholes and pits) as well as problems that need to be solved, the both disturbed and undisturbed samples were taken fully in accordance with the applicable standards. More samples were taken than it was planned. After being adequately packed, samples were taken to the laboratory at the Mining Institute, Zemun.

Within the previously performed investigations, 82 (eighty two) samples were taken from the narrower area of the adopted alignment.

Within the investigations performed for the purpose of Final design, 115 (one hundred and fifteen) samples were obtained and transported to the laboratory.

When selecting the both disturbed and undisturbed samples, special care was exercised to samples that represented the relevant media required for design of alignment and related structures.

1.3.4.3.1.6. Ground water level monitoring

Monitoring of ground water level has been performed directly in the course of drilling. Observation wells for detailed and long term monitoring have not been installed.

Ground water in alluvium zones and terrace sediments has been identified in boreholes as well as in certain areas allocated in diluvial and proluvial formations. Results referring to identification of ground water level are shown on engineering-geological profiles of boreholes and geotechnical ground sections.

1.3.4.3.1.7. Geophysical, geoelectrical and seismic considerations

Geophysical investigations have been performed for the purpose of defining seismic ground properties in the area of newly-designed structures, tunnels and cuts as well as electric resistance of ground in the area of slopes. Geoelectrical probing has been performed so as limits, thickness, depths and spatial allocation of medium characterized with specific electric resistances could be defined. Refraction seismic investigations have been performed so as spreading velocity of elastic longitudinal waves can be defined together with geodynamic ground model required for defining of engineering seismic parameters for structures to be constructed alongside the studied highway.

Data on geophysical investigations represent more detail results of exploratory boring or basic data on ground/terrain due impossibility to perform soil investigations.

In the phase of preparation of Preliminary design, about 100 (one hundred) geoelectrical probes have been placed along the corridor of the adopted alignment. Probes are placed on 25 (twenty five) geoelectric profiles as well as 8 (eight) seismic profiles of different length. Geoelectric profiles are marked Gs... E1,..., and seismic S1,..., SP1,......

In the phase of preparation of Final design, additional testing of tunnels, cuts and smaller structures was performed through 56 (fifty six) geoelectric probes adjusted to 14 (fourteen) geoelectric profiles each 100 m long as well as 14 (fourteen) seismic profiles of different length. Geoelectric profiles were designated as E_1... and seismic as S_1,....

1.3.4.3.2. GEODETIC SURVEYING AND MICROLOCATION OF SOIL INVESTIGATION WORKS

Surveying of ground in defined width and length along the corridor for alignment analysis has been performed for the purpose of Preliminary design. Photometric surveying was performed and results shown on the general map, 1:2500 scale.

For the purpose of Final design preparation, allocation of performed investigation works was surveyed in detail. Moreover, additional geodetic surveying of ground was performed terrestrially in tunnel area as well as in areas planned for displacement of the Juzna Morava river bed.

1.3.4.3.3. GEOMECHANICAL LABORATORY TESTING OF SOIL SAMPLES

Tests on samples carried out in the laboratory of the Mining Institute, Zemun have included all lithological media the future highway and related structures will be constructed on. The following tests were performed:

- Identification and classification	
* Grain size composition	108 tests
* Atterberg consistency limits	39 tests
*Water content	67 tests
*Bulk density	38 tests
- Direct shear test	31 tests
- Compressibility and consolidation parameters in oedometer	31 tests
- Maximum compressibility according to Proctor	15 tests
- California bearing ratio CBR	15 tests
- Uniaxial compressive strength	7 tests
- Compressive strength method	4 tests.

1.3.4.4. OVERVIEW OF INVESTIGATION AND TEST RESULTS

Results of engineering-geological and geotechnical soil investigations obtained fully in accordance with regulations and standards are suppose to be an integrating part of documentation required for multidiscipline approach in solving problems referring to design of highway especially due to difficult terrain and alignment design.

The section herein will show results of investigations and testing together and offer detail explanations for certain media and type of structures.

1.3.4.4.1. GEOGRAPHIC POSITION, GEOMORPHOLOGICAL, CLIMATIC AND OTHER CONSIDERATIONS OF THE STUDIED AREA

Geographic position and geomorphological ground properties

The studied area of the E75 highway, Gornje Polje - Caricina Dolina section follows the flow of the Juzna Morava River transferring its position from the left to the right riverside.

The present relief of the studied area is the result of all relevant natural influences (temperature changes, wind, water and frost actions and dynamic effects). The lithological members constituting the relief of the studied area are mostly formed through the long period of time (from Paleozoic to Quaternary). Tectonic movements (especially in formation of Juzna Morava river bed and its tributaries have had the most significant importance in relief creation.

In both tectonic and morphostructural aspects, the studied area is situated on the western part of the Serbian and Macedonian massive with fluvial-denudation slope areas and erosion-accumulated areas (diluvium, proluvial fans and Juzna Morava alluvium).

Dependant on lithological composition, long erosion and tectonic activities, and changeable inclinations show that slopes of the Juzna Morava River are the result of fluvial activities. Different slope inclinations are the result of lithological composition (in diluvium slope angle is 10-30°, in proluvial areas 15-30°, in alluvium areas and river terraces 2-5°, in cuts and fills composed of shales 45-70°, in schist 25-35-45°, in diluvial-eluvium materials 20-35°, in diluvial-proluvial materials 10-30°, in diluvial-alluvial materials 16-25°, in alluvial-proluvial materials – zone of Predejanska River and Aiski brook up to 5°).

Erosion process of parent rocks (shales) constituting the Juzna Morava banks is usually followed by filling with thick alluvial, diluvial or proluvial sediments.

The previously erosion process of the Juzna Morava River have affected the both left and right banks thus causing inundation and terrace sediments to be formed. Since the river has moved toward west (to the left bank) numerous mixed or deposed sediments from the slope along edge areas of the Juzna Morava banks have been formed. Data obtained through the drilling of numerous boreholes have confirmed this fact showing heterogeneous deposits as a result of different processes.

The same may be applied to tributaries of the Juzna Morava River that were affected by erosion process causing ravines to be filled with sediments which provoked further erosion. The most extensive erosion processes (fluvial and proluvial) were caused by the river and its tributaries.

The studied area is intersected with numerous ravines that at the same time represent temporary or permanent streams although dry ravines may be also identified through the area. They mostly vary 3 m to 5 m in depth although ravens with depths exceeding 10 m or 12 m may be also identified. Shallower ravens are provided with smooth sides inclined at 30°, while deeper ravens are characterized with higher inclinations varying from 40 to 45° and more. Usually, ravens follow the "V" shape with symmetrical sides.

Regulation of ravens on the right river bank has been performed through construction of channels and torrent partitions that lowered down hydraulic gradients and prevent deposition of significant quantities of proluvial material into the highway area. Non-regulated ravens are affected with erosion process and lower ravens are affected with accumulation.

In the area of the newly-designed alignment, the terrain in lower part is mostly represented by alluvial plain of the Juzna Morava River and slopes positioned in the close proximity to the alluvium are composed of different Quaternary sediments or shales.

Climate

The studied area belongs to moderate continental climate.

The average annual precipitation amounts 488 mm per 1 m2. Number of snowy days during the year is 101 days (from December to March) and the mean maximum height of snow cover is considered to be 31.3 cm.

The mean annual air temperature is +9°C. It should be mentioned that the absolute maximum temperature during the year is +32°C and minimum temperature is -25.8°C. Average number of frost days has been measured in the period November-March (22) and number of frost days for period October-April is 77.

Data on precipitation, snow cover and air temperatures have been obtained through measurements performed in Predejane water measuring station and overtaken from the General design for the E75 Belgrade - Nis – Skopje highway, Grabovnica-Presevo section, precisely from the Study on climatic, hydrologic and hydrographic parameters (Institute for Spatial and Urban Planning Nis – September, 1993).

Although measurements referring to frost have not been available it can be estimated that, considering altitude, minimum average annual temperature and depth of ground water level, the biggest frost depth in this area varies from 0.80 m to 0.90 m.

Vegetation cover

Slopes are almost fully covered with forest or pasture lands. The exception is side cuts in areas build of shales and small local communities (mostly along the right bank of the Juzna Morava River).

Population and traffic arteries

The natural direction of the northeast orientation represents both old and new corridor of roads and railroads to Greece and Middle East.

The studied area is poorly populated except Predejane Settlement.

The highway alignment intersects the M1 arterial road in the area immediately before Sarajevski Bridge, the Nis – Skopje international railway line as well as numerous local earth roads.

1.3.4.5. GEOTECHNICAL REQUIREMENTS FOR DESIGN AND CONSTRUCTION

1.3.4.5.1. GEOTECHNICAL GROUND ZONING AND SPECIFIC CHARACTERISTICS OF THE ALIGNMENT AND TERRAIN

Geotechnical ground plan is shown in detail and provided with all relevant data so as position of the alignment can be comprehended in detail together with soil investigations.

Longitudinal profile of the ground has been prepared for either carriageway. This profile is not shown in detail although is provided with the Table containing important soil properties required for different structures to be constructed along the future highway alignment.

Geotechnical cross sections of ground are shown in detail and therefore interrelations between the alignment and the ground can be more precisely defined. In cooperation with the design engineer responsible for the alignment, certain number of cross sections has been analyzed and adjusted and smaller number of sections (55-fiftiy five) has been shown in final interpretation.

In accordance with the results obtained through previously soil investigations and ground testing, synthesis of available data have been prepared and computational analysis of parameters performed together with engineering-geological and geotechnical ground modeling for the purpose of optimization – adjustment of both type and position of the alignment according to soil properties.

6 (six) basic models – typical engineering-geological and geotechnical ground structures have been identified, as stated below:

Model 1

The model 1 includes segments of ground for the newly-designed alignment. The alignment will be positioned:

- On the present road and ground,
- In smaller cut section, side cut (< 5 m),
- On lower embankment (< 5 m).

Model 2

The model 2 includes segments of ground for the purpose of establishment of the newly-designed alignment. The new alignment will be positioned on embankments (> 5 m):

- On completely new embankments,
- As an extension to the present embankments.

Model 3

The model 3 includes segments of ground for the purpose of establishment of the new alignment in side cuts (> 5 m) in rock mass composed of shales and eluvial-deluvial-proluvial cover not exceeding 3 m in thickness, provided that slope shall be inclined at 5:1 and not higher than 8 m with berms not exceeding 3 m in width.

Model 4

The model 4 includes segments of ground for the purpose of establishment of the new alignment in side cuts (> 5 m) in earth and debris materials in areas composed of thicker Quaternary diluvia-proluvial-alluvial-terrace sediments where new inclinations cannot be obtained without adequate protection.

Model 5

The model 5 includes segments of ground where the newly-designed alignment will intersect the Juzna Morava riverbed. Construction of revetment will be planned for the purpose of slope protection.

Model 6

The model 6 includes segments of ground where the newly-designed alignment will be established over the stabile slope or intersect it. Terrains within this model can be classified as follows:

- Stabile slopes having up to 5 m in thickness,
- Slopes thicker than 5 m.

The models stated above are supposed to be combination of several models. More complex solution for design considerations will be required as well as applying of more complex protection measures.

Presence of the stated ground models identified on the adopted alignment is shown in Tables 1 and 2.

Typical sections and specific conditions such as: alignment position on the high cut sections made of earth/stone or on high embankments positioned on alluvium, diluvium or proluvion sediments, problems referring to fitting of new embankments into the existing ones, geostatical calculations (stability, bearing capacity and settlement) have been identified and carried out and shown in the Attachment 7.

Therefore, complex figure of ground along the highway alignment is obtained together with all data required for design works.

1.3.4.5.2. GEOSTATICAL ANALYSES

The newly-designed highway section is characterized with unfavorable and very difficult segments for both design and construction considerations. However, construction of complex engineering structures and facilities through carefully performed design work will result in achieving satisfaction in terms of quality once the studied highway has been completed.

The reliable data and unification of soil properties in the phase of Preliminary design preparation have enabled precise calculation to be carried out for real soil conditions.

More precise calculation for concrete examples has been performed for the level of Final design. Through geostatical analyses for the purpose of alignment (structures have been separately analyzed) the following tests have been performed:

- Embankment slope stability – different heights on medium compressive materials integrating the surface areas consisting of diluvium, proluvium and alluvium sediments;

- Settlement of soil below the higher embankments – on medium compressive materials integrating the surface areas composed of diluvium, proluvium and alluvium sediments;

- Slope stability of earth cuts – prepared for alluvial or deluvial-proluvial Quaternary sediments of different heights;

- Stability of rock cuts (slopes in shales) – prepared for different slope position.

1.3.4.5.2.1. Calculations referring to embankment slope stability and settlement

The section herein includes analyses referring to slope stability against shearing in the area where new embankments have to be fit into the existing ones. It also includes prediction of soil settlements due to loading imposed by higher embankments.

The analyzed examples are obtained for uniform conditions (properties):

- Old embankments -
  - Bulk density $\gamma = 18$ kN/m^3,
  - Angle of internal friction $\varphi = 20°$,
  - Cohesion $c = 20$ kN/m^2.
- Earth material for construction of new embankments -
  - Bulk density $\gamma = 19$ kN/m^3,
  - Angle of internal friction $\varphi = 22°$,
  - Cohesion $c = 15$ kN/m^2.
- Debris material for construction of new embankments -
  - Bulk density $\gamma = 20$ kN/m^3,
  - Angle of internal friction $\varphi = 30°$,
  - Cohesion $c = 0$ kN/m^2.
- Embankment bedding (alluvium) -
  - Bulk density $\gamma = 19$ kN/m^3,
  - Angle of internal friction $\varphi = 18°$,
  - Cohesion $c = 15$ kN/m^2,
  - Compressibility for different loading patterns
    - $\sigma = (100\text{-}200$ kN/m$^2)$ Ms= 7000- 15000 kN/m^2.
- Embankment bedding (diluvium and proluvium, not exceeding 5 m in thickness) -
  - Bulk density $\gamma = 20$ kN/m^3,
  - Angle of internal friction $\varphi = 22°$,
  - Cohesion $c = 20$ kN/m^2,
  - Compressibility for different loading patterns
    - $\sigma = (100\text{-}200$ kN/m$^2)$ Ms= 10000 kN/m^2.
- Embankment bedding (diluvium and proluvium thicker than 5 m) -
  - Bulk density $\gamma = 20$ kN/m^3,
  - Angle of internal friction $\varphi = 20°$,
  - Cohesion $c = 15$ kN/m^2,
  - Compressibility for different loading patterns
    - $\sigma = (100\text{-}200$ kN/m$^2)$ Ms= 10000 kN/m^2.

Calculations referring to embankment slope stability – According to typical cross section prepared by the responsible design engineer, embankment slopes shall be executed with gradients stated below:

- For embankments < 3 m, 1:1.5;
- For embankments > 3 m, 1:1.5 - 1:2.

Calculations for embankment slope stability have been performed for the highest embankments on the adopted alignment variant not exceeding 8 m (eight) in height. Calculations have been carried out by applying Teylor's and Spenser's methods.

Factors of safety obtained through the use of Teylor's method are stated in the Table below:

Chainage (km)	Slope inclination n	Safety factor Fs
874+350	1:1.5	2.53
879+100	1:1.5	2.23

Factors of safety obtained through the use of Spenser's method are stated in the Table below:

Chainage (km)	Slope inclination n	Safety factor Fs
878+500	1:1.5 - 1:2	1.486

For higher embankments positioned on difficult terrain (km 883+425), analysis of different parameters of refueled materials has been carried out. Since the embankment will be constructed of debris materials, strength parameters used for calculation of slope stability have been given in intervals:

- Bulk density $\gamma = 20$ kN/m^3,
- Angle of internal friction $\varphi = 30 - 33°$,
- Cohesion $c = 0 - 3$ kN/m^2.

The obtained results have shown that increment of angle of internal friction against cohesion will result in obtaining the approximately similar factors of safety.
According to the analyzed calculations it can be concluded that slope inclination stability for adopted inclinations of 1:1.5 is characterized with adequate safety factors.

Calculations referring to settlement of soil under the embankment have been performed for specific cases identified along the alignment. The selected examples are referring to higher embankments (ramps for structures) to be constructed on ground surfaces composed of diluvium, proluvium and alluvium sediments and deeper non-compressible zones composed of coarse grained or debris materials or in zones where embankments will be positioned in the close proximity of the existing arterials (railway line or arterial road). Negative impacts to the present arterials as a result of settlement of high embankments have been verified. In accordance with the performed calculations and dependant on bedding (7.40-11.50 cm), settlements of embankments varying from 3.00 m to 7.00 m in height have been identified. The suitable circumstance is that compressible layers can be drained either horizontally or vertically so as the greatest settlement will be recognized in the course of construction. The performed calculations have shown that settlement of newly-designed embankments will cause no negative impact to the existing arterials.

Computational values for embankments of different height founded on different bedding are stated below:

Embankment height h (m)	Chainage (km)	Predicted settlement (cm)
3.00	873+800	7.43
5.50	874+350	8.99
7.00	879+100	11.65

1.3.4.5.2.2. Calculations of cut slope stability

According to the adopted variant solution, cutting of slopes shall be performed on different heights. Four types of cuttings can be identified:

a) Cutting in hard or slightly modified shale mass,
b) Cutting in modified shale zones covered with thick Quaternary sediments,
c) Cutting in less thicker Quaternary sediments and
d) Cutting in thicker Quaternary sediments (diluvium and proluvium) appropriate under certain conditions.

a) Cutting in hard or slightly modified shale mass

These cuttings are different and vary from 3-5-10 m but not exceed 40 m in height. Decomposition and fissibility of shales can be identified at the depth of 3-5 m from the ground surface (in average), but position of slope in relation to schistosity and fissure location is very important for the cutting stability.

The detailed analyses performed for the purpose of Preliminary design preparation have also included calculations of stability for flat model of rock shale slopes and rock masses of different hardness but without schistosity effects and fissures (without water influence).

The analysis herein points out that slope inclinations may be executed without adequate protection but this may result in significant excavated masses and increment of number of cutting slopes along the slope. During excavation, shales will be broken in pieces thus forming thicker or less thick areas ("wedges") out of which certain deformations as rockfall can be identified. These deformations can collapse in an uncontrolled manner and extend to adjoining masses directly affecting the areas along the highway right-of-ways. Maintenance of the said slopes is supposed to be very difficult since degradation processes will get worse in time. Therefore, excavation of steeper slopes together with slope protection will be recommended.

Through the application of fracture system analysis and use of contour diagrams of discontinuity distribution (Schmidt's polynomials) smaller values of slope inclinations have been obtained due to presence of unstable "wedges". These ''wedges'' will cause the slope to become unstable in time due to precipitation thus resulting in rockfalling or sliding the blocks from the cutting.

According to results obtained for the level of Preliminary design as well as detailed analyses performed by the design engineer responsible for engineering structures for the level of Final design, specific cuttings together with relevant protection measures have been defined.
For cuttings not exceeding 5 m in height in modified and decomposed shale mass, protection walls inclined at 1:1 will apply.

Segments of the ground on which the studied alignment will be established in cuttings and side cuts exceeding 5 m in height, in the area of shale mass or in area of modified and decomposed shales, slopes inclined at 5:1 and sections up to 8 m in height provided with 3 m wide berms will be constructed. Stability of slope will be obligatory secured through the use of wire mesh, 5 m long anchors and shotcrete layer, 5 cm thick.

Results referring to slope stability in hard or less modified shale mass are shown in Book of Engineering Structures (K7).

b) Cutting in modified shale zones covered with thick Quaternary sediments

More detailed analysis has been performed for these cuttings. The analysis has shown where protection or retaining walls should be constructed or where slopes should be constructed in combined inclinations varying between 5:1 and 1:1 in rock or 1:1.5 to 1:2 in Quaternary sediments.

In segments of the terrain where the newly-designed alignment will be positioned in cuttings or side cuts higher than 5 m in earth-debris materials and in areas of thicker diluvial-proluvial-alluvial-terrace sediments or similar Quaternary sediments and where it would not be possible to construct new slope gradients without protection, slopes must be protected by applying the following methods:

- Construction of retaining wall along the entire height that will rest on relevant foundation. Adequate drainage system should be installed behind the wall and the wall itself should be sized according to relevant calculations dependent on local ground conditions;
- Construction of retaining wall up to the relevant height. Sloping should be performed so as natural gradient of the terrain 1:1.5 - 1:2 can be maintained. Resoiling or application of adequate biotechnical protection measures will be required.

Results of calculations performed for stability of slope in the area of modified shales with thick Quaternary cover are shown in the Book of Engineering Structures (K7).

c) Cutting in less thick Quaternary sediments

Cuttings in diluvial-proluvial materials are mostly performed as small cuttings in 1:2 gradient. Calculation for the stability of cutting slope has been performed for cuttings of maximum height through the use of Teylor's and Spenser's methods.

According to calculation through the use of Teylor's method the following safety factors have been obtained:

Chainage (km)	Slope inclination n	Safety factor Fs
874+000	1:2	3.03
878+625	1:2	3.63

Through the use of Spenser's method the following safety factors have been obtained and stated in the Table below:

Chainage (km)	Slope inclination n	Safety factor Fs
874+000	1:1.5	1.754

For deeper cuttings, safety factors are shown below:

Slope height h (m)	Slope inclination n	Safety factor Fs	Notes
6 - 8	1:2	3.03 - 3.63	earth material

If these sediments are identified above shale mass that will be completely cut of, inclination of 1:2 will be rarely applied and slopes will be provided with protection and/or retaining walls.

d) Cutting in stabile thicker Quaternary sediments (diluvium and proluvium) appropriate under certain conditions

This is the most complex method applied in slope cutting. Cuttings may be performed in different heights. Since the slopes are stabile under certain conditions (instable due cutting or additional loading), retaining walls of significant sizes will be constructed.

Sizing of the said walls and defining soil properties and relation between lithological complexes carried out by the Department of Geotechnical Engineering was performed by the Department of Stations, Institute of Transportation CIP.

Detailed analyses, geotechnical calculations and final solutions referring to slope protection against cutting in Quaternary and shale rock masses will be studied separately in books referring to engineering structures.

1.3.4.5.3. GEOTECHNICAL REQUIREMENTS FOR ALIGNMENT DESIGN AND CONSTRUCTION

Geotechnical requirements for alignment design and construction of the future highway are consisting of propositions and recommendations referring to construction method that will be applied on certain sections dependent on both composition and properties of the studied ground.

In relation to the alignment design (position of centre line and reference level), propositions and recommendations are referring to the following:

- Possibilities and conditions for construction of cuttings in stabile terrains and terrains stabile under certain conditions,
- Possibilities and conditions for embankment construction,
- Possibilities and conditions for harmonization of old and new embankments,
- Possibilities and conditions of soil that will carry embankments, cuttings or side cuts,
- Possibilities and conditions to fulfill requirements for substructure (filling materials).

Common and general provisions of the main conditions and possibilities of construction are stated in sections below.

Longitudinal geotechnical profiles are provided with comment of certain characteristics of the alignment and terrain in relation to construction and studied and shown in detail on cross sections.

Recent geodynamic processes and occurrences are supposed to be an important characteristic of the terrain (Quaternary sediments and shales).

Segments of slopes provided with thicker Quaternary sediments and characterized with higher water levels and steeper inclinations have been considered as sections appropriate under certain conditions due to easy activation and sliding as a result of loading or slope cutting.

Physical and mechanical as well as engineering properties of the separated complexes have been obtained through laboratory geomechanical tests and field geophysical, seismic and geoelectrical testing. In accordance with performed investigations and basic genetic classification, smaller segments of similar parameter properties have been separated. Grouping of these segments in relation to the certain lithological media characterized with specific properties performed is supposed to be very important for the future design work.

In such a way, a unique ground model that could be further analyzed has been obtained.

Steep gradients, significant number of the existing arterials and arterials to be constructed (completely new highway alignment, the existing M1 road, the railway line and J.Morava riverbed) as well as heterogeneity of different geological formations have caused complex and more expensive solution for establishment of the studied alignment. This has been analyzed on cross sections.

Construction of the studied highway will include as follows: alignment establishment, construction of certain structures (bridges and galleries), construction of the ″Predajane″ tunnel, dislocation of the segment of the existing arterial road on two locations, construction of ″Predajane″ interchange and relocation of the Juzna Morava riverbed.

A. Alignment establishment

Zoning of ground has been performed through the geotechnical analysis for the alignment. Textual description and explanations are stated on the ground modeling.

Model 1 – **Construction of embankments not exceeding 5 m in height**, is planned to be performed along the significant segment of the alignment. The cross section has shown that the ground is flat or slightly sloped as kilometrage increases. These embankments mostly cover the existing slopes. Since the embankment structure is not so complex and causes no negative effects or significant settlements, its construction may be performed without any problem. Slopes will be inclined at 1:1.5 and resoiled with top soil. Embankment length may be reduced by constructing retaining walls on lower slope segments or through fitting the alignment into other arterials (arterial-regional road, railway line). Construction of embankments not exceeding 5 m in height is planned to be performed at the following km points:

km 873+720 - km 873+880	km 874+340 - km 874+730	km 874+760 - km 875+310
km 875+830 - km 876+095	km 876+405 - km 876+525	km 877+190 - km 877+570
km 878+025 - km 878+325	km 878+465 - km 878+630	km 878+730 - km 878+850
km 879+010 - km 879+075	km 879+360 - km 879+390	km 879+520 - km 879+680
km 879+725 - km 879+780		

Model 1 – **Construction of cuts – side cuts not exceeding 5 m in depth** is planned to be executed on considerably smaller length of the studied alignment. Cuttings shall be carried out in Quaternary sediments where slopes with gradients of 1:2 - 1:1.5 can be executed with no timbering or mass removal. Construction of cuts and fills up to depth of 5 m is planned to be performed at the following km points:

km 873+880 - km 874+225	km 874+220 - km 874+240	km 876+095 - km 876+195
km 876+525 - km 876+540	km 876+690 - km 876+740	km 879+390 - km 879+520
km 879+680 - km 879+725	km 879+780 - km 879+870	

Model 2 – **Construction of embankments higher than 5 m** is planned to be performed in areas before and behind the designed structures. Transition and enlargement of embankments can be performed without difficulties. Slopes will be executed in gradients of 1:1.5 - 1:2 and resoiled with top soil. Construction of embankments higher than 5 m is planned to be performed at the following km points:

km 874+730 - km 874+760	km 876+740 - km 876+760	km 877+975 - km 878+025
km 879+075 - km 879+360		

Model 3 – **In side cuts exceeding 5 m in shales and diluvial-eluvial formations made as a result of shale decomposition-** cuts inclined at 5:1 and not higher than 8 m provided with 3 m wide berms will be executed. Slopes will be secured by mesh reinforcement, anchors and sprayed concrete. Construction of cut sections exceeding 5 m in rock environment is planned to be performed at the following km points:

km 875+500 - km 876+240	km 876+520 - km 876+750	km 878+640 - km 879+050
km 879+350 - km 879+575		

Model 5 – **Construction of embankments exceeding 5 m in height together with bank revetment** is planned to be executed in areas close to the Juzna Morava riverbed. Bank revetment will include construction of massive retaining wall founded below the area affected by river sediments. The height will be greater than those calculated for average high waters. The embankment slopes shall be lined with stone or covered with concrete slabs to the maximum flood protection level.

Construction of embankments higher than 5 m together with bank revetment is planned to be performed at the following km points:

km 874+340 - km 875+275 km 877+720 - km 878+090

Model 6 – The alignment is passing over the slopes stabile under certain conditions. In such a case lower embankments or shallower and deeper fills provided with retaining walls and adequate drainage piping behind the wall will be required. Wall dimensions, type of foundation to be applied together with foundation depth will be in compliance with conditions and soil properties. Construction of embankments and cuts in slopes stabile under certain conditions is planned to be performed at the following km points:

km 873+875 - km 874+220 km 875+575 - km 875+660 km 876+405 - km 876+525
km 878+850 - km 879+010 km 879+520 - km 879+780

B. Structures along the alignment

On sections difficult for design purposed due to specific difference of levels between the ground and reference level of the newly-designed highway, bridge, overpasses, underpasses and galleries are planned to be constructed.

Selection of adequate foundation method (shallow foundation on footing or deep foundation on piles) will depend on structural characteristics of a certain structure and geotechnical soil properties.

Geotechnical requirements have been discussed and explained in detail in the Book referring to structures (K2-S2).

D. Construction of engineering structures

Construction of engineering structures is planned to be executed on sections where the alignment is positioned in deeper cuts composed of earth materials or rock mass of reduced strength properties or where slope stability cannot be maintained due to specific differences of level between the ground and reference level of the newly-designed highway.

Protection method to be applied on slopes will depend on structural characteristics of the alignment and geotechnical soil properties.

Geotechnical requirements for construction of engineering structures are discussed and explained in detail in the Book referring to engineering structures (K2-S4).

E. Displacement of the M1 arterial road

Considering the position of the alignment of the newly-designed E75 highway, the existing M1 arterial road (Gornje Polje - Caricina Dolina section) will suffer minimum modifications and become regional road, i.e. an alternative route to the newly-designed highway.

The regional road is supposed to be the arterial that will connect all surrounding settlements and the future highway.

The existing arterial road is mostly positioned in cuts, side cuts, embankments and tunnels. The road is also provided with significant number of culverts and bridges for the purpose of control of small and big water flows (tributaries of the Juzna Morava River). In side cuts the road is secured by retaining and retaining-facing walls (below and above the reference level). Embankments are mostly stabile. Smaller segment of the road passing through the marked landslides will be secured by walls above the reference level or through the application of similar measures so as the required stability and safety could be obtained.

The newly-designed alignment solution will require the arterial road to be dislocated at the following two points:

- At the beginning of the alignment in the area of Sarajevski Bridge

In the area of Sarajevski Bridge (km 873+714 - km 873+950) the existing alignment of the M1 arterial road will be used as right carriageway of the future highway upon the completion of rehabilitation works. On the segment where the arterial road ″becomes″ carriageway of the new highway, new alignment of the arterial road will be designed. Since the intersection of highway and arterial road cannot be carried out in the same horizontal plane, the problem will be solved through the construction of overpass that will span the arterial road and carry traffic to the highway. The alignment of the dislocated arterial road along the said overpass is designed on the ground or lower embankments.

Geotechnical requirements for founding of the said structures are based on data obtain from boreholes drilled in the close proximity of the overpass. The terrain planned for structure construction is composed of proluvial, alluvial, diluvial-proluvial, proluvial-alluvial sediments and shales.

Proluvial sediments (5) are composed of sandy silt with shale debris of mm size. Silt is characterized with hard consistency and low plasticity and suitable resistance and deformability properties.

Alluvial sediments can be identified in elevated shales. They are consisting of silt (8) and sand (9). Silt (8) is sandy-clayey material rarely intersected with gravel grains of mm size. It is characterized with medium to small compressibility and medium to high plasticity. Leveled bedding can be identified in both vertical and horizontal planes. These sediments are characterized with appropriate to medium appropriate resistance and deformability properties for founding purposes. Sand (9) is fine-graded silty material intersected with 5 % of fine-grained gravel. It is characterized with appropriate resistance and deformability properties.

Diluvial-proluvial sediments (14) can be identified in areas of piers S1 and S2, but not in the area of the pier S3. These sediments are debris of heterogeneous shale material varying from cm to dm in size characterized with suitable parameter characteristics.

Proluvial-alluvial sediments (16) can be identified on wider area of the pier S3. The sediments are consisting of fine grained shale debris and gravel partially intersected with silty sand and characterized with suitable parameter properties.

Shale (12) 1.00-1.50 m thick can be identified on surfical areas. It is intersected with cracks and characterized with low values of resistance and deformability properties. Deeper shale areas (13) are characterized with cracks of preserved primary structure and significantly low parameter properties.

In the structure area, ground water level is identified at level 265.50-266.50 mnm.

The bridge shall be founded on three piers. Piers shall be 49 m spaced apart. Foundation will be carried out on alluvial sandy-clayey silt sediments.

Displacement of the M1 arterial road in the area of Sarajevski Bridge is shown in detail on graphical documentation K2-S1-C4. The overpass is analyzed in the Book referring to structures K2-S2.

G. Displacement and regulation of the Juzna Morava riverbed

Displacement of the Juzna Morava riverbed will be performed on 5 (five) locations so as adequate space required for arterials (highway and railway line) can be obtained.

These 5 locations are positioned on the following km points:
km 874+225 (640 m),
km 875+125 (640 m),
km 877+525 (630 m),
km 878+325 (190 m)

Excavation on the opposite bank will be performed to provide adequate flowing width due to displacement of the highway alignment.

On these locations excavation in riverbed up to depth of 3-4 m will be performed. Slope of the refilled roadbed toward the bank must be secured through the construction of retaining wall in riverbed to the mean water level. Bank revetment or retaining wall inclined at 1:1.5 will be constructed to the high water level.

Excavation will be performed in alluvial sediments mostly in flood area (gravel sand) and river bed (sandy gravel). The excavated material will be of II and III category, although certain excavation works will be performed in water (in the period of low water level). This material is suitable for sub-base construction.

Construction of embankments not exceeding 6 m in height will be performed on low to medium compressible sands or gravel sand. Settlements will not be expected since this process is expected in the course of construction. For embankment construction, very heterogeneous material can be used as well as coarse grained material for the embankment lower zones. Shale blasting will result in coarser block material that cannot be used for road embankment construction but can be used for embankment enlargement. Although the bank revetment wall may be founded, the required depth must be carefully computed to escape sediment erosion.

1.3.4.5.3.1. General geotechnical recommendations for subsoil formation

The alignment of the studied section will be established on the ground mostly consisting of alluvial, diluvial and proluvial sediments as well as rock mass composed of shales.

In the area composed of Quaternary sediments, top soil shall be stripped down to 10-30 cm. Such an excavated top soil shall be temporary stockpiled and later used for resoiling of slopes. In most cases the soil will be composed of sandy-silty slightly clayey material intersected with organic material found in top soil, such as roots.

In accordance with analyses performed on samples obtained from boreholes and pits along the alignment right-of-way, favorable compactness and bearing capacity values have been obtained.

In accordance with tested samples taken from trial pits and boreholes, California Bearing Ratio of CBR = 5-30% has been obtained while maximum compactness according to Proctor was $\gamma_{dmax} \geq 17$ kN/m^3, for optimum moisture of Wopt = 12-19%.

For the purpose of compaction, evaluation criteria for sub-soil the following values will be required:

- For embankments not exceeding 2 m in height and sub-soil composed of coherent material the required compaction degree will be $D_{pr} \geq 97\%$, $E_{v2} \geq 30$ MN/m^2 and $E_{din} \geq 25$ MN/m^2, and for soil consisting of non-coherent material the required compaction degree will be $D_{pr} \geq 100\%$, $E_{v2} \geq 60$ Mn/m^2 and $E_{din} \geq 35$ MN/m^2;
- For embankments higher than 2 m and sub-soil composed of coherent material, the required compaction degree will be $D_{pr} \geq 92\%$, $E_{V2} \geq 20$ MN/m^2 and $E_{din} \geq 20$ MN/m^2.

Therefore, the detailed preparation of sub-soil can be performed with minimum works once the top soil has been stripped down. Minimum moisture content and small run-overs with appropriate machinery can result in compactness to the required degree that corresponds to 100% according to Proctor. Usually, compactness of natural moisture content in soil is very close to compactness of 95% according to Proctor and therefore requires no stabilization.

In a case of maximum ground water levels (during rain periods), moisture cannot be easily reduced which can be a problem in the course of sub-soil preparation.

Drainage shall be enabled in the course of sub-soil preparation as well as during the execution of construction works.

If the alignment will rest directly on the sub-soil composed of hard shale rock masses or deeper zones of highly consolidated debris composed of diluvium and proluvium formations, only evenness of the constructed layer will be required. Since the natural moisture content in soil will be adequate, only appropriate drainage system shall be required.

1.3.4.5.3.2. General geotechnical recommendations for embankment construction

Materials to be used for embankment construction are stone, debris and earth materials of appropriate grain size composition obtained in cuts and fills that will meet all required criteria. Since the level of ground water usually does not exceed 5.0 m measured from the ground surface and the embankment bedding is water permeable and less compressible, embankment can be constructed without any problem once the top soil has been stripped down.

Drainage of runoff during construction and operation shall be possible through embankment foot. In a case of flood waters and if the embankment bars natural runoff, the contact between the ground and the fill will be formed of a drainage subgrade course (in the culvert areas).

Materials to be used for embankment construction must fulfill the following requirements:

- Moisture close to an optimum (± 2%),
- Maximum bulk density $\gamma_{dmax} >$ 15,5 kN/m^3 according to Proctor,
- Optimum moisture Wopt < 25%,
- Liquid limit Wl < 65%,
- Plasticity index Ip < 30%,
- Degree of non-uniformity Y > 9,
- Content of organic matter < 10%.

Non-coherent materials (debris and earth-debris) to be used in embankment construction must fulfill the following criteria:

- The size of grain shall not exceed 40 cm in the whole embankment except in the top layer where the largest grain shall not exceed 10 cm;
- Degree of non-uniformity Y > 9;
- Stone material for embankment construction must be composed of rock masses resistant to atmospheric influences.

Subgrade shall be constructed over the completely prepared sub-soil.

- Haulage and Filling – The haulage and filling of material will be performed over a prepared foundation soil. In defined sections, layers shall be spread in the longitudinal direction, horizontally, or at gradient at most equal to the designed longitudinal gradient (single-sided 2.5% or double-sided). Coherent materials shall be spread immediately. Layer thickness will be defined once compaction technology has been defined and appropriate compaction tools selected. Coherent materials will be compacted to the thickness of 30 cm and non-coherent materials will be compacted to the thickness of 40 cm.

- Compaction – Compaction shall be carried out with appropriate mechanical devices from the edge toward the centre of the embankment or along the structures. Moisture content for coherent materials shall be close to optimum according to Proctor, which means that work shall not proceed during unfavorable weather conditions. Bringing and spreading of material for any new fill layer may start as soon as the underlying layer is compacted and its density has a proper value. No filling may continue in winter and frost.

- Fitting the new embankments – into the old ones will be performed according to separate solutions provided that old embankments are stepped cut to the height similar to the thickness of the layer (30-50 cm) and in cut width of 1.0 - 1.5 m. Top soil shall be stripped down from slopes. The most of old embankments has been constructed of non-coherent materials composed of debris sandy and silty material characterized with good compactness and stability thus enabling transition to be performed easily without non-uniform settlements and cracks at the point of contact.

Considering the good bearing capacity of the bedding, these embankments will suffer no settlement, sliding or similar deformations.

Criteria for evaluation of quality required for fine-grained (coherent) material are listed below:

- For embankments not exceeding 2 m in height degree of compactness $D_{pr} \geq 97\%$ and $E_{v2} \geq 30$ Mn/m^2, i.e. $E_{din} \geq 20$ Mn/m^2 will be required;
- For embankments higher than 2 m, degree of compactness of $D_{pr} \geq 92\%$ and $E_{v2} \geq 20$ Mn/m^2, i.e. $E_{din} \geq 20$ Mn/m^2 will be required.

Quality criteria required for coarse-grained materials are:

- For embankments not exceeding 2 m in height degree of compactness shall be $D_{pr} \geq 100\%$ and $E_{v2} \geq 60$ Mn/m^2, $E_{din} \geq 35$ Mn/m^2;
- For embankments higher than 2 m, degree of compactness will be $D_{pr} \geq 95\%$ and $E_{v2} \geq 45$ Mn/m^2, i.e. $E_{din} \geq 30$ Mn/m^2.

In the area of earth formation CBR ~ 10 shall be required.

Drainage around embankment will be studied in the hydrotechnical report and performed by means of culverts placed in road bed.

Inclinations of slopes and embankments as well as settlements in higher embankments have been separately analyzed in previous sections.

1.3.4.5.3.3. General geotechnical recommendations for side cuts construction

The newly-designed section will be partly positioned in cuts and side cuts.

On segments where new alignment is passing through the side cuts, numerous types of these sections varying in height and type of material as well as supporting method applied may be identified, as stated below:

a) Side cuts in hard and compact shales and side cuts in shales provided with thin cover of Quaternary formations,
b) Side cuts in earthen and earthen-debris materials and
c) Side cuts in ground segments stabile under certain conditions.

a) Side cuts in hard and compact shales and shales provided with thin cover of Quaternary formations, 3-5 m thick.

These side cuts are planned to be executed in deeper zones in hard metamorphic shales of different thickness and mostly stabile gradients. Lower side cuts in modified and cracked areas are often supported by retaining/facing walls.

Problem of execution of new slopes on stone side cuts lies in blasting method since mechanized cutting cannot be performed. Although massive and controlled blasting is usually applied it may have negative consequences to the slope stability. Therefore, smooth blasting ″down the slope ″ with relevant arrangement of blasting holes is recommended as well as cutting of smaller masses and application of ″pret-spliting″ system. In such a way gas energy will be transmitted to the smaller mass segments causing blasted mass to be cut up in small pieces provoking no disturbance to the deeper zone. In such a way material suitable for transport and placing can be obtained and the slope is characterized with better stability.

The proposed slope gradients in this type of material (shales) vary from 1:1 in modified shales with debris cover in surface slope segments to 5:1, if side cuts are deeper.

For side cuts exceeding 10 m in height, cutting will be performed at the height of 8 m, in gradient of 5:1 and provided with 3 m wide berms. If thicker Quaternary deposits are identified in the surficial areas, side cuts will be inclined at 1:2 and 1:1.5.

b) Side cuts in earthen and earthen-debris materials

Side cuts in earthen and earthen-debris materials are not so frequent. Due to material erodibility, construction of retaining and protection walls will be required especially in lower side cuts.

In higher slopes, these side cuts will be executed in gradients 1:1 and provided with wire mesh, if necessary.

c) Side cuts in ground segments stabile in certain conditions

These structures will require construction of retaining walls of significant sizes. These walls will be studied in detail through the separate Book of the design herein (K7 – Engineering structures).

Analysis of slope gradients has shown suitable factors of safety for gradients 1:2 provided that soil is characterized with appropriate properties (extremely thick diluvium sediments 5-10 m). In such a case, these gradients are possible for slopes exceeding 5 m in height, while for lower slopes side cuts are stabile and inclined at 1:1.5.

If the soil is characterized with poor properties, gradients of 1:2 (up to 5 m) shall be adopted while higher gradients cannot be obtained without construction of retaining structures. The same applies to slopes stabile under certain conditions.

Mechanized digging shall be performed in horizontal layers so as activation of earth masses could be escaped especially during rainfalls and soil saturation.

If slopes are executed in designed gradients, the following measures must be undertaken:
- Properly draining of both surface and ground waters,
- Resoiling and grass seeding of slope surface areas and
- Application of technical protection measures in the course of construction of both retaining and retaining-facing walls.

1.3.4.5.3.4. General geotechnical recommendations for subgrade preparation

Preparation of subgrade, 30 cm thick, shall be performed fully in accordance with general technical requirements and standards and already sized pavement structure. Preparation of subgrade will be carried out after completion of lower course taking into account compactness and evenness of the finished layer.

Subgrade shall not be placed over frost ground or on ground covered by ice crust. The following criteria must be met:
- Maximum bulk weight $\gamma_d > 16,0$ kN/m^3 (according to Proctor),
- Liquid limit $W_l < 50\%$,
- Plasticity index $I_p < 20\%$,
- Swelling after 4 days in water (according to standard CBR) <3%,
- Non-uniformity degree Y>9 for coherent and Y>4 for crushed stone materials,
- Material moisture in the course of placing shall not vary more than ± 2%
  Of the optimum moisture content according to Proctor,
- Laboratory California Bearing Ratio CBR > 7% I
- Content of organic matters < 6%.

Preparation of subgrade will include as follows: procurement, transport, testing and spreading of the required material and its rough/fine leveling and compacting. Subgrade must not be placed during frosty days. Compaction shall be performed mechanically through the use of sheepsfoot rollers and vibro rollers with appropriate wetting. Quality control of the placed material will be required. The material must be provided with the following properties:
- For subgrade composed of fine-grained material, compactness degree shall be
  Dpr ≥ 100% and $E_{v2} \geq 45$ MN/m^2, i.e. $E_{din} \geq 30$ MN/m^2,
- For subgrade composed of coarse-grained stone material compactness degree shall be
  Dpr ≥ 100% and $E_{v2} \geq 60$ MN/m^2, i.e. $E_{din} \geq 35$ MN/m^2.

If material does not meet requirements specified for subgrade preparation, certain improvements shall be required. Poor material shall be removed in the thickness of 30-50 cm and replaced with material of better quality (gravel or debris).

1.3.4.5.3.5. Other geotechnical recommendations

- Dewatering and drainage of ground and surface waters

Dewatering and drainage of waters from slope sides shall be discussed in separate designs. Cut and side cut sections shall be provided with stormwater sewage system to discharge water accumulated on the pavement surface.

Water in the close proximity of the studied alignment shall be taken and channeled outside the highway area.

Water accumulated on the asphalt pavement shall be channeled into roadside systems to escape twisting of pavement.

- Resoiling and grass seeding

Upon completion, slopes shall be resoiled with 20 cm thick layer and covered with grass. Top soil stripped down in the thickness of 10-30 cm during the embankment construction may be reused for resoiling. However, considering sandy composition and poor content of organic matters (roots only) this material is not completely appropriate and therefore material taken from other locations will be required.

- Transitions from embankments to structures - ″wedges″

Wedges made of non-coherent material along structures are constructed in order to eliminate deformation on the contact line between the embankment and the relevant structure.

In addition to small openings in the lower embankment segments, the studied section will be also provided with culverts exceeding 10 m in width. These locations must be provided with wedges.

Wedge sizes depend on embankment height.

Wedges shall be constructed of sandy gravel or stone debris of appropriate grain size. Previously defined construction method shall apply (0.3 – 0.5 m thick layer) together with compaction.

- Material stockpiles

Construction of the embankment will commence once the ground masses have been properly planned.

Massive block materials from side cuts must be transported outside the alignment. Establishment of temporary stockpiling areas for top soil material will be required. Top soil shall be latter used for covering of slope embankments.

- Local arterials

Traffic on adjoining roads will be completely cancelled after completion of the studied highway. Therefore local roads that will cross the highway or run below it will be constructed.

1.3.4.5.4. Stockpiling of surplus material along the highway route

Possible local stockpiling areas are identified on edge parts of alluvium formations, higher embankments and areas not planned for regulation of the J. Morava riverbed i.e. stockpiling areas will occupy segments of alluvial formations between the river and the highway alignment.

Alternative stockpiling areas will be situated at following km points:

Chainage according to highway alignment chainage	Approximate stockpile height (m)	Stockpile area (m^2)	Material volume (m^3)
1. km 874+850 - km 875+125 right from the highway	3	> 10 300	31 000
2 .km 875+800 - km 876+075 left from the highway	8	> 15 200	121 000
3. km 877+440 - km 877+725 right from the highway	2	> 22 800	45 000

Therefore, stockpiling of all surplus materials and selection for their further use shall be enabled at stockpile areas positioned in the vicinity of the construction site.

1.3.4.5.6. Geotechnical requirements for stockpiling

All planned stockpiling areas will be used for temporary or permanent stockpiling of material obtained through excavation. The first three stockpiles will be used for stockpiling of material for subbase layers excavated in the J. Morava riverbed (displacement of riverbed).

In the course of stockpiling, material shall be selected, and stone and coherent materials separated. After unloading, material will be mechanically leveled. On the segment reserved for stockpiling of coherent formations, especially neo-coherent sandy gravel sediments, top soil shall be stripped down and soil mechanically stabilized. Stockpile slopes shall be inclined at 1. 1.5 - 1:2 (coherent materials) and 1:1 - 2:1 (stone materials). The permanent surplus materials shall not be compacted in the course of spreading. In stockpile bases (closest to the riverbed) the coarsest material shall be stockpiled at the places not affected by erosion process during flood events.

1.3.4.5.7. POSSEBILITY FOR USE OF BORROW PITS FOR STONE, DEBRIS, EARTHEN AND SANDY-GRAVEL MATERIALS FROM CUTS, SIDE CUTS, AND REGULATIONS FOR CONSTRUCTION OF EMBNAKMENTS ALONG THE HIGWAY

Qualitative stone material to be used for superstructure (bituminous aggregate or carbonate crushed stone) is hard to be found in the close proximity of the studied alignment. The required quantities of this material must be transported from the nearest certified quarry. On the other side, sandy gravel material for subbase preparation may be found in adequate quantities and provided from alternative borrow pits from the riverbed or in the course of excavation performed for the purpose of regulation of the J. Morava river bed.

In the course of slope blasting, the "smooth blasting" method will apply.

Massive blocks obtained in blasting may be used for enlargement purposes (area of regulation of the J.Morava river bed).

2.0 DESIGN BASIS

2.1 LAWS AND REGULATIONS

The legal framework for final design included the following laws, codes and regulations:

- Law on Planning and Construction (Official Gazette of the Republic of Serbia, No. 72/09)
- Law on Public Roads (Official Gazette of the Republic of Serbia, No. 101/05)
- Law on Waters (Official Gazette of the Republic of Serbia, No. 46/91)
- Law on Protection of Water Sources (Official Gazette of the Republic of Serbia, 27/77)
- Safety at Work Act (Official Gazette of the Republic of Serbia, No. 42/91)
- Law on Amendments to Safety at Work Act (Official Gazette of the Republic of Serbia, No. 53/93)
- Law on Protection of Cultural Heritage (Official Gazette of the Republic of Serbia, 28/77).
- Amendment to Law on Protection of Cultural Heritage (Official Gazette of the Republic of Serbia, Nos. 34/81 and 47/84)
- Law on Land Acquisition (Official Gazette of the Republic of Serbia, No. 53/95)
- Law on Soil Investigations (Official Gazette of the Republic of Serbia, No. 44/95)
- Environmental Law (Official Gazette of the Republic of Serbia, No. 135/04)
- Law on Strategic Environmental Impact Assessment (Official Gazette of the Republic of Serbia, No. 135/04)
- Law on Amendments to Law on Planning and Construction (Official Gazette of the Republic of Serbia, No. 34/06)
- Law on Occupational Health Act (Official Gazette of the Republic of Serbia No. 101/05).
- Code on technical standards for defining bridge loading diagram (Official Gazette of the SFRY, No. 1/91)
- Code on maintenance of arterial and regional roads (Official Gazette of the Republic of Serbia, No. 2/93)
- Code on technical standards and specifications for design and construction of road tunnels (Official Gazette of the SFRY, No. 59/73)
- Code on road traffic signs (Official Gazette of the Republic of Serbia, No.15/05)
- Technical code on installation of overhead electrical lines of 1 kV to 400 kV (Official Gazette of the SFRY, No. 65/88)
- Code on basic traffic safety criteria for public roads outside urban area (Official Gazette of the SFRY, No. 35/81)
- Code on environmental impact assessment of structures and/or works (Official Gazette of the Republic of Serbia, No. 61/92)
- Code on defining and maintaining sanitary zones and belts around water supply facilities (Official Gazette of the Republic of Serbia, No. 33/78)
- Standards - SRPS for structural members and design
- Methodology of road design – Civil Engineering Faculty, Belgrade, 1993 and other relevant laws and regulations

2.2 ARCHIVAL DOCUMENTATION

2.3. TOPOGRAPHIC MAPS

Topographic maps in 1:1000 scale were prepared in Saobraćajni institut CIP, Belgrade and used in the final design stage.

Maps in 1:25 000 scale were used to get a better impression of space and traffic and for hydrological analyses.

2.4. LAND USES

The highway section is located in the Juzna Morava River corridor. The highway runs alternatively along the left and right river banks. The corridor also includes other traffic arteries such as: M1 arterial road, Nis – Skopje railway line and R214 regional road. In addition, high speed railway line shall be constructed in the same area. The general conceptual design of this railway line was prepared in 1998 but it was not verified by Commission for technical control and the only point where highway crosses over the railway line is at km 876+718.80, at different levels. In the meantime, the concept of future railway traffic changed a lot and it can be considered that the mentioned project is time-barred.

Due to unfavorable conditions (steep slopes of Grdelicka gorge, torrential nature of the river and lateral watercourses, relatively small area of arable lands, etc.) small settlements were formed along the old road running through valley of the Juzna Morava River which was the only traffic artery (except the railway line) towards the south till twenty sixties.

Design of traffic infrastructure in this corridor is very complex and requires harmonization of old and new traffic arteries, settlements and watercourses in the narrow space of Grdelicka gorge under specific geological and geotechnical conditions.

The future highway will mainly occupy areas under forests, meadows and pasture ground and arable land to smaller extent. It will run through urban areas belonging to municipalities of Leskovac, Vladicin Han, Vranje and Bujanovac. This highway section passes through the following cadastral municipalities: Bojsina, Bocevica, Graovo, Palojce, Licin Dol, Krpejce, Koraćevac, Predejane, Bricevlje, Repiste and Susevlje, all in Leskovac municipality.

2.5. ZONES AND THEIR PROTECTION

The preliminary environmental study attached to the Preliminary design identified risks and impacts of the highway in its immediate surroundings. This kind of knowledge was one of determining factors to make a choice of road corridor.

The Final design includes protective measures against highway impact to the environment.

Depending on local conditions appropriate measures were planned for:

- Air pollution
- Noise level (in settlements),
- Soil contamination (arable land, pastures and forests)
- Concentration of harmful matters in rainwater, and
- Concentration of harmful matters in watercourses.

Protective measures were planned for the safety of regular traffic operations with forecast traffic load and for accidents with extreme risks and contamination levels.

The designed highway section will run through settlements: Oraovica, Boćevac, Palojska Rosulja and Predejane and intersect streams of: the Juzna Morava River, the Palojska River, Govedarski brook, Caricin brook and several small watercourses.

As it was necessary to prevent intolerable air pollution, the road route had to be placed in a corridor beyond the settlement boundaries, i.e. at a distance which will guarantee that harmful gas concentration will fall to an acceptable level before arriving to the boundaries of the protected zone.

Protection against intolerable noise may be effected with walls and specific cross sections in critical zones (cuttings) or even by speed limit.

The surrounding grounds and water streams shall be protected from chemical contamination by preventing uncontrolled spill of pavement runoff by channeling and guiding it properly.

Accident risk is a statistical category that depends on the number of environmentally risky vehicles in traffic. Therefore protective measures include list of equipment allocated for intervention in case of environmentally risky traffic accidents.

2.6. ROADS AND TECHNICAL INFRASTRUCTURE

Moravsko-Vardarska valley is the most suitable natural corridor for land connection between Europe and Asia and therefore this is a traffic route from ancient times. It means that traffic infrastructure was developed over centuries and the studied area was treated in the projects which were not implemented.

R214 regional road is the oldest road in this corridor modernized to the needed and possible extent. Nis - Skopje - Athens main railway line and R 214 regional road run along the corridor of M1 arterial road which follows stream of the Juzna Morava River. When M1 road was constructed R214 road lost its role of intercontinental road and today serves for local needs.

According to the Spatial Plan of the Republic of Serbia, planned traffic-related structures in this corridor are: highway (treated in this design), railway line for high-speed trains (or modernization of main railway line for speed of 160 km/h or higher).

2.6.1 Technical infrastructure

The highway alignment was defined in the Preliminary design. It runs through the valley of the Juzna Morava River so that its influence is noticeable along the whole route. Apart from the river, natural negative effects considered in the design were: erosion activity of 1st and 2nd category river basin and torrential watercourses of 1st and 2nd priority in regard to the designed road while erosional river basin of 3rd category has conditionally positive effects.

Impacts in the water resources management were also grouped in two categories: negative and conditionally negative. Negative impacts may occur in the sanitary zones of water sources and water supply systems while conditionally negative ones in flood zones.

The existing electrical infrastructure shall be reconstructed to meet the needs of the highway. At crossing points 10 KV overhead lines will be converted to buried cables. Collisions with the existing 35 KV, 110 KV and 400 KV lines will be eliminated by reconstruction of overhead lines enabling overhead crossing.

The following telecommunication equipment is located in the highway area: long-distance coaxial cable, optic cable and automatic telephone exchange in Predejane.

3.0. FUNCTIONAL AND TECHNICAL CHARACTERISTICS OF APPLIED DESIGN CONCEPTS

3.1. LIMITING ELEMENTS IN PLAN AND PROFILE

3.1.1. Limiting elements in plan and profile for highway alignment

Limiting elements include calculation of minimum and maximum values in the layout, longitudinal profile, cross section and sight distance depending on design speed on the road section - Vr = 100 km/h.

Layout:

- Maximum tangent length max L = 2000 m
- Minimum radius of horizontal curve min R = 450 m
- Minimum radius of horizontal curve with i_{pk} min R' = 3000 m
- Minimum length of transition curve min L = 110 m
- Minimum stopping sight distance with i_n = 1% min Pz = 180 m
- Maximum width of visibility zone max b_p = 9.2 m

Longitudinal profile:

- Maximum longitudinal gradient max i_n = 5%
- Minimum longitudinal gradient min in = 0% - embankment
min in = 0.5% - cutting
- Maximum superelevation max i_{rv} = 0.75%
- Minimum radius of vertical curve sag min R_v = 5000 m
- Minimum radius of vertical curve crest min Rv = 7500 m

Cross section:

- Width of traffic lane for continuous driving t_v = 3,50 +3.50m
- Width of emergency lane t_z = 2.50 m
- Width of verge t_i = 0.35 i 0.2 m
- Width of shoulder b = 1.0 m i 1.5 m.
- Minimum crossfall of pavement min i_p= 2.5%
- Maximum crossfall of pavement in curve max i_{pk} = 7%

The applied elements may equal limiting ones or be better.

3.1.2. Limiting elements in plan and profile for alternative road

Limiting elements include calculation of minimum and maximum values in the layout, longitudinal profile, cross section and sight distance depending on design speed on the road section - Vr = 60 km/h and road category and they are related to reconstruction or relocation of arterial road.

Layout:

- Maximum tangent length max L = 1200 m
- Minimum radius of horizontal curve min R = 120 m
- minimum radius of horizontal curve with i_{pk} min R' = 2000 m
- Minimum length of transition curve min L = 50 m

Longitudinal profile:

- Maximum longitudinal gradient max i_n = 7%
- Minimum longitudinal gradient min in = 0% - embankment
min in = 0.5% - cutting

- Maximum superelevation max i_{rv} = 1.0%
- Minimum radius of vertical curve sag min R_V = 1100 m
- Minimum radius of vertical curve crest min Rv = 700 m

Cross section:

- Width of traffic lane for continuous driving t_v = 3.0 m
- Width of verge t_i = 0.3 m
- Width of shoulder b = 1.0 m
- Minimum crossfall of pavement min i_p= 2.5%
- Maximum cross fall of pavement in curve max i_{pk} = 7%

The applied elements may equal limiting ones or be better.

3.2. TYPICAL CROSS SECTIONS

A typical cross section is standard solution in standard field and traffic conditions. It defines physical scale of road structure, interrelations among the applied elements and resolves standard structural details. Based on traffic load forecast, traffic composition, road category and designed speed (Vr=100 km/h) the following cross section was adopted for geometry of a highway with two carriageways:

• Travel lanes 4 x 3.50 m	14.00 m
• Emergency lanes 2 x 2.50 m =	10.00 m
• Verges 2 x (0.35 m + 0.20 m) =	1.10 m
• Shoulders 2 x 1.00 or 2x1.5 m =	2.00 m(3.0) m
• Central reserve	4.00 m
Total width	**26.10 m**

Shoulder of 1.50 m in width was designed at the point of erection of noise walls according to the separate design – protective measures against environmental impacts of the highway.

Topsoil of required thickness shall be stripped and stockpiled as specified in the technical specifications to be reused on embankment and cutting slopes.

If a new embankment lies on ground steeper than 20%, slopes shall be benched.

Pavement on straight road section shall have symmetrical crossfall camber of i_p=2.5% and uniform crossfall in curve of 2.5% ≤ i_{pk} ≤ 7% towards the curve center. Shoulder inclination is 4% at higher pavement side and 7% along lower pavement edge directed outwards.

The subsoil shall fall same as the pavement except where the roadway is superelevated when its fall will remain 2.5% for I_{pk}< 2.5%.

The pavement design calls for substitution of material in subsoil, 30-50 cm thick per km points and of the thickness specified in the pavement design.

In cuttings this means excavating down to the specified depth beneath subsoil level and filling high-quality material where necessary.

Top subgrade layer of designed thickness in embankment shall be constructed of materials of specified geotechnical properties.

Central reserve shall have crossfall camber of minimum 4% directed inwards. A single two-sided safety barrier shall be erected along the central reserve with the highest point 0.75 m above pavement edges.

The central reserve area shall be topsoiled with 15 cm thick humus layer and planted with grass and other low greenery provided it does not interfere with visibility.

Roadbed slope inclinations are the result of consideration of geotechnical parameters, aesthetic and safety criteria and quantity and usability of local materials.

The geotechnical report recommends maximum embankment and cutting slope inclinations to ensure their stability.

From the section start point to the section end point recommended slope inclinations are: 1:1.5 for cuttings and 1:2 for embankments.

The adopted slope inclinations in cuttings will remain 1:2 in shallow cuttings and side cuts and 1:5 in very deep cuttings. In the area with rocks, cutting slope inclinations will be 10:1 and slopes shall be protected with lining wall depending on cutting depth and rock mass condition.

There are three slope protection types. Embankment slope inclinations were adopted according to safety criteria as follows:

- Inclination of embankment slope up to 3 m high will be 1:1.5 or 1:2;
- Inclination of embankment slope 3-6 m high and higher than 6 m will be 1:1.5 along the first 3 m measured from the embankment crown and 1:2 at the bottom segment;

- Along the embankment section which slope shall be protected with a revetment from flood waters of the Juzna Morava River, i.e. in the bridge zone, slope inclination will be 1:2 regardless of embankment height. Embankment slopes inclined at 1:1 to 1.1.5 shall be protected i.e. lined.

Along the whole section road periodically runs over rock soil generally in very deep cuttings or side cuts.

Cutting slope inclinations recommended for that soil are: 10:1 on sections up to 8 m high next to 3 m wide berms and 1:2 in shallower cuttings which surface layer is generally of diluvial origin.

The contact area between embankment/cutting slopes and the ground shall be rounded off to create an impression of roadbed blending in the surroundings in the following way:

- For slope height $h \geq 2$ m the rounding tangent is $T = 3.0$ m
- For slope height $h < 2$ m the rounding tangent is $T = 1.5$ x

In addition to rounding off, slopes shall be planted with grass and appropriate biological cover, provided always that the principles of traffic safety and optic guidance are observed.

At the same time plants shall serve as protection against erosion. Besides, vegetation will act as an air filter between highway and rare arable lands as it will retain solids of dust and soot and heavy metals partially.

Surface and riparian waters will be efficiently discharged in surface channels, gutters and underground sewers.

For central reserve on straight section with camber crossfall, drainage elements were not designed because run-off flows towards outer pavement edges.

In curves with uniform crossfall, runoff water from inside pavement area will flow towards the edge while 0.75 m wide triangular concrete gutter placed next to pavement edge will receive run-off from outside pavement area which flows towards the central reserve. Run-off from gutters will be received by rainwater sewers and gullies outside the gutters.

In a cutting, along shoulder edge, 1.5 m wide segmental ditch minimum 0.30 m deep below subsoil level will receive pavement runoff. Perimeter intercepting ditch shall be provided on the top of deep cutting slopes and on berms.

On embankments higher than 3 m the curb next to emergency lane edge will protect embankment slope against erosion. Water will flow down the embankment slope through concrete drain channels placed at maximum 50 m spacing.

Considering that the highway is a high category road, it will be protected with a wire fence placed along both road sides. The safety wire fence shall be placed at 1.0 m spacing from the most distant point of cross section. The outside area of safety wire fence, 5.0 m wide, will serve for operation of farming machinery, where possible. It cannot be achieved in the area between the highway and the existing railway line where distance between the railway center line and edge of highway superstructure is 8 m.

The safety wire fence designed in this way has two functions:

- It will protect highway users against animals and people unforeseeably rushing out to highway which can be fatal both for passengers and any strayed pedestrian or animal on the road of this category with high-speed traffic.
- At the same time, it will border state-owned road land maintained by the highway operator. A land strip 5.0 m wide on the fence outside also belongs to a road land and will serve for movement of farming machinery and pedestrians and for access to arable lands located next to highway. If possible, local roads will be located next to this land strip, when necessary.

Land acquisition required for whole road will be effected prior to start of works.

3.3 LAYOUT AND LONGITUDINAL PROFILE

The layout of highway alignment is the result of all known superposed factors of influence shown on thematic and synthesis maps of constraints (topography, geological, geotechnical, hydrological, spatial and urban planning requirements – land use, locations of settlements, traffic infrastructure, utilities and environmental impacts). As it was mentioned above, the highway alignment is already defined in the adopted Preliminary design.

In the highway alignment two different topographic characteristics can be distinguished:

- Highway alignment passing along the Juzna Morava River through plain land on diluvium, and
- Highway alignment passing over steep slope generally on the left river bank in side cut or deep cutting where it turns into alignment on rolling and hilly ground.

These two different topographic characteristics alternate along the whole designed highway section.

The section starts at km 873+714.86 where Grdelica – Grabovnica section ends. Immediately after the newly designed bridge over the Juzna Morava River at km 874+302.00 the highway alignment enters Grdelicka gorge. According to this variant, the highway follows completely new alignment from the above-mentioned bridge in the gorge while the existing M1 road will serve as an alternative road along the whole section length. Practically, it means that traffic will smoothly run along the existing road during works on the highway construction and after completion of works the present M1 road will serve as a parallel road for users who do not want to pay highway toll and/or all other participants in the local traffic. The main point of this variant is that one excellent road which pavement was completely rehabilitated in the meantime shall remain for local traffic and traffic during works on highway construction.

Nis – Skopje railway line, the above-mentioned M1 road and former "imperial" road – nowadays R214 road which some sections will be used for local traffic, are already located in the narrow gorge area and therefore the highway must be situated in the area between the river banks and the present railway line. Therefore the designed highway alignment passes at seven points from one bank to another over bridges of different length. Some of these points are conditioned by unfavorable angles at which the highway alignment passes over the river center line. The structure length frequently depends on lateral watercourses to be bridged, their positions or frequency and embankment height which would be constructed instead of bridge i.e. viaduct.

After reaching the right river bank, the highway alignment runs about one kilometer along the present railway line between the river and the railway line. From km 874+620.00 to km 874+780.00 the river bed will be relocated.

The highway reference level on this section through flat land runs at minor gradients: minimum down-gradient of 0.5% and maximum up-gradient of 1.21%. In the area next to railway line it follows railway line reference level at almost same elevation but in no way higher than railway line reference level in order to avoid that snow covers the railway line because it is located between the existing M1 road, which is at higher elevation than railway line, and the newly designed highway.

When the highway passes at unfavorable angle over the bridge at km 875+365.00 it continues along the left bank of the Juzna Morava River on rolling terrain with steep slopes but generally in geologically stable ground intersected with lateral ravines. On the highway section where the above-mentioned bridge is located the minimum radius of horizontal curve of 450 m was applied with appropriate transition curve. Reference levels of left and right highway carriageways are at different elevations in order to reduce earthworks, which are really enormous. On this highway section the highest up-gradient is 3.74% and down-gradient 3.05% on the right carriageway. Other up- and down-gradients on this highway section range between the values of above-mentioned gradients.

To the point when the highway passes over the new third bridge at km 876+970.00 and continues along the right river bank, the highway alignment is straight with horizontal curve radii above minimum. When the highway alignment with minimum (or close to minimum) elements of horizontal plan passes to right river bank near Palojska Rosulja it resumes a flatland alignment. It follows the existing Nis – Skopje railway line in line and grade. From km 877+500.00 to km 878+125.00 relocation of river bed was designed again. The right carriageway “treads” on the present river bed over the whole width while the left carriageway does it partially and therefore the river bed must be relocated as specified in the separate design. The reference level on this highway section is +0.5% to the point where it passes over the new bridge at km 878+400.00 and continues along the left river bank.

The highway alignment was designed with about 1000 m long tunnel in the zone of Predejane village. Such solution was possible in the arisen situation. Due to possible need for another track in the future, the variant which includes railway line relocation and construction of highway on its place is not possible any more. Therefore the railway line remains at its location and the highway moves towards a hilly ground and passes through a tunnel near Predejane village. As compared to the initial solution with railway line relocation and new bridge over the Juzna Morava River, this solution seems significantly more expensive but does not satisfy neither local authorities in Leskovac nor inhabitants of Predejane village.

Paved area of about 55 m in length from km 879+745,602 to km 879+795,766 was designed in the central reserve to enable pulling out of vehicles from tunnel.

The section starts at km 873+719.941 and its end point at said km point is adjusted to preceding and next sections in line and grade. Two design organizations cooperated very efficiently over the last months during preparation of the design documentation.

Median openings on this highway section were designed at the following km points:

km 874+627
km 877+800
km 879+625

The number of median openings is somewhat higher than usually, but they were designed for maintenance of many bridges on this section in order to easily redirect traffic flow on shorter sections.

3.4. CROSS SECTIONS

Cross sections of this highway section were designed at each 25 m for the final design level with all necessary data based on which all applied solutions can be recognized. Width of pavement, shoulders, gutters and green belt was already mentioned in this report and total highway length is 26.10 m when carriageways are not separated horizontally. Carriageways are frequently separated by more than 4 m what is a width of green belt due to reduced earthworks when highway assumes slope alignment or it is done to ensure required visibility in curves.

At first 50 m of the highway section the cross section of preceding highway section was adjusted to this one where cross section of 28.40 m total width with 10.05 m pavement width was designed for design speed of 120 km/h. In addition, there is a difference in shoulder width: on the preceding section shoulder was 1.5 m wide as compared to 1.0 m on this section (except at places envisaged for installation of noise walls where shoulder is 1.5 m wide). To the first bridge over the Juzna Morava River the highway alignment is in cutting and passes over the river at level lower than a level of the existing bridge on M1 road but sufficiently high as compared to flood flow level. After reaching the right river bank the highway is on embankment squeezed between the railway line and river against which is protected by revetment on the right embankment slope up to 0.5 m above the forecast flood flow level which occurs once in 100 years. Supporting structure will be installed on the section envisaged for relocation of the Morava River and sidewise displacement of river bed to ten-year water level. It will protect a highway base against any harmful effects of the river and above that level up to 0.5 m above the (100-year) flood flow level the mentioned revetment will have the same function. River training, supporting structure and revetment are treated in the separate design.

After reaching the left river bank, highway profile is completely changed and since the highway alignment passes through hilly ground, a side cut or cutting (often deep) exists in its cross section. On this section the highway was designed through different geological strata from debris on surface, 1 – 2 m in depth, weathered shales or weathering shales in the next stratum to hard shales – compact rock which must be blasted during excavation. Slope in such cuttings or side cuts were designed at inclination of 5:1, up to 8 m high with berm at eighth meter, 3.0 m wide in the rock as protection of possible rockfall because shales exposed to long-time weathering lose their compactness.

This solution includes protection of slopes with sprayed concrete or anchors.

On the highway section where carriageways are grade separated and if highway passes through rocks, one of three protection methods was designed depending on rock mass condition. Retaining wall was designed at points where highway runs through diluvium/proluvium or along the river with grade-separated carriageways.

From km 876+535.00 to km 876+667.00 deep cutting with four “sections”, each 8 m high was designed on the right carriageway towards hill. A solution in the form of subvariant is available here with tunnel gallery in the right carriageway instead of cutting but with cutting in the left carriageway. Based on the construction method for this gallery and construction costs the Designer decided to adopt a solution with cutting in full profile. Namely, construction of gallery requires excavation in highway full profile and stockpiling of excavated material near the gallery; during construction period slopes shall be provided with appropriate lining walls and after completion of works on gallery, one part of excavated material shall be reused on the gallery. Comparison of costs of works on this highway section in both variants has shown that the variant with cutting is by about 25% cheaper than the variant with a gallery in the right carriageway. The variant with a gallery in the right carriageway has advantage as compared to the adopted variant with deep cutting in terms of highway maintenance (especially in the winter period) but considering that its length is only 132 m (same as gallery length) and difference in construction price, variant with deep cutting was chosen.

The highway passes near Predejane village and its cross section there is interesting. As already said, because of bridges near villages the reference level was raised by 2.0 m approx. in relation to the existing railway station area of Predejane on the Nis – Skopje railway line. In order to protect Predejane station against negative effects of the highway, retaining walls with concrete channels were designed in the station area to enable proper drainage of railway facilities in the station area.

To the section end point there are no highway sections of interest and they are not treated in this report. Cross sections of flatland and rolling/hilly ground are at alternation. Cross sections were designed in 1:200 scale for A1 size drawing and/or 1:400 for A3 size drawing.

3.5. DRAINAGE

Highway drainage was designed in standard manner. Pavement run-off will be discharged through concrete gutters and ditches to water receiving body, such as: the Juzna Morava River and several lateral watercourses and dry ravines over which the highway passes.

On this highway section and along the whole highway length from Leskovac to Macedonian border pavement run-off is not treated prior to discharging into rivers and brooks, it is directly discharged into rivers and brooks near the highway through pavement drainage system.

There are two highway drainage systems:

- Pavement drainage system which in addition to gutters and ditches includes sewage system with gullies, inspection manholes and lateral discharge down the embankment slope or into ditches along the highway or into lateral watercourses and/or culverts. Rainwater sewage system can be always applied in long cuttings where run-off in the gutter with low flow capacity must sporadically be “cut” and pavement run-off discharged away from the highway base through the gully.
- Raised curb was designed on high embankments at lower pavement side to prevent run-off spill over shoulder - the special gutters along the curb will receive pavement run-off which will be discharged down the embankment slope sporadically at specific points. It was envisaged on the section where ditches were designed on embankment between the railway line and highway to receive water run-off from highway pavement and from slopes of road and railway line and beyond the track area. This drainage method also includes drainage of riparian waters. The highway is protected against riparian water with perimeter ditch in cuttings or side cuts where the ditch was designed at the end of cutting slope or placed on the berm of certain “section” in the cutting slope.

Drainage of capillary water was not designed except at beginning of the section due to several reasons. The major length of highway alignment passes through rocks in cuttings and side cuts where capillary water cannot occur. Highway embankments will be constructed of high-quality material from excavation pit on the alignment or from borrow pit (sandy gravel material from regulated section of the Morava River mixed with shales from excavation pit) with top subgrade layer of crushed shales so that there is no risk of capillary water. For that reason it was not treated in this design, except on the beginning of highway alignment.

Structures, bridges, viaducts and culverts, except concrete pipes of 2.0 m dia. were treated in the separate volume – Structures. Some pipe culverts on lateral watercourses were designed within regulation and stilling of streams and their designs and investment value are included into the volume: Pipe culverts. Concrete culverts of 2.0 m dia. were designed for easy maintenance because their length in the embankment base is about 35 m and over. That length is significantly shorter on the highway section with grade-separated carriageways and manhole in the green belt and therefore pipes of minor diameter from 1.0 m to 1.5 m were designed.

3.6. EARTHWORKS

Earth works are extensive. The highway alignment partially passes through hilly ground with deep cuttings and through flatland along the Juzna Morava River with high embankments as protection against flood flow.

3.7. PAVEMENT STRUCTURE

This chapter gives a summary of design concepts for highway pavement structure:

1. Pavement structure on travel and emergency lanes
2. Pavement structure in cuttings and side cuts
   2.1 In cuttings and side cuts in rocks
   2.2 In cuttings and side cuts in mixed material
3. Pavement structure on bridges (structures) along the main alignment and on overpasses within grade-separated junctions
4. Pavement structure on local roads
5. Pavement structure on relocated sections of M - 1 road

3.7.1. New pavement structure of highway on embankment

The adopted design concept for new pavement structure on travel and emergency lanes of E75 highway on embankment is shown on Figure 3.1.

Travel and fast lanes	**Emergency lane**
SMA 0/11s - surfacing 4 cm	**SMA 0/11s - surfacing 4 cm**
BNS 22 sA 8 cm base course	**BNS 22 sA 8 cm base course**
BNS 22 sA 8 cm base course	**DK 0/31 38 cm broken stone**
DK 0/31 15 cm broken stone	
DK 0/31 15 cm broken stone	
subsoil CBR ≥ 10% top embankment layer - of stable stone material, 0/63 mm 70 cm	**subsoil CBR ≥ 10% top embankment layer - of stable stone material, 0/63 mm 70 cm**

Figure 3.1 Schematic view of flexible pavement structure for new E75 highway lanes on embankment

In order to attain predefined load-bearing capacity of the whole road base, designed permanent load-bearing capacity at subsoil top level shall be assisted with 70 cm thick layer of 0/63 mm stable stone material placed in the top embankment layer where elasticity modulus shall be E = 120 MPa.

3.7.2. Pavement structure in cuttings and side cuts

3.7.2.1 In cuttings and side cuts in rocks

Cuttings or side cuts in rocks are present on some highway stretches. Considering that load-bearing capacity of the existing material on these stretches is higher than required load-bearing capacity of bed, dimensions of loose material in sub-base can be reduced.

The adopted design concept for new pavement structure on travel and emergency lanes of E75 highway is shown on Figure 3.2

Travel and fast lanes

SMA 0/11s - surfacing	**4 cm**
BNS 22 sA course	**8 cm base**
BNS 22 sA course	**8 cm base**
DK 0/31 blinding course broken stone	**min 10 cm**
rock mass	

Emergency lane

SMA 0/11s - surfacing	**4 cm**
BNS 22 sA course	**8 cm base**
DK 0/31 blinding course broken stone	**min 18 cm**
rock mass	

Figure 3.2 Schematic view of pavement structure cross section of new highway lane in the rock and stone area

3.7.2.2 In cuttings and side cuts in mixed material

Cuttings or side cuts in mixed material are present on some highway stretches. Considering that load-bearing capacity of the existing material on these stretches expressed by CBR $\geq$ 5% is lower than required design value ($CBR_{min} \geq 10\%$), local soil shall be chemically stabilized with 30 cm thick layer of cement/lime in order to attain required subsoil load-bearing capacity.

The adopted design concept for new pavement structure on travel and emergency lanes of E75 highway in cutting and side cut in chemically stabilized mixed local soil is shown on Figure 3.3.

Travel and fast lanes	**Emergency lane**
SMA 0/11s - surfacing 4 cm	**SMA 0/11s - surfacing 4 cm**
BNS 22 sA 8 cm base course	**BNS 22 sA 8 cm base course**
BNS 22 sA 8 cm base course	**DK 0/31 38 cm broken stone**
DK 0/31 15 cm broken stone	
DK 0/31 15 cm broken stone	
subsoil CBR $\geq$ 10% subsoil of mixed local soil chemically stabilized and improved with cement and lime 70 cm	**subsoil CBR $\geq$ 10% subsoil of mixed local soil chemically stabilized and improved with cement and lime 70 cm**

Figure 3.3 Schematic view of flexible pavement structure for new E75 highway lanes in cutting and side cut

Chemical stabilization of the existing material will be performed in cutting/side cut on the following highway stretches:

km 873+719.94 to km 874+225.00
km 875+525.00 to km 875+650.00
km 876+000.00 to km 876+100.00
km 876+425.00 to km 876+550.00
km 876+725.00 to km 876+759.00
km 877+400.00 to km 877+425.00
km 877+600.00 to km 877+825.00
km 878+100.00 to km 878+250.00
km 878+575.00 to km 879+125.00
km 879+900.00 to km 879+375.00

Note:
Alternative design concept – If approved by the Supervising Engineer and the Contractor, material can be substituted and subsoil stabilized in cutting and side cut by using stable stone material (rock) from the local borrow pit (tunnel, cutting, side cut) in 70 cm thick layer.

3.7.4. Pavement structure on bridges and overpasses

The adopted design concept for new pavement structure on bridges along the E75 highway, Gornje polje - Caricina dolina section, is shown on Figure 3.5.

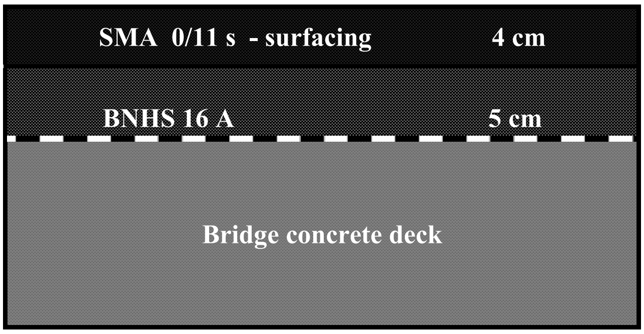


Figure 3.5 Schematic view of pavement structure on bridges along the E75 highway with ~ 1.0 cm thick waterproofing layer

The adopted design concept for new pavement structure on overpasses is shown on Figure 3.6.

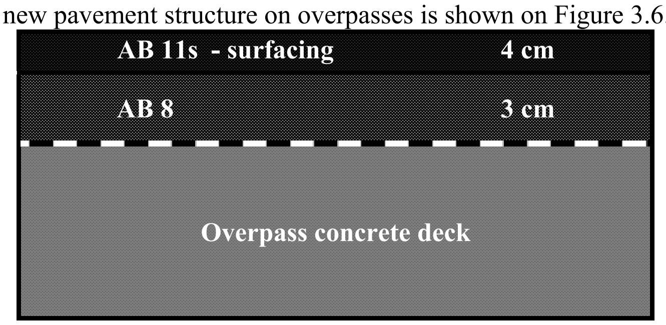
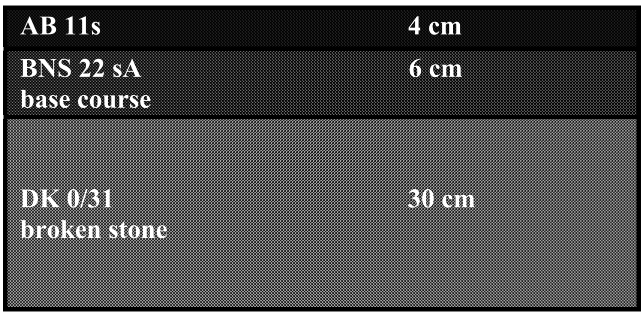


Figure 3.6 Schematic view of pavement structure on overpasses with ~ 1.0 cm thick waterproofing layer

3.7.6. Pavement structure on local roads

The adopted design concept for new pavement structure on local roads is shown on Figure 3.8.



subsoil CBR $\geq$ 5%

Figure 3.8 Schematic view of pavement structure on local roads

3.7.7. Pavement structure on relocated sections of M - 1 road

The adopted design concept for new pavement structure on relocated sections of M1 road is shown on Figure 3.9.

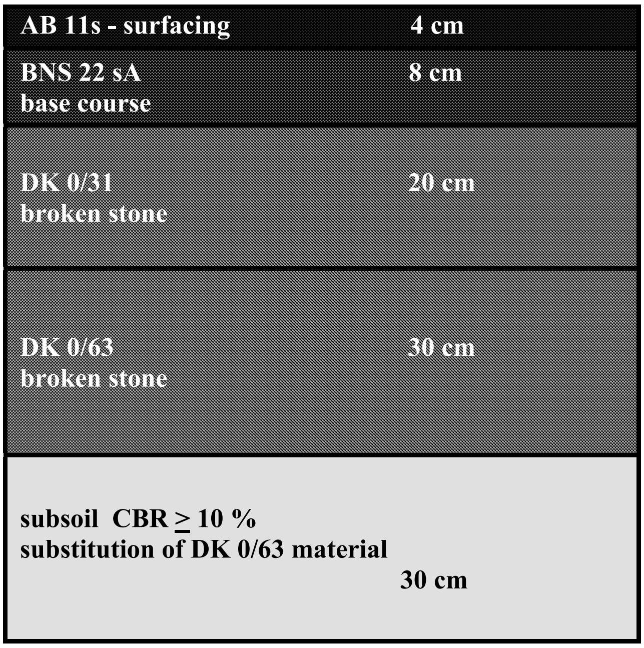


Figure 3.9 Schematic view of pavement structure on M1 road

3.9. CROSSINGS WITH OTHER ROADS AND LOCAL ROAD NETWORK

3.9.1. LINK BETWEEN A PARALLEL ROAD AND M1 ROAD

At the end of preceding Grdelica – Gornje Polje section, right highway carriageway coincides with the alignment of the existing M1 state road of first category so that parallel road (without toll station) was designed on the right highway side. On Gornje Polje - Caricina Dolina section the existing M1 road generally is not used for a bed of one section of highway pavement so that abandoned M1 road will become a parallel road.

Subject of this design is a link between the parallel road (from preceding section) and M1 road at the very beginning of Gornje Polje - Caricina Dolina section. The design was prepared on the basis of Terms of Reference, adopted Preliminary design and geodetic plans.

The layout shows that link between parallel road and M1 road begins at the end point of transition curve on the preceding section and by several curves it branches from the highway thus enabling grade-separated crossing with E75 highway and then the parallel road fits into the current M1 road next to the bridge over the Morava River.

Longitudinal road profile follows the road centerline. The first section of designed road follows the existing terrain at inclination of 5.8% and then joins the existing M1 road at inclination of 4% and 0.05%.

According to Terms of Reference and the adopted Preliminary design, local road width amounts to 6.6 m with 1 m wide shoulders.

Crossfall of tangent road is 2.5% and 3.0% in curves. Designed shoulders have crossfall of 4% (higher shoulder) and 7% (lower shoulder).

The alignment mostly runs on embankment of small height or in side cut with minor earthworks. Embankment and cutting slopes are inclined at 1:1.5 which can be seen on cross sections.

Pavement run-off will be drained by gravity – it will naturally flow down the longitudinal gradient and crossfall and shoulder to the channels i.e. embankment slopes. Segment channel was designed rightwards to receive pavement run-off and riparian water and channelize it to pipe culvert at km 0+080.69. The pipe culvert with opening of Ø1000 was designed as continuation of pipe culvert passing through highway base and detour of local road 1.

The following pavement structure was applied:

AB 11s .... 5.0 cm
BNS 22sA... 7.0 cm
Stone aggregate, 0/31.5 mm................20.0 cm
Stone aggregate, 0/63 mm...................25.0 cm
Subsoil

3.9.2. DETOUR OF LOCAL ROAD 1

The Final design of local road detours at crossings between the highway and the existing local road network was integrated in the Final design of E75 Beograd - Nis - Macedonian border highway, Gornje Polje - Caricina Dolina section.

At the very beginning of section, left highway carriageway coincides with the existing local road made of broken stone. In order to enable future local communication, 191.42 m long detour of local road 1 was designed.

The layout plan indicates that the detour is continuation of the detour of studied local road from the preceding Grdelica - Gornje Polje section and it fits into the existing road. Two circular curves of 100 m radius were applied.

Longitudinal road profile follows the road centerline. The designed road has constant inclination of 2.52%.

According to Terms of Reference and the adopted Preliminary design, local road width amounts to 3 m with 0.8 m wide shoulders.

Crossfall of tangent road is 2.5% and 3.0% in curves. Designed shoulders have crossfall of 4% (higher shoulder) and 7% (lower shoulder).

The road runs on embankment with slopes inclined at 1:1.5 as designed on cross sections.

Pavement run-off will be drained by gravity – it will naturally flow down the longitudinal gradient and crossfall and shoulder to the channels i.e. embankment slopes. Segment channel was designed rightwards between the highway and local road to receive run-off from pavement and embankment slopes and channelize it to pipe culvert at km 0+083.80. The pipe culvert was designed as continuation of pipe culvert passing through highway base and has same opening of Ø1600.

Pavement structure is chosen on the basis of adopted Preliminary design and Terms of Reference, namely pavement made of broken stone was applied.

DK 0/31.5	15 cm
DK 0/63	20 cm
	35 cm

Earthworks are not voluminous. Considering that the highway runs on embankment, there is a shortage of material to the amount of 918.246 m^3.

3.9.3. DETOUR OF LOCAL ROAD 2

Detour of local road 2 is located on the right side of newly designed highway at the very beginning of section (from ~km 873+850 to ~km 874+200) and enables communication of local inhabitants. The designed detour is 411.20 m long.

The layout indicates that detour starts at the point where it branches from the existing local road. Afterwards the alignment continues through several circular curves to the point where it joins the existing local road.

Longitudinal road profile follows the road centerline. The designed road has mild inclinations (max i = 1.50%).

According to Terms of Reference and the adopted Preliminary design, local road width amounts to 3 m with 0.8 m wide shoulders.

The alignment mostly runs in side cut with minor earthworks. According to cross sections, embankment slope is inclined at 1:1.5 and cutting slope at 1:1.

Pavement run-off will be drained by gravity – it will naturally flow down the longitudinal gradient and crossfall and shoulder to the channels i.e. embankment slopes. Segment channel was designed rightwards to receive riparian water and pavement run-off and channelize it to pipe culvert of Ø1000 opening at km 0+300.00.

Pavement structure is chosen on the basis of adopted Preliminary design and Terms of Reference, namely pavement made of broken stone was applied.

DK 0/31.5	15 cm
DK 0/63	20 cm
	35 cm

3.9.4. DETOUR OF LOCAL ROAD 3

A bridge over the Morava River at ~km 874+235 designed in the highway base is in collision with the existing local road. A detour of local road with slab top culvert through the highway base was designed in order to reinstate interrupted communication line. Considering that the existing local road is also affected by the Morava River regulation, the detour was extended and its total length is 154.27 m.

The layout plan indicates that the detour starts after the existing bridge (bridge over the Morava River in the base of M1 road). Circular curves of 30 m and 80 m radii with necessary enlargements were applied.

Longitudinal road profile follows the road centerline.

According to Terms of Reference and the adopted Preliminary design, local road width amounts to 3 m with 0.8 m wide shoulders. Pavement crossfall of 2.5% is constant and oriented towards the river. Designed shoulders have crossfall of 4% (on the higher pavement side) and 7% (on the lower pavement side).

Regulated bed of the Morava River is located on the left road side while retaining wall was designed on the right road side.

Pavement run-off will be drained by gravity – it will naturally flow down the crossfall and shoulders. Riparian water will be received in concrete gutter and channelized to pipe culvert. Pipe culvert discharging riparian water through road base was designed at km 0+113.

Pavement structure is chosen on the basis of adopted Preliminary design and Terms of Reference, namely pavement made of broken stone was applied.

DK 0/31.5	15 cm
DK 0/63	20 cm
	35 cm

3.10. ENGINEERING STRUCTURES

As required for construction of E75 Belgrade - Nis – FYR of Macedonia border highway, section: Gornje polje - Caricina dolina, the highway alignment shall be protected with appropriate types of engineering structures along with necessary adjustment to local road alignment.

Geotechnical requirements for design of engineering structures are very complex so that there are a lot of various types of engineering structures required for construction and protection of highway base which depends on very specific alignment positions as shown in the close laying highway cross sections, on local morphological complexity of slope segments and on changeable geological soil composition and characteristics.

Results of engineering geological and geotechnical soil investigations and tests are integrated in basic data for preparation of this design.

Elements of location and leveling plan of alignment and local ground conditions have conditioned layout and types of engineering structures required for construction and protection of highway base.

The design includes following types of engineering structures which shall satisfy the above-mentioned requirements:

1) Supporting structures of reinforced earth
2) Reinforced concrete retaining walls
3) Gravity stone walls
4) Supporting structures made of piles with ties
5) Protection of cutting slopes

3.10.1. Supporting structure of reinforced earth

These structures are designed on highway section where it was impossible to construct high embankments on slopes and where it was necessary to cut embankment slopes especially in the zones where several roads are in complex interrelations in the narrow cross section of terrain.

Applied structure of reinforced earth is a composite of stone or earth fill (embankment), geogrids and dry bonded concrete blocks for finishing of unoccupied areas with maximum height of 6.50 m measured from the crown to foundation. Front face of the structure is vertical thus minimizing the amount of occupied ground area.

Supporting structures of reinforced earth are designed on the following sections:

1) Supporting structure of reinforced earth 5 - leftward, from km 875+844.00 to km 876+085.00, which total length is 241 m
2) Supporting structure of reinforced earth 6 - leftward, from km 876+202.99 to km 876+228.99, which total length is 26 m
3) Supporting structure of reinforced earth 8 - leftward, from km 876+409.40 to km 876+506.02, which total length is 95 m
4) Supporting structure of reinforced earth 10 - leftward, from km 878+730.00 to km 878+829.17, which total length is 101 m
5) Supporting structure of reinforced earth 11 - leftward, from km 879+005.00 to km 879+120.23, which total length is 117 m
6) Supporting structure of reinforced earth 13 - leftward, from km 879+518.01 to km 879+680.00, which total length is 162 m

An embankment for road base and supporting structure will be made of material excavated on the alignment which 30% must be composed of maximum 125 mm stone fractions. Larger fractions are not permitted. Layers shall be compacted to M_s^{min}=35 MPa. At distance smaller than 2.00 m from the wall the embankment shall be compacted with light rollers and vibrating plates and not in any way with heavy vibrating rollers. Subsoil shall be compacted to minimum 95% according to standard Proctor test.

Geogrids for this type of structure are uniaxial, made of high-density polyethylene (HDPE) resistant to chemical and mechanical effects. Based on performed calculations two types of uniaxial geogrids were adopted according to required load-bearing capacity.

Prefabricated concrete blocks, $b \times d \times h = 40 \times 22 \times 15$ cm, made of concrete MB30, V4 and M150 will be used for finishing of exposed free areas.

Combination of geogrids and lining concrete blocks will form a massive retaining wall by engaging a portion of embankment which now can receive horizontal pressures of the remaining portion of soil. In this composite system a geogrid receives tension forces in surrounding soil while concrete blocks serve only for formation of desired wall face geometry. Structure stability shall be achieved by friction and stiffened grains of soil with geogrid and by bonds between the geogrid and lining elements.

Since local regulations are not available for this type of structure, the instructions and algorithms for calculation from test certificates of the British Board of Agreement were used. These test certificates strictly stipulate quality requirements for applied materials, design concepts and methodology for calculation of load-bearing capacity and stability.

Work starts with construction of concrete strip foundation on prepared subsoil. Then the first row of blocks shall be placed on prepared foundation over mortar layer and positioned precisely horizontally and vertically in order to avoid mistakes in the alignment of joints of the wall being built. Concrete blocks shall be placed in vertical line and geogrid spread to the top of embankment preceding layer. Geogrids shall be spread over compacted, leveled and prepared layer, joined to concrete members and tensioned with appropriate tool. After fixing a free geogrid end, the next embankment layer will be spread and compacted. Filling over the tensioned geogrid shall be performed from the middle to the ends. A wheel passing directly over geogrid is forbidden.

3.10.2. Reinforced concrete retaining walls

This type of structure shall be constructed on the major length of designed highway and on left and right banks of the Juzna Morava River as well as in the area of relocation of arterial or regional road where side cuts and cuttings will be excavated in quaternary deposits (dl, pr, dl-pr rarely t_1 and t_2) and partially in shales. In addition, this type of structure will be applied on some locations with specific soil structure such as conditionally stable quaternary covers or small zones of shallow active or stilled landslides.

The design includes construction of retaining walls on the following sections:

1) Wall 1 rightward from km 873+875.00 to km 874+224.00, total length L = 357.43 m
2) Wall 2 leftward from km 875+580.00 to km 875+618.00, total length L = 39.13 m
3) Wall 3 leftward from km 875+630.00 to km 875+656.00, total length L = 26.78 m
4) Wall 12 rightward from km 879+362.00 to km 879+450.00, total length L = 88.03 m
5) Wall 14 rightward from km 879+590.00 to km 879+773,63, total length L = 183.00 m

These walls will be constructed of reinforced concrete MB30, V4, M150 while top segment will be made of plain concrete MB30 with inclination of 4%.

Total height of these walls is up to 7.0 m.

In case of soil of poor material, stability of the walls will be ensured by placing a cantilever behind the wall.

Walls will be constructed ring by ring, fully as designed.

Run-off behind the walls above the reference level will be discharged through ϕ100 mm weepholes at every 2.5 m of wall according to designed details while gravel drainage filter will be made behind the walls. Weepholes are not designed for walls below the reference level.

3.10.3. Gravity stone walls

This type of economical structure is designed on alignment section in the central reserve where carriageways are grade-separated to a level of about 3-5 m so that side cuts must be lined. This type of structure is also designed on some alignment sections as supporting structure that protects a slope above the road.

Top segment of stone walls is always 1.00 m. Wall faces are inclined at 5:1 and inner surfaces at 8:1.

Walls will be constructed with excavated stone consisting of 20-40 cm irregular fractions in cement mortar. Total height of the walls shall not exceed 6.50 m. Foundation of stone walls shall be constructed of concrete MB30 inclined at 1:5 towards back side in 50 cm thick layer.

The design includes construction of stone walls on the following sections:

1) Wall 4 in the central reserve from km 875+730.396 to km 876+229.09, total length L = 498.69 m
2) Wall 9 in a central reserve from km 878+675.00 to km 879+025.38, total length L = 350.00 m

Protection of cutting slopes

Cutting slopes shall be protected in the area where slopes are cut deep mostly in shales varying in the intensity of fissibility and alternation and in quaternary surface covers. Depth of cuttings and side cuts along the highway ranges from 5.00 m to 30.00 m and over. General ground characteristics in the area of deep side cuts are similar but they can be divided in two shale complexes – Scom consisting of dual-component shales and Sabcom consisting of triple-component shales. Both complexes are divided by depth in zones of different fissibility and alternation degree. Generally, there are three zones evaluated by quality and alternation of rock mass. Regarding two-component shales they are: a) zone of poor quality, b) zone of fair quality and c) zone of good quality and regarding three-component shales they are: a) zone of poor quality, b) zone of inadequate quality and c) zone of inadequate to fair quality. Detailed description of these strata with evaluation of relevant geotechnical parameters is given in the separate geotechnical documentation, Book 2, Volume 4.

Excavation by means of explosive makes a considerable contribution to degradation of rock mass. Therefore the first step in the opening of cutting will be to make excavation from the top edge of designed slope and to continue downward with smooth blasting down the slope. Height of cutting section is limited to 8.00 m with contour inclination of 5:1. Protection berm, 3.00 m wide is designed between two cutting sections.

Careful blasting, forming of cutting sections and slope lining enable permanent stability of excavated cuttings.

Cutting slopes shall be protected with 5-10 cm thick layer of shotcrete MMB30 including a reinforcement mesh and systematic anchoring with SN anchors, Rϕ25, 5 m long, where one anchor covers about 8.00 m^2.

The design includes protection of slopes on the following sections:

1) Slope 1 rightward from km 875+505.00 to km 876+245.00
2) Slope 2 rightward from km 876+510.00 to km 876+745.00
3) Slope 3 leftward from km 876+555.00 to km 876+685.00
4) Slope 4 rightward from km 878+625.00 to km 879+090.00
5) Slope 5 rightward from km 879+450.00 to km 879+590.00

3.10.6. Protection structures – civil engineering part

Environmental protection design includes construction of noise walls along the E75 Belgrade - Nis - Macedonian border, Gornje polje - Caricina dolina section in order to reduce traffic noise.

The design includes the following noise walls:

6) Noise wall 1 - leftward from km 873+879.14 to km 874+109.76, L=224.00 m
7) Noise wall 2 - leftward from km 877+564.60 to km 878+163.76, L=604.00 m

Noise protection

Noise walls are designed on the left highway side in total length of 1500 m.

The walls are defined in the layout and leveling plan.

The walls shall be 2.00 – 4.00 m high above the level of emergency lane edge. For structural reasons and because of predefined height of prefabricated panels and reinforced concrete sheeting, a height of designed walls as compared to a level of emergency lane edge is somewhat bigger than the required wall height. For psychological effect of protection structure on drivers the noise walls are designed at continuous spacing from the highway center line and at 1.6 m from the pavement edge.

A noise wall on embankment shall consist of prefabricated absorptive members (sheetings) placed between steel posts planted at 4.0 m center-to-center spacing. Steel posts shall be planted into prefabricated reinforced concrete foundation of circular section D=60 cm. Foundation depth is 2.50 m. Absorptive sheeting is of standard dimensions, L=3.96 m. The posts shall be vertical and aligned the same as the structure itself. It will be achieved by placing prefabricated reinforced concrete sheeting prior to fixing the next steel section. Then absorptive sheeting shall be placed between the adjacent posts.

Absorptive sheetings used for construction of noise barriers must satisfy the general criteria:

- to meet the acoustic requirements
- to take into consideration traffic safety requirements
- to be structurally stable and of constant shape
- to be resistant or protected against ageing and corrosion
- to be of precise dimensions
- to be of consistent color shade
- to be fire-resistant
- to be resistant to stone strike
- to be easy for maintenance

Dimensions and structure of absorptive sheetings shall fully meet the relevant applicable quality standards and requirements (DIN 52210, DIN 52212, DIN 1725/1, ZTV-LSW 88, EN 1793/1794 etc.).

The work shall start with excavation of hole for foundation at predefined point on embankment slope. For good drainage in the operation phase the top foundation edge shall be 5 -20 cm above the embankment slope. Prefabricated reinforced concrete members will be then placed into prepared holes and earth around foundation compacted to increase load-bearing capacity of the structure under horizontal loads. The next step is planting of reinforced concrete posts in the hole of reinforced concrete foundation. The posts shall be vertical and aligned the same as the structure itself. Reinforced concrete sheeting shall be placed prior to fixing the next steel post. Structural continuity shall exist for proper functioning of noise wall. In case of road on embankment, one section of reinforced concrete sheeting shall be placed in the road base so that pavement edge level is always between the top and bottom edges of reinforced concrete sheeting. In addition, this sheeting enables horizontal placing of other absorptive sheetings over it regardless of reference level gradient. The absorptive sheetings shall be placed above the reinforced concrete sheeting between the adjacent steel posts.

Finally, broken stone (16-32 fractions) shall be filled in the form of "wedge" which will be then bordered with the wall, the embankment plane and the side of the shoulder extending to the wall plane.

Drainage of noise wall in whole length will be performed under the reinforced concrete sheeting and above the road embankment slope. Run-off drained from shoulder to wall shall flow downward the crushed aggregate, pass through an opening under the reinforced concrete sheeting and continue down the embankment slope.

Noise walls are designed on embankments and bridges. The differences are reflected in method of fixing steel post to the structure. On the bridges, HEA 140 steel posts shall be planted at 2.0 m center-to-center spacing. A steel post shall be joined to bridge structure and/or concrete in the footway by using steel plate, 350x200x20 mm in size of S235JO (C0362 according to SRPS.C.B0.500) grade. Anchors for steel plate shall be made of RA 400/500-2, Ø12 reinforcing steel in the form of closed-up stirrup and welded to the plate with a=4 mm angle weld of 150 mm minimum length fully in accordance with a detail in graphical documentation. It is important to point out that **anchors and anchor plate shall be fixed at same time with reinforcement for bridge deck, namely prior to concreting.** After concreting, posts will be cast in situ and welded with 1/2 V weld. The posts are vertical and level grade of the structure will be achieved by casting reinforced concrete sheeting in situ. Transparent panels will be then placed between the adjacent posts.

Transparent sheetings used for construction of noise barriers must satisfy the general criteria:

- to meet the acoustic requirements
- to take into consideration traffic safety requirements
- to be structurally stable and of constant shape
- to be resistant or protected against ageing and corrosion

- to be of precise dimensions
- to be of consistent color shade
- to be fire-resistant
- to be resistant to stone strike
- to be resistant to vehicle impact
- to be easy for maintenance

Dimensions and structure of transparent sheetings shall fully meet the relevant applicable quality standards and requirements (DIN 52210, DIN 1725/1, ZTV-LSW 88, EN 1793/1794 etc.).

Standard dimensions of transparent sheetings for noise barriers on bridges are: L=1.96 m.

Structural analysis

Geostatic calculation was made for typical cross section and geotechnical parameters were taken from the geotechnical report.

The calculation was made for the following loads:

- dead weight of the structure
- wind load – EN 1991-1-4:2005
- dynamic loads produced by snow clearing – EN 1974-1

The calculation was made to control load-bearing capacity of HEA 140 steel posts and to determine dimensions of reinforced concrete sheeting and reinforced concrete circular foundation of ϕ600 mm based on influences calculated by the structural analysis.

3.11. BRIDGES AND GALLERIES

OVERVIEW OF STRUCTURES ALONG THE E75 HIGHWAY

Gornje Polje - Caricina Dolina section

No.	Structure	New km point	Length (m')	Pavement width (m')
1	Bridge	874+286.563	100	26.1
2	Overpass	874+080.470	110	10.5
3	Bridge	875+371.465	228	26.1
4	Bridge	876+319.196	173	26.1
5	Bridge	876+973.313	432	26.1
6	Bridge	877+386.56	10	27.8
7	Bridge	878+305.468	6	27.8
8	Bridge	878+394.758	138	26.1

No.	Structure	New km point	Length (m')	Pavement width (m')
15	Culvert	879+770.542	3	27.8
16	Culvert	884+067.303	3	27.8
17	Culvert	884+983.191	3	27.8
18	Culvert	885+335.85	5	27.8
23	Bridge on M1 road	0+264.889	8	10.3

4. TRAFFIC EQUIPMENT AND SIGNALIZATION

Traffic equipment and signalization were designed 1:500 in scale, and harmonized with civil engineering design and adopted chainage.

According to the design documentation, the studied highway shall be designed in full profile and provided with traffic lines, 3.5 m wide. The emergency lane shall be 2.5 m wide with 0.2 m wide verge, as stated in the Terms of Reference.

Open section

Traffic signs and signals

Since the alignment of the studied section runs from one bank of the Juzna Morava River to another and vice versa, each span shall be marked with non-standard board sign III-58.

In addition to numerous bridges, the ``Predejane`` tunnel shall be also constructed on the section herein. According to TEMV Standard, the tunnel will be announced by signs at 500 m, 350 m and 50 m before the entry portal. Danger sign I-24 will be erected as approaching the tunnel. Additional board at 500 m will be placed on the same post. At 150 m before the tunnel tubes, LED variable message signs will be installed showing speed limit of 80 km/h. This sign will be connected to a measuring station, a controller and VMS, and the inscription will be on input from these automated elements. At 50 m before the portal, the ,,No Overtaking for HGVs`` sign is designed as well as ``Mandatory Vehicle Spacing 100 m``. Traffic sign posts shall be also provided with flashing light. The entry portal shall be marked with chevron boards. Immediately before entering the tunnel tubes sign III-56 shall be installed. Signaling inside the tunnel is consisting of LED variable message signs.

Road markings

Road marking is consisting of 0.2 m wide continuous edge lines and 0.2 m wide centre broken line that follows 6 M12 m pattern (6 m mark/12 m gap). The Supplier of road markings shall apply them onto pavement and give warranty for his work.

Traffic related equipment

Equipment implies the placement of direction posts, single-sided safety barriers and retro-reflectors.

In order to make road width easily discernible, direction signs shall be placed on the existing shoulder. A direction sign consists of marker for driving in daylingt (daytime marker) and at night (nightime marker) fixed to white background. Daytime markers are black romboid areas at the angle of 30 degree with apex turned closer to pavement, while nightime markers are of retro-reflective material. A red rectanlge shall be placed on the right side and two smaller wihite rectangles one on top of another, on the left side. Their supports are white and do not pose danger to motorists even if they run into them. They will be embedded on the outer edge of the shoulder. On dawings, direction post symbol is a circle divided in two parts (red and white) and their positions are shown on the layout.

Direction posts will be erected at all places where single-sided safety barrier is not foreseen and they will be spaced at 24 m. The drawing indicates the position of bodies on barriers and direction signs oppoiste to them. Procurement and placement of direction posts shall be performed according to type specified by the Investor.

Single-sided safety barrier shall be installed along the inner edge of the traffic ridden areas due to 4 m wide distance. The barrier shall comply with N2 safety level, index W 8. (according to technical specifications given by the Investor). The said protection level shall be achieved by placing the single-sided safety barrier H1W5 along the central reserve. On segments where traffic ridden areas are designed in two levels, double-sided safety barrier, type H2W8 shall be installed.

Traffic signs and signals

Traffic sings specified in the design are of standard type. Signs $1200 \times 1200 \times 1200[mm]$ and circle $\varnothing 900[mm]$ shall be installed, while on segment of the displaced R214 regional road signs $\varnothing 600[mm]$ will be installed. Deviation from the specified clearances is allowed for +/-2%. Sign face together with all accompanying symbols, letters and numbers shall be made of retroreflection material characterized with standard retroreflectivity. Traffic signs shall be in conformity with detailed drawings and JUS Standards, and in compliance with applicable Traffic Signs Code. Signs shall have their planes horizontally deviating for $3\text{-}5^0$ outwards from the vertical line in the road center. On the backside of each sign the manufacturer shall inscribe sign code according to Traffic Signs Code with contents (numerals or lettering) in brackets, if any. Single tubular supports shall be secured in place by cross pieces in foundation. Length (height) of the traffic sign supports shall depend on the number and kind of signs to be fixed to them.

For gantries and non-standard signs, relevant computation, construction and mounting to be performed by the Manufacturer shall be required.

Traffic signs and signals in tunnel shall be designed as unchangeable LED sign (signs F600 mm, 600x900 mm and 600x150 mm) that will also display textual messages and other types of danger and mandatory signs.

Road markings

Road markings will include as follows:

Longitudinal markings

- Continuous lines - JUS U.S4.222
- Broken lines - JUS U.S4.223

Road marking will be performed fully in accordance with layouts stated in the design, detailed drawings and separated detailed drawings specified in the design. Road markings will be tick-layered and marked in white paint. Road marking on the studied section shall be performed by thick-layered marks made of cold plastic to enable long durability and higher retroreflection values. Materials and technical specifications for road markings shall be fully in compliance with JUS Z.S2.240 Standard.

Road markings shall be provided with following:

- Centre lines, 0.20 m wide (white color);
- Broken line, 0.20 m wide, 6.0-12.0 m pattern, (white color);
- Broken line, 0.20 m wide, 6.0-12.0 m pattern, (white color);
- Broken line, 0.50 m wide, 3.0-3.0 m pattern, (white color);

- Broken line, 0.20 m wide, 1.0-1.0 m pattern, (white color);

On the displaced segment of the M1 arterial road, centre line 0.15 m wide (white color) is planned to be applied, and on the displaced segment of the R214 regional road, centre line 0.12 m wide (white color) shall apply.

Road marking inside the tunnel shall also include placing of markers on the centre line at 18 m interval. The arrangement of markers will be in compliance with the broken line that follows 6.0 m - 12.0 m pattern. Markers will be retroreflective meaning that they can reflect the light from vehicle headlamps. Edge lines will be provided with markers that operate on the inductive loop principle thus delineating the road edge in unlit conditions. Therefore problem referring to visibility of pavement edge will be solved. Arrangement of edge markers will be in compliance with markers placed on the pavement surface.

Traffic related equipment

Direction posts are planned to be placed at all places where safety barrier is not foreseen, i.e. on sections positioned on low embankment. Direction posts shall be installed at intervals of 50 m. Procurement and placement shall be performed according to type adopted by the Investor. Reflecting studs shall be placed on safety barrier, in grooves. Reflecting studs shall be spaced apart similarly as direction posts. Although not shown on the layout, wire fence is stated in the priced bill of quantities.

″Km point″ (III-17) signs shall be placed at each full km point along the outer edge of the carriageway on either direction fully in accordance with JUS-u Z.S2.320 (but not shown in traffic signalization plan). Sign face will have white background and black inscriptions free of retroreflection properties. Signs will have 450x400 mm in size. Detail of this sign is stated in the Attachment.

In the course of designing of traffic equipment and signalization, the design engineer was adherent to the Yugoslav standard. When forming prices for cost estimate, the design engineer contacted equipment manufacturers.

5. PROTECTIVE MEASURES

5.1. Noise protection

Noise levels obtained by the use of LIMA software for noise calculation and mapping in the environment (version 5.2) and guidelines "Rihtlinien für den Larmshutz an Strassen" (RLS-90), where used to draw isophone maps for the Gornje Polje-Caricina Dolina section.

Protection against noise shall be performed only on the highway left side on the segment where residential buildings were constructed. They are mostly single floor or two-floor and three-floor buildings. Noise suppression walls varying from 2 to 4 m in height shall be constructed above the shoulder level.

The height required for noise suppression walls have been defined through the use of software package designed for computation and mapping of environmental noise LIMA (Version 5.3), together with "Rihtlinien für den Larmshutz an Strassen" (RLS-90) guidelines (due to lack of national legislations).

The noise suppression wall shall be built of precast absorption elements (boards) inserted between steel posts erected at 4.0 centre to centre distance. Steel posts shall be embedded into the pre-fabricated reinforced concrete foundation. Absorber boards shall have standard dimensions of 3.96 m in length. The pre-fabricated boards shall be 0.5 m high. The studied section shall be provided with 4 noise suppression walls.

Placing of noise suppression walls at relevant km points are stated in the Table below:

		Km points from km	Height (m)	Length (m)
Wall No. 1	Left	873+880.00	2.5-4.0	224
Wall No. 2	Left	877+565.87	2.5-4.0	596
			Σ=	820

It is recommended to plan a procedure for monitoring noise levels in the corridor prior to constructing any physical protective barriers. Construction shall start as soon as the monitoring procedure indicates excessive noise levels.

Layout, leveling plan for protection of the structure and highway, methodology to be applied in construction of noise walls, structural analysis for noise protection, traffic equipment and BoQ are stated in Book 10, Volume 2 – Protective structures – civil engineering design.

6. POWER SUPPLY WORKS

a) Reconstruction of segments where power lines overcross the E75 highway

For the purpose of construction of the E75 highway (Belgrade - Nis – border with FYR of Macedonia, Gornje Polje - Caricina Dolina section), reconstruction of power supply lines in collision with the alignment of the studied road is planned to be carried out, fully in accordance with applicable regulations and conditions issued by PD "Jugoistok" Company from Nis and Leskovac Power Distribution Company (PDV).

Power supply lines of nominal voltage 10kV and 1 kV are in collision with the studied highway section. Locations of power supply lines and data sheets were derived from geodetic surveys and available technical documentation of PD "Jugoistok" and Leskovac PDC. The following collisions have been identified:

- "Grdelica - Palojce" 10kV, spur to Graovo
- Low voltage lines for power supply of "Mahala Pasevluka" Settlement, two crossings.

Any crossing and/or parallel taking over of overhead power line must be performed fully in accordance with the Technical Norms for Construction of Overhead Power Supply lines 1kV - 400kV rated voltage", (Official Gazette SFRY, 65/1988).

The height clearance between the line and the highway shall be 7.0 m, as stated in provisions. Distance of any pole member from the highway edge will be minimum 40.0 m.

When the line is passing over the highway, distance of any pole member may be smaller, if ground conditions allow, but in any case not smaller than 10.0 m.

Insulation must be mechanically fastened.

Joining of conductors/protection wires shall not be allowed in the area of crossing.

The angle of crossing shall not be less than 30°.

When lines are taking over the highway, distance between the line and the highway on sections longer than 5 km must be as follows:

1) For lines with voltage not exceeding 35 kV - minimum 50.0 m
2) For lines with voltage greater than 35 kV - minimum 100.0 m

In hilly and forest areas, distance between the line and the highway may be reduced to 40.0 m.

All abovementioned heights and distances are referring to lines not exceeding 110 kV rated voltage.

Transmission lines not in compliance with provisions stated in the "Technical Norms for Construction of Overhead Power Supply lines 1kV - 400kV rated voltage"" (Art.124 to Art.129) and "Law on Roads" (Official Gazette RS, No.48/81 (Art.36), must be reconstructed.

According to conditions of PD "Jugoistok" and Leskovac PDC and geodetic surveys, 10kV overhead power line shall cross the studied highway. For low voltage lines, underground crossings are planned to be installed. Each crossing shall be studied in detail in Technical Report to the Final design.

d) Overhead catenary on the Belgrade-Skopje railway line

Two overbridges on the highway E75 (Belgrade– Nis– border with FYR Macedonia), Gornje Polje – Caricina Dolina section, from km 873+719.94 to km 885+522.78, are planned to be constructed. These overpasses will span the Belgrade-Mladenovac-Nis-Presevo-National border railway line at km 314+066.5 where new interchange that connects the new highway section and the existing road will cross the railway line and at km 314+310.8 where the highway will cross the railway line (km 883+113.7 of the E75 highway).

The electric traction system on the Belgrade-Mladenovac-Nis-Presevo-National border 25kV, 50Hz shall be reconstructed at the above points to allow contact wire to pass beneath the overbridge.

It will be necessary to remove old masts and erect new ones, replace a number of cantilever assemblies, reduce catenary system and contact wire heights and replace droppers in some spans, fully as tabulated and shown on attached design drawings.

Metal structures on overpasses in the zone of the electrified line shall have double earth, i.e. shall be bonded to track rail and to a special earth electrode.

Since reconstruction and construction works shall be executed in the close proximity of catenary system of the railway line electrified by 25kV, 50 Hz system, Health and Safety rules attached here shall be observed.

7. TELECOMMUNICATIONS

7.1. Displacement and protection of the existing telecommunication cables (TC) in collision with the newly-designed highway alignment and access road structures

An analysis of the newly-designed highway alignment, access road structures and local roads overlapping the existing telecommunication cables revealed numerous points of collision that will be discussed in the text below and shown in the Graphical Attachment. In general, they are due to parallel running of the highway alignment and the existing cable routes, intersections and threat to existing cables when new bridge piers are constructed and access elements (junctions, overpasses, interchanges, local roads...) are either newly constructed or rehabilitated.

Depending on the severity of threat to the existing cables, they will be either displaced or protected. Since these are underground, coaxial and fibre optic telecommunication cables, they will be adequately spliced. The cable will pass under the highway through two or four double-corrugated pipes made of hard plastics, 110 mm in dia. that will be laid at the depth of 1m under the lowest point of the highway roadbed.

The existing TC cable is to be relocated by the standard procedure: cut the cable in a proper place, lay a new cable, splice appropriately, measure relevant parameters, backfill the trench, mark the cable route in advance, and put into operation.

Prior to commencement of works, all fibres shall be measured by OTDR instrument that will measure the optical link loss at the appropriate wavelengths of 1300 mm and 1550 mm. Splicing of optical cables will be enabled through the use of UCS 4-8 fibre joints, and then optical fibres will be joined together by welding. PE pipes, if any, will be extended with plastic

joints. Afterwards, the optical cable shall be measured again by OTDR instrument. On certain points on the new fibre optic cable route, cable tracers shall be placed above splices and pipe joints. Cable markers shall be placed at all characteristic points on the new cable route, its turning points, above the joints in cable and in pipes. Particular attention shall be paid to the fact that intense telecommunication traffic is taking place on the said cables and interruptions should be as short as possible. Approval for work on cables and on structures that may threaten such cables shall be obtained from the respective office in Telekom Srbija telecommunication operator in charge of internal supervision.
Timing and periods of traffic suspension along the said cables for the purpose of reconnection shall be the responsibility of Telekom Srbije telecommunication operator.

Protection (and/or temporary displacement) of the existing telephone cable shall be performed as follows: the existing cable shall be removed or temporarily displaced and return into the earth trench and buried on greater depth once the works have been completed. When cable is not planned to be removed it shall be protected with adequate PE pipes.

NOTE: The existing cables shown on drawings are only approximately positioned considering the fact that "original" existing cables (obtained from the "Telekom" Company) are also approximately located.

7.2. Overview of collision points of the existing telecommunication cables and newly-designed highway alignment.

Each point of collision bears ordinal number, km point, type and problem solving. The future TC conduit will be positioned in the shoulder. Bridges shall be provided with TC conduit for routing of telecommunication cables.

Note 1: If beginning/end of collision point is identified at the certain distance from the highway, km point of works shall follow the highway km point.

Note 2: When passing under the highway, minimum distance between the pavement level and telecommunication cable shall not exceed 1.5 m.

Note 3: Protection pipes on either regulation zone shall protrude by 3 m.

Note 4: At the point of collisions with the newly-designed pipe culverts, TC network shall be properly protected.

Collision No.: 1

Km point: from km 874+415.000 to 875+365.000, highway alignment

Collision type: Parallel running of the existing fibre optic cable route and the newly-designed highway alignment

Solution: A cable tracer shall be used to find and mark the route of the fibre optic cable TOSM 03(6x4+1h2)xIIx0.4x3.5CMAN. Since the planned works may threaten the cable, from the existing splice N13 to the new splice N13A, the cable TOSM 03(8h6)xIIx0.4x3.5CMAN blown in the pipe 2 x RE ø40mm laid into the new trench, shall follow the new route. On the bridge, 2 x RE ø40mm shall be routed through metal pipes and the cable shall be placed inside one of them. The trench will be backfilled and cable route properly marked. Relevant measurements will be performed and as-built drawings prepared.

Collision No.: 2

Km point: from km 878+750.000 to 879+100.000, highway alignment

Collision type: Parallel running of the existing fibre optic cable route and the newly-designed highway alignment

Solution: From km 878+750.000 to 879+100.000 pipes 2 x RE ø40 mm shall be laid into the trench. At km 878+750.000 one newly laid pipe RE ø40 mm shall be bond to the existing stand-by pipe toward splice N15. The cable TOSM 03(8x6)xIIx0.4x3.5CMAN shall be drawn in a stand-by pipe RE ø40mm from the splice N15 at km 878+475.000 to the new splice N15A at km 879+100.000. The existing splice N15 shall be replaced with new N15A. Old cable shall be dismounted from the splice N15 to the new splice N15A and the other newly-laid pipe RE ø40mm bond at km 878+750.000 and km N15A as future standby pipe. The trench will be backfilled and cable route properly marked. Relevant measurements will be performed and as-built drawings prepared.

Collision No.: 3

Km point: from 879+475.000 to 879+625.000, highway alignment

Collision type: Parallel running of the existing fibre optic cable route and the newly-designed highway alignment

Solution: A cable tracer shall be used to find and mark the route of the fibre optic cable TOSM 03(6x4+1h2)xIIx0.4x3.5CMAN. Since the planned works may threaten the cable, it shall be manually released and protected by covering with PVC pipes ø110 mm. Stand-by PVC pipe ø110 mm shall be also laid. These PVC ø110 mm pipes shall be end at 3 m outside the highway. The trench will be backfilled and cable route properly marked. Relevant measurements will be performed and as-built drawings prepared.

NOTE: After being positioned by the cable tracer, excavation in the vicinity of the said cables will be performed strictly by hand.

7.3. General provisions on safety at cable lying and installation work

Pursuant to Article 9, Paragraph 2 of the «Occupational Safety and Health Act» (Official Herald SRS No. 42/91) and «Law on Amendments to the Occupational Safety and Health Act » (Official Herald RS No. 53/93, 97/93, 48/94)

PREAMBLE

A completed cable installation *(infrastructure – trench, conduits, and equipment) is neither dangerous for the environment nor users since:*

- *It does not involve life threatening voltages;*
- *It is, as a rule, inaccessible ;*
- *The terminal units at the user's are so designed that they are never dangerous if operated properly;*
- *It is chemically inactive and does not pollute the environment – concrete, bricks, neutral plastics (PVC, PET etc);*
- *If cables are heavily damaged (copper and optic) only very little quantities of chemically neutral and non-poisonous matter occur (filling gels, thixotropic compounds) ;*
- *Laser radiation of optic fibre cables is prevented because emission stops as soon as a fibre breaks.*

To this end, the protection of the environment and users will be achieved if cable installation works are executed in strict accordance with these conditions (Technical specification, Technical rationale, Graphic documentation) and the relevant regulations and standards.

This text on safety at work refers to the here designed cable installation and its maintenance by qualified staff.

SITE ORGANIZATION

TT cables shall meet the requirements and regulations for safety at work and the Rulebook on Safety at work in construction industry.

The Contractor shall observe the design concepts and instructions of the cable, accessories, equipment and civil elements manufacturers as well as manuals and regulations that govern the operation of the machinery, instruments, tools and accessories so that the cabling would suit its use, ensure safety at work and a long life of the plant finished.

Workers engaged in construction and maintenance operations shall observe the relevant regulations and provisions of the Safety at Work Act.

In order to ensure conditions for the safe execution of works it will be necessary to do in advance the following:

1. The site manager shall draw a safety plan based on this text and on the local site conditions prior to the commencement of work.
2. The following documentation shall be available at the site:
   - Rulebook on safety at the work issued by the Contractor's organization
   - This design and plan for safety at work
3. The following health data of all employees (full time and part time employees) must be available:
   - Blood type
   - Data on possible allergies
   - Data on vaccination – especially anti-tetanus
   - Data on medications that may affect work performance
4. Data on nearest health centers (address, phone numbers) must be available.
5. The first aid kit must be available at the construction site. First aid supplies must be ready available and during the execution of works at least one experienced trainer in first aid must be present.

Potential hazards and injuries are listed below:

1. Mechanical hazards
2. Electric shock (lighting discharge)
3. Fire and explosion
4. Chemical hazards
5. Biological hazards

1. Mechanical hazards and protection measures

1.1. Vehicles, trailers, machinery etc. shall suit the works. Load cases of trucks and trailers shall be easy for cable loading and unloading. Hoists shall have the appropriate bearing capacity. During transport, drums shall be tied well and secured with pads against rolling. Speed and driving shall be controlled. The vehicles transporting cables and hoists shall be marked with yellow rotational lights. If the transported unit (hoist, machine, cable drum) exceeds the clearances specified for road vehicles, a vehicle with yellow rotational light shall accompany it.

1.2. Staff engaged in loading/unloading of cables must wear protective gloves, helmets and protective clothes. Staff on traffic ridden areas must wear reflective clothing (fluorescent yellow).

1.3. The construction site must be properly enclosed; if works are planned to be carried out on traffic ridden areas they must be properly marked by placing adequate traffic signs "WORK IN PROGRESS". If obstacles are planned to stay over night, yellow rotating lights and reflecting signboards should be placed. Open trenches shall be properly marked (for example, by yellow PVC tape with inscription "CAUTION, TC CABLE" that will be laid into the trench). For all works planned to be executed on arteries, approvals from relevant authorities shall be obtained.

1.4. Wherever pedestrians have to cross the trench there shall be a crossing made of strong sufficiently wide boards.

1.5. In the course of works, open cable shafts shall be properly enclosed (pegs and tape). Open shafts must be permanently supervised and adequately covered at the end of work day.

1.6. Use only specified, appropriate and proper tools and equipment and accessories for excavation, lying, mounting and finishing. The use of worn out, handy, improper and unsuitable tools, equipment and accessories is not permitted. The equipment and accessories that require periodical checking shall be accompanied with a certificate.

1.7 Two individuals shall be always engaged in execution of works in TC shafts. One of them must always be outside the manhole.

2. Electric shock (lightning discharge) and safety measures

During the excavation of trench, cable laying and joining workers may come into contact with plants, parts of plants and objects under voltage which bear danger to life and health so that adequate protection measures shall apply:

2.1. The apparatuses and instruments shall be either earthed or double insulated (mark)
The supply voltage to electric soldering units and torches shall be 24 V.

2.2. Metallic mass in cables (wires, sheath, armouring) may be on a high potential. During electrical measurements and tests of cables, two types of instruments may be used:

- Instruments earthed via their cords. The sockets on the instruments shall have the puncture strength to mass of 2000 $V\sim_{eff}$.
- Double insulated instruments (mark)

During cable measurements, metallic masses may be touched only if they are found to have the potential below 48 V= to earth.

2.3. Tools and accessories shall be suitable and tested with regard to insulation.

2.4. If there is a risk induced voltage (vicinity of power supply lines or 25 kV/50 Hz electric traction) cable wires at both ends shall be protected and the sheaths and armouring of the cables to be joined shall be conductively bonded before joints are made. The ends of two cables to be joined shall never be handed with bare hands before a conductive bond is made.

2.5. No cable work may be undertaken in stormy weather and during lightning discharges.

2.6. When doing the work close to power supply facilities, heightened alertness will be necessary as well as attendance of an authorized representative of the facility owner.

2.7. At the points where underground power supply cables cross, the regulations that govern such crossings shall be observed (given in the Technical specification and Technical description herein).

2.8. No underground installations (cables, pipelines, gas pipelines etc) that have been encountered may be damaged as any damage may invoke danger besides costs.

3. Fire and explosion and protection measures

Cable laying and finishing are closely associated with danger due to fire and explosion for two reasons:

a. Presence of flammable and explosive gases and liquid in the ground and in shafts due to spills from improper underground installations and above ground containers (tank trucks and other). During earth works there will exist a risk of damaging underground gas and fuel installations which will bear an acute threat from fire and/or explosion.
b. Flammable and explosive matter used in cable treatment technology – sealing compounds, glues, solvents, petrol, propane-butane etc.

The following measures shall be undertaken:

3.1. Prior to descending into a shaft two adjacent shafts shall be opened and the first shaft shall be well ventilated if necessary by forced ventilation and suction. When it is certain that there are no flammable, explosive and poisonous gases (checked with appropriate instruments) work may start.

3.2. As solely petrol filled torches are used in shafts petrol containers shall not be held in it. Torches shall be left to develop their flames outside the shaft.

3.3. Before working with an open flame check if there are spills of fuel and flammable liquid in the shaft.

3.4. Use solely suitable petrol and butane-propane burners. Undertake regular inspection of the cylinders, reduction valves, connections, seals and hoses and repair damages. Replace suspicious elements with new and proper ones. Everything shall be controlled repaired and replaced before taken to the place of work. Repairs shall not be attempted in situ.

3.5. Never leave burners and flame without surveillance. During long period without work, burners shall be put out and valves shut off and in the case of a butane-propane burner then also the valve on the butane-propane cylinder shall be shut off.

3.6. Sealing compound for joints shall be heated solely with petrol or butane propane burner (if needed with several of them). Heating above an open fire of wood or similar is not permitted.

3.7 Only the quantity of materials needed for a job shall be taken into shaft.

4. Chemical danger and protection

Contrary to mechanical danger and electric shocks, fire and explosion that may be eliminated if protection measures are undertaken, chemical danger (and biological) bears somehow an omnipresent impact upon workers' health.

a. Underground poisonous gases in shafts.
b. Vapors of lead and thermoplastics (polyvinyl and polyurethane) and of other coats which occur when cable sheaths are warmed up and joints are mounted and soldered, glues, solvents and thinners, lead dust when sheaths are ground and cleaned, poisonous gases due to combustion of petrol and butane propane and heating compounds.
c. Some persons may have allergic reaction to hardeners (polymerizers) of epoxy resin (SMOLIT joints) or polyurethane (joints in self carrier cables), to various glues, thinners and solvents.

The following protective measures shall be undertaken:

4.1 Workers shall wear protective clothing and shoeware and if necessary gloves and head masks.
4.2. Ventilation (if necessary forced) of shafts.
4.3. Protective gloves when working with lead. Remove oxide with a knife never a file or emery paper.
4.4. Low octane petrol (less tetraethyl lead) and even better unleaded fuel shall be used for torches.
4.5. Sealing compound shall be heated at the spot where smoke will not be dangerous nor ignited and where workers will not be in contact with smoke and vapors.
4.6. The shafts shall be regularly cleaned from waste.
4.7. Strictly observe the instructions and measures specified by the manufacturers of the joints made of two components and inscriptions on packaging of chemical agents.
4.8. Workers handling lead and/or poisonous materials shall drink milk every day.

5. Biological danger and measures of protection

In the working environment (cable shafts, trenches and even open area) there may be microorganisms and other live organisms – insects, rodents, noxious plants, remains of dead animal bodies or decayed organisms which all present health danger.

Workers may be exposed to various unfavorable factors such as bad and unhealthy body position at work, humidity, cold, heat, dust, odours, long exposure to sun rays, strong or insufficient light.

Manholes and trench may be contaminated with waste waters and other dirt.

Tetanus bacilli are omnipresent in soil.

Therefore, the following protection measures shall be undertaken:

5.1 Water shall be pumped out and dirt removed from shaft. Never leave food in shafts, on galleries and at the inlet areas to prevent insects and rodents. Rotten organic matter and decayed animal bodies are venomous.
5.2. Workers shall wear protective clothing and shoe ware suitable to work environment and gloves and head mask.
5.3 If workers are exposed to unfavorable impact such as bad conditions, bad position of body, the work shall be interrupted and working shifts shortened. If natural light is insufficient – in shafts and at night, appropriate white colour light shall be provided good for distinguishing the wire colours.
5.4. There shall be drinking water supply on site. In case of long exposure to sun rays, a shade shall be provided over the work area. In really hot water - over 30°C – work may be eventually done at night.
5.5 Workers shall not drink alcohol or take drugs. Appropriate control shall be undertaken.
5.6 Workers taking medication shall possess doctor's statement that they may proceed with their usual work.
5.7. Health and safety measures and caution shall be undertaken to prevent injuries. Any injuries, sun stroke, heat stroke ad lightning stroke shall be attended according to the first aid instructions while in case of severe injuries, sun stroke, heat stroke and lightning stroke, it will be imperative to send the worker to the doctor's.

7.4. Safety at the work of cable lying and installation on structures close to 25 kV/50 Hz OCS

Pursuant to Article 9, Paragraph 2 «Occupational Health and Safety Act » (Off.Herald SRS No. 42/91) and «Law on amendments to the Occupational Health and Safety Act » (Official Herald RS No. 53/93, 97/93, 48/94)

GENERAL CONDITIONS AND WARNINGS

General conditions and warnings for the works going on close to a railway line electrified with single phase 25 kV/ 50 Hz electric traction system.

- Nominal voltage in the OCS is 25,000 V and maximum 27,500 V/50 Hz (the system is permanently under voltage);
- The height of live parts min 5.020 mm above the high rail level and the insulators are also live;
- When the voltage is switched off in OCS, the return conductor is still dangerous as it is a continuous conductor;
- Voltage shall be shut down and the system earthed solely by the authorized OCS maintenance staff thus making safe any site close to OCS and an electrified track ;
- No works on the structures subjected to these requirements may start before a permit is given by the authorized person from the OCS maintenance division

FORBIDDEN AND DANGEROUS FOR LIFE

- If with body, tools, materials and water jet one gets closer than 2 m to live catenary system danger zone;
- If with body, tools, materials and water jet one touches the return conductor and earthing components;
- If working without protective clothing – boots and gloves;

- If using a conductive tool to bond rails of one of more tracks;
- If touching the OCS masts and return conductor and leaving material against them;
- If using metallic utensils and gear higher than 2.5 m above the high rail level in the zone 8 m left and right from an electrified track without having bonded it to a special earthing rod and/or the OCS return conductor ;
- If setting fire and using water under pressure near electrified tracks as water jets may foul the danger zone;
- If failing to observe the instructions of the Engineer and of the authorized staff from the OCS maintenance division.

The Contractor shall acquaint the workers with dangers from electric traction voltage and current and with measures for personal, collective and traffic safety on the railway lines electrified with single phase 25 kV/50 Hz system.

If scaffolds, pile drivers and other are used in 8 m wide zone left and right from an electrified track and are higher than 2.5 m above the high rail level, they shall be in a galvanic bond, and connected to earth and/or to OCS return conductor as directed by the Engineer and/or the authorized representative of the OCS maintenance division.

ADDITIONAL SAFETY MEASURES

Voltages dangerous to life and health may be induced in the metallic sheath, armature and core of a cable laid along the tracks electrified with a single phase 25 kV/50 Hz system. For this reason when working with these cables workers shall strictly observe the above instructions and safety measures as well as the additional ones listed below:

1. **Instruments and tools**
   - Insulated tools are obligatory;
   - Plug boxes for cable measuring instruments shall have puncture strength to mass of 2,000 V_{eff}; if not they shall be connected to cable pairs via translators having the primary-to mass and primary-to-secondary puncture strength of 2,000 VV_{eff};
   - The instruments to be connected to cable core shall not be earthed via safety socket. Any instrument not earthed shall be held on an insulated base.
   - -- If reference potential has to match the measuring value, an instrument shall be bonded to the earth busbar in the cable cabinet or directly to cable sheath;
   - When measuring coaxial pairs, the instruments shall not be bonded to cable earthing in order to avoid outer tube conductor bond to earth.
2. **Mounting**
   - During working on cables along electrified tracks it is not permitted to use the OCS return conductor as earth unless explicitly permitted in the design.
   - It is not permitted to touch with bare hands the cable core and the cable sheath simultaneously with any some earthed object;
   - The sheath and/or armature shall be bonded to earth with special caution. When two points of different potential are bonded it shall be done with insulation tools, boots and gloves; if sparking may threaten, eyes shall be protected with safety glasses;
   - When making joints it is not permitted to touch with bare hands the cable ends to be joined before a reliable galvanic bond is made to a copper strand of the cross section specified for joint bypassing; joining two cables means joining two points at different potential (see the preceding section);
   - Cable ends shall be prepared (cleaning, stripping the armature and sheath and other) provided the other cable, earth and return conductor are not touched at the same time;
   - When cutting a cable in order to inlay a splice or do something else, the armature and sheath shall be first bonded at either side of the future cutting line.
   - When opening the existing joints, care shall be taken that the bypass bond connecting two cable ends is never interrupted.
3. **Cable installation**
   - The earthing system of a cable plant (and other facilities, too) shall not have a single non-insulated component in a zone, 8 m wide left and right from the centre line of the electrified track; puncture strength of earth components in that zone (earth downleads) shall be 2,000 V_{eff}/50 Hz;
   - The cable sheath and armature and the equipment in galvanic bond with them (cable terminations, end joints etc.) shall be reliably insulated from any metallic mass connected to electric traction return conductor; the cable installation may be earthed to the electric traction return conductor only in the cases and in the way explicitly specified in the Cable plant Detailed.
   - Bypassing cable metallic armature and sheath (Al, Pb and Fe) is obligatory only in the cases and in the way explicitly specified in the Cable Plant Detailed design; thin steel protection tapes (against rodents) and Al foil (against humidity and heat insulation) shall never be bypassed within the splices nor bonded to earthing; at termination points such Fe tapes and/or Al foils shall be carefully isolated from earthed metallic masses in the way shown in the Cable Plant Detailed Design.

8. LANDSCAPING DESIGN OF THE ROAD AREA

The following arterials may be identified within the corridor of the studied highway: the M1 arterial road, Nis-Skoplje railway line and the R214 regional road. Construction of the high speed railway line is also planned. The General design of the railway line was prepared at the end of last century but not revised. The highway will intersect the railway line at km 876+718.80, on different levels.

The "Predejane" interchange is also planned to be constructed within the stated corridor. The interchange will connect the existing motel in Predejane and arteries that connect the R214 road (Nis-Vranje) and R-240 (to Crna Trava) and the future highway.

The Final horticultural landscaping design of the road area shall be in harmony with natural environmental conditions and character of the landscape through which this section runs.

Landscaping solution is shown on the layout plan integrated in the civil engineering design, 1:1000 in scale – graphical attachments 3.1-3.....

8.1. Land use and landscaping characteristics of the area – current situation

Gornje Polje - Caricina Dolina section runs along the right bank of the Juzna Morava River. At km 874+302.00 the section will enter the Grdelicka Gorge after spanning the newly-designed bridge. Since the section will follow the river flow, it will transfer its position from the left to the right river side by numerous bridges. The highway route on this section passes through two types of different topographic characteristics:

Flat – highway route is located on the Juzna Morava river draft;

Hilly – mountainous – with the route located in a cut or deep cut with steep slopes on the left bank of the Juzna Morava

In general, area around the Grdelicka Gorge is supposed to be a very attractive location.

Cultivated areas are fields, meadows, and gardens next to river streams, while mountains may be identified on left (Cemernik Mountain) as well as on right (Kukavica Mountain) side. Slopes are mostly covered with forests and/or pastures. The exception is areas composed of shales and small areas populated with settlements. The entire landscape is intersected with valleys and ravens.

Predejane is the only settlement that may be identified in the Grdelicka Gorge. Due to unfavorable conditions (steep slopes in Grdelicka Gorge, torrent nature of river streams and its tributaries, insufficient arable lands) only small settlements may be identified. These settlements belong to Leskovac and Vranje Municipalities. The cadastral districts through which the future highway will run are as follows: Bojsina, Bocevica, Graovo, Palojce, Licin Dol, Krpejce, Koraćevac, Predejane, Bricevlje, Repiste and Susevlje.

On the wider area of the studied corridor the following forest phytocoenosis may be identified **(**data overtaken from the Environment Impact Assessment Study):

8.2. Quercetum farnetto cerris Rud.

This is climatogene forest native to the Balkans and also the most common forest type in Serbia. These forests consist mainly of shoots; they are low in height and medium in thickness with well separated and rich layers of bushes, and vascular plants, i.e. species of ground flora.

Quercetum farnetto cerris Rud. forest includes the following species:

Quercetum frainetto, Quercus cerris, Tilia argentea, Pyrus piraster, Sorbus domestica, Sorbus torminalis, Fraxinus ornus, Acer campeste, Acer tataricum, Cornnus mas, Crataegus monogyna, Viburnum lantana, Rosa gallica, Lonicera caprifolium, Tamus cormmunis, Lathyrus niger, Danaa cornubiensis, Lychia coronaria, Silene viridiflora, Fanacetum corynbosum, Heleborus odorus, Trifolium alpestre, Campanula persicifolia, Veronica charmaedrus.

In lower parts of their common height area, Quercetum farnetto cerris Rud. forests have mostly been destroyed in order to increase agricultural areas. Larger areas of these phytocenoses can be found mostly in the mountainous parts, but they have been anthopogenetically altered, i.e. degraded. Apart from logging, these forests which are close to peoples settlements suffer other negative influences such as: cutting off branches for the purpose of livestock feeding, sheep pastures, goat graying. In this way, low forests became shrubs dominated by xerophyle bushes and some of the most resistant tree spaces: *Fraxinus ornus, Carpinus orientalis, Acer tataricum, Juniperus cormmunis Crataegus spp., Prunus spinosa, Cornnus mas, Evonymus spp., Ligustrum vulgare, Rhamnus carthartica, Viburnum lantana, Rubus spp.* and other.

2. Beside the typical Quercetum farnetto ceris Rud forests, in the area of the closer and wider perimeter of the E75 highway route, certain associations (i.e. ecological and geographical variant of the already described phytocenosis) i.e. **Carpino orientalis - Quercetum frainetto – cerris** may be identified. These forests are formed by a large number of species of heterogeneous structure, often quite opposite in character, which in the further cause frailty of this phytocenosis, as well as in a tendency towards degradation and its difficult natural and artificial biological reactivation.

In the entire area common for forests of Carpino orientalis-Quercetum frainetto-cerris deforestation, logging and other factors has had a great influence. Thus these forests are degraded by regressive succession into Chrysopogonetum grylly Meadows (which is a typical form of dry, bare meadows of Mediterranean-steppe character).

These forests support the following tree species: *Quercus frainetto, Quercus cerris, Carpinus orientalis, Quercus pubescens,Quercus petraea, Sorbus torminalis, Frahinus ornus, Sorbus domestica, Pirys piraster, Acer campestre, Ulmus campestre, Pyrus armigdaliformis, and other*. Otherwise, the phytocenosis appears on slopes as steep as 23 degrees and on both north and south sides.

The bush level, apart from shoots of the above said trees, the following species have been determined: *Rosa arvensis, Crataegus monogyna, Cornus mas, Lonicera caprifoliurm, Viburnum lantana, Crataegus oxyacanta.*

3. Forest association that could be identified in the area of the future corridor is **Lauroceraso-Fagetum Jov.**

This forest de facto represents specific tertiary relict of *Prunus laurocerasus var. serbica, Laurocerasus officinalis.*

Since the edafic conditions are not suitable for beech trees, these are characterized with reduced vitality and thus young plants are very difficult to find. The broken levels of trees and significant moisture enable survivor and development of this forest that at bush level constitutes facias as a result of vegetative procreation.

4. The next phytocintesis to be identified along the corridor of the E75 highway is **Carpinetum orientalis serbicum Rud.**

As a consequence of orographic dependence on warm expositions of steep slopes and on a series of shallow, skeletal and dry soils the limestone houses communities of Carpinetum orientalis serbicum Rud. These are offshoot forests rich in flora at all three levels; they don't grow high and are not thick. The phytocenosis includes 300-500 species (which is regularly stumped and often devastated on degraded soils). The following species may be identified: *Carpinus orientalis, Fraxinus orunus, Quercus pubescens, Acer hircanum, Acer monspesulanum, Quercus cerris, Sorbus domestica, Pirus amigdaliformis, Sorbus graeca, Cornus mas, Syringa vulgaris, Viburnum lantana, Crataegus monogyna, Evonymus verrucosa, Cotinus coqqygria, Berberis vulgaris, Rhamnus cathartica, Asparagus tenuifolius, Hipericum perforatum, Arabis hirsuta, Viola hirta, Melica ciliata, Festuca vallesiaca, Galium purpureum* and many other xerothermic basophile species.

6. The following forest phytocenosis is also present, along with other phytocenosis, in the wider area of the highway route: **Ass. Fagetum montanum s.lat (Fagetum montanum serbicum Rud.)**

This biocenosis is mostly dependent on the orographic factors, i.e. it appears as a permanent canopy in colder and fresher oak regions. These beech forests on cold slopes of hills and hillocks depend on the relief and not on the regional climate on that altitude.

Phytocenoses of beech forests are exposed to the penetration of the neighboring oak phytocenosis (*Quercus petraeae, Carpinus betulus, Quercus cerris, Sorbus torminalis, Prumus avium, Pirus piraster, Acer camprestre and other*). These species appear along each other as different from the forests in the beech-fir tree area.

Beside beech, as auxiliary and dependent species in a Serbian beech forest, the following species might appear: *Carpinus betulus, Quercus petraeae, Quercus cerris, Sorbus torminalis, Prumus avium, Malus silvestris, Pirus piraster, Acer pseudoplatanus, Acer platanoides, Tilia grandifolia, Corylus colurna.*

Precisely, this phytocenosis is represented by relict community of beech trees and walnut tree - Juglando-Fagetum submontanum (Misić 1966) Jov. 1969.

6.The next phytocenosis (identified mostly along torrential flows on low relief points) is **Populeto salicetum Raj. 1950. s. l. Soo).**

Along all rivers in Serbia, different species of poplar and willow trees may be identified. Sometimes, they are mono-dominant forests.

In addition to different species of poplar and willow trees, the said phytocenosis also includes the following species: *Ulmus effusa, Fraxinus oxycarpa, Viburnum opulus, Crataegus nigra, Crataegus monogyna, Cornus sanguinea, Amorpha fruticosa (subspon.), Sambucus nigra, Rhamnus frangula* and other.

7.On the areas of hydrogravitating meritory watersheds, forests of only **- Quercetum montanum (Jovanović 1948) Cernjavski et Jovanović 1953** can be identified.

These cover large areas in Serbia as oroclimatic stripe in the hilly region at an altitude of 500-900 m. These forests have been registered covering large areas in South-East Serbia.

Certain authors (Horvat, Glavac, Ellenberg, 1974) believe that in the entire South Serbia these forests cover the higher (submontaneous) region of zonal vegetation. The basis in such forests is acid silicate rocks, and the acid brown soil is more or less shallow, skeletal and erosion exposed.

The bush level is often undeveloped in typical forests, but a larger number of species may be identified on the ground due to the tendency of this type of oak to seek the sunlight.

Beside Quercus petraeae, the tree level also includes a smaller number of other tree species: *Quercus cerris, Fraxinus ornus, Tilia argentea, Pyrus pyraster, Carpinus betulus, Acer campestre, Prunus avium,* and other. The bush level is poor in flora and only the following species can be found: *Cornus mas, Crataegus monogyna, Prunus spinosa, Juniperus communis,Corylus avellana* and other. The following species occur on the ground flora level: *Rosa arvensis, Genista ovata, Lathyrus niger, Lathyrus venetus, Campanula persicifolia, Helleborus odorus, Festuca montana, Poa nemoralis, Veronica chamaedrus* and many others.

Since these forests are identified on inclined slopes they are prone to erosion as a result of pedosequence skeleton. Combination of both biotopes and zooantropogene factors, these forests are prone to fast degradation. Since soil erosion has been increasing, the green cover (ground flora) disappears and movable skeleton and ravine erosion identified on the surface. On less inclined areas, underbushes may be identified represented by different species and Pteridium aquilinum formations.

Areas occupied by state-owned forests and soils are stated in the documents (specifications) submitted by the "Srbijasume" PE.

8.3. Landscaping - description

The purpose of the landscaping plan is based on the following:

- Make driving more comfortable
- Providing safety for all highway users
- Traffic concept must be harmonized with the environment.

Landscaping of the highway route shall also be in compliance with functional traffic requirements and landscape characteristics so as both physical and aesthetic criteria could be met.

According to modern landscaping concept for roads of this rank, the solution implies landscaping with natural forms. This means groups of different categories of planting material. In order to preserve the characteristic scenery of the area, deciduous species are used more with different heights, pherophases and colours and coniferous species are foreseen at accentuated points.

If the landscaping has been done incorrectly along the road area, it may significantly affect the traffic safety, as a result of unsuitable distance between vegetation and pavement edge that may obstruct the vision of motorists.

Compliance with traffic safety principle is achieved by adopting the values below, regarding the position of plants in traffic profile:

- Minimum distance of trees taller than 4.5 m is 9 m from shoulder edge on motorway and 4 m from shoulder edge on local road
- Minimum distance of shrub seedlings is 4 m from shoulder edge on motorway and 3 m from shoulder edge on local roads
- Minimum distance of trees is 4 m from channel edge and minimum distance of shrub is 3 m from channel edge.

Vegetation in road profile is shown in graphical attachment – typical cross section, sheet 4.1

- According to the proposed solution, slopes shall be covered with plants that will hold the soil thus preventing erosion process. Slopes on embankment and cuttings shall be covered with underbushes and high embankments shall be covered with higher plants to be harmonized with the environment. In addition to protection against erosion, vegetation on slopes shall also perform optical guidance.
- At the same time, the vegetation will perform anti-erosion protection and have an effect of an air filter for hard particles of dust and soot and some heavy metals between the motorway and arable land. On embankments positioned in curves, underbush planted along the outer curve side shall be also used as protective measure if a vehicle deviates from the road. The underbush plants planned to be used on embankment slopes shall not disturb visibility on the inner curve side.
- Central reserve shall be covered with grass (as stated in the civil engineering design), while on the smaller segment in the vicinity of the tunnel, underbush resistant to exhaust gases shall be planted.
- Protective greenery formed of different plants is foreseen to be developed in the vicinity of settlements. The greenery shall also be used as a barrier that will mitigate negative impacts (gasses, dust, and noise) and will improve the area from the visual aspect. Plant species of different height, color and different habitus will preserve their decorative characteristics all the year around.
- In the area of interchange, groups of different greenery categories will be planted in order to improve traffic functioning and aesthetic experience in the landscape.
- Moreover, between the highway and alternative road as well as between the highway and railroad adequate vegetation is planned to be planted to provide relevant protection against vehicle headlights.
- Vegetation along rivers and brooks shall be preserved as far as possible and on places where regulation works will be required to enable structure stability, the area will be recovered through adequate landscaping measures and thus bring into original state. Due to restricted spatial possibilities, in a close proximity of the Juzna Morava regulation, new vegetation is not planned to be planted so as flow profile in the flood area could be maintained unchanged.

Geomechanicaly unstable slopes marked as K1-K..... have been rehabilitated through the application of different technical protection measures stated in the road alignment design.

Topsoiling in a 20 cm layer and sewing of grass in central reserve and on cutting and embankment slopes is foreseen in the civil engineering design. The remaining green areas extending to the limit of the land strip will grow spontaneously, and form natural lawn.

The massifs of shrub, medium-high and high vegetation are foreseen, in principle, as far as motorway fence, and out of that zone where appropriate. The belt from the motorway fence to the land strip limit will be left unoccupied for maintenance purposes.

Detailed plan specification is attached to this technical description. Selection of autochthonous plant species will enable natural and attractive visual effect. Conditions required for plan growth are more favorable and small investments will be required for maintenance of the stated plant species.

Since the design documentation does not include synchronized layout plan for the landscaping purposes, the Contractor must be familiar with the existing and completed installations in the highway right-of-way. In the course of planting, minimum distances between the high trees and certain installations must be satisfied, as stated below:

- From the water supply pipe line – 1.5 m
- From the sewage system- 2.5-3 m
- From electrical installations - 1. 5 m
- From public lighting masts – 1.5 m
- From telephone installations -
- From gas pipeline 2-2.5 m
- From hot water pipeline - 2-2.5 m

SCOPE OF WORKS

on the E 75 Grabovnica – Levosoje highway, Predejane - Caricina Dolina section, LOT 2

1.0. GENERAL DATA

1.1. SUBJECT OF THE PROJECT

The E 75 highway is a section of the European Highway Network that runs through the both Serbia and Montenegro from the Hungarian border (Horgos) via Novi Sad, Belgrade and Nis to the state border with the FYR of Macedonia (Presevo) and further on to Skopje and Athens. In Belgrade, the E 75 highway is connected to both the E 70 highway (from Croatian to the Romanian border) and the E763 highway running to Podgorica, while feeding roads in Nis enable the E75 highway to be connected to E80 highway toward Sophia.

The section of the studied highway running through Serbia is under different phases of construction. At the time of preparing this report, traffic operations from the state border with Hungary to Novi Sad are enabled on single carriageway that will be integrated into the future highway. The other carriageway is under construction fully in accordance with the plan and should be completed to the end of 2010. The highway has been completed from Beska (bridge over the Danube River) to Batajnica, while the bridge over the Danube River is under construction.

From Belgrade to Nis, the highway has been built in full profile during the 1980s and 1990s. On the already constructed section, from Belgrade to Nis, the existing pavement has been improved through rehabilitation works performed on either carriageway. The highway section from Leskovac to Grabovnica has been completed in 2006 and put into operation afterwards.

The subject of the Final design herein is Predejane - Caricina Dolina section, which is considered to be the final phase in construction of the E 75 highway considering its segment passing through Serbia, from Leskovac (Grabovnica) to the border with FYR Macedonia (Cukarka village). The Preliminary design has been prepared for this section and approved by the Revision Commission for expert verification of technical documentation at the meeting hold on January 28, 2009, fully in accordance with the decision No. 350-01-00792/2003-03 dated February 17, 2009. Preparation of the Preliminary design was entrusted to the Institute of Transportation CIP, Belgrade. The Preliminary design was developed fully in accordance with the Enactment on Town Planning referring to construction of E-75, Nis – Macedonian border highway, Grabovnica – Levosoje section, No. 350-01-01416/2007-10 dated August 17, 2008 issued by the Ministry of Environmental Protection and Spatial Planning. Pursuant to the Preliminary design, the Ministry of Environmental Protection and Spatial Planning has issued the Decision on Building Approval, No. 351-03-01149/2/2009-07 dated April 6, 2010.

1.2 OVERVIEW OF CONCLUSIONS MADE THROUGH EXPERT VERIFICATION OF THE PRELIMINARY DESIGN, GENERAL MEASURES AND SUGGESTIONS GIVEN BY THE REVISION COMMISSION TO BE APPLIED BY THE INVESTOR THROUGH THE DEVELOPMENT OF THE FINAL DESIGN

Terms of Reference for the purpose of Final design preparation requires design speed to be defined fully in accordance with provisions stated in the Law on Public Roads so as other elements integrating the highway can be properly sized. Widening of the typical cross section, from 10.70 m to 11.50 m per direction is proposed to be reconsidered in the ToR.

It should also be necessary to reconsider conceptual solution referring to toll payment system. Since state-of-the-art technologies enable more rational and effective solutions for toll payment, additional activities should be performed and design requirements defined adequately through the development of ToR for the purpose of Final design preparation.

Introduction of ITS along the whole highway section should be considered. However, this system should be harmonized with other models installed within the entire Serbian Highway Network.

1.3. RESULTS OF TRAFFIC, SURVEYING, HYDROLOGICAL AND GEOTECHNICAL INVESTIGATIONS

Technical characteristics of Grdelica (Gornje Polje) - Caricina Dolina section are shown in the Table below:

Technical characteristics of Grabovnica - Vladicin Han section

Technical characteristics	
Section length (km)	12,000
Number of traffic lanes	2
Traffic lane width (m)	3.50
Distance from side obstacles (m)	1.0
Gradient (%)	1.7
Minimum horizontal curve radius (m)	250
Average curvature (^{o}/1000m)	0.77
Sight for safe overtaking (%)	30
Height above sea level (m)	290
Section type	Suburban

The studied section as well as the entire M1 road was constructed more than 40 years ago. During that time, this road with single carriageway and two traffic lanes was officially named ''highway'' and was provided with the following cross section elements: carriageway (7.5 m wide); shoulder (0.90 m wide); verge (0.35 m wide); formation (10.00 m wide). According to modern criteria, M1 is suppose to be the road for motor vehicle operations since there is no separate carriageway with two traffic lanes minimum.

The original pavement structure was covered by asphalt-concrete/cement-concrete layer. In a meantime, the pavement structure was improved by placing the new asphalt-concrete layer over the entire length.

During the next period, forecast of traffic flows within the Serbian Road Network will include considerations referring to relation between economic indicator growth and growth of traffic flows within the network. Once the solid basis has been defined, it will be possible to make real forecasts of traffic flow based on plans referring to sustainable economic growth in the Republic of Serbia.

The forecast traffic load during the operation period (2002-2021) on the existing M1 road (E75) has been obtained as an average forecast traffic flow as shown in the Table below.

T.7.6: Forecast traffic load on the existing road

Year	Vehicle type				
	PC	BUS	FV	TT	**AADT** (vehicle/day)
2002.	3033	219	1597	564	**5413**
2005.	3928	283	2068	730	**7010**
2010.	5782	417	3044	1075	**10317**
2015.	8504	613	4476	1581	**15174**
2021.	11560	833	6086	2150	**20629**

Note: PC (passenger car), FV (freight vehicle), TT (truck trailer).

TRAFFIC FORECAST ON THE NEWLY-DESIGNED E 75 HIGHWAY AND ALTERNATIVE ROAD

Traffic forecast for the newly-designed E 75 highway, Gornje Polje - Caricina Dolina section, is shown in the Table T.8.1, while traffic load for the alternative variant is shown in the Table T.8.2.

The forecast traffic load on M1 arterial road is based on solution that will require "splitting the traffic" to the future highway and alternative roads network in relation 85% to 15%.

T.8.1: Forecast of traffic load on the planned highway

Table 01

Traffic section	Year	Vehicle type						
		PC	BUS	FV	TT	AADT (vehicle/day)		
						sum	national	internat.
Vlasotince interchange - Predejane interchange	2002	3550	44	678	708	**4980**	4332	648
	2005	4226	48	772	855	**5901**	5075	826
	2010	5268	55	923	1056	**7302**	6207	1095
	2015	6348	64	1091	1254	**8757**	7268	1489
	2021	7940	76	1332	1541	**10889**	8820	2069
Predejane interchange - Vladicin Han interchange	2002	3501	50	665	685	**4901**	4264	637
	2005	4170	54	756	827	**5807**	4994	813
	2010	5196	63	904	1021	**7184**	6106	1078
	2015	6261	73	1069	1213	**8616**	7151	1465
	2021	7832	86	1306	1491	**10715**	8679	2036
Vladicin Han interchange - Vranje interchange	2002	3313	48	586	630	**4577**	3982	595
	2005	3914	52	667	761	**5394**	4639	755
	2010	4916	61	797	939	**6713**	5706	1007
	2015	5924	70	943	1115	**8052**	6683	1369
	2021	7410	82	1151	1371	**10014**	8111	1903
Vranje interchange - Bujanovac interchange	2002	3171	38	449	585	**4243**	3691	552
	2005	3776	41	512	707	**5036**	4331	705
	2010	4705	49	613	872	**6239**	5303	936
	2015	5670	55	724	1036	**7485**	6213	1272
	2021	7092	65	883	1274	**9314**	7544	1770

T.8.2: Forecast of the traffic loading on alternative road

Year	Vehicle type				
	PC	BUS	FV	TT	**AADT** (vehicle/day)
2002	455	33	240	85	812
2005	589	42	310	110	1051
2010	867	63	457	161	1548
2015	1275	92	671	237	2276
2021	1734	125	913	322	3094

1.3.2. SURVEY INVESTIGATIONS

The area covered by surveying has been marked on the map, 1:1000 in scale. The survey works have covered the area by entire width and length for the purpose of Final design preparation, including all relevant enlargements so as the alternative road could be designed and the existing Nis-Skopje railway line relocated, if necessary.

Geodetic plans (layouts) required for preparation of the Final design for the studied highway have been developed by the Institute of Transportation CIP, Belgrade.

1.3.3. HYDROLOGICAL INVESTIGATIONS

1.3.3.1. Hydrological considerations and drainage concept

The subject of the design herein, which is considered to be an integral part of the design for the E 75 highway alignment, is storm water drainage.

Regulation works of the roadside water streams are incorporated into the separate design (Book 6).

Corridor of this highway section is mostly stretching along the right valley of the Juzna Morava River. The most important tributaries gravitating toward Juzna Morava are as follows: Predajanska River, Palojska River, Licindolska River, Bakarni brook and Caricina Dolina. Considering natural conditions, the following have been identified as the most unfavorable ones: watershed erosion (category 1 and 2) and torrents (category 1 and 2).

The standard drainage system will apply. The highway runoff will be intercepted in concrete gutters and channeled into the relevant recipient through drain trenches. The highway alignment will intersect smaller water streams and dry ravines. These water streams are tributaries of both Juzna Morava and Moravica Rivers. On sections not covered by the drainage system, the highway runoff will be taken to the watershed area gravitating toward Juzna Morava River.

On this highway section as well as on the entire length from Leskovac to the national border with FYR of Macedonia, treatment of surface water runoff prior to releasing into natural streams and brooks will not be performed. Water will be directly released into rivers and streams along the highway through the relevant drainage system.

There are two systems of protection against accumulation of storm water on the highway surface:

- Drainage system that in addition to gutters and trenches also includes sewage system provided with inspection manholes and outlets into embankment slope or roadside ditches/water streams and culverts. Stormwater sewage system will be installed in the embankment so as water cannot be spilled over (small embankment height, populated area). Due to small outflow profile of the gutter, runoff from the pavement will be discharged and taken away from the highway.
- On the segment where trenches are planned to be designed below the embankment, water runoff will be taken either by pipes passing along the central lane and released laterally or will be discharged in curbs and conveyed by special gutters alongside the embankment slope. On such sections, water will be taken along the embankment slope to trenches through the use of concrete flumes.

Drainage of capillary water is not planned due to several reasons. The entire highway alignment is positioned on the embankment and there are no possibilities for capillary water accumulation. Embankments will be constructed of high quality materials excavated on the studied area or taken from the relevant borrow pit (sandy-gravel material from Morava River). Since the top subgrade layer will be composed of crushed shales, capillary water will not be expected.

Structures, bridges, viaducts and culverts except concrete pipes not exceeding 1.6 m in diameter, are separately analyzed in the volume named ’’Structures’’. Pipe culverts positioned on water streams have been incorporated into the regulation works stated in the volume named ’’Hydroengineering structures’’. However, the design herein only includes concrete pipe culverts varying from 1.0 m to 1.6 m in diameter required for proper highway drainage. Concrete culverts having 1.6 m in diameter are easy for maintenance. On the segment of the alignment where the existing carriageway (M1 road) is in use, the already constructed culverts will be retained. These culverts mostly have opening of 1.0 m and some of them are provided with manholes placed on green areas to enable easy maintenance.

1.3.3.2. Hydraulic computation of drainage features

The hydraulic computation includes input parameters required for both hydrological and hydraulic analyses for storm water sewage and other related drainage features.

Roadside ditches

Main watersheds (analyzed in the design referring to water stream control (Volume 3.1) and subwatersheds with littoral waters gravitating toward the studied highway are marked on the general map, 1:25000 in scale. The biggest watershed (watershed 10) occupies 20 ha in area. Time of runoff concentration in the stated areas varies from 10 to 25 minutes. Hydraulic computation also includes hydraulic characteristics of roadside channels that will be constructed in accordance with all relevant criteria.

Sewage pipes

Hydraulic computation is obtained by applying the Rational Method (see Tabular attachments).

Input parameters for the purpose of estimation are as follows:

- Relevant rainfalls adopted for ’’Grdelica’’ rainfall gauging station
- Adopted recurrence interval of T = 10 years
- Rainfall duration as a function of concentration time for relevant roadside watershed areas with the time of concentration t_0 = 5 min
- Coefficient of runoff from the asphalt surfaces $\psi_a = 0.9$
- Coefficients of runoff from green areas $\psi_z = 0.1 - 0.2$

1.3.3.3. Design considerations

Drainage of both surface and riparian waters is suppose to be one of the most important tasks to be fulfilled in the course of road designing from the aspect of both structure stability and safe driving. For the studied section, relevant analyses have been performed and adequate drainage solutions proposed. The graphical part of documentation includes drainage plans together with drainage features.

For the purpose of drainage of both surface and riparian waters the following concept has been considered:

Median drainage is planned to be installed across the median area along the entire highway provided with uniform crossfalls. The drainage system will also cover the right side of the highway due to morphological ground properties.

On the segment of the roadway where installation of longitudinal drainage system is not possible to be performed, side inlets will be placed after each manhole.

Storm water runoff from the pavement provided with uniform crossfall will be collected in standard concrete gutter placed along the pavement edge;

Recipient structures are considered to be manholes provided with pipe gully grating (due to lack of space for placing of separate drainage system and pipe gully joints). They will be spaced at 40 to 50 m apart (at critical segments where the gutter is inclined at 0.3% maximum, manholes (gutters) will be spaced at 20 m apart) and further convey of water will be enabled through storm water sewage to the roadside channel.

Manholes are consisting of prefabricated conical top and pipe having 1.0 m in diameter cast in situ by concrete, class MB30. The conical top is of standard shape with standard grating and the pipe is of changeable length provided with 0.5 m deep separator.

Storm water sewage is consisting of HDPE pipes having 300-400 mm in diameter laid in trenches varying 0.90 - 1.10 m in width on minimum 0.10 m thick sandy-gravel layer.

The both layout and longitudinal profile show manholes marked as follows:

1. Manholes for acceptance of both storm and drainage waters are marked as "Kd"
2. Manholes for acceptance of only drained water are marked as "D"

Drainage system in the median area is not planned to be installed in a case of camber.

On sections having medians provided with segmented gutter characterized with twice as much capacity comparing to the standard gutter of triangular section, storm water will be collected in manholes provided with pipe gully grating. Drainage pipes are planned to be installed above the sewage pipes.

Roadside ditches of semi-round shape characterized with minimum depth of 30 cm that will collect water runoff from the pavement and embankment slopes are planned to be constructed along embankment and cut sections.

Certain single-sided sections will be provided with pipe storm water sewage system due to urban or spatial restrictions in a case that water cannot be released on the lower slope side.

Releasing of storm water into recipient will be enabled by manhole located at the most downstream position. Water shall enter the relevant structure (bridge, slab top or pipe culvert) or **"lateral outlets"** and released into natural depressions or roadside ditches, if conditions allow. The so-called "lateral outlets" are pipes that accept water from the storm water sewage and convey it to the roadside ditches through the substructure. In a case of significant change of level, drop manhole will be installed so as relevant requirements can be met.

Lateral outlets are HDPE pipes of adequate diameter (200 mm -400 mm) laid onto the 10 cm thick layer made of concrete, class MB 20 at the minimum depth of 1.20 m measured from the pavement surface. The stated parameters are in compliance with the allowable peak pressure of pipes and pavement dynamic load.

Embankment slope ends will be provided with prefabricated concrete flumes that will accept water from outlets and convey it to the roadside ditch or adjoining areas. At the inlet point, the drain trench will be lined with concrete, 2 m long, to prevent erosion as a result of water action. Water from drain trenches will be further conveyed into relevant structures (pipe and top slab culverts), brooks or natural depressed sections (road alignment design -Book 1).

Drainage system is mostly consisting of perforated PVC pipes laid onto the lean concrete layer. The drain trench filling is composed of aggregate, as designed.

Graphical presentation of storm water sewage features in this design is also stated in the road alignment design (Book 1), drainage chart.

Graphical part also includes standard profiles and typical drainage details.

Outlet points including outlet pipe shortcuts are shown in the Table below:

Watershed	**Mark**	**Position**	**Starting point**	**End / Recipient**	**DN**	**Length**
			Km	*Km*	*mm*	*m*
14	**D14'**	Left				
		Central	881,194.50	881,454.65	400	260.2
		Right				
	D14''	Left				
		Central	881,594.50	881,454.65	400	139.8
		Right				
	ISP 14-1	Left	881,454.65	Slope	400	16.1
15	**D15'**	Left				
		Central	881,817.80	882,096.90	400	279.1
		Right				
	D15''	Left				
		Central	882,216.60	882,096.90	300	119.7
		Right				
	ISP 15-1	Right	882,096.90	Slope	400	15.0
16	**D16'**	Left				
		Central	882,700.00	882,750.00	300	50.0
		Right				
	D16''	Left				
		Central	882,840.50	882,750.00	300	90.5
		Right				
	ISP 16-1	Left	882,750.00	Slope	300	15.3
17	**D17**	Left				
		Central	883,380.00	883,539.60	300	159.6
		Right				
	ISP 17-1	Right	883,539.60	Slope	300	20.0
18	**D18**	Left				
		Central	883,650.00	883,581.50	300	68.5
		Right				
	ISP 18-1	Right	883,581.50	Brook	300	8.3
19	**D19**	Left				
		Central	884,782.40	884,582.00	400	200.4
		Right				
	ISP 19-1	Right	884,582.00	Slope	400	16.3
20	**D20**	Left				
		Central	885,320.10	885,200.00	300	120.1
		Right				
	ISP 20-1	Right	885,200.00	Slope	300	16.5
21	**D21**	Left				
		Central	885,309.95	885,442.31	300	132
		Right				
	ISP 21-1	Right	885,442.31	Caricina dolina	300	12.8
22	**D22**	Left				
		Central	885,500.00	885,444.25	300	56
		Right				
	ISP 22-1	Right	885,444.25	Caricina dolina	300	15.7

1.3.3.4. Works execution methodology, bill of quantities and cost estimate

Since the alignment of the studied highway is positioned in the embankment along the entire studied section, drainage and sewage systems will be carried out successively together with construction of bottom layers on the road embankment.

In the course of embankment compaction, minimum works on filled material will be required so as adequate thickness required for pipe lying can be obtained regardless of drainage/storm water sewage.

Material around the trench and formwork for drainage filling will be compacted by hand in 25 cm-30 cm thick layers.

Together with placing of material below the highway formation sewage and drainage manholes will be installed. Material in the manhole areas will be also compacted by hand.

In accordance with everything mentioned above, quantities of earth works will refer to fillings in the area of pipes, sewage and drainage trenches.

1.3.3.5. Protection and displacement of water supply system

1.3.3.5.1.Current situation and design considerations

Since the studied section of E 75 highway is passing through the territory of ’’Grdelica’’ public utility company, conditions issued by this company has been obtained for the purpose of preparation of the design herein.

Concerning water supply installations, one collision with the designed alignment at the beginning of the section has been identified. Technical requirements and proposition referring to displacement of the existing PEHD F90 water supply system have been obtained. Through the contacts with representatives of the said company, it was concluded that the technical documentation for the water supply system herein is not available and that its position has been marked approximately.

In accordance with the stated requirements, the design herein will include displacement as well as applying of adequate protection measures.

For the purpose of design preparation, relevant solution plans referring to alignment, reference level and cross sections have been obtained.

1.3.3.5.2.Description of technical solution

Analysis of the available technical documentation and conditions issued by the relevant public companies in Pirot and Dimitrovgrad has shown two collisions with the alignment of the future highway identified at following km points:

- At km 53+985 (displaced water supply installations intersect the highway at km 54+010.74) Water supply piping system is consisting of AC pipes, 100 in dia., (Ciflik Settlement).
- At km 59+558 (displaced water supply installations intersect the highway at km 59+549.19) Water supply piping system is consisting of AC pipes, 100 in dia., (Crnokliste Settlement).

Distribution pipe will have 90 in dia, as designed.

The purpose of the said system is to supply the users on the left side of the future highway. Pipe route is parallel to the highway alignment.

The water supply system, 405 m long, is provided with two outlets (394 m spaced apart).

1.3.3.5.3. Reference levels of the water supply system

Reference levels of the displaced water supply system have been defined so as gradients of the existing pipes can be maintained and placing of new outlets or air valves escaped. Gradient has been defined according to ground levels.

1.3.3.5.4.Pipe material

Regardless of materials used for the existing water supply pipes, all displaced pipelines will be made of PEHD material capable to support pressure of 10 bar. Pipes will be provided with adequate nominal diameters.

Pipes shall be backfilled with excavated material.

1.3.3.5.5.Water supply system and related facilities

Outfall manholes are planned to be installed at km 0+060 and km 0+394.11. The designed manholes of adequate volume will have 1.2 x 1.3 m and 1.4 x 1.4 m in size.

Pipeline turnouts and reinforcing bars in manholes will be secured by anchor blocks embedded in concrete base.

The pipeline shall be displaced in the course of preliminary works so as damages during the execution of works can be escaped, if any. Prior to commencement of works, test grooving shall be performed so as position of the pipeline could be precisely defined and connection between new and the existing water supply systems enabled once the route of the new pipeline has been defined.

1.3.3.6. Water flows control

The subject of the Final design herein is control of water flows in the area of the future highway section passing through Grdelicka Gorge. The chainage of the studied section is taken from the already approved General design. Kilometrage to be used in this design are those taken from the road alignment design.

In the course of design preparation, Study on climatic, hydrologic and hydrographic parameters (Institute for Spatial and Urban Planning - Nis - 1993) incorporated into the General design was studied as a baseline document for defining the input parameters required for hydrologic analysis.

For sizing the structures positioned at points where a water stream intersects the highway alignment (culverts and bridge opening) as well as for the purpose of analysis addressing to the potential threat the permanent/temporary water streams might have to the studied highway, the 100-year frequency storm event has been adopted. Storm events with the return period of 1000 years have also been considered.

Location and sizes of structures planned for intake and evacuation of permanent and temporary water streams alongside the highway at the section planned for reconstruction and extension have been retained, as designed, although on certain sections control works must be performed so as the structure could be aligned with the existing riverbed.

Hydrologic analysis has been performed for all locations planned for intersection of both regulated and unregulated water streams so as data on high waters and hydraulic calculation required for testing of function and capacities of the existing and newly-designed structures can be obtained.

In addition to design criteria and analysis specified in the design, the competent water management companies and the Republic Hydrometeorologic Service have been also asked for their opinion and their requirements were taken into account in the course of design preparation.

The alignment of the E 75 highway in Grdelicka Gorge runs through morphologically unsuitable areas. The first segment is stretching along the right bank of Juzna Morava River and the second one that passes along the left bank of Juzna Morava River is in collision with numerous torrents.

This section of the studied highway starts at km 873+719.94. Its first segment runs along the valley of Juzna Morava River (right bank). The highway alignment crosses from one river bank to another and vice versa through seven bridges.
Water streams on both left and right banks are torrent in nature. At the points of intersection with the alignment of the newly-designed highway (valley variant), 3 and 4 m wide box culverts and pipe culverts having 1600 mm and 2000 mm in diameter have been planned.

The subject of the hydrotechnical segment of the design is stated below:

- Regulation of the Juzna Morava river bed,
- Regulations of tributary beds,
- Securing the Juzna Morava river bed in the bridge areas (upstream and downstream)
- Testing of hydraulic permeability of cross structures on the highway.

1.3.3.6.1. Basic documents for design preparation

Among all available documents, the design engineer has used data integrated into the previously prepared design documentation for the area concerned (preliminary designs from earlier period), geodetic maps, geological basic data as well as opinion of the Republic Hydrometeorological Service of Serbia and ’’VP Morava Nis’’ Water Management Company. Sensitive spots on the designed alignment have also been identified during site visits.

1.3.3.6.2. Design considerations

Through design considerations referring to high water events, adequate solution must be find so as transient flowing regimes could be escaped. At the beginning as well as at the end of every regulated section of the Juzna Morava River, adequate retaining structures are planned to be constructed.

The Juzna Morava River frequently collides with the alignment of the studied highway and planned intersections are enabled at unfavorable angles. Crossfalls of natural river bed vary from 0.22% to 0.35% and the river itself is characterized with rapid streams as a result of high water in the gorge area.

Characteristics of the regulated bed of Juzna Morava River are listed below:

- Bottom width of 25 m
- Slopes (banks) inclined at 1:1.5
- Height of 4.5 m after the bed was being provided with adequate support.

The highway alignment is in collision with the Juzna Morava River at six locations planned for execution of regulation works.

Beds of tributaries are planned to be made of concrete. Regulation works in the Juzna Morava riverbed will require using of stone embedded in cement mortar.

Small structures alongside the highway are pipe and slab top culverts.

Mean profile speed for relevant high water is shown below:

Mean profile speed [m^3/s]	Elevation of the structure bottom edge [m]
0.5	0.60
1.0	0.65
1.5	0.75
2.0	0.80
2.5	0.90
3.0	1.10
3.5	1.25
4.0	1.40
>4.0	1.50

This was performed due to ease maintenance and cleaning since torrents are temporary in nature and characterized with significant deposits.

The design herein also includes alternative highway route (regional highway) not included in toll payment system for the purpose of local traffic operations.

At the point of intersection with tributaries, the newly-designed alignment of the regional road will be provided with adequate structures of similar sections as those positioned along the highway.

Torrents will be provided with inflow structures and ramps to overcome the significant differences of levels and calming of the adjoining soil. On points where overcoming of significant grade-separation between water streams and the highway would require expensive regulation works, previously stilled side water streams will be taken to the drain channels. Side channels will be placed at the top of retaining walls parallel to the highway alignment provided with similar longitudinal grades (retaining walls are discussed in the separate book).

Water streams affected with regulation works are listed below:

No	CHAINAGE	WATER STREAM NAME	REGULATION LENGTH	STRUCTURE
10	881+002.79	Juzna Morava River	181.38	-
11	881+763.53	Juzna Morava River	567.27	-
12	885+445.07	Caricina dolina Brook	72.11	-

List of water streams intersecting the studied highway not planned to be affected with regulation works is given in the text below.

No	**Structure**	**Water stream name**	**Chainage**
6	Pipe	Brezovacka Valley	882+759.295
7	Bridge	Bunavejska Valley	883+576.299
8	Pipe	Bratez Brook	883+884.458
9	Pipe	Vaulted culvert	883+955.556
10	Culvert 3x2	Karina Baraka	884+067.303
11	Pipe	Planiste Brook	884+240.282
12	Pipe	Nameless stream	884+363.301
13	Pipe	Vaulted culvert	884+496.097
14	Culvert 3x2	Slivacka Valley	884+815.865
15	Pipe	Popova Valley	884+983.191

1.3.3.6.3. Hydraulic calculation

Hydraulic calculation for the Juzna Morava River has been performed so as water table line and gravitation flow could be defined in the area of regulated sections. Water table lines have be calculated for two flows stated below:

- 100-year frequency storm event $Q_{1\%}$ and
- 1000-year frequency storm event $Q_{0.1\%}$.

Level lines for both flows and capacity of the newly-designed and existing bridges are attached to this section (graphs and tables included).

For lateral water streams planned to be affected with regulation works, testing of capacity of the newly-designed openings has been performed through the application of FLOW MASTER Program for the 100-year frequency storm event $Q_{1\%}$.

Pipe culverts having the minimum diameter of 2000 mm will be used fully in accordance with the mean profile speed for the relevant storm event computed according to the Table below:

Mean profile speed [m^3/s]	Elevation of the structure bottom edge [m]
0.5	0.60
1.0	0.65
1.5	0.75
2.0	0.80
2.5	0.90
3.0	1.10
3.5	1.25
4.0	1.40
>4.0	1.50

1.3.4. ENGINEERING – GEOLOGICAL INVESTIGATIONS

1.3.4.1. INTRODUCTION

In 1999 and 2002, Department of Geotechnical Engineering, Institute of Transportation CIP, Belgrade has performed field investigations and related tests fully in accordance with the relevant schedule of works for the purpose of preparation of Preliminary design for the E 75 highway, Gornje Polje - Caricina Dolina section, from km 873+714.86 to km 885+726.74. Reports on geotechnical soil investigations for the purpose of the Preliminary design were prepared in 2000, 2003 and 2007. The Preliminary design for the E 75 highway, Gornje Polje - Caricina Dolina section was adopted in 2007 after expert verification of technical documentation has been performed.

Pursuant to the Contract concluded with the ’’Roads of Serbia’’ PE, the Institute of Transportation CIP has undertaken the obligation to design and perform all relevant surveys, investigations and tests for Gornje Polje - Caricina Dolina section (E 75 highway) for the Final design preparation fully in accordance with the alignment position developed through the Preliminary design. The Department of Geotechnical Engineering has performed field investigations in the period November-February (2009/2010) according to the both schedule of works and the offer.

In the phase of investigations performed for the purpose of Preliminary design, all engineering, geological and geotechnical conditions that may affect the construction of the future highway have been completely analyzed. Otherwise, geotechnical conditions for the purpose of construction of related structures and tunnels have been partly studied. According to the defined schedule, geotechnical soil investigations for the Final design level have been mostly performed on locations planned for construction of future structures and partially alongside the studied highway on locations where engineering structures are planned to be constructed, Juzna Morava riverbed and locations reserved for revetments and tunnel structures.

Geological and geotechnical documentation required for the Final design preparation includes results of investigations and tests performed for the purpose of Preliminary design as well as results of performed additional field investigations and tests.

Results of additional geotechnical investigations and tests performed for the purpose of development of the Final design for the E 75 highway, Gornje Polje - Caricina Dolina section, are stated in the Book 2: "Report on geological and geotechnical investigations, tests and analyses". The book is consisting of the following Volumes:

Volume 1: "Report on geotechnical soil investigations for the highway alignment" (textual and graphical parts),

Volume 2: "Report on geotechnical investigations for structures" (textual and graphical parts and geostatic calculations),

Volume 3: "Report on geotechnical investigations for the tunnel" (textual and graphical parts),

Volume 4: "Report on soil investigations for engineering structures on the studied highway" (textual and graphical parts),

Volume 5: "Geotechnical field investigations for alignment, structures, tunnel and engineering structures on the studied highway" (documentation).

’’Design of aquifers and stockpiling area’’ has been integrated into the separate Book that contains information about all borrow pits for materials including locations planned for permanent stockpiling of surplus material.

1.3.4.2. RESULTS OF PREVIOUSLY PERFORMED ENGINEERING, GEOLOGICAL AND GEOTECHNICAL ANALYSES

Basic analyses and data on geological composition, stratigraphic relationships, engineering, geological, hydrogeological and seismic properties of the ground as well as basic engineering, geological and geotecnical conditions required for design considerations of the E 75 highway have been stated in the ’’Study on engineering, geological and geotechnical conditions in the corridor for all highway variant solutions’’ as an integrating part of the General design prepared by the Highway Institute – Belgrade, 1991 (B. Jelisavac).

Considering content and extent as well as accuracy and level of site investigations, results of the stated Study have been used for optimization of both type and scope of investigations and tests required for the Preliminary design, fully in accordance with problems identified on the ground-structure relation.

In the course of preparation of Preliminary design for the studied highway, Gornje Polje-Caricina Dolina section, certain investigations have been performed. Investigations have included as follows:

- Lithological composition, structural-textural properties and spatial position of separated lithological members in the area of the designed highway,

- Watering and hydrogeological soil properties,
- Identification and classification, resistance and deformable properties of soil,
- Occurrences and possible occurrences of recent geodynamic processes and
- Geophysical, seismic and electric soil properties.

For the purpose of preparation of the report for the level of Final design, basic data stated in the Preliminary design for the E 75 highway, Predejene - Caricina Dolina section, from km 880+950 to km 885+726.74 (Lot 2) have been used. Phase V: Adopted variant, Book 4.1. "Engineering, geological and geotecnical conditions for establishing the highway alignment'. Field works have been performed in the period September-November, 1999 and September-November, 2002.

The following documents have been used:

- Engineering and geological maps,
- Boreholes (75 boreholes were drilled along the corridor of the adopted alignment),
- Test pits (11 test pits were excavated along the corridor of the adopted alignment),
- Laboratory and geomechanical testing of soil samples,
- Geophysical investigations and
- Geodetic survey.

Geotechnical categorization and soil classification have been performed fully in accordance with soil properties.

1.3.4.3. OVERVIEW OF THE PERFORMED ENGINEERING, GEOLOGICAL AND GEOTECHNICAL TESTS AND SOIL INVESTIGATIONS

Department of Geotechnical Engineering, Institute of Transportation CIP, has performed all field investigations and tests required fully in accordance with the applicable legislation.

Method applied in defining the alignment is stated in the Preliminary design. Design work and construction of the studied highway will require additional investigation works to be performed and related tests to be carried out.

1.3.4.3.1. FIELD INVESTIGATIONS AND TESTING

Field investigation works for the level of Final design have been performed fully in accordance with the defined schedule in the period November-February 2009/2010 in areas planned for construction of structures, engineering structures, revetments, displacement of riverbed and tunnel.

1.3.4.3.1.1. Detailed engineering-geological mapping

Detailed engineering-geological ground mapping has been performed in the course of Preliminary design preparation. The mapping has included 12 km long zone of changeable width. The studied zone occupies 7 km^2 in area, approximately.

According to engineering-geological mapping, surface boundaries between different lithological media have been defined, hydrological occurrences identified and spatial boundaries of present geodynamic process defined (alluvium, diluvium, proluvial and terrace sediments). Rock exposures have been measured through spatial orientation of structural members while degree of rock mass failure (RQD) has been performed in the area of portals and tunnel tubes. Mapping results have been modified and harmonized with data obtained during exploratory boring and therefore represent synthesis of all results obtained in previous investigations.

Engineering-geological ground mapping has been performed in the course of investigations required for the Final design level. Small modifications referring to positions of geological boundaries have been carried out according to the precisely performed surveying and data obtained from the additional exploratory boring.

In accordance with the results obtained through additional investigation works for the level of Final design, certain modifications of position of Quaternary lithological complexes and modification of results obtained through preliminary engineering-geological mapping have been obtained.

1.3.4.3.1.2. Exploratory boring and detailed engineering-geological core mapping

Exploratory boring for the level of Preliminary design has covered the area of both right and left banks of J. Morava River as well as segment of the terrain on the right bank in the area close to the river itself (at points where the alignment spans the one bank and goes to another) or in the zone of possible variant solutions. Exploratory boring was carried out so as areas along the alignment where tunnel and related structures will be constructed could be investigated. Since the exploratory boring has been performed in two different periods (1999 and 2002) and for different variant solutions, detailed analysis has shown results of all investigations. This report shows boreholes drilled along the corridor of the adopted variant (75 boreholes of the total length of 639.80 m). Boreholes drilled in 1999 were designated as MBt, MBol, MBod, MBk and MBv, and boreholes drilled in 2002 were designated as Bvt and Bvo.

Exploratory boring for the level of Final design has already been performed according to investigation design with insignificant modifications as a result of local ground properties. Drilling was carried out in the period November-February, 2009/2010 in the area of designed structures, engineering structures, revetments, river bed displacement and tunnel, considering the fact that geological composition and ground properties along the studied alignment have been precisely defined. Although 137 boreholes have been planned for drilling, only 90 boreholes were drilled as a result of conditions of local ground. Instead of boreholes, test pits have been excavated in difficult areas. Boreholes varied from 4.00 to 30.00 m in depth with the total length of 820.40 m. Although boreholes provided with designation V followed by the relevant number are not shown in the continuity, they are stated fully in accordance with the previous borehole arrangement developed through the investigation works.

Drilling has been performed by Bort Longer drill rig (DB 505, BG-1 and GDR-150). Continuous rotary core drilling has been applied and small quantity of water was used for tools cooling. So called ’’dry’’ drilling where no water was anticipated has been applied on slopes.

The drilled boreholes varied from 146 mm to 101 mm in diameter. Boreholes drilled in rock environment had diameters varying from 76 mm to 86 mm. Percentage of the obtained core varied dependent on type of material in which drilling was performed. In silty sand environments, this percentage varies between 90% and 100 % and in coarser alluvial and proluvial sediments the said percentage ranged between 60% and 70 %, or less. Percentage of core samples in eluvial zones obtained through drilling in hard rock mass varied from 40% to 60% while in less disturbed zones almost 100% of core sample was obtained.

Detail engineering-geological core mapping and selection of samples for laboratory geomechanical testing has been carried out during the field work upon completion of boreholes drilling. In the course of mapping, identification of lithological media, presence of water, moisture, plasticity, physical and chemical modification, type, shape and number of inclusions have been identified. Since drilling in hard rock mass was carried out in eluvial zone that suffered intensive physical, mechanical and chemical changes, degree and type of fissibility, failure, etc. could not be precisely defined.

1.3.4.3.1.3. Exploratory excavation and detail engineering-geological mapping of pits

In the course of investigations for the purpose of Preliminary design preparation, exploratory excavation has been performed in the subsurface that will support the construction of the future highway so as type of materials and their physical and mechanical properties can be precisely defined and depth of ground water identified as well as thickness of topsoil to be removed. The exploratory excavation has been performed on locations difficult for drilling rig approach. In the area of the studied alignment, 12 (twelve) trial pits designated as Jvt were excavated.

The exploratory excavation in the course of investigations for the purpose of Final design preparation has been also performed on difficult terrain through the use of drill rigs. Twenty five (25) test pits in total designated as JV were excavated in the area of the studied alignment.

Detail engineering and geological mapping of pits together with monitoring of change in lithological members and taking samples for laboratory geomechanical testing have been performed in the course of excavation.

1.3.4.3.1.4. Detail mapping of rock mass exposures

Detail mapping of rock mass exposures have been performed together with engineering geological ground mapping. Shale exposures have been analyzed so as fracture texture according to both RMR and Q classifications could be defined. Direction of fractures and spaces between them have been measured and failure state identified.

1.3.4.3.1.5. Sample selection for the purpose of laboratory geomechanical testing

In accordance with soil investigations stated above (exploratory boreholes and pits) as well as problems that need to be solved, the both disturbed and undisturbed samples were taken fully in accordance with the applicable standards. More samples were taken than it was planned. After being adequately packed, samples were taken to the laboratory at the Mining Institute, Zemun.

Within the previously performed investigations, 82 (eighty two) samples were taken from the narrower area of the adopted alignment.

Within the investigations performed for the purpose of Final design, 115 (one hundred and fifteen) samples were obtained and transported to the laboratory.

When selecting the both disturbed and undisturbed samples, special care was exercised to samples that represented the relevant media required for design of alignment and related structures.

1.3.4.3.1.6. Ground water level monitoring

Monitoring of ground water level has been performed directly in the course of drilling. Observation wells for detailed and long term monitoring have not been installed.

Ground water in alluvium zones and terrace sediments has been identified in boreholes as well as in certain areas allocated in diluvial and proluvial formations. Results referring to identification of ground water level are shown on engineering-geological profiles of boreholes and geotechnical ground sections.

1.3.4.3.1.7. Geophysical, geoelectrical and seismic considerations

Geophysical investigations have been performed for the purpose of defining seismic ground properties in the area of newly-designed structures, tunnels and cuts as well as electric resistance of ground in the area of slopes. Geoelectrical probing has been performed so as limits, thickness, depths and spatial allocation of medium characterized with specific electric resistances could be defined. Refraction seismic investigations have been performed so as spreading velocity of elastic longitudinal waves can be defined together with geodynamic ground model required for defining of engineering seismic parameters for structures to be constructed alongside the studied highway.

Data on geophysical investigations represent more detail results of exploratory boring or basic data on ground/terrain due impossibility to perform soil investigations.

In the phase of preparation of Preliminary design, about 100 (one hundred) geoelectrical probes have been placed along the corridor of the adopted alignment. Probes are placed on 25 (twenty five) geoelectric profiles as well as 8 (eight) seismic profiles of different length. Geoelectric profiles are marked Gs... E1,..., and seismic S1,..., SP1,......

In the phase of preparation of Final design, additional testing of tunnels, cuts and smaller structures was performed through 56 (fifty six) geoelectric probes adjusted to 14 (fourteen) geoelectric profiles each 100 m long as well as 14 (fourteen) seismic profiles of different length. Geoelectric profiles were designated as E_1... and seismic as S_1,....

1.3.4.3.2. GEODETIC SURVEYING AND MICROLOCATION OF SOIL INVESTIGATION WORKS

Surveying of ground in defined width and length along the corridor for alignment analysis has been performed for the purpose of Preliminary design. Photometric surveying was performed and results shown on the general map, 1:2500 scale.

For the purpose of Final design preparation, allocation of performed investigation works was surveyed in detail. Moreover, additional geodetic surveying of ground was performed terrestrially in tunnel area as well as in areas planned for displacement of the Juzna Morava river bed.

1.3.4.3.3. GEOMECHANICAL LABORATORY TESTING OF SOIL SAMPLES

Tests on samples carried out in the laboratory of the Mining Institute, Zemun have included all lithological media the future highway and related structures will be constructed on. The following tests were performed:

- Identification and classification	
* Grain size composition	108 tests
* Atterberg consistency limits	39 tests
*Water content	67 tests
*Bulk density	38 tests
- Direct shear test	31 tests
- Compressibility and consolidation parameters in oedometer	31 tests
- Maximum compressibility according to Proctor	15 tests
- California bearing ratio CBR	15 tests
- Uniaxial compressive strength	7 tests
- Compressive strength method	4 tests.

1.3.4.4. OVERVIEW OF INVESTIGATION AND TEST RESULTS

Results of engineering-geological and geotechnical soil investigations obtained fully in accordance with regulations and standards are suppose to be an integrating part of documentation required for multidiscipline approach in solving problems referring to design of highway especially due to difficult terrain and alignment design.

The section herein will show results of investigations and testing together and offer detail explanations for certain media and type of structures.

1.3.4.4.1. GEOGRAPHIC POSITION, GEOMORPHOLOGICAL, CLIMATIC AND OTHER CONSIDERATIONS OF THE STUDIED AREA

Geographic position and geomorphological ground properties

The studied area of the E 75 highway, Predejane - Caricina Dolina section follows the flow of the Juzna Morava River transferring its position from the left to the right riverside.

The present relief of the studied area is the result of all relevant natural influences (temperature changes, wind, water and frost actions and dynamic effects). The lithological members constituting the relief of the studied area are mostly formed through the long period of time (from Paleozoic to Quaternary). Tectonic movements (especially in formation of Juzna Morava river bed and its tributaries have had the most significant importance in relief creation.

In both tectonic and morphostructural aspects, the studied area is situated on the western part of the Serbian and Macedonian massive with fluvial-denudation slope areas and erosion-accumulated areas (diluvium, proluvial fans and Juzna Morava alluvium).

Dependant on lithological composition, long erosion and tectonic activities, and changeable inclinations show that slopes of the Juzna Morava River are the result of fluvial activities. Different slope inclinations are the result of lithological composition (in diluvium slope angle is 10-30°, in proluvial areas 15-30°, in alluvium areas and river terraces 2-5°, in cuts and fills composed of shales 45-70°, in schist 25-35-45°, in diluvial-eluvium materials 20-35°, in diluvial-proluvial materials 10-30°, in diluvial-alluvial materials 16-25°, in alluvial-proluvial materials – zone of Predejanska River and Aiski brook up to 5°).

Erosion process of parent rocks (shales) constituting the Juzna Morava banks is usually followed by filling with thick alluvial, diluvial or proluvial sediments.

The previously erosion process of the Juzna Morava River have affected the both left and right banks thus causing inundation and terrace sediments to be formed. Since the river has moved toward west (to the left bank) numerous mixed or deposed sediments from the slope along edge areas of the Juzna Morava banks have been formed. Data obtained through the drilling of numerous boreholes have confirmed this fact showing heterogeneous deposits as a result of different processes.

The same may be applied to tributaries of the Juzna Morava River that were affected by erosion process causing ravines to be filled with sediments which provoked further erosion. The most extensive erosion processes (fluvial and proluvial) were caused by the river and its tributaries.

The studied area is intersected with numerous ravines that at the same time represent temporary or permanent streams although dry ravines may be also identified through the area. They mostly vary 3 m to 5 m in depth although ravens with depths exceeding 10 m or 12 m may be also identified. Shallower ravens are provided with smooth sides inclined at 30°, while deeper ravens are characterized with higher inclinations varying from 40 to 45° and more. Usually, ravens follow the "V" shape with symmetrical sides.

Regulation of ravens on the right river bank has been performed through construction of channels and torrent partitions that lowered down hydraulic gradients and prevent deposition of significant quantities of proluvial material into the highway area. Non-regulated ravens are affected with erosion process and lower ravens are affected with accumulation.

In the area of the newly-designed alignment, the terrain in lower part is mostly represented by alluvial plain of the Juzna Morava River and slopes positioned in the close proximity to the alluvium are composed of different Quaternary sediments or shales.

Climate

The studied area belongs to moderate continental climate.

The average annual precipitation amounts 488 mm per 1 m2. Number of snowy days during the year is 101 days (from December to March) and the mean maximum height of snow cover is considered to be 31.3 cm.

The mean annual air temperature is +9^{o}C. It should be mentioned that the absolute maximum temperature during the year is +32^{o}C and minimum temperature is -25.8^{o}C. Average number of frost days has been measured in the period November-March (22) and number of frost days for period October-April is 77.

Data on precipitation, snow cover and air temperatures have been obtained through measurements performed in Predejane water measuring station and overtaken from the General design for the E 75 Belgrade - Nis – Skopje highway, Grabovnica-Presevo section, precisely from the Study on climatic, hydrologic and hydrographic parameters (Institute for Spatial and Urban Planning Nis – September, 1993).

Although measurements referring to frost have not been available it can be estimated that, considering altitude, minimum average annual temperature and depth of ground water level, the biggest frost depth in this area varies from 0.80 m to 0.90 m.

Vegetation cover

Slopes are almost fully covered with forest or pasture lands. The exception is side cuts in areas build of shales and small local communities (mostly along the right bank of the Juzna Morava River).

Population and traffic arteries

The natural direction of the northeast orientation represents both old and new corridor of roads and railroads to Greece and Middle East.

The studied area is poorly populated except Predejane Settlement.

The highway alignment intersects the M1 arterial road in the area immediately before Sarajevski Bridge, the Nis – Skopje international railway line as well as numerous local earth roads.

1.3.4.5. GEOTECHNICAL REQUIREMENTS FOR DESIGN AND CONSTRUCTION

1.3.4.5.1. GEOTECHNICAL GROUND ZONING AND SPECIFIC CHARACTERISTICS OF THE ALIGNMENT AND TERRAIN

Geotechnical ground plan is shown in detail and provided with all relevant data so as position of the alignment can be comprehended in detail together with soil investigations.

Longitudinal profile of the ground has been prepared for either carriageway. This profile is not shown in detail although is provided with the Table containing important soil properties required for different structures to be constructed along the future highway alignment.

Geotechnical cross sections of ground are shown in detail and therefore interrelations between the alignment and the ground can be more precisely defined. In cooperation with the design engineer responsible for the alignment, certain number of cross sections has been analyzed and adjusted and smaller number of sections (55-fiftiy five) has been shown in final interpretation.

In accordance with the results obtained through previously soil investigations and ground testing, synthesis of available data have been prepared and computational analysis of parameters performed together with engineering-geological and geotechnical ground modeling for the purpose of optimization – adjustment of both type and position of the alignment according to soil properties.

6 (six) basic models – typical engineering-geological and geotechnical ground structures have been identified, as stated below:

Model 1
The model 1 includes segments of ground for the newly-designed alignment. The alignment will be positioned:
- On the present road and ground,
- In smaller cut section, side cut (< 5 m),
- On lower embankment (< 5 m).

Model 2
The model 2 includes segments of ground for the purpose of establishment of the newly-designed alignment. The new alignment will be positioned on embankments (> 5 m):
- On completely new embankments,
- As an extension to the present embankments.

Model 3
The model 3 includes segments of ground for the purpose of establishment of the new alignment in side cuts (> 5 m) in rock mass composed of shales and eluvial-deluvial-proluvial cover not exceeding 3 m in thickness, provided that slope shall be inclined at 5:1 and not higher than 8 m with berms not exceeding 3 m in width.

Model 4
The model 4 includes segments of ground for the purpose of establishment of the new alignment in side cuts (> 5 m) in earth and debris materials in areas composed of thicker Quaternary diluvia-proluvial-alluvial-terrace sediments where new inclinations cannot be obtained without adequate protection.

Model 5
The model 5 includes segments of ground where the newly-designed alignment will intersect the Juzna Morava riverbed. Construction of revetment will be planned for the purpose of slope protection.

Model 6
The model 6 includes segments of ground where the newly-designed alignment will be established over the stabile slope or intersect it. Terrains within this model can be classified as follows:
- Stabile slopes having up to 5 m in thickness,
- Slopes thicker than 5 m.

The models stated above are supposed to be combination of several models. More complex solution for design considerations will be required as well as applying of more complex protection measures.

Typical sections and specific conditions such as: alignment position on the high cut sections made of earth/stone or on high embankments positioned on alluvium, diluvium or proluvion sediments, problems referring to fitting of new embankments into the existing ones, geostatical calculations (stability, bearing capacity and settlement) have been identified and carried out and shown in the Attachment 7.

Therefore, complex figure of ground along the highway alignment is obtained together with all data required for design works.

1.3.4.5.2. GEOSTATICAL ANALYSES

The newly-designed highway section is characterized with unfavorable and very difficult segments for both design and construction considerations. However, construction of complex engineering structures and facilities through carefully performed design work will result in achieving satisfaction in terms of quality once the studied highway has been completed.

The reliable data and unification of soil properties in the phase of Preliminary design preparation have enabled precise calculation to be carried out for real soil conditions.

More precise calculation for concrete examples has been performed for the level of Final design. Through geostatical analyses for the purpose of alignment (structures have been separately analyzed) the following tests have been performed:

- **Embankment slope stability –** different heights on medium compressive materials integrating the surface areas consisting of diluvium, proluvium and alluvium sediments;
- **Settlement of soil below the higher embankments –** on medium compressive materials integrating the surface areas composed of diluvium, proluvium and alluvium sediments;
- **Slope stability of earth cuts –** prepared for alluvial or deluvial-proluvial Quaternary sediments of different heights;
- **Stability of rock cuts (slopes in shales) –** prepared for different slope position.

1.3.4.5.2.1. Calculations referring to embankment slope stability and settlement

The section herein includes analyses referring to slope stability against shearing in the area where new embankments have to be fit into the existing ones. It also includes prediction of soil settlements due to loading imposed by higher embankments.

The analyzed examples are obtained for uniform conditions (properties):

- Old embankments -

Bulk density	$\gamma = 18$ kN/m^3,
Angle of internal friction	$\varphi = 20°$,

Cohesion $c = 20\ kN/m^2$.

- Earth material for construction of new embankments -
  - Bulk density $\gamma = 19\ kN/m^3$,
  - Angle of internal friction $\varphi = 22°$,
  - Cohesion $c = 15\ kN/m^2$.
- Debris material for construction of new embankments -
  - Bulk density $\gamma = 20\ kN/m^3$,
  - Angle of internal friction $\varphi = 30°$,
  - Cohesion $c = 0\ kN/m^2$.
- Embankment bedding (alluvium) -
  - Bulk density $\gamma = 19\ kN/m^3$,
  - Angle of internal friction $\varphi = 18°$,
  - Cohesion $c = 15\ kN/m^2$,
  - Compressibility for different loading patterns
    - $\sigma = (100\text{-}200\ kN/m^2)$ Ms= 7000- 15000 kN/m^2.
- Embankment bedding (diluvium and proluvium, not exceeding 5 m in thickness) -
  - Bulk density $\gamma = 20\ kN/m^3$,
  - Angle of internal friction $\varphi = 22°$,
  - Cohesion $c = 20\ kN/m^2$,
  - Compressibility for different loading patterns
    - $\sigma = (100\text{-}200\ kN/m^2)$ Ms= 10000 kN/m^2.
- Embankment bedding (diluvium and proluvium thicker than 5 m) -
  - Bulk density $\gamma = 20\ kN/m^3$,
  - Angle of internal friction $\varphi = 20°$,
  - Cohesion $c = 15\ kN/m^2$,
  - Compressibility for different loading patterns
    - $\sigma = (100\text{-}200\ kN/m^2)$ Ms= 10000 kN/m^2.

Calculations referring to embankment slope stability – According to typical cross section prepared by the responsible design engineer, embankment slopes shall be executed with gradients stated below:

- For embankments < 3 m, 1:1.5;
- For embankments > 3 m, 1:1.5 - 1:2.

Calculations for embankment slope stability have been performed for the highest embankments on the adopted alignment variant not exceeding 8 m (eight) in height. Calculations have been carried out by applying Teylor's and Spenser's methods.

Factors of safety obtained through the use of Teylor's method are stated in the Table below:

Chainage (km)	Slope inclination n	Safety factor Fs
885+300	1:1.5	2.04

Factors of safety obtained through the use of Spenser's method are stated in the Table below:

Chainage (km)	Slope inclination n	Safety factor Fs
883+425	1:1.5 - 1:2	1.311-1.546

For higher embankments positioned on difficult terrain (km 883+425), analysis of different parameters of refueled materials has been carried out. Since the embankment will be constructed of debris materials, strength parameters used for calculation of slope stability have been given in intervals:

- Bulk density $\gamma = 20\ kN/m^3$,
- Angle of internal friction $\varphi = 30 - 33°$,
- Cohesion $c = 0 - 3\ kN/m^2$.

The obtained results have shown that increment of angle of internal friction against cohesion will result in obtaining the approximately similar factors of safety.

According to the analyzed calculations it can be concluded that slope inclination stability for adopted inclinations of 1:1.5 is characterized with adequate safety factors.

Calculations referring to settlement of soil under the embankment have been performed for specific cases identified along the alignment. The selected examples are referring to higher embankments (ramps for structures) to be constructed on ground surfaces composed of diluvium, proluvium and alluvium sediments and deeper non-compressible zones composed of coarse grained or debris materials or in zones where embankments will be positioned in the close proximity of the existing arterials (railway line or arterial road). Negative impacts to the present arterials as a result of settlement of high embankments have been verified. In accordance with the performed calculations and dependant on bedding (7.40-11.50 cm), settlements of embankments varying from 3.00 m to 7.00 m in height have been identified. The suitable circumstance is that compressible layers can be drained either horizontally or vertically so as the greatest settlement will be recognized in the course of construction. The performed calculations have shown that settlement of newly-designed embankments will cause no negative impact to the existing arterials.

Computational values for embankments of different height founded on different bedding are stated below:

Embankment height h (m)	Chainage (km)	Predicted settlement (cm)
6.00	881+500	8.13
6.00	882+850	18.09
8.00	885+300	17.66

1.3.4.5.2.2. Calculations of cut slope stability

According to the adopted variant solution, cutting of slopes shall be performed on different heights. Four types of cuttings can be identified:

a) Cutting in hard or slightly modified shale mass,
b) Cutting in modified shale zones covered with thick Quaternary sediments,
c) Cutting in less thicker Quaternary sediments and
d) Cutting in thicker Quaternary sediments (diluvium and proluvium) appropriate under certain conditions.

a) Cutting in hard or slightly modified shale mass

These cuttings are different and vary from 3-5-10 m but not exceed 40 m in height. Decomposition and fissibility of shales can be identified at the depth of 3-5 m from the ground surface (in average), but position of slope in relation to schistosity and fissure location is very important for the cutting stability.

The detailed analyses performed for the purpose of Preliminary design preparation have also included calculations of stability for flat model of rock shale slopes and rock masses of different hardness but without schistosity effects and fissures (without water influence).

The analysis herein points out that slope inclinations may be executed without adequate protection but this may result in significant excavated masses and increment of number of cutting slopes along the slope. During excavation, shales will be broken in pieces thus forming thicker or less thick areas (″wedges″) out of which certain deformations as rockfall can be identified. These deformations can collapse in an uncontrolled manner and extend to adjoining masses directly affecting the areas along the highway right-of-ways. Maintenance of the said slopes is supposed to be very difficult since degradation processes will get worse in time. Therefore, excavation of steeper slopes together with slope protection will be recommended.

Through the application of fracture system analysis and use of contour diagrams of discontinuity distribution (Schmidt’s polynomials) smaller values of slope inclinations have been obtained due to presence of unstable "wedges". These ’’wedges’’ will cause the slope to become unstable in time due to precipitation thus resulting in rockfalling or sliding the blocks from the cutting.

According to results obtained for the level of Preliminary design as well as detailed analyses performed by the design engineer responsible for engineering structures for the level of Final design, specific cuttings together with relevant protection measures have been defined.

For cuttings not exceeding 5 m in height in modified and decomposed shale mass, protection walls inclined at 1:1 will apply.

Segments of the ground on which the studied alignment will be established in cuttings and side cuts exceeding 5 m in height, in the area of shale mass or in area of modified and decomposed shales, slopes inclined at 5:1 and sections up to 8 m in height provided with 3 m wide berms will be constructed. Stability of slope will be obligatory secured through the use of wire mesh, 5 m long anchors and shotcrete layer, 5 cm thick.

Results referring to slope stability in hard or less modified shale mass are shown in Book of Engineering Structures (K7).

b) Cutting in modified shale zones covered with thick Quaternary sediments

More detailed analysis has been performed for these cuttings. The analysis has shown where protection or retaining walls should be constructed or where slopes should be constructed in combined inclinations varying between 5:1 and 1:1 in rock or 1:1.5 to 1:2 in Quaternary sediments.

In segments of the terrain where the newly-designed alignment will be positioned in cuttings or side cuts higher than 5 m in earth-debris materials and in areas of thicker diluvial-proluvial-alluvial-terrace sediments or similar Quaternary sediments and where it would not be possible to construct new slope gradients without protection, slopes must be protected by applying the following methods:

- Construction of retaining wall along the entire height that will rest on relevant foundation. Adequate drainage system should be installed behind the wall and the wall itself should be sized according to relevant calculations dependent on local ground conditions;
- Construction of retaining wall up to the relevant height. Sloping should be performed so as natural gradient of the terrain 1:1.5 - 1:2 can be maintained. Resoiling or application of adequate biotechnical protection measures will be required.

Results of calculations performed for stability of slope in the area of modified shales with thick Quaternary cover are shown in the Book of Engineering Structures (K7).

c) Cutting in less thick Quaternary sediments

Cuttings in diluvial-proluvial materials are mostly performed as small cuttings in 1:2 gradient. Calculation for the stability of cutting slope has been performed for cuttings of maximum height through the use of Teylor's and Spenser's methods.

According to calculation through the use of Teylor's method the following safety factors have been obtained:

Chainage (km)	Slope inclination n	Safety factor Fs
883+350	1:2	3.37

Through the use of Spenser's method the following safety factors have been obtained and stated in the Table below:

Chainage (km)	Slope inclination n	Safety factor Fs
883+425	1:2	2.013

For deeper cuttings, safety factors are shown below:

Slope height h (m)	Slope inclination n	Safety factor Fs	Notes
6 - 8	1:2	3.03 - 3.63	earth material

If these sediments are identified above shale mass that will be completely cut of, inclination of 1:2 will be rarely applied and slopes will be provided with protection and/or retaining walls.

d) Cutting in stabile thicker Quaternary sediments (diluvium and proluvium) appropriate under certain conditions

This is the most complex method applied in slope cutting. Cuttings may be performed in different heights. Since the slopes are stabile under certain conditions (instable due cutting or additional loading), retaining walls of significant sizes will be constructed.

Sizing of the said walls and defining soil properties and relation between lithological complexes carried out by the Department of Geotechnical Engineering was performed by the Department of Stations, Institute of Transportation CIP.

Detailed analyses, geotechnical calculations and final solutions referring to slope protection against cutting in Quaternary and shale rock masses will be studied separately in books referring to engineering structures.

1.3.4.5.3. GEOTECHNICAL REQUIREMENTS FOR ALIGNMENT DESIGN AND CONSTRUCTION

Geotechnical requirements for alignment design and construction of the future highway are consisting of propositions and recommendations referring to construction method that will be applied on certain sections dependent on both composition and properties of the studied ground.

In relation to the alignment design (position of centre line and reference level), propositions and recommendations are referring to the following:

- Possibilities and conditions for construction of cuttings in stabile terrains and terrains stabile under certain conditions,
- Possibilities and conditions for embankment construction,
- Possibilities and conditions for harmonization of old and new embankments,
- Possibilities and conditions of soil that will carry embankments, cuttings or side cuts,
- Possibilities and conditions to fulfill requirements for substructure (filling materials).

Common and general provisions of the main conditions and possibilities of construction are stated in sections below.

Longitudinal geotechnical profiles are provided with comment of certain characteristics of the alignment and terrain in relation to construction and studied and shown in detail on cross sections.

Recent geodynamic processes and occurrences are supposed to be an important characteristic of the terrain (Quaternary sediments and shales).

Segments of slopes provided with thicker Quaternary sediments and characterized with higher water levels and steeper inclinations have been considered as sections appropriate under certain conditions due to easy activation and sliding as a result of loading or slope cutting.

Physical and mechanical as well as engineering properties of the separated complexes have been obtained through laboratory geomechanical tests and field geophysical, seismic and geoelectrical testing. In accordance with performed investigations and basic genetic classification, smaller segments of similar parameter properties have been separated. Grouping of these segments in relation to the certain lithological media characterized with specific properties performed is supposed to be very important for the future design work.

In such a way, a unique ground model that could be further analyzed has been obtained.

Steep gradients, significant number of the existing arterials and arterials to be constructed (completely new highway alignment, the existing M1 road, the railway line and J.Morava riverbed) as well as heterogeneity of different geological formations have caused complex and more expensive solution for establishment of the studied alignment. This has been analyzed on cross sections.

Construction of the studied highway will include as follows: alignment establishment, construction of certain structures (bridges and galleries), construction of the ″Predajane″ tunnel, dislocation of the segment of the existing arterial road on two locations, construction of ″Predajane″ interchange and relocation of the Juzna Morava riverbed.

A. Alignment establishment

Zoning of ground has been performed through the geotechnical analysis for the alignment. Textual description and explanations are stated on the ground modeling.

Model 1 – **Construction of embankments not exceeding 5 m in height**, is planned to be performed along the significant segment of the alignment. The cross section has shown that the ground is flat or slightly sloped as kilometrage increases. These embankments mostly cover the existing slopes. Since the embankment structure is not so complex and causes no negative effects or significant settlements, its construction may be performed without any problem. Slopes will be inclined at 1:1.5 and resoiled with top soil. Embankment length may be reduced by constructing retaining walls on lower slope segments or through fitting the alignment into other arterials (arterial-regional road, railway line). Construction of embankments not exceeding 5 m in height is planned to be performed at the following km points:

km 881+450 - km 881+620 km 881+800 - km 882+270
km 882+700 - km 882+825 km 883+270 - km 883+320 km 883+520 - km 883+570
km 883+580 - km 883+725 km 884+860 - km 884+890 km 885+030 - km 885+100
km 885+175 - km 885+250.

Model 1 – **Construction of cuts – side cuts not exceeding 5 m in depth** is planned to be executed on considerably smaller length of the studied alignment. Cuttings shall be carried out in Quaternary sediments where slopes with gradients of 1:2 - 1:1.5 can be executed with no timbering or mass removal. Construction of cuts and fills up to depth of 5 m is planned to be performed at the following km points:

km 882+270 - km 882+290
km 882+500 - km 882+700 km 884+625 - km 884+730 km 884+830 - km 884+860
km 885+100 - km 885+175 km 885+350 - km 885+500.

Model 2 – **Construction of embankments higher than 5 m** is planned to be performed in areas before and behind the designed structures. Transition and enlargement of embankments can be performed without difficulties. Slopes will be executed in gradients of 1:1.5 - 1:2 and resoiled with top soil. Construction of embankments higher than 5 m is planned to be performed at the following km points:

km 881+275 - km 881+450 km 882+825 - km 882+865 km 885+250 - km 885+350.

Model 3 – **In side cuts exceeding 5 m in shales and diluvial-eluvial formations made as a result of shale decomposition-** cuts inclined at 5:1 and not higher than 8 m provided with 3 m wide berms will be executed. Slopes will be secured by mesh reinforcement, anchors and sprayed concrete. Construction of cut sections exceeding 5 m in rock environment is planned to be performed at the following km points:

km 882+225 - km 882+725.

Model 4 – **Construction of side cuts exceeding 5 m in depth in diluvial-proluvial sediments** will require construction of retaining walls. Construction of cuts exceeding 5 m in depth in diluvial-alluvial sediments is planned at the following km points:

km 883+320 - km 883+370 km 883+600 - km 884+025 km 884+730 - km 884+830.

Model 5 – **Construction of embankments exceeding 5 m in height together with bank revetment** is planned to be executed in areas close to the Juzna Morava riverbed. Bank revetment will include construction of massive retaining wall founded below the area affected by river sediments. The height will be greater than those calculated for average high waters. The embankment slopes shall be lined with stone or covered with concrete slabs to the maximum flood protection level. Construction of embankments higher than 5 m together with bank revetment is planned to be performed at the following km points:

km 881+425 - km 881+600.

Model 6 – **The alignment is passing over the slopes stabile under certain conditions.** In such a case lower embankments or shallower and deeper fills provided with retaining walls and adequate drainage piping behind the wall will be required. Wall dimensions, type of foundation to be applied together with foundation depth will be in compliance with conditions and soil properties. Construction of embankments and cuts in slopes stabile under certain conditions is planned to be performed at the following km points:

km 882+725 - km 882+770 km 883+725 - km 884+625.

B. Structures along the alignment

On sections difficult for design purposed due to specific difference of levels between the ground and reference level of the newly-designed highway, bridge, overpasses, underpasses and galleries are planned to be constructed.

Selection of adequate foundation method (shallow foundation on footing or deep foundation on piles) will depend on structural characteristics of a certain structure and geotechnical soil properties.

Geotechnical requirements have been discussed and explained in detail in the Book referring to structures (K2-S2).

D. Construction of engineering structures

Construction of engineering structures is planned to be executed on sections where the alignment is positioned in deeper cuts composed of earth materials or rock mass of reduced strength properties or where slope stability cannot be maintained due to specific differences of level between the ground and reference level of the newly-designed highway.

Protection method to be applied on slopes will depend on structural characteristics of the alignment and geotechnical soil properties.

Geotechnical requirements for construction of engineering structures are discussed and explained in detail in the Book referring to engineering structures (K2-S4).

E. Displacement of the M1 arterial road

Considering the position of the alignment of the newly-designed E 75 highway, the existing M1 arterial road (Gornje Polje - Caricina Dolina section) will suffer minimum modifications and become regional road, i.e. an alternative route to the newly-designed highway.

The regional road is supposed to be the arterial that will connect all surrounding settlements and the future highway.

The existing arterial road is mostly positioned in cuts, side cuts, embankments and tunnels. The road is also provided with significant number of culverts and bridges for the purpose of control of small and big water flows (tributaries of the Juzna Morava River). In side cuts the road is secured by retaining and retaining-facing walls (below and above the reference level). Embankments are mostly stabile. Smaller segment of the road passing through the marked landslides will be secured by walls above the reference level or through the application of similar measures so as the required stability and safety could be obtained.

The newly-designed alignment solution will require the arterial road to be dislocated at the following two points:

- At km 883+600 - 884+600.

At km 883+600 - 884+600 (1000 m long section) the alignment of the arterial road shall be dislocated toward the left side from the newly-designed highway on the higher reference level and different distances. Since the alignment is positioned mostly in cut sections construction of retaining and retaining-facing walls will be required (below and above the reference level). This displacement shall require no structure construction.

Displacement of the M1 arterial road at km 883+600-884+600 is shown in detail in the graphical documentation K2-S1-C5.

F. Interchange

″Predejane″ interchange represents connection between local roads and the highway with the possibility of circular connection to both directions. The interchange is planned to be constructed from km 882+650 to km 883+650. Upon completion, the interchange will enable connection between the E 75 highway and the existing M1 arterial road (that will become the regional road designated as R-214).

Within the interchange, construction of three structures is planned. The remaining segment of the interchange is embankments not exceeding 6 m in height. Cut sections not exceeding 4 m in depth has also been planned.

The designed structures will also enable crossing with the Nis-Presevo main railway line positioned between the existing M-1road and the E 75 highway.

Embankment and cut sections will be executed with slopes having 1:1.5 in gradient while smaller segments of slope will be provided with retaining walls.

Geotechnical requirements for structures within the interchange are based on data obtained through the detailed engineering-geological ground mapping and exploratory drilling.

″Predejane″ interchange is shown in detail in graphical documentation K2-S1-C6. Structures constituting the ″Predejane″ interchange are shown in the Book referring to structures K2-S2.

G. Displacement and regulation of the Juzna Morava riverbed

Displacement of the Juzna Morava riverbed will be performed on 5 (five) locations so as adequate space required for arterials (highway and railway line) can be obtained.

These 5 locations are positioned on the following km points:

km 874+225 (640 m),
km 875+125 (640 m),
km 877+525 (630 m),
km 878+325 (190 m) and
km 880+950 (180 m).

Excavation on the opposite bank will be performed to provide adequate flowing width due to displacement of the highway alignment.

On these locations excavation in riverbed up to depth of 3-4 m will be performed. Slope of the refilled roadbed toward the bank must be secured through the construction of retaining wall in riverbed to the mean water level. Bank revetment or retaining wall inclined at 1:1.5 will be constructed to the high water level.

Excavation will be performed in alluvial sediments mostly in flood area (gravel sand) and river bed (sandy gravel). The excavated material will be of II and III category, although certain excavation works will be performed in water (in the period of low water level). This material is suitable for sub-base construction.

Construction of embankments not exceeding 6 m in height will be performed on low to medium compressible sands or gravel sand. Settlements will not be expected since this process is expected in the course of construction. For embankment construction, very heterogeneous material can be used as well as coarse grained material for the embankment lower zones. Shale blasting will result in coarser block material that cannot be used for road embankment construction but can be used for embankment enlargement. Although the bank revetment wall may be founded, the required depth must be carefully computed to escape sediment erosion.

1.3.4.5.3.1. General geotechnical recommendations for subsoil formation

The alignment of the studied section will be established on the ground mostly consisting of alluvial, diluvial and proluvial sediments as well as rock mass composed of shales.

In the area composed of Quaternary sediments, top soil shall be stripped down to 10-30 cm. Such an excavated top soil shall be temporary stockpiled and later used for resoiling of slopes. In most cases the soil will be composed of sandy-silty slightly clayey material intersected with organic material found in top soil, such as roots.

In accordance with analyses performed on samples obtained from boreholes and pits along the alignment right-of-way, favorable compactness and bearing capacity values have been obtained.

In accordance with tested samples taken from trial pits and boreholes, California Bearing Ratio of CBR = 5-30% has been obtained while maximum compactness according to Proctor was $\gamma_{dmax} \geq 17$ kN/m^3, for optimum moisture of Wopt = 12-19%.

For the purpose of compaction, evaluation criteria for sub-soil the following values will be required:

- For embankments not exceeding 2 m in height and sub-soil composed of coherent material the required compaction degree will be $D_{pr} \geq 97\%$, $E_{v2} \geq 30$ MN/m^2 and $E_{din} \geq 25$ MN/m^2, and for soil consisting of non-coherent material the required compaction degree will be $D_{pr} \geq 100\%$, $E_{v2} \geq 60$ Mn/m^2 and $E_{din} \geq 35$ MN/m^2;
- For embankments higher than 2 m and sub-soil composed of coherent material, the required compaction degree will be $D_{pr} \geq 92\%$, $E_{V2} \geq 20$ MN/m^2 and $E_{din} \geq 20$ MN/m^2.

Therefore, the detailed preparation of sub-soil can be performed with minimum works once the top soil has been stripped down. Minimum moisture content and small run-overs with appropriate machinery can result in compactness to the required degree that corresponds to 100% according to Proctor. Usually, compactness of natural moisture content in soil is very close to compactness of 95% according to Proctor and therefore requires no stabilization.

In a case of maximum ground water levels (during rain periods), moisture cannot be easily reduced which can be a problem in the course of sub-soil preparation.

Drainage shall be enabled in the course of sub-soil preparation as well as during the execution of construction works.

If the alignment will rest directly on the sub-soil composed of hard shale rock masses or deeper zones of highly consolidated debris composed of diluvium and proluvium formations, only evenness of the constructed layer will be required. Since the natural moisture content in soil will be adequate, only appropriate drainage system shall be required.

1.3.4.5.3.2. General geotechnical recommendations for embankment construction

Materials to be used for embankment construction are stone, debris and earth materials of appropriate grain size composition obtained in cuts and fills that will meet all required criteria. Since the level of ground water usually does not exceed 5.0 m measured from the ground surface and the embankment bedding is water permeable and less compressible, embankment can be constructed without any problem once the top soil has been stripped down.

Drainage of runoff during construction and operation shall be possible through embankment foot. In a case of flood waters and if the embankment bars natural runoff, the contact between the ground and the fill will be formed of a drainage subgrade course (in the culvert areas).

Materials to be used for embankment construction must fulfill the following requirements:

- Moisture close to an optimum (± 2%),
- Maximum bulk density $\gamma_{dmax} > 15{,}5$ kN/m^3 according to Proctor,
- Optimum moisture Wopt < 25%,
- Liquid limit Wl < 65%,
- Plasticity index Ip < 30%,
- Degree of non-uniformity Y > 9,
- Content of organic matter < 10%.

Non-coherent materials (debris and earth-debris) to be used in embankment construction must fulfill the following criteria:

- The size of grain shall not exceed 40 cm in the whole embankment except in the top layer where the largest grain shall not exceed 10 cm;
- Degree of non-uniformity Y > 9;
- Stone material for embankment construction must be composed of rock masses resistant to atmospheric influences.

Subgrade shall be constructed over the completely prepared sub-soil.

- Haulage and Filling – The haulage and filling of material will be performed over a prepared foundation soil. In defined sections, layers shall be spread in the longitudinal direction, horizontally, or at gradient at most equal to the designed longitudinal gradient (single-sided 2.5% or double-sided). Coherent materials shall be spread immediately. Layer thickness will be defined once compaction technology has been defined and appropriate compaction tools selected. Coherent materials will be compacted to the thickness of 30 cm and non-coherent materials will be compacted to the thickness of 40 cm.

- Compaction – Compaction shall be carried out with appropriate mechanical devices from the edge toward the centre of the embankment or along the structures. Moisture content for coherent materials shall be close to optimum according to Proctor, which means that work shall not proceed during unfavorable weather conditions. Bringing and spreading of material for any new fill layer may start as soon as the underlying layer is compacted and its density has a proper value. No filling may continue in winter and frost.

- Fitting the new embankments – into the old ones will be performed according to separate solutions provided that old embankments are stepped cut to the height similar to the thickness of the layer (30-50 cm) and in cut width of 1.0 - 1.5 m. Top soil shall be stripped down from slopes. The most of old embankments has been constructed of non-coherent materials composed of debris sandy and silty material characterized with good compactness and stability thus enabling transition to be performed easily without non-uniform settlements and cracks at the point of contact.

Considering the good bearing capacity of the bedding, these embankments will suffer no settlement, sliding or similar deformations.

Criteria for evaluation of quality required for fine-grained (coherent) material are listed below:

- For embankments not exceeding 2 m in height degree of compactness $D_{pr} \geq 97\%$ and $E_{v2} \geq 30$ Mn/m^2, i.e. $E_{din} \geq 20$ Mn/m^2 will be required;
- For embankments higher than 2 m, degree of compactness of $D_{pr} \geq 92\%$ and $E_{v2} \geq 20$ Mn/m^2, i.e. $E_{din} \geq 20$ Mn/m^2 will be required.

Quality criteria required for coarse-grained materials are:

- For embankments not exceeding 2 m in height degree of compactness shall be $D_{pr} \geq 100\%$ and $E_{v2} \geq 60$ Mn/m^2, $E_{din} \geq 35$ Mn/m^2;
- For embankments higher than 2 m, degree of compactness will be $D_{pr} \geq 95\%$ and $E_{v2} \geq 45$ Mn/m^2, i.e. $E_{din} \geq 30$ Mn/m^2.

In the area of earth formation CBR ~ 10 shall be required.

Drainage around embankment will be studied in the hydrotechnical report and performed by means of culverts placed in road bed.

Inclinations of slopes and embankments as well as settlements in higher embankments have been separately analyzed in previous sections.

1.3.4.5.3.3. General geotechnical recommendations for side cuts construction

The newly-designed section will be partly positioned in cuts and side cuts.

On segments where new alignment is passing through the side cuts, numerous types of these sections varying in height and type of material as well as supporting method applied may be identified, as stated below:

a) Side cuts in hard and compact shales and side cuts in shales provided with thin cover of Quaternary formations,
b) Side cuts in earthen and earthen-debris materials and
c) Side cuts in ground segments stabile under certain conditions.

a) Side cuts in hard and compact shales and shales provided with thin cover of Quaternary formations, 3-5 m thick.

These side cuts are planned to be executed in deeper zones in hard metamorphic shales of different thickness and mostly stabile gradients. Lower side cuts in modified and cracked areas are often supported by retaining/facing walls.

Problem of execution of new slopes on stone side cuts lies in blasting method since mechanized cutting cannot be performed. Although massive and controlled blasting is usually applied it may have negative consequences to the slope stability. Therefore, smooth blasting ″down the slope ″ with relevant arrangement of blasting holes is recommended as well as cutting of smaller masses and application of ″pret-spliting″ system. In such a way gas energy will be transmitted to the smaller mass segments causing blasted mass to be cut up in small pieces provoking no disturbance to the deeper zone. In such a way material suitable for transport and placing can be obtained and the slope is characterized with better stability.

The proposed slope gradients in this type of material (shales) vary from 1:1 in modified shales with debris cover in surface slope segments to 5:1, if side cuts are deeper.

For side cuts exceeding 10 m in height, cutting will be performed at the height of 8 m, in gradient of 5:1 and provided with 3 m wide berms. If thicker Quaternary deposits are identified in the surficial areas, side cuts will be inclined at 1:2 and 1:1.5.

b) Side cuts in earthen and earthen-debris materials

Side cuts in earthen and earthen-debris materials are not so frequent. Due to material erodibility, construction of retaining and protection walls will be required especially in lower side cuts.

In higher slopes, these side cuts will be executed in gradients 1:1 and provided with wire mesh, if necessary.

c) Side cuts in ground segments stabile in certain conditions

These structures will require construction of retaining walls of significant sizes. These walls will be studied in detail through the separate Book of the design herein (K7 – Engineering structures).

Analysis of slope gradients has shown suitable factors of safety for gradients 1:2 provided that soil is characterized with appropriate properties (extremely thick diluvium sediments 5-10 m). In such a case, these gradients are possible for slopes exceeding 5 m in height, while for lower slopes side cuts are stabile and inclined at 1:1.5.

If the soil is characterized with poor properties, gradients of 1:2 (up to 5 m) shall be adopted while higher gradients cannot be obtained without construction of retaining structures. The same applies to slopes stabile under certain conditions.

Mechanized digging shall be performed in horizontal layers so as activation of earth masses could be escaped especially during rainfalls and soil saturation.

If slopes are executed in designed gradients, the following measures must be undertaken:

- Properly draining of both surface and ground waters,
- Resoiling and grass seeding of slope surface areas and
- Application of technical protection measures in the course of construction of both retaining and retaining-facing walls.

1.3.4.5.3.4. General geotechnical recommendations for subgrade preparation

Preparation of subgrade, 30 cm thick, shall be performed fully in accordance with general technical requirements and standards and already sized pavement structure. Preparation of subgrade will be carried out after completion of lower course taking into account compactness and evenness of the finished layer.

Subgrade shall not be placed over frost ground or on ground covered by ice crust. The following criteria must be met:

- Maximum bulk weight $\gamma_d > 16{,}0$ kN/m^3 (according to Proctor),
- Liquid limit $W_l < 50\%$,
- Plasticity index $I_p < 20\%$,
- Swelling after 4 days in water (according to standard CBR) <3%,
- Non-uniformity degree Y>9 for coherent and Y>4 for crushed stone materials,
- Material moisture in the course of placing shall not vary more than ± 2%
  Of the optimum moisture content according to Proctor,
- Laboratory California Bearing Ratio CBR > 7% I
- Content of organic matters < 6%.

Preparation of subgrade will include as follows: procurement, transport, testing and spreading of the required material and its rough/fine leveling and compacting. Subgrade must not be placed during frosty days. Compaction shall be performed mechanically through the use of sheepsfoot rollers and vibro rollers with appropriate wetting. Quality control of the placed material will be required. The material must be provided with the following properties:

- For subgrade composed of fine-grained material, compactness degree shall be
  Dpr ≥ 100% and $E_{v2} \geq 45$ MN/m^2, i.e. $E_{din} \geq 30$ MN/m^2,
- For subgrade composed of coarse-grained stone material compactness degree shall be
  Dpr ≥ 100% and $E_{v2} \geq 60$ MN/m^2, i.e. $E_{din} \geq 35$ MN/m^2.

If material does not meet requirements specified for subgrade preparation, certain improvements shall be required. Poor material shall be removed in the thickness of 30-50 cm and replaced with material of better quality (gravel or debris).

1.3.4.5.3.5. Other geotechnical recommendations

- Dewatering and drainage of ground and surface waters

Dewatering and drainage of waters from slope sides shall be discussed in separate designs. Cut and side cut sections shall be provided with stormwater sewage system to discharge water accumulated on the pavement surface.

Water in the close proximity of the studied alignment shall be taken and channeled outside the highway area.

Water accumulated on the asphalt pavement shall be channeled into roadside systems to escape twisting of pavement.

- Resoiling and grass seeding

Upon completion, slopes shall be resoiled with 20 cm thick layer and covered with grass. Top soil stripped down in the thickness of 10-30 cm during the embankment construction may be reused for resoiling. However, considering sandy composition and poor content of organic matters (roots only) this material is not completely appropriate and therefore material taken from other locations will be required.

- Transitions from embankments to structures - ″wedges″

Wedges made of non-coherent material along structures are constructed in order to eliminate deformation on the contact line between the embankment and the relevant structure.

In addition to small openings in the lower embankment segments, the studied section will be also provided with culverts exceeding 10 m in width. These locations must be provided with wedges.

Wedge sizes depend on embankment height.

Wedges shall be constructed of sandy gravel or stone debris of appropriate grain size. Previously defined construction method shall apply (0.3 – 0.5 m thick layer) together with compaction.

- Material stockpiles

Construction of the embankment will commence once the ground masses have been properly planned.

Massive block materials from side cuts must be transported outside the alignment. Establishment of temporary stockpiling areas for top soil material will be required. Top soil shall be latter used for covering of slope embankments.

- Local arterials

Traffic on adjoining roads will be completely cancelled after completion of the studied highway. Therefore local roads that will cross the highway or run below it will be constructed.

1.3.4.5.4. Stockpiling of surplus material along the highway route

Selection of alternative locations for stockpiling of material obtained in excavation is supposed to be a significant problem in the narrow area of the Juzna Morava River. Steep slopes, areas covered by forest or segments of ground composed of Quaternary formations stabile under certain conditions have imposed certain restrictions for stockpiling on slope segments above the highway alignment.

More precise instructions for possible selection of local stockpiling areas have not been obtained through contacts with competent authorities in Leskovac Municipality.

Therefore, possibilities to stockpile the excavated material on lower slope segments below the highway alignment in suitable alluvial flat formations positioned on the left and partly on right side of J. Morava River have been considered. These locations will occupy areas of arable lands. However since these segments of ground are not populated they will not affect the future spatial developments. Stockpiling of material on similar areas on the territory of Leskovac Municipality, outside the alignment and gorge has also show certain restrictions. It should be taken into account that on the segment of the highway alignment: Grdelica – Gornje Polje section, deficit of 400.000 m^3 of material for embankment construction has been identified which will be in compliance with the surplus material obtained on this segment of the alignment.

Considering huge quantities (about 420.000 m^3) of surplus material excavated along the highway alignment, it is not possible to define a unique stockpile area. However, certain microlocations for stockpiling may be identified.

The most rational solution (considering restrictions referring to land acquisition, recultivation, etc) is to select certain small locations within the section along the existing alignment characterized with lowest transport costs.

Possible local stockpiling areas are identified on edge parts of alluvium formations, higher embankments and areas not planned for regulation of the J. Morava riverbed i.e. stockpiling areas will occupy segments of alluvial formations between the river and the highway alignment.

Alternative stockpiling areas will be situated at following km points:

Chainage according to highway alignment chainage	Approximate stockpile height (m)	Stockpile area (m^2)	Material volume (m^3)
1. km 881+950 - km 882+250 left from the highway.	4	> 11 800	47 000

Therefore, stockpiling of all surplus materials and selection for their further use shall be enabled at stockpile areas positioned in the vicinity of the construction site.

1.3.4.5.6. Geotechnical requirements for stockpiling

In the course of stockpiling, material shall be selected, and stone and coherent materials separated. After unloading, material will be mechanically leveled. On the segment reserved for stockpiling of coherent formations, especially neo-coherent sandy gravel sediments, top soil shall be stripped down and soil mechanically stabilized. Stockpile slopes shall be inclined at 1. 1.5 - 1:2 (coherent materials) and 1:1 - 2:1 (stone materials). The permanent surplus materials shall not be compacted in the course of spreading. In stockpile bases (closest to the riverbed) the coarsest material shall be stockpiled at the places not affected by erosion process during flood events.

1.3.4.5.7. POSSEBILITY FOR USE OF BORROW PITS FOR STONE, DEBRIS, EARTHEN AND SANDY-GRAVEL MATERIALS FROM CUTS, SIDE CUTS, AND REGULATIONS FOR CONSTRUCTION OF EMBNAKMENTS ALONG THE HIGWAY

Qualitative stone material to be used for superstructure (bituminous aggregate or carbonate crushed stone) is hard to be found in the close proximity of the studied alignment. The required quantities of this material must be transported from the nearest certified quarry. On the other side, sandy gravel material for subbase preparation may be found in adequate quantities and provided from alternative borrow pits from the riverbed or in the course of excavation performed for the purpose of regulation of the J. Morava river bed.

2.0 DESIGN BASIS

2.1 LAWS AND REGULATIONS

The legal framework for final design included the following laws, codes and regulations:

- Law on Planning and Construction (Official Gazette of the Republic of Serbia, No. 72/09)
- Law on Public Roads (Official Gazette of the Republic of Serbia, No. 101/05)
- Law on Waters (Official Gazette of the Republic of Serbia, No. 46/91)
- Law on Protection of Water Sources (Official Gazette of the Republic of Serbia, 27/77)
- Safety at Work Act (Official Gazette of the Republic of Serbia, No. 42/91)
- Law on Amendments to Safety at Work Act (Official Gazette of the Republic of Serbia, No. 53/93)
- Law on Protection of Cultural Heritage (Official Gazette of the Republic of Serbia, 28/77).
- Amendment to Law on Protection of Cultural Heritage (Official Gazette of the Republic of Serbia, Nos. 34/81 and 47/84)
- Law on Land Acquisition (Official Gazette of the Republic of Serbia, No. 53/95)
- Law on Soil Investigations (Official Gazette of the Republic of Serbia, No. 44/95)
- Environmental Law (Official Gazette of the Republic of Serbia, No. 135/04)
- Law on Strategic Environmental Impact Assessment (Official Gazette of the Republic of Serbia, No. 135/04)
- Law on Amendments to Law on Planning and Construction (Official Gazette of the Republic of Serbia, No. 34/06)
- Law on Occupational Health Act (Official Gazette of the Republic of Serbia No. 101/05).
- Code on technical standards for defining bridge loading diagram (Official Gazette of the SFRY, No. 1/91)
- Code on maintenance of arterial and regional roads (Official Gazette of the Republic of Serbia, No. 2/93)
- Code on technical standards and specifications for design and construction of road tunnels (Official Gazette of the SFRY, No. 59/73)
- Code on road traffic signs (Official Gazette of the Republic of Serbia, No.15/05)
- Technical code on installation of overhead electrical lines of 1 kV to 400 kV (Official Gazette of the SFRY, No. 65/88)
- Code on basic traffic safety criteria for public roads outside urban area (Official Gazette of the SFRY, No. 35/81)
- Code on environmental impact assessment of structures and/or works (Official Gazette of the Republic of Serbia, No. 61/92)
- Code on defining and maintaining sanitary zones and belts around water supply facilities (Official Gazette of the Republic of Serbia, No. 33/78)
- Standards - SRPS for structural members and design
- Methodology of road design – Civil Engineering Faculty, Belgrade, 1993 and other relevant laws and regulations

2.2 ARCHIVAL DOCUMENTATION

2.3. TOPOGRAPHIC MAPS

Topographic maps in 1:1000 scale were prepared in Saobraćajni institut CIP, Belgrade and used in the final design stage.

Maps in 1:25 000 scale were used to get a better impression of space and traffic and for hydrological analyses.

2.4. LAND USES

The highway section is located in the Juzna Morava River corridor. The highway runs alternatively along the left and right river banks. The corridor also includes other traffic arteries such as: M1 arterial road, Nis – Skopje railway line and R-214 regional road. In addition, high speed railway line shall be constructed in the same area. The general conceptual design of this railway line was prepared in 1998 but it was not verified by Commission for technical control and the only point where highway crosses over the railway line is at km 876+718.80, at different levels. In the meantime, the concept of future railway traffic changed a lot and it can be considered that the mentioned project is time-barred.

Due to unfavorable conditions (steep slopes of Grdelicka gorge, torrential nature of the river and lateral watercourses, relatively small area of arable lands, etc.) small settlements were formed along the old road running through valley of the Juzna Morava River which was the only traffic artery (except the railway line) towards the south till twenty sixties.

Design of traffic infrastructure in this corridor is very complex and requires harmonization of old and new traffic arteries, settlements and watercourses in the narrow space of Grdelicka gorge under specific geological and geotechnical conditions.

The future highway will mainly occupy areas under forests, meadows and pasture ground and arable land to smaller extent. It will run through urban areas belonging to municipalities of Leskovac, Vladicin Han, Vranje and Bujanovac. This highway section passes through the following cadastral municipalities: Bojsina, Bocevica, Graovo, Palojce, Licin Dol, Krpejce, Koraćevac, Predejane, Bricevlje, Repiste and Susevlje, all in Leskovac municipality.

2.5. ZONES AND THEIR PROTECTION

The preliminary environmental study attached to the Preliminary design identified risks and impacts of the highway in its immediate surroundings. This kind of knowledge was one of determining factors to make a choice of road corridor.

The Final design includes protective measures against highway impact to the environment.

Depending on local conditions appropriate measures were planned for:

- Air pollution
- Noise level (in settlements),
- Soil contamination (arable land, pastures and forests)
- Concentration of harmful matters in rainwater, and
- Concentration of harmful matters in watercourses.

Protective measures were planned for the safety of regular traffic operations with forecast traffic load and for accidents with extreme risks and contamination levels.

The designed highway section will run through settlements: Oraovica, Boćevac, Palojska Rosulja and Predejane and intersect streams of: the Juzna Morava River, the Palojska River, Govedarski brook, Caricin brook and several small watercourses.

As it was necessary to prevent intolerable air pollution, the road route had to be placed in a corridor beyond the settlement boundaries, i.e. at a distance which will guarantee that harmful gas concentration will fall to an acceptable level before arriving to the boundaries of the protected zone.

Protection against intolerable noise may be effected with walls and specific cross sections in critical zones (cuttings) or even by speed limit.

The surrounding grounds and water streams shall be protected from chemical contamination by preventing uncontrolled spill of pavement runoff by channeling and guiding it properly.

Accident risk is a statistical category that depends on the number of environmentally risky vehicles in traffic. Therefore protective measures include list of equipment allocated for intervention in case of environmentally risky traffic accidents.

2.6. ROADS AND TECHNICAL INFRASTRUCTURE

Moravsko-Vardarska valley is the most suitable natural corridor for land connection between Europe and Asia and therefore this is a traffic route from ancient times. It means that traffic infrastructure was developed over centuries and the studied area was treated in the projects which were not implemented.

R214 regional road is the oldest road in this corridor modernized to the needed and possible extent. Nis - Skopje – Athens main railway line and R 214 regional road run along the corridor of M1 arterial road which follows stream of the Juzna Morava River. When M1 road was constructed R214 road lost its role of intercontinental road and today serves for local needs.

According to the Spatial Plan of the Republic of Serbia, planned traffic-related structures in this corridor are: highway (treated in this design), railway line for high-speed trains (or modernization of main railway line for speed of 160 km/h or higher).

2.6.1 Technical infrastructure

The highway alignment was defined in the Preliminary design. It runs through the valley of the Juzna Morava River so that its influence is noticeable along the whole route. Apart from the river, natural negative effects considered in the design were: erosion activity of 1st and 2nd category river basin and torrential watercourses of 1st and 2nd priority in regard to the designed road while erosional river basin of 3rd category has conditionally positive effects.

Impacts in the water resources management were also grouped in two categories: negative and conditionally negative. Negative impacts may occur in the sanitary zones of water sources and water supply systems while conditionally negative ones in flood zones.

The existing electrical infrastructure shall be reconstructed to meet the needs of the highway. At crossing points 10 KV overhead lines will be converted to buried cables. Collisions with the existing 35 KV, 110 KV and 400 KV lines will be eliminated by reconstruction of overhead lines enabling overhead crossing.

New electrical energy facilities will have to be designed for Predejane interchange.

In addition to electrical energy facilities, mechanical installations for tunnel ventilation, fire fighting installations (injectors, sprinklers, etc.) and video monitoring shall be provided for "Predejane" tunnel.

The following telecommunication equipment is located in the highway area: long-distance coaxial cable, optic cable and automatic telephone exchange in Predejane.

2.7. Engineering geological and geotechnical conditions

Geotechnical soil investigations for the Final design were performed on the basis of the following facts:

Soil investigations for the Preliminary design were performed pursuant to the Design of geotechnical investigations for E 75 Leskovac (Grabovnica) – Macedonian border road, km 865+845,65 - km 964+337 (L=98.492 km). For the Final design geotechnical investigations were supplemented to the required level.

Geotechnical investigations were grouped into: investigations for road alignment, engineering structures, buildings and borrow pits.

Geotechnical investigations were performed at the right angle to the alignment and/or centre lines of designed structures.

3.0. FUNCTIONAL AND TECHNICAL CHARACTERISTICS OF APPLIED DESIGN CONCEPTS

3.1. LIMITING ELEMENTS IN PLAN AND PROFILE

3.1.1. Limiting elements in plan and profile for highway alignment

Limiting elements include calculation of minimum and maximum values in the layout, longitudinal profile, cross section and sight distance depending on design speed on the road section - Vr = 100 km/h.

Layout:

- Maximum tangent length — max L = 2000 m
- Minimum radius of horizontal curve — min R = 450 m
- Minimum radius of horizontal curve with i_{pk} — min R' = 3000 m
- Minimum length of transition curve — min L = 110 m
- Minimum stopping sight distance with i_n = 1% — min Pz = 180 m
- Maximum width of visibility zone — max b_p = 9.2 m

Longitudinal profile:

- Maximum longitudinal gradient — max i_n = 5%
- Minimum longitudinal gradient — min in = 0% - embankment; min in = 0.5% - cutting
- Maximum superelevation — max i_{rv} = 0.75%
- Minimum radius of vertical curve sag — min R_v = 5000 m
- Minimum radius of vertical curve crest — min Rv = 7500 m

Cross section:

- Width of traffic lane for continuous driving — t_v = 3,50 +3.50m
- Width of emergency lane — t_z = 2.50 m
- Width of verge — t_i = 0.35 i 0.2 m
- Width of shoulder — b = 1.0 m i 1.5 m.
- Minimum crossfall of pavement — min i_p= 2.5%
- Maximum crossfall of pavement in curve — max i_{pk} = 7%

The applied elements may equal limiting ones or be better.

3.1.2. Limiting elements in plan and profile for alternative road

Limiting elements include calculation of minimum and maximum values in the layout, longitudinal profile, cross section and sight distance depending on design speed on the road section - Vr = 60 km/h and road category and they are related to reconstruction or relocation of arterial road.

Layout:

- Maximum tangent length — max L = 1200 m
- Minimum radius of horizontal curve — min R = 120 m
- minimum radius of horizontal curve with i_{pk} — min R' = 2000 m
- Minimum length of transition curve — min L = 50 m

Longitudinal profile:

- Maximum longitudinal gradient — max i_n = 7%
- Minimum longitudinal gradient — min in = 0% - embankment; min in = 0.5% - cutting
- Maximum superelevation — max i_{rv} = 1.0%

- Minimum radius of vertical curve sag — min R_V = 1100 m
- Minimum radius of vertical curve crest — min Rv = 700 m

Cross section:

- Width of traffic lane for continuous driving — t_v = 3.0 m
- Width of verge — t_i = 0.3 m
- Width of shoulder — b = 1.0 m
- Minimum crossfall of pavement — min i_p= 2.5%
- Maximum cross fall of pavement in curve — max i_{pk} = 7%

The applied elements may equal limiting ones or be better.

3.2. TYPICAL CROSS SECTIONS

A typical cross section is standard solution in standard field and traffic conditions. It defines physical scale of road structure, interrelations among the applied elements and resolves standard structural details. Based on traffic load forecast, traffic composition, road category and designed speed (Vr=100 km/h) the following cross section was adopted for geometry of a highway with two carriageways:

• Travel lanes 4 x 3.50 m	14.00 m
• Emergency lanes 2 x 2.50 m =	10.00 m
• Verges 2 x (0.35 m + 0.20 m) =	1.10 m
• Shoulders 2 x 1.00 or 2x1.5 m =	2.00 m(3.0) m
• Central reserve	4.00 m
Total width	**26.10 m**

Shoulder of 1.50 m in width was designed at the point of erection of noise walls according to the separate design – protective measures against environmental impacts of the highway.

Topsoil of required thickness shall be stripped and stockpiled as specified in the technical specifications to be reused on embankment and cutting slopes.

If a new embankment lies on ground steeper than 20%, slopes shall be benched.

Pavement on straight road section shall have symmetrical crossfall camber of i_p=2.5% and uniform crossfall in curve of 2.5% ≤ i_{pk} ≤ 7% towards the curve center. Shoulder inclination is 4% at higher pavement side and 7% along lower pavement edge directed outwards.

The subsoil shall fall same as the pavement except where the roadway is superelevated when its fall will remain 2.5% for I_{pk}< 2.5%.

The pavement design calls for substitution of material in subsoil, 30-50 cm thick per km points and of the thickness specified in the pavement design.

In cuttings this means excavating down to the specified depth beneath subsoil level and filling high-quality material where necessary.

Top subgrade layer of designed thickness in embankment shall be constructed of materials of specified geotechnical properties.

Central reserve shall have crossfall camber of minimum 4% directed inwards. A single two-sided safety barrier shall be erected along the central reserve with the highest point 0.75 m above pavement edges.

The central reserve area shall be topsoiled with 15 cm thick humus layer and planted with grass and other low greenery provided it does not interfere with visibility.

Roadbed slope inclinations are the result of consideration of geotechnical parameters, aesthetic and safety criteria and quantity and usability of local materials.

The geotechnical report recommends maximum embankment and cutting slope inclinations to ensure their stability.

From the section start point to the section end point recommended slope inclinations are: 1:1.5 for cuttings and 1:2 for embankments.

The adopted slope inclinations in cuttings will remain 1:2 in shallow cuttings and side cuts and 1:5 in very deep cuttings. In the area with rocks, cutting slope inclinations will be 10:1 and slopes shall be protected with lining wall depending on cutting depth and rock mass condition.

There are three slope protection types. Embankment slope inclinations were adopted according to safety criteria as follows:

- Inclination of embankment slope up to 3 m high will be 1:1.5 or 1:2;
- Inclination of embankment slope 3-6 m high and higher than 6 m will be 1:1.5 along the first 3 m measured from the embankment crown and 1:2 at the bottom segment;
- Along the embankment section which slope shall be protected with a revetment from flood waters of the Juzna Morava River, i.e. in the bridge zone, slope inclination will be 1:2 regardless of embankment height. Embankment slopes inclined at 1:1 to 1.1.5 shall be protected i.e. lined.

Along the whole section road periodically runs over rock soil generally in very deep cuttings or side cuts.

Cutting slope inclinations recommended for that soil are: 10:1 on sections up to 8 m high next to 3 m wide berms and 1:2 in shallower cuttings which surface layer is generally of diluvial origin.

The contact area between embankment/cutting slopes and the ground shall be rounded off to create an impression of roadbed blending in the surroundings in the following way:

- For slope height h ≥ 2 m the rounding tangent is T = 3.0 m
- For slope height h < 2 m the rounding tangent is T = 1.5 x

In addition to rounding off, slopes shall be planted with grass and appropriate biological cover, provided always that the principles of traffic safety and optic guidance are observed.

At the same time plants shall serve as protection against erosion. Besides, vegetation will act as an air filter between highway and rare arable lands as it will retain solids of dust and soot and heavy metals partially.

Surface and riparian waters will be efficiently discharged in surface channels, gutters and underground sewers.

For central reserve on straight section with camber crossfall, drainage elements were not designed because run-off flows towards outer pavement edges.

In curves with uniform crossfall, runoff water from inside pavement area will flow towards the edge while 0.75 m wide triangular concrete gutter placed next to pavement edge will receive run-off from outside pavement area which flows towards the central reserve. Run-off from gutters will be received by rainwater sewers and gullies outside the gutters.

In a cutting, along shoulder edge, 1.5 m wide segmental ditch minimum 0.30 m deep below subsoil level will receive pavement runoff. Perimeter intercepting ditch shall be provided on the top of deep cutting slopes and on berms.

On embankments higher than 3 m the curb next to emergency lane edge will protect embankment slope against erosion. Water will flow down the embankment slope through concrete drain channels placed at maximum 50 m spacing.

Considering that the highway is a high category road, it will be protected with a wire fence placed along both road sides. The safety wire fence shall be placed at 1.0 m spacing from the most distant point of cross section. The outside area of safety wire fence, 5.0 m wide, will serve for operation of farming machinery, where possible. It cannot be achieved in the area between the highway and the existing railway line where distance between the railway center line and edge of highway superstructure is 8 m.

The safety wire fence designed in this way has two functions:

- It will protect highway users against animals and people unforeseeably rushing out to highway which can be fatal both for passengers and any strayed pedestrian or animal on the road of this category with high-speed traffic.

- At the same time, it will border state-owned road land maintained by the highway operator. A land strip 5.0 m wide on the fence outside also belongs to a road land and will serve for movement of farming machinery and pedestrians and for access to arable lands located next to highway. If possible, local roads will be located next to this land strip, when necessary.

Land acquisition required for whole road will be effected prior to start of works.

3.3 LAYOUT AND LONGITUDINAL PROFILE

The layout of highway alignment is the result of all known superposed factors of influence shown on thematic and synthesis maps of constraints (topography, geological, geotechnical, hydrological, spatial and urban planning requirements – land use, locations of settlements, traffic infrastructure, utilities and environmental impacts). As it was mentioned above, the highway alignment is already defined in the adopted Preliminary design.

In the highway alignment two different topographic characteristics can be distinguished:

- Highway alignment passing along the Juzna Morava River through plain land on diluvium, and

- Highway alignment passing over steep slope generally on the left river bank in side cut or deep cutting where it turns into alignment on rolling and hilly ground.

These two different topographic characteristics alternate along the whole designed highway section.

Near Predejane village the highway alternatively passes from the left to the right river bank including the bridge at km 881+150.00, "touches" Predejane railway station area, passes through flatland and at the point where the Predejanska River empties into the Juzna Morava River it crosses the sixth big bridge over the Morava River at km 881+700.00.

The reference level on this section is "raised" by about 2.0 m in relation to railway station area due to level of the Morava flood flow i.e. due to proximity of bridges in order to ensure required "gap" between flood flow level and the level of bottom edge of structure.

On this section the layout shows that minimum elements of horizontal plan were applied. Because of ground configuration, changes from flatland to hilly ground and tendency to reduce earthworks, the highway alignment was designed with horizontal curve radii R = 450 and minimal transition curves and therefore due to higher refracted angles it meanders between the river and left bank slope. Finally, the highway passes over the last bridge on the Juzna Morava River at km 883+100.00 and continues along the right river bank. This bridge is one of the biggest structures on this section because the highway crosses over the river, the existing Nis – Skopje railway line and R – 214 road and runs straight between the railway line and M1 road to the section end point. The highest longitudinal gradient of reference level of 3.82% was designed on the bridge.

This bridge is incorporated in the final concept of Predejane interchange.

The highway alignment on the right river bank is straight to the section end point with applied elements of horizontal plan above the minimum ones and sporadically grade-separated pavement due to slope alignment in flatland/rolling ground. The only problematical point on this section is need to relocate the existing M1 road in length of about 1300 m because it was impossible to squeeze the highway in the terrain profile between M1 road, railway line and river. Being in dilemma either to relocate the river bed in length of about 350 m and railway line in length of about 550 m and left M1 road to remain on its location or to relocate M1 road without interfering with the river and railway line, the design engineer chose the second option. The road was relocated to slope leftward from the existing M1 road because the left carriageway will be laid next to the road alignment using sporadically the existing pavement as a bed for the new carriageway. The section end point is at km 885+522.77 and the next section through Grdelicka gorge is Caricina dolina - Vladicin Han section designed by the Highway Institute, Belgrade. The section starts at km 873+719.941 and its end point at said km point is adjusted to preceding and next sections in line and grade. Two design organizations cooperated very efficiently over the last months during preparation of the design documentation.

Median openings on this highway section were designed at the following km points: km 881+450

The number of median openings is somewhat higher than usually, but they were designed for maintenance of many bridges on this section in order to easily redirect traffic flow on shorter sections.

Tunnel traffic management center shall be constructed at km 879+875.00 next to tunnel exit portal on the left carriageway.

3.4. CROSS SECTIONS

Cross sections of this highway section were designed at each 25 m for the final design level with all necessary data based on which all applied solutions can be recognized. Width of pavement, shoulders, gutters and green belt was already mentioned in this report and total highway length is 26.10 m when carriageways are not separated horizontally. Carriageways are frequently separated by more than 4 m what is a width of green belt due to reduced earthworks when highway assumes slope alignment or it is done to ensure required visibility in curves.

In addition, there is a difference in shoulder width: on the preceding section shoulder was 1.5 m wide as compared to 1.0 m on this section (except at places envisaged for installation of noise walls where shoulder is 1.5 m wide). To the first bridge over the Juzna Morava River the highway alignment is in cutting and passes over the river at level lower than a level of the existing bridge on M1 road but sufficiently high as compared to flood flow level. After reaching the right river bank the highway is on embankment squeezed between the railway line and river against which is protected by revetment on the right embankment slope up to 0.5 m above the forecast flood flow level which occurs once in 100 years. Supporting structure will be installed on the section envisaged for relocation of the Morava River and sidewise displacement of river bed to ten-year water level. It will protect a highway base against any harmful effects of the river and above that level up to 0.5 m above the (100-year) flood flow level the mentioned revetment will have the same function. River training, supporting structure and revetment are treated in the separate design.

After reaching the left river bank, highway profile is completely changed and since the highway alignment passes through hilly ground, a side cut or cutting (often deep) exists in its cross section. On this section the highway was designed through different geological strata from debris on surface, 1 – 2 m in depth, weathered shales or weathering shales in the next stratum to hard shales – compact rock which must be blasted during excavation. Slope in such cuttings or side cuts were designed at inclination of 5:1, up to 8 m high with berm at eighth meter, 3.0 m wide in the rock as protection of possible rockfall because shales exposed to long-time weathering lose their compactness.

This solution includes protection of slopes with sprayed concrete or anchors.

On the highway section where carriageways are grade separated and if highway passes through rocks, one of three protection methods was designed depending on rock mass condition. Retaining wall was designed at points where highway runs through diluvium/proluvium or along the river with grade-separated carriageways.

The highway passes near Predejane village and its cross section there is interesting. As already said, because of bridges near villages the reference level was raised by 2.0 m approx. in relation to the existing railway station area of Predejane on the Nis – Skopje railway line. In order to protect Predejane station against negative effects of the highway, retaining walls with concrete channels were designed in the station area to enable proper drainage of railway facilities in the station area.

To the section end point there are no highway sections of interest and they are not treated in this report. Cross sections of flatland and rolling/hilly ground are at alternation. Cross sections were designed in 1:200 scale for A1 size drawing and/or 1:400 for A3 size drawing.

3.5. DRAINAGE

Highway drainage was designed in standard manner. Pavement run-off will be discharged through concrete gutters and ditches to water receiving body, such as: the Juzna Morava River and several lateral watercourses and dry ravines over which the highway passes.

On this highway section and along the whole highway length from Leskovac to Macedonian border pavement run-off is not treated prior to discharging into rivers and brooks, it is directly discharged into rivers and brooks near the highway through pavement drainage system.

There are two highway drainage systems:

- Pavement drainage system which in addition to gutters and ditches includes sewage system with gullies, inspection manholes and lateral discharge down the embankment slope or into ditches along the highway or into lateral watercourses and/or culverts. Rainwater sewage system can be always applied in long cuttings where run-off in the gutter with low flow capacity must sporadically be “cut” and pavement run-off discharged away from the highway base through the gully.
- Raised curb was designed on high embankments at lower pavement side to prevent run-off spill over shoulder - the special gutters along the curb will receive pavement run-off which will be discharged down the embankment slope sporadically at specific points. It was envisaged on the section where ditches were designed on embankment between the railway line and highway to receive water run-off from highway pavement and from slopes of road and railway line and

beyond the track area. This drainage method also includes drainage of riparian waters. The highway is protected against riparian water with perimeter ditch in cuttings or side cuts where the ditch was designed at the end of cutting slope or placed on the berm of certain “section” in the cutting slope.

Drainage of capillary water was not designed except at beginning of the section due to several reasons. The major length of highway alignment passes through rocks in cuttings and side cuts where capillary water cannot occur. Highway embankments will be constructed of high-quality material from excavation pit on the alignment or from borrow pit (sandy gravel material from regulated section of the Morava River mixed with shales from excavation pit) with top subgrade layer of crushed shales so that there is no risk of capillary water. For that reason it was not treated in this design, except on the beginning of highway alignment.

Structures, bridges, viaducts and culverts, except concrete pipes of 2.0 m dia. were treated in the separate volume – Structures. Some pipe culverts on lateral watercourses were designed within regulation and stilling of streams and their designs and investment value are included into the volume: Pipe culverts. Concrete culverts of 2.0 m dia. were designed for easy maintenance because their length in the embankment base is about 35 m and over. That length is significantly shorter on the highway section with grade-separated carriageways and manhole in the green belt and therefore pipes of minor diameter from 1.0 m to 1.5 m were designed.

3.6. EARTHWORKS

Earth works are extensive. The highway alignment partially passes through hilly ground with deep cuttings and through flatland along the Juzna Morava River with high embankments as protection against flood flow.

3.7. PAVEMENT STRUCTURE

This chapter gives a summary of design concepts for highway pavement structure:

1. Pavement structure on travel and emergency lanes
2. Pavement structure in cuttings and side cuts
   2.1 In cuttings and side cuts in rocks
   2.2 In cuttings and side cuts in mixed material
3. Pavement structure on approaches to "Predejane" grade-separated junction
4. Pavement structure on bridges (structures) along the main alignment and on overpasses within grade-separated junctions
5. Pavement structure on "Predejane" toll station
6. Pavement structure on local roads
7. Pavement structure on relocated sections of M1 road
8. Pavement structure in "Predejane" tunnel

3.7.1. New pavement structure of highway on embankment

The adopted design concept for new pavement structure on travel and emergency lanes of E 75 highway on embankment is shown on Figure 3.1.

<table>
<tr><th>Travel and fast lanes</th><th>Emergency lane</th></tr>
<tr><td>SMA 0/11s - surfacing 4 cm</td><td>SMA 0/11s - surfacing 4 cm</td></tr>
<tr><td>BNS 22 sA 8 cm base course</td><td>BNS 22 sA 8 cm base course</td></tr>
<tr><td>BNS 22 sA 8 cm base course</td><td rowspan="3">DK 0/31 38 cm broken stone</td></tr>
<tr><td>DK 0/31 15 cm broken stone</td></tr>
<tr><td>DK 0/31 15 cm broken stone</td></tr>
<tr><td>subsoil CBR ≥ 10%
top embankment layer - of stable stone material, 0/63 mm
70 cm</td><td>subsoil CBR ≥ 10%
top embankment layer - of stable stone material, 0/63 mm
70 cm</td></tr>
</table>

Figure 3.1 Schematic view of flexible pavement structure for new E 75 highway lanes on embankment

In order to attain predefined load-bearing capacity of the whole road base, designed permanent load-bearing capacity at subsoil top level shall be assisted with 70 cm thick layer of 0/63 mm stable stone material placed in the top embankment layer where elasticity modulus shall be E = 120 MPa.

3.7.2. Pavement structure in cuttings and side cuts

3.7.2.1 In cuttings and side cuts in rocks

Cuttings or side cuts in rocks are present on some highway stretches. Considering that load-bearing capacity of the existing material on these stretches is higher than required load-bearing capacity of bed, dimensions of loose material in sub-base can be reduced.

The adopted design concept for new pavement structure on travel and emergency lanes of E 75 highway is shown on Figure 3.2

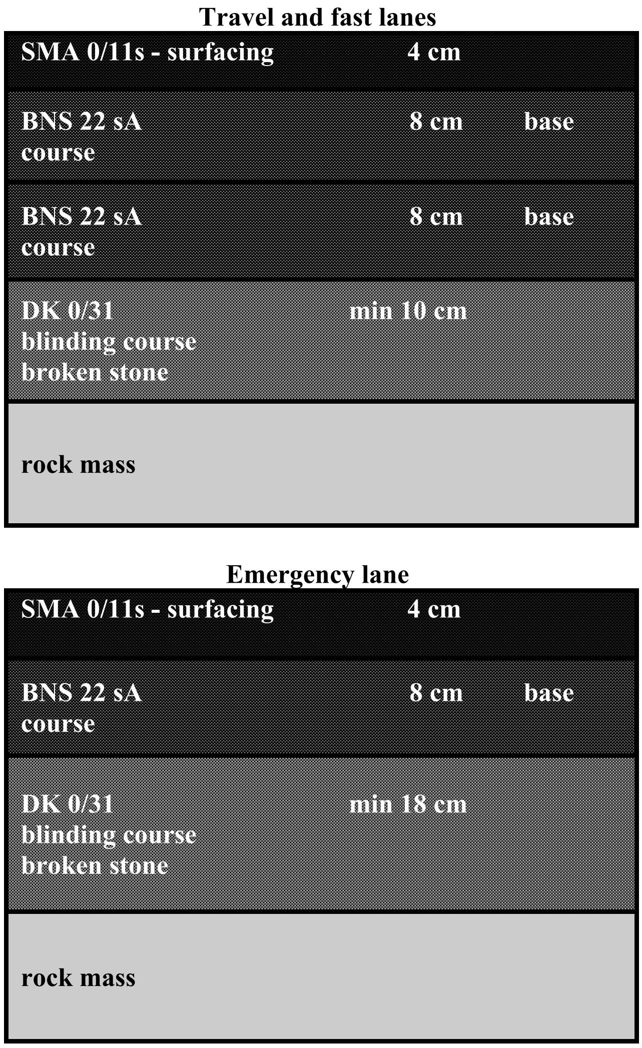


Figure 3.2 Schematic view of pavement structure cross section of new highway lane in the rock and stone area

3.7.2.2 In cuttings and side cuts in mixed material

Cuttings or side cuts in mixed material are present on some highway stretches. Considering that load-bearing capacity of the existing material on these stretches expressed by CBR $\geq$ 5% is lower than required design value ($CBR_{min} \geq 10\%$), local soil shall be chemically stabilized with 30 cm thick layer of cement/lime in order to attain required subsoil load-bearing capacity.

The adopted design concept for new pavement structure on travel and emergency lanes of E 75 highway in cutting and side cut in chemically stabilized mixed local soil is shown on Figure 3.3.

Travel and fast lanes	Emergency lane
SMA 0/11s - surfacing 4 cm	**SMA 0/11s - surfacing 4 cm**
BNS 22 sA 8 cm base course	**BNS 22 sA 8 cm base course**
BNS 22 sA 8 cm base course	**DK 0/31 38 cm broken stone**
DK 0/31 15 cm broken stone	
DK 0/31 15 cm broken stone	
subsoil CBR $\geq$ 10% **subsoil of mixed local soil chemically stabilized and improved with cement and lime 70 cm**	**subsoil CBR $\geq$ 10%** **subsoil of mixed local soil chemically stabilized and improved with cement and lime 70 cm**

Figure 3.3 Schematic view of flexible pavement structure for new E 75 highway lanes in cutting and side cut

Chemical stabilization of the existing material will be performed in cutting/side cut on the following highway stretches:

km 880+825.00 to km 880+875.00
km 882+150.00 to km 882+225.00
km 882+300.00 to km 882+500.00
km 882+675.00 to km 882+775.00
km 883+300.00 to km 883+575.00
km 883+650.00 to km 884+875.00
km 885+100.00 to km 885+175.00
km 885+425.00 to km 885+522.78

Note:
Alternative design concept – If approved by the Supervising Engineer and the Contractor, material can be substituted and subsoil stabilized in cutting and side cut by using stable stone material (rock) from the local borrow pit (tunnel, cutting, side cut) in 70 cm thick layer.

3.7.3. Pavement structure on approaches to Predejane grade-separated junction (interchange)

The adopted design concept for new pavement structure on approaches to “Predejane” interchange is shown on Figure 3.4.

AB 11s - surfacing 6 cm
BNS 22 sA 10 cm base course
DK 0/31 15 cm broken stone
DK 0/31 15 cm broken stone
subsoil CBR $\geq$ 10 % **top embankment layer of stable stone material, 0/63 mm** **50 cm**

Figure 3.4 Schematic view of pavement structure on approaches to “Predejane“ interchange

3.7.4. Pavement structure on bridges and overpasses

The adopted design concept for new pavement structure on bridges along the E75 highway, Gornje polje - Caricina dolina section, is shown on Figure 3.5.

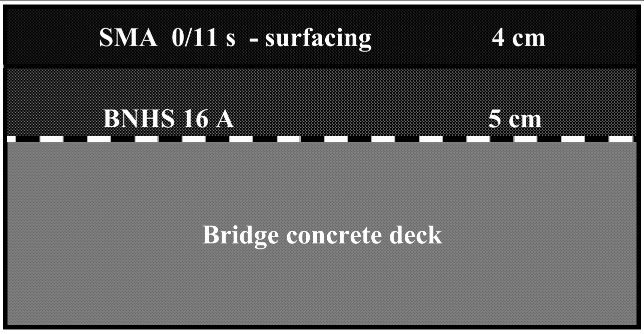


Figure 3.5 Schematic view of pavement structure on bridges along the E 75 highway with ~ 1.0 cm thick waterproofing layer

The adopted design concept for new pavement structure on overpasses is shown on Figure 3.6.

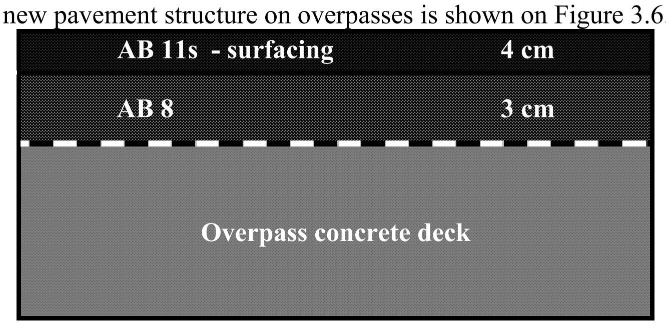
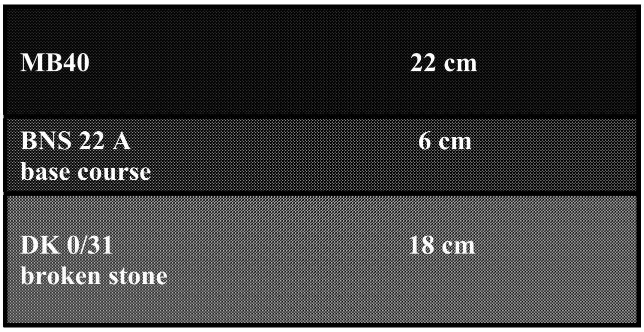


Figure 3.6 Schematic view of pavement structure on overpasses with ~ 1.0 cm thick waterproofing layer

3.7.5. Pavement structure on „Predejane“ toll station

The adopted design concept for new pavement structure on “Predejane” toll station is shown on Figure 3.7.

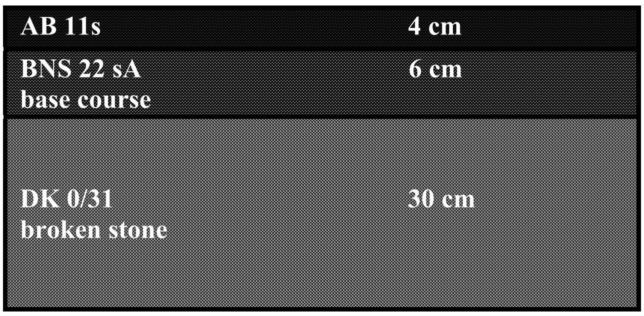


subsoil CBR $\geq$ 5%

Figure 3.7 Schematic view of pavement structure on " Predejane" toll station

3.7.6. Pavement structure on local roads

The adopted design concept for new pavement structure on local roads is shown on Figure 3.8.



subsoil CBR $\geq$ 5%

Figure 3.8 Schematic view of pavement structure on local roads

3.7.7. Pavement structure on relocated sections of M - 1 road

The adopted design concept for new pavement structure on relocated sections of M - 1 road is shown on Figure 3.9.

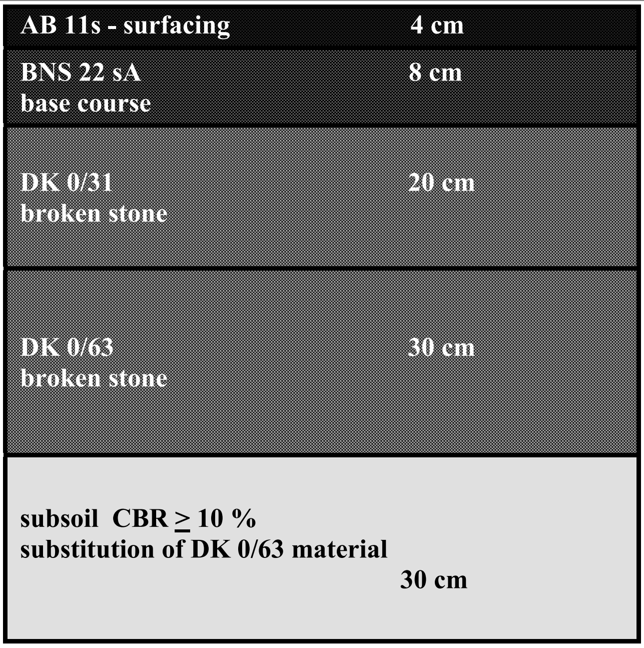


Figure 3.9 Schematic view of pavement structure on M 1 road

3.8. DESIGN OF "PREDEJANE" GRADE-SEPARATED JUNCTION

3.8.1. GEOTECHNICAL REQUIREMENTS FOR CONSTRUCTION OF “PREDEJANE” INTERCHANGE

″Predejane″ interchange connects local roads and highway and allows circular connections in both directions. The interchange is designed at km 882+650 to km 883+650 and will enable connection between the designed E 75 highway and the existing M1 arterial road (in the final design concept it will be classified as regional road R-214).

Three structures shall be constructed within the interchange area. The interchange mostly lays on embankment up to 6 m in height and its minor part is in up to 4 m deep cutting.

Designed structures will enable crossing over the Nis – Presevo main railway line which is located between the existing M1 road and the designed E 75 highway.

Embankment and cutting slopes will be inclined at 1:1.5 and 1:2 (alleviated in embankment toe) while some slopes will be provided with supporting structures in order to make slopes shorter.

Data obtained after detailed engineering geological mapping of ground and exploratory boring were used for definition of geotechnical requirements for construction of structures integrated in the interchange.

″Predejane″ interchange alignment is shown in detail in graphical documentation K2-S1-C6. The structures within ″Predejane″ interchange area were shown in detail in the book K2-S2 Structures.

3.8.2. RESULTS OF GEOTECHNICAL INVESTIGATIONS FOR BORROW PITS

High-quality stone material for superstructure – bituminous aggregate or bed made of crushed broken stone cannot be found in the immediate vicinity of highway alignment. Required quantities of this material must be supplied from the nearest certified quarry. More favorable situation is found with material (sandy gravel) for construction of sub-base which quantity is sufficient for this highway section. It can be provided from alternative borrow pits, from river bed or from excavation area for the Juzna Morava regulation.

For construction of newly designed highway about 926 600 m^3 of material can be provided from excavation pit out of which about 398 000 m^3 (II-III excavation category) will be diluvial-proluvial and detritus-earth materials and about 518 000 m^3 rock shales (IV-V and rarely VI excavation category).

For construction of embankment about 557 000 m^3 of material are required. When these quantities were measured, embankment profiles made of reinforced earth and retaining walls were not taken into consideration. That embankment was measured in the Book 7.

Based on preliminary analyses total mass was rebalanced so that total surplus material for earthworks is ~ 360 000 m^3.

Possible local stockpiles will be: highway sections on higher embankments, sections where the Juzna Morava River will not be regulated and/or on bank sections with alluvial deposits between the river and designed highway alignment, sections without compressible layers in the bed and sections where additional filling out of highway base will not have influence on highway stability and the Juzna Morava flow.

The above-mentioned sections are:

Km point	Stockpile area (m2)
km 874+850-km 875+125	10 300
km 875+800-km876+075	15 200
km 877+440-km877+725	22 800
km 880+200-km880+600	37 300
km 881+950-km882+250	11 800
Total: 5 stockpiles	Total: 97 400 m2

In that way all surplus excavated material can be stockpiled in the vicinity and materials selected according to grading for different fillings.

Final decision on stockpiles for surplus excavated material is presented in the Book K3.

Regarding slope blasting, smooth blasting down the slope is better due to small shattering of slope mass and better fragmentation.

Coarse blocks obtained by blasting can be used for filling – enlargement of river bank (embankment) in the area envisaged for regulation of the Juzna Morava River.

3.9.3. TOPOGRAPHIC MAPS

Topographic maps in 1:1000 scale were prepared in Saobraćajni institut CIP, Belgrade and used in the final design stage.

Maps in 1:5 000 scale were used to get a better impression of space and traffic and for hydrological analyses.

3.8.4. LIMITING ELEMENTS IN PLAN AND PROFILE FOR "PREDEJANE" INTERCHANGE

Limiting elements include calculation of minimum and maximum values in the layout, longitudinal profile, cross section and sight distance depending on design speed - V_r = 60 km/h being the maximum speed on grade-separated junction. Speed on some approach and exit junction legs is V_r = 40-60 km/h and limiting elements are adjusted to that speed.

Layout:

• Minimum radius of horizontal curve	min R = 50 m
• Minimum radius of horizontal curve with i_{pk}	min R' = 2000 m
• Minimum length of transition curve	min L = 30-50 m

Longitudinal profile:

• Maximum longitudinal gradient	max i_n = 5%
• Minimum longitudinal gradient	min i_n= 0% - embankment min i_n= 0.5% - cutting
• Maximum superelevation	max i_{rv} = 1.5%
• Minimum radius of vertical curve sag	min R_v = 1250 m
• Minimum radius of vertical curve crest	min R_v = 1250 m

Cross section (bidirectional traffic):

• Width of traffic lane for continuous driving	t_v = 4.80 m
• Width of verge	t_i = 0.35 m
Central reserve	R_t = 2.0 m
• Width of shoulder	b = 1.5 m
• Minimum crossfall of pavement	min i_p= 2.5%
• Maximum crossfall of pavement in curve	max i_{pk} = 6%

Cross section (unidirectional traffic):

• Width of traffic lane for continuous driving	t_v = 4.8 m
• Width of verge	t_i = 0.35 m
• Width of shoulder	b = 1.5 m
• Minimum crossfall of pavement	min i_p= 2,5%
• Maximum crossfall of pavement in curve	max i_{pk} = 6%

Cross section (interchange – bidirectional traffic – after toll station):

• Width of traffic lane for continuous driving	t_v = 3.50 m
• Width of verge	t_i = 0.35 m
• Width of shoulder	b = 1.5 m
• Minimum crossfall of pavement	min i_p= 2.5%
• Maximum crossfall of pavement in curve	max i_{pk} = 6%

Limiting elements of pavement cross section:

- Bidirectional traffic:
  - Travel lanes 2x4.80 m
  - Verges 4x0.35 m
  - Central reserve 2.00 m
  - Shoulders 2x1.50 m

  TOTAL: **16.00 m**

- Unidirectional traffic:
  - Travel lanes 4.80 m
  - Verges 2x0.35 m
  - Shoulders 2x1.50 m

  TOTAL: **8.50 m**

are taken from the Terms of Reference.

3.8.5. TYPICAL CROSS SECTION

A typical cross section is standard solution in standard field and traffic conditions. It defines physical scale of road structure, interrelations among the applied elements and resolves standard structural details.

Topsoil of required thickness shall be stripped and stockpiled as specified in the technical specifications to be reused on embankment and cutting slopes.

Pavement on the bidirectional straight section in the interchange shall have uniform crossfall of i_p=2.5% which in curve is i_{pmax}=6.0% towards the curve center.

Center line of bidirectional pavement is the midst of central reserve.

Pavement on unidirectional straight section in the interchange shall have uniform crossfall of i_p=2.5% which in curve is i_{pmax}=6.0% towards the curve center.

Center line of unidirectional pavement is right pavement edge.

Shoulder inclination is 4% at higher pavement side and 7% along lower pavement edge directed outwards.

Subsoil shall have minimum inclination of i_{pmin}=2.5% or follow pavement inclination when it is higher than 2.5%.

Top subgrade layer of designed thickness in embankment shall be constructed of materials of specified geotechnical properties.

Typical cross section of bidirectional central route in the interchange includes travel lanes B=5.50 m with central reserve R_t=2.0 m in between. Travel lanes have uniform gradient i_p=2.5% (tangent section) and/or i_{pmax}=6.0% (in curve).

Curbs of 20/30 cm in height shall be placed along the central reserve. If standard 18/24 cm curbs were designed, flexible barrier in the central reserve would be necessary. In that case lighting poles for grade-separated junction couldn’t be erected in the midst of central reserve (which is rational solution) but two rows of poles would be erected along the pavement edges. For this reason 20/30 cm curbs were designed so that flexible barrier will be unnecessary and space for lighting poles provided.

On the cross section of bidirectional central route in the interchange gully was designed along the lower edge of higher carriageway. The gully will collect run-off from higher carriageway and through transverse Ø160 mm sewer it will be discharged into concrete channel units down the embankment slope. Distance between channel units shall be maximum 30 m. Position of gullies and transverse pipes and relevant measurements are given in the Book 5: Drainage design.

For drainage of run-off from sections where grade-separated junction is in high embankment, 18/24 cm curbs were designed on the profile lower side to collect pavement run-off which will be discharged into concrete channel units down the embankment slope. Distance between channel units shall be maximum 30 m.

On high embankments (higher than 3 m) single-sided flexible barrier was designed on both pavement sides. The highest point of flexible barrier is at 0.75 m above the pavement level. Horizontal distance between flexible barrier and pavement edge is 0.50 m.

Central reserve next to cross section of central route in the interchange will be abandoned at the beginning of toll area enlargement.

Typical cross section of interchange center line after toll station includes:

- Travel lanes 2x3.50 m
- Verges 2x0.35 m
- Shoulders 2x1.50 m

TOTAL: **10.70 m**

Roadbed slope inclinations are the result of a consideration of geotechnical parameters, aesthetic and safety criteria and quantity and usability of local materials.

The geotechnical report recommends maximum embankment and cutting slope inclinations to ensure their stability.

Embankment slope inclinations were adopted according to safety criteria as follows:

- Inclination of embankment slope up to 3 m high will be 1:1.5
- Inclination of embankment slope 3-6 m high will be 1:1.5 along the first 3 m measured from the embankment crown and 1:2 at the bottom segment.

The contact area between embankment/cutting slopes and the ground shall be rounded off to create an impression of roadbed blending in the surroundings in the following way:

- For slope height $h \geq 2$ m the rounding tangent is $T = 3.0$ m
- For slope height $h < 2$ m the rounding tangent is $T = 1.5$ m

In addition to rounding off, slopes shall be planted with grass and appropriate biological cover, provided always that the principles of traffic safety and optic guidance are observed.

At the same time plants shall serve as protection against erosion. Besides, vegetation will act as an air filter between highway and rare arable lands as it will retain solids of dust and soot and heavy metals partially.

Surface and riparian waters will be efficiently discharged in earth ditches, gutters, channel units and surface channels down the embankment slope into surrounding ground.

Shoulders and embankment slopes will be topsoiled with 20 cm thick humus layer and planted with grass.

Considering that the highway is high-category road it will be protected with a wire fence placed along both road sides including "Predejane" interchange. The safety wire fence shall be placed at 1.0 m spacing from the most distant point of cross section. The outside area of safety wire fence, 5.0 m wide, will serve for operation of farming machinery, where possible. The fence borders state-owned road land maintained by the highway operator. A land strip, 5.0 m wide on the fence outside also belongs to a road land.

Land acquisition required for whole highway will be effected at one time and highway land will be fenced regardless of phased construction.

3.8.6. CROSS SECTION AND LONGITUDINAL PROFILE

"Predejane" interchange is the only grade-separated junction on this section. It is located southeastward from Predejane village at distance of about 2 km. The interchange cannot be classified into one specific type; it looks like two "semi-interchanges" merged just before the toll station. Such design concept was imposed by big spatial constraints (relief, M1 arterial road, railway line, the Juzna Morava River and new highway) existing in the small area within Grdelicka gorge. Such design concept of "Predejane" interchange was elaborated in the adopted Preliminary design. The only deviation from the Preliminary design is relocation of interchange link to M1 arterial road due to enlargement of toll area (introduction of modernized toll system).

1. Bidirectional central route in the interchange 1

"Predejane" interchange starts at grade junction with M1 arterial road at distance of about 2 km from Predejane village. The existing pavement in the junction area (20 cm from the edge for AB course; 15 cm from the edge for BNS course) will be cut out and the existing pavement enlarged as designed. M1 road will be enlarged only on the lower, right side because higher slopes and retaining walls in some places are located on the left road side. Centerline and the existing reference level of M1 arterial road in the junction area will be completely retained and the enlargement made in accordance with crossfall of the existing pavement.

After junction, bidirectional central route in the interchange 1 in curve (R=40 m, A1=0, A2=35) is located in the narrow area between M1 road and railway line.

At location of toll area, pavement will be enlarged on both sides. Toll area is located on tangent road section. After toll station, central route in the interchange 1 remains straight to the end. On the section after toll station, a level link to central route in the interchange 2 was designed. In that way bidirectional traffic from both highway directions will be connected before toll station.

Bidirectional central route in the interchange 1 connects ingress/egress lane from Macedonia direction. Total length of bidirectional central route in the interchange 1 is 340.05 m.

In the beginning a reference level of central route in the interchange 1 has gradient of 2.50% for adjustment into new junction and/or crossfall of M1 arterial road. Afterwards a gradient changes into 0.5% to the end point (km 0+340.05) meaning that toll station area has the same gradient.

Central route in the interchange 1 at point where central reserve R_t=2.0 m was designed shall have uniform crossfall of i_p=2.5% (on tangent section).

Cross section of central route in the interchange 1 from km 0+150 to the end point shall be provided with an embankment of reinforced earth with protection wall on the right side to protect railway line clearance. Minimum distance between the edge of embankment made of reinforced earth and the railway line is 8.0 m or over.

2. Bidirectional central route in the interchange 2

The layout shows that bidirectional central route in the interchange 2 is almost vertical to centerline of interchange 1 and crosses over the existing railway line and the Juzna Morava River. It is straight in whole length.

Bidirectional central route in the interchange 2 connects ingress/egress lane from Nis direction. Total length of bidirectional central route in the interchange is 40.22 m.

A reference level of central route in the interchange 2 has gradient of 2.55% in whole length which is resulting crossfall of central route in the interchange 1.

Central route in the interchange 2 with central reserve R_t=2.0 m (on whole length) has camber crossfall of i_p=2.5%.

3. Leg 1 – unidirectional traffic

Leg 1 is egress lane from Nis direction. At km 0+219.37 leg 1 will be physically separated from the highway and at km 0+754.53 it will be fitted to central route in the interchange 2. When separated from the highway, leg 1 passes under the bridge along which the highway crosses over the Juzna Morava River and railway line. Afterwards the route of leg 1 runs in curves R=50 m, A=40 and R=50 m, A=50 and will be fitted to centerline of interchange 2.

Total length of leg 1 is L=754.53 m. Width of leg 1 is B=5.50 m.

Reference level of leg 1 is defined from the point of physical separation from the highway (km 0+219.37). A section of leg 1 preceding that km point is defined in highway cross sections.

When separated from the highway, a reference level of leg 1 follows the resulting inclination (longitudinal gradient and crossfall) of highway in the separation point (ascending gradient of 2.17%) and then it continues freely. The longitudinal profile shows a line of pavement levels on the highway edge at separation point.

Vertical clearance between the highway and bridge above the highway is 7.48 m.

At the end point of longitudinal profile a reference level of leg 1 will be fitted into the reference level of centerline of interchange 2 and/or to a line of pavement levels on the edge of central route in the interchange 2.

4. Leg 2 - unidirectional traffic

Leg 2 is ingress lane for Nis direction. At the beginning centerline of leg 2 is a continuation of centerline of interchange 2. Afterwards the leg 2 runs in curve A1=90, R=160 m, A=200 and fits into highway centerline.

Total length of leg 2 is L=439.62 m. Width of leg 2 is B=5.50 m.

Reference level of leg 2 is defined from the beginning – it is continuation of reference level of central route in the interchange 2 and/or of line of pavement levels on the edge of central route in the interchange 2 and then it continues freely.

At the end of defined section of longitudinal profile, reference level of leg 2 will be fitted into the resulting inclination (longitudinal gradient and crossfall) of highway (ascending gradient of 1.76%). The longitudinal profile shows a line of pavement levels on the highway edge at the joining point.

Reference level of leg 1 is defined to the point of physical joining to the highway (km 0+226.02). A section of leg 2 after this km point is defined in highway cross sections.

5. Leg 3 - unidirectional traffic

Leg 3 is ingress lane for Macedonian border direction. At the beginning centerline of leg 3 is a continuation of centerline of interchange 1. Afterwards the leg 3 runs in curve A=140, R=320 m, A=140 almost in parallel to railway line and passes under the bridge along which the highway crosses over the Juzna Morava River and railway line. Afterwards the route of leg 3 runs in curve A=160, R=420 m, A=160 approaches and fits into the highway centerline.

Total length of leg 3 is L=958.37 m. Width of leg 3 is B=5.50 m.

Reference level of leg 3 is defined from the beginning – it is continuation of reference level of central route in the interchange 1 and/or of line of pavement levels on the edge of central route in the interchange 1 and then it continues freely.

Vertical clearance between the highway and bridge above the highway is 6.04 m.

At the end of defined section of longitudinal profile, reference level of leg 3 will be fitted into the resulting inclination (longitudinal gradient and crossfall) of highway (descending gradient of 2.69%). The longitudinal profile shows a line of pavement levels on the highway edge at the joining point.

Reference level of leg 3 is defined to the point of physical joining to the highway (km 0+741.94). A section of leg 3 after this km point is defined in highway cross sections.

Longitudinal profile of leg 3 from the start point to km 0+110 includes embankment of reinforced earth with protection wall on the right side to protect railway line clearance. Minimum distance between the edge of embankment made of reinforced earth and railway line is 8.0 m or over.

6. Leg 4 - unidirectional traffic

Leg 4 is egress lane for Macedonian border direction. At km 0+227.55 leg 4 will be physically separated from the highway and then it will run in parallel to M1 arterial road at necessary distance to adjust the reference level of these two sections. Leg 4 alignment runs through two codirectional curves of R=1500 m and its centerline fits into the center line of interchange 1.

Total length of leg 4 is L= 623.94 m. Width of leg 4 is B=5.50 m.

Reference level of leg 4 is defined from the point of physical separation from the highway (km 0+227.55). A section of leg 4 to this km point is defined in highway cross sections.

After separation from the highway the reference level of leg 4 follows the resulting highway inclination (longitudinal gradient and crossfall) at separation point (ascending gradient of 1.67%) and then it continues freely. The longitudinal profile shows a line of pavement levels on the highway edge at the separation point.

At the end point of longitudinal profile, the reference level of leg 4 will be adjusted to the reference level of central route in the interchange 1, namely to the line of pavement levels on the edge of central route in the interchange 1.

Retaining wall is designed rightward between the leg 4 and M1 arterial road and it can be seen in the cross section of leg 4 from the start point to km 0+304.00. Supporting structure is not required for spacing between center lines and relationship between reference levels but concrete wall is necessary because of conditionally stable slope. For same reason this supporting structure also continues on highway cross sections before physical separation of leg 4.

3.8.7. DRAINAGE

1. Bidirectional central route in the interchange

Bidirectional central route in the interchange 1 will be drained down the lower shoulder.

On the high embankment section, 18/24 cm curbs were designed on the lower profile side to collect pavement run-off which then will be discharged into concrete channel units down the embankment slope. Maximum distance between channel units is 30 m. Arrangement and km points of channel units are shown in the layout of central route in the interchange 1.

On the embankment section where the right embankment side is made of reinforced earth, surface drainage will be performed down the lower shoulder. A curb along the lower pavement edge was not designed on that section because channel units would pool pavement run-off at some sections of this embankment. In that way uniform drainage down the whole embankment of reinforced earth was enabled.

Leftward from the central route in the interchange 1 drainage will be performed through earth ditches which will channelize the run-off to a culvert at km 0+224.61 and to a bridge over Bakarni brook. These ditches serve for drainage of whole area between the central route in the interchange 1 and M1 arterial road.

2. Leg 1 – unidirectional traffic

Leg 1 will be drained down the lower shoulder.

On the high embankment section, 18/24 cm curbs were designed on the lower profile side to collect pavement run-off which then will be discharged into concrete channel units down the embankment slope. Maximum distance between channel units is 30 m. Arrangement and km points of channel units are shown in the layout of leg 1.

After separation from the highway earth ditch was designed rightward in the embankment toe as extension of similar highway ditch. At same time this ditch will receive riparian water.

The earth ditch ends at km 0+420.00 (because it will not be necessary anymore) where embankment slope revetment starts (rightwards) due to flood flow of the Juzna Morava River and continues to the beginning of a bridge on the leg 1.

Pipe culvert, Ø1000, was designed at km 0+535.00 to discharge run-off collected in the leg 1 area through road base to the Juzna Morava River.

3. Leg 2 - unidirectional traffic

Leg 2 will be drained down the lower shoulder.

On the high embankment section, 18/24 cm curbs were designed on the lower profile side to collect pavement run-off which then will be discharged into concrete channel units down the embankment slope. Maximum distance between channel units is 30 m. Arrangement and km points of channel units are shown in the layout of leg 2.

Earth ditch was designed leftward in the embankment toe to receive run-off from the area between the highway and leg 2.

From the bridge start point to km 0+240.00 a revetment was designed rightward due to flood flow of the Juzna Morava River.

Pipe culvert, Ø2000, was designed at km 0+167.81. A pipe culvert was also designed on the highway and regulated section of ravine brook passes through these two culverts rightward from the highway.

4. Leg 3 - unidirectional traffic

Leg 3 will be drained down the lower shoulder.

On the high embankment section, 18/24 cm curbs were designed on the lower profile side to collect pavement run-off which then will be discharged into concrete channel units down the embankment slope. Maximum distance between channel units is 30 m. Arrangement and km points of channel units are shown in the layout of leg 3.

On the embankment section where embankment of reinforced earth was rightward designed, surface drainage will be performed down the lower shoulder. A curb along the lower pavement edge was not designed on that section because channel units would pool pavement run-off at some sections of this embankment. In that way uniform drainage down the whole embankment of reinforced earth was enabled.

After embankment made of reinforced earth, earth ditch between the leg 3 and the railway line was designed to channelize collected run-off to arch culvert on the railway line and further on toward the Juzna Morava River.

Concrete gutter was designed leftward along the pavement edge to collect run-off from leg 4 to the leg 3 branching off point. When conditions for earth ditch in the embankment toe are created concrete gutter will be abandoned and ditch water channelized to Ø2000 pipe culvert at km 0+184.50 and further on through above-mentioned arch culvert on the railway line.

At the point where leg 3 passes under the highway, earth ditch in the embankment toe was designed to collect run-off from the area between the highway and the leg 3 and to retain it beyond the leg 3 base. This ditch extends leftwards to the joining point of leg 3 and highway.

5. Leg 4 - unidirectional traffic

Leg 4 will be drained down the lower shoulder.

On the high embankment section, 18/24 cm curbs were designed on the lower profile side to collect pavement run-off which then will be discharged into concrete channel units down the embankment slope. Maximum distance between channel units is 30 m. Arrangement and km points of channel units are shown in the layout of leg 4.

Pipe culvert, Ø2000, was designed at km 0+386.20. It is an extension of the existing arch culvert, L=2.0 m on M1 arterial road. When discharged from the new pipe culvert, a run-off will be channelized through open earth channel to pipe culvert on leg 3 (km 0+184.50) and further on to the existing arch culvert on the railway line.

Concrete gutter was designed rightward along the pavement edge to receive run-off from the slope between M1 arterial road and leg 4. From km 0+340.98 (it is the highest point on the pavement) run-off from concrete gutter will be channelized backward to the highway and forward to earth ditch at km 0+575.00 and further on to pipe culvert on the central route in the interchange 1 (km 0+224.61).

3.8.8. PAVEMENT STRUCTURE

Pavement structure designed on the approach ramps of “Predejane” interchange includes:

Wearing course AB 11s	6 cm	
Base course BNS 22sA	10 cm	
Sub-base of 0/31.5 mm broken stone	30 cm	
TOTAL		**46 cm**

Pavement structure designed on the toll station at “Predejane” interchange includes:

Cement concrete MB 40	22 cm	
Base course BNS 22A	6 cm	
Sub-base of 0/31.5 mm broken stone	18 cm	
TOTAL		**46 cm**

Pavement structure on toll station will cover an area from front end to back end of platform enlargement, km 0+122.63 - km 0+261.93.

Pavement structure designed on the enlargement of M1 arterial road in the interchange area includes:

Wearing course AB 11s	4 cm	
Base course BNS 22sA	8 cm	
Sub-base of 0/31.5 mm broken stone	20 cm	
Subgrade of 0/63mm broken stone	30 cm	
TOTAL		**62 cm**

Detailed calculations of pavement structure are presented in the Book 4: Pavement structure design.

3.8.9. TRAFFIC SIGNALIZATION AND EQUIPMENT

Book 7: Design of traffic signalization and equipment includes needed calculations, sketches and drawings and here is presented a short abstract from that design.

"Predejane" interchange

1. Traffic signs and signals

“Predejane” interchange is located at km 883+250.00. The interchange area starts at **km 881+600.00 to km 884+650.00**. An approach is marked with IV information stages.

- Interchange ahead – board indicating interchange name will be mounted at 1500 m from the exit.

- First information stage from Nis direction is sign III-72 (1) indicating "Vranje - Vranje" straight ahead and "Predejane - Predejane" right turn. Bridge over the Juzna Morava River was designed at 1000 m from the start point of egress lane and therefore this sign will be mounted at distance of 1200 m from the start point of egress lane.
- Second information stage is sign III-65.1 mounted on Γ gantry indicating a start point of egress lane.
- Sign III-66 "EXIT" together with a direction sign informs road users about the exit from highway (third stage)
- As fourth information stage after the interchange, confirmatory sign III-61 (1) shows kilometer distances to Presevo, Bujanovac, Vranje and Vladicin Han or V.Han abbreviated.

Signs for the opposite highway direction are identically mounted. Sign III-72 (2) was used for the first information stage. The straight ahead board contains lettering: "Nis - Nis" and right turn board lettering: "Predejane - Predejane". It shall be mounted at 1000 m from the start point of egress lane. The confirmatory sign III-61 (2) contains kilometer distances to Belgrade, Nis and Leskovac. Details of these signs are given in the attachment.

The sign III-19 on the ingress ramp confirms category of a road ahead. The sign II-1 mounted on the same post with the sign II-43 emphasizes priority and mandatory direction. Immediately before the ingress lane the sign II-43 (mandatory direction) is mounted on the right pavement side.

According to interchange curve radii, speed is limited to 50 km/h and/or 60 km/h. Traffic lanes to Nis and Presevo direction are physically separated.

2. Road markings

The interchange approach is characterized by 0.2 m wide continuous edge lines and 0.2 m wide centerline of 6-12 m pattern. At point of change of roadway construction width where Γ gantry will be installed, right edge line stops to be continuous and becomes 0.3 m wide broken line of 3-3 m pattern. In front of divisional island a belt between the edge line of ramp and edge line of next highway section will be marked with white painted area up to 2 m wide. An empty area, 2 m long, will be marked twenty meters after end point of that area. The exit from highway will be identically marked, except that continuous line will be 30 m long.

Slanted limit line on egress lane will be 30 m long while slanted limit line on ingress lane will be 45 m long. Interchange centerline is continuous, 0.2 m wide. Supplier of road marking elements shall apply and position them and guarantee the quality of work. This is the only way to choose the Contractor.

3. Traffic equipment

The equipment includes direction posts, single-sided safety barrier and retroreflective studs.

In order to perceive the over-all road size, direction signs shall be positioned on the existing shoulder. The direction sign consists of sign for daylight driving (daytime sign) and sign for night driving (nighttime sign) fixed to white support. Daylight sign is in the form of black rhomb positioned at 30° angle so that a vertex is oriented towards pavement while night sign is made of light-reflective retroreflective material. Red rectangle shall be positioned rightwards while two minor white rectangles leftwards one above the other. The supports are white and so designed that they do not present any risk to drivers hitting them. They shall be installed just on the outer shoulder edge. In the graphic documentation a direction post is marked with a circle divided in two halves (red and white) which position is shown in the layout.

Direction posts shall be erected at places without single-sided safety barrier at minimum spacing of 24 m. A drawing shows position of studs on barrier. Direction signs shall face them. Direction posts of type approved by the Investor shall be procured and erected.

Retroreflective studs shall be installed on barrier according to SRPS and observing pattern given in tables in the attachment. These elements are marked in the layout with a circle divided in two halves - red and white.

Each of non-standard boards is protected with single-sided safety barrier, type H1W5, 60 m ahead and 16 m behind. Γ gantry is designed in the interchange area. It will be protected with single-sided safety barrier H2W4 type, same distances. This gantry is standard for highway. The price includes manufacture and installation of gantry and its base. Lighting elements will be installed along all interchange legs and they must be protected with safety barrier. At points where speed is reduced to 50 km/h, installation of safety barrier was studied case by case.
Toll collection and/or signalization and elements of toll collection at Predejane interchange are not treated in this design.

"Predejane" level junction

1. Traffic signs and signals

Speed on interchange approaches is limited to 40 km/h and/or 60 km/h. In addition, interchange ahead signs III-8 will be uniformly mounted on all approaches and direction board III-13 in the very interchange area. They designate approaching direction. Direction 1-3 is indicated for major road and direction 2 for secondary road. Vehicles may enter the traffic stream from the secondary approach where they respect the traffic sign. Sign II-1 is designed on the approach 1 for right turn.

2. Road markings

The interchange approach is characterized by 0.12 m wide continuous edge lines. Broken center line is of 3-3 m pattern and 0.12 m wide. Section of the pavement not intended for traffic can be approached along the channelizing area. Characteristic distances are indicated on the drawing.

Supplier of road marking elements shall apply and position them and guarantee the quality of work. This is the only way to choose the Contractor.

3. Traffic equipment

The equipment includes direction posts, single-sided safety barrier and retroreflective studs.

In order to perceive the over-all road size, direction signs shall be positioned on the existing shoulder. The direction sign consists of sign for daylight driving (daytime sign) and sign for night driving (nighttime sign) fixed to white support. Daylight sign is in the form of black rhomb positioned at 30° angle so that a vertex is oriented towards pavement while night sign is made of light-reflective retroreflective material. Red rectangle shall be positioned rightwards while two minor white rectangles leftwards one above the other. The supports are white and so designed that they do not present any risk to drivers hitting them. They shall be installed just on the outer shoulder edge. In the graphic documentation a direction post is marked with a circle divided in two halves (red and white) which position is shown in the layout.

Direction posts shall be erected at places without single-sided safety barrier at spacing indicated in the table. A drawing shows position of direction signs. Direction posts of type approved by the Investor shall be procured and erected.

3.8.10. TOLL STATION

Toll area begins at km 0+122.63 and ends at km 0+261.93. Central reserve next to bidirectional central route in the interchange stops at the front end of toll station and the paved area continues in full width of 13.00 m.

Pavement shall be enlarged on both sides at location planned for toll station. Toll area will be on straight highway section. A profile of central route in the interchange is 13.00 m wide at the front end of toll station and 7.70 m wide at its back end and that will be a width of pavement connecting "Predejane" interchange and M1 arterial road which will become regional road after highway construction.

The toll area shall be enlarged by curves of 100 m radii. In that way vehicles from highway will be channelized to toll station with minimum turning. The same curve radii are applied to reduce the width of toll station area. On the other side toll station area shall be enlarged by curves of 50 m radii for vehicles entering the highway.

Toll station will have 4 (four) toll collection points, one on the outer ramp side for electronic toll collection and for out-sized vehicles and one for manual toll collection.

An island in toll area shall be 52.0 m long what is appropriate for electronic toll collection. The island is 2.20 m wide.

The adopted Preliminary design includes 3 (three) toll lanes, one for each direction and the middle lane when necessary for one or another traffic direction. Installation of modernized toll system including electronic toll collection was not discussed at a time of preparation of the Preliminary design. The Investor's decision to install modernized toll system resulted in change of toll lanes because in the new toll system one lane cannot be used for both directions. For that reason number of toll lanes was increased from 3 to 4.

Moreover, length of toll area was increased to be appropriate for 52.0 m long island. For that reason grade junction (link between the interchange and M1 arterial road) was relocated as compared to the Preliminary design.

In the toll area the reference level has ascending gradient of 0.5% (as km points increase). In this way efficient longitudinal and cross drainage of toll station area was enabled.

The Terms of Reference does not specify if there is a need for service facilities. The Designer has envisaged an area for service facilities, if necessary. It is included in the right-of-way.

According to the Terms of Reference, infrastructure facilities in toll area (toll equipment, toll islands, water pipes, sewers, electric power supply, telephony, etc.) and facilities for toll station staff, offices, rooms for police needs etc. will be specified in the special urban development plan pursuant to provisions of detailed regulation plan for the section from Nis to Macedonian border. It will be treated in the separate design (Toll station design). This design includes an area for these purposes.

Traffic control center shall be constructed for whole section from Nis to Macedonian border but its exact location is a subject-matter of separate design. At a time of preparation of this report the Investor did not contract elaboration of design for Traffic control center.

A platform (5.0x5.0 m) for pole-mounted transformer which will feed a toll station with electric current is designed leftwards in the area intended for service facilities at the front end of toll area enlargement.

Toll station will be supplied with power from outdoor distribution and metering cabinet (MRO) via RR00 4x16 mm^2 cable which shall be connected to cable termination box. This phase does not include a cabin and platform so that tentative length of feeder cable is given in the design. This design did not treat indoor installations in the facilities.

3.8.11. LIGHTING SYSTEM ON GRADE-SEPARATED JUNCTION

The design includes lighting system on "Bujanovac 2" grade-separated junction and power supply to facilities of toll area on the Srpska Kuća – Levosoje section (km 934+354,725 – km 942+413,318) of the E 75 Belgrade - Nis - Skopje highway.

1. Public lighting system

Design concept of road lighting system was prepared according to CEI 115 recommendations from 1995 as shown in the relevant photometric calculation.

Twenty seven lighting poles, 13 m high with 1.5 m long double arms will be centrally arranged along the highway. The poles will be made of iron, round, tapered, hot galvanized inside and outside and provided with anti-vandal locks similar to AMIGA KRS-A 13/76 type with LR arms. Light fitting ONIX 3N/1399/250/B5 with SON-T-PLUS lamps of 250 W will be used. Poles will be planted at 45 spacing.

The lighting system on access roads (interchange legs) includes 76 poles, 9 m high, also made of iron, round, tapered, hot galvanized inside and outside and provided with anti-vandal locks similar to AMIGA KRS-A 9/76 type. Light fittings ONIX 2N/1419/150/C3 with SON-T-PLUS lamps of 150 W shall be mounted directly to pole. Poles will be planted at 28 m – 33 m spacing.

All poles shall be provided with foundation slab and fixed to foundation with anchor bolts. On grade-separated interchange section the poles will be anchored to overpass concrete structure according to attached drawing. Bottom segment of each pole will be provided with connecting gear (three-phase power supply) with FRA 16/A fuses which will be used for feeding the light fittings with electric power via PP00-Y 3x2.5 mm^2 + Cu 2.5 mm^2 cables. The poles are designed for up to 30 m/s wind speed, for 150 kN/m^2 load-bearing capacity of a soil and to carry standard equipment from the catalogue (light fitting support, arm and flood light support).

Impedance bonds of dual power rating and control relay shall be installed in light fittings to enable full-night/half-night lighting regime by using 2.5 mm^2 Cu control conductor.

According to requirements of "Elektrodistribucija" Vranje regarding a power supply to lighting system on “Predejane” interchange and toll station facilities, 10 kV overhead line shall branch from the existing overhead line, "Jugokop" terminal of 35/10 kV transformer station "Svetlost" Bujanovac and 10/0.4 kV, 50 kVA pole-mounted transformer station will be installed along with standard low-voltage cabinet and corresponding number of low-voltage terminals.

The cabinet shall have a space for installation of 3x230/400 V 10-60 A three-phase electricity meter and NVO 125/63 A fuses. Lighting system will be controlled automatically via MTK-device (optional photo-relay or timer) with an option of manual control if necessary.

The cabinet and active energy meter shall be installed by "Elektrodistribucija" Vranje.

Public lighting poles shall be supplied with power from a low-voltage cabinet via 1 kV, PP00-A, 4x35 mm^2 cables based on “in/out” principle from one pole to another. A cable shall be laid in earth at minimum depth of 0.8 m and drawn through ∅110 mm hard plastic (‘Juvidur’) pipes at crossing points with communication lines.

TT system is designed for protection against indirect touch voltage. Galvanized strips FeZn 25x4 mm shall be placed in the same trench width 0.4 kV cable starting from the new 10/0.4 pole-mounted transformer station to the last pole. All metallic poles along the road lighting route shall be connected to galvanized strip by means of cross member, SRPS NB.4 936 placed in the housing which will be finally sealed with bitumen.

Lighting system on toll station will be installed in the next phase (after determination of toll station area dimensions) and shall include NEOS 3N/1709/400 light fittings with 400 W high pressure sodium lamps mounted on 13 m high poles (6 in total). Power will be supplied via 1kV, PP00-A, 4x35 mm^2 cable terminals from low-voltage cabinet in the transformer station.

2. Power supply for toll station

Toll station will be supplied with power from outdoor distribution and metering cabinet (RMO) via RR00 4x16mm^2 cable which shall be connected to cable termination box. This phase does not include a cabin and platform so that tentative length of feeder cable is given in the design. TN-C-S system is designed for protection against indirect touch voltage in each toll facility. Hard plastic (‘Juvidur’) pipes of ∅110 mm shall be laid at crossing points of feeder cable and communication lines. This design did not treat indoor installations in the facilities.

3.9. CROSSINGS WITH OTHER ROADS AND LOCAL ROAD NETWORK

3.9.1. DETOUR OF M1 ROAD

Position of highway alignment from km 883+475 to km 884+700 has conditioned a detour of the existing M1 state road of 1st category.

In order to define geometry of the existing M1 road in the best possible way, start point of defined center line does not coincide with the point where the work will commence i.e. detour alignment starts at km 0+133.23. From this km point along the curve of 500 m radius and A=190 parameter it branches from the existing M1 road and along the curve of R=700, A=230 follows the geometry of E 75 highway. At the end it is fitted into the current state along the curve of R=700, L=70. Total length of designed detour is 1289.68 (from km 0+133.23 to km 1+422.91).

Longitudinal road profile follows the road centerline. The detour reference level will allow the best possible position of that section in relation to the newly designed highway and the present terrain. Moreover, with regard to very unfavorable terrain, retaining walls between the highway and M1 road and towards the slope were designed. From km 0+950 to detour end point the reference level falls in relation to the existing M1 road in order to achieve the best possible detour position as compared to the newly designed highway. Maximum applied reference level gradient is 6%.

According to the Terms of Reference and the adopted Preliminary design, the detour width is:

Travel lanes	2 x 3.50	= 7.00 m
Verges	2 x 0.35	= 0.70 m
Shoulders	2 x 1.50	= 3.00 m

Crossfall of tangent road is 2.5% and up to 4.5% in curves. Designed shoulders have crossfall of 4% (on the higher pavement side) and 7% (on the lower pavement side). The alignment is mainly along the side cut.

Pavement run-off will be drained by gravity – it will naturally flow down the longitudinal gradient and crossfall and shoulder to the channels (gutters) i.e. embankment slopes. Riparian water will be collected in the perimeter channels and channelized to pipe and slab top culverts.

The following pavement structure was applied:

AB 11s .... 5.0 cm
BNS 22sA.. 7.0 cm
Stone aggregate, 0/31.5 mm..............20.0 cm
Stone aggregate, 0/63 mm.................25.0 cm
Subsoil

3.9.2. DETOUR OF LOCAL ROAD 4

The newly designed highway alignment crosses the existing local road made of broken stone at km 884+732.40. Detour of 284.63 m in length was designed in order to reinstate the interrupted local road network.

The layout shows that detour starts at point where it branches from the existing local road. The detour alignment was designed to satisfy criterion of minimum distance between the track centerline and requirement for minimum land acquisition. A bridge in the highway base will be used for road detour to cross over to the other highway side, namely road detour will pass under the bridge.

The first alignment section is tangent and then in several curves runs under the highway and joins the existing broken stone road. Radii of 30 m and 25 m were applied.

Longitudinal road profile follows the road centerline. With regard to ground characteristics, the detour reference level has significant inclination (9% at the very beginning of detour via 7% to 15% just before it joins the existing broken stone road).

According to Terms of Reference and the adopted Preliminary design, local road width amounts to 3 m with 0.8 m wide stabilized shoulders. Enlargements were designed in curves.

Crossfall of tangent road is 2.5% and 7.0% in curves. Designed shoulders have crossfall of 4% (higher pavement side) and 7% (lower pavement side).

The alignment initially runs along the side cut with minor earthworks. After passing under the highway and just before joining the existing broken stone road the alignment is on embankment. As shown on cross sections, embankment slope is inclined at 1:1.5 and cutting slope at 1:1.

Pavement run-off will be drained by gravity – it will naturally flow down the longitudinal gradient and crossfall and shoulder to the channels i.e. embankment slopes. From km 0+008 to km 0+200 gutter was designed leftwards to collect riparian water. Considering that gutter follows the road reference level, water collected in gutter will be drained into channel at km 0+008 and discharged through Ø 400 concrete pipe in the road base at km 0+005.62. In addition, water collected in gutter will be discharged into channel at km 0+200 and then at km 0+213.77 it will be discharged through Ø1000 concrete pipe in the road base and channelized towards the existing slab top culvert in the track base. From pipe culvert to detour end point lined channel was designed leftwards to channelize collected water to pipe culvert.

Slab top culvert of 3.6 m opening was designed over the brook at km 0+082.308.

Pavement structure is chosen on the basis of adopted Preliminary design and Terms of Reference, namely pavement made of broken stone was applied.

DK 0/31.5	15 cm
DK 0/63	20 cm
	35 cm

3.9.7. DETOUR OF LOCAL ROAD 5

At the very end of section the highway alignment is in collision with the existing local road. A detour of local road 5 from ~km 875+300 to ~km 885+500 was designed in order to enable communication. Total length of designed detour is 178.30 m.

The layout indicates that detour of local road 5 branches from the existing road and joins the existing local road just before the underpass in the M1 road base. The alignment passes over Caricin brook at km 0+115.37.

Longitudinal road profile follows the road centerline. The reference level follows the existing ground and has inclination of 3% - 6%.

According to Terms of Reference and the adopted Preliminary design, local road width amounts to 3 m with 0.8 m wide shoulders.

Crossfall of tangent road is 2.5% and 3.0% in curves. Designed shoulders have crossfall of 4% (higher shoulder) and 7% (lower shoulder).

Pavement run-off will be drained by gravity – it will naturally flow down the longitudinal gradient and crossfall and shoulder to the channels i.e. embankment slopes. Segment channel was designed rightwards between the highway and local road to receive run-off from pavement and embankment slopes and channelize it to slab top culvert on detour of local road 6.

Pavement structure is chosen on the basis of adopted Preliminary design and Terms of Reference, namely pavement made of broken stone was applied.

DK 0/31.5	15 cm
DK 0/63	20 cm
	35 cm

3.9.3. DETOUR OF LOCAL ROAD 6

At the very end of section the highway alignment is in collision with the existing local road. A detour of local road 5 and detour of local road 6 from ~km 875+300 to ~km 885+500 were designed in order to enable communication. Total length of designed detour 6 is 161.44 m.

Detour of local road 6 branches off at a junction from the local road 5, passes under the highway, runs in parallel to highway and finally joins the existing local road.

The reference level with inclination of 12% falls to underpass in the highway base and then follows the existing ground.

Pavement run-off will be drained by gravity – it will naturally flow down the longitudinal gradient and crossfall and shoulder to the channels i.e. embankment slopes. Segment channel was designed leftwards between the highway and local road to receive run-off from pavement and embankment slopes and channelize it to Ø1000 pipe culvert at km 0+061.00 on detour of local road 6.

Pavement structure is chosen on the basis of adopted Preliminary design and Terms of Reference, namely pavement made of broken stone was applied.

DK 0/31.5	15 cm
DK 0/63	20 cm
	35 cm

3.9.4. DETOUR OF LOCAL ROAD 6

A platform for transformer station required for the tunnel was designed next to entry portal of left tunnel tube at ~km 880+830 close to the existing local road. The existing road satisfying necessary access requirements (minimum width of 3 m and maximum gradient of 12%) is designed for approach to the above-mentioned platform.

After bridge over the Morava River, the existing local road will be reconstructed and enlarged as needed for the platform.

3.10. ENGINEERING STRUCTURES

As required for construction of E 75 Belgrade - Nis – Macedonian border highway, section: PREDEJANE - CARICINA DOLINA, the highway alignment shall be protected with appropriate types of engineering structures along with necessary adjustment to local road alignment.

Geotechnical requirements for design of engineering structures are very complex so that there are a lot of various types of engineering structures required for construction and protection of highway base which depends on very specific alignment positions as shown in the close laying highway cross sections, on local morphological complexity of slope segments and on changeable geological soil composition and characteristics.

Results of engineering geological and geotechnical soil investigations and tests are integrated in basic data for preparation of this design.

Elements of location and leveling plan of alignment and local ground conditions have conditioned layout and types of engineering structures required for construction and protection of highway base.

The design includes following types of engineering structures which shall satisfy the above-mentioned requirements:

1) Supporting structures of reinforced earth
2) Reinforced concrete retaining walls
3) Gravity stone walls
4) Supporting structures made of piles with ties
5) Protection of cutting slopes

3.10.1. Supporting structure of reinforced earth

These structures are designed on highway section where it was impossible to construct high embankments on slopes and where it was necessary to cut embankment slopes especially in the zones where several roads are in complex interrelations in the narrow cross section of terrain.

Applied structure of reinforced earth is a composite of stone or earth fill (embankment), geogrids and dry bonded concrete blocks for finishing of unoccupied areas with maximum height of 6.50 m measured from the crown to foundation. Front face of the structure is vertical thus minimizing the amount of occupied ground area.

Supporting structures of reinforced earth are designed on the following sections:

1) Supporting structure of reinforced earth 16 - leftward, from km 881+332.32 to km 881+450.00, which total length is 114.81 m
2) Supporting structure of reinforced earth 18 - leftward, from km 882+320.00 to km 882+480.20, which total length is 160 m
3) Supporting structure of reinforced earth 20 – in the central reserve, from km 883+582.42 to km 883+685.14, which total length is 102.60 m
4) Supporting structure of reinforced earth 21 - rightward, from km 883+591.72 to km 883+810.00, which total length is 220 m
5) Supporting structure of reinforced earth 27 - leftward, from km 880+820.00 to km 880+896.37, which total length is 49.80 m

   In the area provided for relocation of arterial road:

6) Supporting structure of reinforced earth M2 - rightward, from km 0+565.38 to km 0+604.10 (along the centerline of M1 road detour), which total length is 38.40 m
7) Supporting structure of reinforced earth M6 - rightward, from km 0+435.30 to km 0+457.00 (along the centerline of link between the parallel road and M1 road), which total length is 21.70 m

   In the interchange area:

8) Supporting structure of reinforced earth P1 - rightward, from km 0+150.00 to km 0+283.81 (along the centerline of interchange 1), which total length is 135.79 m
9) Supporting structure of reinforced earth P2 - rightward, from km 0+300.56 (along the centerline of interchange 1) to km 0+125.00 (along the centerline of leg 3), which total length is 165.20 m

An embankment for road base and supporting structure will be made of material excavated on the alignment which 30% must be composed of maximum 125 mm stone fractions. Larger fractions are not permitted. Layers shall be compacted to M_s^{min}=35 MPa. At distance smaller than 2.00 m from the wall the embankment shall be compacted with light rollers and vibrating plates and not in any way with heavy vibrating rollers. Subsoil shall be compacted to minimum 95% according to standard Proctor test.

Geogrids for this type of structure are uniaxial, made of high-density polyethylene (HDPE) resistant to chemical and mechanical effects. Based on performed calculations two types of uniaxial geogrids were adopted according to required load-bearing capacity.

Prefabricated concrete blocks, $b \times d \times h = 40 \times 22 \times 15$ cm, made of concrete MB30, V4 and M150 will be used for finishing of exposed free areas.

Combination of geogrids and lining concrete blocks will form a massive retaining wall by engaging a portion of embankment which now can receive horizontal pressures of the remaining portion of soil. In this composite system a geogrid receives tension forces in surrounding soil while concrete blocks serve only for formation of desired wall face geometry. Structure stability shall be achieved by friction and stiffened grains of soil with geogrid and by bonds between the geogrid and lining elements.

Since local regulations are not available for this type of structure, the instructions and algorithms for calculation from test certificates of the British Board of Agreement were used. These test certificates strictly stipulate quality requirements for applied materials, design concepts and methodology for calculation of load-bearing capacity and stability.

Work starts with construction of concrete strip foundation on prepared subsoil. Then the first row of blocks shall be placed on prepared foundation over mortar layer and positioned precisely horizontally and vertically in order to avoid mistakes in the alignment of joints of the wall being built. Concrete blocks shall be placed in vertical line and geogrid spread to the top of embankment preceding layer. Geogrids shall be spread over compacted, leveled and prepared layer, joined to concrete members and tensioned with appropriate tool. After fixing a free geogrid end, the next embankment layer will be spread and compacted. Filling over the tensioned geogrid shall be performed from the middle to the ends. A wheel passing directly over geogrid is forbidden.

3.10.2. Reinforced concrete retaining walls

This type of structure shall be constructed on the major length of designed highway and on left and right banks of the Juzna Morava River as well as in the area of relocation of arterial or regional road where side cuts and cuttings will be excavated in quaternary deposits (dl, pr, dl-pr rarely t_1 and t_2) and partially in shales. In addition, this type of structure will be applied on some locations with specific soil structure such as conditionally stable quaternary covers or small zones of shallow active or stilled landslides.

The design includes construction of retaining walls on the following sections:

1) Wall 19 leftward from km 883+250.00 to km 883+515.00, total length L = 267.00 m
2) Wall 26 leftward from km 884+725.00 to km 884+846.00, total length L = 120.05 m

In the area of arterial road relocation:

3) Wall M1 leftward from km 0+410.00 to km 0+554.00 (following the center line of M1 road detour), total length L = 140.87 m

4) Wall M3 leftward from km 0+606.00 to km 0+635,72 (following the center line of M1 road detour), total length L = 30 m

5) Wall M4 leftward from km 0+675.00 to km 0+748.00 (following the center line of M1 road detour), total length L = 73.67 m

6) Wall M5 leftward from km 0+875.00 to km 0+919.78 (following the center line of M1 road detour), total length L = 45.14 m

These walls will be constructed of reinforced concrete MB30, V4, M150 while top segment will be made of plain concrete MB30 with inclination of 4%.

Total height of these walls is up to 7.0 m.

In case of soil of poor material, stability of the walls will be ensured by placing a cantilever behind the wall.

Walls will be constructed ring by ring, fully as designed.

Run-off behind the walls above the reference level will be discharged through ϕ100 mm weepholes at every 2.5 m of wall according to designed details while gravel drainage filter will be made behind the walls. Weepholes are not designed for walls below the reference level.

3.10.3. Gravity stone walls

This type of economical structure is designed on alignment section in the central reserve where carriageways are grade-separated to a level of about 3-5 m so that side cuts must be lined. This type of structure is also designed on some alignment sections as supporting structure that protects a slope above the road.

Top segment of stone walls is always 1.00 m. Wall faces are inclined at 5:1 and inner surfaces at 8:1.

Walls will be constructed with excavated stone consisting of 20-40 cm irregular fractions in cement mortar. Total height of the walls shall not exceed 6.50 m. Foundation of stone walls shall be constructed of concrete MB30 inclined at 1:5 towards back side in 50 cm thick layer.

The design includes construction of stone walls on the following sections:

1) Wall 17 in the central reserve from km 882+203.00 to km 882+675.00, total length L = 472.71 m
2) Wall 23 in the central reserve from km 883+685.14 to km 884+570.00, total length L = 886.00 m
3) Wall 24 leftward from km 883+940.00 to km 884+030.00, total length L = 90.00 m

3.10.4. Supporting structures made of piles with ties

Supporting structures made of ϕ100 cm reinforced concrete piles with ties of prestressed geotechnical anchors are designed on alignment sections where deep cuttings shall be excavated in very narrow area of poor soil where numerous roads form a quite complex pattern.

Piles are made of concrete MB30, 7.00 – 11.00 m high, at 2 m center-to-center spacing and include RA 400/500-2 reinforcement. Pile cap is 1.30 m wide and 0.80 m high, made of concrete MB30 and include RA 400/500-2 structural reinforcement. Reinforced concrete carcase (curtain wall) of designed height, 15 cm thick made of concrete MB30 shall be built on the exposed side of piles. A carcase shall include MAG 500/560 and RA 400/500-2 structural reinforcement.

Supporting structure made of piles shall be fixed with SPB SUPER prestressed geotechnical anchors consisting of three ϕ16 mm strands of 1770 N/mm^2 nominal strength (class A). Anchor length is la=ls+lv=10+7=17 m. Anchors are designed on every second pile i.e. at 4.0 m spacing. There is an option to add a new anchor, if necessary.

The design includes construction of supporting structures consisting of piles with ties on the following sections:

1) Supporting structure made of piles and stone walls 22 leftward from km 883+630.00 to km 883+896.59, total length L = 270.46 m
2) Supporting structure made of piles 25 leftward from km 884+265.00 to km 884+390.00, total length L = 125.22 m

<u>Protection of cutting slopes</u>

Cutting slopes shall be protected in the area where slopes are cut deep mostly in shales varying in the intensity of fissibility and alternation and in quaternary surface covers. Depth of cuttings and side cuts along the highway ranges from 5.00 m to 30.00 m and over. General ground characteristics in the area of deep side cuts are similar but they can be divided in two shale complexes – Scom consisting of dual-component shales and Sabcom consisting of triple-component shales. Both complexes are divided by depth in zones of different fissibility and alternation degree. Generally, there are three zones evaluated by quality and alternation of rock mass. Regarding two-component shales they are: a) zone of poor quality, b) zone of fair quality and c) zone of good quality and regarding three-component shales they are: a) zone of poor quality, b) zone of inadequate quality and c) zone of inadequate to fair quality. Detailed description of these strata with evaluation of relevant geotechnical parameters is given in the separate geotechnical documentation, Book 2, Volume 4.

Excavation by means of explosive makes a considerable contribution to degradation of rock mass. Therefore the first step in the opening of cutting will be to make excavation from the top edge of designed slope and to continue downward with smooth blasting down the slope. Height of cutting section is limited to 8.00 m with contour inclination of 5:1. Protection berm, 3.00 m wide is designed between two cutting sections.

Careful blasting, forming of cutting sections and slope lining enable permanent stability of excavated cuttings.

Cutting slopes shall be protected with 5-10 cm thick layer of shotcrete MMB30 including a reinforcement mesh and systematic anchoring with SN anchors, Rϕ25, 5 m long, where one anchor covers about 8.00 m^2.

The design includes protection of slopes on the following sections:

1) Slope 6 rightward from km 882+200.00 to km 882+720.00
2) Entry approaching cut in front of the right tunnel tube from km 879+780.00 to km 879+805.00
3) Entry approaching cut in front of the left tunnel tube from km 879+900.00 to km 879+920.00
4) Exit approaching cut behind the left tunnel tube from km 880+775.00 to km 880+890.00
5) Exit approaching cut behind the right tunnel tube from km 880+905.00 to km 880+950.00

3.10.6. Protection structures – civil engineering part

Environmental protection design includes construction of noise walls along the E 75 Belgrade - Nis - Macedonian border, GORNJE POLJE - CARICINA DOLINA section in order to reduce traffic noise.

The design includes the following noise walls:

6) Noise wall 3 - leftward from km 881+077.24 to km 881+328.14, L=244.00 m
7) Noise wall 4 - leftward from km 881+451.00 to km 881+613.74, L=164.00 m
8) Noise wall 5 - leftward from km 885+132.85 to km 885+399.70, L=264.00 m

Noise protection

Noise walls are designed on the left highway side in total length of 1500 m.
The walls are defined in the layout and leveling plan.
The walls shall be 2.00 – 4.00 m high above the level of emergency lane edge. For structural reasons and because of predefined height of prefabricated panels and reinforced concrete sheeting, a height of designed walls as compared to a level of emergency lane edge is somewhat bigger than the required wall height. For psychological effect of protection structure on drivers the noise walls are designed at continuous spacing from the highway center line and at 1.6 m from the pavement edge.
A noise wall on embankment shall consist of prefabricated absorptive members (sheetings) placed between steel posts planted at 4.0 m center-to-center spacing. Steel posts shall be planted into prefabricated reinforced concrete foundation of circular section D=60 cm. Foundation depth is 2.50 m. Absorptive sheeting is of standard dimensions, L=3.96 m. The posts shall be vertical and aligned the same as the structure itself. It will be achieved by placing prefabricated reinforced concrete sheeting prior to fixing the next steel section. Then absorptive sheeting shall be placed between the adjacent posts.
Absorptive sheetings used for construction of noise barriers must satisfy the general criteria:

- to meet the acoustic requirements
- to take into consideration traffic safety requirements
- to be structurally stable and of constant shape
- to be resistant or protected against ageing and corrosion
- to be of precise dimensions
- to be of consistent color shade
- to be fire-resistant
- to be resistant to stone strike
- to be easy for maintenance

Dimensions and structure of absorptive sheetings shall fully meet the relevant applicable quality standards and requirements (DIN 52210, DIN 52212, DIN 1725/1, ZTV-LSW 88, EN 1793/1794 etc.).
The work shall start with excavation of hole for foundation at predefined point on embankment slope. For good drainage in the operation phase the top foundation edge shall be 5 -20 cm above the embankment slope. Prefabricated reinforced concrete members will be then placed into prepared holes and earth around foundation compacted to increase load-bearing capacity of the structure under horizontal loads. The next step is planting of reinforced concrete posts in the hole of reinforced concrete foundation. The posts shall be vertical and aligned the same as the structure itself. Reinforced concrete sheeting shall be placed prior to fixing the next steel post. Structural continuity shall exist for proper functioning of noise wall. In case of road on embankment, one section of reinforced concrete sheeting shall be placed in the road base so that pavement edge level is always between the top and bottom edges of reinforced concrete sheeting. In addition, this sheeting enables horizontal placing of other absorptive sheetings over it regardless of reference level gradient. The absorptive sheetings shall be placed above the reinforced concrete sheeting between the adjacent steel posts.

Finally, broken stone (16-32 fractions) shall be filled in the form of “wedge” which will be then bordered with the wall, the embankment plane and the side of the shoulder extending to the wall plane.

Drainage of noise wall in whole length will be performed under the reinforced concrete sheeting and above the road embankment slope. Run-off drained from shoulder to wall shall flow downward the crushed aggregate, pass through an opening under the reinforced concrete sheeting and continue down the embankment slope.

Noise walls are designed on embankments and bridges. The differences are reflected in method of fixing steel post to the structure. On the bridges, HEA 140 steel posts shall be planted at 2.0 m center-to-center spacing. A steel post shall be joined to bridge structure and/or concrete in the footway by using steel plate, 350x200x20 mm in size of S235JO (C0362 according to SRPS.C.B0.500) grade. Anchors for steel plate shall be made of RA 400/500-2, Ø12 reinforcing steel in the form of closed-up stirrup and welded to the plate with a=4 mm angle weld of 150 mm minimum length fully in accordance with a detail in graphical documentation. It is important to point out that **anchors and anchor plate shall be fixed at same time with reinforcement for bridge deck, namely prior to concreting.** After concreting, posts will be cast in situ and welded with 1/2 V weld. The posts are vertical and level grade of the structure will be achieved by casting reinforced concrete sheeting in situ. Transparent panels will be then placed between the adjacent posts.

Transparent sheetings used for construction of noise barriers must satisfy the general criteria:

- to meet the acoustic requirements
- to take into consideration traffic safety requirements
- to be structurally stable and of constant shape
- to be resistant or protected against ageing and corrosion
- to be of precise dimensions
- to be of consistent color shade
- to be fire-resistant
- to be resistant to stone strike
- to be resistant to vehicle impact
- to be easy for maintenance

Dimensions and structure of transparent sheetings shall fully meet the relevant applicable quality standards and requirements (DIN 52210, DIN 1725/1, ZTV-LSW 88, EN 1793/1794 etc.).

Standard dimensions of transparent sheetings for noise barriers on bridges are: L=1.96 m.

Structural analysis

Geostatic calculation was made for typical cross section and geotechnical parameters were taken from the geotechnical report.

The calculation was made for the following loads:

- dead weight of the structure
- wind load – EN 1991-1-4:2005
- dynamic loads produced by snow clearing – EN 1974-1

The calculation was made to control load-bearing capacity of HEA 140 steel posts and to determine dimensions of reinforced concrete sheeting and reinforced concrete circular foundation of ϕ600 mm based on influences calculated by the structural analysis.

3.11. BRIDGES AND GALLERIES

3.11.1. Overpasses above the highway and on "Predejane" grade separated junction

Three overpasses were designed on this section:

- 1 overpass on the highway
- 2 overpasses on "Bujanovac 2" grade-separated junction

All overpasses have several spans and structural system is continuous frame. Regarding cross sections, two types of overpasses are adopted:

- Members of box cross section cast in situ
- Cross section of solid deck cast in situ on "Predejane" grade-separated junction

All overpasses are made of prestressed reinforced concrete.

3.11.4. Other structures

According to construction technology, a bridge, slab top culvert on "Predejane" grade-separated junction and two bridges on service roads are cast in situ. The structural system is open or closed frame.

3.11.5. Foundation

Foundation of the structure depends on bedding and presence of high level ground water.

A bedding surface mostly consists of gravel and sand while rocks are present in deeper strata. There are locations where rocks are present on the ground surface.

High level of ground water even close to the ground surface is identified.

Almost all foundation types are present. Bridges over the Juzna Morava River and overpasses shall be founded on piles to the rock area. Piers in the bed of Juzna Morava River rest on open caissons. All small structures are shallow founded.

All is in accordance with geological and geomechanical report.

3.11.6. Miscellaneous

All bridges shall be equipped with flexible safety barrier on the both highway sides, footway railing and high safety fence on overpasses and on the bridge over railway line.

Pavement structure drainage will be performed through gullies placed along curbs on lower pavement side. Pavement run-off will be then discharged into retention units through drain pipes.

Overview of structures along the highway is given on the next page.

OVERVIEW OF STRUCTURES ALONG THE E 75 HIGHWAY
Predejane - Caricina Dolina section LOT2

No.	Structure	New km point	Length (m')	Pavement width (m')
9	Bridge	881+006.705	450	26.1
10	Bridge	881+705.81	176	26.1
11	Bridge	883+067.252	450	26.1
12	Bridge	883+576.495	11	27.8
13	Bridge	884+958.43	138	26.1
14	Bridge	885+445.066	6	27.8

No.	Structure	New km point	Length (m')	Pavement width (m')
16	Culvert	884+067.303	3	27.8
17	Culvert	884+983.191	3	27.8
18	Culvert	885+335.85	5	27.8
19	Overpass on leg 1 of "Predejane" interchange	0+713.98	119.4	7.6
20	Overpass on leg 2 of "Predejane" interchange	0+044.89	119.4	7.6
21	"Predejane" culvert	0+030.0	5	10
22	"Predejane" culvert	0+112.53	4	10
23	Bridge on M1 road	0+264.889	8	10.3
24	Bridge on L-5 road	0+115.365	6	6.9

4. TRAFFIC EQUIPMENT AND SIGNALIZATION

Traffic equipment and signalization were designed 1:500 in scale, and harmonized with civil engineering design and adopted chainage.

According to the design documentation, the studied highway shall be designed in full profile and provided with traffic lines, 3.5 m wide. The emergency lane shall be 2.5 m wide with 0.2 m wide verge, as stated in the Terms of Reference.

Open section

Traffic signs and signals

Since the alignment of the studied section runs from one bank of the Juzna Morava River to another and vice versa, each span shall be marked with non-standard board sign III-58.

Road markings

Road marking is consisting of 0.2 m wide continuous edge lines and 0.2 m wide centre broken line that follows 6 m-12 m pattern (6 m mark/12 m gap). The Supplier of road markings shall apply them onto pavement and give warranty for his work.

Traffic related equipment

Equipment implies the placement of direction posts, single-sided safety barriers and retro-reflectors.

In order to make road width easily discernible, direction signs shall be placed on the existing shoulder. A direction sign consists of marker for driving in daylingt (daytime marker) and at night (nightime marker) fixed to white background. Daytime markers are black romboid areas at the angle of 30 degree with apex turned closer to pavement, while nightime markers are of retro-reflective material. A red rectanlge shall be placed on the right side and two smaller wihite rectangles one on top of another, on the left side. Their supports are white and do not pose danger to motorists even if they run into them. They will be embedded on the outer edge of the shoulder. On dawings, direction post symbol is a circle divided in two parts (red and white) and their positions are shown on the layout.

Direction posts will be erected at all places where single-sided safety barrier is not foreseen and they will be spaced at 24 m. The drawing indicates the position of bodies on barriers and direction signs oppoiste to them. Procurement and placement of direction posts shall be performed according to type specified by the Investor.

Single-sided safety barrier shall be installed along the inner edge of the traffic ridden areas due to 4 m wide distance. The barrier shall comply with N2 safety level, index W 8. (according to technical specifications given by the Investor). The said protection level shall be achieved by placing the single-sided safety barrier H1W5 along the central reserve. On segments where traffic ridden areas are designed in two levels, double-sided safety barrier, type H2W8 shall be installed.

“Predejane” interchange

Traffic signs and signals

“Predejane” interchange is located at km 883+250.00. The interchange area starts at **km 881+600.00 to km 884+650.00**. An approach is marked with IV information stages.

- Interchange ahead – board indicating interchange name will be mounted at 1500 m from the exit.
- First information stage from Nis direction is sign III-72 (1) indicating "Vranje - Vranje" straight ahead and "Predejane - Predejane" right turn. Bridge over the Juzna Morava River was designed at 1000 m from the start point of egress lane and therefore this sign will be mounted at distance of 1200 m from the start point of egress lane.
- Second information stage is sign III-65.1 mounted on G gantry indicating a start point of egress lane.
- Sign III-66 "EXIT" together with a direction sign informs road users about the exit from highway (third stage)
- As fourth information stage after the interchange, confirmatory sign III-61 (1) shows kilometer distances to Presevo, Bujanovac, Vranje and Vladicin Han or V.Han abbreviated.

Signs for the opposite highway direction will be identically mounted. Sign III-72 (2) was used for the first information stage. The straight ahead board contains lettering: "Nis - Nis" and right turn direction inscription: "Predejane - Predejane". It shall be mounted at 1000 m from the start point of egress lane. The confirmatory sign III-61 (2) contains kilometer distances to Belgrade, Nis and Leskovac

The sign III-19 on the ingress ramp confirms category of a road ahead. The sign II-1 mounted on the same post with the sign II-43 emphasizes priority and mandatory direction. Immediately before the ingress lane the sign II-43 (mandatory direction) is mounted on the right pavement side.

According to interchange curve radii, speed is limited to 50 km/h and/or 60 km/h. Traffic lanes to Nis and Presevo direction are physically separated.

Road markings

The interchange approach is characterized by 0.2 m wide continuous edge lines and 0.2 m wide center line, 6-12 m pattern. At point of change of roadway construction width where G gantry will be installed, right edge line stops to be continuous and becomes 0.3 m wide broken line of 3-3 m pattern. In front of divisional island a belt between the edge line of ramp and edge line of next highway section will be marked with white painted area up to 2 m wide. An empty area, 2 m long, will be marked twenty meters after end point of that area. The exit from highway will be identically marked, except that continuous line will be 30 m long.

Slanted limit line on egress lane will be 30 m long while slanted limit line on ingress lane will be 45 m long. Interchange center line is continuous, 0.2 m wide. The Supplier of road marking shall apply them onto pavement and give warranty for his work.
This is the only way to choose the Contractor.

Traffic related equipment

Equipment implies the placement of direction posts, single-sided safety barriers and retro-reflectors.

In order to make road width easily discernible, direction signs shall be placed on the existing shoulder. A direction ign consists of marker for driving in daylingt (daytime marker) and at night (nightime marker) fixed to white background. Daytime markers are black romboid areas at the angle of 30 degree with apex turned closer to pavement, while nightime markers are of retro-reflective material. A red rectanlge shall be placed on the right side and two smaller wihite rectangles one on top of another, on the left side. Their supports are white and do not pose danger to motorists even if they run into them. They will be embedded on the outer edge of the shoulder. On dawings, direction post symbol is a circle divided in two parts (red and white) and their positions are shown on the layout.

Direction posts will be erected at all places where single-sided safety barrier is not foreseen and they will be spaced at 24 m. The drawing indicates the position of bodies on barriers and direction signs oppoiste to them. Procurement and placement of direction posts shall be performed according to type specified by the Investor.

Installation of retroreflective studs on the barrier shall be in compliance with SRBS and according to pattern show in the Attachment. On dawings, direction post symbol is a circle divided in two parts (red and white) and their positions are shown on the layout.

Every non-standard board will be protected with single-sided safety barrier, type H1W5 installed 60 m in front and 16 m behind. In the zone of interchange, G gantry protected with single-sided safety barrier, index H2W4 will be installed. G gantry is of standard type installed over the highway, and the price shall include construction of base, fabrication of gantry and mounting. Since lighting system will be installed along the all interchange legs, safety barrier will be installed due to protection. At segments where the speed is decreased to 50km/h, installation of barrier will be separately discussed.

Toll collection system and signaling system of the Predejane interchange is not covered by the design herein.

‘’Predejane" level junction
Traffic signs and signals

Speed on interchange approaches is limited to 40km/h and/or 60 km/h. In addition, interchange ahead signs III-8 will be uniformly mounted on all approaches and direction board III-13 in the very interchange area. Approaching direction is indicated on them. Direction 1-3 is indicated for major road and direction 2 for secondary road. Vehicles must stop before merging into the highway traffic from the secondary approach. Sign II-1 is designed on the approach 1 for right turn.

Road markings

On approach to the junction, 0.12 m wide continuous edge lines will be marked. Centre broken line, 0.12 m wide, 3-3m pattern. Segment of the carriageway not planned for vehicle operations shall be marked with channelising area. Distances are shown on the drawing.

Supplier of road markings shall give warranty for his work once the road marking has been performed.

Traffic related equipment

Equipment implies the placement of direction posts, single-sided safety barriers and retro-reflectors.

In order to make road width easily discernible, direction signs shall be placed on the existing shoulder. A direction ign consists of marker for driving in daylingt (daytime marker) and at night (nightime marker) fixed to white background. Daytime markers are black romboid areas at the angle of 30 degree with apex turned closer to pavement, while nightime markers are of retro-reflective material. A red rectanlge shall be placed on the right side and two smaller wihite rectangles one on top of another, on the left side. Their supports are white and do not pose danger to motorists even if they run into them. They will be embedded on the outer edge of the shoulder. On dawings, direction post symbol is a circle divided in two parts (red and white) and their positions are shown on the layout.

Direction posts will be erected at all places where safety signle-sided barrier is not foreseen and they will be spaced as stated in the Table. Position of direction posts will be shown on drawing. Procurement and placement of direction posts shall be performed according to type specified by the Investor.

Traffic signs and signals

Traffic sings specified in the design are of standard type. Signs $1200\times1200\times1200[mm]$ and circle $\varnothing 900[mm]$ shall be installed, while on segment of the displaced R-214 regional road signs$\varnothing 600[mm]$ will be installed. Deviation from the specified clearances is allowed for +/-2%. Sign face together with all accompanying symbols, letters and numbers shall be made of retroreflection material characterized with standard retroreflectivity. Traffic signs shall be in conformity with detailed drawings and JUS Standards, and in compliance with applicable Traffic Signs Code. Signs shall have their planes horizontally deviating for $3\text{-}5^0$ outwards from the vertical line in the road center. On the backside of each sign the manufacturer shall inscribe sign code according to Traffic Signs Code with contents (numerals or lettering) in brackets, if any. Single tubular supports shall be secured in place by cross pieces in foundation. Length (height) of the traffic sign supports shall depend on the number and kind of signs to be fixed to them.

For gantries and non-standard signs, relevant computation, construction and mounting to be performed by the Manufacturer shall be required.

Traffic signs and signals in tunnel shall be designed as unchangeable LED sign (signs F600 mm, 600x900 mm and 600x150 mm) that will also display textual messages and other types of danger and mandatory signs.

Road markings

Road markings will include as follows:

Longitudinal markings

- Continuous lines - JUS U.S4.222
- Broken lines - JUS U.S4.223

Road marking will be performed fully in accordance with layouts stated in the design, detailed drawings and separated detailed drawings specified in the design. Road markings will be tick-layered and marked in white paint. Road marking on the studied section shall be performed by thick-layered marks made of cold plastic to enable long durability and higher retroreflection values. Materials and technical specifications for road markings shall be fully in compliance with JUS Z.S2.240 Standard.

Road markings shall be provided with following:

- Centre lines, 0.20 m wide (white color);
- Broken line, 0.20 m wide, 6.0-12.0 m pattern, (white color);
- Broken line, 0.20 m wide, 6.0-12.0 m pattern, (white color);
- Broken line, 0.50 m wide, 3.0-3.0 m pattern, (white color);
- Broken line, 0.20 m wide, 1.0-1.0 m pattern, (white color);

On the displaced segment of the M1 arterial road, centre line 0.15 m wide (white color) is planned to be applied, and on the displaced segment of the R-214 regional road, centre line 0.12 m wide (white color) shall apply.

Road marking inside the tunnel shall also include placing of markers on the centre line at 18 m interval. The arrangement of markers will be in compliance with the broken line that follows 6.0 m - 12.0 m pattern. Markers will be retroreflective meaning that they can reflect the light from vehicle headlamps. Edge lines will be provided with markers that operate on the inductive loop principle thus delineating the road edge in unlit conditions. Therefore problem referring to visibility of pavement edge will be solved. Arrangement of edge markers will be in compliance with markers placed on the pavement surface.

Traffic related equipment

Direction posts are planned to be placed at all places where safety barrier is not foreseen, i.e. on sections positioned on low embankment. Direction posts shall be installed at intervals of 50 m. Procurement and placement shall be performed according to type adopted by the Investor. Reflecting studs shall be placed on safety barrier, in grooves. Reflecting studs shall be spaced apart similarly as direction posts. Although not shown on the layout, wire fence is stated in the priced bill of quantities.

″Km point″ (III-17) signs shall be placed at each full km point along the outer edge of the carriageway on either direction fully in accordance with JUS-u Z.S2.320 (but not shown in traffic signalization plan). Sign face will have white background and black inscriptions free of retroreflection properties. Signs will have 450x400 mm in size. Detail of this sign is stated in the Attachment.

In the course of designing of traffic equipment and signalization, the design engineer was adherent to the Yugoslav standard. When forming prices for cost estimate, the design engineer contacted equipment manufacturers.

5. PROTECTIVE MEASURES

5.1. Noise protection

Noise levels obtained by the use of LIMA software for noise calculation and mapping in the environment (version 5.2) and guidelines "Rihtlinien für den Larmshutz an Strassen" (RLS-90), where used to draw isophone maps for the Gornje Polje-Caricina Dolina section.

Protection against noise shall be performed only on the highway left side on the segment where residential buildings were constructed. They are mostly single floor or two-floor and three-floor buildings. Noise suppression walls varying from 2 to 4 m in height shall be constructed above the shoulder level.

The height required for noise suppression walls have been defined through the use of software package designed for computation and mapping of environmental noise LIMA (Version 5.3), together with "Rihtlinien für den Larmshutz an Strassen" (RLS-90) guidelines (due to lack of national legislations).

The noise suppression wall shall be built of precast absorption elements (boards) inserted between steel posts erected at 4.0 centre to centre distance. Steel posts shall be embedded into the pre-fabricated reinforced concrete foundation. Absorber boards shall have standard dimensions of 3.96 m in length. The pre-fabricated boards shall be 0.5 m high. The studied section shall be provided with 4 noise suppression walls.

Placing of noise suppression walls at relevant km points are stated in the Table below:

		Km points from km	Height (m)	Length (m)
Wall No. 3 starting point on the bridge	Left	881+077.20	2.0	244
starting point on the ground		881+329.00	4.0	284
Wall No. 4	Left	885+130.00	2.5-4.0	304
			Σ=	832

It is recommended to plan a procedure for monitoring noise levels in the corridor prior to constructing any physical protective barriers. Construction shall start as soon as the monitoring procedure indicates excessive noise levels.

Layout, leveling plan for protection of the structure and highway, methodology to be applied in construction of noise walls, structural analysis for noise protection, traffic equipment and BoQ are stated in Book 10, Volume 2 – Protective structures – civil engineering design.

6. POWER SUPPLY WORKS

1. General

For the purpose of construction of the E 75 highway (Leskovac- border with FYR Macedonia, section III, Predejane-Caricina Dolina), certain displacements and reconstruction of power supply lines in collision with the studied road alignment shall be carried out. The design also includes lighting and ventilation systems to be installed inside the "Predejane" Tunnel as well as lighting system of "Predejane" interchange.

a) Reconstruction of segments where power lines overcross the E 75 highway

For the purpose of construction of the E 75 highway (Belgrade - Nis – border with FYR Macedonia, Gornje Polje - Caricina Dolina SECTION), reconstruction of power supply lines in collision with the alignment of the studied road is planned to be carried out, fully in accordance with applicable regulations and conditions issued by PD "Jugoistok" Company from Nis and Leskovac Power Distribution Company (PDV).

Power supply lines of nominal voltage 10kV and 1 kV are in collision with the studied highway section. Locations of power supply lines and data sheets were derived from geodetic surveys and available technical documentation of PD "Jugoistok" and Leskovac PDC. The following collisions have been identified:
- "Grdelica - Palojce" 10kV, spur to Graovo
- Low voltage lines for power supply of "Mahala Pasevluka" Settlement, two crossings.

Any crossing and/or parallel taking over of overhead power line must be performed fully in accordance with the Technical Norms for Construction of Overhead Power Supply lines 1kV - 400kV rated voltage”, (Official Gazette SFRY, 65/1988).

The height clearance between the line and the highway shall be 7.0 m, as stated in provisions. Distance of any pole member from the highway edge will be minimum 40.0 m.
When the line is passing over the highway, distance of any pole member may be smaller, if ground conditions allow, but in any case not smaller than 10.0 m.
Insulation must be mechanically fastened.
Joining of conductors/protection wires shall not be allowed in the area of crossing.
The angle of crossing shall not be less than 30°.

When lines are taking over the highway, distance between the line and the highway on sections longer than 5 km must be as follows:

1) For lines with voltage not exceeding 35 kV - minimum 50.0 m
2) For lines with voltage greater than 35 kV - minimum 100.0 m

In hilly and forest areas, distance between the line and the highway may be reduced to 40.0 m.
All abovementioned heights and distances are referring to lines not exceeding 110 kV rated voltage.

Transmission lines not in compliance with provisions stated in the "Technical Norms for Construction of Overhead Power Supply lines 1kV - 400kV rated voltage”" (Art.124 to Art.129) and "Law on Roads" (Official Gazette RS, No.48/81 (Art.36), must be reconstructed.

According to conditions of PD "Jugoistok" and Leskovac PDC and geodetic surveys, 10kV overhead power line shall cross the studied highway. For low voltage lines, underground crossings are planned to be installed. Each crossing shall be studied in detail in Technical Report to the Final design.

b) Lighting system for "Predejane" interchange

The "Predejane" interchange and toll stations shall be powered from 10/0.4kV transformer station. Power supply line (10 kV) shall be used for supplying of transformer station.

Pole mounted transformer station, 100kVA, shall be installed on 12/1600 reinforced concrete post positioned in the interchange area.

The following equipment shall be mounted on the pole carrying transformer:
- Post insulators for 10kV connection lines;
- Three-pole disconnectors, outdoor type with surge arresters,
- High voltage fuses that are to be mounted directly on insulators on the transformer primary side,
- 100 kVA transformer
- Low voltage cabinet

The low voltage cabinet is planned to be provided with two outlets for switchboard supply.

The power supply line (10kV) for the pole-mounted transformer station shall be ground Al/C 3x50/8mm^2 spur branched from 10kV "Predejane - Susevlje" line. The existing 10kV line shall be provided with new pole that will carry the spur for transformer station connector.

The design shall also include lighting of the "Predejane" interchange and toll stations on the E 75 highway (Belgrade - Nis – border with FYR Macedonia), Gornje Polje - Caricina Dolina SECTION. Pole-mounted 10/0.4kV transformer station provided with 10kV supply line is planned to be installed for the purpose of interchange lighting, as stated in technical specifications issued by PD "Jugoistok" and Leskovac PDC.

Technical solution for lighting of the interchange and toll stations has been developed fully in accordance with CEI 115 recommendations dated 1995, as shown through relevant photometric calculation.

Two switchboards are planned to be installed in the interchange area. Switchboard has room to house a three-phase electricity meter 3x230/400V 10-60 A and fuses. The lighting control is foreseen over an MTK device (optional photo-relay or timer) with manual control options, if needed.

The switchboard and active power meter shall be installed by "Elektrodistribucija" Leskovac.

For the purpose of lighting of both interchange and toll stations, poles made of iron, round, tapered hot-dip galvanized on the outside and inside, fitted with anti-vandal locks, shall be installed. Poles shall be fitted with suitable luminaries provided with adequate bulbs.

Poles are to be provided with base plates to be fixed to holding down bolts in foundations. At the bottom of each pole there is a terminal board (three-phase power supply) with adequate fuses from which luminaries shall be supplied via cables PP00-Y 3x2.5 mm^2 + Cu 2.5 mm^2.

Public lighting switchboards shall be supplied by 1kV lines, type PP00-A, 4x70 mm^2 powered by the newly-designed pole-mounted transformer station 10/0.4kV. Supplying of poles shall be performed by 1kV lines, type PP00-A, 4x35 mm^2 + Cu 2.5mm^2 at "in-out" principle from one pole to another. The cable shall be laid in ground at the minimum depth of 0.8m. On crossing points, the cable shall be routed through ∅110 mm juvidur pipes.

Protection against indirect touch voltage shall be performed through automatic switching off in TT distribution system. Galvanized strips FeZn 25x4 mm used as insulators shall be placed into the same trench.

NOTE: In accordance with technical specifications issued by "Power Distribution Company" Leskovac, referring to the method of supply of tunnel transformer stations and requirements related to reconstruction of the existing 35kV Predejane-Belo Polje transmission line in the length of about 19.5 km, increased costs may be expected.

d) Overhead catenary on the Belgrade-Skopje railway line

Two overbridges on the highway E 75 (Belgrade– Nis– border with FYR Macedonia), Predejane – Caricina Dolina section, are planned to be constructed. These overpasses will span the Belgrade-Mladenovac-Nis-Presevo-National border railway line at km 314+066.5 where new interchange that connects the new highway section and the existing road will cross the railway line and at km 314+310.8 where the highway will cross the railway line (km 883+113.7 of the E 75 highway).

The electric traction system on the Belgrade-Mladenovac-Nis-Presevo-National border 25kV, 50Hz shall be reconstructed at the above points to allow contact wire to pass beneath the overbridge.

It will be necessary to remove old masts and erect new ones, replace a number of cantilever assemblies, reduce catenary system and contact wire heights and replace droppers in some spans, fully as tabulated and shown on attached design drawings.

Metal structures on overpasses in the zone of the electrified line shall have double earth, i.e. shall be bonded to track rail and to a special earth electrode.

Since reconstruction and construction works shall be executed in the close proximity of catenary system of the railway line electrified by 25kV, 50 Hz system, Health and Safety rules attached here shall be observed.

7. TELECOMMUNICATIONS

7.1. Displacement and protection of the existing telecommunication cables (TC) in collision with the newly-designed highway alignment and access road structures

An analysis of the newly-designed highway alignment, access road structures and local roads overlapping the existing telecommunication cables revealed numerous points of collision that will be discussed in the text below and shown in the Graphical Attachment. In general, they are due to parallel running of the highway alignment and the existing cable routes, intersections and threat to existing cables when new bridge piers are constructed and access elements (junctions, overpasses, interchanges, local roads...) are either newly constructed or rehabilitated.

Depending on the severity of threat to the existing cables, they will be either displaced or protected. Since these are underground, coaxial and fibre optic telecommunication cables, they will be adequately spliced. The cable will pass under the highway through two or four double-corrugated pipes made of hard plastics, 110 mm in dia. that will be laid at the depth of 1m under the lowest point of the highway roadbed.

The existing TC cable is to be relocated by the standard procedure: cut the cable in a proper place, lay a new cable, splice appropriately, measure relevant parameters, backfill the trench, mark the cable route in advance, and put into operation.

Prior to commencement of works, all fibres shall be measured by OTDR instrument that will measure the optical link loss at the appropriate wavelengths of 1300 mm and 1550 mm. Splicing of optical cables will be enabled through the use of UCS 4-8 fibre joints, and then optical fibres will be joined together by welding. PE pipes, if any, will be extended with plastic joints. Afterwards, the optical cable shall be measured again by OTDR instrument. On certain points on the new fibre optic cable route, cable tracers shall be placed above splices and pipe joints. Cable markers shall be placed at all characteristic points

on the new cable route, its turning points, above the joints in cable and in pipes. Particular attention shall be paid to the fact that intense telecommunication traffic is taking place on the said cables and interruptions should be as short as possible. Approval for work on cables and on structures that may threaten such cables shall be obtained from the respective office in Telekom Srbija telecommunication operator in charge of internal supervision.
Timing and periods of traffic suspension along the said cables for the purpose of reconnection shall be the responsibility of Telekom Srbije telecommunication operator.

Protection (and/or temporary displacement) of the existing telephone cable shall be performed as follows: the existing cable shall be removed or temporarily displaced and return into the earth trench and buried on greater depth once the works have been completed. When cable is not planned to be removed it shall be protected with adequate PE pipes.

NOTE: The existing cables shown on drawings are only approximately positioned considering the fact that "original" existing cables (obtained from the "Telekom" Company) are also approximately located.

7.2. Overview of collision points of the existing telecommunication cables and newly-designed highway alignment

Each point of collision bears ordinal number, km point, type and problem solving. The future TC conduit will be positioned in the shoulder. Bridges shall be provided with TC conduit for routing of telecommunication cables.
Note 1: If beginning/end of collision point is identified at the certain distance from the highway, km point of works shall follow the highway km point.
Note 2: When passing under the highway, minimum distance between the pavement level and telecommunication cable shall not exceed 1.5 m.
Note 3: Protection pipes on either regulation zone shall protrude by 3 m.
Note 4: At the point of collisions with the newly-designed pipe culverts, TC network shall be properly protected.

Collision No.: 4

Km point: from km 881+175.000 to 881+475.000, highway alignment

Collision type: Parallel running of the existing fibre optic cable route and the newly-designed highway alignment

Solution: A cable tracer shall be used to find and mark the route of the fibre optic cable TOSM 03(6x4+1h2)xIIx0.4x3.5CMAN. Since the planned works may threaten the cable (filling and raise of pavement level for 5-6 m in relation to the existing ground), cables shall be released by manual excavation and protected by spliced PVC pipes, 110 mm in dia. PVC pipe, 110 mm in dia shall be also laid along the studied section. These pipes shall end at 3 m outside the highway. The trench will be backfilled and cable route properly marked. Relevant measurements will be performed and as-built drawings prepared.

Collision No.: 5

Km point: Interchange 2 Predejane at km 882+875.000, highway alignment

Collision type: Orthogonal crossing of the existing fibre optic cable and alignment of the newly-designed interchange 2 Predejane

Solution: A cable tracer shall be used to find and mark the route of the fibre optic cable TOSM 03(6x4+1h2)xIIx0.4x3.5CMAN. Since the planned works may threaten the cable (interchange 2 Predejane km 0+020.00) cables shall be released by manual excavation and protected by spliced PVC pipes, 110 mm in dia in the area of newly-designed piers of overpass within the interchange 2 Predejane. The pipe shall end at 3 m outside the pier foundation. The trench will be backfilled and cable route properly marked. Relevant measurements will be performed and as-built drawings prepared. The protection method is stated in the civil engineering design (overpass).

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Collision No.: 6

Km point: km 883+125.000, highway alignment

Collision type: Inclined crossing of the existing fibre optic cable and piers of the newly-designed overpass

Solution: A cable tracer shall be used to find and mark the route of the fibre optic cable TOSM 03(6x4+1h2)xIIx0.4x3.5CMAN. Since the planned works may threaten the cable, cables shall be released by manual excavation and protected by spliced PVC pipes, 110 mm in dia. In the area of the newly-designed overpass piers. The trench will be backfilled and cable route properly marked. Relevant measurements will be performed and as-built drawings prepared. The protection method is stated in the civil engineering design (overpass).

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Collision No.: 7

Km point: from km 883+700.000 to 883+925.000, highway alignment

Collision type: Parallel running of the existing fibre optic cable route and the newly-designed highway alignment

Solution
: A cable tracer shall be used to find and mark the route of the fibre optic cable TOSM 03(6x4+1h2)xIIx0.4x3.5CMAN. Since the planned works may threaten the cable, cables shall be released by manual excavation and protected by spliced PVC pipes, 110 mm in dia. PVC pipe, 110 mm in dia shall be also laid along the studied section. These pipes shall end at 3 m outside the highway. The trench will be backfilled and cable route properly marked. Relevant measurements will be performed and as-built drawings.

NOTE : After being positioned by the cable tracer, excavation in the vicinity of the said cables will be performed strictly by hand.

7.3. GENERAL PROVISIONS ON SAFETY AT CABLE LYING AND INSTALLATION WORK

Pursuant to Article 9, Paragraph 2 of the «Occupational Safety and Health Act» (Official Herald SRS No. 42/91) and «Law on Amendments to the Occupational Safety and Health Act » (Official Herald RS No. 53/93, 97/93, 48/94)

PREAMBLE

A completed cable installation *(infrastructure – trench, conduits, and equipment) is neither dangerous for the environment nor users since:*

- *It does not involve life threatening voltages;*
- *It is, as a rule, inaccessible ;*
- *The terminal units at the user's are so designed that they are never dangerous if operated properly;*
- *It is chemically inactive and does not pollute the environment – concrete, bricks, neutral plastics (PVC, PET etc);*
- *If cables are heavily damaged (copper and optic) only very little quantities of chemically neutral and non-poisonous matter occur (filling gels, thixotropic compounds) ;*
- *Laser radiation of optic fibre cables is prevented because emission stops as soon as a fibre breaks.*

To this end, the protection of the environment and users will be achieved if cable installation works are executed in strict accordance with these conditions (Technical specification, Technical rationale, Graphic documentation) and the relevant regulations and standards.

This text on safety at work refers to the here designed cable installation and its maintenance by qualified staff.

SITE ORGANIZATION

TT cables shall meet the requirements and regulations for safety at work and the Rulebook on Safety at work in construction industry.

The Contractor shall observe the design concepts and instructions of the cable, accessories, equipment and civil elements manufacturers as well as manuals and regulations that govern the operation of the machinery, instruments, tools and accessories so that the cabling would suit its use, ensure safety at work and a long life of the plant finished.

Workers engaged in construction and maintenance operations shall observe the relevant regulations and provisions of the Safety at Work Act.

In order to ensure conditions for the safe execution of works it will be necessary to do in advance the following:

1. The site manager shall draw a safety plan based on this text and on the local site conditions prior to the commencement of work.
2. The following documentation shall be available at the site:
   - Rulebook on safety at the work issued by the Contractor's organization
   - This design and plan for safety at work
3. The following health data of all employees (full time and part time employees) must be available:
   - Blood type

- Data on possible allergies
- Data on vaccination – especially anti-tetanus
- Data on medications that may affect work performance

4. Data on nearest health centers (address, phone numbers) must be available.
5. The first aid kit must be available at the construction site. First aid supplies must be ready available and during the execution of works at least one experienced trainer in first aid must be present.

Potential hazards and injuries are listed below:

1. **Mechanical hazards**
2. **Electric shock (lighting discharge)**
3. **Fire and explosion**
4. **Chemical hazards**
5. **Biological hazards**

1. **Mechanical hazards and protection measures**

1.1. Vehicles, trailers, machinery etc. shall suit the works. Load cases of trucks and trailers shall be easy for cable loading and unloading. Hoists shall have the appropriate bearing capacity. During transport, drums shall be tied well and secured with pads against rolling. Speed and driving shall be controlled. The vehicles transporting cables and hoists shall be marked with yellow rotational lights. If the transported unit (hoist, machine, cable drum) exceeds the clearances specified for road vehicles, a vehicle with yellow rotational light shall accompany it.

1.2. Staff engaged in loading/unloading of cables must wear protective gloves, helmets and protective clothes. Staff on traffic ridden areas must wear reflective clothing (fluorescent yellow).

1.3. The construction site must be properly enclosed; if works are planned to be carried out on traffic ridden areas they must be properly marked by placing adequate traffic signs "WORK IN PROGRESS". If obstacles are planned to stay over night, yellow rotating lights and reflecting signboards should be placed. Open trenches shall be properly marked (for example, by yellow PVC tape with inscription "CAUTION, TC CABLE" that will be laid into the trench). For all works planned to be executed on arteries, approvals from relevant authorities shall be obtained.

1.4. Wherever pedestrians have to cross the trench there shall be a crossing made of strong sufficiently wide boards.

1.5. In the course of works, open cable shafts shall be properly enclosed (pegs and tape). Open shafts must be permanently supervised and adequately covered at the end of work day.

1.6. Use only specified, appropriate and proper tools and equipment and accessories for excavation, lying, mounting and finishing. The use of worn out, handy, improper and unsuitable tools, equipment and accessories is not permitted. The equipment and accessories that require periodical checking shall be accompanied with a certificate.

1.7 Two individuals shall be always engaged in execution of works in TC shafts. One of them must always be outside the manhole.

2. Electric shock (lightning discharge) and safety measures

During the excavation of trench, cable laying and joining workers may come into contact with plants, parts of plants and objects under voltage which bear danger to life and health so that adequate protection measures shall apply:

2.1. The apparatuses and instruments shall be either earthed or double insulated (mark)

The supply voltage to electric soldering units and torches shall be 24 V.

2.2. Metallic mass in cables (wires, sheath, armouring) may be on a high potential. During electrical measurements and tests of cables, two types of instruments may be used:

- Instruments earthed via their cords. The sockets on the instruments shall have the puncture strength to mass of 2000 $V\sim_{eff}$.
- Double insulated instruments (mark)

During cable measurements, metallic masses may be touched only if they are found to have the potential below 48 V= to earth.

2.3. Tools and accessories shall be suitable and tested with regard to insulation.

2.4. If there is a risk induced voltage (vicinity of power supply lines or 25 kV/50 Hz electric traction) cable wires at both ends shall be protected and the sheaths and armouring of the cables to be joined shall be conductively bonded before joints are made. The ends of two cables to be joined shall never be handed with bare hands before a conductive bond is made.

2.5. No cable work may be undertaken in stormy weather and during lightning discharges.

2.6. When doing the work close to power supply facilities, heightened alertness will be necessary as well as attendance of an authorized representative of the facility owner.

2.7. At the points where underground power supply cables cross, the regulations that govern such crossings shall be observed (given in the Technical specification and Technical description herein).

2.8. No underground installations (cables, pipelines, gas pipelines etc) that have been encountered may be damaged as any damage may invoke danger besides costs.

3. Fire and explosion and protection measures

Cable laying and finishing are closely associated with danger due to fire and explosion for two reasons:

a. Presence of flammable and explosive gases and liquid in the ground and in shafts due to spills from improper underground installations and above ground containers (tank trucks and other). During earth works there will exist a risk of damaging underground gas and fuel installations which will bear an acute threat from fire and/or explosion.

b. Flammable and explosive matter used in cable treatment technology – sealing compounds, glues, solvents, petrol, propane-butane etc.

The following measures shall be undertaken:

3.1. Prior to descending into a shaft two adjacent shafts shall be opened and the first shaft shall be well ventilated if necessary by forced ventilation and suction. When it is certain that there are no flammable, explosive and poisonous gases (checked with appropriate instruments) work may start.

3.2. As solely petrol filled torches are used in shafts petrol containers shall not be held in it. Torches shall be left to develop their flames outside the shaft.

3.3. Before working with an open flame check if there are spills of fuel and flammable liquid in the shaft.

3.4. Use solely suitable petrol and butane-propane burners. Undertake regular inspection of the cylinders, reduction valves, connections, seals and hoses and repair damages. Replace suspicious elements with new and proper ones. Everything shall be controlled repaired and replaced before taken to the place of work. Repairs shall not be attempted in situ.

3.5. Never leave burners and flame without surveillance. During long period without work, burners shall be put out and valves shut off and in the case of a butane-propane burner then also the valve on the butane-propane cylinder shall be shut off.

3.6. Sealing compound for joints shall be heated solely with petrol or butane propane burner (if needed with several of them). Heating above an open fire of wood or similar is not permitted.

3.7 Only the quantity of materials needed for a job shall be taken into shaft.

4. Chemical danger and protection

Contrary to mechanical danger and electric shocks, fire and explosion that may be eliminated if protection measures are undertaken, chemical danger (and biological) bears somehow an omnipresent impact upon workers' health.

a. Underground poisonous gases in shafts.

b. Vapors of lead and thermoplastics (polyvinyl and polyurethane) and of other coats which occur when cable sheaths are warmed up and joints are mounted and soldered, glues, solvents and thinners, lead dust when sheaths are ground and cleaned, poisonous gases due to combustion of petrol and butane propane and heating compounds.

c. Some persons may have allergic reaction to hardeners (polymerizers) of epoxy resin (SMOLIT joints) or polyurethane (joints in self carrier cables), to various glues, thinners and solvents.

The following protective measures shall be undertaken:

4.1 Workers shall wear protective clothing and shoeware and if necessary gloves and head masks.

4.2. Ventilation (if necessary forced) of shafts.

4.3. Protective gloves when working with lead. Remove oxide with a knife never a file or emery paper.

4.4. Low octane petrol (less tetraethyl lead) and even better unleaded fuel shall be used for torches.

4.5. Sealing compound shall be heated at the spot where smoke will not be dangerous nor ignited and where workers will not be in contact with smoke and vapors.

4.6. The shafts shall be regularly cleaned from waste.

4.7. Strictly observe the instructions and measures specified by the manufacturers of the joints made of two components and inscriptions on packaging of chemical agents.

4.8. Workers handling lead and/or poisonous materials shall drink milk every day.

5. Biological danger and measures of protection

In the working environment (cable shafts, trenches and even open area) there may be microorganisms and other live organisms – insects, rodents, noxious plants, remains of dead animal bodies or decayed organisms which all present health danger.

Workers may be exposed to various unfavorable factors such as bad and unhealthy body position at work, humidity, cold, heat, dust, odours, long exposure to sun rays, strong or insufficient light.

Manholes and trench may be contaminated with waste waters and other dirt.

Tetanus bacilli are omnipresent in soil.

Therefore, the following protection measures shall be undertaken:

5.1 Water shall be pumped out and dirt removed from shaft. Never leave food in shafts, on galleries and at the inlet areas to prevent insects and rodents. Rotten organic matter and decayed animal bodies are venomous.

5.2. Workers shall wear protective clothing and shoe ware suitable to work environment and gloves and head mask.

5.3 If workers are exposed to unfavorable impact such as bad conditions, bad position of body, the work shall be interrupted and working shifts shortened. If natural light is insufficient – in shafts and at night, appropriate white colour light shall be provided good for distinguishing the wire colours.

5.4. There shall be drinking water supply on site. In case of long exposure to sun rays, a shade shall be provided over the work area. In really hot water - over 30°C – work may be eventually done at night.

5.5 Workers shall not drink alcohol or take drugs. Appropriate control shall be undertaken.

5.6 Workers taking medication shall possess doctor's statement that they may proceed with their usual work.

5.7. Health and safety measures and caution shall be undertaken to prevent injuries. Any injuries, sun stroke, heat stroke ad lightning stroke shall be attended according to the first aid instructions while in case of severe injuries, sun stroke, heat stroke and lightning stroke, it will be imperative to send the worker to the doctor's.

7.4. SAFETY AT THE WORK OF CABLE LYING AND INSTALLATION ON STRUCTURES CLOSE TO 25 kV/50 Hz OCS

Pursuant to Article 9, Paragraph 2 «Occupational Health and Safety Act » (Off.Herald SRS No. 42/91) and «Law on amendments to the Occupational Health and Safety Act » (Official Herald RS No. 53/93, 97/93, 48/94)

GENERAL CONDITIONS AND WARNINGS

General conditions and warnings for the works going on close to a railway line electrified with single phase 25 kV/ 50 Hz electric traction system.

- Nominal voltage in the OCS is 25,000 V and maximum 27,500 V/50 Hz (the system is permanently under voltage);
- The height of live parts min 5.020 mm above the high rail level and the insulators are also live;
- When the voltage is switched off in OCS, the return conductor is still dangerous as it is a continuous conductor;
- Voltage shall be shut down and the system earthed solely by the authorized OCS maintenance staff thus making safe any site close to OCS and an electrified track ;
- No works on the structures subjected to these requirements may start before a permit is given by the authorized person from the OCS maintenance division

FORBIDDEN AND DANGEROUS FOR LIFE

- If with body, tools, materials and water jet one gets closer than 2 m to live catenary system danger zone;
- If with body, tools, materials and water jet one touches the return conductor and earthing components;
- If working without protective clothing – boots and gloves;
- If using a conductive tool to bond rails of one of more tracks;
- If touching the OCS masts and return conductor and leaving material against them;
- If using metallic utensils and gear higher than 2.5 m above the high rail level in the zone 8 m left and right from an electrified track without having bonded it to a special earthing rod and/or the OCS return conductor ;
- If setting fire and using water under pressure near electrified tracks as water jets may foul the danger zone;
- If failing to observe the instructions of the Engineer and of the authorized staff from the OCS maintenance division.

The Contractor shall acquaint the workers with dangers from electric traction voltage and current and with measures for personal, collective and traffic safety on the railway lines electrified with single phase 25 kV/50 Hz system.

If scaffolds, pile drivers and other are used in 8 m wide zone left and right from an electrified track and are higher than 2.5 m above the high rail level, they shall be in a galvanic bond, and connected to earth and/or to OCS return conductor as directed by the Engineer and/or the authorized representative of the OCS maintenance division.

ADDITIONAL SAFETY MEASURES

Voltages dangerous to life and health may be induced in the metallic sheath, armature and core of a cable laid along the tracks electrified with a single phase 25 kV/50 Hz system. For this reason when working with these cables workers shall strictly observe the above instructions and safety measures as well as the additional ones listed below:

1. Instruments and tools
   - Insulated tools are obligatory;
   - Plug boxes for cable measuring instruments shall have puncture strength to mass of 2,000 V_{eff}; if not they shall be connected to cable pairs via translators having the primary-to mass and primary-to-secondary puncture strength of 2,000 VV_{eff};

- The instruments to be connected to cable core shall not be earthed via safety socket. Any instrument not earthed shall be held on an insulated base.
-- If reference potential has to match the measuring value, an instrument shall be bonded to the earth busbar in the cable cabinet or directly to cable sheath;
- When measuring coaxial pairs, the instruments shall not be bonded to cable earthing in order to avoid outer tube conductor bond to earth.

2. Mounting

- During working on cables along electrified tracks it is not permitted to use the OCS return conductor as earth unless explicitly permitted in the design.
- It is not permitted to touch with bare hands the cable core and the cable sheath simultaneously with any some earthed object;
- The sheath and/or armature shall be bonded to earth with special caution. When two points of different potential are bonded it shall be done with insulation tools, boots and gloves; if sparking may threaten, eyes shall be protected with safety glasses;
- When making joints it is not permitted to touch with bare hands the cable ends to be joined before a reliable galvanic bond is made to a copper strand of the cross section specified for joint bypassing; joining two cables means joining two points at different potential (see the preceding section);
- Cable ends shall be prepared (cleaning, stripping the armature and sheath and other) provided the other cable, earth and return conductor are not touched at the same time;
- When cutting a cable in order to inlay a splice or do something else, the armature and sheath shall be first bonded at either side of the future cutting line.
- When opening the existing joints, care shall be taken that the bypass bond connecting two cable ends is never interrupted.

3. Cable installation

- The earthing system of a cable plant (and other facilities, too) shall not have a single non-insulated component in a zone, 8 m wide left and right from the centre line of the electrified track; puncture strength of earth components in that zone (earth downleads) shall be 2,000 V_{eff}/50 Hz;
- The cable sheath and armature and the equipment in galvanic bond with them (cable terminations, end joints etc.) shall be reliably insulated from any metallic mass connected to electric traction return conductor; the cable installation may be earthed to the electric traction return conductor only in the cases and in the way explicitly specified in the Cable plant Detailed.
- Bypassing cable metallic armature and sheath (Al, Pb and Fe) is obligatory only in the cases and in the way explicitly specified in the Cable Plant Detailed design; thin steel protection tapes (against rodents) and Al foil (against humidity and heat insulation) shall never be bypassed within the splices nor bonded to earthing; at termination points such Fe tapes and/or Al foils shall be carefully isolated from earthed metallic masses in the way shown in the Cable Plant Detailed Design.

8. LANDSCAPING DESIGN OF THE ROAD AREA

The following arterials may be identified within the corridor of the studied highway: the M1 arterial road, Nis-Skoplje railway line and the R-214 regional road. Construction of the high speed railway line is also planned. The General design of the railway line was prepared at the end of last century but not revised.

The "Predejane" interchange is also planned to be constructed within the stated corridor. The interchange will connect the existing motel in Predejane and arteries that connect the R-214 road (Nis-Vranje) and R-240 (to Crna Trava) and the future highway.

The Final horticultural landscaping design of the road area shall be in harmony with natural environmental conditions and character of the landscape through which this section runs.

Landscaping solution is shown on the layout plan integrated in the civil engineering design, 1:1000 in scale – graphical attachments 3.1-3.....

8.1. Land use and landscaping characteristics of the area – current situation

Predejane - Caricina Dolina section runs along the right bank of the Juzna Morava River. The highway route on this section passes through two types of different topographic characteristics:
Flat – highway route is located on the Juzna Morava river draft;
Hilly – mountainous – with the route located in a cut or deep cut with steep slopes on the left bank of the Juzna Morava

In general, area around the Grdelicka Gorge is supposed to be a very attractive location.

Cultivated areas are fields, meadows, and gardens next to river streams, while mountains may be identified on left (Cemernik Mountain) as well as on right (Kukavica Mountain) side. Slopes are mostly covered with forests and/or pastures. The exception is areas composed of shales and small areas populated with settlements. The entire landscape is intersected with valleys and ravens.

Predejane is the only settlement that may be identified in the Grdelicka Gorge. Due to unfavorable conditions (steep slopes in Grdelicka Gorge, torrent nature of river streams and its tributaries, insufficient arable lands) only small settlements may be identified. These settlements belong to Leskovac and Vranje Municipalities. The cadastral districts through which the future highway will run are as follows: Bojsina, Bocevica, Graovo, Palojce, Licin Dol, Krpejce, Koraćevac, Predejane, Bricevlje, Repiste and Susevlje.

On the wider area of the studied corridor the following forest phytocoenosis may be identified (data overtaken from the Environment Impact Assessment Study):

8.2. Quercetum farnetto cerris Rud.

This is climatogene forest native to the Balkans and also the most common forest type in Serbia. These forests consist mainly of shoots; they are low in height and medium in thickness with well separated and rich layers of bushes, and vascular plants, i.e. species of ground flora.

Quercetum farnetto cerris Rud. forest includes the following species:

Quercetum frainetto, Quercus cerris, Tilia argentea, Pyrus piraster, Sorbus domestica, Sorbus torminalis, Fraxinus ornus, Acer campeste, Acer tataricum, Cornnus mas, Crataegus monogyna, Viburnum lantana, Rosa gallica, Lonicera caprifolium, Tamus cormmunis, Lathyrus niger, Danaa cornubiensis, Lychia coronaria, Silene viridiflora, Fanacetum corynbosum, Heleborus odorus, Trifolium alpestre, Campanula persicifolia, Veronica charmaedrus.

In lower parts of their common height area, Quercetum farnetto cerris Rud. forests have mostly been destroyed in order to increase agricultural areas. Larger areas of these phytocenoses can be found mostly in the mountainous parts, but they have been anthopogenetically altered, i.e. degraded. Apart from logging, these forests which are close to peoples settlements suffer other negative influences such as: cutting off branches for the purpose of livestock feeding, sheep pastures, goat graying. In this way, low forests became shrubs dominated by xerophyle bushes and some of the most resistant tree spaces: *Fraxinus ornus, Carpinus orientalis, Acer tataricum, Juniperus cormmunis Crataegus spp., Prunus spinosa, Cornnus mas, Evonymus spp., Ligustrum vulgare, Rhamnus carthartica, Viburnum lantana, Rubus spp.* and other.

2. Beside the typical Quercetum farnetto ceris Rud forests, in the area of the closer and wider perimeter of the E 75 highway route, certain associations (i.e. ecological and geographical variant of the already described phytocenosis) i.e. **Carpino orientalis - Quercetum frainetto – cerris** may be identified. These forests are formed by a large number of species of heterogeneous structure, often quite opposite in character, which in the further cause frailty of this phytocenosis, as well as in a tendency towards degradation and its difficult natural and artificial biological reactivation.

In the entire area common for forests of Carpino orientalis-Quercetum frainetto-cerris deforestation, logging and other factors has had a great influence. Thus these forests are degraded by regressive succession into Chrysopogonetum grylly Meadows (which is a typical form of dry, bare meadows of Mediterranean-steppe character).

These forests support the following tree species: *Quercus frainetto, Quercus cerris, Carpinus orientalis, Quercus pubescens,Quercus petraea, Sorbus torminalis, Frahinus ornus, Sorbus domestica, Pirys piraster, Acer campestre, Ulmus campestre, Pyrus armigdaliformis, and other*. Otherwise, the phytocenosis appears on slopes as steep as 23 degrees and on both north and south sides.

The bush level, apart from shoots of the above said trees, the following species have been determined: *Rosa arvensis, Crataegus monogyna, Cornus mas, Lonicera caprifoliurm, Viburnum lantana, Crataegus oxyacanta.*

3. Forest association that could be identified in the area of the future corridor is **Lauroceraso-Fagetum Jov.**

This forest de facto represents specific tertiary relict of *Prunus laurocerasus var. serbica, Laurocerasus officinalis.*

Since the edafic conditions are not suitable for beech trees, these are characterized with reduced vitality and thus young plants are very difficult to find. The broken levels of trees and significant moisture enable survivor and development of this forest that at bush level constitutes facias as a result of vegetative procreation.

4. The next phytocintesis to be identified along the corridor of the E 75 highway is **Carpinetum orientalis serbicum Rud.**

As a consequence of orographic dependence on warm expositions of steep slopes and on a series of shallow, skeletal and dry soils the limestone houses communities of Carpinetum orientalis serbicum Rud. These are offshoot forests rich in flora at all three levels; they don't grow high and are not thick. The phytocenosis includes 300-500 species (which is regularly stumped and often devastated on degraded soils). The following species may be identified: *Carpinus orientalis, Fraxinus orunus, Quercus pubescens, Acer hircanum, Acer monspesulanum, Quercus cerris, Sorbus domestica, Pirus amigdaliformis, Sorbus graeca, Cornus mas, Syringa vulgaris, Viburnum lantana, Crataegus monogyna, Evonymus verrucosa, Cotinus coqqygria, Berberis vulgaris, Rhamnus cathartica, Asparagus tenuifolius, Hipericum perforatum, Arabis hirsuta, Viola hirta, Melica ciliata, Festuca vallesiaca, Galium purpureum* and many other xerothermic basophile species.

6. The following forest phytocenosis is also present, along with other phytocenosis, in the wider area of the highway route: **Ass. Fagetum montanum s.lat (Fagetum montanum serbicum Rud.)**

This biocenosis is mostly dependent on the orographic factors, i.e. it appears as a permanent canopy in colder and fresher oak regions. These beech forests on cold slopes of hills and hillocks depend on the relief and not on the regional climate on that altitude.

Phytocenoses of beech forests are exposed to the penetration of the neighboring oak phytocenosis (*Quercus petraeae, Carpinus betulus, Quercus cerris, Sorbus torminalis, Prumus avium, Pirus piraster, Acer camprestre and other*). These species appear along each other as different from the forests in the beech-fir tree area.

Beside beech, as auxiliary and dependent species in a Serbian beech forest, the following species might appear:

Carpinus betulus, Quercus petraeae, Quercus cerris, Sorbus torminalis, Prumus avium, Malus silvestris, Pirus piraster, Acer pseudoplatanus, Acer platanoides, Tilia grandifolia, Corylus colurna.

Precisely, this phytocenosis is represented by relict community of beech trees and walnut tree - Juglando-Fagetum submontanum (Misić 1966) Jov. 1969.

6.The next phytocenosis (identified mostly along torrential flows on low relief points) is **Populeto salicetum Raj. 1950. s. l. Soo).**
Along all rivers in Serbia, different species of poplar and willow trees may be identified. Sometimes, they are mono-dominant forests.

In addition to different species of poplar and willow trees, the said phytocenosis also includes the following species: *Ulmus effusa, Fraxinus oxycarpa, Viburnum opulus, Crataegus nigra, Crataegus monogyna, Cornus sanguinea, Amorpha fruticosa (subspon.), Sambucus nigra, Rhamnus frangula* and other.

7.On the areas of hydrogravitating meritory watersheds, forests of only **- Quercetum montanum (Jovanović 1948) Cernjavski et Jovanović 1953** can be identified.

These cover large areas in Serbia as oroclimatic stripe in the hilly region at an altitude of 500-900 m. These forests have been registered covering large areas in South-East Serbia.

Certain authors (Horvat, Glavac, Ellenberg, 1974) believe that in the entire South Serbia these forests cover the higher (submontaneous) region of zonal vegetation. The basis in such forests is acid silicate rocks, and the acid brown soil is more or less shallow, skeletal and erosion exposed.

The bush level is often undeveloped in typical forests, but a larger number of species may be identified on the ground due to the tendency of this type of oak to seek the sunlight.

Beside Quercus petraeae, the tree level also includes a smaller number of other tree species: *Quercus cerris, Fraxinus ornus, Tilia argentea, Pyrus pyraster, Carpinus betulus, Acer campestre, Prunus avium,* and other. The bush level is poor in flora and only the following species can be found: *Cornus mas, Crataegus monogyna, Prunus spinosa, Juniperus communis,Corylus avellana* and other. The following species occur on the ground flora level: *Rosa arvensis, Genista ovata, Lathyrus niger, Lathyrus venetus, Campanula persicifolia, Helleborus odorus, Festuca montana, Poa nemoralis, Veronica chamaedrus* and many others.

Since these forests are identified on inclined slopes they are prone to erosion as a result of pedosequence skeleton. Combination of both biotopes and zooantropogene factors, these forests are prone to fast degradation. Since soil erosion has been increasing, the green cover (ground flora) disappears and movable skeleton and ravine erosion identified on the surface. On less inclined areas, underbushes may be identified represented by different species and Pteridium aquilinum formations.

Areas occupied by state-owned forests and soils are stated in the documents (specifications) submitted by the "Srbijasume" PE.

8.3. Landscaping - description

The purpose of the landscaping plan is based on the following:
- Make driving more comfortable
- Providing safety for all highway users
- Traffic concept must be harmonized with the environment.

Landscaping of the highway route shall also be in compliance with functional traffic requirements and landscape characteristics so as both physical and aesthetic criteria could be met.

According to modern landscaping concept for roads of this rank, the solution implies landscaping with natural forms. This means groups of different categories of planting material. In order to preserve the characteristic scenery of the area, deciduous species are used more with different heights, pherophases and colours and coniferous species are foreseen at accentuated points.

If the landscaping has been done incorrectly along the road area, it may significantly affect the traffic safety, as a result of unsuitable distance between vegetation and pavement edge that may obstruct the vision of motorists.

Compliance with traffic safety principle is achieved by adopting the values below, regarding the position of plants in traffic profile:

- Minimum distance of trees taller than 4.5 m is 9 m from shoulder edge on motorway and 4 m from shoulder edge on local road
- Minimum distance of shrub seedlings is 4 m from shoulder edge on motorway and 3 m from shoulder edge on local roads
- Minimum distance of trees is 4 m from channel edge and minimum distance of shrub is 3 m from channel edge.

Vegetation in road profile is shown in graphical attachment – typical cross section, sheet 4.1

- According to the proposed solution, slopes shall be covered with plants that will hold the soil thus preventing erosion process. Slopes on embankment and cuttings shall be covered with underbushes and high embankments shall be covered with higher plants to be harmonized with the environment. In addition to protection against erosion, vegetation on slopes shall also perform optical guidance.
- At the same time, the vegetation will perform anti-erosion protection and have an effect of an air filter for hard particles of dust and soot and some heavy metals between the motorway and arable land. On embankments positioned in curves, underbush planted along the outer curve side shall be also used as protective measure if a vehicle deviates from the road. The underbush plants planned to be used on embankment slopes shall not disturb visibility on the inner curve side.
- Central reserve shall be covered with grass (as stated in the civil engineering design), while on the smaller segment in the vicinity of the tunnel, underbush resistant to exhaust gases shall be planted.

- Protective greenery formed of different plants is foreseen to be developed in the vicinity of settlements. The greenery shall also be used as a barrier that will mitigate negative impacts (gasses, dust, and noise) and will improve the area from the visual aspect. Plant species of different height, color and different habitus will preserve their decorative characteristics all the year around.
- In the area of interchange, groups of different greenery categories will be planted in order to improve traffic functioning and aesthetic experience in the landscape.
- Moreover, between the highway and alternative road as well as between the highway and railroad adequate vegetation is planned to be planted to provide relevant protection against vehicle headlights.
- Vegetation along rivers and brooks shall be preserved as far as possible and on places where regulation works will be required to enable structure stability, the area will be recovered through adequate landscaping measures and thus bring into original state. Due to restricted spatial possibilities, in a close proximity of the Juzna Morava regulation, new vegetation is not planned to be planted so as flow profile in the flood area could be maintained unchanged.

Geomechanicaly unstable slopes marked as K1-K..... have been rehabilitated through the application of different technical protection measures stated in the road alignment design.

Topsoiling in a 20 cm layer and sewing of grass in central reserve and on cutting and embankment slopes is foreseen in the civil engineering design. The remaining green areas extending to the limit of the land strip will grow spontaneously, and form natural lawn.

The massifs of shrub, medium-high and high vegetation are foreseen, in principle, as far as motorway fence, and out of that zone where appropriate. The belt from the motorway fence to the land strip limit will be left unoccupied for maintenance purposes.

Detailed plan specification is attached to this technical description. Selection of autochthonous plant species will enable natural and attractive visual effect. Conditions required for plan growth are more favorable and small investments will be required for maintenance of the stated plant species.

Since the design documentation does not include synchronized layout plan for the landscaping purposes, the Contractor must be familiar with the existing and completed installations in the highway right-of-way. In the course of planting, minimum distances between the high trees and certain installations must be satisfied, as stated below:

- From the water supply pipe line – 1.5 m
- From the sewage system- 2.5-3 m
- From electrical installations - 1. 5 m
- From public lighting masts – 1.5 m
- From telephone installations -
- From gas pipeline 2-2.5 m
- From hot water pipeline - 2-2.5 m

Specification

Equivalency of Standards and Codes
Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards that ensure substantially equival or higher quality than the standards and codes specified shall be accepted subject to the Engineer's prior review and written consent. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's consent. In the event the Engineer determines that such proposed deviations do not ensure substantially equal performance, the Contractor shall comply with the standards specified in the documents.

<u>List of Specification:</u>

The Special Specifications should be read in conjunction with General Specifications and shall extend and modify them as appropriate.

CD with the specifications is enclosed to bidding documents.
In case of discrepancy, printed version will prevail.

Section 1
Preliminaries

Contents

1.1. Definitions and Interpretation

1.1.1. Definitions

Terms used in these Specifications are as defined in the Conditions of Contract with the following additions::

- “Special Specifications” shall, together with these General Specifications, comprise the “Specifications” or “Technical Specifications” for this Contract. The Special Specifications shall be read in conjunction with these General Specifications and shall extend and modify them as appropriate. The Facilities for the Engineer and Employer’s Representative, Environmental Management Plan and Check List should be treated as “Special Specifications”.

- "Works Manager" is synonymous with the term “Contractor’s Representative”

- "Preliminary works" are those works and auxiliary structures of a temporary character that are performed in order to organize the Site and apply certain work execution technologies.

- "Designs" mean technical solutions and specifications for the execution of works adopted by the Employer. The designs include any alterations of and/or additions to the designs adopted by the Employer during the execution of works.

- "Technical Documents" means all designs for a structure.

- "Designer" is the organization that prepared the Technical Documents for the works within the scope of Contract.

1.2 Scope of the Works

1.2.1 The scope of the Works shall be as defined in Section 1.2 of the Special Specifications.

1.3. Documents on Site

1.3.1. Building Journal

The Contractor shall keep a Building Journal throughout the execution of works.
The Building Journal shall be kept in the form of a bound book with double pages (an original and copy); the copy being tearable from the book.
The Building Journal shall be kept by the Works Manager, or a person appointed by him, starting from the date of introduction of the Contractor into the work until the date of taking over of the works after their completion.

The Building Journal shall daily record data on the course and method of execution of the works, along with all those data that may affect the safety and quality of the works, such as the data on: inspection of all those works that will be impossible to inspect in later stages (foundation pits and sub-strata before the resumption of works, formwork and reinforcement before concreting, the subgrade before the construction of the pavement, masonry elements before plastering, clear profiles and rock masses in tunnels before lining, installations before sealing the insulation, before back-filling, etc.); sampling materials for testing; tests on the site; testing and compliance testing results; variations from the Technical Documents; weather conditions and temperature; any natural events and accidents; the delivery, origin, and quality of materials and equipment delivered to the site; spot heights; staking and the like; ground investigations; inspection of the site by inspection authorities and their findings; and on other works and events that affect the safety and quality of the works.

Furthermore, all those data that may serve as evidence in the calculation of executed works shall be entered into the Journal, such as the data on: alterations and amendments to the designs; halts and suspension of the works; the works that are stated in overhead hours; unforeseen and additional works; groundwater; alterations in working conditions; number of employees and their qualification structure; machines on the site; excavation levels; soil category; altered working conditions etc.

The Engineer and Contractor shall record any exchange correspondence through the Building Journal regarding the mentioned data and other problems, particularly regarding the meeting of deadlines, provision of necessary documents, elimination of identified defects, quality assessment, payment for works etc.; in particular, the Engineer shall record the issue of all necessary instructions to the Contractor in the Journal.

The Works Manager and Engineer shall daily confirm the accuracy of data entered within one day by affixing their signatures on these pages.

The Engineer shall have one copy of signed pages safeguarded with the Employer, and the other copy shall remain with the Contractor.

The data entered into the Building Journal shall not be corrected, altered, nor supplemented. Any corrections, supplements, or alterations shall be entered into the Journal with a new entry.

If any Republic or Provincial regulation in the territory where the works are executed has some other requirements regarding the keeping of Building Journals, the Contractor shall follow these requirements.

All entries into the Building Journal shall be considered as true, until proven otherwise. The costs of proving shall be borne by the party who entered untrue data into the Building Journal.

1.3.2. Measurement Book

The Contractor shall keep a Measurement Book, unless the works were contracted ‘on a turnkey basis’ or the like.
The adminstration of the Measurement Book, notices of measurements etc. shall be in full accordance with the Conditions of Contract. The Contractor’s entitlement to payment for any Works completed and recorded in the Measurement Book shall be in full accordance with the Conditions of Contract.

Accurate data on measures and quantities of actually executed works shall be entered into the Measurement Book; the Book serves as evidence (document) for the statement and payment of the Works. If necessary, appropriate sketches shall be drawn in the Measurement Book as well.

The Contractor's Works Manager and the Engineer shall prepare necessary draft calculations that are considered as constituent parts of the Measurement Book, and these shall be kept in one copy on a copy of the Final Design.

All alterations shall be entered in several colours. A draft calculation may be accompanied with special key details with a reference to the Building Journal or Measurement Book, when, why and by whom the alteration was made. Draft calculations shall be signed by the Engineer and Works Manager.

The Measurement Book shall be kept in one copy, so that each item from the Priced Bill of Quantities shall be on a separate sheet. After the completion of final calculation, all sheets of the Measurement Book shall be bound together and submitted to the Employer.

Data for the Measurement Book shall be jointly collected by the Engineer and Works Manager, entering, near the end of each moth, the quantities of works completed in that month, with calculation data for these quantities, and verifying with their signatures the accuracy of these data. All quantities stated in the Measurement Book that are impossible to check at a later stage, but are verified by the Engineer, shall be considered as finally determined quantities.

Any correction in the Measurement Book shall be signed and countersigned.

1.3.3. Other Documents

The Contractor shall have on the site at all times:

- The Building Permit, i.e. the general approval for the construction of the entire structure
- The Technical Documents based on which the Building Permit was issued
- Detailed Drawings with alterations and amendments added on the drawings
- The Documents from which it is possible to determine whether the works are executed according to current regulations, technical norms, and Serbian standards (rules, standards, compliance certificates, test results, etc.),
- The Decision on entry into the Serbian Business Registers Agency and appropriate building Licenses
- The Building Journal
- The Measurement Book
- The Act on assignment of the responsible Site Manager, with special contractual regulations or provisions
- The technical description of the Contractor's organization
- The Site organization scheme
- The programme (operational plan) of works,
- The financial spending plan, and
- Other documents if needed by the current regulations or the Contract.

1.4. Fulfilment of Contractual Obligations in Good Faith

1.4.1. Principles of honesty and good faith
Honesty and good faith are basic principles that the Contracting Parties shall follow in activities specified in the Contract.

1.4.2. Fulfilment of obligations

During the fulfilment of their obligations, the Contracting Parties shall act with due care required in business relations (due diligence), and in the fulfilment of obligations from their professional activity, they shall act with more care, according to professional rules and practices (due professional diligence). A Contracting Party shall not ask the other Contracting Party to fulfill his obligation, if the asking Party himself did not or is not ready to fulfil his obligation to which the fulfilment of the other Contracting Party's obligation is related, unless otherwise specified in the Contract.

A Contracting Party shall inform the other Contracting Party in a timely manner of any facts the occurrence of which affects the fulfilment of the Contract, such as obstacles to the fulfilment of Contract, changes in circumstances, etc.

The notifications shall be in writing, and therefore the other Party shall be considered as informed by an entry into the Building Journal.

1.5. Contractor's General Obligations

1.5.1. Notification and Clarifications
The Contractor shall timely, in writing and recorded in the Building Journal, notify the Engineer of all issues relevant for the fulfilment of contractual obligations, commencement of particular technological phases of works, sources for the supply of materials, shops and plants where preliminary works are performed, or where semi-finished and finished products are fabricated, and machines that the Contractor engages for the execution of works.

The Contractor shall timely ask the Engineer for any clarification of the Technical Specifications, Technical Documents, and other documents. If the Contractor fails to do so, he shall not have the right to any compensation due to the halt in works or modification of executed works due to a variation from documents or the Contract. The Engineer shall give the requested clarification and instructions to the Contractor in writing and recorded in the Building Journal.

1.5.2 Setting Out Of Work And Protection Of Survey Monuments

Immediately after receiving notice to commence the Works the Contractor shall carry out the following:

(a) The Contractor shall carry out a thorough survey check of the coordinates and levels of the ground control traverse stations (primary beacons) against data supplied by the Engineer and will immediately report to the Engineer any discrepancies between the measured locations or levels of the ground control points and that data. The Contractor may expect that some of the stations will have been disturbed or destroyed. The Contractor and the Engineer shall agree either to disregard erroneous data or to substitute new values of coordinates and/or levels.

(b) The Contractor shall establish construction control points along the length of the road alignment. These control points shall be located outside the area to be occupied by the Permanent Works, and successive points shall be mutually inter-visible and shall be at spacings and locations such that all future setting out can be carried out from them. The Contractor shall clearly mark and protect the construction control points, which shall comprise steel pins set in concrete, until completion of the Contract.

(c) Coordinates and levels of the construction control points shall be determined by the Contractor, and notified to the Engineer, based on the ground control coordinates and levels supplied by the Engineer.

When a primary beacon is likely to be disturbed during construction operations, the Contractor shall establish suitable reference beacons at locations where they will not be disturbed during construction. Beacons shall be established on a steel pin set in concrete or a similar permanent manner as approved by the Engineer. No beacon shall be covered over, disturbed or destroyed before accurate reference beacons have been established and details of the position and levels of such beacons have been submitted to the Engineer and approved by him. The Contractor's reference beacons shall be of at least the same quality and durability as the existing beacons.

The Contractor shall, prior to any setting out, submit to the Engineer for his approval, the method of setting out he proposes to employ. The plan shall include the accuracy, positions of the various types of stakes, method of marking stakes, and methods to be used for protecting stakes, etc. No survey work shall proceed prior to the Engineer's approval of the Contractor's plan. At least 24 hours before he intends to survey any portion of the Works, the Contractor shall give written notice to the Engineer. Such notice shall include time, location and type of Works to be set out. The Contractor shall set out the Works and obtain approval of his setting out before proceeding with construction.

Special care shall be exercised during construction not to damage, displace or disturb property and trigonometrical survey beacons. If such beacons are disturbed or destroyed by the Contractor they shall be replaced without delay by a registered land surveyor at the Contractor's expense. In cases where displacement of or damage to such beacons is unavoidable the Contractor shall also be responsible for relocation or suitably referencing later reinstatement of such beacon at his own cost.

Accurate control of line and level shall be provided by the Contractor at all stages of construction. In respect of the road itself control shall be at 20 m intervals, or such closer intervals as may be directed by the Engineer on horizontal and vertical curves. After the clearing and grubbing and removal of topsoil and completion of any preparatory road bed treatment which may have been ordered by the Engineer, but prior to commencement of any earthwork operations, the Contractor shall level cross sections of the ground line. Wherever necessary, but particularly on completion of the subgrade and the base, the Contractor shall re-establish stake line pegs at sufficiently close intervals to determine accurately the edges of the base, surfacing and especially kerbing, guardrails and other road elements permanently exposed to view.

No work in connection with survey, setting out and with any requirement of this Section of the Specifications shall be subject to measurement or payment. All costs in connection with survey and setting out shall be deemed to be covered by the rates and prices included in the Bills of Quantities.

1.6. Contractor's Workers

1.6.1. Transport, Lodging, and Board
The Contractor shall, at his own expense, ensure the transport of works from the place of lodging to the site, and organize the accommodation and board for workers on the site, etc., in compliance with the regulations on associated labour, and regulations on occupational safety.

1.6.2. Works Manager

The Contractor shall ensure that the Works are managed directly by a competent person (Works manager) who will, in compliance with the law, have specific qualifications and experience with this type of works.

The Contractor shall retain in his organisation a management expert who is familiar with the FIDIC Conditions of Contract, whose duties will include liaison with the Engineer, attending meetings with the Engineer concerning all contract matters and obligations of the parties to the Contract; on the job training of Contractor's staff concerning project management, contract administration and quality assurance.

Three days before the commencement of Works, the Contractor shall submit to the Employer and the Engineer, in writing, the name of the responsible Works Manager. If in the course of works the responsible Works Manager is replaced, the Contractor shall immediately inform the Engineer thereof.

1.7. Quality of Materials and Works

1.7.1. Quality Control
Quality Control and Management shall include, but shall not be limited to, the conduct of laboratory testing of materials, semi-finished and finished products, and by the testing of completed works "in situ".

The Contractor shall execute the works in the order that ensures a good quality of performance, and timely inform the Engineer of the execution of each phase, for the purpose of determining the quality of works.

1.7.2. Control Testing

The Contrator shall provide a Site laboratory in accordance with the requirements of Sub-Clause 1.7.7 of the Technical Specifications and shall be responsible for staffing and equipping the laboratory in order that it can complete all the testing specified in the Contract at a rate compatible with the programmed rates of construction of the Works.

1.7.3 Independent Laboratory

The Engineer shall carry out control tests, through an Independent Laboratory, accredited in accordance with current regulations in operation in Serbia . The primary objective of the Independent testing shall be to establish the accuracy, or otherwise of the on Site testing, although the final assessment of quality of materials and works, and the results of control tests shall be considered as relevant.

The Independent laboratory shall execute testing at not less than 10% of the rate of testing stated in the Specifications for Site testing. The cost of all such Independent Testing shall be borne by the Contractor.

1.7.4. Testing Costs

The costs of pre-testing and regular testing and Independent testing of building materials, semi-finished and finished products shall be borne by the Contractor.

1.7.5. Approval of Materials for Use

The Contractor shall, before the delivery and/or use of adequate building materials, semi-finished, and finished products, provide from a professional, i.e. authorised Serbian institution the certificate on the completed pre-testing of quality and suitability of the materials, semi-finished and finished products he intends to use, and the Contractor shall submit them to the Engineer for check-over and approval.

The Contractor shall provide compliance certificates when so specified in the contract specifications.

The Contractor shall not use any building materials without the Engineer's approval, and if he uses them, he shall bear the risk and costs that may arise on such grounds.

1.7.6. Materials from Abroad

The contractor shall have the right to import, for the purpose of execution of works, the materials that cannot be procured in Serbia, in compliance with regulations on the import of goods. The imported materials shall be provided with compliance certificates issued by an organization registered in the Court Register for the testing of materials and constructions in Serbia, such certificates confirming that the materials meet the contract specifications.

1.7.7 The Laboratory and Laboratory Resourcing

The laboratory building shall comprise an internal floor area of at least 150 m2 and a further external covered area of at least 30 m2 and shall include the following rooms:

- 2 offices (one each for the Engineer and the Contractor) of minimum 15 m2
- 1 main laboratory room of minimum 50 m2
- 2 subsidiary laboratory rooms of minimum 20 m2
- 2 store rooms of minimum 10 m2 each
- toilet facilities

Adequate light fittings shall be provided in each room together with sufficient power points to supply all equipment.

The laboratory provided by the Contractor shall be used exclusively for the selection, design and control testing of materials to be incorporated in the works.

The Contractor shall supply new furniture and equipment for the laboratory as listed in the Special Specifications TABLE 1.7.7 – A for use as directed by the Engineer. The Contractor shall provide additional furniture and equipment for his own use. (Materials testing equipment is addressed separately):

The laboratory shall be fully equipped to carry out all of the tests indicated below and the testing equipment provided shall conform in every respect to the standards listed. The Contractor shall provide sufficient quantities of testing equipment to meet the specified testing requirements, commensurate with his planned rates of production, including an adequate stock of breakable and consumable items. All furniture fittings and equipment provided for the laboratory shall be new, unless otherwise agreed by the Engineer. The Contractor shall submit the proposed layout and a full list of the equipment and furniture he intends to order, within 14 days of the receipt by the Contractor of the Letter of Acceptance, for the comment and approval of the Engineer. Such approval by the Engineer shall not relieve the Contractor of his responsibility to ensure that the laboratory is adequately equipped and the Contractor shall have no claim for delays resulting from the inadequacy of the testing facilities.

The Contractor shall be responsible for staffing the laboratory. He shall provide a suitably qualified and experienced and licensed senior laboratory technician and sufficient technicians and assistants to meet the testing requirements. It is anticipated that this will require not less than 5 technicians and 10 skilled assistants. Details of the proposed staffing shall be submitted to the Engineer for approval and he shall be entitled to ask the Contractor to remove or replace any member of the laboratory staff, whether previously approved or not, if in doubt about their competence. The Contractor shall have no claim for delays resulting from the inadequacy of numbers or inexperience of laboratory staff.

The Contractor shall provide all transport necessary to the proper functioning of the laboratory and its day-to-day field investigation, sampling and testing requirements. For this purpose the Contractor shall provide not less than 3 vehicles together with drivers, maintenance and all running costs, as defined in Section 1.8 of the Special Specifications which shall be for the exclusive use of the laboratory. In cases when this provision of laboratory transport is inadequate to meet laboratory requirements the Contractor will supplement the laboratory transport on a temporary basis. The cost of providing all laboratory transport shall be deemed to be included in the rate for maintaining the laboratory. The Contractor shall have no claim for delays resulting from insufficient laboratory transport.

All testing and the running of the laboratory shall be carried out under the direction of the Engineer, who shall appoint a suitably qualified and licensed Engineer for this purpose, except that the Contractor shall be permitted to carry out tests to confirm potential materials sources and mix design prior to their adoption for the Works and other such tests as the Contractor may require in direct connection with the Works.

The Contractor shall supply all samples of materials for testing. He shall provide assistance, labour, technician staff, attendance, transport and anything else necessary, as may from time to time be required by the Engineer, in taking and packing samples in approved containers, dispatching them for test, preparing them for test, examining and testing them and presenting the test results. In the event that any sampling and testing is carried out at the manufacturer's plant or at any laboratory other than the site laboratory, the cost of such sampling and testing or the furnishing of test certificates shall be borne by the Contractor.

The Engineer may require the Contractor to provide additional temporary laboratory accommodation for the use of laboratory staff, for testing purposes, at key locations on Site. Such key locations may include crushing plant, asphalt plant and major bridges sites. The temporary laboratory accommodation may comprise not more than three, lockable, 6 m long shipping containers or other similar moveable, weather proof, secure shelters acceptable to the Engineer. The Contractor shall relocate such temporary facilities about the Site when requested to do so by the Engineer.

The laboratory shall be supplied with a continuous recording rain gauge and a maximum/minimum thermometer to the approval of the Engineer.

The laboratory building and all furniture, equipment and apparatus to be provided shall remain the property of the Contractor upon completion of the Contract.

The materials testing laboratory shall be fully equipped with all the necessary equipment and a full range of consumable stores to carry out all required tests. Where other tests are required by the Contract in order to ascertain compliance with the required standards, the Contractor may choose to provide the required testing facilities at the Site laboratory or may choose to provide the necessary testing at a remote laboratory, subject to the approval of the Engineer. In either case the cost of such testing shall not be the subject of separate payment but shall be deemed to have been included in the rates and prices included in the Bills of Quantities

Testing equipment for pre-construction testing of bitumen and other specialised tests, may be performed at authorised testing institutes approved by the Engineer. The cost of such testing shall not be the subject of separate payment but shall be deemed to have been included in the rates and prices included in the Bills of Quantities.

Areas Around Laboratory(ies)

The access and other roads around the offices shall be treated to make them dust free either by using crushed stone, suitable dust laying oils, bituminous surfacing or other approved means. They shall be well-drained and kept trafficable and free from mud at all times. Footpaths shall be similarly treated to provide convenient access to all buildings.

Heaters and air-conditioning

The Contractor shall provide and install heaters and air-conditioning, in the laboratory, as required by the Engineer.
Heaters shall preferably be of space heating type without exposed elements and shall have a capacity of not less than 1.5 kW each.

Toilet-washroom Units

Toilet-washroom units shall be well-ventilated units. Latrines shall be provided with vitreous enamel W.C. pans with PVC seats and covers and flush cisterns. Wash basins shall be in vitreous enamel complete with taps and drains. Provision shall be made for suitable sewerage.

1.8. Facilities for the Engineer

1.8.1 The Contractor shall provide, for the exclusive use of the Engineer's Staff at the Site, the facilities and equipment described in detail below.-

1.8.1.1 Offices for the Engineer

General
The Engineer shall be provided with Principal Offices, which shall be constructed on land acquired by the Employer, at a location to be specified for each contract.

The Engineer shall also be provided with Site Offices which shall be situated at the Contractor's principal compound and convenient to the laboratory, and at other major construction locations. In the event that the Contractor's compound is also located in the vicinity of the Principal Offices then the Engineer shall agree with the Contractor upon an alternative location for the Site Offices.

The Principal Offices :

General

An area of approximately 2000m.sq. shall be allocated, from land acquired by the Employer for the construction of a fenced compound and, within it, Principal Offices for the Engineer in buildings of permanent and temporary construction. The Contractor shall be provided with a layout and detailed design drawings / specifications for the buildings as well as details of the provisions / furnishings selected by the design architects.

Paving shall be required over approximately 1500m.sq. of the allocated area and the remainder shall be landscaped and planted.

The Permanent Building

The furniture and equipment to be provided for the Permanent Building Offices, in accordance with this Technical Specification and Annex A1 in the Special Specifications, shall be handed over into the property of the Employer at the end of the Contract.

The offices in the permanent building shall include the preparation of all necessary working drawings as well as all of the provisions indicated in the designs, including but not limited to, the provision of all services and utilities, air conditioning and heating throughout, the work stations and furnishing, four telephone lines and connections to all offices, provision of a file server and computer networking of the work stations, printers etc., fire extinguishers, smoke alarms and fire exit signs according to the Fire Authority regulations or, otherwise, as directed by the Engineer, doormats in the entrances, a boot scraper and 6 lever security locks on the entrance doors.

The Office of the Chief Resident Engineer :

As shown in the drawings, the office of the Chief Resident Engineer shall be a minimum 20m.sq., and provided / furnished with equipment listed in Table CRE in the Special Specifications.

The Offices of Senior Engineering Staff :

As shown in the drawings four offices for Senior Engineering Staff shall be a minimum of 12 m.sq., and each one provided / furnished with:

(a) 1 x work station, comprising of a 1.6m x 0.80m x 0.75m high, executive desk with a 1.2m x 0.6m x 0.68m high, computer table, a 3 drawer lockable cabinet 0.45m x 0.47m x 0.57m high and an upholstered executive office chair with arm rests.
(b) 1 x 4 drawer lockable steel filing cabinet
(c) 1 x double door cupboard with shelves (matching the desks), 0.90m x 0.45m x 1.40m high.
(d) 2 x standard, matching chairs for visitors
(e) 1 x Computer Pentium 4 at 2.9GHz or higher, hard disk 80 GB, monitor TFT LCD 17”, DVDRW, floppy drive, modem/fax/voice 56k linked to the office network.
(f) 1 x telephone set with contact saving, re-dial and call-back functions
(g) 1 x Wall clock
(h) 1 x Heavy duty document hole punch ‘SAX 608’ or equivalent
(i) 1 x Stapler ‘SAX 620’ or equivalent
(j) Name plate on door
(k) 1 x Paper trays, 3 tier
(l) 1 x Waste paper basket
(m) 1 x 2.4m x 1.2m pin board
(n) Set of coat hooks
(o) 1 x indoor evergreen plant (approx 1.5m in height)

The Offices of Engineering Staff :

As shown in the drawings four offices for Engineering Staff shall be 15 m.sq plus, and each one provided furnished with :

(a) 3 x work stations, each comprising of a 1.6m x 0.80m x 0.75m high, desk, a 3 drawer lockable cabinet 0.45m x 0.47m x 0.57m high and an upholstered office chair with arm rests.
(b) 2 x 4 drawer, lockable steel filing cabinets
(c) 1 x double door, lockable steel wardrobe cabinet, 0.90m x 0.45m x 2.00m high.
(d) 2 x standard, matching chairs for visitors
(e) 2 x Computers Pentium 4 at 2.9GHz or higher, hard disk 80 GB, monitor TFT LCD 17”, DVDRW, floppy drive, modem/fax/voice 56k linked to the office network.
(f) 1 x telephone set with contact saving, re-dial and call-back functions
(g) 1 x Heavy duty document hole punch ‘SAX 608’ or equivalent
(h) 1 x Stapler ‘SAX 620’ or equivalent
(i) Name plate on door
(j) 3 x Paper trays, 3 tier
(k) 3 x Waste paper basket
(l) 1 x 2.4m x 1.2m pin board
(m) Set of coat hooks

2.6 The Secretaries' Office

As shown in the drawings the office for Secretarial Staff shall be 15 m.sq plus, and provided/furnished with :

(a) 2 x work stations, comprising o a 1.6m x 0.80m x 0.75m high, executive desk, with a 1.2m x 0.6m x 0.68m high, computer table, a 3 drawer lockable cabinet 0.45m x 0.47m x 0.57m high and an upholstered office chair designed for typists.
(b) 4 x 4 drawer, lockable steel filing cabinets fitted for hanging files
(c) 1 x double door, lockable steel cabinet with shelves, 0.90m x 0.45m x 1.40m high.
(d) 1 x double door cabinet 0.90m x 0.45m x 0.73m high, with work surface top, containing 1 x electric kettle, 12 cups, 12 tea spoons, 1 tray and 4 dish towels.
(e) 2 x standard, matching chair for visitors
(f) 2 x Computers Pentium 4 at 2.9GHz or higher, hard disk 80 GB, monitor TFT LCD 17", DVDRW, floppy drive, modem/fax/voice 56k to act as server for the other computers and equipment in the network
(g) 1 x laser fax/printer/scaner HP LaserJet 3015 with USB cable or equivalent
(h) 1 x photocopier Canon NP-7161 with document feeder or equivalent
(i) 1 x telephone set KX-T7630 or equivalent
(j) 1 x Document shredder, 'bis Rabbit' or equivalent
(k) 1 x Document binding machine 'Leitz CB600 DL' or equivalent
(l) 1 x Heavy duty document hole punch 'SAX 608' or equivalent
(m) 1 x Stapler 'SAX 620' or equivalent
(n) Name plate on door
(o) 4 x Paper trays, 3 tier
(p) 2 x Waste paper basket
(q) 1 x 2.4m x 1.2m pin board
(r) Set of coat hooks
(s) 2 x First Aid Set

The secretaries' office shall be so arranged as to provide for and control the reception of visitors into the foyer and their admittance into the offices.

The Conference Room

As shown in the drawings, the conference room shall be a minimum of 30m.sq., provided/furnished with :

(a) 1 x executive quality conference table
(b) 12 x chairs of a compatible quality
(c) 1 x double door cupboard with shelves (matching the table), 0.90m x 0.45m x 0.85m high.
(d) 1 x set of telephone conferencing equipment

The Foyer

As shown in the drawings, double doors shall separate the foyer from the entrance and the foyer shall be furnished with :

(a) 4 x chairs for visitors
(b) 1 x coffee table
(c) 1 x indoor evergreen plant (approx 1.5m in height)
(d) 1 x 2.4m x 1.2m pin board for safety regulations, the fire escape plan etc.

The Server Room, Store Room, Drying Room, Kitchen, Wash-rooms / Toilets etc.

The ancillary office provisions shall be as shown in the drawing and the provisions / furnishing shall be as specified by the architects.

Maintenance General

The provisions that the Contractor is required to make for maintaining and cleaning all of the offices of the Engineer shall include for all necessary repair works as well as the provision of all necessary cleaning equipment, rubbish bins and materials as well as the provision of liquid soap for hand washing, dish washing etc., lavatory cleaner and brushes, toilet paper, the daily provision of clean hand towels, fly spray, the extermination of any rodents and any other such incidentals as the Engineer may reasonably require for maintaining decent conditions for the operations of the offices.

1.8.1.2 Protective Equipment for the Engineer

General

The contractor shall initially provide the Engineer with protective clothing and equipment, as follows, and, as the Engineer considers necessary, provide replacement items under the provisions for maintenance of the Engineer's facilities. Prior to making this provision, the Contractor shall obtain a list of appropriate sizes from the Engineer. As and where the Contractor's methodology, activities or planned testing programme may require additional protective equipment (such as gloves, ear plugs, goggles, torches etc), the Contractor shall make these available to the Engineer as and when the need arises.

List of Protective Equipment is shown in Table LPE in the Special Specifications.

1.8.1.3 Surveying Equipment for the Engineer

General

The Contractor shall provide and maintain, for the use of the Engineer throughout the term of the Contract and until all measurement relevant to the Final payment Certificate has been completed and agreed, two sets of precise survey equipment as well as all of the ancillary and consumable items, attendance and assistance necessary to measuring the works, determining the necessary scope and quantities of any works and determining the precise levels and locations of any parts of the Works.

At the end of its term of use, the survey equipment shall be returned into the property of the Contractor. The following list of equipment is intended to be indicative of the principal requirements for each set and does not impose any limit upon the Contractor's selection of a fully operative sets of total station and associated equipment from a recognized manufacturer :

Precise Survey Equipment

Two complete sets of equipment are to be provided, according to the list shown in Table PSE in the Special Specifications. One set shall be provided for the initial survey works and the second set shall be provided in accordance with instructions issued by the Engineer.

1.8.1.4 Vehicles for the Engineer

The Contractor shall provide the Engineer with new cars acceptable to the Engineer, having the following characteristics:

- 4-door, mini-bus with minimum 10 seats, AC, central locking and ABS braking, with engine capacity exceeding 1990 cc [Type A]
- 5-door car, with four / five seats, AC, central locking and ABS braking, with engine capacity exceeding 1600 cc [Type B]
- 5 door car, with 4 seats, AC, with engine capacity 1400 - 1600cc, to be delivered to the site office of the Engineer [Type C].

When no longer required by the Engineer for the supervision of the Works, but no later than the end of the Defects Liability Period, the ownership of the above vehicles shall be transferred to the Employer who will then become responsible for fuel servicing, repair, maintenance, insurance and miscellaneous costs.

They shall be delivered (with registration plates, vehicle licence, and be fully and comprehensively insured) prior to the Commencement of works on site.

The Contractor shall be responsible for provision of fuel, lubricants, servicing, repair, maintenance and comprehensive insurance of the vehicles of the Engineer. Reimbursement of maintenance, insurance and fuelling costs shall be by a charge against the provisional sum allowance.

In the case of accidental damage, the Contractor shall be responsible for reinstatement of the damaged vehicle to its original condition. The Contractor shall supply temporary replacement vehicles during periods when the cars are immobilised.

1.8.1.5 Miscellaneous Services for the Engineer

The Contractor shall supply all necessary stationery and office consumables for the Engineer's staff on site including A3 and A4 sized paper for photocopier, notebooks, pads of writing paper, file holders, lever arch files, ball pens, highlighter pens, pencils, erasers, staplers and staples, punchers, clips, adhesive tape, marking pens, wipers, printer toner, etc. Reimbursement of the costs of supply shall be by a charge against the provisional sum allowance.

1.9 Relocation of Services

Whenever an existing over-ground or underground installation carrying services is to be diverted in order to perform the Works, the Contractor shall arrange for this work to be carried out by the owner of the service, or as directed by the Engineer in accordance with the Works scheduled to be carried out by the Contractor in the Bills of Quantities and in these Technical Specifications..

The Contractor shall provide attendance as necessary and shall be responsible for taking all measures to provide the protection of such installation and for the consequences of damages that could appear.

The Contractor shall take whatever measures are necessary to avoid damage to any pipes, cables or conduits, telegraph or telephone installations, poles or pylons etc.

It will be the responsibility of the Employer and the Engineer to obtain prior approvals from the owners of services regarding the relocation of existing installations but the Contractor shall be responsible for agreeing the programme of the work and for paying any necessary costs and fees, when instructed by the Engineer.

Whenever the Contractor, during the execution of the Works, finds additional installations that require to be moved or protected, he shall immediately inform the Engineer: the Engineer will accordingly notify the Employer in order to obtain the necessary approval. Unless decided otherwise by the Employer, the Engineer and the service owner, the removal or protection works will be carried out by the service owner.

A Provisional Sum is provided in the Bill of Quantities covering the costs for design and execution of diverting, removing or protecting such installations.

If any service installation exists but does not require to be diverted, it shall be the Contractor's responsibility to protect the service while working near it, all to the approval of the service owner and the Engineer.

The Contractor shall inform the relevant offices immediately in the event of any damage being caused by him to pipelines, cables or other such installations on Site and shall immediately arrange for the performance of necessary repairs at his own cost.

1.10 Health and Safety

The Contractor shall appoint an experienced Accident Prevention Officer and take all necessary measures to provide for the health, safety and welfare at work of all his employees and of all other persons on the Site or, otherwise, affected by the Works including:

(i) The provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe and without risk to health;
(ii) Arrangements for ensuring, so far as is reasonably practicable, the safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances;
(iii) The provision of such protective clothing and equipment (such as hard hats, reflectorised clothing and steel capped boots) first aid, medical and health services, information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of all persons employed on the Works;
(iv) The maintenance of all places on the Site in a condition that is safe and without risks to health and the provision and maintenance of access to and egress from such places that are safe and without risk.

The Contractor shall provide sanitary conveniences for the use of all persons employed on the Works in such a manner and number and at such places as shall conform to the statutory or other appropriate regulations and the whole shall be to the approval of the Engineer.

The Contractor shall maintain such conveniences in a satisfactory and sanitary manner and all such conveniences shall be removed at the completion of the Works and the sites restored. The Contractor shall remove immediately from Site any employee found to have committed a nuisance on the Site or adjoining lands and the Contractor shall not again employ him on the Works without approval of the Engineer.

1.11 Quality Assurance Management System

In pursuance of Sub-Clause 4.9 of the Conditions of Contract Part 1, The Contractor shall institute a Quality Assurance system to demonstrate compliance with the requirements of the Contract. Pursuant to the 1st paragraph of Sub-Clause 7.4, the Contractor shall institute a Quality Assurance system having the consent of the Engineer that is:

(a) Designed to demonstrate that the materials used and his adopted methods, procedures and controls combine to produce works and workmanship with less than statistically significant risk that the works will fail to be in accordance with the Contract
(b) Verified by a programme of confirmatory tests carried out in an independent laboratory.

The Contractor shall be wholly responsible for ensuring that the quality of all materials and workmanship shall be in accordance with the Specification and to the satisfaction of the Engineer.

The Contractor shall carry out his own inspection of materials and workmanship and satisfy himself that they meet the specification before offering them to the Engineer for acceptance or payment.

The Contractor shall prepare and submit to the Engineer within 60 days of the Letter of Acceptance a written quality assurance management system (QAMS) similar to that described in ISO 9000 series. This shall show the Contractor’s Site organisation and responsibilities for all members of the Contractor’s organisation to check and report on the quality of materials and workmanship.

For each elemental task to be performed by operatives carrying out a construction operation there should be listed a quality check that he and others perform to ensure that that task is fully and correctly completed. The management system shall contain a check- list of quality checks for each operative, ganger, supervisor, foreman, inspector, etc.

The Engineer will issue non-conformance notices if any work materials, workmanship or any other thing is not in accordance with the Contract. Until such a non-conformance is rescinded, the Engineer will not certify any payment for the work or thing affected.

The QAMS proposed shall show the procedures for communication with the Engineer. The QAMS shall be operated and maintained by the Contractor’s Quality Controller.

The Contractor shall within 28 days of the date of the Letter of Acceptance, submit to the Engineer the names, CVs and duties of all key personnel whether or not they are related to quality assurance directly.

1.12 Specifications and Standards

In the execution of the Works, the Contractor shall comply with these Technical Specifications.

The Contractor shall also comply with the laws, technical standards and regulations regarding the quality of materials and works in force in Serbia.

All references to technical standards shall be taken to refer to the latest approved published version of each standard as at a date 28 days before the latest date for submission of tenders for this Contract.

Whenever in these Technical Specifications a specific Serbian standard is identified and another equivalent internationally recognized standard may be proposed for acceptance, the Engineer shall determine which standard may be used in consultation with the Employer and the Designer as appropriate.

1.13 Specified Manufacturers

Where, in the Specifications, any manufacturer's name may be referred to in relation to any product or material that is merely to provide an example, setting the required standard of product or material. The manufacturer referred to in the Specifications shall not be considered to be nominated .The Contractor is entitled to propose a different manufacturer subject to his demonstrating the item, he intends to procure, to be an equivalent product or material in full compliance with the specified standards and subject to the approval of the Engineer.

1.14 Environmental and Social Impact

1.14.1 General

The Contractor shall comply with the guidelines of the Environmental and Social Impact Assessment (EIA) already completed for this project, in accordance with the requirements of the Employer.

The Contractor should also comply with the guidelines of the World Bank, EBRD and EIB in this regard as well as those for resettlement and rehabilitation of the affected population.

The design should include appropriate cost-effective mitigation measures, which should form part of the project cost..

An Environmental Management Action Plan (EMAP) shall be prepared by the Contractor incorporating proposals concerning the implementation, management and monitoring of the proposed environmental components of the project.

1.14..2 Environmental Protection Plan

Within one month of his arrival on site the Contractor shall submit an Environmental Protection Plan with operational details of his proposals to the Employer and the Engineer for approval. The Plan shall comply with the requirements of Environmental Management Action Plan that is included in this contract document.

1.14.3 Environmental Officer

The Contractor shall have on his staff on Site for the duration of the Contract a designated officer qualified to promote and maintain sound environmental management during construction and specifically the implementation of the approved Environmental Protection Plan. This officer shall have authority to issue instructions and shall take precautionary measures to prevent environmental damage, including but not limited to the establishment of environmentally sound working practices and the training of staff and labour in their implementation.

1.14.4 Resettlement Liaison Officer

The Contractor shall have on his staff on site at least one individual who has had practical experience in the public consultations, management and implementation of a Resettlement Plan. The Contractor's Resettlement Liaison Officer will be required to coordinate with the Employer and the Engineer, to assist the Employer in its duties, to implement and complete the Resettlement Plan for this project, and to maintain good public relations throughout the contract period.

1.14.5 Environmental Protection during Construction

The Contractor shall use such construction methods and shall maintain all borrow/stockpile/spoil disposal area so as to assure the stability and safety of the Works and any adjacent feature, to assure free and efficient natural and artificial drainage and to prevent erosion.

The Engineer and the Employer have the power to disallow the methods of construction and/or the use of any borrow/stockpile/spoil disposal area if in their opinion the stability and safety of the Works or any adjacent feature is endangered, or if there is undue interference with the natural or artificial drainage, or if the method or use of the area will promote undue erosion.

Borrow areas and quarries shall be sited, worked and restored in accordance with the Specifications. Spoil shall be disposed of at approved disposal sites prepared, filled and restored in accordance with the related Specification requirements.

Following excavation for the works, the Contractor shall take all steps necessary to complete drainage and slope protection works in advance of each rainy season. Erosion or instability or sediment deposition arising from operations not in accordance with the Specifications shall be made good immediately by the Contractor at his expense. The Contractor shall also take all steps necessary to complete drainage in advance of each winter rainy season in the areas excavated for borrowing materials.

Notwithstanding approval of the intended method of working, the Contractor shall at all times be responsible for constructing the earthworks in accordance with the Specifications, the Design and his working drawings.

The Project area can experience inclement weather, climatic seasonal variations, and heavy snowfall. It will be deemed that the Contractor is familiar with these conditions and has formulated his work programme considering possible loss of time due to these causes, and it shall be the obligation of the Contractor to revise his work programme and enhance his construction efforts as necessary to ensure timely completion of the work scheduled for each working season.

Where directed by the Employer, the Contractor shall establish vegetation on fill slopes, cut slopes or less, worked out borrow pits, and other areas which may include roadway shoulders and verges, spoil disposal areas, stockpile areas, quarries, access tracks, plant sites, camps, landslide scars, gullies, and stream and river banks. Prior to placing topsoil and/or establishing vegetation on embankments, all fill material not compacted to the required standards shall be removed from the side slopes.

The Contractor shall be responsible for supplying sufficient planting material to carry out all re-vegetation work, and shall establish and operate plant nurseries as necessary and shall make his own arrangements for procuring cuttings, slips and seed for growing.

1.14.6 Prevention of Pollution

The Contractor shall ensure that his activities do not result in any contamination of land or water by polluting substances. He shall implement physical and operational measures such as earth dikes of adequate capacity around fuel, oil and solvent storage tanks and stores, oil and grease traps in drainage systems from workshops, vehicle and plant washing facilities and service and fuelling areas and kitchens, the establishment of sanitary solid and liquid waste disposal systems, the maintenance in effective condition of these measures, the establishment of emergency response procedures for pollution events, and dust suppression, all in accordance with normal good practice and to the satisfaction of the Engineer and the Employer.

1.14.7 Protection of Trees and Vegetation

Unless otherwise provided in the Specifications, the Contractor shall ensure that no trees or shrubs or waterside vegetation are felled or harmed except for those required to be cleared for execution of the Works. The Contractor shall protect trees and vegetation from damage to the satisfaction of the Engineer and the Employer.

The Contractor shall be responsible for obtaining any necessary felling permits and for ensuring the disposal of felled trees in accordance with prevailing regulations. No tree shall be removed without the prior approval of the Engineer and the Employer.

In the event that trees or other vegetation not designated for clearance are damaged or destroyed, they shall be repaired or replaced by the Contractor at his own expense to the satisfaction of the Engineer and the Employer.

1.14.8 Use of Wood as Fuel

The Contractor shall not use or permit the use of wood as a fuel for cooking, space and water heating in all his camps and living accommodations. Any wood so used must be harvested legally, and the Contractor shall provide the Engineer and the Employer with copies of the relevant permits if required.

1.14.9 Fire Prevention

In addition to the provision of adequate fire-fighting equipment at his offices, workshops, construction areas and other facilities to the satisfaction of the Engineer and the Employer, the Contractor shall take all precautions necessary to ensure that no vegetation along the line of the road outside the area of the permanent works is affected by fires arising from the execution of the Works.

Shold a fire occur in the natural vegetation or plantations adjacent to the project area for any reason the Contractor shall immediately take all measures to suppress it. In the event of any other fire emergency in the vicinity of the Works the Contractor shall render assistance to the civil authorities to the best of his ability.

Areas of forest, scrub or plantation damaged by fire considered by the Engineer and the Employer to have been initiated by the Contractor's staff or labour shall be replanted and otherwise restored to the satisfaction of the Engineer and the Employer at the Contractor's expense.

1.14.10 Restricted Areas

In undertaking the Works, the Contractor shall be aware that the Engineer and the Employer may not grant permission for temporary facilities including but not limited to borrow pits, quarries, and labour camps (except for watchmen) and ancillary activities in forested areas or land officially declared as forest.

The Engineer and the Employer may also prohibit or restrict the Contractor's activities in other ecologically, culturally or historically sensitive areas, which become known to them during the course of the project. The location of any such areas shall be notified to the Contractor by the Engineer and the Employer at the earliest opportunity.

1.14.11 Relations with Local Communities and Authorities

In siting and operating his plant and facilities and in executing the Works the Contractor shall at all times bear in mind and to the extent practicable minimise the impact of his activities on existing communities.

Where communities are likely to be affected by major activities such as road widening or the establishment of a camp or quarry or extensive road closure or bypassing, he shall liaise closely with the concerned communities and their representative and if so directed, shall attend additional meetings arranged by the Engineer and the Employer to resolve issues and claims and minimise impacts on local communities.

Any problems arising from his operations and which cannot be resolved by the Contractor shall be referred to the Engineer and the Employer. The Contractor shall be responsible for any compensation due or reinstatement necessary with respect to any damage caused by him to areas outside the Site and no separate payment will be made in this regard.

1.14.12 Water Supply for Construction

The Contractor shall make his own arrangements at his own expense for water supply for construction and other purposes. Only clean water free from deleterious materials and of appropriate quality for its intended use shall be used. In providing water the Contractor shall ensure that the rights of and supply to existing users are not affected either in quality, quantity or timing.

In the event of a dispute over the effect of the Contractor's arrangements on the water supply of others, the Engineer shall be informed immediately and shall instruct the Contractor as to appropriate remedial actions to be undertaken at his expense.

Environmental Mitigation Action Plan (EMAP)

Project Actions/ Environmental Attributes	Contractor's Mitigation Measures	Responsibilities
ENVIRONMENTAL MITIGATION PLAN FOR CONSTRUCTION STAGE		
Setting out and clearing operations of ROW	• Statues and roadside shrines are to be relocated to adjacent locations in close consultation with local community leaders. • Re-location of utilities to adjoining areas of the Project Highway • Permission for tree felling is to be obtained from the Forest Department • During right of way clearing operations, any treasure trove, slabs with epigraphical evidence or edicts, sculptural or any material that are found and appear to have historical importance, it should be brought to the notice of the Engineer.	The Employer will be required to initiate the actions for seeking the permission for tree felling and re-location of the public utilities within the corridor. Environmental Officer under the Employer will co-ordinate and ensure implementation and ensure adequacy & appropriate implementation
Diversion of traffic	• Appropriate traffic diversion schemes shall be implemented so as to avoid inconvenience due to project operations to present road users, particularly during night time. • Proper diversion schemes will ensure smooth traffic flow minimises accidents, traffic snarl ups, and commotion. • The diversion signs should be bold and clearly visible particularly at night.	Contractor is responsible for implementation subject to approval from the Engineer.
Construction Camp Sites	• The construction campsites are to be located away from any local human settlements and preferably located on lands, which are not productive presently. The camps shall have adequate water supply, sanitation and all requisite infrastructure facilities. The water supplied to the construction camps shall be free from Arsenic contamination The camps shall have septic tank/soak pit of adequate capacity so that it can function properly for the entire duration of its use.	All facilities are to be planned and implemented by contractor subject to approval by the Engineer and the Employer. The Engineer and the Employer will monitor and ensure appropriate implementation. The Engineer and the Employer will visit the camp sites for inspection and compliance by the Contractor.
Haulage roads	• The alignment of haulage roads shall be finalised to avoid agricultural lands to the extent possible. In unavoidable circumstances, suitable compensation may be paid to people whose land will be temporarily acquired for the duration of operations. The compensation shall cover for loss of income for the duration of acquisition and land restoration. • Prior to construction of roads, topsoil shall be preserved or atleast shall be used for any other useful purposes rather than allowing its loss by construction activities. • Water tankers with suitable sprinkling system are to be deployed along the transportation links. Water, may be sprinkled for at least 6 times per day all along the route to suppress the airborne dust due to the truck movement particularly on unpaved roads. Roads, which are subjected for huge material movement, provision for sprinklers can be made which may become economical as compared to water sprlinking by tankers • The vehicles deployed for material transportation shall be spillage proof to avoid or minimise the spillage of the material during transportation. In any case, the transportation links are to be inspected at least twice daily to clear accidental spillage, if any. • The borrow and material dumping sites must be access controlled to keep away-unauthorised entry of people, livestock and any other stray animals.	The planning, design and construction/up-gradation of existing roads to be used as haulage roads are responsibilities of the Contractor subject to approval by the Engineer. The Engineer will regularly monitor and ensure appropriate implementation by the Contractor. The Contractor will co-ordinate regularly with the local population to ensure that their interests are protected and no social resentment arises.
Quarries	• Material, particularly aggregates shall be sourced only from licensed quarries. • Quarries, which have occupational safety procedures/practices in place only, are to be sourced for materials and regular inspection shall be carried to ensure compliance of safety procedures/practices by quarry agencies subsequently. • In case, unlicensed quarries are to be chosen for viable	The selection of quarries and material selection will be the responsibility of the Contractor subject to approval of the Engineer. The Engineer will monitor and ensure appropriate implementation of mitigation actions by the Contractor.

Project Actions/ Environmental Attributes	Contractor's Mitigation Measures	Responsibilities
	reasons, ensure compliance of all measures mentioned above.	
Work sites	• All personnel in work sites shall have protective safety equipment like helmets, boots etc so that injuries to personnel are avoided. • No personnel should be allowed to work at site for more than 10 hours per day. • Personnel who are likely to be exposed to noise levels beyond stipulated limits shall be provided with protective equipment like ear protectors etc and regularly rotated. • Regular water sprinkling of water shall be ensured so that dust levels are kept to minimum.	All facilities are to planned and implemented by the Contractor subject to approval by the Engineer. The Engineer will monitor and ensure appropriate implementation by the Contractor.
Construction Equipment and Vehicles	• All equipment/vehicles deployed for construction activities shall be regularly maintained. • Vehicles/equipment deployed for construction activities shall be regularly maintained for smooth operation, a measure contributing to air quality and noise • Vehicles/equipment shall be regularly subjected for emission tests and shall have valid **POLLUTION UNDER CONTROL** certificates. Revalidation of certificates shall be done once in a month. • All vehicles deployed for material movement shall be spill proof to the extent possible. • In any case all material movement routes shall be inspected daily twice to clear off any accidental spills.	Contractor is responsible for ensuring provision of facilities subject to approval by the Engineer. The Engineer will monitor and ensure appropriate implementation by the Contractor.
Water resources & Drainage channels	• Adequate precaution is to be taken to prevent oil/lubricant/hydrocarbon contamination of channel beds. Spillage if any, shall be immediately cleared with utmost caution to leave no traces. • Channel beds are to be cleaned up and restored to its previous state after completion of construction. • Adopting mitigative measures like construction of coffer dams, cessation of operations intermittently for limiting turbidity, limiting hours of operation to day time hence recuperation of turbidity, strict prohibition of disposal of solid and liquid waste disposal into waters etc, good sanitary and hygiene practices on river beds etc can largely minimize impacts on water quality during rehabilitation/repair of bridges across the water bodies.	The planning, and construction/up-gradation of existing/new cross drainage structures roads are responsibilities of the Contractor subject to approval by the Engineer. The Engineer will regularly monitor and ensure appropriate implementation by the Contractor.
Borrow areas	• Borrow areas are to be demarcated with signboards. All operational areas are to be access controlled. • The top soil recovered from borrow areas are to be restored or to be used for turfing of embankment(s) of Project highway • All equipment deployed for excavation shall have appropriate monitoring and control facilities to improve accuracy of positioning and excavating depths. • Scrapping and tamping of the borrowed areas shall be carried out to minimise localised depressions and render a smooth profile. • Limit operations to day hours only. Rotation of personnel should be considered to minimise exposure of noise levels beyond limits. • Provide protective gear like ear protectors if necessary to operating personnel are likely to be exposed to noise levels beyond threshold limits • All equipment deployed shall be well-maintained and meet emission norms of diesel vehicles. • Demarcate areas identified for operations and install signboards prohibiting unauthorised movement of local population. • All borrow areas are to be re-vegetated. The side walls shall have gentle slope.	Sourcing of borrowing materials and all related activities like planning & deployment of the most optimum number of vehicles without disregarding the existing users in case of existing linkages and construction/up-gradation of existing/new haulage roads subject to approval by the Engineer. The Engineer will monitor and ensure appropriate implementation by the Contractor.
Air Quality & Noise	• All operational areas under project development like borrow areas, haulage roads, work sites, construction camp sites, hot mix plants, etc are to be regularly monitored (at least **ONCE** in a week) for air quality parameters such as SPM, RPM, SO2, NOx, HC, CO etc. • This will ensure identification of operations/areas of concern with regard to air pollution. Mitigation measures such water sprinkling for dust suppression, permitting construction equipment/vehicles having **POLLUTION UNDER**	Contractor is responsible for ensuring a occupationally healthy environment for all personnel irrespective of category subject to approval of the Engineer. The Engineer will independently monitor these parameters at least **once a month**

Project Actions/ Environmental Attributes	Contractor's Mitigation Measures	Responsibilities
	CONTROL certificates will reduce work area concentration of air pollutants like RPM, SO2, NOx, HC, CO etc. and therefore does not contribute to build up of pollutants • Like for air quality, all operational areas under project development shall be monitored for noise levels representing all hours of a typical work shift. • This will ensure identification of operations/areas of concern with regard to noise pollution. Operational areas include, work sites, haulage roads, hot mix plants, quarries, borrow sites etc. mitigation measures such provision of ear plugs, rotation of personnel, ensuring regular maintenance/lubrication, limiting operations to day time etc will contain noise levels to permissible/threshold limits.	
Soil erosion and conservation	• Measures to ensure embankment stabilisation including selection of less erodable material, good compaction, re-vegetation, placement of gabbions /riprap or any suitable measures around bridges and culverts etc are included in technical specifications and contract documents. The engineering measures for countering soil erosion, slope protection, drainage wherever required considered for project highway and detailed in Project design documents. • Many of impacts on soil can be significantly mitigated by some of the following measures a) Minimising area of ground clearance only to the extent required b) Balancing the filling and cutting of earth to the extent possible c) Avoiding creation of cut slopes and embankments which are of an angle greater than natural angle of repose for locally available soil type d) Replanting disturbed area(s) immediately after disturbance due to construction has stopped and **NOT** after construction has been completed.	Erosion control/embankment protection measures as governed by local site conditions shall be prepared by Contractor and subject to approval of the Engineer The Engineer will monitor and ensure appropriate implementation by the Contractor.
Hot Mix Plants	• Hot mix plants shall be atleast 500m away from any human settlements and preferably located on leeward side. • As mentioned else where under this section all such plant/sites shall be located on barren/uncultivable lands. Diversion of cultivable/agricultural lands, shall not be allowed unless otherwise warranted by specific local conditions	Contractor is responsible for ensuring a occupationally healthy and hazard free environment for all personnel irrespective of category and also for communities in and around operational areas The Engineer will monitor and ensure appropriate implementation by the Contractor.
Loss of Fertile soil	• Clearing operations within the right of way and at all places of operational areas like borrow areas, work sites, labour camps, construction of new/up-gradation of existing to new haulage roads, hot mix plants, storage areas etc shall consider preservation of fertile soil • As a first option, topsoil should be restored to its initial place after the specific activity is completed for which the area was vacated, or for enriching some other place like embankment slopes for turfing/erosion protective measure. The topsoil can also be used for supporting re- plantation activities within right of way.	Contractor is responsible for ensuring a proper utilisation of fertile soil under approval of the Engineer. The Engineer will monitor and ensure appropriate implementation by the Contractor.
Loss of access	• The construction works shall not lead to temporary loss of access from one side of project highway to the other side. • Efforts shall be directed for minimising such situations even if it amounts to small deviation for project operations. • The local people shall be taken into confidence through opening up of communication with local population and/or community leaders	Contractor is responsible for ensuring minimum disturbance to local populace due to operations and provide alternatives wherever access is temporarily disrupted due to operations and restore it as soon as possible and subject to approval of the Engineer. The Engineer will monitor and ensure appropriate implementation by the Contractor.
Location of campsites, storage depots,	• The location of campsites, storage depots shall preferably on unproductive/barren lands. • All fuel loading, unloading, storage areas shall be spill proof, leakage proof and carried out on impervious/paved areas. • The sites shall have suitable system to drain storm water, sanitary facilities and shall not contaminate any near by water courses/drains	Contractor is responsible for ensuring suggested actions and subject to approval of the Engineer. The Engineer will monitor and ensure appropriate implementation by the Contractor.

Project Actions/ Environmental Attributes	Contractor's Mitigation Measures	Responsibilities
	• The site shall also have a system for handling any emergency situation like fire, explosion etc.	
Storage of hazardous materials	• All areas intended for storage of hazardous materials shall be quarantined and provided with adequate facilities to combat emergency situations complying all applicable statutory stipulations • The personnel in charge of such areas shall be properly trained, licensed and with sufficient experience. • The areas shall be access controlled and entry shall be allowed only under authorization	Contractor is responsible for ensuring a occupationally healthy and hazard free environment for all personnel irrespective of category and also for communities in and around all operational areas subject to approval of the Engineer. The Engineer will monitor and ensure appropriate implementation
Roadside amenities and service stations	• All parking bays, service stations and rest places planned under project development shall have appropriate water, sanitation facilities and paved surface with facilities for removal of hydrocarbon and oil & grease content.	The contractor is responsible for implementation of appropriate designs and as directed by the Engineer. The Engineer will monitor and ensure appropriate implementation by the Contractor.

Section 2
Preliminary works

Contents

2.1. Geotechnical investigations

2.1.1. Scope and purpose

2.1.1.1. Introduction

These works cover all additional geotechnical investigations that are carried out during construction, and may, in the form of observations and proper measurements, be studied even after completed construction, if the geological conditions and type of structures require so, and if so specified in the design. As a rule, these additional works are carried out only if not performed during the designing stage, or if, in the course of works, unforeseen problems come up, and also for the purpose of the monitoring of construction control.

2.1.1.2. Purpose

The purpose of geotechnical investigations is: to verify assumptions given in the design; to determine differences between the type and the condition of soil (geological medium) during the execution of excavation works (for cuts, bridge foundation, retaining structures, drainage, tunnels, etc.), and the data obtained through investigations performed for the purpose of designing; to determine necessary geotechnical parameters during and after construction (most frequently variable with time, climate, and hydrological conditions). During construction, these parameters are most often determined by field tests, and also by laboratory tests on representative samples. The geotechnical control of quality of executed works during construction (quality of used geological-building materials and their incorporation into the works) shall be performed according to the quality requirements given for particular types of works (material for embankments, and compaction of embankments, both those made of earth, and those made of stone, etc.), and technical regulations, standards, and provisions set in the technical specifications.

2.1.2. Investigations Related to Construction of Embankments, and Slopes of Cuts and Embankments

2.1.2.1. Quality Control of Materials from Cuts and Borrow Pits for Construction of (Stone and Earth) Embankments

2.1.2.2. Settlement of Soil under Embankment

Checking the soil under embankment (after top soil stripping), its bearing capacity, geotechnical parameters, groundwater table, the need for drainage or other forms of drying out, i.e. measures for speeding up its consolidation under the embankment’s weight. Checking the time flow of the settlement of soil under embankment. Comparing the behaviour of the embankment during the construction with calculation values given in the design. The need for interventions during construction and for alterations in the design. The occurrence of instability of soil and the embankment above it, caused by cutting and filling, not specified in the design, and additional geotechnical investigations for the remedy of such stretches.

2.1.2.3. Checking Stability of Slopes

Checking the stability of slopes (particularly those of cuts), and of the excavation of cuts and cut-and-fills. Defining the types of instability of slopes (the type of deformation, the shape and depth of sliding surfaces, groundwater table, and other influences). Determining the parameters of shearing resistance in and out of the sliding surface, pore pressure and other hydraulic forces. For solid rock masses, checking the system of fracture (discontinuity), and climatic possibilities of potential sliding surfaces. Shearing resistance along the discontinuity.

2.1.2.4. Settlement monitoring

The measurement, during construction, of vertical movement (settlement) and horizontal movement (sliding), particularly for high embankments built on soil of a low bearing capacity (compressible soil). The control of devices for reducing settlement and hastening consolidation (vertical drains, etc.). The measurement of horizontal movement for retaining structures. The measurement of changes in pore overpressure and moisture.

2.1.2.5. Control

The control of work of drainage systems during construction (and particularly later on, after completed construction). The control of forces in anchors, if applied in the construction of retaining and other structures.

2.1.3. Geotechnical Investigations During Construction

For undertaking geotechnical investigations during construction, aside from exploratory drilling, field tests are recommended as well: penetration (static and dynamic), field vanes, pressiometers, observation wells (piezometers) and non-destructive hardness tests. These tests are simple and easy to perform, provide a certain continuity in the depth of ground (which is particulalry important), and are easy to perform during construction.

2.1.4. Scope and Type of Geotechnical Investigations During Construction

The need for geotechnical investigations during construction depends on the complexity of structure and ground, and cannot be predicted neither by scope nor by type. Nevertheless, the design should indicate some stretches that shall be investigated additionally. Control observations and measurements on behaviour during construction (and later on) shall be indicated in the design and included in the Priced Bill of Quantities.

The type and scope of geotechnical investigations shall be defined in the design of investigations, and control works, by type and scope, in accordance with the design, and shall be defined by the Engineer.

The preparation of the design of investigations, and the execution of geotechnical works, in terms of rights and obligations, are stipulated by the Law on Geological Investigations, and as directed by the Engineer.

2.1.5. Records

During construction, it shall be necessary to keep records and a summary of geotechnical investigations carried out during construction, for the purpose of control of performed works, as well as alterations and amendments of the design, all of which shall be submitted to the Engineer.

2.1.6. Legislation

All these geotechnical works and investigations are stipulated in the current technical legislation, the Law on Geological Investigations, and the Law on Planning and Construction, the Rules about technical standards for designing and executing works of the foundation of building structures, and relevant SRPS (Serbian Standards) and shall be as directed by the Engineer.

In special cases, when such investigations go beyond the scope of existing technical legislation and standards, or they are not available, the Engineer shall select a testing method, and decide the importance of its application, and issue instructions accordingly.

2.2. Setting out

2.2.1. Description

This work covers the setting out of road alignment, all geodetic measurements related to the transfer of data from designs onto the site, or from the site into drawings, and the maintenance of set out marks on the site throughout the work process – from the commencement of works to the handover of all works to the Investor. The work also includes the taking over and maintenance of all submitted basic geodetic surveys and drawings, setting out on the site handed over by the Engineer on behalf of the Investor to the Contractor at the beginning of works.
The scope of work shall fully meet the requirements of construction, control of works, statement of works, and other reasons necessary for the work.

2.2.2. Handover and Taking-Over of Road Alignment

The Engineer shall hand over to the Contractor a set out road alignment with all necessary data in writing. The road alignment shall be set out on the site with all data in writing. The road alignment shall be marked on the site with wooden stakes, 4*4 cm, or iron wedges ∅10 mm, or cut into stone with a carved cross that shall be painted with minium. Main marks shall each have a stake with a nail on it. On the right side of stake, looking in the direction of increasing chainage, at 45^0 angle, at the 20 cm distance from the stake, there is a small wooden board carrying the number of cross section, painted with minium on the top of it. The hand over procedure shall be carried out with a protocol on taking over.

The Contractor shall survey the status of the site handed over together with the Engineer and take it as the agreed basis for all measurement.

The road alignment is set out at spacing determined by terrain features, but not larger than 50 m.

Service connections are set out along the edge of speed change lane, i.e. right along the centre line of the service.
The Engineer shall hand over to the Contractor traverse points on the site, each marked with a concrete pillar, 12*12*50 cm, with a hole in the middle and a buried centre mark, or a gas pipe ∅1" in populated places, or on roads. In special cases, traverse points are cut in stone and marked with a cross. The traverse is tied to trigonometric points calculated according to the Gauss-Kruger, with tolerance values according to the rules for a traverse network of the 1st order.

The Engineer shall hand over to the Contractor a drawing of the road alignment containing the following attachments:

1. Location plan, scale 1:1000, indicating the centre line, chainage, road alignment elements, and elements of drainage structures to recipients. The location plan also contains the sketches for the tying of main traverse points, including the data required for setting out.
2. Computations for main points, i.e. in electronic computation, the coordinates of main and auxiliary points with chainage, and the coordinates of apices.
3. The list of traverse points, i.e. apices, with their coordinates and topography.
4. The list of bench marks, with their height levels and topography.

The Contractor shall, after the completion of subgrade, renew the road alignment (horizontally and vertically) based on the sketch of setting out from traverse points. The accuracy of the renewed road alignment shall be checked by the Engineer. The centre line shall be renewed as well, before placing the finishing course of pavement structure.

From the date of handover, the Contractor shall protect all traverse points and bench marks. If any data on the site become lost, changed (a traverse point, bench mark), the Contractor shall restore them at his own expense. The regularity of the point restoration process may be reviewed and checked by the Engineer.

2.2.3. Setting out Cross Sections

The Contractor and the Engineer both have the right, if not satisfied with proposed cross sections from the final design, to repeat surveying, levelling or tacheometric, of cross sections – the ground line normal to the road centre line, and to design cross sections on scale 1:100 (the same as in the design), however, all revisions shall remain subject to the final approval of the Engineer.

For the slopes of cuts and fills, it is necessary to set out sections needed for construction with gradients as given on the cross sections.

The section of a slope and the ground shall be defined by computation, taking into account the given changes of grade on slopes. Set out sections, as a rule, shall be made with laths, 2.4/5 cm, and small wooden wedges, 5/5cm, indicating the edges and gradients of slopes. For high cuts or fills, the cross sections may be spaced at not more than 50 m. The gradient of a slope shall imply the line of a cut or fill, with top soil stripped, and without the curvature at the bottom or on the top of the cut.

2.2.4. Protection of Set Out Centre Line

When the Contractor takes over a set out centre line, regardless of the configuration of ground, he shall secure, on both sides, each cross section at such a distance from the end of cut or fill, to ensure its undisturbed position until the completion of construction. Each securing point shall be protected with a triangle made of laths 2.4/2.5 cm. A securing stake, 5/5 cm, shall have a nail and be painted with minium on the top. Each securing point shall be double levelled.
Next to the triangle, to the left and right of the centre line, a small board shall be placed, with the minimum painted number of the cross section (in large digits), and its chainage below the number.

2.2.5. Control during Construction

Throughout construction, the Contractor shall control the set out data on road alignment and restore all marks on the site all the time, regardless of the cause of damage. In case of any alterations to the design, the Contractor shall repeat all the works under 2.2.3. and 2.2.4., if this would be necessary with the alteration in the design. The Contractor shall submit all setting out data to the Engineer for approval, and allow him to use all set out marks he may need.

The Contractor shall not start work until he receives the consent of the Engineer to the setting out control. Within three days of the Contractor's submission, the Engineer shall give such a consent or make an entry in the construction journal of the requirements that the Contractor shall have to meet for the purposes of being granted such a consent.

2.2.6. Setting Out Structures

The Contractor shall, based on data mentioned under 2.2.2., set out all structures according to his needs, but shall propose to the Engineer a setting out plan, with all necessary data in terms of Sub-Sections 2.2.3. and 2.2.4. The setting out of cross sections, the securing of a set out centre line, and control shall be carried out under the same conditions as the setting out of road alignment, but adjusted to the construction requirements applicable for structures.

2.2.7. Taking over after Completion of Works

After the completion of works, the Contractor shall hand over the finally set out road alignment at the road centre line, and traverse points and bench marks in terms of Sub-Section 2.2.2., while supplementing them with the data for structures. Cross sections shall be marked along the pavement edge. This shall be entered into a protocol on hand-over / taking over.

2.2.8. Payment

The staking works shall not be paid separately, but included in the offered price.

2.3. Site Equipment

Before the commencement of construction, the Contractor shall submit to the Engineer the organization plan (machines needed to execute the works, auxiliary structures and equipment, time schedules, etc.).
The specified machines, auxiliary structures and equipment, and the entire organization of construction work shall enable the execution of works in full compliance with the design and these Technical Specifications, following the time schedule that will ensure a timely completion of works.

The Engineer shall have the right to ask for alterations in the proposed organization plan, if such plan does not match the conditioned progress of works and technical specifications for the construction of this structure.
The Engineer shall issue an approval for the commencement of works, as soon as he ascertains that the machines, auxiliary structures, equipment and devices specified in the plan are in place and ready for work.
In the course of works, the Contractor shall keep the machines, auxiliary structures, and equipment in a good working order, in order to avoid any possibility of jeopardizing the agreed time and technical specifications for the construction of this structure.

These works shall not be paid separately, but included in the offered prices.

2.4. Removal of Shrubs and Trees

2.4.1. Description

This work includes the removal of shrubs, up to 10 cm thick, felling of trees of any thickness, with pruning and cutting trunks to a specified length, and the digging, pulling out and removal of stumps of new and previously cut trunks, and all other works that are needed because to technical conditions. The surfaces that need to be cleaned or uncovered shall be shown on drawings, or determined by the Engineer before the commencement of works.

The clearing up or uncovering of surfaces shall include the clearance of surfaces from trees, shrubs, waste, and any other excessive vegetation, including the digging up of stumps, and the removal of roots and all other harmful materials left behind the removal of shrubs, trunks, and stumps.

2.4.2. Procedure

The removal of shrubs, trunks, and stumps shall be performed on all indicated, i.e. specified surfaces, and in those places specified by the Engineer for certain trunks and stumps.

The trunks for which the Engineer specifies so, shall be left, and thus shall not be damaged. To prevent any damage to the trunks that will stay, other trunks shall be cut down so as to prevent such damage. If it is necessary to prevent any damage on other trunks or property, trunks shall be cut down carefully from the top down. Surfaces excavated for the road shall be cleared from all stumps and roots to the depth of 50 cm below the finished levelled surface, except on rounded surfaces of cuts and fills where they can be cut flush with the ground surface.

All stumps and roots to the depth of at least 20 cm below the future finished foundation soil, i.e. at least 50 cm below the roadbed shall be removed from the surfaces of foundation soil from which any non-bearing layers of foundation soil shall be removed, or those surfaces of foundation soil that will have to be tamped.

Holes from the removal of stumps and roots on the surfaces below future embankments shall be filled with earth material and tamped well. Cut trees and stumps shall be hauled to appropriate places along the road alignment, so that they not interfere with the execution of works, and shall be delivered, with the quantity recorded, to the Engineer or any other person specified by the Engineer.

2.4.3. Measurement

The cutting of shrubs and trees, the digging up, pulling out and removal of stumps of new and previously cut trunks, with all works mentioned under 2.1 and 2.2., shall be measured in meters of length of the final length of the constructed basic road alignment; this length also includes the works on regulation of water courses, local roads, etc., i.e. they are not measured separately.

2.4.4. Payment

The quantities defined under 2.4.3. shall be paid at a unit price given per 1 km of the road alignment from the negotiated Priced Bill of Quantities, and the price is a full compensation for all working procedures mentioned under 2.4.1. and 2.4.2. as needed to complete the works, and as approved by the Engineer.

2.5. Clearance of Site

2.5.1. Description

The work includes the excavation and dismantling of traffic signs, demolition of walls, demolition of existing pavement structures, removal of kerbs, demolition of fences, demolition of buildings, or any other similar obstacles, materials, or waste that would interfere with the execution of works in any way, or stay after the completed construction of the structure. The work excludes any removal of facilities in use, such as: power lines, or high-voltage and low-voltage lines, telephone lines and cables, water supply pipelines, cemeteries that need to be relocated or reconstructed, but includes parts of those facilities, such as foundations or parts of structures made of massive stone material, concrete, bricks, or similar, that need to be demolished after the relocation or reconstruction of the mentioned lines and facilities. This work, unless otherwise specified on drawings, shall include the removal of existing buildings that interfere with the work subject to the approval of the Engineer.

2.5.2. Procedure

The clearance of site works shall be performed on all designated or determined surfaces, as approved by the Engineer, that need to be cleared for the execution of construction works, or for the sake of aesthetics of the immediate vicinity of the road, and on all surfaces to be used by the Contractor in the course of works.

The digging up and dismantling of traffic signs, crash barriers, and other fences, marker posts, direction signs, kilometre marks, and similar, shall be performed so that all their components remain undamaged and reusable. For that purpose it is necessary to determine, before dismantling, and in agreement with the Engineer, which elements should be kept, stored and protected against deterioration, and which of them can be disposed of, i.e. eliminated. The place of storage shall be approved by the Engineer, and the Contractor shall temporarily store dismantled pieces, in the warehouses, accessible for transport, until the pieces are taken over by the Engineer. The date of taking over shall be determined by the Engineer.

The demolition of walls and structures of any kind shall be performed in a way that ensures the least possible damage to adjacent structure, or agricultural land - crops, or the existing road.

The removal of kerbs, demolition of fences, buildings, and similar obstacles shall be performed so that the mentioned obstacles are removed entirely and do not affect either the construction or quality of works, or the aesthetic appearance of the road and its surroundings.

Parts of any structures, various lines, installations, that need to be reconstructed for the sake of road construction, and that have foundations or massive structural parts such that they are impossible to dismantle or cut to be removed, shall be removed in a similar way as other removal, i.e. site clearance works.

The work method shall be determined by the Contractor and submitted for the approval of the Engineer, while observing all regulations of occupational safety, and preventing any damage to someone else’s property. Any damaged caused due to the work shall be at the Contractor’s expense only. All materials can be used for the contracted work, , except for the material that shall be taken over by the Engineer. Buildings shall be demolished in such a way to preserve the material as much as possible.

2.5.3. Measurement

All this work, except for the demolition of entire buildings, shall not be measured separately, but included in the item covering excavation works, as its constituent part. The demolition of residential and economic buildings shall be measured in square metres of actually demolished floor surfaces of the buildings, as per their outside walls, and as approved by the Engineer. The removal of foundations of already demolished buildings shall not be measured separately, but included in the item covering excavation works.

2.5.4. Payment

All this work, except for the demolition of entire buildings, shall not be paid separately, but included in the unit price given for excavation work, thus taking that the Contractor received the full compensation for all work procedures mentioned under 2.5.2., or needed to complete the works.

The demolition of buildings (residential and economic) shall be paid at the unit price for 1 sq.m. of floor surface from the Priced Bill of Quantities and as approved by the Engineer. The price includes all works foreseen under 2.5.2. for the storage of demolished materials in a place approved by the Engineer, and the Contractor shall have no right to claim any compensation or additional payment for that. The demolition of facilities put up by the Contractor for his own needs shall not be paid, and they are at the Contractor’s expense.

2.6. Preparation of Existing Pavement

2.6.1. Description

This work includes all phases for the preparation of existing pavement surface, if it is to be overlaid with a new pavement structure.

2.6.2. Procedure

If the existing pavement made of mechanically stabilized materials is directly overlaid with a new macadam-type pavement structure, it shall be scarified at 25 cm spacing at most. In other cases, the existing pavement shall be cleaned and washed, and its width levelled, before applying new layers. If asphalt layers are to be applied over the existing asphalt pavement, the pavement shall be thoroughly cleaned from dirt, washed, and sprayed with emulsion in the amount of 150 gr/m^2. If the existing pavement is made of cement-concrete, the preparatory procedure shall be performed according to a separate design.

All procedures to be adopted shall be subject to the prior agreement and approval of the Engineer.

2.6.3. Measurement and Payment

The measurement is performed in m^2 of scarified, i.e. cleaned and prepared pavement, and as approved by the Engineer.

2.7. Demolition of Existing Pavement

2.7.1. Description

This item includes the demolition of an existing pavement structure on surfaces specified in the design, or where directed by the Engineer, and the selection, loading, transport, and unloading of material at the dump site approved by the Engineer.

2.7.2. Work procedure

The existing pavement structure shall be demolished mechanically, layer by layer.

Bulldozers, graders, loaders, etc. shall be used for demolition. For asphalt layers, hot or cold planing machines can be used, if the existing asphalt is to be recycled.

Material from each particular demolished layer shall be gathered into piles and loaded onto trucks immediately, taking care not to mix different materials.

Materials from particular courses can be reused for the construction of a new pavement structure, if they meet required quality criteria.

When demolishing an existing pavement structure, the Contractor shall take care of existing installations, not to damage them (water supply, sewerage, electrical installations, telecom installations, etc.). Any damage caused due to breakdowns, or repairs of breakdowns, shall fall at the Contractor's expense.

2.7.3 Measurement and Payment

The measurement is performed in m^2 of demolished pavement structure as approved by the Engineer, including loading, transport, and unloading of demolished material at the dump site that is to be approved by the Engineer.

Section 3
Earthworks

Contents

3.1. Topsoil Stripping

3.1.1. Description, Scope and Contents of Works

The work includes the stripping of topsoil obtained from bulk excavation on the road alignment and in borrow pits, and under embankments up to 40 cm thick, including transport or mechanical pushing to a roadside stockpile, within the road's right of way.

All work shall be completed in line with the design, these Technical Specifications, and SRPS.U.E1.010. If topsoil and soil suitable for being used as subsoil-foundation soil cannot be visually differentiated, the depth of the topsoil layer shall be determined in the laboratory by testing the organic matter content (JUS U.B1.024, soil with organic content exceeding 6%).

3.1.2. Execution of Works

The stripping of topsoil, up to 40 cm thick, shall be performed wherever necessary to prepare the subsoil – foundation soil.

Topsoil shall be stripped down to the subsoil –bearing soil, as specified in the design and these Technical Specifications. All excavated material shall be stockpiled along the road alignment, out of the roadbed surfaces, in order to ensure that any later use of the material and access to it remain unobstructed. The haulage, i.e. pushing of material to stockpiles shall be performed carefully in order to preserve the quality of stripped topsoil for the later landscaping of slopes and green surfaces, as to avoid the mixing of that material with other non-topsoil material. Topsoil shall be stockpiled in such a way as not to jeopardize the stability of slopes and to enable the runoff of water.

3.1.3. Measurement

This work shall not be measured for payment, but any achieved thickness of topsoil shall be indicated on cross sections and submitted for the approval of the Engineer.

3.1.4. Payment

The stripping and stockpiling of topsoil, protection of stockpiles during the execution of construction and other works, including the clearing of the entire site after the removal of stockpiles are included in the offered unit price for bulk excavation and filling, and shall not be paid extra.

If the measurements performed in the course of works show that the actual topsoil stripping is less than the designed amount, the excess topsoil and omitted excavation, or less topsoil and excess excavation, shall then be determined and calculated and submitted for the approval of the Engineer.

3.2. Bulk Excavation and Haulage

3.2.1. Scope and Contents of Works

The work includes any bulk excavation of all types of earth materials specified in the design, including the haulage, or pushing of excavated materials to fills, stockpiles, or special-purpose stockpiles, depending on how the material will be used in the execution of works. These works include any excavation of cut and fills, cuts, borrow pits, training of water courses, road detouring, and bulk excavation during the development of structures. All excavations shall be performed according to sections, described levels, gradients specified in the design, taking into account the required features for a purposeful use of excavated material, as specified in these Technical Specifications.

3.2.2. Regulations Applicable for the Execution of Works

SRPS U.E1.010 Earthworks in Road Construction.

3.2.3. Execution of Works

As a rule, excavation shall be performed with machines and other devices, reducing any manual work to a necessary minimum.

Excavation in hard stone material shall be performed by mechanical drilling, deep and ordinary blasting, and re-blasting for larger rocks, if so required for an intended use of excavated materials. It shall also be necessary to take into consideration mechanical pushing, loading of material, and transport to a place where it would be used, or to a stockpile, including unloading. All excavated materials shall be adjusted to the requirements for intended uses according to the design and these Technical Specifications, both for embankments and for processing into aggregates for the blanket course, and so on, and shall be sorted by quality,subject to the approval of the Engineer.

All excavations shall be performed according to the sections, foreseen height levels, and specified gradients as per the design and the Engineer's instructions. When performing excavations, it shall be necessary to take necessary protective measures for full safety at work and ensure all necessary protection for existing structures and communications.

In this stage of work, an efficient drainage of the roadbed shall be ensured. Work hindered due to the occurrence of water in drilling shall not be paid extra.

Gradients of excavation slopes shall be developed as per the design and/or Engineer's instructions. That work shall also require the clearing of all inadequate places in rock material, which requires special protection and safety solutions, such as the stabilization of disturbed zones, pockets, caverns, water sources, etc., if such works are not already envisaged within other works, such as, for instance: the protection of cut slopes in accordance with the conditions of soil material, geological findings, and other occurrences in excavations, which shall be taken into consideration by the Contractor in the course of works, because of which the Contractor shall have no right to the adjustment of unit prices.

During the execution of works, it is necessary to prevent any undermining, disbalance, or damage of excavation slopes specified in the design. The Contractor shall remedy each such case as instructed by the Engineer, without the right to claim any compensation, or approval of payment for larger or unforeseen works.

For any excavation with the use of explosives, the Contractor shall hire trained and qualified specialists for such works, and also have a valid certificate for that. When using explosives, it is necessary to act in compliance with applicable regulations for such works, ensuring a proper handling of explosives, and the protection of surroundings, structures, roads, and people. In blasting operations, in the same way as during the execution of excavation works, all impacts that would disturb traffic, people, and the environment, should be minimized by providing, among other things, all necessary traffic and safety signalling in accordance with a special approval issued by competent authorities, which should be provided by the Contractor and submitted for the approval of the Engineer.

If such disturbances occurred, the Contractor should eliminate them immediately at his own expense.

3.2.4. Haulage of Local Materials for Aggregates and Testing

Before and during the works, all changes in excavation, i.e. in the quality of earth materials shall be appropriately sampled for the testing of their usability for applications for which they are intended. Compliance certificates shall be provided from competent authorities in terms of the usability of materials from every major cut, or in places where local materials could be used for blanket course, concrete, and asphalt aggregates. If there is an intention to use excavated materials for such purposes, loose clayey layers shall be removed before blasting. and used for fills or stockpiled on a special place proposed and/or accepted by the Engineer. In that case, the Contractor shall, at his own expense, compensate for material for fills in the amount taken for other needs. The production of aggregates for concrete and asphalt from local materials is allowed only if their washing prior to use is foreseen.

3.2.5. Balance of Earthworks and Borrow Pits

If, according to the balance of earthworks specified in the design, there is a lack of material on the road route, and the design does not define any borrow pit in its proximity, the Contractor shall propose the location of borrow pits and request the approval of the Engineer. As a rule, all borrow pits shall be specified in the design.

If the Contractor is of the opinion that there is a more favourable borrow pit for him than the one foreseen in the design, the Contractor shall, at his own expense, prove the quality and quantity of material, and based on that ask the Engineer to give his approval for the use of that borrow pit, and acquire the land at his own expense.

Before starting to use the borrow pit, the Contractor shall submit to the Engineer , for approval, a proposal with the location plan and cross sections of the borrow pit according to which the excavation will be carried out, unless otherwise specified in the design.

The location plan shall also have a place indicated for the stockpiling of topsoil and other unusable materials, and the method of final restoration of the borrow pit after its closure for use.

Based on that proposal, the Engineer and Investor shall consider permission for its use.

The Contractor shall ask in due time for any subsequent extension or deepening of borrow pits, in order to obtain the Engineer's approval. All other expenses due to the works not covered in the Investor's approval for land use shall be at the Contractor's expense, including any indemnity for destroyed crops and soil, and for any other resulting damage to borrow pits and surrounding land.
Before starting to use a borrow pit, the Contractor shall survey the ground together with the Engineer. These surveys, approved and signed by both parties, will serve as a basis for the calculation of used quantities of materials, taking into consideration the transport and distance. The Contractor shall prepare a proposal for the restoration of borrow pit after its closure for use. After obtaining the Engineer's approval, the Contractor shall restore the borrow pit according to the approved plan (levelling and humification).

The opening and use of borrow pits shall be carried out properly, with necessary gradients, to ensure smooth runoff of precipitation and seepage water. This also prevents the waterlogging of materials in borrow pits, and makes easier the work in wet weather.

The material proved as unsuitable for the construction of roadbed shall be removed. The Contractor shall form stockpiles where approved by the Engineer and/or foreseen in the design. Unless otherwise determined, excess materials shall first be used to extend the embankment and create parking places and belvederes. Places for such and other stockpiles shall be submitted for approvalby the Engineer.

Stockpiles shall be formed in such a way as to prevent landslide, and after the completion of works they shall be levelled and restored according to the Engineer's instructions. For all stockpiles not specified in the design it is necessary to prepare a design at the Contractor's expense.

For borrow pits and stockpiles specified in the design or by the Engineer, the Investor shall bear the costs of land acquisition or compensation, and the Contractor shall bear the expenses of compensation for destroyed crops and land out of the boundaries of borrow pits and stockpiles.

For borrow pits and stockpiles determined at the Contractor's proposal, all buying, compensation, and similar expense, and all related expenses due to the change of location shall be borne by the Contractor, if the Investor has already made available a necessary borrow pit and/or stockpile.

3.2.6. Measurement

The measurement of quantities for the calculation of excavation works shall be performed based on the actual volume of excavation, measured in an original natural condition, based on the measurements of cross sections after topsoil stripping, and after the final excavation within the design framework, and/or changes approved by the Engineer. Any quantities excavated in excess of the designed ones shall not be paid if they were caused by the Contractor's fault. The following criterion shall be adopted for the quantification of different types of earth materials in excavation:

According to cross sections, the quantities of particular types of earth materials shall be determined in the course of construction, in a percentage of the entire surface of cross section, which makes the basis for determining total quantities for each type - category.

For the bulk excavation in mixed material, the categorization of excavations is obligatory, and, whether there is the Contractor's request or not, it shall be performed in due time, and, for finished excavation facilities, in the next month for the past month at the latest, and, for excavations performed in the current year, until the preparation of the statement for payment.

The categorization of excavations shall be performed by the Engineer and the Contractor's authorized representative. The Contractor shall prepare a protocol on its work, and based on accepted percentage values, through the protocol, the Engineer shall calculate categories and enter them in the Measurement Book (GN 200 is applicable).

Lenses, nests, and caverns within certain types of earth materials, not in excess of 1 m^2, shall not be subtracted when determining the area and/or volume, but larger surfaces shall be subtracted from the areas of particular types.

Voids above 1 m^2 shall be subtracted. All excavated material used for any purpose other than for the embankment, and if not compensated for by the Contractor from a borrow pit, shall be subtracted when determining the quantity of total excavation mass.

The excavation from borrow pits not used for the embankment shall be subtracted during the quantification.

3.2.7. Payment

The payment shall be made per m^3 of original natural excavation per unit price from the agreed Priced Bill of Quantities, separately for each type of earth material. This price includes topsoil stripping with stockpiling, protection, development, and clearing of slopes from all unstable blocks and slide, levelling of all excavated and adjacent surfaces, humification and grassing over the slopes, all works on excavation with loading, haulage, and unloading of material in places specified for its use according to the balance of earthworks – including the works under 2.4. and 2.5., and the Contractor shall have no right to claim any extra compensation for that work.

STD given in the tender document (Contractor's Priced Bill of Quantities) is approximate, and serves for a temporary calculation of works. STD is the distance between the mass centre of earth mass in original natural state, and the mass centre of the mass after transport and according to the plan of earthworks. After the completion of all excavation works on the route and in borrow pits, the actual STD shall be determined, and according to it, the transport of masses shall be finally calculated, and/or the prices (estimate ±) from the Priced Bill of Quantities adjusted. For borrow pits and stockpiles, this unit price also includes works on the final development of terrain. The construction of berms shall not be paid extra, neither shall the quantities of works be calculated separately, since this work shall be paid within the price of bulk excavation and/or the price of fills, when, according to the design, berms are formed by filling and tamping the material. The formation of berms in case of filling and tamping the material is the same as for the horizontal parts of road shoulders.
The extension of cuts for the sake of borrow pits shall be paid as the excavation in cuts. If borrow pits are located out of the road alignment, the volume of excavation from the borrow pits shall be calculated based on the quantity of fill in compacted state, performed from the material from a borrow pit applying the principle that 1 m^3 of compacted fill is equal to 1 m^3 of excavation in the borrow pit. If a fill is made from a cut along the road and from a borrow pit, it is necessary to make the fill from the road excavation first, and then from the borrow pit, unless otherwise required by the Engineer. The reason for this is to accurately determine the volume of fill made from excavations along the road route, and the missing volume to be filled from the borrow pit. This shall be supported with evidentiary statements, both in the Measurement Book and in the design (cross sections). These quantities shall be determined by the Engineer applying the same procedure as for the categorization of bulk excavated materials.

3.3. Formation of Subsoil

3.3.1. Scope and Contents of Works

Subsoil is original natural soil on which the embankment is founded (constructed). The work includes tamping, scarifying, if needed to dry or wet natural soil in the thickness specified in the design (approximately 30 cm), or the improvement of soil of insufficient bearing capacity by applying geotextile or PVC foil.

The regulations for the control of quality of materials are:

- SRPS U.B1.010 - Sampling
- SRPS U.B1.012 – Determination of soil moisture
- SRPS U.B1.014 – Determination of specific gravity of soil
- SRPS U.B1.016 – Determination of bulk density of soil
- SRPS U.B1.018 – Determination of granulometric composition
- SRPS U.B1.020 – Determination of consistency limits
- SRPS U.B1.024 – Content of combustible and organic matter
- SRPS U.B1.038 – Determination of optimum water content

If the composition of soil – subsoil of embankment is such that an embankment cannot be constructed directly over it (saturated soils, slurry soils, soils of organic origin, and similar), before constructed the embankment it is necessary to prepare, i.e. rehabilitate subsoil in the way specified in the design, or as determined by the Engineer.

Regulations for the control of quality for incorporation are:

- SRPS U.B1.010 – Sampling
- SRPS U.B1.012 – Determination of soil moisture
- SRPS U.B1.016 - Determination of bulk density of soil
- SRPS U.B1.046 – Determination of the modulus of compressibility

3.3.2. Criteria for Assessing Quality of Work

Before starting the filling work, the cleared and levelled foundation soil – subsoil shall be compacted in accordance with the following requirements:

The required minimum % of density (degree of compaction) according to the standard Proctor procedure (and/or other methods):

a) original natural soils composed of cohesive earth materials, with the designed embankment not higher than 2.00 m	100%
b) original natural soils composed of cohesive earth materials, with the design embankment higher than 2.00 m	95%
c) original natural soils composed of noncohesive earth materials, with the designed embankment not higher than 2.00 m	100%
d) original natural soils composed of noncohesive earth materials, with the design embankment higher than 2.00 m	95%

If the compaction of noncohesive materials is checked with the plate-bearing test, the same requirements shall apply as for embankments of corresponding height, as defined under 3.4.5.3.

The height of embankment is considered the height from the height level of prepared subsoil – foundation soil, to the height level of finished formation level (subgrade) , at its lowest part.

Tests shall be performed each 40-50 m^1 of prepared subsoil.

3.3.3. Measurement
This work is measured per m^2 of actually prepared subsoil as approved by the Engineer.

3.3.4. Payment
This work shall be paid per m^2 of prepared subsoil. In the case of replacement of material of poor quality in subsoil, the payment shall be made as defined under 3.4.

3.3.5. Application of Geotextile and PVC Foil

3.3.5.1. Scope and Contents of Works
Geotextiles are placed on foundation soil of insufficient bearing capacity, in order to improve its soil mechanics properties, and reduce remedial works.

The functions of geotextiles are:
- To separate the foundation soil from the embankment layers;
- To ensure unobstructed flow of groundwater from the foundation soil in embankment and vice versa;
- To strengthen the foundation soil in order to take over a portion of stress induced by embankment load;
- To prevent suffosion of fine particles of material in embankment due to the change in surface water level.

Before placing a geotextile it is necessary to level the ground, clear it from roots, large boulders, and sharp stones, and fill large depressions.

The geotextile is placed in such a way as to form an overlap of adjacent strips that is joined together. The overlap is secured by placing small heaps of embankment material along it, at each 1 - 2 m, in order to prevent it from moving. The geotextile is joined together by sewing, so that those ends that are to be joined together are placed face to face and bent in the width 100 mm, with the seam parallel to the edge of joined surfaces at the distance of 50 mm from the edge. Seam strength shall be 50% of the tensile strength of geotextile.

After completed joining, the geotextile shall be covered with the first layer of fill, so that vehicles run over the fill, not over the geotextile. The filling is performed from the ends toward the centre, in order to keep the surface tight. Its ends overlap the first layer and are covered with the next layer.

3.3.5.2. Acceptance of Geotextile
After the unloading of rolls on site, it is necessary to check their quantity, and whether they meet the technical specifications given in the design.

3.3.5.3. Storage of Geotextile
It is of key importance to ensure the protection of geotextile against damage before its placement. Since the product is delivered in a protective shop packaging, it is necessary to check whether it is damaged, and if there are damages, these shall be repaired. It is particularly important to protect the geotextile against UV radiation and moisture. In contact with moisture, the geotextile (particularly unwoven) absorbs the moisture, sometimes even until the rolls become soft, which makes it impossible to check its weight and to place it, particularly at low temperatures. Furthermore, it is necessary to protect the geotextile from getting dirty with mud, because this will reduce its filtering properties.

If the geotextile becomes damaged, the damaged parts shall be removed.

3.3.5.4. Quality Assessment Criteria
The geotextile rolls shall be arranged so that they could be checked and sampled for laboratory tests.

Each roll shall bear the following data:
- Manufacturer's name
- Commercial name
- Production method
- Fabric composition
- Mass per unit of area
- Nominal thickness
- Roll dimensions and weight

Aside from a general check on the site, it is also necessary to check the mass per unit of area, with the accuracy of up to 10 gr/m^2.

All other tests shall be performed in a laboratory, and they shall meet the following standards:
- Normal thickness
- Pore size
- Filtering properties
- CBR penetration
- Tensile strength
- Skidding in soil
-

Samples are taken from each roll, and all tests are performed in compliance with IGS standards.

3.3.5.5. Procedure

Geotextile rolls have the same weight that mainly ranges from 75 to 150 kg. Lighter rolls shall be placed manually, and heavier – mechanically.

3.3.6. Application of PVC Foil

3.3.6.1. Scope and Contents of Works

Waterproofing PVC foils shall also be placed under the embankment to prevent the penetration of water into the ground.

3.3.6.2. Material

Materials manufactured in our country are based on soft PVC, with a layer of unwoven PES textile.

3.3.6.3. Execution of Works

The material is supplied in rolls, 30-50m. Two workers are needed for its placement. If one roll is not sufficient, another one is added next to it, with simple overlapping. The overlaps shall be 5-10 cm wide. It is joined with strips of lioplast 16 or PVC foil, with hot air, or by adhesion.

3.3.7. Measurement

This work shall be measured per m2 of geotextile or PVC foil as approved by the Engineer.

3.3.8. Payment

The work is paid at the unit price per square metre, according to actually executed works.

3.4. Construction of Embankments

3.4.1. Embankments from Earth Materials

3.4.1.1. Scope and Contents of Works

The construction of embankments includes the filling, spreading, rough and fine levelling, wetting, and compaction of fill material, according to dimensions specified in the design. All works shall be executed in accordance with the design, these Technical Specifications, and SRPS U.E1.010 – Earthworks in road construction.

When constructing an embankment using dredged sand, the works also cover the humification of slopes in a 20 cm thick layer.

3.4.1.2. Material

For the construction of embankments, all inorganic materials of specified quality shall be used.

Organic waste, roots, turf, i.e. material that would, in time, due to biochemical actions, change its mechanical and physical properties cannot be incorporated into embankments.

The material for construction of embankments can be obtained from cuts on the road route, borrow pits, and by dredging sand from the Sava or Danube rivers "on site" or from a stockpile of dredged sand.

3.4.1.2.1.Regulations for Control of Quality of Materials

- SRPS U.B1.010 – Sampling
- SRPS U.B1.012 – Determination of soil moisture
- SRPS U.B1.014 – Determination of bulk density of solid particles
- SRPS U.B1.016 – Determination of bulk density
- SRPS U.B1.018 – Determination of granulometric composition
- SRPS U.B1.020 – Determination of consistency limits
- SRPS U.B1.024 – Determination of combustible and organic matter
- SRPS U.B1.038 – Determination of optimum water content.
- SRPS U.B1.042 – Determination of California Bearing Ratio (CBR%)

The determination of content of organic and combustible matter, as well as changes in soil volume shall be resorted to only in specific cases (suspicious materials).

3.4.1.2.2. Classification of Materials

For the classification of materials for construction of embankments, a universal terminology according to the USCS and AASHO classification (attached tables) and the Casagrande plasticity chart will be used.

3.4.1.2.3. Preliminary Testing of Materials for Embankments

When testing earth materials for their suitability for embankments, all materials from cuts and borrow pits with cohesive soil, including cohesive materials in mixed materials, shall be tested. The following tests are necessary:

1. Natural moisture
2. Proctor test (max. dry bulk density and optimum moisture)
3. Granulometric composition, and degree of non-uniformity.
4. Atterberg’s limits of consistency: liquid limit, flattening limit, plasticity index, and Casagrande frost criterion.
5. Based on above mentioned, to determine the group index (Ig).

These preliminary tests should be described through the design, in the soil mechanics report.

3.4.1.2.4. Criteria for Assessing Quality of Materials before Incorporation

- Moisture of materials shall be such that during compression it is possible to reach the specified quality (close to an optimum);
  Minimum bulk density achieved in the laboratory applying the energy E=600 KN/m^3 should be:
  - For fills up to 3 m 15.0 kN/m^3,
  - For fill over 3 m 15.5 kN/m^3;
- Optimum moisture lower than 25%;
- Liquid limit lower than 65%;
- Plasticity index lower than 30%;
- Degree of non-uniformity "U" not lower than 9;
- Content of organic matter lower than 6%;
- If an embankment is made of non-cohesive materials, the size of grain shall not be greater than 2/3 of the layer thickness, i.e. 40 cm, except in the final layer of the embankment where the largest grain shall not be larger than 10 cm.

- Only materials of proven stability in the roadbed can be used for embankments (dredged sand, ash, slag etc.).

When testing earth materials for their suitability for embankments, materials from every cut and borrow pit shall be tested, and at every change of material. Tests shall be performed on at least two samples for every type of material.

When testing sands obtained by dredging for their suitability, the check shall be performed at every 50000 m^3.

- The mentioned tests shall be performed even if there are soil mechanics tests given in the design.

3.4.1.3. Haulage and Filling

The haulage and filling of materials over a prepared foundation soil, or on an already built layer of fill may start only after the Engineer has approved the lower layers.

When constructing an embankment from dredged sand from a stockpile, the haulage of material shall not be performed over a rolled layer, but shall be dumped over the end.

Every single layer shall be spread in the longitudinal direction, horizontally, or at gradient at most equal to the designed longitudinal gradient. Every single layer, in crosswise terms, shall have a two-sided or one-sided 4% grade. That grade is needed for the runoff of atmospheric water, due to which the surface of layer, when incorporating cohesive earth materials, shall be spread and tamped immediately (daily).

Every single layer shall be filled according to the designed cross section. The approaching ways for transport vehicles shall be as uniformly distributed as possible all across the width of formation level.

The height (thickness) of every spread layer shall be in compliance with the tamping effect by depth of the used tamping device, type of fill material, and segregation occurrences.

If there are requests and possibilities for the construction of embankments in layers thicker than 30cm, the Engineer may approve such request if the Contractor meets the following requirements: on a trial section 30-50 m long, using mechanical devices for the compaction of embankments, to determine: thicknesses, mechanical equipment, number of passes, properties of material with the compaction moisture of every layer at five places, at least 2 of which are in the bottom half of the layer. The entire process of adopting the thickness via a trial section shall be subject to the approval of the Engineer. Based on results, the Engineer shall enter the necessary findings and give his instructions through the Building Journal. Any extraordinary expenses of the work on the trial section shall be borne by the Contractor, but the constructed layer, if on the road route and if the compaction is satisfactory, shall be accepted as constructed fill subject to the approval of the Engineer.

Every type of material to be incorporated in an embankment shall be tested on the trial section, while adopting machines according to the procedure described in the previous paragraph.

3.4.1.4. Compaction

Every layer of embankment shall be compacted in full width with an appropriate mechanical device, while tamping, as a rule, from the edge toward the centre. All places inaccessible for machines, or places where the use of heavy tamping devices would be unsuitable for other reasons (filling behind structures, retaining walls, etc.) shall be tamped with other suitable devices or methods, the use of which shall be subject to the approval by the Engineer.

Every layer of embankment shall be wetted or dried to optimum moisture in compliance with preliminary tests, using the type of material that can be tamped to the required degree of compaction. If after tamping and quality control, the filling of the next layer is not undertaken immediately, but after a longer period, under different weather conditions, before filling it is necessary to re-check the quality of compaction. In such case, the work may start only when the test proves, once again, the quality of compaction.

In case of the use of cohesive materials, when weather conditions make the compaction impossible, it is allowed to use other procedures, such as, for instance, stabilization, treatment, or replacement of materials that will be required by the Engineer, with the expense borne by the Contractor. When a risk of rain is present during the daytime, the Engineer shall, if needed, decide on the suspension of further filling work, without any compensation of expenses. On an embankment made of cohesive materials, the top surface layer shall be levelled and rolled with a lightweight smooth roller (3-5 tons), so that the surface is at 2 - 5% grade on one side, smooth and free from deflections that could collect atmospheric water. Before filling a new layer, it is necessary to roughen such smooth surface in order to achieve better bonding between layers. This also applies for other major interruptions in works on the construction of embankments, due to the end of construction season, etc.

Filling shall be carried out so that layers are, longitudinally, as horizontal as possible, and to avoid any sudden changes in height between layers of different height, constructing them at a gradient that could still allow a proper compaction work.

The filling work shall be stopped at any time when it is impossible to achieve satisfactory results, particularly because of rain, high groundwater, or some other atmospheric disasters. The Contractor shall not have the right to any compensation on such grounds.

Filling material shall neither be incorporated on frozen surfaces, nor on snow and ice.

On any ground of a grade higher than 20^0, fills shall be placed on stepped cuts about 2 m wide, cut into the terrain on which the embankment is constructed. Side surfaces of the stepped cuts shall be constructed at 2:1 gradient, with a step grade of 4% and a downhill gradient.

When the ground has a gradient higher than 30^0, the stepped cuts shall be made without any intermediate space, and when the ground has a gradient between 20 and 30^0, a space up to 1 m wide shall be left between each two steps. The crossfall of stepped cuts in cohesive material shall be made with a 4% grade from the slope (side of cut). If these works on the construction of steps are not specified in the design, they shall be determined by the Engineer, and the Contractor shall execute them.

The finishing layer of earth embankment, 50 cm thick, shall be made, if possible, using rock or gravel material from excavation on the road route. If this is impossible, then from excavation in a borrow pit, if specified so by the Engineer.

If the pavement structure is not sized with the finishing layer of rock material, and there is a possibility to achieve a more cost-effective sizing, the Investor shall have the right to make necessary changes, and the Contractor shall proceed according to the modified solution (earthworks balance and finished road level). The provisions given under 3.6. shall apply to everything else.

3.4.1.5. Quality Control for Incorporation

3.4.1.5.1. Regulations for Control

- SRPS U.B1.010 – Sampling
- SRPS U.B1.012 – Determination of soil moisture
- SRPS U.B1.016 – Determination of bulk density of soil
- SRPS U.B1.046 – Determination of modulus of compressibility with a round plate

3.4.1.5.2.Criteria for Assessment of Quality for Incorporation of Cohesive and Mixed Materials with up to 20% Rock Material

Description

The requirements: minimum % of compaction per standard Proctor's procedures E=600 KN/m^3

a) Embankment layers, over 2.0m from the embankment bottom to the height of 2.00 m below the pavement 95%
b) Layers of embankments up to 2.00 m high, and layers of higher embankments, from the formation bottom layer – subgrade, to 2.00 m below the pavement 100%
c) For dredged sand 97%

3.4.1.5.3. Criteria for Assessment of Quality for Incorporation of Non-cohesive Mixed Materials with over 20% of Rock Material

A minimum required value of the modulus of compressibility (MC) for non-cohesive and mixed materials of different granulometric composition shall be determined according to the following criteria, with a plate, Ø30 cm.

- For mixed materials with 20-35% of rock materials MC = 25 - 30 MPa
- For mixed materials with 30-50% or rock materials MC = 30 - 35 MPa
- For mixed materials with over 50%of rock materials at optimum or close moisture MC = 40 MPa

For coarse-grained crushed rock materials (grain size over 200 mm) and mixed materials, the control of compaction may also be performed, if needed, applying volumetric methods, or the modulus of compressibility (Standard SRPS U.B1.046).

3.4.1.5.4.Humification of Embankment Slopes

For an efficient protection of slopes of embankments made of dredged sand, after the removal of loose non-compacted material for embankment slopes, the slopes shall be humified with a 20 cm thick layer. Grass shall be sown on this topsoil.

3.4.1.5.5.Scope of Regular Control Tests

The compaction of embankment layers shall be tested at every 50-100 m with two tests in the immediate vicinity, giving one result.

The moisture of material shall be tested daily. The construction of the next layer may not start until the required quality of the previous layer has been proven and approved by the Engineer.

If, in control tests, the Engineer determines major variation of results from the specified values, he may subsequently change the scope of testing. In agreement with the Engineer, the quality of incorporated layers may also be determined applying other accepted methods. In that case, the criteria of quality for incorporation shall be stated, along with the method and scope of testing, in agreement with the Engineer.

3.4.1.6. Acceptance of incorporated material

Every layer of embankment shall be subject to approval by the Engineer as specified under 3.4.1.5., in compliance with specified criteria.

The Contractor shall remedy, i.e. eliminate, any identified defects with respect to the mentioned quality requirements to the full satisfaction of the Engineer.

3.4.1.7. Measurement

The quantity of incorporated material shall be measured in m^3 of actually incorporated quantities within the project, excluding the topsoil layer on embankment slopes, but including the shoulder core, and as approved by the Engineer.

3.4.1.8. Payment

Quantities determined as per 3.4.1.7. shall be paid at agreed prices for $1m^3$ of incorporated fill material.

The contract prices shall include all works on topsoil stripping, spreading, wetting or drying, compaction, construction of stepped cuts and fills, levelling of embankment slopes and shoulders with the accuracy of ±5 cm with respect to the designed embankment slopes, humification and grassing of slopes, and other works from this description, including all materials and labour, transport and haulage, and the Contractor shall have no right to claim any extra monies for the construction of embankments.

Materials of poor bearing capacity (of poor quality) in subsoil shall be replaced with other materials with favourable soil mechanics properties. The excavation of materials shall be paid per item of excavation of material of category III and IV, i.e. V and VI, if the replacement is performed using rock or gravel materials and if approved by the Engineer.
The construction of embankments, when for the replacement of subsoil materials of category III and IV are used, shall be paid at the price for construction of embankment from materials of category III and IV increased by 20%, if the replacement is performed with materials of category V and VI or gravel material, the construction of embankments
shall be paid at the price for construction of embankment using materials of category V and VI increased by 20%, subject to the approval of the Engineer.

For the replacement of material of poor bearing capacity in the subgrade, at places of cut-and-fills and cuts, completely everything said for the replacement of material of poor bearing capacity in subsoil, for the construction of embankment, shall apply. The excavation in subgrade and subsoil, for the sake of replacement of material, shall be paid at agreed unit price for bulk excavation on the road alignment in the corresponding category, subject to the approval of the Engineer.

The calculation of filling quantities shall be determined according to cross sections, and these quantities do not include the quantity of topsoil on slopes and shoulders. The calculation of filling quantities shall include the part of embankment constructed in the place of stripped topsoil in subsoil. The work on topsoil stripping and humification of slopes and shoulders is included in the unit price for the construction of embankments. If the topsoil stripping under embankment is in thickness greater or less than the designed one, evidentiary statements shall be used as a basis to calculate excess or omitted topsoil stripping, i.e. excess or omitted construction of embankment which shall be submitted for the approval of the Engineer.

The construction of finished layer according to 3.4.1.4. shall be paid at contracted unit price for adequate category (bulk excavation and excavation in embankment).

3.4.1.9. Construction of Embankments from Aerated Concrete (Gas-Concrete) Blocks

3.4.1.9.1.Description

On soil of insufficient bearing capacity, with low possibilities of accepting the load, the highway embankment could be made of materials lighter than the conventional ones: clayey-silty and sandy-gravelly materials. Among lighter materials that could be used to construct the roadbed is aerated concrete (gas concrete).

3.4.1.9.2 Quality Requirements

Aerated concrete (Gas concrete) is a material composed of:

- Sand with a high silicium oxide content
- Industrial ash and slag
- Calcium oxide,
- Cement, and
- Al powder

The proportions of mentioned materials shall be such that the following physical/mechanical and resistance/deformability characteristics are obtained in gas concrete:

- Bulk density ....4-5 kN/m^3
- Percentage of pores with respect to
  solid ingredients ....< 80%
- Average compressive strength
  (as per YTONG norm SB).......................>100kN/m^2
- Modulus of elasticity ....> 1700 MN/m^2
- Water absorption < 8% of volume

3.4.1.9.3 Execution of Works

For the construction of roadbed, gas concrete is used in blocks, 2.00*1.00*0.50 m.

The construction of gas-concrete roadbed shall start on a layer of sandy-gravelly material, min. 50 cm thick.
The blocks shall be laid so as to achieve bonding between them both in longitudinal and transverse directions. Each gas concrete block shall be mechanically bound at 8 places with adjacent blocks using steel dowels, in order to achieve horizontal and vertical stiffening, as specified in the design. The arrangement of blocks, as well s dimensions and shape of steel dowels shall be as given in the design.

The gradient of gas concrete embankment slope shall be 1:1.

The slopes of embankment made of gas concrete blocks shall be protected with a layer of expanded clay, at least 25 cm thick. The layer of expanded clay shall be topped with a layer of topsoil, 20 cm thick, and the surface shall be grassed, as described in this section.

The top surface of gas concrete embankment shall be covered with a concrete slab, 10 cm thick, reinforced in the middle with a wire mesh Ø238*238. The concrete slab shall be made of concrete, class 30. Expansion joints on the slab shall be left at every 10 m. The expansion system shall be performed as per the design. Below the surfaces of shoulders and (green) reserve, no concrete slab shall be constructed. A specifically designed pavement structure shall be constructed above the slab. The reinforced concrete slab shall be cured according to the instructions given under item 5.

3.4.1.9.4. Measurement

The work is measured in m^3 of the constructed gas concrete embankment as approved by the Engineer.

3.4.1.9.5. Payment

The price per 1 m^3 of placed gas concrete includes all work and material needed to construct this item, namely :

- Sandy-gravelly bedding
- Construction of gas-concrete embankment
- Facing of slopes with a layer of expanded clay
- Reinforced-concrete slab, 10 cm thick
- Steel dowels, etc.

The price shall include the purchasing costs of materials, external and internal transport, and workmanship.

3.5. Wedges along Structures

3.5.1. Description

Wedges along structures are constructed in order to eliminate pavement deformations on the transition from the embankment to the structure.

3.5.2. Execution of Works

Deformations along a structure result, partially, due to the settlement of soil under the embankment, and mostly due to the settlement (consolidation) of subsoil. In order to make the subsoil settle as much as possible before the construction of pavement structure, wedges shall be constructed in one of the following ways:

- If the structure is completed before the construction of embankment, the wedge shall be constructed at the same time as the embankment.
- If the structure is not completed, and the embankment is being constructed, the embankment shall be constructed as close to the structure as possible, so that the subsoil could consolidate as quickly as possible (See Section 8.4.5.2.3.).

The size of wedge depends on the height of structure and length of transition plate, and accordingly, its maximum dimensions can be: height 1.5 m, length in base 2.0 m, slope gradient 1:2, and minimum dimensions for wedges are: height 0.5 m, length in base 0.8 m, and slope gradient 1:2. Pipe culverts placed in embankments and cuts shall be constructed without wedges.

The pavement structure on the wedge section and somewhat further shall be constructed as late as possible, due to the consolidation of embankment and subsoil.

3.5.3. Material

The material used for wedges shall meet the quality of material specified for the upper road base of the pavement structure, fully in accordance with Sub-Section 4.3 of these Technical Specifications.

3.5.4. Execution of Works

The wedge shall be constructed in layers, up to 50 cm thick. The compaction of material by layers along structures is performed in the same way as the compaction of a layer in the pavement structure. Other materials shall be compacted according to requirements specified in the design.

3.5.5. Testing

The testing of wedge compaction shall be performed as specified in Sub-Section 4.3. of these Technical Specifications.

3.5.6. Compaction Criteria

A minimum compaction of layers on the finished layer is 70 MPa, and at every 0.5 m of depth, it falls by 10МПa.

3.5.7. Measurement

The measurement of quantities under this item shall be performed per cubic metres of incorporated materials, according to specifications for embankments and as approved by the Engineer.

3.5.8. Payment

The payment is made at the contracted unit price that includes the procurement, transport, and incorporation of materials, and all finishing works, as for the construction of embankments.

3.6. Replacement of Removed Soil of Insufficient Bearing Capacity

3.6.1. Replacement of removed soil of Insufficient Bearing Capacity with a layer of Sandy-Gravelly Material

3.6.1.1. Description

For the permanent stability of embankment, the material below the future embankment shall be replaced to the designed depth and as directed and approved by the Engineer.

3.6.1.2. Materials

Material shall be in compliance with the intended use and meet the requirements set in SRPS U.B1.018; B.B8.004, and B.B8.044.

3.6.1.3. Execution of Works

The excavation and transport of material shall be performed mechanically, and transported to a specifically designated stockpile. After the completed excavation, LIO 300 geotextile shall be placed over the levelled surface of excavation, and backfilled with sandy-gravelly material to the ground level. After reaching the ground level, a finishing layer shall be placed using the material of the same quality, 0.40-0.50 cm thick (as per the design). Further works on the construction of embankment shall be executed using designed materials. .

This section of embankment shall be constructed in a layer of 0.50 m of length, free from the presence of water in excavations (if present, it shall be removed).

Compaction shall be performed until reaching the modulus of compressibility M=75 MPa.

3.6.1.4. Measurement and Payment
The works are measured in m^3.and as approved by the Engineer. The price of works includes the pumping of water from excavation during the placement, the procurement, transport and placement of sandy gravel, the levelling of finishing layer, and the preparation for "carpeting".

The procurement and placement of geotextile shall be calculated extra and paid per m^2.and as approved by the Engineer.

The excavation of material, transport to stockpile, and levelling of stockpile shall be calculated as for bulk excavation.

3.6.2. Construction of Carpet from Sandy-Gravelly Materials

3.6.2.1. Description
On the road route section where specified so, a layer of gravel – carpet shall be constructed.

On the road route section where soil of insufficient bearing capacity was replaced, the carpet shall be placed directly on the replaced sandy-gravelly material.

On the road route section where soil of insufficient bearing capacity was not replaced, and where specified so in the design, after stripping the topsoil, LIO plastics, LIO 300 type, shall be placed and topped with a gravel carpet, thickness as per the design, over which the embankment is constructed.

3.6.2.2. Materials
The material shall be in compliance with the intended purpose and meet the requirements set in SRPS U.B1.018; B.B8.004, and B.B8.044.

3.6.2.3. Execution of Works
Topsoil shall be stripped mechanically and transported to a specifically designated stockpile. After completed stripping, LIO 300 geotextile shall be placed on the levelled excavation surface, and covered with a carpet made of gravelly material. Thickness of layers is defined in the design and on cross sections.

Compaction shall be performed until reaching the modulus of compressibility M=75 MPa.

3.6.2.4. Measurement and Payment
The works are measured in m^3.and as approved by the Engineer. The price includes all work on carpeting, including procurement, transport, and placement.

For the work on the stripping of topsoil, its transport to a stockpile, and the levelling of the stockpile, Sub-Section 3.1. shall apply.

3.7. Levelling of Ground

3.7.1. Description
For better drainage and future landscaping it is necessary to level the ground. If it is a partially used and deformed ground, it shall be levelled by digging and levelling to the depth of 1 m, closing any cracks, and grading the surface to have slopes everywhere (without any depressions) in order to make drainage as efficient as possible.

All levelling works shall be subject to prior inspection, agreement and approval of the Engineer.

3.7.2. Materials
Materials used for levelling shall be those present on the site, by removing excess materials and transferring them to depressions.

3.7.3. Execution of Works
The works shall be carried out mechanically, and the levelling shall be performed to the designed levels. Filled depressions shall be compacted using the same machines as used for excavation.

3.7.4. Measurement and Payment
Measurement and payment shall be carried out per m^3 of excavated, levelled, and, using the same machines, compacted materials, and as approved by the Engineer. The price includes all expenses related to full execution of this operation.

3.8 Monitoring Instrumentation

3.8.1 Introduction

This section of the Specification describes the requirements for the installation and operation of monitoring instrumentation related to the construction of earthworks where this may be instructed by the Engineer.

3.8.1 Definitions

- “Settlement gauges” - Measuring devices for vertical displacement of earthworks

- “Inclinometers"- Devices to record horizontal displacements of earthworks by measuring inclinations of a flexible tube installed inside a vertical borehole
- “Piezometers” - Pore-pressure measuring devices. Most commonly the open hydraulic piezometer or standpipe. However for a short response time, closed or “constant volume” piezometers can be used.

3.8.2 Instruments

The Contractor shall provide for approval of the Engineer full details of the measuring devices and ancillary equipment that he intends to use together with details of authorised suppliers prior to the purchase of such equipment.

3.8.3 Transport, handling and storage

Transport, handling and storage of instrumentation equipment shall be carried out in accordance with the supplier's requirements.

3.8.4 General Execution/ construction of the work

Where required by the Contract or instructed by the Engineer, the Contractor shall supply and install earthworks monitoring instrumentation and shall provide details of the qualified staff who will record and report the results of such monitoring.

The Contractor shall submit a programme and detailed proposals for installation of the instruments, the taking of readings and the periodic checking of the equipment for accuracy, for the approval of the Engineer not less than two weeks before he proposes to commence the work, unless otherwise stated in the Contract.

The Contractors proposal shall include full details of the types of instrumentation, method and equipment for installation and plans and sections showing the geometrically coordinated locations of instrumentation.

The Contractor shall ensure that any boreholes used to house instruments shall be kept free of any loose material before and while such instruments are placed.

During the installation of instruments the Contractor shall ensure that such work does not damage the completed works. Should damage occur the Contractor shall submit his proposals for remedial works to the Engineer for approval

3.8.5 Access for monitoring

The Contractor shall provide suitable access to instruments for monitoring staff at all times.

3.8.6 Protection of instruments

Following the installation of instruments the Contractor shall carry out his works in such a way that instruments are not damaged.

Instrumentation and/or boreholes with measuring devices inside them, shall be protected by three 100mmx100mm wooden stakes, arranged as a triangle, 1.8m long, embedded in concrete footings at least 300mm deep, strip-painted in red and white, or any similar arrangement. The Contractor shall replace damage or missing stakes as soon as these are identified.

3.8.7 Reporting results

The Contractor shall provide a full report of instrumentation monitoring once a month or as otherwise required by the Contract or by the Engineer.

The report shall include but not be limited to the following:

1) Details of the recording staff
2) Description of the location of instrumentation together with supporting plans and sections.
3) Date, time and weather conditions when the readings were taken.
4) Condition of the measuring equipment and if damaged reasons for damage.
5) Observed data from the settlement gauge, inclinometer or piezometer.

3.8.8 Calibration of instruments

When first installed, the instruments shall be calibrated and validated in accordance with the supplier's recommendations and the Contractor shall report the results to the Engineer.

The Contractor shall carry out full calibration and validation of any instrumentation added or replaced during monitoring and shall report the results to the Engineer.

The Contractor shall carry out periodical checks on the accuracy of the instruments as stated in his agreed programme.

3.8.9 Measurement and Payment

The supply, installation, operation and maintenance of the Monitoring Installations shall be based on the related items in the Bills of Quantities or as otherwise determined by the Engineer in accordance with the Contract.

Section 4
Drainage

Contents

4.1. Roadbed Drainage

4.1.1. Scope and Contents of works

The roadbed drainage shall be performed according to details from the final design and Engineer's instructions, and includes:

- Construction of full drainage systems including outlets from the roadbed;
- Construction of sewer systems for draining cuts and cut-and-fills ;
- Construction of ditches (covered under 3.12.);
- Construction of gutters (covered under 4.10.);
- Regulation of water sources (covered under 3.14.).

4.1.2. Materials

All used materials shall be in compliance with JUS, i.e. relevant requirements from particular Sub-Sections of these Technical Specifications, depending on the type of material, and the Contractor shall prove the usability of materials with prior tests which shall be submitted for the approval of the Engineer.

4.1.3. Execution of Works

4.1.3.1. Excavation

The excavation shall be carried out according to dimensions given on drawings from the final design and the Engineer's instructions.

The excavation of channels also includes any strutting of trenches needed for the protection against collapse, and water pumping.

Material excavated from trenches shall be used for backfilling and/or hauled to a place approved by the Engineer, which is included in the price of excavation works.

4.1.3.2. Placement of Sand Layer

Spreading sand over the trench bottom (excavation of sewers), below the bottom of inspection manhole, and below concrete elements for surface water runoff, shall be performed in thickness specified on drawings from the final design. Sand shall be free from organic matter, non-plastic, and with a maximum grain size of 10 mm.

4.1.3.3. Construction of Bedding for Pipes

The construction of a bedding layer from concrete or clay, under and around pipes shall be performed according to details given on drawings from the final design, with slopes from trench walls toward the pipe. The class of concrete is specified in the design.

Clay material shall have characteristics of high-plasticity clay, and the moisture of material during placement shall be within the range of ± 2% of optimum moisture according to the Proctor procedure. Clay material shall be placed in 10 cm thick layers, and compacted at 95% using the Proctor compaction method.

The bedding shall be laid only after the excavation of drainage trench in full length and after its approval by the Engineer according to height levels and longitudinal gradients that shall match the designed ones.

4.1.3.4. Pipe Laying

Drainage pipes and connections, collecting pipes, and sewer pipes shall be laid over prepared bedding previously approved by the Engineer. Pipes shall be laid so that they lie on the same centreline and at the same gradient as specified in the design.

Pipes can be made of concrete, plastics, or asbestos-cement ("Salonite"). The type and size of pipe shall be specified in the final design. On the motorway section out of the protection zone of Belgrade water supply company, instead of pipes, a French drain can be constructed from concrete square prisms, as per the design. Drainage pipes shall be perforated on the upper half, and if this is not in compliance with the specified standards , the Engineer shall instruct the Contractor to redo perforation.

The joints of drainage pipes shall not be sealed, except inlets into manholes etc. Sewer pipes shall be joined together with couplings, or by sealing joints in the way specified in the final design. Pipes shall be laid so as to prevent the accumulation of mud in already laid pipes.

Sewer pipes used to carry away the content from collecting drainage pipes and/or shafts shall be placed according to details from the final design in appropriate dimensions and at appropriate longitudinal gradients. The construction of outlets from the road bed shall necessarily include the construction of concrete outlet end.

If the drainage, in exceptional cases, shall be constructed in sections, not in full length, then the reference level shall be precisely defined for each section, and it is also necessary to ensure that the drainage system is buried in a water-impermeable layer in its full length.

4.1.3.5. Filter material

Filters above drainage pipes shall be constructed according to details from the final design. The granulometric composition of filter material shall depend on material around the drainage trench, and shall fully meet criteria applicable to filtering joints (JUS U.S4.062 and Sub-Section 4.2. below). The Contractor may propose another solution as well. The quality of incorporated materials shall meet standards and these Technical Specifications for particular filter materials.

The drainage filter layers shall be compacted with lightweight compactors at 70% of the standard Proctor, in such a way as not to damage and displace laid drainage pipes.

Particular types of drainage material shall be laid in layers, according to dimensions specified in the design.

4.1.3.6. Inspection manholes

Inspection manholes (shafts) shall be constructed from finished concrete elements, or concreted in situ, according to details given in drawings from the final design, and the work covers: excavation, formwork, concreting (assembling), transport, procurement and placement of covers, and all other works needed to complete the job. The finished elements shall be fabricated with necessary branches as per position and dimensions, in order to avoid any subsequent boring.

If subsequent boring occurs, the joints shall be performed in a good quality manner. Step irons shall be installed too. Foundation elements of prefabricated shafts shall be laid on a concrete bedding, and separate elements shall be fitted over 'tongue and groove' joints, while other joints may be sealed with a sealing compound.

4.1.3.7. Filling

After the construction of the filter layer, drainage trenches shall be backfilled as specified in the design, after the approval of performed filtering fill by the Engineer. Rock used for filling shall be durable and meet the specifications given under 5.2.1.1.20.

Drainage trenches shall be capped with clay or turfing, in order to prevent the penetration of surface water and accumulation of mud in the drainage system.

4.1.3.8. Placement of Clay Plug

A clay plug shall be placed over the drainage system fully in accordance with details from the design, in order to block the penetration of surface water and enable the treatment of land in the zone of rehabilitation. It shall be made of local clay materials of good workability (medium plastic clays, loess, etc.). It shall be tamped in 20-30 cm thick layers, manually or mechanically, to 90% of bulk density of natural original material.

4.1.4. Testing

The quality of materials and finished products for all works under 3.7.3. shall be tested according to standards and provisions of these Technical Specifications.

For prefabricated elements, before using them, the Contractor shall provide compliance certificates from Sub-Section 8.3.4.1. of these Technical Specifications for the approval of the Engineer.

Monolithic concrete shall be tested according to requirements specified in Section 5 of these Technical Specifications.

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

4.1.5. Measurement

Excavation shall be measured in m^3 of actually executed works in original natural soil, according to dimensions from the design and as approved by the Engineer. Excavation down to the subsoil level shall be measured as bulk excavation.

Drainage pipes (together with connections), outlets (with outlet ends), sewer pipes, French drains, and inspection manholes shall be measured in m^1. Filtering, backfilling of drainage system and clay plugging shall be measured in m^3, in tamped condition.

No measurement for payment purposes shall be made for the transport and haulage, reinforcement, strutting, water pumping, work in wet soil, formwork, scaffolds, bedding made of clay, concrete, or sand, joining of pipes and connections, strengthening, inspection manhole covers, trench turfing, since all these works are to be included in the unit price.

4.1.6. Payment

Executed works shall be paid at unit prices from the Bill of Quantities for respective types of works and according to measurements from Sub-Section 3.7.5. The unit prices shall include the procurement of all necessary materials, all transport and haulage operations, and the entire work related to the completion of a certain item of works under 3.7.3., and the Contractor shall have no right to claim any extra payment. Works that are not measured shall be included in contracted unit prices and shall not be paid extra.

4.1.7. Vertical Gravel Drains Ø20 cm

4.1.7.1. Description

In order to speed up consolidation at places where soil is not to be replaced, vertical gravel drains – gravel piles are foreseen for construction to a depth indicated on cross sections.

4.1.7.2. Materials

Materials shall meet the standards for building materials of the kind, according to JUS U.B1.018; B.B8.004, and B.B8.044.

4.1.7.3. Execution of Works

Vertical drains shall be constructed using a Ø200 mm tubing and a 350 kg drop hammer dropped from the height of 6 m. The tubing shall be placed in a vertical position with a gravel plug formed in it at its bottom end by light tamping. After that, the tubing – steel pipe, is hammered down through the formed plug to reach the required depth. Then the plug is forced out with the same hammer, while pulling out the tubing, putting gravel into the tubing, tamping it, while constantly pulling out the tubing. The quantity of gravel is variable, depending on geological conditions, and amounts to at least that much gravel as may fit into the tubing in compacted condition.

If plastic drains are envisaged, the Contractor shall recommend the technology and equipment that shall be subject to approval by the Engineer.

The Contractor may also recommend another way to construct vertical drains within the contract price limits, and subject to the Designer's and Engineer's approval.

4.1.7.4. Measurement and Payment

Measurement and payment shall be made in m^1 of constructed drains as approved by the Engineer. The price shall include all work operations, costs of equipment, and procurement and transport of materials needed to complete this item of works.

4.2. Filter layers

4.2.1. Description

This work shall include the procurement and placement of rock or gravel material for filter layers that are built behind retaining walls, for drainage in places specified in the design, and for the construction of footways. The place of construction of filter layers and a required granulometric composition shall be defined by the Engineer as per the design, based on the granulometric composition of material in foundation soil.

The entire work shall be executed in accordance with these Technical Specifications and dimensions indicated in the design.

4.2.2. Applicable Regulations

- SRPS B.B0.001 – Natural aggregate and rock; sampling
- SRPS B.B8.038 – Determination of muddy ingredients in aggregate
- SRPS B.B8.039 – Approximate determination of contamination with organic materials
- SRPS B.B8.040 – Testing of sand contaminated with organic matter
- SRPS U.B1.018 – Determination of granulometric composition
- SRPS U.B1.046 – Determination of the modulus of compressibility applying the round plate-bearing method
- SRPS U.S4.062 – Construction of filter layers behind walls

4.2.3. Materials

The primary choice for filter layers are natural sandy-gravelly, sandy, or crushed materials.

If using other materials, the Contractor shall submit to the Engineer a compliance certificate on the usability of such material for filter layers, and shall obtain the Engineer's approval in writing.

4.2.3.1. Sandy-Gravelly Material

This material may be composed of grains of gravel, sand, and filler material in such ratio that, depending on the granulometric composition of soil material, the requirements from Sub-Section 4.2.4 of these Specifications are met.

4.2.3.2. Mixed Material

The mixed material shall be composed of grains of gravelly or crushed stone material that may be added, if needed, to natural material in order to obtain the granulometric composition as specified in Sub-Section 4.2.4. of these Specifications. The materials may be mixed during sieving, crushing, or on the site, as chosen by the Contractor.

4.2.4. Quality of Materials

The materials for filter layers shall meet the following requirements:

- Not to contain any organic impurities
- The granulometric composition of filter material shall meet the following criteria:
  1. $D_{15}^f / D_{85}^t \leq 5$
  2. $D_{50}^f / D_{50}^t \leq 25$
  3. $D_{15}^f / D_{15}^t \geq 5$
  4. D_{85}^f / max d_p
     - D_{15}^f, D_{50}^f, and D_{85}^f are the sizes of grains read from the grain size distribution chart for filter material, where the passability through sieve is 15% and/or 50% of the total mass.
     - D_{15}^t, D_{50}^t, and D_{85}^t are the sizes of grains read from the grain size distribution chart for foundation soil, where the passability through sieve is 15%, 50%, and 85% respectively, of the total mass.

     - max d_p is the largest aperture on the perforated part of drainage pipe
  5. The granulometric line for filter material shall be approximately parallel to the granulometric line for foundation soil.

6. For vertical filters, the granulometric composition of material shall be composed of one fraction that shall match the medium into which the material is to be placed. Gravelly material for filter layers shall be tested, before use, according to the requirements set in these Technical Specifications, on at least three samples for each material.

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

4.2.5. Procedure

4.2.5.1. Source of Materials

The Contractor shall notify the Engineer of any place from which the material for filter layer is to be obtained, inform him about necessary tests, and obtain approval from the Engineer to use the place. Borrow pits and quarries shall be first cleared in a proper way.

4.2.5.2. Compaction of Materials

4.2.5.2.1. Construction of Filter layer for Footways

Before setting to construct a blanket course, it is necessary to perform a fine grading of the subgrade according to height levels indicated on cross sections with the accuracy of 1 cm, and final rolling of the graded surface to reach the required compaction as per the design and these Technical Specifications.

The prepared subgrade, previously approved by the Engineer, shall be covered with a layer of sandy-gravelly material of required thickness. The spread material shall be compacted using appropriate equipment to the required compaction.

The constructed blanket course shall be maintained within the designed profile and with required compaction until the commencement of work on the next layer.

4.2.5.2.2. Compaction of Material in Other Filter layers

After finished spreading of each layer of material it is necessary to grade it and then compact it in full width using appropriate equipment for compaction.

All places inaccessible for compaction with a roller shall be compacted with other equipment for compaction.

The usability of equipment for compaction and the technological procedure shall be previously tested on a trial area, and the results shall be submitted to the Engineer for his written approval.

4.2.5.3. Quality Control

At the beginning of placement of filter material, it is necessary to check its granulometric composition and the granulometric composition of foundation soil.

Samples shall be taken at least at every 50 m^3 of filter material, and obligatorily for every separate structure, regardless of the quantity of filter material. If there are any major variations in results, the Engineer shall increase the number of tests at the Contractor's expense.

The compaction of filter layer shall be controlled on its surface, i.e. every layer shall be controlled, if possible. Control methods and criteria shall be defined by the Engineer depending on field conditions.

The compaction of spread material for footways shall be performed with appropriate equipment at 95% compaction according to the modified laboratory procedure (2.75 MNm/m^3).

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

A layer constructed below the specified standards shall be removed and replaced at the Contractor's expense.

4.2.6. Measurement and Payment

The quantity of placed filter material shall be measured per m^3 of actually executed works within the project as approved by the Engineer, and for filter materials for footways the measurement shall be carried out per m^2 of the constructed layer in designed thickness, also as approved by the Engineer.

Payment shall be made at the contracted unit price per m^3 or m^2 of incorporated filter material. The contracted price shall also include all other expenses related to the procurement, placement, transport, etc., and the Contractor shall have no right to claim any other compensation for the final completion of works.

4.3. Drainage Ditches

4.3.1. Scope and Contents of Works

This Section includes the works on construction of drainage ditches of different structure, according to detailed design drawings, namely:

a) Excavation for drainage ditches
b) Lining of drainage ditches with concrete
c) Lining of drainage ditches with stone:
   - on sand bedding
   - on concrete bedding
d) Stabilization of drainage ditches
e) Lining with prefabricated elements
f) Humification and grassing.

4.3.2. Material

All used materials shall be of good quality and their functional performance in compliance with Yugoslav regulations and standards, as well as these Technical Specifications.

4.3.3. Execution of Works

4.3.3.1. Excavation

Ditches shall be excavated before stating the construction of embankment. The excavation shall be carried out precisely according to details from the design. All excavation surfaces, both the bottom and slopes, shall be flat and of required slope and grade, in order to prevent any collection of water or crumbling of soil.

All (manually or mechanically) excavated material shall be used for embankments or other particular works, or transported to stockpiles approved by the Engineer.

If weather or climatic conditions have an adverse impact on excavated surfaces, their lining shall be continued immediately.

4.3.3.2. Lining of Drainage Ditches with Concrete

This work shall be executed as per the design, with construction joints made at every 3.0 m and filled with sealing compound. Concrete shall be compacted by vibration, and the surface shall be homogenous, flat, and pore-free.

4.3.3.3. Lining of Drainage Ditches with Stone

It is performed in a thickness specified in the design, at least 15 cm, on a 10 cm sand bedding, in compacted condition, covered with a layer of cement mortar, 3 cm thick, on which rubble is laid. Joints shall not be wider than 2 cm and shall be filled with 1:3 cement mortar. The work shall be executed precisely according to detailed drawings and instructions from the design, and/or Sub-Section 8.3.3. of these Specifications.

4.3.3.4. Lining of Drainage Ditches with Stone over Concrete Bedding

Drainage ditches shall be lined with stone, in thickness as per the design, over concrete bedding, with joints filled with 1:3 cement mortar, which shall be performed according to detailed drawings and instructions from the design, and/or Sub-Section 8.3.3. of these Specifications.

4.3.3.5. Stabilization of Drainage Ditches

It is performed using 1:3 cement mortar (30 1 m^2), and local material (on the site); the layer shall be rolled, and then sprayed with a semi-stable bituminous emulsion (0.7 kg/m^2). The bottom of ditch shall be of width as per the design, and its sides shall be secured with a dry-stone lining of thickness and width as per the design. Everything shall be performed according to detailed drawings and instructions from the design.

4.3.3.6. Lining of Ditches with Finished Concrete Elements

It shall be performed according to details from the design. The quality of concrete and finished elements shall meet the requirements from Section 5 of these Specifications.

Concrete elements shall be laid over a sand layer according to elements from the design. Joints shall be filled with a sealing compound. Sills for fixing shall be constructed as per the design.

Humification and grassing of ditches (those not to be lined) shall be carried out according to Sub-Section 3.11. of these Specifications.

4.3.4. Quality

All finished surfaces of ditches shall be constructed according to the design, at required longitudinal gradients, crossfalls, and surface areas. The requirement is to ensure perfect drainage, and it is, therefore, not allowed to leave any uneven areas that would prevent water from running off, or cause the sedimentation of muddy material.

Every layer of bedding and lining shall be of thickness in conformity with measurements from the design and these Technical Specifications, and no variation shall be permitted.

4.3.5. Quality Control

The Contractor shall control the reference level and gradient regularly to the full satisfaction of the Engineer.

If these works are not executed according to the required quality, the Engineer shall instruct the elimination of defects at the

Contractor's expense.

Control tests shall be performed at every 250 m^1.

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

4.3.6. Measurement

The amount of work approved by the Engineer shall be measured:

- Excavation in cubic metres of actually excavated ditch as per the design, particularly by groups of different categories. Excavation to the subgrade level shall be calculated as bulk excavation;
- Lining in square metres of actually completed lining, measured in extended width and actual length as per the design and by lining type;
- Stabilization in metres of length - m^1 of actually stabilized ditch as per the design.

4.3.7. Payment

Quantities determined according to Sub-Section 4.3.6 of these Technical Specifications shall be paid at contracted unit prices for respective types of works, except for humification and grassing, which is included in the unit price of excavation. Furthermore, the unit price for the lining of ditches with finished concrete elements shall also include the fabrication of fixing sills (excavation and concreting). The unit price includes all works that are, directly or indirectly, related to a full completion of works, i.e. to all materials, labour, transport, transfer, and everything else required for a full completion of works, and thus the Contractor shall have no right to claim any compensation for that work out of the contracted unit price.

4.4 Closed Storm Sewer System

4.4.1. Earthworks

4.4.1.1. Excavation Works

Introductory Notes

Open excavation works cover:

a) Excavation of trenches applying a proper method according to the soil mechanics properties of the ground, including loading and haulage;
b) Protection of trench walls;
c) Drainage of seepage and ground water.

The works may be executed according to the approved and authorized:

a) Final Design or Detailed Drawings (hereinafter: the design) containing appropriate longitudinal and cross sections with levels and necessary dimensions; and
b) Construction organization plan that defines: the method of excavation, including types of machines and equipment, organization of transport, technical solutions and approvals for any protection and security measure in the zone of construction site.

Excavation shall be performed according to gradients and dimensions indicated in the design or to the level and dimensions approved by the Engineer.

Incorrect excavation shall not be accepted, and works caused by incorrect excavation shall be at the Contractor's expense. Excessive or incorrect excavation (if the channel bottom level is deeper than specified in the design) shall be filled with gravel and compacted well with vibrosoil compactors, fully as instructed by the Engineer.

Only when bedding is prepared in this way and approved by the Engineer, the next phase may start – construction of collectors.

A trench for laying a pipeline may be excavated manually or mechanically. The width of trench is conditioned by the pipeline diameter and shall be at least 0.80 m. The trench bottom shall be excavated with the accuracy of +5 cm. For deeper excavation, in excess of 1.0 m, the trench shall be strutted, if required due to the stability of ground. Excavated material, used to backfill the pipeline after its assembly, shall be stockpiled on one side of the trench, protected against failure, and dumped at least 1.0m away from the edge of trench. The other side of trench is "reserved" for the stockpiling of piping material. As a rule, all piping material to be used (pipes, couplings, etc) shall be completed on the route before excavating the trench.

The Construction Organization Plan shall ensure that traffic is diverted (for structures built in urban zones) to the unoccupied part of road. Access to all buildings shall be ensured in case of fire fighting, rescue of people, delivery of goods, etc. The Contractor shall take measures and ensure conditions that the usual traffic regime near the site is not disturbed longer than approved by the Engineer. Any material and other consequences of such disturbance of traffic shall be at the Contractor's expense, if he fails to observe adopted construction measures, procedures, and timing in the course of works.

In his work programme, the Contractor for installation works shall foresee and coordinate all related works, both if he performs them on his own or with the assistance of other contractors.

The Contractor shall be responsible for an ongoing coordination and execution of:
a) main works on installations, and
b) related works – relocation of all types of installations, protection of structures, reinstatement of pavement, etc.

When excavating the trench, the Contractor shall take care of any circulation of traffic that may cause a collapse of trench and jeopardize the safety of workers. The Contractor shall take special measures for full safety at work on all sections of the excavated trench to the full satisfaction of the Engineer.

If the trench is excavated in the zone of existing installations (power supply, telecom, gas, hot water, water supply, and sewerage), the routes of which are not specified on the site, before the commencement of works it is necessary to define their position by digging up across the route. The uncovered installations shall be surveyed geodetically, and the data shall be submitted to the organization in charge of their maintenance, i.e. organization that will synchronize the existing and designed installations. The excavation of trenches shall start on checked sections following the adopted method, and subject to the Engineer's approval.

Regardless of requirements based on which the Contractor shall obtain the approval for every work plan, arrangement of machines, and progress method, the Contractor shall bear the sole responsibility for the work method, good performance, a timely completion of work, and for safety and protective measures during the execution of works.

These Technical Specifications regulate only major issues that define the method and quality of excavation work. Any other issue not specified herein is subject to relevant technical norms, standards, regulations, and rules, and the approval of the Engineer.

Categorization of Excavated Material

This description adopts a unique categorization of soil, such as "excavation in soft ground", and covers all excavation works in soil, clay, debris, river load, decomposed rock, and other similar materials in which the Contractor may excavate mechanically or manually. Excavation in soft ground includes all round stones and solid blocks found in original natural material, not exceeding 0.75 m^3 in volume.

The categorization in excavation work may be defined by mutual agreement in a protocol, with a mandatory presence of the Engineer.

The Engineer shall inspect the bottom of excavated trench, and certify that by making an entry into the Building Journal.

Shoring and Protection of Working Cross Section

The Contractor shall shore and strengthen the excavated surfaces of the trench as stated in the design and these Specifications.

The Contractor shall, fully in accordance with regulations, shore and strut the sides of trench using boards, beams, and wedges for trenches deeper than 1.0m. Shoring shall be such as to meet requirements from the Law on Safety at Work, i.e. shall be 100% safe for life of people working in the trench. The degree of trench protection depends on the material in which the trench is excavated, and on its strength. The trench shall be protected with horizontal and vertical planks fixed with lateral beams and strutted with round timber. Formwork shall "stick out" from the trench at least 0.20m. Earth thrown out shall be protected against collapse.

Spacing between planks shall not exceed 1.50m. Ladders shall be used to climb down to the trench, and all excavations shall be protected with fencing. Every day, before the commencement of works, formwork shall be checked, and any defects removed immediately. The check shall be thorough after heavy rainfall and longer interruptions in work. Findings shall be stated in the Building Journal.

The Contractor shall advise the Engineer if he finds the approved type of shoring inadequate for soil conditions, and the Contractor shall check and change the shoring within 12 hours or as otherwise directed by the Engineer.

The Contractor shall be responsible for the stability of structures and safety at work, and if there is a hazard of caving in, the Contractor shall take appropriate protective measures.

The Contractor shall control, maintain, and renew shoring, to the full satisfaction of the Engineer.

Depending on geotechnical and hydrogeological conditions, an assessment shall be carried out by the Contractor in order to determine the type and strength of shoring, and a maximum time allowed from the moment of excavation to the time of shoring, and this assessment shall be submitted for the approval of the Engineer.

Blanket Course

For pipes to rest better, and to achieve more uniform load all along the pipeline, it is necessary to construct a blanket course. The blanket course shall be prepared carefully and made of sand spread all across the trench, with 10 cm thickness for pipelines up to 500 mm, and 20 cm thick for pipelines over 500 mm. Sand shall be free from stones, or any other objects that might damage a pipeline or its insulation. The blanket course shall be compacted mechanically, and where this is impossible, by standard hand compaction.

Disposal of Materials

Excavated materials shall be disposed of on locations approved by the Engineer. The disposal shall be performed in such a way that stockpiles are always dewatered and levelled. Their slopes, just as stockpiles themselves, shall be stable. The disposal of material shall not cause any landslide of the ground on which the stockpiles are located, or of the surrounding ground. In case of a landslide of the surrounding ground due to a careless disposal of material, the Contractor shall take, at his own expense, all remedial measures instructed by the Engineer.

Sometimes, the Contractor shall also dispose of excavated material on temporary locations approved by the Engineer. After the completion of planned works, when there is no more need for a temporary disposal of excavated material, the Contractor shall haul all remaining material to permanent dump sites and level them in a way approved by the Engineer.

Transport of Pipes

When taking over pipes, each delivery shall be checked carefully to determine whether it is complete and undamaged or not. Damages on pipes are usually caused by mishandling during transport and unloading. Pipes shall be unloaded and reloaded under a constant control of a qualified person, particularly assigned for that task. Pipes shall be stacked on a completely flat base, in the shape of a prism.

Pipes and all fittings and couplings shall be stored so that their inside cannot become dirty. It is necessary to take care that pipes do not become dirty with: soil, mud, oils, grease, paint, and similar material. When loading and transporting pipes, it is necessary to take care that they are not drawn over the loading surface of a transport vehicle or over the ground. The contractor for assembly work shall observe instructions given by the supplier of pipes, as well as the way of handling piping material during transport and storage.

When storing pipes, they shall be stacked so that they lie on a flat ground in their full length. Rows of pipes shall be supported laterally. An alternate arrangement of sockets will ensure that each particular layer of pipes rests almost completely. Rubber seal rings shall not be exposed to sunrays for a longer time.

4.4.1.2. Sidefilling and Backfilling of Pipelines

Backfilling works include:

a) Taking over of material from a stockpile of excavated material, or from a borrow pit, and
b) Backfilling of trenches, applying appropriate procedures for incorporation of material.

Backfilling works on the remaining part of a trench shall be performed in accordance with specifications given in this Section, drawings, or as instructed by the Engineer.

Joints on a pipeline shall remain uncovered in order to be checked during trial pressure testing. The Contractor is particularly warned not to start the backfilling of trenches before all test pressure checks have been performed, and before concrete in anchor blocks and structures (inspection manholes, overflow and other structures) on the pipeline has achieved the required strength.

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

If the securing of transition or permanent points hinders (prolongs) the execution of works, then, subject to the Engineer's approval, it is allowed to secure these points on a temporary basis.

After completed test pressure checks and securing permanent and transition points, the backfilling shall be resumed with material that shall not contain stones larger than 5 cm.

Gaps between the pipeline and the trench wall shall be filled with sandy material in layers up to 25 cm thick, and compacted. The layers shall be spread and compacted mechanically or applying other approved methods, alternately from the left and right side of the pipeline.

The compaction of a spread section shall meet the specified compaction requirements, particularly on road sections, and on sections in the green belt.

Embankments above pipelines shall be constructed in layers not thicker than 30 cm, with proper mechanical compaction. Filling material shall be taken from a stockpile of excavated material or a borrow pit, if in compliance with requirements for specified compaction. Only inorganic material free from topsoil and muddy components may be used. It is necessary to achieve the compaction Me=39.2N/mm^2.

Backfilling on road sections shall be performed with gravel, in accordance with requirements for renewed pavement. The layers shall not be thicker than 30 cm, and it is necessary to achieve the compaction of Me=60N/mm^2. A backfilled layer shall be spread longitudinally in the entire trench width, and compacted immediately.

The compaction of spread material shall be checked regularly, registering the test results.

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

The compaction of incorporated material shall meet specified compaction requirements, both on road sections and in the green belt.

Haulage of Excessive Excavated Material

The haulage of excavated materials includes loading, transport of excavated material to a stockpile approved by the Engineer, unloading of material, and levelling of the stockpile.

4.4.2. Groundwater Drainage and Pumping

During the execution of works, the Contractor shall drain and pump water in order to ensure a smooth execution of works. The drainage of foundation pit and/or trench shall be performed using hand pumps or mobile pumps. Within the Construction Organization Plan, the Contractor shall enclose a drainage plan. In the preparation of plan, gravity drainage shall be used wherever possible. If this is impossible to manage, the Contractor shall construct drainage channels to a shaft (collector) and a system of pumps for the removal of water from the shaft (trench).

In the project organization study, the Contractor shall shall propose a groundwater drainage and pumping system that shall be submitted for approval by the Engineer before the commencement of works.

The amount of water not exceeding 15 l/s on the entire section (or a certain location) shall be considered as normal inflow, and the drainage of this amount of water shall not be paid extra, but be included in the unit price.

The amount of water in excess of 15 l/s, measured on the control point inlet, shall be paid within special items of works.

The Contractor shall maintain installations and pumping facilities so that, at any time, they can remove water in amounts up to 30 l/s.

4.4.3. Assembly Work

Before unloading it is necessary to check if pipes are in good condition.

Unloading, as well as relocation, lowering of pipes into a channel, and pipe laying shall be performed using appropriate cranes, trench digger, loaders, or equipment for precision lifting (all this depending on the diameter and material of pipeline), thus excluding any damage to the pipeline. It is not allowed to lay pipes by jerking them or dropping them to fall down freely.

Cables and ropes shall be used to hang pipes. Pipes shall not be unloaded and placed into the trench with a longitudinally inserted rope or with several pipes in one grip.

4.4.3.1 Pipe Joining

Spigot-and-socket and ogee joints, along with a sealer (rubber ring) make a structural whole of the pipeline.

Sealing rubber rings are of solid structure and made of material resistant to chemicals and aging. They are delivered together with pipes.

When joining and sealing, it is necessary to take care of the following:

- Only clean and dry sealers may be used, and sealing surfaces on the socket or free end shall be cleaned and dried.
- A sealing ring shall be placed straightened up (untwisted) and uniformly stretched at the very end of the free end of pipe.
- Before joining, a pipe hanging from the unit for pipe transfer and laying shall be straightened horizontally and vertically (according to the pipeline alignment) and carefully brought to an already laid pipe (sealing surfaces shall not be damaged at any cost).

4.4.3.2 Testing of Pipeline for Water-Tightness

The hydraulic testing of sewerage (i.e. testing of pipeline for water-tightness) shall be carried out after the assembly of pipeline, with the trench partially backfilled.

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

4.4.4. Sewer System Structures

Inspection manholes shall be constructed in places of horizontal and vertical transitions, at joints of two and more pipes, and on straight sections if they are longer than specified. They are built from reinforced concrete pipes – finished prefabricated rings (and a cone-shaped segment, 1.0m long, at the end), Ø1000mm, with incorporated step irons and a reinforced concrete ring and cast iron cover.

Inside walls of inspection manholes are plastered with cement mortar and trowel finished. The bottom of inspection manhole is at the level of the lowest pipeline and half-round gutters are constructed in it for joining all pipelines that run into that manhole.

To construct an inspection manhole, it is necessary to dig a round hole, 1.50m in diameter. Trench sides shall be almost vertical (5:1), so that in case of emergency, the excavated trench could be strutted. The bottom of trench shall be covered with gravel, in a 10 cm layer, and, on top of it, a bedding made of lean concrete (concrete class MB15), 10 cm thick.

4.4.5 MEASUREMENT AND PAYMENT

Works on water supply and sewerage shall be executed fully in accordance with the Design that has passed technical control and agreed Bill of Quantities and subject to the approval of the Engineer. Integral part of the agreed Bill of Quantities is complete design including specifications for materials, bill of quantities and all necessary details and drawings.

All works shall be carried out according to the Engineer's instructions, and no changes or major phases (such as backfilling of ditch, checking of pipes and installations) shall be carried out without him. This Bill of Quantities and specifications for giving over and execution of works are integral part of the construction contract.

Unit rates for these items of work in Bill of Quantities are the Contractor's selling prices and they include:

a) All necessary preparatory and final works that include high-quality and fully completed job.

b) All costs of execution of works: labour, material including distribution, equipment, formworks and scaffolding, prefabricated elements, assembly costs, transport, setting, as well as all other costs according to the valid regulations for price structure.

c) The Contractor is obliged to perform, at his own expense, testing of pipes, installations and sanitary facilities in accordance with the existing technical regulations: water supply shall be tested on pressure set and submitted for approval by the Engineer, and sewerage tested with gauge pressure not less than 1.5 m.

The Contractor is obliged to perform, at his own expense, disinfection of all pipeline installments, water supply, as well as test analysis of water upon completion of works, which shall be stated in construction diary with documentation on water analysis attached. Only after this, technical control and taking over shall be carried out.

It shall be necessary to create committee report on control of water supply and sewerage system in the presence of the Engineer, and the representative of the Employer.

d) Excavation costs include excavation of ditches with parallel vertical cutting of side ends and bottom of ditch, all accompanying works on protection from sliding or atmospheric waters, pumping of atmospheric or underground waters, planning of excavation and filling, backfilling, compacting of land in layers of 20 to 30 cm, transport of the remaining soil (up to 100 m) with spreading in place approved by the Engineer, compacting and planning of the same, setting out of ditches and other.

e) Measuring and payment of concrete shall be made up to the lines shown in drawings, in a way described in these specifications and subject to the approval of the Engineer.

In measuring for payment of concrete, all openings with cross section area greater than 400 cm^2 shall be rejected.

Payment of concrete shall be made per cubic meter in accordance with the unit rates given in the Bill of Quantities. These unit rates shall include costs of labour, all material, equipment, formworks and scaffolding and all other direct or indirect costs that must be made in order to finish work on proposed items, and all fully in accordance with the provisions of these technical specifications, regulations and standards.

Unit rates for reinforced concrete shall also include 5 cm thin layer of lean concrete, concrete class MB15, that shall be placed on surfaces that are not solid and plane enough and on which concreting is to be carried out by using reinforced concrete.

Measuring and payment for item: supply and construction of reinforcement, shall include only those quantities of reinforcement that are really incorporated into concrete, in accordance with reinforcement plans and as approved by the Engineer.

Payment for supply and construction of reinforcement shall be made per kilogram in accordance with the unit rates given in the Bill of Quantities. These unit rates shall include costs of supply and transport of reinforcement, bailing wire, bar supports and other necessary material, cleaning, cutting, bending, construction, welding and all other costs related to the supply and construction of reinforcement.

Unit rate per one ton or kilogram for reinforcement of Ø12 mm shall also include bars whose diameter is Ø12 mm.

If works are executed with material that does not meet technical requirements from design or Engineer's approval, the Contractor shall repeat these works again, at his own expense, without right to ask for reimbursement.

Upon completion of works or, as instructed by the Engineer, during certain phases of work, the Contractor is obliged to bring structure into proper condition for use, as well as to backfill and plan all ditches and holes, clean all structures, installations, devices and parts.

All works are included in main items and shall not be paid separately.

The Contractor is obliged to maintain all executed and constructed structures, installations, devices and parts until they are taken over and to provide necessary protection. This shall be included in the unit rate.

4.4.6 TECHNICAL SPECIFICATIONS FOR PVC PIPES

Material for PVC pipes and joints is mixture of non-plasticized PVC and □=10MPa with necessary additions.

Physical chemical properties

- specific weight 1,38-1,45 g/cm^3
- tensile strength 30-60 MPa
- average density 1,40 g/cm^3
- longitudinal extension coefficient in 1/K $80x10^{-6}$
- heat conductivity 0,16 W/Km
- surface resistance $>10^{12}\ \Omega$
- water absorption 4 mg/cm^2

Quality of products and quality control conditions are defined by SRPS C6.502 and SRPS C3.511 standards.

Type of pipes used depends on place of installation, quality of soil and type of ground, loading and other conditions.

Placing of sewage pipes and joints is allowed without special static evidence under following conditions:

- Under traffic areas or areas that are only temporary exposed to the traffic of light vehicles minimal cover layer should be 0.8 m.

- Under non-traffic areas or areas that are only temporary exposed to the traffic of light vehicles minimal cover layer should be 0.8 m.
- On placing into the ground under buildings, cover layer over the socket should be at least 150 mm. If loadings due to built-in structure parts cannot be avoided, protective pipes should be placed.
- On placing into the channels of minimal width, cover layer should not exceed 6 m, while on placing under embankment into the very wide channels, that layer should not exceed 4 m.
- Soil for filling should have nearly following characteristics $8 \leq 20{,}5 KN/m^2$; $8 \leq 22{,}5 KN/m^2$.
- Placing in areas of underground waters is allowed only under condition that erosion of filling material is prevented. Erosion shall be prevented by placing pipes in filter layer of gravel or in concrete.
- If there is a departure from these norms, it is necessary to make calculation of bearing capacity for pipes where standard conditions for filling and compacting (DIN 4033) shall be provided, which means that in the area of pipeline from the bottom of channel to at least 30 cm above vertex of pipe, following compacting values shall be achieved:
- 97% density of non-dig soil for non-cohesive soil
- 97% density of non-dig soil for cohesive soil . All compaction values shall be proved during construction
- Filling in area of pipeline (from the bottom of channel to at least 30 cm above pipe) shall be done by using non-stone material that can be compacted. Filling material which is in direct contact with pipe may be taken from excavated channel but first it needs to be cleaned from coarse material. Compacting around pipes shall be carried out by using manual or hydraulic equipment. Each time material shall be filled only up to the vertex of pipe and compacting shall be carried out only at sides, and never in the pipe area. Material shall be compacted all until good side support for sewage line is obtained. Filling above pipe vertex shall be carried out in layers so that higher layers compact lower ones.

4.4.7 TECHNICAL SPECIFICATIONS FOR PEHD PIPES

By using technology of spiral rolling and polythen of high density (PEHD) the following can be produced:

- profiled pipes [with sockets]
- full wall pipes [without sockets]
- arch rings
- Prefabricated elements and manholes

Polythen of high density is thermoplastic mass on base of ethylene homopolymer and addings. In construction of pipes, PEHD designed for extrusion with addition of soot as UV stabilizer is used.

Physical chemical properties

- density 0.945 g/cm^3
- elasticity module 800 H/mm^2
- coefficient of linear extension $1.3 – 2.0\ 10^{-4}\ K^{-1}$
- heat conductivity coefficient (at 23^{o}C) 0.35 – 0.40 W/mK

Quality of products and quality control conditions are defined by EN ISO 9969 standard. In accordance with the mentioned standard, depending on ring stiffness, pipes are classified in six classes according to the ascending loading. Ring stiffness is a measure that provides information on loading limit at permissible deformation of 3%.

Pipes produced by using spiral rolling technology provide full homogeneity of wall and absolute non-porosity. In order to achieve that entire pipeline keeps these properties, technology of connecting pipes by extrusion welding has been developed.

Resistance of PEHD pipes on aggressive medias is such that enables their successful use in:

- pipelines for transport of industrial waste waters,
- foul main sewers and sewers of general system,
- vent pipelines,
- outlets located at the bottom of the sea and
- chimneys for waste gases.

PEHD pipes have following characteristics:

- they are lightweight which allows significant savings in transport, manipulation and construction ,
- great resistance on aggressive medias,
- great corrosion resistance,
- excellent physical properties which means longer service life (of pipes and joints) and low maintenance costs,
- smooth inner surface which reduces flowing friction,
- great abrasion resistance which means longer service period,
- possibility of construction and servicing in all weather conditions from (–40 ^{o}C to +80 ^{o}C).

4.4.7.1 Chemical resistance of pipes

It is well known that plastic masses are corrosion proof and that their chemical resistance is good.

However, in contact of working material with pipe wall different processes may occur, such as liquid absorption (swelling), extraction of soluble parts of material (shrinking), hydrolysis, oxidation or other. Behavior of PEHD pipes is explained in DIN 8075 – addendum 1.

4.4.7.2 Transport and stockpiling

Due to great resistance on impacts and deformations and because of small weight, PEHD pipes do not require demanding procedures of transport and stockpiling. Even on low temperatures, below 0ºC, they are elastic enough and resistant on impacts.

In spite of all, it must be taken care that pipes are stockpiled on even surface and that they are not in contact with sharp objects, in transport or at stockpiling place.

Pipes should be placed on surface at full length.

4.4.7.3 Installation method

Installation of pipes must be carried out by qualified workers under professional supervision.

In installation of pipeline it is necessary to obey general guidelines for placing of pipeline in ground, and which are defined by EN 1610 standard.

It is necessary to have a good preparation of subgrade (thickness is 15cm) from sand or other material that can be compacted and that does not contain grains larger than 20 mm. Compactness of material around pipeline must be 95% according to Proctor. Compacting shall be carried out in layers of 20 cm and up to the ¾ of outer pipe diameter. Testing has shown that compacting of material with adequate vibrating equipment is much better than manual compacting. If formwork for bracing of channel is being placed then compacting of gravel must be carried out after removal of formwork also.

In order to protect pipe from mechanical damages, it is necessary to cover it 30 cm above pipe vertex with material that does not contain coarse stone, groge or similar. That part of ditch may be filled with excavation material if does not contain material that possibly might damage the pipe.

4.4.7.4 Connecting pipes

For connecting pipes, method of extrusion welding is used. This method insures fully watertight connection.

Welding locations must be protected from strong solar radiation, wind, dust and temperature below +5 ºC.

During excavation of ditch, the Contractor must take care on traffic flow that might cause cave in of ditch and endanger safety of workers. The Contractor is obliged to undertake special measures for full protection and safety at work on all sections of excavated ditch.

If the ditch excavation is being carried out in the area of existing installations (electric lines, telecommunication lines, gas lines, heat lines, as well as water supply and sewerage system), and their routes are not marked on the terrain, before start of works on route position of these installations must be established by cross wise digging. Discovered installations shall be surveyed and data shall be submitted to the company responsible for maintenance of these installations, which means that reconciliation of the existing and designed installations shall be made. On checked sections excavation of ditch shall start in accordance with the accepted working method and subject to approval by the Engineer.
Notwithstanding requests according to which Contractor must have approval for each programme of works, arrangement of equipment and method of progress, only the Contractor is responsible for working method, high-quality of works, completion of work within agreed period and for safety and protection measures during execution of works.

These technical specifications define only major items that specify method and quality of work on excavation. For everything else that is not stated here, corresponding technical norms, standards, regulations and rulebooks are valid.

4.5 Relocation of water supply and sewerage systems

4.5.1 DESCRIPTION OF THE WORKS.

Works on water supply and sewerage systems by which parts of pipeline or other elements of system are being relocated shall be fully executed in accordance with construction design that has previously passed technical control and approved by public service. Integral part of agreed Bill of Quantities is complete design with material specification, bill of quantities and all necessary details and drawings.

Works shall be executed according to the Engineer's instruction, without which no changes or major phases (such as backfilling of ditch, testing of pipes and installations or other) shall be carried out, and with approval of public service's representative. This Bill of Quantities and conditions for takeover and execution of works are integral part of construction contract.

Unit rates for these items of work in the Bill of Quantities are Contractor's selling prices and they include:

All necessary preparatory and final works that include high-quality and fully completed job.

All costs of execution of works: labour, material including distribution, equipment, formworks and scaffolding, prefabricated elements, assembly costs, transport, setting, as well as all other costs according to the valid regulations for price structure.

The Contractor is obliged to perform, at his own expense, testing of pipes, installations and sanitary facilities in accordance with the existing technical regulations: water supply shall be tested on pressure set and submitted for approval by the Engineer, and sewerage tested with gauge pressure not less than 1.5 m.

The Contractor is obliged to perform, at his own expense, disinfection of all pipeline installments, water supply, as well as test analysis of water upon completion of works, which shall be stated in construction diary with documentation on water analysis attached. Only after this, technical control and taking over shall be carried out.

It shall be necessary to create committee report on control of water supply and sewerage system in presence of the Engineer and the representative of the Employer and representative of public service responsible for these systems.

Excavation costs include excavation of ditches with parallel vertical cutting of side ends and bottom of ditch, all accompanying works on protection from sliding or atmospheric waters, pumping of atmospheric or underground waters, planning of excavation and filling, backfilling, compacting of land in layers of 20 to 30 cm, transport of the remaining soil (up to 100 m) with spreading in place approved by the Engineer, compacting and planning of the same, setting out of ditches and other.

4.5.2 MEASUREMENT AND PAYMENT

Works on water supply and sewerage shall be measured fully in accordance with the Design that has passed technical control and agreed Bill of Quantities and subject to the approval of the Engineer.

Unit rates for these items of work in Bill of Quantities are the Contractor’s selling prices.

Section 5
Slope Protection

Contents

5.1. Boring, and Installation of Anchors

In order to protect the face of excavation and excavated slopes, and their interaction with the surrounding hill mass, it is required to apply “Sn” anchors (rock bolts) . These anchors are partially pre-tensioned and embedded in cement mortar. The tensioning force is 20% of a minimum force in the anchor that is specified in the design.

a) For the excavation front, SN anchors, RΦ25, L= 4.0/ 6.0m, RΦ19, L= 3.0m are foreseen.
   A minimum force in anchors is foreseen to be 85kN.
b) For excavation slopes, SN anchors RΦ19, L= 3.0m/4.0m, RΦ19, L = 2.50m are foreseen.
   A minimum force in anchors is foreseen to be 55 kN, and 35 kN for 2.5 m long anchors.

The pre-tensioning force is 10-20 kN and is, most often, applied to the anchor with a torque wrench, and represents a control of an embedded anchor.

Foreseen anchors are made of ribbed steel RΦ19 (25) , with a thread L= 15 cm, and a pointed or bevelled tip for easier penetration into the borehole, through mortar.

The contact between the anchor and the primary lining or excavated slope shall be achieved over a (steel) plate, 160 x 160, d = 10 mm thick. The length of anchors is specified in the design.

The holes for anchors shall be bored in dry.

The borehole diameter:
Min d = 41 mm
Max d = 51 mm

After finished boring, the borehole shall be cleaned with compressed air in order to remove dust and fractions of rock mass, and then wetted before the injection of mortar, i.e. insertion of anchor. If an anchor is not to be inserted immediately into the borehole, it shall be closed with a proper plug.

An SN anchor is formed by driving a steel rod into a borehole of a larger diameter filled with 1:2 cement mortar with the addition of an accelerator.

Anchors are installed mechanically, applying a special equipment for mechanical installation of anchors, or using a creasing hammer.

Thick cement mortar – pudding consistency - (water-cement mortar 0.3-0.35) shall be injected into the borehole by inserting a rubber hose to the end of borehole, keeping it lightly in place until the grout from the borehole forces it out completely.

A plastic plug shall be used to close the borehole, to prevent the grout from leaking out.

Before the mortar hardens, an anchor plate shall be placed on prepared bedding, which is then pressed to adhere to the rock (primary lining) by tightening the nut to achieve the required pre-tensioned force.

The anchor shall be protected against corrosion in its full length (it shall be embedded in cement mortar or in shotcrete).

Pull-out tests are obligatory for anchors and shall be carried out in compliance with the Swiss standard SIA 191.

The anchor body shall be absolutely clean, rust- and grease-free. Control tests ordered by the Engineer are obligatory, namely:

Steel shall be in compliance with the Rules on technical norms for plain and reinforced concrete (PBAB/87) , the instructions for use, and related standards:
SRPS C.K6.020 Hot-rolled steel. Reinforcing steel. Technical Specifications. 1987
SRPS C.K6.120 Hot-rolled steel. Reinforcing steel. Shape and dimensions. 1986
SRPS EN 10002-1: 1996 ICS 77.040.10

The quality of materials shall also be proved as directed by the Engineer.

Measurement

The contracted unit price shall include all material and equipment, work, labour, tools, kits, and all trial work and work related to the quality control of embedded anchors (pull-out tests).

Measurement for payment shall be based on the number of completed anchors as approved by the Engineer.

Payment

The Contractor shall be paid at the contracted unit price per 1 embedded anchor of specified diameter and length.

5.2. Reinforcement Mesh Q139,M.A. 500/560

The protection of front and side excavation slopes with a mesh Q139.M. A. 500/560. The mesh shall be in shotcrete, below anchors. Mesh ends shall overlap by three apertures and be tied with a wire. Overlapped surface area is included in the unit price. The mesh shall have the Manufacturer’s compliance certificate which shall be submitted for the approval of the Engineer. Transport and storage shall be organized in such a way to avoid damaging and deformation. Before placement, the mesh shall be cleaned from any dirt and grease, corrosion, and other possible damages. The bearing capacity of a welded reinforcement mesh shall be tested before its placement. The quality of samples shall be in compliance with SRPS U. M1.091 and subject to approval by the Engineer.

Before concreting, the Contractor shall request that the Engineer shall inspect and approve the placed reinforcement mesh.

Reinforcing steel shall be in compliance with the Rules on technical norms for plain and reinforced concrete (PBAB/87) , the instructions for use, and related standards:

SRPS C. K6.020 Hot-rolled steel. Reinforcing steel. Technical Specifications. 1987
SRPS C. K6.120 Hot-rolled steel. Reinforcing steel. Shape and dimensions. 1986
SRPS U. M1.091 Structural, welded reinforcement mesh. 1986

The quality of materials shall also be proved as directed by the Engineer.

Measurement

The quantity to be paid to the Contractor at the contracted unit price is the number of kilograms of embedded reinforcement, as indicated on drawings and in specifications, i.e. reinforcement plans, and as determined and approved by the Engineer.

The unit price for reinforcement quoted by the Contractor in his tender shall also include waste from cutting and forming reinforcement, overlaps, “S” bars.

SRPS C. K6.120 is applicable for the calculation of weight of reinforcing steel.

Payment

For quantities determined in this way, the Contractor shall be paid at the contracted unit price (for 1 kg) that makes his full compensation for the scope and contents of works covered in this item.

5.3. Protection of Excavation Slopes with Sprayed Concrete - SHOTCRETE

Protection of slopes with Mt 30 sprayed concrete

This is a technology where cement mortar (with additives) is projected pneumatically (under high pressure and at high velocity) from a hopper to a surface. The force of that jet hitting the surface compacts the material to such a degree that it stays in place, without leaking, not only on vertical surfaces, but also on tunnel intrados. This concrete is applied in two or more layers. The layer thickness ranges from 2 to 10 cm. The shotcrete mixing and spraying technology shall be particularly defined within a design by the Contractor, in line with standards SRPS U.E3.011, and SRPS U.M2.008 / 1994 and subject to approval by the Engineer.

The shotcrete mixing and spraying programme shall be subject to approval by the Engineer. Shotcrete may be sprayed applying a dry or wet procedure.

Requirements for the quality of components in sprayed concrete

Use cement Pc 35, 45, 50. SRPS B.C1.011 and SRPS B.C1.014.

Any aggregate used to prepare the shotcrete shall meet the requirements for concrete (SRPS B. B2.010) and special requirements for sprayed concrete.

Special requirements for shotcrete (sprayed concrete)

The granulometric composition of aggregate shall be in the following range:

Grain size A - 0.15 - 9.50 mm
Grain size B - 0.15 -12.50 mm
Grain size C - 0.20 - 5.00 mm – for finishing

ϕ 0 – 0.2 mm = 15%
ϕ 0.2 – 1.0 mm = 25%
ϕ 1.0 – 3.0 mm = 35%
ϕ 3.0 – 5.0 mm = 25%

The above-stated grain size ranges may be revised by the Contractor if proved justified experimentally, through the concrete plans and subject to approval by the Engineer.

Additives for shotcrete (sprayed concrete)

Additives shall meet the requirements from SRPS U. M1.036, the Rules for plain and reinforced concrete, and special requirements from these Rules. The usage of accelerators is envisaged, and plasticizers may also be used subject to approval by the Engineer. Accelerators should meet two requirements: bonding time, and strength rank. The sprayed mix that contains an accelerator shall start setting immediately (within 1 minute at latest), and finish bonding in 10 minutes at most, after leaving the mixer.

The compressive strength of sprayed concrete (unless otherwise specified in the design) that contains an accelerator, shall be at least 5.0 MPa, after 10 hours.

Plasticizers for a dry mix procedure have the task to reduce the surface pressure of water and accelerate the wetting of a dry mix in the nozzle. Plasticizers enhance the cohesion of a mix (its plasticity and adhesiveness) , thus producing less rebound. All additives shall be checked during test spraying, and may be applied only if the test spraying gave positive results. If additives are in liquid state, they shall be batched through water injected into the nozzle. If additives are powders, they shall be batched into a dry mix. Additives are added and selected so that their action does not start before they leave the nozzle.

The type of shotcrete lining and required class of concrete shall be specified in the design. A mean thickness of the lining shall not be less than specified in the design. The thickness of layers shall be checked during work by occasional testing and placement of signs – reference marks. (Minimum control implies one control per $10m^2$).

Seepage water in a tunnel, after making a shotcrete lining, shall be drained. The stone surface shall be completely clean and wet before the commencement of spraying.

If shotcrete with an accelerator is used, homogeneity is required with the coefficient of variation below 18%. If accelerators are not used, homogeneity is required with the coefficient of variation below 15%.

Preliminary tests and proofs

A programme of preliminary tests according to requirements from the design shall be submitted to the Engineer for approval by the Contractor. During preliminary tests, all components of concrete and equipment shall be included in the tests, and all properties of finished concrete specified in the design shall be proved. These tests shall form a basis to prepare a mix for sprayed concrete. Test spraying shall be performed in all directions. Concreted test surfaces shall be serve to check workers and equipment. Hardened concrete shall later be subjected to core testing as and where directed by the Engineer.

If accelerators are used, it is necessary to prove the strength of concrete at 6, 12, 24 hours, and then 3, 7, and 28 days. If accelerators are not used, the strength of concrete shall be proved at 7 and 28 days. The class of concrete shall be defined by a 20 cm cube. The final approval of a planned mix is given after completed testing of all properties specified in the design. The Engineer and Designer shall give the approval in writing, through the Building Journal.

The control testing procedure shall include the properties of sprayed concrete in a fresh, hardening state and in a hardened condition, as specified in the Design. The testing of sprayed concrete in a fresh state shall be performed at least once at every 100 - 200 m^3 of sprayed concrete. The testing of sprayed concrete in a hardened condition shall be carried out on cylinders, D=5cm in diameter, on a series of three cylinders taken at every 50 m^3 of placed sprayed concrete. The mean strength of three successively tested samples shall be higher or equal to the specified class of concrete. Each particular result shall not be less than 90% of the specified class of sprayed concrete. Compressive strength shall be tested according to SIH NORM 162/66.Tensile strength shall be tested on the same samples as for compressive strength, applying the so-called Brazilian method.

The preparation of a dry mix shall be even and uniform, in order to obtain a homogeneous mix. Gravity mixers shall not be used. The duration of mixing shall be at least 20 revolutions of the mixer drum. The moisture of a dry mix shall be 3-5% of the weight of dry fractions, and its age – 1 hour at most.

If, due to a thicker lining, sprayed concrete is to be applied in several layers, it is necessary to take care that a new layer is applied immediately after the bottom layer has set, not on an already hardened layer. If aggressive water appears, the Contractor shall propose a concrete protection method, by drainage or use of appropriate materials for approval by the Engineer.

Measurement

The basis for calculation for a lining made of shotcrete (sprayed concrete) is the scope specified in the design.

The thickness of lining shall be defined in the design depending on rock properties.

The Contractor shall include a higher consumption of concrete for filling up overexcavations in unit prices.

Depending on rock properties, the Contractor shall foresee appropriately larger dimensions of excavations, in order to ensure, due to related rock deformations, the necessary space around the excavation for a shotcrete lining within the limits specified in the design.

All expenses of additional excavation and protection of a needed profile shall be borne by the Contractor and be included in the unit prices.

The controlled mean thickness of a measured section is relevant for the calculation. If a lining is identified to be constructed in a smaller thickness, the calculation shall be performed by interpolating the contracted prices for set thicknesses.

All calculations and measurement shall be submitted for the approval of the Engineer.

Payment

The Contractor shall be paid at the contract price per m^3 of placed shotcrete, in specified thickness.

5.4. Protection of Slopes with Mesh (Anchored and Hanging)

5.4.1. Contents of Works

The work shall include the protection, with mesh, of the rock slopes that are, by themselves, stable at a certain gradient, but are prone to surface erosion.

5.4.2. Material

5.4.2.1.Mesh

Mesh shall be made of a galvanized steel wire, 3mm in diameter, with rectangular or hexagonal openings, 5-10 cm large. The mesh shall be double galvanized, with a zinc layer of at least 0.07 mm.

5.4.2.2.Anchors

Mesh shall be fixed to slopes with anchors as per details given in the steel design, in compliance with SRPS C.B3.021, with a double-galvanized anti-corrosive coating, 0.07 - 0.08 mm thick.

5.4.2.3. Wires and Pipes

For fixing mesh on slopes, aside from anchors, as per details in the design, it is necessary to use double-galvanized pipes according to SRPS C.B5.311, with a diameter of 48 mm, wall thickness of 3.5 mm, and thickness of double-galvanized coating of at least 0.07 mm.

5.4.2.4. Weights for hanging mesh

Concrete weights shall be used, as per details given in the design. The concrete for weights shall be of class MB-20, and meet the requirements from Sub-Section 5 of these Technical Specifications.

5.4.3. Execution of Works

The places and type of protection with mesh shall be specified by the Engineer, in conformity with requirements from the design and these Technical Specifications. Before placing mesh, a slope shall be prepared according to requirements from the design and these Technical Specifications. Everything that could prevent a normal rest of mesh on the ground shall be removed. For safety against rockfall, on steeper gradients (3:1 to 2:1), hanging mesh shall be used, burdened with concrete weights at the bottom end, and with anchors and pipes on the top of slope, so that any rock broken off slides controllably to the bottom of cut.

For milder slopes, anchored mesh shall be envisaged. The spacing between anchors shall be selected according to the geomechanical properties of rock – the spacing of about 1.0m should be taken into account. When it is impossible to drive an anchor directly into a rock, holes shall be drilled to serve the purpose. Meshes shall be joined together by interweaving with a double-galvanized wire of the same diameter as those in the meshes.

5.4.4. Quality control

The Contractor shall submit for approval to the Engineer a compliance certificate from the mesh producer. The quality control of used material and workmanship shall be performed by the Contractor, in accordance with the requirements from these Technical Specifications and subject to the approval of the Engineer.

5.4.5. Measurement

The surface protected with mesh shall be determined based on the measurement of surface covered with mesh in m^2, measured as per slope gradient, and as approved by the Engineer

5.4.6. Payment

The protection of slopes with mesh shall be calculated at the unit price for m^2 of spread and fixed mesh. The price shall include all works, all materials, and all transports for the protection with mesh as per the design, and the Contractor shall have no right to claim any additional payment.

5.5. Fixing Individual Blocks

5.5.1. Contents of Works

Individual blocks shall be fixed with anchors in places specified by the Designer and the Engineer, depending on geological conditions.

5.5.2. Material

Anchors shall meet requirements from Sub-Sections 5 and 8.2. of these Technical Specifications.

Cement mortar 1:1 for grouting shall be in compliance with Sub-Section 5 of these Technical Specifications.

5.5.3. Execution of Works

Stone blocks that need to be fixed to the slope shall be fixed in the way described under Sub-Section 8.2. of these Technical Specifications and according to the description given in the design.

5.5.4. Quality Control

It shall be performed according to Sub-Sections 8.2. and 5 of these Technical Specifications and subject to the approval of the Engineer.

5.5.5. Measurement

The work shall be measured in m^1 of embedded anchors as approved by the Engineer.

5.5.6. Payment

Payment shall be made at the contract unit price per m^1 of embedded anchors, separately by each type.

This price includes the procurement of necessary material, hole boring, anchoring, erection of scaffolds, costs of injecting cement mortar, pre-tensioning, costs of protection of anchor heads, all transport and other costs needed to complete the work on fixing individual blocks; thus the Contractor shall have no right to claim any other additional payment.

5.6. Protective Vegetation of Slopes, Cuts, Embankments, Shoulders and Green Areas

5.6. 1 General conditions

The protection of slopes and other surfaces is carried out in accordance with the design solution in several ways, and is applied in the construction of cuts, cuts-and-fills, embankments, green areas, etc. The works must be performed in accordance with the design, regulations, quality control and assurance programme (QCAP), construction works organisation plan (CWOP), requirements of the Engineer, and these Technical Specifications.

Before the beginning of these protection works, for the purposes of slope stability, it is necessary that the basic requirements are met to the full satisfaction of the Engineer:

- slopes are to be executed with a gradient that ensures the terrain stability and prevent subsequent sinking (deformation)
- unstable slopes, created by the operation of water, are to be repaired by appropriate intervention,
- surface and ground waters of the catchment watercourses shall be monitored and channelled into the recipient channels or appropriate depressions by applying grassy semicircular groves or drainage conduits,
- the embankment toes and tops of cutting slopes shall be rounded off, if not provided for in the design,
- surfaces of embankment slopes or cuttings shall be roughly levelled for greater roughness and better grip of grass, and smooth surfaces should be horizontally furrowed by appropriate tools (rake, etc.)

After the construction of embankment, cuts or other road structures and implemented basic stability requirements, the slope surfaces need to be immediately protected in an appropriate manner and as directed by the Engineer.

5.6.1.1. Protection of slopes with topsoil material and grass vegetation

Work description

The work involves the protection of embankment slopes, cuts and green areas that are exposed to small quantities of water by applying topsoil material and grass on the surfaces specified in the design or as directed [requested] by the Engineer.

The application of this type of protection also depends on the pedological properties of the soil. The actual executed thickness of the topsoil layer shall be determined by the Engineer.

Procedure

Prior to the beginning of works on this protection, the contractor shall ensure that the basic slope surface stability requirements are met in accordance with these Technical Specifications and to the full satisfaction of the Engineer.

Active topsoil material shall be used for this type of protection, without any twigs, roots, stone or other material that are unsuitable for the development of vegetation.

The topsoil material shall be applied from the bottom to the top of the slope. The thickness of topsoil layer is usually determined in the design. If this is not the case, the thickness for slope layer shall be 0.15 to 0.25m, and for the green area up to 0.45m.

The topsoil shall be levelled and compacted by light compaction hammers. Grass shall be sown on the finely prepared topsoil layer. Sowing shall be done broadcast and then the surface rolled over so that the seed is set firmly in the soil. The type and mix of grass shall be selected in accordance with environmental conditions of the area to provide for the secure vegetation growth. The grass mix shall be proposed by an expert. The amount of seed shall be about 30-50g/m2, and of fertilizer about 80g/m2.

After the completion of the topsoil and grass layer, the surfaces must be tended until final growth. The contractor shall water the sown surfaces until the grass fully grows, and, if necessary, cut the grass once or twice.

Quality control

The contractor must [show] submit for the approval of the Engineer the results of analyses regarding the proper selection of grass and fertilizer types, as well as the quality control results for seeds.

The seed producer's compliance certificates must be [presented] submitted for approval to the Engineer.

The surfaces protected by topsoil material and grass shall be taken over on the basis of quantity of surface under grass of uniform density, fresh colour and healthy appearance, subject to the approval of the Engineer

Measurement

Slope protection using topsoil material and grass shall be calculated in square meters as part of earthworks, for works, actually perform and as approved by the Engineer. , and paid at agreed unit prices

The unit price shall include all material needed for such type of protection and the works described in this sub-section.

5.6.1.2 Slope protection by turfing

This type of protection shall be applied where large quantities of rainwater flow over the slope. The covering is carried out by placing individual pieces of turf or grass mat rolls.

5.6.1.2.1. Protection of slopes by laying individual pieces of turf

Work description

The works involve the protection of slopes by laying individual pieces of turf, on the surfaces specified in the design, or [requested] as directed by the Engineer.

This type of slope protection shall particularly be performed for the stabilisation of the embankment bottom against wearing away as well as on sensitive spots on the top of slope, where the topsoil base is easily washed away.

Material

Individual pieces of turf, fertile soil, appropriate mix of grass and stakes shall be used for this type of protection. Individual pieces of turf shall be rectagonal, 0.25 x 0.25 m or 0.30 x 0.30m and 0.07m thick. It is usually obtained from natural fields by machine cutting. Cut pieces of turf shall be stored until application, for a maximum of 7 days. The turf placed in storage must be protected from deterioration and must be tended. Fertile soil and grass mix should fit the pedological properties of the soil and environmental conditions of the surrounding area. The willow and other stakes shall be about 30 cm long, 2-4 cm thick.

Procedure

Prior to the commencement of works on this protection the contractor shall ensure that the basic slope surface stability requirements are met, in accordance with these Technical Specifications and to the full satisfaction of the Engineer

The protection shall be established by placing individual pieces of turf on prepared and levelled slope surfaces, or on previously laid unwoven textile carpets. The pieces of turf shall be placed in the form of a chess-board with very little space in between. These spaces shall then be filled with fertile soil and sown with grass. On the slope surfaces that are exposed to erosive action of water, the pieces of turf shall be placed in such a manner that the edges between individual pieces of turf are at an angle of 45^{O} to the direction of water flow.

The turf placed on the slope surface shall be fixed by willow or other stakes. Slope protection made of individual pieces of turf shall be tended during and after the work is completed until it attaches to the substratum and grows into it. Depending on weather, watering shall serve as protection.

Measurement

Slope protection by placement of individual pieces of turf shall be calculated in square metres, for actually completed works as approved by the Engineer, and paid at agreed unit prices.

The unit price shall include all material needed for such type of protection: procurement, transport and tending of turf, transport to the storage site, work on laying the turf, filling spaces in between with fertile soil and plating of grass, procurement and making of stakes, fixing the turf with stakes, tending of established surfaces and all the necessary work described in this sub-section.

5.6.1.2.2 Slope protection with rolled turf (carpet lawn)

Description

The work involves the protection of slopes using a finished compact rolled turf on surfaces specified in the design or [requested] as directed by the Engineer.

Material

This type of protection is manufactured by covering large surfaces of appropriate unwoven textile with topsoil and sowing the appropriate seeds. On the upper side, unwoven textile has 50mm curls ensuring the capture of the deposited soil and grass. On the other hand, unwoven textile serves as a protective layer against washing off of soil particles from the slope surface. Until the grass grows stronger, watering should be intensive. Turfs are cut by a machine in the shape of rolls of 0.30 x 2.00 metres. Immediately after cutting, the rolls shall be transported to the construction site and fixed on the prepared slope surfaces.

Rolls may also be taken from natural pastures in the vicinity of works if the Engineer establishes that their quality meets the [ToR] specified requirements and quality standards.

Procedure

Prior to the execution of this protection, the slope surfaces shall be cleared of rough waste and levelled. Rolls shall be placed on prepared surfaces and fixed on the top and bottom of the slopes with □ 10mm stakes. The spaces between adjacent rolls should be small, and filled with fertile soil and seeded.

Protection executed in this manner requires tending during and after the completion of works until uniform vegetation is achieved.

Measurement

Slope protection with rolled turf shall be calculated in square metres, for actual works performed and as approved by the Engineer, and paid at agreed unit prices.

The unit price shall include all materials and work needed for such type of protection: making of rolls, procurement, transport to the site of execution, fitting, filling of spaces between rolls, necessary tending and everything described in this sub-section.

5.6.1.3 SLOPE PROTECTION WITH GRASS COVER _ HYDROSEEDING

Work description

The work involves the construction of a grass cover by hydroseeding, which achieves stabilisation and vegetation protection of cut, embankment, shoulder slopes as well as steep and inaccessible terrain.

Such protection may be specified in the design or [requested] directed by the Engineer with the designer's consent.

Materials

This type of protection uses appropriate grass mixes that are mixed with high molecular weight polymer emulsion and water with the addition of appropriate fertilizers and cellulose. Hydroseeding shall use only grass varieties of completely new properties: low growth of vegetation mass, poor reproductive capacity, high resistance to environmental deviations, very strong and well developed root system taking over the function of erosion protection.

Procedure

This type of protection is most often carried out without prior preparation of topsoil material or any other preparation on all types of soil, regardless of their pedological composition. These can be soils without the topsoil, sterile and devastated soils (blue sandstone, alluvial deposit, quarries, embankment material, industrial waste disposal sites, coal, gravel, waste rock, etc.). The absence of humus substances and physiologically active substances in the soil of the above types of soil shall be compensated by organic-humus-peat ingredients in an alkali suspension. Work on this protection shall be phased.

Prior to the commencement of work, the terrain shall be tested by the Contractor for data on general environmental and vegetation properties of the environment. On that occasion, basic soil properties shall be established as well as the objective to be achieved by hydroseeding defined. On the basis of the above, the formula and work technology shall be elaborated and submitted for approval by the Engineer.

The hydroseeding itself shall be carried out by a special machine of a wide operating radius, which projects jets of the mix comprising different ingredients directly to the treated surface. This application is economical when treating large surfaces. After the treatment of the soil by hydroseeding, it should be protected until the grass cover forms. In the parts where the grassing is unsuccessful, the contractor shall repeat the procedure as directed by the Engineer

Measurement

Slope protection with a grass cover by hidroseeding shall be calculated in square metres of treated area as approved by the Engineer, and paid at agreed unit prices.

Unit price shall include the procurement, necessary equipment and all the necessary work and material described in this sub-section and appropriate tending until hand-over time.

5.6.2 Slope protection with unwoven textile cover with embedded grass seeds

Work description

This work includes the protection of slopes using the unwoven textile cover with embedded grass seeds on surfaces specified in the design or [requested] directed by the Engineer with the consent of the designer.

Material

A material also known as grass carpet is used for this type of protection. It is unwoven textile of polyester origin, to which an appropriate mix of grass seed is added in the course of industrial production. The grass seed mix is selectively produced with respective shares of species depending on environmental and terrain conditions. The technology used for producing the unwoven textile gives it appropriate physical-mechanical and hydraulic properties, and the specific structure enables good seed protection and optimal conditions for its normal development.

Appropriate grass mixes are used for the protection of slopes and other surfaces prone to erosion such as *Festuca ovina, Festuca rubra falax, Festuca rubra genuina , Poa annua, Poa pratensis Merion, Cunodon dactulon, Trifolium repens*, etc., in the amount of 0.2-2.5kg/m2.

Procedure

Prior to the commencement of work on protection, slopes usually need to be aerated at the depth of 5omm and cleared of rough waste. Then appropriate fertilizers shall be applied. The type and amount of fertilizer shall be determined on the basis of soil analysis.

After the processing and fertilising the upper layer of soil, the surface is levelled and rolled over, and then the grass carpet is placed over. The ends of the carpet shall be fixed with wooden wedges or covered with earth. On soils with low moisture content water spraying is mandatory in the amount of 10 to 15 l/m2 daily. Further tending comprises of water spraying in the amount of 4-5 l/m2 daily.

The contractor shall tend the grass surfaces until the vegetation finally grows and attaches properly.

Quality control

The Contractor shall present to the Engineer for approval the results of previous analyses for the purposes of proper selection of grass and fertilizer type, as well as the certificate of compliance for the seeds.

The surfaces protected by the grass carpet shall be taken over on the basis of the surface covered at the appropriate ratio according to current standards and as approved by the Engineer.

Measurement

Slope surfaces protected by covers made of unwoven textile with embedded grass seeds shall be calculated in square metres of formed grass carpet as approved by the Engineer, and paid at the agreed unit prices.

The unit price shall include: procurement and fitting, all work and materials necessary for this type of protection, described in this sub-section. After the sprouting (growth) ends, the contractor shall repeat the procedure on the surfaces where seeding failed as directed by the Engineer.

5.6.3 Slope protection by planting shrubs and grassy vegetation

Description

The work involves the protection of slopes by planting low shrubs sparsely and grass vegetation at specific exposed surfaces. The protection shall be carried out on surfaces specified in the design or [requested] directed by the Engineer.

Material

This type of protection uses the seedlings of low and sparsely planted shrubs and grass vegetation, selected on the basis of pedological properties of the terrain. Selected vegetation must be resistant to wind and snowdrifts and other unfavourable impacts.

The selection of the seedlings, fertilizer as well as the manner of planting and tending shall be in accordance with the Responsible designer recommendations and as directed by the Engineer. Local or adapted types of shrubbery should be used.

The protection of steep slopes with trees or thick shrubbery is not recommended, because after heavy rains great load on the layers of soil is created due to leaves retaining water, which may jeopardize the stability of slopes.

Procedure

This protection shall be used on slopes where the basic stability requirements under these Technical Specifications are ensured. It shall be carried out by planting low shrub seedlings at a specified distance (one every 2.0m^2 if not otherwise specified in the design).

Afterwards, semicircular groves shall be created on the slopes and the entire surface shall be seeded with grassy vegetation.

Grassy groves regulate and slow down the flow of water caused by heavy rains, showers and rapid melting of snow, so that it is diverted in a controlled manner to recipient channels or depressions.

Measurement

The protection of slopes by planting low shrubs and grass vegetation shall be calculated in square metres, for works actually performed and approved by the Engineer, and paid at the agreed unit prices.

The unit price shall include the procurement, planting and placement as well as all necessary material and work described in this sub-section. The excavation and construction of groves shall be paid as a separate item, and calculated per meter of length.

5.6.4 Protection of slopes with intervowen willow twigs (withies)

Description

The work involves the construction of protection by interwoven withies for the cut and embankment slopes with materials of unstable structure (crumbled dolomites, marl, flysch, loos water permeable material and the like) non-resistant to atmospheric and hydrological impacts.

The surfaces on which this type of protection is to be applied shall be given in the design or as [requested] directed by the Engineer.

Material

Willow or other stakes of Ø 20-50mm and 0.70-0.80m long shall be used for the support of the interwoven withies. . For the weaving between the stakes, the fresh willow twigs of Ø 5-30mm shall be used. Turf or topsoil may be used as filler between the withies.

Humified fields shall be grassed in the manner described in Technical Specifications. The selection of the vegetation and fertilizer type depends on the pedological properties of the soil and environmental conditions.

Procedure

Protection of slopes using interwoven withies with humification and grassing shall be carried out on prepared slopes mostly of cuts where the basic stability requirements are provided for in accordance to these Technical Specifications. Protection shall be carried out using interwoven withies directly on the slope without topsoil according to design solutions. If the design does not provide the solutions for protection, it should be carried out by fixing the stakes at a distance of 0.50m and intertwining with in between. The surfaces should be covered in withies up to 3m of slope length. Interwoven withies are placed with their upper edge at the same height as the top of the slope. When protecting river bank slopes, interwoven withies shall be placed diagonally to the water flow. Grass shall be seeded on the carpet of straw or hay (in the amount of 0.60 kg/m2) which shall be sprayed with bitumen emulsion (approximately 0.8 kg/m2) or directly on topsoil surface with the addition of fertilizer (80 g/m2), and which can be protected with a thin unwoven textile. After the construction, protection shall be cared for until it finally grows. The protection using interwoven withies shall be carried out on surfaces on which other forms cannot produce proper results.

Measurement

Slope protection with intertwined withies shall be calculated in square metres for works actually performed and approved by the

Engineer and paid at paid at the agreed unit prices.

The unit price shall include procurement, transport and fitting as well as all the necessary work and material described in this sub-section, as well as the proper care.

5.6.5 Protection of slopes with gabions

Work description

The work involves the protection of slopes using gabions on slopes specified in the design or [requested] directed by the Engineer with the consent of the designer.

Materials

This type of protection uses gabion elements that are made of cages (meshes) and fillers (construction material). The cage shall be made of wire or polymer mesh.

Wire meshes are made of steel wire (Č.0146 and Č.0147) with hexagonal apertures and double threads at the joint. The mesh shall have the shape of a rectagonal prysm. The steel mesh shall be galvanized for durability and greater resistance to corrosion. The size of aperture and the diameter of the wire depend on the filler material, which may be large gravel or crushed stone material, broken stone. Gabion dimensions differ and depend on the producer's programme. As a rule, the gabions are made in the folllowing sizes: 1.0 x 1.0 x 1.0; 1.0 x 1.0 x 2.0; or 1.0 x 1.0 x 3.0; or as per design.

Polymer mesh shall be made of HDPE, polyvinyl-chloride, polyethylene, or polypropylene. The meshes normally have rectangular apertures (openings). The manner of assembling, joining and executing gabion elements is the same as with wire meshes. Local stones that have the necessary and proper quality for this type of works may be used as fillers.

Quality control

The netting and the joining material for gabions shall comply with the quality requirements under these Technical Specifications. The quality of material for the filling (large gravel, crushed stone material or broken stone) should meet the requirements of these Technical Specifications for such materials. Prior to the commencement of work the contractor shall obtain proof of usability of all materials from the competent body and present the original documentation on quality to the Engineer for review and approval.

Execution

For this type of protection, the gabion elements shall be filled at the site of wall construction. According to the design or [request] instructions of the Engineer, first the excavations for the foundation shall be carried out. In the executed excavation, the gabions that are filled with stone material shall be placed. The smallest parts of stone filling must be larger than the mesh holes. The material shall be distributed manually or with hand tools, to fill the cavities as best as possible. After the gabions are filled, they shall be closed with lids, tied with vertical and angular ties, and edges shall be extended along the entire length of the section; gabions shall then be successively placed in the same layer or subsequent layers.

All adjoining gabions in the same layer or subsequent layers shall be tied with a steel wire for joint action of elements and greater strength. Between the gabions and natural soil appropriate filter material shall be fitted to prevent the infiltration of particles into the filler. It is also important to allow for the draining of water from the deepest part of the foundation through drainage conduits.

If the wall is specified to be higher than one gabion (over 1m) the design shall calculate and ensure its stability and set the needed dimensions which shall be confirmed by the Designer and the Engineer.

Measurement

Protection of slopes using gabions shall be calculated in cubic metres for actual works performed and approved by the Engineer and paid at the agreed unit prices.

The unit price shall include procurement, transport and fitting as well as all the work and materials described in this sub-section.

The excavation for the foundation and filter materials shall be calculated in cubic metres, and paid at agreed unit prices, for actual works performed and approved by the Engineer as a separate item.

5.6.6 Protection of slopes by stone lining

Description

The work involves the protection of stone embankment slopes by lining with selected stone on surfaces specified by the design or [requested] instructed by the Engineer.

Material

This type of protection applies stone material used for the construction of embankment. The material shall be of appropriate mineralogical and petrographic composition, sound and of the right size (the largest edge of 0.40m)

Execution

This type of protection is most commonly applied in higher stone embankments for the purposes of constructing steeper slopes and preventing erosion.

Stone lining shall be executed by making a dry wall from selected stone during the construction of the embankment. The longer edge of the stone should be vertical to the surface of the slope to have the stone well wedged into the embankment and stable.

The stone shall be shaped and finished with a hammer if necessary. When making the stone lining, it is particularly important that the foot foundation is built into the firm and sound substratum. The finishing of the lining at the top of the slope should be executed in such a manner that it becomes a whole with the shoulder.

The shape and gradient of the lining shall comply with the design requirements, and the deviation may be within the tolerance range. After the lining is completed, the slope and the surrounding area shall be cleared of stone rubble.

Measurement

The protection of slopes by stone lining shall be calculated in square metres for actual works performed and approved by the Engineer and paid at agreed unit prices.

The unit price shall include excavation for the lining foundation, selection, procurement and finishing of stone, transport and laying of the stone in the lining, and all the materials and work described in this sub-section.

5.6.7 Protection of slopes with mesh

Work description

The work involves the securing and protecting the slopes in rock terrain with meshes in parts where there is a possibility of collapse of unstable parts. The surfaces to be protected shall be specified in the design or determined by the Engineer.

Material

This type of protection uses steel or polymer wire mesh. The steel wire mesh shall have hexagonal apertures with triple wire thread. The steel wire shall be galvanized for greater durability and resistance to corrosion. The wire diameter shall be 1.2-3.1mm, and the apertures shall be 50-100mm. Wire ends shall have a larger diameter (Ø 1.4 to 4.0mm). The width of the net shall depend on the manner of application and range between 1.0 and 3.0 m and is delivered in 25.0m rolls.

Steel anchors of Ø 10-12mm shall be used for the fixing of mesh to the slope. The distance between the anchors shall be about 2.0-3.0m. The anchors shall be fixed to the slope rock at about 0.50 m of depth. The top end of the protective mesh may be fixed to the concrete beams embedded in the slope, and the bottom end fixed with anchors or concrete weights. The Contractor shall obtain the compliance documents for all the materials from the competent body and present it to the Engineer for inspection and [consent] approval.

Execution

Prior to placing this protection, the slope shall be cleared of loose and unstable parts and major rough parts removed. Then the safety mesh shall be placed.
The mesh shall be fixed with anchors.
Concrete weights at the bottom end allow for the removal of collapsed and collected materials. Meshes shall be joined together with galvanized or plasticized wire.

Measurement

The protection of slopes with mesh shall be calculated in square metres, for actual work performed and approved by the Engineer, and paid at agreed unit prices.

The unit price shall include the procurement, transport, fitting and all the work and materials described in this sub-section.

5.6.8 Protection of slopes with sprayed concrete

Description

The work involves the protection of slopes made of rock material prone to surface erosion due to climate or mechanical impact, or in places where the rocks are prone to greater decomposition and where there are clay interbeds or clay nests.

This type of protection shall be applied on surfaces specified in the design or [requested] instructed by the Engineer.

Materials

This type of protection requires anchors, meshes, injection mortar and concrete. Anchors shall be made of steel wires Ø 5.0mm and of required strength. Injection mortar shall be prepared according to special formula. Meshes shall be from steel wire of Ø 2mm, with apertures of square or hexagonal shape of about 400mm in size. Meshes are usually galvanized, however, non galvanized ones may be used but only if they are not corroded. Sprayed concrete shall be mixed according to the formula set by the authorized body. Mortars of class PC25 or PC35 meeting the requirements of HRN B.C.1.011 norm. The sand and aggregates should have the appropriate granule composition, clean and with no harmful admixtures. The water must be chemically pure, suitable for concrete works. Sprayed concrete must have a proper consistency. A layer of sprayed concrete shall be applied with a special machine.

Prior to the commencement of protection work, the Contractor shall obtain required quality documentation for all construction materials as well as the working formula for the mixes in accordance with requirements referred to this Technical Specifications and present them to the Engineer in the original for review and [consent] approval.

Execution

Prior to the commencement of protection, the rocky slopes shall be regulated according to design or [request] instructions of the Engineer, by removing all unstable, major rough parts and dust.

The mesh shall be fixed to the slope with anchor wire built into sound rock by bored holes of Ø 32mm and about 0.20m of depth. Anchor wires shall be placed in such holes so that both ends stick out, and the wire shall be fixed with cement mortar based on quick-setting cement. Sprayed concrete of the proper thickness as per design but of no less than 30mm shall be applied with a machine to the prepared substratum with fixed wire meshes.

The executed protection shall be cured for 7 days, by watering or coating with verified chemicals that prevent evaporation from the layer, and the quality control shall be carried out in accordance with these Technical Specifications.

The application of such chemicals shall be approved by the Engineer on the basis of documents on quality obtained from the competent body.

On slopes where rocks have only surface cracks, this protection shall be carried out without the wire mesh, and the thickness of the sprayed concrete shall be about 30mm.

Quality control

Quality control of basic materials, injection mortar, sprayed concrete and built in layer of sprayed concrete shall be performed fully in accordance with these Technical Specifications.

Measurement

The protection of slope with sprayed concrete shall be calculated in square metres of a specified thickness, for actual work performed and approved by the Engineer, and paid at agreed unit prices.

The unit price shall include the procurement and fitting, as well as all work and material described in this sub-section, depending on the layer thickness, work technology, needed transport and carriage, scaffolding, curing and possibly difficult working conditions.

5.6.9 Protection of slopes by fixing individual blocks

Description

The work involves protection of slopes made of rock by fixing individual unstable blocks with anchors, on surfaces with unfavourable geological, hydrological and geo-mechanical properties, specified in the project or as per Engineer's [request] instructions.

Material

This type of protection requires anchors and injection cement mortar. Material quality and formulation of cement mortar shall be proven with appropriate documentation of the competent body that the Contractor shall present to the Engineer in the original for inspection and [consent] approval.

Anchors shall comply with the HRN requirements for steel, and be made of ribbed steel Ø 16, 19, 22, and 25mm or use patented anchor (Perfo, Dibel rock anchors, Williams's hollow, BBRV, Polensky and Zöllner, IMS etc.)

Anchors shall be placed in the previously bored holes and fixed with cement mortar. Cement mortar also serves as an anti-corrosion protection. To increase viscosity of the mix, cement mortar shall be prepared with expansive cement and with inhibitors.

Execution

This protection shall be carried our according to the description and conditions set forth in the design. The work involves placing appropriate anchors into previously bored holes to secure individual unstable blocks. The fitted anchors shall be tested for tensioning by a competent body according to appropriate norms for such materials and purpose, and according to the quality criteria from the design and these Technical Specifications.

Measurement

The slope protection by fixing individual blocks shall be calculated in meters of length of embedded anchors of specific profiles as approved by the Engineer, and paid at agreed unit prices.

Unit price shall include procurement, boring and fitting anchors and all materials and works needed for such type of protection, described in this sub-section.

5.6.10 Protection of slopes with geomeshes

Description

The work involves protection of slopes, cuts and embankments with geomeshes as the reinforcement of topsoil, which reduces the thickness of topsoil (topsoil thickness is 5 cm) and increases friction on the contact plane and erosion protection and grassing of steep and high slopes of embankments and cuts, as indicated in the Design or as directed by the Engineer.

Materials

Types of materials with technical properties of geomeshes are given. in table .

Execution

The substratum on which the meshes are to be laid shall be executed without rough spots. The mesh shall be fixed to the slopes of embankment or cuts with U/V shaped anchors (wedges).

The distance between anchors shall be determined on the basis of the following parameters: height and gradient of the slope, tape of material of the slope, load, etc.

The usual number of anchors (wedges) is 4pcs./m2 , and they are made of reinforced steel of 6-0mm in diameter, 50cm length, pointed at the end for easier fixing to the sub-stratum. Canals shall be excavated on the top and bottom of the embankment or cut.
Laid geomesh shall be fixed in the canal with wedges and unrolled down the slope and fixed with wedges at every 2-3m for better contact between the soil and the geomesh.

The geomesh shall be cut to a desired length (with scissors or cutter) prior to anchoring in the bottom canal.

Laid meshes must overlap by at least 10cm along their length (vertical) and 5 cm along their width, and the wedges shall be hammered in at approximately 1.5m distance.

The anchoring canals may be filled with excavated material, and it is possible to fill them with concrete or stone.

After that, the geomesh shall be covered and completely filled with topsoil material, there should be about 10mm of topsoil left on top of the geomesh.

The grass shall be dispersed over the surface in the amount of 50g/m2 or hydroseeding shall be performed.

Quality control

Quality control shall be performed in accordance with these Technical Specifications.

Measurement

The surface covered with geomesh shall be paid at unit price for a square metre [set forth in the contract documentation] completed in accordance with the Design, these Technical Specifications and as approved by the Engineer.

The unit price shall include the procurement and fitting and all the work described in this sub-section as well as the necessary materials and transport.

5.6.11. Trees and shrubs planting

Description

Trees and shrubs planting shall be carried out within the landscaping in accordance with the Design proposal during afforestation of road areas: cuts, side cuts, embankments, green areas and around the objects next to the road area.

This project encompasses digging of holes, rubble disposal, transport of fertile soil, planting trees, anchoring tree-trunks, watering seedlings on the areas defined by the design.

Materials

Tree and shrub seedlings shall be well-developed, with properly developed root systems and over-ground parts, without phyto-pathological diseases or entomological damages, aged between 10 and 12 years (for trees), and between 4 and 6 years (for shrubs). The selection of planting material must be adjusted to existing microclimate and pedological habitat conditions. Preference should be given to domestic autochthonous species and variances, as well as allochthonous species resistant to negative biotic and abiotic factors.

Planting material transported from a nursery should be kept in adequate manner from the moment of planting.

For thermal insulation, seedlings with baled turf should be put into a pit, and container seedlings should be covered with straw or jute bags. To prevent the drying of turfs, seedlings should be occasionally watered.

Planting seedlings with turf must be done during the rest period of vegetation. Container seedlings should be planted during the whole year.

Work procedure

Planting holes shall be dug in the geo-mechanically stable substrates.
Dimensions of the pits for planting, according to the greenery categories, dimensions of planting holes shall be:

- for deciduous and coniferous trees 0,80x0,80x0,80
- for shrubs and flattened conifers 0,40x0,40x0,40

Planting holes, having been dug, are filled with a mixture of humus and organic fertilizer, or a humus mixture with chemical (starting) fertilizer added. Organic fertilizer shall be added in the ratio of 1:4 (one part of organic fertilizer to four parts of humus). Chemical fertilizer NPK (15:17:24) in the ratio defined in the Manufacturer's instruction.

While planting trees, right before putting a seedling into a hole, it shall be required to trim back the damaged roots and corona proportionally.

After the planting, fully-grown tree-trunks shall be anchored, and then watered by mild spout, so that the water can get to every part of a root system. Minimum water quantity used for watering replanted trees shall be 45-60 litres per seedling, and for shrubs – 30 litres per seedling.

Planting density according to the green categories:

- lower deciduous shrubs – 1 to 2 seedlings per m²
- higher deciduous shrubs – one seedling per 2m²
- coniferous shrubs – one seedling per 1,5 to 2,5 m²
- low deciduous trees – one seedling per 2-3 m²
- medium deciduous trees – one seedling per 3-5 m²
- high deciduous trees – one seedling per 5-7 m²
- low conifers – one seedling per 3-5 m²
- high conifers – one seedling per 5-7 m²

A proposal for planting density shall be made by the Designer in accordance with biological characteristics of the suggested plant species and ground properties.

If a planting material is smaller and younger, and having all characteristics required in these technical conditions, Engineer may take a decision to increase a planting density, in order to achieve the purpose of the Design task.

Quality control

Complete planting material must have a health certificate.

Green areas, made by planting trees and shrubs, should be maintained regularly: by watering, earthling up if necessary, pruning and fertilizing. Dried or damaged plants should be replaced with healthy and regular ones.

Engineer shall be required to control the health of plants, the seedlings preservation until the moment of planting, the regularity of planting process and plant nursing measures.

Measurement

Planting of trees and shrubs shall be measured according to the operation that is actually carried out and approved by Engineer and shall be paid by Contract Unit Prices. The Contract Unit Price shall include: purchase of plants, transport, storage of plants, digging of planting holes, removal of rubble, filling the holes with humus mixture, planting, anchoring, watering plants and all required labour as described in this paragraph.

5.7. Lining of Slopes with Stone

5.7.1. Scope and Contents of Works

This work include the lining of slopes, rock embankments, and hill sides, in a 30 cm thick layer, with selected stone, as a substitute for humification of slopes on rock embankments and hill sides. This work may be undertaken using other methods and materials, as proposed by the Contractor subject to approval by the Engineer.

The lining of slopes of earth embankments with stone or concrete is covered under Sub-Section 8.3.3.6. of these Specifications.

5.7.2. Material

Undressed stone from excavation on the road route may be used for lining, if such stone meets requirements. The size of blocks shall be 20-30 cm.

5.7.3. Execution of Works

Lining shall be performed at the same time with the construction of embankment, with stones laid accurately in the cross-section of embankment, as defined in the design and marked on the site with the construction cross-section. Each stone shall have a secure bearing and be fixed, so that the slope cannot possible collapse due to instability of some stone blocks, or for any other reasons whatsoever. The foot of a lined slope or hill side shall be firmly built into a sound substratum, and constructed in such a way that the lining cannot collapse under atmospheric influences or any other harmful actions.

The end of lining on the top of slope shall be constructed in a good quality, so that any damages to shoulders and similar are impossible to occur.

The work includes all transport, selection, laying, and fixing of stones.

5.7.4. Quality

Quality requirements are such that the surface shall meet requirements from the design with respect to the gradient of shaped slopes, and subject to the approval of the Engineer.

Any variation from foreseen surfaces in the design may be allowed within the limits of a visual accuracy between particular construction cross-sections that must be set according to Sub-Section 2.2. of these Technical Specifications and subject to the approval of the Engineer.

5.7.5. Slope Protection for Embankments made of Stone Material

These Technical Specifications and the Design allow for the slopes of embankments made of stone material to be lined with stone or concrete. Since this procedure may be difficult at some locations , this Sub-Section provides for the Contractor to propose variant solutions as follows, subject to the approval of the Engineer, but all expenses resulting from such solutions shall be borne by the Contractor.

To humify and grass slopes of low embankments, with this being obligatory in places where climatic conditions allow effective humification and grassing.

To shape and secure slopes of high embankments so that they allow the runoff and prevent the erosive action of surface water. The basic objective is to make slopes stable and to fix all unstable rocks in an adequate way (by garreting, etc.). Besides, on very high embankments, on the downstream side, a raised monolithic concrete kerb shall be constructed according to details from the design, or a raised kerb with a half-gutter.

In that case, shoulders shall be constructed at the level of the upper edge of raised kerb and from rock material mixed with earth, compacted at 40 MPa.

To ensure the road drainage, channel pipes shall be set along the embankment slope (in the form of segment or similar) on the downstream side.

The Contractor's proposal regarding the method of protection shall be subject to approval by the Engineer.

5.7.6. Measurement

This work shall not be measured.

5.7.7. Payment

This work shall not be paid extra, as it is already included in the unit price for construction of embankment.

Section 6
Sub-base layers

Contents

6.1. Sandy-gravelly materials – construction of subgrade

6.1.1. Description and Objective

The subgrade layer is the top layer of roadbed, made of selected material and constructed in a cut or over an embankment. Depending on material in the cut, the subgrade can be made of local soil, or local soil of inadequate properties shall be excavated and replaced with appropriate material, with prior treatment of subsoil in the cut.

Over the subgrade layer goes the sub-base of pavement structure.

This item includes the procurement of material of adequate quality, haulage to the site, levelling, and compaction according to levels and gradients specified in the final design. Depending on physical properties of material, the item includes any wetting or drying of hauled and spread material before its compaction. The item also includes any replacement of subgrade in the cut, if local soil has inadequate physical and mechanical properties.

6.1.2. Execution of Works

The works on construction of this layer may start only when a lower layer, by height level, has been prepared and approved by the Engineer. The works shall not be executed over a frozen underlying layer.

* Subgrade on Embankment

The layer is constructed by dumping material over the end, so that trucks that haul the material to the site do not run over the underlying layer. For the compaction of subgrade layer made of cohesive soil, it is necessary to use sheepsfoot rollers, and the surface of layer shall be closed with light smooth steel rollers. It is necessary to achieve the compaction degree Sz≥100% for the Standard Proctor Test.

For the compaction of a subgrade layer made of sand or gravelly material or rock debris, it is necessary to apply the equipment for compaction of non-cohesive material (vibro roller, vibro plates, static rollers). It is necessary to achieve the compaction degree Sz≥95% for the Modified Proctor Test.

The compaction of subgrade layer shall start from the higher edge toward the lower edge by their height level on the cross section, with the compaction equipment going longitudinally with overlapping.

* Subgrade on Soil

Local Soil of Favourable Properties

On the part of road route where the subgrade is on existing ground made up of cohesive soil that meets the quality criteria for subgrade, the subgrade shall be made of local soil (levelling and compaction).

The technology for preparation of subgrade is directly related to the natural moisture in the period of works and the type of soil. Preliminary soil investigations identified a high natural moisture content in soil comparing to an optimum moisture for the compaction of silts and clays. Climatic features of the season during which the works will be executed may result in soil moisture considerably lower than the one identified during soil investigations, i.e. the moisture close to the optimum one. Therefore it is preferable to execute this item of works in a summer and dry period.

In the light of everything mentioned above, with the aim of selecting a work technology, it is necessary that the field soil mechanics laboratory identifies, immediately upon the commencement of earth works, the natural moisture of soil at the subgrade level, and to confirm, or amend, statements on the type of silty-clayey soil and its physical and mechanical properties specified in the pavement structure design. Based on these indicators, the Contractor shall apply an adequate work technology, i.e. the technology recommended in these Technical Specifications, or technology proposed by the Engineer and the soil mechanics laboratory, or technology proposed by the Contractor and approved by the Engineer.

If silty-clayey soil has a higher moisture content comparing to an optimum for the compaction of soil, and as assessed by the soil mechanics laboratory the soil can be dried under favourable climatic conditions (summer, dry period), it is necessary to apply the following work technology in a hot and dry period:

a) Construction of temporary canals to receive and drain any rainwater;
b) Soil ripping with a bulldozer equipped with a special plough blade as an implement or with a tractor-drawn plough, to the depth of at least 30 cm;
c) Loosening of ripped – ploughed soil with disc and spading machines;
d) Due to a risk of rain, at the end of work day, the surface shall be lightly levelled and rolled with a crossfall toward temporary canals;
e) On the next work day, the steps b, c, and d shall be repeated;
f) Final levelling (levels and gradients as per the design) and compaction with sheepsfoot rollers shall star, and after achieving the required compaction the surface shall be closed with light static rollers; temporary ditches shall be backfilled and the soil compacted immediately before the construction of pavement structure layers.

The compaction of subgrade layer shall start from the higher edge toward the lower edge by their height level on the cross section, with the compaction equipment going longitudinally with overlapping.

Local Soil of Favourable Properties, but with High Natural Moisture Content

If the silty-clayey soil has a higher moisture content comparing to an optimum for soil compaction, and as assessed by the soil mechanics laboratory the soil cannot be dried under favourable climatic conditions (summer, dry period), it is necessary to compact the soil with the natural moisture content and achieve a maximum compaction with the standard compaction energy (defined with the Proctor test curve). It is necessary to achieve the compaction degree Sz≥97% for the Standard Proctor Test. The surface of subgrade layer compacted in this way shall be covered with "filter plastics – geotextile", type ≥250 g, according to the Manufacturer's instructions. Locations with subsoil prepared in this way shall be precisely defined and noted down in the construction records on the execution of works.

The compaction of subgrade layer shall start from the higher edge toward the lower edge by their height level on the cross section, with the compaction equipment going longitudinally with overlapping.

Local Soil of Unfavourable Properties

On the part of road route where the subgrade is on existing ground with identified, by the field soil mechanics laboratory, places or stretches with clayey silt of uniform granulometric composition (U<9) and low bearing capacity (CBR_{lab}≤3%), it is necessary to excavate and replace the soil in thickness as per the design. The bottom of excavation in such type of soil shall be levelled in order to form a gradient as design for the subgrade and just lightly rolled to make a relatively flat surface. Such surface shall then be covered with "filter plastics - geotextile", type ≥250 g, according to the Manufacturer's instructions. The geotextile shall be spread with a substitute material for subgrade dumped over the end.

For the compaction of substitute material made up of sand or gravelly material, or rock debris, it is necessary to apply compaction devices for non-cohesive material (vibro roller, vibro plates, static rollers). It is necessary to achieve the compaction degree Sz≥ 95% for the Modified Proctor Test.

The compaction of subgrade layer shall start from the higher edge toward the lower edge by their height level on the cross section, with the compaction equipment going longitudinally with overlapping.

6.1.3. Material for Construction of Subgrade

Only previously tested material that meets the quality criteria may be applied for the construction of subgrade layer on embankments or in cuts (on existing ground), or substitute layer for subgrade in cuts (on existing ground).

Testing Standards

The testing of physical and mechanical properties of materials for subgrade shall be performed in compliance with the following standards:

SRPS U.B1.010 - Sampling
SRPS U.B1.012 - Determination of soil moisture content
SRPS U.B1.014 - Determination of specific gravity
SRPS U.B1.016 - Determination of bulk density of soil
SRPS U.B1.018 - Determination of granulometric composition
SRPS U.B1.020 - of limits of liquidity and flattening
SRPS U.B1.024 - Determination of content of combustible matter in soil
SRPS U.B1.038 - Determination of optimum water content
SRPS U.B1.042 - Determination of California Bearing Ratio

Tests shall be performed for every change in material and/or at least once at every 1000 m^2 of subgrade.

6.1.4. Quality Assessment Criteria for Subgrade Material

Local soil or material from borrow pits to be used to construct the subgrade shall have the following physical and mechanical properties:

- Maximum bulk density according to the Standard Proctor Test ≥1.60 t/m^3;
- Moisture content in material shall be close to an optimum moisture and (W_{opt}±2%), i.e. the required compaction degree should be achievable during compaction;
- Liquid limit W_l<55%
- Plasticity index Ip<20%
- Degree of non-uniform grain size distribution U>9
- Content of organic matter <6%, uniformly distributed
- Laboratory California Bearing Ratio value CBR≥8% at the compaction degree Sz=100% for the Standard Proctor Test, and swelling <3 %.

A substituted subgrade layer shall be constructed using sand or coarse-grained non-cohesive material (rock debris or sandy gravel) that meets the following criteria:

* Criteria for Sand
  - Non-plastic sand;
  - Degree of non-uniformity of grain size distribution U≥9;
  - According to AASHTO classification of soil, material shall belong to Class A3;
  - Laboratory California Bearing Ratio value shall be CBR≥15% at the compaction of 100% for the Standard Proctor Test.
* Criteria for Gravel and Rock Debris
  - Index of plasticity for silty fractions Ip≤6%;
  - Degree of non-uniformity of grain size distribution U=15-100 for sandy gravel, and/or U=15-50 for rock debris;
  - The largest grain shall not be larger than 100 mm;
  - According to AASHTO classification of soil, material shall belong to Class A1-a or A1-b;
  - Laboratory California Bearing Ratio value shall be CBR≥20% at the compaction of 95% for the Modified Proctor Test.

6.1.5. Control of Constructed Subgrade

Control of Material

The control of material hauled and spread on the roadway shall be conducted at least once at 1000 m^2 according to the following standards:

- Natural moisture SRPS U.B1.012
- Specific gravity SRPS U.B1.014
- Granulometric composition SRPS U.B1.018
- Consistency limit SRPS U.B1.020

Material shall meet quality criteria and results of prior tests specified in the previous Sub-Section.

6.1.6. Compaction Control

The control of compaction shall be performed by testing the dry bulk density of a compacted layer and comparing it with a maximum dry bulk density defined by the Proctor Test. Tests shall not be performed on a frozen layer. This test shall be performed at least once at every 30 м[1] according to the following standards:

- Sampling SRPS U.B1.010
- Determination of soil moisture content SRPS U.B1.012
- Determination of bulk density SRPS U.B1.016
- Determination of modulus of compressibility by round plate bearing test SRPS U.B1.046

It is necessary to reach the compaction degree Sz≥100% for the Standard Proctor Test in case of fine-grained cohesive material, and Sz ≥95 % for the Modified Proctor Test in case of coarse-grained non-cohesive material.

The criteria for a required modulus of compressibility shall be defined on a test section, while determining relations between a required degree of compaction and the modulus of compressibility, for actual conditions regarding moisture content and interaction of layers. The criteria for every typical stretch shall be created by a commission composed of the Engineer, the Contractor, and the representatives of control laboratory, based on tests performed on test sections.

The test results from test sections, and modifications in compaction evaluation criteria shall be recorded by the Engineer in the Building Journal.

Any repeated tests due to unsatisfactory results shall be at the Contractor's expense.

Control of Evenness and Level of Surface of Constructed Layer

The control of evenness shall be performed in any place selected by the Engineer, but the least frequency of test points shall be at every designed cross sections. When measuring with a 4m long levelling staff in any direction, a maximum variation below the staff may be 2 cm.

The control of levels of subgrade surface shall be performed at every designed cross sections, but, besides, it is possible to carry out control at any other place as selected by the Engineer. The allowable variation of constructed levels from the designed ones is -2 cm and/or +1 cm, provided that the designed cross fall has been provided.

6.1.7. Calculation of Works

Measurement:

Executed work, previously checked and accepted by the Engineer, shall be measured in m^2.

Payment:

Previously accepted and calculated executed work, shall be paid at unit prices from the contract per square metre (m^2) of constructed subgrade layer.

6.2. Construction of Sub-base Layer from Crushed Stone 0/31 mm and 0/63 mm, Mechanically Stabilized

6.2.1. Description

This item includes the procurement, haulage, placement, rough and fine spreading, watering if needed, and compaction of a sub-base layer made of crushed stone material, as per dimensions given in the design.

6.2.2. Work Execution

The work shall be executed in one or two layers depending on machines. Material shall be spread longitudinally at the same gradient as the formation level. When speaking of cross section, the layer shall have the crossfall of the present formation level, i.e. as needed for rainwater drainage.

The layer shall be compacted in full width (i.e. carriageway width) with appropriate compaction equipment. Compaction shall be performed from a lower edge to a higher edge.

Sub-base material shall neither be embedded over a frozen surface, nor over a layer of snow and ice.

6.2.3. Quality Control of Material for Sub-base Layer Made of Crushed Stone

Crushed rock aggregate shall be used to construct a lower sub-base layer. Quality control at preliminary tests shall be performed according to the following regulations:

SRPS B.B0.001 – Natural aggregate and stone, sampling
SRPS B.B8.012 – Natural stone, compressive strength tests
SRPS B.B8.010 – Determination of water absorbed by natural stone
SRPS B.B8.002 – Testing of stone for frost resistance
SRPS B.B8.045 – Testing of stone and rock aggregate for resistance to wear according to the Los Angeles method.
SRPS B.B8.037 – Determination of friable grains in coarse-grained aggregate
SRPS B.B8.047 – Definition of shape and surface appearance of grains in rock aggregate
SRPS B.B8.048 – Testing of shape of grains in rock aggregate
SRPS U.B1.018 - Determination of granulometric composition as per Section 5 Determination of particles of 0.02mm in size by hygrometry (or according to YUS B.B8.036)
SRPS B.B8.036 – Determination of the particles in aggregate that pass through a screen with 0.02 mm mesh (the applicable procedure is the one from this SRPS)

SRPS B.B8.038 - 1.5.52 Content of clay and muddy components
SRPS B.B8.031 – Absorption of water by aggregate
SRPS B.B8.030 – Bulk density of aggregate with pores and voids (in compacted and loose condition)
SRPS B.B8.032 – Bulk density of rock (with and without pores and voids), rock porosity and density
SRPS U.B1.012 – Determination of moisture content
SRPS U.B1.016 – Determination of bulk density of soil
SRPS U.B1.038 – Determination of optimum water content
SRPS U.B1.042 – Determination of California Bearing Ratio

Tests shall be performed for any change in material.

6.2.4. Criteria for Quality Assessment of Sub-Base Material

Crushed stone aggregate composed of grains of crusher-run stone, chippings, sand, and fill material shall meet certain requirements regarding:

- Physical, mechanical, mineralogical, and petrographic properties of stone itself and rock aggregate;
- Granulometric composition of entire material ;
- Load-bearing capacity;
- Content of organic matter and light particles.

Crushed material for mechanically stabilized lower sub-base layers shall be composed of grains that meet the following requirements:

6.2.4.1. Physical and Mechanical Properties of Stone

Mean compressive strength(MPa)
- in dry condition min 120

Water absorption (% by mass) 1.0

Frost resistance (after 25 cycles of freezing)
(Stone is resistant to frost if the drop of mean compressive strength after freezing is up to 20% comparing to mean compressive strengths in dry condition).

Mineralogical / Petrographic Composition

Stone may be of eruptive, sedimentary, or metamorphic origin.

6.2.4.2. Physical and Mechanical Properties of Crushed Rock Aggregate

- Grain shape, proportion of grains of unfavourable shape (3:1)...................................... max 40%
- Water absorption (SRPS B.B8.031).................. max 1.6%
- Friable grains.. max 7%
- Resistance to wear, Los Angeles method .... max 40%
- Content of muddy-clayey and organic particles... max5%

Note: For unscreened rock material, the specified limit values for: the proportion of grains of favourable shape; the proportion of friable/poor quality grains; water absorption; and the loss at Na_2SO_4, are calculated as the percentages of mass on separated laboratory fractions, i.e. as the proportion of grains larger than 4 mm.

For screened rock material, the specified limit values are expressed as the percentages of mass on the tested – nominal fraction.

The granulometric composition of crushed rock aggregate for the sub-base layer, 0/31mm fraction, shall be within the following limit curve values

Square sieve size (mm)	% of weight in relation to total weight of material 0/31 mm
0,1	2-9
0,2	5-14
0,5	8-20
1	11-30
2	15-40
5	25-55
10	30-65
20	60-80
31,5	100
50	

The granulometric composition of crushed rock aggregate for the sub-base layer, 0/63mm fraction, shall fall within the following limit curve values:

Square sieve size (mm)	% of weight in relation to total weight of material 0/63 mm
0,125	2-15
0,25	5-20
0,5	7-26
0,71	9-30
1	11-34
2	18-44
4	26-56
8	36-69
16	50-85
22,4	59-93
31.5	71-100
45	85-100
63	100

Aside from the above-mentioned criteria, the material shall also meet the following requirements:
- The content of grains smaller than 0.02 mm shall not exceed 3%
- The degree of non-uniformity in granulometric composition U=15-50.

From the aspect of load-bearing capacity, the aggregate shall have the laboratory California Bearing Ratio CBR=80% at the compaction degree Sz=95% for the Modified Proctor Test, and an optimum moisture W_{opt} =7-9%.

The content of organic matter and light particles shall not exceed 3% by weight.

6.2.5. Control of Prepared and Compacted Sub-Base Layer

The control of a prepared and compacted sub-base layer shall be performed by determining its degree of compaction or modulus of compressibility at every 500 m^2. If the determination of the compaction degree and the modulus of compressibility are performed in parallel, tests shall be run at every 50 m.

The tests shall be performed in compliance with the following regulations:
SRPS U.B1.010 - Sampling
SRPS U.B1.012 – Determination of moisture
SRPS U.B1.016 – Determination of bulk density

The sub-base surface shall be checked in relation to designed levels, and also for evenness.

6.2.5.1. Work Quality Evaluation Criteria

Depending on the pavement structure design solution, the following criteria shall be met:

Thickness of sub-base made of crushed stone (cm)	Required degree of compaction Sz for the Modified Proctor Test, Sz (%)
30	98%

When placing this material over a hard substrate, it is necessary to adjust compaction equipment, i.e. vibrations, to such conditions so that aggregate would be compacted to a required degree.

Any repeated tests due to unsatisfactory results, shall be at the Contractor’s expense. The sub-base surface levels on randomly chosen places may vary by ±10 mm.

The evenness of surface shall be measured with a rope or crosses at randomly chosen places, and variations from the measure plane may be 10 mm at most in any direction.

6.2.6. Measurement and Payment

Payment shall be made per m^2 of an actually prepared, compacted sub-base layer, as approved by the Engineer.

6.3. Sub-base Layer Made of Crushed Stone 0/31.5 mm, Cement Stabilized

6.3.1. Description and Objective

This item includes the procurement of material, mixing, haulage, spreading, compaction, and curing of a layer of designed thickness, according to requirements of these Specifications and the design. The sub-base layer made of cement-stabilized material shall be placed using finishers in its full width and thickness, thereby achieving a proper height of the layer and its preliminary compaction. The material to be placed shall be produced in central plants with automatically controlled batching of all basic materials.

6.3.2. Basic Materials

The basic materials are:
- Crushed rock aggregate
- Portland cement, grade as defined in SRPS B.C1.011 and/or SRPS B.C1.012
- Construction-grade water
- Protection of a constructed layer with a semi-stable bituminous emulsion (PE) defined as per SRPS U.M3.020.

An approximate percentage of materials to be added for the construction of sub-base is:

- Portland cement PC 25 ....3-6%
- Water 5-7%

Granulometric Composition

The granulometric composition of mineral mix is specified in the design and shall be within the following limit range for the types A and B:

Sieve size, mm	Percentage passing through, %	
	Type A	Type B
0.1	3-25	0-12
0.2	7-32	2-18
0.5	12-45	5-27
1	17-57	8-36
2	24-70	14-47
4	32-84	21-60
8	44-100	33-73
16	60	49-90
31.5	100	75-100
50		100

Physical and Mechanical Properties of Stone

- Grain shape, proportion of unfavourably shaped grain (3:1) max 40%
- Water absorption (SRPS B.B8.031) max 1.6%
- Friable grain max 7%
- Resistance to wear, Los Angeles method max 40%
- Frost resistance, Na2SO4
  Mass loss after 5 cycles max 12%
- Content of muddy-clayey and organic particles max 2%

Optimum Moisture and Maximum Dry Bulk Density with Added Binder

A sample of crushed stone aggregate with the addition of an approximately expected amount of binder shall be compacted with energy for the Modified Proctor Test (2.66 MNm/m^3). The test result is optimum moisture, and/or the amount of water in the sample that enables a maximum compaction of the stabilized mix for the given energy. The stabilized mix of crushed stone aggregate shall be embedded into the sub-base layer at optimum moisture increased by 1%. A maximum dry bulk density obtained according to the Modified Proctor Test is used as a parameter when determining the degree of compaction of embedded material.

6.3.3. Quality Requirements for Used Materials

6.3.3.1. Quality Requirements for Cement

Pure Portland cement is used as binder, with the addition of pozzolan or slag class 25, 35, and 45. Used cements shall be in compliance with SRP Standards, as follows:

SRPS B.C1.011 – Portland cement, Portland cement with additives, metallurgical cement, pozzolanic cement, composite cement

SRPS B.C1.012 – Cements. Method of packaging, delivery, storage, and sampling.

All binder samples are tested for the following properties:

- Standard consistency
- Time of setting
- Soundness
- Sieve residue
- Compressive strength (for cement classes 25 and 35 after 7 and 28 days, and for cement class 45 after 3 and 28 days).

6.3.3.2. Quality Requirements for Water

Water that meets the following requirements shall be used:

- pH higher than 6
- The content of sulphates (SO_3) lower than 2700 mg per 1 l of water
- The content of chlorides (Cl) lower than 300 mg per 1 l of water
- The indicator of organic matter expressed as consumption of potassium permanganate ($KMnO_4$) using the method of oxidation is lower than 200 mg per 1 l of water
- Total salt content, expressed as dry residue, is lower than 5000 mg per 1 l of water. Drinking water or water from the mains can be used without testing.

6.3.3.3. Quality Requirements for Cement-Stabilized Mix

Cement-stabilized mix is tested for the following properties:

- Determination of uniaxial – compressive strength according to SRPS U.B1.030
- Testing of cement-stabilized soil for frost resistance according to SRPS U.B1.050

The mix shall meet the following requirements:

Layer	Compressive strength of stabilized mix (MN/m^2)	
	after 7 days	after 28 days
Pavement structure sub-base for motorways and very heavy traffic load	2.0 – 5.5	3.0 – 6.0
Pavement structure sub-base for heavy and medium traffic load	1.5 – 5.5	2.5 – 6.0

These requirements apply to cement classes 25, 35, and 45 (SRPS B.C1.011).

A cement-stabilized mix, aside from the above-mentioned compressive strength, shall also be frost resistant. The compressive strength reduction index according to SRPS U.B1.050 may be at least 80%.

6.3.4. Documents for Preparation of Preliminary Mix Design

In accordance with Sub-Section 5.3, and/or conducted quality control of rock aggregate, cement, water, and mix of these materials, a preliminary mix design is issued for the construction of sub-base from cement-stabilized rock aggregate. The preliminary mix design serves as laboratory proof that, with approved materials and designed mix composition, it is possible to achieve the quality of mix as set in these Technical Specifications.

The preparation of mix according to the preliminary mix design shall be such that any minor variations in the quality and proportion of component materials during production do not have a considerable effect on physical and mechanical properties of the mix.

The preliminary mix design determines:
- The granulometric composition of basic, non-bound, rock aggregate,
- The proportion of basic, non-bound, rock aggregate,
- The proportion of a binder (cement),
- The proportion of water,
- An optimum moisture content and a maximum dry bulk density of the mix,
- The compressive strength of mix after 7 and 28 days, and
- The resistance of mix to frost and thaw.

All tests necessary for the preparation of a preliminary mix design shall be conducted according to SRPS U.E9.024, and the test results shall be shown in a report (preliminary design for the preparation of a cement stabilization mix). In case of any crucial change in the properties of any of component materials, the location of a borrow pit for basic, non-bound, rock aggregate, or the producer of a binder, a new preliminary mix design shall be prepared.

Before starting to construct this layer, the Contractor shall provide from the authorized laboratory all compliance certificates for designed component materials and the mix design for the approval of the Engineer.

6.3.5. Production and Placement

The stabilization technology shall be prepared in the central plant. Necessary production phases are:
- Mixing of the basic material with a binder and water in a stationary plant
- Transport of the determined mix to a prepared substrate, and its spreading
- Compaction of the spread mix
- Finish treatment of the stabilized layer
- Protection and curing of the completed structure.

For mixing in a central place, bunker or continuous concrete mixers are required. Related installations and equipment for handling the basic material and for precise batching of cement and water shall be provided within the stationary plant. The quantities of materials, binder and water shall be batched by their weight proportions. A minimum mixing time is about 30 seconds after feeding all component materials into the mixer. Mixed material is spread with appropriate spreaders or modern finishers. Dumping mixed material on piles and subsequent spreading are not allowed. A fresh mix shall be spread in full width at once, with one or more spreaders.

6.3.6. Compaction of Stabilized Layers

Immediately after obtaining a satisfactory mix with optimum moisture, it should also be compacted to a required degree that corresponds to 98% of a maximum laboratory compaction for the modified procedure. The stabilizing mass is compacted with vibro rollers and rollers with rubber wheels, separately or combined. The layer shall be compacted uniformly and carefully over its entire surface.

The compaction work shall be organized in such a way to avoid any longitudinal trails. During compaction, the mass shall have suitable moisture content. The range of moisture content is:
W = Wopt + 2%
where:
W – working moisture during compaction
Wopt – optimum moisture according to working mix design.

The time from mixing the stabilization mass to its final compaction shall be 2 hours at most.

6.3.7. Finishing

Several methods for finishing a completed stabilization surface are allowed, depending on the type of employed machines, site conditions, and characteristics of basic material. Regardless of methods used to assure the quality of surface, the requirements that shall be met are to achieve required compaction, and to eliminate any trails from compacting machines on the stabilized surface. The surface shall be flat, compacted, and free from any projections and cracks.

6.3.8. Execution of Construction Joints

After completed daily stabilization work, a transverse, vertical, construction joint shall be executed by cutting into the previously stabilized layer at its end. This shall be done as the last operation at the end of work day, or as the first operation at the beginning of the next day.

Protection and Curing of Constructed Sub-Base Layer

Immediately after completing the stabilization work, it is necessary to protect the structure, and prevent the evaporation or sudden drying of the mix.

Special care is required in hot weather. In any case, the layer shall be kept wet for at least 7 days.

The layer may also be protected by watering its surface, and then spraying it with bituminous agents (bituminous emulsion, diluted bitumen) in the amount needed to for an impermeable film, usually 0.5 – 1.0kg/m^2, which shall be done for three days. After the layer has been constructed, it shall not be open to any traffic for 7 days, nor shall any new stabilization layers and pavement structure be constructed on it. In case of a freezing hazard in winter, the stabilized sub-base shall be covered with other layers of pavement structure.

6.3.9. Weather Conditions

Rain

In case of rain while spreading the binder during stabilization, the spreading shall be immediately stopped on the site, the spread binder embedded into the mass as fast as possible, and the final mixing and completion of the stabilization process resumed when rain stops.

Performed and completed cement stabilization is later not affected by rain. In case of preparing stabilization in the central plant, and spreading it with the finisher, it is necessary to envisage protection of the spread layer with plastic foils or other suitable means.

Cold Weather

Stabilization shall not be carried out at temperatures below 5^{o}C. It is necessary to protect a stabilized layer against freezing for a 7-day period. The protection shall be carried out by covering the surface with a suitable cover.

Stabilization shall not be carried out if the layer below it is frozen, and stabilizing mixes shall not be produced from frozen basic materials.

6.3.10 Control Tests

Control tests during the stabilization of the basic material with cement or other similar hydraulic binders include:

- Prior tests
- Control tests

Prior tests imply

- Performing all prior tests of component materials and preparing a preliminary work mix in laboratory conditions;
- Transferring the preliminary work mix to stabilization machines and determining the required work mix composition in working conditions;
- Determining and adopting a stabilization technology on a test section.
- Submitting all test results and technology proposals to the Engineer for approval

Transferring Results of Preliminary Work Mix to Machines on Site.

When transferring results of a preliminary work mix to machines on the site, accurate weight ratios for batching individual component materials shall be determined. In this process, the current moisture of basic material used for work shall be taken by adding only the difference in the amount of water needed for the mix to fall within specified moisture content limits.

Fresh mix samples are taken from trial production and tested in order to confirm their required stabilization properties. At least three mix samples shall be tested, by controlling their:

- Granulometric composition
- Uniaxial – compressive strength with tubes previously cured for 7 days in a wet chamber.

If these tests give the results that match with the laboratory findings, stabilization may be performed subject to the approval of the Engineer.

If this compliance is not achieved, necessary adjustments shall be performed before starting the work.

The contractor engaged for stabilization work shall constantly maintain the adopted work mix throughout his work on the site.

Determination of Work Technology on Test Section

A test section should have an area of at least 600 m^2. Compaction achieved shall be determined on a freshly embedded layer, before setting, on at least four places for each particular work stage.

The granulometric composition shall be checked on these places. On at least two places testing is performed on samples prepared from a fresh mass and of uniaxial strength, after specified curing for 7 days in a wet space.

If tests show that the achieved quality matches the one obtained in laboratory conditions, the work may be resumed; otherwise, the work shall be stopped.

Control Tests

These tests imply the following minimum testing performed during the work executed by the Contractor as a part of his quality assurance programme:

- The degree of compaction (for the Modified Proctor Procedure) of a freshly embedded layer, at every 500 m^2;
- The granulometric composition of mineral mix at every 300 m^2;
- Basic parameters that define the quality of binder, for every 100 t of binder;
- Compressive strength on tubes made of a fresh mix, at every 1000 m^2 of a completed layer;
- Constant control of evenness, profile accuracy, and thickness of the completed layer at every cross-section.

Requirements To Be Met for Stabilization Layer

An embedded layer of stabilizing mix shall meet the following requirements:

- The achieved degree of compaction shall be at least 98%;
- Evenness measured with a 4 m long levelling staff, or another suitable apparatus, shall fall within the range of ±15 mm;
- Any variation in the thickness of placed layer shall not exceed ±15 mm;
- Completed stabilization shall show necessary homogeneity in achieved compaction.

The sub-base made of stabilized soil – material can be considered homogeneous, if the coefficient of variation KV in one series of compactions measurements conducted on the stabilized layer is:

KV < 3%

The coefficient of variation shall be calculated applying the formulae:

$$KV = \frac{\sigma}{\bar{x}}, \qquad \sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n} (x_i - \bar{x})^2}$$

where:
x_i – the results of compaction measurements on site
x – the arithmetic mean of all compaction measurements on the tested stabilized section
n – the number of compaction measurements on the tested stabilized section
σ- standard deviation

6.3.11 Calculation of Works

Measurement:
Measurement in cubic metres (m^3) of the layer completed, measured, and approved on the site and after testing by the Engineer.

Payment:
The quantity of works, as specified in the above-described way, shall be paid at the contracted unit price, and this payment shall make full compensation for all works, equipment, tools, and everything else needed for the execution of works as previously described in this Section.

Section 7
Superstructure

Contents

7.1. Edge strips, kerbs, and prefabricated elements

7.1.1. Edge strips and kerbs

7.1.1.1. Description

This section includes the construction, i.e. procurement and placement of:

- Concrete or asphalt edge strips adjacent to asphalt or concrete pavement, dimensions as per the design;
- Raised concrete or asphalt kerbs at rest and parking areas, dimensions as per the design;
- Raised concrete or asphalt kerbs at high embankments, dimensions as per the design, sloped, including necessary hand excavation, haulage of surplus material, and concrete bedding, all according to details from the design.

7.1.1.2. Work Technology

Before constructing edge strips, the sub-base shall be compacted well, and previously tested and accepted by the Engineer.

Edge strips and kerbs shall be constructed before asphalt layers. For concrete pavements, concrete edge strips shall be constructed in the following way:

- Transverse joints, 8 mm wide, shall be performed as contraction joints at 3.00 m^1 spacing;
- The lower part of each joint shall be filled with sand, grain size 0-3 mm, and its upper part with a joint sealing compound. Joints shall be sealed only when concrete sets, and joints are dry, with their sides cleaned. If the compound sinks, joints shall be re-sealed immediately.

Concrete edge strips for asphalt pavements, and concrete kerbs for concrete and asphalt pavements, shall be constructed as monolithic with contraction joints, while placing tar paper at every 3.0 m. If these works are executed by segments with compaction joints, then for edge strips, tar paper is placed between two segments, and for kerbs, concrete for one segment shall lean freely on concrete for another segment.

Edge strips shall be constructed in two layers, and/or in a single layer, in full accordance with the design and the Engineer's instructions.

Asphalt kerbs shall be constructed with a special machine, and using a special mix.

Concrete shall be placed with special finishers for this type of work. Edge strips less than 0.50 m wide may also be constructed without a special finisher, by mechanical compaction, with the Engineer's special approval. Classes of concrete are 15 or 20 kN/m^2, depending on design solutions. Asphalt edge strips and kerbs shall be constructed using a special machine. This pertains to the construction of kerbs and edge strips at concrete pavement, whereas for asphalt pavement, asphalt edge strips shall be laid down together with asphalt for the pavement structure. In principle, it is allowed to use pre-fabricated concrete elements for concrete kerbs subject to approval by the Engineer. All details, such as excavations, concrete bedding, laying kerbs, sealing joints, and so on, shall be performed exactly as per detailed design drawings. Their levels and position shall be constructed in line with the design.

When laying elements, all measures for proper execution of works shall be taken, i.e. excavations shall be properly shaped, subsoil for concrete bedding shall be prepared in a professional manner, non-wetted prefabricated elements shall be placed, and joints shall be constructed professionally to ensure good adhesion between concrete and kerbs. Only elements with no or minor damages, invisible after placement, may be laid. After laying kerbs, protective measures shall be taken against the action of wind, sun, and frost.

After laying kerbs, and finishing all pertaining works, all kerbs shall be cleaned completely, and any damages on them, incurred during execution of other works, shall be fixed by the Contractor in a way agreed with the Engineer, or the damaged elements shall be replaced with new ones where directed by the Engineer.

7.1.1.3. Quality Control

Regular controls shall be performed in full accordance with Sub-Section 4.5. for asphalt, and Sub-Section 5. for concrete from these Technical Specifications.

The quality of materials for asphalt kerbs shall be controlled fully as indicated in Sub-Section 4.5. of these Technical Specifications. Along with regular controls, the final work quality control shall be ensured in plants for pre-fabricated elements. The quality of concrete prefabricated kerbs shall be assess based on the quality of concrete and finished products, and their frost resistance, in compliance with requirements set out in Sub-Section 5 of these Technical Specifications.

7.1.1.4. Applicable Regulations

SRPS U.E3.020 – Technical specifications for construction of concrete pavement (Section on concrete concrete lanes and kerbs);
SRPS U.M3.095 – Sealing compound for joints on pavements.

7.1.1.5. Measurement and Payment

The amount of executed works shall be measured according to the amount of actually executed works in metres of length, within the scope of design and as approved by the Engineer.

All works from this Section shall be calculated at an agreed unit price that makes a full compensation for the procurement of all materials and elements, transport, preparation and placement, and for concrete bedding for asphalt kerbs, strips, and everything else needed to complete this work, and the Contractor shall have no right to claim any other fee for completed work.

7.1.2. Typical Prefabricated Concrete Elements on Service Passageways

7.1.2.1. Description

This item includes the procurement and placement of typical prefabricated concrete elements at the ends of service passageways.

7.1.2.2. Work Execution

The work includes the procurement, transport, and placement of finished elements made of concrete, class MB-45, over MB-15 concrete bedding, in full accordance with details from the design. Placed elements shall have levels and longitudinal gradients as designed.

The entire work shall be executed according to the design based on these Technical Specifications, requirements set in Sub-Section 4.7, and applicable standards for this type of works.

7.1.2.3. Measurement and Payment

Calculation per metre length of actually placed element as approved by the Engineer.

7.2. Open channels

7.2.1. Description

Open channels shall be constructed to drain water from the carriageway, in full accordance with the design.

7.2.2. Material

Concrete for open channels shall be at least of class MB 30, depending on solutions from the design, and its grade shall be in compliance with Sub-Section 5 of these Specifications.

All materials used to construct open channels shall be tested for compliance and meet PBAB and other applicable Yugoslav standards and the requirements of these Technical Specifications.

7.2.3. Work Execution

The construction of open concrete channels shall precede the placement of layers of asphalt pavement. Open concrete channels may be constructed as monolithic, prefabricated, or semi-prefabricated (where kerbs are semi-prefabricated). If kerbs are prefabricated, then they shall be placed into fresh concrete bedding that ensures the stability of kerbs from the bottom and sideways – toward the slope.

For such construction of kerbs of open channels, immediately after the bedding and kerbs have set, berms shall be constructed as per the design.

Open channels shall be constructed in 3-4m long segments, with joints, which depends on the geological composition of soil. Open channels shall be constructed as monolithic, with tar paper placed in construction joints.

If works are executed by segments, compaction joints shall be constructed in two layers and with tar paper. These joints shall be normal to the centreline and with sharp edges. Whether the kerbs of open channels are constructed as monolithic or by segments, tar paper is not needed at places of compactions (construction) joints, and two adjacent segments of concrete shall be in direct contact.

When constructing open channels in situ, it is forbidden to shape the upper surface with a trowel, but this should be done with a screed or corn broom, vertically to the road surface.

Open channels are laid on a previously compacted and accepted blanket course, if the thickness of asphalt layers is equal tot he thickness of open channels. If asphalt pavement layers are thicker, the difference in thickness shall be made up with sand that needs to be compacted and tested, otherwise the blanket course shall be excavated to a required level and re-compacted.

Formwork for open channels shall be properly fixed and firm, so as not to warp. Proper vibrators or machines for open channels shall be used for construction.

Open channels shall be precisely shaped in terms of geometry, without any variation from the design, and in vertical terms, open channels shall be constructed exactly as per designed levels and appropriate gradients, in general and by segments, with the accuracy of - 5mm. Evenness shall be measured with a levelling rule. For semi-prefabricated and prefabricated open channels, no damaged elements shall be used.

Protection, safekeeping, and curing of open concrete channels shall be performed in accordance with relevant provisions of Sub-Section 5 of these Specifications.

Open channel width shall be specified in the design, and is, usually, 0.50 or 0.75 m.

7.2.4. Quality Control

The Contractor shall submit to the Engineer all prior tests for materials and concrete that will be used to construct open channels, in order to obtain his approval for use, and it shall meet the following quality requirements:

- Tensile bending strength βzs = 5 MPa
- Water-permeability of concrete V = 6
- Frost resistance MB - 30
- Resistance to frost and salts - damage 0%
- Bohme wear resistance in dry 18 cm^3 / 50 cm^2 and water-saturated 35 cm^3 / 50 cm^2
- Water absorption: max. 1%
- Control of concrete shall be performed both at the place of mixing, and that of concreting.

Both at the place of mixing, and that of concreting it is necessary to determine batches of concrete and assess them according to one of criteria from Art. 46 of PBAB.

7.2.5. Measurement

This work shall be measured per metre length of constructed open channels, for each relevant width and type of open channel separately, and as approved by the Engineer.

7.2.6. Payment

Payment shall be made at the contracted unit price for metre length of open channels, according to measurements from Sub-Section 4.10.5. The unit price shall include all necessary works on the construction of open channels, and any extra excavation or filling, all materials for construction, formwork, and equipment, all transports and haulages, curing, protection, and all other expenses, and the Contractor shall have no right to claim any extra payment on top of the contract price.

7.3. Shoulders

7.3.1. Scope and Contents of Works

This Section includes the construction of shoulders, namely:

- Shoulders covered with a 5 cm layer of sand, gravel, rock chippings, the width as per the design;
- Shoulders topsoiled in a layer 15-25 cm thick, sown with grass, the width as per the design.

7.3.2. Material

To fill the part of shoulders above the blanket course surface, it is possible to use material that meets requirements for materials intended for the finish layers of embankments according to Sub-Section 3.4.1.2. of these Technical Specifications, and the finishing part of shoulder shall be executed according to Sub-Section 3.13.1.1. or 3.13.1.2.

On both sides of carriageway, up to the surface of blanket course, the shoulders shall be constructed using the same material and in the same thickness as the sub-base.

For sanding and gritting it is possible to use sand made of sound rock material, grain size 0/8 mm, the grade of which is in compliance with SRPS U.E9.020, and gravel and rock chippings of grain size 0/30 mm.

Top soil shall meet requirements set in Sub-Section 3.1. of these Technical Specifications.

7.3.3. Execution and Quality of Works

All works shall be executed according to detailed drawings from the design documents, unless otherwise set out in these Technical Specifications.

Spread material shall be compacted. In principle, characteristics defined in Sub-Section 3.4.1. of these Technical Specifications shall be observed.

The surface of a spread layer shall be constructed with crossfall and gradient according to the design, taking into account the reduced level of surface by the thickness of a compacted layer of sand, gravel, or chippings.

Shoulders shall be covered with planned materials in the thickness of 5 cm exactly as per the designed cross-section, with a special superelevation for the sake of compaction. Compaction shall be performed with a 3 ton roller.

The horizontal edges of shoulders shall be constructed as per the design. Variations from designed lines are allowed only to avoid any visual intrusion.

The levels of finished shoulder surface are allowed within the range of 1 cm below the designed surface.

Deviations in the thickness of a constructed layer in compacted condition are allowed within the range of ±1 cm of designed values.

Humification shall be performed in thickness as specified in the design, with grass seeding, according to requirements set out in Sub-Section 3.11. of these Technical Specifications.

In general, all requirements as given in Sub-Section 3.13.3.1. hereof shall apply for evenness, compaction, and thickness.

7.3.4. Acceptance and Measurement

The works shall be subject to approval by the Engineer based on the quality requirements of these Technical Specifications .

The quantities for calculations shall be determined in square metres of completed shoulder surfaces, covered with sand, gravel, etc. based on actually executed works within the scope of design and as approved by the Engineer. The construction of shoulder cores above the blanket course surface shall be calculated within the volume of embankment, and the shoulder cores on both sides of carriageway up to the blanket course surface level shall be calculated within the volume of blanket course.

7.3.5. Payment

The amount of works determined according to Sub-Section 3.13.5. and accepted according to Sub-Section 3.12.4. hereof, shall be paid at the agreed unit price for 1 m^2. The agreed price shall include all works pertaining to the procurement of material, transport, placement, and everything else needed to complete the works entirely, and the Contractor shall have no right to any extra compensation.

The construction of shoulder cores, humification, and grassing shall be paid within the construction of embankment under Sub-Section 3.4.1. of these Specifications.

Section 8
Concrete

Contents

8.1. Summary and General Provisions

8.1.1. General

These technical measures and specifications apply to all types of concrete, all plain and reinforced concrete elements and constructions on roads, cement mortars and grouts for grouting cables.

This is the purpose of the requirements for quality and quality control of basic materials for concrete; the technological requirements for construction and maintenance of the structure and its elements, the requirements for regular control of production, transport and placement of concrete, design, and pre-testing of concrete, quality control of fresh and hardened concrete; and the instructions for calculation and taking over of works depending on their quality.

8.1.2. Quality Assessment

As generally defined in these Technical Specifications, to verify the value of key indicators of particular production operations, or properties of particular materials or products, the criteria of probability and statistics are obligatory, and all works and materials shall be subject to the approval of the Engineer.

8.1.2.1. Categories of Concrete

Regarding the determination of concrete mix composition, according to the Rules for Plain and Reinforced Concrete - PBAB/87, concrete may be classified into one of two categories: B-I and B-II. Category I concrete (B-I) may be mixed without pre-testing up to MB 25. A minimum amount of cement of class 35, for category I concrete (B-I) (of plastic consistency), in a fresh concrete mix with the largest fraction 16-32 mm, shall not be less than specified in the table below:

Minimum amount of cement MB	Class 35 (kg/m3)
10	220
15	260
20	300
25	350

For Class 45 cement, the above-stated amount of cement may be reduced by 10%, and for Class 25 cement these should be increased by 10%.

The above-given amounts of cement shall be increased by:
- 10% - for 8-16 mm fraction in the mix
- 20% - for 4-8 mm fraction in the mix
- 10% - when placing concrete of liquid (thin) consistency

Category I concrete (B-I) may be: MB-10, 15, 20, and 25, and may be placed only on the site where it is mixed, and shall not be delivered to any other contractor without pre-testing of fresh and hardened concrete. Composition of Category II concrete (B-II) shall be defined based on pre-testing of fresh and hardened concrete with envisaged materials, for foreseen construction conditions, and planned use of the structure. As for plain and reinforced concrete of Category II (B-II), the following classes of concrete shall be used for the construction of elements and structures:

MB-10, 15, 20, 30, 35, 40, 45, 50, 55, and 60.

For reinforced concrete it is not allowed to use any class lower than MB-15. The granulometric composition of aggregates for the production of Category I concrete (B-I) without pre-tests and with the range of granulometric composition aggregate for the production of Category I concrete (B-I), with obligatory pre-testing, and of Category II concrete (B-II) is defined by SRPS U.M1.05 7/84.

8.1.2.2. Concrete Quality Control

The concrete quality control comprises the control of production and the control of compliance with the structural design and concrete design. Overall responsibility for the quality control of all concrete materials and all concrete works shall remain with the Contractor and subject to the approval of the Engineer. The concrete production control and compliance control shall be performed by:
- The producer of concrete until the handover of concrete to the contractor in charge of concrete works;
- The contractor in charge of concrete works from the taking over of concrete to the completed curing of placed concrete.

The producer of concrete shall control each class of Category II concrete – B-II that is produced in the concrete plant and shall meet SRPS U.M1.050, SRPS U.M1.051, and SRPS U.M1.052;
- The production and compliance control are complementary procedures of overall performance quality assurance activities. Most often, the production control refers to the control of particular phases in the production of materials and execution of works, and the compliance control to the control of final properties. The first control (production control) is usually performed by producers of materials themselves (cement, screening, additive production plants, etc) and contractors (concrete plants, concrete production points), and the latter control (compliance control) by competent external authorities (investor's engineer, representatives of authorized institutions for such activities, laboratories of authorized institutions, inspection services) determined by the Investor. Inevitably, both controls overlap partly. An optimum solution is to programme and organize them as complementary, and the compliance control shall use the results from the production control. For cement, aggregate, and concrete additives, these obligations are defined in the ordinances on mandatory quality compliance testing, which, for concrete production, has still not been done;
- For Category I concrete – B-I, the compliance control is mandatory, with requirements for the site of placement, and the control of the least quantity of cement depending on required class of concrete (visual control of cement batching and accuracy of batching equipment);
- For Category II concrete – B-II, the concrete production control is mandatory and the compliance control, with requirements for the site of placement;
- According to new Rules, both controls shall be defined with the structural design and concrete design.

The class of concrete is considered to be concrete of the same grade and with the same special properties, as specified in the structural design and concrete design.

The producer of concrete shall test the ingredients of concrete (aggregate, cement, additives), as shown in Art. 39 of the new Rules on Plain and Reinforced Concrete PBAB/87. The producer of concrete, when producing B-II concrete, shall test its compressive strength on a sample taken for each class of concrete, namely:

- Every day when concrete is placed: at every 50 m3 of produced concrete, i.e. at every 75 mixes, taking into account a larger number of tests (samples). In exceptional cases, if the quantities of produced concrete in the period of compressive strength tests are large (greater than 2000 3), samples for testing shall be taken at every 100 m3 and 150 m3 of mixes, respectively. The total number of tests for every class of concrete, produced in large quantities (greater than 1000m3) during the assessment period, shall not be below 30. For lesser quantities of concrete (lesser than 1000 m3), in the period of assessment it is necessary to perform at least 10 tests for each type of concrete;
- The Technical Specifications for production, testing, and assessment of quality of B-II concrete produced in the concrete plant are defined in SRPS U.M1.051.

8.1.2.3. Sampling

Testing for water-impermeability, resistant to frost, wear, and other harmful influences from the environment, shall be done according to parts specified in the concrete design, and in compliance with relevant Yugoslav standards. For the production control, concrete samples shall be taken by the producer of concrete at the concrete plant. From that mix, only one sample of fresh concrete shall be taken to form all test bodies needed for testing strength and other properties of concrete. The quality of each type of concrete shall be assessed separately, taking into account all test results. If assessing concrete grade (MB), concrete is taken by batches in conformity with the control programme as specified in Art. 46 of the new Rules on Plain and Reinforced Concrete PBAB/87.

8.1.2.4. Types of Materials and Production

Particular types of materials and products shall mean certain materials and products from the same source and same production, i.e. of same nominal characteristics:

- For mineral aggregate, every fraction by itself (separately) shall be defined as a particular material, and also the fractions having the same name, if differ by their material composition, place of production (deposits), or production method;
- For cement, cements having the same name, produced in the one and same cement plant, under the same material and technological/processing criteria and conditions, shall be taken as a particular type;
- For concrete additives and other industrially-produced materials, the same applies as for cement;
- For B-I and B-II concrete, particular types are defined primarily according to key technical characteristics. Types of concrete are classified by grade (MB), provided that they meet design requirements and these specifications. Concretes composed of different basic materials are treated separately, all the same as concretes from different production sources.

8.1.3. Concrete Production Control

B-I and B-II concretes shall be produced from previously tested and visually inspected basic materials in concrete production plants that are designed to be functionally adequate, are previously tested, and are controlled during operation. The concrete production control covers:

- Testing of concrete for production capabilities according to SRPS U.M1.050,
- Testing of components of concrete,
- Testing of fresh concrete, and
- Control of placement and curing of concrete.

The control is conducted by the producer of concrete, under control of the Contractor and subject to the approval of the Engineer.

Concrete production plants are considered to be completely equipped plants that include: reception, storage, and handling of basic materials, mixing, handling, and placement of fresh concrete, and curing of placed concrete. Outside the concrete production plant (concrete plant), plants for the production of mineral aggregate (screening plant) are separated as independent plants.

The control of quality of B-II concrete (fresh and hardened) shall be performed at the place of production (concrete plant) and on the site of placement (compliance control), and the control of quality of B-I concrete - on the site of placement (compliance control), and the control of the least amount of cement, which is performed by the Contractor in the presence of the Engineer who shall also accept batches of concrete.

As a rule, concrete plants shall receive only those basic materials that meet required quality criteria. The producer of concrete shall necessarily organize the storage and handling in the concrete plant in such a way to make it possible to precisely remove from use any defective batch of basic materials.

Control tests of basic materials for concrete also includes a visual inspection of properties of fresh concrete before and after placement.

Pre-testing of basic materials shall be performed by the Producer in conformity with these Technical Specifications, and their use shall be subject to the approval by the Engineer.

8.1.4. Final Concrete Quality Assessment

For B-II concrete it is necessary to give a final quality assessment that includes:

- Documents on taking over of concrete by batch;
- An opinion on the quality of placed concrete given based on a visual inspection of the construction, perusal of documents on construction, and verification of results from the records on regular production control with results of the control of compliance with quality requirements. The final assessment of the quality of concrete in the construction is used to prove the safety and durability of the construction or to request an additional proof of the quality of concrete by special tests.

The constructions or structures for which trial load tests are specified or envisaged in the design, or required by the Investor, shall be taken over after a trial load test based on measured deformations and strains in the construction, and based on other necessary data on the quality of material. The constructions or structures for which trial load tests are not required, shall be taken over according to other suitable and applicable methods.

8.1.5. Concrete Mix Design

B-II concrete mixes shall be designed in accordance with the applicable Rules on technical measures and requirements for plain and reinforced concrete (Art. 28-30).

8.1.6. Concrete Plant Manager

For every concrete plant or group of concrete plants, the producer of concrete shall appoint a responsible manager qualified for concrete technology. The job of this manager shall be related only to technological problems of concrete plants.

8.2. Basic Components of Concrete

8.2.1. Quality of Rock Aggregate for Concrete

8.2.1.1. Definitions

8.2.1.1.1 Rock Aggregate

A general name for a non-screened, or from several screened fractions composed mix of granular rock material that may be natural aggregate, a product of stone crushing, or a product of recrushed natural aggregate.

8.2.1.1.2. Natural Aggregate

A loose stone made by mechanical accumulation of coarse- and fine-grained material moved (transported) by water energy. Its main characteristic is the roundness of granular fragments.

8.2.1.1.3. Non-Screened Natural Aggregate (Natural Mix of Aggregates)

Natural aggregate from which grains have not been separated by fraction size. This is a natural mix, as obtained by exploitation of deposits. Another synonym used for it is “a natural mix of sand and gravel”.

8.2.1.1.4. Rock

A smaller or larger piece of solid stone taken from its natural environment in a natural or artificial way.

8.2.1.1.5. Screened Rock Aggregate

Aggregate divided into fractions in the screening plant may be:

- Screened natural aggregate
- Screened crushed aggregate
- Screened mixed aggregate

8.2.1.1.6. Screened natural aggregate

Natural aggregate divided into fractions in the screening plant.

8.2.1.1.7. Screened crushed rock aggregate

Crushed stone produced by crushing and divided into fractions in the screening plant.

8.2.1.1.8. Screened Mixed Rock Aggregate

Fractions of rock aggregate with mixed screened crushed rock aggregate and screened natural aggregate.

8.2.1.1.9. Rock Aggregate Fraction

A mix of rock aggregate grains limited by the lower nominal size (d) and the upper nominal size (D) of grain.

8.2.1.1.10. Total Aggregate Mix for Concrete

A mix of several aggregate fractions.

8.2.1.1.11. Largest Grain

The size of opening in a standard screen through which all rock aggregate grains pass.

8.2.1.1.12. Oversized Grain

Rock aggregate fraction grains that stay on screen mesh the upper nominal size (D).

8.2.1.1.13. Undersized Grain

Rock aggregate fraction grains that pass through screen mesh of the lower nominal size (d).

8.2.1.1.14. Sand (Fine Rock Aggregate)

Fine rock aggregate i.e. rock aggregate fractions with grains that pass through a standard laboratory screen with 4mm mesh. The following three categories of sand are distinguished from the coarsest grain to the finest grain:

- Coarse grain, with a nominal size of fraction 4/0;
- Medium grain, with a nominal size of fraction 2/0
- Fine grain, with a nominal size of fraction 1/0 mm.

Depending on whether it is obtained by screening natural aggregate or crushed stone, it may be called natural sand or crushed sand.

8.2.1.1.15. Coarse-grained aggregate

Natural aggregate fractions with grains that pass through a standard laboratory screen with a 63 mm mesh, but stay on a standard laboratory screen, with a 4 mm mesh. It may contain recrushed grains of natural aggregate, but only to the degree that more than 50% of the surface area of every grain remains round in shape.

8.2.1.1.16. Natural aggregate (natural mix)

Natural aggregate that serves as basic component for the production of screened natural aggregate shall be composed of firm – mechanically resistant, fresh and weather-resistant pebbles (cobbles). The surface of pebbles shall be clean, without any scum that could prevent a good (intimate) bond with a cement binder.

Their shape shall be as spherical as possible. Their petrographic and mineral composition shall be favourable, and any substances potentially harmful for the physical and mechanical properties, as well as durability, of concrete or its components (reinforcing bars) shall be defined in quality and quantity.

The usability of a natural mix for the production of natural aggregate fractions shall be proven through tests of particular properties, with quality requirements as defined in Table 1.

Table 1. Quality requirements for natural aggregate for the production of aggregate for concrete

No.	Property and relevant standard	Quality requirement
1	Petrographic and mineral composition (B.B8.004)	Favourable *
2	Components that prevent hydration of cement	Not allowed
3	Bulk density of grain (B.B8.031)	2000-3000 kg/m^3
4	Resistance to crushing (U.M8.030)	max 30% (m/m)
5	Water absorption (B.B8.031)	max 1,5 (m/m)
6	Resistance to frost (B.B8.044)	
	– Plain and reinforced concrete	max 12% (m/m)
	– Wearing course of pavement structure	max 3% (m/m)
	– Lower part of pavement slab	max 5% (m/m)
7	Total sulphur content, expressed as SO3(B.B8.042)	max 1% (m/m)
8	Chloride content, expressed as C1 (B.B8.042)	
	– Reinforced concrete	max 0.10% (m/m)
	– Pre-stressed concrete	max 0.02% (m/m)
9	Content of organic matter (B.B8.039; B.B8.040)	colour of liquid lighter than standard
10	Grain shape (volumetric coefficient, (B.B8.049)	min 0.18%
11	Resistance to crushing and wear (B.B8.045)	max 35% (m/m)
12	Content of fine particles, clay balls, friable grains, light particles, coating of grains... (B.B8.030)	***
*	If a petrographic analysis shows the presence of components that may be reactive, it is necessary to perform tests according to SRPS B.B8.056 or B.B8.057.	
**	In the cement-stabilized load-bearing courses of pavement structure, it may amount up to 3% if the required resistance to frost is met.	
***	Requirements for natural aggregate shall not be defined, but the test results shall be given in the test report.	

8.2.1.1.17. Small Particles

Particles that pass through a standard screen, mesh 0.09 mm and 0.063 mm, respectively.

8.2.1.1.18. Silty Particles

Particles from 0.005 mm to 0.09 mm, and from 0.005 to 0.063 mm in size, respectively.

8.2.1.1.19. Clayey particles

Particles smaller than 0.005 mm in size.

8.2.1.1.1.20. Basic Feedstock

Rock that serves as an initial component (feedstock) for the production of screened crushed rock aggregate shall be of a favourable mineral composition, fresh, and of good mechanical strength. It shall be resistant to atmospheric influences. According to its structural characteristics (structure and texture), it shall be such as to enable the provision of solid fragments (grains) of favourable shape. Petrographic analyses shall define all components that are potentially harmful for the durability of concrete and its components (reinforcing bars). The usability of stone for the production of screened crushed rock aggregate shall be proven through tests of particular properties, with quality requirements as defined in Table 2.

Table 2 Quality requirements for stone for the production of screened crushed rock aggregate for concrete

No.	Property and relevant standard	Quality requirement
1.	Petrographic analysis (B.B8.003)	Favourable *
2.	Abrasive wear resistance (B.B8.015)	
	• Plain and reinforced concrete	
	• Concrete exposed to wear and erosion	max 35 $cm^3/50\ cm^2$
	Very heavy and heavy traffic	max 10 $cm^3/50\ cm^2$
	Medium, light, and very light traffic	max 18 $cm^3/50\ cm^2$
3.	Bulk density (B.B8.032)	2000-3000 kg/m^3
4.	Water absorption (B.B8.010)	max 1% (m/m)
5.	Compressive strength (B.B8.012)	
	• In dry condition	
	Plain and reinforced concrete	min. 80 MPa
	Concrete exposed to wear and erosion	min. 160 MPa
	• In water-saturated condition	
	Plain and reinforced concrete	min. 64 MPa
6.	Resistance to crushing and wear (B.B8.045)	
	• Plain and reinforced concrete	max 30% (m/m)
	• Wearing course of pavement structure	
	Very heavy traffic	max 16% (m/m)
	Heavy traffic	max 18% (m/m)
	Medium, light and very light traffic	max 22% (m/m)
7.	Resistance to frost (B.B8.002)	
	• Plain and reinforced concrete	max 5% (m/m)
	• Wearing course of pavement structure	max 3% (m/m)
8.	Total sulphur content, as SO3 (B.B8.042)	max 1% (m/m)
	Chloride content, as Cl (B.B8.042)	
	• Plain and reinforced concrete	max 0.1% (m/m)
	• Pre-stressed concrete	max 0.02% (m/m)
*	If a petrographic analysis shows the presence of components that may be reactive, it is necessary to perform tests according to SRPS B.B8.056 or B.B8.057.	

8.2.1.1.21. Fractions of rock aggregate

Fractions of rock aggregate, whether they are produced by screening natural aggregate, or from crushed stone, shall be produced in technologically appropriate procedures (washing, crushing, sieving), in order to obtain rock aggregate of required quality. The usability of screened aggregate by fraction (whether from natural or crushed aggregate) shall be proven through tests of particular properties, with quality requirements as defined in Table 3.

Table 3. Quality requirements for screened rock aggregate

No.	Property and relevant standard	Quality requirement
1.	Petrographic and mineral composition (B.B8.004)	Favourable
2.	Components that prevent hydration of cement	Favourable
3.	Bulk density (aggregate grains) B.B8.031.	2000-3000 kg/m3
4.	Water absorption (B.B8.031)	-
5.	Resistance to crushing (U.M8.030)	max 30% (m/m)
6.	Resistance of aggregate to frost B.B8.044.	max 12% (m/m)
	• for wearing course of cement-concrete pavement	max 3% (m/m)
	• for the lower part of cement-concrete pavement	max 5% (m/m)
7.	Total sulphur content (as SO) B.B8.042.	max 1% (m/m)
8.	Total chloride content (as Cl) B.B8.042.	
	• for plain and reinforced concrete	max 0,1% (m/m)
	• for pre-stressed concrete	max 0,02% (m/m)
9.	Content of organic matter B.B8.039 and B.B8.040	Lighter than standard
10.	Grain shape (volumetric coefficient) B.B8.049	
	• natural aggregate	min. 0,18
	• crushed aggregate	min. 0,15
11.	Content of small particles,frak.0-4 mm B.B8.036.	
	• natural and mixed aggregate	max 5% (m/m)
	• aggregate of rock origin	max 10% (m/m)
12.	Content of small particles in fractions larger than 4 mm	max 1% (m/m)
13.	Ball clay content (B.B8.038)	
	• in fine aggregate	max 0.5% (m/m)
	• in coarse aggregate	max 0.25% (m/m)

No.	Property and relevant standard	Quality requirement
14.	Weak grain content (B.B8.037)	
	• for frost-resistant concretes	max. 3% (m/m)
	• for other concretes	max. 4% (m/m)
15.	Content of light particles (B.B8.034)	
	• Appearance of concrete not important	max. 1% (m/m)
	• Appearance of concrete important	max.0,5% (m/m)
16.	Clay-coated grains (B.B8.004)	Not allowed
17.	Resistance to crushing and wear (Los Angeles) B.B8.045.	
	• Plain and reinforced concrete (resistant to erosion and abrasion)	max 30% (m/m)
	• Wearing course of cement-concrete pavement, "B" grading	
	Very heavy traffic	max 16% (m/m)
	Heavy traffic	max 18% (m/m)
	Other traffic load	max 22% (m/m)
	• Lower part of cement-concrete pavement	max 30% (m/m)
18	Bulk density in loose and compacted conditions B.B8.030.	To be tested and logged
*	If a petrographic analysis shows the presence of components that may be active, it is necessary to perform tests according to SRPS B.B8.056 or B.B8.037.	

8.2.1.2. Granulometric Composition

The grains of aggregate shall be as much cubical or spherical as possible.

Aggregate fractions to be used for the preparation of concrete shall be washed or dedusted; fine-grained from 0 to 4 mm, and coarse-grained from 4 to 125 mm.

As a rule, for structural concrete, it is mandatory to use fractions: 0-4, 4-8, 8-16, 16-32, 32-63, and 63-125, and mid-fractions: 0-1, 0-2, 1-4, 2-4, 8-11, 11-16, 16-22, 22-32, 32-45, and 45-63 mm, in conformity with SRPS B.B3.100 and B.B2.010.

When determining the grain composition for mineral aggregate, the values for diameters shall refer to screening through square mesh.

The granulometric composition of fine aggregate (0-4 mm) shall be within the following ranges (according to SRPS B.B2.010)

Sieve	(mm)	0.125	0.25	0.50	1.0	2.0	4.0	8.0
Passing through sieve	(% mass)	2-13	8-30	20-50	40-80	65-100	90-100	100

Depending on need and importance of available materials, it is possible to separate aggregate into two fractions (e.g. 0-1 mm and 1-4 mm, or 0-2 mm and 2-4 mm), so that the mix of the two fractions in a certain ratio meets specified limits. Such separation may be undertaken when it is impossible to produce sand fractions with a satisfactory grain size distribution, which is determined by tests, particularly from the aspect of achieving the required degree of grain size distribution in fresh concrete and its castability and workability with used machines (W/C ratio, cement portion, consistency). Fine aggregate shall have 45% residue at most between any two successive sieves. The grading modulus of fine aggregate shall be within the range from 2.3 to 3.60. The grading modulus is a sum of the residues on standards laboratory screens with mesh: 0.125; 0.25; 0.5; 1; 2; 4 and 8 divided by 100.

The diameter of a maximum aggregate grain for structural concrete shall neither be larger than 1/3 of the smallest size of elements to be concreted, nor larger than the smallest free gap between reinforcing bars in a horizontal row, and 1/4 - 1/3 of the distance between the nearest sides of the form. When determining a maximum diameter of grain, the effect of forms and reinforcement is taken into consideration according to Faury’s method.

The total granulometric composition of aggregate for B-I and B-II concrete shall take, i.e. treat, as general guidelines with determined maximum diameters of grain, the values of limit curves according to SRPS U.M1.057/84. In principle, it is necessary to determine the total granulometric composition of aggregate based on experimental tests of concrete (pre-tests), in terms of getting as close as possible to an optimum conformity between technical and economic solutions, considering the requirements of production, handling, and placement of fresh concrete, and the highest possible utilisation of available materials, in order to meet quality criteria for hardened concrete.

The grading composition implies an absolute volumetric proportion of particular groups of grains. Experimentally adjusted and adopted curves of the total grading composition shall not be corrected subsequently, i.e. changed without particular proof tests.

8.2.1.3. Handling requirements

(Stockpiling and handling of aggregate in phases after the exit from the screening plant until the mixing of fresh concrete.)

Every aggregate fraction shall be treated as a separate element for stockpiling and handling. When working on the same site with two or more fractions with the same name considering their grading, but from different sources, the criterion that it is not allowed to mix together such materials non-systematically, i.e. uncontrollably without necessary tests shall be strictly observed.

Particular fractions shall be handled and stockpiled in accordance with the following requirements:

- Segregation of fractions: each particular fraction shall pass through all phases of stockpiling and handling to the phase of direct batching in a concrete mix, and all appropriate measures shall be taken (gravity transport by group of materials, proper gradients of belt conveyers, pile spreading in order to prevent the formation of a cone, etc.);
- Changes in grading due to grain crushing: particularly for coarser fractions it is necessary to take care that grains do not crush due to fall under the impact of gravity;
- Moisture of materials: regardless of weather conditions, an even distribution and sufficiently low moisture level shall be properly and safely assured in particular fractions in the phase of their batching into a concrete mix, which primarily applies to fractions up to 4 mm in size, if the plant is not equipped with instruments for measuring moist percentage for each fraction. The use of frozen aggregate, or aggregate mixed with ice and snow is not allowed for the production of concrete;

- Tempering of aggregate: considering the entire complex of works in the concrete plant, the possibility of tempering fractions (beside water) in a technically appropriate way shall also be assured in cold weather, before and during their processing into concrete, as well as the possibility of warming the water.

8.2.1.4. Pre-testing of Mineral Aggregate

Only previously tested mineral aggregate shall be used for the production of concrete. Pre-tests shall be conducted according to provisions Sub-Section 8.2.1. of these Technical Specifications and subject to the approval of the Engineer.

The number of samples and sampling method shall reproduce, in a reliable way, the quality of aggregate and degree of quality homogeneity according to SRPS B.B0.001/84. Pre-tests shall be performed for each type of mineral aggregate separately. The type of mineral aggregate shall imply different geological sources, and different locations and preparation methods. The validity of compliance tests for pre-testing of rock and aggregate shall be in conformity with the applicable legislation.

8.2.1.5. Control Testing of Mineral Aggregate

For each particular type of mineral aggregate, throughout its production, i.e. use for the project, control tests shall be performed at least as much as for all items specified in Sub-Section 5.2.1., if there are changes in the mineralogical composition.

8.2.1.6. Control Testing of Mineral Aggregate within Concrete Plant

The control tests of mineral aggregate within the concrete plant in the phases of production, stockpiling, handling, and transport, until its processing into concrete. The testing of mineral aggregate within quality control shall be, in principle, distinguished by samples that are taken:

a) Immediately under the screening unit;
b) From stockpiles in the screening plant, or from local stockpiles in the concrete plant;
c) From the discharge points of the batching units in concrete plants.

The control tests of mineral aggregate for the production of B-I, B-II, and transport concrete shall be performed in concrete plants in compliance with the Rules for Plain and Reinforced Concrete - PBAB/87, and SRPS U.M1.051/87, as follows:

- Granulometric composition of aggregate according to SRPS B.B8.029, at least weekly
- Proportion of particles smaller than 0.09 mm in fractions or mid-fractions according to the procedure defined in SRPS B.B8.036, at least weekly
- Proportion of particles up to 0.063 mm in size in aggregate fractions according to the procedure defined in SRPS B.B8.036/82, or the hygrometry procedure defined in SRPS U.B1.018, at least weekly
- Moisture of aggregate fractions according to SRPS B.B8.035/84, at least once in 8 working hour
- Organic impurities in fractions smaller than 4 mm in size shall be tested only when there is a possibility of their presence and in specific time intervals, according to SRPS B.B8.039 or SRPS B.B8.040, when needed.

The one-time group testing of samples is the one-time taking of at least three individual samples from three places on the stockpile that are most typical regarding the possibility of indicating the heterogeneity of grading and moisture, and are, therefore, tested separately as well. Aggregates shall be sampled and tests in equal time intervals considering the amount of materials. Samples are taken with respect to the quantitative replenishment of stockpiles, and quantitative use of aggregate for the production of concrete according to SRPS B.B0. 001/84. For concrete works, it is necessary to perform tests according to special programmes for each particular concrete plant, or for each particular group of functionally interconnected plants, all in conformity with the applicable legislation. These programmes shall be prepared by the concrete plant (producer of concrete) and submitted for the approval of the Engineer.

Tests mentioned in Sub-Section 8.2.1.6. shall be performed by the concrete plant under the supervision by the Engineerin full compliance with all requirements of the Technical Specifications. An overview of the applicable standards for testing of mineral aggregate is given at the end of this Sub-Section in A. Legislation and A/1. Standards. All concrete plants shall meet the requirements of SRPS U.M1.050.

8.2.1.7. Material Balance of Mineral Aggregate

With a special study, the producer of concrete shall prove the possibility of a reliable supply of concrete plants with mineral aggregate. The control of aggregate and production in the concrete plant also includes the current mineral balance, which deals with the balancing between consumption and production of aggregates. This balancing shall be separated, in terms of achieving optimum technological solutions.

8.2.2. Cement

Types of cement, quality requirements, handling requirements, prior and control tests.

8.2.2.1. Types of Cement according to SRPS

The concrete works envisage the use of Portland cements, quality grades: 25, 35S, 35B, 45S, 45B, and 55; Portland cements with the addition of pozzolane up to 20%, and 15% for pre-stressed concrete; Portland cements with the addition of slag or mixed additives up to 30%, class 35 and 45, according to type and use of the structure. For constructions and elements made of pre-stressed concrete it is possible to use cement based on Portland cement clinker, with not more than 15 % of smelting slag. These cements should meet the requirements given in Sub-Section 8.2.2.3.1. of these Technical Specifications.

Pozzolanic and metallurgical cement may be used for the stabilization of earth works and shall meet the quality requirements from Sub-Section 8.2.2.3.2. of these Technical Specifications.

Imported cement may be used to mix concrete only if such cement is provided with a compliance certificate (quality certificate) from a Yugoslav company registered for the activity that encompasses the testing of cement and issue of such compliance certificates.

8.2.2.2. Types of Cement out of SRPS and Special Cement

For special concrete works it is envisaged to use Portland cement of appropriate composition, with or without additives, and some other types of cement as well. Which of these cements will be used depends on the type and use of structure, conditions to which the structure is exposed in operation, and thus the selection of cement shall be performed on a case-by-case basis for every major or crucial structure, which is to be determined based on pre-testing of cement and concrete. These pre-tests shall be preceded by soil and groundwater tests, which is of influence for the selection of cement.

8.2.2.2.1. Special Cement for Pavement and Other Structures

Special cement for pavement and other structures is Portland cement of previously defined mineralogical composition, or this cement with the addition of a selected type and amount of blast furnace slag or pozzolane. These cements shall meet the requirements specified in Sub-Section 8.2.2.3.3. of these Technical Specifications.

8.2.2.2.2. Cement of High Early Strength – Quick Hardening Portland Cement

Quick hardening Portland cement shall be used for structures that require high early strength. This cement may be obtained from the clinker of a specific mineralogical composition, i.e. clinker with a high content of C_3S and finely ground, and shall meet requirements set out in Sub-Section 8.2.2.3.5. and 8.2.2.3.4. of these Technical Specifications.

8.2.2.2.3. Sulphate-resisting Cement

Sulphate-resisting cement and sulphate-resisting Portland cement with the addition of slag or pozzolane shall be used for structures that will be exposed to the action of aggressive sulphate ions during their operation. These cements shall be obtained from clinker of a specific mineralogical composition with a low content of carbon sulphate C3S.

8.2.2.2.4. Cement for Wearing Course on Edge Strips of Pavement and Concrete Kerbs

White cement, the grade of which meets requirements set in Sub-Section 8.2.2.3.6. of these Technical Specifications.

8.2.2.2.5. Cement for Grouting

Cement for grouting is Portland cement designated as PCk or Portland cement with the addition of granulated blast furnace slag, pozzolane, or both in the amount of not more than 15%, designated as: PC 15z k, PC 15p k, PC 15d (z or p) k. Cement used for the preparation of grout need not be the same as cement used for the basic construction, or element of the construction. The cement shall meet the quality requirements set out in SRPS B.C1.011/82 and special requirements for the chloride ion content (Cl-), not more than 0.025%.

8.2.2.3. Quality Requirements for Cement

Cement shall be tested according to methodologies given in Table 7.

8.2.2.3.1. Additional Quality Requirements

According to SRPS, cement shall meet requirements set out in SRPS B.C1.011/82. Aside from these requirements, these cements shall also meet the following additional quality requirements:

- For Portland cement:
  autoclave expansion max 0.8%
- For Portland cement with the addition of slag (not more than 30%) or pozzolane (not more than 20%):
  Autoclave expansion max 0.5%
  The content of additives shall not vary from the declared content max ± 2%

8.2.2.3.2. Cement for Stabilisation

Pure Portland cement with the addition of pozzolane or slag, or metallurgical cement, class 25, shall be used for stabilisation. In terms of quality, used cements shall meet the quality requirements set out in SRPS B.C1.011/82.

8.2.2.3.3. Special Cement for Pavement Structure

- Portland cement,
- Portland cement with the addition of a selected type and amount of blast furnace slag or pozzolane.

Mineralogical composition of clinker

This composition may vary depending on the type of structure and conditions of operation, which is to be determined with pre-tests.

- Content C3 A max 8%
- Content C3S 55-65%
- Shape and size of crystals C3 S and C3 S, determined by the microscopic analysis of clinker Must be regular.

Chemical composition of cement

- Loss on ignition max 5.0%
- Content of SO3 max 3.0%
- Content of MgO max 5.0%
- Insoluble residue:
  a) For Portland cement with the addition of slag max 2.0%
  b) For Portland cement with the addition of pozzolane max 10.0%
- Control of the content of added slag or pozzolane, with allowed variations from the declared value, max ± 2%

Physical properties of cement

- Fineness (Blaine's specific surface area)
  a) For Portland cement and Portland cement with the addition of slag, 2400-3700 cm2/g
     For class 35 cement min 3250 cm2/g
     For class 45 cement max 15%
     (pozzolane max 5% mm)
  b) For Portland cement with the addition of pozzolane max 3900 cm2 /g

- Standard consistency max 29 %
- Setting:
  - Start of setting at 20°C after 2.0 hours
  - at 30°C after 1.0 hour
  - End of setting not after 10 hours
- Volumetric soundness (Le Chatelier's rings) increased spacing between needle tips after boiling max 5 mm
- Autoclave expansion max 0.5%
- Deformations:
  Shrinking (measured per mortar according to the method specified in Table 7), after 28 days max 0.6 mm/m
- Cement strength:
  Compressive strength of cement min 6 MPa after 28-day aging, and
  Flexural strength of cement shall meet the quality requirements of Yugoslav standard B.C1.011/82.

8.2.2.3.4. Quick-Hardening Cement (Portland)

Mineralogical composition of cement
- Content of C3A max 15%
- Shape and size of crystals of C3S and C2S, determined by the microscopic analysis of clinker Must be regular.

Chemical composition of cement
- Loss on ignition max 3.0%
- Content of SO3 max 3.5%
- Content of MgO max 5.0%
- Insoluble residue max 2.0%

Physical properties of cement
- Fineness: Blaine's specific surface area min. 3000 cm2/g,
- Volumetric soundness on pats and Le Chatelier's rings shall meet the requirements set out in C.C1.011/82
- Autoclave expansion max 0.8%
- Setting
  - Start of setting not less than 60 minutes
  - End of setting not after 10 hours
- Strength (tested according to SRPS B.C8.022 or the Rilem-Cembureau procedure) after 3 days
  - Compressive strength min 23.5 MPa,
  - Flexural strength 4.0 MPa.

8.2.2.3.5. Sulphate-Resisting Portland Cement, Sulphate-Resisting Portland Cement with Added Slag, Sulphate-Resisting Cement with Added Pozzolane

Mineralogical content:
- Content 3CaO Al2O3 (C3A).................... max 3.5%
  or if 2 C3A + C4AF <= 20%
  the content of C3A is allowed..................... max 5.0%
- Shape and size of C3S and C2S crystals, determined by a microscopic analysis, shall be regular.

The percentage and type of added material shall be selected depending on the type of structure and aggressive environment to which the structure will be exposed during operation.

Chemical composition of cement
- Loss on ignition max 5.0%
- Content of SO3 max 3.5%
- Content of MgO max 5.0%

Insoluble residue:

a) For sulphate-resisting Portland cement and sulphate-resisting Portland cement with the addition of slag..................not more than .3%
b) For sulphate-resisting Portland cement with the addition of pozzolane.......not more than 15%

Physical properties of cement
- Fineness:
  residue on 0.09 mm sieve...............not more than 10%
  Blaine's specific surface area............. min 2400 cm2/g
- Standard consistency..................................... max 29%
- Bulk density,
  without pores and voids .... min 3.0 g/cm3
- Time of setting:
  Start ....not in less than 60 min

End ....not more than 10 hours
- Volumetric soundness
  a) on small pats, cement shall be of sound volume, after 3 hours of boiling;
  b) Le Chatelier's rings:
     increase in spacing of arms .... max.10 mm
- Autoclave expansion .... max 0.5%
- Shrinking (measured on mortar according to the method given in Table 7) ....max 0.6 mm/m

Strength of cement

Determined as specified in SRPS B.C8.022, and shall meet the quality requirements set out in SRPS B.C1.014/82, Classes 25, 35, or 45.

Resistance to corrosion

Shall meet the requirements for sulphate corrosion tested according to V.V. Kind's method.

8.2.2.3.6. White Portland Cement

White Portland cements, grade class 25, 35, 45, and 55, and whiteness groups A, B, and C, that meet the quality requirements set out in SRPS B.C1.009/82 shall be used.

Chemical composition of cement
- Content of SO_3
  For cements with specific surface area up to 4000 cm2/g, ... max 3.5%
  For cements with specific surface area above 4000 cm2/g,................................ max 4.5%
- Loss on ignition for classes 35, 45, and 55 .. max 5.0%
- Insoluble residue .... max 2.0%
- Content of MgO... max 5.0%

Physical properties of cement
- Fineness on 0.09 mm sieve ....not more than 10%
- Whiteness
  Group A ....at least 80%
  Group B ....at least 75%
  Group C ....at least 70%
- Specific surface area......................at least 2400 cm2/g
- Bulk density
  without pores and voids ....at least 2.9 g/cm3
- Time of setting
  Start of setting ....not less than 45 min.
  End of setting...........................not more than 10 hours
- Volumetric soundness, SRPS B.C8.023
  On small pats: cement shall be of sound volume after 3 hours of boiling
  According to Le Chatelier's method:
  increased spacing between needle tips after boiling.. max. 10 mm
- Autoclave deformations for cement with the content of MgO > 5%.................max. + 0.8%
- Strength of cement
- Compressive strength and flexural strength shall meet the requirements set out in SRPS B.C1.009/82.

8.2.2.3.7. Cement for Grouting

Cement for grouting shall meet the requirements set out in these Technical Specifications for the relevant type of cement. The cement for grouting cables in pre-stressed concrete shall meet the quality requirements set out in the Rules on technical norms for grouts for pre-stressing cables, and/or quality requirements set out in the 1963 International recommendations for suspensions for pre-stressed concrete, and German provisional guidelines for injection of cement mortar into ducts. This cement may contain chloride ions not more than 0.025%, and not more than 0.013% of chloride ions in water, i.e. the mix of cement-aggregate and water shall not be more than 100 mg/l of used water. Before being used for grouting, cement shall be particularly tested for the content of calcium-chloride.

8.2.2.3.8. Supersulphate cement

Cement components
- Granulated blast furnace slag 70-90%
- Portland cement clinker, not more than 5%
- Anhydrite 10-25%

Chemical composition of cement:

The chemical composition of cement shall meet the following requirements:
- Content of SO_3 max 15%

Physical properties of cement:
- Fineness:
  Residue on 0.090 mm sieve max 10%
- Soundness:

On small pats:	Cement shall be of sound volume after 3 hours of boiling and after resting for 28 days in water at the temperature of 20 ± 1°C
According to Le Chatelier's method:	
Increased spacing between needle tips after boiling	not more than 10 mm

- Setting:

Start of setting	not less than 45 min.
End of setting	not more than 10 hours

- Strength of cement:
  Compressive strength and flexural strength shall meet the requirements set out in SRPS B.C1.011/82.

8.2.2.3.9. Low-Heat Cements

For massive concrete, and only for structures for which this is required in the design, the cements with a low heat of hydration shall be used, grade class 25 and 35, that shall meet the quality requirements set out in SRPS B.C1.013/80 for the given type and class of cement.
- Components of cement shall meet the requirements set out in SRPS B.C1.011.

Chemical composition of cement

– Loss on ignition (moist-free at 105°C)	not more than 5%
– Insoluble residue for pozzolane-free cements	not more than 2%
– Content of SO3 for cements designated as:	
NPC, NPC mp, NP mp	max 3.5%
NPC nz, NPC nz mp,NP mp nz	max 4.0%
– Content of MgO for cements designated as:	
NPC, NPC mp, NP mp, NP mp nz	max 5.0%
NPC nz, NPC nz mp, NM nz, NM nz mp (If MgO is not in the form of periclase, and the soundness of volume is confirmed with an autoclave test)	max 7.0%

Physical properties of cement

– Fineness:	
Residue on 0.09 mm sieve	max 15%
Blaine's specific surface area	at least 2400 cm2/g
– Bulk density	at least 3.0 g/cm3
– Quantity of water for standard consistency, for cements:	
NPC, NPC nz, NPC mp, NM nz, NM nz mp .	not more than 30%
NP mp, NP mp nz	not more than 32%
– Time of setting:	
Start	not less than 2 hours
End	not more than 10 hours
– Volumetric soundness:	
Le Chatelier's method	not more than 10 mm
The big pat method	no cracks allowed
– Hydration heat	
the dissolution method:	
after 7 days	not more than 250 J/g
after 28 days	not more than 295 J/g
the method with a vacuum flask:	
after 3 days	not more than 230 J/g
after 7 days	not more than 275 J/g

Strength of cement

Determined as specified in SRPS B.C8.022, and shall meet the quality requirements set out in SRPS B.C1.013/80. The strength of cement after 90 days shall also be tested, with the results stated in the test report which shall be submitted for the approval of the Engineer.

8.2.2.4. Handling Requirements

Transport and storage of cement, and handling of cement in phases – from the supplier to the entry into the process of preparation of a fresh concrete mix.

8.2.2.4.1. Transport of Cement

Every type of cement shall be supplied in bulk with silo trucks and silo wagons, and in bags with trucks and wagons. White Portland cement and supersulphate cement shall be supplied to concrete plants in bags only.

Silo trucks and silo wagons for bulk cement transport shall be hermetically closed, and when taking over cement, they shall be tamperproofed until the cement has be repumped into the silo. Such transport vehicles shall not be used for transport of any other materials. Cement may be filled into transport silos only if they are completely dry. Silo trucks and silo wagons shall be equipped with a unit for repumping cement into silos on the site.

Bagged cement shall be transported in covered trucks only, or in closed wagons. The bottom of a truck, or wagon, shall be completely dry. Bags shall be loaded and reloaded only in covered places, to exclude any possibility of dampness. All cement damaged with damp or in any other way shall be removed from the site immediately.

Every cement delivery shall be documented with an accompanying Manufacturer's specification list indicating:

- Type and class of cement
- Origin – Manufacturer of cement,
- Production date
- Shipment date,
- Quantity of cement.

Besides, a certificate with test data, as specified in Sub-Section 8.2.2.6.2, shall also be enclosed.

8.2.2.4.2. Storage of Cement

To store cement, the concrete plant shall be equipped with silos in a qualitative and quantitative way that ensures the reception of delivered bulk cement, and with a storage area for bagged cement.

In the concrete plant, cement shall be stored by types and used for preparing concrete according to the order of reception on the site. Silos in the concrete plant shall be protected against weather conditions, equipped with a platform and sampling kit, with the possibility of sampling over the full height of silo, and with a kit for measuring the quantity of cement in the silo. Silos shall be equipped with units for discharging any inadequate cement deliveries. From the outside, silos shall be painted in light colours. Cement silos in the concrete plant shall be of a capacity needed for a 3-day production of concrete, and at least 3 units. From one of such units cement is pumped for the production of concrete, another one is refilled, and the third one is for control. Any fourth unit, or subsequent unit, shall be used as a back-up for any case of untimely procurement, and inadequate quality of cement.

One and the same silo shall store cements of a single type and class, from the same factory. Cements of the same type and class from different manufacturers may be stored in the same silo only if previously proven that they are compatible, and that mixing them has no adverse impacts on the properties and uniformity of produced concrete, which shall be proven with a comparative test. Cement storages shall be built to ensure a dry storage of bagged cement, regardless of weather conditions.

A safe way of keeping different types of cements in the storage shall be ensured. Cements, in principle, may be stored for 3 month at most, with a one-time monthly restacking, except for special cements that require a faster application, namely:

- Quick hardening cement not longer than 1 month
- Supersulphate cement not longer than 14 days

8.2.2.5. Pre-Testing of Cement

Only previously tested cements shall be used for the production of concrete. Pre-tests shall be performed by an authorized institution.

Pre-tests shall be performed for each type of cement separately. A type of cement is considered to be a different mark, i.e. name of cement, and a different origin. Pre-tests shall be performed according to specifications provided for each type of cement separately, as given in Table 6.

8.2.2.5.1. Time for Cement Pre-Tests

According to PBAB/87 (Official Journal of SFRY, No. 11/87), it is obligatory to ensure a compliance certificate on performed pre-testing of cement, for each type, as follows: 1 compliance certificate for the monthly consumption of up to 2000 tons, 2 certificates for the monthly consumption of 2000-5000 tons, and 3 certificates for the monthly consumption in excess of 5000 tons. If the producer of concrete requires the use of cements of Yugoslav manufacturers without pre-test compliance certificates, the Engineer shall allow their use only when assured that they meet the basic properties of cement: a standard consistency, time of setting, volumetric soundness, and fineness. The Engineer shall make an entry on his approval into the Building Journal, and set a time limit within which the producer of concrete shall provide a pre-test compliance certificate. The longest time may be 35 days.

The application of the first paragraph above shall be obligatory for the use of cement for concrete pavements, and concrete for bridges. For other concretes, the Engineer may require a lower frequency in the provision of compliance certificates, with each shipment of cement tested before its use against the properties from the second paragraph above, and if the results are met, the Engineer shall approve the cement for use. This paragraph shall not apply to imported cements, for which the application of the first paragraph of this Sub-Section is mandatory.

During sampling, a protocol shall be prepared and enclosed with the compliance certificate. Sampling shall be in compliance with SRPS B.C1.012/79.

8.2.2.6. Regular Tests of Cement

- Regular test within the concrete plant.
- Supplier's certificate on cement testing.

Table 6.
Specification of tests for particular indicators of cement properties for different cements within pretesting (x: to be tested , -: not to be tested)

Cement type code		Pavement and other structures	Quick hardening	For stabilisation	White	Sulphate-resisting	Grouting	Super-sulphate	Low-heat
1	2	3	4	5	6	7	8	9	10
8.2.2.5.1.		Chemical analysis							
		x	x	x	x	x	x	x	x
8.2.2.5.2.		Structural composition							
- Bogue's method		x^0	x	-	x	x^0	x^0	-	x^0
- X-raying		x	x	-	x	x	x	x	x
-microscopic		x^0	x	-	x	x	x^0	x	x^0
		^{0}/ for Portland cement							
8.2.2.5.3.		Fineness							
- residue on 0.090 mm sieve		x	x	x	x	x	x	x	x
8.2.2.5.4.		Blaine's specific surface area							
		x	x	x	x	x	x	x	x
8.2.2.5.5.		Bulk density w/o pores and voids							
		x	x	x	x	x	x	x	x
8.2.2.5.6.		Bulk density in loose and compacted condition							
		x	x	x	x	x	x	x	x
8.2.2.5.7.		Water required for standard consistency							
		x	x	x	x	x	x	x	x
8.2.2.5.8.		Time of setting							
- at 20°C		x	x	x	x	x	x	x	x
- at 5, 10, 30°C		x	x	x	x	x	x	x	x
8.2.2.5.9.		Volumetric soundness							
- on small pats		x	x	x	x	x	x	x	x
Chatelier-y method		x	x	x	x	x	x	x	x
- autoclaving		x	x	x	x	x	x	x	x
8.2.2.5.10.		Water absorption posle 30 minuta							
		x	x	x	x	x	x	x	x
8.2.2.5.11.		Water retention							
		x	x	x	x	x	x	x	x
8.2.2.5.1.12.		Linear deformations on mortar prisms							
		x	x	x	x	x	x	x	x
8.2.2.5.13.		Mechanical flexural and compressive strengths after (1),3,7,28,(90) days							
		x	x	x	x	x	x	x	x
8.2.2.5.14.		Whiteness							
		x-	x-	x-	x	-	-	-	-
8.2.2.5.15.		Hydration heat							
		x^-	x^-	x^-	x^-	x^-	x^-	x^-	x
8.2.2.5.16.		Susceptibility to cracking according to L'Hermite's method or AFNORP 15-351 (the method applied in the Institute)							
		x	x	-	-	x	x	-	-
8.2.2.5.17.		Corrosion according to V.V. Kind's method in the solution that matches the composition of aggressive water in nature (according to the procedure adopted in the Institute)							
		x	-	x	-	x	x	x	x

8.2.2.6.1. Regular Control Tests within Concrete Plant

Regular control tests within the concrete plant shall be performed by the laboratory of the producer of concrete. The tests shall be performed on samples taken from transport vehicles or from silos, at every repumping of a one-time delivery of bulk cement. Samples of cements that are used in a small quantity (special cements) and delivered in bags to the concrete plant, shall be taken from every delivery.

All control tests shall be completed to the satisfaction of the Engineer.

Samples from bulk and bagged deliveries shall be taken for one-time measurement and overall testing, individually or all at once, in the quantity needed for testing, which means that tests are not performed on samples to achieve a certain degree of average condition.

Regular control tests for all types of cements from Table 6. of these Technical Specifications are obligatory in the following scope:

- Cement used for concrete pavements and concrete for bridges shall be tested every day when concrete works are executed, which is in accordance with PBAB/87 (Off. Journal of SFRY, No. 11/87, Art. 11);
- For cement used for other concrete works, every delivery shall be tested.

Control tests in both cases shall determine as follows:

- Standard consistency SRPS B.C8.023
- Time of setting SRPS B.C8.023
- Volumetric soundness
  by 3-hour boiling of small pats SRPS B.C8.023
- Fineness
  - residue on a 0.09 mm sieve SRPS B.C8.023

8.2.2.6.2. Supplier's Cement Testing Certificate

The producer of concrete shall submit to the Engineer, for each delivery of cement, a cement quality test certificate. The certificate shall contain results of the tests performed according to SRPS standards, and of other tests as set out in these Technical Specifications. The certificate shall have the code and source of cement, the stamp and signature of the supplier, i.e. of his authorized representative.

8.2.2.7. Storage of Cement Samples

For every type and class of cement, the producer of concrete shall take and store samples according to the applicable Yugoslav standard for cement sampling. One cement sample taken in that way may refer to not more than 250 tons of received and/or used cement.

Cement samples shall be taken immediately, and within one week from the delivery at latest. Cement samples shall be stored in the laboratory of the producer of concrete until the time of handover/taking over of completed structures, while ensuring that the qualitative soundness of cement samples shall not be compromised.

Samples are taken in the presence of the Engineer or person in charge of that, and shall be sealed.

Table 7. Types of tests in the Institute that is authorized for certification, and test methodologies

Type of test	Test method
Sampling	SRPS B.C1.012/79
Chemical analysis of cement based on Portland clinker	SRPS B.C8.020/75
Potential mineralogical composition of Portland cement (to be tested if needed)	According to Bogue's calculations or according to Leo-Parker's correction of Bogue's formulae
Mineralogical composition of Portland cement, if needed	Microscopic or X-ray diffraction
Content (%) of slag or pozzolane	According to a procedure elaborated in the Institute
Physical properties of cement:	
- Fineness, on sieve	SRPS B.C8.023/82
- Blaine's specific surface area	
a) For Portland cement	SRPS B.C8.024/63
b) For cement with admixtures	SRPS B.C8.026/66
- Bulk density w/o pores and voids	SRPS B.C8.023/82
- Bulk density in compacted and loose conditions	SRPS B.C8.023/82
- Standard consistency	SRPS B.C8.023/82
- Time of setting	SRPS B.C8.023/82
- Volumetric soundness	
a) on small pats	SRPS B.C8.023/82
b) on Le Chatelier's rings	SRPS B.C8.023/82
Autoclave expansion of cement	SRPS B.C8.025/79
Linear deformations –shrinking	SRPS B.C8.029/79
Construction of bodies according to expansion. Curing: water=20±1°C	SRPS B.C8.029/79
Strength	SRPS B.C8.022/76
Whiteness of cement	SRPS B.C1.009/82
Cement hydration heat	
a) Vacuum flask method	SRPS B.C8.027/75
b) Dissolution method	SRPS B.C8.028/75
L'Hermite's method, or AFNORP 15-351	
Susceptibility to cracking	(According to a method applied by the Institute)
If the cement in question shall be resistant to aggressive sulphate environment	Resistance to sulphate aggressiveness and corrosion determined according to a procedure adopted by the Institute for Testing of Materials

8.2.3. Water for Production of Fresh Concrete

Water for the production of concrete shall not show an unfavourable impact on the setting and hardening of cement. Plain drinking water (tap water) may be considered suitable for mixing concrete; if water is chlorinated, it shall be subjected to a full test. Industrial waste water and marsh water that contain harmful ingredients that disrupt normal setting and hardening of concrete shall be considered unusable.

Water from rivers and lakes, and/or groundwater, shall be used only when a qualified company, registered for the activity that covers water quality testing, issues satisfactory compliance certificates.

8.2.3.1. Quality Requirements for Water

Water may be considered suitable for the production of concrete if it meets the following requirements:

Properties		Plain concrete	Reinforced concrete	Pre-stressed concrete
pH value		4.5 - 9.5	4.5 - 9.5	4.5 - 9.5
Chloride content (Cl^-), mg/l	max	-	300	100
Sulphate content ($SO42^-$), mg/l	max	2700	2700	1000
Sulphate content ($S2^-$), mg/l	max			100
Nitrate content ($NO3^-$), mg/l	max	500	500	500
Phosphate content (P2O5), mg/l	max	100	100	100
Bicarbonate (alkaline) content (NaHCO3), mg/l	max	1000	1000	1000
Consumption of potassium-permanganate (KMnO4), mg/l	max	200	200	200
Content of dissolved matter, as a residue from the evaporation of clear or filtered water, mg/l		5000	5000	2000
Content of undissolved matter, as a difference from the residue from evaporation of unfiltered and filtered water, mg/l		2000	2000	2000
Difference in time of setting between cement pastes prepared with tested water and with distilled water, in minutes		30	30	30

Water shall not contain oils, grease, oil products, and sugar. Their presence shall be determined visually, and the presence of sugar by a qualitative chemical analysis.

The quality of water shall be tested by an institute authorized for certification, according to test methods specified in the Yugoslav standard U.M1.058/85.

The pre-test compliance certificates shall be valid for one construction season.

Regular control tests by the concrete manufacturer's laboratory shall be performed when needed or as directed by the Engineer.

8.2.4. Concrete admixtures

"Concrete admixtures" mean chemical substances that are added to concrete in small quantities before or during mixing in order to obtain certain properties in fresh or hardened concrete, as defined in SRPS U.M1.034/81.

For concrete mixing it is allowed to use only admixtures confirmed, by a compliance certificate, to possess declared properties and whose use does not weaken the basic properties of concrete, and does not cause the corrosion of reinforcing bars. (Certification for compliance is obligatory according to "Off. Journal of SFRY" No. 34/85.)

Compliance certificates are issued by qualified companies registered for the activity that covers the testing of such admixtures for quality.

Before the use of concrete with admixtures, the concrete producer shall test its qualities and confirm this by a compliance certificate issued by a qualified company registered for the activity that covers the testing of such concrete.

The concrete producer shall require the manufacturer's instructions for use and follow them. The concrete producer shall furnish the Engineer with a quality certificate for every delivery of every type of admixtures.

The certificate shall contain the test results for properties specific for the intended use, non-harmfulness for concrete, the code and source of the admixture, production date, quantity, delivery date, stamp, and signature. The certificate shall be submitted by the producer, or by his authorized representative.

The producer of admixtures shall, for every admixture separately, define with what types of cement they may be used. The selection of type of admixture shall be confirmed by the Engineer on a case-by-case basis.

8.2.4.1. Classification of Concrete Admixtures

Concrete admixtures are classified into the following basic groups:

- Plasticizers,
- Air entrainers,
- Retarders,
- Accelerators,
- Hardeners,
- Sealants,
- Admixtures for concreting at low temperatures.

Concrete admixtures may have a combined effect on the properties of concrete. In that case, the title of the pertaining group shall first state its primary characteristic that has the greatest impact on the properties of concrete.

8.2.4.2. Quality Requirements for Concrete Admixtures

For the production of concrete it is allowed to use admixtures that meet quality requirements according to SRPS U.M1.035/82.

Testing of Chemical and Physical/Chemical Properties

The following physical and chemical properties shall be tested according to SRPS U.M1.039/82:

- Bulk density in fluid state
- Bulk density in solid state
- Surface tension of plasticizers and air entrainers,
- Content of dry matter in fluid state,
- Solubility in fluid state in distilled water and lime-saturated water ,
- Loss on ignition in solid state,
- pH value,
- Chlorine-ion content, qualitative, and quantitative only if the qualitative analysis turns up positive,
- IR spectroscopy,
- Determination of reduction matter,
- Stability of foam from air entrainers.

Physical/chemical properties of an admixture are not subject to requirements. Test results are entered into a protocol.

Testing impacts of admixtures on the properties of cement paste and mortar
- Testing impacts of admixtures on the properties of cement paste shall be performed according to SRPS U.M1.038,
- Standard consistency shall be tested according to SRPS B.C8.023,
- Time of setting for admixtures for concreting at low temperatures shall be determined at - 5°C and at a lower limit temperature declared by the manufacturer,
- Volumetric soundness shall be determined according to SRPS B.C1.023
- Testing impacts of admixtures on the properties of cement mortar shall be performed according to SRPS U.M1.038,
- Reduced amount of necessary water shall be determined according to SRPS U.M1.038,
- Flexural and compressive strength shall be determined according to SRPS B.C8.022,
- Linear deformation shall be tested according to SRPS B.C8.029,
- Air content shall be determined according to SRPS B.C8.050.

The qualities to be met by cement paste and mortar with an admixture are given in Table 1 of SRPS U.M1.035/82. Tests not subject to requirements shall be performed and their results entered into a protocol.

Testing Impacts of Admixtures on Corrosion of Steel in Concrete.

Admixtures do not have any impact on the corrosion of steel in concrete, if a rod (test specimen) made of concrete, according to SRPS U.M1.044, with a maximum amount of admixture as declared by the manufacturer, at the voltage of 225 mV according to a calomel electrode and the procedure set out in SRPS U.M1.044, has the current density of less than 60 A/cm^2.

Testing Impacts of Admixtures on Properties of Concrete

Fresh concrete:
- Bulk density in compacted state.
- Consistency shall be determined according to SRPS U.M8.054.
- Time of setting shall be determined according to SRPS U.M1.019.
- Air content shall be determined according to SRPS U.M1.031.

Hardened concrete:
- Bulk density.
- Compressive strength shall be tested according to SRPS U.M1.020.
- Resistance to frost shall be tested according to SRPS U.M1.016.
- Water-impermeability shall be tested according to SRPS U.M1.015.

The quality to be met by hardened concrete with admixtures is given in Table 2 of SRPS U.M1.035/82, and the impacts of admixtures on concrete properties shall be tested according to SRPS U.M1.036/81. For bulk density in compacted state, time of setting, as well as the content of air in fresh concrete, the quality shall not be determined, but the tests shall be performed and their results entered into a protocol.

8.2.4.3. Checking Primary Use

Before mixing concrete with the use of admixtures, it is necessary to check whether the admixture to be used in concreting is suitable for its primary use, as defined in SRPS U.M1.037/81 ("Pre-testing for the selection of concrete admixture with particular aggregate and cement").

8.2.4.4. Checking Admixtures in Concrete Plant Before Use

Before applying admixtures, the producer of concrete shall check every received batch of admixtures, or a part thereof, for the following properties:
- Standard consistency of cement paste,
- Time of setting of cement paste of standard consistency,
- Compressive strength of concrete samples.

8.2.5. Chemical agents for surface protection of placed concrete against drying out

For the surface protection of placed fresh concrete that has to harden it is allowed to use liquid chemical spraying agents. These agents shall be pre-tested by a qualified company registered for the activity that covers the testing of qualities of these agents, and shall be used according to the manufacturer's instructions. The contractor shall furnish the Engineer with a quality certificate for every delivery of every type of protective agent.

The certificate shall contain the test results for properties specific for the intended use, non-harmfulness for concrete, code and source of the agent for surface protection of concrete against drying out, production date, quantity and date of delivery, stamp, and signature. The certificate shall be submitted by the manufacturer or his authorised representative.

Before using a chemical agent for surface protection of places concrete against drying out, the Contractor shall have a report on testing of water retention effects, through the measurement of their ability to prevent the loss of moisture during the early setting period. The method ASTM C-156 shall be applied for the test.

8.3. Quality Requirements for Concrete

8.3.1. Quality Requirements

8.3.1.1. General

For all concrete works within the construction (except for any specifically set requirements) the applicable technology shall be the technology of plasticized, thick, compact, and technically water impermeable concrete that is, for certain uses, artificially micro-aerated or capillary-densified. Only concrete found to meet specified quality requirements, through pre-tests and special requirements, may be used for this procedure. Concrete shall be placed only mechanically. Concrete for concrete pavements shall meet the requirements set out in SRPS U.E3.020/87.

8.3.1.2. Composition of Class B-II Concrete

The composition of class B-II concrete, considering its properties in fresh and hardened conditions, shall be determined through calculations and experimentally.

8.3.1.3. Properties of Concrete

In designs, the required grades and other properties of concrete (MB) shall apply for concrete after 28-day aging, and shall refer to destructive strengths of moulded cubes, with 20-cm sides, and a maximum grain size of 63 mm, cured at 95% humidity, at least, and the temperature of 20±4°C, and tested according to SRPS U.M1.020.

The quality of concrete shall be defined in the design based on technical specifications for concrete works, and specifications for relevant constructions and elements in the course of operation. Regardless of its intended use, concrete shall also bear, aside from the designation of its grade (MB), its special properties in the design, if special purpose structures are constructed.

The design may envisage that concrete, aside from the designation from paragraph 2 above, also bears designations of other properties, such as: water impermeability, frost resistance, frost and salt resistance, resistance to chemical impacts, and wear resistance.

8.3.1.3.1. Provision of Proof for Concrete Grade

Every 3 months, in order to prove the grade of concrete, all results of compressive strength tests, grouped by batch for the past three months, shall be processed statistically for every type of concrete. The statistical processing of test results shall include the calculation of the typical strength of concrete: Fk. The typical compressive strength is the value below which not more than 10% of all strengths of tested concrete may be expected, with the number of samples $n \geq 30$, and meeting the following requirement:

$Fk = Fkm - 1.28\ S$ where:
Fk - Typical compressive strength in MPa
Fkm - Mean compressive strength value for all test results in MPa
S - Standard squared deviation in MPa, defined according to Art. 46 of the new PBAB/87 (standard deviation).

When producing B-II concrete, the producer of concrete shall test its compressive strength according to SRPS U.M1.020 on a sample taken for every type of concrete, on every day of production, or at every 50 m^3 of produced concrete, and/or at every 75 mixes, taking into account the already obtained number of tests. In exceptional cases, if the quantities of produced concrete in the assessment period are large (in excess of 2000 m^3), then samples for testing shall be taken at every 100 m^3, i.e. 150 mixes. The total number of tests for every class of concrete produced in larger quantities (in excess of 1000 m^3) in the assessment period shall be not more than 30. For smaller quantities of concrete, at least 10 tests shall be performed for every type of concrete in the assessment period. The results of concrete compressive strength tests shall be assessed according to SRPS U.M1.051.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.3.1.4. Concrete Grade Control Programme

Grade of concrete (MB) shall be assessed by batch, in line with the control programme against one of criteria, as specified in Art. 46 of the new Rules on technical norms for plain and reinforced concrete ("Off. Journal of SFRY", No. 11 dated 23 February 1987).

8.3.1.4.1. Other Requirements

Having in mind various requirements for the basic load (dead load) and the useful load of a construction and/or structure, concrete shall be mixed and placed according to criteria for achieving other relevant technical properties conditioned by the values of W/C factor of fresh concrete that shall not exceed specific limit values, by achieving the required degree of castability and water impermeability of hardened concrete, as set out in SRPS U.M1.015.

8.3.1.5. W/C Factor for Concrete without Special Requirements

For concretes for which there are no special requirements in the design or technical specifications, water shall be used only as much as necessary to compact concrete well, considering the placement conditions, but the applicable criterion is that they shall not be mixed and placed with a W/C factor in excess of 0.60.

8.3.1.6. W/C Factor for Frost-Resistant and Water impermeable Concretes

The criterion that a maximum W/C ratio shall not exceed 0.50 shall apply to concretes for which specifications or technical specifications require, or for which a need arises, subsequently, considering field conditions, to ensure the freeze-thaw resistance or impermeability. If a need arises for a higher W/C factor, because of the placement needs, it is necessary to use special technological procedures, such as the addition of plasticizers, micro-aeration, capillary densification, or other appropriate procedures. Such concrete shall be impermeable, according to the Rules on technical norms for concrete pavement (SRPS U.E3.020/87).

8.3.1.7. W/C factor for concrete on pavement and concrete exposed to frost and salt

For concrete pavements and other concretes particularly exposed to the action of frost and salts, micro-aeration shall necessarily be applied. Based on prior documented tests, instead of the micro-aeration of these concretes, it is allowed to apply their capillary densification. For these concretes, in general, the criterion of a maximum W/C factor value of 0.60, and the criterion of impermeability are becoming stricter. For concrete on pavement, an additional requirement is that the value of a maximum W/C factor shall not exceed 0.50. For concrete in pre-stressed structures that shall not be aerated, the applicable criterion is the one set out in the Rules on technical measures and requirements for pre-stressed concrete.

8.3.1.8. Testing Concrete for Frost Resistance

The frost resistance of concrete shall be tested according to SRPS U.M1.016/77. The grades for frost resistance of concrete are M-50, M-100, M-150, and M-200, where the number indicates the highest number of alternate freezing at a stable temperature of -20°C for 4h, and thawing in water of temperature +20°C for 4h. The objects to be tested shall be in the shape of a cube, with 150 or 200 mm long sides, or cylindrical specimens taken from a completed structure, 150/150 mm in size. The number of samples, cycles, and the test procedure shall be in line with the requirements set out in the above-mentioned SRPS, depending on the required grade of concrete (MB). When pretesting for the frost resistance of concrete, it is necessary to test aggregate, water, cement, and any admixtures of concrete according to requirements set out in relevant SRPS, Rules on technical norms for plain and reinforced concrete, and Rules on technical measures and requirements for pre-stressed concrete.

In the previous procedure, it is necessary to get a mix design for concrete that should be resistant to frost from a relevant institution registered for that type of activities. In the designs it is necessary to specifically state those elements of construction that also require frost resisting concrete. The pertaining appendices to the design shall state the compressive strengths of concrete – concrete grades, the types of steel and reinforcing bars, and the relevant grades of frost resistance, or frost and salt resistance of concrete.

When testing concrete for frost resistance, the compressive strength of frozen concrete test bodies shall be at least 75% of strength of non-frozen test bodies of respective age (standard).

Four days before starting the test, all test bodies shall be put into water of temperature 20°C+2, that should be at least 2 cm above the top surface of test body.

Mandatory pre-tests for the frost resistance of concrete shall be conducted for concrete pavements, bridge span structures and gutters, and for other concrete structures, if for concrete works, i.e. mixing of concrete, non-standard mineral aggregates are used (all gravels with the presence of hornstone, all volcanic rocks with the content of glass, dolomites, etc.), with the presence of small particles of 0.02 mm in size.

The mentioned pre-tests shall be conducted for concrete in constructions and elements on such road sections where the freeze-thaw process is present in the range from 0 to 20°C, and if the number of freeze-thaw cycles per year is over 10, particularly in environments where water and aggressive substances are present (in the air, water, soil, and during winter road maintenance), where the Designer shall take these conditions into consideration when designing the structure.

Mandatory control tests for the frost resistance of test concrete bodies (kerns) shall also be performed for concrete pavements. If mineral aggregate for concrete works (this does not apply to concrete pavement and lanes, bridge span structures, gutters, and tunnel arches) has a smaller presence of particles finer than 0.02 - 2.5 mm in size, the testing for frost resistance is not necessary, but if their share is over 2.5% but not more than 4%, to approve the mineral aggregate for use in the above-mentioned concrete works, the frost resistance of such concrete constructions and elements shall be proven according to the procedure already described above.

8.3.1.8.1. Testing Concrete for Frost and Salt Resistance

The frost and salt resistance of concrete shall be tested according to SRPS U.M1.055. A minimum requirement is that it shall be resistant.

8.3.1.9. Concrete Exposed to Aggressive Action of Water or Soil

Concrete placed in the environment exposed to the aggressive action of water or soil shall fully meet the quality requirements set out in the Rules on technical measures and requirements for the design and construction of concrete and reinforced-concrete constructions in environments exposed to the aggressive action of water and soil (SRPS U. M1.014 and PBAB/87).

8.3.1.10. Degree of Aggressiveness of Water and Soil to Concrete

The degree of aggressiveness of water and soil to concrete shall be determined by chemical analyses of water and soil performed by a qualified company registered for that activity. The action of water on a structure may be under pressure of 15 atm, and with a unilateral hydrostatic pressure, a pressure with a gradient in excess of 5, which is a criterion whether the structure is under water pressure or not.

8.3.1.11. Water sampling

Water samples to be sent for testing shall be taken at water temperature of 0°C to +25°C. If the temperature of water during sampling is not within the stated range, this should be stressed in particular.

8.3.1.12. Indicators of aggressive actions of water and soil

The indicators of aggressive actions of water and soil, as set out in the Rules specified under 8.3.1.9., relate to concrete mixed with Portland cement, with the addition of pozzolane or slag, or with special Portland cement that has a required water impermeability after 28-day setting under normal conditions.

8.3.1.13. Basic forms of aggressive action of water on concrete are:

1. General acidic aggressiveness determined over the concentration of acids, i.e. pH value;
2. Carbon-acidic aggressiveness, determined over the concentration of free carbonic acid, taking into account the content of calcium, chlorides, and sulphates, as well as carbonate hardness;
3. Leaching, determined by the value of hydro carbonate alkalinity;
4. Sulphate aggressiveness, determined by the concentration of sulphates, taking into account the chloride content;
5. Magnesium aggressiveness, determined by the concentration of magnesium ions depending on the content of sulphate ions;
6. Ammonium aggressiveness, determined by the content of ammonium ions;
7. Alkaline aggressiveness determined by the concentration of alkalis.

8.3.1.14. Concrete exposed to aggressive action of water and soil

Concrete exposed to aggressive action of water and soil shall be mixed with appropriate cement and aggregate, but after 28 days of normal hardening it shall have water impermeability that meets the following coefficient of permeability 8.10 cm/sec K=26.10 cm/sec.

Water impermeability shall be tested by a qualified company registered for the testing of materials and constructions, according to SRPS U.M1.015/78, on cylinders, 15 cm in diameter, 15 cm high, or plates, 20x20x15 cm, that are exposed to the action of water for 8 hours under the pressure of 1 atm, and then to the action of water under the pressure of 2 atm for another 8 hours.

The grades of water impermeability of concrete are: B-2, B-4, B-6, B-8, B-12, where the numbers 2, 4, 6, 8, and 12 indicate pressures in bars that concrete (test specimens) shall meet according to SRPS U.M1.015/78.

Based on the given indicators of aggressiveness of water and soil, the cement shall be selected so as to ensure the durability of concrete. If the environment is very aggressive, it is necessary to envisage measures for the protection of concrete in the form of coating. A minimum quantity of cement per 1 m^3 of finished concrete shall be 350 kilograms.

If the aggregate used for concrete, exposed to alkaline aggressive actions of water and soil, contains amorphous silicon (opal, chalcedony, chert), its potential alkali-silicate reaction shall be tested according to SRPS B.B8.056/81. If concrete is exposed to occasional or permanent contact with water or damp soil, and is mixed with cement of a high alkali content (Na_2O + K_2O), the potential alkali-silicate (SRPS B.B8.056) and potential alkali-carbonate (ASTM C-586) reactivity shall be tested.

For mixing concrete exposed to aggressive actions of water and soil, it is necessary to adopt a minimum amount of water needed to obtain the required strength, castability, and water impermeability, as determined experimentally.

Fresh cast concrete and prefabricated elements in an aggressive environment under normal conditions of hardening, shall not come into contact with water for at least 14 days from the date of placement, and for at least 21 days if concrete is made with pozzolanic cements.

For reinforced concrete in an aggressive environment, a minimum thickness of the protective layer of reinforcement shall be 5.0 cm, with the surface as enclosed as possible, without any sharp edges, i.e. with rounding of a minimum radius of 5.0 cm.

The concrete design, or investment/technical documents for structures whose particular parts are in an aggressive environment, shall give data on the aggressiveness of water and soil, types of adopted cement, aggregate, and W/C factor, curing of concrete, degree of water impermeability, method for ensuring water impermeability, additional protective measures, methods for control of quality of performed works, and other, full as specified in PBAB/87 from Sub-Section 8.3.1.9.

8.3.1.15. Water Absorption

Water absorption of concrete in pavement structure and pre-stressed constructions shall not be more than 1.3% of concrete mass.

8.3.1.16. Content of particles smaller than 0.25 mm in size

The total amount of cement and aggregate grains smaller than 0.25 mm for B-II concretes shall not be below the values given in Table 8.

Table 8

The largest aggregate fraction (mm)		The lowest total amount of cement and particles of 0.25 mm in size (kg/m3 of concrete)
4	8	500
8	16	425
16	32	350
32	63	300

8.3.2. Requirements in Production of Concrete

8.3.2.1. Designing B-II concretes and concretes for transport

8.3.2.1.1. General

Before starting the production of B-II concretes and concretes for transport, it is necessary that an authorized institution designs their mixes, by computation and experimentally, taking care of specific properties of the basic components to be used for the production of concrete. It is necessary to take care of the castability of concrete, which is primarily determined by the degree of consistency, and a maximum diameter of aggregate grains.

8.3.2.1.2. Design-Related Tests

Design-related tests shall be started in time that enables the provision of necessary results on the properties of concrete to be placed, while ensuring that, aside from proofs on the quality of concrete after 28-day aging, there must also be a proof on the quality of concrete for the age at which the construction and its elements are pre-stressed, on specimens stored under the same conditions as the construction and its elements. Apart from a mandatory proof on the quality of concrete after 28-day aging, it is not mandatory, but is possible, if needed, to conduct a test to prove the quality of concrete after 7 and 90 days.
All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.3.2.1.3. Concrete Mix Design

The concrete mix design shall contain:

1. Aggregate test certificate
2. Binder test certificate
3. Water test certificate
4. Concrete admixtures test certificate
5. Designed grain size distribution curve of mineral mixture
6. Water-cement ratio analysis and designed consistency of concrete
7. Proportions of mineral aggregate, particular fractions, cement, admixture, and water in 1 m3 of concrete,
8. Proportion of mineral aggregate, particular fractions, cement, admixture, and water for one batch, depending on the capacity of mixer.
9. Results of tests on test cubes for each required grade of concrete (MB), including other tests of concrete, if so required in the design.
10. Control of measuring instruments in the concrete plant (mixer), i.e. control of scales and water gauges, performed according to SRPS U.M1.050; adoption of a mix for 1 batch in the mixer, namely for:
    - cement,
    - water,
    - aggregate:
      granulometric composition,
      dosage by fraction,
      particles of 0.09 mm in size in a fraction, and
      particles of 0.063 mm in size in an aggregate fraction,
    - consistency of concrete.

8.3.2.2. Working Condition in Concrete Plants

8.3.2.2.1. Equipment in Concrete Plant

The equipment and working processes in a concrete plant shall ensure the required degree of homogeneity in the properties of fresh cast and prefabricated concrete, according to SRPS U.M1.050 and SRPS U.M1.051.

8.3.2.2.2. Thermal Calculations at Low Temperatures

If concreting is performed at low temperatures, the possibility of tempering fresh concrete shall be ensured, i.e. its relevant components (water - aggregate), according to the required temperature. The concrete plant operations shall ensure the possibility of an adequate protection of fresh concrete during handling and placement, as well as of placed concrete, and concrete during hardening, against weather conditions. Thermal calculations shall be made with respect to caloric properties of the components of concrete, forms, and ambient temperatures, and the temperature of fresh concrete that is being placed.

8.3.2.2.3. Handling Time

The duration of fresh concrete handling and transport, i.e. time from its preparation until placement, is subject to the requirement that within that time there shall be no change in the consistency of concrete. In general, the applicable rule is that the duration of handling and transport shall not be longer than 1 hour. Variations from this limit are possible based on a proven experimental procedure, or with the use of "retarders" – admixtures that slow down the cement hydration process.

8.3.2.2.4. Allowed Drop Height

The allowed drop height of fresh concrete and the height of drop chute shall depend on the concrete mix, and the Contractor shall determine them for each case separately, so as to exclude any segregation of concrete under the impact of gravity. In general, the drop height of fresh concrete shall not be over 1 m.

8.3.2.2.5. Maintenance of vessels for fresh concrete

After every filling and emptying, vessels with concrete shall be cleaned thoroughly. When using vessels that are filled continually (e.g. “transitory” silos), it is necessary to prevent any retention of old concrete on the walls of vessels in a special and adequate way.

8.3.2.2.6. White and coloured concretes

White and coloured concretes shall be mixed separately in concrete plants adequately equipped and supplied for that purpose. For handling and transport of white and coloured concretes, specifically prepared and supplied equipment shall be used. For coloured concretes only resistant pigments, non-harmful for cement clinker, may be used.

8.3.2.3. Use of Admixtures for Concrete

In order to improve properties of fresh and hardened concrete, it is necessary to use admixtures for concrete, according to SRPS U.M1.034.

8.3.2.3.1. Major Types of Admixtures for Concrete and Their Use

In general, the following admixtures may be used:

- Plasticizers,
- Air entrainers,
- Additives for concreting at lower temperatures,
- Thickeners (primarily capillary thickeners),
- Accelerators,
- Retarders,
- Colouring agents for fresh concrete,
- Inhibitors, i.e. agents for the protection of reinforcement steel against corrosion,
- Surface protection of fresh cast concrete (concrete pavement).

It is allowed to use only pre-tested admixtures for concrete according to SRPS U.M1.035, as well as for the selection of admixtures for concrete with a certain aggregate and cement according to SRPS U.M1.037.

It is necessary to check the impact of used admixtures on the properties of concrete, according to SRPS U.M1.036. Furthermore, it is also necessary to check the impact of admixtures to concrete on cement paste and mortar, according to SRPS U.M1.038, and the impact of admixtures on the corrosion of reinforcement steel, according to SRPS U.M1.044.

Admixtures shall be batched precisely. Concrete plants shall be equipped with devices for simultaneous batching of two different types of admixtures. In general, admixtures are added in a diluted state to finished fresh concrete, and to water for mixing concrete.

Devices for handling and batching of admixtures shall be resistant to corrosive impacts of admixtures.

Admixtures made of finely ground mineral materials (rock flour or similar), materials with colloid and hydrophobic properties (bentonites, ground paraffin etc.) shall not be treated as admixtures for concrete. All mentioned pre-tests shall be performed by an institution authorised for that type of activities.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.3.2.3.2. Special Requirements for Micro-Aeration of Concrete

To increase water impermeability, freeze-thaw resistance, and resistance to salt, for certain concretes, and as obligatory for concretes in pavement structures, artificial micro-aeration is used, unless this is compensated for with artificial chemical/mineralogical capillary thickening.

The content and structure of micro-pores in finished concrete shall meet the specified requirements

The batching of a selected and tested air entraining agent shall be determined carefully by the Contractor, with each particular mix of fresh concrete pre-tested. In all phases, the batching of air entrainers shall be precise, continuous, controlled in quantity, according to SRPS U.M1.031.

For the achieved content of micro-pores in fresh concrete, in the mixing phase, it is necessary to take into account the factors listed below, for an air entrainer otherwise batched in the same way:

- Type and composition of mineral aggregate, shape and surface properties of its grains, and the quantity of grains smaller than 0.25 mm;
- The amount and type of cement, particularly the grain size composition, shape and surface properties of grains;
- Consistency of fresh concrete;
- Time and method of mixing fresh concrete;
- Temperature of fresh concrete.

Technically relevant is the content of micro-pores in fresh concrete, and it refers to placed concrete. This is why it is necessary to determine the content of micro-pores in fresh concrete immediately after mixing, while including the impact of the method and duration of handling, and method of placement, particularly the vibration power and duration.

The air content (micro-porosity) shall be controlled and assessed, both on laboratory test specimens in the concrete plant, and on the test specimens taken on site from the structure, according to SRPS U.M1.031.

8.3.3. Cement Mortar

Two basic types of cement mortar are used, according to their intended use:
- Masonry cement mortar, and
- Plastering cement mortar.

Cement mortars shall be made of cement, sand, and water.

8.3.3.1. Masonry cement mortar

By consistency, two types of masonry cement mortar shall be used:
- Liquid mortar, and
- Plastic mortar.

8.3.3.1.1. Quality requirements for materials for preparation of masonry mortar

Cement that serves for mixing mortar shall meet the quality requirements set out in SRPS B.C1.011 and SRPS B.C1.012 (Sub-Section 8.4.1.2. of these Technical Specifications).

Sand for mortars may be:
- Sand from rivers (river sand), reefs, and sandy terrains (quarry sand),
- Crushed sand made of good-quality solid rock material.

Quality requirements for sand for mixing masonry mortar are set out in SRPS U.M2.010.

Quality requirements for sand for mixing masonry mortar

No.
Characteristic of quality Quality Requirement

A. Content of harmful components:
(in percentage by mass)
1. Clay balls (over 0.5 cm3):
   For river sand.. 1%
   For quarry sand 1.5%
2. Fine particles passing through
   0.090mm sieve (wet sieving) 10%
3. Particles under 0.02 mm in size 2%
4. Organic matter.. max 0.01%
5. Suspended matter .... max 0.3%
6. Total sulphur, expressed as SO3 .... max 1%
7. Chlorides, nitrates, nitrites .... max 0.1%

B.Granulometric composition of sand shall be as follows:

Mesh	Passing through sieve	
	natural sand (%)	crushed sand (%)
4	100	100
2	70 – 100	70 - 100
1	48 – 88	45 - 90
0.5	26 – 57	30 - 57
0.25	10 – 26	16 - 37
0.09	0 – 10	0 - 10

Methods for testing particular properties of sand are set out in SRPS U.M8.002.

Water from the drinking water supply mains may be used to mix mortar without any pre-tests. Water of any other origin may be used if it meets the quality requirements set out in SRPS U.M1.058, which is proven by pre-testing.

8.3.3.1.2. Quality requirements for masonry cement mortar

Quality requirements for mortar are set out in SRPS U.M2.010.

8.3.3.1.3.Consistency of fresh of mortar

Consistency of fresh of mortar shall be according to the following values:

Type of mortar	Cone spreading (mm)
Liquid mortar	over 180
Plastic mortar	from 130 to 180

Consistency shall be determined according to the method given in SRPS B.C8.023.

8.3.3.1.4.Strength of Mortar

Strength of mortar shall be according to the following values:

Mortar grade	Compressive strength, MPa After 28 days		Flexural strength, MPa After 28 days	
	Average value, min.	Singular value, min.	Average value, min.	Singular value, min.
0.5	0.5	0.3	0.3	0.2
2.5	2.5	1.7	1.0	0.8
5.0	5.0	3.5	1.7	1.4
10.0	10.0	7.0	2.4	2.0

For testing strength, a test cement-mortar specimen shall be made and cured according to the procedure set out in SRPS U.M8.002. Compressive and flexural strengths shall be tested according to SRPS B.C8.022.

8.3.3.1.5. Frost Resistance

Frost resistance of cement mortar, if specified in the structural design as a quality requirement, shall be tested according to SRPS U.M8.002.

8.3.3.1.6. Homogeneity

Homogeneity of cement mortar shall be tested according to the procedure set out in SRPS U.M8.002.

8.3.3.2. Plastering Cement Mortar

Plastering cement mortar shall serve for making flat, smooth, or specifically finished concrete or stone surfaces. An approximate composition of plastering cement mortar (ratio of cement and sand) shall be:

- for base and finishing coats 1:4.

8.3.3.2.1.Quality Requirements for Materials for Mixing Plastering Mortar

Cement and water shall meet standard quality requirements specified under 8.3.3.1.1. The quality requirements for sand for mixing plastering mortar are set out in SRPS U.M2.012.

Quality requirements for sand for mixing plastering mortar.

No.
Characteristic of quality Quality Requirement

A. Content of harmful components:
(in percentage by mass)

1. Clay balls (over 0.5 cm3):
   For river sand..1%
   For quarry sand 1.5%
2. Fine particles passing through
   0.090mm sieve (wet sieving) 15%
3. Particles under 0.02 mm in size 5%
4. Organic matter..max 0.01%
5. Suspended matter ....max 0.3%
6. Total sulphur, expressed as SO3 ....max 1%
7. Chlorides, nitrates, nitrites ....max 0.1%

B.Granulometric composition of sand shall meet the following requirements:

Coat of mortar	Type of sand	Residue on 0.50 sieve (%)
Base	Coarse	50 - 70
	Medium	30 - 50
Finishing	Fine	20 - 35
	Very fine	7 - 20

The largest grain size in base coat..............................5 mm
The largest grain size in finishing coat ....3 mm

8.3.3.2.2. Quality Requirements for Plastering Cement Mortar

Quality requirements for mortar are set out in SRPS U.M2.010.

8.3.3.2.3. Consistency of Fresh Mortar

Consistency of fresh plastering mortar shall be according to the following values:

Type of mortar	Spreading (mm)	Largest grain (mm)
For base coat	200 – 230	2.5 - 5
For finishing coat	170 – 180	1.2

Consistency shall be determined according to the method set out in SRPS B.C8.023.

8.3.3.2.4. Strength and Quality of Mortar

The strength of mortar shall be according to the values given under 8.3.3.1.4. of these Technical Specifications. The quality of plastering cement mortar shall be checked according to SRPS U.M8.002.

8.3.3.3. Mixing of Cement Mortar

The composition of mortar shall be determined according to:

- Design requirements,
- Thickness of joints or layers,
- Cement class
- Envisaged consistency.

Mixing shall ensure mortar of uniform composition and plasticity. The time of mixing shall be determined by testing for homogeneity of cement mortar for each type of mixer.

The temperature of water for mixing mortar shall not exceed 80°C, and that of sand shall not exceed 40°C.

Mortar shall be mixed only in the quantity that can be placed before the setting starts, while keeping the specified consistency.

8.3.4. Grouts for Pre-Stressing Cables

8.3.4.1. General

Grouts for grouting tensioned cables shall be prepared (mixed) and placed according to the Rules on technical measures and requirements for pre-stressed concrete and according to SRPS U.E3.015/86. The grouts shall be mixed mechanically. SRPS U.E3.015/86 shall determine the composition, quality requirements, pre-tests and control tests for grouts for grouting cables.

8.3.4.2. Pre-Testing

Each used grout shall be pre-tested by a qualified company registered for the testing of materials and constructions, as ordered by the Contractor. Before the commencement of works on the grouting of pre-stressing cables, all materials and grouts based on materials to be used shall be tested.

Test reports on the tested composition and tested materials of the same type and from the same source shall be valid for one year at most.

These tests of grouts shall be performed in laboratory conditions at the temperature of 20 ± 2°C and cover:

- Flow, SRPS U.M8.024/84,
- Bleeding, SRPS U.M8.023/84,
- Change in volume, SRPS U.M8.023/84,
- Compressive strength after 28 days, SRPS U.M8.022/84,
- Frost resistance, SRPS U.M8.025/84.

If grouting is performed at a temperature higher than 25°C, or lower than 5°C, it is necessary to perform some additional tests under appropriate temperature conditions, namely for:

- Flow,
- Bleeding,
- Change in volume,
- Also, in case of lower temperatures, compressive strength after 3, 7, and 28 days, on test specimens cured at 50°C for 7 days, than at 20°C until the 28th day.

8.3.4.3. Mixing and Placement of Grouts

The Contractor shall check the mixing and placement of grouts visually and by measurements according to a schedule approved by the Engineer. The Contractor shall keep a log on pre-stressing, grouting, and controls, which shall be confirmed by the Engineer.

8.3.4.3.1. Control Tests

Before use, the Contractor shall test each delivery of cement regarding: water for standard consistency, setting time, volumetric soundness, and fineness according to SRPS B.C8.023. Samples from each delivery shall be kept in the following amounts: cement about 3 kg, chemical additives 500 g, mineral additions about 3 kg, or dry grout about 10 kg, until the commissioning of the structure, while ensuring that the quality of taken samples is not compromised during that time.

The quality of fresh grout with materials with which the mix is prepared shall be determined at least a day before grouting. The tests shall include flow rate, bleeding, and change in volume.

Throughout the works, the flow rate of grout shall be checked several times at the upper and lower ends of the chute or pipe, and grout samples for the testing of bleeding, change in volume and 28-day compressive strength shall be taken at least once a day. For the testing for change in volume and strength, test specimens shall be made from the mix taken at the lower end of the chute or pipe. Test specimens shall be kept in tightly closed boxes for 24 hours on the site, and then for the remaining time in the laboratory.

The Contractor shall keep a log on grouting works and quality test results with the following data:

- Manufacturer's name,
- Site,
- Structural element,
- Code and dimensions of pre-stressing cables,
- Pre-stressing method,
- Date, start and end of grouting,
- Type of usable materials,
- Composition and water-cement factor of the grout,
- Data on mixer used to prepare the mix,
- Mixing time,
- Air temperature and humidity, temperature of used materials and fresh grout,
- Flow of the grout,
- Bleeding,
- Change in volume,
- Number of taken specimens,
- Conditions of curing for the specimens,
- Date of taking over the specimens for strength tests,
- Special notes,
- Sketch of elements with cable layout,
- Signature of person in charge.

Based on the data from the site and results for 28-day compressive strength tests a report on the quality of placed grout shall be prepared.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.3.4.3.2. Pre-stressing log keeping schedule

The schedule shall include:

- Project name,
- Name of construction,
- Name and position of the element to be pre-stressed,
- Date of concreting and prestressing of the element,
- Codes and characteristics of patented tendons,
- Layout of cables, i.e. tendons for prestressing,
- Required initial force (stress) in the cable,
- Required final force (stress) in the cable,
- Loss of force in cables due to weather impacts on concrete and cables (contraction and creep of concrete, relaxation of cables), insertion of anchor bolts, friction with the change of direction of cables, sum of losses),
- Measured force in cable tensioning,
- Cable elongation value (before and after anchoring),
- Stress obtained by direct measurements, if specified in the design,
- Notes related to the stages and sequence of tensioning.

8.3.5. Special types of concrete

Special types of concrete shall be mixed and placed, if an opportunity for that arises, according to appropriate instructions and recommendations approved by the Engineer. Special types of concrete include: pumped concrete, vacuumed concrete, sprayed concrete (shotcrete) and sprayed mortar.

8.3.5.1. Pumped concrete

Pumped concrete is considered to be fresh concrete of certain properties that is transported and cast on the site under special conditions. Basically, the system consists of a funnel into which concrete is fed from the mixer, then a pump with which concrete is pushed forward (with a direct piston action or suction-push type), and a pipe through which concrete is delivered to the place of concreting.

The principal advantage of pumped concrete is that it is supplied in that way to places hard to access, with the mixing plant out of the site. This advantage is particularly important for the concreting of tunnel lining, or for construction sites in urban areas with very restricted space. Piston pumps may transport fresh concrete to distances of up to 450 m horizontally, or up to 40 m in height, and "pressure pumps" may reach distances of up to 90 m horizontally or up to 30 m in height.

The transport of fresh concrete in this way requires mixes of certain properties, so that concrete mass could pass smoothly through pump pipes, which is determined in the schedule according to T.T.Schwine Manual, or similar internal instructions for this type of activity.

8.3.5.2. Vacuum Concrete

A special technique of work with concrete, providing good workability at a minimum water/cement ratio, is called "vacuum concrete" in practice. The procedure goes as follows: concrete mix of medium workability is cast into moulds - forms, and a considerable amount of water is sucked out from the lower layer of concrete of certain thickness by applying vacuum on the concrete surface, thus decreasing the water/cement ratio (before cement sets); since the strength of concrete depends on this ratio to a great degree, in this way a higher grade of concrete is achieved, along with a higher density, water impermeability, and general performance of hardened concrete. This type of concrete is particularly suitable for applications in the plants that manufacture finished concrete elements, particularly from B-II concrete, since moulds may be used incomparably more often than without vacuuming. One of other good properties of vacuum concrete is that it makes an excellent bond with old concrete, and is thus applicable for making a new surface on worn concrete pavements, or for any similar repairs or patching of concrete surfaces. This method of concreting, too, requires a technology schedule – design that shall be submitted for the approval by the Engineer.

8.3.5.3. Sprayed concrete and mortar

This is a technology where cement mortar or concrete is expelled pneumatically from a nozzle (under high pressure and at high velocity) and applied to a solid base. The force of such jet that hits the base compacts the material to a such degree that it stays without leaking not only on vertical surfaces, but on ceilings or intrados in tunnel or other structures as well. The properties of sprayed concrete (shotcrete) are as good as those of concrete placed in a usual way, but prepared according to the same mix design, and acquires its major advantages by the very method of placement. Sprayed concrete (shotcrete) does not require any forms and is applied in certain cases, such as: thin, lightly reinforced constructions (shells – corrugated roofs), tunnel lining and cuts, pre-stressed tanks, and so on. Sprayed concrete is also applied for repairing those places where concrete has already degraded, for stabilizing friable rock slopes, cuts, and cut-and-fills of roads or tunnel approach cuts, for lining steel constructions in order to protect them against fire. This concrete is very often added an admixture (accelerator) that sets quickly and thus enables a fast repair of damaged surfaces. Sprayed concrete is applied in 2-3 layers, 2 -10 cm thick, in two different ways: the first, more frequent one, starts with a dry cement mix and wet aggregate, and the second one is with wet concrete, when it is possible to use a pump similar to the one used for pumped concrete. Both procedures are good, but the first (dry) procedure is, nevertheless, more suitable when using concrete with light aggregate, or when a quick-setting accelerator is added, and this procedure may give even thicker layers of applied concrete. For this technology it is necessary to have a schedule with appropriate mix designs and equipment, which is to be submitted for approval by the Engineer in line with SRPS U.E3.011, the preparation of which is underway.

8.3.5.4. Standard under preparation - SRPS U.E3.011

This standard (which is about to be released) determines technological and technical requirements for the design, production, and application of sprayed concrete and mortar. According to the new SRPS U.E3.011, "sprayed concrete and mortar" mean all names previously used in our country and worldwide: shotcrete, spray-concrete, gunite, etc.

Sprayed concrete or mortar has been increasingly used lately in tunnel construction, with or without a wire mesh, with mesh openings about 4 cm in size, and a 2 mm thick wire.

When sprayed concrete or mortar is to be used depends on the category of base material, and geomechanical properties of the rock to be stabilized.

Each special type of concrete shall be pre-tested by a qualified company registered for that activity and submitted for approval by the Engineer.

The producer of these concretes shall control the mixing and placement of special concretes through a laboratory, in compliance with applicable technical specifications and schedule submitted for approval by the Engineer.

For concrete for pre-stressed and composite constructions it is necessary to observe the following requirements as well, apart from all others:

- Types of cement: according to Sub-Section 8.2.2.1.;
- Amount of cement:
  min. 350 kg/m3 of finished concrete,
  max 420 kg/m3 of finished concrete;
- Aggregate ;
- Good-quality, strong and tough materials, of a natural shape, or of cubic, crushed, shaped, that meet requirements from Sub-Section 5.2.1.;
- River sand, quartz sand if possible, shall be used;
- The sieving curve of an optimum composition of aggregate, where an optimum is considered as meeting the required strength, good castability, i.e. cohesiveness of fresh concrete, with the content of cement mortar as low as possible, considering the given values for the amount of cement.
- Concrete admixtures:
  Plasticizers may be used, but air entrainers and chloride-containing admixtures are not allowed; for special concrete mixes and constructions of major importance, the creep of concrete measured from the start of aging shall also be taken into consideration according to experimental tests, and in other cases according to the new Rules on technical measures and requirements for pre-stressed concrete and based on experimental tests.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.3.6. Prefabricated concrete elements

Prefabricated concrete elements may be fabricated in a concrete plant, in a testing area, or on the site immediately next to the structure. They are arranged and mounted after the concrete reaches the strength required in the design.

Hardening of concrete (aside from hardening under usual conditions) may be speeded up by applying surface temperatures, with a damp environment as an obligatory condition, which prevents the evaporation of water and eliminates negative effects of the contraction of concrete (hydrothermal treatment, steam curing). In a proportionally short time this could help in releasing forms and moulds, and thus speed up the production of various elements (pre-stressed reinforced concrete girders, columns, gutters, kerbs, and so on). Concrete elements are fabricated applying this technological method according to a special schedule for this type of fabrication of concrete elements.

The following types of prefabricated concrete elements may be installed:

- Elements made of plain concrete,
- Elements made of reinforced concrete,
- Elements made of pre-stressed concrete.

When designing, fabricating and applying prefabricated concrete elements, the provisions of SRPS U.E3.050 and other standards and technical norms relevant for this area shall be observed, along with special requirements set out in the design.

Before starting the fabrication, the manufacturer of prefabricated concrete elements shall have the necessary design documents at his disposal, according to provisions of SRPS U.E3.050/84, namely as follows:

a) Design of the prefabricated element,
b) Production technology design, and
c) Quality control programme.

Minimum allowed dimensions of reinforced and pre-stressed concrete elements and their parts, as well as types of joints between elements and their quality requirements, are all set out in SRPS U.E3.050/84.

8.3.6.1. Quality requirements for materials for production of prefabricated concrete elements

Only materials and parts for installations specified in technical norms, Yugoslav standards, and the design may be used for the production of prefabricated concrete elements.

8.3.6.1.1. Aggregate

Aggregate for concrete shall be in compliance with regulations for plain and reinforced concrete (Sub-Section 8.2.1.of these Technical Specifications.

Granulometric composition of aggregate shall be adjusted to reinforcement, installation elements, shape, dimensions, and function of the prefabricated concrete element, ensuring good castability, cohesiveness, and workability of fresh concrete.

The largest grains in an aggregate mix shall not be larger than:

a) 1/3 of the smallest dimension of the element to be concreted,
b) the smallest spacing between reinforcing rods in a horizontal row, taking into account the position of element during fabrication,
c) 1/4 of the dimension of a linear element, of an approximately square or round cross-section.

8.3.6.1.2. Cement

Cement used for mixing concrete for plain and reinforced prefabricated concrete elements shall be in compliance with regulations for plain and reinforced concrete (Sub-Section 5.2.2.), and for pre-stressed concrete – with regulations for pre-stressed concrete.

If fresh concrete is technically treated in the production of prefabricated reinforced concrete elements (heating, steam curing, addition of steam to concrete during mixing, etc.), cement may be used only if prior experimental tests determine its suitability and its behaviour during thermal treatment.

High-alumina cement may be used only for plain, non-bearing prefabricated concrete elements, or for concrete for prefabricated reinforced concrete elements, provided that prior experimental tests show its suitability and an appropriate technology is elaborated.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.3.6.1.3. Water

Water for mixing concrete shall meet the quality requirements for the respective type of concrete.

8.3.6.1.4. Concrete Admixtures

Concrete admixtures, for prefabricated elements made of plain and reinforced concrete, shall be in compliance with regulations for plain and reinforced concrete (Sub-Section 8.2.4. of these regulations), and for pre-stressed concretes – with regulations for pre-stressed concrete.

8.3.6.1.5. Concrete

Concrete shall be used for the production of prefabricated concrete elements only if prior experimental tests show that it possesses properties specified in the design, rules for plain and reinforced concrete, or rules for pre-stressed concrete, as well as other technical norms and Yugoslav standards relevant for this area.

The following shall apply for the quality of concrete and mortar:

a) The quality of concrete shall be determined in the design of a prefabricated concrete element or construction, and shall be designated with the grade of concrete. The design may specify that concrete, aside from the designated grade, may also be designated for other properties (tensile strength, wear resistance, degree of water impermeability, frost resistance, resistance to aggressive impacts, etc.);
b) Reinforced concrete in prefabricated concrete elements shall not be envisaged with the grade of concrete lower than MB-20, and for pre-stressed concrete – lower than MB-30;
c) Concrete and fine-grained concrete mortar for the construction of load-bearing joints for prefabricated reinforced and pre-stressed concrete elements shall have at least the quality of concrete for elements that are to be joined together;
d) The quality of cement mortar for sealing joints shall be defined in the design, but the grade of mortar shall not be lower than M-5.

A minimum amount of cement in 1 m^3 of finished concrete shall be in accordance with the regulations for plain and reinforced concrete.

If a concrete mix has a maximum grain in aggregate of 16 mm in size, the amount of cement from the paragraph above shall be increased by at least 15%, and by 30% if a maximum grain in aggregate has 8 mm in size.

The quality of concrete is proven in the following ways:

a) For concrete in prefabricated concrete elements, by determining the grade of concrete according to the rules for plain and reinforced concrete;
b) For prefabricated pre-stressed concrete elements of less than 28 days of aging, the producer shall provide evidence, aside from the evidence for the grade of concrete, the quality of concrete for the age at which the elements are pre-stressed, on specimens kept under the same conditions under which the elements themselves were during fabrication;
c) If the achieved grade of concrete installed in prefabricated concrete elements is lower than the required one, such elements shall not be used.

As an exception to the provision of the paragraph above, when the achieved grade of concrete for a prefabricated concrete element is higher than 70% of the designed grade of concrete, the Contractor may require that the actual state of quality of produced concrete elements is determined and that additional theoretic or experimental tests of produced elements are ensured. If such tests determine that the achieved quality of concrete meets the specified requirements, the Designer may allow the use of such elements. In all other cases, fabricated or installed elements cannot be used without a proper repair of elements, aimed at bringing them to the condition specified in the design.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.3.6.1.6. Steel

Steel for reinforcement and pre-stressing may be used if it meets Yugoslav standards, regulations for plain and reinforced concrete, and regulations for pre-stressed concrete.

8.3.6.1.7. Grout

The compound for grouting pre-stressing cables shall be in compliance with SRPS U.E3.015 (Sub-Section 8.3.4. of these Technical Specifications).

8.3.6.1.8. Transport and storage of elements

Prefabricated elements shall be stored and transported in the position specified for their final installation. They shall be strutted or suspended only at places indicated on drawings and protected appropriately against damaging. Damaged elements, as well as those that do not meet the requirements set out in these Technical Specifications and requirements indicated on drawings shall be replaced by the Contractor, or repaired, if so allowed by the Engineer. All prefabricated elements shall be marked in a visible and durable way, in order to ensure a safe installation in accordance with the place and position specified on detailed drawings. Each element shall be marked with the date of fabrication. Within the concrete design, i.e. work plans, the Contractor shall submit to the Engineer, for his approval, the plans of facilities that show all workshops, the flow of work process, means of transport, and drawings of elements showing all additional supporting materials and tools.

8.3.6.1.9. Installation of Elements

The assembly of prefabricated concrete elements, as well as girders in spanning structures, shall be performed in accordance with the assembly design. According to Sub-Section 9, SRPS U.E3.050, the assembly design for prefabricated girders shall also contain the following parts:

a) Technical description and assembly requirements
b) Time schedule for assembly work
c) Scaffolds plan with a structural analysis and drawings,
d) List of equipment and devices for assembly work with defined technical and other characteristics,
e) Study on safety-at-work measures.

The assembly design shall be subject to approval by the Engineer. Prestressed girders over a single span shall be of approximately the same age. The difference in age of adjacent girders shall not exceed 14 days. The storage period for prestressed girder shall not exceed 3 months from the date of concreting of the deck, i.e. parts of cross girders concreted with a pre-fabricated girder. If the schedule of works foresees the storage of girders for more than 3 months, they shall not be tensioned immediately after concreting, but not more than three months before installation. Machines and equipment that should be employed for the finishing works on the bridge shall not cause any overload or damage on any part of the structure. The Contractor shall be solely responsible for a smooth operation of all machines and equipment in all stages of construction.

8.3.6.1.10. Measurement

The same as for 8.10.4

8.3.6.1.11. Payment

The same as for 8.10.4.

8.3.6.2. Quality of Concrete for Prefabricated Elements

Quality of concrete for prefabricated concrete elements shall meet the requirements from the rules for plain and reinforced concrete, rules for pre-stressed concrete, and SRPS U.E3.050, as well as additional requirements, if specified in the design.

The allowed variations for finished prefabricated elements are as follows:

- For parapet elements and other pre-fabricated concrete elements according to Sub-Section 7.30. SRPS U.E30.050 for accuracy degree 1.
- For dimensions of cross girders – not more than 5 mm
- For other measures of length – not more than 9 mm
- For variations from vertical sides – up to 6 mm
- For variations from direction - not more than 10 mm

8.3.6.3. Quality Control

The plant for prefabrication of concrete elements shall be equipped with a laboratory, according to SRPS U.M1.052, for the control of production performed by the manufacturer in compliance with SRPS U.M1.051 and SRPS U.E3.050.

The manufacturer of prefabricated concrete elements shall control components of concrete, concrete, and finished concrete elements according to the control programme.

When manufacturing prefabricated elements on the site or in the testing area, the manufacturer shall ensure the quality control in the site-based laboratory.

The production and quality control of prefabricated concrete elements shall be in compliance with the provisions of SRPS U.E3.050 and these Technical Specifications.

8.3.7.Production, Placement, and Curing of Concrete under Special Conditions

The placement of concrete into moulds or forms at ambient temperatures below +5°C or above +30°C shall be considered as concreting under special conditions. Special measures for protection of concrete shall be ensured for concreting under special conditions.

8.3.7.1. Requirements for Low Temperatures

Requirements and technology for the production, placement, and curing of concrete at ambient temperatures below +5°C shall be given in the concrete design, if the Contractor plans to execute concrete works at low temperatures.

8.3.7.1.1. Equipment

In plants where the production and placement of concrete at ambient temperatures below +5°C are envisaged, before first frosts it is necessary to prepare and check equipment and tools to be used for the production, placement, and curing of concrete at low temperatures.

8.3.7.1.2. Aggregate

Aggregate shall be resistant to frost, particularly for several freeze-thaw cycles. Aggregate shall not contain any organic impurities that slow down the hydration of cement. The use of frozen aggregate shall not be allowed.

Aggregate may be heated, but higher temperatures (above 15°C) shall be avoided due to non-uniform heating. If coarse-grained aggregate is dry, and without frozen portions, an adequate temperature of fresh concrete may be reached by increasing temperature of sand up to 40°C.

For the heating of aggregate, water vapour, circulating in pipes, cyclones or hot air sprayers may be used, and for works of smaller scope, aggregate may be heated carefully above a channel with fire maintained in it. If the vapour circulating in pipes is used, aggregate shall be covered with tarpaulin.

Vapour sprayers are not recommended for the heating of aggregate, because they may cause differences in the content of moist.

8.3.7.1.3.Cement

When selecting cement, highly active cements with a lower standard consistency and quicker release of hydration heat shall be given priority. As a rule, cement with added pozzolane shall not be used.

It is not allowed to heat cement at a higher temperature. Cement shall be stored in a dry storage place where temperatures are not below 0°C. Temperature of at least +5°C is favourable.

8.3.7.1.4.Water

Water for mixing concrete may be heated, most favourably up to +40°C, i.e. not more than +60°C if aggregate is not to be heated.

8.3.7.1.5.Concrete admixtures

Concrete admixtures shall not slow down the process of hydration at low temperatures, increase water-permeability of concrete, and corrosion of steel in concrete. Any action of admixtures on concrete shall be checked at the temperatures of +5°C and +20°C, foreseeing even a double amount for batching.

Accelerators for concrete or freezing-inhibitors for fresh concrete may be used. For reinforced and pre-stressed concrete the use of these admixtures is not allowed if they are chloride-based.

Before concreting it is necessary to ensure that all surfaces in contact with newly placed concrete shall be at a temperature (at least +2°C) that cannot cause the freezing of new concrete or prolong its hardening.

The Contractor for concrete works shall measure the temperature of concrete that is being placed at ambient temperatures below +5°C. The temperature of fresh concrete on the place of concreting shall be, at least +6°C, and the most optimum temperature is about +11°C. Temperature shall be measured during the curing of newly placed concrete. Its temperature shall be measured on the surface, under the protective cover, and the inner temperature of concrete shall also be checked.

Recorded temperature data for ambient temperature and temperature of concrete shall clearly indicate temperature periods. The temperature list shall be enclosed with the work journal.

Aside from the application of thermo-insulating materials for the protection of fresh concrete against freezing, other methods to bring heat into fresh concrete during hardening: steam treatment, electrode heating, infra-red radiation, induction heating, etc. may be applied, provided that the applied method does not cause local overheating of concrete, drying out its surface.

Before the first freezing, concrete shall have at least 50% of the required strength. Concrete that will be exposed to freezing in use shall have the required strength after the first freezing, and concrete that will also be exposed to the action of de-icing salt at the same time, shall also have the required resistance to frost and de-icing salt.

When forms or thermal protection are to be removed on very cold days, concrete shall not be exposed to sudden cooling, and the outer surfaces of concrete shall be protected.

8.3.7.2. Requirements for High Temperatures

8.3.7.2.1. General

Requirements and technology for the production, placement, and curing of concrete at ambient temperatures above +30°C shall be given in the concrete design, if the Contractor plans to execute concrete works at high temperatures.

8.3.7.2.2. Protection of Materials

In concrete plants, materials shall be protected against overheating, and cooling shall be provided for concrete components, if needed.

Cement silos shall be painted white, or protected against sun heat with a suitable protective material.

8.3.7.2.3. Cooling

In concrete plants of higher output, it is possible to install facilities for cooling water to +4°C (chillers).

Aggregate storage boxes may be fitted with water sprinklers that cool aggregate fractions by fine sprinkling.

When concreting at high temperatures, the initial workability shall be determined according to a previously defined loss of workability during transport and construction.

8.3.7.2.4. Admixtures

If retarders or workability enhancers are used, their action shall be proved previously on specimens with the selected cement and expected temperature of concrete.

Cement and composition of concrete incorporated into massive elements shall be such that the temperature of concrete incorporated into the element shall not be above +65°C in any case. Otherwise, the measures for cooling concrete components or concrete in the element itself shall be taken.

8.3.7.2.5. Prevention of Drying Out

The Contractor shall particularly take measures to prevent the drying out of placed concrete by frequent watering or use of protective chemical agents.

8.3.7.3. Composition of Concrete

Components used for the production of concrete shall be in compliance with technical norms for plain and reinforced concrete/87 and appropriate Yugoslav standards.

8.4. Concrete Plants - Technical Requirements

8.4.1. Technical Requirements for Equipment in Concrete Plants

8.4.1.1. Requirements for Concrete Plants

Concrete plants shall be designed and equipped so that their methodology and scope gives them a functional capacity to produce B-II concrete, as specified in SRPS U.M1.050/87.

The production capacity of a concrete plant is the ability to accurately batch components of concrete mixes, homogenizing concrete mixes, and mixing an envisaged number of lots per unit of time. Devices used for the production of B-II concrete shall meet the requirements set out in SRPS U.M1.050/87. Concrete plants shall be equipped with all possible safety instruments and valves and ensure a precise operation of all instruments, excluding any errors and obstacles in the batching of basic materials (components), and in the mixing and handling of concrete.

Batchers for particular components of concrete shall be provided with compliance certificates issued by an authorized institution, the validity of which is one construction season (compliance certificates on calibration of scales).

8.4.1.2. Batching Accuracy

Particular basic materials shall be batched separately and by weight. The accuracy in batching cement, mixing water, and admixtures shall be at least ±1%, and for particular aggregate fractions ±3%. The protection against any tempering with the nominal batching by unauthorized persons shall be fully ensured.

8.4.1.3. Handling Fresh Concrete

Discharging concrete mixers, further handling and storage of fresh concrete in the concrete plant shall be performed so as to avoid segregation, drying, heating, cooling, or exposure of concrete to precipitation.

8.4.1.4. Batching Control

Concrete plants shall ensure the possibility of a quick comparison between the planned and actually batched basic material by means of certain batching instruments.

The nominal values for each batching shall be put up in a visible place.

8.4.1.5. Batching Admixtures for Concrete

Concrete plants shall necessarily be equipped with a batcher for simultaneous feeding of at least two current admixtures for concrete. The possibility of batching diluted admixtures shall be ensured, indirectly with mixing water.

8.4.1.6. Technical Requirements

Technical requirements for the production, testing, and quality assessment for B-II concretes produced in the concrete plant, from the moment of delivery of concrete mix to the user (Contractor) into the transport vehicle (mixer), are defined in SRPS U.M1.051/87. Provisions of this standard shall also be applied for transport concretes, regardless of their category.

8.4.1.7. Laboratory Equipment

A laboratory within the concrete plant (the obligation of the producer of fresh concrete) dealing with the testing of basic materials, properties of fresh and hardened B-II concrete (over concrete specimens), according to SRPS U.M1.051, shall have a minimum laboratory equipment as specified in SRPS U.M1.052/87.

8.5. Regular Control of Production, Handling, and Transport of Fresh Concrete

8.5.1. Preparation of Specimens

Starting form the requirement that from the phase of handling and transport of fresh concrete until the phase of its placement, any subsequent change in its composition, that is of its properties, shall not be allowed, the focus of control may be in the implementation of tests on fresh concrete specimens taken in concrete plants immediately after mixing concrete (at the place of concrete production).

A certain number out of the total number of particular tests by concrete lots shall be performed on concrete specimens taken at the place of incorporation, immediately before setting. The number of these tests shall be defined considering test results, devices, the system for handling and transport of concrete, the possibility of occurrence of impacts that would change the quality and homogeneity of fresh concrete.

A certain number out of the total number particular tests shall be performed on concrete specimens taken at the place of incorporation, immediately before setting (compliance control). The number of these tests shall be defined considering test results, devices, the system for handling and transport of concrete, the possibility of occurrence of impacts that would change the quality and homogeneity of fresh concrete, according to the defined concrete design for major structures.

Certain test specimens shall be taken randomly (once at some places). If several indicators (e.g. consistency, temperature, micro-pore content) are tested and/or measured, these tests/measurements shall be performed simultaneously on a once taken specimen from the same lot of concrete for each type and class. The size of specimen taken shall be appropriate for the tests. When dividing the sampled concrete into quantities needed for testing for particular indicators, the entire specimen taken from the same lot shall be homogenized well. Samples taken in concrete plants (on the place of production) shall refer to a specific mix, type, and class of concrete.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.5.2. Specification for Regular Control of Fresh Concrete
The requirements for a minimum total number of results of measurement, for the assessment of values of certain indicators, and for maximum quantities of concrete that shall be tested, and requirements for size of specimens, and measurement methods, are given in compliance with PBAB/87 (Art. 43-44). When determining the total number of tests, a requirement specifying a larger number of tests shall always be met.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.5.2.1. Consistency of Fresh Concrete
Consistency of fresh concrete shall be tested once every day, when concreting, for each class of concrete (MB) according to PBAB/87 (Art. 40) on the place of production, and, if needed, on the site of placement as well.

Required degrees of consistency, depending on the means of placement, shall be determined when designing concrete, and during trial placement. If consistency is not defined in the design, as a rule, concrete of wet consistency shall be used. Variation values shall depend on the composition of concrete, particularly on the degree of consistency and method of measurement that must be defined when designing concrete, or designing concrete for major structures, or based on experiments.

The least number of specimens shall be appropriate for the method of measurement. As a rule, the consistency of concrete shall be tested by slump test (Abrams cone - SRPS U.M8.050). If approved by the Engineer , the consistency of concrete may also be tested by a flow table test (SRPS U.M8.052), Vebe test (SRPS U.M8.054), or vibration-slump test (SRPS U.M8.056).

At the place of production of concrete (in the concrete plant), or at the site of placement, if needed or instructed by the Engineer, the time of setting of concrete mixes shall be determined (for grades of concrete that are used) by the penetration resistance method as set out in SRPS U.M1.019/81.

8.5.2.2. Preparation of Samples in Moulds and Testing for Certain Properties of Hardened Concrete
Specimens in moulds shall imply different samples prepared by casting fresh concrete into moulds (cubes, beams, prisms, cylinders), for each type and class of concrete. Fresh concrete shall be taken according to a system of samples in the concrete plant immediately after mixing (at the place of production) or at the site of placement (compliance control), if specifically required. The samples shall be store in the laboratory, under specific conditions, as set out in the applicable standard SRPS U.M1.005/84. The tests on concrete specimens in moulds make an integral part of the regular control of production and handling, and are under responsibility of the producer of concrete, according to PBAB/87 (Art. 43) until the hand-over to the Contractor, and from the moment of taking over of fresh concrete, its transport and placement, under responsibility of the Contractor (PBAB/87 Art.44).

Fresh concrete for the preparation of specimens in moulds shall be taken along with the sampling for fresh concrete testing by lots, so that concrete placed into moulds is marked with all markers from Sub-Section 8.5.2.
All sampling and testing shall be subject to the approval of the Engineer.

8.5.3. Types of Tests

8.5.3.1. Types of Tests on Moulded Specimens
The laboratory of the producer of concrete shall take individual samples of fresh concrete by lot and prepare moulded specimens according to a special, previously prepared, detailed programme, concrete design, but so that they are uniformly distributed over the entire quantity of concrete the properties of which are under test.

All sampling and testing shall be subject to the approval of the Engineer.

For certain types of concrete, moulded specimens shall be tested for the following properties:

Compressive strength on test cubes, dim. 20x20x20 cm, after 28-day aging.

- The test shall be performed fully in compliance with PBAB/87 (Art. 46) and SRPS U.M1.020/78. To check the quality of produced concrete, the test on concrete specimens shall be performed every day when concrete is produced, from each type and class of concrete used on the specific date. Class of concrete (MB) shall be assessed by lot, in accordance with the control schedule, applying one of the specified criteria (PBAB/87, Art. 46).

Tensile strength (in special cases of tensile strength) by bending prisms, 10x10x40 cm (SRPS U.M1.010/57) or splitting cylinders, 15x30 cm or cubes (SRPS U.M1.022/81).

- This test shall refer to concrete pavements and be performed once per 500 m of finished pavement, or as specified in the design, or according to SRPS U.E3.020/87 (Art. 8).

For concrete pavements, it is also necessary to perform the control tests listed below on cylindrical specimens (kerns) taken from a finished pavement, at every 500 m at least, or when specified in the design:

1. Compressive strength, according to SRPS U.M1.040/78 and minimum tensile strength, according to SRPS U.M1.010/57,
2. Water impermeability, according to SRPS U.M1.015/78,
3. Water absorption of concrete, according to SRPS B.B8.010/80,
4. Abrasive wear resistance, according to SRPS B.B8.015/84,
5. Resistance to frost and salt, according to SRPS U.M1.055/84,
6. Frost resistance of concrete, according to SRPS U.M1.016/77, with a drop in strength and loss of bulk density, fully in accordance with Sub-Section 8.3.1.8. of these Technical Specifications.

8.5.3.2. Type of Tests on Moulded Specimens according to Age of Concrete (periodic tests of moulded specimens)
Tests specified under 8.5.3.1.shall be divided, in principle, by particular types and classes of concrete, as interpreted in Sub-Section 8.1.2.2., and selected by group and indicated according to the place of direct incorporation of concrete into structures, or parts thereof. For particular main types of concrete by lot, certain sets (groups) of indicators from Sub-Section 8.5.3.1. are tested, while observing the rules that, apart from those defined in Sub-Sections 8.5.3.1. - 8.5.3.1.5., the quality tests shall be conducted in full compliance with PBAB/87.

8.5.3.2.1. Concrete for Structures

a) Compressive strength (Sub-Section 8.5.3.1 item 1.)

– The principal term is 28 days, periodic preparation of samples

– Additional, non-mandatory terms are: 7, 14, 90, and 365 days,

– For concrete in pre-stressed constructions, aside from the test for strength after 28 days, it is also necessary to provide a proof at the age of prestressing, and at the time of cable tensioning and testing of the structure on specimens stored under the same conditions in which the construction and elements are;

b) Freeze-thaw resistance (Sub-Section 8.5.3.1, item 6);

c) The Engineer may instruct, for some structures, or parts thereof, the performance of tests for particular properties or groups of properties according to a special programme or Final Design, which will ensure the structural testing of the quality of concrete;

d) All mentioned tests shall be performed by a suitably equipped laboratory or a qualified company registered for testing materials and constructions that shall be subject to the approval of the Engineer. Any additional tests shall be paid extra, according to conditions set out in the contract documents if instructed by the Engineer.

8.5.3.2.2. Sampling Test Cubes

If test cubes are sampled by lot in a sufficient number during the placement of concrete, but the requirement for the class of concrete is not met because a single results in the lot is lower than the lowest allowed strength (f min), and the requirement for the arithmetic mean is met, and then, if the test cubes are sampled in a sufficient number, but the requirement for the class of concrete is not met, then if the number of sampled test cubes in a lot of concrete taken during the works is less than specified, but not less than 80% of the specified number, and the class of concrete cannot be proven, and if less than 80% of the specified number of tests cubes in a lot of concrete is taken, then the procedure of subsequent determination of compressive strength of incorporated concrete in the cylindrical shape, taken from the structure, shall be undertaken according to SRPS U.M1.048/85.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

8.5.3.2.3. Subsequent Concrete Quality Test

A subsequent determination (testing) of concrete quality based on specimens taken from the structure may be performed by also applying one of non-destructive procedures (by a sclerometer or ultra-sound method).

8.5.3.2.4. Non-Destructive Concrete Quality Tests

The procedure of non-destructive concrete quality testing shall be applied only in combination with the extraction and testing of concrete specimens from the structure.

8.5.3.2.5. Sclerometer Test for Quality of Concrete

The determination of concrete quality (in a non-destructive way) by a sclerometer test for “determining a sclerometer index and calibration curve” can be specified in compliance with SRPS U.M1.041/86.

8.5.3.2.6. Ultra-Sound Test for Quality of Concrete

The determination of concrete quality (in a non-destructive way) by a method for “determining the speed of ultra-sound and calibration curve" can also be specified in compliance with SRPS U.M1.042/87.

8.5.3.3. Other Tests

If the Designer or Investor also requires, within the Contract, other tests that are not foreseen in these Technical Specifications, as instructed by the Engineer, the Contractor shall conduct these tests.Also, all tests required in the applicable PBAB/87, but not covered in these Technical Specifications, shall be performed by the Contractor or another related institution approved by the Engineer, depending on whether these are pre-tests or regular tests, and whether the Engineer orders such tests or not. These tests too shall not be paid extraunless otherwise agreed by the Engineer.

8.5.3.4. Transport of Fresh Concrete

8.5.3.4.1. General

Transport of fresh concrete from the concrete plant, where concrete mix is prepared, to the site of placement, shall be performed in compliance with technical requirements set out in SRPS U.M1.045/87.

8.5.3.4.2. Transport and Handling

Transport and handling of fresh concrete from the place of mixing in the concrete plant to the site of placement into the structure shall be such that fresh concrete keeps the designed composition and required properties.

8.5.3.4.3. Type and Method of Transport and Handling

The type and method of transport and handling of fresh concrete shall be selected so as to provide as fast and simple transport of fresh concrete as possible, from the place of mixing to the site of placement, while keeping the homogeneity of concrete mix. In the concrete plant, at the place of production, before transporting fresh concrete, it is necessary to determine the time of setting for concrete mixes for all used grades of concrete, by the penetration resistance test according to SRPS U.M1.019/81. Fresh concrete shall be transported mechanically from the concrete plant to the site. On the site, when incorporating concrete into a structure, or element, fresh concrete may be transferred and moved with shovels, wheel-barrows, carts, tipping wagons, mechanical pumps, tower cranes, cable cranes, etc. Shovels shall be used to transfer smaller quantities of fresh concrete from platforms into forms and for homogenizing and removal of concrete from other means of transport. Wheel-barrows shall be used to transfer concrete to distances up to 30 m', and carts for up to 100m'. If the distance is greater than 150m', fresh concrete shall be stirred – homogenized - with shovels before placement.

8.5.3.4.4. Transport

The following vehicles may be used to transport fresh concrete from the concrete plant to the site of placement:

- A vehicle with a stirrer for concrete mix;
- A truck mixer, provided that the mixer rotates and stirs concrete mass at a reduced speed, as determined by the manufacturer;
- A vehicle without a stirrer for concrete mix, designed so that the vessel in which concrete mix is transported has smooth inside surfaces, is impermeable to water, and ensures that concrete mix is discharged easy and uniformly enough.

8.5.3.4.5. Transport Time

Concrete mix shall be poured out of the transport vehicle within not more than two hours from the moment when water is batched in the concrete plant, if the transport is performed in a vehicle with a stirrer for concrete mass, and within not more than one hour if the transport is performed in a vehicle without a stirrer. The transport may last longer than that if the weather is cold, and when a retarder is added to concrete, but this shall be previously determined experimentally. Adding water during the transport of concrete mass shall not be allowed.

8.5.3.4.6. Feeding Admixtures into Mixers or Vehicles

Exceptionally, if the consistency of delivered fresh concrete on the site of placement would not allow a good compaction of concrete before its placement, it is allowed to add a super-plasticizer directly into the vehicle – mixer, under conditions specified in SRPS U.M1.045/87 subject to the prior approval of the Engineer..

8.5.3.4.7. Temperature of Concrete on Site of Placement

The temperature of concrete during the discharge of concrete mass out of the vehicle shall neither be higher than 30°C, nor lower than +5°C. In cold weather (below +5°C), a higher temperature of concrete than +5°C may be required. Each delivery of concrete mass shall be accompanied with a pertaining data sheet in compliance with SRPS U.M1.045/87.

8.5.3.4.8. Control on Site of Placement

Concrete mass delivered to the site shall be under constant control. At the place of discharge from transport equipment, i.e. at the site of placement of concrete, the Contractor for concrete works shall record data on typical properties of concrete and transport duration time. The consistency of concrete shall be checked visually, and measured with the slump test at least for each delivery for which this measurement is performed during the loading of vehicles, i.e. at least once in each shift, and it shall be in line with the consistency specified in the design. On the site, as needed and if specified in the design of the structure, the amount of entrained air shall be checked according to SRPS U.M1.031 and the temperature of concrete mass according to SRPS U.M1.032 at least once in every shift. Numbers of pertaining sheets and results of all tests performed on the site shall be entered into the Building Journal.

8.6. Placement of Fresh Concrete

8.6.1. Constant Operation of Concrete Plant, concrete Schedule, Commencement and Termination of Concrete Works

8.6.1.1. Site Organization and Equipment

The site organization and equipment shall be appropriate for the constant operation of the concrete plant. The constant operation of the concrete plant implies the possibility of non-stop day and night concreting, at ambient temperatures above +5°C without relevant protective measures.

8.6.1.2. Back-Up Equipment

The plant shall be provided with a back-up power generator set for the generation of power, back-up compressors for pneumatic devices and machines, equipment for the protection of concrete against unfavourable weather conditions, a sufficient number of generator sets for achieving the cohesiveness of concrete and secure supply, and other needed materials.

8.6.1.3. Concreting Schedule

Before setting to concrete each particular section or part of the structure, the Contractor shall prepare a concreting schedule every time.

The concreting schedule, or concrete design, shall show the entire operation system for the plant, i.e. preparation, handling, transport, and placement of concrete with respect to scaffolds and forms, and its protection against unfavourable weather conditions while being handled during and after the placement.

The schedule shall give the actual quantity of placed concrete and a computational proof that the concrete plant has sufficient capacities regarding all requirements, i.e. those that determine a minimum speed of progress in the incorporation of concrete into the structure.

The schedule shall also show the number and composition, by area of expertise, of the Contractor's work groups, with the names of managers in charge of the works under construction.

The schedule shall also show the composition of concrete mix, trial mix, designed according to the requirements set out in 8.3.2.

8.6.1.4. Commencement of Works

The Contractor may start concreting when the Engineer confirms, by an entry made in the Building Journal, that he has accepted the condition of bedding, scaffolds, forms, and reinforcement, and approved the concreting schedule.

8.6.1.5. Suspension of Works

If the Engineer identifies that the requirements, design, or Technical Specifications have not been met, he may unconditionally suspend the concrete work and order the elimination of inadequate portions of concrete from the works. In such case, all requirements for construction joints shall be met.

8.6.2. Timber formwork and scaffolds

8.6.2.1. Technical requirements for all types of timber formwork and scaffolds

The technical requirements for design, erection, use, and maintenance of elements and constructions of supporting formwork and scaffolds made of timber and wood products in construction industry, shall be determined according to SRPS U.C9.400/84 and technical regulations PBAB (Art. 242-249). This standard does not apply to scaffolds made of steel tubes and sections, that, too, can be used for scaffolds for which a special design is prepared. Formwork consists of form surfaces made of planks or prefabricated plates, and a system of beams, posts and braces over which the load imposed on formwork is transferred to scaffolds. Although both formwork and scaffolds are temporary constructions, the stability of scaffolds and formwork shall be calculated in accordance with all acknowledged principles and usual rules of structural engineering. The quality of timer used for scaffolds and formwork shall be in compliance with SRPS U.D0.001. Round and sawn timber is used for scaffolds. For formwork, aside from planks, veneer panels, plywood panels, and similar materials may also be used. The quality of fittings used for the erection of formwork and scaffolds shall be in compliance with SRPS U.C9.200.

8.6.2.1.1. Formwork Design

All formwork plain and reinforced concrete shall be made according to measures given in the design. The Contractor shall prepare a design for every formwork, unless it is given within the Final Design of the structure, and if the Contractor cannot implement the given design with available equipment and technology, the Contractor's alternative design shall be subject to the approval of the Engineer. For formwork for visible concrete surfaces, it is necessary to meet special requirements that shall be given in the design of the structure.

8.6.2.1.2. Quality of Formwork

Formwork shall be tightly sealed to prevent any leach and bleed of cement – sand mortar out of fresh concrete. Only materials without harmful effects on the hydration of cement and those that cannot stain the surface of concrete may be used to seal formwork.

8.6.2.1.3. Strutting and Anchoring Formwork

Formwork shall be strutted and anchored so as to prevent any later deformation or displacement due to the pressure of fresh concrete and dynamic impacts during concreting. The stability and load-bearing capacity of scaffolds and formwork shall be proven in the design by a structural analysis and ensure such security and rigidity that they can receive loads and impacts that occur during the works without settlement and harmful deformations, and that the safety of workers and any traffic on scaffolds is ensured.

8.6.2.1.4. Preparation of Formwork

Formwork that absorbs water shall be prepared before concreting so that they do not take water from concrete (sprayed with water or protected with appropriate coating).

8.6.2.1.5. Coatings for Formwork

Formwork and coatings for formwork shall not affect the hue of concrete surfaces. Coatings for formwork shall not interact chemically with concrete, nor have any harmful effect on the quality of concrete.

8.6.2.1.6. Removal of Formwork

For starting the removal of formwork for concrete that sets under normal temperature conditions (the lowest temperature of concrete above +5°C), the following general requirements shall apply:

- Formwork may be removed only when placed concrete reaches required hardness as specified in the design or concrete design;
- For pre-stressed constructions, the design shall give special instructions for the removal of formwork.

8.6.2.1.7. Fixing Formwork

The use of woven wire fittings for fixing formwork shall not be allowed. All metal elements for anchoring, tensioning, and fixing formwork shall be made so that each piece that stays in concrete, and may rust, i.e. oxidise, shall be removed, and then covered with a layer of cement mortar, at least 2 cm thick, or protected in another appropriate way, i.e. that cement mortar is incorporated in concrete mass. All crosswise anchors shall be fitted with adjusting heads that can be used for post-tensioning, and can be removed after concreting without damaging concrete.

Openings from which anchors, or adjusting heads, are taken out, shall be carefully filled with fresh concrete to be water-impermeable. For visible concrete surfaces, the arrangement of anchor holes and method of dressing them shall be appropriate technologically and visually for visible concrete.

8.6.2.1.8. Cleaning Formwork

Formwork shall be cleaned thoroughly before each use. In cold periods, formwork shall be cleaned from snow, stuck mud and ice without fail, and subject to the approval of the Engineer.

8.6.2.2. Requirements for Erection of Formwork for Concrete Edge strips and Carriageways

As a rule, according to the technology of construction, concrete pavement of roads is constructed according to the system that carriageways are limited with edge strips on both sides, or limited with edge strips on one side, and a lane for other purposes on one side. Considering the significance of traffic volume, i.e. different capabilities of concrete and asphalt traffic-ridden surfaces under different temperature conditions, a combination of parallel asphalt and concrete strips on a carriageway shall not be allowed.

When constructing a concrete carriageway, as a rule, edge strips and lanes for other purposes shall be concreted first, since they serve as formwork when concreting the carriageway, i.e. as a base for running the finisher. In exceptional cases, carriageways are concreted using other special formwork or road forms.

Formwork for edge strips or secondary lanes may be erected with special forms or road forms. All lanes and carriageways shall be concrete using finishers. This requires adequately erected systems of steel forms, i.e. road forms and slip forms. For concreting places where concreting with finishers is technically impossible, the Contractor shall submit to the Engineer for approval a proposed technical solution for concreting in such places and erection of formwork.

The evenness of upper edges of road forms and slip forms shall ensure that the requirements for evenness of concrete surfaces are achieved. The variation of form edges from the designed horizontal direction may be max. 10cm. This variation shall occur only on continuous unbroken curves, so as not to be noticeable visually. On curves of radius smaller than 2000 m, only specifically designed systems of forms, road forms, or slip forms may be used, to exclude any visible broken lines, and obtain a proper, designed curve.

Formwork, road forms, and slip forms shall be structurally fabricated and placed in such way that their stability in all directions is ensured without fail, that completely clean and smooth surfaces are obtained in full thickness of concrete, and that there is no possibility of leakage of fresh concrete, or leaching of fine cement mortar out of fresh concrete through joints or below formwork. The Contractor shall submit to the Engineer, in due time - before the commencement of concrete works, documents that prove the degree of usability of the foreseen formwork system, and the good condition of road forms and slip forms. In case of inadequate formwork, the Engineer may, before and during the works, order the replacement of, or structural addition to the entire system of formwork, road forms, or slip forms, but before the commencement of concreting.

The placed concrete on which rails are placed shall be loaded with vehicles at the age of concrete at which its required strength of at least 70% of the required class of concrete is reached. The rails shall prevent any local traffic overloading of concrete (according to Sub-Section 8.6.8.3.).

Formwork, road forms, and slip forms, shall ensure concreting in the length for at least 3-day work, and in no case less than 1000 m of pavement. Formwork removal is subject to the requirement that it shall not damage concrete, which is ensured by achieving 30% of specified hardness.

8.6.3. Construction Joints

8.6.3.1. Construction Joints on Structures

Construction joints are considered water-impermeable joints between fresh concrete and hardened (old) concrete, while meeting the requirement of good adhesion of both concretes.

The places of construction joints, their execution and continued concreting on structures shall be foreseen in advance in the design.

Manual or mechanical bush-hammering of hardened concrete surfaces at construction joints, in order to prepare them for resumed concreting with fresh concrete, shall not be allowed.

Everywhere where the design specifies that surfaces of placed concrete shall be roughened for horizontal joints, and where this is possible for all other joins, the surfaces shall be washed and cleaned under high pressure with a mixture of air and water. That type of treatment of construction joints shall be performed several hours after concreting, when concrete reaches a required degree of hardness. During such treatment it is necessary to ensure that dirt from washed concrete is not thrown onto other concrete surfaces.

The surfaces of construction joints that are impossible to treat in the above-mentioned ways shall be treated by sand-blasting or other appropriate procedures, as specified by the Designer.

After the treatment, the surfaces of works joints shall be cured, i.e. protected against drying out, and in cold periods against frost-induced damages, which generally applies to all exposed surfaces of placed concrete (covered in Sub-Section 8.6.8.). The surfaces of construction joints shall be protected against any contamination.

Before applying fresh concrete on a hardened surface of a construction joint, it shall be cleaned thoroughly by blowing out. Surfaces shall be wetted to a minimum degree ("matt surfaces").

When placing fresh concrete over hardened concrete that still has side forms unremoved, any leakage of cement-sand mortar into joints between the forms and the surface of hardened concrete shall be prevented.

Other ways of making construction joints are allowed as well (using special resin coatings, etc. combined with pre-stressing), but such joints shall be checked with pre-tests.

8.6.3.2. Construction joints on Roadway

When concreting particular lanes or carriageways, construction joints shall be divided according to places specified in the design for the construction of visible joints, and which are considered as control joints according to Sub-Section 8.6.4.2.

Construction joints shall be shaped as dowelled ‘dummy’ joints, later sawn, like other crosswise visible joints.

Construction joints shall be protected against mechanical damages, drying out, and in cold weather periods, they shall also be thermally protected.

8.6.4. Control Joints

8.6.4.1. General

Control joints are considered to be ‘dummy’ or spaced joints of two or several mutually non-connected parts based on hydration adhesion.

Control joints on structures shall be covered in the design. The work shall be executed in compliance with the design requirements.

8.6.4.2. Control Joints on Roadway

All longitudinal joints between particular pavement slabs, and all longitudinal and crosswise, subsequently sawn visual joints, shall be executed as dry control joints.

All joints on roadway shall be water-impermeable and constructed according to the design.

The construction of joints shall ensure the same properties of hardened concrete in the zone of edges, as on other road surfaces. The required evenness of concrete surfaces and joints themselves, and their uniform sawing shall be ensured.

The water-impermeability of all joints in the upper portion of concrete that will be finished as sawn and sealed shall be achieved in the way and with compounds as specified in Sub-Section 8.6.6. of these Technical Specifications.

When sawing at sealing joints between two concretes cast in two different phases, the cut shall match the actual interface, so that the joint is sawn in both parts of concrete.

All cut joints shall be saw-cut in due time using appropriate machines for cutting in concrete, and protected, until filling with sealants, against mechanical damage, drying of concrete from early phases of concrete hardening, or any other dirt or effects that would reduce the adhesion of a sealant to concrete.

The joint saw-cutting schedule shall follow the concrete placement schedule without fail. Saw-cutting shall be performed in such time intervals, after concrete placement, that irregular cracking is prevented, but the strength of concrete shall be such that concrete is not damaged when saw-cutting the edges of joints.

The 6m spacing of crosswise visual joints is envisaged on all carriageways, or as specified in the design.

On edge strips, the spacing of crosswise visual joints shall be half of the length of paving concrete slabs. For concrete edge strips at an asphalt roadway, the spacing of crosswise visual joints may be up to 5 m, or as specified in the design.

Coatings applied before additional concreting to vertical sides of hardened (old) concrete, for the adhesion of the newly concreted part, shall be applied in a particularly careful manned and in conformity with the design requirements.

Before applying coatings, any defective places on vertical surfaces shall be repaired with mortars that are adequate for the patching of concrete surfaces.

All joints in a pavement structure, except for crosswise visual joints of edge strips, shall be dowelled. In places where edge strips are exposed to traffic load, the crosswise visual joints of edge strips shall be dowelled, too.

Tying with dowels shall be performed in accordance with the design requirements and requirements set out in Sub-Section 4.5. of these Technical Specifications, and/or SRPS U.E3.020/87.

8.6.5. Visual Concrete Surfaces on Structures ("visual concretes")
When designing visible concrete surfaces, it is necessary to take care of special technological requirements for the preparation of formwork and joints, and preparation and placement of concrete.
All proposals for preparations shall be submitted to the Engineer for approval.

8.6.5.1. Experimental Model
For visual concrete, it is necessary to design a required experimentally developed model that the Contractor shall prepare before the commencement of works, and that will show the texture and visual effect of the surface, where the macro-geometry and micro-geometry of surface visibility is primarily conditioned by the type and structure of formwork.

8.6.5.2. Compaction and Stability of Formwork
Dense compaction and stability of formwork shall be ensured without fail.

8.6.5.3. Composition of Fresh Concrete
The composition of fresh concrete for visible surfaces shall be determined experimentally, with basic materials specified for use (cement, aggregate, concrete admixtures, pigments, etc.), while meeting structural and technological-rheological requirements.

8.6.5.4. Hardened Concrete
Visible concrete, once hardened, shall be water impermeable, resistant to leaching, carbonation, and other chemical impacts, and resistant to freezing/thawing, and industrial de-icing salts for concrete surfaces. Particular visible surfaces that make a whole shall be of uniform texture and the same colour.

8.6.5.5. Selection of Materials
For the execution of this type of concrete works, the Contractor shall select materials and, either in the design or concrete design, elaborate in full detail production-technology requirements and instructions to be submitted for approval by the Engineer.

8.6.6. Placement of Fresh Concrete and Regular Control

8.6.6.1. Composition and Castability of Fresh Concrete
After every concreting, the Contractor shall present tot he Engineer a proof of a properly selected composition of fresh concrete, designed in compliance with Sub-Section 8.3.2., and on its favourable castability with available equipment for the placement of concrete. The equipment for placement of concrete shall be adequate for the properties of concrete and formwork, so that the required cohesiveness may be achieved.

For every composition of fresh concrete and every concrete placement procedure, before the initial commencement of concreting, the Contractor shall execute a test-trial concreting.

If the trial concreting is executed on the structure itself, i.e. scaffolds of the structure, the required quality of placed concrete shall be achieved; otherwise, the Contractor shall remove the concrete at his own expense.

8.6.6.2. General Requirements for Placement, i.e. for Achieving Cohesiveness of Fresh Concrete
Concrete shall be placed in a systematic and planned manner, without fail, according to a programme prepared in advance and selected system, as specified in Sub-Section 8.6.1.3. and subject to the approval of the Engineer.

A maximum heterogeneity of density, expressed as standard deviation, may be 0.04 kg/dm3 of placed concrete, unless otherwise specified in these Specifications.

Every started concrete section or structural part or element of the structure shall be concreted continuously in the initiated scope, as specified in the concreting programme, regardless of working hours, and also in case of sudden weather changes, or exclusion of certain sections of machines from operation. For that purpose, the site shall be equipped as required in Sub-Sections 8.6.1.1. and 8.6.1.2.

In case of unavoidable (unforeseeable according to the concreting programme) termination of concreting, concreting shall be ended so that it is possible (at the place of terminated work) to create a structurally and technologically proper construction joint. The formation of such construction joint is possible only upon the Engineer’s approval, but according to the method specified in the technical description of the project.

The initial temperature of freshly placed concrete shall be at least +7°C during concreting. If the ambient air temperature is below +5°C or above +30°C, all measures for the normal setting of concrete shall be taken.

A maximum temperature of concrete, not placed according to a special procedure, for a higher grade of tempered concrete, shall not be higher than +24°C, and for slow-setting cements not higher than +30°C.

For special concreting (e.g. submerged concreting, shotcreting, pre-packed concrete, vacuuming, pumping, etc), special procedures for the placement of concrete shall be applied, and these shall be treated in accordance with Sub-Section 8.6.1.3., and also according to the programme from Sub-Section 8.6.1.3. in terms of Sub-Section 8.3.5.

When placing concrete, all requirements from Sub-Section 8.3.2.2. shall be met.

Fresh concrete shall be placed by vibration in layers 30-50 cm thick.

Particular successively concreted joints of concrete shall be bonded well with previous, lower layers by vibration. If a previous, lower layer of concrete is not able to receive vibration treatment any longer, the joint between that layer and the next layer shall be treated, i.e. a construction joint shall be formed according to Sub-Section 8.6.3.

Spreading of concrete case into formwork in layers, according to the vibration method (e.g. with vibrators) shall not be allowed. When vibrating spread concrete in layer, its creep shall be avoided.

8.6.6.3. Requirements for Placement and Compaction of Fresh Concrete in Pavement Structures

The placement of fresh concrete for all strips and lanes of pavement structure shall be performed using previously tested high-frequency compression-vibration pavers.

Every layer of concrete shall be compacted with at least two runs of a paver. Based on measured visual findings, the Engineer may, to ensure reaching the required degree of cohesiveness of concrete, order a larger number of runs at the Contractor's expense.

For two-layer placement, full adhesion of both layers shall be ensured. The lower layer shall be protected against drying out and other weather impacts until the placement of the upper layer.

Placement and spreading of concrete in front of the paver shall be done mechanically.

Before placement, each layer to be placed and spread separately, shall be levelled mechanically with appropriate levelling devices that work separately or are mounted on the paver, but shall run over the entire width in which concrete shall be placed.

If fresh concrete spread in front of the paver is dried out or exposed to precipitation, it shall not be incorporated in the pavement structure. The Contractor shall remove such concrete from the pavement structure at his own expense.

In case of any storing of concrete on the site of placement before regular application, concrete may be deposited on special platforms or in silos, and be protected against mixing and weather impacts.

After the last compacting run of the paver, the concrete surfaces shall be closed. This shall be done in compliance with requirements set out in Section 10. of these Technical Specifications.
Hand repair of defective surfaces or any strengthening of concrete shall not be allowed.

The surface of concrete on particular lanes, compacted with the paver, shall be treated with special high-frequency vibration plates.

After such surface treatment, the necessary geometry requirements set out in Sub-Section 4.5. of these Technical Specifications shall be met.

The surface treatment of concrete according to Sub-Section 8.6.6.3.8. shall not cause additional surface bleeding of cement-sand mortar.

Subsequent repair of traffic-ridden concrete surfaces in hardened condition shall not be allowed.

For smaller or irregular surfaces of pavement structures, where handling paver is impossible, it is allowed to spread concrete manually and compact it with high-frequency vibrating plates.

All strips and lanes of the pavement structure shall have markers in large letters. Slabs of particular carriageways shall be numbered in increasing order so that the opposite numbers on the carriageway shall be identical. Edge strips that have half of the slab length shall, too, be marked with slab numbers, with letters "A" and "B" added. On an asphalt pavement structure, concrete edge strips shall have their own designation. Every beginning and end of daily production shall be marked with the main marker for the lane (large letters and date). The duration of a one-day production is considered to be 24 hours, with the work shift starting in the morning. The marking shall be impressed into fresh concrete to the depth of at least 8 mm. The Contractor shall perform marking at this own expense. The shape and place of markings shall be determined by the Contractor and submitted for the approval of the Engineer.

Along with decisions from Sub-Section 8.6.6.3. that are general for the placement of fresh concrete into the pavement structure, all other related decisions, particularly the decisions set out in Sub-Sections 8.6.1. - 8.6.3., and Sub-Sections 8.3. and 8.5. of these Technical Specifications shall apply.

8.6.6.4. Regular Control of Placement of Fresh Concrete

The regular control of placement of fresh concrete shall be performed continually – visually and by measurement, applying all criteria and detailed requirements specified under particular items of works In these Technical Specifications and subject to the approval of the Engineer.

The visual control of measurement shall be continually performed by the Contractor's appropriate qualified personnel.

The control of measurement shall include statistical examination and determination of the following properties (characteristics) in particular:
- Density and moisture of placed concrete;
- Temperature of concrete, sub-base, and air, and relative air humidity;
- Special technical measurements, such as: evenness of pavement surface, thickness of concrete layers placed in the pavement structure, evenness of edges, and a general control of measures, geometric requirements that apply for particular structures.

Density and moisture of placed concrete
- Measurement method: with radioactive isotopes or properly conducted volumetric method,
- Criteria for conducting measurements:

When concreting all strips and lanes, measurements shall be conducted continuously, as a rule, on every separate compacted layer. The Engineer shall also order that such measurements be carried out on every other structure where this is technically required and feasible. The measurement of density and moisture of placed concrete shall be conducted in terms of prevention and control. Lots of concrete determined, by measurements, not to be of nominal density, or to exceed a maximum moisture degree, shall be compressed and corrected by decompression by appropriate measures, or removed, eliminated, from the structure or any part thereof. New measurements shall prove that corrective measures were successful.

When concreting carriageways, parking lanes, or other lanes, at least one measurement shall be performed on not more than 50 m2, and when concreting edge strips - not more than 10 m2, or as specified in the design for each separately compacted layer of concrete. On traffic-ridden and other lanes, points of measurement shall be distributed so that limit and mean ranges of the strips are tested. Frequency and places of measurements on structures are determined and measurements are performed in the Engineer's presence And subject to the approval of the Engineer.

The measurement of temperature of concrete, base, temperature and relative air humidity during the placement, shall be performed continually, at least three times a day when concreting pavement structure.

The Contractor shall (for the sake of control) conduct and organize, before, during, and after placement, all necessary regular and particular measurements, check whether the geometric requirements set out in the design and technical specifications are achieved, and whether measurements are conducted for the implementation of any corrections that may be needed, and shall submit all measurements for the approval of the Engineer.

When concreting pavement structures, the Contractor shall constantly perform measurement controls, particularly in order to meet requirements from Sub-Sections 8.6.2.2. and Section 10 of these Technical Specifications all to the satisfaction and approval of the Engineer.

8.6.7. Subsequent Treatment of Placed Concrete

After placing fresh concrete into the structure or pavement, the Contractor shall perform all subsequent treatments in properly selected time intervals as set out in these Specifications or design.

Concrete surfaces of construction joints shall be treated by the Contractor as shown under 8.6.3.

The Contractor shall treat the "texture" of all surfaces of pavement structure according to the "brushing" procedure, in a crosswise direction with respect to the roadway centre line.

The Engineer may stipulate other methods for surface treatment of pavement structure as well, as agreed with the Contractor, and the Contractor shall implement them at his own expense.

8.6.8. Curing and Protection of Placed Concrete against Weather and Other Conditions

Immediately after concreting pavement, concrete shall be protected against:

- Rapid drying,
- Rapid transmission of heat between concrete and the base, and concrete and the air,
- Precipitation (weather conditions)
- High and low temperatures,
- Vibrations (traffic-induced and other) that may also change the inner structure and adhesion of concrete and reinforcement, and other mechanical damages at the time of setting and initial hardening.

8.6.8.1. Protection of Concrete against Drying Out

Concrete pavement shall be protected after placement in order to ensure satisfactory hydration on its surface and avoid damages due to early and rapid shrinkage.

The Contractor shall protect the placed concrete against drying out with a wet procedure, or the procedure of closing up concrete surfaces by spraying them with chemical agents that shall be tested before use in an institution for that type of activity.

The protection of concrete against drying out shall be effective as early as in the first hours from the placement of concrete, as soon as the concrete surface condition permits. The effectiveness of protection shall last for at least 7 days for engineering structures, and at least 21 days for pavement structures. Immediately after placement, concrete shall be protected against sun and precipitation.

Immediately after placement and surface finishing, until curing, concrete for pavement structures shall be covered with protective materials, closed and water-impermeable roofs of light colour, protecting it against drying out.

For wet curing of concrete in pavement structures, previously thoroughly wetted concrete shall be immediately, when permitted by its degree of hardening, covered with appropriate covers that need to be kept moist until its 7-day age. In the period from day 7 to day 21, concrete surfaces shall be kept moist constantly, i.e. until concrete reaches 60% of its foreseen grade.

When protecting concrete cast in pavement structures against drying by spraying it with chemical agent, it is necessary to take care that such agents can be applied to concrete surfaces as soon as concrete becomes "matt".

The use of spray-on chemical agents shall be allowed in accordance with 8.2.5.

The duration of effective protection of concrete surfaces by sprayed chemical agents shall be, under any weather conditions, at least 21 days. This shall be proved by prior compliance tests and regular controls Which shall be submitted for the approval of the Engineer.

A regular control of effective protection of concrete by sprayed chemical agents shall be performed by measuring the moist level of hardening concrete. The control measurements shall be carried out on all concrete surfaces, for the entire period for which the duration of effective protection is specified. If the protection of concrete by sprayed chemical agents is shown to be of less than sufficient effectiveness, concrete shall still be cured according to the wet curing procedure.

Spray-on chemical agents shall not have a harmful impact on the quality of concrete in any way, nor shall they affect the colour of concrete surface. Before paint marking concrete surfaces of the pavement structure, a chemically created film shall be removed completely.

If spray-on chemicals are also used for the protection of joints saw-cut in concrete, they shall not decrease the adhesion of joint fillers to concrete.

Chemicals shall be sprayed on concrete surfaces uniformly and in a specified amount, by fine sprinkling, in accordance with instructions of the manufacturer of the spray-on chemicals.

The work section of a concreted strip, or "duty" for pavement structures, which end every day, shall be marked particularly visibly with signboards showing the day of concreting. These boards may be removed only after the curing of concrete against drying ends.

8.6.8.2. Protection of Placed Concrete Against Cooling and Freezing

In cold intervals, the Contractor shall protect placed concrete thermally by an adequate procedure.

Considering regional climatic conditions, for every concreting in the period when a drop in temperature below +5°C may be expected, the Contractor shall have a sufficient amount of adequate agents for thermal protection of the base layer and placed concrete.

8.6.8.3. Protection of Placed Concrete Against Mechanical Damages and Dirt

The Contractor shall properly protect every placed and hardened concrete against any mechanical damages.

For the protection of all construction and control joints in the pavement structure, decisions from Sub-Sections 8.6.3.1., 8.6.3.2., and 8.6.4.2 shall apply.

In principle, the pavement structure may be burdened with traffic load, only after the Engineer's prior written approval, as specified in Section 10 of these Technical Specifications. For loading concrete with guided working vehicles, general decisions from Sub-Section 8.6.2.2. shall apply, but the loading possibility shall be proven based on performed tests of achieved strength of concrete and calculated estimate of load-bearing capacity. Before loading the pavement structure with other lighter transport vehicles, at least 70% mechanical strength of the required grade of concrete shall be reached. Before loading with heavier vehicles, 100% mechanical strength of the required grade of concrete shall be reached. The pavement may be loaded with tracked and other vehicles the weight of which on the pavement is not transferred over rubber tracks, only with special safety measures and subject to the Engineer's approval.

After finished after-treatment of pavement surface, the Contractor shall keep it clean until the final handover of pavement to the Investor or user of services.

8.7. Testing Achieved Quality of Hardened Concrete and Taking Over of Structure or Its Parts

8.7.1. General Provisions

The achieved quality of hardened concrete shall be controlled and established by "destructive" and "non-destructive" tests on moulded specimens, and by direct tests and measurements of structures, i.e. by assessing the achieved grade of concrete by lots according to PBAB/87 (Art. 46), or SRPS U.M1.048/85, SRPS U.M1.041/86, and SRPS U.M1.042/84.

The tests shall be organized and conducted, and their results assessed according to all requirements set out in these Technical Specifications and applicable PBAB/87 and subject to the approval of the Engineer..

Tests on moulded specimens shall be performed according to specification given in Sub-Section 8.4.3.2. of these Technical Specifications.

Tests on specimens taken from a structure and measurements on structures shall be performed and defined according to a special programme to be submitted for approval by the Engineer, and as specified in these Technical Specifications and/or applicable PBAB/87 rules.
The Contractor shall remove all materials and equipment that obstruct sampling, testing and measuring from places on structures determined by the Engineer for extraction of cylinders, or for "non-destructive" tests, and from places on a structure or any parts thereof determined by the Engineer for trial load tests. The Contractor shall not stand in way of sampling, testing, and measuring on structures.

Any defective places on concrete of a structure, or parts thereof, and any variation from the design, shall be properly repaired or replaced or reconstructed by the Contractor, i.e. brought into compliance with the design requirements,and these Technical Specifications all in accordance with the instructions of the Engineer.

8.7.2. Taking Over Concrete in Structures

The quality of concrete in structure shall be generally assessed based on the results of tests on moulded specimens, by lots for each grade of concrete, prepared during the production as specified in Sub-Section 8.5.3. and in line with the quality requirements for particular characteristics according to designs and these Technical Specifications, and/or PBAB/87 and submitted for the approval of the Engineer.

Based on any indications of doubt and results of tests for reached quality of concrete, and/or structure, the test results shall be supplemented with results of other tests on the structure or its parts As directed by the Engineer

A trial load test, or other test methods as determined by the Designer and/or Investor and as instructed by the Engineer shall be performed for those constructions or structures for which it is specified.

The acceptance of structures or parts of a structure shall be carried out based on actually executed works within the project and tests that prove the quality of concrete and components required in the design and these Technical Specifications, i.e. based on PBAB/87 rules, and trial tests performed on the structure, or its segments.

With a centralized mixing of concrete and its transport by modern means of transport, mixer trucks, or agitators, if possible, concrete shall be transported on the site by pipelines, i.e. a pump. The application of "pumped" concrete shall ensure the continuity in the execution of concrete works.

Additives, i.e. admixtures for concrete – superplasticizers shall be used in order to eliminate segregation of concrete, and to make the "pumping" work easy. Their task is to increase plasticity, which is manifested as increased sliding (plasticization) of concrete.

The application of "pumped" concrete requires a reorientation of work on the site. Work timing shall be strictly planned (by means of cyclograms), along with a full coordination between the supply (feeding) and the placement of concrete.

8.7.3. Taking Over Concrete Pavement

8.7.3.1. General

The quality of concrete pavement shall be assessed based on results of tests on extracted concrete cylinders and additional “non-destructive” tests performed directly on the structure, according to SRPS U.E3.020/87 (Sub-Section 8.4.2.).

8.7.3.2. Quality Assessment

Whether the pavement meets the quality requirements shall be established based on the results of tests performed on extracted cylinders, complemented with special measurements performed on the pavement, according to SRPS U.E3.020/87 (Sub-Section 5.6.) and subject to the approval of the Engineer.

8.7.3.3. Sampling

For all tests, concrete cylinders, diam. 10, 15, or 20 cm, shall be extracted from the concrete pavement in full thickness. Diamond drill bits shall be used for drilling.

8.7.3.4. Quality of Concrete in Pavement

The quality of concrete in pavement structures on drilled cylindrical specimens shall be controlled for the following characteristics:

- Compressive strength
- Tensile splitting strength
- Water impermeability
- Water absorption
- Freeze-thaw resistance
- Resistance to frost and salt
- Wear resistance in dry and water-saturated condition
- Thickness of cement-concrete slabs
- Evenness in the height and direction of cement-concrete pavement.

For all test mentioned in Sub-Section 8.7.3.4., except for the water-impermeability tests, separate cylinders shall be drilled. Water impermeability shall be tested on extracted cylinders, where compressive strength and tensile splitting strength tests are required on them . Before any destructive tests, the concrete cylinders shall be dried at the temperature of +105°C.

For testing compressive strength, tensile splitting strength, and water impermeability, freeze-thaw resistance, resistance to frost and ice, wear resistance, and water absorption, concrete cylinders shall be extracted at every 500 m at least, or as specified in the design. When requirements for certain properties are not achieved, the Contractor shall, at his own expense, extract additional cylinders in accordance with SRPS U.M1.048, and only the “destructive” method shall be applied in the scope defined by the Engineer within the design. Cylinders shall be extracted from the concrete pavement at the 60-day age of concrete.

The subsequent determination of flexural tensile strength of concrete shall be performed on cylinders taken from a pavement slab, provided that a correlation between the compressive strength and the flexural tensile strength is determined beforehand on the trial section, on at least three prisms that were cut from the pavement slab in the immediate vicinity of the place from which cylinders were taken.

The tensile strength of concrete in the pavement shall be determined on extracted cylinders when the age of concrete is 90 days, when the ration of the height (v) of cylinder to the diameter (d)o of cylinder is at least 1:1. Bored cylinders shall be cut for the test on their bottom side with respect to their position in the pavement. For the possibility of a convincing calculation of the tensile strength of concrete cylinders with respect to the tensile strength of cubes, it is necessary to first establish their correlations in a laboratory, according to Sub-Section 8.7.3.4. These tests, performed at the Contractor’s expense, shall be conducted by a qualified company registered for the testing of materials and constructions.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

The water-impermeability of concrete pavement shall be determined at the 90-day age of concrete, according to SRPS U.M1.015. Water impermeability shall be tested on cylinders and cubes.

The water absorption of concrete pavement shall be determined on concrete parts of cylinders, when the age of concrete is 90 days. A concrete cylinder shall be cut in four 5 cm cylinders, normal to its axis.

The freeze-thaw resistance of concrete pavement shall be established on cylinders applying the method from Sub-Section 8.3.1.8.

The wear resistance of concrete pavement shall be determined using Bohme’s method, when the age of concrete is 90 days, on 7.07x7.07x7.07 cm cubes cut out from concrete cylinders, in compliance with SRPS B.B8.015. The cubes are cut out from concrete cylinders so that the upper wearing surface of the cylinder remains unremoved. For tests in dry and water-saturated condition, it is necessary to prepare separate cubes every time from two separately drilled cylinders.

The tests of concrete quality according to Sub-Section 8.7.3.4. if needed or required in the design, shall be complemented with non-destructive testing for strength and water-impermeability directly on the pavement, applying the principle of large statistical samples, at the age of concrete of 60 and 90 days, in order to get the best possible picture about the heterogeneity and indication of local defective places or parts of the pavement.

8.7.3.5. Control of Pavement Geometry

It is necessary to check whether the geometry requirements for the pavement are met according to the following characteristics:

- Thickness of concrete,
- Unevenness of surfaces,
- Riding comfort index according to AASHO test,
- Deviation of height from the reference level.

The thickness of concrete slabs in pavement shall be determined on all drilled cylinders for tests according to Sub-Section8.7.3.4. If the requirements specified in Section 10 are not met, the applicable criteria for taking over shall be as given in Sub-Section 8.7.3.4.

The unevenness of pavement surface shall be determined in the longitudinal direction of particular lanes, where ‘a lane’ shall always mean the width between two longitudinal joints. When taking over carriageways, the relevant evenness of approximately 1 m from the right edge of carriageway shall be measured, looking in the driving direction, and on other lanes at the middle and in the longitudinal direction.

Evenness shall be measured in full length, uninterruptedly, using a planograph or 4 m levelling staff.

When measuring with a staff, each subsequent measurement shall overlap the previous one in the length of 2 m. If a distance between two adjacent uneven segments is less than 6m, a one-sided addition shall be reduced to a half of that distance.
The riding comfort index according to AASHO test shall be determined with a special apparatus in the longitudinal direction of particular lanes.

For lanes to be taken over, the relevant riding quality index approx. 1 m from the left edge of lane, looking in the driving direction, and for other lanes in the middle and in the longitudinal direction. In case of any failed requirements set out in Section 10., the same criteria shall apply as in Sub-Section 8.7.3.5.2.
The height deviation – the pavement surface level - from the reference level shall be determined by means of geodetic survey instruments. In order to enable such measurements, the Contractor shall prepare, along the road alignment, a system of fixed and surveyed height benchmarks from which control surveys may be done. Any deviation of the pavement surface from the reference level shall be surveyed along the centre line of particular lanes at every 15 m.
All measurements shall be submitted to the Engineer for approval.

8.7.3.6. Acceptance of concrete

The acceptance of concrete in the two-layer pavement structure shall be carried out based on tests and measurements that prove the proper condition of works, fully in accordance with these Technical Specifications.

All tests and measurements shall be submitted to the Engineer for approval.

8.8. Final Evaluation of Quality of Concrete in Structure

The final evaluation of the quality of concrete to be given for B-II concrete shall include:

- Documents on taking over of concrete by lots;
- Opinion on the quality of placed concrete issued based on a visual inspection of structures, perusal of documents on construction, and verification of results from the regular production control records, including the results of the control of compliance with quality requirements.

Based on the final evaluation of the quality of concrete in a structure, the safety and durability of the structure is proved, or an additional proof of the quality of concrete is requested. The final evaluation of the quality of concrete shall be given by the Engineer based on available documents and inspection of the structure and its elements.

8.9. Maintenance of Structure

Concrete and reinforced concrete structures shall be maintained in a safe and functional condition as specified in the design. If the structure suffers a damage, the necessary protective measures, including remedial measures, shall be taken subject to the approval of the Engineer.

8.9.1. Frequency of Control Inspections

The design of structure shall define the frequency of control inspections of the structure that include:

- A visual inspection, including a survey of location and size of fissures and cracks, as well as damages to the structure crucial for its safety;
- Control of deflection of main load-bearing elements of the structure under permanent load. In case of a highly aggressive environment, the condition of the protective coating on reinforcement shall also be checked.

8.10. Concrete for Structures

8.10.1. Scope and Content of Works

The works covered in this Sub-Section of Technical Specifications include the provision of all facilities, equipment, materials, and labour, and the execution of all operations related to materials that are used for: storage, measurement, and handling of materials, for batching and mixing, and, unless otherwise specified in other Sub-Sections of these Technical Specifications, for assembling formwork, transport, placement, curing, and finishing of all concretes for bridge structures, construction of concrete piles, and other auxiliary works on concrete structures, in accordance with terms and provision of the Contract, and in full compliance with this section of the Technical Specifications, drawings, and the Engineer’s instructions.

8.10.2. Technical Legislation

PBAB. 87 "Rules on technical norms for plain and reinforced concrete"("Off. Journal of SFRY" No. 11/87) and the Comment on provisions of PBAB (Off. Journal, 1988)
PPB "Rules on technical measures and requirements for pre-stressed concrete" ("Off. Journal of SFRY" No. 51/71)
SRPS B.B2.010. Screened aggregate for concrete. Technical requirements
SRPS B.C1.011. Portland cement. Portland cement with additives. Metallurgical cement. Pozzolanic cements. Technical requirements (1982)
SRPS B.C1.014. Sulphate-resisting cements. Portland cement. Metallurgical cement. Technical requirements (1982)
SRPS U.M1.058. Mixing water for concrete. Technical requirements and testing methods(1985)
SRPS U.M1.034. Concrete admixtures. Definition and classification (1981)
SRPS U.M1.035. Concrete admixtures. Quality and quality control (1982)
SRPS U.M1.037. Pre-testing for selection of concrete admixtures with specific aggregate and cement. (1981)
SRPS U.M1.020 Determination of compressive strength of test specimens made of fresh concrete (1978)
SRPS U.M1.050 Control of production capacities of concrete plants (1987)
SRPS U.M1.051 Control of production in concrete plants for concrete (1987)
SRPS U.M1.052 Minimum equipment for laboratories within concrete plants (1987)

8.10.3. Materials

8.10.3.1. Aggregate
Sub-Section 8.2.1. shall apply.

8.10.3.2. Cement
Sub-Section 8.2.2. shall apply

8.10.3.3. Water
Sub-Section 8.2.3. shall apply

8.10.3.4. Concrete Admixtures
Sub-Section 8.2.4 shall apply.

8.10.3.5. Concrete

8.10.3.5.1. Classification of Concrete
The designs shall indicate a class of concrete for each element of the structure, or for the entire structure, covering only the grade of concrete (MB), or the grade of concrete and other properties that concrete shall have under special conditions of the environment.

For everything else, Sub-Sections 8.1. and 8.3. shall apply.

8.10.3.5.2. Concrete Properties under Special Conditions of Environment

8.10.3.5.2.1. General Provisions
A prerequisite for production of concrete with special properties implies that such concrete shall be designed, mixed, and placed properly, in compliance with Sub-Section 8.3.7.

8.10.3.5.2.2. Water Impermeable Concrete
Sub-Section 8.3.1.4. shall apply.

8.10.3.8.2.3. Frost-Resistant Concrete
Sub-Section 8.3.1.8. shall apply.

8.10.3.5.2.3.1. Concrete Resistant to Frost and Salt
Sub-Section 8.3.1.8.1 shall apply.

8.10.3.5.2.4. Concrete Resistant to Chemical Impacts
Sub-Sections 8.3.1.9 and 8.3.1.10. shall apply.

8.10.4. Execution of Concrete Works

8.10.4.1. General Requirements
Before construction of structures and elements from plain, reinforced, and pre-stressed concretes, the Contractor shall, based on their structural design, according to Art. 232 of PBAB, prepare the concrete design that contains:
a) Concrete mix designs, quantities, and technical requirements for designed classes of concrete;
b) Plan for concreting, organization, and equipment,
c) Method of transport and placement of concrete mix,
d) Method of curing placed concrete,
e) Programme of control tests for concrete components,
f) Programme for control, sampling, and testing of concrete mix and concrete by lots,
g) Plan for assembly of elements, scaffolding design for complex structures, and formwork design for special types of formwork.

8.10.4.2. Scaffolds and Formwork
See Sub-Section 8.4.5.3. Scaffolds and Formwork

8.10.4.3. Reinforcement and Cables
See Sub-Sections 8.4.5.6.2. and 8.4.5.6.7., and Sub-Section 8.10.6, respectively

8.10.4.4. Placement of Concrete
Sub-Section 8.6. shall apply.

8.10.4.5. Underwater Concreting
Underwater concreting shall be performed in such a way that cement and water do not segregate from the concrete mix. Concrete for load-bearing elements cast underwater shall contain at least 400kg of cement per cubic metre of finished concrete, a granular material with a maximum grain size of 32 mm, a plasticizer as an admixture for concrete, with the slump of about 15 cm according to the cone slump test. Cement shall be of appropriate quality and resistant to any aggressive action of water.

The concreting funnel shall consist of pipes, at least 25 cm in diameter, designed from segments with flanges and seals. Concreting funnels shall be supported so as to enable the movement of the discharging end all over the working surfaces, and to enable fast lowering when it is necessary to slow down or stop the flow of concrete.

The discharging end shall be closed at the commencement of works, in order to prevent the penetration of water into the tremie, and shall be at 20 cm from the bottom at most. When the batch is poured into the funnel, the flow of concrete shall be controlled by carefully raising the discharging end, while keeping it in placed concrete at all times.

The flow of concrete shall be continual. The pumping of water and cleaning of the surface may start only when concrete has hardened.

8.10.4.6.Bedding Mortars

Bedding mortars shall be made of mortar mixed with expansion cements, where a minimum reached strength shall comply with concrete of grade MB 45. In terms of quality of applied materials, the provisions of this Sub-Section shall apply. Bedding mortars shall be placed so that over-pressure is present at all times: it is possible to apply the principle of communicating vessels or the grouting procedure. Mortars shall have a permanent increase in volume of at least 1%. Beddings thicker than 50 mm shall be reinforced separately. Within the works on bearings, gulleys, and similar elements where the application of bedding mortar is foreseen, the Contractor shall enclose with the work technology design all necessary proofs that the foreseen composition of mortar to be used for bedding is in full compliance with specified requirements. The mentioned design, along with a detailed work technology description, is subject to the Engineer's approval.

8.10.4.7. Finishing of Surfaces and Tolerances

All concrete surfaces shall be thoroughly treated during placement. The treatment shall be such that coarse-grained material is pulled down from the surface and that mortar leans fully against formwork in order to create a flat finished surface without water and air bubbles or voids. As soon as concrete hardens enough, and formwork is removed, the entire surface shall be cleaned thoroughly, removing any traces of formwork or projecting parts, in order to leave a flat surface, without depressions or flaws. For pavement slabs, after concrete is placed and compacted, it shall be levelled to the limits and height indicated on the cross section and finished to obtain a smooth and flat surface. The quality of work shall be such that when the finished surface is controlled with a 4 m long levelling staff, it shall not show any deviation larger than 10 mm from the height specified on the cross section. Other allowed variations in the finishing concrete works are:

a) For dimensions on the cross sections of columns and supports: not more than 6 mm,
b) For other dimensions of columns and supports: not more than 10 mm, while the height levels on bearing blocks may vary by not more than 5 mm,
c) Flatness of vertical or inclined surfaces shall be within the 8 mm range, measured with a 3m levelling staff
d) Deviation of columns and walls from the vertical plane, measured with a plummet, shall not exceed 6 mm.

The method of execution of finishing works for special elements or parts of the structure shall be given on drawings or indicated in the Priced Bill of Quantities.

8.10.4.8.Measurement

The amount to be paid to the Contractor at an agreed unit price for the quantity of incorporated concrete, as indicated in the Priced Bill of Quantities (m', m^2, m^3, piece), shall be determined in plans, specifications, or by the Engineer. The volume of reinforcing steel shall not be deducted, but the volume of incorporated structural steel shall be deducted.

8.10.4.9.Payment

For the amount determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all works and materials as stated in the description of the scope and content of works.

8.10.5. Prefabricated elements

Sub-Section 8.3.6. shall be applicable.

8.10.6. Prestressing concrete structures and elements

8.10.6.1.Scope and Content of Works

Works within this Section of Technical Specifications cover the procurement of plants, equipment, materials, and labour, and execution of all prestressing-related operations in compliance with the terms and conditions of Contract, and in full conformity with this Section of Technical Specifications, structural analyses, drawings, and the Engineer's instructions.

8.10.6.2.Technical regulations

Structures and elements made of pre-stressed concrete shall be in compliance with:

- "Rules on technical measures and requirements for pre-stressed concrete" ("Off. Journal of SFRY", No. 51/71)
- "Rules on technical norms for steel wires, rods, and ropes for prestressing constructions" ("Off. Journal of SFRY", No. 41/85)
- "Rules on amendments to the Rules on technical norms for steel wires, rods, and ropes for prestressing constructions" ("Off. Journal of SFRY", No. 21/88)
- SRPS U.E3.015 Grouts for grouting cables. Technical requirements.

8.10.6.3. Prestressing System

The Contractor shall select the prestressing system, while ensuring the following requirements to be met, regardless of the applied system:

- The safe anchoring of prestressing elements and their suitability for the transfer of forces into concrete,
- The actual friction losses shall match the computed losses, and
- The suitability of planned measures for the protection of cables against corrosion over time.

For prestressing a structure and its members, the design specified certified systems made locally by IMS and SPB – the systems for post-tensioning, i.e. applied only when concretes reach a certain strength. The prestressing system selected by the Contractor shall be as specified in the Tender Unless otherwise agreed with the Designer and the Engineer.

8.10.6.4..Materials

8.10.6.4.1. Prestressing Steel

Only steel that meets the requirements from the "Rules on technical norms for steel wire, bars, and ropes for prestressing structures" may be used for prestressing steel. The quality of pre-stressing steel shall be proved with the Manufacturer's compliance certificate, and a compliance certificate (quality certificate) issued by a qualified company registered for activities that include steel quality testing. Prestressing steel shall be transported in clean, dry, and closed transport vehicles. Steel shall be stored in completely dry rooms, with a wooden floor with no possibility of condensation. At the time of acceptance of cables and ropes, and prior to incorporation, cables shall have no marks of oxidation, dents, rough spots, notches, or any other damage.

8.10.6.4.2. Protective ducts

Ribbed, flexible ducts, made of white sheet metal, shall be used for cabling. They shall be rigid enough to keep their shape under the weight of cable and concrete during concreting, yet flexible enough to follow the cable line without any problem. Ducts shall be tight to cement slurry, and made of material that does not cause the corrosion of prestressing steel, either directly or in an electro-chemical action.

8.10.6.4.3. Anchors

For all anchors, according to their number and type, the Contractor shall possess compliance certificates. The certificates shall cover bushes and wedges. The Contractor himself shall fabricate spiral elements from GA 240/360 according to the Catalogue for prestressing systems. Tie-plates are not covered in compliance certificates. Anchor bolts shall be stored on the construction site, protected from dampness, dirt, and mechanical damage. Until the tensioning of cables, anchor bolts shall be protected against weather conditions and mechanical damage. Before pre-stressing, anchors shall be inspected, with any dirty surfaces cleaned.

8.10.6.5. Execution of Works

8.10.6.5.1. Fabrication of Cables

When fabricating cables, the Contractor shall follow the instructions given for the adopted prestressing system. Before cutting wires, or ropes, the Contractor shall perform a numerical check of given theoretical lengths of cables, and increase the lengths by a necessary length of grip, depending on the type of press and foreseen tensioning, on one or both ends. All wires or ropes in a cable shall be kept parallel, and shall thus be interconnected. The formed cable may remain straight or bent in a convenient ellipsoid or round shape, depending on the method of transport to the place of insertion, but shall have an attached plate with the cable marker. Formed in this way, cables shall be stored properly, unless inserted into ducts immediately.

8.10.6.5.2. Cabling

When cabling, the designed position of both the resultant and singular cables shall be achieved. Therefore, it is necessary to lay protective cable ducts on fixed supports that will also remain an unchanged position during the installation work. Holders of cable ducts shall be placed at 1-2 m spacing, and even less spaced at bending points. Ducts shall be tied firmly to their holders. Tie-plates for anchors shall be placed normally to the cable axis, and fixed firmly to formwork so as not to become displaced during concreting work. Allowed deviations of the resultant of cables with respect to the designed position may be not more than 2% from the height on cross section, and deviations of singular cables not more than 2 cm. Special attention shall be paid to the jointing of protective duct segments and to the bond between ducts and tie-plates. These bonds shall ensure water tightness, aside from keeping a fixed position during concreting. Depending on the length and shape of cable, a number of plastic straws for deaeration shall be placed, as well as grouting joints. Cables inserted in the structure or an element thereof, shall be subject to inspection and approval by the Engineer prior to approval for concreting.

8.10.6.5.3. Prestressing

The tensioning of cables may start only when concrete has reached the required minimum strength. When prestressing is performed at the age of concrete younger than 28 days, the strength of concrete shall be determined on test specimens cured under the same conditions as concrete in the structure. Prior to commencement of prestressing works, it is necessary to elaborate a prestressing programme. The prestressing programme shall be elaborated by the Contractor based on data from the Design, and approved by the Engineer, and the programme shall contain, apart from the prestressing time, data on prestressing force, sequence of tensioning of cables and elongations for each cable with an appropriate view of the contraction of concrete in length due to stress, and also the values for friction and yielding.

The cable tensioning sequence shall be determined in a way to avoid the creation of prohibited stress. After the Engineer has accepted the programme and approved the commencement of pre-stressing, the following preliminaries shall be performed: check the movability of cables, inspect anchor blocks, set up required scaffolds, power supply connections, and shorten cables to a minimum length for the press to grip. After shortening the cables, anchors with wedges and a press shall be set up. The prestressing procedure shall be carried out in compliance with the operation manual for hydraulic prestressing systems. The diagrams for calibration of a hydraulic kit shall not be older than 6 months. A maximum temporary force in a cable, at the anchorage point, shall not exceed 70 % of the prescribed typical breaking force. The magnitude of force in a cable shall be determined by a pump pressure gauge. The measurement of elongations of a cable, and its comparison with the reached force shall serve to assess whether friction losses have been calculated correctly. In case of significant differences, it is necessary to check the calculation of forces given in the Design.

A log on cable tensioning shall be kept during the work. All measures taken during prestressing shall be noted by the Contractor, with a copy submitted to the Engineer. If the sum of deviations from the designed prestressing force measured on the pressure gauge, expressed in %, and deviations from prescribed elongation, expressed in %, too, for each cable, is greater than 15%, this shall be reported in writing to the Engineer. Also, if the deviation from the prescribed total prestressing force, or from the total prescribed elongation, is greater than 5%, this shall be reported in writing to the Engineer. This procedure shall be carried out whether the Engineer is present or not during cable tensioning operations. In special cases, the Engineer may order a measurement of forces on critical cross-sections along the cable, with special instruments that will be set up in advance. These places shall be protected well after completed work.

8.10.6.5.4. Grouting Cables

In order to protect placed cables against corrosion and bond them to the surrounding concrete, protective ducts for prestressing shall be carefully grouted with a selected grout. The composition of grout, quality requirements for applied materials, prior and control testing of grout for grouting cables, and the grouting procedure are all defined in:

SRPS U.E3.015 Grouts for grouting cables. Technical Requirements./ 1986 /

All cables shall be grouted within two days after the prestressing has been completed and approved by the Engineer. Immediately after concreting, all protective ducts shall be cleaned from water that penetrated into them. This shall be performed thoroughly by blowing them out with compressed-air. Then, before grouting, the ducts shall be protected against repenetration of water. It is also necessary to prevent any circulation of air in the ducts. If protective agents for a temporary protection of cables against corrosion are applied, and such protection requires the Engineer's approval, it is necessary to check that the stipulated properties of grout mix and necessary bonds have not been disturbed.

All materials used for the preparation of grouts, shall be carefully batched and measured, the entire procedure running in accordance with provisions of the mentioned standard. Grouting shall be performed at temperatures above +5°C. If the frost is expected after grouting or grouting is performed at temperatures below +5°C, but above 0°C, all the provisions stipulated in SRPS U.E3.015 Sub-Sections 7.6. and 7.7. of this mentioned standard shall be applied, provided that all pre-tests have given satisfactory results in compliance with SRPS U.E3.015 Sub-Section 5.3.

8.10.6.6. Alternatives

If the Contractor offers another system of prestressing which fails to meet requirements given in the Design, with respect to the position of total prestressing force and the magnitude of final effective prestressing forces, the Contractor shall submit with his alternative offer summarized documents, suitable for control, that shall contain: the prestressing system, the type of cables, the number of wires, ropes, or bars in a bundle of steel, the surface areas, diameters, and grade of steel, the method of assembly and type of anchoring, the prestressing force in time t=0 and t= infinity , as well as the methods of protection and control.

The calculations shall include the losses due to friction, shrinking, yielding, and relaxation of steel. The proof of stress notation on all cross-sections of structures and for all loading phases, as well as the result of difference in load on substructure elements (columns and foundations) shall be given.

All works to be performed shall be in accordance with provisions of the Technical Specifications referred to in this Section, as well as in accordance with all other specified design and construction requirements.

Acceptance of the Contractor's alternative offer shall be decided by the Designer and the Investor and as instructed by the Engineer.

8.10.6.7. Measurement

All steel for pre-stressing shall be calculated according to the computed weight of installed cable lengths, as shown on drawings or instructed by the Engineer. No compensation shall be given for any material, labour, forms, equipment, and other works needed for the procurement, preparation, installation, pre-stressing, and grouting of cables, including anchors, plates, and hoops, protective ducts for cables, spacers, washers, and cable supports, grout, and all other secondary activities that the Contractor shall perform during the execution of works, as determined by the Engineer and specified herein.

8.10.6.8. Payment

For the amount determined in the way described above, the Contractor shall be paid at the agreed unit price per 1 kg of steel, and this shall be the full compensation for the scope and content of work within this item.

8.11. Measurement

The works on a structure, or a part of it shall be measured, in principle, in cubic meters of placed concrete, unless otherwise specified in the agreed Priced Bill of Quantities, or Technical Specifications for particular types of works.

8.12. Payment

The amount measured as specified in Sub-Section 8.10. of these Specifications shall be charged at the unit price stated in the agreed Priced Bill of Quantities. This price shall be a full compensation for procurement and installation of all materials and for all work, transport, tools, equipment, supplied energy, scaffolds, formwork, and everything else needed to complete the work, and the Contractor shall have no right to claim any subsequent payment.

8.13. Forms

The types of pretests for concrete are to be shown in a standard format summary sheet to be called form "A" to be agreed with the Engineer.

A completed form "A" shall be submitted with interim or final payment certificates to the Investor, i.e. Engineer. If the form "A" does not include certain obligatory pre-tests, the Contractor shall proceed as specified in relevant Sub-Sections of these Technical Specifications or contract documents, while adding such test at an appropriate place in form "A".

8.14. Regular Control Tests

The summary of scopes of regular control tests are to be shown in a standard format sheet to be called the list "B" to be agreed with the Engineer.

The Engineer shall compile a list of performed regular control tests and submit it to the Investor with interim and final payment certificates.

A. Legislation

A/1. STANDARDS

A/1.1. ROCK AND AGGREGATE (GRANULAR MATERIAL)

SRPS L.J9.010	Laboratory sieves
SRPS L.J0.001	Laboratory sieves and sieving tests
SRPS L.J0.002	Sieving tests
SRPS B.B0.001	Natural stone. Sampling stone and rock aggregate
SRPS B.B2.009	Natural aggregate and rock for the production of aggregate for concrete. Technical requirements
SRPS B.B2.010	Screened aggregate (granular material) for concrete. Technical requirements
SRPS B.B3.100	Fractionated rock aggregate for concrete and asphalt
SRPS B.B3.050	Technical requirements for rock aggregates for modern road surfacing
SRPS B.B3.100	Rock aggregate. Fractionated rock aggregate for concrete and asphalt. Minimum quality requirements
SRPS B.B3.200	Natural stone. Tiles for floors and plinths. Shape, measures, and classification
SRPS B.B8.001	Testing of natural stone. Frost resistance by using sodium sulphate
SRPS B.B8.002	Testing of natural stone. Testing for frost resistance.
SRPS B.B8.003	Natural stone. Testing for mineralogical/petrographic composition (natural stone)
SRPS B.B8.004	Rock aggregate. Testing for mineralogical/petrographic composition (rock aggregate)
SRPS B.B8.010	Testing of natural stone. Determination of water absorption
SRPS B.B8.012	Natural stone. Testing for compressive strength
SRPS B.B8.013	Testing of natural stone. Testing for weather resistance
SRPS B.B8.014	Testing of stone for toughness
SRPS B.B8.015	Testing for resistance to abrasive wear
SRPS B.B8.017	Testing of stone for flexural strength
SRPS B.B8.018	Testing of stone with a Deval machine
SRPS B.B8.019	Testing of crushed stone for resistance to impact with the Treton apparatus
SRPS B.B8.029	Rock aggregate. Determination of granulometric composition by dry sieving method
SRPS B.B8.030	Rock aggregate. Determination of bulk density in loose and compacted condition
SRPS B.B8.031	Rock aggregate. Determination of bulk density and water absorption

SRPS B.B8.032	Testing of natural stone. Determination of bulk density with pores and voids, bulk density without pores and voids, and coefficients of bulk density and porosity
SRPS B.B8.034	Rock aggregate. Determination of light particles
SRPS B.B8.035	Rock aggregate. Determination of surface moisture in aggregate
SRPS B.B8.036	Rock aggregate. Determination of the amount of small particles by wet sieving method
SRPS B.B8.037	Rock aggregate. Determination of weak – friable grains in coarse aggregate
SRPS B.B8.038	Natural and crushed rock aggregate. Determination of clay ball content in aggregate
SRPS B.B8.039	Rock aggregate. Approximate determination of contamination with organic matter. Calorimetric method
SRPS B.B8.040	Rock aggregate for concrete and mortar. Testing of aggregate contaminated with organic matter.
SRPS B.B8.042	Rock aggregate. Chemical testing of aggregate for concrete and mortar
SRPS B.B8.043	Testing of natural stone. Testing of coarse rock aggregate for wear resistance with a Deval machine
SRPS B.B8.044	Natural crushed rock aggregate. Testing for frost resistance with sodium sulphate
SRPS B.B8.045	Testing of natural stone. Testing of natural and crushed aggregate with "Los Angeles" machine
SRPS B.B8.047	Testing of natural stone. Definition of shape and surface appearance of grains in aggregate
SRPS B.B8.048	Rock aggregate. Determination of grain shape by calliper rule method
SRPS B.B8.049	Rock aggregate. Determination of grain shape by volumetric coefficient method
SRPS B.B8.056	Stone and rock aggregate. Determination of alkali-silica reactivity. Chemical method
SRPS B.B8.057	Rock aggregate. Testing of alkali-silica reactivity by mortar prism method
SRPS U.M8.030	Determination of crushing resistance of aggregate for concrete
ASTM C-586	Standard test method for determination of potential alkali reactivity of carbonate rocks for concrete aggregates (Cylindrical rock specimen method)

A/1.2. CEMENT

SRPS B.C1.001	Testing of cement. Standard sand
SRPS B.C1.009	Cement. White Portland cement. Definition, classification, quality requirements, and testing of whiteness
SRPS B.C1.011	Cement. Portland cement. Portland cement with additives. Pozzolanic cement. Definition, classification, and technical requirements
SRPS B.C1.012	Cement. Method of delivery, packaging, storage, and sampling
SRPS B.C1.013	Low-heat cements. Definition, classification, technical requirements, and application
SRPS B.C1.014	Cements. Sulphate-resisting cement. Portland cement. Metallurgical cement. Definition, classification, and quality requirements
SRPS B.C1.015	Cement. High-alumina cement. Definition, classification, and technical requirements
SRPS B.C1.018	Pozzolanes. Quality and testing
SRPS B.C8.020	Cements. Method for chemical testing of Portland clinker-based cements
SRPS B.C8.021	High-alumina cement. Chemical testing methods
SRPS B.C8.022	Cement. Testing of cement for strength
SRPS B.C8.023	Cement. Methods for testing of physical properties of cement
SRPS B.C8.024	Determination of specific surface area of Portland cement
SRPS B.C8.025	Cement. Autoclave expansion of cement
SRPS B.C8.026	Determination of specific surface area of cement, pozzolane, slag, and similar
SRPS B.C8.027	Cements. Determination of hydration heat of cement by vacuum flask method
SRPS B.C8.028	Cements. Determination of hydration heat of Portland cement with additives by dissolution method
SRPS B.C8.029	Cement. Shrinkage of cement mortar due to drying
SRPS B.C8.050	Determination of air content in cement mortar
SRPS U.M8.015	Chemical and physical testing of blast furnace slag
SRPS U.M9.011	Blast furnace slag. General provisions
SRPS B.C1.020	Building lime. Types, applications, and quality requirements

A/1.3. WATER

SRPS U.M1.058	Concrete. Mixing water for concrete. Technical requirements and testing methods

A/1.4. CONCRETE ADMIXTURES

SRPS U.M1.034	Concrete. Concrete admixtures. Definitions and classification
SRPS U.M1.035	Concrete. Concrete admixtures. Quality and quality control
SRPS U.M1.036	Concrete. Concrete admixtures. Testing of impacts of admixtures on properties of concrete
SRPS U.M1.037	Concrete. Concrete admixtures. Pre-testing for selection of concrete admixtures with specific aggregate and cement
SRPS U.M1.038	Concrete. Concrete admixtures. Testing of impacts of concrete admixtures on cement paste and mortar
SRPS U.M1.039	Concrete. Concrete admixtures. Testing of physical and chemical properties
SRPS U.M1.044	Concrete. Concrete admixtures. Testing of impacts of admixtures on corrosion of reinforcement steel

A/1.5. CONCRETE

SRPS U.M1.004	Testing of concrete. Test specimens (concrete test specimens). Shape, measures, and allowed variations
SRPS U.M1.005	Concrete. Making and curing of concrete test specimens for strength tests
SRPS U.M1.010	Testing for flexural tensile strength of concrete on prisms (concentrated mid-span load)
SRPS U.M1.011	Testing for flexural tensile strength of concrete on prisms (load at one-thirds of span)
SRPS U.M1.012	Testing for compressive strength of concrete on fragments of prisms obtained from their flexural failure. Modified cube method
SRPS U.M1.014	Concrete. Action of materials aggressive to concrete and protection against them
SRPS U.M1.015	Concrete. Testing of concrete for water-impermeability
SRPS U.M1.016	Concrete. Testing for frost resistance
SRPS U.M1.019	Concrete. Determination of setting time for concrete mixes by penetration resistance
SRPS U.M1.020	Concrete. Determination of compressive strength of test specimens made of fresh concrete
SRPS U.M1.022	Concrete. Testing for tensile splitting strength of concrete
SRPS U.M1.025	Concrete. Determination of static modulus of elasticity by compression
SRPS U.M1.027	Concrete. Determination of creep
SRPS U.M1.028	Concrete. Testing for homogeneity of concrete for mixing with a concrete mixer.
SRPS U.M1.029	Concrete. Determination of volumetric deformations

SRPS U.M1.030 Concrete. Determination of composition of fresh concrete by rinsing
SRPS U.M1.031 Concrete. Determination of air content in fresh concrete
SRPS U.M1.032 Concrete. Measurement of temperature of fresh concrete
SRPS U.M1.040 Concrete. Determination of compressive strength of test specimens made of hardened concrete
SRPS U.M1.041 Concrete. Determination of sclerometer index and calibration curve
SRPS U.M1.042 Concrete. Determination of ultra-sound velocity and calibration curve
SRPS U.M1.045 Concrete. Transported concrete. Technical requirements
SRPS U.M1.046 Testing of bridges with trial load
SRPS U.M1.048 Concrete. Subsequent determination of compressive strength of placed concrete
SRPS U.M1.050 Control of production capacities of concrete plants
SRPS U.M1.051 Control of production in concrete plants for B-II concrete
SRPS U.M1.052 Minimum equipment for laboratories within concrete plants
SRPS U.M1.055 Concrete. Testing of concrete surface for resistance to frost and de-icing salt
SRPS U.M1.057 Concrete. Granulometric composition of aggregate mixtures for concrete
SRPS U.M1.090 Concrete. Determination of adhesion between reinforcement and concrete
SRPS U.M8.050 Testing of concrete for consistency by slump test
SRPS U.M8.052 Testing of concrete for consistency by flow table test
SRPS U.M8.054 Concrete. Determination of consistency of concrete by Vebe test
SRPS U.M8.056 Concrete. Testing of consistency of concrete by vibration-slump test
ASTM C-156 Standard test method for determination of water retention by means of protective materials for curing concrete
SRPS U.E3.020 Technical requirements for construction of cement-concrete pavement

A/1.6. PREFABRICATED CONCRETE ELEMENTS

SRPS U.E3.050 Prefabricated concrete elements. Technical requirements for fabrication and placement
SRPS U.N2.062 Prefabricated concrete products. Kerbs. Technical requirements

A/1.7. SPRAYED CONCRETE AND MORTAR

SRPS U.E3.011 Sprayed concrete and mortar. Technical requirements
SRPS U. E3.012 Testing of tensile splitting strength of sprayed concrete

A/1.8. GROUTS

SRPS U.E3.015 Grouts for pre-stressing cables. Technical requirements
SRPS U.M8.022 Grouting. Testing of compressive strength of grout
SRPS U.M8.023 Grouting. Testing of bleeding and volumetric changes of grout
SRPS U.M8.024 Grouting. Testing of flow of grout
SRPS U.M8.025 Grouting. Testing of frost resistance of grout

A/1.9. TIMBER SCAFFOLDS AND FORMWORK

SRPS U.C9.400 Design and erection of wooden constructions. Technical requirements

A/1.10. CEMENT MORTARS

SRPS U.M2.010 Masonry mortar
SRPS U.M2.012 Plastering mortar
SRPS U.M8.002 Masonry and plastering mortar. Testing methods

A/2. BOOKS OF RULES

A/2.1. Rules on technical norms for plain and reinforced concrete (Off. Journal of SFRY No. 11 dated 23rd February 1987)
A/2.2. Rules on technical norms for pre-stressed reinforced concrete constructions in environments exposed to aggressive actions of water and soil
A/2.3. Rules on mandatory application of particular standards for:

- aggregate (granular material)
- cement
- water
- admixtures for concrete
- concrete
- prefabricated concrete elements
- grouts
- concrete sewer pipes, and
- other related to concrete work.

Section 9
Asphalt pavements

Contents

9.1. Mesh reinforcement

9.1.1 Description

Mesh reinforcement is a layer in the pavement structure intended to prevent the propagation of cracks onto a new asphalt layer. The mesh reinforcement laying works shall be performed according to these technical instructions or the mesh reinforcement manufacturer's instructions, subject to the Designer's and Engineer's approval.

9.1.2 Technical requirements

Characteristics of mesh reinforcement

Mesh reinforcement shall meet the following requirements:

- Mesh size up to 20x20mm
- Tensile strength min. 20 kN/m
- Heat resistance min 190 °C
- Weight min 220 gr/m2
- Strip width min 250 cm
- Strip length max. 50 m.

9.1.3 Procedure

The work execution procedure implies:

- Preparation of underlying surface
- Spreading, fixing, and protection of mesh reinforcement

Preparation of Underlying Surface

Before laying mesh reinforcement, the underlying surface shall be cleaned from all dirt to the satisfaction of the Engineer. Before placing mesh reinforcement, the underlying surface shall be sprayed with a binder. The amount of binder shall be about 0.45 kg/m^2. A suitable diluted polymer-modified bitumen, a polymer-modified bituminous emulsion, or a hot polymer-modified bitumen may be used as binder. Spraying shall be performed so as to form a homogenous layer. The underlying surface, before applying a binder and mesh reinforcement shall be levelled so that any uneven spots both longitudinally and crosswise are not larger than 8 mm under a 4 m long straight edge.

Spreading, Fixing, and Protection of Mesh Reinforcement

The mesh shall be spread by hand or mechanically. Once laid, the mesh shall be flat in both directions, fixed, and slightly tensioned (strip elongation up to 3%). A strip may be up to 50 m long. If shorter, strips may be extended up to 50 m in length. Longitudinally, strips are joined by 30cm overlaps. Once tensioned, the strip is fixed to the underlying surface at both ends with special rivets. A one-layer surface treatment is applied over the mesh to protect it during the execution of works.

9.1.4 Laying of Asphalt over Mesh

Asphalt mix is laid mechanically. The underlying surface shall be dry. The air temperature in the shade shall be at least +10°C. All other issues are subject to the requirements for the construction of asphalt layers given in these Technical Specifications and subject to the approval of the Engineer.

During asphalt laying, machines and transport vehicles shall not turn suddenly or brake on the mesh. Transport required for the technology of work shall be minimized. A quick start of vehicles on the laid mesh is forbidden.

9.1.5 Quality Control

A sheet with mesh properties shall be supplied and verified by the Manufacturer, who shall also furnish the quality guarantee for the mesh. Before the commencement of works, the Engineer shall check the required properties of mesh at every 200 m^2 of mesh.

The quality of spread, tension, and fixation of mesh shall be checked visually. The application of binder and asphalt layers shall be controlled in accordance with procedures defined for these operations.

Before laying an asphalt layer over a laid mesh, the Contractor shall request the Engineer's inspection and approval.

If the mesh is laid improperly or not tight, it shall be removed and the mesh laying procedure repeated. Any work over an improperly laid mesh shall not be allowed.

9.1.6 Measurement and Payment

Measurement and payment shall be done per 1 square metre (m^2) of laid mesh at the contracted price that includes all work and materials needed to execute this item of works (preparation of underlying surface, application of binder, procurement and placement of mesh, etc.).

9.2. Spraying of Bituminous Emulsion

Prior to making reinforcing layers, the underlying surface shall be dry, and shall not be frozen in any case. After levelling and final compaction, all free grains shall be removed from the surface with a rotary brush. This shall be done carefully, not to disturb material deeper down the layer. The cleaned surface shall be uniform and free from segregated areas.

Before cleaning, the underlying surface shall be levelled according to designed values. Its flatness shall be checked with a 4m long straight edge, according to requirements given in the Specifications.

The underlying surface prepared in this way is ready for spraying with bituminous emulsion.

If the surface is extremely dry or dusty, it shall be uniformly sprinkled with water, waiting for all water on the surface to evaporate, and then sprayed with bituminous emulsion.

For spraying a layer made of crushed aggregate, an anionic emulsion shall be used: AN-55, AN-60, or AN-65, fully in compliance with SRPS U.M3.022.

The quantity of emulsion used shall be about 700 g/m^2, so that after the evaporation of water, oils, and other ingredients, 300 g/m^2 of pure binder remain. After spraying, the surface shall dry for at least 24 hours.

Spraying shall be done with a sprayer, evenly and uniformly over the entire surface.

Calculation and payment shall be done per 1 m^2 of sprayed surface.

9.3. Construction of Base Course with Bitumen Bound Aggregate BNS 22SA (Bit 60)

9.3.1. Description

This item of works includes the procurement, preparation, laying, and compaction of a mixture of granular mineral material and bitumen.

9.3.2. Basic Materials

For the construction of base course with bitumen bound material, the following basic materials shall be used:

- Crushed carbonate rock material 0/4; 4/8; 8/16, and 16/22 ; 22 mm
- Rock flour of carbonate composition;
- Bit 60 binder.

9.3.3. Quality of Basic Materials

9.3.3.1. Chippings

Chippings shall be composed of carbonate rock mass of the following properties:

- Compressive strength in dry and water-saturated condition .... min 140 MPa
- Frost resistance, drop in mean compressive strength after 25 cycles .... max 20%

Chippings shall meet the following requirements:

- Wear according to Los Angeles test method... max 30%
- Grains of unfavourable shape .... max 20%
- Content of silty particles under 0.09 mm in size.. max 5%
- Bitumen-coated aggregate surface .... min 100/80
- Absorption of water on 4/8 mm fraction 1.2%

9.3.3.2. Granulometric composition

The grain size distribution curve shall be such that the grain size accumulation curve lies within the following limit range:

Square mesh, mm	Passing through sieve, % mass, BNS 22s
0.09	5-11
0.25	8-17
0.71	13-27
2.00	24-40
4.00	34-53
8.00	50-70
11.20	61-81
16.00	75-94
22.40	97-100
31.50	100

9.3.3.3. Rock Flour

Rock flour shall fully meet the criteria set out in JUS B.B3.045 for Quality Class I.

9.3.3.4. Bitumen

Bitumen may be Bit 45 or Bit 60. Bitumen shall fully meet the criteria set out in JUS U.M3.010.

9.3.3.5. Mix

In an asphalt mix, the proportion of bitumen shall be about 4%. A precise content of bitumen shall be determined in a trial asphalt mix. Mineral mix grain size accumulation curves shall fall within the limits stated in Sub-Section 9.3..3.2 above.

Properties of test specimens according to the Marshall test shall be as follows:

- Void content (vl.%) 3-9%
- Stability (kN).. min 6.0
- Stability/flow ratio (kN/mm)................................... 2.2
- Voids in mineral mix filled with bitumen 50-70%

9.3.4. Work Technology

9.3.4.1. Preparation of Underlying Surface

An asphalt layer may be laid over a surface that is dry and not frozen in any case. Prior to the commencement of works, the underlying surface shall be cleaned thoroughly with steel brushes and blown out with a compressor. After the surface has been cleaned, the Contractor will survey the reference level and evenness of the surface. In places where the underlying surface varies from the specified height by more than +15 mm, the Contractor shall repair the surface according to requirements set out in the design and subject to the approval of the Engineer, i.e.:

- In places where the surface level is below the specified reference level, the repair shall be done by increasing the thickness of layer of asphalt mix with asphalt concrete - wearing course or BNS;
- In places where the surface level is above the specified reference level, excessive asphalt mass shall be removed by grinding.

9.3.4.2. Preparation and Transport of Asphalt Mix

The asphalt plant shall be equipped with a screen, 22.4 mm mesh, to remove unpermitted coarse grains from mineral mix.

The temperature of bitumen shall be 150-160°C. The temperature of asphalt mix in the mixer shall be within the range 150-170°C (in exceptional cases 175°C).

9.3.4.3. Laying of Asphalt Mix

The temperature of asphalt mix on the site shall neither be lower than 140°C nor higher than 175°C.

9.3.4.4. Work Execution Period

A base course of specifications as set out herein may be laid only in the period from 15th April to 15th October, i.e. in the period when air temperatures are higher than 5°C in windless conditions, or min 10°C with wind, unless otherwise agreed in writing by the Engineer.

Asphalt mix shall not be laid during misty or rainy weather.

The temperature of underlying surface shall not be lower than +5°C.

9.3.5. Quality control

9.3.5.1. Pre-Testing of Asphalt Mix

Prior to the commencement of works, the Contractor shall prepare a trial asphalt mix design in an authorized laboratory, in full compliance with requirements set in these Technical Specifications.

No operation shall start before the Contractor has proposed the trial mix design to the Engineer for approval and the Engineer has issued formal written approval. Compliance certificates for basic materials and trial mix shall not be older than 6 months. If any changes in basic materials or their selection occur, the Contractor shall submit to the Engineer a written proposal for modification of the adopted asphalt mix, i.e. propose a new trial mix design for approval, before the use of these materials starts.

9.3.5.2. Verified Job Mix Formula for Asphalt

The quality of a trial asphalt mix shall be verified through trial work, with the asphalt mix adopted in the plant, and the application quality on a trial section. If the quality of basic materials on site is not in compliance with these Technical Specifications, the Contractor shall ensure new basic materials of good quality. If the batching of basic materials, according to the trial mix formula, cannot meet all specified requirements for physical and mechanical properties of asphalt mix and for constructed layer, it is necessary to modify the batching of basic materials and repeat the trial procedure.

Only when the trial procedure meets all specified requirements, the Engineer shall adopt the trial mix and give his approval for work to continue.

The proving job mix formula for asphalt shall be prepared in an authorized operative laboratory which shall be subject to the approval of the Engineer.

9.3.5.3. Quality Control

To ensure the specified quality in the course of construction, the control laboratory approved by the Engineer shall perform regular control tests, namely:

9.3.5.4. Testing of Bitumen

The Contractor may procure bitumen only provided that for each delivery he ensures the Manufacturer's compliance certificate that will be immediately presented for approval to the Engineer and/or laboratory. Apart from looking into the Manufacturer's compliance certificate, the operative control laboratory shall perform regular tests as directed by the Engineer (PK, penetration, and point of failure), as follows:

- At the beginning of works, and
- At every 500 t of supplied bitumen
- All other tests as required by the Engineer

9.3.5.5. Testing of Filler

The laboratory shall test the granulometric composition of filler:

- At the beginning of works, and
- At every 100 t of supplied filler.
- Whenever required by the Engineer

9.3.5.6. Testing of Asphalt Mix and Constructed Layer for Physical/Mechanical Properties

These tests shall be performed by the operative laboratory:

- At the beginning of works, and
- At every 1000 m2
- Whenever required by the Engineer

A specimen of asphalt mass shall be taken from hot, just laid, asphalt mix, behind the paver. The control of compaction and voids in the surfacing shall be performed on “cores” extracted from a finished layer at the same place where a specimen of hot asphalt mix is taken.

9.3.6. Criteria for Calculation of Executed Works

9.3.6.1. Evenness of Layer

Measurement shall be performed by the Contractor and submitted for checking and approval by the Engineer on cross sections, with spacing not larger than 20 m.

Measurements shall be done with a 4 m straight edge (left, right, middle), and/or with a transprofilograph, continuously in full length.
The criteria are as follows:

- Evenness 0-4 mm is satisfactory and acceptable.
- Evenness above 4-mm is not satisfactory or acceptable and the noncompliant area shall be rectified, or removed and replaced as directed by the Engineer at the full cost of the Contractor.

9.3.6.2. Variation in Specified Height of Layer

Measurements shall be performed on every profile:

- Permitted deviation of the surface of the base course shall not exceed +/- 10 mm when compared with the designed value .
- Deviation above 10 mm shall not be accepted and the noncompliant area shall be rectified, or removed and replaced as directed by the Engineer at the full cost of the Contractor..

9.3.6.3. Content of Residual Voids in Compacted Marshall Specimen

If residual voids are in excess of 6% limits, the base course layer value shall be rejected . and the noncompliant area shall be rectified, or removed and replaced as directed by the Engineer at the full cost of the Contractor..

9.3.6.4. Granulometric Composition of Mineral Mix

If the granulometric composition of an extracted mineral mix deviates from the limit curve for required physical and mechanical properties, the base course layer shall be rejected and the noncompliant area shall be rectified, or removed and replaced as directed by the Engineer at the full cost of the Contractor.

9.3.6.5. Rolling (Compaction) of Surfacing

For under compaction in excess of 3%, the works shall be rejected . and the noncompliant area shall be rectified, or removed and replaced as directed by the Engineer at the full cost of the Contractor.

9.3.7. Measurement and Payment

Measurement and payment shall be per m^2 of an actually constructed asphalt layer of specified thickness, fully in accordance with this description, the Technical Specifications, and subject to the approval of the Engineer.

9.4. Construction of Base Course with Bitumen Bound Aggregate BNS 32SA (Bit 60)

9.4.1 Description

This item of works includes the procurement, preparation, laying, and compaction of a mixture of granular mineral material and bitumen, in a single layer of thickness as specified in the Design.

9.4.2 Basic materials

For the construction of base course with bitumen bound material, the following basic materials shall be used:

- Crushed carbonate rock material 0/4; 4/8; 8/16; 16/22, and 22/32 mm;
- Rock flour of carbonate composition;
- Bit 60 binder.

9.4.3 Quality of Basic Materials

9.4.3.1 Chippings

Chippings shall be composed of carbonate rock mass of the following properties:

- Compressive strength in dry and water-saturated condition .... min 160 MPa
- Frost resistance, Na2SO4, loss after 5 cycles .... max 5%
- Wear according to Los Angeles test method... max 28%
- Grains of unfavourable shape .... max 20%
- Content of silty particles under 0.09 mm in size.. max 3%
- Bitumen-coated aggregate surface .... min 100/80
- Absorption of water on 4/8 mm fraction 1.2%

The grain size distribution curve shall be such that the grain size accumulation curve lies within the following limit range:

Square mesh, mm	Passing through sieve, %
0.09	4-10
0.25	7-15
0.71	12-23
2.00	20-35
4.00	29-46
6.00	41-62
11.20	50-71
16.00	61-82
22.40	76-94
31.50	97-100
45.00	100

9.4.3.2 Rock Flour

Rock Flour shall fully meet the criteria set out in SRPS B.B3.045 for Quality Class I.

9.4.3.3 Bitumen

Bitumen may be Bit 60. Bitumen shall fully meet the criteria set out in SRPS U.M3.010.

9.4.3.4 Mix

In an asphalt mix, the proportion of bitumen shall be about 4%. A precise content of bitumen shall be determined in a trial asphalt mix. Mineral mix grain size accumulation curves shall fall within the limits stated in Sub-Sections above (9.3.3.2).

Properties of test specimens according to the Marshall test shall be as follows:

- Void content (v/v%) 5-9%
- Stability (kN) .... min 8.0
- Stability/flow ratio (kN/mm)................................... 2.5

9.4.4 Work Technology

9.4.4.1 Temperature of Bitumen and Asphalt Mix

The temperature of bitumen shall be 150-165^{o}C. The temperature of aggregate shall not be higher than the temperature of bitumen by more than 15^{o}C. The temperature of asphalt mix in the mixer shall be within the range 150-170^{o}C (in exceptional cases 175^{o}C).

9.4.4.2 Preparation of Underlying Surface

Preparation shall comply with the requirements of Sub-Section 9.3.4.1.

9.4.4.3 Spraying

Suitable bituminous emulsion shall be used for spraying. Spraying shall be done with a sprayer, with 0.2 kg/m^2.

9.4.4.4 Work Execution Period

The base course with specifications as set out herein may be laid only in the period in the period from 15th April to 15th October, i.e. in the period when air temperatures are higher than 5°C in windless conditions, or min 10°C with wind unless otherwise agreed in writing by the Engineer. Asphalt mix shall not be laid during misty or rainy weather. The temperature of underlying surface shall not be lower than +5°C.

9.4.4.5 Laying of Asphalt Mix

BNS is laid with a paver. A manual work is allowed only where a paver cannot be used because of spatial restrictions and subject to the approval of the Engineer.. The temperature of asphalt mix at the place of laying shall neither be lower than 140°C nor higher than 160°C.

9.4.4.6 Compaction

Rollers of various types and weight may be used for compaction, with the requirement to reach a compaction degree of min 98%. Single runs of rollers shall always overlap.

9.4.4.7 Construction Joints

When resuming work after longer pauses, irregular ends shall be trimmed vertically in full thickness and coated with a hydro-carbon binder.

9.4.5 Quality control

The quality control shall cover the pre-testing of quality, regular tests, and control tests.

To ensure a prescribed quality in the course of works, the control laboratory approved by the Engineer shall perform regular control tests as directed by the Engineer.

9.4.5.1 Pre-Testing of Asphalt Mix

Prior to the commencement of works, the Contractor shall elaborate a trial asphalt mix design in an authorized laboratory approved by the Engineer, fully in accordance with the requirements from these Technical Specifications. No operation shall start until the Contractor has proposed a trial mix design to the Engineer for approval and the Engineer has issued formal approval. Compliance certificates for basic materials and trial mix shall not be older than 6 months. If any changes in basic materials or their selection occur, the Contractor shall submit to the Engineer a written proposal for modification of the adopted asphalt mix design, i.e. propose a new trial mix design for approval, before the use of these materials starts.

9.4.5.2 Job Mix Formula for Asphalt

The job mix formula for asphalt shall be determined through trial work in the asphalt plant and by its application.

If the quality of basic materials on site is not in compliance with these Technical Specifications, the Contractor shall ensure new basic materials of good quality. If the batching of basic materials, according to the trial mix formula, cannot meet all specified requirements for physical and mechanical properties of asphalt mix and for constructed layer, it is necessary to modify the batching of basic materials and repeat the trial procedure to the full satisfaction and approval of the Engineer.

Only when the trial procedure meets all specified requirements, the Engineer shall adopt the trial mix and give his approval for work to continue. The proving job mix formula for asphalt shall be prepared in an authorized operative laboratory approved by the Engineer.

In the course of works, the granulometric composition of rock mix of particular test samples may vary from the trial and job mixes within limits prescribed in SRPS U.E9.021 'Table 14' and subject to the approval of the Engineer.

9.4.5.3 Regular Testing of Component Materials

Scope and frequency of regular tests of component materials (filler, bitumen) is defined in SRPS U.E9.021 –Sub-Section 14.2.2.

9.4.5.4 Testing of Asphalt Mix and Constructed Layer for Physical/Mechanical Properties

Testing of asphalt mix and constructed layer for physical/mechanical properties. These tests shall be performed by the operative laboratory:

- At the beginning of works, and
- At every 2000 m2
- Whenever required by the Engineer

A specimen of asphalt mass shall be taken from hot, just laid, asphalt mix, behind the paver. The control of compaction and voids in the surfacing shall be performed on "cores" extracted from a finished layer at the same place where a specimen of hot asphalt mix is taken.

9.4.6 Criteria for Calculation of Executed Works

9.4.6.1 Evenness of Layer

The criteria stated in Sub-Section 9.3.6.1 shall apply..

9.4.6.2 Variation in Specified Height of Layer

The criteria stated in Sub-Section 9.3.6.2 shall apply.

9.4.6.3 Content of Residual Voids

The criteria stated in Sub-Section 9.3.6.3 shall apply.

9.4.6.4 Granulometric Composition of Mineral Mix

The criteria stated in Sub-Section 9.3.6.4 shall apply.

9.4.6.5 Rolling (Compaction) of Surfacing

The criteria stated in Sub-Section 9.3.6.5 shall apply.

9.4.7 Measurement and Payment

Measurement and payment shall be performed per m^2 of an actually constructed asphalt layer of specified thickness, fully in accordance with this description and criteria, the Technical Specifications, and subject to the approval of the Engineer.

9.5. Construction of Wearing Layer with Stone Mastic Asphalt 0/11S

9.5.1. Description and Purpose of Work

This item of works includes the procurement, preparation, laying, and compaction of a wearing layer with stone mastic asphalt SMA 0/11S.

Stone mastic asphalt is a mix of crushed aggregate and sand of discontinuous grain distribution curve that, due to a relatively high content of aggregate (70- 80%), has an extremely skeletal structure that is filled with bituminous mastic composed of filler, dope, polymer-modified bitumen, and stabilizing fibres.

The basis for preparation of technical specifications for this item of works is SRPS U.E4.015 (Construction of skeletal asphalt surfacing for maintenance, strengthening, and construction of a new pavement structure) and SMA 0/11 - ZTV Asphalt-Stb, 1998 *Empfehpungen für die Zusammensetzung, die Herstellung und den Neubau von Splittmastixasphalt, FGSV 1966*.

9.5.2. Basic materials

- Crushed high-grade chippings 2/4, 4/8, and 8/11 mm;
- Crushed sand 0/2 mm (silicate or carbonate)
- Rock flour of carbonate composition,
- Cellulose fibres, and
- Polymer-bitumen PmB 60 S.

9.5.3. Quality of Component Materials

Polymer-Bitumen PmB 60S

Polymer-modified bitumen, based on SBS-polymer, 50-90S type, according to Austrian specifications ÖNORM B3613 (Elastomer-modifizierte Bitumen für den Strassenbau – Anforderderungen) shall be used as binder, with the characteristics as given in the table below.

Test type	PmB 50-90C	Test method
Penetration at 25°C (1/10 mm), (100 r/5s)	50 – 90	SRPS B.H 8.612
Softening point according to PK,(°C)	> 65	SRPS B.H 8.613
Frass breaking point (°C)	< -19	SRPS B.H 8.616
Ductility, (cm), at 25°C	> 50	SRPS B.H 8.615
Cleveland flash point , (°C)	> 250	DIN ISO 2592
Reversible elastic deformation at 25°C,%	> 80	ÖNORM C 9219
Homogeneity during storage, Δ PK, (°C)	< 2.0	TL PmB Teil 1 (1991) Tube Test
After RTFOT according to ASTM D 2872		
Mass loss, % (m/m)	< 0.5	-
Change in penetration at 25 °C, (%) ● decrease ● increase	 < 40 < 10	SRPS B.H8.612
Reversible elastic deformation at 25°C,%	> 80	ÖNORM C 9219

Instead of polymer-bitumen PmB 60S, standard road bitumen Bit 60 may be used, with the addition of 0.6% (m/m), with respect to asphalt mix, of polymer-modified bitumen cellulose granules.

Rock Flour

Rock flour for the preparation of asphalt mix SMA 0/11S shall be of carbonate composition, Quality Class I, according to SRPS B.B3.045.

Crushed Sand 0/2 mm

Crushed sand 0/2 mm, for the preparation of SMA 0/11S, may be of either silicate or carbonate composition, provided that it meets the following requirements:

Granulometric distribution of crushed sand 0/2 mm

Square mesh size (mm)	Passing through sieve, % (m/m)
0.09	0 – 10*
0.25	15 - 35
0.71	40 - 85
2.00	90 - 100
4.00	100
Grading modulus	1.70 - 2.55

* If the content of filler (particles < 0.09 mm in size) is larger than 10%, sand may be used only if of carbonate composition, and if the sand equivalent is larger than 60%. Silicate sand, with more than 10% of filler, shall not be used regardless of the sand equivalent value.

Physical/chemical properties of crushed sand 0/2 mm

CHARACTERISTICS	QUALITY REQUIREMENTS
Content of particles < 0.09 mm in size, %(m/m)	< 10
Sand equivalent, %	> 60
Content of clay balls, % (m/m)	0
Content of organic impurities , %(m/m)	0

Chippings

For the preparation of stone mastic asphalt, eruptive rock chippings shall be used, with the granulometric composition in conformity with requirements set out in SRPS U.E4.014/90 and SRPS B.B3.100.

Rock aggregates shall be accompanied with valid compliance certificates issued by an authorized laboratory pursuant to the "Ordinance on mandatory compliance testing of fractionated rock aggregate for asphalt and concrete", published in the Official Journal of SFRY No. 41 dated 19th June 1987. Chippings shall possess the following physical/mechanical characteristics:

	Standard	Characteristics	Quality requirements
1.	SRPS B.B8.045	Resistance to crushing and wear according to Los Angeles method	< 18 %(m/m)
2.	SRPS B.B8.120	Polished value	> 48 VPK
3.	SRPS U.M8.096	Percentage of rock aggregate surface coated in polymer-bitumen	> 100/90
4.	SRPS B.B8.044	Frost resistance with sodium sulphate; mass loss aftr 5 cycles	< 3 %(m/m)
5.	SRPS B.B8.031	Water absorption on 4/8 mm fraction	< 1.2 % (m/m)
6.	SRPS B.B8.048	Proportion of grains with the maximum-to-minimum size of grain >3:1	< 20 % (m/m)
7.	SRPS B.B8.037	Proportion of weak grains in fractions > 4 mm	< 3 % (m/m)
8.	SRPS B.B8.038	Proportion of clay balls in a particular fraction	< 0.25 % (m/m)

9.5.4. Composition of Mineral Mix for SMA 0/11S

Granulometric Composition of Mineral Mix

The proportion of basic materials in mineral mix shall be adjusted in such way that the grain size accumulation curve lies within the following limit range :

Mesh size	Limit range SMA 0/11S
0.09 мм / 0.09 mm	11 - 13
0.25 мм / 0.25 mm	13 - 17
0.71 мм /0.71 mm	16 - 22
2.0 мм / 2.0 mm	23 - 27
4.0 мм / 4.0 mm	23 - 32
8.0 мм / 8.0 mm	50 - 64
11.2 мм /11.2 mm	95 - 100
16.0 мм / 16.0 mm	100

Allowed deviations in granulometric composition

Allowed deviations in the granulometric composition of rock mix in a job mix formula and individual specimens in the course of production, from the granulometric composition of rock mix in a trial mix formula shall be within the following tolerances

Tolerances for variations in granulometric composition of mineral mix

Square mesh size	Allowed variation of the granulometric composition of rock in a job mix and particular specimens during the production process from the granulometric composition of rock in a trial asphalt mix, ± % (m/m)
0.09 мм / 0.09 mm	± 0.5
0.25 мм / 0.25 mm	± 1.0
0.71 мм /0.71 mm	± 1.5
2.0 мм / 2.0 mm	± 1.0
4.0 мм / 4.0 mm	± 2.0
8.0 мм / 8.0 mm	± 3.0

Orientational asphalt mix formula

An orientational asphalt mix formula is:
- Filler 0-0.09 mm.. 10%
- Sand 0.09-2 mm... 15%
- Chippings 2-11 mm 75%

Total 100%

In order to achieve good resistance to deformation, the ratio of fractions 0/2, 2/4, 4/8 and 8/11 mm in mineral mix shall be 1:1:3:4, and for good resistance to wear, the ratio of fractions shall be 1:1:2:4.

An optimum composition of asphalt mix and polymer-bitumen shall be determined when preparing trial and job asphalt mix formulae.

9.5.5. Quantity of Polymer-Bitumen

The content of polymer-bitumen in asphalt mix SMA 11S shall fall within the range 6.0-6.5%. A precise amount of binder shall be defined when preparing trial and job mix formulae.

An optimum amount of polymer-bitumen in asphalt mix shall be checked with the Schellenberg test.

9.5.6. Quantity of Stabilising Fibres

In mixing SMA-11S, bitumen-impregnated cellulose fibres in granular shape are used as a stabilising admixture in the amount of 0.4% (m/m) in proportion to asphalt mix. Special mountable batchers are used to batch cellulose granules in the right amount per mass.

9.5.7. Trial asphalt mix design

Prior to the commencement of works, the Contractor shall prepare a trial asphalt mix design in an authorized laboratory approved by the Engineer in full compliance with requirements set in these Technical Specifications.

No operation shall start before the Contractor has proposed the trial mix design to the Engineer for approval and the Engineer has issued formal written approval. Compliance certificates for basic materials and trial mix shall not be older than 6 months. If any changes in basic materials or their selection occur, the Contractor shall submit to the Engineer a written proposal for modification of the adopted asphalt mix, i.e. propose a new trial mix design for approval, before the use of these materials starts.

Testing of Characteristics of Component Materials

When designing a trial asphalt mix, the supplied specimens of basic materials shall be subjected to the following tests:

a) Testing of polymer bitumen: softening point according to PK, penetration at 25°C, penetration index, ductility at 25°C, reversible elastic deformation, homogeneity and thermostability tests, relative density at 25°C, and Frass breaking point.
b) Testing of rock flour: granulometric composition, Rigden voids, and density at 25°C.
c) Testing of sand: granulometric composition, proportion of particles smaller than 0.09 mm in size, sand equivalent, and grading modulus.
d) Rock aggregate: granulometric composition of fractions, water absorption for 4/8 mm chippings fraction, resistance to crushing and wear (Los Angeles), adhesion of binder to aggregate, and grain shape.

Designing of Asphalt Mix Formula and Physical/Mechanical Properties

The granulometric composition of rock mix in a trial mix formula shall be designed within the limit range given in these Technical Specifications. The mineral mix and quantity of polymer bitumen shall be designed so that the physical/mechanical properties of asphalt mix meet the following requirements:

Physical/Mechanical properties of Marshall specimens

	Type of specimen	Characteristic	Standard	Trial and job asphalt mix
1.	Laboratory test specimen compacted with 2 x 50 blows at the temperature of 155 ± 5°C	Marshall stability at 60°C, (kN)	SRPS U.M8.090	> 8.0
2.		Stability/Flow ratio at 60°C,(kN/mm)	SRPS U.M8.090	> 2.0
3.		Void content, % (v/v)	SRPS B.B8.031	3.5 - 4.5
4.		Voids in rock mix filled with bitumen, % (v/v)	SRPS B.B8.031	70 - 85
5.		Voids in mineral mix, % (v/v)	SRPS B.B8.031	17 - 19

Characteristics of Constructed Asphalt Layer

A constructed layer SMA 0/11S shall possess the following properties:

	Characteristics	Quality requirements
1.	Voids in constructed layer, % (v/v)	3 - 5
2.	Compaction degree, %	> 98 %
3.	Evenness of layer determined with a 4 m levelling staff	< 3 mm
4.	Variation of the surface of layer from the specified reference level	< 3 mm
5.	Variation from the specified cross fall	< ± 0.2 %
6.	Granulometric composition of extracted mineral mix shall lie within the range set out in these Technical Specifications	-
7.	Variation of the amount of binder from the amount specified in the trial asphalt mix	< ± 0.3 % (m/m)
8.	Physical/mechanical properties of asphalt specimens shall meet the requirements from these Technical Specifications	-

Report on Preparation of Trial Asphalt Mix Formula

The report on preparation of trial asphalt mix formula shall contain:
- Data on origin, quality, and properties of component materials
- Data on proportion of rock material fractions in mineral and/or asphalt mix
- Granulometric composition of mineral mix
- Optimum content of binder
- Physical/mechanical properties of a laboratory test specimen, and
- Grain size distribution chart for mineral mix.

The Report on trial mix formula shall be accompanied with compliance certificates for component materials, not older than 6 months, and a valid compliance certificate for rock material issued by an authorized laboratory, pursuant to the “Ordinance on mandatory testing of fractionated rock aggregate for asphalt and concrete” issued in the Official Journal of SFRY No. 41 dated 19th June 1987.

9.5.8. Job Mix Formula for Asphalt

Prior to the commencement of works, a job mix formula for asphalt shall be prepared and submitted for the approval of the Engineer. The job mix formula for asphalt shall serve as proof that the asphalt plant can produce asphalt mix of quality designed in the trial asphalt mix design to the full satisfaction and approval of the Engineer. The pre-requisite for proving the trial asphalt mix formula is the verification of quality of component materials stored in the asphalt plant.

Proving Quality of Produced Asphalt Mix (Trial Production)

The production of asphalt mix is considered proven when the testing of at least three specimens of asphalt mix taken from continuous production shows that:
- The granulometric composition of rock mix is within the allowed range of deviations set out in these Technical Specifications
- The proportion of binder for each specimen is within the allowed range of deviations of ± 0.3% (m/m) from the values given in the trial asphalt mix design, and
- Physical/mechanical properties of all specimens meet the requirements set out in these Technical Specifications.

The job mix formula for asphalt is to be given in a form of written report.

When a job mix formula for asphalt in the asphalt plant cannot fully fit into allowed variations, it is necessary to correct the trial mix formula for asphalt with the Designer’s approval and also subject to the approval of the Engineer.

The trial mix formula for asphalt shall be redesigned, if it cannot be proven in the asphalt plant due to major differences in the composition and properties of component materials in the asphalt plant or due to specifics of the asphalt plant, or as otherwise directed by the Engineer.

9.5.9. Proving Quality of Laid Asphalt Mix (Trial Section)

Prior to the commencement of works, a trial section shall be constructed. The trial section serves as proof that the job mix, with an appropriate work technology, can construct a regulating course in the quality specified in these Technical Specifications to the full satisfaction and approval of the Engineer.

In the course of construction of a trial section, the following shall be controlled:

- Asphalt mass transport method
- Temperature during rolling
- Rolling method
- Compaction, and
- Evenness of constructed surface.

The quality of a trial section is considered to be proven once the testing of at least three specimens from the laid asphalt layer obtain satisfactory characteristics in accordance with the criteria from these Technical Specifications and subject to the approval of the Engineer.

The assessment of trial section quality, including test results, shall be given in the form of a written report.

Based on the proved quality of trial production and trial section, the Engineer shall approve the commencement of works in writing.

9.5.10. Technology of Work

Production of Asphalt Mix

Asphalt mix shall be produced mechanically. For the production of asphalt mix, a discontinuous plant, with a minimum capacity of 60 t/h and automatic batching and production control, shall be used.

The asphalt plant shall have at least two back-up tanks, and a working tank for storing polymer-bitumen. The tanks shall be equipped with thermometers.

The asphalt plant shall have an incorporated automatic batcher by mass for cellulose granules. The batching method, according to the Manufacturer's instructions, shall foresee the feeding of granules along with rock material directly into the asphalt mixer, followed by rock flour, and, after 10-15 seconds of mixing in dry, by binder.

The asphalt plant shall have sieves according to adopted trial mix, and batchers for component materials shall have four scales for: rock aggregate, rock flour, polymer-bitumen, and cellulose granules.

The asphalt plant shall be equipped with thermometers for binder and mineral aggregate, and also for hot asphalt mix in a silo.

The number of pre-batchers shall be at least six; each of them shall have mechanical and automatic flow regulation.

A cyclone in the asphalt plant shall have an option to adjust the degree of dedusting and removal of silty particles in order to remove the content of filler above 10% in sand fractions, as needed.

The plant shall have at least 4 hot bunkers for fractions of rock material. There shall be appropriate square mesh sieves put in place in the plant, so that the following fractions could be provided in hot bunkers:

- Fraction 0/2 mm (with max 10% particles below 0.09 mm)
- Fraction 2/4 mm
- Fraction 4/8 mm – fraction 8/11 mm

Furthermore, in the set of sieves, there shall also be a limit sieve that will remove grains of chippings above 11 mm in size.

Immediately after production, asphalt mass shall not be stored, but transported to the place of laying without delay, so as not to cool down.

To prevent asphalt mass to stick to the transport hopper, it is necessary to regularly lubricate the hopper with 40% silicone emulsion sprayed through an automatic nozzle.

Acceptance and Storage of Basic Materials

The Contractor shall ensure all required quantities of rock material, as foreseen for this project, on stockpiles at least 10 days before the commencement of works.

Rock aggregate foreseen for the production of asphalt mix shall be stored on special, new stockpiles. It is not allowed to mix it with earlier supplies of material. The stockpiles shall be on a firm surface (concrete, asphalt, macadam); it is forbidden to use stockpiles on earth surfaces. The stockpiles shall be at sufficient distance to prevent any mixing of fractions; the stockpiles shall be clearly marked by aggregate fractions.

Rock flour shall be stored in a special silo that shall be previously emptied from any prior supplies.

Polymer-bitumen shall be delivered to the asphalt plant immediately before the commencement of production of asphalt mass in order to avoid any unnecessary storage in a higher temperature. The delivery schedule for polymer-bitumen shall be arranged so that the amount of binder delivered to the asphalt plant is immediately used for the production of asphalt mix. In the asphalt plant, polymer-bitumen shall be discharged into working and back-up tanks previously emptied from old bitumen.

The delivery of basic materials shall be submitted for the approval of the Engineer based on a quality certificate issued by an authorized institution.

Preparation of Rock Aggregate

Rock aggregate shall be dried and heated in a heating drum at the temperature of 170-180ºC.

In no case shall the temperature of aggregate be higher than the temperature of binder by more than 15ºC.

Preparation of Binder – Temperatures of Polymer-Bitumen and Asphalt Mix

Temperatures of polymer-bitumen, during storage and preparation of asphalt mix, shall not be higher than those shown in the table below. Also, the time of exposure of polymer-bitumen to elevated temperatures during storage shall be limited. Polymer-bitumen should be exposed to elevated temperatures as little as possible, in order to prevent its demixing and separation of polymer on top of bitumen.

Optimum working temperatures for polymer-bitumen and SMA mix

Temperature of PmB	Recommended	Maximum
In a tank	155° C	165°C
SMA at the mixer discharge point	170°C - 175°C	180°C

Before the process of mixing with rock material, it is recommendable to additionally homogenize polymer-bitumen. This is achieved by recirculating binder from one tank to another.

Mixing

The time of mixing, and the entire batching and mixing process shall be adjusted so that all aggregate grains are coated with binder uniformly. The mixing time shall be determined by the Contractor and submitted for the approval of the Engineer.

Hot mineral mix, cellulose granules, and rock flour shall be mixed together in the asphalt mixer for 10-15 seconds, and then heated binder shall be added, with everything mixed together for another 30 seconds. The mixing of asphalt mix components shall be proportioned according to the approved job mix formula.

To prevent the sticking of asphalt mass, the hopper shall be sprayed with 40% solution of silicone emulsion or water solution of potassium soap.

Temperature of aggregate, polymer-bitumen and asphalt mix shall be in compliance with temperatures stated in Sub-Section 9.9.4. If the temperatures of asphalt mix, after mixing, are lower or higher than those specified in the table, the mass shall be discarded. The same applies to the mix, if foamy or contains moisture.

Asphalt Mix Transport

Transport vehicles for asphalt mix shall have a tipping mechanism. Every truck shall have a tarpaulin to protect asphalt mix from cooling, weather conditions, dust, and wind, i.e. to keep its temperature until laying and prevent the moistening of asphalt mix. The temperature of asphalt mix during laying shall neither be lower than 165 ºC nor higher than 180ºC. The Contractor shall ensure a sufficient number of trucks for transport, with regard to the capacity of asphalt plant, transport distance, and the size of site, in order to avoid interruptions in the work of paver. The paver shall not stop!

The hopper of a truck for transport of asphalt mix shall be clean and sprayed before every feeding with an agent that prevents asphalt mix from sticking to its sides. The most suitable agents for that are a 40% silicone emulsion, or a water solution of potassium soap. The use of oil derivatives for spraying is not allowed.

Every truck of delivered asphalt mix shall be accompanied with a delivery note with specified weight, temperature, and time of loading of asphalt mix, signed by the Contractor and submitted for the approval of the Engineer. Without this document, the laying of delivered asphalt mix shall not be allowed..

It is allowed to keep asphalt mix in silos in the asphalt plant up to 2 hours, or if the silos are thermally insulated, that time can be longer, all this provided that the temperature of asphalt mix remains within the prescribed range and subject to the approval of the Engineer.

Laying of Asphalt Mix

General Note

The construction of an asphalt layer may start only when the Engineer accepts and confirms approval for the report on trial section, and/or report of performed trials.

Weather Conditions During Construction

A wearing layer made of stone mastic asphalt may be constructed only in warm and dry weather, only in in the period when air temperatures are higher than +10°C in windless conditions, or min. +15°C with wind. The temperature of underlying surface shall be higher than +10°C. The Contractor and Engineer shall pay particular attention to that, because SMA mix cools down rapidly and the prescribed compaction will not be reached.

The laying of asphalt mix may start only when approved by the Engineer

SMA Laying Machines

Pavers

Pavers shall be electronically guided over a steel wire rope, or laser-guided.

Rollers

For the compaction of SMA layers, only 10-tonne static steel-rim rollers shall be used. The use of combined rollers or rubber-tyre rollers is not allowed. Vibrations during rolling are not allowed. 4-5 rollers in total are needed. Rollers shall have functional water sprayers for wheels.

Preparation of Underlying Surface

The underlying surface on which the asphalt layer is to be constructed shall be dry and dedusted (with compressed air). The surface on which SMA 0/11S is laid shall be dry and clean, and shall not be frozen. Before constructing the layer, the underlying surface shall be sprayed with bituminous emulsion in the amount of 0.2 kg/m^2.

Temperature of Mix on Place of Construction

The temperature of spread asphalt mix on the place of construction shall neither be lower than 165^{o}C nor higher than 180^{o}C. Asphalt mix that does not have a specified temperature shall be discarded.

Spreading of Asphalt Mix

The layer shall be spread mechanically, with a paver with automatic height guidance.

The Contractor shall set the timing of production, transport, and spreading of asphalt mix so as to avoid interruptions in the work of paver, since longitudinal joints are not foreseen.

The paver shall be adjusted regarding all elements, and its speed adjusted so that the layer has a flat surface, and its thickness and cross fall are as specified in the design. There shall be no segregated spots, nor scratched places due to the unheated screed, or asphalt stuck to the screed; there shall be no oily stains, etc. Before the commencement of work, the screed shall be heated from a separate source (butane-gas). The compaction obtained with the paver shall be at least 90% of the laboratory value.

Compaction of Asphalt Mix

The compaction of asphalt mix shall be performed in a standard way, with 10-tonne static steel-rim rollers. The use of vibrations is not allowed. Rollers go immediately behind a paver and shall pass 6 runs in one direction to achieve the specified compactions, which is determined on a trial section. Rolling shall start at the temperature of 170^{o}C, with an optimum temperature between 160^{o}C and 140^{o}C. Rolling shall be finished when the temperature drops below 130^{o}C. A minimum compaction of the layer shall be 98 %.

Rollers are not allowed to stay on a still non-compacted layer of asphalt, when the temperature is over 80^{o}C. For filling up with water, rollers shall be out of the working surface. All precaution measures shall be taken to prevent any leakage of oils, diesel, and lubricants to the pavement under rollers.

During rolling, the thickness, profile, and evenness of layer shall be checked constantly.

Longitudinal and Transverse Joints

If traffic cannot be diverted in the course of works, and one half of the road has to be constructed at a time, it is necessary, when joining the layer of asphalt concrete – SMA mix, use a joint tape. This tape is used for all asphalt layers in the surfacing, and for the bond between concrete and asphalt, or asphalt and stone. Joint tapes are bitumen-coated machined thermoplastic sections that soften under higher temperature (heating). These tapes contain different admixtures, with mineral filler. The tape, which shall be placed vertically or at 20° angle, should be higher by approx. 5 mm than the layer thickness. A usual height of these tapes is 25-50mm. The width of tape is 10 mm and shall not be increased.:

The tapes are placed in the same weather conditions as asphalt: in dry weather and at ambient temperatures over +5°C. After the completion of works, the redundant part of tape above the pavement shall be cut and ground.

Opening to Traffic

A properly rolled layer of asphalt may be opened to traffic not earlier than 24 hours after rolling.

9.5.11. Quality Assurance

Quality assurance requires the pretesting of quality, the testing of job mix, the construction of a trial section, regular and control tests, fully in compliance with these Technical Specifications and to the full satisfaction and approval of the Engineer.

Regular Tests

The primary objective of regular control is to have the clearest possible comprehension of the quality of basic materials, produced and laid asphalt, in order to act in the production process if needed and thus ensure the specified quality of asphalt. Regular tests shall be performed by the Contractor or at the Contractor's expense, by a laboratory registered for that type of control subject to the approval of the Engineer.

Laboratory Equipment for Regular Control

The laboratory shall have all equipment for specified tests, for regular tests in the production process, and for tests performed during the production of a job mix formula for asphalt and the work on a trial section, as defined in these Technical Specifications. The regular control includes the testing of component materials and asphalt mix, as follows:

- Polymer-bitumen (PK, penetration)
- Rock flour (granulometric composition)
- Crushed sand (granulometric composition)
- Chippings 2/4, 4/8, and 8/11 (granulometric composition)
- Granulometric composition of rock mix
- Content of binder in asphalt mix, and
- Physical/mechanical properties of asphalt mix.

Asphalt mix specimens are taken at the place of production or construction from a hot, just spread asphalt mix behind the paver. The control of compaction, voids, and thickness shall be performed by the extraction of asphalt specimens (cores) at the same place where the specimens of hot asphalt mix are taken.

The scope and frequency of regular tests shall be such to ensure a uniform quality in compliance with these Technical Specifications, namely:

- Regular tests of rock flour, crushed sand, and chippings shall be performed at every 500 t of produced asphalt mix
- Regular tests of polymer-bitumen shall be performed at the beginning and at every 25 t of consumed polymer-bitumen, and
- Regular tests of the composition and physical/mechanical properties of asphalt mix shall be performed at every 500 t of produced asphalt mix.

Control tests

Control tests shall be performed by the Contractor or, at his expense, at a laboratory registered for this type of work subject to the approval of the Engineer.

Control tests include the testing of quality of: polymer-bitumen, rock flour, sand, and chippings.

The scope and frequency of control tests shall be such to ensure a comprehension of quality of constructed layer in compliance with these Technical Specifications, namely:

- Polymer-bitumen – at least 1 specimen at every 50 t of delivered polymer-bitumen (full-scale testing in accordance with these Technical Specifications)
- Rock flour – at least 1 sample at every 1000 t of produced asphalt (granulometric composition, proportion of voids in dry compacted condition)
- Crushed sand - at least 1 sample at every 1000 t of produced asphalt (granulometric composition, content of particles <0.09 mm, and sand equivalent)
- Chippings – at least 1 sample from each fraction at every 1000 t of produced asphalt (granulometric composition, content of particles < 0.09 mm, grain shape, and content of friable grains).

In the course of works, the physical/mechanical properties and composition are checked on the samples of asphalt mix taken from hot, just spread, asphalt mix at every 1000 t of produced asphalt mass. The quality of constructed layer shall be determined by the extraction of cores at the same place where hot asphalt mix samples are taken, at least at 6000 m^2 of constructed layer, when the following is tested: density, thickness, voids, compaction, and adhesion to the underlying surface.

Furthermore, evenness, variations from the profile and reference levels, and the position of centre line shall be checked as well.

9.5.12. Criteria for Calculation of Executed Works

Evenness of Layer

Measurement shall be performed with a 4 m straight edge (left, right, middle), or bump integrator, continuously in full length.

The criteria are as follows:

- The criteria stated in Sub-Section 9.3.6.1 shall apply...

Variation in Specified Height of Layer

Measurements shall be performed on every profile:

- The criteria stated in Sub-Section 9.3.6.2 shall apply...

Content of Residual Voids

The criteria stated in Sub-Section 9.3.6.3 shall apply...

Granulometric Composition of Mineral Mix

The criteria stated in Sub-Section 9.3.6.4 shall apply...

Compaction (Rolling) of Surfacing

The criteria stated in Sub-Section 9.3.6.5 shall apply...

9.5.13. Calculation of Works

Measurement and Payment:

Measurement and payment shall be performed per m^2 of an actually constructed stone asphalt layer, fully in accordance with this description and criteria, the Technical Specifications, and subject to the approval of the Engineer.

9.6. Construction of Wearing Layer with Asphalt Concrete AB 11 (Bit 60)

9.6.1. Description

This item of works includes the procurement, preparation, laying, and compaction of asphalt concrete in a 5 cm thick layer. The basis for elaboration of technical specification for this item of works is SRPS U.E4.014.

9.6.2. Basic materials

- High-grade crushed chippings 2/4 mm, 4/8 mm, 8/11 mm;
- Crushed sand 0/2 mm (carbonate)
- Rock flour of carbonate composition
- Bitumen BIT 60 (PK=49-55; Pen=50-70).

9.6.3. Quality of Basic Materials

9.6.3.1. Chippings

Chippings shall be made of rock mass of the following properties:

Property	Quality requirements
Compressive strength	min 160 MPa
Abrasion wear	max 12 $cm^3/50\ cm^2$
Frost resistance	good *

*/ Drop in mean compressive strength after 25 freeze-thaw cycles – max. 20 %

Chippings shall meet the following requirements:

1. Granulometric composition of fractions according to SRPS U.E4.014/90
2. Wear, Los Angeles test.................................. max 16%
3. Content of grains of unfavourable shape ...... max 20%
4. Content of friable grains.................................. max 3%
5. Content of clay balls in a single fraction, according to SRPS B.B8.038 .... max 0,25%
6. Bitumen-coated surface of aggregate, SRPS U.M8.096 .... min 100/90

9.6.3.2 Sand

For sand, high-grade crushed sand obtained from rock mass of carbonate composition may be used. The granulometric composition of sand shall meet the following requirements:

Sieve mesh in mm		Passing through sieve in % weight Crushed sand 0/2 mm
0,09	0.09	0-10 *
0,25	0.25	15-35
0,71	0.71	40-85
2	2	90-100
4	4	100

*/ If sand contains over 10% of filler fractions it may be used provided that the sand equivalent is over 60%

Sand shall also meet the following requirements:
1. Sand equivalent min 60%
2. No clay balls shall be present in sand
3. Sand shall not contain organic impurities
4. No clays of particles glued together shall be formed in sand.

9.6.3.3 Rock Flour

Carbonate rock flour, Quality Class I according to SRPS B.B3.045 shall be used. The use of rock flour made of ground dolomite rock is not recommendable due to its lower adhesion to bitumen.

Prior to the commencement of works, the Contractor shall provide, from an authorized laboratory for the approval of the Engineer, a quality certificate for rock flour, which will guarantee for the quality according to SRPS B.B3.045 (Quality I).

9.6.3.4 Bitumen

Bitumen Bit 60 shall be used as binder, with the following properties: softening point (ring-and-ball PK 49-55°C), penetration 50-70, penetration index higher than -1.0, content of paraffin max 2%, and ductility min 100 cm. Other properties according to SRPS U.M3.010.

9.6.3.5 Mineral Mix Composition

The proportion of basic fractions in mineral mix shall be adjusted so that the grain size accumulation curve is as follows:

Sieve and screen mesh		Pre-tests and trial machine operation Passing through sieve and screen in % weight
0,09	0.09	3-12
0,25	0.25	8-28
0,71	0.71	16-38
2	2	31-54
4	4	49-69
8	8	75-90
11,2	11.2	97-100
16,0	16.0	100

9.6.3.6 Asphalt Mix Composition

An orientational asphalt mix composition is as follows:

– Filler 0-0.09 mm...8%
– Sand 0.09-2 mm...25%
– Chippings 2-11 mm...67%

Total: 100%

– Binder Bit 60 – the amount of binder needed for asphalt mix to meet the specified qualities shall be determined in a trial asphalt mix formula.

An optimum amount of bitumen in asphalt mix shall not be less than 5.0%, in order to prevent rapid fatigue of asphalt concrete. For chippings of rock mass origin, that use a small amount of bitumen for coating, so that an optimum amount of bitumen would be below 5.0%, it is necessary to apply the upper limit grain size accumulation curve regarding filler and sand, and the lower limit values on the grain size accumulation curve for chippings.

9.6.3.7 Physical/Mechanical Properties of Asphalt Mix

Asphalt mix compressed into Marshall's moulds at 147-153°C and mineral mix of extracted asphalt mass shall meet the following requirements:

		Quality requirements	
No.	Type of test	Pre-tests and trial operation of the machine	Control tests
1.	Residual voids (%)	3-6	2.5-7.5
2.	Stability (kN)	7	7
3.	Flow (mm)	4	4
4.	S/F ratio	1.8	1.8
5.	Tolerances for variations of the sieving line of extracted mineral mix with respect to the mix adopted by trial machine operation	sieve 0.9 mm sieve 0.25 mm sieve 0.71 mm sieve 2 mm sieve 4 mm screen	>1.0 >2.0 >2.0 >1.0 >3.0 >3.0
6.	Tolerance for variations in the amount of binder with respect to the adopted mix formula	Determined through pre-tests, and the tolerance is within limits >0.3% of the value determined in the trial asphalt mix composition	

9.6.4 Properties of Constructed Wearing Layer

A constructed layer of asphalt concrete shall have the following properties

No.	Properties	Quality requirements
1.	Residual voids (5)	2.5-7.5
2.	Rolling (compaction) of layer (%)	min 95
3.	Evenness of layer under 4 m levelling staff	max 6 mm
4.	Variation of layer surface from specified height	max > 3 mm
5.	Variation from specified cross fall	max > 0.2%

9.6.5 Work Technology

9.6.5.1 Preparation of Underlying Surface

An asphalt layer may be laid over a surface that is dry and not frozen in any case. Prior to the commencement of works, the underlying surface shall be cleaned thoroughly with steel brushes and blown out with a compressor. After the surface has been cleaned, the Contractor will survey the reference level and evenness of the surface and submit all survey data for the inspection and approval of the Engineer. In places where the underlying surface varies from the specified height by more than +15 mm, the Contractor shall repair the surface according to requirements set out in the design and subject to the approval of the Engineer, i.e.:

- In places where the surface level is below the specified reference level, the repair shall be done by increasing the thickness of layer of asphalt mix with asphalt concrete - wearing course
- In places where the surface level is above the specified reference level, excessive asphalt mass on the surface shall be removed by grinding.

9.6.5.2 Preparation and Transport of Asphalt Mix

The asphalt machine shall be equipped with a 16 mm mesh screen, to remove unpermitted coarse grains from mineral mix.

The temperature of bitumen shall be 150-165°C. The temperature of aggregate shall not be higher than the temperature of bitumen by more than 15°C.

The temperature of asphalt mix in the mixer shall be within the range 150-170°C (in exceptional cases 175 °C).

9.6.5.3 Laying of Asphalt Mix

The temperature of asphalt mix on the site shall neither be lower than 140°C nor higher than 175°C.

9.6.5.4 Work Execution Period

A wearing course of specifications as set out herein may be laid only in the period from 15th April to 15th October unless otherwise approved by the Engineer, i.e. in the period when air temperatures are higher than 5°C in windless conditions, or min 10°C with wind. Asphalt mix shall not be laid during misty or rainy weather. The temperature of underlying surface shall not be lower than +5°C.

9.6.6 Quality control

9.6.6.1 Pre-Testing of Asphalt Mix

Prior to the commencement of works, the Contractor shall prepare a trial asphalt mix design in an authorized laboratory approved by the Engineer, in full compliance with requirements set in these Technical Specifications.

No operation shall start before the Contractor has proposed the trial mix design to the Engineer for approval and the Engineer has issued formal written approval. Compliance certificates for basic materials and trial mix shall not be older than 6 months. If any changes in basic materials or their selection occur, the Contractor shall submit to the Engineer a written proposal for modification of the adopted asphalt mix, i.e. propose a new trial mix design for approval, before the use of these materials may start.

9.6.6.2 Verified Job Mix Formula for Asphalt

The quality of a trial asphalt mix shall be verified through trial work, with the asphalt mix adopted in the plant, and the application quality on a trial section. If the quality of basic materials on site is not in compliance with these Technical Specifications, the Contractor shall ensure new basic materials of good quality. If the batching of basic materials, according to the trial mix formula, cannot meet all specified requirements for physical and mechanical properties of asphalt mix and for constructed layer, it is necessary to modify the batching of basic materials and repeat the trial procedure. Only when the trial procedure meets all specified requirements, the Engineer shall adopt the trial mix and give his approval for work to continue.

The proving job mix formula for asphalt shall be prepared in an authorized operative laboratory approved by the Engineer.

9.6.6.3 Quality control

To ensure the specified quality in the course of construction, the control laboratory approved by the Engineer shall perform regular control tests, namely:

Testing of Bitumen

The Contractor may procure bitumen only provided that for each delivery he ensures the Manufacturer's compliance certificate that will be immediately presented to the Engineer and/or laboratory for approval.

Apart from looking into the Manufacturer's compliance certificate, the operative laboratory shall perform regular tests (PK, penetration, and point of failure), as follows:

- At the beginning of works, and
- At every 200 t of supplied bitumen
- Whenever directed by the Engineer

Testing of Filler

The laboratory shall test the granulometric composition of filler:

- At the beginning of works, and
- At every 100 t of supplied filler.
- Whenever directed by the Engineer

Testing of Asphalt Mix and Constructed Layer for Physical/Mechanical Properties

These tests shall be performed by the operative laboratory:

- At the beginning of works, and
- At every 2000 m^2.
- Whenever directed by the Engineer

A specimen of asphalt mass shall be taken from hot, just laid, asphalt mix, behind the paver. The control of compaction and voids in the surfacing shall be performed on "cores" extracted from a finished layer at the same place where a specimen of hot asphalt mix is taken.

9.6.7 Criteria for Calculation of Executed Works

9.6.7.1 Evenness of Layer
The criteria stated in Sub-Section 9.3.6.1 shall apply...

9.6.7.2 Variation in Specified Height of Layer
The criteria stated in Sub-Section 9.3.6.2 shall apply...

9.6.7.3 Content of Residual Voids
The criteria stated in Sub-Section 9.3.6.3 shall apply...

9.6.7.4 Granulometric Composition of Mineral Mix
The criteria stated in Sub-Section 9.3.6.4 shall apply...

9.6.7.5 Rolling (Compaction) of Surfacing
The criteria stated in Sub-Section 9.3.6.5 shall apply.

9.6.8 Measurement and Payment
Measurement and payment shall be performed per m^2 of an actually constructed asphalt concrete layer, 4 cm thick, fully in accordance with this description and criteria, , the Technical Specifications, and subject to the approval of the Engineer

9.7 Wearing Course of Bituminous Concrete BC 8

9.7.1 Description

This Item shall include supply, mixing, placing and compacting bituminous concrete in 3 cm thick layer. The basis for work specification is SRPS U E4.014.

9.7.2 Basic Materials

- Crushed noble stone grit 2/4 mm, 4/8 mm,
- Crushed sand 0/2 mm (carbonate)
- Stone flour, carbonate composition
- Bitumen Bit 60 ((PK = 49-55; Pen. =50-70)

9.7.3 Basic Materials Quality

9.7.3.1 Stone Grit

Stone grit shall be prepared of rock massif with following properties:

Properties	Quality requirements
Compressive strength	min 120 MPa
Wear by grinding	max 35 cm^3/50 cm^2
Resistance against frost	good*

*/ The loss of mean compressive strength after 25 freezing/thawing cycles shall be max. 20%.

Stone grit shall meet the following properties:

1. Grading of fraction Acc. to SRPS U.E4.014

2. Abrasion by Los Angeles method… max. 22%

3. Unfavorable shaped grains contents… max. 20%

4. Feeble grains contents … max 3%

5. Clay balls contents in particular fraction acc. to SRPS B.B8.038 …… max 0,25%

6. Aggregate surface cover by bitumen ………. min 100/90 (SRPS U.M8.096)

9.7.3.2 Sand

The noble crushed sand produced of carbonate rock mass shall be used for sand fraction.

Grading of sand shall meet the following requirements:

Sieve openings in	Passing the sieve, in weight %
mm	Crushed sand 0/2 mm
0,09	0-10 *
0,25	15-35
0,71	40-85
2	90-100
4	100

*/ When contents of filler fractions would exceed 10%, such sand may be used under condition that sand equivalent exceeds 60%.

The sand shall meet also the following properties:

1. Sand equivalent shall be min 60%
2. Clay balls are not permitted within sand
3. Sand shall not contain organic impurities
4. Balls of adhered particles shall not be permitted within the sand

9.7.3.3 Stone Flour

Only I class carbonate stone flour shall be used, quality as required by SRPS B.B3.045. Use of stone flour from grinded dolomite rock is not desirable, for lower adherence to bitumen.

Contractor shall provide quality attest issued by an authorized laboratory before work commencement, as to guarantee the quality as required by SRPS B.B3.045 (I quality)

9.7.3.4 Bitumen

Binder shall be bitumen Bit 60 which is characterized by: softening point (ring and ball PK 51 – 55^{o}C), penetration 50-70, and penetration index above -10, paraffin contents max. 2%, and ductility min 100 cm. Other properties according to SRPS U.M3.010.

9.7.3.5 Mineral Mixture Composition

Participation of basic fractions with mineral mixture shall be adjusted as to achieve the following grade curve:

Sieve and coarse sieve	Preliminary tests and machine dummy run
openings	Passing the sieve and coarse sieve in weight %
0,09	4-12
0,25	11-27
0,71	20-41
2	38-56
4	56-74
8	96-100
11,2	100

9.7.3.6 Asphalt Mixture Composition

Tentative asphalt mixture composition shall be as follows:

-	Filler	0-0,09 mm	8%
-	sand	0,09-2 mm	25%
-	stone grit	2-8 mm	67%
		Total	100%

Binder BIT 60 – the quantity as necessary to achieve asphalt mixture that meets requirements shall be established with trial mix.

Optimum bitumen quantity in asphalt mix should not be bellow 5%, as to prevent quick fatigue of bituminous concrete. With stone grit originated from rock massif asking for small bitumen quantity and reducing the bitumen quantity bellow 5,0%, the upper limit of grading line should be used in filler and sand range, but lower limit values within stone grit range.

9.7.3.7 Physical-Mechanical Properties of Asphalt Mixture

Asphalt mixture, when compressed into Marshall's cast at 147-153^{o}C, and mineral mixture of extracted asphalt mass, shall both meet the following requirements:

No.	Test Type	Quality Requirements	
		Preliminary testing and trial machine operation	Control tests
1.	Remaining voids (%)	3-8	3-8
2.	Stability (kN)	min 8	min 8
3.	Flow (mm)	2-4	2-4
4.	Relationship S/F	2,0	2,0
5.	Grading line discrepancy tolerance of the extracted mineral mixture related to proposed mixture by trial machine operation	sieve 0,9 mm	>1,0
		sieve 0,25 mm	>2,0
		sieve 0,71 mm	>2,0
		sieve 2 mm	>1,0
		sieve 4 mm	>3,0
		coarse sieve	>3,0
6.	Tolerance of binder quantity discrepancy related to proposed mix formula	Shall be established based on of preliminary testing, and tolerance shall be within limits >0,3% of the value as established for preliminary asphalt mix formula	

9.7.4 Properties of Placed Wearing Course

The placed bituminous concrete course shall have following properties:

No	Properties	Quality requirements
1.	Remaining voids (5)	3-8
2.	Layer compactness (%)	min 97
3.	Course Flatness under 4 m. long straightedge	max 6 mm
4.	Course surface deviation of required height	max >3 mm
5.	Deviation of required cross-fall	max >0,2%

9.7.5 Work Technology

9.7.5.1 Bedding Preparation

Asphalt course may be laid over dry and not frozen bedding. The bedding shall be cleaned by steel brushes and the dust shall be blown off by compressors before work commencement. After the cleaning completion, the Engineer shall establish the gradient and bedding flatness. On sections where the surface differs of the heights designed for more than +15 mm., Contractor shall obligatory correct the bedding, in conformity with requirements from Design, i.e.:

- On spots where the bedding surface is under the required level, the correction shall take place by increasing asphalt mixture course using bituminous concrete.
- On spots where the bedding surface is above the required level, the correction shall consist of removing asphalt mixture surplus using cutting machine.

9.7.5.2 Preparation and Transport of Asphalt Mixture

Asphalt machine shall be supplied with coarse sieve with 16 mm openings, as to remove non-acceptable coarse grains within mineral composition.

Bitumen temperature shall be 150 – 160 ^{o}C. Aggregate temperature shall not exceed bitumen temperature for more than 15 ^{o}C.

Asphalt mix temperature in mixing machine shall remain within limits 150-170^{o}C (exceptionally 175^{o}C).

9.7.5.3 Placing Asphalt Mixture

Asphalt mixture temperature at placing location shall not be under 140^{o}C and over 175^{o}C

9.7.5.4 Season for Work

Wearing course, as specified within, shall be placed exclusively between April 15, and October 15, i.e. during the period when air temperature is above 5^{o}C, without wind, or, when wind, temperature shall be over 10^{o}C. Placing mixture shall not take place when foggy weather, or when rain. Bedding temperature shall not be bellow +5 ^{o}C.

9.7.6 Quality Control

9.7.6.1 Preliminary Testing of Asphalt Mixture

Before work commencement, the Contractor is obliged to prepare the preliminary asphalt mixture design with authorized laboratory, in full accordance with requirements of this Work Specification. No work shall take place before the preliminary mixture was proposed to Engineer for approval. Attest on basic materials and preliminary mixture shall not be older than 6 months. When any change in basic materials occurs, or the material choice is changed, the Contractor shall propose in written to Engineer the alteration of previously determined asphalt mixture, i.e. he shall propose a new mixture for approval before he commences the use of such materials

9.7.6.2 Proved Job Mix

Asphalt mixture quality shall be proved during probation work at asphalt plant, where the mixture shall be accepted, and the construction quality shall be proved on trial section. When the basic materials quality, established on site, differs of this Work Specification, the Contractor shall provide new basic materials of appropriate quality. When it is not possible to meet all requirements for physical-mechanical properties of asphalt mixture and for constructed layer by proportioning basic materials according to probation mixture, the proportioning correction is obligatory, as well as the probation work. Engineer shall accept the job mixture only when all requirements are met during the probation work, and then the approval for continuous work may be issued.

Job mix shall be proved by authorized Laboratory.

9.7.6.3 Quality Control

The Employer or the laboratory, engaged by the Employer, shall carry out regular control testing as to assure the quality required during construction, as follows:

9.7.6.4 Bitumen Testing

The Contractor shall procure bitumen only under condition that for each shipment a manufacturer attest is provided, which shall be immediately presented to Engineer, i.e. to Laboratory.

Independently of information on manufacturer attest, the Laboratory shall perform regular testing of reduced volume (PK, penetration, and breaking point) as follows:

- At the work commencement, and
- At each 200t of bitumen delivered

9.7.6.5 Filler Testing

The Laboratory shall test grading curve of filler as follows:

- At the work commencement, and
- At each 100 t of filler delivered

Testing physical-mechanical properties of asphalt mixture and layer constructed shall be performed by authorized Laboratory as follows:

- At the work commencement
- At each 2000 m2.

Sampling asphalt mixture shall take place from the hot, just spread asphalt mixture behind paver. Compactness and voids control in the compacted layer shall take place by taking □cores□ from the layer completed, at the same spot where hot mixture sampling took place.

9.7.7 Criteria for Payment

9.7.7.1 Layer Flatness

Measurement shall be done by Engineer on cross sections, but the distance between sections shall not exceed 30 m.

Measurement shall take place using straightedge 4 m. long (left end, right end, middle), or using Bump-Integrator, continuously along the length.

Criteria are as follows:

- Flatness 0-6 mm is satisfactory
- Flatness 6-10 mm is not satisfactory, and 5-25% of such surface shall not be paid
- Flatness over 100 mm is not satisfactory, and 100% of such surface shall not be paid

9.7.7.2 Layer Surface Deviation of Required Height

Measurement shall take place on each cross section:

- When height lowering 4-8 mm, 10-25% of such surface shall not be paid
- When height lowering 8-10 mm, 26-50% of such surface shall not be paid
- When height lowering over 10 mm, the work shall not be accepted

9.7.7.3 Remained Void Content

- When remaining voids within 8-9% limit, the value of wearing course shall be reduced for 5-25% of surface covered by sample.
- When remaining voids 9-10%, the value of wearing course shall be reduced for 25-50% of surface covered by sample.
- When remaining voids are over 10% limit, work shall not be accepted for the area covered by sample tested.

9.7.7.4 Mineral Mixture Grading Curve

When the Grading Curve of extracted mineral mixture differs from limit curve for required physical-mechanical properties, the value of wearing course to be paid to Contractor shall be reduced 5% for the area covered by sample tested.

When the number of results, deviating of permissible values for filler and bitumen fraction, exceeds 5%, asphalt course shall not be accepted as satisfactory.

9.7.7.5 Surfacing Compactness

- For compactness loss 1-3%, work value shall be reduced for 2-10% of surface covered by sample tested.
- For compactness loss 3-5%, work value shall be reduced for 10-50% of surface covered by sample tested.
- For compactness loss over 5%, the work completed shall not be acceptable.

9.7.8 Measurement And Payment

The quantity to be paid for shall be the number of square meters (m2) of the asphalt course completed in required thickness 3 cm, in full accordance with this specification and criteria.’’

Section 10
Concrete pavements

Contents

10.1. Description

This item of works includes the procurement, mixing, and casting of fresh concrete as surfacing, and the curing of fresh and hardened concrete. This item also includes the procurement and placement of kraft paper or PVC foil under the concrete slab, over the base course made of crushed stone.

10.2. Materials

For the construction of cement-concrete surfacing, the following basic materials shall be used:

- Crushed rock aggregate
- Cement
- Water
- Steel
- Chemical admixtures for concrete

The quality of basic materials shall fully comply with the Technical Specifications and all applicable standards.

10.2.1. Crushed Rock Aggregate

Crushed rock aggregate used for the construction of cement-concrete pavement shall meet the following criteria:

- Crushed rock aggregate shall meet SRPS B.B3.100 and SRPS B.B2.010 standards;
- Wear resistance, Los Angeles,
  SRPS B.B8.048, grading B. ....max 22%
- Frost resistance of aggregate 4 mm,
  SRPS B.B8.044 ....max 5%
- Mineral and chemical composition of aggregate shall not contain any components harmful for concrete;
- Granulometric composition of aggregate shall be determined based on its delivery, sieving.

The granulometric composition of aggregate shall be such that the specified grade of concrete is achieved. The grain size accumulation curve should, if possible, lie within the zone given in the table below. The given recommendations are not mandatory, and other curves of continuous or discontinuous grading may be used as well, if pre-tests show that they give the required grade of concrete subject the approval of the Engineer.

Mesh (mm)		Passing (%)
0,2	0.2	3-7
1,0	1.0	18-30
3,15	3.15	33-46
8	8	52-62
16	16	62-77
31,5	31.5	100

10.2.2. Cement

For the construction of concrete pavement, class 35 and 45 cement shall be used, made of Portland cement clinker that meets the quality requirements according to SRPS B.C1.011/01 and B.C1.013 standards. Other cement quality requirements are:

- Content of admixtures not more than 20% (m/m), of which pozzolane not more than 5% (m/m);
- Carbonate content ....up to 10% (m/m);
- Fineness (residue on sieve) ....≤10%
- Start of setting... ≥ 60 (≥ 50)min
- End of setting ....≤ 600min
- Flexural strength after 28 days............................40 MPa

10.2.3. Water

Mixing water for concrete shall be clean and clear. Water shall not contain any substances harmful for concrete, such as: sulphuric, hydrochloric, carbonic and humus acids, chlorides, magnesium sulphates, etc, or waste water. Water shall be tested constantly and fully meet the standard SRPS U.M1.058.

10.2.4. Steel – dowels and tie bars

The designed solution foresees the application of dowels and tie bars, according to design details. For dowels and tie bars, GA 240/360 steel shall be used. Lengths and diameters of reinforcing steel, and the length of insulation – coating, are given in design details. Baskets for fixing dowels and tie bars in proper positions in cement-concrete pavement decks shall be made of welded mesh reinforcement, wire diameter 6 mm. If a modern equipment for the construction of cement-concrete pavements is used, where dowels are inserted into fresh concrete, such baskets are not needed.

Mesh reinforcement and reinforcing bars for dowels and tie bars shall be transported and stored in compliance with regulations for plain and reinforced concrete. The grade of steel shall be checked according to regulations for plain and reinforced concrete and relevant standards.

10.2.5. Chemical Admixtures for Concrete

When preparing concrete, it is allowed to use plasticizers, air-entrainers, or admixtures giving other properties that meet the quality requirements set out in SRPS U.M1.035, subject to the approval of the Engineer. Before preparing concrete with admixtures, it is necessary to check whether the admixture meets its purpose, according to SRPS U.M1.037 and SRPS U.M1.035. Specimens of concrete prepared with admixtures shall be tested for:

- Chemical and physical/chemical properties
- Impact of admixtures on the corrosion of steel in concrete
- Impact of admixtures on properties of hardened concrete.

Admixtures to concrete shall be controlled regularly, with the constancy of their quality monitored in compliance with SRPS U.M1.035.
All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

10.2.6. Materials for Joints

Fillers and sealants may be used to fill joints. Fillers in expansion joints shall not prevent the extension of concrete pavement slabs, but shall be rigid enough not to lose their form during compaction of concrete. They shall not be water soluble, nor absorb water from fresh concrete. Fillers made of soft wood , if used, shall be of regular edge, knot-free, flat, and properly protected. If control joints are foreseen with bottom fillers, they shall be made of suitable non-friable material, protected soft wood or plastics usually, and of appropriate shape, so as not to lose their form during the placement of concrete. Sealants shall be elastic and adhere well to concrete. They shall fully comply with the standards for joint sealants for concrete pavements, SRPS U.M3.095. As primer for the sides of joints between the slab and the edge strip, very liquid agents shall be used that could be spread in very thin layers.

10.2.7. Surface Treatment Agents

Chemical protective agents may be used to protect, cure, and impregnate the surface of cement-concrete pavement. The applied film of a protective agent shall act effectively for at least 7 days, without disturbing the cement setting process in any way, and without any harmful physical impacts on the concrete surface.

10.3. Concrete

10.3.1. Mechanical Properties

For the construction of cement-concrete surfacing, concrete shall meet the following quality requirements:

- Grade of concrete .... min MB 40
- Flexural tensile strength
  according to SRPS U.M1.010................... min 5.00 MPa
- Water-impermeability class
  according to SRPS U.M1.015............................. min ϖ 6
- Frost resistance class according to
  SRPS U.M1.010 .... min 200
- Salt resistance,
  damage degree SRPS U.M1.055 0
- Wear resistance (cm^3/50 cm^2), SRPS B.B8.075
  - In dry .... min 18
  - In moist .... max 35

10.3.2. Composition of Concrete Mix

The composition of concrete mix for cement-concrete pavement slabs shall be determined based on pre-tests of fresh and hardened concrete with specified materials, for specified conditions of construction, and project purpose, as set out in the regulations for plain and reinforced concrete for B-II category. The amounts of concrete mix components shall be computed in mass and absolute volumes, and the mix formula shall be expressed in kg.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

Particles smaller than 0.25 mm

Total amount of cement and aggregate grains smaller than 0.25 mm shall not be less than 350 kg/m^3 of placed concrete.

Amount of Water and Consistency

The amount of water and consistency of fresh concrete shall be determined according to the regulations for plain and reinforced concrete so as to ensure easy placement and good compaction of concrete, achieving specified properties in fresh and hardened concrete, while applying available tools and equipment. The highest value of water-cement ratio for cement –concrete pavement slabs shall be 0.50.

Quantity of Micro-Pores

Concretes for cement-concrete pavements shall be aerated due to their exposure to frost and salt. The amount of entrained air in fresh concrete (according to SRPS U.M1.031) shall be 3-5%..

10.4. Production of Concrete

Concrete mix for cement-concrete pavement shall be produced in concrete plants that, regarding equipment and work procedures, shall meet requirements set out in SRPS U.M1.050; SRPS U.M1.051, and SRPS U.M1.052, i.e. have the capacity to accurately batch concrete mix components in a foreseen number of batches per unit of time, while achieving allowed tolerances for the content of mss of each fraction and total amount of aggregate ± 3%, calculated from the total mass of required aggregate. The content of cement shall be within the limit of +2% of required mass. The content of water ± 2% of required mass or volume. The content of each admixture ± 3% of required mass.

10.5. Execution of Works

10.5.1. Concrete Production Control

For B-II concrete, all tests of concrete in concrete plants shall be conducted fully in accordance with SRPS U.M1.051, while achieving the required capacity of concrete plant and laboratory for monitoring work on the plant-based production of concrete.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

10.5.2. Concrete Pavement Construction Procedure

Concrete for cement-concrete pavement slabs shall be cast according to the concrete design, in compliance with the regulations for plain and reinforced concrete and the requirements of these Technical Specifications. Before the commencement of works, the underlying surface shall be completely clean, previously repaired, and dry and subject to the inspection and approval by the Engineer.

10.5.3. Formwork and Track

Concrete shall be placed between fixed formwork that need to be secured against displacement in any direction, in order to achieve the required width, height, and evenness of cement-concrete pavement, or with a paver with hauled slip-forms. As forms, steel and concrete (e.g. a previously constructed cement-concrete edge strip) may be used.

Every formwork shall be coated with appropriate release agents, according to concrete casting. Formwork and rails to be used by compaction and levelling machines, and surfaces used by concrete casting machines that are not rail-guided, shall be stable and clean in order to ensure the required height and evenness of cement-concrete pavement.

10.5.4. Transport of Concrete

Concrete shall be transported to the place of casting in a way and under conditions that prevent any segregation and drying of concrete, as well as any changes in the composition and properties of concrete.

10.5.5. Placement of Concrete and Reinforcing Steel

The placement of concrete may start when the place of concreting (underlying surface, formwork, etc.) are prepared in full compliance with the structural and concrete designs. For cement-concrete pavements, concrete shall be spread and cast mechanically. Tie bars and dowels shall be placed on baskets before the casting of concrete, according to design details, if such work technology is applied. If concrete is constructed with state-of-the-art equipment, dowels shall be inserted in fresh concrete during its placement.

Concrete shall be compacted over the entire surface and in full thickness of layer completely and uniformly, using machines that act in full width of the placed strip, and run uniformly and uninterruptedly. The needed number of runs with a paver, or vibratory board and vibrators, shall be determined on a trial bay. If evenness and uniformity of concrete on the surface are not achieved, on such placed concrete shall be added and compacted in an additional run of paver, or by other means. Any addition of cement, water, or mortar is not allowed. The entire placement of cement-concrete pavement slabs shall be completed:

- In warm and dry weather, in .... max 2 hours
- In cold and moist weather, in .... max 3 hours

from the commencement of concrete preparation in the concrete plant.

For the finishing of pavement, vibratory floats shall be used, so that they are guided diagonally or normally to the road centre line and act in the full width of the strip of cement-concrete pavement.

10.5.6. Concreting at Low and High Temperatures

If concreting is done at temperatures below +5°C and above +30°C, special measures for the execution of concrete works under special conditions shall be taken, according to the regulations for plain and reinforced concrete. The temperature of concrete at the place of casting shall not be:

- Lower than +10°C at air temperature around .... 0°C
- Lower than +20°C at air temperature below ....-3°C
- Higher than +30°C at air temperature above ....+25°C

10.5.7. Interrupted Concreting

Every interruption in work shall be foreseen with the concreting plan in the concrete design, and shall match with the completion of one bay, in order to ensure the construction of a technically adequate joint in cement-concrete pavement.

10.5.8. Construction of Control Joints

At control joints, concrete shall have the same properties and quality as on other parts of the cement-concrete pavement slab. The procedure for construction of joints shall ensure that joint grooves are of specified dimensions. Control joints shall be duly cut, in order to prevent an uncontrollable cracking of cement-concrete pavement slab due to contraction of concrete.

10.5.9. Construction of Construction-Contraction Joints

At contraction joints, concrete shall have the same properties and quality as on other parts of the cement-concrete pavement slab. The procedure for construction of joints shall ensure that joint grooves are of specified dimensions. Contraction joints may be structural and construction joints. In contraction joints, the vertical surface (side) of hardened concrete shall be permeated well with primers. The amount of that agent shall depend on its viscosity and the porosity of concrete. Before resuming works, a finish coat shall be applied over the dried coat of primer, in the amount of /1.0-1.5/ kg/m^2.

10.5.10. Cutting and Sealing of Joints

Machines for notching and cutting shall ensure a straight cut with sharp edges. Before filling, grooves and cuts shall be dried and cleaned. Appropriate brushes, and compressed air if needed, shall be used for cleaning. Sides of cuts shall be primed first. Sealant shall be filled into cuts with appropriate tools, filling them up to the surface, and with additional re-fills if needed.

10.5.11. Curing and Protection of Concrete

Cement-concrete pavement shall be protected and carefully cured during and after the placement of concrete. Curing shall start immediately after performed surface finishing of freshly cast concrete. For curing fresh and hardening concrete, moistening may be used (spraying or moistening over proper materials on the concrete surface - jute or bass) or appropriate protective liquid chemicals.

A protective chemical agent shall be uniformly sprayed on surfaces over dried cement-concrete pavement slabs, in order to achieve a uniform film (closed surface). Cement-concrete pavement shall be protected immediately after construction with low, mobile protective ‘roofs’ of a light colour, closed on all sides, for at least 6 hours. The entire surface of cement-concrete pavement shall be kept moist for at least 7 days or until the concrete reaches 60% of the specified class. Covers (made of straw or other materials) shall be used to prevent rapid drying of young concrete, until it reaches at least 50% of specified strength.

10.5.12. Impregnation

For the protection of concrete against the action of salt, the surface of cement-concrete pavement slabs may be impregnated with appropriate agents. The efficiency of an impregnating agent shall be pre-tested and verified.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

10.5.13. Opening to Traffic

Concrete pavement may be used for on-site traffic when concrete reaches at least 70% of its specified class subject to the prior approval of the Engineer. Cement-concrete pavement shall be opened to traffic after 28 days from the date of completion of last slab on the section, or earlier if the strength of concrete specified in the design is reached subject to the prior approval of the Engineer. Concrete shall reach the designed frost resistance.

10.6. Quality Control

The control of quality shall be performed fully in compliance with SRPS U. E3.020, Section 8.

All tests shall be completed to the satisfaction of the Engineer and all results shall be submitted for the approval of the Engineer.

10.7. Evenness, Height, and Direction

The allowed variations of the surface of cement-concrete pavement from the evenness of designed height and direction in any place on the pavement shall be within the following limits:

- Evenness .... ± 4 mm
- Height .... ±20 mm
- Direction ....±30 mm

Variations in evenness shall be determined with a straight edge, 4 m long, in any position. Allowed variations of the surface of cement-concrete pavement shall not cause any noticeable uneven spots, or accumulation of liquids on the pavement.

10.8. Calculation and Payment of Executed Works

The executed work, previously accepted by the Engineer, shall be calculated in m^2. If variations are greater than allowed in these specifications, the Contractor shall, at his own expense, remove the surfaces of poor quality and construct a new, good concrete pavement, according to these specifications.

Executed and previously calculated work shall be paid at unit prices from the contract given per m^2.

Section 11
Structures

Contents

11.1 Retaining and Retaining-Facing Walls

11.1.1 Excavation for Retaining Structure Foundation

Item Description

The item includes manual or machine excavation of natural original soil of the 3rd and 4th category per percentages determined by the Design.

The excavation shall be done per sizes provided by the Design. Excavation depth is provided by the Design and may vary from 0 to 6 m^1. The excavated pit shall be timbered after the excavated depth of 1, 00 m^1. The type of timbering and timbering technology shall be proposed for approval by the Contractor in accordance with his available equipment and adopted technology. The Engineer shall approve the selected timbering type and technology. Timbering shall support foundation pit to remain stable both during the excavation and during the execution of supporting/ retaining structure. It is also necessary that the terrain around the foundation pit remains stable during execution of foundation.

Excavation for strip foundations shall be done in tunnel liners, whose length is determined by the Design, or by the Contractor subject to the approval of the Engineer.

Besides excavation, the item includes throwing of excavated soil 2-3 m1 from the foundation pit, either manual or machine loading of excavated soil into transporting means and transportation to the disposal area anticipated by the Design or proposed by the Contractor subject to the approval of the Engineer. The excavated soil shall be unloaded by tipping and then spread either manually or by machine.

In the vent of underground water in the foundation pit, the water should be pumped out. It should be ensured that pumping of underground water does not cause suffusion of vertical and horizontal sides of foundation pit.

This item also includes excavation in moisture soil.

Equipment

The hand tools like pick, spade, shovel, hand-barrow, etc., shall be necessary for the excavation of foundation pit in the 3rd and 4th category soil, if done manually.

If excavation is performed by machine, the Contractor should have excavator of the sufficient capacity to ensure effective excavation of anticipated foundation excavation.
The sufficient quantity of tipping trucks shall be provided for the transportation and tipping of excavated material to the disposal area.

Manual spreading of unloaded material on the disposal area shall be done by shovels, or if done by machine by grader or smaller size bulldozer.

Measuring

Measuring of works on soil excavation for the foundation of supporting structure shall be done in m^3 of the works actually performed and approved by the Engineer.

Payment

The payment for executed works on excavation for supporting structure foundations shall be made in dinars per m^3 of actual works done as determined by measuring.

11.1.2 Concreting of Retaining Structure

Item Description

Concrete works on retaining structure shall be done per sizes provided by the Design. Concrete shall be of class as specified by the Design. This item shall also include execution of formworks, and if necessary scaffolding. Prior to commencement of concrete works, the Contractor shall submit for the inspection and approval of the Engineer both the formworks and scaffolding to enable checks of the stability of formworks and scaffolding to avoid deformation and demolition of structures during, or immediately upon completion of concrete works.

Materials

Retaining structure shall be made of concrete class as anticipated by the Design. The concrete shall be composed of componential materials: mineral aggregate, sand, cement, water and necessary agents added to concrete that correspond to the norms of the Standardization Institute of SAM.

Fresh and hardened concrete shall fulfil quality conditions stipulated by the Design, particularly compressive strength, and if required, frost resistance.

Prior to execution of reinforced concrete (RC), it shall be necessary to make concrete tests required by the Design by registered and accredited organization for this type of laboratory testing works and as approved by the Engineer.

Execution of Works

The formworks and scaffolding shall be executed first. Both the formworks and scaffolding shall be executed in good quality as to avoid structure deformation during concreting works. The material used for execution of scaffolding shall be steel pipes. Formworks and particularly the scaffolding part that belongs to exposed part of the structure shall be executed of high quality steel sheet or high quality boards oil-coated as ensure smooth concrete surface.

It is recommended that the concrete shall be made in concrete plants and transported to the works by means of concrete mixers. Concrete shall be compacted in layers of 30 to 50 cm by advanced compaction devices. The technology of building in of concrete shall be such as to ensure later hardened concrete which is to fulfil not only anticipated physical-mechanical features, but aesthetic as well: even and smooth surfaces, even edges free from segregated spots, etc.

The scaffolding and horizontal formworks may be removed 28 days after concreting of structural elements, while the vertical formworks may be removed after 10 days.

Immediately upon completion of concrete works, and during the concrete hardening process, it is necessary to cure and protect concrete from the heat or cold weather depending on the season when concreting is performed.

Equipment

Concrete shall be made in concrete plants with weight-batching of component materials (mineral aggregate, cement, water, agents). Period of mixing time shall be sufficient as to ensure uniform concrete production. Transportation of concrete from the plant to the works/build-in spot shall by done by mixing trucks and shall not exceed 60 minutes.

Concrete compaction during building-in shall be done by suitable vibrating-devices of sufficient power as to receive compact built-in concrete. This is to be achieved by selecting vibrating devices, like pervibrators, platvibrators, etc., on the site in agreement with the Engineer.

Norms for Execution and Quality Control of Concrete Works

The adherence to below listed norms and working rules shall be ensured during the execution of concrete works:

- Rule Book on technical conditions for concrete and reinforced concrete (Official Gazette of SFRY No. 11/87);
- Comments on the stipulations of the Rule Book for concrete and reinforced concrete (Official Gazette 1988);
- Technical conditions, separated aggregate for concrete, SRPS B.B2.010;
- Portland cement, Portland cement with agents SRPS B.C1.011;
- Sulphate-resistant cements, technical conditions SRPS B.C1.014;
- Water for concrete production, technical conditions SRPS U.M1.034;
- Agents to concrete, definition and classification SRPS U.M1.035;
- Agents to concrete, quality and control SRPS U.M1.035;
- Pre-building in of concrete testing for selection of agents SRPS U.M1.037;
- Determining compressive strength of concrete cube SRPSU.M1.020;
- Testing production efficiency of concrete plant SRPS.U.M1.050;
- Testing of production in concrete plants, SRPS U.M1.051

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

Measuring

The quantity of constructed retaining structure shall be measured in cubic meters (m^3) of actually executed concreting approved by the Engineer.

Payment

The Contractor shall be paid the contracted price per 1 m^3 for the quantity of actually performed works per 1 m^3, i.e. complete and high quality concreted retaining structure per the Design together with formworks and scaffolding. The price shall represent the compensation for the supply of all materials, execution of scaffolding and formworks, usage of plant and equipment and the labor price needed for the execution of retaining structure.

11.1.3 Supplying, Cutting and Placing of Reinforcement

Item Description

This Item includes supplying, cutting, and placing of steel reinforcement needed for reinforcing of retaining structure.

The reinforcement used for reinforcing of concrete structures may be: of wires $\Phi<12$ *mm* round or rods $\Phi>12$ *mm* or round steel (*GA*-240/360) or high-tensile ribbed bars (*RA*-400/500) depending on Design solution.

The reinforcement may be classified per type as main, distribution and structural steel. The type of reinforcement to be used shall be as specified by the Design.

The reinforcement of the retaining structure shall be placed in accordance with the plans/schedule and the specification of the Design, per type, diameter and spacing.

The reinforcement to be placed before concreting shall be corrosion-free. If there is a corroded layer on the reinforcement (volume), it should be removed by steel brushes.

The reinforcement shall be machine-treated in reinforcement workshop.

Treated reinforcement shall be transported to the site by adequate means of transportation.

Splicing, if necessary, shall be made in accordance with regulations.

The overall works on cutting and placing of reinforcement shall be performed per Rule Book on technical norms for reinforced concrete and subject to the approval of the Engineer.

The construction welded nets, if anticipated by the Design, shall be applied per the Design plans in accordance with *SRPS.U.M1.091*

Equipment

The Contractor shall necessarily possess the following equipment and work tools for proper cutting, transporting and placing of reinforcement

The reinforcement shall be cut and bent per Design Specification in the reinforcement workshop, equipped with adequate machines. The reinforcement shall be fixed into slabs, beams and cages as anticipated by the Design. Reinforcement shall be transported from the workshop to the site by adequate transportation means as to avoid reinforcement being damaged during transportation. Loading and unloading of reinforcement from the truck shall be performed by crane, as well as its placing on the build-in spot in the structure on the site.

Measuring
The reinforcement actually built into the structure, shall be calculated in kilograms per diameter and length approved by the Engineer.

Payment
The payment of reinforcement actually built-into the structure shall be made as measured per contracted price in dinars for 1 kilo of built-in reinforcement.

11.1.4 Mineral Filler behind Supporting Structure
The function of mineral filler behind the supporting structure and in the ditches is to ensure delivering of drained underground water to the inspection chamber, or to the drainage outlet onto the terrain surface, as well as to ensure hardness in the ditch sufficient to receive and bear the soil pressure.

Mineral filler consists of:
- Sandy-gravel soil
- Stone chips 1-6 cm, and
- Crushed stone 7-25 cm.

The layer of stone chips shall be executed per the drawing in the Design. This layer is to be laid above the drainage pipe. The minimum layer height shall be 30 cm. Stone chips function is to protect the pipe from concentrated pressure of the crushed stone filler. Thus protected, perforated pipe is safe and can bear the pressure of the crushed stone filler.

The function of the crushed stone filler, grain size 7-25 cm, is to ensure hardness of the ditch both to receive and to bear the compressive force of the surrounding terrain and underground water. The significant function of the crushed stone filler for the ditch is to facilitate draining of water.

Mineral grains which of the stone chips and crushed stone fillers are composed of, shall be resistant to the effects of water and the effects of chemical constituents of chlorides, nitrates, and nitrites. Besides, mineral grains of crushed stone shall have compressive strength that exceeds 100.000 *kPa*, which is necessary to avoid crushing of stones upon the execution of filler.

Stone chips filler shall be built-in compaction-free by filling and planning.

Crushed stone filler shall be built-in by filling and manual spreading of stone grains as to fill in the cavities and openings in the filler. The filler needs not to be compacted.

The filler behind the retaining wall shall be executed in sandy-gravel soil material. The grain size distribution of mineral grains shall be continual. Uniformity coefficient of sandy-gravel soil shall be $C_u > 4$, and Curve coefficient $C_z = 1\text{-}3$.

Measuring
Actually executed quantity of works shall be measured by cubic meter (m^3) approved by the Engineer.

Payment
Actually executed quantity of works shall be paid per Contract prices for 1 m^3 of executed works.

11.1.5 Compressed Clay Plug at the End of Ditch
Each either collecting or draining ditch shall be mandatory closed by clay plug per the Design. The function of clay plug is to prevent break-through of surface waters and small particles into the drainage.

Clay plug shall be executed of hard clay of *CL – classification* with addition of optimal quantity of water per *standard Proctor* Test.

Measuring
Actually executed quantity of works shall be measured in cubic meters (m^3) approved by the Engineer.

Payment
Actually executed quantity of works shall be paid per contract prices for 1 m^3 of executed works 1 m^3.

11.1.6 Geotextile
Scope and Content of Works
Geotextile shall be placed at the perimeter of the ditch.

Geotextile functions are:
- separation of natural original soil from the drainage fill;
- ensuring undisturbed circulation of underground waters from the natural original soil into the ditch;
- preventing of suffusion of small particles from the natural original soil due to measuring of underground water level.

Prior to placing geotextile, the terrain shall be leveled, and weeds, large stones and sharp rocks removed, as well as larger recesses filled.

Geotextile shall be placed as to form an overlap between the strips that are to be joined. Overlaps shall be length wise secured by small piles of filling material placed at each 1 to 2 m to avoid moving. Geotextile strips are sewn in such a way as to have ends to be joined placed face side to face side and bent in the width of 100 mm, provided that seam runs parallel with the edge of joined surfaces at the distance of 50 mm from the edge. Seam hardness shall be 50% of geotextile tensile strength.

After having been joined, geotextile is laid in the ditch and then the ditch filling with drainage material commences.

Receipt of Geotextile
Upon unloading of geotextile rolls on the site it is necessary to check their quantity, as well as whether they correspond to the technical specifications provided by the Design.

Keeping of Geotextile

It is of utmost importance to ensure protection of geotextile from damage prior to placement. The product is delivered factory packed and protected and it shall be necessary to check whether the protection is damaged, and if damaged, the damages should be repaired. It is particularly important that the geotextile is UV and moisture protected. Geotextile, specially unwoven, when exposed to moisture absorbs it in some cases up to the rolls softening point, which makes impossible checkup of weight and placement of geotextile under low temperatures. It is also necessary to keep geotextile free from mud as if otherwise their filtering features would be diminished.

If geotextile gets damaged, the damaged parts shall be removed.

Quality Assessment Criteria

Geotextile rolls shall be laid out in such a manner to facilitate their inspection and samples taken for laboratory tests.

Each roll shall bear the following data:
- Name of manufacturer;
- Commercial name;
- Method of production;
- Raw-materials composition;
- Mass per area unit;
- Nominal thickness;
- Product size and weight in roll.

Besides general inspection, the mass per area unit is inspected in the field with the precision up to 10 g/m2.

All other tests are performed in the laboratory and shall fulfill the following norms:
- normal thickness;
- pore size;
- filtering capacities;
- CBR penetration;
- Tensile strength;
- Sliding in soil.

The samples are taken from each particular roll and all tests shall be made in accordance with IGS norms.

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

Execution of Works

Geotextile rolls have weight that mainly varies from 75 to 150 kg. Light weight rolls shall be placed manually, while the heavier rolls shall be placed by machine.

Measuring and Payment

These works are measured per square meter of geotextile approved by the Engineer.
The works are paid per unit price per square meter of actually performed works.

11.1.7 Execution of Bored Piles with Large Diameters

Item description

Bored piles shall be applied with deep founded supporting structures when the slip layer is at 5-6 m^1 from the terrain surface. It is then that they achieve their full effectiveness. Retaining structures of bored piles receive soil horizontal soil pressure and transfer them in the depth beneath the slide layer into the unmoved parts of the terrain. In order to properly execute the structure of bored piles, the Contractor shall strictly adhere to the Design and below listed special technical conditions subject to the approval of the Engineer.

Method of Piles Execution

Prior to execution of bored piles, it shall be necessary to execute the following preliminary works: execution of access road and plateau for work, for the needs of delivering, installing and operating of drilling equipment, placing of reinforcement cages and for the access when concreting. The plateau shall have the width of 5-7 m^1, and the road 3-5 m^1. Longitudinal elevation of the finished road level shall not exceed 15%. The pavement on the road and plateau shall be executed of high quality materials like gravel, broken stone, stone, etc.

Bored piles of design given diameter shall be executed per Design plans both horizontally at the designed distance and vertically per the levels specified in the Design.

Pile diameter shall be defined by outer pipe diameter. Possible diameter increase that might occur when concrete is poured shall not be taken into consideration for the payment of executed works.

The execution of piles both during the excavation and execution of concrete works should be followed by casing, which might be partial or complete or may not exist when working in stones. Complete casing prevents sliding of small and big soil particles from the drill hole walls or eliminates larger scale movement of land which could further cause closing of drill hole. Partial casing is feasible with bored holes executed of hard consistency clay, soft rocks (marlstone, cement rock, shale, flysch, etc.). With hard rock masses (sandstone, limestone, dolomite, etc.), it is possible to execute bored hole without casing.

The technology of execution of bored piles shall consist of three main phases: excavation of bored hole (boring); execution and placement of reinforcement cage and production and placement of concrete, i.e. pile concreting.

In practice, bored piles can be executed either with extended or non-extended base. Generally, there is no need to widen the pile base for retaining structures, with dominant effects of horizontal forces, because there is no static need and widening itself is technologically hard to execute. This is only possible in clay soil. Widening of pile base, when executed, is generally done up to the double pile diameter.

Pile excavation, for bored piles for retaining structures, as we have already mentioned, can be with partial or complete casing. Complete casing is more frequently applied. The order of execution of works, firstly an excavator (drill) and hydraulic pipe oscillators are brought to the spot of pile execution. Tolerances for deviation from the designed coordinates, vertical pile axis, shall be within the limit of 1-2 cm.

Together with placing the plant on the pile location, it shall be necessary to check up and ratify the verticality of wagon (drill) and telescopic rotary drilling device. Vertical tolerance allows for 1-2%.

As to commence drilling, it is required driving home of auxiliary pipe (guide frame) in the length of 2-4 m^1, which serves to secure pile position and direction. It is from the driven home guide frame (auxiliary pipe), that the excavation and transportation of excavated soil is performed. A protection steel pipe is placed in thus prepared borehole, which serves to secure further excavation. Simultaneously with progressing of excavation (drilling), protection pipe is sunk by torsion oscillation alternately to the left and to the right, by hydraulic pipe oscillator. The pipes are added during drilling up to the bottom of the drill hole in accordance with progressing of drilling process. Drilling and removing of material from the bore hole is performed through the pipe.

Drilling and removing of material is performed by spirals for soils of constitution (dust and clay) and by buckets (scoops) for loose soils (sand, gravel) and slurries. The bottom of pipe casings should progress faster than drilling, particularly if performed in slurry and loose soils. Thus the break through of soil underneath the bottom of pipe casings is prevented. Drilling is executed when the designed bottom is reached, which is checked with two to three successive measuring tests of bore hole height by volume tape. The precision of measuring is 1 cm.

Equipment

Machinery and equipment for high quality and effective execution of works on bored piles shall include: excavator with adequate tools, protection pipes, hydraulic pipe oscillator for rotary oscillating of protection pipes to ease their sinking in the ground, crane for extracting protection pipe and lifting and placing reinforcement cage, as well as equipment for contractors concreting.

Excavators or dredgers for drilling (excavation) of bore holes are the basic machines that are used for the execution of bored piles. The excavators serve for excavation in protection pipe. Excavators should be
equipped with adequate tools, like spirals or buckets, extenders, chisels, etc. These tools are mounted on the telescopic rotary systems of the basic excavator and constitute a technological unity for pile excavation (drilling).

For temporary placing of protection pipes, i.e. bore hole casing, steel pipes are used that oscillate by means of hydraulic oscillator, as the separate plant complete with standardized pipes and couplings. The length of protection pipe should be equal to pile length. The maximal pipe length is 20 m^1. If the pipe length exceeds 20 m^1, the pipe shall be extended. The pipes are extended by special mechanic couplings that provide axial and torsion hardness, as well as water-tightness at the spot of extension.

Contractors concreting is performed by means of contractor pipe with the diameter of 200 mm, complete with extensions and couplings. Preparing and transporting of concrete is done by traditional equipment.

Piles are concreted by contractors procedure. Concreting shall commence by lowering of contractors pipe at the height of 20 cm from the bore hole bottom. During concreting, contractors pipe is being withdrawn per the pace of increasing the level of concrete in the pile. Contractors pipe shall be sank in concrete at least 2-3 m^1 during pile concreting. The diameter of contractors pipe is most frequently 200 mm. The contractors pipe is made of extensions each of 1-3 m^1 in length. The extensions are connected by couplings or threads. Tremie is placed at the top of the contractors pipe to facilitate better receiving and feeding of concrete mass. The tremie is fixed at the beginning of the bore hole and has the volume of 100 liters.

Concreting procedure of contractors type with bore hole casing shall be performed in synchronized manner so that withdrawal of protective casing corresponds to the increase in concrete level provided that a concrete column of 1-2 m^1 remains in the pipes.

The pipes are removed from the ground in the following manner:
- airtight lid is placed at the upper end of the protection pipe;
- air under 2 atmospheres pressure is let into the put and it activates the device for rotary oscillation;
- the pipe is lifted by crane;

Thus allowing for relatively fast removal of protection pipes from the ground. Long protection pipes are removed in parts depending on the number of couplings. Shorter protection pipes are removed upon completion of pile concreting.

Inlet of pressurized air in the protection pipe has multiply beneficial:
- makes easier removal of protection pipes from the ground;
- the holes made by removal of protection pipe are filled in thus realizing the full contact between concrete and surrounding land;
- Concrete is poured under pressure which increases its compactness.

Materials

Concrete components like mineral aggregate, cement, water and agents shall fulfill the conditions of a world wide recognized norms for making high quality concrete for this type of work, in full compliance with the requirements of the Design and these Technical Specifications and subject to the approval of the Engineer.

Each component material used for making concrete shall be attested before use and later during execution works checked up in the manner as prescribed by the adopted norm. The Contractor shall propose the norm that component materials for concrete are to fulfill both for the test prior to commencement of works and for the control check up. The Contractor's proposal shall be subject to the approval of the Designer and the Engineer.

Concrete used for bored pile shall be of the class (MB) as stipulated by the Design. Concrete quality is determined per one of the world wide recognized norms which will be adopted prior to commencement of works. The Contractor shall propose a norm to be used for making and building-in of concrete, as well as for quality control of concrete. The Contractor's proposal shall be subject to the approval of the Designer and the Engineer. The piles are concreted by plastic concrete which quality shall correspond to the adopted norm.

Round (GA 240/360) bars and ribbed bars (RA 400/500) shall be used for the reinforcement of bored piles. The reinforcement works shall be done per plan from the Design. Main reinforcement shall be of ribbed bars, while stirrups and other structural or bonding reinforcement may be of round bars.

Reinforcement cages for bored piles shall have the following features:

Internal rings which are placed at 1 - 1,5 m^1 of the pile height and serve as structural supports of vertical steel bars (pile main reinforcement). Vertical bars are welded to internal ring minimum on 50% of joints.

The main vertical reinforcement calculation is static calculation of pile bearing capacity, taking into account the loading acting on the pile. The length of vertical reinforcement shall be equal to pile length and increased for the height of pile cap (beam), if such beam exists in the supporting structure.

Beam hanger/stirrups on drilled piles are spiral and are welded to minimum 50% of joints. They are of reinforcement steel with diameter per Design normally 8 or 10 mm. Beam hanger/stirrups travel is provided by the Design and should be observed.

Centralizers or fenders serve to center pile reinforced cage. They are steel metal sheet or steel reinforcement. They are welded to main vertical reinforcement at adequate spacing and per adequate sequence. Centralizers exceed the size of reinforced cage for the thickness of protection layer of concrete in compliance with accepted norm for reinforced concrete.

Reinforced cage shall be placed, centered and fixed into drilled hole, protected by steel pipes, upon the completion of drilling and clearing of bore hole, directly before pile concreting. Placing of reinforced cage shall be performed by cranes. Reinforced cage may be executed in full or partially, if extended, by overlapping per regulations of the accepted norm for reinforced concrete.

Work Log
During the execution of piles, each pile shall be described in the minutes: the type of soil to be drilled shall be stated as well as appearance and the level of underground water, other obstacles, if any. Besides the afore mentioned, the log should also record the time of commencement and completion of works on piles, lower pipe height level, reinforcement level, commencement and completion of concreting, the quantity of built-in concrete, etc.

The Contractor shall be obliged to keep complete documentation on execution of each particular pile.

All works and all documentation shall be subject to the approval of the Engineer.

Measuring
Measuring of the quantity of actually executed piles shall be made in linear meters (m^1). The designed pile length may be changed subject to approval of the Engineer and Designer.

Payment
The Contractor shall be paid for the quantity of actually performed works, i.e. completely built-in piles per the Design per m^1. The price shall include compensation for supply of all materials, plant and equipment, necessary labor for the execution of bored piles per the Design.

Testing of pile bearing capacity shall be paid in accordance with the Contract signed by and between the Employer and the Contractor and subject to the approval of the Engineer.

11.1.8 Execution of Pile Cap (Beam)
Pile Cap (beam) shall be executed in high quality reinforced concrete (RC). Pile Cap (beam) has the function to connect piles of retaining structure into a whole. Uneven soil pressure alongside retaining structure is more evenly distributed on the piles by means of pile cap (beam). Thus the structure is not exposed to concentric loading which adds to her integrity.

Method of Pile Cap Execution
Pile Cap (beam) is to be executed over bored piles. The concrete used for execution of pile cap (beam) shall be of high quality. Concrete class (CC) is determined by the Design and shall be observed. Formworks for pile cap (beam) shall be made before concreting, in accordance with the sizes provided for in the Design. Formworks shall be made of hard timber or metal structure, properly fixed, as to avoid its being deformed due to weight of concrete.

It is possible to execute pile cap (beam) reinforcement either on the spot or in reinforcement workshops and then transport it and place on the site. The reinforcement shall be placed in all respects per the Design. Reinforcement RA 400/500 or GA 400/500 shall be used as determined by the Design. Stirrups and other structural reinforcement may be of GA. The reinforcement of pile cap (beam) shall be connected to pile reinforcement on each contact point.

Static wise, the pile cap (beam) is continuous girder, therefore during the execution of works attention should be paid that work breaks are made at favorable spots (approximate on the spots where bending moments equal zero).

Concreting shall be done in layers of maximal thickness of 40 cm. Concrete shall be compacted by adequate vibrating devices which are to be subject to the approval by the Engineer.

It is possible to remove vertical formworks in 4-5 days upon the completion of concrete works, while the horizontal is to be removed in three weeks upon the completion of concrete works. Preferably, the concrete shall be cured upon formworks removal, up to 28 days from the date of concreting.

Expansion joints shall be placed on the spots as determined by the Design. They shall be executed in the manner as determined by the Design.

Concreting shall be executed in the manner anticipated by one of world-wide recognized norms and in full compliance with the requirements of the Design and these Technical Specifications. Norms are proposed by the Contractor and are subject to Engineer’s and Designer’s approval.

Equipment
Concrete shall be made in concrete plants equipped with weight-feeders of componential materials (mineral aggregate, cement, water, agents). Mixing time shall be sufficient as to allow for production of uniform concrete. Transportation of concrete from the plant to the building-in spot on site shall be done by mixer-trucks and shall not exceed 60 minutes.

Concrete shall be compacted during placing by adequate vibrating devices of sufficient power, as to achieve compacted built-in concrete. This is achieved by selecting among vibrating devices (like pervibrators, platvibrators, etc) on the site subject to Engineer’s approval.

Materials

Componential materials for concrete like mineral aggregate, cement, water and agents shall fulfill the conditions of a world wide recognized norm for mixing high quality concrete for this type of works. Each componential material that is used for concrete production shall be previously attested and, at later stage during the execution of works, check-up tested in the manner determined by the adopted norm. The Contractor shall propose the norm for the componential materials for concrete mixing which is to observed both in the prior testing and control testing during the execution of works. The norm proposed by the Contractor shall be subject to both the Engineer's and the Designer's approval.

The concrete of which the pile cap (beam) is made shall be of the class stipulated by the Design. Concrete quality is determined in accordance with one of the world-wide recognized norms, which is to be adopted prior to commencement of works. The Contractor shall propose the norm to be adhered to when mixing and pouring concrete, as well as when controlling the concrete quality for the approval of the Engineer and the Designer.

The reinforcement of pile cap (beam) shall be of round bars (GA 240/360) and ribbed reinforcement (RA 400/500). Reinforcement works shall be done per schedule provided by the Design. Main reinforcement shall be of ribbed bars while stirrups and other structural or bonding reinforcement shall be of round bars.

Measuring

Measuring the quantity of built-in pile cap (beam) shall be done in cubic meters (m^3) of works actually performed and approved by the Engineer.

Payment

The quantity of actually executed works i.e. completed pile caps (beams) together with formworks per the Design shall be paid per contracted price for 1 m^3 to the Contractor. The price shall represent the compensation for supply of all materials, plant and equipment, the price of labor required for the execution of pile helmet per the Design.

11.2 Drainage Slabs of Single-Grain Concrete 4-8 mm

11.2.1 Description

These slabs are made of high quality single-grain gravel as to ensure satisfactory water-tightness (k=10 to 10m/s).

11.2.2 Quality of Basic Materials

The requirements of Technical Specifications Sub-Section 8.2 shall apply.

11.2.3 Execution of Slabs

The mix of 250 kg of cement per cubic meter of concrete with w/c factor in the interval 0.50 to 0.60 shall be used for the execution of slabs. Compacting shall be done manually in moulds and attention shall be by all means paid to avoid the decrease of slab' water-tightness.

11.2.4. Measurement and Payment

The calculation shall be made per cubic meter of concrete approved by the Engineer and the price shall include all materials, execution and erection within the structure.

11.3 Smaller Size Structures – Pipe and Box Culverts

11.3.1 Description

This item includes execution of smaller-size structure of the opening up to 5,00 m' and they are:

- Pipe culverts opening of 1-2 m, of prefabricated pipes to be concreted on the site in all respects per the details of the Design, with;
- Box culverts with the opening of 1 – 5 m' by concreting on the site.

The execution shall include all excavation works, strutting, execution of formworks, mounting and placing, i.e. filter execution together with overall supply of materials and prefabricated elements, as well as all other necessary for the execution of works. All works shall be done in accordance with the Design and these Technical Specifications and subject to the approval of the Engineer.

Frame culverts are identical by form and structure to smaller-size beam system bridges.

11.3.2 Materials

Concrete shall comply with the requirements of Technical Specifications Section 8 on concrete quality.

The reinforcement also shall be complied with conditions of the reinforcement regulations hereof.

The formworks for prefabricated elements shall be executed as to avoid deterioration from the sizes of prefabricated elements in serial production, as well as to secure smooth surfaces upon the removal of formworks.

If anticipated by the Design, filter materials like stone, wedges by the structures and insulations, shall fulfill the conditions hereof.

11.3.3 Execution of Works

Excavations shall be performed in accordance with the Design and the Contractor's instructions and subject to the approval of the Engineer. The form of excavation shall be adjusted to the detailed drawing from the Design and the terrain conditions. Excavation category shall be determined per types of earth material (G.N.200).

Excavations shall include all additional works like strutting, transporting of excavated material, water pumping.

Prior to placing base courses of concrete, gravel or sand, the height levels should be re-determined.

Concrete is reinforced by reinforcement per the Design and Rules Book on concrete and reinforced concrete. Attention should be paid when placing concrete that all reinforcement is covered by concrete at all sides and that the Design anticipated thickness of protection layer is achieved.

An extensive cure and protection should be performed in accordance with the conditions hereof, for the first 7 days from concrete pouring

Concrete quality is determined by concrete class in accordance with the Technical Specifications Section 8.

Placing of concrete pipes for culverts (concrete class 20), i.e. placing of individual pipe parts on fresh concrete base class 15 shall commence on the downstream side with cast culvert end on previously prepared base. Cracked pipes and damaged elements shall not be used. When the pipes, which have been previously cleaned and sprayed with water, are placed they shall be lined by concrete class 20 if so anticipated by the Design. Concreting of foundation and culvert's end is executed in compliance with the requirements on concrete works, as well as concreting of culvert inlet and outlet.

11.3.4 Measuring

The excavation is measured as wide excavation by m^3 of actually executed works in original natural soil per sizes from the Design up to the subsoil height level, and as foundation excavation if below the above mentioned height level, and as approved by the Engineer.

The culverts are measured per actual length in meters alongside the bottom of the pipe and as approved by the Engineer. These lengths include inlets and culvert ends.

Frame culverts are measured per actual length in meters as approved by the Engineer.

11.3.5 Payment

All works are calculated per contracted unit prices. Unit price shall cover complete culvert execution.

11.4 Retaining Structures of Soil and Plastics – Lining Free

11.4.1 Item Description

The retaining structures of soil and plastics are structures both fine-grained and coarse-grained soil and of geo-synthetics (woven geotextile or geo-net).

Bearing function of this structure is overtaken by interaction between the soil and reinforcement, meaning that the friction that appears in reactive zone of the structure, between the reinforcement of plastic material and soil, keeps the structure in stable condition.

Retaining structure of soil and plastic should satisfy the conditions of external stability (stability to the rotary and translational movement, allowed stress at the contact of soil and foundation, setting of structure and plinth sliding). The retaining structure shall also fulfill interior stability conditions (soil compressive force shall be for 1,5 times lower than compressive force between the soil and geo-synthetic, both globally and on vertical segments).

11.4.2 Work Technology

Retaining structures of soil and plastic are constructed over already prepared subsoil in accordance with the conditions for execution of roads' subsoil. Prepared subsoil is covered by the "clean" layer of sand-gravel soil or crushed stone 0-30 cm, which is 10-30 cm thick. Then the first layer of geotextile is applied over which a layer of soil (fine-grained and coarse-grained) is spread, leveled and compacted. When the first layer is compacted according to the regulations, then it is covered by geotextile, minimal 1.00 m^1.

Then the second layer is executed, i.e. geotextile is laid first which over another layer of soil is spread, leveled and compacted. This schedule of works shall be adhered to, starting from the bottom and progressing to the top of the structure, i.e. schedule of successive placing geotextile (reinforcement) and execution of embankment layers. Embankment shall be constructed per technical conditions for road embankments.

11.4.3 Materials

The reinforcement used with these types of structures is woven geotextile, or geo-net of polyvinyl alcohol *(PVA),* polyester *(PES)*, polypropylene *(PP)* or polyethylene *(PE).*

Orientation values of main mechanical characteristics of tensile strength (β_Z) and maximum dilatation (ε) of geosynthetic for these types of structures are woven geotextile and geo-net of polyester, polypropylene or polyethylene:

$\beta_Z = 40 - 300$ kN/m^1, and the dilatation at the top tensile strength is $\varepsilon<15\%$ Geosynthetic that is applied on retaining structures of soil and plastic shall be resistant to ultra-violet rays (UV) . If geosynthetic fails to be resistant to UVrays, the slope of the embankment shall be protected by topsoil. For top soil stability, it shall be necessary to use plastic subgrade of high-density polyethylene (HDPE) 16-18 mm thick which receives tensile force of minimum 3, 00-3, 50. kN/m^1. Plastic subgrade shall be fixed to the road embankment by plastic wedges of HDPE of 70 cm in length that are laid in <check-mat> pattern at the distance of 70-100 cm. A layer of topsoil mixed with grass seeds is placed between the embankment slope of geosynthetic and plastic subgrade.

The soil used for the structure shall possess the following geo-mechanical characteristics:
$\gamma > 18$ kN/m^3; $\phi > 25^0$; and that the soil is not polluted by chemically aggressive agents to geotextile as well as that the presence of slurry particles is less than 4%.

11.4.4 Quality Control

The quality of treated subsoil shall be checked by one of world-wide acknowledged norms for:
- Determining soil moisture;
- Determining soil bulk density;
- Determining modulus of soil volume change.

Subsoil compaction shall be determined per standard Proctor compaction test:
- Natural original fine-grained and coarse-grained soils with the embankment height not exceeding 2 m1 in height, 100%.
- Natural original fine-grained and coarse-grained soils with the embankment height exceeding 2 m1 in height, 95%.
- Tests shall be made at each 50 m1 of treated subsoil.

The quality of executed embankment layer shall be checked by one of world-wide acknowledged norms for:

- Determining soil moisture
- Determining soil bulk density
- Determining modulus of soil volume change.

Fine-grained material like clay, dust shall fulfill the compaction condition per standard Proctor procedure E= 600 MN/m^3:

- For the embankment layers of below 2,00 m^1 from the finished height level 95%.
- For the embankment layers up to 2,00 m^1 below the finished height level 100%.
- For coarse-grained soils like sand, gravel, the modulus of soil volume change M_C= 600kPa.

The compaction of embankment layers shall be tested at each 50 m^1 by two tests from close locations that will give the same results.

The quality of geotextile shall be proved by testing tensile strength and elongation (dilatation) at peak strength as well as resistance to UV rays with one of registered institutions for this type of jobs.

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

11.4.5 Measuring

The quantity of executed retaining structure of soil and plastic approved by the Engineer shall be measured in two ways:

- in m^3 of actually executed embankment, and
- in m^2 of placed geotextile.

11.4.6 Payment

The payment for retaining structure of soil and plastic shall be made per actually executed quantities for the embankment as well as for supplying and placing geosynthetic per unit price stated by the contracted bill of Quantities.

11.5 Geotechnical Prestressed Ties

11.5.1 Description and Scope of Works

The works included hereof consist of supply of materials, labor, plant, equipment and the execution of all necessary operations. All specific preliminary works like scaffolding, water-supply, electricity supply, etc., shall be also included. All works shall be in full compliance with the Design, these Technical Specifications and subject to the approval of the Engineer.

11.5.2 Execution of Works

Execution of Borehole

Bore holes for ties are executed with casing in the slope anticipated by the Design. Drilling method shall be harmonized with geotechnical conditions of the terrain, which have been defined by prior examination works. All materials through which the bore hole passes through are identified and recorded in the Work Log. On the basis of the established profile, the length of tie or road-stead zone will be possibly corrected. Corrections in respect of the Design shall be exclusively made by the Designer or Engineer. The position and slope of bore holes shall be in strict compliance with the Design. Finally, the bore hole is water flushed upon completion. Drilling mud usage shall not be allowed when executing bore holes for geotechnical works.

Building in of Anchors

Already prepared tie, whose structure and bearing capacity is complied with the Design, is upon water flushing inserted in the bore hole. Any changes on the tie could be only made with Designer’s consent. After the tie is inserted into the bore hole, protection pipes are removed. Injecting of tie, road stead zone, shall be made by cement-water mix with addition of contents that increase the volume. The composition of injection mass/compound is determined by the Design depending on rock mass and force in the tie and shall not be changed without prior consent of the Designer.

Injecting shall be performed under small pressure and shall last until injecting mass reaches bore hole outlet. The part of tie exposed to elongation-prestressing is protected by special structure. When mass hardens, which is determined by laboratory tests, then it shall be proceeded to tie prestressing. Prestressing is performed in several cycles, which are precisely detailed by the Design. The tie is found correct, if deformation-free during straining. After prestressing, tie-head is fixed and subjected to protection against corrosion. Part of tie whereon elastic deformation is applied is injected and tie-head is covered by concrete per the detail of the Design.

Protection against corrosion completes the works on tie execution.

The data on method of execution of works and used materials is recorded in the Work Log , which shall be maintained by the Contractor and the Engineer for eventual submission to remain with the Employer.

Attests for all used materials shall be handed-over to the Employer through Work Log.

Measuring

In principle, the tie length shall be determined by the Design on the basis of examination works and Design requirements. However, under complex engineering-geological conditions, the tie length is determined after the bore holes have been executed. Therefore, the quantities to be paid for are determined on the basis of actually executed works approved by the Engineer.

Payment

The payment shall be made per contracted unit price for linear meter of tie. The price shall cover all material, usage of plant and equipment, all work operations until the tie completion. Testing of tie bearing capacity, if anticipated by the Design, shall be paid separately and shall also include all labor, material and equipment.

11.6 Gabion retaining structure

Gabions are retaining or lining structures for receipt of soil pressure, made of wire or plastic cages of different sizes and filled with broken stone.

Method of Gabions' Execution
Gabions shall be placed on the leveled earth base cleared from weeds, stumps and other elements that might damage the net with 5% incline to the slope of the terrain. A layer of broken stone or gravel 5-10 cm thick is placed over thus leveled earth base, which serves as cleaning layer. Instead of clean layer of mineral soils, it is possible to place non-woven textile, which in this particular case has separation function, meaning it protects gabion from penetration of fine-grained soil (dust, clay) into its mass.

Wire or plastic cages (boxes) where in broken stone is placed, shall be of sizes as stipulated by the Design, normally 1,00x0,50x2,00. It is necessary to execute a diaphragm (partition) in the cage center, if the cage length is 2, 00 m^1. The cages are made of hexagonal or square steel net with double thread of steel wires with tensile strength of 550 N/mm^2; dilatation at elongation is 10%. The wires have diameter of 2,4, 2,7 and 3,0 mm and they are galvanized by 275 - 290 g zinc per m^2, or steel wires galvanized by Galfanalloy of 95% zinc, 5% aluminium and "Mischmetall" (mixed metal) alloy. If so required, both wire types may be PVC coated as additional protection against chemical effects, if exposed to polluted or aggressive environment. The edges of gabion cages are reinforced by galvanized steel wire with diameter that is higher than the diameter of gabion net wire. Stainless steel or galvanized steel rings are used to horizontally or vertically connect gabions as well as the sides of gabion cages. Ring diameter is 3, 05 mm and it is galvanized by 280 g/m^2 zinc. The rings are placed either at horizontal or vertical distance of 20 cm by manual of hydraulic device, specially manufactured for this type of job.

Gabions are anchored per schedule provide by the Design detail. Anchors are made of the same steel net, which quality is described in this item on gabion cages.

The filler used for gabions shall be crushed stone whose minimal grain size should exceed the size of cage wire mesh. The density of crushed stone filler for gabion shall be min. 60%. Crushed stone used for gabion filler shall fulfill physical and mechanical conditions anticipated hereof. Final/top gabion filler shall be fine grained stone as to provide as smooth as possible upper gabion surface. Also, the top gabions filler shall be placed 50 to 75 mm above the top of the net as to facilitate setting due to gabion own weight. Filled case /cage shall be closed and the lid shall be tied by wire or steel rings. If the cage is made of plastic, ties shall be made by plastic thread. Gabions are to be made on site.

Specially, if thus required by the Design, gabions shall be cross or longitudinally tied/connected by reinforcement of 6 mm in diameter. Horizontally, the reinforcement shall be placed at each linear meter of gabion width, and vertically at each two meters of gabion length.

Horizontal wise, gabions shall be placed in such a manner as to avoid overlapping of vertical joints of the layers, i.e. vertical joints of one layer shall be at the center o the gabion of the other layer. Gabion cavities should be filled with natural materials like clay and dust which would further facilitate seeding of grass or bushes that would stabilize gabion structure. The space between gabions and embankment slope shall be filled with earth and broken stone compound, diameter 1-6 cm, in the ratio of 1:10 as allow for plants to take better root.

Equipment
Hand tools for cutting of galvanized steel wire, or sheradized steel wire shall be needed to make cages for gabions, as well as a device to connect sides of gabion cages, or to connect gabions. The tools to be used to make plastic gabion cages are tongs, ruler, needles, etc.

Cages are to be filled both by loader and manually.

Materials
The following materials shall be needed for gabion production:

The net of hexagonal steel wire, double folded, with ultimate strength 550 N/mm^2 , at the elongation of 10%, galvanized with 275-290 g zinc per m2 or steel wire galvanized by Galfan alloy of 95% zinc, 5% aluminium and "Mischmetall"(mixed metal) alloy. Both nets, if required by the Design, may have PVC coat 1,00 mm thick. The edges of gabion cages and diaphragm shall be reinforced by galvanized steel wire of the same quality as for net wire, but with higher diameter 3,20 mm. The sides of gabion cages shall be connected, as well as internal ties, by steel rings with diameter of 3,05 mm, galvanized by 280 g/m^2 zinc or by wire of the same quality which of the cage net is made of. Instead of steel nets, Plastic polyethylene (PE) nets of high density (HDPE) may be used instead of steel wire nets, with square wire mesh size 8-10 cm or hexagonal wire mesh size 10-12 cm. The sides of plastic cages and internal cross connections shall be connected by plastic thread, 3x0,6 mm thick.

Crushed stone grain size 10-25 cm, for cage filler, shall fulfill the following conditions:
- volume mass with cavities 22 kN/m^3 ;
- water absorption min. 1%;
- compressive strength in water-saturated condition min. 100 MPa;
- Resistance to moisture and frost M-50, per one of world-wide acknowledged norms.

Reinforcement shall be of geosynthetic polyester (PET) net or polyvinyl alcohol (PVA), which shall possess basic physical-mechanical characteristics:
- ultimate strength $\beta_Z = 50 – 300$ kN/m^1;
- dilatation at peak strength: $\varepsilon = 6\text{-}12$ %

In concrete case, geosynthetic net per the Design shall be used.

Connecting reinforcement to lining concrete blocks may be executed in two different ways:
- direct connecting;
- Indirect connecting.

Direct connecting understands placing of reinforcement directly into concrete block. This is possible, if geosynthetic net of polyvinyl alcohol (PVA) is used as reinforcement. This net is resistant to pH values, 9 for concrete, and therefore it is possible to directly anchor the net onto the concrete block, as provided for by the Design.

Indirect connecting shall be necessary if geosynthetic polyester (PET) net is used which is not resistant to pH values of concrete and therefore indirect connecting shall be used as provided for as a variant by the Design.

The Contractor shall select one of the two proposed ways of connecting reinforcement to concrete block and submit his proposals for the approval of the Designer and the Engineer.

Measuring
Measuring the quantity of executed gabions shall be made in cubic meters (m^3) of actually performed works approved by the Engineer.

Reinforcement of geosynthetic net which is actually placed shall be measured separately in m^2.

Payment
The Contractor shall be paid for the quantity of actually executed works, i.e. completed gabions per the Design, per contracted price for 1 m^3. The price shall represent the compensation for supply of all materials (net of galvanized wire or plastic, crushed stone, broken stone, etc.) and the price of labor needed for execution of gabions per the Design.

11.7 Water flows control

11.7.1 Excavation

11.7.1.1 General provisions

Excavation includes excavation, loading and transport to the disposal area or place determined by the Engineer, unloading and arrangement of disposal areas.

Excavation shall be carried out to the lines, slopes and dimensions given in the Final Design or to the lines, slopes and dimensions approved or instructed by the Engineer. Overbreak beyond these lines shall not be considered for the payment except the overbreak or additional excavation that may be approved by the Engineer.

All operations that the Contractor plans to carry out on the excavations must be stated in the programme for these works which is to be submitted to the Engineer for the approval, at least 30 days before the commencement of the works. Material, equipment and labour for the stated operations shall be subject to the approval of the Engineer. The Engineer has the right to deepen and enlarge anticipated excavations, to change slopes of excavation and to make all necessary changes in order to ensure the required quality of the excavation or construction material. All excavations that the Contractor carries out beyond the approved dimensions and levels defined in the design or not approved in written by the Engineer shall not be accepted for payment, and the costs of filling works, which are to be carried out according to the filling specifications, are to be paid by the Contractor.

Within 10 days from the reception of the excavation plan, the Engineer shall issue written approval or rejection, partly or completely, of the Contractor's proposal. In case of rejection, the Contractor shall submit a new excavation plan.

No excavation should start without the previous approval and signing of the mentioned plan by the Engineer. The payment for excavation shall be done according to the unit rates for 1 m3 stated in the Bill of Quantities.

During excavation works, working areas are to be kept dry and the measures and method that the Contractor takes in order to fulfill this condition must be fully in accordance with the design and approved by the Engineer and they must have no negative effect on the surrounding area.

11.7.1.2 Approved overbreak

Approved overbreak is overbreak which, according to the Engineer's opinion, is an inevitable result of bad material, and is not caused by negligence or carelessness of the Contractor. Additional measuring shall be carried out for the approved overbreak and it shall include unstable material which did not fell off by itself, but needed to be removed mechanically or manually during the cleaning.
For those quantities which are beyond theoretic excavation lines defined by the drawings or beyond excavation lines determined by the Engineer, the Contractor has right to request payment as per same prices stated in the Bill of Quantities. These prices include costs of loading, transport and disposal of material. The Contractor shall immediately submit applications for payment of costs for overbreak caused by inevitable break and sliding of material to the Engineer who will establish causes of overbreak and decide whether the overbreak may be considered as approved or not. Only the Engineer is competent to decide on causes of overbreak.

11.7.1.3 Disposal areas

Material not suitable for construction or left after excavation shall be disposed. Disposal of excavation material shall be carried out in the areas proposed by the Contractor subject to approval by the Engineer, in principle in the areas of the existing depressions. In case of necessity, the Contractor may carry out temporary disposal of excavation material, in other places subject to approval by the Engineer, which are usually in already expropriated areas. On completion of works, when there is no more need for temporary disposal of excavation material, the Contractor is obliged to transport all of the remaining material to the permanent disposal areas and bring temporary disposal area into the previous state arranging it in a way to be agreed with the Engineer. Material disposal shall be carried out in such way that disposal areas are always drained and planned. Slopes of disposal areas, as well as disposal areas by themselves, must be stabile.
Arrangement of temporary disposal areas shall not be paid separately but included in unit rates for excavation.

11.7.1.4 Excavation of channels and river beds

Unlined part of the profile

Unlined part of the profile shall be excavated fully in accordance with dimensions and slopes defined in drawings. If stability conditions, or some other conditions require that, the Contractor may propose to finish the excavation to the different dimensions and slopes and request the approval of the Engineer. Surpluses or shortages in quantities resulting from these changes may not have effect on offered unit rates for channel excavation.

Lined part of the profile
Special attention shall be paid to prevent overbreak of material on the bottom and slopes over which channel lining will be placed. In places where natural terrain line is beneath the channel bed, channel bed is to be filled up to the lining base in the same way as it is specified for filling and compaction of the channel embankment.

In case of ordinary excavation, channel excavation is to be carried out from the lining foundation, as it is shown in drawings or as it is specified, in order to provide required lining thickness.

On those sections where underground water is present, which is to be established by the Contractor, part of the profile that is to be lined shall be excavated so that the space is left between the excavation surface and lower side of the lining. This additional excavation of channel lining is to be filled with drainage material selected in accordance with the Design and subject to the approval of the Engineer.

Overbreaks of excavation surfaces resulting from bad structure of material in which excavation is carried out, shall be filled with the selected material as directed by the Engineer.

Measuring and payment
Measuring and payment for channel excavation shall be made to the excavation borders given in the drawings, borders defined by these specifications or borders approved by the Engineer.

On those sections where ordinary excavation of profile which is to be lined is carried out, measuring of excavation, except the one anticipated in this item, shall be made to the line of the lower side of lining.

In those places where additional excavation for placing drainage material is required, measuring of excavation shall be made to the line parallel with the lining, 0.10 m under the lower side of the lining. Costs of filling this lining excavation shall be included in unit rate for one square meter, given in the Bill of Quantities for lining base preparation in the areas with high level of underground water.

Measuring for payment of excavation of unlined part of the channel profile shall be made to the excavation borders and slopes shown in drawings and as approved by the Engineer, taking into consideration the following:

If excavation is carried out in material that can be excavated exactly to the defined borders and slopes, excavation is to be done exactly to the mentioned borders and slopes up to which measuring for payment shall be made. Any overbreak beyond these borders shall not be accepted.

If excavation is carried out in material that contains large boulders or large pieces of debris, excavation is to be done to the excavation borders and slopes shown in drawings or those approved by the Engineer.

Measuring for payment shall be made to the anticipated borders and slopes, and in cases of overbreak caused by bad structure of material, which is subject of the Engineer’s decision, measuring for payment shall be made to the excavation lines ..

Payment for channel excavation shall be made per unit rates for one cubic meter, given in the Bill of Quantities for ordinary excavation and excavation of channel in rock. Unit rates shall include work of machines and labour, transport of excavated material to the embankment or disposal area not more than 150 m away from the excavation place, water pumping or drainage as well as any other work required for keeping excavation in good condition during construction works.

11.7.1.5 Excavation from the borrow pits

General provisions
If the excavation does not provide sufficient quantity of necessary material for filling, the Contractor shall establish place from which additional material is to be procured and request the approval of the Engineer. Material is to be taken in such way that the smallest possible agricultural area is destroyed. Surface of borrow pits is to be left reasonably even, and subject to approval by the Engineer.

Where it is necessary, in order to prevent accumulation of standing water, borrow pit holes are to be drained by open channels to the full satisfaction of the Engineer.

Measuring and payment
Measuring for payment of material taken from the borrow pit shall be made in the excavation place. Measuring for payment of borrow pit excavation shall be made only in those quantities that are necessary and as approved by the Engineer. Paying for the excavation material from the borrow pit shall be made per unit rates given in the Bill of Quantities for borrow pit excavations. Besides excavation costs, unit rate shall include costs of borrow pit drainage.

11.7.1.6 Excavation for structures

Excavation for structures is to be carried out to the excavation borders and slopes shown in drawings or as approved by the Engineer.

Notwithstanding excavated quantity, measuring for payment of excavation shall be made only to the above described borders and subject to the approval of the Engineer.

Excavation for abutments of bridge or other structures lying out of the channel profile, if it has not been required from the Contractor to carry out these excavations before the channel excavation, are to be considered as excavations for structures, but they shall include only necessary excavation out of the normal channel profile and they will be measured to the borders described within this item.

If it has been required from the Contractor to carry out these excavations before the channel-bed excavation, all required excavations shall be considered as excavations for structures and shall be measured to the designed, required borders. This applies in cases of deck bridges construction, before excavation of channel, which is obligatory on flat and unoccupied areas (costs of scaffolding shall not be charged).

Excavation for culverts and other structures below channel-bed: if this excavation is done before excavation of channel, all necessary excavations below terrain surface between vertical surfaces at the beginning and at the end of the structure, including all necessary excavations upstream and downstream from the structure, shall be considered as excavation for structures.

If waste material is found in foundations of structure it shall be excavated to the depth that shall be approved by the Engineer in order to enable filling of material suitable for base, and measuring shall be in accordance with this item.

If this excavation is carried out after channel excavation, excavation out of required normal profile shall be considered as excavation for structures, and it shall be measured to the borders of the channel.

Excavation for foundations of structure shall be carried out to the level shown in drawings, or those approved by the Engineer. The Contractor shall prepare structure’s foundations providing firm base for concrete structures. Bed and slopes of ordinary excavation on which concrete is to be placed are to be manually dug to the specified dimensions, and in that way prepared surfaces shall be, if necessary, watered and compacted with appropriate tool in order to get firm base for concrete.

If in any place of ordinary excavation overbreak is done below the specified founding level, it shall be filled with adequate material compacted fully in accordance with these specifications.

If this overbreak is done by the Contractor’s mistake, or by any other reason, except if it was instructed by the Engineer, the overbreak shall be filled, as stated above, and at the expense of the Contractor.

If the Engineer instructs additional excavation, and in order to remove bad founding material, measuring for payment shall be made to the ordered depth and dimensions, and payment for filling and compacting shall be made in accordance with the provisions of these Technical specifications.

If overbreak is result of the Contractor’s mistake, or any other reason, except if it was instructed by the Engineer, the overbreak shall be fully filled up to the required level with concrete of same quality as anticipated concrete structure, and at the expense of the Contractor, including costs of his work and material.

If it is necessary, material provided from excavation for structures shall be used for filling around the structure or for construction of the embankment. Otherwise, it shall be used for filling of connecting beds and depressions or distributed, subject to approval by the Engineer.

Payment for excavation for structures in ordinary excavation or in rock shall be made according to the unit rates given in the Bill of Quantities. Offered unit rates for excavation for structures in ordinary excavation shall include all the costs of work and material, water pumping and drainage, and any other works necessary to keep excavation in a good condition during construction, as well as transport of the excavated material to the distance of 150 m.

11.7.1.7 Transport

One kilometer cubic meter (km/m3) of transport is defined as one cubic meter of excavated material transported 1 km out of the borders within which transport is not being paid, since it is already included in the unit rates. That border shall be 150 meters.

Payment for transport shall be made only for the excavated materials that are necessary for forming bed-channel and other embankments for filling of old beds and other depressions, as well as for excavated and disposed waste materials which is decided to be transported beyond the border of 150 m.

If it is not anticipated otherwise, payment of transport of material for filling around the structures shall not be made.

Measuring and payment of transport shall be made as it is described here, notwithstanding the method and type of equipment used for excavation and transport.

If the material is taken from excavation of bed or channel and used for filling or disposed to the disposal area within border of 75 m, including the area left and right from the channel centre line, transport length is to be measured along the channel centre line from the center of material bulk in excavation to the center of material bulk in place of filing or disposal.

If the material is taken from the borrow pits located within 75 m, including the area left and right from the channel centre line, transport length is to be measured along the channel centre line from the center of material bulk in excavation to the center of material bulk in place of filing.

Notwithstanding the actual length of transport, the upper length of transport shall be distance measured along the channel centre line between the normal projection on the channel centre line of center of material volume in excavation and normal projection on the channel centre line of material volume in place of filing.

If the material is taken from the borrow pits located more than 75 m away from the channel centre line, transport length is to be measured along the shortest possible route, which is to be determined by the Engineer, and that is from the center of material bulk in excavation to the center of material bulk in place of filling.

If the material is to be transported to the disposal area located more than 75 m away from the channel centre line, transport length is to be measured along the shortest possible route, which is to be determined by the Engineer, and that is from the center of material bulk in excavation to the center of material bulk in place of disposal.

In measuring of quantities of material for the purposes of transport payment, volume of material for transportation is to be measured in excavation and as approved by the Engineer.

Transport length shall be measured in units of 50 m. .
Payment of transport shall be made according to the unit rate per kilometer given in the Bill of Quantities.

11.7.1.8 Tolerances and quality of finishing works

The Contractor is required to perform works on excavation so that he immediately continues with work after excavation, which means to synchronize works in order to prevent moistening, sliding, ditching, loosening or any other degradation of quality of surfaces on which excavation is completed and filling did not yet started.

The Engineer shall instruct , at the expense of the Contractor, removal of damaged parts of completed excavation and filling of those parts with filling material.

Approval by the Engineer for the excavation is to be made after definite preparation of excavation surface, in naturally damp, fresh, compact state, after removal of any loose material. Approval for the excavation is to be carried out parallel with surveying of surfaces of the completed excavation, and the Contractor is not allowed to continue with further work until he receives written approval for the excavations.

The Engineer shall instruct additional deepening or widening of excavation in parts where specified dimensions were not achieved before issuing any final approval.

11.7.2 Filling

11.7.2.1 General provisions

Dimensions and tolerances

The Engineer shall instruct all necessary corrections of excavation or embankment or any other modifications during construction works in order to adjust the structure to the real conditions.

The tolerance for filling, in respect to the levels given in the Design and obligatory for the Contractor, shall be 0.05 m, or as otherwise directed by the Engineer.

If deviation from the mentioned tolerances is found, the Contractor is obliged, at his own expense, to make necessary corrections, remove incorrectly executed filling and bring inadequate parts into the right condition as determined by the Engineer.

Maintenance of embankment

The Contractor has obligation to maintain outer surfaces of fill in the same condition as on completion of works and all until works are finally accepted by the Engineer All changes that occur during the mentioned period, including the damages, the Contractor is obliged to fix and bring filled areas into the previous state at his own expense.

Method of execution

The Contractor shall submit for the approval of the Engineer, at least one month before the commencement of works, his programme of works where he proposes phases in embankment construction, method of construction for each phase and equipment for construction.

Transportation and build-in equipment must be submitted for approval by the Engineer.

Build-in may start only after the Engineer issues approval for the surfaces prepared for filling of the next layer.

In construction of the embankment with section in cut and fill, it is necessary first to remove topsoil on the entire surface of excavation and embankment, and then follows excavation, embankment construction, trimming of the entire slope of the section, top-soiling and grass seeding.

Topsoiling of visible surfaces of the embankment shall be done by using topsoil material disposed along the embankment.

Slopes and crowns of the embankment shall be covered with topsoil material in layer of 10 cm. Topsoil that remains shall be distributed over both sides of the embankment.

Topsoiled areas are to be grassed with a mixture of selected shrubby grasses so that the grass cover undertakes function to protect surface layer from erosion.

Grassing shall be performed in accordance with the agro-technical measures and by adding fertilizer in quantity of 200kg/ha.

Calculation shall be made per 1 m2 of topsoiled and grassed surface.

Temporary access roads

Final works on access road shall be performed in accordance with description given in the Design and subject to the approval of the Engineer.

Subject to the approval of Engineer, the Contractor may use existing roads or cut temporary roads.

On completion of works, Contractor shall:

a) bring the existing roads into the previous state or better
b) level and plough temporary roads in order to bring area to its previous purpose

All such reinstatement works shall be completed to the satisfaction and approval of the Engineer.

Costs of the work on roads are included in prices for permanent works (excavation, filling, concrete…)

Testing and control

All testing and control shall be completed in accordance with Section 1 of these Technical Specifications and as directed by the Engineer. .

Compacting equipment

Considering used material, Contractor shall choose most appropriate equipment for compacting, such as, for example, manual vibrating rammers.

The manual vibrating rammers are to be used where there is no access for the machines and they must have vibrating deck weighing at least 30 kg. Type and number of these rammers is to be submitted for approval by the Engineer.

The Contractor is obliged to timely submit his proposal for type of compacting equipment to the Engineer.

11.7.2.2 Execution of filling and protection around structures

General

Details of specifications for material incorporation are as defined in the Design, these Technical Specifications and as determined by the Engineer.

Measuring for payment shall be made per m3 of the material incorporated (compacted) in filling and as approved by the Engineer, where unit rate includes all works on excavation, transport within 150 m, placing in layers, moistening and compacting.

The Contractor is not entitled to ask for any reimbursement of costs above the offered unit rate for any work related to the drying of material, such as spreading and turning over in order to speed the process of drying, nor he is entitled to ask for reimbursement of costs resulted from delay caused by need to dry the material.

Preparation of surface for filling
The surface of terrain under all fillings shall be ploughed forming open rills of depth not smaller than 0.20 m from the natural level of terrain surface, and distance between them shall not be greater than 1.00 m. In places where terrain is inclined, berms shall be constructed as it is shown in cross sections.

Prior to placing of the first embankment layer, it shall be necessary to rough the base in depth of 5 cm, moisten it to the optimal moisture, and if it is too wet it shall be dried to the specified moisture as described in the following item.

In places where soil composition under embankment is not suitable for foundations, as determined by the Engineer, the Contractor shall remove that material to the depths and border established by the Engineer. The removed material shall be disposed as described in this item.

Measuring for payment of costs caused by removal of material not suitable for foundations base shall be made only to the depths and border approved by the Engineer, and payment shall be made according to the unit rates given for the ordinary ditch excavation in the Bill of Quantities.

Except costs of removal of material not suitable for foundations base (m2), costs of all other works described in this paragraph shall be included in the unit rates given in the Bill of Quantities for the ordinary ditch excavation ($m^{3)}$.

Moisture of material and compacting
During incorporation, material shall have uniform moisture adequate for compacting. During construction, in case of non-cohesive materials or poorly cohesive materials, the Contractor shall provide systematic watering in order to achieve better compacting results. In case of batches with higher percentage of fine fractions (semi-cohesive material), moisture of fine fractions shall be near to the optimal, from -1% to + 3% of water content according to the standard Proctor. Density of material filled shall be at least 95% of dry volume weight obtained by standard Proctor's test. Incorporation of material with compacting shall be done in layers of 25 cm.

All works shall be subject to the approval of the Engineer.

Filling around structure
The Contractor shall execute filling around all structures, to the lines shown in drawings or as determined by the Engineer. From case to case, the Contractor shall establish type of material to be used for filling and method of filling and submit his proposals for approval by the Engineer. Filling material shall be taken from excavation for structures, channel excavation or from borrow pit.

Limit for filling amount depends on sequence of works execution.
In the place where structure was built before excavation of adjacent channel sections, The Engineer shall determine the limit for the amount of filling around structure above the terrain level to the minimum required for protection of structure, performed with or without compacting.

In the place where structure, except for the culvert and other structures above channel, was built after excavation of adjacent channel sections, filling around structure, including parts of normal channel fill within filling borders around structure, shall be carried out as filling around structure with compacting, and it shall be measured for payment in accordance with the provisions of this item and subject to the approval of the Engineer.

Measuring for payment of filling around structures shall be made to the approved borders of executed excavation for structure, and only those quantities that are really incorporated within borders established for payment shall be calculated as approved by the Engineer.

Except for already anticipated, measuring of filling around structure above terrain level shall be made to the dimensions and slopes shown in drawings or those determined by the Engineer.

Filling of unapproved overbreak arrised during excavation for structure shall be performed at the cost of the Contractor, in accordance with the provisions of this item, and without any right to request reimbursement.

If it is not shown different in drawings or decided otherwise by the Engineer, filling shall be carried out in a way described in this item. Filling and compacting around and above the mentioned structures shall be performed in accordance with the following:

- Filling and compacting around and above pipes of these structures shall be done to the surface of terrain or to the level of 0.8 m above the top of the pipe. Under terrain surface filling and compacting shall be done to the full width of ditch. Filling and compacting around watertight rings shall be done up to the level of 0.80 m above the top of the rings, at width of 0.60 m on each side and to the slope of 1:1.
- Where position of sloped concrete walls or decks is such that they are partly above the terrain surface, and if it is necessary, as determined by the Engineer , to place concrete wall or deck directly on ground base without use of double sided formwork, the Contractor shall construct compacted embankment whose shape and dimensions present suitable base for the sloped concrete wall or deck.
- Measuring for payment of filling around structure with compacting shall be made to the borders shown in drawings, described in this item or determined by the Engineer. Payment for compacting shall be made per unit rate given in the Bill of Quantities. This price includes only compacting work described in item 4.2.7.3 and it shall be added to the unit rate for filling around structure without compacting, given in the Bill of Quantities. Payment for filling around structure with compacting shall be made per unit rate which presents sum of two above mentioned unit rates.

11.7.2.3 Subsoil preparation
This work refers to the natural original soil on which construction of embankment is performed.

The work includes compacting, and possibly digging up for the purposes of drying or moistening of natural soil in thickness defined in design, approximately 30 cm.

In case that the composition of soil – subsoil of embankment is such that it is not possible to carry out direct construction of embankment on it (saturated soils, muddy soils, soils of organic origin and similar), it shall be necessary to prepare the subsoil before construction of the embankment, that is to take remedial measures in a way defined in design or in any other way determined by the Engineer.

Prior to filling, cleared and leveled base soil – subsoil shall be compacted in accordance with the following conditions:

Description	Minimal required degree of density according to the standard Proctor's test
a) Natural original soils of cohesive materials, designed embankment is not higher than 2.00 m	100%
b) Natural original soils of cohesive materials, designed embankment is higher than 2.00 m	95%
c) Natural original soils of non-cohesive materials, designed embankment is not higher than 2.00 m	100%
d) Natural original soils of non-cohesive materials, designed embankment is higher than 2.00 m	95%
e) If density test on non-cohesive materials is done with a test plate, same condition shall be applied as for embankments of corresponding height:	
-for mixed materials with 20-30% of stone materials	Mc = 25-30 MH/m^2
- for mixed materials with 30-50% of stone materials	Mc = 30-35 MH/m^2
- for mixed materials with more than 50% of stone materials at optimal or near moisture	Mc = 25-30 MH/m^2

For coarse-grained crushed stone materials (grain size over 150 mm) and mixed materials, density test may also be performed by using volume methods if necessary and subject to the approval of the Engineer.

Embankment height is height from level of prepared subsoil – base soil to the level of roadbed formation (subgrade), at the lowest part, or to the level of embankment crown (dam).

Tests shall be done at every 1000 m2 of prepared subsoil, or as otherwise determined by the Engineer.

11.7.2.4 Structural embankment "SE"

If the material in construction place does not meet stated requirements, material for this embankment shall be provided from the borrow pit subject to approval by the Engineer.

Grain size curve shall be between limit lines shown in the appended diagram.

Organic content shall not exceed 5%.

Cohesive or non-cohesive material may be used in construction of this embankment.

Compacting shall be carried out by machines in layers up to 25 cm, in compacted condition, while compacting around concrete structures shall be carried out manually in layers up to 15 cm.

Spreading in layers shall be manual or by bulldozer, depending on available working area. Compacting shall be carried out by vibrators, rollers or manual rammers. Hydraulic compacting may be carried out in case of non-cohesive materials (sands).

For cohesive materials, density in place should be 95% of standard Proctor's test with variation of moisture compared to the optimal from -1% to +3%. Moisture of incorporated material should be uniform. Surface of previous layer shall be rough up to depth of 5 cm and moisten before placing next layer.

In case of non-cohesive materials, minimal achieved density should be 70% of relative density.

In the areas where design anticipates compacting only by machine passing, this may be achieved with 4 passes of bulldozer in layers up to 0.5 m.
All works shall be completed to the full satisfaction and approval of the Engineer.

11.7.2.5 Waterproof embankment "WPE"

If the material in construction place does not meet stated requirements, material for this embankment shall be provided from the borrow pit subject to the approval of the Engineer.

Grain size curve shall be between limit lines shown in diagram of definition of grading of embankment.

"Atterberg's" limits-
Flow limits: $25 \leq LL \leq 45$
Plasticity index: $5 \leq IP \leq 20$
"Darcy's" coefficient of water permeability should be max K = 10^{-5} cm/sec.

Organic content shall not exceed 3%.

Minimal density should be 95% of standard Proctor's test with variation of optimal moisture from -1% to +3%. Moisture of incorporated material should be uniform. Test shall be performed on quantities of 200 m3 of incorporated material and not less than two tests per structure shall be done.

Compacting shall be carried out by machines in layers up to 35 cm, while compacting around concrete structures shall be carried out manually in layers up to 15 cm. Surface of previous layer shall be rough up to depth of 5 cm and moisten before placing next layer.

The embankment is constructed in layers of thickness of 0.20 m to 0.35 m. Thickness of layers depends on type of machine used for compacting. Optimal thickness of layers shall be established by test compacting on trial section. Each layer shall be compacted to the required density. Density test is performed over modulus of compressibility defined for this embankment Ms = 50.000 KN/m^2 which is controlled after compacting of each layer by test plate at every 50 m of constructed embankment.

All works and materials shall be tested for full compliance with these Technical Specifications and to the full satisfaction and approval of the Engineer.

Transport of material is to be made over already constructed and compacted part of embankment. During excessive rainfalls moving across constructed embankment shall not be allowed.

Compacting of end lines of embankment shall be carried out by using light rollers or manual equipment. During execution of works, it shall be necessary to prevent sliding of material on already constructed parts of embankment and slopes must be protected from erosion caused by rainfalls. Damaged parts of slope shall be repaired and material shall be incorporated in a same way as in permanent works. It is necessary to achieve required density of Ms=50.000 KN/m2. Compacting shall be performed equally over the entire width and length of the embankment. Compactness of material must ensure required water permeability.

Results of circular deck test shall not depart more than 5% from allowed. All control tests and test results shall be submitted for the approval of the Engineer.
Embankment slopes shall be compacted upon removal of all remaining material located out of the embankment section.

11.7.3 Stonework

11.7.3.1 General provisions for stonework

Stone used for regulation works shall be provided from the quarry and shall fulfill following conditions:

- Size of stone material depending on type of works shall be in limits defined by design curve of stone grading
- stone shall be resistant on abrasion and frost, with pressure resistance not smaller than 100 N/mm2
- to have certificate for this type of works. According to the certificate it shall have 35% of weight loss after 5500 revolutions, and frost resistance shall be satisfactory (according to JUS B.88. 1).

For construction of lining larger stone shall be selected having dimensions defined by design which is to be corrected by hammer corrections on site. Each stone shall have required thickness. Corrections shall not be larger than 2 cm.

11.7.3.2 Sand and gravel base for stone lining

For sand and gravel base, filter layer, for stone lining natural sand-gravel material shall be used. Material for stone lining base shall fulfill condition that grain size does not exceed 50 mm and that is within limit curves shown in design diagram for limit curves. Spreading is carried out in layers in accordance with the design dimensions.

Measuring for payment is made per number of m3 of material incorporated in base and as approved by the Engineer. Payment shall be made per unit rates given in Bill of Quantities. Price includes excavation works, transport, unloading, construction, compacting, base preparation and other.

11.7.3.3 Protection of bank and bed by stone mound

For protection of slope and bed of regulated channel by stone mound only solid and compact stone shall be used, persistent on frost and in water, and in accordance with size shown in design diagram for stone mound.

After transport to incorporation place, stone shall be unloaded, rough calibration (manual and mechanical) shall be done in order to form constant inclination of slope and finish grade of regulated channel bed.

Measuring for payment shall be made per m3 of calibrated stone and as approved by the Engineer.

Payment shall be made per unit rate given in Bill of Quantities.

11.7.3.4 Crushed stone lining in cement rendering

Securing shall be carried out by using stone with measures and dimensions shown in drawings. For securing construction, stone resistant on atmospheric conditions and frost shall be used, which is defined by JUS B.B.8 044, JUS B.B.8 001 and JUS B.B.8 013 standards. Minimal pressure resistance of stone shall be 100 MN/m2. Measuring shall be made per m3 of incorporated material.
For protection of beds, minimal diameter of stone shall be 25 cm.
After unload from transport mean, stone shall be manually calibrated and incorporated.

Stone lining in cement rendering, ratio 1:3, by cyclopean method of construction, shall be constructed from calibrated crushed stone of polygonal calibration, and stone calibration shall be made in a way that three connections are connected approximately in one point. Each part shall be placed in bedding of rendering and all contact surfaces shall be filled with rendering. Construction stone shall be compact, non-hydroscopic and resistant on hammer impact, without lode, abrasion and frost resistant. The Contractors proves quality of stone by certificate issued from the authorized organization. Separate parts shall have approximately same size with minimal rest edge 1/3 – 1/2 of thickness in the upper part. Joints shall not be wider of 2 cm, which is to be achieved by using hammer and awl. Visible surface shall be separately treated and may have roughness up to +- 3 cm which is tolerable.

Paving of lining shall be carried out in lines, and joints of longer sides shall be placed vertical to water flow.

11.7.3.5 Construction and securing of thresholds

Fixed thresholds shall be constructed from crushed stone on base in accordance with 6.2, if otherwise is not stated in the Bill of Quantities.

Stone used in construction shall fully comply with the specifications for regulation works.

Thresholds securing shall be also carried out by using crushed stone for hydro technical works. Work shall be done by machine, except for the final part which is performed by hand. Work shall be performed in dry conditions. Lining thickness is as shown in drawings.

11.7.3.6 Variations, tolerances and quality of executed works

Finished surfaces shall be in accordance with the designed ones. Allowed variations from designed dimensions for machine work are +/- 10 cm, and for fine planning +/- 3 cm.

11.7.3.7 Gabion structures

Construction of stabilization thresholds and reno mattress linings

Construction of these thresholds and mattresses shall be performed on locations anticipated by design along regulation sector and from crushed stone of dimensions from specifications given in the item that follows. Stone shall be placed manually into the prepared gabion boxes without processing or treatment, and according to dimensions given in design.

Parallel gabion structures and reno mattresses

Wire cases - gabions shall be delivered in joints and transported to the construction place in accordance with manufacture's recommendations. Cases shall be formed in construction place and

bonded in horizontal layers. Cases of each following layer shall be bonded mutually and with cases in previous layer in order to have homogeneous unit which tolerates all anticipated loadings and deformations. All connections shall be executed according to details for edge reinforcement and bonding of sides recommended by the manufacturer, and which, prior to construction, Contractor shall submit for the Engineer's approval.

Filling of gabion cases shall be done by material that allows maximal filling of perfect volume of case in layers of 30 cm. Constant control of filling shall be carried out in order to avoid pinholes (voids). Filling stone shall have minimal dimensions of 120 mm, average grain size of 190 mm and maximal pieces that allow proper filling of cases. Reno mattresses shall be filled with stone of dimensions from 100 mm to 170 mm and average grain size of 140 mm. Filling stone shall fulfill requirements stated in the previous item – construction stone for bed lining in respect of required parameter values. Stone shall not be fragile, rotten, easily breakable or porous which means that it must fulfill durability requirements in the existing use conditions.

Only certified products which comply with standards UNI 3598, BS 1052/1980, US Federal Specification QQ-W-461 H, or equivalent, for wire characteristics and corresponding ones for galvanizing, shall be used for gabion cases. Prior to delivery to the Site, the Contractor shall submit certificates for the approval of Engineer. For cases, type of net 8x10 may be used with wire thickness of 3 mm or equivalent with characteristics that provide same or better behavior of filled cases under loading. All cases longer then 1.5 m shall be reinforced by diaphragms in accordance with manufacturer's recommendations, as well as with wire reinforcements sidelong in angles of shorter sides. For reno mattresses, net shall be used in accordance with the same standards for galvanized wire, and type of net 6x8 or equivalent with thickness of 2.2 mm. As alternative to reno mattresses, the Contractor may use gabion boxes, but previously he shall submit request for approval of the Engineer in order to confirm stability and durability of structure in changed conditions.

11.7.4 Construction of filter for gabions and reno mattresses

It is possible to use natural filter material or geotextile in function of filter.

11.7.4.1 Geotextile shall have following characteristics:

1. $0_{90} = 0.3$ mm $Už = (d_{100}' / d_o')^{1/2}$ (according to EN ISO 12 956)
   $d_{100}' = 0.2$ mm
   $d_0' = 0.005$ m
   $U' = 6.32$
   $O_{90}/d_{50} = 5.4$
   $d_{50} = 0.035$ mm

2.Coefficient of vertical water permeability $K \geq 1 \times 10^{-1}$ cm/s
3.Friction coefficient – greater than limit of sliding surface creation
4. Tensile strength according to ASTM D4632 minimum 450 N
5. Splitting strength according to ASTM D4533 minimum 180 N
6. Breaking strength according to ASTM D3787 minimum 180 N
7. Min. rupture ductility 50% according to ASTM D4632
8. Cracking strength according to ASTM D4632 minimum 1300 kN/m^2 (190 PSI)

Prior to delivery to the Site, the Contractor shall submit certificates for the approval of Designer and the Engineer.

11.7.4.2 Natural filters

Natural filter layers are defined by filter analysis for corresponding parts of structures and they are shown in a separate diagram in the Design

Section 12
Traffic Markings andTraffic Equipment

Contents

12.1. General

A. Technical conditions for production, supply and erection of certain marking elements are described through individual items of these works.
B. Ordering of marking elements shall be based on specifications provided for in the Design and in accordance with these Technical Specifications.
C. Execution of individual elements shall be based on SRP norms and detailed drawings from the Design respectively and in accordance with these Technical Specifications.
D. Positioning and executing of individual marking elements respectively shall be based on the layout plans, cross sections and other drawings in the Design, as well as on the Work Rules on Traffic Signs and Yugoslav norms and in accordance with these Technical Specifications.

12.2 Standard traffic signs

1.1 Size 1: Triangular 120 cm, round 90 cm, additional boards 120 x 35

1.2 Size 2: Triangular 90 cm, round 60 cm, supplementary boards size 60 x 35

a) Standard traffic signs are in all respects executed per the detailed drawings provided for by SRP norms, under the name, code and appearance per the Work Rules on Traffic Signs SRPS.Z.S.2 from no.301 through 309 "Official Gazette of the RS" no. 15/04.
b) Traffic sign background shall be white per the Work Rules on Road Traffic Signs ("Official Gazette of the RS", no. 3/2002 dated 01.2004).
c) Material for the traffic sign base/background shall have retro-reflecting features, class HI (high intensity) for the principal/country roads R-251 and for the trunk roads M-22 shall be of class III (diamond grade).
d) Traffic sign back side including possible reinforcements and all fixing elements shall be protected by artificial resins-based paint in dark-gray shade. Back side of the traffic sign, as well as its supporting documents shall be adequately marked per SRPSZ.S2.300 item 7 and protected by weather-proof ing agent/coat.
e) Traffic signs shall be protected against damage during transportation. Prior to their erection/building-in on the spot, the Engineer shall confirm that they are in order. The traffic signs have to fulfill requirements in respect of their resistance to mechanical effects and show no signs of destruction or self-separation of fixed parts, after having been exposed to mechanical effects.
f) Positioned traffic signs shall be secured from turning and shearing.
g) Traffic signs are erected in a manner that allows for deviation of their plane for 3 to 5° to the field from the normal to the road axis.
h) The position of the traffic sign in the cross section is determined by the Design. If during the execution of works on some micro-location a need arises to change sign position, it shall be specially recorded in the design documentation (as built drawings). The conditions for the erection of traffic sign – position of traffic sign in the cross section are provided for in the Detail enclosure.
i) The manufacturer shall warrantee for sign unchanged quality for at least 5 years from the date of erection, as to avoid extensive reflection and reduction of contrast between the sign symbol and the illuminated background.
j) The price of standard traffic sign shall include delivery and transportation to the place of sign erection, all fixing elements for the support (reinforcement, bolts, packings and other), as well as sign mounting to the built-in post.
k) Quality control: manufacturer shall possess attest for all materials used for manufacturing of standard traffic signs. Quality control shall be performed in accordance with the norm SRPS.Z.C2.300. and subject to the approval of the Engineer.
l) The manufacturer shall be obliged to put the code on the back side of the traffic sign, according to the Work Rules on Traffic Signs, together with the contents either numerical or textual in brackets; if the sign is packed in non-transparent wrapping, than the same shall be applied also to the wrapping.
m) Number of erected traffic signs shall be recorded through Measurement Book per offered specification. The payment shall be made per piece of erected traffic sign in accordance with the specification from the Measurement Book and as approved by the Engineer and offered unit price.

Other norms that are used for traffic signs:

SRPS.Z.S2.300 Road traffic signs – Technical conditions
SRPS.Z.S2.300 Cyrillic alphabet of normal width for traffic signs – Form and size

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

12.3 Direction Boards

12.3.1 Direction signs and special signs

a) Direction signs and special traffic signs are executed per the drawings from the Design.
b) Direction signs and special traffic signs are manufactured of the materials and in the manner as stipulated by SRPS.Z.C2.300 (Technical Conditions – general conditions for execution and examination/testing).
c) Sign boards of larger sizes shall have adequate reinforcements (stiffener plate).
d) These signs are placed on supports, which consist of a single or several parallel vertical supports, or on special structures.
e) Positioned traffic signs shall be secured from turning and shearing.
f) The traffic signs boards have to fulfill requirements in respect of their resistance to mechanical effects, as stipulated by SRPS and show no sign of destruction or self-separation of fixed parts, after having been exposed to mechanical effects. The quality of materials used for sign manufacturing shall fulfill the same conditions as for standard signs. The manufacturer shall warrantee for sign unchanged quality for at least 5 years.
g) Calculation and payment shall be made per m2 of sign size, mounted and positioned on site, including execution of sign and complete structure, delivery to the spot of sign positioning, excavation of holes for foundations, execution of foundations and placement of supports into foundations, shoulder backfilling, compacting and leveling and subject to the approval of the Engineer.

The price for sign board shall include supply, delivery and transportation to the positioning spot, all fixing elements, supports (structure), as well as erection of board onto anticipated structure. The above stated price shall also include delivery to spot of placement, preliminary works on the terrain and execution of foundations, tool kits for connecting certain elements, board placing and leveling, backfilling of holes, shoulder compacting and leveling, as well as the price of rain seal, and the quality control of used materials provided that the calculation is based on the area of the traffic sign which is mounted onto this type of support. The price of directional sign or special sign shall include: price for the support, all elements to be fixed onto support, as well as delivery of both sign and support, their transportation to the spot of placement, soil treatment and execution of foundation, fixing support for the foundation and fixing the traffic sign onto support as well as quality control per SRPSZ.C2.300.

Other norms that are used for traffic signs:

SRPS.U.C4.201 Latin alphabet of normal width for traffic signs – Form and sizes
SRPS U.C4.203 Cyrillic alphabet of normal width for traffic signs – Form and sizes
SRPS Z.S2.313 Information signs for traffic guidance in the intersection zone
SRPS Z.S2.314 Direction signs and direction boards–Form and sizes
SRPS Z.S2.316 Direction confirmation – Form and sizes
SRPS Z.S2.316/1 Direction confirmation – Form and sizes-Amendments and supplements
SRPS Z.S2.317 Information signs – Intersection - Graphic presentation
SRPS Z.S2.321 Information signs – Name of settlement-Graphic presentation
SRPS Z.S2.330 Paint for traffic signs

All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

12.4 Supports

12.4.1 Pedestal tubular supports

a) Pedestal tubular supports are manufactured of steel drawn pipe of uniform section and thickness, depending on the number and type of signs to be mounted on the support, which is stated in the specifications for the supports.
b) The calculations for supports shall be made in accordance with wind effects in the zone of the road where the sign is mounted.
c) The supports have to be protected against corrosion by artificial resin-based paint or to be plasticized, without painting, in dark-gray shade.
d) Upper side of the support shall be rain-protected, that is closed by plastic cork or welded.
e) All metal parts of the traffic sign supports and support structures for the shown boards and mounting elements shall be zinc-coated under hot procedure with zinc coat 60 microns . The supports shall be protected against corrosion by artificial resins-based paint or plasticized, without painting, in dark gray shade.
f) Single pedestal tubular support shall be secured from turning by means of staves in the foundation.
g) Pedestals are placed into, either prefrabricated or cast in-situ concrete foundations.
h) Foundation sizes shall also be determined taking into account wind effects taking into account the size and the number of signs mounted on the support.
i) Support length (height) shall be determined from the sign position detail in accordance with the sign size and number of signs to be mounted on it, required foundation depth and selected method of fixing signs onto support. Support’s extension or shortening, due to the slope of the terrain, shall be determined by the manufacturer on the site, or by the Design.
j) The price of the support shall include delivery to the spot of mounting, preliminary works on the terrain and execution of foundation, placement of support, as well as the price for the set for connections between support elements.

12.4.2 Braced girders/supports

a) Braced girders are manufactured for traffic signs – direction boards with their overall area exceeding 3m2.
b) Braced girders and special structure supports (portal supports) are designed and executed specially, per sign they have mounted on and per the basic measures provided for by the traffic design. The number of vertical supports and their height are determined by calculation based on sizes of the relevant sign, but also the sign position in the cross section on the given location, per attached drawing, shall be taken into account, as well as the wind effects on the surface of the relevant sign. They are made of seamless steel pipes of constant section, inter-connected by portable elements into the braced structure. The upper side of the support shall be rain protected, that is closed by plastic cork or welded. Larger-size sign boards shall have adequate reinforcements (stiffener plates) that secure compactness of sign area (sign face). The sign is generally fastened to specially executed support by these elements. The manufacturer shall warrantee wind-resistance of overall structure. The calculation for supports shall be also based on the wind effects in the road zone where in the sign is to be erected.
c) Braced girders are placed into concrete foundations concrete class 30, either prefabricated or cast in-situ, and secured by staves, or welded to dug-in steel horizontal slabs (footing). The sizes of foundations and steel footings respectively, as well as the dug depth, shall be determined in accordance with the type of structure and wind effects on the given sign location, taking into account the size and number of signs mounted onto support (generally, in accordance with the sign manufacturer norm). Possible extension of vertical supports and their shortening due to the slope of the terrain, or any other reason, shall be stated by the Contractor on the spot and shall ensure that corresponding change of design documentation has been made by the manufacturer of traffic signs.
d) All structure elements shall be protected against corrosion by machine-applied coat of paint resistant to atmospheric effects in dark gray shade, without additional manual painting, or plasticized also in dark gray shade.

12.4.3 Portal supports

Portal support is specially constructed steel structure frame. Portal support structure shall be separately calculated according to the number and size of boards that are to be mounted on the structure, taking into account the wind effects. Portal support shall be placed on special foundation over anchor footings and sank-in anchor bolts. The foundation shall not sail over shoulder.
Portal supports shall be protected against corrosion by protection coat of artificial resins based paint in dark gray shade or by galvanizing/zinc coating.
The manufacturer shall possess statistic calculation for both portal and foundations, as well as attests for the materials that have been used in execution and placement of portal supports.
All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.
The price for portal supports shall include their delivery and transportation to the spot of placement, preliminary works on the terrain and execution of foundations, execution and building in of anchors with threads, set for connecting individual elements, placing and leveling, backfilling of holes, shoulder compacting and leveling/planning, as well as quality control of used materials. Calculation and payment of portal supports shall be made per piece of built-in structure on site, including sign mounting onto portal supports subject to the approval of the Engineer.

12.5 Road markings

Pavement markings serve to mark the part of pavement designated for traffic from the opposite directions, traffic lanes or parts of pavement reserved for the traffic of certain categories of motor vehicles, pavement edges, marking the spots on pavement reserved for stopping and parking of motor vehicles respectively on the spots where traffic participants have to observe certain orders and bans.

12.5.1 Longitudinal markings – SRPS U.S4.221 through 224

12.5.1.1 Centre line – SRPS U.S4.222

12.5.1.2 Curb marking/edge line – SRPS U.S4.222

12.5.1.3 Guiding lines – SRPS U.S4.223

12.5.2 Road markings across carriageway – SRPS U.S4.226

12.5.2.1 Sprags/stays and stop beads – SRPS U.S4.226

12.5.3 Other markings – SRPS U.S4.229 through 230

12.5.3.1 Arrows – SRPS U.S4.229

12.5.3.2 Fields for traffic direction – SRPS U.S4.230

12.5.4. Application

a) Road marking is performed in accordance with the location plans from the design, detailed drawings from the location plans and special detailed typical drawings.
b) Widths, colors and frequency of breaks are provided for by the drawings in the Design.
c) The price of works on road markings is calculated per m2 of marking executed on the surface and approved by the Engineer. The price shall include measuring on site, cleaning of carriageway and applying.
d) Road markings shall be tick-layered and marked in white paint. Executed road markings shall have retro-reflection of min. 150mcd/lux/m2.
e) The quality of executed road markings on site shall be verified and confirmed on trial section subject to the approval of the Engineer. If it is found out upon completion of works that there is more than 10% of road marking surface with paint layer thickness less than minimal determined of (>2.0mm), the layer shall be re-applied as directed by the Engineer.
f) The warranty period for permanent marking shall be two years.
g) Changing of determined marking forms on carriageway per SRPS norms, like markings' deformations, incorrect execution of marked surfaces or inserting new elements shall not be allowed. Markings which are not in compliance with the determined form shall be permanently removed.
h) The duration of the time period during which the traffic flow over the carriageway with applied markings shall be banned shall not exceed 45 minutes.
i) The edges of lines and figures/forms shall be sharp and even and deviation from the designed line shall not exceed 5 mm. Allowed deviation from the measurements provided for by the design shall not exceed 5%. It shall be necessary to have confirmed on the trial section that the Contractor possesses the equipment, which can without any oscillations in operation apply the constant quantity of paint, reflecting beads and other required additives as to ensure continual application of the same quantity of paint regardless to the machine speed,.
j) The warranty period for these works shall be at least 12 months.

12.6 Traffic equipment

The elements of traffic equipment included hereof are:

12.6.1 Steel guard rail

12.6.1.1 Continual stretches of steel guard rail

SRPS EN 1317-1, 1317-2, 1317-3

12.6.1.2 End elements of steel guard rail:

- Inclined ends 12 m

a) The kind and type of steel guard rail shall be determined by the level of holding in accordance with SRPS-EN 1317-1, 1317-2, and 1317-3.
   Guard rail types:
   - N2 (W4) (on loop terminals)
   - H1 (W5) (on shoulder)
   - H2 (W8) (on the green area)
   - H2 (W4) (on the structure)
b) All guard rail elements as well as necessary elements for rail mounting shall be protected by hot galvanizing with 60 microns thick coat.
c) The guard rail is mounted per location plan from the Design and detailed drawings, all in accordance with SRPS U. S4.110. and subject to the approval of the Engineer.
d) Guard rail end elements shall both volume and length wise correspond to the technical conditions for guard rail mounting provided for by SRPS U.S4.110.
e) Before the guard rail is mounted, the Contractor shall prove guard rail quality by attests presented to the Engineer for approval.
f) The quality of built-in guard rail elements shall correspond to usual quality norms for industrial products. Control tests shall be made at each 1000 m of rail to check the quality of basic materials. The thickness of anti-corrosion layer/coat shall be tested at each 100 m of built-in rail. The elements that fail to correspond to the required quality shall be replaced.

   All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

g) The rail price shall be calculated per linear meter of mounted rail as approved by the Engineer.

h) The price of rail end elements shall be calculated per built-in piece.

Other norms used for steel guard rail are:

SRPS U.S4.100 Guard rails, steel – technical conditions for execution and delivery
SRPS U.S4.108 Guard rails, steel – Form and measures

12.6.2. Reflecting road studs (catadioptres)

a) Road reflecting studs are built-in to the rail duct – catadioptres, which color and spacing is the same as with direction posts. They are installed on site, as to harmonize their frequency with the frequency of direction signs.
b) Catadioptre is of regular shape with galvanized sheet metal body, or with body made of plastic or any other resistant material which on reflecting foils (red, yellow and white) are laid, or of honeycomb structure with each cell having reflecting area.
c) Road reflecting studs – catadioptres are mounted on guard rail, tunnel walls, retaining walls, on the curb sides and other spots where direction posts could not be placed.
d) Catadiopres' features stated in the attest are checked by control tests. Each 1000th sample is checked.

All tests including SRPS Z.S2.235 shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

Measurement

The exact quantity of installed material are determined based on the measurement book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

Payment

The price includes delivery, transport and placing.

Payment is per placed piece as approved by the Engineer.

12.6.3 Guard posts

a) The type and kind of guard posts and their supports are determined by the Designer per SRPS.Z.S2.235.
b) Guard posts shall be two-sided (they have markings on both sides which are visible to drivers) regardless whether placed on one-way or two-way lanes. Guard posts shall not be placed on the stretches with guard rails or retaining-lining walls instead catadioptres are installed. Placement of guard posts in the soil shall be resolved in a manner that facilitates their easy replacement or re-installment, if possible by machine, and the guard post that is placed shall be secured from shearing, turning or pulling out. Guard posts shall be placed in concrete casing, concrete class MB 20, and fixed by crossed steel clips diameter 10 mm. Concrete casings are foundations in the shape of hemmed pyramid 30 cm high, with the side of bottom square of 30 cm, and the side of upper square 20 cm, dug into earth. The shoulder shall be compacted and leveled, after the guard posts have been placed. The guide posts shall allow for mounting of snow rods/boards. Possible deviations in execution from the design shall be separately determined and changes shall be entered into as built drawings subject to the approval of the Engineer.
c) The quality of built-in elements (retro-reflecting material and support) shall correspond to standard quality norms for industrial products, and the manufacturer may refer to corresponding attests and other proofs that verify the quality of anticipated element. Guide post support shall be made neither of concrete or metal pipes.
d) Control checks are made at each 100 pieces of guide posts to check the quality of basic materials (support and retro-reflecting markings) and retro-reflecting markings.
All tests shall be completed to the full satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.
e) The number of built-in guide posts shall be measured as approved by the Engineer. The payment shall be made per piece of built-in guide posts. The guide post price shall include the support and reflecting road studs, the costs of their delivery and transportation to the spot of placement, as well as the price of material and execution of foundations with adequate excavation, placement of guide posts and prism respectively, digging in and leveling of shoulder.

12.6.4. Direction sign

- is made of painted polyethylene;
- resistant to UV rays and weather-sealed;
- in green or blue color, and may be made at request as the case is in the subject Design where the base is yellow;
- With two retro-reflecting foils class II (High Intensity).

Sizes
Type 1000 - Ø 1.0m and x=1.25м
Type 2000 - Ø 2.0m and x=1.70м
May be both of open and closed type.

The subject design uses closed type of direction sign Type 1000 with yellow background as shown on the location plan of the Design.

Measurement

The exact quantity of installed material are determined based on the measurement book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

Payment

The price includes delivery, transport and placing.

Payment is per placed piece as approved by the Engineer.

12.6.5 Plastic rail "NEW JERSEY"

Item description:

Item includes supply and erection of plastic rail " NEW JERSEY", which serves to close the loop legs that are not in function during the first phase of construction.

Technical details:
The rail is made of polyester, size 800x1250x550 mm with an opening for filling and discharging. The colors used are red and white set in turns (red, white). The rails are visible at night because of reflecting strips.

Their location is determined by the Design, and they are filled with water as to disable their easy removal.

Measurement

The exact quantity of installed material are determined based on the measurement book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

Payment

The price includes delivery, transport and placing.

Payment is per placed piece as approved by the Engineer.

12.6.6 Concrete rail "NEW JERSEY"

Item description:
The item includes supply and erection of concrete rail "NEW JERSEY" which has function to physically close the loop legs that are not in function.

Technical details:
The rail is made of concrete of adequate class (per regulations). The designed rail is single sided, 80 cm high, 46 cm wide and the length of an element is 6 m. Concrete "NEW JERSEY" shall have the attests required for this type of rail.

Measurement
The exact quantity of installed material are determined based on the measurement book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

Payment
The price includes delivery, transport and placing.

Payment is per placed piece as approved by the Engineer.

12.6.7 Linear – delineator with vertical barrier

Item description:
The item includes execution, supply and erection of delineators which serve to divide traffic lanes per traveling directions and direct the traffic and under special circumstances simultaneously facilitating that vehicles ride over them.

Delineators are placed with catadiopres and vertical barriers.

Technical details:
They consist of three segments: Central segments (directional) which connect and tie one another, while at the beginning and at the end end segments are placed (male and female). Catadioptres made of retro-reflecting material are installed on segments. Delineators are made of high density polypropylene (HDPP).

Delineators are yellow. The sizes of central segment are 988x242x80. Delineators have vertical directional barriers at the distance of three meters. Vertical barriers are double-sided in red and white color, size 155x680.

Execution and erection:

Linear - delineator is placed per location plan and detailed drawings from the Design.

Quality control:

The Contractor shall prove delineator quality, prior to its placing, by attest, which is to be presented to the Engineer for approval.

Measurement
The exact quantity of installed material are determined based on the measurement book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

Payment
The price includes delivery, transport and placing.

Payment is per placed piece as approved by the Engineer.

12.6.8 Protective Wire Fence

a) Protective wire fence shall be placed in conformity with layout plans of Design along the right-of-way limits, completely as required by SRPS U.S4.102/106/112),
b) Type, shape and measures of the protective wire fence shall meet technical specifications of SRPS U.S4.112.
c) Protective wire fence elements shall meet technical requirements of SRPS U.S4.106.
d) Protective wire fence shall be protected against corrosion as required by SRPS U.S4.102. Manufacturer shall guarantee unchanged quality of the wire fence for the period of 20 years (for aluminum fence) or 10 years for the wire fence of galvanized wire,
e) Contractor shall proof fence quality by test that shall be delivered to Employer before placing.
f) Fence price shall be given by linear meter, where the price shall include supply to location, ground preparation and footings construction, placing, extending and set for connections between elements.''

Section 13
Bridges

Contents

13.1. General

13.1.1. Description

This Section contains the Technical Specifications of works for the following structures:

- Underpasses
- Overpasses
- Bridges
- Viaducts

Because of the scope and significance of concrete works in bridge construction, this work is specified in Section 8.10. STRUCTURAL CONCRETE. For the construction of these structures, the Contractor shall use the final designs provided by the Investor. Solutions (final designs) offered by the Contractor as his suggestion shall be considered as alternative solutions and are subject to the requirements from this Section of the Technical Specifications.

13.1.2. Legislation

Final designs provided by the Investor are aligned with all applicable regulations of the Republic of Serbia. Alternative solutions - final designs - offered by the Contractor, shall also be developed in compliance with applicable legislation of the Republic of Serbia. If legislation of the Republic of Serbia is unavailable for any area, or incomplete in covering any elements, relevant DIN or SIA regulations shall be applied, in conformity with the situation foreseen by the Investor in the preliminary or final designs and subject to the approval of the Investor and the Designer as confirmed by the Engineer.

13.1.3. Quality of Materials and Products

The quality of materials and products shall fully comply with requirements from this Section of Technical Specifications, and if such requirements for certain items of works are not defined specifically, provisions from other Sections of the Technical Specifications shall be applied, if the design covers such works, or otherwise as directed by the Engineer.

13.1.4. Preparation of Design

If the Contractor elaborates Final Designs as alternative solutions, or elaborates Final Designs of related structures that need to be constructed, the Contractor shall elaborate them in compliance with applicable technical regulations, pursuant to Sub-Section 13.1.2. LEGISLATION, to ensure the Investor's approval and a building permit for them. In such case, the Contractor shall undertake all Designer's and Contractor's obligations. Every design shall contain:

- All necessary detailed plans
- Structural analysis
- Structural details
- Priced Bills of Quantities
- Description of Works in line with these technical specifications.

The Priced Bill of Quantities shall include works by their type, i.e.:

a) Preliminary works
b) Earth works
c) Timber structures
d) Stone works
e) Concrete works
f) Metal works
g) Finishing and other works
h) Works not covered in the technical specifications for bridges in this section.

In case of any amendments to a design, both those provided by the Investor, and any adopted alternative designs of the Contractor, their adoption shall be decided upon by a commission that shall, mandatorily, be composed of the Designer, Engineer, and Contractor or their representatives. All amendments shall be noted in the Measurement Book and Building Journal in order to be taken into consideration for measurement and payment.

13.2. Earth Works

13.2.1. Excavation for Foundations – General Provisions

Scope and Contents of Works

The works under this item include the excavation of earth/rock material from the ground level to the base of foundation pits, or sub-base or leveling courses, as given in the design, where the edges of a foundation pit are considered to be the edges of foundations on the base plan according to the design. Transport to a dump site or fill (if material is suitable for that) shall be considered a constituent part of the works under this item. The Bill of Quantities shall make distinction by the depth of excavation, namely: 0-2 m, 2-4 m, 4-6 m, 6-8 m, and so on. The Bill of Quantities shall also distinguish by the category of soil, namely:

- Categories III and IV, as one category, and
- Categories V and VI, as another category.

For excavations within sheet pile walls, cofferdams, and caissons, Category II is defined separately when there are conditions for that. For carrying out excavations, the technology indicated in the design shall be applied, which implies a connection between the excavation and the designed foundation structure, and thus the items of excavation works shall be distinguished in the way specified in these Technical Specifications.

Measurement

For the work executed under a certain item of works and above-mentioned provisions, the Contractor shall be paid at the agreed unit price for the number of m^3 of excavated original soil, measured from the mean ground level in the area of the foundation base and/or element and subject to the approval of the Engineer. Over-excavated parts by the Contractor's mistake, and caved in parts from the sides of excavation pits shall not be paid. If the Contractor, by his own fault, excavates foundations deeper than the designed level, he shall fill in the space between the excavation base level and the designed level with material specified by the Engineer. For special items of excavation works, appropriate extra requirements are specified.

Payment

For the quantity of excavated material, determined in the above-described manner, the Contractor shall be paid at the agreed unit price that makes a full compensation for all excavation works, including material and works on the protection and strutting of the foundation pit, water pumping, and haulage of excavated material to a dump site, or to the road embankment, if the excavated material is assessed to be useable for that purpose by the Engineer. For special items of excavation works, appropriate extra requirements are specified.

13.2.2. Excavation of Foundations Out of the Zone of Perennial or Deep Surface Waters

Scope and Contents of Works

The work under this item refers to the excavation of foundations in those cases when the excavation may be executed in an open pit without using sheet piles, cofferdams, open, box or other caissons. Strutting shall be used to protect the sides of a foundation pit.

Execution of Works

Before the commencement of excavations, the Contractor shall mark and protect the marks of the foundation pit edges in one of the typical ways. The marked foundation pit edges shall be subject to approval by the Engineer, after which the excavation works may start. Depending on the depth of excavation, according to the design and the type of material in which the excavation works are to be done, the Contractor shall select an appropriate way to shore and strut the foundation pit. The excavation works under this item shall also be executed in perennial streams provided that the water depth and influx are not such to require another method of work, i.e. provided that it is possible to make on the surface an adequate provisional protection against the penetration of surface water into the foundation pit. During excavation, water shall be drained with an adequate number of pumps of necessary capacity, as determined by the Contractor based on the influx of water and geological composition of ground. Parallel with the progress of excavation, the shoring and strutting of the foundation pit shall be strengthened. Appropriate machines and tools, including pneumatic hammers, shall be used for excavation. The decision on any blasting of rock mass shall be made before the commencement of excavation based on the types and composition of rock masses as identified in a geotechnical test pit. In case of blasting, it is necessary to prepare the design of blasting operations and protection of foundation pit and surrounding structures and already executed works, which is subject to the Engineer's approval based on the opinion of the designing company. After reaching the designed level, the foundation pit base shall be leveled to be in full compliance with the designed condition. If this is impossible, the excavation shall be somewhat deeper (by 10–30 cm) at critical points, and the obtained extra space down to the foundation base level shall be filled with MB15 concrete. If water is present, concrete shall be cast under water, applying the tremie concreting procedure. If this leveling layer of concrete is not specified in the design, an unlevelled foundation pit base shall not be levelled in this way. The excavation shall be performed so that the highest spot on the pit base is in line with the designed foundation base level, and any extra space will be filled with concrete during the concreting of footings. If a footing is reinforced in its lower part, a levelling course shall be constructed as described above. A levelling course or concrete footings shall be paid extra to the Contractor, as well as the excavation to the actual depth, all this if the foundation pit is deepened below the designed foundation level without the Contractor's fault. During the excavation it is necessary to monitor the change in soil strata, comparing them with the geological profile. In case of any variation from the geological profile given in the design documents, it s necessary to warn the Designer and ask for his opinion on further steps. In case of spatial and technical possibilities, and subject to the Engineer's approval, the Contractor may excavate the foundation pit by omitting shoring and strutting, while applying machines of higher capacity for "sloped" excavation. In that case, the excavation for the lowest parts of strip, multi-angular, or round footings shall be done within the base dimensions, according to the above-given description, and the total scope of digging accepted to the Contractor shall not include over-excavated parts, as stressed above.

Measurement

According to provisions of Sub-Section 13.2.1.

Payment

According to provisions of Sub-Section 13.2.1.

13.2.3. Excavation of Trenches and Channels Less than 1.5 m Wide and Less than 2.0 m Deep

Scope and Contents of Works

The works under this item consist of the excavation of narrow and relatively shallow trenches and channels, such as the excavation for foundations of end slopes, including the provision of all plants, equipment, and labour, and carrying out all operations related to excavation, any water pumping, protection of the foundation pit from caving in, and haulage to a stockpile.

Execution of Works

The parts of end slopes that are to be lined shall be founded as specified in the design, i.e. trenches shall be excavated there for any other purpose related to the bridge structure. Trenching is foreseen to be done with a trencher, or manually if the ground conditions do not allow the use of machines, which shall be identified by the Contractor based on the perusal of design documents. The Contractor shall identify the need for full or partial strutting of foundation pits. Excavated material shall be hauled to a stockpile.

Measurement

The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^3 of excavated material measured on site and approved by the Engineer.

Payment

For the amount determined in the way described above, the Contractor shall be paid at the agreed unit price that makes the full compensation for all work and material, according to the scope of works under this item, including any strutting and water pumping.

13.2.4. Backfilling of Foundations of Piers/Abutments

Scope and Content of Works

Work under this item includes the backfilling of excavated material into the space left after the excavation and foundation and next to the parts of piers/abutments located in the ground.

Execution of Works

Material from excavation shall be hauled from the stockpile to which it was stored and backfilled into the space above and next to foundations and parts of piers/abutments located in the ground. If needed, material from borrow pits shall be used as well. The material shall be placed in layers, about 30 cm thick, and tamped. The degree of compaction shall be adjusted in such a way that after completed works on backfilling of foundations no subsequent settlement shall occur. In case of foundations constructed under the protection of open or box caissons, the space above them shall be backfilled, too. Where the presence of water makes compaction difficult, such material (rock, gravel) shall be selected that will set down optimally under its own weight and due to the ratios between sizes and shapes, subject to the approval of the Engineer. The finishing layer of compacted material shall be levelled and adjusted to the surrounding terrain. To allow for the possibility of immediate short term settlement, it may be necessary to leave the backfill about 5-10 cm higher, subject to the approval of the Engineer.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^3 of incorporated material as approved by the Engineer.

Payment
For the quantity determined in the way described above, the Contractor shall be paid at the agreed unit price that makes the full compensation for all equipment, material, loading, transport, backfilling, and compaction of earth material. If borrow pits are used, the excavation from borrow pits shall be paid extra.

13.2.5 Construction of Gravel Wedge
Scope and Content of Works
Gravel wedges shall be constructed on the rear side of bridge abutments, between wing walls, under transition slabs, in order to eliminate or reduce, to an acceptable degree, the deformations of the deck at the contact with the structure, resulting from settlements during the consolidation of subsoil and embankments. Wedges shall be constructed at the same time as approach embankments, after abutments have been constructed. There are two possible cases:

- The spanning structure is constructed. In this case there are no limitations regarding the construction of wedges.
- The spanning structure is not constructed. It is necessary to determine, in consultations with the Engineer and by perusing documents, whether abutments are calculated for such load phase.

Execution of Works
Soil embankments shall be finished at the contact with abutments, according to details from the design, and the construction of wedges shall be started afterwards. In the direction of the road (bridge) centre line, the cross section through a wedge is trapezoidal, and the trapezoid side at the end of transition slab, toward the embankment, shall be at least 50 cm high, unless a greater height is specified in the design. Material used for wedges, by its properties and granulometric composition, shall meet the requirements for sub-base courses, i.e. sub-base layers in flexible pavements. Material shall be spread in layers, up to 50 cm thick, and tamped with suitable mechanical devices until the required degree of compaction is achieved. The compaction of every layer is controlled applying a procedure specified for sub-base courses. The following degrees of compaction are required:

- Top layer : 70 MPa;
- Each next layer downward: reduced by 10 MPa.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^3 of constructed gravel wedges in compliance with the description above, and as approved by the Engineer.

Payment
For the quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all equipment, material, and production, transport, placement and compaction of wedges made of gravel-sand material.

13.3 Timber Constructions

13.3.1. Scaffolds and Formwork
Scope and Content of Works
Work under this Sub-Section of the Technical Specifications includes the provision of all plants, equipment, materials, and labour, and execution of all operations related to fabrication, necessary foundations, erection, and removal of scaffolds and formwork needed for the execution of concrete works, and for other auxiliary works on concrete constructions in conformity with the Conditions of Contract, and in full compliance with this Sub-Section of the Technical Specifications, drawings, and Engineer's instructions.

Technical Regulations

PBAB 87	"Rules on technical norms for plain and reinforced concrete" (Off. Journal of SFRY, No. 11/87)
PPB	"Rules on technical measures and specifications for pre-stressed concrete" (Off. Journal of SFRY, No. 51/71)
SRPS U.C9.400	Timber scaffolds and formwork. Technical Specifications (1984)

Scaffolds and formwork made of different materials (steel and timber, concrete and timber, etc.) shall be designed and erected according to the provisions of SRPS U.C9.400, and applicable regulations for the areas of applied materials and constructions.

Scaffolds and Formwork Plans
Based on data and specifications from the structural design, and on data on foundations of the structure, and in view of traffic requirements and the surveyed condition, the Contractor shall prepare necessary documents for scaffolds and their supports, and for special formwork he intends to use. The documents, prepared according to provisions of relevant standards, shall be submitted to the Engineer for approval, but the Engineer's approval shall not relieve the Contractor from any inappropriate, yet adopted, solutions. When scaffolds are erected for parts of constructions above roads in a regular traffic regime, frames shall be erected above the road, on both sides, at appropriate distance from the scaffolds, to provide for the headway. The frames shall be constructed with the headway somewhat smaller than the one under the scaffolds. All traffic control signs and protections shall be put in place by the Contractor, at his own expense, in accordance with requirements of a competent authority, whom the Contractor shall also ask for approval for traffic regime changes.

Erection of Scaffolds and Formwork
Scaffolds and formwork shall be designed and erected in such a way that they can withstand loads and impacts that occur during the works without harmful settlements and deformations, and ensure the accuracy specified in the design.

Scaffolds

Scaffolds shall be erected in such a way to ensure designed gradients of constructions shown on drawing, taking care of any necessary superelevation given in the design, or required by the Engineer, contractions, deflections of spanning elements of the scaffolds, squeezed material, and sinking of scaffolding trestles. The sinking of scaffolds shall be monitored and measured during concreting. It is necessary to take measures to ensure the correction of any unexpected settlements. Concreting may start upon the Engineer's approval, but only after the acceptance of scaffolding structures by a commission, specifically established by the Contractor, in charge of checking dimensions of erected elements, quality of workmanship, and implemented safety-at-work measures.

Formwork

Formwork for concrete elements or parts of the structure shall ensure that the shape and dimensions of elements given on drawings are kept within the limits of allowed tolerances. Formwork shall be erected of materials and in a way depending on requirements set out in the design, Serbian standards, and provisions of these Technical Specifications. The formwork construction shall be such that formwork may be removed without damaging concrete once concrete hardens. All supports and beams used to support formwork shall be particularly rigid, and their constructions shall be specified based on deflections values that shall not exceed 1/1000 of the span under full load. Formwork shall be as watertight as possible, and shall be moistened thoroughly on both sides before concreting. Only agents that do neither cause any change in the appearance and color of concrete, nor act aggressively on fresh or hardened concrete and reinforcing steel may be used to coat formwork and moulds. Unless otherwise specified in the design, corner fillets, triangular cross-section, 2 cm long legs, shall be placed along corner sides of formwork, to protect the edges of concrete elements against damage during the removal of formwork. Wires used to tie up formwork shall be inserted through plastic tubes, and their arrangement on visible surfaces shall be regular.

- Formwork for Foundations and Inner Surfaces:

For formwork for foundations, cushions, inner surfaces of concrete elements and the parts of constructions that are in contact with the ground, there shall be no special requirements regarding the selection of formwork type, and/or material, except for compliance with minimum requirements set out in these Technical Specifications.

- Formwork for Visible Surfaces:

Formwork for outer, visible surfaces of concrete elements: central piers and abutments, bearing beams and caps, spanning structures, and parts of structures, unless specifically indicated on drawings, shall be smooth with discreet joints.

- Metal formwork:

Formwork requirements: for construction, evenness, stiffening, direction, angle finish, removal, reuse, lubrication, and cleaning, they shall also apply for metal formwork, i.e. moulds. Metal used for formwork shall be of such thickness that formworks retain their shape. Connectors and other connecting accessories shall be designed so as to connect formwork firmly, and to ensure its removal without damaging concrete. Special attention shall be paid to protect metal formwork against rust, grease, or other external substances that could change the color of concrete.

- Cleaning the inside of formwork:

Where the base of formwork is inaccessible from the inside, the base panels of formwork shall be left free, so as to be removable for cleaning any undesired material immediately before placing concrete.

- Acceptance of formwork:

Before the commencement of concreting every element, based on a previously performed geodetic control survey and geometric control of the element to be concreted, the Engineer shall inspect, and note in a protocol, whether the erected formwork is satisfactory regarding:

- Horizontal position of elements and their vertical levels,
- Dimensions of elements as given in the design
- Fixing and tying up of formwork
- Cleanliness of formwork.

Removal of Scaffolds and Formwork

Scaffolding under the span structures, as well as parts of the structures, may be removed only after concrete class specified by the Design is achieved, not earlier than 28 days from the day of concreting. The exact time of release and removal of scaffolding shall be determined by the Engineer, and it will depend on concrete curing and average temperature on the Site, as well as on the results of test cubes taken during concreting and cured under the same conditions as the structure in the place where they were taken.

A precise number of days and permission for the release of scaffolds shall be defined by the Engineer, which will depend on the curing of concrete, the average temperature on the site after the placement of concrete, and on the results of tests performed on test cubes taken during concreting and cured under the same conditions as the structure at the place of extraction. For pre-stressed structures, notes given on drawings shall apply. Scaffolds under all spans shall be completely released, before parapets, railings, and road surfacing are placed. Formwork of concrete elements shall be removed in phases, without shocks and impacts, when concrete is of sufficient hardness. Unless otherwise specified in the structural design, the provisions of Art. 246 PBAB shall be applicable during the removal of formwork. All formwork shall be removed, whether above or under ground or water level. The inner formworks of hollow piers, girders, and other elements shall be removed if made of material susceptible to decay, or if they could have a harmful impact on the structure in any way.

Payment

The works covered in this Sub-Section of the Technical Specifications in the described scope shall be included in the price offered in the Priced Bill of Quantities for different items for payment that refer to concrete works. No extra compensation shall be paid.

13.4. Concrete Works

13.4.1. Plain Concrete

13.4.1.1. Concreting of Foundations of End Slopes – Foundations of Lining of Straight and Rounded Soil Surfaces

Scope and Content of Works
This item includes the construction of parts of foundations with plain concrete. The grade and class of concrete shall be specified in the Design.

Concrete Requirements
The requirements to be met for concrete for foundations are given in Section 8. CONCRETE and Sub-Section 8.10. STRUCTURAL CONCRETE in these Technical Specifications.

Execution of Works
Concreting may start after the excavation and preparation of foundation pits. The method of production, transport, and placement is set out in Section 8. CONCRETE. Concrete shall be placed in layers, 20-30 cm thick, and compacted. Before the commencement of concreting, the Contractor shall present the equipment for placement and compaction of concrete to the Engineer, and try it out in the Engineer's presence. The Contractor shall have at least one back-up vibrator for compaction of concrete at his disposal. The diameter of "needle" and frequency of the vibrator shall be adjusted to the thickness of compacted layer and W/C ratio of fresh concrete mass. The height to which foundations will be concreted with plain concrete shall be marked in advance on the struts of foundation pit. Concrete shall be cured in compliance with Section 8. CONCRETE of these Technical Specifications.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^3 of concrete cast into foundations in full compliance with the Specification given above, and as approved by the Engineer.

Payment
For the quantity determined in the described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all used equipment, material, and work on the production, transport, placement, and curing of concrete in foundations.

13.4.1.2. Lining of End Slopes – Lining of Straight and Rounded Soil Surfaces

Scope and Contents of Works
The work under this item includes the lining of end slopes or of 'let-through' embankments, which means provision of the plant, equipment, materials, and labour, to carry out all operations needed for the production, preparation of surface, and placement of a gravel layer on which the lining is placed.

Material
Concrete slabs of designed size shall be used for lining.

Concrete grade and class for precast concrete or "B-T" slabs will be specified in the design documents, while everything else shall be subject to provisions in Sub-Section 8.10. STRUCTURAL CONCRETE.

Execution of Works
The lining thickness and type will be specified in the design documents. The face to be lined shall have designed shape and slope. The space to be filled with lining shall be left earlier, at the time of backfilling. The surface shall be well compacted and even. The compaction degree shall equal 95% in standard Proctor's test and if the fill is made of uncohesive materials, the modulus of compressibility shall be MS=25-30 MPa. First a gravel bed, 10 cm thick, shall be spread over earlier prepared subsoil. Gravel shall be clean without organic matter and comply with the technical specifications for sub-base course.

Then concrete slabs shall be placed on top of the bed provided always that this building operation shall start at the end slope footing. Slabs shall be aligned with joints of minimum width except the "B-T" slabs on less inclined slopes and on slopes on which grass will be sown. Joints between concrete slabs shall be filled with 1:3 cement mortar mix. They shall first be wetted and the placed mortar mix shall also be intensely wetted and protected from moisture loss during setting.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^2 of completely finished lining based on measurement approved by the Engineer on the site.

Payment
For the quantity determined as described above, the Contractor shall be paid at the agreed unit price that makes a full compensation for all used equipment, incorporated material, and all work on the fabrication, transport, and placement of the lining elements, including the bed and joints.

13.4.2. Piles and Sheet Piling

13.4.2.1. Large Diameter Concrete Piles Cast in Situ

Scope and Contents of Works
The works covered in this Sub-Section of the Technical Specifications include the procurement of all materials, plants, equipment, and labour, and in the execution of all operations related to the construction of concrete piles of a large diameter, in dry or in water, in conformity with the Conditions of Contract and in full compliance with this Sub-Section of the Technical Specifications and pertaining drawings.

Pile Construction Method
The Design foresees concrete piles, 900 - 1500 mm in diameter, just as indicated on respective drawings, which are to be constructed in soil, including digging through casings in full height. The diameters of piles are defined with the outer diameter of casing, and any enlargement of piles during the placement of concrete shall not be taken into consideration for the measurement or

increase of allowed bearing capacity of piles. The Contractor shall provide complete details on the pile driving system he intends to apply, including the specification of materials and pile construction method. Considering the importance of the construction of larger diameter piles, an engineer specialized for this work, appointed by the Contractor, shall be present on the site throughout the execution of these operations. If the Contractor wishes to construct piles the diameter of which is different than the diameter shown on drawings, he shall submit detailed plans and calculations for approval by the Designer and the Engineer. If the approval is issued for the construction and use of piles of a diameter that requires the extension of foundations, the costs of such extensions shall be borne only by the Contractor.

Equipment

Equipment that the Contractor wishes to use shall be in full compliance with the adopted pile construction system. It shall provide the best possible guarantee for precision in the construction of piles, with a minimum disturbance of adjacent soil, as well as continuity of piles and quality of concrete. The casing for work shall be completely straight. Any extension shall be welded to be watertight.

Materials

Concrete, cement, aggregate, water, and admixtures shall be in conformity with Sub-Section 8. CONCRETE of these Technical Specifications and with notes given in the Design. The content of cement shall not be less than 400 kg/m^3 of concrete, when concreting under water. The consistency shall be such that concrete runs uniformly out of the tremie, and the end of it shall be under the concrete surface at all times.

Reinforcing steel shall be in compliance with Sub-Section 13.5.1. of these Technical Specifications and with notes and details given in the Design. A reinforcing cage is lowered in a proper position before concreting. The specified protective concrete cover for reinforcing steel shall be ensured. It is also necessary to prepare several additional bars, which project sufficiently above the water level from within the casing, in order to easily monitor the reinforcing cage during concreting.

Excavation

During the excavation and driving of the casing, it is forbidden to disturb the adjacent soil or to cause a hydraulic caving in of soil at the base of borehole. The casing shall be filled with water at all times, to the level higher than the level of ground or water on the outside, if so required by the geotechnical conditions. When digging with a clamshell bucket, it is necessary to ensure that the digging does not cause a suction effect on the bottom side, when the clamshell bucket goes up. It is not allowed to lower the casing with the assistance of water jet. The base of casing shall always be lower than the base of borehole. The base of finished boreholes shall be clean and with a horizontal surface. After cleaning the base of borehole, the Contractor shall perform at least two standard penetration tests in each borehole. The testing equipment and method shall be subject to approval by the Engineer, and the test shall be performed in his presence. If piles are constructed for retaining structures, the test is not necessary. Based on the results of standard penetration tests, the Engineer shall accept the borehole or decide that it shall be lowered to a greater depth, if needed. In the latter case, the cleaning and testing shall be repeated for the new depth of base. When the Engineer agrees that the base of borehole is at the level where the bearing capacity of soil is sufficient, and that the cleaning was performed properly, he shall accept the borehole with a written note. This approval shall not relieve the Contractor from any of his responsibilities.

Concreting

Concreting shall start as soon as possible after the acceptance of excavations and assembly of reinforcing cages. If concreting fails to start within four hours from the cleaning of the borehole base, the cleaning shall be repeated. Piles shall be concreted without any construction joints. Concreting under water shall be performed applying the tremie concreting method, in full compliance with Sub-Section 8.10.4.5. of these Technical Specifications. The level of water within the casing shall be maintained at a constant height, sufficiently above the level of ground and water outside the casing. During concreting, the casing shall be retrieved slowly, without lifting the reinforcement. The surface of concrete within the casing shall be kept at all times at a sufficient height above the casing base, so as not to reduce the diameter of pile or cause the penetration of water. When determining at what distance the concrete surface shall be kept above the casing base, it is necessary to take care that the quantity of concrete below the casing base is larger than that within the casing.

Only the Contractor shall be responsible for concreting, until the surface of placed concrete is high enough above a theoretical point of stopping, as indicated on drawings, in order to ensure that all concrete below the stopping level shall reach a specified quality. Once the foundation pit is excavated, and the concrete sub-base constructed, piles shall be finished up to the theoretical stopping level. Reinforcing bars shall not be damaged. In case of broken, fractured, or irregularly positioned piles, additional piles shall be installed at the Contractor’s expense, and the Contractor shall also bear expenses for special constructions needed for the new situation. Before the construction of piles starts, the Contractor shall ensure to have on the site both the equipment and qualified personnel for pile boring in full length. The boring of cores will be necessary when concrete or irregularities that appear during the works indicate that the quality of piles varies from the specified standard. The Engineer shall decide whether and when the core boring shall be performed, and the testing of cores shall be carried out in compliance with the Engineer’s instructions. The Engineer shall approve each pile in writing. Such continuation of works, on any foundation, shall no start until all piles are approved on preliminary foundations.

Tolerances

During boring, the Contractor shall check the position and incline of piles and submit the records for the approval of the Engineer. The position of pile head shall not exceed 5% of the pile diameter, and not more than 5 cm comparing to drawings. The pile incline shall not exceed 1% in the length under the ground surface.

Work Log

During the construction of piles, for every borehole the following shall be noted in the protocol: the type of soil for every stratum, observations related to the occurrence or loss of water in the borehole, and obstacles found. The Contractor shall keep and safeguard complete records on the construction of every pile, and submit them to the Engineer for approval. These records shall be handed over to the Investor at the technical acceptance of the structure. These records should show: the starting and end times for works on the pile, the base level of pipe, the level of reinforcement, and water table, if water is present, the start and end of concreting, the quantity of placed concrete, and during the extraction of pipe – the height of concrete within the pipe before and after every lifting step.

Trial Loading of Piles

Trial loading shall be performed in compliance with the "Rules on technical norms for the design and execution of works on the foundation of civil structures", "Off. Journal of SFRY" No. 34/74 and the Engineer’s instructions, on every pile specifically prepared for trial loading. A trial pile shall be constructed in the completely same way as piles for respective structures, in the place specified by the Contractor and approved by the Engineer. Equipment shall ensure 900 t load for piles of diameter 1200 mm, and 1300 t load for piles of diameter 1500 mm, unless otherwise specified by the Engineer. The Contractor shall perform trial boring in the immediate vicinity of the trial pile, and the properties of soil shall be determined in the laboratory. The trial load testing procedure and testing programme shall be prepared by the Contractor and submitted for approval by the Engineer, with the testing programme covering the data on load with respect to time, i.e. offer data on long-term behaviour and necessary measures.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^1 of constructed piles, depending on the pile diameter, and as approved by the Engineer. Any extra concrete at the pile base, increase in the diameter of pile, or extra concrete in the pile head shall not be measured and will be considered as included in the item of pile concreting works according to the Priced Bill of Quantities.

Payment
For the quantity determined in the described way, the Contractor shall be paid at the agreed unit price that will make a full compensation for the procurement of all materials, plants, equipment, and labour needed for the execution of all operations in dry or in water regarding the construction of concrete piles according to the provisions of this Sub-Section of the Technical Specifications. Testing of piles for their load-bearing capacity shall be paid on a lump sum basis, in accordance with the appropriate BoQ item, and that payment shall make a full compensation for all equipment, materials, labour, and all other auxiliary operations.

13.4.3. Reinforced Concrete Constructions

13.4.3.1. Pad Foundations, Ground Beams, Foundation Plates, Cushions, and Pile Caps
Scope and Content of Works
The work under this item consists of the construction of reinforced-concrete foundations, or their parts, with or without formwork, if specified so in the Design.

Concrete Requirements
Requirements that concrete shall meet are given in Section 8. CONCRETE and Sub-Section 8.10. STRUCTURAL CONCRETE of these Technical Specifications.

After finishing the works that precede the construction of foundation parts according to this item in the Technical Specifications, formwork and reinforcement shall be assembled according to the Design.

Formwork
Formwork shall meet the requirements from Sub-Section 13.3.1. SCAFFOLDS AND FORMWORK, and provisions of this Sub-Section. Formwork for all structural elements shall be assembled in entirety or partially after or during the assembling of reinforcement. Formwork is usually prepared in segments (plates, fields) of smaller or larger length (surface area), and thus assembled in the foundation pit. The Contractor may prepare formwork in the pit itself. When placing formwork it is necessary to perform marking – aligning, so that, after the removal of formwork, the constructed part of foundation is in full compliance with the design regarding the position, shape, horizontal and vertical dimensions, and height levels of the top surface. If protective and release agents are used, they shall be applied to the formwork before placing reinforcement, in order to avoid any contamination of reinforcement with such agents, and formwork may be assembled only when it absorbed completely the applied chemical agent. It is necessary to leave openings for the pre-concreting removal of waste from the space enclosed with formwork at suitable places in the base of formwork.

Formwork shall be sealed well, to minimize any leakage of concrete or cement slurry. Formwork shall be fixed, in order to avoid its displacement, disintegration, deformation, or break of connections. Before the commencement of concreting, formwork shall be wet down, regardless whether it is pre-treated with release agents or not. The class – grade of formwork may be lower regarding the evenness of concrete surface to be obtained after the removal of formwork, but not regarding its rigidity, strength, and ability to withstand the pressure of fresh concrete mass and impact of vibrations during the placement of concrete without any deformations.

Reinforcing steel
Reinforcing steel shall meet the requirements from Sub-Section 13.5.1. REINFORCING STEEL of these Technical Specifications, and this Sub-Section. The shape and dimensions of bars shall be in conformity with the Design, which shall be submitted for approval by the Engineer at the time of inspection for acceptance of reinforcing steel.

If the lengths of prepared reinforcing steel are in conformity with the Design, but the dimensions of formwork do not allow the placement with a proper protective cover, whereas the formwork, too, is in conformity with the Design, the Engineer shall instruct the extension of formwork in order to enable the application of specified protective covers. In that case, any extra costs of work and consumed materials, including concrete, shall be accepted to the Contractor according to the actual expenses and at agreed unit prices. However, if the lengths of reinforcing steel are not in conformity with the Design (and bars are longer than necessary), or formwork is of smaller dimensions than specified in the Design, required protective covers will be ensured as in the previous case, but at the Contractor's expense. The option with an insufficient protective concrete cover is not allowed. To avoid any above-mentioned inconveniences that would lead to the dismantling of formwork, the Engineer shall instruct a trial assembly of the typical reinforcing elements, and carefully measure lengths, heights, and shapes of bars before setting up formwork. Firmly tied reinforcing steel in a designed cage shall be checked by the Engineer. To avoid any subsequent strengthening of ties at the contact between bars, the Engineer shall timely check the steel fixers' method of work and instruct the elimination of defects, if needed. Designed protective covers shall be achieved by inserting plastic spacers (clips) or previously prepared concrete spacers. Pieces of reinforcing steel or wood, or aggregate grains, may not be used for this purpose and their use is strictly forbidden.

Concreting
Before the commencement of concreting of the void within formwork, formwork shall be cleaned from all scrap pieces of wood, wire, steel, or any other foreign objects, using water under pressure and compressed air. These pieces of waste shall be evacuated through openings left in formwork, and the openings shall be sealed after that. Before the concreting starts, it is necessary to check, by geodetic surveying, the position of anchor bolts in piers/abutments, which project out of foundation elements that are subject to this item of works, and to secure them against movement during concreting. The method of production, transport, and placement of concrete is specified in Section 8.CONCRETE of these Technical Specifications.

The measures to prevent segregation shall be taken during the placement of concrete. It is necessary to mark the height to which concreting will be performed on formwork. The definite level of concrete shall be in compliance with the designed level. Tolerances up to 1 cm are allowed, and they shall be made up on the pier/abutment. The removal of formwork shall be in accordance with Section 8. CONCRETE of these Technical Specifications and 1987 PBAB ("Off. Journal of SFRY" No. 11/87).

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^3 of concrete according to the design, except in cases when the quantity is increased to make a protective cover of specified thickness, or due to an error in the design, in which cases the actual quantity shall be paid as determined and approved by the Engineer.

Payment
For the quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all equipment, formwork, concrete, and work on the production, transport, placement, and curing of concrete, including the removal of formwork. For any extra quantities due to an error in the Design, the Contractor shall be paid according to the actual expenses for:

- Formwork
- Any work on dismantling scaffolds or formwork, and re-assembling, at the agreed unit price,
- Concrete, as specified in the paragraph above,
- Reinforcing steel shall be paid extra.

13.4.3.2. Piers/Abutments as Supports for Various Types of Straight Spanning Structures and Supports for an Arched Structure
Scope and Contents of Works
The work under this item includes the construction of reinforced concrete piers/abutments together with such members as wing walls, parapets, cantilevers for transition slabs, covers, and bearing beams of abutments, pile caps with cantilevers on central piers. These members will be grouped in the Bill of Quantities as follows:

- Bodies of abutments
- Face walls
- Counterfort walls
- Wing walls at abutments
- Bearing beams
- Parapets
- Cantilevers
- Transition slabs
- Face covers on abutments and central piers
- Bodies of central piers of designed cross section ;
- Pile caps on central piers as designed.

The members will be distinguished by concrete grade and class indicated in the Bill of Quantities.

Concrete Requirements
The requirements to be met by concrete are given in Section 8. CONCRETE and Sub-Section 8.10. STRUCTURAL CONCRETE of these Technical Specifications and design documents.

Scaffolds and Formwork
Depending on the element of pier/abutment in question, there are different requirements regarding formwork, scaffolds, and dimensions of elements. Furthermore, the work technologies to be applied differ as well, particularly when speaking of vertical elements.

Scaffolds
Scaffolds and formwork shall meet the requirements set out in Sub-Section 13.3.1. SCAFFOLDS AND FORMWORK, and provision of this Sub-Section. Two types of scaffolds are distinguished: fixed and mobile. Fixed scaffolds are those that do not move after erection until the concrete hardening process has finished, i.e. until the time when they are allowed to be removed. Mobile scaffolds are related to the concept of sliding formwork. In both cases, scaffolds design for piers/abutments shall be prepared by the Contractor, unless the Design provides a solution for scaffolds. If the Contractor is to prepare the scaffolds design, it shall be submitted for approval by the Designer and the Engineer.

a) Fixed scaffolds
They shall be erected as working scaffolds and falsework for all parts where the weight of concrete is transferred over already concreted parts (bodies of vertical piers/abutments). They shall be erected as load-bearing scaffolds for all parts where the weight of fresh concrete is received directly onto scaffolds (pile caps, wing walls, etc.), and it is thus necessary to ensure the transfer to the ground of not only the weight of scaffolds, but also the weight received from concrete. For load-bearing scaffolds it is necessary to ensure temporary footings, adequate by dimensions and depth of foundation to the load, or piles under the posts of scaffolds, depending on the location of a post and load-bearing capacity of soil.

Appropriate supports shall be implemented for non-bearing scaffolds, too, since they give the stability and support for dead weight, work load, and any lateral forces to the scaffolds.

b) Mobile Scaffolds
This is a system of a working platform for which a special design is prepared. Dead weight and working load are transferred on already constructed parts of a pier/abutment. It is often accompanied with working scaffolds, usually tubular, that enables the access to the working platform at different heights.

The working platform is subject to the requirements of load-bearing capacity and stability, just as every other temporary construction. The working platform design with the sliding technology shall be submitted for approval by the Engineer.

Working scaffolds shall meet appropriate requirements given under a) above, related to scaffolds that are non-bearing in terms of this description.

Without a written approval for erected scaffolds given by the Engineer and recorded through the Building Journal, scaffolds shall not be used.

Formwork

Formwork solutions may be different. However, since this is about visible surfaces, all formwork shall be erected in such way that after its removal the concrete surface is left without any residues from the material it is made of, and traces of any fastenings (wire and similar). The requirement is to obtain a flat concrete surface that is in compliance with the design in every way: evenness, uniform texture of concrete, and uniform appearance. The strength of formwork shall be ensured with appropriate stiffeners. Timber shuttering implies vertically placed boards, made of softwood, Class II, on all visible surfaces. The points of extension shall be selected so that all boards are neither joined together at the same level, nor staggered too much by height. Unstable knots shall be driven out, and the resulting holes firmly sealed with wedges made of softwood that will be cut flush on the concrete facing side. Horizontal and inclined shutters (the soffit of cantilevers of the pile caps on central piers) shall be placed in the direction of the centreline of a pier, i.e. the centreline of a wing for the shutters for wings. All other boards for visible surfaces shall be vertical, unless the overall height of an element exceeds 50 cm, provided that horizontal boards do not disturb the general appearance of the concrete surface in such case either. Timber shutters may be reused several times, if it is identified as suitable for further use after the removal and cleaning, which is to be subject to approval by the Engineer. Boards that are not suitable for visible surfaces may be used for those surfaces that are not exposed to view, provided that they are of appropriate bearing capacity. Shutters made of engineered wood boards, i.e. treated wood, may also be used without limitations on surfaces not exposed to view. For visible surfaces, it is necessary to prepare a board arrangement schedule that shall be subject to approval by the Engineer.

Reinforcing Steel

Provisions of Sub-Section 13.5.1. REINFORCING STEEL shall apply.

Execution of Works

The works shall be executed in full compliance with provisions of Sub-Section 8.10.4. EXECUTION OF CONCRETE WORKS

Measurement

The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^3 of concrete according to the design of piers/abutments, and/or their elements, and as approved by the Engineer. The quantity shall be determined separately for each part of a pier/abutment according to the Priced Bill of Quantities, as given with "Scope and Content of Works" for this Sub-Section of the Technical Specifications.

Payment

For quantities determined in the above-described way, the Contractor shall be paid at the agreed unit prices for each separate pier/abutment element in the Priced Bill of Quantities. The unit prices shall make a full compensation for full equipment, scaffolds, and formwork, placed concrete, and all work on the erection and removal of scaffolds and formwork, and on the production, transport, placement, and curing of concrete. Reinforcing steel shall be paid extra.

13.4.3.3. Reinforced-Concrete Spanning Structure

Scope and Content of Works

The work under this item includes the construction of all structural elements of the reinforced-concrete superstructure of the bridge, which also implies the provision of all plants, equipment, material, and labour, and the execution of all operations related to the production, transport, placement, and curing of placed concrete, as well as all works and materials for the erection and removal of scaffolds and formwork. Parts of the spanning structure covered with this item of works may be distinguished in the following types:

- Main girders of the bridge, made of reinforced-concrete
- Cross girders of the bridge, made of reinforced-concrete
- Bridge deck (upper deck with cantilevers and beams and/or lower deck), made of reinforced-concrete
- Main plate girder, made of reinforced concrete
- Cross girders, made of reinforced concrete, to link main girders made of pre-stressed concrete
- Bridge deck made of reinforced concrete over pre-fabricated girders

Parts of the spanning structure are divided in the Bill of Quantities according to the grade and class of concrete, as well, if such differences are foreseen in the Design.

Concrete Requirements

Requirements that concrete shall meet are given in Section 8. CONCRETE and Sub-Section 8.10. STRUCTURAL CONCRETE of these Technical Specifications.

Scaffolds and Formwork

Requirements for scaffolds and concrete are given in Sub-Section 13.3.1. SCAFFOLDS AND FORMWORK of these Technical Specifications, and in Sub-Section 13.4.3.2. in the part covering scaffolds and formwork. Scaffolds shall be designed for the entire load from main and cross girders and slab.

Reinforcing Steel

Provisions of Sub-Section 13.5.1. REINFORCING STEEL shall be observed in entirety.

Execution of Works

The works shall be executed entirely in compliance with provisions of Sub-Section 8.10.4. EXECUTION OF CONCRETE WORKS, with a particularly accentuated need for the preparation of and compliance with the concreting plan. Any interruptions and stages in concreting are given in the Design, and no changes in these requirements from the Design shall be allowed without the Engineer's approval. The Engineer shall not give his approval for any changes that may cause unfavourable consequences in the form of fissures and cracks, or the appearance of additional static impacts in the system due to changes in contraction and creeping values with respect to the Design.

The following is specifically pointed out:

- Main and cross girders shall be concreted at the same time, always from the lower edge of bridge deck, i.e. lower edge of cantilever. The bridge deck shall not be concreted at the same time, but only after concrete in girders has passed through the initial setting period.

- In principle, scaffolds shall be loaded symmetrically in each span, which is given in the concreting plan, and in case of its absence, this principle shall be observed by the Contractor.
- The bridge deck and cantilever surfaces shall be finished according to the design in terms of evenness, gradients and cross falls, which shall be checked with a 3 m long metal straight edge. Any variation from the straight edge shall not exceed 5 mm. The evenness checking procedure with a straight edge is performed by moving the straight edge by a half of its length with respect to its previous position. The measurement of evenness shall be carried out in at least two orthogonal directions. If there is a variation in excess of 5 mm, minor repairs shall be performed by moving the straight edge over fresh concrete, and major repairs by removing, or adding, material with appropriate compaction, all subject to the approval of the Engineer.
- The control of evenness and repairs shall be performed on fresh concrete.
- The surface of concrete shall be roughened while concrete is fresh in a proper way, so that after the work is over, the surface remains rough, after which it shall be protected against a rapid loss of water, i.e. against damage induced by precipitation (rain shower, hail, etc.) until sufficient strength is achieved.
- In places where gullies are to be installed, it is necessary to leave openings.
- In the zones foreseen for the installation of expansion joints, concreting shall be properly ended, having in mind dimensions, i.e. quantity of concrete to be cast when installing expansion joints shall be sufficient to perform a good bond.
- When dealing with the construction of reinforced-concrete slabs over precast main girders, everything specified above is of importance. In that case, special attention shall be paid to the cleanliness of anchor bolts for the bond between the precast girders and the subsequently concreted slab.

Measurement

The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^3 of concrete according to the design of spanning constructions, and/or their elements, as approved by the Engineer. The quantity is determined separately for every part according to the Bill of Quantities.

Payment

For quantities determined in the above-described way, the Contractor shall be paid at the agreed unit prices for each separate element of the bridge spanning structure in the Priced Bill of Quantities. The unit prices shall make a full compensation for all equipment, scaffolds, and formwork, placed concrete, and all work on the erection and removal of scaffolds and formwork, and on the production, transport, placement, and curing of concrete. Reinforcing steel shall be paid extra.

13.4.3.4. Precast Cornices or Parapets on Cantilevers Supporting Pedestrian Walkways

Volume and Content of Work

The work under this item includes the casting, transport, and fixing of designed cornices which means the provision of all plants, equipment, materials, and labour to carry out all operations needed for the casting, transport, and fixing of cornices. The shapes and dimensions of cornices, and the grade and class of concrete shall be specified in the Design.

Casting Requirements

Precast cornices shall be of reinforced concrete according to Section 8. CONCRETE and Sub-Section 8.10. STRUCTURAL CONCRETE.

As a rule, precasting, fixing and edge rounding tolerances shall be considered in the Design. If this is not the case the Contractor shall make a formwork proposal that will ensure:

- Sufficient tolerances for cornice fixing,
- Easing of sharp edges,
- Proper positions of reinforcing steel and size of protective cover, which implies a minimum thickness of cornice of 8 cm.

The grade and class of concrete shall be defined in the Design. Regardless of this fact, cornices shall be precast of concrete having the characteristics in compliance with the following standards:

- MB 45 (SRPS U.M1.020)
- V-8 (SRPS U.M1.015)
- M-150 (SRPS U.M1.016; SRPS U.M1.055.)
- Frost and salt resistance (SRPS U.M1.055)

If the design specifications are stricter than the above standards, then they shall be complied with to the full satisfaction of the Engineer.

The Engineer shall consider for approval the Contractor's proposal of dimensions and tolerances, the method of sharp edges easing, and require the compliance with the requirements contained in the standards listed above.

Execution of Works – Fixing

Precast cornices will ensure the final lateral appearance of the bridge. For this reason when put in position they shall fully create the aesthetic effect required by Design.

Cornices shall be fixed as soon as concrete mix reaches its final strength and scaffolds, if any, are removed.

The Contractor shall not be allowed the use of any cornice cast of such concrete type and class that does not comply with this Sub-Section in the Technical Specifications, and any cornice with mechanical damage inflicted during casting, transport and fixing. When cornices are fixed into designed positions the Contractor shall check their positions, arrangement, and geometrical characteristics and request the approval of the Engineer. Subject to the approval of the Engineer, the Contractor shall proceed with the final fixing and concreting of that segment of the superstructure with which the cornices and the remaining part of the bridge structure will make a monolithic structure.

Any incorrect members deemed so by the Engineer on the basis of the requirements in this Sub-Section of the Technical Specifications shall be rejected and replaced with proper ones at the Contractor's expense.

Structural members bearing traces and remains of formwork coating agent may be built in, subject to the approval of the Engineer, provided always that the Contractor will submit evidence that such traces and remains will disappear within 30 days after building in, to the full satisfaction of the Engineer.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^1 of cornice of designed size, as approved by the Engineer.

Payment
The quantity measured in the above described way will be paid to the Contractor at the contract unit price which will mean a full compensation for the use of equipment, work, and materials for casting and fixing precast cornices.

13.4.3.5. Transition Slabs

Volume and Content of Work
The work under this item includes the casting of reinforced concrete slabs on top of a gravel wedge at the contact of approach fill and bridge superstructure. Slabs are to eliminate shocks when vehicles cross from the approach fill to the bridge superstructure due to different degree of settlement between them. Alternatively, the settlement at the approach fill end of transition slabs shall be reduced to zero or to the degree of settlement of the superstructure at the point where the slabs rest on it.

The length of transition slabs shall be given in the Design depending on approach fill height.

The work includes the preparation of bed – gravel wedge, the positioning of reinforcing bars and formwork wherever needed, and the placement and curing of concrete mass.

Concrete Requirements
The grade and class of concrete shall be given in the Design. Everything related to the production, transport, and placement of concrete shall be ruled by provisions of Section 8. CONCRETE, and Sub-Section 8.10. STRUCTURAL CONCRETE of these Technical Specifications.

Execution of Works
After the completion of works on the construction of abutments and cantilevers of transition slabs, and construction of gravel wedges according to provisions of Sub-Section 13.2.5. CONSTRUCTION OF GRAVEL WEDGE of these Technical Specifications, it is necessary to perform the control of evenness, gradients, and cross falls of gravel wedge surfaces on which transition slabs will be placed.

If any variation from the values specified in the Design is identified, higher parts of the constructed gravel wedge shall be removed, and depressions shall be filled with material used for the construction of wedge, and compacted in compliance with provisions of Sub-Section 13.2.5. CONSTRUCTION OF GRAVEL WEDGE of these Technical Specifications and to the full satisfaction of the Engineer.

Before placing reinforcing steel, the gravel bed shall be covered with natron paper from cement bags, with necessary 20 cm overlaps.

Reinforcing cages shall be prepared according to design details and laid on a prepared base. To achieve a required bottom cover for transition slabs, it is recommended to place concrete in thickness that corresponds to the thickness of cover immediately before installing cages.

Before concrete starts to set, reinforcing cages shall be placed and formwork prepared in advance shall be fixed at the place of joints, if joints are foreseen in the Design. At the place of joints, steel formwork is envisaged and shall be coated with appropriate concrete setting inhibitors.

Formwork shall be flat and clean.
After the reinforcing steel and formwork for joints are fixed, concrete shall be placed in the way as specified in relevant provisions of Section 8. CONCRETE and Sub-Section 8.10. STRUCTURAL CONCRETE of these Technical Specifications, with the placement of concrete performed simultaneously for all designed transition slabs next to an abutment, i.e. simultaneously for all slabs of one abutment for which the preparation of base, protective cover, and reinforcing steel is finished.

The most suitable way foreseen is to install every other slab with the use of formwork, so that the remaining slabs between already hardened ones are cast subsequently, using natron or felt paper for making joints.

If transition slabs are not to be concreted at the same time in the entire width of abutment, it is necessary to foresee concreting of the entire number of slabs, secure the position of ending separation formwork against displacement using steel wedges driven into the gravel wedge, by at least 50 cm, and place a protective cover only in the width to be concreted.

After finished casting of concrete, the surface of concrete shall be levelled with rules, manually, so that the finished surface has evenness, gradients, and cross falls according to the Design.

Any movement over fresh concrete shall be forbidden for at least 48 hours after concreting, and then only over previously laid boards, at least 5 cm thick. If the surface evenness becomes damaged due to the Contractor’s negligence, such slab shall be demolished and removed at the Contractor’s expense, and a new one shall be cast, in conformity with provisions of these Technical Specifications.

Separation formwork may be taken out after concrete reaches initial strength, while taking care not to break off the concrete cover. The removed formwork shall be cleaned and coated for the next use.

Reinforcing steel
Fully in accordance with the Design and provisions of Sub-Section 13.5.1. REINFORCING STEEL of these Technical Specifications.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^3 of placed concrete in dimensions as set out in the design, and as approved by the Engineer.

All slabs poorly constructed by the Contractor and removed on the Engineer's instructions shall not be taken into account.

Payment
For quantities determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all equipment, material, and work on the construction of transition slabs in accordance with the provisions of this Sub-Section of the Technical Specifications. Reinforcing steel shall be paid extra.

13.4.4. Pre-Stressed Bridge Structures

13.4.4.1. Precast main girders made of pre-stressed concrete
Scope and Contents of Works
The work under this item includes the construction, transport, and installation of main girders made of pre-stressed concrete, which implies the provision of all plants, equipment, materials, and labour, and execution of all operations related to the fabrication, transport, and installation of girders.

Requirements for Materials
Requirements to be met by concrete are given in Section 8. CONCRETE and Sub-Section 8.10. STRUCTURAL CONCRETE of these Technical Specifications.

Requirements for formwork are given in Sub-Section 13.3. TIMBER CONSTRUCTIONS of these Technical Specifications.

Requirements for reinforcing steel are given in Sub-Section 13.5.1 REINFORCING STEEL FOR CONCRETE ELEMENTS AND STRUCTURES.

Requirements for pre-stressing steel and systems are given in Sub-Section 8.10.6. PRE-STRESSING OF CONCRETE CONSTRUCTIONS AND ELEMENTS

Execution of Works
Fully in accordance with provisions of Sub-Sections 8.10.5. PRECAST ELEMENTS and 8.10.6. PRE-STRESSING OF CONCRETE CONSTRUCTIONS AND ELEMENTS of these Technical Specifications. Apart from provisions from Sub-Section 8.10.5. PRECAST ELEMENTS, the Contractor shall also observe the following:

- Extension of Elements:

If precast girders are fabricated in parts and delivered to the site as such, lengths of particular members shall be adjusted to the method of transport and installation of girders. Unless otherwise specifically stated in the Design how the elements are to be extended, the Contractor shall recommend a way to extend girders, and his proposal shall be submitted for the written approval of the Designer and the Engineer. Transported parts of girders are not pre-stressed in principle, which means that, as a rule, they cannot be exposed to dead load, which the Contractor shall have in mind when handling them. The extension by a direct contact between parts of girders is allowed only with the Designer's and Engineer's approval, as mentioned above. In that case, the Contractor shall prove the stress condition at the place of extension, with the requirement that the stress in a joint at the most unfavourable load in operation be of at least 1.5 MPa pressure, according to the related Serbian regulations.

Contact surfaces at the point of extension shall be roughened and coated with an epoxy coating immediately before tensioning, with the contact achieved before the epoxy coating sets, and the tensioning of cables to reach the full force only after the coating has reached the strength at which it receives tensile stress generated during pre-stressing in the zones in which the cross-section will be pressed in use. For applied epoxy resins, the Contractor shall procure and submit to the Engineer for approval, all necessary compliance certificates, and, among them, particularly evidence on the behaviour of resin in time.

The continuation in concreting of a part of girder is performed using concrete of the same grade and class, with produced cement and aggregate of the same type used for the fabrication of girders in the respective plant. For this purpose it is, therefore, necessary to separate cement and aggregate in the plant and transfer them to the site, with a clear designation for which girders they are to be used. In situ concreting at the place of extension may be performed only in formwork of the same kind and type as the formwork used in the plant, and coated with the same agent as it was done in the plant.

Contact surfaces shall be roughened and wetted down before concreting, and all reinforcing steel shall be properly extended according to provisions of Sub-Section 13.5.1. REINFORCING STEEL FOR CONCRETE ELEMENTS AND STRUCTURES of these Technical Specifications.

Tensioning of cables shall be carried out once concrete for extension has reached a sufficient strength for pre-stressing, according to provisions of Sub-Section 8.10.6. PRE-STRESSING OF CONCRETE CONSTRUCTIONS AND ELEMENTS. In case of the extension of parts of girders on the site, the Contractor shall submit for approval by the Engineer and the Designer the relevant calculation of losses of prestress, stress, and deformations, calculated for a selected extension procedure.

- Pre-stressing:

Fully in accordance with provisions of Sub-Section 8.10.6. PRE-STRESSING OF CONCRETE CONSTRUCTIONS AND ELEMENTS

- Installation of girders:

Before the installation of girders, the Contractor shall check the position and height of bearings on which the precast girders shall lie and request the approval of the Engineer. During the installation, the girders shall be secured in terms of their designed position, and secured against getting into such position in which unfavourable stress conditions appear with respect to values foreseen in the Design.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^3 of placed concrete according to the design, and as approved by the Engineer. Concrete in the parts of extension, and epoxy coatings, shall not be measured extra.

Payment
For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all equipment, scaffolds and formwork, placed concrete, and all other work on the erection and removal of scaffolds and formwork, and on the fabrication and transport of girders to the site, and their assembly into designed positions.

Any work on the extension of girders shall not be accepted for extra payment.

Reinforcing steel, pre-stressing cables, and grouting of cables shall be paid extra.

13.5. Metal Works

13.5.1. Reinforcing Steel for Concrete Elements and Structures
Scope and Contents of Works
The work covered under this Sub-Section of the Technical Specifications includes the procurement of plants, equipment, materials, and labour, and the execution of all operations related to reinforcing steel in conformity with the Conditions of Contract, and in full compliance with this Section of the Technical Specifications, drawings, and the Engineer’s instructions.

Technical Regulations
Reinforcing steel shall be in compliance with the Rules on technical norms for plain and reinforced concrete /PBAB 87/, instructions for use, and relevant standards:
SRPS C.K6.020 Hot-rolled steel. Reinforcing steel for concrete. Technical specifications (1987).
SRPS C.K6.120 Hot-rolled steel. Reinforcing steel for concrete. Shape and sizes (1986).
SRPS U.M1.091 Welded mesh reinforcement for construction industry (1986).

The standards specify shapes and sizes, as well as testing methods, for quality requirements set out in PBAB 87.

Materials
Wires and bars made of smooth steel, high-strength naturally hard ribbed steels, and mesh reinforcement made of cold-drawn smooth wire shall be used for the reinforcement of concrete constructions and elements as specified in the Design.
- Smooth reinforcing steel GA 240/360

Smooth reinforcing steel /GA/ is soft steel, grade 240/360, produced in the form of wires and bars. For reinforced concrete constructions, round, smooth reinforcing steel shall be fabricated according to an approved procedure.
- Ribbed reinforcing steel RA 400/500

Ribbed reinforcing steel /RA/ made of high-strength naturally hard steel, grade 400/500, is produced in the form of wires and bars. For reinforced concrete constructions, round, ribbed, reinforcing steel shall be fabricated according to an approved procedure.
- Welded mesh reinforcement MAG 500/560

Welded mesh reinforcement is made of cold-drawn wire made of smooth steel, grade 500/560. Mesh marks, diameter and spacing of wires, tolerances, etc. are determined in SRPS U.M1.091.

Protection of Materials
Reinforcing steel shall be protected against damage at all times. When placed into a construction, it shall be free from dust, loose flakes of slag and rust, paint, oils, or other foreign materials.

Bending
Reinforcing bars shall be carefully cut and bent by a qualified worker. They shall be bent in cold according to patterns, and shall not noticeably vary from the shape and dimensions shown on drawings. Sharp bends shall be avoided, and radii smaller than those specified in Table 24, PBAB 87, shall not be allowed.

Placement and Fixing
All reinforcing steel shall be accurately placed, bars shall be tied with wire at every crossing, so as to stay in positions shown on drawings during the placement of concrete. Spacers that prevent contact between reinforcing steel and formwork, and between rows of reinforcing steel shall be made of precast concrete cubes, or other materials of approved shape and dimensions. Concrete cubes shall be of such dimensions that it is possible to cover them with concrete. Coarse-grained gravel, crushed stone, or bricks, metal pipes, and wood shall not be used as pads. The inspection of placed reinforcing steel shall be performed macroscopically. The proper positions of placed reinforcing steel and its particular elements with respect to designed positions shall be checked by measurement and submitted for the approval of the Engineer.

Allowed variations are in the following limit ranges:
- Variations between particular bars
  - For piers/abutments and beam girders ....- 10 mm.
  - For slabs and walls ....- 15 mm.
- Variations between vertical rows of reinforcing steel, and variations in the designed dimensions of protective cover
  - For elements with the structural
    height over 1 m ....- 10 mm.
  - For beams and slabs
    thicker than 10 cm ....- 5 mm.
  - For slabs thinner than 10 cm.....................- 3 mm.
- Deviations in stirrups with respect to horizontal or vertical values
  - For elements with the structural
  - height over 1 m .... 10 mm.
  - For elements with the structural
    height under 1 m .... 5 mm.
- Axial deviations for butt-welded bars .... 0.10 Ø.

Extension
All reinforcing bars with overall length smaller than 12 m shall be delivered in full length as indicated on drawings. Bars longer than 12 m may be extended as shown on drawings or specified in PBAB, Section V.5, and/or Engineer's instructions. Butt joints made applying the electronic welding procedure shall be tested according to SRPS C.A4.002 and SRPS C.A4.005.

Acceptance
Before the commencement of concreting of every element or construction, it is necessary to identify and note in a protocol, prepared by the Contractor and submitted for the approval of the Engineer, whether reinforcing steel meets the requirements regarding:

- Diameter, number of bars, and designed geometry of placed steel
- Fixing of steel in formwork
- Mechanical properties: yield strength, breaking limit, quality of welded joints, and
- Cleanliness of placed steel.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of kilograms of placed reinforcing steel, as indicated on drawings and in specifications, i.e. reinforcement schedules, and as determined and approved by the Engineer. Any additions for trimming pieces, concrete cubes, pads, and spacers, as well as wire clips and fasteners to be procured by the Contractor when and as instructed by the Engineer shall not be taken into account. When making overlaps other than specified in Sub-Section V.5., PBAB, no compensation shall be given for extra steel, and for construction joints not indicated on drawings. For the calculation of weight of reinforcing steel, SRPS C.K6.120 shall be applied.

Payment
For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for the scope and content of works given under this Sub-Section of the Technical Specifications.

13.5.2. Metal Work in Pre-Stressed Concrete

13.5.2.1. High-strength patent pre-stressing wire with all anchors, tie plates, and cable ducts
Scope and Contents of Works
The work under this item is described in Sub-Section 8.10.6. PRE-STRESSING OF CONCRETE CONSTRUCTIONS AND ELEMENTS of these Technical Specifications.

Measurement
In full accordance with Sub-Section 8.10.6. PRE-STRESSING OF CONCRETE CONSTRUCTIONS AND ELEMENTS

Payment
In full accordance with Sub-Section 8.10.6. PRE-STRESSING OF CONCRETE CONSTRUCTIONS AND ELEMENTS

13.6. Expansion Joints on Structures

Scope and Contents of Works
The works covered with this Sub-Section of the Technical Specifications include the provision of all plants, equipment, material, and labour, and the execution of all operations related to the fabrication, transport, and installation of all expansion joints, in accordance with the Conditions of Contract and in full compliance with this Sub-Section of the Technical Specifications, structural requirements, drawings, and the Engineer's instructions.

In accordance with structural requirements, drawings, specifications from the Design, this Sub-Section sets out the requirements for the application of materials, and the fabrication and installation of expansion joints, specifically for:

- Special expansion joints that may absorb extremely large amounts of expansion
- Reinforced elastomeric expansion joints.

Materials
Elastomer for expansion joints shall comply with the specifications for bearings for which certification has been issued by the authorised testing institute as approved by the Engineer, and shall be resistant to aging, weather conditions, and chemical impacts.

Protection against Corrosion
The Contractor shall define corrosion protection systems to be applied for particular surfaces on the bridge in accordance with the applicable technical regulations and Rules on technical measures and requirements for the protection of steel structures against corrosion (Off. Journal SFRY, No. 32/1970) and submit his proposals for the approval of the Designer and the Engineer. Alkyd-based corrosion protection systems shall not be accepted. The sequence, type, and technology of application and method of control of coats of the corrosion protection systems specified in the Contractor's proposal shall be defined in appropriate reports. As a rule, surfaces shall be prepared by abrasive jet cleaning. The degree of reached cleanliness of surface shall be determined in accordance with SIS 053900. After cleaning and dedusting, surfaces of steel elements shall be protected either with a primer or immediately with the first basecoat, within 8 hours at most. The Design shall foresee the application of high-strength bolts in some connections, designed as "friction-grip" bolts - TS. Contact surfaces in connections shall be protected by aluminum - AlMg5 - metallization fully in accordance with relevant standards.

The Contractor shall ensure optimum conditions on the site for the storage and application of selected coatings, fully in accordance with approved reports, enclosed Manufacturer's instructions, Institute's certificates, for offered corrosion protection coatings and to the full satisfaction and approval of the Engineer. The Contractor shall provide all necessary equipment and instruments for control on the site.

Measurement and Payment
Measurement and payment shall be made at the unit price per 1kg of steel construction as approved by the Engineer. The unit price shall be quoted for an assembled steel construction protected against corrosion, and shall include all work, tools, and equipment, basic material and fittings, and all necessary temporary and auxiliary constructions. The Contractor's proposal shall contain a cost

breakdown (in percentages) into costs of particular items of work, for the sake of calculations for interim monthly payments. The relevant weight of construction for calculation shall be computed theoretically, namely:

- The theoretical weight shall be determined based on shop specification of material applying the bulk density of steel of 8.00 t/m^3 for sheet steel, and 7.85 t/m^3 for sections. The weight computed in this way shall be increased by 3% for fitting material used in the shop and for installation on the site.

13.6.1 Reinforced Elastomeric Expansion Joints

Fabrication Requirements

These expansion joints shall be shock and sound-absorbing and watertight systems. Their dimensions shall fully comply with drawings and be shaped according to the cross section of the bridge.

The expansion joints shall be delivered as 2 m long elements, and shorter reducer elements that are to be welded together into one unit. Angled joints shall be prefabricated, and the Manufacturer shall weld them.

Sealants shall be applied in accordance with drawings and shall be used strictly in accordance with the Manufacturer's instructions and subject to the approval of the Engineer.

Anchoring shall be performed with anchors of a minimum diameter of 16 mm, while their layout shall be adjusted to details for the elements to which the joints are to be anchored. The fabrication of expansion joints may start only after the Engineer has given his approval for the Contractor's designs.

Installation of Expansions Joints

Expansion joints shall be installed fully in accordance with approved detailed drawings, with the accuracy requirement of - 1 mm vertically for 1m long rule. Expansion joints shall be adjusted to the mean temperature of installation, i.e. if installation is foreseen for concrete constructions, along with the casting of slab, pre-stressing, contraction, and creeping of concrete shall be taken into account as well.

Measurement

The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^1 of constructed expansion joints in accordance with the design and as approved by the Engineer.

Payment

For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all used equipment, incorporated material, and all work on the fabrication, transport, and installation of expansion joints.

13.7. Installation of Cast Iron Gullies for Designed Bridge Deck Drainage

Scope and Content of Works

The work under this item includes the installation of gullies to drain surface water from the bridge according to the drainage design, which implies the provision of all plants, equipment, materials, and labour, and the execution of all operations on the fabrication of complete gullies, with the installation of gully pots to channel water, as specified in the separately elaborated drainage design, their transport to the site, and installation.

Execution of Works

A gully is a finished product, and shall have, as such, the shape and dimensions according to drawings in a separate drainage design. The Engineer shall determine whether delivered gullies are fully compliant to the type specified in the drainage design, and whether they are damaged during handling before their installation. The upper and lower parts of a gully shall not have cracks or voids in casting, and the gully grating shall properly sit in its frame, which means that it shall not be curved, twisted, or of improper size for the frame. Grating bars shall not be cracked or broken.

Unless otherwise shown on design drawings, the opening for a gully and drain pipe shall be left in the concrete slab in advance, so it shall be adequate, by shape and dimensions, for the gully and drain pipe.

Before placing the gully, the concrete surface shall be coated with a hot bitumen coating.

If the opening is larger than needed to place the gully, gaps shall be filled in with plastic cement mortar, 1:3.

Joints between the gully and the road surfacing shall be finished according to specifications given in Sub-Section 13.10.8. CONSTRUCTION AND SEALING OF JOINTS ON ASPHALT ALONG KERBS AND CORNICES ON PEDESTRIAN WALKWAYS AND ALONG EXPANSION JOINTS of these Technical Specifications.

The gully is placed in its frame as a whole, which means, with the grating in place, and then its height is adjusted by means of an instrument, so that after completed paving, the grating lies flush with the pavement, without any of its parts projecting above, or sinking under the road surface. Cement mortar shall be cured with a usual procedure. Before paving, the grating shall be removed, and the opening closed with a timber cover, to prevent asphalt from getting into the gully. From the date of installation of gully to the date of paving, at least a fortnight shall pass, to ensure that cement mortar has reached the required strength. During paving, it is necessary to protect gullies from damaging, which particularly applies to the placement of asphalt concrete in two layers. The first layer before and after the gully shall not be compacted with a roller, but hand rammers. When a paver passes over a gully, measures shall be taken to prevent the spreader from hitting the gully. Gullies shall be covered with gratings after finished paving, and surface is wetted down for testing. This is done to assess the effectiveness of drainage.

If the gully is the reason for insufficient drainage, its position shall be fixed in a proper way to the full satisfaction of the Engineer. At the place where the drain pipe leaves the underside concrete surface, cement mortar shall be shaped conically, to be higher next to the drain pipe than in the contact with concrete.

Measurement

The quantity to be paid to the Contractor at the agreed unit price shall be the number of gullies according to the drainage design, and as approved by the Engineer.

Payment

For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all material and work according to the scope of works for this Sub-Section of the Technical Specifications.

13.8. Designed Steel Barriers on Bridges

Scope and Content of Works

The work under this item includes the shop fabrication and mounting of bridge barriers according to the Design, which implies the provision of all plants, equipment, materials, and labour, and the execution of all operations for the fabrication, transport, mounting, and corrosion protection of barriers.

In the Bill of Quantities, barriers shall be separated by type, as follows:

a) CRASH BARRIERS
b) CRASH BARRIERS WITH HANDRAILS
c) OTHER TUBULAR BARRIERS, OR BARRIERS MADE OF SECTIONS

Quality Requirements

The quality of applied materials, and the requirements for fabrication and corrosion protection of steel materials are specified in Sub-Section 12.6.1. of these Technical Specifications.

Other standards applicable for protective steel barriers are:

SRPS U.S4.100 Protective barriers, made of steel– Technical requirements for fabrication and delivery
SRPS U.S4.108 Protective barriers, made of steel – Shape and dimensions.

Execution of Works

The work on shop fabrication of barriers shall be executed in accordance with requirements of Sub-Section 12.6.1 of these Technical Specifications. Shape, dimensions, and types of steel elements, as well as required dimensions of seams of welded joints, shall be specified in the Design. All visible joints shall be finished off by grinding, to get a clean surface. Before the final joining of individual segments, it is necessary to perform a trial assembly of main elements – posts, handrails, and rails/beams to avoid any variations. If possible, it is necessary to check the position of anchoring points on the construction, and carry out minor adjustments during work in the shop.

Crash barriers are supplied as finished products from the Manufacturer, with connection details previously customized according to details given in the Design. During fabrication of barriers in the shop, it is necessary to ensure that they fit any curves on the bridge. Polygonal barriers on bridges in curves shall not be accepted. After shop fabrication, but before transport to the site, barriers shall be protected with a basecoat, fully in accordance with provisions of relevant standards. The basecoat shall be factory-prepared. It may be applied with a brush or by spraying.

Barriers shall be transported to the site taking necessary precautionary measures to avoid damaging both the steel material, and the basecoat.

Before assembling the barrier, it is necessary to check the condition of openings left for its installation in the structure. The openings shall be cleaned with air under pressure, to remove any foreign objects.

The barrier shall be installed at air temperature in the range from 15°C to 25°C.

The barrier shall be set into its designed position and adjusted in height and direction, and then temporarily fixed in a suitable way.

After fixing the barrier, and wetting down the holes beforehand, anchoring points shall be sealed with fine-grained concrete of the same grade and class as specified for concrete for the superstructure, and the filling is then cured in conformity with requirements set out in Sub-Section 8.10. STRUCTURAL CONCRETE of these Technical Specifications. During and after the installation, it is necessary to check and ensure the effectiveness of expansion joints of the barrier. Before applying protective coatings, the barrier shall be inspected and cleaned from any residues of concrete or traces from welding, and repair the basecoat, if damaged anywhere and to any degree, and de-greased before applying the next coating.

The barrier can then be painted with the second coat, and after it dries, with the finish coat as well, so that there shall be at least three coats in total.

Air temperature during painting on the site shall be neither below +5°C nor over +20°C. The paint shall not be applied to wet and frozen surfaces, nor at a relative air humidity higher than 60%. If painting is done under a cover, and, after applying the paint, weather conditions become unsatisfactory, the cover shall be kept in place until the paint dries, or the weather gets better to the extent that the paint can be exposed to atmosphere.

The Engineer may forbid the application of paint if he considers weather conditions unfavourable. The paint shall not be applied to metal that is too hot and could thus cause the porosity of the applied layer or swelling of the paint due to a sudden loss of the solvent. Inaccessible places shall be protected, too.

Some elements (handrails, posts, railings) shall be finish painted in colours specified in the Design, and if such data are not available in the Design, the decision on colours shall be made by the Engineer.

Crash barriers shall meet the requirements for installation specified for pedestrian barriers. Crash barriers shall be galvanized, and shall not be painted, all the same as anchor plates for pedestrian and safety barriers.

Measurement

The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^1 of installed barrier, prepared according to the Design and as approved by the Engineer.

Payment

For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all used equipment, plants, and material, and for all work on the fabrication, transport, assembly, and painting of barriers according to the Design.

13.9. Bridge Bearings

Scope and Content of Works

The work under this item of the Technical Specifications shall include the provision of all plants, equipment, material, and labour, and the execution of all operations related to the fabrication, transport, and installation, including bedding mortar, of all bearings, in accordance with the Conditions of Contract, and in full compliance with this Sub-Section of the Technical Specifications, drawings, and Engineer's instructions.

In accordance with structural requirements, drawings, and specifications from the Design, this Sub-Section sets out the requirements for applied materials, fabrication and installation of bearings, namely for:

- Special steel bearings
- Neotopf elastomeric bearings, and
- Reinforced elastomeric bearings.

As for materials and design, Neotopf, Neotopf slide bearings, and reinforced elastomeric bearings shall be provided with approval certificates issued by authorized institutes and submitted for the approval of the Engineer.

For all manufactured bearings, in addition to the quality control by the Manufacturer, the control by authorized institutions for this business sector is mandatory.

13.9.1. Reinforced Elastomeric Bearings – Materials and Manufacturing Requirements

Elastomeric bearings are manufactured from synthetic chloroprene caoutchouc resistant to aging, weather conditions, chemical impacts, and ozone.

Elastomer shall meet the requirements related to bearings which are provided with approval certificates issued by authorized institutes.

Bearings shall have all dimensions compliant with data shown on drawings.

Plates that are inserted between layers of elastomer shall be made of high-strength steel and hot-bonded with elastomer layers.

Installation of Bearings

All bearings shall be marked so that the type, size, position, direction, and pre-settings are stated unambiguously. All works on the site regarding the installation of bearings shall be allowed only if performed by the Manufacturer's specialists or representatives authorized and trained by him. The acceptance of bearings and their installation up to the time before the placement of bedding mortar, and after its placement, shall be subject to the approval by the Engineer. Bearings shall be installed according to details and height levels given on drawings, over bedding mortar placed according to requirements specified in Sub-Section 8.10 of these Technical Specifications. Elastomeric bearings shall not come into contact with grease, solutions, and particularly not with oils for formwork. Neotopf slide bearings shall be pre-set in accordance with design requirements. Devices for temporary fixing shall consist of materials that do not damage bearings at the moment of initial movement. Bearings that are not installed properly, or do not meet specified standards, shall be removed and replaced at the Contractor's expense and to the full satisfaction and approval of the Engineer.

Measurement

The quantity to be paid to the Contractor at the agreed unit price shall be the number of bearings according to kind and type, as specified in the design, and as approved by the Engineer.

Payment

For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all materials, equipment, and labour, transport and installation, and for all tests required by the Engineer to determine whether particular bearings meet chemical, physical, and structural requirements stated in this Sub-Section of the Technical Specifications.

The agreed unit price shall include bedding mortar, and all grouting equipment, indicators, and necessary seals, fully as stated in this Sub-Section of the Technical Specifications, indicated on drawings, or instructed by the Engineer.

13.10. Finishing Works on Bridges

13.10.1. Stone and Concrete Kerbs

Scope and Content of Works

The work under this item includes the placement of stone or concrete kerbs, dimensions as specified in the Design, which implies the provision of all necessary plants and equipment, materials, and labour for the production, transport, and placement of kerbs according to the Design and requirements from this Sub-Section of the Technical Specifications.

Material

If the Design foresees stone kerbs, stone shall meet the requirements for stone material set out in Sub-Section 13.4.1.2. LINING OF END SLOPES– LINING OF STRAIGHT AND ROUNDED SOIL SURFACES, while a minimum compressive strength of stone is required to be 70 MPa. Only stone of eruptive origin may be used. If concrete kerbs are foreseen, the grade and class of concrete shall be specified in the Design, while observing the following:

- Grade of concrete shall not be less than MB 50
- Average flexural bending strength (not applicable for the lengths of 250 and 500mm) 6 MPa
- Frost resistance (SRPS U.M1.016) shall not be lower than M-150
- Water impermeability of concrete (SRPS U.M1.015) shall not be less than V-6
- Degree of damage under the action of frost and salt (Table 2-SRPS U.M1.055) shall be "0 – no spalling"
- Wear abrasion resistance, abrasion loss shall not be higher than 15 cm^3 / 50 cm^2

For everything else, concrete kerbs shall be governed by provisions of Section 8. CONCRETE and Sub-Section 8.10. STRUCTURAL CONCRETE of these Technical Specifications. Cement mortar, 1:3 ratio, shall meet the requirements of the same standards, and the same provisions as concrete kerbs.

Execution of Works
After completing the bridge deck according to the description given under Sub-Section 13.4.3.3. SPANNING STRUCTURE, kerbs shall be delivered and stockpiled near the place of installation. Cement mortar is placed over a moistened waterproofing system of the deck, and kerbs are positioned as specified in the Design. A kerb shall be wetted down too. The joint toward the strip on the pedestrian walkway side shall be sealed then. Very wet mortars are not allowed, because of the risk of fissures and cracks in mortar due to water loss.

Joints between kerbs shall also be filled with cement mortar, while leaving out one joint, about 2 cm wide, at every 20 m distance, and sealing it with a durable elastic bituminous putty, at the same time when longitudinal joints are sealed, according to the description given under Sub-Section 13.10.8. CONSTRUCTION AND SEALING OF JOINTS IN ASPHALT ALONG KERBS AND CORNICES ON PEDESTRIAN WALKWAYS.

Standard length of kerbs is 1 m. This may vary in case and within limits specified below within this Sub-Section of the Technical Specifications.

The placement of kerbs shall start from expansion joints toward the centre of each span and ends of wings, i.e. from the ends of wings toward the centre of bridge in case of structures without expansion joints. In the part of bridge in the centre of a 3-5 m span, standard kerbs shall be adjusted to the total length needed, with at least three kerbs shortened to a length not smaller than 70 cm.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^1 of placed kerbs, measured on the site and as approved by the Engineer

Payment
For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all used equipment, incorporated materials, and work on the fabrication, transport, and placement of kerbs, including bedding and joints.

13.10.2 Waterproofing of Concrete Deck Surface

Scope and Content of Works
The work under this item includes the construction of a modern waterproofing system over a constructed concrete deck in the area specified in the Design, which implies the provision of all plants, equipment, materials, and labour, and the execution of all operations related to the procurement of materials, transport, and construction of a waterproofing system.

- A waterproofing system, TESTUDO type, with a polymer-bitumen strip for welding, or a product of the same or better performance by any other Manufacturer, shall be used for the waterproofing of bridge decks, subject to the approval of the Engineer.

Execution of Works
Weather conditions for the execution of works are: dry weather, a minimum temperature of 10°C, and a relative air humidity less than 60%.

The concrete surface shall be cleaned from any loose parts of concrete, oil stains, and other impurities, and dedusted with compressed air, as a final treatment.

The flat, dry, and clean concrete surface shall be primed and covered with a levelling bituminous coating, a mix of bitumen and filler for placement in hot. This layer may also serve to fix any minor uneven areas on the concrete surface. The basecoat material shall have the same characteristics that meet requirements set out in SRPS U.M3.240/1989.

Bitumen strips shall be welded to the placed layer of bituminous coating. For the waterproofing of bridge deck, torch-on bitumen strips made of APP or SBS polymer bitumen with polyester felt sheeting shall be used. The properties of polymer-bitumen strips shall meet the quality requirements set out in SRPS U.M3.300/1989 (Torch-on bitumen strips. Composition and quality requirements).

The material for waterproofing compound shall meet provisions of SRPS U.M3.246, if the compound is based on asphalt mastic, or SRPS U.M3.244, if it is based on polymer-bitumen.

Before the commencement of works, it is necessary to pre-test all materials to be used, and during the work, all necessary control tests shall be performed to the full satisfaction of the Engineer.

Any movement over the basecoat is forbidden, except during the execution of other works on waterproofing. In case of damage, either the coating shall be noted down as improperly applied, or the surface shall be recoated as directed by the Engineer.

The waterproofing works shall be executed with a constant technical supervision of works by the Contractor to the bfull satisfaction of the Engineer.

Measurement and Payment

The quantity to be paid to the Contractor at the agreed unit price, given per $1m^2$ of the placed waterproofing system, shall be determined based on measurements given in the design and as approved by the Engineer.

13.10.3 Coating Concrete Surfaces with Bitumen

Scope and Content of Works

The work under this item includes the application of bitumen coating on concrete surfaces that will get into a direct contact with seepage water from soil, which implies the provision of all plants, equipment, materials, and labour, and the execution of all operations on the preparation of concrete surface, transport, preparation, and application of materials.

Execution of Works

The surfaces of abutments and wing walls, as well as parts of piers that will come into contact with constructed embankment and end slopes, i.e. soil, shall be coated with hot bitumen. Before applying the coating, it is necessary to inspect the concrete surface, remove any spalled and unstable portions, repair concrete on these places with cement mortar, and wait until it sets and loses moisture. The surface shall be clean and dry.

Parts above foundation structures shall be coated. The coating shall be made with bitumen heated to a working temperature, at an ambient temperature above 10°C, over concrete of a minimum temperature above 15°C, in about 2 mm thickness, at the rate of about 3 kg/m. Before applying the coat on the front surfaces of piers/abutments, i.e. external surfaces of wing walls, it is necessary to mark a limit on concrete to which the coating will go, so that the limit is lower by 20 cm than the line of contact of end slope lining, i.e. ground embankment and concrete. The material shall be applied with suitable tools. Any cracks shall be repaired with hot bitumen or emulsion before the construction of embankment and end slopes, i.e. before backfilling foundations.

Measurement

The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^2 of applied coating according to the Design, and as determined and approved by the Engineer.

Payment

For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all mentioned within the scope of works under this Sub-Section of the Technical Specifications. Any workings scaffolds that may be used shall not be paid extra.

13.10.4. Asphalt-Concrete Surfacing

Scope and Content of Works

The work under this item includes the construction of road surfacing with asphalt concrete over a completed waterproofing layer in the thickness of 1 cm and over the surface specified in the Design, which implies the provision of all plants, equipment, materials, and labour, and the execution of all operations related to the production, transport, and placement of asphalt concrete in accordance with Sub-Sections 9.5. and 9.6. of these Technical Specifications.

Materials

The construction of surfacing is foreseen with the use of asphalt concrete, AB-11 type, according to requirements set out in SRPS U.E4.014 (1983), and stone mastic asphalt, SMA 0/11S, according to requirements set out in SRPS U.E4.015.

Basic materials and asphalt mix are subject to provisions of Sub-Sections 9.5.2. (9.5.3.-9.5.3.7.) and 9.6.3. (9.6.3.1. - 9.6.3.7.) of the Technical Specifications for Asphalt and Pavement.

Execution of Works

Fully in compliance with Sub-Section 9.5.10. Technology of Work in the Technical Specifications for bridge deck.

Quality Control

Fully in compliance with Sub-Sections 9.5.11. and 9.6.6. of these Technical Specifications, and Sub-Sections 9.5.12. and 9.6.7. in terms of criteria for measurement and payment.

Measurement

The quantity to be paid to the Contractor at the agreed unit price shall be the number of m2 of asphalt placed in full designed thickness and width according to the Design, with limitations from Sub-Sections 9.5.13. and 9.6.7. of these Technical Specifications and as approved by the Engineer.

Payment

For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all equipment, material, and work on the production, transport, and placement of asphalt under Sub-Sections 9.5.13. and 9.6.7. of these Technical Specifications.

13.10.5. Testing of Finished Bridge

Scope and Content of Works

The work under this item includes the provision of all plants, instruments, equipment, and labour needed to test the finished bridge with trial load, and the preparation of test reports as a component part of the report for the technical acceptance of the bridge.

Testing Procedure

The finished bridge shall be tested fully in accordance with requirements from this Sub-Section of the Technical Specifications and provisions of SRPS U.M1.046 Testing of bridges with trial load (1984)

The testing may be awarded only to an authorized institution whose eligibility shall be previously determined by the Contractor, submitting specific evidence on that to the Engineer for approval.

The tests shall be performed as regular (Sub-Section 2.1.1. SRPS U.M1.046) and normal (Sub-Section 2.2.1.), and in case of any doubt regarding connections or other qualities of the bridge structure, the Engineer will require a special test load (Sub-Section 2.2.2.). Tests shall be performed with static and dynamic test loads for all bridges with a span L≥15 m, and if conditions from Sub-Section 2.2.2. SRPS U.M1.046 are present, trial load shall be applied for bridges of smaller span as well. Tests shall be performed on a completely finished bridge and access structures, which implies a completely finished pavement on the bridge. Trial load shall not be applied before concrete of the main load-bearing structure has reached the age of at least 28 days. Aside from the required age of concrete in the main load-bearing structure, it is also necessary to have evidence that the placed concrete has reach the required grade. If this is not the case, trial load shall be postponed until the required grade of concrete has been achieved. Before trial loading, it is necessary to release the structure from all scaffolds and formwork. Parts of scaffolds that will be used to accommodate testing specialists during their work shall not be dismantled; it is necessary to make these parts as self-supporting as possible, and to provide access to working platforms to the testing group. The Contractor shall be responsible for safe operation on such working scaffolds and platforms. Before performing the tests, the Contractor shall provide a testing programme, which shall be subject to approval by the Designer and Engineer. The testing programme shall include all requirements set out in Sub-Section 3.2.2. SRPS U.M1.046. During the testing, all other loads shall be removed from the bridge, except for those loads that will be used for trial load tests. The testing of the bridge in key phases shall be attended by the Designer and Engineer as well as the Contractor, and shall be completed to the full satisfaction and approval of the Engineer.

Assessment of Results and Report
Trial load tests results shall be considered positive and the bridge a technically correct structure, if the requirements from Sub-Section 4.1. SRPS U.M1.046 are met to the full satisfaction of the Engineer. If, according to Sub-Section 4.2. SRPS, the trial load test shall be repeated, the bridge shall not be open to traffic until the structure has been re-analyzed and adequate measures have been taken. The organization that performed the test shall issue an interim test report, and then the final test report. In case of a negative opinion in the interim report, the bridge may be used for traffic until necessary measures have been taken and defects eliminated only if approved by the Designer and the Engineer. A copy of every report shall be submitted to the Designer and the Engineer. Bridge test reports make a component part of the study report for the technical acceptance of the bridge.

Measurement and Payment
For work performed on trial load testing of the bridge, the Contractor shall be paid in an agreed lump sum amount that makes a full compensation for all materials, auxiliary scaffolds, smaller platforms, loads, and labour, and for the preparation of a bridge test report, all completed to the full satisfaction and approval of the Engineer. In case of repeated tests, for such tests the Contractor shall not be entitled to any compensation, if these tests are required because of defects in construction or testing. If the test is repeated because of a designing mistake, the test shall be paid extra.

13.10.6. Taking Photographs during Bridge Construction
Scope and Content of Works
The work under this item includes taking and printing photographs during bridge construction, which implies the provision of all cameras and equipment, materials, and labour, and the delivery of 5 (five) copies of colour photographs in albums (2 copies for the Investor, 1 copy for the Engineer and 2 copies for the Designer), and negatives (for the Investor) or electronic files on CD for digital photography.

Procedure
Photographs should be taken with a high quality camera and a set of lenses that has to contain, as mandatory, a standard lens of optical power 1:1.7 to 1:2.8, 0=50-55 mm, and an adequate wide-angle telephoto lens. The camera should be equipped with a built-in electric light meter, and a flash for taking pictures in the conditions of insufficient illumination. The camera should have an automatic date stamping feature. Equipment for taking photographs shall be available on the site at all times. First photographs shall be taken of the site before the commencement of bridge construction works. Wherever possible, geodetic flags (ranging poles) shall be put up in places of future bridge piers/abutments. Where ranging poles cannot be placed, a visible object that stands out from the background by colour and shape shall be used. Photographs shall be taken particularly of:
- Excavation after reaching designed levels
- Pile construction process
- Construction in slide formwork
- Formwork and auxiliary scaffolds for piers/abutments
- All reinforcing steel and cables in designed positions
- Scaffolds and formwork for the superstructure
- Placed bearings and expansion joints (before paving)
- Space between wing walls before and after the construction of wedges
- Transition slabs
- Bridge deck surface before and after waterproofing
- Paving process
- All typical details
- Front (rear) view of the bridge taken from the pavement in front of / behind the bridge before its opening to traffic
- Side view of the finished bridge
- Trial loading

Photographs shall show a clearly visible object. Each photograph shall also show a size reference object (a matchbox, levelling staff, flag, man).

Aside from everything mentioned above, on the Engineer’s instructions, photographs shall also be taken of any accidents during the works, and of conditions at the time of unplanned or unfavourable interruption of work. Such photographs, aside from the condition, should also show, if possible, the cause and consequences of the event. The Investor, Engineer and Designer shall be handed over photographs arranged in albums, with a legend written under each photograph with the following data:
- The number of photographs
- Date and time of taking the photograph (if the camera does not have an automatic date stamping feature)
- The name of the shot object
- Any description of the photograph
- The distance from which the photograph was taken, with a sketch, if possible
- The type of lens

The photographs may also bear identification marks, if needed, with their meaning and explanation given in the legend. Negatives shall be handed over cut in strips, with 6 photographs in each strip, packed in a way that protects them against damage. CD’s shall be provided for digital photography. Albums shall bear the following inscription:
- The name of road, and road and section codes

- Bridge chainage and name
- Name of obstacle
- The Investor and Contractor
- Photographer(-s)

On the inside cover, the following shall be written:
- Make and type of the camera and film
- Make, type, and characteristics of lens
- Make and type of flash

An average number of photographs is:
- For smaller and less complex bridges................20 pcs
- For larger and more complex bridges ....50 pcs
- For large and complex bridges ....200 pcs

Measurement and Payment
For the work under this item, the Contractor shall be paid a lump sum amount that makes a full compensation for all material, used equipment, and labour, and everything else mentioned in the scope and contents of work for this item.

13.10.7. Fabrication and Installation of Plate with Year of Bridge Construction

Scope and Content of Works
The work under this item includes the fabrication and installation of a plate with a year of bridge construction, which implies the provision of all devices and equipment, materials, and labour needed to fabricate and install the plate.

Material
Material of which the plate is to be made is brass.

Shape and Size of Plate
The plate shall be rectangular, 210x300 mm in size, 4 mm thick. If needed, the size of plate may also be 420x600 mm, 6 mm thickness.

Inscription, Type and Shape of Letters
The following shall be inscribed on the plate:
- The year of bridge construction (e.g. 2009-2010)
- The Contractor (in the following format: Contractor: ...name...)
- The Designer (Designer: ...name...)
- For bridges with a technical solution (layout, span size, etc) that represents a special, rare, or outstanding design or outstanding achievement, the name of the engineer-Designer who developed the design is to be stated (in the following format: Designed by: ... Name and Surname...).

Capital block letters shall be used. With the Contractor's and Designer's names, their logos may be inserted. The applied script (Cyrillic - Latin), and the size and shape of letters shall be decided by the Investor after receiving the plate drawing proposed by the Contractor.

Position of Plate
The plate shall be put up on a visible, but not overly exposed place, which means that it shall be protected against damage caused by traffic, high water, and the like. Furthermore, the plate shall be out of reach for the protection against vandalism. The position of plate shall be determined by the Contractor and Engineer together, taking into account the given requirements.

Fabrication and Mounting
The plate shall be flat and smooth on the backside that lies against the structure. The visible surface may be machined in a suitable way. In the plate corners, Ø14 mm holes shall be drilled. The plate shall be fixed onto concrete, or steel, with bolts, thread root diameter Ø12 mm, made of standard steel for bolts. Heads shall be machined so that bolts cannot be loosened without special tools.

Measurement and Payment
For work under this item the Contractor shall be paid an agreed lump sum amount that makes a full compensation for all materials, used equipment, and labour, according to the given scope and contents of works under this item.

13.10.8. Construction and Filling of Joints in Asphalt along Expansion Joints and Kerbs and Cornices on Pedestrian Walkways

Scope and Content of Works
The work under this item includes the construction of longitudinal joints along kerbs on the upper and lower sides, and along the pedestrian walkway cornice, and/or along expansion joints, and their filling with durable elastic bitumen putty, which implies the execution of all operations related to the construction of joints, procurement, transport, and placement of a joint filling compound.

Execution of Works
During the construction of the finishing asphalt layer, hardwood strips, 1.5 cm wide, and as high as the finishing layer, shall be placed on the road surface, and along the upper side of kerb and cornice, strips made of the same material shall be placed, but 1 cm wide, and of the same height as the overall thickness of asphalt on the walkway. The strips shall stay in place during paving, and be removed after asphalt cools down to a temperature suitable for the placement of putty, according to the Manufacturer's instructions. After removing strips, the contact surfaces shall be coated with a primer, and sealed with the putty, all in compliance with instructions of the putty manufacturer. Before applying the primer, joints shall be cleaned from all foreign objects and dried with compressed air. The placement of putty shall follow immediately after the application of primer. The Contractor shall provide compliance certificates from the Manufacturers for materials he intends to use, as well as instructions for preparation and placement of those materials, and to submit them timely to the Engineer for perusal and approval. The Engineer shall demand these documents and compliance with them from the Contractor.

The Engineer shall turn down any proposal that he may consider inadequate for the basic purpose, and this is the sealing of joints and ensuring the contraction of asphalt without cracking. Also, the putty shall be resistant to ravelling and other traffic-induced damage. A fully completed joint shall be flush with the surrounding surface.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^1 of completely finished joint as approved by the Engineer.

Payment
For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all mentioned within the scope of works under this Sub-Section of the Technical Specifications.

13.11. Special Works

13.11.1 Installation of Plastic Pipes in Pedestrian (Inspection) Walkways as Designed

Scope and Content of Works
The work under this item includes the placement of plastic pipes in pedestrian, and/or inspection walkways in the position as indicated in the Design, which implies the provision of materials, transport, and labour, and the execution of all operations on the assembling, fixing, and ensuring the free passage through the pipes.

Material
The plastic pipes shall be made of high-quality plastic material, without mechanical damage (cracks, broken edges). The pipes shall be socketed. The thickness of wall shall ensure the pipe to receive load from concrete and asphalt above it, and evenly distributed load on the walkway at the rate of 3 kN/m. The load-bearing capacity of pipes shall be proven with the Manufacturer's compliance certificate which shall be submitted for the approval of the Engineer. The material from which the pipe is made shall be resistant to cement components and aggressive substances.

Execution of Works
The pipes are placed into designed position and fixed to avoid their "surfacing" during the placement of concrete fill. They shall be joined together over spigot-and-sockets joints, taped over to ensure watertightness.

At the end of pedestrian (inspection) walkways, the pipes shall be closed with plastic caps that must be protected against theft. Caps shall be provided with a drain outlet on the underside. A free passage through the pipe shall be ensured in its full length from one end to another end of the walkway, i.e. from one manhole to another, if they are foreseen.

At the points of manholes, there shall be plastic drain pipes, 50 mm diameter, placed at the lowest point, so as to protrude under the structure by at least 10 cm.

During concreting around the pipe at its contact with the manhole, the pipe shall be protected against the penetration of concrete with suitable formwork, and if concrete gets into the pipe anyway, it shall be taken out after removing formwork, while fresh if possible. The surface of concrete shall be coated with hot bitumen, after concrete has dried completely.

Measurement
The quantity to be paid to the Contractor at the agreed unit price shall be the number of m^1 of placed pipes measured and approved on the site by the Engineer.

Payment
For quantity determined in the above-described way, the Contractor shall be paid at the agreed unit price that makes a full compensation for all material, equipment, and work on the procurement, transport, and installation of pipes according to the scope of works under this Sub-Section of the Technical Specifications.

13.11.2. Protective Coating of Concrete Surfaces

Scope and Content of Works
The application of a protective coating on concrete surfaces.

Execution of Works
Inspection, surveying, and determination of the scope of work shall be performed by the Contractor in the presence of the responsible work manager and submitted for the approval of the Engineer.

The protective coating of concrete surfaces shall be applied using "Sikagard-680S" agent, produced by "SIKA", Switzerland, or using a protective coating of another Manufacturer, but of equivalent or better characteristics, subject to the approval of the Engineer. This is an acrylic-based coating that should be applied in two layers, to obtain a protective film of the mean thickness of 0.23 mm. The application of mentioned layers shall be performed with a special gun.

The application of the coating shall be preceded by the treatment of previously sanded concrete surface with "Sika Mono Top-620" smoothing coat, produced by "SIKA", Switzerland, too, or using a product of another Manufacturer, but of equivalent or better characteristics, subject to the approval of the Engineer. This procedure is necessary for the application of protective coating in order to obtain a completely flat and smooth – skimmed surface. The application of this material shall be performed with usual procedures applied for the skimming of concrete surfaces.

Both above-mentioned products, "Sikagard-680S" and "Sika Mono Top-620", apart from above-mentioned specifications, shall be applied fully in accordance with the Manufacturer's instructions.

Material used for coating shall be durable and resistant to weather conditions, alkaline substances, and aging.

Before applying protective coatings, the concrete surface shall be completely dry, cleaned, and dust-free.

Measurement and Payment

The quantity to be paid to the Contractor at the agreed unit price given per $1m^2$ of the concrete surface protected with the coating, shall be determined based on a protocol on performed works verified and approved by the Engineer.

The agreed unit price shall include all necessary materials, used tools, transport, and work, and necessary working scaffolds for the access to concrete surfaces.

Section 14
Tunnels

Contents

General

The provisions in these Technical Specifications shall be deemed to be integral part of itemized descriptions for each group of works in the Bill of Quantities.

A general description heading each group of works is related to all the items in the group unless otherwise specified.

The Contractor shall also peruse the Design, report and location in order to get a clear picture of the volume and kinds of main and temporary works, transport and transfer to be undertaken in accordance with these Technical Specifications.

If quality of any material in any item is not clearly defined the Contractor shall submit his proposals for the approval of the Engineer.

A unit price for an item of work in the Bill of Quantities shall cover:

- Full completion with all pre-actions, transport and procedures,
- Work, material, waste, joining material, depreciation, levies, fees and other related costs,
- Costs and fees for temporary connections to water supply, sewerage, electricity and telephone systems,
- All necessary mobile, immobile, transport and service scaffolds, fabricated, erected, removed, transported to and from the site. The same applies to temporary facilities.
- Cleaning and maintenance of temporary and service buildings, used during construction.

Setting out shall be performed by the Contractor using previously established benchmarks.

- Provision of unobstructed passage for vehicles and safety of workers during the works.
- Health and safety measures for all persons on site
  - Temporary electricity installation

    Reflector lighting shall enable safe construction work. Lights might be shadowed if necessary, as to be directed to areas inside construction site and avoid irritation. Lighting inside tunnel shall cover the entire length and shall not be lower than necessary for safe work and approach, meaning at least 100 watts per each 10m of tunnel length.

    Alternative energy source and emergency lighting shall be present as to enable indispensable works and safe evacuation on occasion of primary power cut off. Appropriate number of hand lamps shall be also available on key locations within the tunnel.

  - Air circulation during construction

    Tunnel, pits, shafts and bypasses shall be ventilated all the time during excavation as to enable safe work without potentially harmful or explosive gases, dust, and oxygen lack. Contractor shall take all appropriate measures as to create conditions for safe and efficient construction. Contractor shall follow work safety regulations-in-force by all activities. In underground and closed areas the breathing air shall not contain less than 19% oxygen by volume. Smoking is forbidden in tunnels, headings, and pits and in all closed areas. When constructing longer tunnels, where fast natural ventilation would not be possible, any excavation shall not be allowed if a safe ventilation system would not be installed.

    All shaft, pit and deep trenches bottoms shall be ventilated by exhaust ventilation system.

    Measuring equipment in tunnel shall be suitable for continuous measurement of explosive and harmful gases and oxygen percentage.

    The equipment shall alarm by sound and visual signals on explosive or harmful gases presence and on location where oxygen contents would be bellow the level that is safe for works. Direct and efficient signalisation method shall be placed on surface, i.e. on tunnel portals.

    Airflow quantities shall be checked weekly on excavation breast and at 20 m far of shaft bottom and recorded, together with comparison with calculated airflows.

    All mistakes shall be corrected. Documents on ventilation shall be filed and presented to Engineer for approval.

    On the occasion of ventilation equipment failure, all personnel shall be moved back of underground works, and when tunnelling machine, machine operation shall be stopped immediately and machine shall be isolated till ventilation repair would be complete.

    The entrance into underground site where oxygen contents bellow 19% of the present air volume is forbidden, except for rescue, when protection gear would be mandatory.

  - Tunnel drainage during construction

    The contractor shall supply, install, release to operation and maintain sufficient number of pumps and pipes for water control and drainage out of any underground work section. Water hold shall not be allowed. Capacity of pumps installed at each working breast shall always be at least 1,5 times greater than nominal water in-flow volume, plus quantity for wash out that is used by drilling equipment. Contactor shall provide in good operating condition spare pumps of the same or greater capacity than already installed in tunnel.

    Contractor shall supply filters or other decontamination equipment, subject to Engineer's request, before filtered water takes off to environment.

    Contractor shall remove all accumulated mud, silting, and other debris remained after underground work, as requested by Engineer. Contractor shall install, maintain and keep operational all necessary devices and facilities for filtering polluted waters that would be taken off on tunnel portals during works. Such devices and facilities shall include two pools for deposit, separator for light liquids, neutralization device and necessary control stations. Neutralization device shall be provided and released in operation as to assure pH value of filtered waters between 6,5 and 8,5 before take-off.

    Tunnel shall be drained during works as required by Engineer.

- Upon completion of the works and installations, the Contractor shall, at his own cost remove all temporary facilities, tools, inventory and scaffolds, clean the site, reinstate any excavated ground. Construction rubble shall also be removed to a place Designated for the purpose and approved by the Engineer.

14.1. Tunnel Excavation

General

This work shall include all excavations for the construction of a tunnel as stated in the Design, including the transport, i.e. haulage of excavated material to stock piles for various purposes depending on what the material will be used for.

All excavations shall be performed according to cross-sections, Designed height levels, Designed grades, taking into account required properties for planned used of excavated material, as set out in these Technical Specifications.

Excavation profiles shall be surveyed, recorded and entered in the Measurement Book.

Spacing between surveyed profiles shall not exceed 5 m.

Geological mapping shall be carried out following Engineer's order as to enable rock massif categorizing following the same methodology as specified in Design

The costs of work interruptions for the purpose of surveys or geological mapping shall be covered by the relevant unit prices.

Owing to specific features of a tunnel structure, a method of "smooth" excavation by blasting shall be consistently applied and advanced blasting methods in particularly delicate cases undertaken (powder explosives or Cardox system).

All blasting shall take place without any harm to already constructed primary lining. The blasting method to be applied shall minimize damage to rock massif and shall produce smooth excavation contours.

The Contractor shall provide Engineer's approval for the blasting technology.

Contractor shall engage qualified and skilful labourers for excavation work

The regulations governing blasting shall be observed and care exercised in handling, storage, and transport of explosive, as well as in the provision of safety of the surrounding area and workforce.

If, in the course of works, the Engineer and/or Contractor would find out that geological conditions are essentially different from those stated in the forecast geological profile document, based on which the technology of work during excavation was approved. The technology may be changed with Engineer's consent.

This item of works shall include the tunnel excavation in materials of category II-VII according to GN200.

All tunnel excavations are classified into the following categories:

14.1.1 Excavations in Hard Rock Masses

14.1.1. 1 Tunnel Excavations for Type 3

GN200 - VI, VII

Excavation shall be performed by blasting, opening up the profile in one stage (full profile), with improved safety measures and preceding follow-up, analyses and tests.

Before starting the excavation for this type, it is necessary to specify and submit for the approval of the Engineer the length of boring for blast holes.

14.1.1. 1a Tunnel Excavation for Type 4

GN200- V, VI

Excavation shall be performed by blasting and mechanically, by opening up the profile in two stages, with preliminary analyses and tests.

Before starting the excavation for this type, it is necessary to specify and submit for the approval of the Engineer the stages of work.

14.1.2. Excavations in Semi-Hard Hill Masses

14.1.2.1. Tunnel Excavation for Type 5

GN200- IV, V

Excavation shall be performed by blasting and mechanically opening up the profile in several stages with intensive safety measures and prior monitoring, analyses and tests.

Before starting the excavation for this type, it is necessary to specify and submit for the approval of the Engineer, the stages and sub-stages of work for the given type.

14.1.2.2. Tunnel Excavation for Type 6

GN200- III, IV

Excavation shall be performed mechanically. Tunnel with/without invert arch.

Manual picking off and refining, if needed.

Opening up the profile in several stages

Mandatory prior monitoring, analyses, and tests.

14.1.2.3. Tunnel Excavation for Type 7

GN200 - III

Excavation shall be performed mechanically. Tunnel with invert arch.

Manual refining, if needed.

Opening up the profile in several stages

Mandatory prior monitoring, analyses, and tests.

Before starting the excavation for any type, it shall be necessary to specify and submit for the approval of the Engineer the stages and sub-stages of work for the given type.

14.1.3. Excavation in Soft Materials

14.1.3. 1. Tunnel Excavation for Type 2

GN200- I, II, III

Excavation shall be performed with a tunnel boring machine (TBM), with a shield.

14.1.3. 2 Tunnel Excavation for Type 2.1

GN200 II, III

Excavation shall be performed mechanically, the opening up of a profile in several stages, under the protection of a tube shield.

14.1.3. 3 Tunnel Excavation for Type 2.2

GN200 II, III

Excavation shall be performed mechanically, the opening up of a profile in several stages, under the protection of a shield made of self-drilling anchor bolts

14.1.4. Tunnel Excavation in Open Cut

Excavation for tunnel type 1 – Tunnel with strip foundations

Excavation for tunnel type 1a – Tunnel with invert arch

Measurement

Excavation shall be done in conformity with profiles, tunnel types, planned levels and designed gradients, and as approved by the Engineer.

Payment

The quantity to be paid for shall be the excavated rock massif as presented by Design for given types and/or as approved by Engineer. Price shall depend on actual ground category and number of excavated stages within tunnel cross section.

14.2. Primary.tunnel lining

The work shall comprise excavated tunnel profile supporting, both locally and globally.

The following elements of preliminary tunnel lining shall be built into excavated tunnel profile:

Shotcrete with mesh reinforcement, anchors and steel ribs.

Primary tunnel lining shall accept and transfer all forces occurring around an excavated tunnel profile.

14.2.1. Mesh reinforcement MA 500/600 placing in shotcrete

The work includes placing MA 500/560 mesh reinforcement over the first layer of shotcrete (about 3.5 cm) sprayed over an excavated profile.

The mesh shall be fixed to shotcrete layer with short anchors ø12, 0.2-0.3m long, driven into rock massif trough the fresh concrete, at 0.5x 0.5 m grid.

Common rules for reinforcement shall apply, subject to inspection and approval by the Engineer.

Sections, spacing, tying and concrete cover dimensions shall be checked and submitted for the approval of the Engineer before placing the reinforcement.

Mesh reinforcement shall be accompanied with the manufacturer's test certificate, which shall be submitted for the approval of the Engineer.

Damage and deformation shall be prevented by adequate organization of transport and storage.

The reinforcement shall be wire brushed to remove dirt and grease, corrosion and other flaws.

Reinforcing steel shall comply with the Rules on technical norms for plain and reinforced concrete (PBAB/ 87), instructions for use and the approved standards:

SRPS C.K6.020	Hot rolled steel. Reinforcing steel. Technical requirements, 1987
SRPS C.K6.120	Hot rolled steel. Reinforcing steel. Shapes and measures, 1986
SRPS U.M1.091	Welded mesh reinforcement for civil works, 1986

The quality of material may also be proved in some other way if so instructed by the Engineer.

Measurement

The quantity to be paid to the Contractor at the contract unit price shall be the number of kilograms of placed mesh reinforcement with tail lengths according to drawings and specifications and as directed and approved by the Engineer.

The Contractor's unit price shall include waste from reinforcement cut, tailoring, overlaps, "S" bars.

Payment

Measured quantities shall be paid to the Contractor at contracted unit price, per 1kg of placed mesh and the payment will be full compensation for the volume and contents of the work in this item.

14.2.2. Sn-anchors

The purpose of anchor bolts is to preserve or improve mechanical properties of rock around excavated area and establish an equilibrium of forces in the ground.

To anchor rock massif means to drive metal bars in it, which will strengthen it so that it can take in the stresses that otherwise it would not be able to do for its structure and mechanical characteristics.

Effect of Anchor Bolts

To make an anchor functional it will be necessary to anchor it deep in rock massif and bring it to the intimate contact with.

The anchor part lying on a free rock massif face is called fixing head or outer head or just an anchor head.

Materials: corrugated steel grade 500 or 600 MPa. Anchor plate dimensions160 x 160 x 10 (12) mm.

Anchor tensile force shall be transferred to surrounding rock by friction of the anchor bar over the entire surface, when embedded in mortar (SN anchor).

The bearing capacity of anchor bar after a period of two hours shall be 50% of the breaking strength. If not, this shall be achieved by adding rapid setting additives to grout.

In the choice of cement mortar (grout) the composition of rock shall be considered.

Unless otherwise defined in the Design, two cubes of grout (15x15x15 cm) for 3-day and 28 day tests shall be taken.

Anchor bearing capacity determination shall take place by tensioning anchor to pullout. If not differently determined by Design, pullout check of anchors shall take place for 3% of anchors driven

Satisfactory bearing capacity shall be 80KN, unless otherwise specified for some tunnel sections by the Design.

Anchors subjected to much lighter pull-out tests shall be driven once again in the close vicinity of their pull-out points. Unsatisfactory anchor bolts will not be counted in the sum of 3%.

Place, time and location of anchor bolt tests shall be decided by the Engineer

Anchor bolts shall be monitored (pull-out test) by an accredited institution.

Separate records and protocol of anchors driving, indicating places of driven anchors, anchors length and method of driving and other shall be kept.

A protocol on anchors driving shall be incorporated in the Measurement Book.

Trial anchor driving shall be obligatory. The same is valid for anchors pull-off.

Anchor bearing plates

There are two types:

1. Flat bearing plate with round or oval hole, respectively

2. Arched bearing plate with round or oval hole, respectively.

Plates shall be placed on top of a coat of mortar and lightly tightened to rest on it and come into full contact with it.

A PVC hose 10-15 mm dia shall be placed from anchor tip to borehole outlet and protrude by about 50 cm from it. It shall let the air out during grouting and show whether the grout mix fills the area around the anchor body in borehole well.

Before any grouting starts, the borehole top shall be plugged to prevent grout leakage. Then plate with nut shall be fitted and injection started.

Grout mixing

Plastic cementations mixture can be obtained with various additives: hydrophilic and hydrophobic.

Plasticizer shall be fed to the mix in 2% increments of cement mass.

When a most suitable powder additive is chosen during an anchor driving trial, it shall be added to sand mix prior to cement.

Ratio of cement to sand shall be 1:1 (1:2), and it shall be finally defined in situ by a trial and error method, depending on actual site conditions and type of additive.

Addition of water shall depend on the additive as its presence will considerably reduce the required water quantity and make the mixture plastic and liquid, easy for transport.

Water quantity to be added shall be defined experimentally and water cement factor shall not exceed W/C = 0.34 to 0.45.

For the purpose of smooth grout transport, maximum sand grain size shall be 2 mm.

The quality of grout shall fulfil the requirements in the following standards:

SRPS U.E3.O15	Grouts for grouting.
SRPS U.M8.O22	Grouting. Testing of compressive strength of grout
SRPS U.M8.O23	Grouting. Testing of bleeding and volumetric changes of grout
SRPS U.M8.O24	Grouting. Test of flow of grout

Measurement

The contracted unit price shall cover all material, work, work force, tools, accessories and labour, as well as the quality control of driven anchor bolts (pull-out tests) as approved by the Engineer.

Payment

Payment to the Contractor shall be made at unit contract price per each anchor of appropriate diameter and length.

Following anchor types may be used for stabilization of tunnel excavation:

14.2.2.2 IBO -anchors

IBO -anchor is a steel pipe with outside round thread that have boring crown at one end, and the other end an appropriate nut and bearing plate. IBO -anchors may be united (elongated) by couplings with inside thread.

IBO -anchors shall posses declared limit force of unit: shank + nut + bearing plate (for instance 250 kN). Coupling shall have the same bearing capacity as the unit above. Anchors shall be usually manufactured of steel as per SRPS C B0 500 or of wellness tubes as per SRPS C B5 021.

Contractor shall present to Engineer for approval the proof of shank + nut + bearing plate unit bearing capacity as well as for anchor couplings.

IBO -anchors shall be used when efficient bar -anchors placing of other type would be impossible. IBO -anchors shall be placed by driving the bar into the ground without pulling. Grout, grouting pressure and grout quantity shall be determined by Contractor, depending on ground conditions and in conformity with anchor manufacturer instructions. Placing procedure shall be approved by Engineer.

Payment

Payment for IBO -anchors shall be by one piece for different types and lengths. Drilling and grouting shall not be paid separately. Auxiliary materials as bearing plates, anchor plates, nuts, couplings, shall not paid separately, but these shall be incorporated in contract unit price

14.2.2.3 Swellex -anchors

“Standard” Swellex -amchors may be used for local anchoring and rock anchoring during construction

Front plates of anchor shall enable good contact and anchor force sure transfer to shotcrete, steel arch or rock surface.

Boring holes shall be drilled to the required depths. The hole shall be cleaned of all boring remnants, mud and debris. Latest time for anchor placing shall be two hours after drilling.

Anchor placing and swelling shall take place in conformity with manufacturer suggestions. Equipment for swelling shall be as proposed by manufacturer.

Anchors shall be drained after swelling

Payment

Payment for Swellex -anchors shall be by one piece for different types and lengths. Drilling, grouting and swelling shall not be paid separately. Auxiliary materials as bearing plates, anchor plates, nuts, couplings, shall not paid separately, but shall be incorporated in contract unit price The contract unit price shall include all labour, equipment and materials for construction and work completion, testing and quality control.

14.2.3. Protection of excavated profile with jet (spray) concrete class MMb30.

General technical specifications, Sub-Sections related to shorcrete: 8.3.5.3. 8.3.5.4, and special requirements for jet (spray) concrete shall apply.

The granulometric composition of aggregate shall fall within the following limit ranges:

Grain size A - 0.15 - 9.50 mm

Grain size B - 0.15 -12.50 mm

Grain size C - 0.20 - 5.00 mm – for finishing treatment

∅ 0 – 0.2 mm = 15%

∅ 0.2 – 1.0 mm = 25%

∅ 1.0 – 3.0 mm = 35%

∅ 3.0 – 5.0 mm = 25%

The specified limit ranges for grain size may be revised, if proven justified by experimental tests through the concrete Design and subject to the approval of the Engineer.

Admixtures for Spray (Jet) Concrete

Admixtures shall meet requirements from SRPS U.E3.011 and the Rules for plain and reinforced concrete, and special requirements from these Rules. The usage of accelerators is envisaged, and plasticizers may also be used. Accelerators should meet two requirements: setting time, and hardening rank. The sprayed mix that contains an accelerator shall start setting immediately (within 1 minute at latest), and finish setting in 10 hours at most, after leaving the mixer.

The compressive strength of sprayed concrete that contains an accelerator (unless otherwise specified in the Design) shall be at least 5.0 MPa, after 6 hours.

All admixtures shall be checked during test spraying, and may be applied only if the test spraying gave positive results. If admixtures are in liquid state, they shall be batched through water injected into the nozzle. If admixtures are powders, they shall be batched into a dry mix. Admixtures are added and selected so that their action does not start before they leave the nozzle.

Preliminary Tests and Proofs

Contractor shall submit to Engineer for approval the programme of preliminary tests according to requirements from the Design. During preliminary tests, all components of concrete and equipment shall be included in the tests, and all properties of finished concrete specified in the Design shall be proved. These tests shall form a basis to prepare a mix for shotcrete. Test shotcrete shall be considered necessary. Concreted test surfaces shall serve to check personnel and equipment. Hardened concrete shall later be subjected to core testing.

If accelerators would be used, it is necessary to prove the strength of concrete at 6, 12, 24 hours, and then 3, 7, and 28 days. If accelerators would not be used, the strength of concrete shall be proved at 7 and 28 days. Concrete class shall be defined by a 20 cm cube. The final approval of a planned mix shall be issued after completed testing of all properties specified in the Design. The Engineer shall issue the approval in writing, through the Site Log.

The control testing procedure shall include the properties of sprayed concrete in a fresh, hardening state and in a hardened condition, as specified in the Design. The testing of sprayed concrete in a fresh state shall be performed at least once at every 50 - 70 m3 of sprayed concrete. The testing of sprayed concrete in a hardened condition shall be carried out on cylinders, D=12.5мm in diameter, on a series of three cylinders taken at every 50 m3 of placed sprayed concrete. The mean strength of three successively tested samples shall be higher or equal to the specified class of concrete. Each particular result shall not be less than 90% of the specified class of sprayed concrete. Compressive strength shall be tested according to SIH NORM 162/66.Tensile strength shall be tested on the same samples as for compressive strength, applying the so-called Brazilian method.

If, due to a thicker lining, the shotcrete would be applied in several layers, it is necessary to take care that a new layer is applied immediately after the bottom layer has set, not on an already hardened layer.

Measurement

The thickness of lining shall be defined by Design depending on rock properties.

Depending on rock properties, the Contractor shall foresee appropriately larger dimensions of excavations, in order to ensure, due to related rock deformations, the necessary space around the excavation for a shotcrete lining within the limits specified in the Design.

All expenses of additional excavation and protection of a needed profile shall be borne by the Contractor and be included in the unit prices.

Payment

The Contractor shall be paid at the contract price per m3 of placed shotcrete, in specified and approved thickness.

14.2.5. Protection of excavated profile with ribs.

Steel ribs constitute one of construction methods for rock stabilization around excavation. Their role is to facilitate protection of workers from unexpected collapse of ground from arch and sides. A combination of ribs and anchors, mesh and shotcrete forms a skeleton that prevents rock massif from deforming in the direction of the profile bored. Ribs shall be of high-grade steel, mostly bell-shaped ∪, beam section or lattice. They may have another form if a calculation proves that their bearing capacity, spacing and support are satisfactory. Ribs shall be joined in the way that fully preserves the arch static. Ribs shall be supported in all points of their circumference. Voids, if any, shall be filled with concrete mix as directed by the Engineer.

Measurement

Measurement shall be done by considering the theoretical weight of profile with the circumference that must be covered by a steel arch, as approved by the Engineer.

The unit price shall cover labour, overlaps, connections, bonding material and all required stiffeners.

If horizontal or tilted stiffeners are needed to tie ribs, then the weight of these selected stiffening sections shall be measured and paid at the same quoted prices and under the same conditions as support arched-ribs where approved by the Engineer.

Payment

Payment to the Contractor will be made at the unit price per kg of fixed rib.

14.2.6. Improvement of Mechanical Properties of Hill Mass - - “Jet-Grouting”

JET GROUTING is a comprehensive and efficient soil stabilization technique applied in most diverse building conditions. The essence of this technology lies in the use of a jet of cement and water that, under pressure, break the ground and become mixed together “in situ”. A conglomerate made of the ground and cement is formed in this way, with its characteristics being considerable strength and low water-permeability.

This procedure shall be applied for all ground types, including clay, dust, sand, and gravel, or their various combinations.

According to experiences to date, the depth where “JET GROUTING“ may be applied is 60-70 м1.

During the works execution, the procedure does not cause harmful vibrations. It does not require large working space. It is safe for labourers and equipment. The works might be executed next to structures in operation, without any consequences for their operation and existence.

Description of Procedure

The jet grouting procedure consists in the formation of a borehole in the ground with a specified diameter and depth. After drilling completion, a rotary drilling rod with nozzles, shall disperse stabilizing mass under pressure, when the ground structure becomes eroded and these two substances – the stabilizing solution and the eroded ground – mix together forming a new substance, mix of bonding material and ground.

There are four possible types of "JET GROUTING" depending on the type of soil to be eroded and the design of working machine, and these are:

Single fluid system

Triple fluid system

Double fluid system

Super "JET GROUTING" system

The single fluid "JET GROUTING" system is the one where the applied stabilizer serves both to erode the structure of soil and to form the mix with soil. The stabilizer is pumped into the soil under high pressure through a drilling rod with a set of nozzles located above the drill bit. Due to a high rotation speed (10-30 rpm) and high grouting pressure (20-60 MPa), a column is formed from the improved soil. Based on international experience, column diameters are within the range from 40 to 120 cm.

The triple fluid "JET GROUTING" system differs from the single fluid system in that, to erode the structure of original soil in the depth, this system uses, instead of stabilizer, water under pressure whose action is enhanced with compressed air molecules concentrated around the water jet. Compressed air extends the action of water jet. When drilling to designed depth is complete, the stabilizer is dispersed through a special nozzle, while lifting the rod.

The double fluid "JET GROUTING" procedure is the procedure that makes a combination with one and three fluids. Namely, the working method is the same as that of the single fluid procedure, but compressed air is added in the synergy with cementitious solution jet. This procedure achieves a two times faster erosion of soil structure. This procedure gives stabilized columns of 1.00 – 1.80 m1 in diameter, depending on the soil type.

The super "JET GROUTING" procedure is a modification of the double fluid system. A cementitious solution, as a stabilizer, and compressed air are pumped through special chambers in the drilling equipment.

To strengthen the soil and cement combined column created by "JET GROUTING", one steel reinforcing bar, diameter 25-32 cm, RA or GA 400/500 steel grade, may be driven through the middle of column immediately after completing the jet grouting procedure, while cement has not started setting yet.

Materials

Basic factors that serve to create columns (piles) by "JET GROUTING" are natural formations of clayey, silty, sandy, or gravelly soils, or their mixes. Eroded soil and the stabilizing compound made from water and cement, with or without any admixture, become mixed mechanical to produce the soil; with better mechanical properties. The stabilizing mix composition depends on the soil type, size of soil grains, and natural moisture. Based on the required column strength, constructed by "JET GROUTING", the cement quantity for 1 м3 of the mix of soil and cement shall be defined.

It is possible to use any stabilizer for grouting; the most often used are water-cement mixes. To achieve the soil impermeability, the most often used grout is the one made by mixing cement, water, and bentonite.

To achieve the desired effect of quality for columns, it is very important to determine the water-cement ratio. A higher water-cement ratio will produce a higher plasticity of the cement-water compound, but the ultimate compressive strength is lower.

The cement contents in the stabilized soil column plays a significant role. A higher content of cement will produce higher deformation-resistant columns properties, but the time of treatment is increased.

The higher grout pumping pressure, the spreading energy will be greater, i.e. the faster soil structure eroding. Higher pressure will not result with wider column.

Piles constructed by "JET GROUTING" procedure may be constructed individually or in groups. When they are in groups, they may be spaced or in contact. They may be in one or more rows, depending on the Design solution.

Equipment

To perform grouting by the "JET GROUTING" procedure, the Contractor shall possess equipment depending on the type of "JET GROUTING" procedure. In general, the required equipment shall cover:

A drilling rig, with a special drill rod and a timer to control the rod retrieval speed (20-50 cm/min), a nozzle support for stabilizing material.

A high-capacity pump for high-pressure water jet (70 MPa, 300l/min).

A pump for low-pressure stabilizer (7MPa, 120l/min).

A grout batcher.

A water tank.

Quality Control

To apply effectively the soil stabilizing "JET GROUTING" procedure, it is necessary to conduct preliminary controls ("preliminary tests"). Control of work shall be carried out after operation completion.

- Preliminary tests

Preliminary tests shall be agreed with Engineer before grouting operations commencement. When constructing the columns, it is necessary to test equipment and work procedure, to obtain the designed diameter and required compressive strength of the columns. For that purpose, it is necessary to test pressure under which the cement stabilizer, compressed air, and water are pumped out.

Also, the testing of rod retrieval speed shall serve to determine the diameter of grouted column. The amount of cement per 1m3 of the constructed grouted column shall be tested in order to obtain the Designed strength.

- Tests during works

In the course of construction of stabilized piles it is necessary to collect real data and surveys (computer monitoring) on the entire grouting operation, which will then serve to get important data on the time and depth of grouting. This will help in creating necessary documents for each column separately, and in checking whether the columns are constructed according to the Design.

- Follow-up tests

This testing phase includes the laboratory tests of specimens taken in situ from hardened columns for the reached strength and bulk density, and the control of achieved diameter of columns by inclined boring.

All testing shall be completed to the satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

Remedial measures shall be taken on the parts of piles where there is any variation with respect to the Design and as directed and approved by the Engineer.

Measurement

Actually constructed columns (stiffening) applying the "JET GROUTING" procedure shall be measured in m3 as approved by the Engineer.

Payment

The measured condition of actually constructed columns (stiffening) applying the "JET GROUTING" procedure, shall be paid at the agreed price given for 1 m3 of performed and approved works.

14.2.7 Pipe Shield (Pipe Umbrella)

Pipe roofing (umbrella) is composed of steel pipes that are placed with tunnel vault (calotte). It is applied with materials where initial stability of underground opening is not present (soil and very feeble rock massif). The purpose is to enable excavation of upper tunnel half avoiding the necessity for opening development within the zone.

Perforated steel weldless pipes with outer diameter 114,3 mm (4'') and wall thickness 5 mm at least. The steel shall be Č1213 as per standard SRPS C. B5.021.

Pipe roofing shall be placed as presented with drawings in Design, or as instructed by Engineer.

Steel pipes shall be placed simultaneously with boring in the way that central or eccentric crown pulls behind the pipe into borehole.

Steel pipes shall be placed from the driving front towards non-excavated ground. In non-stable boreholes steel pipes may be used as borehole formwork. The distance between steel pipes in excavation profile apex shall conform to the distance presented in drawings, but also adapted to geologic conditions on tunnel front.

Steel pipes shall be cleaned after boring by compressed air before grouting. The grouting shall be carried out under low pressure.

Payment

Pipe shield shall be paid by number of drilled and grouted pipe of real length or otherwise, as directed by Engineer.

14.2.8 Micro Piles

Micro piles shall be placed in bas of upper gallery with shallow layer zones and-or under houses. Micro piles transfer loads from shotcrete structure to surrounding rock massif, reducing that way shotcrete structure settlements in upper gallery and shear risk between upper gallery structure and temporary invert arch. Simultaneously they increase sidewalls safety during bench excavation.

Micro pile is composed of weldless steel pipe with wall thickness at least 6 mm. Steel pipe shall be completely grouted by mortar. Borehole diameter shall conform to external pile diameter.

Steel grade for pipe shall be determined by Design, in conformity with standard SRPS C.B5.02. IBO anchors may be used for micro piles.

Steel pipes shall be placed in previously bored holes or self-drilling anchors might be used (for instance, IBO). Corrugated pipe of steel or PVC with internal diameter q20 mm or more shall be placed in shotcrete lining as to ease boring.

Tests are necessary before placing as to prove that steel piles are completely covered by mortar. The number of piles tested and testing procedure shall be proposed by Contractor and shall be approved by Engineer.

Payment

Micro piles shall be paid by piece for different type and length

14.2.9 Steel Pipes or Spears

Steel pipes or spears are safety elements that are placed before any excavation work. They shall be applied when rock and earth material condition might demonstrate tendency to result with over-profile excavation, fall down or material impact immediately after excavation.

Welded steel pipe of nominal diameter 42,4 mm and 48,3 mm shall be used. Wall thickness shall be at least 3 mm. The length of steel pipes/spears shall be at least 1,0 m longer than estimated excavation stage. Pipe steel quality shall conform to SRPS C.B5.025

Spears of deformed steel bars might be used instead steel pipes. The minimal spear diameter shall be 25 mm. Steel pipes or spears shall be placed into prior bored holes. Pipe filling by mortar before or after pipe placing, shall be determined by Contractor, as agreed with Engineer.

Payment

Pipes or spears shall be paid by piece for different length. Boring and grouting shall not be paid separately. The Contract Unit Price shall include all labour, equipment and materials as necessary for construction and work completion, testing and quality control.

14.3. Concrete and Reinforced Concrete

General Conditions and Special Provisions from these Technical Specifications, Section 8, shall be in force.

14.3.1 Placing concrete in Footing of Primary Lining,

The description of works refers to the footing of primary lining for Type 1.

The work shall be executed in one-sided formwork.

The foundation pit shall be protected against all types of water during placing concrete and concrete setting.

Concrete shall meet the Design requirements regarding grade, resistance to water absorption, frost, and salt.

The concrete placing may start when the Engineer inspects and approves the reinforcement put in place.

Concrete shall be placed in 30 cm high layer and compacted with an immersion vibrator.

The Engineer will not allow concreting if the Contractor does not have at least one functional STAND-BY immersion vibrator at his disposal.

Concrete shall be mixed mechanically.

Transport shall be organized in such way to ensure the homogeneity of mix and prevent segregation.

Concrete shall be placed before the setting process starts.

The type of checks and tests according to the prepared and accepted concrete Design shall be submitted for the approval of the Engineer.

All testing shall be completed to the satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

Measurement

The quantity to be paid is the number of cubic meters of placed concrete, measured on site and approved by the Engineer.

Payment

The quantities determined in the above-described way shall be paid at Contract Unit Prices stated for respective units of measurement, and the unit prices shall make a full compensation for all work on the procurement, transport, placement, and curing of concrete, and any pumping of water out of the foundation pit.

14.3.2 Reinforcing Footing of Primary Lining, P.A. 400/500, M.A. 500/560

The work under this item includes the reinforcement of footing of the primary lining.

General specifications for reinforcing steel shall apply.

Before making the reinforcement, the Engineer shall check the number of rods, spacing, tying method, and thickness of cover.

Reinforcing rods (mesh reinforcement) shall be provided with the Manufacturer's compliance certificates which shall be submitted for the approval of the Engineer.

Transport and storage shall be organized in such a way to avoid any damage and deformation.

Before fixing reinforcing steel, it shall be cleaned from any dirt and grease, corrosion, and any other damage.

Reinforcing steel shall be in compliance with the Rules on technical norms for plain and reinforced concrete (PBAB/87), instructions for use, and related standards:

SRPS C.K6.020 Hot rolled steel. Reinforcing steel. Technical requirements. 1987

SRPS C.K6.120 Hot rolled steel. Reinforcing steel. Shape and dimensions. 1986

The grade of material shall be proved in other ways as well, if so agreed and instructed by the Engineer.

Measurement

The quantity to be paid to the Contractor at the agreed unit price is the number of kilograms of placed reinforcing steel, as shown on drawings and stated in specifications, i.e. reinforcement schedules, i.e. as determined and approved by the Engineer.

The Contractor shall include in the unit price for reinforcing steel, waste that he will have in cutting and bending reinforcing steel, overlaps, and "S" steel pieces.

Payment

For the quantities determined in this way, the Contractor will be paid at the Contract Unit Price (for 1 kg) that makes a full compensation for the scope and contents of works given under this item.

14.3.3. Placing Concrete in Primary Lining –open Cut

The tunnel structure completed shall be post-filled by chosen excavation material (crushed material and stone pices < 130mm)

Placing concrete shall take place in double-sided formwork.

The tunnel arch construction shall be concreted under steel formwork on a mobile platform in 6.0m rings. The formwork Design and the Design of working platform with sliding technology are necessary and shall be provided by the Contractor, and submitted for approval by the Engineer and Designer.

Before starting the concreting of lining, the Contractor shall submit to the Engineer for approval, certificates on proper functioning and quality of all elements for the execution of this type of works (certificate on suitability of formwork, scaffolds, certificate on required functioning of external or immersion vibrators).

Certificates shall be issued by an authorized institution for this type of works.

The quality of formwork shall be such that concrete is left with a smooth surface after its removal.

The rings shall be joined with a tongue-and-groove system, or by overlaping of longitudinally positioned reinforcing steel, 1.20 m in length, or in any other way agreed with the Engineer.

Formwork shall be coated with appropriate agents for easy release from concrete. The release agent shall have the compliance certificate issued by an authorized laboratory.

Formwork shall have horizontal, vertical, and diagonal braces to prevent any deformation.

Material used to joint concrete shall have appropriate certificates for this type of work.

The Concrete DESIGN, prepared by the Contractor, and approved by the Engineer, shall define all operations in time and space (formwork removal time, time and method of curing and protection of concrete, appearance of visible surfaces...)

The placement of concrete shall start only when the Engineer approves formwork, scaffolds, reinforcing steel.

General technical requirements for plain and reinforced concrete shall be met in full.

Measurement

The quantity to be paid is the number of cubic meters (m^3) of placed concrete, measured on site and approved by the Engineer.

Payment

The quantities determined in the above-described way shall be paid at agreed unit prices stated for respective units of measurement, and the unit prices shall make a full compensation for all work on the procurement, transport, placement, and curing of concrete, scaffolds, and formwork.

14.3.4. Reinforcing of Primary Tunnel Lining,

General specifications for reinforcing steel

The works included in this Sub-Section of Technical Specifications consists of the procurement of plants, equipment, material, and labour, and the execution of all operations related to reinforcing steel, in conformity with Conditions of Contract, and in full compliance with this Sub-Section of the Technical Specifications, drawings, and the Engineer's instructions.

Reinforcing steel shall be in compliance with the rules on technical norms for plain and reinforced concrete (PBAB/87), instructions for use, and related standards:

SRPS C.K6.020 Hot rolled steel. Reinforcing steel. Technical requirements. 1987

SRPS C.K6.120 Hot rolled steel. Reinforcing steel. Shape and dimensions. 1986

SRPS U.M1.091 Welded mesh reinforcement for construction. 1986

The quality of material shall be proven in another way as well, if so agreed and instructed by the Engineer.

All reinforcing steel shall be put in place according to drawings from graphical documents of this Design. The Designed concrete cover requirements shall be met. A gap, at least 3.5-4.0 cm, shall be left between profiles for proper placement of concrete.

The Contractor shall tie wires around all intersected reinforcing bars to ensure that their position is not disturbed during concreting. .

The placement of pieces of gravel or rock between formwork and reinforcing cages is forbidden. “S” steel pieces shall be used to accurately place and space reinforcement.

If there is no detailed reinforcement drawing for any item of works, the Contractor shall prepare and submit it to the Engineer for approval before putting the reinforcement in place.

Concreting shall start when the Engineer approves the implemented arrangement of reinforcing cages in writing.

For reinforcing concrete structures and elements, wires and rods made of smooth steel, G.A. 240/360, high-strength naturally hard ribbed steels, grade 400/500, and welded mesh reinforcement made of cold drawn wire, grade 500/600, shall be used.

Before putting reinforcing steel in place, the Contractor shall submit to the Engineer for approval a quality certificate for procured reinforcing steel.

The certificate shall be issued by an institution authorized for this type of works.

Reinforcing steel shall be protected against damage at all times, be free from dust, loose flakes and rust, paint, oils, or other foreign materials.

Reinforcing rods shall be cut and bent carefully by a qualified person. They shall be bent in cold according to pattern, and shall not vary noticeably from shape and dimensions shown on drawings.

Measurement

The quantity to be paid to the Contractor at the agreed unit price is the number of kilograms (kg) of placed reinforcing steel, as shown on drawings and stated in specifications, i.e. reinforcement schedules, i.e. as determined and approved by the Engineer.

The Contractor shall include in the unit price for reinforcing steel, waste that he will have in cutting and bending reinforcing steel, and “S” steel pieces.

Payment

For the quantities determined in this way, the Contractor will be paid at the agreed unit price (for 1 kg) that makes a full compensation for the scope and contents of works given under this item.

14.3.5 Concrete Placing in Footing of Secondary Lining MB35, V8, M100

Everything as specified for Sub-Section 14.3.1 shall apply.

14.3.6 Reinforcing Footing of Secondary Lining, R.A. 400/500, M.A. 500/560

Everything as specified for Sub-Section 14.3.2 shall apply.

14.3.7 Concreting Secondary Lining,

Concrete shall be placed in one-sided formwork.

The tunnel arch construction shall be concreted under steel formwork on a mobile platform in 6.0m rings. The formwork Design and the Design of working platform with sliding technology are necessary and shall be provided by the Contractor, and submitted for approval by the Engineer and Designer.

Since these are exposed surfaces, formwork shall also be fabricated for that purpose, in order to leave, after its removal, a flat concrete surface, visually regular arched lines, and even texture of concrete.

The placement of concrete may start only when the Engineer approves formwork, scaffolds, and reinforcing steel.

Concrete shall be placed in 30 cm high layers, and compacted with immersion vibrators.

General technical specifications for plain and reinforced concrete shall be fully complied with.

Measurement

The quantity to be paid is the number of cubic metres of placed concrete, measured on site and approved by the Engineer.

Payment

The quantities determined in the above-described way shall be paid at agreed unit prices stated for respective units of measurement, and the unit prices shall make a full compensation for all work on the procurement, transport, placement, and curing of concrete, scaffolds, and formwork.

14.3.8 Reinforcing Secondary Lining, R.A. 400/500, M.A. 500/560

Everything as specified for Sub-Section 14.3.4 shall apply.

14.3.9 Concreting Precast Round Segments of Tunnel Lining MB40, V8, M100

Tolerance with segment dimensions shall be 0.2 mm.

General technical specifications for plain and reinforced concrete shall be fully complied with.

Specifications from Sub-Sections 8.3.6, 8.3.6.1.-8.3.6.1.5 Precast Concrete Elements shall be fully complied with.

Specifications from Sub-Section 8.10 shall be complied with.

14.3.10 Reinforcing Precast Round Segments of Tunnel Lining, R.A.400/500, M.A.500/560

Everything as specified for Sub-Section 14.3.4 shall apply.

Sub-Sections 8.3.6.1.1 - 8.3.6.1.5, and Sub-Section 8.10 of these Technical Specifications shall be fully complied with.

14.3.11 Concreting Footing of Tunnel Refuges MB35, V8, M100

Everything as specified for Sub-Section 14.3.1 shall apply.

14.3.12 Reinforcing Footing of Refuges, R.A. 400/500, M.A. 500/560

Everything as specified for Sub-Section 14.3.2 shall apply.

14.3.13 Concreting Secondary Lining in Refuges MB35, V8, M100

Concreting shall be performed in one-sided formwork.

The formwork Design is necessary and shall be provided by the Contractor, and submitted for approval by the Engineer and Designer.

Since these are exposed surfaces, formwork shall also be fabricated for that purpose, in order to leave, after its removal, a flat concrete surface, visually regular arched or straight lines, and even texture of concrete.

The placement of concrete may start only when the Engineer approves formwork and reinforcing steel.

Concrete shall be placed in 30 cm high layers and compacted with vibrations, and then the procedure shall be repeated in agreement with the Engineer.

General technical specifications for plain and reinforced concrete shall be fully complied with.

Measurement

The quantity to be paid is the number of cubic metres of placed concrete, measured on site and approved by the Engineer.

Payment

The quantities determined in the above-described way shall be paid at agreed unit prices stated for respective units of measurement, and the unit prices shall make a full compensation for all work on the procurement, transport, placement, and curing of concrete, scaffolds, and formwork.

14.3.14 Reinforcing Secondary Lining of Refuges, R.A. 400/500, M.A. 500/560

Everything as specified for Sub-Section 14.3.4 shall apply.

14.3.15 Concrete of Channel Segments under Service Paths MB35, V8, M100

These precast elements shall be tied (fixed) with reinforcing steel to the adjacent reinforced concrete elements. The way to perform such tying up shall be agreed with the Engineer.

General technical specifications for plain and reinforced concrete shall be fully complied with.

Specifications from Sub-Sections 8.3.6.1.1-8.3.6.1.5 Precast Concrete Elements shall be fully complied with.

Specifications from Sub-Section 8.10 shall be complied with.

14.3.16 Concrete of Round Shaft for Reception of External Drainage Water

Concrete shall be placed in two-sided formwork. Concrete shall be placed in 20 cm high layers, and compacted with immersion vibrators.

General technical specifications for plain and reinforced concrete shall be fully complied with.

14.3.17. Concrete of Shaft for Reception of External Drainage Water behind Secondary Lining

Concrete shall be placed in single-sided formwork.

Precast shafts might be used also, if all necessary conditions are fulfilled (constant longitudinal gradient and cross fall in tunnel)

Everything as specified for Sub-Section 14.3.16 shall apply.

14.3.18. Plain Concrete under Foundations, Invert Arch, Channels, and Other Reinforced Concrete Structures

General specifications for concrete shall apply.

The foundation pit shall be protected against all types of water during placing concrete and concrete setting processes.

Concrete shall comply with the Design requirements regarding the class.

The placement of concrete may start after the Engineer approves the excavated foundation pit.

Concrete shall be placed in 10-30 cm high layers (depending on the overall height of plain concrete) and shall be compacted with an immersion vibrator.

Measurement

The quantity to be paid is the number of cubic meters of placed concrete, measured on site and approved by the Engineer.

Payment

The quantities determined in the above-described way shall be paid at agreed unit prices stated for respective units of measurement, and the unit prices shall make a full compensation for all work on the procurement, transport, placement, and curing of concrete, and any pumping of water out of the foundation pit.

14.3.19. Concrete above Drainage Pipes, MB10

This item of works refers to concrete around and above drainage pipes.

The description of works is in compliance with General Specifications for concrete works within these Technical Specifications.

Measurement

The quantity to be paid is the number of cubic meters of concrete of grade MB10, fully completed and approved by the Engineer.

When calculating quantities for payment, the Designed dimensions shall be used, or the Engineer’s instructions shall be followed.

If concrete reaches a higher grade, only the required grade shall be recognized for payment.

Payment

The quantities determined in the above-described way shall be paid at agreed unit prices stated for respective units of measurement, and the unit prices shall make a full compensation for all material, work, and use of machines, equipment, and tools

14.4. Waterproofing

14.4.1. General Characteristics of Waterproofing Membrane

Waterproofing for tunnel structure shall be done with new technology materials, which will come with test certificates issued by accredited institutions in EU and submitted for the approval of the Engineer.

Such materials shall be supplied with quality attest issued by accredited institutions in Serbia.

Quality testing of such materials shall take place on specimens taken from batch, delivered for use on site.

For tunnel structure waterproofing might be used prefabricated materials (bitumen-based membranes, PVC or polyethylene - HDPE or LDPE membranes), or sprayed waterproofing materials.

Waterproofing membrane shall be: d= 1.5 mm, 2.0 mm, 2.50 mm

Minimum general properties that a watertight membrane shall meet are:

1. Bubble-free exposed surfaces
2. Extension – stretch > 200%
3. Outer exposed surface without scratches and pits.
4. Frost resistance: no fissures when rolled (∅20mm), -20°C
5. 6-hour temperature stability at 80 °C (no surface changes or discolouring).
6. Breaking strength tested in two directions >15N/ mm2.
7. 72-hour long water tightness property at 4 bar pressure

The waterproofing membrane shall be made of thermoplastic polyolefins (low density polyethylene) and be highly flexible.

It shall be easy for welding, of good mechanical characteristics, provided with signal tape.

The membrane must contain polymer antioxidant and thermal stabilizers.

The product shall not contain plasticizers and fillers that may migrate with time.

The product must satisfy fire fighting requirements according to DIN 4102 standard.

Special requirements for technical characteristics of a waterproofing membrane are summarised in the following table:-

Waterproof membrane characteristics -LDPE

Surface		Smooth		
	Tested properties	Unit	Test method	Value
	Density (white)	g/cm³	ASTM D 792 UNE EN ISO 1183-1	0,900-0,920
	Density of geomembrane	g/cm³	ASTM D 792 UNE EN ISO 1183-1	0,910-0,930
	Flow index during melting	g/10min	ASTM D 1238, 1905,00-1902,16 UNE-EN ISO 1133, 1905,00-1902,16	≤2,5 - ≤0,7 ≤2,5 - ≤0,7
	Soot content	%	ASTM D 218	0,2-0,3
	Dispersion		ASTM D 596	A1 / A2
	Soot content		UNE 53131	≤4
	Oxidation induction time	min	ASTM D 3895	
	Resistance to cracking under strain	h	ASTM D 1683 ASTM D 5397	> 3000 > 300
	Resistance to ozone		ASTM D 1149: 7d 100 ppm	No cracks
	Brittleness at low temperatures		UNE 104302	[no cracks
	Water absorption	%	UNE-EN ISO 62	≤0,1
	Coefficient of longitudinal thermal expansion 10^n(n=-4)	1/° C	ASTM D 696	-
	Dielectric constant		ASTM D1248	-
	Unevenness	mm	GRI GM12	-
	Coextruded layer thickness	%		50
	Self-destruction	-	DIN 4102	B1/B2

Waterproofing membrane characteristics and properties-LDPE

	Tested properties	Unit	Test method	Value		
	Thickness	mm	ASTM D 751 UNE 53213-2	1,5	2,0	2,5
	Tolerance	%			±4	
	Tensioning properties					
	Breaking tension force	N/mm	ASTM D 638 Type IV	-	-	-
	Breaking elongation	%			-	
	Limit tension force	N/mm	UNE-EN ISO 527 Type V	35(33)	46(44)	58(55)
	Limit elongation	%		800-900 (>800)		
	Cleavage resistance	N	UNE 53516 ISO 34-1	100(96)	134(128)	167(160)
	CBR	kN	UNE-EN ISO12236	2,2	3,0	3,7
	Strength of short duration	-	UNE-EN ISO 868	40(38)		
	Stability of dimensions	%	ASTM D 1204(1h, 80°C) UNE 104302(1h, 80°C)	±2		

Physical and mechanical properties of thermoplastic PVC foil

Property		Requirement	Testing method
Eveness -maximum		50 mm	DIN 16726
Breaking strength (longitudinal and transversal) - minimum		10 N/mm^2	DIN EN ISO 527-3
Tensile (longitudinal and transversal) - minimum		200%	DIN EN ISO 527-3
Shearing test		Cracking outside joints	DIN EN ISO 527-3
Water pressure; at 5.0 Bars- 72 hours		Immpereable	DIN 16726
Punching resistance; at 750 mm high		Immpereable	DIN 16726
Bending at low temperatures		No cracks identified	DIN 16726
Behaviour after being exposed to 80°C	Visual evaluation	No bubbles identified	
	Change in sizes (longitudinal and transversal) - mahimum	3%	DIN 16726
	Change of tensile strength (longitudinal and transversal) – maximum	± 20%	DIN 16726 DIN EN ISO 527-3
	Change of elongation (longitudinal and transversal) - maximum	± 20% (rel.)	DIN 16726 DIN EN ISO 527-3
	Bending at low temperatures	No cracks identified	DIN 16726
Behaviour after being treated with water solutions	Change of tensile strength (longitudinal and transversal) - maximum	± 20%	DIN 16726 DIN EN ISO 527-3
	Change of elongation (longitudinal and transversal) - maximum	± 20% (рел.)	DIN 16726 DIN EN ISO 527-3
	Bending at low temperatures		DIN 16726

14.4.2. Waterproofing in Open Cut Parts of Tunnel

Waterproofing membrane shall be placed:

1. On outer side of tunnel structure in open cut

The base on which waterproofing membrane should be placed must be prepared first. Preparation shall comprise all unevenness removal – sharp edges, pots, etc. Surface shall be clean, without any cement, oil, lime traces, or other impurities. Waterproofing shall be properly protected against any possible mechanical damage during tunnel structure fill.

Inside tunnel structure in open cut

2. On inner side of tunnel structure in open cut

In such case the waterproofing shall be between primary tunnel structure, constructed in open cut, and secondary lining. Waterproofing **shall be placed same way as in underground constructed tunnel section (Bored Parts).**

14.4.3. Waterproofing of Bored Parts of Tunnel

For bored parts of the tunnel, the membrane shall be placed over the primary tunnel support, but only when determined that the tunnel profile achieved the state of equilibrium with surrounding hill mass.

Between jet concrete and membrane, geotextile shall be placed (300 gr/m2) as a protective base for the waterproofing membrane. This geotextile also plays the role of a filtration layer.

Then, round plastic discs with steel nails shall be hammered.

The waterproofing membrane shall be welded to the base over plastic discs with hot air, using a wedge machine specifically Designed for this purpose.

This membrane shall have a certificate issued by recognized international and national authorized institutions, specialized for this type of works and submitted for the approval of the Engineer.

This waterproofing membrane is practically sandwiched between the primary and secondary tunnel linings and conducts water from rock mass into the tunnel drainage system.

Measurement

The quantity payable to the Contractor at the unit price will be the number of square meters of placed waterproofing measured in situ and approved by the Engineer.

Payment

The contracted unit price shall cover procurement of main and other kinds of material, tools, accessories and labour.

14.4.4. Sprayed waterproofing membrane

MASTERSEAL 345 (MEYCO-BASF) or Similar
Chemical base - E.V.A.- ethylene vinyl acetate
Dispersion will be ordered already prepared from manufacturer. Water added percentage should be between 24 and 50% of the product eight,

Extent of Activity:
The product is an elastic watertight membrane that should be applied by spraying. It may be used both with shotcrete or/and “in situ” concrete.

Application:
- Facility surfaces prepared with shotcrete;
- Replacement for foil membranes;
- Intercalations with layered structures (concrete/membrane/concrete);
- In tunneling, when shotcrete would be used;
- For waterproofing of facilities that are constructed of shotcrete with complex geometry;
- Directly on rock, after mine firing;
- Directly on steel, for example: anchor heads, iron joints, etc;

Description and Functioning:

Waterproof membrane applicable by spraying using the equipment for dry application;

Extraordinary elasticity and high pull-off resistance on both linings (primary and secondary one);

Powder without any harmful matter, usable within very small rooms;

Hardening by a chemical process within 4-6 hours, depending on environment conditions. Afterwards it can be coated by shotcrete or by “in situ”

concrete;

Membrane attains final strength after one week approximately;

Membrane may be applied on wet surfaces also.

On the occasion of stronger water penetration, the combined use is recommended with polyurethane based injection systems.

Technical data:
Delivery form…………………………………powder
Color………………………………………light brown
Water pressure resistance…………………….5 bar
Density (at 20°C)………………………..590±100 g/l
Consumption (powder) by m²…………..0,72kg/mm
Layer thickness……………………………3 – 6 mm
Usable at temperature………………….+5 to +40°C
Compressive strength (at 20°C)……..1,5 –3,5 MPa
Breakpoint deformation………….. (@ 20°C)>100%
Adhesion to concrete strength (7days)…1,2 ± 0,2 MPa
Limit hardness…………………………………...80±5
Fire risk (DIN4102,B2)…………..Self-extinguishing

14.5. Drainage and De-watering

This item includes all materials, accessories and labour needed to install a drainage system and connect it to main discharge outlet through a manhole or directly to a drainage channel.
.

Materials shall comply with SRPS standards and the relevant subsections in this specification. Drain pipes shall be used as interceptors as shown on Design drawings.

The Contractor shall check whether the levels of excavation comply with the Design prior to the commencement of the works and request the approval of the Engineer.

Drain pipes shall be laid on a blinding course of concrete class MB 20 as to enable water drainage and channelling to interceptor and discharge outlet into the tunnel drainage system.

Drain pipes shall be perforated at top half and joints shall not be grouted except the connection with the manhole.

Drain pipes shall be wrapped with geotextile (300 gr/m3)

As detailed in Design, mono concrete (MB10) shall be placed on top of drain pipes or mono-granular gravel serving as a pre-filter for percolating and ground water.

These pre-filters shall be fixed very carefully to avoid damage to drain pipe and impairment of its function.

Material for drain pipes: PVC, and/or HDPE - high density polyethylene.

Measurement

Measurement will be done per m of pipe length actually measured and approved by the Engineer. Manholes shall be measured per each completed manhole as approved by the Engineer.

Payment

Drain pipes will be paid per contracted unit prices per 1 m of length and shall cover work and materials so that the Contractor will not be entitled to any additional compensation. Manholes shall be paid per each completed manhole.

14.6. Miscellaneous

14.6.1. Contact Grout for Filling Up Gap between Segments and Bored Profile in Hill Mass When Installing Segments with TBM

Prior to application, the grout shall be tested by trial installation. Compactness, adhering and plasticity shall be tested.

Depending on the geological structure, the Engineer shall set the quality requirements that this grout should meet andthe proof of contact grout quality according to requirements from the following standards:

SRPS U.E3.O15 Grouts for injection grouting. Technical requirements

SRPS U.M8.O22 Grouting. Testing of compressive strength of grout.

SRPS U.M8.023 Grouting. Testing of bleeding and volumetric changes of grout

SRPS U.M8.024 Grouting. Testing of flow of grout

A mandatory admixture to such contact grout is Bentolit that gives water-impermeability to this mix.

Aside from its role to produce a surface peripheral interconnection of concrete segments and excavated tunnel profile, this contact grout also interconnects precast concrete segments crosswise and lengthwise, thus creating conditions for the redistribution of a part of pressure of the relieving hill arch from the segments to this grout.

This contact grout also reduces and balances the total settlement of the tunnel structure.

Measurement

The quantity to be paid to the Contractor at the agreed unit price is the number of m3 of placed contact grout, measured on site (at the end-of-pipe from the grouting machine) and approved by the Engineer.

The quantity recognized is the volume of the mass of the outer radius, 10 cm thick, with a 10% variation.

2xR1 x 0.10 x 1.10

R1= outer diameter of the tunnel segment

Payment

The agreed unit price shall include the procurement of materials and auxiliary materials, tools, accessories, and labour.

14.6.2. Fire Protection of Internal Tunnel Lining

This protection is achieved by applying a 3.5 cm thick layer

The layer shall be applied in two runs. The first run, 2.5 mm thick, a minimum 24hour break for hardening, and then achieving designed thickness.

The base shall be dry. Dampness on the base shall not be allowed either.

The compound is a chemical mix of calcium silicate and resistant agents that withstand temperatures of 1200°C – for 60 minutes with all the characteristics and quality standards as specified in the following tables.

The layer is applied with a robotic machine.

The layer shall be distributed uniformly around the tunnel space, and of uniform texture.

This layer shall be resistant to aggressive gases that may appear in the tunnel.

The chemical compound shall be tested in Serbian institutes for compliance with all the characteristics and quality standards as specified in the following tables.

The chemical compound for this layer shall be environmentally harmless in set – hardened condition.

Core sampling for tests, after the compound hardens, is mandatory to ensure compliance with all the characteristics and quality standards as specified in the following tables.

Workers and technical staff present during this operation shall wear protective masks.

Before applying this protective layer, the lining shall be washed from any dirt.

Fire-Protection Mortar Characteristics

Colour and finish layer	Almost white, monolithic spraying texture, finishing layer may be smooth or with a roller
Minimum actual thickness	8 mm without reinforcement, 15mm with reinforcement
Theoretical coverage	62m2/tonne for 25mm thickness
Cleaning	With a hydraulic kit
Initial settings	2-6 hours at 20°C and 50%RH
Density (normal)	775kg/m3 ±15% (when dry and in place)
Corrosion resistance	Does not cause corrosion of metal, even recommended for corrosion protection
pH value	12.0-12.5
Sound absorption	Sound reduction coefficient 0.35
Fire protection	Concrete and steel structures that are protected may ensure resistance to fire for up to 240 minutes. They do not release toxic and destructive fumes and are not health hazards before, during and after application. They are applied throughout the world and are subject to the following standards: - UK (BS 476; Section 20-21; 1987, Appendix D) - International Standards ISO 834 - Holland, RWS (Fire protection test for tunnels, Procedure GT-98036-1a) - France. Hydrocarbon modified HCM - Italy (UNI 11076) - USA (ASTM E119, UL263 and UL 1709 – Proj. No. HR719)

Preparation

Typical bases	Concrete and steel
Preparation of base	The base shall be clean, dry, and free from visible drops (including condensate), concrete particles, oils from reinforcing steel, rust, and other conditions that prevent good adhesion
Mesh reinforcement	All fire tests were done on the protection without mesh to prove good properties and that it stays undamaged under most fire conditions. Low-bearing -HDPE mesh is recommended for outer works and for inner when vibrations are high, with a high possibility of mechanical damage.

Application

First steps	The application shall be under supervision and implementation by a person from the Supplier's factory, operating under the management and control of the Contractor and subject to the approval of the Engineer.
Methods	- Mix with water in an appropriate mixer and apply by spraying mechanically - Finish may be as sprayed, skimmed, or patterned - For minor repairs, use mix for application by hand
Limits	May be used at temperatures of the base of 2°C and higher, but shall not be applied at ambient temperature below 4 °C. Maximum temperature of the base and air is 50 °C

Measurement

The quantity to be paid to the Contractor at the agreed unit price is the number of m2 of the constructed protection system, measured on site and approved by the Engineer.

Checking of thickness by inserting the steel needle of 1.5mm in diameter at 100m^2 intervals of the placed layer immediately afeter placing but not later than 1 hour after the machine placing the fire protection mortar stops operation.

Payment

The Contract Unit Price includes the procurement of materials and auxiliary materials, tools, accessories, machines, and labour.

14.6.3. Steel Lattice for TBM to Press Against in the Beginning Phase of Tunnelling

Steel lattice shall be made of steel, Č363

The lattice elements are hot rolled sections- SRPS C.B3.131

The lattice shall be fixed to the concrete base with M22.10.9 bolts over an adequate contact plate.

The Contractor shall provide the lattice, according to the type of TBM selected for work. Shop drawings for the assembly of lattice and its fixing shall be submitted for approval by the Engineer and Designer.

Measurement

The quantity to be paid to the Contractor at the agreed unit price is given per 1 kg of mounted steel, measured on site and approved by the Engineer.

Payment

The agreed unit price shall include the procurement of materials, auxiliary materials, tools, accessories, and labour.

14.6.4. Steel Panels Made of Sheet Steel

The panels are made of flat, wide steel Č 363 as specified in the Design and as shown on the Design Drawings.

The panels shall be installed into concrete segment during precasting.

During the opening (excavation) of a refuge for the removal of vehicles, steel panels shall be straighten up to ensure a connection with the primary lining of the refuge (ribs and concrete lining)

Measurement

The quantity to be paid to the Contractor at the agreed unit price is given per 1 m2 of incorporated panels, measured on site and as approved by the Engineer.

Payment

The agreed unit price shall include the procurement of materials, auxiliary materials, tools, accessories, and labour.

14.6.5. Contact Grouting

Grouting shall take place as to achieve:

- A full bond between the tunnel segment and surrounding mass;
- Water-impermeability of the contact area;
- Tightening sand-containing, gravel-containing and mud-containing layers;

Grouting shall take place using:

- Low-viscosity hydro mortar based on colloidal silica;
- Highly reactive two-component polyurethane foam.

Mixing of grout

In order to obtain a plastic cement mix various admixtures are added: hydrophilic and hydrophobic.

Plasticizers are batched in the units of weight, as 2% of the weight of cement in the mix

Once the most suitable powder admixture is selected through test grouting, it is added into the mix of sand before adding cement.

Cement mix to sand ratio is 1:1 (1:2), which shall be determined by trial, according to actual conditions on the site and the type of admixture.

The addition of water depends on the addition of admixtures, since the presence of admixtures substantially reduces the need for adding water, and makes the mix more plastic and fluid, with the possibility of easy transport.

When the compound hardens, it expands to a certain degree that may be up to 0.3 %.

The addition of water shall be determined experimentally, and the water/cement ratio shall not exceed W/C = 0.34 – 0.45

To transport grout without major problems, a maximum sand grain size shall be 2 mm, whereas quartz sand shall be sieved through 2 mm mesh sieve.

The proof of grout quality according to requirements from the following standards:

SRPS U.E3.O15 Grouts for injection grouting. Technical requirements

SRPS U.M8.O22 Grouting. Testing of compressive strength of grout.

SRPS U.M8.023 Grouting. Testing of bleeding and volumetric changes of grout

SRPS U.M8.024 Grouting. Testing of flow of grout

All testing shall be completed to the satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

Measurement

The quantity to be paid to the Contractor at the agreed unit price is the number of m3 of placed grout for 1 m of performed contact grouting measured on site and as approved by the Engineer.

Through test grouting, depending on the characteristics of the geological environment, the Engineer shall prescribe the average consumption (m3) of grout for injecting for the length of 1m of grouting

Payment

The agreed unit price shall include the procurement of materials, auxiliary materials, tools, accessories, and labour.

14.6.6 Grouting for Consolidation

Segments and spots in tunnel that shall be grouted for consolidation shall be determined by Engineer. Boreholes grid, their depth, boring direction, grout composition and grouting pressure shall be determined by Design or by proposal prepared based on trial section.

Grout composition shall be determined by proposal for grouting work that shall be based on geo-technical properties of rock massif; it may be cement suspension, cement mortar, or a mix based on clay suspension, with or without additives, combined with cement. Grouting mixes shall be tested and checked during the work.

Grouting shall take place as to achieve same pressures on primary lining vault circumference, if possible.

Control of grouting for consolidation success shall be carried out using test borings with pressure test, when the watertightness of grouted rock shall be determined.

No work on grouting for consolidation shall be accepted for payment to Contractor on rock where the rock instability was produced by himself, disregarding regulations for excavation and supporting (bad blasting, incorrect excavation protection, etc)

All expenses for: installing, moving and dismantling of necessary equipment and scaffolds, tidy closure by cement mortar of all grouting boreholes along the entire length, cleaning of cement suspension from boreholes in concrete lining, cleaning debris and grout remnants in tunnel, all obstructions and breaking due to parallel work – shall be incorporated by Contractor into unit price for boring and grouting, for such expenses shall not be accepted for payment.

Grouting quality shall be as regulated by following standards:

SRPS U.E3.015 Grouting Mixtures. Technical Specifications

SRPS U.M8.022 Grouting. Compressive Strength Testing of Grouting Mixtures

SRPS U.M8.023 Grouting. Water Separation Testing; Volume Changes of Grouting Mixture

SRPS U.M8.024 Grouting. Grouting Mixture Flow Test

Measurement

Measurement and payment for grouting work shall take place following items of Cost Estimate from Contract, by 1 m' (one linear meter) of boring, and by quantity in kg (kilograms) of grouting mix used, all based on Measurement Book, daily signed by Engineer.

Payment

The Contract Unit price shall include materials supply, auxiliary materials, tools and labour.

14.6.7. Convergence Measurement in Tunnel

Benchmarks movements on primary tunnel lining shall be measured.

The number of points for measurement as presented with Design.

Measurements shall take place using surveying equipment in Global Positioning System

The measurement of movement shall be performed at 6 hours, 12 hours, 2 days, one week, one month, depending on the programme and algorhythm that is given indepedently from the detailed tunnel Design.

14.6.8. Geological survey of rock mass during tunnelling works

The number of surveyed profiles shall be defined through the Engineer's office.

14.6.9. Records of justified and unjustified deviations from Design and of finished details

<u>This activity shall be performed by the Contractor and submitted for the approval of the Engineer for the purposes of recording the as-built status and preparation of as built drawings</u>

14.6.9.1 Designing of the Executive design for formwork

Includes: 1.Formwork design for cut and cover parts of tunnel

2 Formwork design for secondary lining in tunnel

14.6.10 Wooden support in cases of danger of collapse and breaking in materials from tunnel faces

Wooden balks- dia ∅25-30cm, length – 3-6m

Timber – conifers II class

14.6.10.1 Tunnel Supports Protection against Vehicle Exhaust and Industrial Salt Aggression during Winter Season

First coat: Three – component epoxy mortar and compound for fine leveling and strengthening

Color – gray

A perfect concrete protection in aggressive environment

Coat thickness min 5mm, max 3mm

Bedding temperature +8°C min / +30°C max

The coat may be applied on the fresh or wet concrete without standing water

Consumption : 2kg/m2 2mm

Second – finishing coat : one – component reactive coating, silane based, white colored

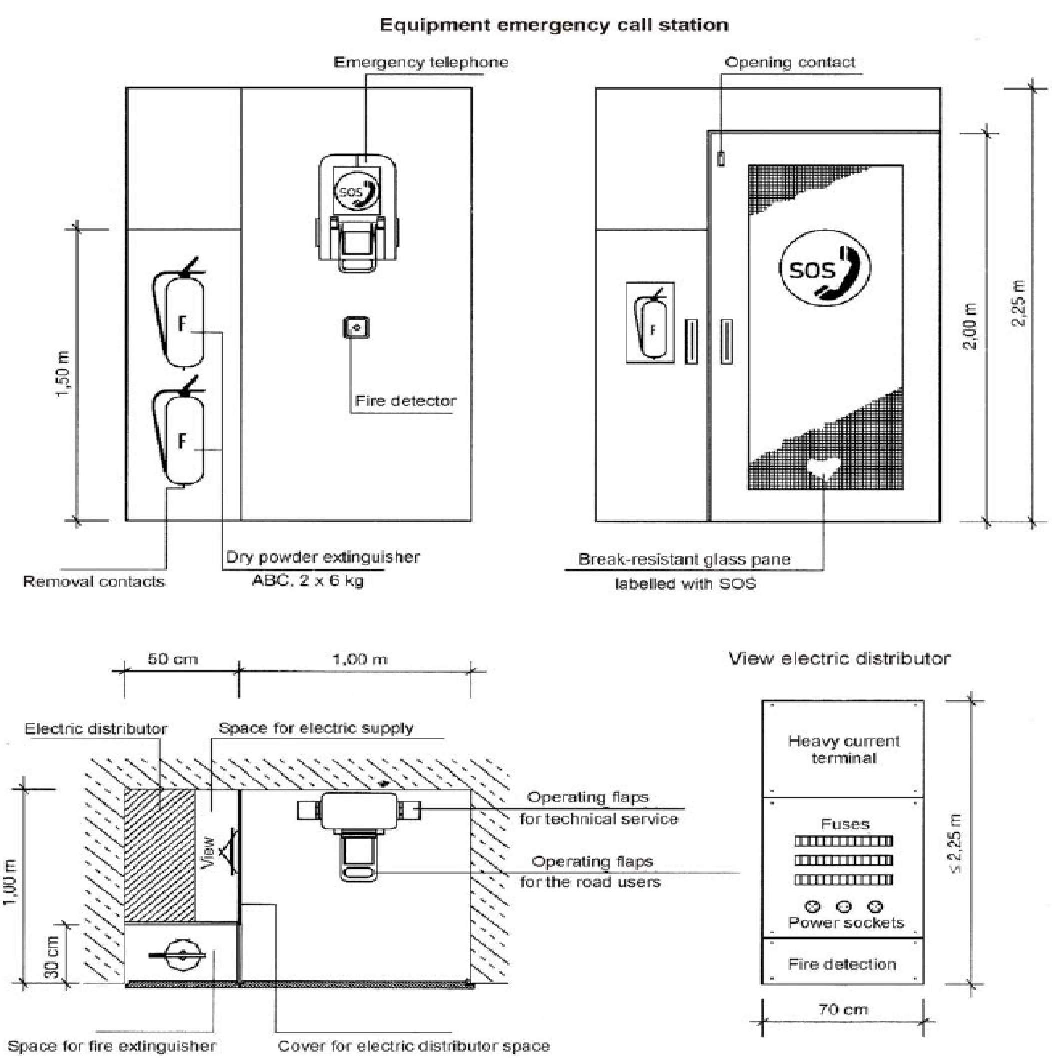
It prevents water penetration, eliminates chlorides and increases concrete resistance against freezing-thawing cycles and against the salt action.

The coating shall be applied in one pass, by brush or paint roller. Theoretically consumption 200-300 g/m2.

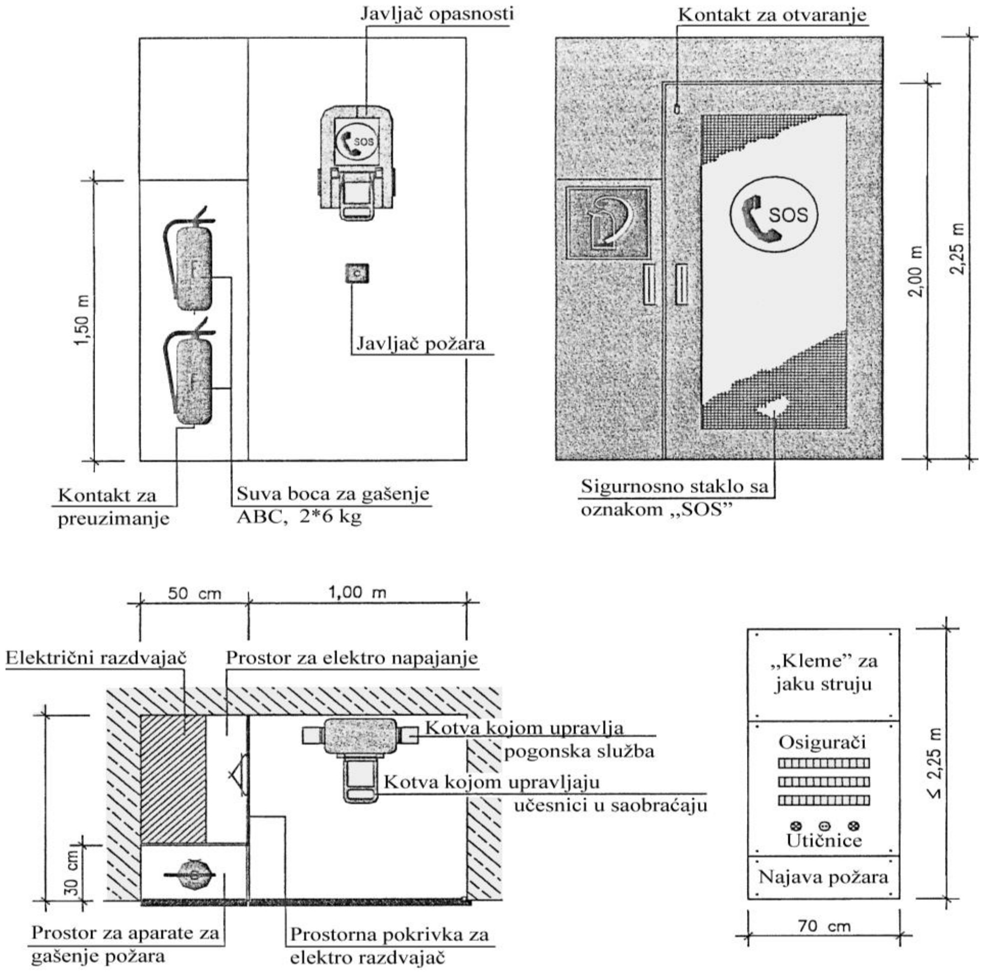
Application temperature: +5°C min / +30°C max.

14.6.11. D o o r s

S.O.S- Niches



OPREMA GOVORNICE ZA POZIVE U SLUČAJU OPASNOSTI

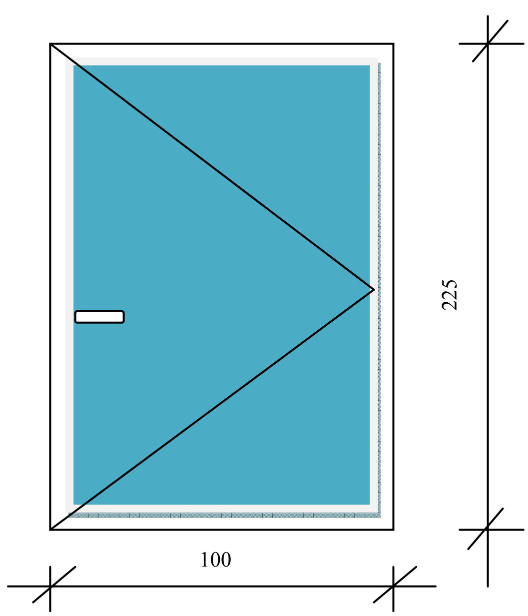


Characteristic for doors : Single wing , with safety glass light and S.O.S marking Dimension (cm/cm) : 100/200
Material for doors : Aluminium profiles
Partitition wall : Reinforced concrete t= 10 cm
Finishing : Plastification in grey colour

Other characteristics : Warning inside and outside of the cabine - **In the case of fire emergency immidiatelly leave the cabine**

14.6.11. D o o r s

Doors for E.N. niche
Vrata za E.N-nišu



Characteristic for doors: Single wing Dimension (cm/cm): 100/225

Material for door: Steel pickled sheet, with fire resistant filling materials

Partitition wal: Reinforced concrete, t=10cm, with protection – fire resistant plaster with thickness min 3.5cm, based on calcium silicate

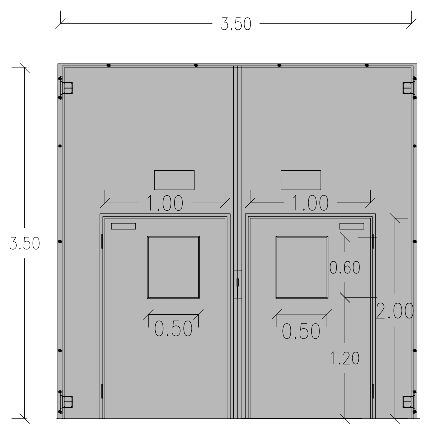
Fire protection is to be aplied outside (tunnel side)

Fire resistent conditions : 90min (according to fire resistant dimensioning „ZTV Tunnel (D)"

Finishing : Plastification in grey colour

14.6.11. D o o r s

Doors for cross connsctions



Characteristics for doors: Slide, self closed doors, multypurpose – pedestrian or vehicles (if needed) openings (single,multy wings)

Dimension (cm/cm): Single wing – 100cm x 200cm – opening in the direction of movement

Material for door: Steel pickled sheet, with fire resistant filling materials

Partitition wall: Reinforced concrete, t=10cm, with protection – fire resistant plaster with thickness min 3.5cm, based on calcium silicate. Protection is to be aplied outside (tunnel side)

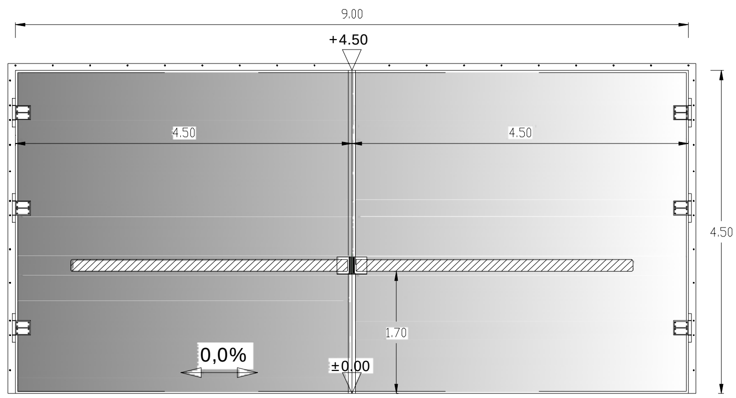
Fire resistent conditions: 90min (according to fire resistant dimensioning „ZTV Tunnel (D)"

Finishing: Plastification in green colour

Other characteristics: The doors are equiped with appropriate door furnitutr,handles and closing mechanizm. Opening force shoud not excede 100 N

14.6.11. D o o r s

Doors for cross connsctions for vehicles



Characteristics for doors: Slide, self closed doors, for vehicle openings (multy wings)

Dimension (cm/cm): Double wing – 900cm x 450cm – opening in the direction of cross connection

Material for door: Steel pickled sheet, with fire resistant filling materials

Partitition wall: Reinforced concrete, t=20cm, with protection – fire resistant plaster with thickness min 3.5cm, based on calcium silicate. Protection is to be aplied outside (tunnel side)

Fire resistent conditions: 30min

Finishing: Plastification in green colour

Other characteristics: The doors are equiped with appropriate door furnitutr,handles and closing mechanizm

14.6.12 Cutting and removing the temporary invert

- Cutting and removing the temporary invert shall be done according to technological procedure recommended by Contractor, approved by Supervisor
- Cutting the temporary invert - mechanically, with cutter for concrete
- Cutting and removing the temporary invert shall be done in several phases
- After removing the temporary invert, it is needed to measure the displacements of marks
- Works on cutting and removing the temporary invert must be proceeded in phases symmetrically to the tunnel axis.

14.7 Tunnel dewatering and hydrat system

14.7.1 Polymer – Concrete Channel in tunnel

Prefabricated polymer-concrete channel shall be used for collecting and discharge surface runoff within the tunnel. Channel shall be opened on top by ACO Drain or similar.

Tunnel channel Type 4, left/right 77035/77036. Channels shall fit to the edge profile of the tunnel. Channel placing shall take place in conformity with graphics. The channel shall meet requirements for loading class 400KN. Linear elements joining together shall be carried out by polymer-bituminous mass. The layer shall be correctly leveled as to assure homogenous flow trough the channel without any obstacles.

Characteristics of polymer-concrete element shall be as follows:

- Flexural strength 22N/mm^2;
- Compressive strength >22N/mm^2;
- Elasticity modulus, about 25кN/mm^2;
- Density 2,1 – 2,3 g/cm^3;
- Water penetration depth 0 mm;
- Resistance to chemicals impact – high;
- Depth of surface irregularities – about 25µm;
- 600x370x2500 mm, weight 460 kg/piece.

Measurement

The quantity to be paid for shall be the number of pieces placed.

Payment

For the quantity as determined above the Contractor shall be paid at the contract unit price, which price and amount shall be full compensation for all supply, transport, preparation and placing and quality control and all necessary labor.

14.7.1.1 Channel of polymer-concrete

The pre-fabricated channel of polymer-concrete shall be used for collecting and evacuation of surface discharge. The channel shall have grill on top, ACO Drain or similar, Tunnel channel Type 400kN-V200 and V300. Channels shall be incorporated in the tunnel edge profile. Channel shall be placed in conformity with graphical attachments. The channel shall comply with requirements for loading class 400KN. Joining of linear elements shall be carried out by polymer-bitumen mass. It shall be necessary that the joint be leveled as to enable undisturbed water flow trough the channel, without obstacle.

Characteristics of polymer-concrete element shall be as follows:

- Flexural strength 22 N/mm^2
- Compressive strength >22 N/mm^2
- Elasticity modulus, about 25 κN/mm^2
- Density 2,1 – 2,3 g/cm^3
- Water penetration 0 mm
- Resistance against chemical action - high
- Depth of surface unevenness – about 25 µm

Measurement

The quantity to be paid shall be the number of pieces placed.

Payment

Payment shall be based on the number of pieces. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.2 Revision with Bucket and Outlet on tunnel channel

ACO Drain collecting shaft with outlet DN200 for the ***Tunnel channel - Type Progon***. The element that will be placed at outlet spots from the channel to the collector. The material shall be the same as for the channel. The bucket shall be placed as to collect residue. This element will provide outflow to the collector on defined locations for openings. 570x1530x1117 mm weighing 620 kg/piece. Collecting shaft shall be provided by certificate M0 on fire resistance. Covers shall fit to the edge profile of the tunnel. Loading class D400.

Polymer-concrete shaft properties shall be the same as for the channel.

Collecting shaft-outlet from the channel with grating V200, which shall be placed with left recesses for vehicles removal shall have same technical properties as the applied tunnel channel.

Measurement

The quantity to be paid for shall be the number of pieces placed.

Payment

For the quantity as determined above the Contractor shall be paid at the contract unit price, which price and amount shall be full compensation for all supply, transport, preparation and placing and quality control and all necessary labor.

14.7.2.1 Revision with Bucket and Outlet

ACO Drain or similar catch shaft with outlet DN200 for ***Tunnel Channel*** **- Type V200 and V300.** The element that shall be placed on location of discharge from the channel into collector. The material shall be the same as for the channel itself. The bucket shall be placed as to collect the deposit. By means of this element the discharge into collector will take place on designed locations for openings. The catch shaft shall be supplied by M0 cerificate for fire resistance. Covers shall fit to the edge profile of the tunnel. Loading class D400.

Measurement

The quantity to be paid shall be the number of pieces placed.

Payment

Payment shall be based on the number of pieces. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.3 Plaster Lath

The double plaster lath shall be placed on openings of channel shaft outlets with grating V200 and V300.

Measurement

The quantity to be paid shall be the necessary area in square meters (m^2).

Payment

Payment shall be based on area in square meters (m^2). The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.4 Separator

ACO Passavant OLEOPATOR or similar, NG6 SF1200 D400, separator for light oils and gasoline, filtration class (up to 5 mg/l of oil derivatives at the separator outlet), manufactured of reinforced concrete, with flow 6 l/sec, with catch basin 1200 l, coalescent filter and fitting DN150. Loading class 400 KN, version with superelevation. The separator shall be equipped by safety ball float and connector for *Securat* alarm-call element. Separator diameter shall be ϕ1470. The separator shall be equipped by watertight internal protection.

The durability of an ACO separator shall be the same as concrete durability. Bodies shall be manufactured of reinforced concrete following EN 206-1, strength class C35/45, exposure to environment HA3 (chemically aggressive waters in facilities for waste water treatment); XF4 (traffic surfaces treated by de-icing chemicals, elements dominantly horizontal, exposed to water spraying from traffic surfaces where de-icing chemicals are sprayed, parking lots without protective layer).

Measurement

The quantity to be paid shall be the number of separators, necessary couplings included.

Payment

Payment shall be based on the number of separators with couplings. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.5 SECURAT

SECURAT is a device for surveillance and alarming with optic and acoustic alarm call. Protection system Eex IIB for range "zone 0" of danger of explosion, device conforming to EN 50014. Installation of two potential-less probes (for oil and ascendance) with 5 m long cables, connecting box for range of zone 0, holders etc. inside the separator, conforming to EN858. The device for surveillance and alarming (IP30) shall be installed in the separate casing with near facility, out of range of explosion risk (not included with supply). Connection to mains 230V/50-60Hz.

Protective casing for installation of SECURAT for surveillance and alarming device in IP 65 protection.

Measurement

The quantity to be paid shall be the number of pieces placed.

Payment

Payment shall be based on the number of pieces. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.6 Valve Shaft

Valve shaft of System ACO or similar, manufactured of reinforced concrete as per DIN 4281, with inter-flange valve DN 150. The valve activation shall be by electro-motorized valve drive (activation impulse received by SECURAT surveillance and alarming device). Passage pipe DN 150 as per DIN 19534/19537, with inspection opening and connector for evacuation (S-coupling with bolt. Connectors DN150 as per DIN 19534/19537. Anti-explosion protection included.

Installation depth T = 955 mm, with uplift possibility (measured of pipe bottom to cover top) with watertight openings in the wall.

Measurement

The quantity to be paid shall be the number of pieces placed

Payment

Payment shall be based on the number of pieces. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.7 Reservoir with Entrance Portal for Discharges originated on the Occasion of Fire Extinguishing

Placing precast pipes of reinforced concrete with internal diameter ϕ2400, on sand bedding. Total reservoir volume shall be minimal about 100 m3 (72+30).

The total net reserved space shall be 6 x 12 m, with excavation as presented by drawing attached.

Operation description is presented with Technical Report and graphics.

Openings shall be provided on reservoir top as to enable placing of reinforced concrete inspection shafts ϕ1000 for evacuation and control.

Reservoir characteristics shall be in conformity with physical and mechanical characteristics as required for structures of reinforced concrete.

Measurement

Quantities to be paid for shall be as follows:

- The number of placed pieces per linear meter (m^1) of pipe ϕ2400 or as agreed with manufacturer, if some other pipe length would be more favorable, depending on technology.
- The number of placed pieces of pipes for placing shafts ϕ1000 on reservoirs ϕ2400
- The number of placed conical parts ϕ1000/ϕ600.
- For openings on pipe ϕ2400 closed by reinforced concrete plates 25 cm thick - concrete quantity in cubic meters (m^3); double reinforcement mesh MA500/560, Q424 number of kilograms (kg).

Payment

For quantities as determined above the Contractor shall be paid at the contract unit price per each item, which price and amount shall be full compensation for all supply, transport, preparation and placing and quality control and all necessary labor.

14.7.8 Pipes of Ductile Cast Iron

Importance of proper placing of pipes

Placing pipes is practical work on site. Nevertheless:

- Manufacturer's instructions;
- Engineer's requirements;
- Contractor's precaution,

impact risk, ditch cave-in, pipe damage, non-proper bedding or fill-up material, etc. may occur on site. Such occurrences may be sudden (when damaged parts replacement would be required) or they might be demonstrated trough time by parts failure or by serious problems, as leakage, breaking or disintegration of couplings.

By using pipes of ductile iron a safety reserve would be achieved, enabling pipes to sustain certain risks without damage. The success is guaranteed from the very beginning by a simple and safe placing procedure.

Ductile material

The ductile iron is an alloy of iron, carbon and silica where the carbon is pure, in form of spherical graphite. The carbon in previously used casting pig is in form of thin leafs, resulting with material brittleness.

Graphite particles in ductile iron look like small balls, excluding any possibility of fractures expansion. The material is not brittle any more. It is now strong and elastic, i.e. ductile. Basic properties of ductile iron are:

Elasticity Re ≥270 Mpa)

Tensional strength (Rm≥420 Mpa)

Strength on impact

Large extension (>10%)

Compliance with standards

Specification	French	EN	ISO	
General technical specifications for pipes	NF EN 545	EN 545	2531	
From ductile iron under pressure:				
Coupling EXPRESS	NF A 48-860	-	-	
Coupling STANDARD	NF A 48-870			
Pipes with sockets	NF EN 545	EN 545	2531	
Pipes with flanges	NF EN 545	EN 545	2531	
Pipes with conn. and sockets	NF EN 545	EN 545	2531	
Pipes with conn.and flanges	NF EN 545	EN 545	2531	
Dimensions of flanges – rotating	NF A 48-840			
Dimensions of flanges – fixed	NF A 48-840			
Gaskets for connections of spec. material	NF T 47-305		4633	
Pipe surround of zinc	NF EN 545	EN 545	8179	
Exterior pipe surround of polyurethane	NF EN	EN 545	-	NF A 48-851
Pipe surround of cement mortar	NF EN 545	EN 545	4179	
Model for quality assurance in design,	NF EN 29001	EN 29001	9001	
development, manufacturing, placing and maint.	(NF X 50-131)			
Model for quality assurance in manufacturing	NF EN 29002			
and placing	(NF X 50-132)	EN 29002	9002	

Ductile pipes have great safety reserve above their indicated working pressures. That is the consequence of material ductility, giving great capability to iron pieces to accept work and energy in elasticity domain (which is alone considered in design).

Measurement

The quantity to be paid shall be the measured pipe length in linear meters (m')

Payment

Payment shall be based on the length in linear meters (m') of the pipe placed. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.9 Fittings

Fittings are specified with design and presented in graphical attachments. Mechanical, physical and hydraulic characteristics are the same as for the pipeline.

Measurement

The quantity to be paid shall be the number of fittings.

Payment

Payment shall be based on the number of fittings. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.10 Gate Valves

Gate valves shall be of the same material as the pipeline. They were designed for working pressure 10 bars. Placing shall conform to graphical attachments.

Measurement

The quantity to be paid shall be the number of gate valves.

Payment

Payment shall be based on the number of gate valves. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.11 Manhole Covers

Manhole covers on elements of the system shall be for loading 400 KN. Graphical attachments shall be followed.

Measurement

The quantity to be paid shall be the number of manhole covers

Payment

Payment shall be based on the number of manhole covers. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.12 Manhole Step Irons

Graphical attachments shall be followed. Appropriate Serbian standard shall be respected.

Measurement

The quantity to be paid shall be the number of step irons.

Payment

Payment shall be based on the number of step irons. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.13 Pump Station

Pump station with necessary uplift height and power shall be installed in conformity with graphical attachments. The unit composed of three pumps - two of them operating and one spare – with suction and uplift as per DN100, PN10, including valves, non-return falling cover, pressostats, electricity board, all on base. The pump shall be placed immediately after reservoir box. It shall be located into pre-fabricated manhole of polypropylene in conformity with graphical attachment.

The quantity to be paid shall be the number of pump stations.

Payment

Payment shall be based on the number of pump stations. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.14 Tunnel Hydrants

Tunnel hydrants “Valman” or similar are defined by the head and footing of nodular cast and by the body of prochrome with the wheel for fast opening. The hydrant is equipped by a system for automatic drain, which comprises the incorporated air valve with the hydrant head and the automatic outlet with the footing.

Characteristics: Working pressure shall be 12 bars, DN100, The network within which hydrants will be installed is of the ring-type. Flow within the network will be Q=20 l/sec. The height shall be 1m.

Tunnel hydrants shall be distributed in conformity with graphical attachments, within fire stop refuges Fire stop refuges shall be located opposite SOS refuges. The distance between hydrants was graphically presented.

The hose and the hose reel shall be supplied with fire stop refuge.

Measurement

The quantity to be paid shall be the number of hydrants.

Payment

Payment shall be based on the number of hydrants. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.15 Reservoir

Installeer voorafvervaardigde houers gemaak van polipropileen of die wil. Material te ryp weerstand is bereik deur termiese beskerming (die voering van veselglas en alumnium laag). Staal klampe voorspel 3m. Reservoirs (3 pieces) shall be placed in the reservoir case of reinforced concrete, as presented with graphical attachment. The volume necessary is presented with graphical attachment (72 + 30) m^3. It is necessary to provide a mobile pump within the technical center as to enable the possible water surplus evacuation from the casing.Vehicle step on reservoir casing shall not be allowed, because the cover with allowable loading 400 KN was not foreseen.

Measurement

The quantity to be paid shall be the number of reservoirs.

Payment

Payment shall be based on the number of reservoirs. The unit price shall include supply, transportation, placing, preparation and placing and quality control.

14.7.16 Waterproofing

Waterproofing of HDPE shall be placed und RC reservoir plates and on vertical sides up to the level of fill-in limit, in conformity with graphical attachment.

Measurement

The quantity to be paid shall be the necessary area in square meters (m^2).

Payment:

Payment shall be based on the area placed in square meters. The unit price shall include supply, transportation, placing, preparation and placing and quality control..

14.7.17 Manhole Covers

Manhole covers shall be placed on system segments with allowable loading 400KN. Placing shall be in conformity with graphics.

Measurement

The quantity to be paid for shall be the number of pieces placed.

Payment

For the quantity as determined above the Contractor shall be paid at the contract unit price, which price and amount shall be full compensation for all supply, transport, preparation and placing and quality control and all necessary labor.

Section 15
Telecommunications

Contents

15.1. Fire alarm and gas detection system

15.1.1 General

A fire alarm system with equipment shall be supplied and executed in accordance with attached plans, technical description, Priced Bill of Quantities, these Technical Specifications and Rules on technical norms for fixed fire alarm installations (Off. Journal of FRY, No./93) and subject to the approval of the Engineer.

Installation cables in a fire alarm system shall be placed in ceiling voids, false floors, on dedicated cable trays for signal, alarm and telecommunication installations, clipped on walls, and drawn in dedicated pipes in mortar.

Installation cables to be clipped on walls shall not be exposed to mechanical damage and shall be as little eye-catching as possible. Clip spacing shall depend on cable outside diameter and shall not exceed 30 to 50cm.

Plastic pipes for installation cables in walls shall be fully covered with an entire layer of wall finishing materials.

Trays for signal, fire alarm and telecommunication installations shall be mounted as instructed by the Manufacturer in harmony with other installations. Metal cable trays shall be bonded and earthed to building earthing system.

Within false floors, installation cables shall be laid in sheet metal troughs fitted with the accessories required. In relation to power cables, fire alarm cables shall be laid in dedicated sections in a multiple trough at the distance which will prevent interference.

Parallel running of fire alarm wiring and power lines shall be avoided. If this is not possible then the following instructions shall be observed:

- telephone and fire alarm installation shall be fixed 10cm below ceiling
- clock, talk-back and other telecommunication installation 10cm below these
- power cables 10cm below the preceding ones.

Crossing of fire alarm wiring and power lines shall be avoided. If unavoidable they shall cross at the right angle. The distance between them shall be minimum 1cm and in case this is not possible then an insulating bed minimum 3 mm thick may be inserted.

The system shall be supplied with power from two sources: electrical mains and back-up battery. A dedicated circuit with a specially marked fuse (red) shall be used for power supply.

Fire alarm panels and cabinets in the fixed installation shall be red.

Fire alarm elements (sounders, bells, lamps, flashing lights) shall differ from other alarming components. These shall be red or carry inscription plates with “fire alarm” lettering.

Joints (bonds) shall be minimum in number. Each bond shall be effected by soldering or with splicing modules. Cables and conductors for call points and detectors may be bonded only in them.

Cable terminals for connections to devices shall have sufficient lengths. Terminals to be connected to call point/detector bases shall be minimum 30cm.

Manual call points shall be mounted at 1.5 m above the floor, at easily accessible places, along routes of evacuation or on staircases.

The completed installation and the cables laid shall be marked with appropriate metal rings by the Contractor.

Cable cross sectional area shall be selected to cater for power consumption of used appliances and to meet the required maximum allowable electric resistance in the line. Conductor section in a cable shall not be below 0.6mm.

Insulation resistance between a line and earth shall be minimum 500kΩ. It shall not be measured with an instrument operating at a voltage above 50V, unless the fixed installation is separated from the line and the cable.

Fully bonded equipment in a fixed installation shall be subjected to functional tests and the operation of each component – manual call point/detector, alarm component and signal transmission components, as well as of central unit and all its controls shall be tested.

All tests shall be completed to the satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

15.1.2. Mounting of Spot Detectors

Distance of detectors from walls, high pieces of furniture and stored goods shall not be smaller than 0.5m, except in corridors, shafts or similar openings in building fabric whose width is less than 1m.

If beams or ventilation shafts are not more than 0.15m away from the ceiling, then side distance to a call point shall not be less than 0.5m.

If a ventilation shaft exists in ceiling, a call point shall not be fitted closer than 0.4m to it.

In ventilated rooms with grilles in side walls, call points shall be mounted not closer than 1.5m to these.

Call points shall be mounted onto a gallery ceiling at the distance of 1/3 of the gallery treading width measured from its free edge.

15.1.3. Fire Alarm Control Unit

The control unit shall be addressable, in a mechanically resistant metal housing, for wall-on mounting with well visible indicators and unauthorized handling prevented.

It shall have a programmable option for incorporation of names in Serbian, of holding times, day and night operation and of all other parameters for each detector, module and zone.

The control unit shall be fed with 230V/50Hz power, and have an inbuilt battery charger, a multiline LCD display with background lighting, LEDs and a keyboard for control and programming operations (on the front).

The unit shall have terminals for two addressable loops, a relay NO/NC terminal for a general alarm case, a relay NO/NC terminal for a general fault case, a terminal to the line with parallel LCD displays, a terminal to 24 VDC (one fixed, one resettable) if some modules are not fed directly from loop, and a terminal to series printer.

The control unit shall have an option to add a distant ("parallel") LCD display that will show the same data as the unit itself and an option to be connected to an automatic telephone alarm set.

Fire alarm shall be signalled both by light and sound on the control unit. Sounds (alarm) on the unit shall differ from an audio signal of fault (defect).

The control unit shall be accompanied with a manual in Serbian and instructions printed on a single sheet of plasticized paper to be hung on the wall next to it. The control unit shall bear an inscription plate giving data on the manufacturer, type identification, year of manufacture, factory number and reference number of the quality statement.

15.1.4 Measurement

The exact measurement of installed equipment and used material is determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

15.1.5 Payment

Payment of installed equipment and material is executed according to the prices determined by the Contract, and the measurement approved by the Engineer

15.2. Computer Networking (IP Video Monitoring)

The structural cable installation in this project shall fully comply with the technical description, these Technical Specifications, Priced Bill of Quantities, drawings and the international standard ISO/IEC 11801, and subject to the approval of the Engineer.

Prior to commencement of the works the Contractor shall determine and mark precise positions of all system elements (power outlets, distribution boards, active components, cable conduits etc).

One end of hTP cables shall terminate on a panel in cabinet and the other end at RJ45 socket, while braided cables shall be earthed properly.

An hTP cable shall neither be interrupted nor extended.

An hTP cable shall be drawn through troughs, a walled-in hose, underfloor ductwork or clipped to wall as provided in the design.

An hTP cable shall not be twisted along its length, knotted, kinked or damaged in any other way. Mechanical loads on hTP cables while drawn in or laid shall not exceed the ratings specified by the cable manufacturer (tensile force during drawing in, radius of bending etc.)

hTP cables shall be mounted in vertical or horizontal positions. Positioning under an angle is not permitted.

An hTP cable shall neither be laid nor drawn near a heating source (heating pipes, radiators, stoves, heaters). If unavoidable, then heat insulation shall be necessary.

Outdoors, hTP cables shall be drawn through dedicated thermo-plastic pipes. These pipes (e.g. on outer walls of buildings) shall be weather resistant (-35˚C to +50˚C / 95% relative humidity). It is not permitted to place them under direct sun rays. Standard PVC or PE pipes shall be used for TT cables to be buried in the ground.

An hTP cable shall not be run near appliances, objects or sources that may cause damage to it.

Maximum link length in horizontal cabling, ISO/IEC 11801 standard shall not exceed 90m. A link means a cable section between a plug-in outlet on the panel and a socket outlet on the wall.

Structural cabling elements (cabinets for passive and active components, wall-on ductwork if any, plug-in outlets) shall be fitted in the way to preserve functionality of the network without deteriorating however the use of rooms, aesthetics (harmonization with interior decoration) and the like.

Sockets shall be placed at the level 20 - 40cm above floor. If due to physical requirements cable troughs are to be fixed on the wall at desk level (80 - 100cm above floor) sockets can be incorporated into them.

Cable tail at a power outlet shall be 10cm long and at the end at the panel 30 cm - 100 cm long.

Both ends of a drawn cable shall be given identical numbers (label) immediately after drawing in.

Cable identification number shall correspond to the power outlet number where it is terminated.

The drawn in hTP cables shall be tested for breaks and short circuits. If positive, the cable shall be pulled out and replaced.

Properly arranged cables shall be terminated in power outlets, or on the panel as provided in the design.

RJ45 connectors, plug and socket outlets and connecting panel shall be mounted using professional tools.

Connection of a terminal unit (computer) to a wall power outlet and reconnecting of the panel and active components shall be done with appropriate cable lengths (max 5m).

When cables and power cables in a structural cable system run in parallel and are directly laid in walls the minimum distance shall be 20cm, i.e. 10cm if the structural cable is braided.

Structural cable system can be laid together with power cables in partitioned plastic troughs or partitioned floor ducts specially constructed.

The cables in a structural cable system may cross power cables under the angle of 90°.

When cables and passive network components are mounted in place, the following measurements and tests shall be performed on the structural cabling: link length (max 90m), attenuation per pair, crosstalk level, DC loop resistance, impedance (100Ω), attenuation to crosstalk ratio. Instruments for measurements and testing shall come with test certificates issued by the accredited institution (not dated earlier than 12 months ago).

All tests shall be completed to the satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

Required measured values (standard ISO/IEC 11801) for cable category 6 are given in the table below:

f [MHz]	1	16	100	250
Return Loss (min) [dB]	19	18	12	8
Insertion Loss (max) [dB]	4	8,3	21,7	35,9
NEXT (min) [dB]	65	53,2	39,9	33,1
PS NEXT (min) [dB]	62	50,6	37,1	30,2
ACR (min) [dB]	61	44,9	18,2	-2,8
PC ACR (min) [dB]	58	42,3	15,4	-5,8
ELFEXT (min) [dB]	63,3	39,2	23,3	15,3
PS ELFEXT (min) [dB]	60,3	36,2	20,3	12,3
Prop.Delay (max) [µs]	0,580	0,553	0,548	0,546

Required mechanical characteristics of cables:

- Conductor diameter: 0.4 to 0.8 mm
- Temperature for mounting: 0˚C to 50˚C
- Working temperature: -10˚C to 40˚C
- Minimum bending radius for mounting: as per manufacturer’s catalogue

- Minimum bending radius after mounting:
  25mm for cable diameters to 6mm,
  50mm for cable diameters over 6mm

15.2.1 Measurement

The exact measurement of installed equipment and used material is determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

15.2.2 Payment

Payment of installed equipment and material is executed according to the prices determined by the Contract, and the measurement approved by the Engineer

15.3. Talk-Back (SOS) System

Telephone and Talk-Back installations shall be delivered and executed in strict accordance with plans, technical description, Priced Bill of Quantities, these Technical Specifications and ZJPTT instructions governing telephone subscriber installation, and subject to the approval of the Engineer.

Cables, conductors, equipment and materials shall comply with JUS standards, and ZJPTT rules and technical requirements.

Cables (instalation conductors) in a telephone installation shall be laid in pipes as designed.

Pipes with cables (installation conductors) shall be laid in a straight line (vertical or horizontal). Laying in a curved line is permitted in exceptional cases when tangent route is not possible provided the Engineer's consent is obtained. Horizontally laid pipes shall be slightly graded towards distribution boxes in the installation. Free pipe ends shall be fitted with insulated bushings.

A cabled connection between expansion joints shall not be damaged when one expansion joint happens to sink.

Cables and conductors shall be drawn into pipes after rendering. They shall not be twisted along its length, knotted, kinked or damaged in any other way. Mechanical loads on a cable being drawn in or laid shall not exceed the technical data specified by the cable manufacturer (tensile force during drawing in, radius of bending etc.)

Cables to be drawn in pipes may be powdered but only with talcum powder.

Drawn installation conductors shall be continuous without splices along the section from a termination and/or distribution panel to a telephone outlet. Conductors may be spliced only in exceptional cases if continuous drawing is not possible, and this may be done solely in installation boxes. Conductors shall be soldered or extended with a special module.

Both ends of a drawn cable shall be numbered (labelled) immediately after drawing. Cable number shall correspond to the number of the socket where it terminates.

Distribution boxes shall be fitted at the points where cables change grade and branch and at the terminals of the telephone installation.

Telephone boxes shall have the required capacity, comply with the applicable PTT conditions, be accessible at 1.6 m above the floor level on public premises and be provided with lock and key.

Pipes in walls or under floor shall not be covered with any aggressive etching material. Scraps of gypsum and mortar shall be carefully removed from them.

Parallel runs with smoke channels or heating pipes shall be avoided. If impossible, they shall be placed 5 cm away from each other or minimum 3 cm where they cross smoke channels and heating pipes. A telephone installation shall be protected with appropriate thermal insulation.
A telephone installation parallel to other installations shall be executed as follows:

- telephone installation 10 cm below ceiling,
- TV installation 10 cm below telephone installation
- signal wires 10 cm below TV installation
- power cables 10 cm below signal lines.

Telephone sockets shall be fitted at the level of 0.3 m above the floor (as indicated in the design) and not closer than 0.3 m from a 230V/50Hz socket outlet measured along a horizontal line.

Metal cabinets (termination - ITO and distribution -RO) in a telephone installation shall be connected by a 10 mm^2 conductor to the nearest potential equalizing bond in the switchboard in the power supply system. If telephone installation cables and conductors are within static enclosures these shall be bonded to earth at end side only, i.e in the switchboard of higher order.

The following tests and measurements are required: numbering and insulation resistance. Loop resistance if requested by the Engineer. The results of these measurements and tests shall comply with ZJPTT specifications. Measurements and tests shall be performed between ends of cable and conductor from the switchboard of higher order towards the end with disconnected loads.

Insulation resistance shall be measured with a megohmmeter, minimum 100 V test voltage. Between conductors it shall be not less than 20 MΩ, and between the conductor and earth not less than 10 MΩ , for all wires in a multi pair cable namely for the a/b wire in an installation conductor, with devices and power source disconnected.

Loop resistance shall be measured by the Witson bridge method and comply with the values of the cables specified in the Manufacturer's catalogue

All tests shall be completed to the satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

15.3.1 Measurement

The exact measurement of installed equipment and used material is determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

15.3.2 Payment

Payment of installed equipment and material is executed according to the prices determined by the Contract, and the measurement approved by the Engineer

15.4. Cable Conduits, Laying of Copper and Optic Telecommunication Cables

15.4.1. General Specifications

These Technical Specifications are an integral part of the final design documents for which the Contractor shall fully comply without exception.

Cables, equipment and accessories shall be supplied and executed as shown on the plans, in the Technical Description, the Priced Bill of Quantities, and these Technical Specifications, and subject to the approval of the Engineer.

Cables, equipment, accessories and material shall comply with JUS, DIN or VDE standards. Pieces of equipment and cables shall be delivered ready for mounting unless otherwise stated.

During the execution of the works the Contractor shall take care of any other works executed, existent underground and above ground installations in the work area to the full satisfaction of the Engineer. If during civil works and mounting of cable and equipment other buildings or installations suffer damage, it shall be remedied by the Contractor at his cost and subject to the approval of the Engineer.

15.4.2. Civil Works Specifications

15.4.2.1. Cable conduits

Cable conduits serve for drawing in cables and armoured cables of small size if provided so in the design.

Cable conduits consist of manholes and pipes in between them.

Manholes

Manholes can be of hand and standing type. Hand manholes serve for cable drawing in and accommodation of joints and other equipment. Their appearance, construction and use comply with the final design.

Standing manholes, clear height 180cm enable workers to stand. Trench crosswise dimensions shall be given in the design and shall be not less than 150 × 150 cm.

Manholes will be built with solid bricks in cement lime mortar, 25 cm thick walls. Outer and inner vertical and horizontal waterproofing shall be placed as provided in the final design. The bottom shall be cast of lean concrete, be gently graded towards the middle (2%) and be drained in the absence of waterproofing.

The top plate shall be of reinforced concrete, calculated to withstand local load.

The cover shall be of cast iron pursuant to ZJPTT Technical specification No.02-3128/1 dated 5th March 1964. Lightweight or heavy covers shall suit local loads but in principle lightweight covers shall be placed in lawns, sidewalks and unbuilt area and heavy ones in road pavement. They shall be flush with ground (sidewalk, pavement) level. Each cover shall sit in the midst of the top plate but it may also be differently placed if provided in the design. The collar between the plate and ground surface shall hold the cover in place. It shall be cast of concrete together with the top plate and shall be statically analyzed to suit specified loadings.

Burial depth (from top plate level up to ground level) shall be indicated in the final design.

Pipe inlets in side walls shall be placed as provided in the design. Minimum depth of the top edge of any such inlet pipe shall be not less than 0.8 m and its top edge not deeper than 0.4 m below underside of the top plate.

Cables shall be hung on consoles in manholes, fixed in manhole walls. Consoles shall be inserted at a later date and their positions and dimensions shall depend on the requirements.

Pipes

Manholes shall be interconnected with PVC pipes, of 110 mm nominal diameter, 6m long compliant with ZJPTT Technical specification no. 02-11550/1-72; pipes shall be enlarged at one end.

Pipes shall be laid between manholes in a horizontal line, one next to the other, 2 pipes, 3 pipes, 4 pipes. If pipes exceed four in number they shall be positioned in rows one on top of another: 2×2, 2×3 and N×4, N being one number between 1 and 8.

Pipes shall be fixed in position with plastic combs placed at the distance of not more than 2 m.

Pipe bundles shall be covered with sand. If necessary they shall be covered with concrete. Concrete class shall be decided in the structural analysis in the final design.

Pipes to be laid in a straight line between manholes shall be laid according to designed lines and grades and extended by inserting one pipe into the enlarged end of the next pipe. The joint shall be covered with sealing ring.

If pipes are to be laid along a curve their exact position and radius shall be specified in the final design, and a minimum cable bending radius shall be taken into account.

Upon completion of the cable conduit (manholes and pipes) it shall be tested by pushing a round brush with a rope at its end through all pipes. This will also help to remove possible dirt from pipes

15.4.2.2. Trench

A trench route shall be set out as designed and shall be tied to permanent unchangeable points: road, structures along the road, buildings, regulation lines, control points and the like.

A trench shall satisfy the following requirements:
- Be straight wherever possible and follow road curves.
- Privately owned parcels of land shall be avoided but if this is not possible trenches shall run close to their boundaries.
- Be sufficiently distant from roots of trees and other vegetation to avoid damage.
- Be not less than 10m far from 110kV transmission line towers and 15m from 220kV transmission line towers.
- Be 1.0 m deep and 0.4 m wide near the bottom. In privately owned arable land the depth shall not exceed 1.2 m. Otherwise, a different route shall be selected or cable conduits laid in. The trench bottom width shall be increased by 5 cm for each additional cable to be laid.
- Excavated earth shall be thrown out of trench to one side only to the distance of about 0.5m.
- Trenches shall be, as a rule, backfilled with excavated soil in 20 cm thick layers and tamped. If specifically required in the design or ordered by the Engineer for civil works, backfilling may be done with gravel or sand respectively. Surplus soil shall be hauled to a dump site.
- Prior to cable laying the trench bottom shall be carefully cleaned and covered with a layer of sand (fragmented earth if foreseen by the design) 10cm thick. Laid cables shall be covered with another layer of sand (fragmented earth) 10 cm thick. On top of this, plastic shields or bricks shall be placed in a continuous row (two rows in parallel for several cables). At about the mid point of trench depth yellow warning tape bearing the inscription "PAŽNJA TT KABL" (Caution Telecommunication cable) shall be placed.
- The surface of a backfilled trench shall be reinstated: sidewalk and pavement repaired and asphalted, and grass lawn restored by returning bushes to their original places.
- Under obstacles: roads, railway tracks, embankments and other, Ø100 mm inside dia. hard plastic pipes shall be laid, two of them in sand or concrete bed, depending on load. Minimum depth of these pipes shall be 0.8 m below the ground surface. Obstacles shall be crossed at the angle of 90° and not less than 45°.

15.4.2.3. Cable Laying

As a rule, a cable shall be pulled out (unreeled) off a mobile drum. If a cable is pulled from a stationary drum then pulleys shall be used to avoid dragging cables over ground surface and/or trench bottom. If the use of pulleys is not possible for any reason whatsoever, cables may be pulled out by hand but maximum weight per worker shall then be considered and the cable shall never be bent more than its minimum bending radius would allow.

A cable with a tail length shall be laid close to the trench midst. If several cables are laid in one trench they shall not cross. Abutted cable lengths shall overlap by 1 ÷ 1.5m as instructed by the Cable Manufacturer.

Joints shall be made at trench enlargements the size and shape of which shall depend on the capacity of the cables to be extended, i.e. on joint size. Enlargements shall be excavated at the time of joint construction. A 10 cm thick layer of sand shall be spread over the enlarged area and each finished joint shall be fully covered with sand.

Enlargements shall be designed as follows:
- Joint axis shall be by 0.3m staggered in relation to cable axis in trench for the purpose of tensile force relief,
- Bends in cable approaching a joint shall be by about 50% bigger than the minimum allowable bending curve to avoid radial forces.

There are no constraints on laying the following cables in a trench together with a telephone cable:
- Other telecommunication and signalling cables
- Fibre-optic cables for any purpose
- Other cables that do not transmit energy (feeders to high power antenna systems are considered to be power supply cables).

Horizontal distance between a telephone cable and a power cable (including feeders to high power antenna systems) shall not be less than 50 cm. If otherwise, special safety measures shall be undertaken. Where telephone and low voltage power cables run in parallel, it will be sufficient to lay a continuous row of bricks on edge. High voltage cables running in parallel shall be laid in earthed steel pipes and telecommunication cables in plastic pipes.

Crossing angle of telecommunication cables and power cables shall be 90°, never less than 45°. If the angle is smaller such a case shall be considered as parallel running. As a telecommunication cable shall always cross over and above a power cable, minimum vertical distance shall be 30cm for low voltage cables and 50cm for high voltage ones. If such distances cannot be achieved then additional safety measures shall be undertaken (see the preceding paragraph).

Cables shall be marked with lead clips spaced at 5 m and inscribed with:
- Cable type
- Cable structure,
- Month and year of laying.
- Additional identification if there are two or more identical cables in one trench.

Characteristic points in cable route shall be appropriately marked with brass plates in sidewalks and concrete posts with plates on unbuilt ground. In both cases plates shall bear the following symbols:

- Straight cable runs shall be marked approximately in the midpoint between two joints,

- Above joints,
- At the points of direction changes,
- At the points where cables branch off the main route,
- At blind cable ends,
- At pipe ends (start and end) below obstacles.

15.4.2.4. Drawing cables in pipes and/or conduits

Only one cable may be drawn in one pipe. Several cables may be drawn in one pipe only if the sum of their diameters does not exceed 60mm. Optic cables will be always drawn in special hoses. Cables shall never be spliced in pipes.

Cables shall be first drawn in pipes lying at the lowest row as shown on the design drawing. Cables in manholes cables shall be hung on consoles fixed to side walls.

Cables may be drawn without joints through several manholes if maximum drawing force for the cable type concerned is not exceeded.

Cables shall be drawn with hand or motor powered winch the force being monitored all the time. The best solution will be to have a winch equipped with a union which will slip as soon as pre-set drawing force is exceeded. The pulling rope shall be joined to the cable with a steel sleeve. Cable shall be pulled axially through pipe to minimize friction. If necessary, pulleys needed to stabilize the drawing rope shall be used.

Lubricants may be used to reduce friction in pipes. The best solution will be to blow in plastic pellets having the diameter of several tenth points of a millimetre which will, due to static electricity adhere to the pipe inside and significantly reduce friction resistance.

Cables shall be unreeled from drums positioned according to earlier planned arrangement shown in the site organization plan.

Prior to drawing a cable in a pipe the latter shall be cleaned with a brush and its suitability thus checked.

Damaged and stretched out cable end sections shall be cut off after pulling but a sufficient tail length shall be left as reserve for cables tp be placed on consoles in manholes or overlapped at joints.

15.4.3. Instructions to Contractors

Before commencement of the works the Contractor shall check correctness and compliance of telecommunication cable design with other designs and schedules and schematics of other underground installations and adjust them in cooperation with the Engineer.

The defined items in the Priced Bill of Quantities refer to the supply of the full range of equipment, devices, cables, accessories, materials and all works needed to make these functional unless explicitly otherwise specified in the design.

Transport, preparation of site, health and safety measures and other related costs shall be covered in the unit prices.

The Contractor shall suggest to the Employer modifications and amendments that would contribute to a more rational and quality technical solution. Minor design modifications and amendments may be carried out by the Engineer. Major modifications and deviations shall be approved by the Designer in advance.

All modifications and amendments shall be confirmed in writing by the Engineer and all associated cost revisions shall be resolved by the Engineer in accordance with the Conditions of Contract.

Demolition or any other operations on existing underground or above ground structures are not permitted without the Engineer’s presence and without an approval and attending on the part of the owner.

The Contractor shall provide all required information to the Engineer who shall consult and obtain an approval from the Employer and the Designer if execution of unforeseen or extensively bigger works than planned is pending.

The full compliance of supplied equipment and of the works executed shall be guaranteed by the Contractor in accordance with the conditions of contract, these Technical Specifications and subject to the approval of the Engineer.

15.4.4. Testing and Start-Up

15.4.4.1. Start-Up

The network can be put into operation only after a technical inspection and issue of a certificate for use. The technical inspection shall include:

- Check of compliance of the structure with the design and/or verified modifications and additions by quality and quantity of incorporated cables, equipment and works executed.
- Measurements and tests

15.4.4.2. Measurements and Tests

a. *Measurements and Tests Prior to Execution of the Works*

The equipment, accessories and materials will be subjected to visual inspection. Only sound, undamaged and new equipment may be fitted. Inspection of the equipment, accessories, material and cables by the manufacturer’s commission in factory shall be stipulated in the contract between the Contractor and the Employer and shall be completed to the full satisfaction and approval of the Engineer.

b. *Checks and Tests Prior to Cable Laying*

A drum, its sides and cover planks shall be undamaged. It shall bear an inscription plate with the necessary data which shall also be impressed in the wood on the sides. The drum shall come with a test certificate. Cables from a drum without a compliance certificate shall not be used unless specific additional measurements are carried out.

If the drum is undamaged and therefore suitable, the pressure in the cable shall be checked with a hand pressure gauge (cables with air-paper insulation). If the pressure is within the permitted values the cable may be used without additional checks. If the pressure is lower or zero then causes of gas leakage shall first be identified and appropriate measures undertaken. If the pressure is zero, the insulation shall be checked.

In case the drum is damaged, the cable shall be carefully inspected and used provided the sheath is undamaged and the pressure is good. No use of a damaged or kinked cable is allowed even if the pressure is normal and insulation suitable since other parameters may be disturbed and may become evident while the cable is pulled out (working capacity, capacitance couplings). Damaged cables may be used provided such damaged lengths are cut out and the remainder checked for insulation and dielectric strength.

The insulation of paper insulated cables shall be checked in the above cases. Insulation shall be measured with an insulation meter of appropriate range and measuring voltage not less than 100 V. If voltage is 500 V no further check of dielectric strength between wires will be needed. The Engineer will decide whether an additional check of dielectric strength between wires is needed. Insulation resistance values are given in ZJPTT Technical Specifications, cable catalogues, and compliance certificates .

c. *Measurements and Testing in the Course of Work*

In exceptional cases only the cables laid shall be checked prior to finishing, if the Engineer thinks it necessary and if long time has elapsed between cable laying and finishing so that damages may be rightly suspected.

Measurement of cables for capacitance coupling compensation shall follow the Technical description attached to the design.

d. Measuring and Testing a Finished Cable Installation

These measurements and tests are obligatory and shall be attended by the Engineer. They will be done between cable leads-in, between leads-in and amplifier and between amplifiers. The following measurements shall be performed:

- Insulation resistance
- Dielectric strength
- Numbering and loop resistance
- Working and crosstalk attenuation in low frequency range.

The following additional measurements shall be done on cables with carrier frequency and/or coaxial quads/pairs:

- Working attenuation within the range envisaged for telecommunication transmission.

<u>Carrier frequency symmetrical quads:</u>

- Crosstalk attenuation at near and far ends within the range foreseen for telecommunication transmission between pairs in a quad and pairs of different quads (if there is a number of quads).

<u>Coaxial pairs:</u>

- Resistance of internal and external conductors,
- Insulation resistance and dielectric strength between internal and external conductors and other conductors and Al cable sheath bonded together,
- Cross talk attenuation to 200 kHz
- Reflection and impedance by a reflectometric method.

Measurements method and results shall comply with ZJPTT Instructions on quality control for cabled telephone lines, ref.no. 02-6217/1-67.

All tests shall be completed to the satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

15.4.5 Measurement

The exact measurement of installed equipment and used material is determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

15.4.6 Payment

Payment of installed equipment and material is executed according to the prices determined by the Contract, and the measurement approved by the Engineer

15.5. Laying of Optic Cables

15.5.1. Calculation of Permitted Drawing Force

If a cable is to withstand drawing force without damage the following requirements shall be fulfilled:
- Maintenance of minimum bending radius depending on cable diameter and sheath type along a curved route,
- Maximum permitted drawing force dependent on cable structure shall not be overrun.

Permissible bending radius for a loaded cable shall be minimum 20 times cable diameter.

The drawing force occurring at cable starting end when a cable section is drawn in at a go depends on:
- Friction resistance which has to be overwhelmed while a cable is being drawn in conduit,
- Direction of drawing, i.e. the effect of full cable weight.

Cable weight also has minor or major effect on graded and curved sections.

Insulation friction between a cable and cable conduit depends on:
- Friction coefficient between the cable and conduit surface,
- Cable weight,
- Conduit geometry (curves, up and down gradients...)

Since a small length optic cable is concerned in this case, it will be blown in and drawing force will therefore be below the permitted value of 1500N .

15.5.2 Measurements of Relevant Parameters of an Optic Cable

According to the instructions on measurements on telecommunication lines with optic cables that are aimed at checking whether a cable was laid and mounted in the way that will ensure proper operation in its lifetime the following measurements will be carried out:
1. Measurements prior to laying (on drum)
2. Measurements after laying
3. Measurements during installation
4. Final measurements on a regenerator section

Immediately after laying the fibres shall be measured on a cable length and defects in any identified so that appropriate measures may be undertaken. Optic length and attenuation per unit of length shall be measured with an optic reflectometre at 1300 nm.

In the course of cable laying, before and after a joint is completed, optic depth and longitudinal attenuation of fibres shall be measured as well as attenuation of a joint at 1300 nm at both ends to avoid joining at inappropriate attenuation.

When cable joining is completed along a whole regenerator section then with an optic reflectometer attenuation at all joints at 1300 nm in both directions, longitudinal attenuation of each cable length between joints in one direction and total attentuation shall be measured using in both directions a stabilized optic source and a power meter at 1300 nm. The results shall be entered in appropriate tables in A4 format and will constitute a measurement protocol which shall be an integral part of the record documents.

All tests shall be completed to the satisfaction of the Engineer and all test results shall be submitted for the approval of the Engineer.

15.5. 3. Laying of Cables

The planned works shall be of good quality, shall comply with the applicable technical regulations, shall be executed by approved contractors, using equipment manufactured and tested for compliance according to the relevant ZJ PTT technical regulations, all in full compliance with these Technical Specifications and subject to the approval of the Engineer.

The works shall be done in as short a period as possible.

The Contractor shall observe all requirements and approvals obtained and incorporated in the design documents. Each modification shall be first approved and verified by the designer and shall then be confirmed as an instruction by the Engineer.

The Contractor shall be solely responsible for any damage due to a failure on his part to observe design requirements in the course of works.

The Contractor shall observe the Law on Occupational Health and Safety (Off. Gazette of RS No. 42/91), and undertake protective measures listed in the attachment to the design documentation.

The Contractor shall keep a Measurement Book and a Building Journal and these will have to be regularly verified by the Engineer in charge of the project.

The work shall be so organized as to proceed without interruptions and to end within the term specified. No work may commence until all materials are in place.

The Contractor shall be responsible for proper signage on the site to avoid accidents. Only cables and materials that will be used in one day may be delivered to site. No vehicles and equipment may be left on the road but if unavoidable, then warning signs shall be erected together with regular trafic signs according to the Law on Traffic Safety.

Vehicles used for the above transport on a public road shall be escorted by traffic police if the Contractor thinks that traffic flow may be endangered.

The Contractor shall provide space for the storage of cables according to laying sequence. The cables shall be accessible for testing and use.

The Contractor shall visually check cables on drums and accessories while taking them from the Employer of the factory and measure power on all fibres and accessories with an optic meter .

The Contractor shall lay and install an optic cable fully observing the Instructions governing the laying, installation and measurements of optic cables on telecommunication lines.

After cable laying and installation the Contractor shall plot data about the completed installation on geodetic plans, scale 1:500 or 1:1000, adding the necessary analytical elements (coordinate lines related to the state control network and a measurement protocol in accordance with the applicable instructions on technical records of lines with optic cables).

15.5.4 Preparation of Conduits for Insertion of Optic Cables

These conduits shall be prepared prior to the insertion of optic cables, and/or adjusted for optic cables. Effective adjustment of telecommunication conduits means that a polyethylene pipes of smaller diameter shall be drawn into ø 110 mm telecommunication conduit, namely:

- Three ø40mm pipes
- Four ø32 mm pipes
- Two ø40mm pipes and two ø32 mm pipes.

PE pipes shall be placed in TT conduits in the following way:

- Align drums(coils) with PE pipes on top of the trench at the end opposite to the direction of laying ,
- Fix ends of pipes assembled in a neat bundle with adhesive PVC tape about 30cm long
- Cover the end of the bundle of pipes formed as above with a drawing sleeve and tie a pulling strand or a 3-5 mm steel wire to the other sleeve end.
- One or two workers shall pull the strand and PE pipes from the other end. The required number of workers shall be engaged there.

It is essential that the bundle of PE pipes corresponds to the conduit length between manholes as the bundle shall terminate flush with the wall containing pipe outlets, namely flush with the conduit end.

To prevent movement of PE pipes in the conduit while an optic cable is drawn in, the bundle ends shall be fixed at the points where they enter a manhole with a sufficiently robust rubber ring.. The ring would end at the point where the conduit enters the manhole. It is not recommended to fix PE pipes with concrete.

The duct in a conduit to be selected for drawing in PE pipes shall be the last top one as optic cable will be best protected in it. In manholes, 10 to 15 cm beneath the top plate small wall consoles shall be fitted for optic cables runs. At the points where PE pipes terminate in manholes, the pipes which will remain unused shall be plugged with rubber plugs or heat shrinking caps and those used for optic cable drawing in with plugs ensuring tight contact of the pipe and the cable.

15.5.5. Drawing in a Cable in PE Pipes in Conduits

The following preparatory actions shall precede the laying of an optic cable:

- Erect a fence around the site together with traffic signs,
- Remove covers from the manholes along a section equal to cable factory length, i.e. a section between two consecutive joints,
- Check harmful gas content in manholes and eliminate causes of their presence. Continue checking in the course of the works,
- Ventilate the manholes for about 15-30 minutes,
- Provide lighting
- Remove water and clean manholes (if there is water and objects that may obstructing work in them).

Work may proceed at the temperature not below +5 nor higher than 50°C. Optic cables are very sensitive to longitudinal stresses due to their small size and weight.

A cable shall be drawn in by hand. Therefore many workers shall be engaged and their work shall be fully synchronized. One worker shall be charged with hand drawing of cable in each manhole or gallery.

Strict account of permitted drawing force shall be taken during cable drawing in. It will be 1500 N for the cable type selected here bearing in mind that friction occurring while a cable in a polyethylene sheath is drawn in a PE pipe is 0.35 – 0.45. Minimum allowable cable bending shall not be exceeded either.

15.5.6. Optic Cable Route Setting Out

An optic cable in telecommunication conduits shall be appropriately marked for the purpose of identification and protection. The identification sign shall be inscribed on a plastic plate fixed on the cable with a transparent PVC tape. It shall be positioned at an eye-striking place and shall contain:

- Name of section
- Type, kind and capacity of cable

- Year of construction

Optic distributors at end points shall bear identification similar to the one mentioned above. Supports for optic connectors shall also be marked and enable easy identification of the optic fibre on a section.

15.5.7 Completion/acceptance/handover

All materials and equipment which are to be installed have to be in accordance with the existing SRPS standards, and if they do not exist, with the existing IEC standards.

The equipment, before installation, has to be examined according to the existing regulations.

All installation works have to be executed in accordance with the existing SRPS standards, and if they do not exist, with the existing IEC standards.

During the construction the Contractor is obliged to provide normal traffic conditions, placing the appropriate signs, and to secure excavations at locations where they could cause accidents to pedestrians.

Upon the completed construction, before putting the structure into operation, carry out all necessary examinations and trial work. Upon completion of all works, the Contractor and the Engineer shall create the exact plan of the plant and network and to insert all completed changes in one copy of this design, with the aim to provide exact as-built documentation and to submit through the Employer to the authority which will use this plant and network.

15.5.8 Measurement

The exact measurement of installed equipment and used material is determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

15.5.9 Payment

Payment of installed equipment and material is executed according to the prices determined by the Contract, and the measurement approved by the Engineer

Section 16
Electrical installations

Contents

16.1. Cable Electric Mains 1Kv

16.1.1. General Specifications

These Technical Specifications constitute an integral part of the design and contract documentation for which the Contractor shall ensure full compliance.

Works shall be carried out fully complying with the text and drawings in the technical design documentation, the regulations and norms governing installations of this type, and these Technical Specifications, all subject to the approval of the Engineer.

Prior to the commencement of works, the Contractor shall peruse the design documentation, give his comments and observations, if any, and duly submit them to the Engineer through the Building Journal.

Modifications or variations that may considerably affect the design solution shall be permitted solely upon a written consent of the Designer and subject to the approval of the Engineer.

During the execution of works the Contractor shall keep daily records entering all required data (Building Journal).

During the execution of works due care shall be exercised to avoid damage to other works and existing installations.

Breaking or chasing of reinforced concrete structures to make room for electrical works may be done only upon a written consent of the Engineer.

The materials and equipment to be incorporated shall have the characteristics specified in the design documentation and applicable norms and standards.

The Manufacturer's declaration of quality and appropriate Compliance certificates shall be provided for such equipment and materials.

During the execution of works the Contractor shall undertake safety measures in compliance with the applicable rules and norms.

16.1.2. Cable laying

16.1.2.1. General Recommendations

In general, electrical cables shall be buried direct in the ground. At street, road and path crossings and in all other places where a cable has to be protected from mechanical damage, cables shall be laid in protective pipes and cable conduits respectively.

Cables shall be laid by hand or using mechanical means when allowable bending radii and drawing forces shall be considered.

Allowable bending radii for cable types PP00, PP41 XHE-49, NPO-13 and NPZO-13 is 15 D (mm), and/or 15 D1, and for XP00 cable type it is 12 D.

Allowable drawing forces over tension sleeves for types PP00 ASJ, PP 41 ASJXHE-49A, XP00-AS, is $5D^2$ (N), and for NPO-13 A and NPZO-13 A -3 D^2 (N).

It is not recommendable to lay cables when the outside temperature is below +5 ^oC. If the temperature is lower a cable shall be warmed in advance and laid as quickly as possible. The warming up shall last 36 to 48 hours for a cable on a drum in a room at the ambient temperature of 10^o C to 20 ^oC. Fast warming up can be achieved by letting 5 A/mm² electric current through the cable for about one hour while preventing the cable surface temperature to exceed 25^o C.

The cable route shall be surveyed before backfilling. Points of crossing of the cable with other cables and installations, points of splicing, and cable exact length shall be plotted on the laying plan.

Ends of a laid cable, points of crossing with other underground installations and other characteristic points shall be specially marked with plates containing basic cable data. Such plates shall not be fixed to cable wires.

Routes of electric cable lines are generally specified in urban and technical terms of reference to suit other underground installations. Cables in a public lighting system shall be laid along mast axis.

16.1.2.2. Laying Cables in Trench

The width of the strip of land for cable laying shall be minimum 0.7 m.

The size of a trench for cables to be buried direct in the ground shall depend on its nominal voltage, type of soil, number of cables in trench and available size.

Trench bottom shall be made flat and stones and other sharp objects removed to avoid any burden on the cable. If this is not possible, a 0.2 m thick bedding for cable shall be placed in trench. The cable shall be laid at the bottom of the trench and /or on such a bedding. It shall be laid in a winding line so that cable will be by 2% longer than its route.

As a rule, a cable shall be covered with 0.3 m thick layers of excavated earth. The first layer next to the cable and/or bedding shall consist of excavated fine grained earth, same as cable bedding. If, however, excavated material contains lots of stone, debris, mud, earth contaminated with chemicals, then fine grained earth, sand or specially prepared material of good heat conductivity shall be brought to the place.

A plastic warning tape shall be placed on top of the cable in due time prior to backfilling. The tape shall be red with warning lettering that a power cable lies beneath it. The tape shall be about 0.1 m wide and of the quality guaranteeing the same lifetime as the cable itself.

An open cable trench shall bear visible marks and provide safety for pedestrians and vehicles.

16.1.2.3. Laying Cables in Conduits

Cable conduits shall be used for crossings under streets, roadways, tramway tracks, railway tracks, yards with vehicular passages and where permissible distances of power cables from other underground installations are exceeded.

Cable conduits shall be constructed from plastic, asbestos cement pipes or prefabricated concrete elements (ducts). Warning tapes shall be laid over conduits. As a rule, steel pipes shall be avoided.

Minimum inside diameter of pipes shall be at least 1.5 times the cable outside diameter.

Cable conduits shall be placed on a bedding of 10 cm thick lean concrete. The pipes shall be carefully joined and joints grouted with cement mortar or other suitable materials. Edges of openings in concrete conduits shall be covered with sheet lead.

Unused pipe openings shall be closed with plastic plugs or similarly in another way. Where cable conduits cannot be placed in open trench, they shall be placed in a boring..

16.1.2.4. Convergence and Crossing with Power Cables and Other Installations

Minimum distance of 0.5m shall be required wherever power cables run parallel with telecommunication cables.
They shall cross at the distance of 0.5m.

A power cable shall cross a telecommunication cable at the distance of 0.5 m. Crossing angle shall be as close to the right angle as possible and not less that 45º. As a rule, power cables shall be placed beneath telecommunication ones.

If the above distances, Sub-Section 16.1.2.2. cannot be achieved, power cable shall be placed in a protective pipe but the distance shall never be less than 0.3 m.

Laying power cables parallel to, under or above water supply pipes and sewers is not permitted except at crossings.

Horizontal distance between power cables and water supply or sewerage pipes shall not be less than 0.4m. If such a distance cannot be achieved, power cable shall be drawn through a protective pipe.

At points of crossing a cable may run above or under water supply pipes at the minimum distance of 0.3m shall be ensured between the cable and the pipe.

A trench shall be excavated by hand at the points where power cables run parallel to water supply pipe or sewer (no mechanical means).

It is not permitted to guide power cables above or under heating ducts except at crossings.

At crossings, a cable shall as a rule pass above heating line duct and only in exceptional cases it can pass under it. Minimum horizontal distance between a cable and the outer edge of a heating line duct shall be 0.6m.

Spacing between power cables if running in parallel in a trench shall be minimum 0.07m and 0.2m if crossing.

If one trench has to accommodate cables of low and medium voltage or several cables of medium voltage, they shall be separated with a row of bricks or some other insulating materials, subject to the approval of the Engineer.

The distance between a power cable and a gas pipeline crossing and running in parallel shall be minimum 0.8 m in built up urban environment and 1.2m in unbuilt area.

These distances may be reduced down to 0.3m if a cable is placed in 2 m long sections of a protective pipe at each end of a crossing.

If a cable line crosses a road outside urban area it shall be laid in a protective pipe drawn in a bored passage under the road without breaking it.

Vertical distance of cable conduits and road surface shall not be below 0.8 m.

The distance between a cable line and a road running in parallel shall be:
- Minimum 5 m for a motorway or class I road
- Minimum 3 m for roads below class I

16.1.2.5. Cable Accessories

Use of heat shrinking and cold shrinking cable accessories or prefabricated elements is recommended. It is permitted to use conventional cable accessories for paper insulated cables (IPO 13).

Conductors shall be joined by pressing (SRPS N.F4.101) while special bolted clamps are also permitted.

Cable joints and terminations shall be fitted by skilled persons.

A medium voltage cable termination shall be fitted with accessories for simple fixing of metallic sheath and armour, and of electrical safety elements to earth terminal of a transformer station or a mast.

A cable joint shall not be grounded on its own whether made of insulating materials or metal.

Joints and terminations shall comply with the standards governing works of this kind and with recommendations and instructions issued by the manufacturer.

Each cable of selected type and cross sectional area, bolted clamps and jointing material to be pressed shall be accompanied with prototype Compliance certificates particularly concerning "speedy ageing".

If aluminium cables are used then particular attention shall be paid to jointing quality. These shall be joined by soldering, welding and pressing according to a specific procedure. Aluminium cables shall be connected to copper terminal ends, rails and the like via tin plated copper lugs. Aluminium and copper cables shall not be joined in a cable splice but only in transformer stations, distribution boards and termination boxes. Aluminium cables shall be handled with special tools that have not been in contact with copper. Special bolted clamps can also be used for low voltage cables.

A finished cable joint shall be covered with a sand layer not thinner than 10 cm at any point and bricks all over it. Joints in buildings or in manholes need not be covered with sand.

Joints and terminations shall comply with SRPS N.F4 group of standards. In their absence, work shall proceed according to VDE regulations, manufacturer's instructions and "Elektrodistribucija" requirements.

Finished cable joints shall not be buried until their positions are surveyed by the Contractor and approved by the Engineer.

The laid, spliced and buried power cable shall be subjected to voltage test.
Each joint and termination shall be provided with a plate showing type, cross sectional area, voltage and name of a facility in which the cable is terminated at the other end.

16.1.2.6. Testing of power Cables and Accessories

Power cables shall be tested by type according to SRPS N.C5.025, SRPS N.C5.235 and SRPS IEC 60502.

Cables and cable accessories shall be subjected to obligatory (piece) test, type test, special tests and tests at acceptance.

Cables and cable accessories shall be accompanied with compliance certificates issued by an accredited institution.

The cable laid, spliced and terminated shall be subjected to voltage test along its whole line.

16.1.2.7. Final Requirements

The completed and tested installation with adjusted safety and control units shall be handed over to the Employer during technical acceptance by the Engineer.

The Contractor shall incorporate comments of the Technical Acceptance Commission without any right to compensation.

During the technical acceptance the Contractor shall submit the following to the relevant Technical Acceptance Commission and also during commissioning of the facility to the Employer:

- Two copies of as built drawings
- Compliance certificates and declarations concerning the quality of incorporated equipment and certificates on measurements and tests performed.

Period of guarantee for the works shall start from the date of commissioning.

Anything else concerning the facility unspecified in these technical conditions shall be defined by the contract between the Employer and the Contractor and shall be subject to the approval of the Engineer.

Measurement and payment

The exact quantity of installed material and payment are determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

16.2. Combined Electric Mains 10 kV

16.2.1. General specifications

When erecting a 10 kV overhead line the Contractor shall observe the approved technical regulations and standards, technical documentation, the technical requirements and drawings of the Manufacturer of equipment.

These Technical Specifications constitute an integral part of the design and contract documentation for which the Contractor shall ensure full compliance in the erection of 10 kV overhead power line.

The Contractor shall observe and apply during the execution of the works:
a) Applicable SRPS, IEC regulations and standards;

b) Rules on electrical installations operating at nominal voltage over 1000 V, Off. Journal of SFRY No.4/74, amended in Off. Journal of SFRY No.13/78, Off. Journal of FRY No.61/95;
c) Rules on technical norms for grounding electrical installations operating at nominal voltage over 1000 V, Off. Journal of FRY No.61/95;
d) Rules on technical measures for operation and maintenance of electrical installations and overhead power lines, Off. Journal of FRY No.41/93;
e) Law on Occupational Health and Safety, Off. Gazette of SRS, No.42/91;
f) Rules on general measures for safety at work and protection against dangerous current in rooms intended and used for operating electrical facility and on sites, Off. Gazette of SRS No. 21/89;
g) The manufacturer's requirements ;
h) Technical documents;
i) Regulations and recommendations of EPS and EDB.

The first and main obligation of the Contractor is to peruse the technical documentation, prepare a schedule of works and execute them in accordance with the technical documentation. In case of ambiguities in the technical documentation the Contractor shall ask the Designer to clarify.

The Employer shall nominate an expert (the Engineer) to supervise the execution of works, their quality, quantities and resolve unclear issues. Modifications and deviations of any kind affecting the technical concept and choice of materials shall be permitted solely upon a written consent of the Engineer appointed by the Employer. Prior to giving such a consent the Engineer shall obtain the Designer's approval. The Engineer and/or the Employer shall be responsible for any consequences of a design modification if done without the Designer's approval.

The Design Reviewing Commission that has approved this design documentation shall be responsible for major variations from the approved design.

In executing the works the Contractor shall use planned equipment and materials in the way described in the design and in compliance with standards and regulations governing works of this kind.

The equipment and materials to be incorporated shall comply with IEC, ISO, SRPS standards and recommendations unless otherwise indicated in the design specification.

The equipment and materials to be incorporated shall be controlled and tested by the Buyer's inspectors in the course of production, packing and transport.

Fitting of electrical equipment may start upon the receipt of the Engineer's written statement that the equipment has arrived in orderly condition and that it complies with design characteristics. Materials for transmission lines shall be new and unused.

The equipment to be incorporated shall be supplied by reputable manufacturers and come with Compliance certificates which shall be submitted to the Engineer for approval.

The Contractor shall check the situation along the designed route looking for any impediments to the execution of the works according to design documentation. In the period after completion of the design and before commencement of the works the situation on the designed route earlier surveyed by the designer may worsen. In case of any obstructions the Engineer shall be consulted.

The Contractor shall take care to avoid damage in places where works are executed. Any damage, either due to insufficient care or carelessness at work shall be compensated by the Contractor to the Employer or to any other Contractor working there at the same time, and necessary repairs shall be done by the Contractor at his own cost. The Contractor shall take care to minimize damage to any existent works and installations. He shall also coordinate the works so as to avoid disruptions and improper deviations. Reinforced concrete structures may be demolished, cut or punctured only with a written consent of the Designer and the Engineer.

The use of installations may start only upon completion of the works and tests by the relevant authorities, subject to the final approval of the Engineer.

16.2.2. Masts

The Contractor and the Engineer shall precisely mark support points for new concrete masts before their erection. Mast spacing shall conform to the tension lengths shown on the layout drawing and in the longitudinal profile unless there are justified reasons for deviating from them. Any excavated foundation pits shall be inspected by a geologist.

If such an inspection confirms considerable deviations, then a new foundation or a new placing method shall be selected by the Contractor and submitted for the approval of the Engineer.

The allocated support points shall be:
- In road land strip
- On the property line
- Easily accessible to vehicles for the purpose of erection of equipment
- Easily accessible to vehicles for the purpose of replacement of fittings
- Free from danger of ground collapse
- Free from danger of landslide
- Free from danger of torrents
- Free from danger of ground water
- Free from danger of snow drifts

Masts shall be vertical and aligned on a tangent section of the route. The verticality of each mast shall be checked from two directions at the right angle.

Mast stems shall be carry fittings for conductor erection.

Mast stems shall be of reinforced concrete of circular – ring cross section, in compliance with SRPS U.M1.047 and SRPS IEC 60652.

Mast stems shall be 15m., minimum fixing depth 1.8m, and recommended fixing depth 2.0m.

Mast stems to which disconnectors or switch-disconnectors are to be fitted shall be coated with an agent for additional protection and/or impregnated to prevent corrosion.

Foundations for concrete masts shall be prismatic, made of concrete.

Masts with single stem shall be provided with prismatic foundations of horizontal square cross sectional area while foundations for masts with twin stems shall be rectangular.

Prismatic foundations for concrete masts shall be cast in situ or precast.

Mast dimensions shall adequately prevent strain in materials mounting above permissible stress limit in all load cases. Each mast section shall be calculated assuming loads that will cause maximum stress in it.

The Contractor shall prepare adequate documents for grounding each mast.

Each support point shall bear a number derived from the common numbering system,engraved in an aluminium plate or direct on mast stem in fast colour at the level of 2.50 m above ground.

Each support point shall be provided with a warning notice indicating the presence of voltage at the level of 2.50 m above ground.

At least one plastic pipe, 40-50mm dia shall be inserted in foundation to take an earth wire for the mast through it.

Upper end of the plastic pipe shall protrude above top foundation surface beneath the earthing terminal while its bottom end shall enter the soil at least 0.6 m below the ground surface.

Where underground cables are to be connected to a mast, then its foundation shall contain an appropriate number of plastic pipes, 100 mm dia to allow their passage through the foundation.

Cantilevers for conductor erection shall be of concrete and shall be fitted to a concrete mast stem prior to erection.
Other cantilever types may be used if more adequate in some cases.

All necessary fittings shall be fixed prior to mast erection, if possible.

Assembled masts shall be conveyed and erected to avoid damage or loads in excess of designed ones. Minor damage shall be repaired while masts with damage that may weaken their stability shall not be used.

16.2.3. Conductors

Conductors shall be steel-reinforced aluminium ones with maximum number of wires.

10 kV steel reinforced aluminium conductors are: Al/Č 50/8 i Al/Č 70/12.

Conductor route in unbuilt area shall be short and tangent, without turns, as much as possible.

Conductor route in built up urban environment shall not pass through yards and gardens unless unavoidable and subject to the approval of the Engineer.

The route shall be close to existent streets as this will lower the cost considerably.

In setting a conductor route grounds with possible additional ice load occurrence shall be avoided as well as galloping of phase conductors.

If an overhead power line has to cross arable land, its support points shall be allocated along the existing property lines.

The longitudinal profile shall indicate all structures/ buildings to be crossed by the line.

The distance between live parts and between live and earthed parts and mast sections assuming wind effect or additional loads shall be minimum equal to safety clearance.

Headroom below an overhead power line crossing or getting closer to buildings/structures shall be equal to safety clearance unless a particular value is indicated for it.

In the area accessible to vehicles (around built up areas, above meadows and fields), headroom shall be 6 m and safety clearance 5 m.

For permanently accessible parts of buildings (terraces, balconies), headroom shall be 5m and safety clearance 4 m. Overhead power lines above buildings shall be provided with upgraded electrical insulation and those above houses and public buildings in which large numbers of people sojourn shall require upgraded mechanical insulation, too.

In built up urban environment headroom shall be 7m. Electrical insulation shall be upgraded as well as mechanical at the points of crossing with streets or roads.

On regional and local roads headroom shall be 7 m. As a rule, the distance of any mast section from outer road edge shall not be less than 10m but may be reduced to 5m in exceptional cases. Electrical insulation shall be upgraded. In a crossing tension length only one joint per conductor or a protective wire is permitted. As a rule crossing angle between an overhead power line and a regional road shall be minimum 20°. The crossing angle will be limitless on local roads.

On main roads the headroom shall be 7m. Horizontal distance of any mast section from the outer road edge shall be 20m and may be reduced but not below 10 m. Both mechanical and electrical insulation shall be upgraded. In a crossing tension length no joints will be permitted in conductors. As a rule, the crossing angle shall be minimum 30°.

On a motorway headroom shall be 7 m. The distance of any mast section from the motorway edge shall be minimum 40m and may be reduced but not below 10 m. Both mechanical and electrical insulation shall be upgraded. In a crossing tension length no splices in conductors are permitted. Crossing angle shall be minimum 30°. If overhead power lines are in parallel then their distance from the motorway along 5 km and longer motorway sections may be minimum 50 m.

At the points where a high voltage overhead power line crosses other high voltage lines and at the points where they converge, safety vertical clearance shall be 2.5m, and safety horizontal clearance 1m. These requirements have to be fulfilled even in cases of additional load on the upper line and no load on the lower one. As a rule a higher voltage line shall be placed above a low voltage line. The upper line shall be provided with upgraded electrical insulation.

Running of a low voltage line over and above a high voltage line is not permitted.

Where a high voltage line crosses a low voltage one, safety vertical clearance shall be 2.5 m and horizontal safety clearance 2 m. The upper line shall have upgraded electrical insulation.

At the point where an overhead 10 kV line crosses a telecommunication line, the height from the bottom conductor in the electrical line and the top conductor in the telecommunication line shall be 4m. At the point where an overhead 10 kV line crosses a telecommunication line no safety net shall be placed. At the point where an overhead 10 kV line crosses a telecommunication line mechanical and electrical insulation shall be upgraded and no joints will be permitted in that tension length. As a rule, the crossing angle between an overhead 10 kV line and a telecommunication line shall not be less than 45°, but it may be reduced down to 30°.

It is not permitted to take a telecommunication line over an overhead power line.

Conductors, steel reinforced aluminium ones in our case shall be fitted through the following stages of work:

- Preparations preceding pulling out of steel reinforced aluminium conductors
- Pulling out of conductors along the route
- Tensioning of steel reinforced aluminium conductor
- Attaching steel reinforced aluminium conductors to string insulator units

A steel reinforced aluminium conductor shall be pulled out over an aluminium pulley hung on a cantilever.

Pulleys for conductor pulling-out fitted to tensioning and end masts shall be stronger and bigger than those supporting masts.

Tensioning masts at corners shall be anchored contrary to tensioning force direction during conductor pulling out and tensioning.

Conductors shall not be pulled over sharp objects, rocky ground, fences, or fields sprinkled with fertilizers. If this is unavoidable, then wooden boards, joists, scaffolds and the like shall be placed over such obstructions.

Steel-reinforced aluminium strand shall be tensioned at the values shown in the sag table dependent on temperature and tension length.

The temperature shall be measured very carefully if tensioning is done by taking sight on levelling staff.

It is recommended to measure the ambient temperature of the air with a thermometer placed on a mast, 5 m above the ground level.

In a tension length, the conductor shall be left to rest on pulleys for two days for sag to settle in the meantime. Then conductors shall be attached to carrying string insulators.

Conductors shall be spliced with appropriate splices and/or clamps of the same materials. Steel splices and clamps shall be hot dip galvanized or made of stainless steel.

No more than one splice per conductor shall be permitted in one tension length.

Conductors of different cross sectional area or of different materials may be spliced only at the points where they do not withstand any mechanical load. Clamps shall serve for reliable prevention of electrolytic destruction.

In a tension length, conductor splices shall withstand 90 % of conductor breaking load.

Post and suspended insulators shall be used. Post insulators shall be firmly fixed to masts. Hanging insulators shall be so fitted to a mast that they can freely swing around the point of fixing.

The positions of insulators and/or string insulator units shall not diminish the insulating properties of conductors.

Multiple insulator strings may be used provided that loads are equally distributed over them under normal conditions.

Both mechanical and electrical insulation of each conductor shall be upgraded if necessary.

Upgraded electrical insulation means that the selected insulator will have longer creepage path.

Conductors shall be supported on puncture proof porcelain post insulators.

Conductors in tension shall include string insulators with glass pins.

Tensioned conductors shall be attached to string insulators with wedge clamps or compressive clamps suitable for steel reinforced aluminium conductor.

Tension clamps for fixing steel reinforced aluminium conductor in tension to string insulators shall comply with SRPS N.F2.010.

Concrete cantilevers shall have 22 mm dia holes. String insulators shall be attached to concrete cantilevers with flag supports and anchor bolts already fitted to them. Flag and anchor bolt for string insulator suspension shall withstand nominal breaking force of 40 kN.

Joints in steel reinforced aluminium conductors shall be non-disconnecting. They shall be formed by plastic deformation of the body when pressed or by plastic deformation of the body when notched.

Electrical continuity of steel-reinforced aluminium conductors shall be preserved with at least two conducting clamps and a joint pressurized with bolts or one conducting clamp and an aluminium lug with M12 bolts at conductor unloaded ends.

The joint of a conducting clamp and an aluminium lug shall be formed by plastic deformation by pressing clamp body. M12 bolts shall be fitted with two spring plate-shaped washers and a nut.

A branch circuit shall include at least two conducting clamps and a pressure bolted connection.

The branch circuit shall consist of a conductor of the same type and cross sectional area as branching conductor.

Branch conducting clamps for steel reinforced aluminium conductors shall be fitted along the load free conductor section.

Connections to various units in the equipment shall be made using conductors of the same type and cross sectional area as conductors in the overhead power line.

Levers in a disconnector or a switch disconnector control mechanicms shall be positioned:

– At the side of the overhead power line,
– At the apex of an obtuse angle in overhead power line if the point of support is positioned at an angle,
– At the point where a mast can be most easily approached.

Joints of steel reinforced aluminium and copper shall be done with bimetallic conducting clamps.

16.2.4. 10 kV Cable Trench

16.2.4.1. General Recommendations

In general, electrical cables shall be buried direct in the ground. At street, road and path crossings and in all other places where a cable has to be protected from mechanical damage, cables shall be laid in protective pipes and cable conduits respectively. Cables shall be laid by hand or using mechanical means provided always that allowable bending radii and drawing forces are considered.

Allowable bending radius for cable types PP00, PP41 XHE-49, NPO-13 and NPZO-13 is 15 D (mm), and/or 15 D1, and for XP00 cable type it is 12 D.

Allowable drawing forces over tension sleeves for types PP00 ASJ, PP 41 ASJ XXE-49A, XP00-AS is $5D^2$ (N), and for NPO-13 A and NPZO-13 A is $-3\ D^2$ (N).

It is not recommendable to lay cables when the outside temperature is below +5 ºC. If the temperature is lower a cable shall be warmed in advance and laid as quickly as possible. The warming up shall last 36 to 48 hours for a cable on a drum at the ambient room temperature of 10º C to 20 ºC. Fast warming up can be achieved by letting 5 A/mm² electric current through the cable for about one hour while preventing the cable surface temperature to exceed 25º C.

The cable route shall be surveyed before backfilling. Points of crossing of the cable with other cables and installations, points of splicing, and the cable exact length shall be plotted on the laying plan and submitted for the approval of the Engineer.

Ends of a laid cable, points of crossing with other underground installations and other characteristic points shall be specially marked with plates containing basic cable data. Such plates shall not be fixed to cable wires.

Routes of electric cable lines are generally specified in urban and technical terms of reference to suit other underground installations. Lighting cables shall be laid along mast axis.

16.2.4.2. Laying of Cables in Trench

It is recommended to place power cables direct in the ground.

The size of a trench for cable to be laid direct in the ground shall depend on its nominal voltage, type of soil, number of cables in trench and available size.

Trench bottom shall be made flat and stones and other sharp objects removed to avoid any burden on the cable. If this is not possible, a 0.2m thick bedding for cable shall be placed in trench. Cable shall be laid at trench bottom and/or on such a bedding. It shall be laid in a winding line so that the cable will be by 2% longer than its route.

As a rule, a cable shall be covered with 0.3 m thick layers of excavated earth. The first layer next to the cable and the cable bedding shall consist of fine grained earth. If, however, the excavated material contains lots of stone, debris, mud, earth contaminated with chemicals, then fine grained earth, sand or specially prepared material of good heat conductivity shall be brought to the place.

A plastic warning tape shall be placed on top of the cable in due time prior to backfilling. The tape shall be red with lettering warning of existence of a power cable beneath it. The tape shall be about 0.1 m wide and of the quality guaranteeing the same lifetime as the cable itself.

An open cable trench shall bear visible marks and ensure safety of pedestrians and vehicles.

16.2.4.3. Cables in conduits

Cable conduits shall be used for crossings under streets, roadways, tramway tracks, railway tracks, yards with vehicular passages and where permissible distances of power cables from other underground installations are exceeded.

Cable conduits shall be constructed from plastic, asbestos cement pipes or precast concrete products (ducts). Warning tapes shall be laid over conduits. As a rule, steel pipes shall be avoided.

. Minimum inside diameter of pipes shall be at least 1.5 times the cable outside diameter.

. Cable conduits shall be placed on a bedding of 10 cm thick lean concrete. The pipes shall be carefully joined and joints grouted with cement mortar or other suitable materials. Edges of concrete conduit openings shall be covered with sheet lead.

Unused pipe openings shall be closed with plastic plugs or in another similar way.

Where cable conduits cannot be placed in open trench, they shall be drawn into boring.

16.2.4.4. Convergence and Crossing with Power Cables and Other Installations

Minimum distance of 0.5 m shall be required wherever power cables run parallel with telecommunication cables.

They shall cross each other at the distance of 0.5 m. Crossing angle shall be as close to the right angle as possible and not less that 45º. As a rule, power cables shall be placed beneath telecommunication ones.

If the above distances,cannot be achieved, power cable shall be placed in a protective pipe but the above distance shall never be less than 0.3 m.

Laying the cable lines parallel with, under or above water supply pipes and sewers is not permitted except at crossings.

Horizontal distance between power cables and water supply or sewerage pipes shall not be less than 0.4 m. If such a distance cannot be achieved, power cable shall be drawn through a protective pipe.

At points of crossing, cables may run above or under water supply pipes at a minimum distance of 0.3 m.

A trench shall be excavated by hand at the points where a power cable runs parallel to a water supply pipe or sewer (no mechanical means).

It is not permitted to guide power cables above or under heating ducts except at crossings.

At crossings, a cable shall as a rule pass above a heating line duct and only in exceptional cases it may pass under it. Minimum horizontal distance between a cable and the outer edge of a heating line dust shall be 0.6 m.

Spacing between parallel power cables in a trench shall be minimum 0.07m and 0.2m at crossing points.

If one trench has to accommodate cables of low and medium voltage or several cables of medium voltage, these shall be separated by a continuous row of bricks or some other insulating material.

The distance between a power cable and a gas pipe line at a crossing and in parallel running shall be minimum 0.8 m in urban area and 1.2 m in unbuilt area.

These distances may be reduced down to 0.3m if a cable is placed in a protective pipe 2 m long at each end of a crossing.

If a cable line crosses a road outside urban area it shall be laid in a protective pipe drawn through a bored passage under road without pavement breaking. Vertical distance of cable conduits from the road surface shall not be less than 0.8 m.

The distance between a cable line and a road running in parallel shall be:

- Minimum 5 m for a motorway or class I road, and minimum 3 m in case of convergence
- Minimum 3 m for below class I roads for parallel runs, and/or minimum 1 m in case of convergence

16.2.4.5. Cable accessories

Use of heat shrinking and cold shrinking cable accessories or prefabricated elements is recommended. It is permitted to use conventional cable accessories for paper insulated cables (IPO 13).

Conductors shall be joined by pressing as recommended (SRPS N.F4.101) although special bolted clamps are also permitted.

Cable joints and terminations shall be fitted by skilled persons.

A medium voltage cable termination shall be provided with accessories for simple fixing of metallic sheath and armour, and for connecting electrical safety elements to earth terminal of a transformer station or a mast.

A cable joint shall not be grounded on its own whether made of insulating materials or metal but electrical protection and/or the cable lead sheath shall be bridged.

Joints and terminations shall comply with the standards governing works of this kind and with the fitting recommendations and instructions issued by the manufacturer.

Each cable of selected type and cross sectional area, bolted clamps and jointing material to be pressed shall be accompanied with prototype Compliance certificates.

If aluminium cables are used then particular attention shall be paid to jointing quality. These shall be joined by soldering, welding and pressing according to a specific procedure. Aluminium cables shall be connected to copper terminal ends, rails and the like with tin plated bimetallic Al-Cu lugs. Aluminium cables shall be handled with special tools that were not in contact with copper. Special bolted clamps can also be used for low voltage cables.

A finished cable joint shall be covered with a sand layer not thinner than 10 cm at any point and bricks all over it. Cable joints in buildings or manholes need not be covered with sand.

Joints and terminations shall comply with SRPS N.F4 group of standards. In their absence, work shall proceed according to VDE regulations, manufacturer’s instructions and “Elektrodistribucija” Co. requirements.

Finished joints shall not be buried until their positions are surveyed by the Contractor and submitted for the approval of the Engineer.

The laid, spliced and buried power cable shall be subjected to voltage test.

Each cable joint and termination shall be provided with notices showing type, cross sectional area, voltage and name of the facility in which the cable is terminated at the other end.

16.2.4.6. Testing of Power Cables and Accessories

Power cables shall be tested by type according to SRPS N.C5.025, SRPS N.C5.235 and SRPS IEC 60502. Cables and cable accessories shall be subjected to obligatory (piece) tests, type tests, special tests and tests at acceptance.

Cables and cable accessories shall be accompanied with Compliance certificates issued by an accredited institution and submitted for the approval of the Engineer.

A laid, spliced and terminated cable shall be subjected to voltage test of the whole cable line.

16.2.4.7. Setting Out Cable Routes

Markers shall be placed along a cable route in built up urban environment at ground level to designate: cable in trench, curves and turns in the route, joints, conduits, crossing with water supply pipes, telecommunication cables and the like.

Markers shall be in the form of metallic plates and shall show cable type, cross sectional area and voltage. They shall be placed at ground level at about 100 m spacing.

In unbuilt area, these markers shall be in the form of concrete posts with engraved lightning sign and cable voltage, spaced at 25 – 30 m.

Cable markers in urban and unbuilt areas shall be placed:
- on top and along cable axis
- above each joint
- above each point of crossing
- above cable conduit ends and the like

16.2.4.8. Conversion of a cable line into an overhead power line

A 10 kV cable line may be converted into an overhead line over a special mast for the purpose subject to the approval of the Engineer.

As a rule this shall be done on the tensioning (end) mast in the overhead power line. Exceptionally it can be done on a support mast if it corresponds to the tensioning (end) mast by form and dimensions.

At the point of conversion into an overhead power line the cable shall be protected from mechanical damage along minimum length of 1.70m above ground and 30 cm in it.

Cable mechanical protection shall be formed as a gutter (trough) of steel angles 100x50x10 (two welded sections forming 100x100x10 channel section), total length minimum 2m with at least two attachments to a mast. Alternatively, the cable may be protected with a gutter of min 3 mm thick sheet metal.

At the ends of a cable line converted into an overhead power line, termination boxes, outdoor type, of the size corresponding by type, cross sectional area and voltage shall be fitted.

A termination box shall be fitted on a support mast of the overhead power line and shall be easily accessible for visual inspection. It shall correspond to cable type, cross sectional area and voltage.

Safety clearances of the live parts of a cable termination box from a mast, cantilevers and other parts which are not under voltage shall not be less than 20cm.

Surge diverters are mandatory at the point where a 10kV cable line is to be converted into an overhead power line.

Surge diverters shall be earthed fully in compliance with the applicable regulations.

Supports for termination boxes as well as the boxes need not be earthed on their own as it will be sufficient to bond them to earthing terminals of surge diverters or masts. Switching device- disconnector shall be fitted on a mast in horizontal position.

In specific cases a three pole disconnector may be fitted but in vertical position.

A switching device shall be assembled of such components and quality which comply with Yugoslav standards and Rules on technical norms for erection of overhead power lines.

Steel parts in a switching device shall be protected against corrosion by hot-dip galvanizing.

The switching device design shall conform to SRPS N.K3.301.

The switching device shall meet the following specific requirements:
- Insulators shall be specific by type in compliance with SRPS IEC 273
- Insulator metal supports shall be in a reliable galvanic bond with mast earthing .

Contacts in a switching device shall enable smooth switch-off under ice load.

A switching device may be controlled by hand levers.

A switching device will be provided with an option to be relieved from mechanical load due to conductors in the overhead power line:
- At the base of the switching device
- On a special console.

The parts of a switching device and screwware shall be accessible from underneath.

A hand control device shall be fixed to concrete mast as shown on the typical fixing detail.

Control lever shall be fitted in the following way:
- With lever axis about 1.5m above ground level
- Under the right angle to the route and/or on corner masts in the direction of the line of symmetry in the area of obtuse angle.

Contacts in a switching device shall solely serve to conduct and switch off the currents envisaged.

Clamps shall ensure a reliable galvanic bond of Al/Č conductors in the overhead power line and disconnector terminals.

A switching device shall be fitted with a notice according to standard SRPS N.K3.301. It shall be placed by the switching device manufacturer. The plate shall be visible and legible from underneath.

An earthing electrode in the form of two rings according to TP-9 issued by EPS, Electricity Distribution Directorate shall be obligatorily provided for the mast in the overhead power line that will carry a switching device.

16.2.5. Final requirements

Materials and components to be incorporated shall comply with the presently applicable SRPS standards, and in their absence with the applicable IEC standards.

The equipment shall be tested according to applicable regulations prior to incorporation.

Erection and mounting shall comply with presently applicable SRPS standards and in their absence with the applicable IEC standards.

In the course of work the Contractor shall ensure normal traffic conditions by positioning adequate signs and make excavations that may cause trouble to pedestrians safe.

Tests and trial operation shall be performed upon completion of the works and prior to startup. Upon completion of all the works the Contractor and the Employer's Engineer shall make an accurate layout plan of the installations and overhead power line entering all modifications in one copy and shall thus enable preparation of precise 'as built' drawings for submission, via the Employer, to a future operator of the installations and overhead power line.

Measurement and payment

The exact quantity of installed material and payment are determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

16.3. Overhead Electric Mains 35 kV

When erecting a 35 kV overhead power line the Contractor shall observe the approved technical regulations and standards, technical documentation, the equipment manufacturer's technical requirements and drawings.

These Technical Specifications constitute an integral part of the contract and design documentation for which the Contractor shall ensure full compliance in the erection of a 35 kV overhead power line.

16.3.1. General specifications

The Contractor shall observe and apply during the execution of the works:

a) Applicable SRPS, IEC regulations and standards;
b) Rules on technical norms for electrical installations operating at nominal voltage over 1000 V, Off. Journal of SFRY No.4/74, amended in Off. Journal of SFRY No.13/78, Off. Journal of FRY No.61/95;
c) Rules on technical norms for grounding electrical installations operating at nominal voltage over 1000V Off. Journal of FRY No.61/95;
d) Rules on technical measures for operation and maintenance of electrical installations and power lines, Off. Journal of FRY No.41/93;
e) Law on Occupational Health and Safety, Off. Gazette of RS, No.101/2005, 21.11.2005;
f) Rules on general measures for safety at work and protection against dangerous current in rooms intended and used for operating electrical facility and on sites Off. Gazette of SRS No. 21/89;
g) The equipment manufacturer's requirements ;
h) Technical documentation;
i) Rules and recommendations of EPS and EDB.

The first and main obligation of the Contractor is to peruse the technical documentation, prepare a schedule of works and execute them in accordance with the technical documentation. In case of ambiguities in the technical documentation the Contractor shall ask the Designer to clarify.

The Employer shall nominate an expert (the Engineer) to supervise the execution of works, their quality, quantities and resolve unclear issues. Modifications and deviations of any kind affecting the technical concept and choice of materials shall be permitted solely upon a written consent of the Engineer appointed by the Employer. Prior to giving such a consent the Engineer shall obtain the Designer's approval. The Engineer and/or the Employer shall be responsible for any consequences of a design modification if made without the Designer's approval.

The Design Reviewing Commission that has approved this design documentation shall be responsible for major deviations from the approved design.

In executing the works the Contractor shall use planned equipment and materials in the way described in the design in compliance with standards and regulations governing works of this kind.

The equipment and materials to be incorporated shall comply with IEC, ISO, SRPS standards and recommendations unless otherwise provided in the design specification.

The equipment and materials to be incorporated shall be controlled and tested by the Buyer's inspectors in the course of production, packing and transport.

Fitting of electrical equipment may start upon the receipt of the Engineer's written statement that the equipment has arrived in orderly condition and that it complies with design characteristics. Materials for transmission lines shall be new and unused.

The equipment to be incorporated shall be supplied by approved manufacturers and be provided with Compliance certificates which shall be submitted to the Engineer for approval.

The Contractor shall check the current situation along the designed route and look for any impediments that may prevent the execution of the works in accordance with the design documentation. In the period after completion of design and before commencement of works the situation on the designed route earlier surveyed by the Designer may worsen. In case of any obstructions the Engineer shall be consulted.

The Contractor shall take care to avoid damage in places where works are executed. Any such damage, either due to insufficient care or carelessness at work shall be compensated by the Conractor to the Employer or to any other Contractor working there at the same time and necessary repairs shall be done by the Contractor at his own cost. The Contractor shall take care to minimize damage to any existent works and installations. He shall also coordinate the works to avoid disruptions and improper deviations. Reinforced concrete structures may be demolished, cut or punctured only with a written consent of the Designer and the Engineer.

Use of installations may start only upon completion of the works and tests by the relevant authorities and subject to the final approval of the Engineer.

16.3.2. Masts

The Contractor and the Engineer shall mark support points for new concrete masts before their erection. Mast spacing shall conform to the tension lengths shown on the layout drawing and in the longitudinal profile unless there are justified reasons for deviating from them.

The geological design indicating the load bearing capacity of soil along cable route shall be consulted for the purpose of a proper choice and design of foundations which shall be subject to the approval of the Engineer.

The allocated support points shall be:
- In road land strip
- On the property line
- Easily accessible to vehicles for the purpose of erection of equipment
- Easily accessible to vehicles for the purpose of replacement of fittings
- Free from danger of ground collapse
- Free from danger of landslide
- Free from danger of torrents
- Free from danger of ground water
- Free from danger of snow drifts.

Masts shall be vertical and aligned on the tangent section of the route. The verticality of each mast shall be checked from two directions at the right angle.

Lattice masts shall be calculated as space lattice structures. If they are not calculated as space lattice structures, then forces acting on each mast shall be divided into components parallel to mast sides.

Angle bracing in lattice masts shall be calculated applying the arithmetic sum of forces in it caused by the relevant components.

Diagonal brace in lattice masts shall be calculated assuming forces caused by the component which is parallel to the relevant mast side.

Moment of torsion of external forces acting on rectangular masts may be substituted by two equal pairs of forces in the plane subjected to the action of the moment of torsion. Such calculation shall apply if the ratio of the sides in mast cross section does not exceed 1.5, if the mast is in the form of a truncated cone and if there are horizontal stiffeners in its cross sectional area in the plane subjected to moment of torsion.

Where chords are exposed to strain under axial compressive force, eccentricity of these forces can be ignored.

Where bars in bracing are subjected to axial compressive forces eccentricity of these forces can be ignored if a bar consists of one angle iron attached by one of its sides to angle rods or a gusset plate.

Coefficient of safety assumed in mast structural analysis depending on loading cases shall be:
1) 1.50 – for normal loads
2) 1.10 – for extra loads (a break in conductor or protective wire).

Mast sections shall be designed according to Yugoslav standards for steel structures.

Steel tubes may be used for mast construction.

Restrained masts (single tubular or of appropriate polygonal cross section) shall be calculated with the following coefficients of safety depending on loading cases:
1) 1.65 – normal loads
2) 1.30 – extra loads

Sections of steel masts above ground shall be protected against corrosion with an anti-corrosive coat or metal plating.

Zinc coating shall be applied in a hot-dip galvanizing process if shapes of steel parts would allow that. Metal-plating can also be applied.

Hot dip galvanized threads and nuts may be machined provided their smooth tightening is not impaired.

Buried steel parts shall be coated with bitumen or other appropriate agent.

Steel parts embedded in concrete do not require any anti-corrosive protection. It is not permitted to coat steel parts with any protective agent that may reduce adherence of concrete and steel unless such a possibility was considered in the calculation.

Welds on steel tubular masts shall be waterproofed to avoid penetration of moisture and humidity in tubes. If tubes are not waterproofed, their inside wall faces shall be coated with bitumen or other protective agent of similar effect.

Where mast components are fitted in such a pattern (in which the pitch of diagonal and horizontal braces exceeds 60cm) that climbing may be difficult, step irons shall be provided and the first step iron shall not be lower than 2.5 m above ground.

Masts shall be designed so that stresses in material do not exceed permissible stress limit in any loading case. Each mast section shall be calculated assuming load that causes the highest force in it. The Contractor shall prepare documents showing the kind of earthing for each mast on its own.

Each support point shall bear a number from the common numbering system engraved in an aluminium plate.

Each support point shall be provided with a warning notice indicating the presence of voltage, at the level of 2.50 m above ground.

At least one plastic pipe, 40-50 mm dia. shall be inserted in foundation to make way for mast earthing cable through it.

16.3.3. Conductors

Conductors shall be steel-reinforced aluminium ones with maximum number of wires.

35 kV steel reinforced aluminium conductors are: Al/Č 7012 and Al/Č 95/15 or exceptionally Al/Č 150/25.

Conductor route in unbuilt area shall be short and tangent, without turns, as much as possible.

Conductor route in built up urban environment shall not pass through yards and gardens unless unavoidable and subject to the approval of the Engineer.

The route shall be close to existent streets as this will lower the cost considerably.

In setting a conductor route grounds with possible additional ice load shall be avoided as well as galloping of phase conductors.

If an overhead power line has to cross arable land, support points shall be allocated along existing property lines.

The longitudinal profile shall indicate all structures/ buildings to be crossed by the line.

The distance between live parts and between live and earthed parts and masts assuming wind effect or additional loads shall be minimum equal to safety clearance.

Headroom below an overhead power line crossing or getting closer to buildings/structures shall be equal to safety clearance unless a specific value is indicated for it.

In the **area accessible to vehicles** (around built areas, above meadows and fields), headroom shall be 6 m and safe distance 5 m.

For **permanently accessible parts of buildings** (terraces, balconies), the headroom shall be 5 m and safety distance 4 m. Overhead power lines above buildings shall be provided with upgraded electrical insulation and those above residential buildings and buildings in which large numbers of people sojourn shall require upgraded mechanical insulation.

In **built up urban environment,** headroom shall be 7 m. Electrical insulation shall beupgraded as well as mechanical at the points of crossing with streets or roads.

On **regional and local roads** headroom shall be 7m. As a rule, the distance of any mast section from outer road edge shall not be less than 10m but may be reduced to 5 m in exceptional cases. Electrical insulation shall be upgraded. In a crossing tension length only one joint per conductor or a protective wire is permitted. As a rule the crossing angle between an overhead power line and a regional road shall be minimum 20°. The crossing angle will be limitless on local roads.

On **main roads** headroom shall be 7m. Horizontal distance of any mast section from outer road edge shall be 20m. The distance of any mast section may be smaller but not less than 10m. Both mechanical and electrical insulation shall be upgraded. In a crossing tension length no joints in conductors are permitted. As a rule, the crossing angle shall be minimum 30°.

On a **motorway** headroom shall be 7 m. The distance of any mast section from motorway edge shall be minimum 40 m. The distance of any mast section may be smaller but not less than and may be reduced but not below 10 m. Both mechanical and electrical insulation shall be upgraded. In a crossing tension length no splices in conductors are permitted. Crossing angle shall be minimum 30°. If overhead power lines are in parallel then their distance from the motorway, along 5 km and longer motorway sections may be minimum 50 m.

At the points where a **high voltage overhead power line crosses other high voltage lines** and at the points where they converge, safety vertical clearance shall be 2.5m, and safety horizontal clearance 1m. These requirements have to be fulfilled even in cases of additional load on the upper line and no load on the lower one. As a rule a higher voltage line shall be placed above a low voltage line. The upper line shall be provided with upgraded electrical insulation.

Running of a low voltage line over and above a high voltage line is not permitted.

When a **high voltage line crosses a low voltage one**, safety vertical clearance shall be 2.5 m and horizontal safety clearance 2 m. The upper line shall have upgraded electrical insulation.

At the point where an o**verhead 35 kV line crosses a telecommunication line**, the height between bottom conductor in the power line and top conductor in the telecommunication line shall be 4m. A safety net shall not be placed above the telecommunication line at this point. At the point where an overhead 35 kV line crosses a telecommunication line mechanical and electrical insulation shall be upgraded and no joints will be permitted in that tension length. As a rule, the crossing angle between an overhead power line and a telecommunication line shall not be less than 45°, but it may be reduced to 30°.

It is not permitted **to take a telecommunication line over an overhead power line**.

Conductors, steel reinforced aluminium ones in our case shall be fitted through the following stages of work:
- action preceding pulling out of steel reinforced aluminium conductors
- pulling out of conductors along the route
- tensioning of steel reinforced aluminium conductor
- attaching steel reinforced aluminium conductors to string insulator units.

Steel reinforced aluminium conductors shall be pulled out over aluminium pulleys hung on a cantilever on a mast.

Pulleys on tension and end masts shall be stronger and bigger than those on supporting masts.

Tension masts at corners shall be anchored contrary to the direction of the tensile force acting during conductor pulling out and tensioning.

Conductors shall not be pulled over sharp objects, rocky ground, fences or fields sprinkled with fertilizers. If this is unavoidable, then wooden boards, joists, scaffolds and the like shall be placed over such obstructions.

A steel-reinforced aluminium strand shall be tensioned at the values shown in the sag table dependent on temperature and tension length.

The temperature shall be measured very carefully if tensioning is done by taking sight on levelling staff.

It is recommended to read the ambient temperature of the air on a thermometer placed on mast, 5m above the ground level.

In a tension length, the conductor shall be left to rest on pulleys for two days for the purpose of sag equalizing. Then conductors shall be attached to string insulators.

Conductors shall be joined with appropriate joints and/or clamps of the same material. Joints and steel clamps shall be hot dip galvanized or made of stainless steel.

No more than one joint per conductor shall be permitted in one tension length.

Conductors of different cross sectional area or of different materials may have joints only at the points where they do not withstand any mechanical load. Clamps shall serve for reliable prevention of electrolytic destruction.

In a tension length, conductor joints shall withstand 90% of conductor breaking load.

Post and hanging insulators shall be used. Post insulators shall be firmly fixed to masts. Hanging insulators shall be so fitted to a mast that they can freely swing around the point of fixing.

The positions of insulators and/or string insulator units shall not diminish the insulating properties of conductors.

Multiple insulator strings may be used provided that loads are equally distributed over them under normal circumstances.

Both mechanical and electrical insulation of each conductor may be upgraded, if necessary.

Upgraded electrical insulation means that the selected insulator will have longer creepage path.

Conductors shall be supported on puncture proof porcelain post or rod insulators.

Conductors in tension shall be attached to string insulators since mast cantilevers are not calculated to withstand torsion at the point of insulator suspension.

Conductors in tension shall be attached to puncture proof porcelain rod insulators.

A fitting used to attach a conductor to an insulator string shall be a support clamp for a steel reinforced aluminium conductor.

Support clamp for a steel reinforced aluminium conductor attached to an insulator string shall comply with SRPS N.F2. 010.

Conductors in tension shall be attached to string insulators with wedge clamps or compressive clamps suitable for steel reinforced aluminium conductor.

Tension clamps for fixing steel reinforced aluminium conductor in tension to string insulators shall comply with SRPS N.F2.010.

Fittings for attaching post insulators to the skeleton shall be fork-and-eye clamps as specified in SRPS IEC 471 and SRPS N.F2.010.

Concrete cantilevers shall have 22 mm dia holes. String insulators shall be attached to *concrete cantilevers* on which flag supports and anchor bolts shall already be fitted. Flag and anchor bolt for string insulator suspension shall withstand nominal breaking force of 70 kN.

Joints in steel reinforced aluminium conductors shall be non-disconnecting. They shall be formed by plastic deformation of the body when pressed or by plastic deformation of the body when notched.

Electrical continuity of steel-reinforced aluminium conductors shall be preserved with at least two conductive clamps and a compressive joint with bolts or with one conductive clamp and an aluminium lug with M12 bolts at conductor unloaded ends.

The joint of a conductive clamp and an aluminium lug shall be formed by plastic deformation of clamp body effected by pressing. M12 bolts shall be fitted with two spring plate-shaped washers and a nut.

A branch circuit shall include at least two conducting clamps and a pressure bolted connection.

The circuit shall consist of a conductor of the same type and cross sectional area as branching conductor.

Branching conductive clamps for steel reinforced aluminium conductors shall be fitted on load-free conductor section.

Connections to various units in the equipment shall be made using conductors of the same type and cross sectional area as used for conductors in the overhead line.

Lever in control mechanism for a disconnector or a switch disconnector shall be positioned:
- At the side of the overhead power line ,
- At the apex of an obtuse angle in overhead power line if the point of support is positioned at an angle
- At the point where a mast can be most easily approached.

Steel reinforced aluminium and copper conductors may be joined only by bimetallic conductive clamps.

Masts may be fitted with step irons fixed to universal consoles. Step irons shall be made of hot dip galvanized steel.

16.3.4. Final requirements

Materials and components to be incorporated shall comply with the currently applicable SRPS standards, and in their absence with the applicable IEC standards.

The equipment shall be tested according to applicable regulations prior to incorporation.

All installation works shall comply with presently applicable SRPS standards and in their absence with the applicable IEC standards.

In the course of work the Contractor shall ensure normal traffic conditions with adequate signs as well as the safety of any excavation that may cause trouble to pedestrians.

Tests and trial operation shall be performed upon completion of the works and prior to startup.

Upon completion of all the works the Contractor and the Engineer shall make an accurate layout plan of the installations and network entering all modifications in one copy and shall thus enable preparation of precise ‘as built’ drawings for submission, via the Employer, to a future operator of the installations and network

Measurement and payment

The exact quantity of installed material and payment are determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

16.4. Overhead Installations 110kV and 400kV

Positions of stakes shall be checked before marking and excavating foundation pits to avoid error in case these are displaced by unauthorized persons.

Upon completion of foundations and ground levelling surplus spoil shall be removed to a suitable place because in case a mast is erected on arable land, the land owner may pile it up on top of the foundation and water and mud may pool and accumulate around foundation and bolts.

Instructions for manufacture, anti-corrosive protection and erection of masts/towers are given in the respective design documentation.

The earthing system shall be bonded upon erection of steel structure. Care shall be exercised to inflict as little damage as possible during the works. The quality of materials shall comply with applicable regulations, standards and design requirements. Materials shall be inspected and necessary laboratory testing carried out prior to shipment.

Due to real diversity of materials, it will be necessary to avoid confusion when ordering and erecting them.

Insulator strings shall be fitted with designed details.

Clamps for conductors shall be tightened with torque spanner as instructed by the manufacturer. The torque at which a bolt has to be tightened with a torque spanner is indicated on drawings. Precise tightening of bolts is compulsory for other parts (buffers and knuckles etc.)

Vibration suppressors shall be spaced as shown in the respective chart.

If the Supplier’s written statement that the quality of insulators and fittings complies with the regulations is not available, such materials shall be tested.
All compliance statements and test results shall be submitted to the Engineer for approval.

Tension masts, which are not designed as end towers shall be additionally anchored before conductors and protective wires are erected.

Wires being pulled out shall not be dragged over ground or damaged in some other way.

Lengths shall be quoted when ordering conductors and protective wire, to avoid splicing. Data shall be taken from the construction specification.

Positions of drums from which protective conductors will be pulled out on site shall be allocated according to the applicable regulations and the following instructions shall be observed.

In tension lengths in which splicing is permitted it is strictly prohibited to use more than one compression splice per tension length though this option may be useful at the time of some later intervention. Therefore, more than one compression splice per wire and per tension length shall not be envisaged. The distance of the splice from support and tension clamps shall be minimum 20 m.

Splices shall be compressive by type and guarantee minimum 100% breaking force.

Thanks to a device for controlled pulling out of wire, formation of loops can be strictly monitored. It shall also be necessary to prevent contact between steel-aluminium and copper and avoid tools earlier used for copper strands as this will cause chemical corrosion of materials. The diameter of pulleys for conductor pulling-out shall not be smaller than 0.7 m.

Local manufacturers of conductors and protective wires still do not state values of permanent extension dependent upon the characteristics of materials, wire design and technology. Therefore only empirical value can be given for the compensation of sag increase due to permanent extension the one derived from the existing lines and earlier laboratory tests in "Dalekovod" Co.

For the above reason and for the purpose of safety and low cost a pretension method is here envisaged. While erecting conductors and protective wires they shall be immediately after pulling out be tensioned by a force 20% higher than indicated in erection charts and temperature values and keep them in tension for 3 hours. After that the tension force will be reduced as much as needed for sag equalization.

As most of lasting extension occurs in this process, it means that metallurgical elongation accounts for most of total permanent extension. As tests show it varies from 66% to 83% of total permanent extension.

The other minor part of permanent extension (mostly metallurgical elongation) is compensated with a reserve in safety vertical clearances at temperature side. Namely sag equalization shall be done for the temperature by 15 ^{0}C below the actual ambient temperature.

To facilitate erection the tables indicating sag values calculated for assumed ideal tension length of this kind and these sag values can be directly derived from them. If the temperature measured on site is not in accord with the values given in tables, the sag shall be interpolated for the actual temperature only.

Special care shall be taken in tightening conductors at the points where they cross high and low voltage lines, TT lines and important buildings.

As low and high voltage conductors can cross in this transmission line particular attention shall be paid to temporary grounding and general safety. Pulling out and tensioning of conductors and protective conductors at the points of crossing can be done only when the lines are shut off.

Grounds and bonds shall be removed for a short period before the transmission line is put under trial voltage.

If new buildings are noticed in the course of a transmission line erection, new points of crossing shall be subject to instructions and approvals of the Designer and the Engineer of such transmission line revisions.

Angle tensioning towers of the transmission line shall be related to state control network, and firmly defined in space by the coordinates and levels calculated. Whenever construction of newly planned buildings or installations without such data is pending, particular attention shall be paid to the observance of their positions in relation to the project transmission line.

If any underground installations not indicated in the technical documentation are possibly encountered or happen to be at a distance less than 10m from mast foundations, other buildings or archaeological sites, works shall be suspended, the site protected and the Engineer and the Designer informed thereabout.

Protective measures shall be implemented as regulated and subject to the approval of the Engineer.

Measurement and payment

The exact quantity of installed material and payment are determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

16.5. Lighting

16.5.1. General specifications

These Technical Specifications constitute an integral part of the contract and design documentation for which the Contractor shall ensure full compliance.

Works shall be carried out fully complying with technical regulations and norms governing installations of this type.

Prior to commencement of the works, the Contractor shall peruse the design documentation, give his comments and observations, if any, and duly submit them to the Engineer through Building Journal.

Modifications or variations that may affect the design solution considerably shall be permitted solely upon a written consent of the Designer and subject to the approval of the Engineer.

During the execution of the works the Contractor shall keep daily records entering all required data (Building Journal).

During the execution of the works due care shall be exercised to avoid damage to other works and existing installations.

Breaking or chasing of reinforced concrete structures to make room for electrical works may be done only upon a written consent of the Engineer.

The materials and equipment to be incorporated shall have the characteristics specified in the design documentation and applicable norms and standards. Working up and rearrangement of equipment and devices on site is not permitted.

The manufacturers declaration of quality and appropriate Compliance certificates shall be provided for such equipment and materials and submitted for the approval of the Engineer.

During execution of the works the Contractor shall undertake safety measures in compliance with the applicable rules and norms.

16.5.2. Power supply installations

For these installations, cables, conductors and appropriate installation materials shall be used, fully in compliance with the enclosed technical documents.

Only conductors, protective pipes, supports, boxes, joining and other small installation materials appropriate for the intended use and site conditions may be used.

The installation materials shall mean: distribution cabinets, screw anchors, anchors, screws, washers, clips, clamps, bonding material for wiring within distribution cabinets, insulating materials (insulators, insulating plates, ducts and tapes), cable inlets, inscription plates and other.

All wiring material shall be of copper. Neutral conductors shall not be protected and shall differ from phase conductors by colour. Conductors shall be continuous in electrical and mechanical sense.

Wires shall be installed in horizontal and vertical direction. Vertical cable section (conductor) up to the level of 2m above floor or ground shall be protected against mechanical damage. Wires shall be cut in situ to actual lengths to meet load requirements. Wires, cables and conductors shall be visibly fitted on wall supports or in pipes of adequate diameter. Wires may be spliced in distribution boxes and switchboards only. Cables changing direction shall not be bent sharply.

In floor construction, cables (conductors) shall be drawn through protective pipes or ducts.

For the purpose of coordination, the Contractor in charge of electrical installations shall duly and for the purpose of harmonization, warn the Contractor in charge of civil works of places and ways in which he will install his equipment and wiring. Prior to assembly of distribution panels – cabinets, the Contractor shall submit workshop drawings showing the distribution panels - cabinets and equipment to the Engineer for approval.

Before ordering equipment and wiring materials the Contractor shall determine electrical ratings for the equipment delivered (electric loads) and in case these differ from designed values he shall adjust them.

At the start end of wiring (circuit) in a distribution panel – cabinet, devices providing protection against both overload current and short circuit current shall be fitted, and marked and each panel/cabinet shall be provided with a single pole diagram, durable and legible.

Protection against dangerous voltages shall be executed as designed and the check of its functionality shall be checked before startup as requested in the regulations.

Bonding of steel skeleton and other metal masses in a building in order to form a whole of sufficient electrical conductivity shall be done by welding or other type of bonds (screws with fan like base plates SRPS M.32.151, riveting and the like.)

Upon completion of the Works the Contractor shall test insulation resistance, perform current and voltage tests, measure transient resistance of earthing and issue appropriate Compliance certificates in compliance with the technical regulations and norms governing wiring of this kind for the approval of the Engineer.

16.5.3. Cabinets for public lighting

Places where cabinets will be positioned shall be so allocated to enable the best possible cable connections to luminaires.

In unbuilt area they shall be masked with vegetation, bushes or in some other way so that their positions are not eye striking.

A free standing cabinet in the public lighting system shall be resistant to weather conditions, made of fibreglass armoured polyester or plasticized double pickled metal sheet. Mechanical protection shall be IP65 and shall include a door and special standard lock and universal key. The top of the switchgear block shall be detachable from inside and the door shall bear an inscription „public lighting“.

A cabinet shall stand on a concrete base (foundation) protruding by min. 20 cm above the ground surface. It shall be so designed that cables can be led in and out at the underside.

A cabinet shall be fitted on a metal frame with holding down bolts on foundation top.

A cabient in the public lighting system shall have:
- Entry compartment
- Measuring compartment
- Switchgear compartment

Cabinet components shall be fitted to an asembly frame or plate to enable easy dismantling and refitting of parts.

Cabinet elements shall be joined and bonded in the workshop. Conductors for the wiring system shall be neatly stacked in perforated PVC ducts with covers.

Cabinet doors shall be bonded to protective earthing.

In a wiring system, neutral conductors shall be blue and protective ones yellow-green. Other conductors shall not be of those colours.

Busbars shall be marked according to SRPS as L1, L2, and L3 phases, N – neutral busbar and PE protective busbar.

Bolts used to tighten conductors to busbars shall be provided with spring washers. Cables shall be joined with clamps of appropriate dimensions. The clamps shall bear marks in compliance with SRPS. Cable wires and clamps connecting them shall also be marked. The equipment inside a switchboard and at the inner face of the door shall be provided with glue-free inscribed plates.

An inscription plate for a fuse switch shall be inscribed with a maximum permitted fuse link. All cables shall be led into the switchboard from underside through cable and Pg bushings. To prevent condensation on equipment and inner faces, each switchboard shall be provided with a sufficiently rated interior electric heater.

At the inner door face in the switchboard there must be a pocket for documents. The documents shall include a single pole diagram and functioning scheduled.

16.5.4. Luminaires and lamps

Luminaires for tunnel lighting shall be fabricated from best quality materials resistant to aggressive and contaminated tunnel environment (gases, dampness, dust and the like) and occurrence of electrochemical corrosion.

Luminaire structural design shall enable:

- For the purpose of simple servicing interior connections shall be effected with connectors, housing with inlets shall be robust and resistant to mechanical effects, and replacement of assemblies shall be tool-free.
- Simple to mount and replace worn out and damaged parts in normal service and operation (lamps, lampholders, connecting gear, mirrors, glass shades, inlets and the like).
- Degree of mechanical protection IP 65.
- Luminaires shall have good cooling and be resistant to temperature changes. All interior components and wiring shall be suitable for operation under high temperatures.

Before erecting supports for luminaires their positions shall be adjusted to correspond to data from site. Luminaires with suspended supports shall be prepared in advance in the workshop to enable simple erection in situ as much as possible.

Luminaires shall be fixed in horizontal positions and a row of luminaires shall not deviate in alignment or level.

Luminaires for the illumination of approaching zone shall meet the following structural requirements:

Luminaire metallic body, glass or polycarbonate protector.

Degree of protection against penetration of alien particles IP 66 for the optic block and IP 43 for connecting gear

Each luminaire shall be weather proof and shall ensure normal operation of the light source and fittings in the temperature range form -20^{o}C to +50^{o}C.

A luminaire shall be fixed to a mast, in horizontal or vertical position via a universal fixture.

Luminaire components shall be suitable for simple fixing and replacement of damaged parts in operation.

Each luminaire shall be connected to power supply via a connecting plate in the mast compartment.

Luminaires shall be bonded to power supply with PP-Y or PP00-Y wiring, cross sectional area 3x2.5 mm^2 through mast interior.

Each luminaire shall be provided with fuses of nominal current equal to light source rating, fitted to connecting plate.

16.5.5. Cable laying

16.5.5.1. General Recommendations

In general, electrical cables shall be buried direct in the ground. At street, road and path crossings and in all other places where a cable has to be protected from mechanical damage, cables shall be laid in protective pipes and cable conduits respectively.

Cables shall be laid by hand or using mechanical means and allowable bending radii and drawing forces shall be taken into account.

The cable route shall be surveyed before backfilling. Points of crossing of the cable with other cables and installations, points of splicing, exact length shall be plotted on the laying plan.

The routes of electric cable lines are generally specified in urban and technical terms of reference to suit other underground installations. Lighting cables shall be laid along mast axis.

16.5.5.2. Laying Cables in Trench

The width of the strip of land for cable laying shall be minimum 0.7 m.

The size of a trench for cable to be buried direct in the ground shall depend on its nominal voltage, type of soil, number of cables in trench and available size.

As a rule, a cable shall be covered with 0.3 m thick layers of excavated earth. The first layer next to the cable shall consist of fine grained earth excavated, same as cable bedding. If, however, the excavated material contains lots of stone, debris, mud, earth contaminated with chemicals, then fine grained earth, sand or specially prepared material of good heat conductivity shall be brought to the place.

An open cable trench shall bear visible marks and provide safety for pedestrians and vehicles.

16.5.5.3. Convergence and Crossing of Power Cables and Other Installations

Laying cable lines parallel to, under or above water supply pipes and sewers is not permitted except at crossings.

Horizontal distance between power cables and water supply or sewerage pipes shall not be less than 0.4 m. If such a distance cannot be achieved, power cable shall be drawn through a protective pipe.

At points of crossing cable may run above or under water supply pipes at a minimum distance of 0.3 m.

A trench shall be excavated by hand at the points where power cables run parallel to water supply pipe or sewer (no mechanical means).

The distance between parallel power cables in a trench shall be minimum 0.07 m and 0.2 m at crossing points.

16.5.5.4. Cable Accessories

Use of heat shrinking and cold shrinking cable accessories or prefabricated elements is recommended. Special bolted clamps are also permitted for paper insulated cables (IPO 13).

Cable joint shall not be grounded on its own whether made of insulating materials or metal.

Joints and terminations shall comply with the standards governing works of this kind and with recommendations and instructions issued by the manufacturer.

Each cable of selected type and cross sectional area, bolted clamps and jointing material to be pressed shall be accompanied with prototype Compliance certificates particularly concerning "speedy ageing".

If aluminium cables are used then particular attention shall be paid to joints. They shall be joined by soldering, welding and pressing according to a specific procedure. Aluminium cables shall be connected to copper terminal ends, rails and the like via tin plated copper lugs. Aluminium and copper cables shall not be joined in a cable splice but only in transformer stations, distribution boards and termination boxes. Aluminium cables shall be handled with special tools which were not in contact with copper. Special bolted clamps can be also be used for low voltage cables.

Finished joints shall not be buried until their positions are surveyed by the Contractor and submitted for the approval of the Engineer.

The laid, spliced and buried power cable shall be subjected to voltage test.

Each joint and termination shall be provided with a plate showing type, cross sectional area, voltage and name of a facility in which the cable is terminated at the other end.

16.5.5.5. Testing of Power Cables and Accessories

Power cables shall be tested by type according to SRPS N.C5.025, SRPS N.C5.235 and SRPS IEC 60502.

Cables and cable accessories shall be subjected to obligatory (piece) test, type test, special tests and tests at acceptance.

Cables and cable accessories shall come with Compliance certificates issued by an accredited institution.

A laid, spliced and terminated cable shall be subjected to voltage test of the whole cable line.

All test results and compliance certificates shall be submitted to the Engineer for approval.

16.5.5.6 Poles and foundations

As a rule, poles in a public lighting system are made of metal, tapered, octagonal or tubular segmental prefabricated. Poles shall be fabricated according to detailed drawings contained in the technical design documentation.

Each pole shall have an inspection compartment and cable inlets.

Bottom edge of a compartment door in which connecting gear, fuses and wiring for luminaires are accommodated shall be min 600 mm above the foundation top surface (SRPS EN 40-2).

The lid shall adhere well to the edges of the opening. The opening shall be bolted in a good anti-burglar way.

Pole faces shall be metal plated in a hot-dip galvanizing process against corrosion. Inner and outer faces shall be prepared according to national standards and ISO 1461, ISO 14713, and SRPS EN 40-4.

The manufacturer shall guarantee durability of protection not shorter than 10 years for corrosion category C4 according to ISO 12944.

All poles shall be erected to a vertical line and aligned on each tangent section. The verticality of each column shall be checked from two directions at the right angle.

Poles in a public lighting system shall not be earthed individually as their section in the ground stands for sufficient earth except in cases then they are erected at specific places (metallic bridges, overbridges, specific ground etc.).

The Contractor shall submit a pole design that shall meet the requirements of the terms of reference, the technical design and these Technical Specifications and subject to the approval of the Engineer.

Foundations shall be cast in situ according to detailed drawings.

Pits shall be excavated by cutting vertical sides and supporting them. A gravel subgrade (10 cm) shall be placed on a flattened bottom and/or a bedding of MB 10 concrete if the soil abounds in ground water.

Foundations shall be provided with holding down bolts (anchor bolts) embedded in concrete for the erection of poles. Foundations shall be cast of min MB 15 class of concrete. Concrete from a mixing plant is recommended for use.

The dimensions of "holding down bolts" (centre to centre spacing and bolt thickness) shall suit the dimensions of the pole base plate.

Foundation top shall protrude by 10cm above the level of the surrounding ground considered in the design.

Foundation top shall be finished so that water pooling around the pole base plate will not be possible.

Each foundation shall contain two PVC pipes Ǿ 70 mm for cable inlets. Their positions shall depend on cable route.

16.5.5.7. Final requirements

The Contractor shall submit to the Employer a completed and tested facility with adjusted protection and control devices after a technical acceptance by the Engineer.

The Contractor shall incorporate comments of the Technical acceptance commission without any right to compensation.

For the purpose of technical acceptance the Contractor shall submit the following documents to the relevant Commission and to the Employer on the occasion of commissioning the facility:

- Two copies of as built drawings
- Compliance certificates and quality statements for incorporated equipment or functional parts (assemblies) of devices and equipment containing:
  - Results of light engineering measurements
  - Compliance certificate on insulation resistance measurement
  - Compliance certificate on the continuity of all conductors
  - Compliance certificate on measurement of loop resistance in wiring (where applicable)
  - Compliance certificate for protection by electrical separation (where applicable)
  - Compliance certificate on the efficiency of protection against electric shock
  - Compliance certificate on earthing and bonding measurement
  - Diagrams, operating and maintenance instructions, warnings and the like, data for functional maintenance.

The period of guarantee shall start on the date of commissioning

Measurement and payment

The exact quantity of installed material and payment are determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

16.6. Technical Specifications for Electricity Substations

16.6.1. General specifications

These Technical Specifications constitute an integral part of the contract and design documentation for which the Contractor shall ensure full compliance.

Works shall be carried out fully complying with texts and drawings in the technical documentation and the regulations and norms governing installations of this type.

Prior to commencement of the works, the Contractor shall peruse the design documentation, give his comments and observations, if any, and duly submit them to the Engineer through Building Journal.

Modifications or deviations that may affect the design solution considerably shall be permitted solely upon a written consent of the Designer and subject to the approval of the Engineer.

During the execution of the works the Contractor shall keep daily records entering all required data (Building Journal).

During the execution of works due care shall be exercised to avoid damage to other works and existing installations.

Breaking or chasing of reinforced concrete structures to make room for electrical works may be done only upon a written consent of the Engineer.

The materials and equipment to be incorporated shall have the characteristics specified in the design documentation and in the applicable norms and standards.

The Manufacturer's declaration of quality and appropriate Compliance certificates shall be provided for such equipment and materials.

During the execution of the works the Contractor shall undertake safety measures in compliance with the applicable rules and norms.

16.6.2. Power transformers

A transformer shall comply with the standards governing the "Nova konstrukcija" power transformers, applicable since 01.01.1998.

A transformer shall be provided with an inscription plate with essential data legible and reliable inscribed. It shall be in such a place that the inscribed data can be safely read at any time during operation.

A transformer shall be in such a position that contact thermometre readings can be safe and easy.

A transformer shall be so designed that it can withstand all dynamic and thermal stresses in operation without any damage or impairment of operating capacity.

A transformer shall be so positioned in a plant that no external influences may impede its regular operation, performance and durability and that it will not be harmful to the environment either.

A transformer shall be so positioned that harmful vibrations cannot occur in the adjacent parts of the plant nor any structure may suffer damage.

Cooling shall be sufficient during erection and fixing and ingress of alien particles that may damage the components shall be prevented.

An option for electrical separation of a transformer from other live parts shall exist.

Appliances for protection against overload current and internal and external faults shall correspond to transformer size and equipment.

Sound level of a power transformer shall comply with SRPS.H1.005 standard.

16.6.3. High and low voltage switchgear

Doors and windows shall be metallic and open outwards.

Opening door from inside shall be easy without a tool or a key.

No pipes for heating, water supply and sewerage and similar may be taken into transformer station.

Supports of devices and appliances shall be made of metal or other non-flammable material.

The distance of protective partitions and ledges of some live parts behind them shall not be less than 500 mm.

Notice boards and warning plates "High voltage – danger" shall be placed in the transformer station.

High voltage cubicles shall be provided with blind diagram and a front window.

Operating levers for isolators and circuit breaker shall be fitted outside of the cubicles or on its front fixed wall.

Metallic parts (doors, structural supports) shall be first coated with red lead and then painted with oil paint. High voltage blocks and low voltage distribution board shall be painted in the same colour.

Colour identification of electrical installations such as: busbars, connecting wires for appliances and equipment shall comply with applicable regulations, L1 phase – yellow, L2 phase – green, L3 phase – violet, N wire – white and the earth wire black with white stripes askew.

Inscription plates indicating cubicle use shall be fixed above door to each cubicle. The 0.4 kV distribution board shall be provided with plates giving names of each tapping and measuring instruments.

Switchgear bays, cubicles and other elements shall be provided with appropriate inscription plates and marks as designed by the Contractor and submitted for the approval of the Engineer.

All incoming and outgoing high and low voltage cables shall bear a lead plate, clip-shaped to show use, kind and voltage of a particular cable.

Instrument measuring range shall by 20% be greater than their nominal rating.

Each phase conductor shall be provided with durable markers in all cables.

Secondary circuits in metering transformers shall be earthed direct on transformer clamps.

Metal parts in cubicles, support structures, control levers, housing, appliances and other parts that may be unintentionally touched in operation, not normally under voltage shall be visibly marked with special strip used for protective earthing in the transformer station.

Metal levers, wheels and the like need not be separately earthed if they are bonded to earthed devices.

Gear transmissions if any shall be connected to protective earthing in the transformer station.

For the purpose of periodical checking of earth resistance, test joints shall be envisaged for disconnection.

Earth wires in building shall be laid visibly on walls, on supports at a specified distance from live parts. They shall be black with cross white stripes.

All buried earthing bonds shall be protected against corrosion with reliable agents.

Upon completion of the works, transient earth propagation resistance shall be measured.

Rubber gloves, boots, insulating bases and rod tested under 20 kV voltage are obligatory.

16.6.4. Cables in transformer station

High voltage cables shall be laid and joined in compliance with applicable regulations and the manufacturer's instructions.

Cable sheaths and armour shall be earthed at both ends.

Each cable in transformer station shall be fitted with clips inscribed with working voltage, cable cross sectional area and year of laying.

Each phase conductor shall bear durable marks since a dangerous event such as change in rotary field direction may occur.

16.6.5. Other equipment

In a transformer station at a suitable and visible place the following documents shall be available:

– Single pole diagram for the substation with general data for the equipment ,
– Operating and maintenance instructions ,
– Instructions for administering first aid to injured people due to electricity,
– Fire fighting instructions,
– Protection against dangerous touch voltage,
– Warning notices,
– Records of reviews and audits.

16.6.6. Final requirements

During the technical inspection the Contractor shall hand over fully completed and tested electric facility with adjusted protective and control devices to the Engineer.

The Contractor shall get the electrical facility ready for proper operation by incorporating comments of the Technical inspection Commission without right to any compensation.

For the purpose of technical acceptance the Contractor shall submit the following documents to the relevant Commission and during commissioning of the facility to the Employer:

– Two copies of as built drawings
– Compliance certificates and quality statements for the incorporated equipment or functional parts (assemblies) of devices and equipment,
– Set of documents containing:
    - Compliance certificates (typical and particular) for the equipment and bonding in transformer station
    - Test certificate on adjusting protection for safety in transformer station, inspection of equipment and bonding for the purpose of issuing a compliance statement
    - Compliance certificate for measurement of loop resistance in wiring (where applicable)
    - Compliance certificate for the efficiency of protection against electric shock
    - Compliance certificate for earthing and bonding measurement
    - Diagrams, operation and maintenance manuals, warnings and the like, information necessary for functional operation and maintenance.

The period of guarantee shall start on the date of commissioning.

Anything unspecified in these Technical Specifications but related to the structure shall be defined in the conditions of contract between the Employer and the Contractor and shall be subject to the approval of the Engineer.

Measurement and payment

The exact quantity of installed material and payment are determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

Section 17
Mechanical systems

Contents

17.1. Diesel generator set

1.- Electrical machines with accessories shall meet state-of-the-art requirements governing their building and safety at work.

2.- Each machine shall have an inscription plate showing durable and legible main ratings. It shall be placed in such a position as to be easy to read during machine operation.

3.- Each machine shall be so designed to withstand stresses that may occur in the plant in which it is incorporated, without damage or deterioration of its operating capacity.

4.- Each machine shall be so positioned and fitted to eliminate any harmful impacts from its environment on its operation and service life, and to prevent harmful impacts of the machine (vibrations, noise, heat, sparks, fire) on adjacent parts in the plant and environment.

5.- Each machine shall be isolated from the environment to prevent transfer of mechanical vibration that may interfere with plant operation or affect its parts. Any connections to it shall withstand stresses due to machine operation without damage.

6.- Proper cooling shall result from the machine position and fitting. Cooling devices shall be designed and positioned so that no alien particles borne with cooling agents can get in its sensitive parts and compromise operation.

7.- Smooth and safe access shall exist to all mechanical devices that will need adjustment, maintenance or monitoring during operation.

8.- No parts of the plant whether appurtenant to the machine or its environment may adversely affect and reduce the necessary electrical insulation of the machine.

9.- Devices ensuring safety from electrical and mechanical overload shall prevent machine stress in over and above permitted limits. Therefore devices shall exist that will automatically switch off or short circuit the machine to limit the extent of its destruction in case of a defect.

10.- Live and rotary parts shall be protected from accidental touch. If such safety has not been provided in the machine design then its position shall be properly chosen or specific additional measures shall be undertaken.

11.- It will be possible to gain an insight into the operating condition of each machine via signalling, metering and controlling components and regulate machine startup and shutdown.

12.- The type and range of the components mentioned in the preceding article shall meet the plant requirements and correspond to the size and importance of the machine.

13.- The components shall be so positioned and fitted that monitoring, handling and maintenance can be done during operation without difficulties and with full safety.

14.- Power and voltage for service components as well as constant and peak power at the moment of switching on the driving gear and emergency lighting shall have the values required.

15.- Voltage of service components shall neither be above nor below permitted limit value required for startup and operation of switching and other units. Conductors shall be selected after a consideration of voltage drops in electrical lines.

16.- Cables outgoing to loads that do not belong to service components in the plant but are fed with power from the same power source shall be fitted with own fuses.

17.- First startup of an internal combustion engine and restart after inspection and overhaul shall be supervised by a qualified supervisor.

18.- If not otherwise stipulated in the instructions an internal combustion engine shall be inspected after 2000 to 3000 hours of operation.

19.- An internal combustion engine in cool reserve shall be maintained in working order and shall be put in trial operation from time to time. If the engine will stay ineffective for a long period it will have to be conserved as instructed by the Manufacturer.

20.- The instruments, handling units and the like shall bear visible inscription plates or numbers which correspond to the identification pattern and diagrams contained in the instructions.

21.- Prior and after each inspection and overhaul of an internal combustion engine, all critical clearances shall be measured and checked.

22.- During the operation of a generator or a synchronous condenser the values that enable constant monitoring of operation and condition of the machine shall be monitored and recorded.

23.- Machine axle vibrations (doubled amplitude of position changing) shall not exceed maximum permitted vibrations specified by the Manufacturer.

24.- Generators and synchronous condensers may continually operate under asymmetrical voltage within maximum permissible asymmetry range specified by the Manufacturer.

25.- Insulation resistance of the excitation winding in a generator or synchronous condenser shall not be below the value specified by the Manufacturer. The Manufacturer will also state insulation resistance measurement method, time intervals, megohmmeter voltage and minimum insulation resistance values at required winding temperature. These data shall be available in the manual for operation and overhaul of machines.

26.- Insulation resistance of the stator winding in a generator or synchronous condenser shall be periodically checked against the data indicated in the operation manual provided by the Manufacturer. In the absence of such data, measured resistance values shall be compared to results obtained earlier at the winding temperatures nearly identical, and at the moment when the machine was started for the first time. If the insulation resistance drops significantly the machine shall be inspected and possibly overhauled as well.

27.- If internal safety system responded and an automatic shutdown took place the machine will not be restarted before the cause of such safety response was examined and defect found and remedied. A restart order shall be given by a skilled person nominated by the user. If safety from external faults (overcurrent, overload current, overvoltage and the like.) responded, the machine can be restarted only after a detailed check of the causes such response and after a conclusion that the safety system properly responded as secondary protection, except in the case when there is a risk that the safety system will respond again or the machine is damaged.

28.- Generators or synchronous condensers in cold reserve shall be inspected and maintained in proper working conditions as if they are in operation.

STANDARD FEATURES

- Manufacturer / Model
- Cylinder Arrangement
- Displacement
- Bore and Stroke
- Compression ratio
- Rated RPM
- Piston Speed
- Max. stand by Power at rated RPM
- Frequency regulation, steady state
- BMEP
- Governor : type

EXHAUST SYSTEM

- Exhaust temperature
- Exhaust gas flow
- Max back pressure

FUEL SYSTEM

- 110% (Stand By power)
- 100% (of the Prime Power)
- 75% (of the Prime Power)
- 50% (of the Prime Power)
- Max. fuel pump flow

OIL SYSTEM

- Total oil capacity w/filters
- Oil Pressure low idle
- Oil Pressure rated RPM
- Oil consumption 100% load
- Oil capacity carter

THERMAL BALANCE

- Heat rejection to exhaust
- Radiated heat to ambiant
- Heat rejection to coolant

AIR INTAKE

- Max. intake restriction
- Engine air flow

COOLANT SYSTEM

- Radiator & engine capacity
- Max water temperature
- Outlet water temperature
- Fan power
- Fan air flow w/o restriction
- Available restriction on air flow
- Type of coolant
- Thermostat

EMISSIONS LEVEL

- PM
- CO
- Nox
- HC

ACCEPTANCE CERTIFICATION
Delivery shall be in accordance of:
- Diesel generator set technical Data & Alternator Data Sheet
- Diesel generator set Drawings
- EC declaration of conformity
- Certificate of Performance
- Certificate of Capability
- Certificate of Generator Set Test
- Certificate of Balance/Vibration
- Warranty certificate and
- Certificate of Origin

MEASUREMENT

Delivery in accordance of contract and number of delivered pieces.

All characteristic must be tested in accordance of Certificate of Generator Set Test

The exact quantity of installed material are determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

PAYMENT

Equipment are to be paid in accordance with the contract and number of delivered pieces, as approved by the Engineer.

Works are to be paid in accordance with the contract and number of mounted pieces as approved by the Engineer.

17.2. Roof fan

Fans shall be fire resistant and have the designed capacity, efficiency and number of revolutions that will enable their operation in all conditions, of the size adequate for incorporation in the space foreseen.

Roof fans shall be constructed from steel plates and be assembled of a base, impeller, support and cap with an electromotor.

Steel parts shall be made of Č0361 steel, plasticized or galvanized after manufacture.

Impellers in radial fans have backward curved vanes (250 to 1000 mm dia). Impellers are in a dynamic balance class G-2.5 pursuant to ISO 1940-1.

Fans are fitted with electro motors according to IEC standards, mechanical protection IP 54, insulation class F.

The components other than from mass production shall be manufactured of best materials in the best possible way foreseen for this group of works.

The Contractor shall make a statement about his knowledge and capacities expected from contractors of these plants confirming.

– His understanding of the design and technical solutions
– His ability to purchase, delivery, mount, connect with other elements in the plant, adjust and start operation of the entire plant designed.
– The knowledge and capacities to work out, amend and adjust various designed parts during the installation works doing that at an appropriate technical and esthetic level (suspension of ducts, placing of insulation, fitting of fan etc.)

PERFORMANCE SPECIFICATION
As specified in the Design.

ACCEPTANCE CERTIFICATION

Delivery shall be in accordance of:
- Roof Fan technical Data Sheet
- Roof Fan Drawings
- EC declaration of conformity
- Certificate of Performance
- Certificate of Capability
- Certificate of Roof Fan Test
- Certificate of Balance/Vibration
- Warranty certificate and
- Certificate of Origin

MEASUREMENT

Delivery in accordance of contract and number of delivered pieces.

All characteristic must be tested in accordance of Certificate of Roof Fan Test

The exact quantity of installed material are determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

PAYMENT

Equipment are to be paid in accordance with the contract and number of delivered pieces, as approved by the Engineer.

Works are to be paid in accordance with the contract and number of mounted pieces as approved by the Engineer.

17.3. Jet fan

Fans shall be resistant to increased temperatures 250 °C in a 2-hour period.

Fans shall be reversible, so that the direction of air flow changes with a change in the direction of motor rotation.

Fans shall be delivered with supports for horizontal mounting and hanging from a flat or vaulted tunnel arch. Hanger design shall prevent stress mounting over $\sigma \leq 6$ N/mm2.

Fans shall be fitted with anti-vibration pads and fixing components.

Vanes shall be made of aluminium alloy and subjected to 100 % radiographic test before being fitted pursuant to ASTM E155.

The rotor shall be in static balance to G6.3 level pursuant to ISO 1940.

The housing, central support, motor holders, hangers and protective mesh shall be made of medium carbonized steel, 3-6 mm thick, welded.

Steel parts shall be hot dip galvanized with the coat thickness 60-65 µm (≈ 450 g/m2)

Fans shall be fitted with noise suppressors at suction and delivery sides, each two fan diameter long. Suppressor housings shall be made of galvanically protected steel. Mineral wool can serve as absorbing material. Flashing shall be of perforated stainless steel.

Fans shall be fitted with suction lines on both sides and covered with protective mesh.

Monitoring of imbalance, vibration level, temperature of bearings shall be possible.

Power supply voltage to electro motors shall be 380V/ 50Hz.

Electro motors shall be enclosed, cage, insulation class "F".

Electro motor and connecting box shall meet the requirements in IEC 34-5, class IP 55.

Motor bearings shall be designed for minimum 20,000 hours of operation, criterion L10, namely for an average lifetime of 100,000 hours, pursuant to ISO 281.

Fans shall fulfill or exceed the required parameters (flow, height of head, noise, power etc.).

Fans shall come with test certificates confirming the above characteristics, issued by an accredited institution.

The period of guarantee shall not be shorter than 2 years after start up and confirmation of performances.

This work item shall include the price all tests and confirmation of performance parameters after fan installation.

If any of the envisaged characteristics are to be modified, the Designer shall be asked to approve, and the Engineer shall issue the required instructions to the Contractor accordingly.

PERFORMANCE SPECIFICATION

Performance data must be derived from tests carried out in accordance with ISO13350 and is specifically applicable to the fan, attenuator and motor combination.

- Fan Code
- Fan Diameter / Size
- Fan Speed
- Blade Angle
- Percentage Duty
- Requested Duty
- Actual Duty
- Velocity
- Duty Shaft Power
- Motor Frame
- Motor Rating
- Full Load Current
- Starting Current
- Motor Mounting
- Electrical Supply
- Start Type
- Sound Pressure Level

- Air Density
- Smoke Venting

Acoustic data has been derived from tests carried out in accordance with ISO13350.

Performance

All tests shall be performed on complete units with the appropriate silencers or bellmouth(s) fitted.

The fan shall deliver the volume or velocity specified in accordance with ISO 5801 (2007) with a flow measuring inlet fitted in placed of the inlet bellmouth.

The fan shall give the sound power level specified when tested in accordance with ISO 13350 (1999) and ISO 3741 (2000). Inlet and outlet sound levels shall be measured and in the case of reversible fans, the sound level shall be measured in both directions of airflow.

The fan shall give the thrust specified when tested on a test rig which constrains the longitudinal axis of the fan. The test measurements shall be made after the fan has reached steady operating conditions.

Jetfoils are designed emergency operation at elevated temperatures, up to 400 ºC for 2 hrs

Construction

The impeller shall have aerofoil section blades fitted to a hub in a manner that allows simple adjustment of blade pitch angle. Blades and hubs will be cast from aluminiumsilicon alloy in accordance with EN1676 (1997) - similar to ISO 3522 (2006) and ISO 7720 (1997). Grades EN AB 44100 or EN AB 42100. The hub shall be fitted with a cast iron or steel insert bored and keywayed.
All cast aluminium impeller components shall be X-rayed to show compliance with the specified grade of ASTM E155 - 05. X-ray records shall be traceable to the components and retained for a period of 10 years.

The fan casing shall manufactured from mild steel to EN10111 (2008) - similar to ISO 3574 (2008). Grade HR14 with integral spun flanges. The casing assembly shall be hot dip galvanised in accordance with ISO 460 (1992) and ISO 1461 (1999).

The silencers shall be standard construction with pre-galvanised steel outer skin fastened to hot dip galvanised ends and bellmouths, fitted with internal galvanised steel perforated liner and galvanised aerodynamic pod.

Motor

The motor shall be pad mounted, continuously air stream rated and complying fully with IEC 34-1, with minimal Class F insulation. The fan shall be fitted with an external terminal box connected to the motor via high temperature rated ‘Adaptaflex’/’Kopex’ flexible conduit suitable for use in fire hazard areas. Both motor and terminal box shall comply with IEC 34-5 Grade IP55.
The motor bearings shall have L10 life of not less than 20,000 hours when calculated in accordance with ISO 281 (2007). For emergency operation at 250°C for 2 hours the insulation shall be Class H. Bearings shall have grease suitable for this operation and be fitted with extended lubricators mounted on the fan casing.

Fan Balance and Vibration

The impeller shall be statically balanced to give a fan vibration level of G6.3 in accordance with ISO 1940-1 (2003)

Vibration at the fan feet shall be in accordance with the requirements of ISO 14694 (2003) a test performed with the fan supported on anti-vibration mounts, during which the vibration level shall be measured at rotational frequency in the vertical, horizontal and axial directions at a point on the front and rear feet adjacent to the mounting hole.

Finish

The fan shall be supplied with the manufacturer’s standard finish.

ACCEPTANCE CERTIFICATION

Delivery shall be in accordance of:

- Fan technical Data & Motor Data Sheet
- Fan Drawings
- EC declaration of conformity
- Certificate of Performance, ISO 13350, 13347 part 2and ISO 3741
- Certificate of Capability - Quality Assurance to BS EN ISO 9001
- Certificate of Fan Test
- Certificate of Balance/Vibration - ISO 14694 & BS848 Pt.7 2003, or ISO 13350:1999
- Warranty certificate and
- Certificate of Origin

MEASUREMENT

Delivery in accordance of contract and number of delivered pieces.

All characteristic must be tested in accordance of Certificate of Fan Test

The exact quantity of installed material are determined based on the construction book and the construction journal signed by the supervisor, in accordance with the Bills of Quantities and as approved by the Engineer in accordance with the Design and these Technical Specifications.

PAYMENT

Equipment are to be paid in accordance with the contract and number of delivered pieces as approved by the Engineer.

Works are to be paid in accordance with the contract and number of mounted pieces as approved by the Engineer.

SPECIAL SPECIFICATION – LOT 1

Content:

PAVEMENT STRUCTURE DESIGN

AS-3.4. CONSTRUCTION OF PAVEMENT SUBGRADE

AS-3.4.1. Subgrade

AS-3.4.1.1 Description

Subgrade planned to be constructed on the MAIN ALIGNMENT of the studied highway section shall be made of stone aggregate from the borrow pit along the alignment. Research for the purpose of the studied design has shown that the material is acceptable for pavement subgrade and therefore applicable for use on the primary traffic ridden areas.
The design thickness of the subgrade course shall be d = 70 cm. The course shall be composed of two sub-layers.

AS-3.4.1.2. Material for Subgrade Construction

Pure rock material free of adverse admixtures such as: clay particles, altered aggregate grains and rock massif parts prone to fragmentation, shall be used. It is also necessary to meet the requirement asking to avoid use of other material for subgrade construction without the prior approval of the Design Engineer.
Criteria applied in material feasibility analysis shall be also applied in feasibility evaluation on the site.

AS-3.4.1.3. Construction

Stone aggregate shall be placed mechanically into the subject course. Manual placing shall be accepted only locally, on spots approved by the Engineer.
Stone aggregate shall be supplied to the site by appropriate means.
Any correction of aggregate grading on the site, i.e. on the placing location shall be approved by the Engineer fully in accordance with relevant results obtained in preliminary tests.
The water quantity required for attaining of optimal aggregate moisture for better compaction shall be introduced uniformly into the aggregate volume at the supply location.
If water shall be added on placing location, then water shall be dosed in a way to escape washout of small fractions. The allowable deviation of optimum moisture shall be maximum ± 2m.-% during the course of compacting.
Spreading of stone aggregate shall be performed mechanically in layers not exceeding 35 cm in thickness. Spreading shall be performed on the same day as wetting.
Compacting shall be performed from the lower edge towards the higher edge of the course. Number of passes of appropriate compacting devices, previously determined on the trial section, shall be checked by testing within the regular control of density, i.e. compactness of the placed stone aggregate.
Any irregularity identified in the course of compacting shall be corrected, as directed by the Engineer.
Prior to completion of compaction, bearing capacity of the placed course shall be measured.
If values specified in the design documentation are not obtained, the Contractor shall assure the placed course quality by performing the additional actions.
The compacted course shall be provided with levels, width and gradient, as stated in the Design.
If the Contractor would temporary store stone aggregate fractions prior to placing into the subject course, then the stockpiling area shall be previously prepared in adequate manner (leveled, strengthened and drained).

AS-3.4.1.4. Testing Standards

Testing of physical and mechanical properties of subgrade material shall be performed fully in accordance with standards listed below:

SRPS EN 1097 2	Testing of Stone and Aggregate Resistance Against Abrasion by Los Angeles Method
SRPS B.B8.037	Determination of Frail Grains in Coarse Aggregate
SRPS U.B1.018	Determination of Grain Size Distribution and Determination of 0.08 mm Particles by Aerometry (or applying SRPS B.B8.036)
SRPS B.B8.036	Determination of Particles Passing the Sieve 0.02 mm (procedure stated in this SRPS Standard shall apply)
SRPS B.B8.038	Clay and Mud Contents
SRPS U.B1.042	Determination of California Bearing Ratio
EN 933 8	Sand Equivalent
NF P 94 066	Coefficient de fragmentabilite des materiaux rocheux
SRPS EN 1744-1	Organic Admixtures Participation

AS-3.4.1.5. Criteria For Subgrade Material Quality Evaluation

The stone material to be used for subgrade construction shall meet the following requirements:
- Maximum grain size shall not exceed 75 mm,
- Coefficient of fraction resistance to crushing determined by Los Angeles Method(EN 1097-2) shall not exceed 45 % (category LA45)
- Fragmentability coefficient of stone material specified according to NF P 94-066 standard (Coefficient de fragmentabilite des materiaux rocheux) shall be FR ≤ 7 on sample tested at natural moisture.
- Organic admixtures content in stone aggregate shall not color the 3% solvent of sodium deposit darker than reference color (test as per EN 1744-1).

In addition, material to be incorporated into subgrade course shall also meet the following criteria:
- Plasticity index of possible present fine grains (smaller than 0.425 mm) shall be less than Ip< 6%
- Sand equivalent shall be minimum 60, ES ≥ 60 (according to EN 933-8).

AS-3.4.1.6. Control of Constructed Subgrade

Control of Material

Material shall be in strict compliance with the above specifications and required quality.

Bearing capacity

Control of bearing capacity shall be performed as follows:
- Measuring modulus of deformability by circular plate method - SRPS U.B1.047 :1997
- Measuring deflection of the subgrade surface by Benckleman beam or deflectometer with falling weight.

Required bearing capacities

Criteria for bearing capacity control by measuring the modulus of deformability by circular plate method depend on type of material identified in the road body. According to this, the following criteria have been stated in the original design:

Embankment and subgrade composed of „uncontaminated“ detritus

If embankment and subgrade are to be constructed of material that satisfies criteria stated in Item 3.4.1.5. of these Technical Specifications, then the said material so-called „uncontaminated“ detritus shall be incorporated into two layers provided with overall thickness as shown on Figure 1 of these Technical Specifications.

Subgrade of stone material that satisfies criteria stated in Item 3 .4.1.5. d = 2 x 35 cm

Road bed composed of „uncontaminated“ detritus
Figure 1. Layout of subgrade composed of „uncontaminated“ detritus

In the course of construction, the required bearing capacity shall be as follows:
Modulus of deformability Ev2 = 140 MPa
Maximum deflection measured by Benckleman beam (standard axis) U40kN = 55 mm
Modules relationship Ev2 / Ev1 < 2.5

Subgrade on Roadbed Composed of Mixed Soil in Cutting and Side Cuts
Subgrade composed of previously described material on the roadbed of mixed soil shall be constructed in two layers in overall thickness, as presented on Figure 2 of these Technical Specifications.

Subgrade of stone material that satisfies criteria stated in Item 3 .4.1.5. d = 2 x 35 cm

Roadbed composed of mixed soil
Figure 2. Layout of the subgrade on the earthen roadbed of mixed soil

In the course of construction, the required bearing capacity shall be as follows:
Modulus of deformability Ev2 = 120 MPa
Maximum deflection measured by Benckleman beam (standard axis) U40kN = 0.65 mm
Modules relationship Ev2 / Ev1 < 2.5

Costs for retesting due to unsatisfactory results, shall be borne by the Contractor.
The assessment of test results among which there are also results not fulfilling the required compactness, shall be performed through computation of normal standard deviation, „quality number – Z“, where Z shall be ≥ 0.90. The allowable deviation – quantil shall be less than 10%.

Evenness Control

Evenness of formation of the studied course shall be defined by measuring deviations under the 4 meter long straight edge placed in any direction against road axis. The deviation against design thickness for the entire set of testing data shall be as follows:
- For 90 % of overall control measurements, deviation shall not exceed 20 mm
- Maximum allowable deviation against the designed thickness shall be 30 mm
- Mean thickness of all control measurements shall not deviate for more than 10 mm.

Isolated spots characterized with actual thickness lower than maximum shall be locally repaired and brought to 90% tolerance. Number of samples (tests on control section) shall not be less than 10 except otherwise agreed with the Engineer. If such is the case, structural analysis of „quality number- „Z“, where Z is Z ≥ 0.88 shall apply. Then the required criterion is that the error – quantil shall be less than 10%.
The width of the constructed course shall be at least equal to the width stated in the design so as no single profile of the outer course edge shall be pulled toward the road axis for more than 50 mm related to the designed width.

AS-3.4.1.7. Check of Construction Quality

The compliance with requirements stated in the design documentation and these Technical Specifications shall be determined for each separated type of stone aggregate planned to be incorporated into the subject course:
- Prior to placement compliance with preliminary tests shall be provided and
- In the course of placement, compliance shall be obtained with both regular and external control tests.

Preliminary Tests

Preliminary tests shall be performed to check the compliance of stone aggregate properties with the required ones, i.e.:
- Crushing resistance – Los Angeles Coefficient
- Coefficient of stone material fragmentability defined according to NF P 94-066 Standard
- Grain size distribution of stone aggregate prior and after the fragmentability test
- Plasticity of small particles (smaller than 0.425 mm) prior and after the fragmentability test
- Sand equivalent
- Organic admixtures participation

Results of preliminary tests shall be in compliance with evidences on properties of supplied stone aggregates submitted by the Contractor.

Regular Control

In the course of placing, regular control by the Contractor (to be performed by certified testing facility) must be able to define compliance of aggregates with requirements stated in the design documentation and these Technical Specifications.
In the course of placing of stone aggregate into the subject course, the relevant laboratory shall take samples, and test compliance of their properties against the minimum frequency required.
As a rule, samples of stone aggregates shall be taken from the temporary stockpiling area (2/3) and from constructed non-bound base course (1/3).
Minimum testing frequency of stone aggregate during regular control in the course of placing into the subject course shall be as follows:

Properties Minimum Testing Frequency
- Coefficient of fractions resistance against crushing, determined by Los Angeles method (EN 1097-2) 4000 m2/1000 m3
- Fragmentability coefficient FR
  according to NF P 94-066 4000 m2/1000 m3

•	Participation of grains up to 0.063 mm in size	4000 m2/1000 m3
•	Grain size distribution of stone aggregate mixture	4000 m2/1000 m3
•	Testing of plasticity of small particles	4000 m2/1000 m3
•	Sand equivalent	4000 m2/1000 m3
•	Organic admixtures participation	8000 m2/2000 m3

Minimum testing frequency during regular control in subgrade layer shall be:

Properties	Minimum Testing Frequency
• Bearing capacity:	
- Static deformation modulus Ev2	2000 m2
- Deflections	50 m1
• Formation course:	
- Evenness	20 m1
- Height and gradient	20 m1

External Control

Volume of works for external control during the construction of the subject course shall be 1:4 in relation to regular control volume. Control tests shall be performed by relevant testing facility appointed by the Client.

Spots for taking of stone aggregate samples on the temporary stockpiling area and on the subject course shall be defined by the Engineer according to static method of random sample.

AS-3.4.1.8. Measurement and Payment

The performed work previously controlled and ac accepted by the Engineer shall be measured in m2.
Previously accepted and measured work shall be paid in unit price stated in the Contract per one square meter (m2) of the completed course.

AS-6.2.2. BASE COURSE CONSTRUCTION OF NON-BOUND STONE AGGREGATE 0/31 mm

AS-6.2.2.1 Description

This work shall consist of supply, transportation, placing, rough and fine spreading, possible wetting and compacting of non-bound stone aggregate base course, dimensions as designed.

AS-6.2.2.2 Basic Materials

Basic material shall be a mixture of crushed grains, originated by stone crushing, rough natural grains or artificial stone

Material Quality
Quality requirements are explained in detail with standard SRPS EN 13242:2007-Aggregates For Non-Bound Or Hydraulically Bound Materials For Use In Civil Engineering Works And Road Construction.

Stone Aggregate
The mixture of non-bound stone aggregate is composition of crushed stone fractions, stone grit, sand and filler, as to assure the required grading. Grading determination is defined with standard SRPS EN 933-1:2009.

Grading

Grading of non-bound stone aggregate shall be within the following limits:

Square mesh sieve openings (mm)	Passing trough sieves in mass % Crushed aggregate 0/31 mm
0.09	2-9
0.25	5-15
0.50	8-21
1.0	11-30
2.0	15-40
4.0	20-50
8.0	28-62
16.0	46-75
31.5	95-100
45.0	100

And to meet following requirements:

Uniformity coefficient Cu > 6
Curvature coefficient CC = 1 ÷ 3.
Fine particles presence

Stone aggregate may contain components smaller than 0.063mm (as per SRPS EN 13242:2007) within the following quantity:
- At stockpile: up to 5% (by weight)
- After placing: up to 8% (by weight).

Participation of stone grains up to 0.02 mm shall not exceed 3% (by weight).

Plasticity index of fine particles (smaller than 0.425mm) shall be below 6.

Sand equivalent shall be at least 60 – ESmin=60 (in conformity with SRPS EN 933-8:2008).

AS-6.2.2.3 Mechanical Properties of Stone Aggregate

Coefficient of resistance against crushing, determined by Los Angeles method (SRPS EN 1097-2:2008), shall not exceed 30%.

Frost resistance of stone grains, when determined as per SRPS EN 1367-2:2009, by magnesium sulphate test and expressed in percentage of skinned parts of original sample mixture shall be up to 25m.-%, but when tested by sodium sulphate, up to 5m.-%.
With stone aggregate is allowed maximum 20 m.-% of grains where the shape does not meet the requirement 1 :d □ 3:1 (test as per EN 933-4).
Organic admixtures contents in stone aggregate shall not color the 3% solvent of sodium deposit darker than reference color (test as per SRPS EN 1744-1:2009).
Stone aggregate shall not contain harmful non-quality grains or admixtures (test as per SRPS EN 1744-1:2009).
Bearing coefficient of stone aggregate, when determined by CBR laboratory test , shall be at least 80%.

AS-6.2.2.4 Works

It shall be necessary before work commencement to check whether or not machinery and tools that will be used in construction, meet the work execution requirements as present by the present Work Specifications.
Stone aggregate placing for the subject course shall be performed mechanically. Manual placing shall be allowed only locally, on spots where agreed by Engineer.
Any improvement of aggregate grading on site, i.e. on placing location, shall be allowed by Engineer based on results of preliminary tests.
Water quantity as necessary for optimal aggregate moisture for better compaction shall be introduced uniformly into aggregate just with supply location.
When the water should be added on placing location, than water dosage shall take place in the manner as to avoid washout of small fractions. Deviation of optimal moisture shall be maximum □2% by weight, during the course compacting.
Stone aggregate spreading for this course shall be carried out by pavers Spreading shall take place on the same day when moisturizing took place.
Compacting shall take place from the lower edge towards the higher edge of the course. Number of passes of appropriate compacting devices, previously determined with trial section shall be checked by testing within the regular control of density, i.e. compactness of the placed stone aggregate.
All irregularities that might be detected during compacting shall be corrected as directed by Engineer.
Bearing capacity of the course placed shall be measured before the compaction finishing.
When the properties as required by Design would not be attained, the Contractor shall assure the placed course quality by additional actions.
The course compacted shall have levels, width and gradient as presented by Design.

AS-6.2.2.5 Temporary Stockpile

If the Contractor would temporary store fractions of stone material before placing into the subject course, then the stockpile area shall previously be prepared in an appropriate way (planned, strengthened, drained)
A temporary approach road shall be constructed to the temporary Stockpile

AS-6.2.2.6 Construction Quality

Compaction

Average value of the stone aggregate placed compactness into the subject course as determined relating the density following Proctor procedure, shall exceed 98%. The estimation of results not fulfilling the compactness as required, shall be carried out by calculation of normalized standard deviation, quality number – Z" where the Z value should be ≥ 0.85. The error allowed – quantal – should be bellow 15%.
The Designer proposed to determine placed aggregate layer compactness by using measurements with isotropic measuring device (nuclear density meter).

Bearing Capacity

Bearing Capacity of the completed course shall be determined by static deformational modulus Ev2, which shall comply with following requirements:

Bearing Capacity control shall take place by one of two methods:

1. Deformability modulus measuring by circular plate method - SRPS U.B1.047: 1997
2. Deflection of the course completed measuring by Benckelman beam or by deflectometer with falling weight.

1. Required values for deformability modulus
Required value of the deformability modulus at first sublayer (d= 15cm) shall be Ev2 ≥ 160 MPa.
Required value of the deformability modulus at second sublayer (d=15cm) shall be Ev2 ≥ 200 MPa.
The required value of deformability modules relationship shall be Ev2 / Ev1 < 2.2.
The assessment on acceptability of results where are present such ones that do not fulfill the required density, shall take place by calculation of normalized standard deviation with quality number– Z", the value of which (Z) shall be ≥ 0.90. The error allowed shall be the quantil bellow 10%.

2. Required values for deflection
Eighty-five percent of deflection, when measured by Benckelman beam under standard axle loading shall be U40kN = 0.47 mm at first sublayer (d= 15cm).
Eighty-five percent of deflection, when measured by Benckelman beam under standard axle loading shall be U40kN = 0.40 mm (d= 15cm) at second sublayer (d= 15cm).

Measuring shall take place:
- ON NEW PAVEMENT OF THE MOTORWAY ROUTE in three points within the cross section, in the middle and in zones of the left and right edge of the course completed, distanced longitudinally 50 cm. Measurement may be carried out by deflectometer with falling weight.
- ON PAVEMENT OF EXISTING CARRIAGEWAY WIDENING in one point within the cross section, in contact zone to the existing pavement.

Evenness, levels, gradient

Course formation evenness shall be determined by deviations measurement under the straight edge of 4 m that shall be placed in any direction at the road axis. Deviations allowed are as follows:

- Course formation shall deviate of the straight edge up to 20 mm (top limit). When such deviations would appear continuously, then evenness shall be corrected as ordered by Engineer;
- Levels of measuring spots on the course formation shall be determined by leveling apparatus. Course formation at random spot shall deviate of the level as designed for maximum □10 mm (top limit).

Course formation gradient, in conformity wit Design proposal, shall be the same as lateral and longitudinal gradient of the pavement surface designed.

AS-6.2.2.7 Construction Quality Control

The conformity with requirements of Design and the present Work Specifications shall be determined for each separated type of aggregate that would be foreseen for use with the subject course, as follows:
- Before placing, with preliminary testing;
- During the construction, within the regular and external controls.

AS-6.2.2.8 Preliminary Tests

Preliminary tests shall serve to perform the conformity check of stone aggregate against requirements as presented with these Work Specifications, meaning:
- Stone aggregate grading;
- Participation of grains up to 0,063 mm;
- Grain shape;
- Uniformity degree and curvature coefficient;
- Plasticity of fine particles (finer than 0.425)
- Sand equivalent;
- Resistance against crushing – Los Angeles coefficient;
- Organic admixtures participation;
- Bearing capacity – CBR procedure;
- Testing as per modified Proctor test:
  - Optimal moisture;
  - Highest density

Results of preliminary tests shall conform to the proposed Contractor's proofs on the properties of supplied stone aggregates.

AS-6.2.2.9 Regular Control

The regular control by Contractor (done by a certified laboratory) shall determine the conformity of the aggregate with requirements of Design and the present Work Specifications, during the stone aggregate placing into the subject course.
The laboratory shall take samples and check the conformity of properties with the minimal frequency required during the stone aggregate placing into the subject course.
Statistical principles for materials sampling shall be respected.
Minimal frequency of the stone aggregate testing during regular control of placing into the subject course shall be as follows:

Properties	Minimal testing frequency
Grading of stone aggregate mixture	1000 m3
Grain shape	
Uniformity degree and curvature coefficient	
Participation of grains up to 0,063 mm	
Fine particles plasticity	
Sand equivalent	
Moisture and density as per Proctor	
Organic admixtures participation	2000 m3

Minimal testing frequency during the regular control of placing into the non-bound base course shall be as follows:

Properties	Minimal testing frequency
Moisture participation and density	200 m2
Bearing capacity	
- Statical deformation modulus Ev2	2000 m2
- Deflections on new pavement of motorway route	50 m1 x 3
- Deflections on existing pavement widening of motorway	50 m1
Course formation:	
- Evenness	20 m1
- Levels and gradients	20 m1

Control Tests

External control volume with subject course construction is regularly 1:4 compared to regular control. Control tests shall be done by the institution that is certified by Employer.
Stone aggregate sampling spots at the temporary stockpile and on subject course placing spots shall be determined by Engineer, as per statistical method of random sample.
Protection and Maintenance of the Course
The Contractor shall protect and maintain the course constructed at his own expense all the time before the next course construction. Maintenance shall include corrections of any damages and shall take place within such volume and frequency as to assure the intact course and in good condition. Repairs shall maintain good surface evenness of the course constructed.

AS- 6.2.2.10 Measurement and Payment

The quantity to be paid for to Contractor at the Contract Unit Price shall be the number of cubic meters (m3) of the course completed in the designed thickness and accepted by Engineer.

2. DRAINAGE DESIGN

08.05.01/2.01.03 Positions does not contain any additional description

08.05.01/2.05. CAST IRON COVERS
Description
Procurement, transport and fixing of cast iron covers in frame fully in accordance with SRPS.M.J6.226 for manholes (bearing capacity of 400 kN). The cover and frame shall be mounted onto a reinforced concrete ring seat on top of the manhole.
Payment
Payment will be done per each completely fixed cover.

08.05.01/2.06. CAST IRON RUNGS
Description
Procurement, transport and fixing of cast iron rungs to SRPS.M. J6.285 at the height of 30 cm.
Payment
Payment will be done per each completely fixed rung.

08.05.01/2.07. STREET GULLEYS
Description
Procurement, transport and fixing of a street gulley made of RC pipes, Ø400 mm in dia. The price includes: gulley, connection splice and rain grating fully in accordance with SRPS M.J6.254.
Payment
Payment will be done per each completely fixed gully.

08.05.01/2.08. ROUND GRATINGS DN 600

Description
Procurement, transport and fixing of round grating, Ø 600, class D400 EN 124 mounted on round manholes in the central reserve, as stated in the design.
Payment
Payment will be done per each completely fixed grating.

8.5.1/2.9. GEODETIC SURVEY
Description
The geodetic survey of stormwater sewerage shall be done after the acceptance of the sewerage system but before trench backfilling. The following shall be surveyed: locations of manholes and gullies, distances between them (section lengths), pipe diameters by sections, bottom levels in manholes and bottom levels and diameters of pipes in manholes. After completion of geodetic survey, as-built drawing shall be prepared and submitted to the Employer.
Payment
Payment will be done per m’ of completely surveyed network.REGULATION OF WATER STREAMS

06.04.04.01. REGULATION OF STREAM INFLOW
Description
This work include the lining of slopes of stream inflow at the mouth of major flow, rock embankments, and hill sides, in a 30 cm thick layer, with selected stone. This work may be undertaken using other methods and materials, as proposed by the Contractor subject to approval by the Engineer.
The lining of slopes of earth embankments with stone or concrete is covered under Sub-Section 8.3.3.6. of Scott-Wilson specifications. Lining shall be performed at the same time with the construction of embankment, with stones laid accurately in the cross-section of embankment, as defined in the design and marked on the site with the construction cross-section. Each stone shall have a secure bearing and be fixed, so that the slope cannot possible collapse due to instability of some stone blocks, or for any other reasons whatsoever. The foot of a lined slope or hill side shall be firmly built into a sound substratum, and constructed in such a way that the lining cannot collapse under atmospheric influences or any other harmful actions.
To humify and grass slopes of low embankments, with this being obligatory in places where climatic conditions allow effective humification and grassing.
Payment
Payment per m' of regulated section.

DESIGN OF ENGINEERING STRUCTURES

MAIN WORKS FOR THE SUPPORTING STRUCTURE MADE OF REINFORCED EARTH

07.07.00 EARTH WORKS FOR THE SUPPORTING STRUCTURE MADE OF RAINFORCED EARTH

07.(wall No.)07.03 EMBANKMENT CONSTRUCTION

Description
This item includes filling, spreading, rough and fine levelling, wetting and compaction of earth material containing minimum 30 % of rock aggregates with grains varying from 0 to 125 mm in size. Fragments coarser than those specified in the design will be removed mechanically or by hand or by rough sieving on improvised screens.
When performing embankment construction, standard method will apply except in a 2 m wide belt along the already embedded concrete blocks where spreading will be done by means of lightweight bulldozer and compaction will be performed through the use of vibration smooth roller having maximum 8 tons in weight, to obtain 0.20 m thick layers.
In 2.0 m wide area from concrete blocks, spreading will be done by hand in 15 cm thick layers. The main compaction will be done by 40/50 cm wide vibration plate along the concrete blocks. After stabilizing the material, 60/70 cm wide vibration roller having maximum weight of 1 tone will be used.
The relevant geogrid will be placed after reaching the layer thickness of 30 cm fully in accordance with these Technical Specifications.
Spreading shall be performed according to profiles, heights and relevant slope inclinations stated in the design.
Compacting shall be done until minimum of Ms=40 MPa or equivalent dynamical modulus Evd is obtained. Compactness shall be tested by applying standard round plate test (D=30 cm) or by means of device for dynamic modulus testing. Dynamic modulus test will be performed in accordance with SRPS UB1 047/97, SRPS UE8.010/1981 and SRPS UB1 046/68/92 Standards and NGT 39 Instructions for compactness control of both subgrade and embankment used for substructure in German railways.

Measurement
Measurement will be done per m3 of spread material and payment will be done according to contract unit prices that will include all work on filling, spreading, rough and fine levelling, wetting and compaction of material taken from the local excavation pit.

Payment
Payment will be made according to real quantities and contract unit price per measurement unit.

07.(wall No.)10.00 GEOSYNTHETIC MATERIALS
07.(wall No.)10.01
07.(wall No.)10.02

Description of geosynthetic materials
Uniaxial geogrids and relevant HDPE connectors resistant to chemical and mechanical impacts shall be used, as specified in the design.
Geogrid must be fabricated of HDPE plate oriented in single direction so as the obtained strips will be characterized with high degree of molecules orientated toward the strip direction that will also maintain their continuity through the transverse joining rib.
The required tensile strength for 120 year design life that will cause maximum deformation of 1% for grid M1 must be 8.21 kN/m, and for grid M2, 18.14 kN/m, at mean temperature of 200C. The said values represent relation of maximum tensile strength of geogrids for maximum deformation of 1% at the end of 120 year period and calculated safety factor. Due to lack of national legislation, the safety factor was calculated in accordance with British standards applied to geosynthetical materials.
Tensile strength in control tests at short loading must be 52.5 kN/m for M1 geogrid and 88.0 kN/m for M2 gird, with peak deformation of about 11.5% for the said force value.
The Manufacturer of geosynthetic materials that will be used for construction of this type of structures must be provided with adequate certificate issued by relevant independent institution stating that characteristics of fabricated geosyntetic material are in compliance with the solution applied in the design herein.
For the purpose of elongation, each geogrid junction must be capable to withstand 100% of tensile strength at control tests.
Geogrid must be inert to all chemicals naturally found in soils and must be stabile at ambient temperatures. Geogrid must not be susceptible to hydrolysis and must be resistant to aqueous solutions of salts, acids and alkalis (pH = 2.0 to 12.5) and non-biodegradable. It must also contain minimum 2% of dispersed carbon black which gives a high degree of protection by preventing UV light from penetrating beyond a thin layer at the surface.

STRUCTURE MADE OF REINFORCED EARTH – CONSTRUCTION TECHNOLOGY

Description of works
The structure made of reinforced earth will be constructed according to instructions stated in these Technical Specifications. The following must be taken into account:
The first row of concrete blocks must be precisely aligned to escape mistakes that can occur in joints in the course of wall construction.
Cutting of blocks, if necessary, will be precisely performed by means of adequate cutting tools.
The adjoining geogrid rolls must not be overlapped but positioned edge-to-edge so as problems referring to block levelling could be escaped. The end ribs must be precisely cut off by hand to enable proper connection and required fire resistance (geogrid must not be visible on the outer wall side).
In the course of work execution, the following must be borne in mind:
- Filling must be properly compacted especially along subgrade.
- In each construction phase, compacted layer must be in compliance with subgrade-geogrid connection to escape voids formation.
- Geogrid must be placed at right angle to the subgrade surface with tolerance of 50 mm, and spaced at 5 m.
- Sufficient tension shall be applied to ensure geogrid together with connector is firmly attached to the block wall.
- Tension shall be performed by special tool by applying one- man force.
- Continuity of geogrids should be avoided. If this is necessary due to better use of material, then continuity should be enabled through the use of appropriate joints (HDPE bars) supplied by the same Manufacturer engaged for geogrids and connectors.

Measurement
Unit price for geogrids includes as follows: procurement, cutting and placement of geogrids as well as all relevant accessories for tensioning and continuity, if necessary.
Unit price for connectors includes procurement and installation of polyethilene connectors.
Measurement will be done according to theoretical sizes stated in the design. Measurement unit for geogrids is m2, and for connector m'.
Payment
Quantities defined in the above mentioned way will be paid per contract unit price for measurement unit.

BRIDGES

13.1.4.1 Concrete layer for slope. Concrete class I MB 20.

13.2.6 Erection of shuttering for foundation works. These works include shuttering of foundation pits with wooden planks and steel frames and combination thereof and shuttering with steel material.

13.2.6.1Timber shuttering includes driving and/or placing of wooden planks and beams and struts for supporting the wall made of wooden planks.

The Design Engineer and/or the Contractor shall be responsible for preparation of shuttering design fully in accordance with design documentation, geotechnical report, surveyed ground and ground water levels and forecast oscillation of the said level. The design prepared by the Contractor shall be submitted to Design Engineer and Engineer for their approval. The shuttering design shall secure the pit from surrounding structures and traffic. Tilting and lateral movement of shuttering in the course of placing shall be straighten at the Contractor's cost.

If the Contractor plans to remove the timber, the technological process shall be harmonized in a way that shall prevent damage of the particular structure in the course of removing. The Contractor shall cut the excessive length of shuttering upon the Engineer's approval in the course of foundation backfilling.

Sealing planks may be tongued and grooved. For the purpose of driving, at the point of impact, planks shall be provided with shoe and notched and trimmed top. Sizes of planks shall be defined by structural analyses and quality and class according to JUS U.D0.001.

For round and sawn timber, buckling shall be defined according to JUS u.C9.200. Quality shall be defined according to JUS U.D0.001 and allowable stresses according to JUS U.C9.400. In a case of water impermeable shuttering, joints shall be controlled and sequence in planks driving previously defined. Sheet-pile wall shall be driven deeper than foundation bottom for the height specified in the relevant hydraulic calculations.

13.2.6.2 Shuttering with wooden planks, steel piles and struts

Similar specifications as in 6.2.3.2.2 shall apply. Steel segments shall be sized according to JUS U.E7.081 and JUS U.E7.086. Wedges shall be made only of oak timber, category I. Steel-sheet piles for the purpose of strutting shall be made of rolled and cold formed steel sections.
Works covered by these technical specifications include providing of all material, facilities, equipment and workmen required for execution of works on placing of sheet-pile walls and shuttering of steel-sheet piles in dry and/or water environment as well as works referring to removal and/or cutting the piles, as stated in the design fully in accordance with contractual conditions and these technical specifications, relevant drawings and Engineer's instructions. For the

purpose of protection of foundation pits in the course of excavation, placing of subbase and all works referring to construction of foundation for bridge piers, construction of sheet-pile walls and/or shuttering made of steel-sheet piles shall be required. Type of steel-sheet piles shall be selected by the Contractor provided that thickness of the sheet-pile walls which one segment shall be built into the foundation as a protection against undercutting shall not be less than 9 mm. To improve adhesion, along the whole circumference of sheet-pile walls and/or shuttering which one segment shall be built into the foundation to the height of subbase and foundation footing crown shall be fitted with anchors welded as specified on drawings and cutting of steel-sheet piles after completion of foundation and piers shall be performed up to levels specified in the drawings (top foundation level), or as directed by the Engineer. In a case of sheet-pile walls and/or shuttering consisting of steel-sheet piles planned to be removed after completion of works, in the course of construction of subbase and foundation, the Contractor shall apply all relevant measures to prevent damage of the concrete cover. If he/she fails to apply the said measures and fails to remove the supports he/she shall cut them to the level specified by the Engineer, and costs for supports shall not be accepted. Prior to commencement of works on assembly of sheet-pile walls and/or support, the Contractor shall prepare relevant design fully in accordance with data stated in structural design, geotechnical report, surveyed ground and ground water levels as well as forecast of water level to be expected in the course of foundation construction. The Contractor shall submit the sheet-pile wall design to the Engineer for his/her approval. Prior to commencement of works, the Contractor shall mark and secure edges of sheet-pile walls and control the accuracy of driving. Steel-sheet piles not matching with the surrounding piles shall be removed and replaced. This is also referring to deformed and too short piles. Costs for replacing of damaged sheet-pile walls shall be borne by the Contractor. Movement and lateral displacement of sheet-pile walls and steel-sheet piles in the course of placing shall be straightened at the Contractor's cost so as adequate clearance can be provided, as stated in the design. If not otherwise specified by the Engineer, steel sheet piles shall be driven to the levels specified in drawings provided that top level of piles shall be for 50 cm higher than the adopted level of water expected during the works.

Measurement and Payment

Works shall be measured in square meters of outer vertical surfaces of shuttering and/or sheet-pile walls according to mean measure obtained by measuring the mean height obtained from the mean value of heights of four edge points, or according to the drawing. The measurement herein includes full compensation for all work, material and transport. Segments of shuttering exceeding measures herein and shuttering removed after concreting shall be the property of the Contractor. If works have not been separately measured, price of these works may be included into the price referring to excavation items, as stated in the contract.

13.2.7 Placing the sub-base made of gravel and sand in 30 cm thick layers under foundation including compaction of layers to modulus of compressibility Ms=30 MPa.

13.2.8 Construction of side/back walls

13.2.8.1 Scope and Contents of Works

Construction of side/back walls includes filling, spreading rough/fine leveling and compaction in 30 cm thick layers, fully as designed. All work shall be completed in line with the design, these Technical Specifications and SRPS U.E.010 – Earth Works in Road Construction.

13.2.8.2 Material

For construction of side/back walls, inorganic materials of specified quality shall be used.

Organic waste, roots, turf, i.e. material that would, in time, change its mechanical and physical properties due to biochemical actions, cannot be incorporated into side/back walls.

Material for construction of side/back wols can be obtained from cuts along the road route, borrow pits, and by dredging sand from the Sava/Danube rivers ’’on site’’ or from the stockpile of dredged sand.

13.2.8.2.1.Regulations for Control of Materials Quality

- SRPS U.B1.010 – Sampling
- SRPS U.B1.012 – Determination of Soil Moisture
- SRPS U.B1.014 – Determination of Bulk Density of Solid Particles
- SRPS U.B1.016 – Determination of Bulk Density
- SRPS U.B1.018 – Determination of Granulometric Composition
- SRPS U.B1.020 – Determination of Consistency Limits
- SRPS U.B1.024 – Determination of Combustible and Organic Matters
- SRPS U.B1.038 – Determination of Optimum Water Content
- SRPS U.B1.042 – Determination of California Bearning Ratio (CBR %)

Classification of materials, preliminary testing of materials and criteria for assessing quality of materials prior to incorporation will be performed fully in accordance with Items 3.4.1 – Earth Embankments.

13.2.8.3. Haulage, Filling and Compaction

The haulage and filling of materials over a prepared foundation soil may start only after the Engineer has approved the lower layers.
Filling shall be performed in 30 cm thick layers. The height (thickness) of every spread layer shall be in compliance with the tamping effect by depth of the used tamping device, type of fill material, and segregation occurrences.
Relevant testing, control and machinery adopting shall be performed for every type of material to be incorporated into an embankment.
Every layer of embankment shall be compacted with an appropriate mechanical device. All places inaccessible for machines, or places where the use of heavy tamping devices would be unsuitable for other reasons (filling behind structures, retaining walls, etc.) shall be tamped with other suitable devices or methods, the use of which shall be subject to the approval by the Engineer.
Moisture of material, filling conditions, and compaction shall be perfromed fully in accordance with the Item 3.4.1 – Earth Embankments.

13.2.8.4 Measurement
The quantity of incorporated material shall be measured in m3 of actually incorporated quantities within the project, excluding the topsoil layer on embankment slopes, but including the shoulder core, and as approved by the Engineer.

13.2.8.5 Payment
Quantities determined as per 13.2.8.4. shall be paid at agreed prices for 1 m3 of incorporated fill material.
The contract prices shall include all works on topsoil stripping, spreading, wetting or drying, compaction, construction of stepped cuts and fills, levelling of embankment slopes and shoulders with the accuracy of ±5 cm with respect to the designed embankment slopes, humification and grassing of slopes, and other works from this description, including all materials and labour, transport and haulage, and the Contractor shall have no right to claim any extra monies for the construction of embankments.

13.2.9 Placing 80 cm thick cover protecting a gravel wedge made of gravel sand where top 30 cm shall be stabilized with cement and bottom 50 cm compacted in two layers to modulus of compressibility Ms=40 MPa.

13.4.1.3 Placing of 10 cm thick sub-base blinding layer made of MB 15 concrete under foundations, head beams and crossing slabs.

13.11.6 Lining construction of composite crushed stone

The Item includes all work, material, equipment, and transport for lining made of crushed stone in a culvert.
Protective lining of culvert's bottom shall be made of composite crushed stone embedded in lean concrete, class MB20.
Protective lining shall be extended for 5 m on both upstream and downstream sides. This lining shall end by transverse sill.
If the water stream gradient does not exceed 5 %, joints shall be filled with concrete or cement mortar. If the gradient exceeds 5%, joints shall be 5-15 cm deep.

Quantity of material shall be measured in m3 of actually executed works according to dimensions stated in the design and as approved by the Engineer.
The unit prices shall include all work on lining construction and other related works together with all material, equipment and transport, and the Contractor shall have no right to claim any extra payment for embankment construction.

13.11.8 Underlays shall be made of mixed mortars provided that minimum strength shall be in compliance with the concrete, class MB45. Concerning the quality of used materials, provisions stated in these Specifications shall apply. Underlays shall be installed in a way that shall always enable presence of overpressure. Jointed principle or grouting may apply. Mortars shall be characterized with permanently increased volume of minimum 1%. Underlays exceeding 50 mm in thickness shall be additionally reinforced.

Within the works on installation of bearings, gutters and similar elements that require placing of underlay, the Contractor shall submit within the methodology of installation design all relevant evidences testifying that the mortar mix to be used as underly is in strict compliance with the required specifications. The said design together with detailed description of construction methodology shall be submitted to the Engineer for his/her approval.

13.11.9 Steel plates embedded into a girder at points where girders rest onto bearings.

13.11.15 "Fugeband" bands for ensuring the watertightness joint between two concrete members

The Item includes all work, material, equipment and transport to ensure the watertightness joint between two culvert members. ’’Fugeband’’ rubber bands for sealing of transverse joints in longer culverts cast in situ, shall be placed on outer sides of culvert walls toward the embankment. At the contact point between the two adjoining walls, 2 cm thick styrofoam board shall be placed. Joint in inner side toward the culvert opening shall be filled with plastic putty.

Payment will be done per m’ of completely performed work.

ENVIRONMENTAL PROTECTION DESIGN
DESIGN OF NOISE SUPRESSION STRUCTURES

10. ENVIRONMENTAL PROTECTION DESIGN

NOISE SUPPRESSION WALLS

10.(wall No.)03.01 i 10.(wall No.)06.01 PROCUREMENT AND ERECTION OF HEA 140 STEEL COLUMNS

Description of works
Columns for standard noise barriers shall be made of HEA, HEB or HEM steel (Euronorm 53-62).
Procurement and erection of HEA steel columns shall be fully in accordance with DIN1025, SRPS EN10025 and EN10327.
Nominal spacing between steel columns for standard noise barriers is:
- on embankments and already built structures – 4.00 or 5.00 m
- on new structures – 2.00 or 2.50 m

HEA steel columns for noise barriers on embankment shall be planted into prefabricated reinforced concrete foundation and positioned at 4.00 m centre-to-centre spacing.
HEA steel columns for noise barriers on bridges shall be positioned at 2.00 m centre-to-centre spacing and anchor plate will be used to connect steel column and bridge structure and/or concrete footway.
Steel columns shall be positioned vertically and in line. Column distortion, which can make difficult placing of members, is not allowed.
In order to achieve that steel columns are positioned vertically and in line, reinforced concrete members shall be placed prior to fixing the next steel column and afterwards absorption or transparent panels will be inserted between adjacent steel columns.
Measurement
Payment per kilogram (kg) of planted HEA steel columns.

10.(wall No.)04.01 PROCUREMENT AND INSTALLATION OF ABSORPTION PANELS

Description of works
Absorption panels used in construction of sound barriers shall satisfy the general criteria:
- to meet acoustic requirements
- to take into account traffic safety requirements
- to be structurally stable and to hold its shape
- to be resistant and protected against corrosion and degradation
- to be of adequate size
- to have constant colour shade
- to be fire resistant
- to be resistant to rockfall
- to be easy for maintenance

Size and composition of absorption panels shall fully meet the current standards and quality requirements (DIN 52210, DIN 52212, DIN 1725/1, ZTV-LSW 88, EN 1793/1794 etc.).
Absorption panels shall be stable in size and appropriate for safe placing. Limit values and tolerances of structural members and works shall meet standards for sound barriers. Hollow members shall be designed so that penetrated water can be quickly and completely drained. Water drainage shall not be aimed at

members placed one below the other and in case of a panel with tongue-and-groove joint water shall not be retained on upper members. In case of hollow members or absorbing subwalls, sound absorbing or isolating members shall be placed at spacing of minimum 2 cm from wooden or metal parts. Hollow space shall be airy although it does not apply to aluminium members resistant to salt water. Absorbing and isolating members shall be resistant to light, weather conditions, salting and rotting, hydrophobic and free of any material provoking corrosion.
Absorption panels shall meet requirements at least for B1 class of building materials according to DIN4102.
They shall be placed so that hold required position even after long time period. Absorption panels shall be inserted between adjacent steel columns.
Standard length of absorption panels for sound barriers on embankment is 3.96 m while standard height is 50 cm.
During demolition of absorbing panels standard procedures and technical specifications for each material shall be applied.
Measurement
Payment per one (pc.) absorption panel placed.

10.(wall No.)06.02. PROCUREMENT AND PLACING OF ANCHOR PLATES

Description of works
Connection between steel column and the bridge structure shall be enabled via steel anchor plate, sized as designed, quality S235JO (Č0362 according to SRPS.C.B0.500).
Steel plates are fitted with anchor bolts made of RA 400/500-2, Ø12, fully in accordance with detail shown on graphical documentation.

Measurement and Payment
Payment will be done per piece of installed steel anchor slab.

10.(wall No.)07.01 PROCUREMENT AND INSTALLATION OF TRANSPARENT PANELS

Description of works
Transparent panels planned to be used as sound barriers shall fulfil the following criteria:

- Acoustic requirements
- Safe traffic
- Maintain structural stability and shape
- Resistant and/or protected against corrosion
- Provided with relevant sizes
- Maintain the selected color tone
- Resistant to fire load
- Resistant to stone blows
- Resistant to vehicle impact
- Easy for maintenance

Sizes and composition of transparent panels shall be in strict compliance with applicable standards and quality requirements (DIN 52210, DIN 1725/1, ZTV-LSW 88, EN 1793/1794 and other).
Standard sizes of transparent panels to be used as sound barriers on bridge structures are L=1.96 m.
Standard height may exceed 2.0 m.
When transparent panels are planned to be used as sound barriers (acrylic glass, polycarbonates, standard or safety glass), transparency of plastic materials shall not get worse during their service life. They shall be specially protected against UV radiation and shall be resistant to scratches.
In the course of demolition of transparent panels, standard procedure and technical specifications for each material shall apply.

Measurement and Payment
Payment will be done per piece of installed transparent panel.

DESIGN OF TECHNICAL INFRASTRUCTURE
DESIGN FOR DISPLACEMENT AND PROTECTION OF 10kV I 1kV POWER CABLES

2. GENERAL AND TECHNICAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

2.1. GENERAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

The items in the Bill of Quantities and Cost Estimate include description, labour, material, machinery, tools, costs and company's profit for quality completion of each item.
All equipment shall be fabricated and all works executed according to applicable regulations and standards.

Execution of works

- Works shall be performed in strict accordance with the Design Documentation, the Contract and the "General and Technical Specifications for the Supply of Equipment and Execution of Works''.
- In the case of any discordance the Contractor shall duly request the Engineer's decision. Any design modification shall be supported by a written approval of the Designer and the Engineer. The Contractor shall organize the work to avoid interference with other contractors' performance on the site. The Contractor shall also pay all delays and damage inflicted to other contractors.
- The Contractor shall not assign the contract in full or in parts to any third party without the Employer's consent. The works shall be performed fully as specified in these conditions and other rules governing this kind of work. If during the performance some of these rules are modified, amended or new ones are passed the Contractor shall observe them without any compensation.
- The Contractor shall keep the structures and installations safe from mechanical damage, illegal use and the like, until final commissioning and issue of the final certificate.
- The Contractor shall perform the works (supply of materials included) not envisaged in the design documentation if they are necessary for proper functioning of a structure or for compliance with current regulations. The Contractor shall hand over the structure in proper order for operation
- These Technical conditions give only important general principles for quality performance. Everything else shall be subject to the relevant codes of practice listed in the design documentation.

Measurement and payment
The work shall be done in strict accordance with the approved design documentation and priced bill of quantities. Lists of materials, bills of quantities and detailed and other drawings shall constitute integral parts of the priced bill of quantities. The work shall be performed as directed by the Engineer and no alterations or important work phases (trial energizing and the like) may be done otherwise. The priced bill of quantities and conditions of contract award shall be integral parts of the contract document. The unit prices shall be the Contractor's selling prices and shall cover:

- Preliminary and final works for quality performance.
- Expenditures for the execution such as: labour, materials and waste, tools, formwork, scaffolds, costs of erection and dismantling, transport, overheads and other expenses allowed in the relevant regulation.

The work shall be performed in accordance with the tender documents, technical regulations and standards with the use of quality materials and skilled workforce, and shall be tested as specified.
Improper materials, which are not in compliance with the relevant technical regulations shall be removed from site by the Contractor and replaced with materials of good quality without entitlement to any compensation whatever.
If any work is performed with materials which do no comply with the technical conditions in the design documentation or with the Engineer's instructions the Contractor shall perform them at his own cost without any compensation whatsoever.
If the design documentation is incomplete or inaccurate the Contractor shall duly request its amendment and interpretation. Any costs of redesign or demolition due to the Contractor's failure to comply shall be borne by him and the Contractor will not be entitled to any compensation or time extension.
Upon completion of all the works or if directed by the Engineer in the course of phases, the Contractor shall make the prepare the structure for use and backfill and level off trenches and holes, clean buildings, installations, appliances and components of the equipment installed.
All these works shall be covered by the main items and will not be paid for separately.
The Contractor shall keep the completed plant, installations, appliances and components in order, clean and fully safe until commissioning. This shall be covered by unit price.

Supply of materials
The materials for the contracted works shall comply with SRPS standards but if these are not available then with other approved standards governing various kinds of materials. Each consignment shall be accompanied with test certificates on compliance.
The mechanical and electrical parameters of the equipment shall be confirmed by type and series tests. Each component shall bear indelible marks identifying the Manufacturer and the technology. The Contractor shall have responsibility for the materials used and unused and for the performance until take-over and issue of the final certificate.

2.2. TECHNICAL REQUIREMENTS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

01.01.01.; 02.01.01;03.01.01;
Dismantling of the existing 10 kV and 1 kV masts

Description of works
The Contractor shall dismantle the existing masts indicated in the graphic documentation. The dismantled masts shall be handed over to the User or Employer in his warehouse. The masts shall be carefully dismantled, transported to distance of 5 km and stored to enable their reuse, if any. The Contractor, Engineer, Employer and User shall jointly determine the state of equipment to be dismantled, storing method and location, its further treatment and status. During dismantling care shall be taken neither to endanger human safety and property nor to affect stability of surrounding structures. The masts can be dismantled only when voltage is permanently switched off.

Measurement and Payment
Payment will be done per one dismantled mast.
01.02.01;
Dismanling of equipment installed on 10 kV mast

Description of works
The Contractor shall dismantle the equipment installed on the masts to be dismantled. The dismantled equipment shall be handed over to the User or Employer in his warehouse. The equipment shall be carefully dismantled, transported to distance of 5 km and stored to enable its reuse, if any. The Contractor, Engineer, Employer and User shall jointly determine the state of equipment to be dismantled, storing method and location, its further treatment and status. During dismantling care shall be taken to keep equipment in a good state and neither to endanger human safety and property nor to affect stability of surrounding structures. The equipment can be dismantled only when voltage is permanently switched off.

Measurement and Payment
Payment will be done per completely dismantled 10 kV equipment installed on one 10 kV mast

01.02.02.; Delivery and erection of new steel lattice mast

Description of works
Delivery and erection of new 12/1900 steel lattice mast fully in accordance with erection plan submitted by the Supplier. The mast is 660 kg in weight. The mast shall be delivered together with adequate cantilevers for tensioning and semi-vertical allocation of conductors inside the column head and all required supports for the equipment to be mounted onto the column.

Payment
Payment will be done per piece, complete materaial and work.

01.02.05 ; Delivery, placing and tensioning of s Al/Č 3h50/8 mm2 wire onto the newly-designed steel lattice masts

Description of works
The Contractor shall deliver, place and tension the wire onto the newly-designed steel lattice masts.

Payment
Payment will be done per m of delivered and placed wire.

01.02.06; Control of executed works

Description of works
Control of executed works, all required tests together with issue of relevant certificates and putting into operation.

Measurement and Payment
Payment will be done in lump sum.
01.02.07; Switching off the voltage and securing the site

Description of works
When displacing the existing cable lines, voltage shall be switched off and the site properly secured. The Contractor shall agree with the competent Power Distribution Company to switch off the voltage and secure the site.

Measurement and Payment
Payment will be done per account issued by the competent Power Distribution Company.

DESIGN FOR DISPLACEMENT AND PROTECTION OF 35kV TRANSMISSION LINE

2.1. GENERAL REQUIREMENTS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

The items in the Bill of Quantities and Cost Estimate include description, labour, material, machinery, tools, costs and company's profit for quality completion of each item.
All equipment shall be fabricated and all works executed according to applicable regulations and standards.

Execution of works
• Works shall be performed in strict accordance with the Design Documentation, the Contract and the "General and Technical Specifications for the Supply of Equipment and Execution of Works''.
• In the case of any discordance the Contractor shall duly request the Engineer's decision. Any design modification shall be supported by a written approval of the Designer and the Engineer. The Contractor shall organize the work to avoid interference with other contractors' performance on the site. The Contractor shall also pay all delays and damage inflicted to other contractors.
• The Contractor shall not assign the contract in full or in parts to any third party without the Employer's consent. The works shall be performed fully as specified in these conditions and other rules governing this kind of work. If during the performance some of these rules are modified, amended or new ones are passed the Contractor shall observe them without any compensation.
• The Contractor shall keep the structures and installations safe from mechanical damage, illegal use and the like, until final commissioning and issue of the final certificate.
• The Contractor shall perform the works (supply of materials included) not envisaged in the design documentation if they are necessary for proper functioning of a structure or for compliance with current regulations. The Contractor shall hand over the structure in proper order for operation
• These Technical conditions give only important general principles for quality performance. Everything else shall be subject to the relevant codes of practice listed in the design documentation.

Measurement and payment
The work shall be done in strict accordance with the approved design documentation and priced bill of quantities. Lists of materials, bills of quantities and detailed and other drawings shall constitute integral parts of the priced bill of quantities. The work shall be performed as directed by the Engineer and no alterations or important work phases (trial energizing and the like) may be done otherwise. The priced bill of quantities and conditions of contract award shall be integral parts of the contract document. The unit prices shall be the Contractor's selling prices and shall cover:
• Preliminary and final works for quality performance.
• Expenditures for the execution such as: labour, materials and waste, tools, formwork, scaffolds, costs of erection and dismantling, transport, overheads and other expenses allowed in the relevant regulation.
The work shall be performed in accordance with the tender documents, technical regulations and standards with the use of quality materials and skilled workforce, and shall be tested as specified.
Improper materials, which are not in compliance with the relevant technical regulations shall be removed from site by the Contractor and replaced with materials of good quality without entitlement to any compensation whatever.
If any work is performed with materials which do no comply with the technical conditions in the design documentation or with the Engineer's instructions the Contractor shall perform them at his own cost without any compensation whatsoever.
If the design documentation is incomplete or inaccurate the Contractor shall duly request its amendment and interpretation. Any costs of redesign or demolition due to the Contractor's failure to comply shall be borne by him and the Contractor will not be entitled to any compensation or time extension.
Upon completion of all the works or if directed by the Engineer in the course of phases, the Contractor shall make the prepare the structure for use and backfill and level off trenches and holes, clean buildings, installations, appliances and components of the equipment installed.
All these works shall be covered by the main items and will not be paid for separately.
The Contractor shall keep the completed plant, installations, appliances and components in order, clean and fully safe until commissioning. This shall be covered by unit price.

Supply of materials
The materials for the contracted works shall comply with SRPS standards but if these are not available then with other approved standards governing various kinds of materials. Each consignment shall be accompanied with test certificates on compliance.
The mechanical and electrical parameters of the equipment shall be confirmed by type and series tests. Each component shall bear indelible marks identifying the Manufacturer and the technology. The Contractor shall have responsibility for the materials used and unused and for the performance until take-over and issue of the final certificate.

2.2. TECHNICAL SPECIFICATIONS FOR DELIVERY OF EQUIPMENT AND EXECUTION OF WORKS

2.7; Dismantling of the existing 35 kV masts and equipment installed on 35 kV masts

Description of works
The Contractor shall dismantle the existing 35 kV equipment installed on 35 kV masts to be dismantled (the masts are indicated on drawings). The dismantled equipment shall be handed over to the User or Employer in his warehouse. The equipment shall be carefully dismantled, transported to distance of 5 km and stored to enable its reuse, if any. The Contractor, Engineer, Employer and User shall jointly determine the state of equipment to be dismantled, storing method and location, its further treatment and status. During dismantling care shall be taken to keep equipment in a good state and neither to endanger human safety and property nor to affect stability of surrounding structures. The equipment can be dismantled only when voltage is permanently switched off.

Measurement and Payment
Payment will be done per complete work. (complete work means dismantling of one 35 kV mast and equipment installed on one 35 kV mast).

2.6. Earthing of 35 kV mast

Description of works
Earthing of 35 kV mast. The item includes earth excavation, procurement and installation of earth electrode. The excavated channel shall be protected during backfilling. The earth electrode shall be made of galvanized iron, Ø10 mm. Zinc coat for earth electrode shall be minimum 70 µm thick. Underground joints shall be protected against moisture penetration by grouting with bitumen.
Measurement and Payment
Payment will be done per one earth electrode fully installed on 35 kV mast

4 . Delivery of designs for masts with foundations and lists of mast support points

Description
The Contractor shall order from the manufacturer the final designs of applied masts including detailed description of mast construction with all necessary technical details (exact dimensions and weights, details for fixing flag brackets, connecting pieces, etc.). The Final mast designs include detailed instruction for mast erection and foundation method.
Measurement
Payment per quantity of delivered standard mast designs.

DESIGN FOR DISPLACEMENT AND PROTECTION OF THE EXISTING TELECOMMUNICATION NETWORK

Missing technical specifications for some items in the Bill of Quantities

12.5.01.13, 12.5.02.11, 12.5.03.11, 12.5.04.10, 12.5.05.10, 12.5.06.08, 12.5.07.10
DETECTION OF THE EXISTING CABLE ROUTE BY CABLE DETECTOR
Description
Certified device shall be used for detection of the existing cable route and prescribed safety at work measures respected.
Measurement per meter of length.

12.5.05.15 SEALING OF PIPES WITH CONCRETE
Description
Sealing of transverse telecommunication cable conduit under the road with 3-5 cm thick layer of lean concrete MV-20 in width of 30 cm.
Measurement per meter of length.

12.5.01.19, 12.5.02.18 PLUGGING OF Ø40 mm PIPE
Description
The pipes shall be closed with specified plugs according to the relevant ZJPTT regulations. Take account of preventing penetration of water, earth and rodents prior to plugging.
Measurement per piece.

12.5.03.17, 12.5.04.16 PLUGGING OF Ø110 MM PIPE
Description
The pipes shall be closed with specified plugs according to the relevant ZJPTT regulations. Take account of preventing penetration of water, earth and rodents prior to plugging.
Measurement per piece.

12.5.01.23, 12.5.02.22 STRAIGHT CABLE JOINT ON OPTIC CABLE IN THE TRENCH
Description
Straight cable joint (in trench) shall be made according to the relevant ZJPTT regulations. Cable joint location shall be georeferenced and entered into the As-built design.
Measurement per piece.

12.5.01.27, 12.5.02.28, 12.5.03.21, 12.5.04.20, 12.5.05.21, 12.5.06.17, 12.5.07.20
GEODETIC SURVEY AND MAPPING
Description
Geodetic survey shall be performed according to ZJPTT regulations and professional rules. Survey shall be verified and approved by TELEKOM SRBIJA a.d. Company.
Measurement per meter of length.

12.05.01.26, 12.5.02.27, 12.5.03.20, 12.5.04.19, 12.5.05.20, 12.5.06.16, 12.5.07.19
PREPARATION OF AS-BUILT TECHNICAL DOCUMENTATION
Description
Preparation of as-built technical documentation.
Preparation per set.

12.5.02.24 CONECTING OF NEW RE PIPES Ø40 AND THE EXISTING ONES
Description
Connecting of the planned RE pipes ø40 and the existing ones. All required works and small instalation material included.
Measurement per meter.

12.5.02.23 DISMANTLING OF UNDERGROUND CABLE
Description
Dismanling of the existing telecommunication cable and disposal of dismantled material to the safe place and commisioning to the Employer.
Measurement per meter.

12.5.02.14, 12.5.03.14, 12.5.04.13, 12.5.05.13, 12.5.07.13,
PLACING COMBS INSIDE THE TRENCH
Description
Combs shall be placed according to ZJPTT regulations. Special attention shall be paid to levelling and stability.
Measurement per piece.

DESIGN FOR DISPLACEMENT AND PROTECTION OF THE EXISTING WATER PIPES

12.7/7.02.06 Positions does not contain any additional description

12.7/7.03.00. INSTALLATION WORKS

12.7/7.03.01. PROCUREMENT, TRANSPORT AND ASSEMBLY OF PIPES

Description of works
Procurement, transport, distribution along trench and laying of water pipes into trench as designed. Pipes shall be carefully laid on a sand bed and aligned to designed line and grades. Work shall proceed fully as specified in the technical regulations for this type of pipes, drawings and the Engineer’s instructions.
The price shall cover material, waste, distribution of pipes along trench, inspection of each pipe and joint, lowering on sand bed and joining.

Material
- Pipes for low pressure of 10 bar.
- Ø90 mm (DN90) (HDPE-100)

Measurement and Payment
Payment will be done per m’ of completely assembled pipes.

12.7/7.03.02. CAST IRON PIPE FITTINGS

Description of works
Cast iron pipe fittings for low pressure of 10 bars. Procurement, transport, distribution along and installation of pipe fittings into trench. Installation shall be made according to installation plan (for nodes). All flange joints out of manholes shall be coated with bitumen after completion of trial pressure test.

Measurement and Payment
Payment will be done per kg of completely installed pipe fitting.

12.7/7.03.03. POLYETHYLENE PIPE FITTINGS

Description of works
Polyethylene pipe fitting for low pressure of 10 bars. Procurement, transport, distribution along and installation of pipe fittings into trench. Installation shall be made according to installation plan (for nodes). All flange joints out of manholes shall be coated with bitumen after completion of trial pressure test.

Material
PEHD PE100

Measurement and Payment
Payment will be done per one completely installed pipe fitting.

12.7/7.03.04. EURO 20 VALVES

Description of works
EURO 20 valves (type 21). Procurement, transport and installation of wheel valves in manhole and valves with set of accessories out of manhole for operation pressure of 10 bars. After installation the valves shall be controlled and properly tested. All works shall be performed according to design documentation, current regulations for this type of works and the Engineer instructions.

Material
- EURO 20 Ø 80 mm

Measurement and Payment
Payment will be done per one completely installed valve.

12.7/7.03.05. CAST IRON LIDS

Description of works
Cast iron lids. Procurement, transport and fitting of cast iron lids for manholes of 625 mm, SRPS M.J6.226. Installation shall be performed according to design documentation and the Engineer’s instructions.

Measurement and Payment
Payment will be done per one installed lid.

12.7/7.03.06. CAST IRON RUNGS

Description of works
Procurement, transport and installation of cast iron rungs, SRPS M.J6.285.

Measurement and Payment
Payment will be done per one installed rung.

12.7/7.04.00. PLAIN AND REINFORCED CONCRETE WORKS

For plain and reinforced concrete mentioned in this part of documentation the following will apply:

Material
The following applies to all items: works on concrete and reinforcement shall be performed fully in accordance with design documentation, structural analysis and current codes.
Concrete will be mixed, transported, placed and tested on test sample according to provisions of the Code of Technical Standards for Plain and Reinforced Concrete - PBAB 87 – Official Gazette of the SFRY, No. 11/87. Concrete mix will consist of aggregates and cement certified according to the current Serbian regulations. Concrete shall be mixed mechanically and compacted by vibration. The price of concrete includes formwork and scaffold. Measurement includes all works, materials, auxiliary tool, placing and curing of concrete and other company’s costs and income.
Payment of fully completed work per m³ of placed concrete. Reinforcing bars shall be paid separately. The bars shall be free from rust and dirt, bent and fixed according to reinforcement drawings. Unit price of reinforcing bars includes placing of pads to achieve specified covers and proper position of reinforcing bars in the structure. All distribution steel and stirrups shall be firmly fixed to the main reinforcement to secure their proper position.
The Contractor is responsible for a quality of fixed reinforcing bars. Payment per kg of fixed bars regardless of complexity and reinforcing bar diameter according to tabulated weights.

12.7/7.04.01. LEAN CONCRETE BEDDING

Description of works
Lean concrete, class MB15, 10 cm thick, under the bottom plate of manholes and inspection shafts.

Measurement and Payment
Payment will be done per m³ of placed concrete, class MB15.

12.7/7.05.00. SUNDRY WORKS

12.7/7.05.04. GEODETIC SURVEY

Description of works
As-built survey. After laying of water pipes and prior to backfilling, pipelines, hydrants, manholes, house drains and other facilities in the network shall be surveyed.
After completion of survey, the As-built report shall be prepared and delivered to the Employer.
Payment per m’ of surveyed pipeline.

Measurement and Payment
Payment will be done per m’ of surveyed pipeline.

CIVIL ENGINEERING DESIGN OF TELECOMMUNICATION CABLE CONDUIT

INTRODUCTION
The Technical specifications describe in detail particular parts of the design, requirements for the execution of works and quality of performed works.
If this Technical specification does not cover some work, or does not define quality, testing of materials, safety or health and hygiene provisions, then relevant laws, rules, regulations, and standards shall apply. All works shall be performed in compliance with technical specifications, reviewed and verified designs and here mentioned laws, rules and standards.
These technical specifications will be applied to all civil works. General and special provisions given with the Bill of Quantities are integral part of these Technical specifications.

08.02.01.01.02 Positions does not contain any additional description

08.02.01.04.01. BRICKWORK

Building shall be carried out by qualified workers fully as stated in the current technical regulations and the Code of practices in civil engineering.
Brickwork shall exactly follow the plans; bricks shall be properly bonded in horizontal rows without pieces smaller than 1/4 of brick and such pieces shall not be laid one next to the other in a wall.
Vertical and horizontal joints shall be filled with mortar free of voids. Mortar in joints shall not be thicker than 10 - 12 mm. Outer joints shall be left empty by 15-20 mm to allow good bond during wall rendering.
Mortar escaping from joints still fresh shall be removed with trowel and wiped with hessian cloth.

Care shall be taken during wall building of the following:
- To align designed bonds in brickwork consistently and accurately over the whole wall area,
- To cut bricks with a machine, if necessary,
- To make joint strictly horizontal and/or vertical and continuous in width.

Measurement per m2 or m3, which will be defined in the Bill of Quantities.

08.02.01.05. MISCELLANEOUS

Waterproofing of concrete faces in contact with earth shall be meticulously and accurately done according to the design requirements, bill of quantities and detailed drawings.
Used materials shall conform to the current standards and regulations, shall be accompanied with test certificates of accredited institutions, verified in use, durable same as the structure itself or designed to be replaceable.
Measurement per m2 of coated area with all consumed quantities of materials, transport and labor. Unit price shall be as described above in this item per m2.

08.02.01.05.01. WATERPROOFING

General provisions

The work shall be of good quality strictly according to designed detail. Waterproofing shall be done by qualified manpower with appropriate tools and materials, properly procured and stored complying to technical regulations, codes of practices and SRPS standards. The works only that will be executed properly and have the quality specified, requested or commonly expected in the regulations and design shall be measured.
Prior to the commencement of works the Contractor shall submit test certificates to the Employer for all materials he intends to purchase and use. Test certificates shall be issued by accredited institutions for this kind of works and shall not be older than one year counting from the date of their issue to the date of commencement of the works by the Contractor.
The contracted waterproofing items shall be performed according to the design drawings based on which the Contractor will prepare construction details and method statement for the whole structure or certain phases of the works, to be inspected by the Supervising Engineer and Designer. The Contractor shall be fully professionally and legally responsible for the above if the Designer or the Employer accepts his proposal as a better one than the design concept. The Waterproofing Contractor is particularly warned to pay full consideration to the following:
- Waterproofing may be done only in accordance with technically correct details, relevant regulations, instructions and by a verified, proper and usual method of work at the weather suiting them or with adequate protection in case of sudden weather changes or storm.
- Civil, finishing and other works preceding application of waterproofing layers or phases and either associated with them or in any other way depending on them technologically, and those works whose synchronized or later execution may cause damage to waterproofing shall be done in advance of the above, namely in an appropriate sequence agreed and approved.
- Performance of the civil, finishing and other works that may affect the quality, safety and durability of waterproofing shall be checked before it is commenced. The Waterproofing Contractor shall duly inform in writing the Main Contractor about his needs and the latter shall submit this report to the Supervising Engineer to inspect it together with other relevant procedures in the technology of works that usually precede waterproofing.
- All materials to be used shall be sound in every respect.
- Unsound materials (damaged, stuck together or failing to be of appropriate specified quality) shall not be stored, kept on site or placed.
- Waterproofing shall be done in the way that its segments and layers as well as finished items fully conform to use, quality requirements, safety and durability.

Prior to starting any contracted waterproofing item, the base surface shall be dedusted and carefully and well cleaned from all dirt, loose dust particles, possible stains of oil, grease, acids etc. If these are not cleaned and removed they may form an interim layer between base and waterproofing and prevent a good bond. The base shall be if possible blown with compressed air and washed with a solution of caustic soda and water and some other efficient and approved agent.

08.02.01.05.02. FITTING OF LIDS

The following lids are used to cover manholes of telecommunication cable conduit:
- Light (~130 kg) for manholes in pavement and grassland
- Heavy (~280 kg) for manholes in pavement

The lids enable easy access to the manhole, more favorable bending diameter of telecommunication cables and manhole inspection. The lid shall prevent penetration of water and dirt into a cable conduit in case of precipitation and street washing.
The lids consist of the following elements:

Light lid:	- frame
	- plate (cover)
	- rubber seal
Heavy lid:	- frame
	- outer plate (cover)
	- plate (cover)
	- rubber seal

A frame shall be made of gray cast iron which quality shall comply to SRPS C J2.020/73.
A frame shall be even without any distortion, rectangular, with clean edges and grooves so that all plates uniformly rest on the frame without rocking. A groove with a rubber seal shall be conical, of uniform depth and width.
Lid plates shall be made of grey cast iron which quality shall comply to SRPS C J2.020/73. The plates shall be square without any distortion, with clean edges and appropriate number of adequately located ribs on the bottom side. Top plates shall withstand live load without any damage as follows:
- 12.5 t for plates in grassland and sidewalk
- 25 t for plates in pavement

To prevent slipping, the plate top surface shall have checkered-relief pattern. Sealing rubber shall be without neoprene-based textile insert.
The manufacturer shall complement, sort out and test a quantity prepared for delivery in accordance with these technical specifications and make a test book. The manufacturer shall have a test certificate issued by the authorized institution for tests which cannot be performed in the factory. Fabrication and dimensions shall be checked visually and by measuring dimensions according to documentation and with testing plate seat in the frame and the way plate opens and seals.
Cast iron lid shall be fitted to each manhole – light lid for manhole in sidewalks and heavy lid for manholes in pavement. The lid shall be mounted at height of 0.5 cm above the sidewalk and pavement level but in case of earth surface it will be mounted at height of 1 cm above the ground level. The lid seat shall be concreted with 1:4 mix of cement and gravel.

08.02.01.05.03. FUNNEL-LIKE OPENINGS

Funnel-like openings for pipes in the manhole wall shall be made for whole pipe profile with canted sides. All pipes shall be of same length i.e. aligned for easy mortaring.

08.02.01.05.04. MOUNTING OF CABLE AND CANTILEVER SUPPORTS

Cable supports shall be mounted on walls in telephone manholes and galleries to support cables which are laid there. The supports shall enable easy mounting and safe support of cables and joints. The cable supports consist of one or more components.
Simple support consists of a cantilever and shoe. The cantilever shall be made of appropriate steel section (pipes, Ø section, L section, T section, U section) of specified quality to support cables in manholes and galleries. One cantilever end shall have suitable shape to be mounted directly on the wall or fixed and/or screwed into seat previously placed onto wall. The other cantilever end shall be suitable finished with rounded edges to prevent cable damage of worker injury. Cantilever seat shall be made of steel sheet or casting and have suitable shape to fix or screw the corresponding cantilever. A shoe shall be flexibly mounted to ensure cable laying along the as large as possible surface. A base shall be made of a steel section of specified shape and quality and to enable easy mounting, fixing or screwing of cantilevers.
The manufacture shall complement and test a quantity of cable supports prepared for delivery and make a test book. Fabrication shall be checked by visually inspection of surfaces, complementing and marking while dimensions will be gauged in the appropriate way. The quality of used materials shall be controlled by insight into the factory test certificates and if they are not available, then by laboratory tests.
The lowest row of supports shall be mounted at height of 0.3 m above the ground level while the highest row can be at 0.3 m below the manhole ceiling. Spacing between rows can be 0.3 – 0.5 m. Spacing between supports depends on number and design of cables and can be 0.8 – 1.2 m.

DESIGN FOR DISPLACEMENT AND PROTECTION OF LINESIDE CABLES
12.09.01.02.18, 12.09.01.02.19, 12.09.01.02.20, 12.09.01.02.21, 12.09.01.02.22, 12.09.02.02.17, 12.09.02.02.18, 12.09.02.02.19 12.09.02.02.20 12.09.02.02.21 12.09.03.02.14, 12.09.03.02.15 12.09.03.02.16, 12.09.05.02.17 12.09.05.02.18 12.09.05.02.19 12.09.05.02.20, 12.09.05.02.21, 12.09.06.02.16 12.09.06.02.17 12.09.06.02.18 12.09.06.02.19

COPPER CABLE SPLICING IN A TRENCH

Description
Copper wires in cables shall be spliced by twisting. 0.8 mm diameter and thicker wires shall be soldered. The splices shall be insulated with small paper tubes
Splices in the form of single or multiple wire connectors and multiple modules will be permitted only if explicitly envisaged in the Technical description or specifically directed by the Engineer
Capacitive coupling shall be made for the purpose of crosstalk attenuation in low frequency range as described in the Technical description. Loading coils shall be inserted to reduce pair attenuation in low frequency range

12.09.01.02.14, 12.09.01.02.22.01, 12.09.01.02.23, 12.09.01.02.24, 12.09.01.02.25, 12.09.01.02.26, 12.09.01.02.27, 12.09.01.02.28, 12.09.01.02.29, 12.09.01.02.30, 12.09.01.02.31, 12.09.01.02.37, 12.09.01.02.38, 12.09.02.02.13, 12.09.02.02.22 , 12.09.02.02.23, 12.09.02.02.24, 12.09.02.02.25, 12.09.02.02.26, 12.09.02.02.27, 12.09.02.02.28, 12.09.02.02.29, 12.09.02.02.30 , 12.09.02.02.36 , 12.09.02.02.37, 12.09.03.02.16.01, 12.09.03.02.17, 12.09.03.02.18, 12.09.03.02.19, 12.09.03.02.20, 12.09.03.02.21, 12.09.03.02.22, 12.09.03.02.23, 12.09.03.02.24, 12.09.03.02.25, 12.09.03.02.31, 12.09.03.02.32 Technical specifications for above mentioned Items are given in BoQ.

LANDSCAPING DESIGN

LANDSCAPING

GENERAL SPECIFICATIONS FOR LANDSCAPING

14.01.01. 14.01.02. 14.01.03. 14.01.04. 14.01.05. 14.01.06. LANDSCAPING WORKS

Description of works

Seedlings shall be planted in autumn when growing period is completed or in spring before the start of growing period.

Planting material shall be cultivated in the nursery-garden and properly developed with undamaged root system and aerial part without any entomological or phytopathological disease.

Planting material shall be picked from the nursery-garden and transported immediately prior to planting in permanent place.

If planting is not possible on the spot, planting material transported without baled turfs shall be stored in a clamp at once.

Fertilization with humus-peat fertilizer or well burned two-year manure shall be performed in the following way: at first, specific fertilizer quantity shall be mixed with humus earth and spread around and over the root system at the time of planting.

At the time of planting, seedlings shall be oriented toward marked cardinal point (north) to be at same position as in the nursery-garden thus enabling proper further growing.

Seedlings of deciduous trees shall be fixed by rubber clips with raffia strings or figure-of-eight rope to a stick of specified height with rounded top placed vertically to dominant wind direction prior to covering up the turfs in order to avoid root system damage.

Planting depth and/or position of root tip shall be by 2-3 cm below the level at which a seedling was during cultivation in the nursery-garden. It is expected that earth will be settled to a level of the root neck after planting and watering.

A seedling shall be permanently fixed to a stick 2-3 days after planting and/or settling of earth around the planted seedling.

Coniferous trees shall be anchored in three directions with pegs, wire and rubber clips placed around the tree.

After planting, the ground around seedlings of all vegetation categories shall be adequately prepared to ensure proper watering.

Each planting pit shall be cylinder-shaped with different diameter and depth depending on category:

High conifers	1.0 x 1.0 m2
Middle-high and low conifers	0.8 x 0.8 m2
High deciduous trees	1.0 x 1.0 m2
Middle-high and low deciduous trees	0.8 x 0.8 m2
Shrubs and climbing plants	0.4 x 0.4 m2

For different categories of planting material, each pit requires the following quantities of peat fertilizer:

For high conifers	20 kg
For middle-high and low conifers	10 kg
For high deciduous trees	25 kg
For middle-high and low deciduous trees	15 kg
For shrubs and climbing plants	3-5 kg

Measurement

Measurement will be done per one seedling.

14.02.01. MAINTENANCE OF VEGETATION

Description of works

After complete cultivation of green areas they shall be intensively nurtured and maintained in order to facilitate adaptation of seedlings to the new environment and ensure quick growth and biologically strong vegetation.

In order to meet seedling needs and achieve the above-mentioned, the following shall be performed:

- Pruning the hedge
- Hoeing the seedlings of trees, shrubs, roses and hedge
- Grassland weeding out
- Grassland mowing, raking and rolling
- Watering of grassland and seedlings
- Nutrition and landscaping of flower gardens, change of seasonal flowers, weeding, hoeing, watering, etc.

Vegetation maintenance value is about 20% of landscaping amount for 1 (one) calendar year. Maintenance shall start from the day of technical inspection.

Planted material shall be maintained from the very beginning and the above stated percent serves for provision of financial resources for maintenance till acceptance of works.

During the defect liability period the Contractor shall eliminate at his expense all defects caused by unprofessionally performed works or planting of low-quality vegetation.

Measurement

About 20 % of the landscaping investment value shall be measured.

SPECIAL SPECIFICATION – LOT 2

Content:

PAVEMENT STRUCTURE DESIGN

AS-3.4. CONSTRUCTION OF PAVEMENT SUBGRADE

AS-3.4.1. Subgrade

AS-3.4.1.1 Description

Subgrade planned to be constructed on the MAIN ALIGNMENT of the studied highway section shall be made of stone aggregate from the borrow pit along the alignment. Research for the purpose of the studied design has shown that the material is acceptable for pavement subgrade and therefore applicable for use on the primary traffic ridden areas.
The design thickness of the subgrade course shall be d = 70 cm. The course shall be composed of two sub-layers.

AS-3.4.1.2. Material for Subgrade Construction

Pure rock material free of adverse admixtures such as: clay particles, altered aggregate grains and rock massif parts prone to fragmentation, shall be used. It is also necessary to meet the requirement asking to avoid use of other material for subgrade construction without the prior approval of the Design Engineer.
Criteria applied in material feasibility analysis shall be also applied in feasibility evaluation on the site.

AS-3.4.1.3. Construction

Stone aggregate shall be placed mechanically into the subject course. Manual placing shall be accepted only locally, on spots approved by the Engineer.
Stone aggregate shall be supplied to the site by appropriate means.
Any correction of aggregate grading on the site, i.e. on the placing location shall be approved by the Engineer fully in accordance with relevant results obtained in preliminary tests.
The water quantity required for attaining of optimal aggregate moisture for better compaction shall be introduced uniformly into the aggregate volume at the supply location.
If water shall be added on placing location, then water shall be dosed in a way to escape washout of small fractions. The allowable deviation of optimum moisture shall be maximum □ 2m.-% during the course of compacting.
Spreading of stone aggregate shall be performed mechanically in layers not exceeding 35 cm in thickness. Spreading shall be performed on the same day as wetting.
Compacting shall be performed from the lower edge towards the higher edge of the course. Number of passes of appropriate compacting devices, previously determined on the trial section, shall be checked by testing within the regular control of density, i.e. compactness of the placed stone aggregate.
Any irregularity identified in the course of compacting shall be corrected, as directed by the Engineer.
Prior to completion of compaction, bearing capacity of the placed course shall be measured.
If values specified in the design documentation are not obtained, the Contractor shall assure the placed course quality by performing the additional actions.
The compacted course shall be provided with levels, width and gradient, as stated in the Design.
If the Contractor would temporary store stone aggregate fractions prior to placing into the subject course, then the stockpiling area shall be previously prepared in adequate manner (leveled, strengthened and drained).

AS-3.4.1.4. Testing Standards

Testing of physical and mechanical properties of subgrade material shall be performed fully in accordance with standards listed below:

SRPS EN 1097 2	Testing of Stone and Aggregate Resistance Against Abrasion by Los Angeles Method
SRPS B.B8.037	Determination of Frail Grains in Coarse Aggregate
SRPS U.B1.018	Determination of Grain Size Distribution and Determination of 0.08 mm Particles by Aerometry (or applying SRPS B.B8.036)
SRPS B.B8.036	Determination of Particles Passing the Sieve 0.02 mm (procedure stated in this SRPS Standard shall apply)
SRPS B.B8.038	Clay and Mud Contents
SRPS U.B1.042	Determination of California Bearing Ratio
EN 933 8	Sand Equivalent
NF P 94 066	Coefficient de fragmentabilite des materiaux rocheux
SRPS EN 1744-1	Organic Admixtures Participation

AS-3.4.1.5. Criteria For Subgrade Material Quality Evaluation

The stone material to be used for subgrade construction shall meet the following requirements:
• Maximum grain size shall not exceed 75 mm,
• Coefficient of fraction resistance to crushing determined by Los Angeles Method(EN 1097-2) shall not exceed 45 % (category LA45)
• Fragmentability coefficient of stone material specified according to NF P 94-066 standard (Coefficient de fragmentabilite des materiaux rocheux) shall be FR ≤ 7 on sample tested at natural moisture.
• Organic admixtures content in stone aggregate shall not color the 3% solvent of sodium deposit darker than reference color (test as per EN 1744-1).
In addition, material to be incorporated into subgrade course shall also meet the following criteria:
• Plasticity index of possible present fine grains (smaller than 0.425 mm) shall be less than Ip< 6%
• Sand equivalent shall be minimum 60, ES ≥ 60 (according to EN 933-8).

AS-3.4.1.6. Control of Constructed Subgrade

Control of Material

Material shall be in strict compliance with the above specifications and required quality.

Bearing capacity
Control of bearing capacity shall be performed as follows:
• Measuring modulus of deformability by circular plate method - SRPS U.B1.047 :1997
• Measuring deflection of the subgrade surface by Benckleman beam or deflectometer with falling weight.

Required bearing capacities
Criteria for bearing capacity control by measuring the modulus of deformability by circular plate method depend on type of material identified in the road body. According to this, the following criteria have been stated in the original design:

Embankment and subgrade composed of „uncontaminated" detritus

If embankment and subgrade are to be constructed of material that satisfies criteria stated in Item 3.4.1.5. of these Technical Specifications, then the said material so-called „uncontaminated" detritus shall be incorporated into two layers provided with overall thickness as shown on Figure 1 of these Technical Specifications.

Subgrade of stone material that satisfies criteria stated in Item 3 .4.1.5. d = 2 x 35 cm

Road bed composed of „uncontaminated" detritus
Figure 1. Layout of subgrade composed of „uncontaminated" detritus

In the course of construction, the required bearing capacity shall be as follows:
Modulus of deformability Ev2 = 140 MPa
Maximum deflection measured by Benckleman beam (standard axis) U40kN = 55 mm
Modules relationship Ev2 / Ev1 < 2.5

Subgrade on Roadbed Composed of Mixed Soil in Cutting and Side Cuts
Subgrade composed of previously described material on the roadbed of mixed soil shall be constructed in two layers in overall thickness, as presented on Figure 2 of these Technical Specifications.

Subgrade of stone material that satisfies criteria stated in Item 3 .4.1.5. d = 2 x 35 cm

Roadbed composed of mixed soil
Figure 2. Layout of the subgrade on the earthen roadbed of mixed soil

In the course of construction, the required bearing capacity shall be as follows:
Modulus of deformability Ev2 = 120 MPa
Maximum deflection measured by Benckleman beam (standard axis) U40kN = 0.65 mm
Modules relationship Ev2 / Ev1 < 2.5

Costs for retesting due to unsatisfactory results, shall be borne by the Contractor.
The assessment of test results among which there are also results not fulfilling the required compactness, shall be performed through computation of normal standard deviation, „quality number – Z", where Z shall be ≥ 0.90. The allowable deviation – quantil shall be less than 10%.

Evenness Control

Evenness of formation of the studied course shall be defined by measuring deviations under the 4 meter long straight edge placed in any direction against road axis. The deviation against design thickness for the entire set of testing data shall be as follows:
- For 90 % of overall control measurements, deviation shall not exceed 20 mm
- Maximum allowable deviation against the designed thickness shall be 30 mm
- Mean thickness of all control measurements shall not deviate for more than 10 mm.

Isolated spots characterized with actual thickness lower than maximum shall be locally repaired and brought to 90% tolerance. Number of samples (tests on control section) shall not be less than 10 except otherwise agreed with the Engineer. If such is the case, structural analysis of „quality number- „Z", where Z is Z ≥ 0.88 shall apply. Then the required criterion is that the error – quantil shall be less than 10%.
The width of the constructed course shall be at least equal to the width stated in the design so as no single profile of the outer course edge shall be pulled toward the road axis for more than 50 mm related to the designed width.

AS-3.4.1.7. Check of Construction Quality

The compliance with requirements stated in the design documentation and these Technical Specifications shall be determined for each separated type of stone aggregate planned to be incorporated into the subject course:

- Prior to placement compliance with preliminary tests shall be provided and
- In the course of placement, compliance shall be obtained with both regular and external control tests.

Preliminary Tests

Preliminary tests shall be performed to check the compliance of stone aggregate properties with the required ones, i.e.:
- Crushing resistance – Los Angeles Coefficient
- Coefficient of stone material fragmentability defined according to NF P 94-066 Standard
- Grain size distribution of stone aggregate prior and after the fragmentability test
- Plasticity of small particles (smaller than 0.425 mm) prior and after the fragmentability test
- Sand equivalent
- Organic admixtures participation

Results of preliminary tests shall be in compliance with evidences on properties of supplied stone aggregates submitted by the Contractor.

Regular Control
In the course of placing, regular control by the Contractor (to be performed by certified testing facility) must be able to define compliance of aggregates with requirements stated in the design documentation and these Technical Specifications.
In the course of placing of stone aggregate into the subject course, the relevant laboratory shall take samples, and test compliance of their properties against the minimum frequency required.
As a rule, samples of stone aggregates shall be taken from the temporary stockpiling area (2/3) and from constructed non-bound base course (1/3).
Minimum testing frequency of stone aggregate during regular control in the course of placing into the subject course shall be as follows:

Properties Minimum Testing Frequency
- Coefficient of fractions resistance against crushing, determined by Los Angeles method (EN 1097-2) 4000 m2/1000 m3
- Fragmentability coefficient FR
  according to NF P 94-066 4000 m2/1000 m3
- Participation of grains up to 0.063 mm in size 4000 m2/1000 m3

•	Grain size distribution of stone aggregate mixture	4000 m2/1000 m3
•	Testing of plasticity of small particles	4000 m2/1000 m3
•	Sand equivalent	4000 m2/1000 m3
•	Organic admixtures participation	8000 m2/2000 m3

Minimum testing frequency during regular control in subgrade layer shall be:

Properties	Minimum Testing Frequency
• Bearing capacity:	
- Static deformation modulus Ev2	2000 m2
- Deflections	50 m1
• Formation course:	
- Evenness	20 m1
- Height and gradient	20 m1

External Control

Volume of works for external control during the construction of the subject course shall be 1:4 in relation to regular control volume. Control tests shall be performed by relevant testing facility appointed by the Client.

Spots for taking of stone aggregate samples on the temporary stockpiling area and on the subject course shall be defined by the Engineer according to static method of random sample.

AS-3.4.1.8. Measurement and Payment

The performed work previously controlled and ac accepted by the Engineer shall be measured in m2.
Previously accepted and measured work shall be paid in unit price stated in the Contract per one square meter (m2) of the completed course.

AS-6.2.2. BASE COURSE CONSTRUCTION OF NON-BOUND STONE AGGREGATE 0/31 mm

AS-6.2.2.1 Description

This work shall consist of supply, transportation, placing, rough and fine spreading, possible wetting and compacting of non-bound stone aggregate base course, dimensions as designed.

AS-6.2.2.2 Basic Materials

Basic material shall be a mixture of crushed grains, originated by stone crushing, rough natural grains or artificial stone

Material Quality
Quality requirements are explained in detail with standard SRPS EN 13242:2007-Aggregates For Non-Bound Or Hydraulically Bound Materials For Use In Civil Engineering Works And Road Construction.

Stone Aggregate
The mixture of non-bound stone aggregate is composition of crushed stone fractions, stone grit, sand and filler, as to assure the required grading. Grading determination is defined with standard SRPS EN 933-1:2009.

Grading

Grading of non-bound stone aggregate shall be within the following limits:

Square mesh sieve openings (mm)	Passing trough sieves in mass % Crushed aggregate 0/31 mm
0.09	2-9
0.25	5-15
0.50	8-21
1.0	11-30
2.0	15-40
4.0	20-50
8.0	28-62
16.0	46-75
31.5	95-100
45.0	100

And to meet following requirements:

Uniformity coefficient Cu > 6
Curvature coefficient CC = 1 ÷ 3.
Fine particles presence

Stone aggregate may contain components smaller than 0.063mm (as per SRPS EN 13242:2007) within the following quantity:
- At stockpile: up to 5% (by weight)
- After placing: up to 8% (by weight).

Participation of stone grains up to 0.02 mm shall not exceed 3% (by weight).

Plasticity index of fine particles (smaller than 0.425mm) shall be below 6.

Sand equivalent shall be at least 60 – ESmin=60 (in conformity with SRPS EN 933-8:2008).

AS-6.2.2.3 Mechanical Properties of Stone Aggregate

Coefficient of resistance against crushing, determined by Los Angeles method (SRPS EN 1097-2:2008), shall not exceed 30%.

Frost resistance of stone grains, when determined as per SRPS EN 1367-2:2009, by magnesium sulphate test and expressed in percentage of skinned parts of original sample mixture shall be up to 25m.-%, but when tested by sodium sulphate, up to 5m.-%.
With stone aggregate is allowed maximum 20 m.-% of grains where the shape does not meet the requirement 1 :d □ 3:1 (test as per EN 933-4).
Organic admixtures contents in stone aggregate shall not color the 3% solvent of sodium deposit darker than reference color (test as per SRPS EN 1744-1:2009).
Stone aggregate shall not contain harmful non-quality grains or admixtures (test as per SRPS EN 1744-1:2009).
Bearing coefficient of stone aggregate, when determined by CBR laboratory test , shall be at least 80%.

AS-6.2.2.4 Works

It shall be necessary before work commencement to check whether or not machinery and tools that will be used in construction, meet the work execution requirements as present by the present Work Specifications.
Stone aggregate placing for the subject course shall be performed mechanically. Manual placing shall be allowed only locally, on spots where agreed by Engineer.
Any improvement of aggregate grading on site, i.e. on placing location, shall be allowed by Engineer based on results of preliminary tests.
Water quantity as necessary for optimal aggregate moisture for better compaction shall be introduced uniformly into aggregate just with supply location.
When the water should be added on placing location, than water dosage shall take place in the manner as to avoid washout of small fractions. Deviation of optimal moisture shall be maximum □2% by weight, during the course compacting.
Stone aggregate spreading for this course shall be carried out by pavers Spreading shall take place on the same day when moisturizing took place.
Compacting shall take place from the lower edge towards the higher edge of the course. Number of passes of appropriate compacting devices, previously determined with trial section shall be checked by testing within the regular control of density, i.e. compactness of the placed stone aggregate.
All irregularities that might be detected during compacting shall be corrected as directed by Engineer.
Bearing capacity of the course placed shall be measured before the compaction finishing.
When the properties as required by Design would not be attained, the Contractor shall assure the placed course quality by additional actions.
The course compacted shall have levels, width and gradient as presented by Design.

AS-6.2.2.5 Temporary Stockpile

If the Contractor would temporary store fractions of stone material before placing into the subject course, then the stockpile area shall previously be prepared in an appropriate way (planned, strengthened, drained)
A temporary approach road shall be constructed to the temporary Stockpile

AS-6.2.2.6 Construction Quality

Compaction

Average value of the stone aggregate placed compactness into the subject course as determined relating the density following Proctor procedure, shall exceed 98%. The estimation of results not fulfilling the compactness as required, shall be carried out by calculation of normalized standard deviation, quality number – Z“ where the Z value should be ≥ 0.85. The error allowed – quantal – should be bellow 15%.
The Designer proposed to determine placed aggregate layer compactness by using measurements with isotropic measuring device (nuclear density meter).

Bearing Capacity

Bearing Capacity of the completed course shall be determined by static deformational modulus Ev2, which shall comply with following requirements:

Bearing Capacity control shall take place by one of two methods:

1. Deformability modulus measuring by circular plate method - SRPS U.B1.047: 1997
2. Deflection of the course completed measuring by Benckelman beam or by deflectometer with falling weight.

1. Required values for deformability modulus
Required value of the deformability modulus at first sublayer (d= 15cm) shall be Ev2 ≥ 160 MPa.
Required value of the deformability modulus at second sublayer (d=15cm) shall be Ev2 ≥ 200 MPa.
The required value of deformability modules relationship shall be Ev2 / Ev1 < 2.2.
The assessment on acceptability of results where are present such ones that do not fulfill the required density, shall take place by calculation of normalized standard deviation with quality number– Z“, the value of which (Z) shall be ≥ 0.90. The error allowed shall be the quantil bellow 10%.

2. Required values for deflection
Eighty-five percent of deflection, when measured by Benckelman beam under standard axle loading shall be U40kN = 0.47 mm at first sublayer (d= 15cm).
Eighty-five percent of deflection, when measured by Benckelman beam under standard axle loading shall be U40kN = 0.40 mm (d= 15cm) at second sublayer (d= 15cm).

Measuring shall take place:
- ON NEW PAVEMENT OF THE MOTORWAY ROUTE in three points within the cross section, in the middle and in zones of the left and right edge of the course completed, distanced longitudinally 50 cm. Measurement may be carried out by deflectometer with falling weight.
- ON PAVEMENT OF EXISTING CARRIAGEWAY WIDENING in one point within the cross section, in contact zone to the existing pavement.

Evenness, levels, gradient

Course formation evenness shall be determined by deviations measurement under the straight edge of 4 m that shall be placed in any direction at the road axis. Deviations allowed are as follows:

- Course formation shall deviate of the straight edge up to 20 mm (top limit). When such deviations would appear continuously, then evenness shall be corrected as ordered by Engineer;

- Levels of measuring spots on the course formation shall be determined by leveling apparatus. Course formation at random spot shall deviate of the level as designed for maximum 10 mm (top limit).
- Course formation gradient, in conformity wit Design proposal, shall be the same as lateral and longitudinal gradient of the pavement surface designed.

AS-6.2.2.7 Construction Quality Control

The conformity with requirements of Design and the present Work Specifications shall be determined for each separated type of aggregate that would be foreseen for use with the subject course, as follows:

- Before placing, with preliminary testing;
- During the construction, within the regular and external controls.

AS-6.2.2.8 Preliminary Tests

Preliminary tests shall serve to perform the conformity check of stone aggregate against requirements as presented with these Work Specifications, meaning:

- Stone aggregate grading;
- Participation of grains up to 0,063 mm;
- Grain shape;
- Uniformity degree and curvature coefficient;
- Plasticity of fine particles (finer than 0.425)
- Sand equivalent;
- Resistance against crushing – Los Angeles coefficient;
- Organic admixtures participation;
- Bearing capacity – CBR procedure;
- Testing as per modified Proctor test:
- Optimal moisture;
- Highest density

Results of preliminary tests shall conform to the proposed Contractor's proofs on the properties of supplied stone aggregates.

AS-6.2.2.9 Regular Control

The regular control by Contractor (done by a certified laboratory) shall determine the conformity of the aggregate with requirements of Design and the present Work Specifications, during the stone aggregate placing into the subject course.
The laboratory shall take samples and check the conformity of properties with the minimal frequency required during the stone aggregate placing into the subject course.
Statistical principles for materials sampling shall be respected.
Minimal frequency of the stone aggregate testing during regular control of placing into the subject course shall be as follows:

Properties Minimal testing frequency
Grading of stone aggregate mixture 1000 m3

Grain shape
Uniformity degree and curvature coefficient
Participation of grains up to 0,063 mm
Fine particles plasticity
Sand equivalent
Moisture and density as per Proctor
Organic admixtures participation 2000 m3

Minimal testing frequency during the regular control of placing into the non-bound base course shall be as follows:

Properties	Minimal testing frequency
Moisture participation and density	200 m2
Bearing capacity	
- Statical deformation modulus Ev2	2000 m2
- Deflections on new pavement of motorway route	50 m1 x 3
- Deflections on existing pavement widening of motorway	50 m1
Course formation:	
- Evenness	20 m1
- Levels and gradients	20 m1

Control Tests

External control volume with subject course construction is regularly 1:4 compared to regular control. Control tests shall be done by the institution that is certified by Employer.

Stone aggregate sampling spots at the temporary stockpile and on subject course placing spots shall be determined by Engineer, as per statistical method of random sample.

Protection and Maintenance of the Course
The Contractor shall protect and maintain the course constructed at his own expense all the time before the next course construction. Maintenance shall include corrections of any damages and shall take place within such volume and frequency as to assure the intact course and in good condition. Repairs shall maintain good surface evenness of the course constructed.

AS- 6.2.2.10 Measurement and Payment

The quantity to be paid for to Contractor at the Contract Unit Price shall be the number of cubic meters (m3) of the course completed in the designed thickness and accepted by Engineer.

DRAINAGE DESIGN

08.05.01/2.01.03 Positions does not contain any additional description

08.05.01/2.06. CAST IRON COVERS
Description
Procurement, transport and fixing of cast iron covers in frame fully in accordance with SRPS.M.J6.226 for manholes (bearing capacity of 400 kN). The cover and frame shall be mounted onto a reinforced concrete ring seat on top of the manhole.
Payment
Payment will be done per each completely fixed cover.

08.05.01/2.07. CAST IRON RUNGS
Description
Procurement, transport and fixing of cast iron rungs to SRPS.M. J6.285 at the height of 30 cm.
Payment
Payment will be done per each completely fixed rung.

08.05.01/2.08. STREET GULLEYS
Description
Procurement, transport and fixing of a street gulley made of RC pipes, Ø400 mm in dia. The price includes: gulley, connection splice and rain grating fully in accordance with SRPS M.J6.254.
Payment
Payment will be done per each completely fixed gully.

08.05.01/2.09. ROUND GRATINGS DN 600
Description
Procurement, transport and fixing of round grating, Ø 600, class D400 EN 124 mounted on round manholes in the central reserve, as stated in the design.
Payment
Payment will be done per each completely fixed grating.

8.5.1/2.10. GEODETIC SURVEY
Description
The geodetic survey of stormwater sewerage shall be done after the acceptance of the sewerage system but before trench backfilling. The following shall be surveyed: locations of manholes and gullies, distances between them (section lengths), pipe diameters by sections, bottom levels in manholes and bottom levels and diameters of pipes in manholes. After completion of geodetic survey, as-built drawing shall be prepared and submitted to the Employer.
Payment
Payment will be done per m’ of completely surveyed network.

DESIGN OF ENGINEERING STRUCTURES

MAIN WORKS FOR THE SUPPORTING STRUCTURE MADE OF REINFORCED EARTH

07.07.00 EARTH WORKS FOR THE SUPPORTING STRUCTURE MADE OF RAINFORCED EARTH

07.(wall No.)07.03 EMBANKMENT CONSTRUCTION
Description
This item includes filling, spreading, rough and fine levelling, wetting and compaction of earth material containing minimum 30 % of rock aggregates with grains varying from 0 to 125 mm in size. Fragments coarser than those specified in the design will be removed mechanically or by hand or by rough sieving on improvised screens.
When performing embankment construction, standard method will apply except in a 2 m wide belt along the already embedded concrete blocks where spreading will be done by means of lightweight bulldozer and compaction will be performed through the use of vibration smooth roller having maximum 8 tons in weight, to obtain 0.20 m thick layers.
In 2.0 m wide area from concrete blocks, spreading will be done by hand in 15 cm thick layers. The main compaction will be done by 40/50 cm wide vibration plate along the concrete blocks. After stabilizing the material, 60/70 cm wide vibration roller having maximum weight of 1 tone will be used.
The relevant geogrid will be placed after reaching the layer thickness of 30 cm fully in accordance with these Technical Specifications.
Spreading shall be performed according to profiles, heights and relevant slope inclinations stated in the design.
Compacting shall be done until minimum of Ms=40 MPa or equivalent dynamical modulus Evd is obtained. Compactness shall be tested by applying standard round plate test (D=30 cm) or by means of device for dynamic modulus testing. Dynamic modulus test will be performed in accordance with SRPS UB1 047/97, SRPS UE8.010/1981 and SRPS UB1 046/68/92 Standards and NGT 39 Instructions for compactness control of both subgrade and embankment used for substructure in German railways.
Measurement
Measurement will be done per m3 of spread material and payment will be done according to contract unit prices that will include all work on filling, spreading, rough and fine levelling, wetting and compaction of material taken from the local excavation pit.
Payment
Payment will be made according to real quantities and contract unit price per measurement unit.

07.(wall No.)10.00 GEOSYNTHETIC MATERIALS
07.(wall No.)10.01
07.(wall No.)10.02
Description of geosynthetic materials
Uniaxial geogrids and relevant HDPE connectors resistant to chemical and mechanical impacts shall be used, as specified in the design.
Geogrid must be fabricated of HDPE plate oriented in single direction so as the obtained strips will be characterized with high degree of molecules orientated toward the strip direction that will also maintain their continuity through the transverse joining rib.
The required tensile strength for 120 year design life that will cause maximum deformation of 1% for grid M1 must be 8.21 kN/m, and for grid M2, 18.14 kN/m, at mean temperature of 200C. The said values represent relation of maximum tensile strength of geogrids for maximum deformation of 1% at the end of 120 year period and calculated safety factor. Due to lack of national legislation, the safety factor was calculated in accordance with British standards applied to geosynthetical materials.
Tensile strength in control tests at short loading must be 52.5 kN/m for M1 geogrid and 88.0 kN/m for M2 gird, with peak deformation of about 11.5% for the said force value.
The Manufacturer of geosynthetic materials that will be used for construction of this type of structures must be provided with adequate certificate issued by relevant independent institution stating that characteristics of fabricated geosyntetic material are in compliance with the solution applied in the design herein.

For the purpose of elongation, each geogrid junction must be capable to withstand 100% of tensile strength at control tests.
Geogrid must be inert to all chemicals naturally found in soils and must be stabile at ambient temperatures. Geogrid must not be susceptible to hydrolysis and must be resistant to aqueous solutions of salts, acids and alkalis (pH = 2.0 to 12.5) and non-biodegradable. It must also contain minimum 2% of dispersed carbon black which gives a high degree of protection by preventing UV light from penetrating beyond a thin layer at the surface.
STRUCTURE MADE OF REINFORCED EARTH – CONSTRUCTION TECHNOLOGY
Description of works
The structure made of reinforced earth will be constructed according to instructions stated in these Technical Specifications. The following must be taken into account:
The first row of concrete blocks must be precisely aligned to escape mistakes that can occur in joints in the course of wall construction.
Cutting of blocks, if necessary, will be precisely performed by means of adequate cutting tools.
The adjoining geogrid rolls must not be overlapped but positioned edge-to-edge so as problems referring to block levelling could be escaped. The end ribs must be precisely cut off by hand to enable proper connection and required fire resistance (geogrid must not be visible on the outer wall side).
In the course of work execution, the following must be borne in mind:

- Filling must be properly compacted especially along subgrade.
- In each construction phase, compacted layer must be in compliance with subgrade-geogrid connection to escape voids formation.
- Geogrid must be placed at right angle to the subgrade surface with tolerance of □50 mm, and spaced at 5 m.
- Sufficient tension shall be applied to ensure geogrid together with connector is firmly attached to the block wall.
- Tension shall be performed by special tool by applying one- man force.
- Continuity of geogrids should be avoided. If this is necessary due to better use of material, then continuity should be enabled through the use of appropriate joints (HDPE bars) supplied by the same Manufacturer engaged for geogrids and connectors.

Measurement
Unit price for geogrids includes as follows: procurement, cutting and placement of geogrids as well as all relevant accessories for tensioning and continuity, if necessary.
Unit price for connectors includes procurement and installation of polyethilene connectors.
Measurement will be done according to theoretical sizes stated in the design. Measurement unit for geogrids is m2, and for connector m'.
Payment
Quantities defined in the above mentioned way will be paid per contract unit price for measurement unit.

BRIDGES

13.1.4.1 Concrete layer for slope. Concrete class I MB 20.

13.1.4.2 Waterproofing protection

This item includes all work, material, equipment and transport together with galvanized wire mesh needed to construct a concrete cover on top of waterproofing layer of fine grained concrete class II, MB20, 5cm thick.
Prior to placing of waterproofing layer, 1:3 cement mortar shall apply followed by fine grained concrete layer, 2.5 cm thick.
Lathing made of 2 mm thick iron galvanized wire and 25x25 mm openings shall be placed over the said layer in wet state. Another 2.5 cm thick layer of fine grained concrete of similar quality shall be placed over the said layer. The class of concrete shall be MB20.
Payment will be done per m2 of completed work, including all work, material, equipment and transport.

13.1.4.4 Plain concrete for open caissons.
This item includes all work and amount of plain concrete, klass MB20, that is placed in caissons, accoding to 13.2.2 of Tehnical Specification.

13.2.6 Erection of shuttering for foundation works. These works include shuttering of foundation pits with wooden planks and steel frames and combination thereof and shuttering with steel material.

13.2.6.1Timber shuttering includes driving and/or placing of wooden planks and beams and struts for supporting the wall made of wooden planks.
The Design Engineer and/or the Contractor shall be responsible for preparation of shuttering design fully in accordance with design documentation, geotechnical report, surveyed ground and ground water levels and forecast oscillation of the said level. The design prepared by the Contractor shall be submitted to Design Engineer and Engineer for their approval. The shuttering design shall secure the pit from surrounding structures and traffic. Tilting and lateral movement of shuttering in the course of placing shall be straighten at the Contractor's cost.
If the Contractor plans to remove the timber, the technological process shall be harmonized in a way that shall prevent damage of the particular structure in the course of removing. The Contractor shall cut the excessive length of shuttering upon the Engineer's approval in the course of foundation backfilling.
Sealing planks may be tongued and grooved. For the purpose of driving, at the point of impact, planks shall be provided with shoe and notched and trimmed top. Sizes of planks shall be defined by structural analyses and quality and class according to JUS U.D0.001.
For round and sawn timber, buckling shall be defined according to JUS u.C9.200. Quality shall be defined according to JUS U.D0.001 and allowable stresses according to JUS U.C9.400. In a case of water impermeable shuttering, joints shall be controlled and sequence in planks driving previously defined. Sheet-pile wall shall be driven deeper than foundation bottom for the height specified in the relevant hydraulic calculations.

13.2.6.2 Shuttering with wooden planks, steel piles and struts

Similar specifications as in 6.2.3.2.2 shall apply. Steel segments shall be sized according to JUS U.E7.081 and JUS U.E7.086. Wedges shall be made only of oak timber, category I. Steel-sheet piles for the purpose of strutting shall be made of rolled and cold formed steel sections.

Works covered by these technical specifications include providing of all material, facilities, equipment and workmen required for execution of works on placing of sheet-pile walls and shuttering of steel-sheet piles in dry and/or water environment as well as works referring to removal and/or cutting the piles, as stated in the design fully in accordance with contractual conditions and these technical specifications, relevant drawings and Engineer's instructions. For the purpose of protection of foundation pits in the course of excavation, placing of subbase and all works referring to construction of foundation for bridge piers, construction of sheet-pile walls and/or shuttering made of steel-sheet piles shall be required. Type of steel-sheet piles shall be selected by the Contractor provided that thickness of the sheet-pile walls which one segment shall be built into the foundation as a protection against undercutting shall not be less than 9 mm. To improve adhesion, along the whole circumference of sheet-pile walls and/or shuttering which one segment shall be built into the foundation to the height of subbase and foundation footing crown shall be fitted with anchors welded as specified on drawings and cutting of steel-sheet piles after completion of foundation and piers shall be performed up to levels specified in the drawings (top foundation level), or as directed by the Engineer. In a case of sheet-pile walls and/or shuttering consisting of steel-sheet piles planned to be removed after completion of works, in the course of construction of subbase and foundation, the Contractor shall apply all relevant measures to prevent damage of the concrete cover. If he/she fails to apply the said measures and fails to remove the supports he/she shall cut them to the level specified by the Engineer, and costs for supports shall not be accepted. Prior to commencement of works on assembly of sheet-pile walls and/or support, the Contractor shall prepare relevant design fully in accordance with data stated in structural design, geotechnical report, surveyed ground and ground water levels as well as forecast of water level to be expected in the course of foundation construction. The Contractor shall submit the sheet-pile wall design to the Engineer for his/her approval. Prior to commencement of works, the Contractor shall mark and secure edges of sheet-pile walls and control the accuracy of driving. Steel-sheet piles not matching with the surrounding piles shall be removed and replaced. This is also referring to deformed and too short piles. Costs for replacing of damaged sheet-pile walls shall be borne by the Contractor. Movement and lateral displacement of sheet-pile walls and steel-sheet piles in the course of placing shall be straightened at the Contractor's cost so as adequate clearance can be provided, as stated in the design. If not otherwise specified by the Engineer, steel sheet piles shall be driven to the levels specified in drawings provided that top level of piles shall be for 50 cm higher than the adopted level of water expected during the works.

Measurement and Payment

Works shall be measured in square meters of outer vertical surfaces of shuttering and/or sheet-pile walls according to mean measure obtained by measuring the mean height obtained from the mean value of heights of four edge points, or according to the drawing. The measurement herein includes full compensation for all work, material and transport. Segments of shuttering exceeding measures herein and shuttering removed after concreting shall be the property of the Contractor. If works have not been separately measured, price of these works may be included into the price referring to excavation items, as stated in the contract.

13.2.7 Placing the sub-base made of gravel and sand in 30 cm thick layers under foundation including compaction of layers to modulus of compressibility Ms=30 MPa.

13.2.8 Construction of side/back walls

13.2.8.1 Scope and Contents of Works

Construction of side/back walls includes filling, spreading rough/fine leveling and compaction in 30 cm thick layers, fully as designed. All work shall be completed in line with the design, these Technical Specifications and SRPS U.E.010 – Earth Works in Road Construction.

13.2.8.2 Material

For construction of side/back walls, inorganic materials of specified quality shall be used.

Organic waste, roots, turf, i.e. material that would, in time, change its mechanical and physical properties due to biochemical actions, cannot be incorporated into side/back walls.

Material for construction of side/back wols can be obtained from cuts along the road route, borrow pits, and by dredging sand from the Sava/Danube rivers ’’on site’’ or from the stockpile of dredged sand.

13.2.8.2.1.Regulations for Control of Materials Quality

- SRPS U.B1.010 – Sampling
- SRPS U.B1.012 – Determination of Soil Moisture
- SRPS U.B1.014 – Determination of Bulk Density of Solid Particles
- SRPS U.B1.016 – Determination of Bulk Density
- SRPS U.B1.018 – Determination of Granulometric Composition
- SRPS U.B1.020 – Determination of Consistency Limits
- SRPS U.B1.024 – Determination of Combustible and Organic Matters
- SRPS U.B1.038 – Determination of Optimum Water Content
- SRPS U.B1.042 – Determination of California Bearning Ratio (CBR %)

Classification of materials, preliminary testing of materials and criteria for assessing quality of materials prior to incorporation will be performed fully in accordance with Items 3.4.1 – Earth Embankments.

13.2.8.3. Haulage, Filling and Compaction

The haulage and filling of materials over a prepared foundation soil may start only after the Engineer has approved the lower layers.
Filling shall be performed in 30 cm thick layers. The height (thickness) of every spread layer shall be in compliance with the tamping effect by depth of the used tamping device, type of fill material, and segregation occurrences.
Relevant testing, control and machinery adopting shall be performed for every type of material to be incorporated into an embankment.
Every layer of embankment shall be compacted with an appropriate mechanical device. All places inaccessible for machines, or places where the use of heavy tamping devices would be unsuitable for other reasons (filling behind structures, retaining walls, etc.) shall be tamped with other suitable devices or methods, the use of which shall be subject to the approval by the Engineer.
Moisture of material, filling conditions, and compaction shall be perfromed fully in accordance with the Item 3.4.1 – Earth Embankments.

13.2.8.4 Measurement

The quantity of incorporated material shall be measured in m3 of actually incorporated quantities within the project, excluding the topsoil layer on embankment slopes, but including the shoulder core, and as approved by the Engineer.

13.2.8.5 Payment
Quantities determined as per 13.2.8.4. shall be paid at agreed prices for 1 m3 of incorporated fill material.
The contract prices shall include all works on topsoil stripping, spreading, wetting or drying, compaction, construction of stepped cuts and fills, levelling of embankment slopes and shoulders with the accuracy of ±5 cm with respect to the designed embankment slopes, humification and grassing of slopes, and other works from this description, including all materials and labour, transport and haulage, and the Contractor shall have no right to claim any extra monies for the construction of embankments.

13.2.9 Placing 80 cm thick cover protecting a gravel wedge made of gravel sand where top 30 cm shall be stabilized with cement and bottom 50 cm compacted in two layers to modulus of compressibility Ms=40 MPa.

13.4.1.3 Placing of 10 cm thick sub-base blinding layer made of MB 15 concrete under foundations, head beams and crossing slabs.

13.11.6 Lining construction of composite crushed stone

The Item includes all work, material, equipment, and transport for lining made of crushed stone in a culvert.
Protective lining of culvert's bottom shall be made of composite crushed stone embedded in lean concrete, class MB20.
Protective lining shall be extended for 5 m on both upstream and downstream sides. This lining shall end by transverse sill.

If the water stream gradient does not exceed 5 %, joints shall be filled with concrete or cement mortar. If the gradient exceeds 5%, joints shall be 5-15 cm deep.
Quantity of material shall be measured in m3 of actually executed works according to dimensions stated in the design and as approved by the Engineer.
The unit prices shall include all work on lining construction and other related works together with all material, equipment and transport, and the Contractor shall have no right to claim any extra payment for embankment construction.

13.11.8 Underlays shall be made of mixed mortars provided that minimum strength shall be in compliance with the concrete, class MB45. Concerning the quality of used materials, provisions stated in these Specifications shall apply. Underlays shall be installed in a way that shall always enable presence of overpressure. Jointed principle or grouting may apply. Mortars shall be characterized with permanently increased volume of minimum 1%. Underlays exceeding 50 mm in thickness shall be additionally reinforced.
Within the works on installation of bearings, gutters and similar elements that require placing of underlay, the Contractor shall submit within the methodology of installation design all relevant evidences testifying that the mortar mix to be used as underly is in strict compliance with the required specifications. The said design together with detailed description of construction methodology shall be submitted to the Engineer for his/her approval.

13.11.9 Steel plates embedded into a girder at points where girders rest onto bearings.

13.11.15 "Fugeband" bands for ensuring the watertightness joint between two concrete members

The Item includes all work, material, equipment and transport to ensure the watertightness joint between two culvert members. ’’Fugeband’’ rubber bands for sealing of transverse joints in longer culverts cast in situ, shall be placed on outer sides of culvert walls toward the embankment. At the contact point between the two adjoining walls, 2 cm thick styrofoam board shall be placed. Joint in inner side toward the culvert opening shall be filled with plastic putty.
Payment will be done per m’ of completely performed work.

ENVIRONMENTAL PROTECTION DESIGN

DESIGN OF NOISE SUPRESSION STRUCTURES

NOISE SUPPRESSION WALLS

10.(wall No.)03.01 i 10.(wall No.)06.01 PROCUREMENT AND ERECTION OF HEA 140 STEEL COLUMNS

Description of works
Columns for standard noise barriers shall be made of HEA, HEB or HEM steel (Euronorm 53-62).
Procurement and erection of HEA steel columns shall be fully in accordance with DIN1025, SRPS EN10025 and EN10327.
Nominal spacing between steel columns for standard noise barriers is:

- on embankments and already built structures – 4.00 or 5.00 m
- on new structures – 2.00 or 2.50 m

HEA steel columns for noise barriers on embankment shall be planted into prefabricated reinforced concrete foundation and positioned at 4.00 m centre-to-centre spacing.
HEA steel columns for noise barriers on bridges shall be positioned at 2.00 m centre-to-centre spacing and anchor plate will be used to connect steel column and bridge structure and/or concrete footway.
Steel columns shall be positioned vertically and in line. Column distortion, which can make difficult placing of members, is not allowed.
In order to achieve that steel columns are positioned vertically and in line, reinforced concrete members shall be placed prior to fixing the next steel column and afterwards absorption or transparent panels will be inserted between adjacent steel columns.
Measurement
Payment per kilogram (kg) of planted HEA steel columns.

10,(wall No.)04.01 PROCUREMENT AND INSTALLATION OF ABSORPTION PANELS

Description of works
Absorption panels used in construction of sound barriers shall satisfy the general criteria:

- to meet acoustic requirements
- to take into account traffic safety requirements
- to be structurally stable and to hold its shape
- to be resistant and protected against corrosion and degradation
- to be of adequate size
- to have constant colour shade
- to be fire resistant
- to be resistant to rockfall
- to be easy for maintenance

Size and composition of absorption panels shall fully meet the current standards and quality requirements (DIN 52210, DIN 52212, DIN 1725/1, ZTV-LSW 88, EN 1793/1794 etc.).
Absorption panels shall be stable in size and appropriate for safe placing. Limit values and tolerances of structural members and works shall meet standards for sound barriers. Hollow members shall be designed so that penetrated water can be quickly and completely drained. Water drainage shall not be aimed at members placed one below the other and in case of a panel with tongue-and-groove joint water shall not be retained on upper members. In case of hollow members or absorbing subwalls, sound absorbing or isolating members shall be placed at spacing of minimum 2 cm from wooden or metal parts. Hollow space shall be airy although it does not apply to aluminium members resistant to salt water. Absorbing and isolating members shall be resistant to light, weather conditions, salting and rotting, hydrophobic and free of any material provoking corrosion.
Absorption panels shall meet requirements at least for B1 class of building materials according to DIN4102.
They shall be placed so that hold required position even after long time period. Absorption panels shall be inserted between adjacent steel columns.
Standard length of absorption panels for sound barriers on embankment is 3.96 m while standard height is 50 cm.
During demolition of absorbing panels standard procedures and technical specifications for each material shall be applied.
Measurement
Payment per one (pc.) absorption panel placed.

10.(wall No.)06.02. PROCUREMENT AND PLACING OF ANCHOR PLATES

Description of works
Connection between steel column and the bridge structure shall be enabled via steel anchor plate, sized as designed, quality S235JO (Č0362 according to SRPS.C.B0.500).
Steel plates are fitted with anchor bolts made of RA 400/500-2, Ø12, fully in accordance with detail shown on graphical documentation.

Measurement and Payment
Payment will be done per piece of installed steel anchor slab.

10.(wall No.)07.01 PROCUREMENT AND INSTALLATION OF TRANSPARENT PANELS

Description of works
Transparent panels planned to be used as sound barriers shall fulfil the following criteria:

- Acoustic requirements
- Safe traffic
- Maintain structural stability and shape
- Resistant and/or protected against corrosion
- Provided with relevant sizes
- Maintain the selected color tone
- Resistant to fire load
- Resistant to stone blows
- Resistant to vehicle impact
- Easy for maintenance

Sizes and composition of transparent panels shall be in strict compliance with applicable standards and quality requirements (DIN 52210, DIN 1725/1, ZTV-LSW 88, EN 1793/1794 and other).
Standard sizes of transparent panels to be used as sound barriers on bridge structures are L=1.96 m.
Standard height may exceed 2.0 m.
When transparent panels are planned to be used as sound barriers (acrylic glass, polycarbonates, standard or safety glass), transparency of plastic materials shall not get worse during their service life. They shall be specially protected against UV radiation and shall be resistant to scratches.
In the course of demolition of transparent panels, standard procedure and technical specifications for each material shall apply.

Measurement and Payment
Payment will be done per piece of installed transparent panel.

DESIGN OF TECHNICAL INFRASTRUCTURE

DESIGN OF LIGHTING SYSTEM AT „PREDEJANE" GRADE-SEPARATED JUNCTION AND POWER SUPPLY TO TOLL STATIONS

2. GENERAL AND TECHNICAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

2.1. GENERAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

The items in the Bill of Quantities and Cost Estimate include description, labour, material, machinery, tools, costs and company's profit for quality completion of each item.
All equipment shall be fabricated and all works executed according to applicable regulations and standards.

Execution of works

- Works shall be performed in strict accordance with the Design Documentation, the Contract and the "General and Technical Specifications for the Supply of Equipment and Execution of Works''.
- In the case of any discordance the Contractor shall duly request the Engineer's decision. Any design modification shall be supported by a written approval of the Designer and the Engineer. The Contractor shall organize the work to avoid interference with other contractors' performance on the site. The Contractor shall also pay all delays and damage inflicted to other contractors.
- The Contractor shall not assign the contract in full or in parts to any third party without the Employer's consent. The works shall be performed fully as specified in these conditions and other rules governing this kind of work. If during the performance some of these rules are modified, amended or new ones are passed the Contractor shall observe them without any compensation.
- The Contractor shall keep the structures and installations safe from mechanical damage, illegal use and the like, until final commissioning and issue of the final certificate.
- The Contractor shall perform the works (supply of materials included) not envisaged in the design documentation if they are necessary for proper functioning of a structure or for compliance with current regulations. The Contractor shall hand over the structure in proper order for operation
- These Technical conditions give only important general principles for quality performance. Everything else shall be subject to the relevant codes of practice listed in the design documentation.

Measurement and payment
The work shall be done in strict accordance with the approved design documentation and priced bill of quantities. Lists of materials, bills of quantities and detailed and other drawings shall constitute integral parts of the priced bill of quantities. The work shall be performed as directed by the Engineer and no alterations or important work phases (trial energizing and the like) may be done otherwise. The priced bill of quantities and conditions of contract award shall be integral parts of the contract document. The unit prices shall be the Contractor's selling prices and shall cover:

- Preliminary and final works for quality performance.
- Expenditures for the execution such as: labour, materials and waste, tools, formwork, scaffolds, costs of erection and dismantling, transport, overheads and other expenses allowed in the relevant regulation.

The work shall be performed in accordance with the tender documents, technical regulations and standards with the use of quality materials and skilled workforce, and shall be tested as specified.
Improper materials, which are not in compliance with the relevant technical regulations shall be removed from site by the Contractor and replaced with materials of good quality without entitlement to any compensation whatever.
If any work is performed with materials which do no comply with the technical conditions in the design documentation or with the Engineer's instructions the Contractor shall perform them at his own cost without any compensation whatsoever.
If the design documentation is incomplete or inaccurate the Contractor shall duly request its amendment and interpretation. Any costs of redesign or demolition due to the Contractor's failure to comply shall be borne by him and the Contractor will not be entitled to any compensation or time extension.
Upon completion of all the works or if directed by the Engineer in the course of phases, the Contractor shall make the prepare the structure for use and backfill and level off trenches and holes, clean buildings, installations, appliances and components of the equipment installed.
All these works shall be covered by the main items and will not be paid for separately.
The Contractor shall keep the completed plant, installations, appliances and components in order, clean and fully safe until commissioning. This shall be covered by unit price.

Supply of materials
The materials for the contracted works shall comply with SRPS standards but if these are not available then with other approved standards governing various kinds of materials. Each consignment shall be accompanied with test certificates on compliance.

The mechanical and electrical parameters of the equipment shall be confirmed by type and series tests. Each component shall bear indelible marks identifying the Manufacturer and the technology. The Contractor shall have responsibility for the materials used and unused and for the performance until take-over and issue of the final certificate.

2.2. TECHINAL REQUIREMENTS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

1.1.01.07;1.1.01.08;1.1.02.02; Delivery and placing of cable line marks

Description of works
The Contractor shall deliver and place markers for cable line marking on both developed and undeveloped areas, mark cable ends and points of crossing with ground installations.

Measurement and Payment
Payment will be done per one marker.

1.1.01.09; 1.1.01.10; 1.1.01.11; Delivery and laying of PVC pipes

Description of works
The Contractor shall deliver and lay PVC pipes in routings under arterials in the course of civil engineering works.

Measurement and Payment
Payment will be done per m of laid pipe.

1.1.03.14; Delivery and fitting of arms for public lightning

Description of works
The Contractor shall deliver and fix 1.5 m long single arms onto public lighting colums.

Measurement and Payment
Payment will be done per piece of delivered and fixed arm.

1.1.03.15; Delivery and fitting of double arms onto public lighting columns

Description of works
The Contractor shall deliver and fix 1.5 m long double arms onto public lighting columnts.

Measurement and Payment
Payment will be done per piece of delivered and fixed arm.

1.1.03.16; 1.1.03.17; Delivery and fitting of holders for two lamps onto the public lighting column

Description of works
The Contractor shall deliver and fix the holder for two lamps onto the public lighting column.

Measurement and Payment
Payment will be done per piece of delivered and fixed holder.

1.1.03.18; 1.1.03.19; 1.1.03.20; 1.1.03.21; 1.1.03.22.
Delivery and mounting of public lighting luminaires

Description of works
The Contractor shall deliver and mount luminaires specified in the BoQ onto the steel galvanized public lighting column.

Measurement and Payment
Payment will be done per piece of delivered and mounted luminary.

1.1.03.27. Procurement, delivery and placing of galvanized strip

Description of works
The Contractor shall deliver and lay a FeZn 25x4 mm galvanized strip for protective earthing of the lighting installation in the same trench with 1 kV cable. The metallic columns in the lighting installation and the switchboard ROJO shall be bonded to the strip.

Measurement and Payment
Payment will be done per m of delivered and placed strip.

1.1.03.28. Procurement, delivery and fitting of cross piece

Description of works
The Contractor shall deliver and fit a cross piece in K-U-K housing and seal it with bitumen according to JUS N.B4.936. The case shall be fitted next to each column where earthing strip spurs towards the column and continues along the trench.

Measurement and Payment
Payment will be done per ddelivered and fitted cross piece.

DESIGN OF 10/04kV TRANSFORMER STATION, „PREDEJANE“ INTERCHANGE AND 10kV FEEDER CABLE

2. GENERAL AND TECHNICAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

2.1. GENERAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS
The items in the Bill of Quantities and Cost Estimate include description, labour, material, machinery, tools, costs and company’s profit for quality completion of each item.

All equipment shall be fabricated and all works executed according to applicable regulations and standards.

Execution of works
- Works shall be performed in strict accordance with the Design Documentation, the Contract and the "General and Technical Specifications for the Supply of Equipment and Execution of Works''.
- In the case of any discordance the Contractor shall duly request the Engineer's decision. Any design modification shall be supported by a written approval of the Designer and the Engineer. The Contractor shall organize the work to avoid interference with other contractors' performance on the site. The Contractor shall also pay all delays and damage inflicted to other contractors.
- The Contractor shall not assign the contract in full or in parts to any third party without the Employer's consent. The works shall be performed fully as specified in these conditions and other rules governing this kind of work. If during the performance some of these rules are modified, amended or new ones are passed the Contractor shall observe them without any compensation.
- The Contractor shall keepthe structures and installations safe from mechanical damage, illegal use and the like, until final commissioning and issue of the final certificate.
- The Contractor shall perform the works (supply of materials included) not envisaged in the design documentation if they are necessary for proper functioning of a structure or for compliance with current regulations. The Contractor shall hand over the structure in proper order for operation
- These Technical conditions give only important general principles for quality performance. Everything else shall be subject to the relevant codes of practice listed in the design documentation.

Measurement and payment
The work shall be done in strict accordance with the approved design documentation and priced bill of quantities. Lists of materials, bills of quantities and detailed and other drawings shall constitute integral parts of the priced bill of quantities. The work shall be performed as directed by the Engineer and no alterations or important work phases (trial energizing and the like) may be done otherwise. The priced bill of quantities and conditions of contract award shall be integral parts of the contract document. The unit prices shall be the Contractor's selling prices and shall cover:
- Preliminary and final works for quality performance.
- Expenditures for the execution such as: labour, materials and waste, tools, formwork, scaffolds, costs of erection and dismantling, transport, overheads and other expenses allowed in the relevant regulation.

The work shall be performed in accordance with the tender documents, technical regulations and standards with the use of quality materials and skilled workforce, and shall be tested as specified.
Improper materials, which are not in compliance with the relevant technical regulations shall be removed from site by the Contractor and replaced with materials of good quality without entitlement to any compensation whatever.
If any work is performed with materials which do no comply with the technical conditions in the design documentation or with the Engineer's instructions the Contractor shall perform them at his own cost without any compensation whatsoever.
If the design documentation is incomplete or inaccurate the Contractor shall duly request its amendment and interpretation. Any costs of redesign or demolition due to the Contractor's failure to comply shall be borne by him and the Contractor will not be entitled to any compensation or time extension.
Upon completion of all the works or if directed by the Engineer in the course of phases, the Contractor shall make the prepare the structure for use and backfill and level off trenches and holes, clean buildings, installations, appliances and components of the equipment installed.
All these works shall be covered by the main items and will not be paid for separately.
The Contractor shall keep the completed plant, installations, appliances and components in order, clean and fully safe until commissioning. This shall be covered by unit price.

Supply of materials
The materials for the contracted works shall comply with SRPS standards but if these are not available then with other approved standards governing various kinds of materials. Each consignment shall be accompanied with test certificates on compliance.
The mechanical and electrical parameters of the equipment shall be confirmed by type and series tests. Each component shall bear indelible marks identifying the Manufacturer and the technology. The Contractor shall have responsibility for the materials used and unused and for the performance until take-over and issue of the final certificate.

2.2. TECHNICAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

01.01.08;
Procurement and delivery of Al/Č wire 3x50/8 mm2

Description of works
The Contractor shall deliver the said wire and perform installation and tensioning to the newly-designed poles.

Measurement and Payment
Payment will be done per m of delivered and installed wire.

01.01.09; Control of executed works

Description of works
Control of executed works, all required tests provided with relevant certificates and putting into operation.

Payment
Payment will be done in lump sum.

01.01.10; Voltage switch off and safeguarding the construction site

Description of works
When displacing the existing power cables it is necessary to switch off voltage and safeguard the construction site. Voltage switch off shall be done by the relevant power distribution company at Contractor's request and the construction site shall be safeguarded by the Contractor to avoid putting in risk human health and goods.

Measurement and Payment
Payment will be done upon the invoice issued by the relevant power distribution company.

01.02.04; 01.02.06; 01.02.07; 01.02.08; 01.02.09; 01.02.10; 01.02.11;
Delivery and installation of HV/LV switchgear

Electrical equipment for high and low voltage switchgear shall satisfy the relevant regulations and recommendations.
Supports for devices and apparatus shall be of metal or other non-flammable materials and shall not demand any specific maintenance.

Switchboard door will be provided with danger warning plate: "High voltage – Danger".
Headroom from the ground to live equipment shall not be less than 5 m.
Metallic structures (doors, frames, supporting skeleton etc.) shall be coated with red lead i.e. primed and grey oil paint. High voltage isolator and switchboard metallic parts shall be painted in the same way. Galvanized steel and aluminium parts need not be painted.
0.4kV switchboards shall bear plates with names of each terminal and metering instrument.
The high voltage incoming and outgoing cables shall be marked with collar plates showing their use, type and nominal voltage.
Secondary circuits of current instrument transformers shall be earthed directly at the clamps.
The metallic parts of plants, supporting structure, control levers, casings, devices and other, not normally under voltage but with which servicing staff may come into contact shall have visible connections to transformer station earthing.
The metallic handles, levers etc. need not be separately earthed if they have conductive bond to earthed apparatuses. However, if such bonds are in the form of toothed gearing – jaw couplings they shall be connected to STS earth electrode.
To enable periodic check of earthing propagation resistance an earth circuit connector shall be designed between the earth electrode and protective earthing.
Buried couplings in the earthing system shall be protected against corrosion in a reliable way.
Upon completion of the works the propagation resistance value shall be measured.
Operating staff shall use rubber gloves, boots, insulated base and rod, tested for 10 kV voltage to protect themselves from electric shock.

Measurement and Payment
Payment will be done per delivered and mounted items of equipment given in the Bill of Quantities.

01.02.05; Power transformer for outdoor application

Transformer shall comply with building codes. They shall bear plates with clearly inscribed main data. The plates shall be so positioned that data can be easily and safely read during operation.
Transformers shall be designed to withstand stresses in operation without damage or reduction of their operating capacity.
A pole-mounted transformer shall be in such a position that its operation, characteristics and lifetime will not suffer in adverse ambient conditions, nor will it cause any negative environmental impact.
Transformers shall not cause harmful vibrations in adjacent pole sections or interference and damage to its structural parts.
Sufficient cooling shall be possible which will not cause any damage in the network.
Automatic safety from electrical overload and inside or outside faults shall be designed to match the size and equipment of the transformer.
Automatic shut off control shall be supplemented with manual start control of all devices that have to be electrically separated from operating parts in a transformer station.

01.02.12; Earth electrode for STS

Description of works
Excavation needed to lay protective earth wire, bury it and tamp earth in 15 cm thick layers. The STS earth electrode shall be in the form of two concentric conductors around the foundation of copper strand min. 35 mm2 buried as shown on the drawings. Galvanized iron pipes 2.5" dia 3 m long shall be placed at apex points in the outer concentric conductor.

Measurement and Payment
Payment will be done per m3 of excavated earth and for complete assembly of earth electrode.

01.02.13; Missalaneous works

Description of works
The Contractor shall also supply small material required for mounting and bonding and perform all required measurements and tests together with issuing of relevant certificates. Inspection and putting into operations shall be performed upon completion of all works.

Payment
Payment will be done in lump sum.

DESIGN FOR DISPLACEMENT AND PROTECTION OF 10kV I 1kV POWER CABLES

2. GENERAL AND TECHNICAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

2.1. GENERAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

The items in the Bill of Quantities and Cost Estimate include description, labour, material, machinery, tools, costs and company's profit for quality completion of each item.
All equipment shall be fabricated and all works executed according to applicable regulations and standards.

Execution of works
• Works shall be performed in strict accordance with the Design Documentation, the Contract and the "General and Technical Specifications for the Supply of Equipment and Execution of Works''.
• In the case of any discordance the Contractor shall duly request the Engineer's decision. Any design modification shall be supported by a written approval of the Designer and the Engineer. The Contractor shall organize the work to avoid interference with other contractors' performance on the site. The Contractor shall also pay all delays and damage inflicted to other contractors.
• The Contractor shall not assign the contract in full or in parts to any third party without the Employer's consent. The works shall be performed fully as specified in these conditions and other rules governing this kind of work. If during the performance some of these rules are modified, amended or new ones are passed the Contractor shall observe them without any compensation.
• The Contractor shall keep the structures and installations safe from mechanical damage, illegal use and the like, until final commissioning and issue of the final certificate.
• The Contractor shall perform the works (supply of materials included) not envisaged in the design documentation if they are necessary for proper functioning of a structure or for compliance with current regulations. The Contractor shall hand over the structure in proper order for operation
• These Technical conditions give only important general principles for quality performance. Everything else shall be subject to the relevant codes of practice listed in the design documentation.

Measurement and payment
The work shall be done in strict accordance with the approved design documentation and priced bill of quantities. Lists of materials, bills of quantities and detailed and other drawings shall constitute integral parts of the priced bill of quantities. The work shall be performed as directed by the Engineer and no

alterations or important work phases (trial energizing and the like) may be done otherwise. The priced bill of quantities and conditions of contract award shall be integral parts of the contract document. The unit prices shall be the Contractor's selling prices and shall cover:

- Preliminary and final works for quality performance.
- Expenditures for the execution such as: labour, materials and waste, tools, formwork, scaffolds, costs of erection and dismantling, transport, overheads and other expenses allowed in the relevant regulation.

The work shall be performed in accordance with the tender documents, technical regulations and standards with the use of quality materials and skilled workforce, and shall be tested as specified.
Improper materials, which are not in compliance with the relevant technical regulations shall be removed from site by the Contractor and replaced with materials of good quality without entitlement to any compensation whatever.
If any work is performed with materials which do no comply with the technical conditions in the design documentation or with the Engineer's instructions the Contractor shall perform them at his own cost without any compensation whatsoever.
If the design documentation is incomplete or inaccurate the Contractor shall duly request its amendment and interpretation. Any costs of redesign or demolition due to the Contractor's failure to comply shall be borne by him and the Contractor will not be entitled to any compensation or time extension.
Upon completion of all the works or if directed by the Engineer in the course of phases, the Contractor shall make the prepare the structure for use and backfill and level off trenches and holes, clean buildings, installations, appliances and components of the equipment installed.
All these works shall be covered by the main items and will not be paid for separately.
The Contractor shall keep the completed plant, installations, appliances and components in order, clean and fully safe until commissioning. This shall be covered by unit price.

Supply of materials
The materials for the contracted works shall comply with SRPS standards but if these are not available then with other approved standards governing various kinds of materials. Each consignment shall be accompanied with test certificates on compliance.
The mechanical and electrical parameters of the equipment shall be confirmed by type and series tests. Each component shall bear indelible marks identifying the Manufacturer and the technology. The Contractor shall have responsibility for the materials used and unused and for the performance until take-over and issue of the final certificate.

2.2. TECHNICAL REQUIREMENTS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

01.01.01;02.01.01;
Dismantling of the existing 1 kV masts

Description of works
The Contractor shall dismantle the existing masts indicated in the graphic documentation. The dismantled masts shall be handed over to the User or Employer in his warehouse. The masts shall be carefully dismantled, transported to distance of 5 km and stored to enable their reuse, if any. The Contractor, Engineer, Employer and User shall jointly determine the state of equipment to be dismantled, storing method and location, its further treatment and status. During dismantling care shall be taken neither to endanger human safety and property nor to affect stability of surrounding structures. The masts can be dismantled only when voltage is permanently switched off.

Measurement and Payment
Payment will be done per one dismantled mast.

01.02.01; 02.02.01. Dismantling the equipment from 1 kV mast

Description
The Contractor shall disassemble 1 kV equipment from 1 KV masts planned for pulling down (marked with arrows on drawings) and hand it over to user or the Employer in his store. Dismantling, transport within 5 km distance and storage shall be careful so that dismantled equipment can be reused eventually. The Contractor, the Engineer, the Employer and the User shall jointly assess the condition of the equipment being dismantled, the place and method of storage, further treatment and status. The equipment which is not planned for dismantling shall be kept in order and shall neither threaten safety of people or goods nor impair the stability of installations. The equipment may be dismantled only after turning off the power for good.
Measurement and Payment
Per each dismantled set of 1 kV equipment (a set means the equipment from one 1 kV mast).

02.02.05; Delivery and laying of cable duct

Description of works
Delivery and laying of PPOO-A, 4x150 mm2, 1kV cable into the already prepared trench under and its routing through the Juvidur pipes under the highway. The item includes spreading of sub-base composed of fine grained earth or sand, 20 cm thick, supply and laying of 2 PVC warning tapes - first to be placed at the depth of 0.3 m from the cable and the other at 0.5 m from the cable. Procurement and laying of lead clamps bearing the impressed cable characteristics: type, voltage, section and year of laying.
Marks shall be placed at both entry and exit from the Juvidur pipes an inside the cable trench at every 5 m of the cable length. Backfilling with compaction in layers, bonding of cable ends. Procurement and placing of cable marks for unregulated ground.

Measurement
Measurement will be done per m. Complete material and work included.

01.02.06; Control of executed works

Description of works
Control of executed works, all required tests together with issue of relevant certificates and putting into operation.

Measurement and Payment
Payment will be done in lump sum.

01.02.07;02.02.08; Switching off the voltage and securing the site

Description of works
When displacing the existing cable lines, voltage shall be switched off and the site properly secured. The Contractor shall agree with the competent Power Distribution Company to switch off the voltage and secure the site.

Measurement and Payment
Payment will be done per account issued by the competent Power Distribution Company.

DESIGN FOR DISPLACEMENT AND PROTECTION OF 35kV TRANSMISSION LINE

2.1. GENERAL REQUIREMENTS FOR SUPPLY OF EQUIPMENT AND EXECUTION OF WORKS

The items in the Bill of Quantities and Cost Estimate include description, labour, material, machinery, tools, costs and company's profit for quality completion of each item.
All equipment shall be fabricated and all works executed according to applicable regulations and standards.

Execution of works
• Works shall be performed in strict accordance with the Design Documentation, the Contract and the "General and Technical Specifications for the Supply of Equipment and Execution of Works''.
• In the case of any discordance the Contractor shall duly request the Engineer's decision. Any design modification shall be supported by a written approval of the Designer and the Engineer. The Contractor shall organize the work to avoid interference with other contractors' performance on the site. The Contractor shall also pay all delays and damage inflicted to other contractors.
• The Contractor shall not assign the contract in full or in parts to any third party without the Employer's consent. The works shall be performed fully as specified in these conditions and other rules governing this kind of work. If during the performance some of these rules are modified, amended or new ones are passed the Contractor shall observe them without any compensation.
• The Contractor shall keep the structures and installations safe from mechanical damage, illegal use and the like, until final commissioning and issue of the final certificate.
• The Contractor shall perform the works (supply of materials included) not envisaged in the design documentation if they are necessary for proper functioning of a structure or for compliance with current regulations. The Contractor shall hand over the structure in proper order for operation
• These Technical conditions give only important general principles for quality performance. Everything else shall be subject to the relevant codes of practice listed in the design documentation.

Measurement and payment
The work shall be done in strict accordance with the approved design documentation and priced bill of quantities. Lists of materials, bills of quantities and detailed and other drawings shall constitute integral parts of the priced bill of quantities. The work shall be performed as directed by the Engineer and no alterations or important work phases (trial energizing and the like) may be done otherwise. The priced bill of quantities and conditions of contract award shall be integral parts of the contract document. The unit prices shall be the Contractor's selling prices and shall cover:
• Preliminary and final works for quality performance.
• Expenditures for the execution such as: labour, materials and waste, tools, formwork, scaffolds, costs of erection and dismantling, transport, overheads and other expenses allowed in the relevant regulation.
The work shall be performed in accordance with the tender documents, technical regulations and standards with the use of quality materials and skilled workforce, and shall be tested as specified.
Improper materials, which are not in compliance with the relevant technical regulations shall be removed from site by the Contractor and replaced with materials of good quality without entitlement to any compensation whatever.
If any work is performed with materials which do no comply with the technical conditions in the design documentation or with the Engineer's instructions the Contractor shall perform them at his own cost without any compensation whatsoever.
If the design documentation is incomplete or inaccurate the Contractor shall duly request its amendment and interpretation. Any costs of redesign or demolition due to the Contractor's failure to comply shall be borne by him and the Contractor will not be entitled to any compensation or time extension.
Upon completion of all the works or if directed by the Engineer in the course of phases, the Contractor shall make the prepare the structure for use and backfill and level off trenches and holes, clean buildings, installations, appliances and components of the equipment installed.
All these works shall be covered by the main items and will not be paid for separately.
The Contractor shall keep the completed plant, installations, appliances and components in order, clean and fully safe until commissioning. This shall be covered by unit price.

Supply of materials
The materials for the contracted works shall comply with SRPS standards but if these are not available then with other approved standards governing various kinds of materials. Each consignment shall be accompanied with test certificates on compliance.
The mechanical and electrical parameters of the equipment shall be confirmed by type and series tests. Each component shall bear indelible marks identifying the Manufacturer and the technology. The Contractor shall have responsibility for the materials used and unused and for the performance until take-over and issue of the final certificate.

2.2. TECHNICAL SPECIFICATIONS FOR DELIVERY OF EQUIPMENT AND EXECUTION OF WORKS

2.7; Dismantling of the existing 35 kV masts and equipment installed on 35 kV masts

Description of works
The Contractor shall dismantle the existing 35 kV equipment installed on 35 kV masts to be dismantled (the masts are indicated on drawings). The dismantled equipment shall be handed over to the User or Employer in his warehouse. The equipment shall be carefully dismantled, transported to distance of 5 km and stored to enable its reuse, if any. The Contractor, Engineer, Employer and User shall jointly determine the state of equipment to be dismantled, storing method and location, its further treatment and status. During dismantling care shall be taken to keep equipment in a good state and neither to endanger human safety and property nor to affect stability of surrounding structures. The equipment can be dismantled only when voltage is permanently switched off.

Measurement and Payment
Payment will be done per complete work. (complete work means dismantling of one 35 kV mast and equipment installed on one 35 kV mast).

2.6. Earthing of 35 kV mast

Description of works
Earthing of 35 kV mast. The item includes earth excavation, procurement and installation of earth electrode. The excavated channel shall be protected during backfilling. The earth electrode shall be made of galvanized iron, Ø10 mm. Zinc coat for earth electrode shall be minimum 70 μm thick. Underground joints shall be protected against moisture penetration by grouting with bitumen.

Measurement and Payment
Payment will be done per one earth electrode fully installed on 35 kV mast

DESIGN FOR DISPLACEMENT AND PROTECTION OF THE EXISTING TELECOMMUNICATION NETWORK

Missing technical specifications for some items in the Bill of Quantities

12.5.01.13, 12.5.02.11, 12.5.03.11, 12.5.04.10, 12.5.05.10, 12.5.06.08, 12.5.07.10
DETECTION OF THE EXISTING CABLE ROUTE BY CABLE DETECTOR

Description
Certified device shall be used for detection of the existing cable route and prescribed safety at work measures respected.
Measurement per meter of length.

12.5.05.15 SEALING OF PIPES WITH CONCRETE

Description
Sealing of transverse telecommunication cable conduit under the road with 3-5 cm thick layer of lean concrete MV-20 in width of 30 cm.
Measurement per meter of length.

12.5.01.19, 12.5.02.18 PLUGGING OF Ø40 mm PIPE

Description
The pipes shall be closed with specified plugs according to the relevant ZJPTT regulations. Take account of preventing penetration of water, earth and rodents prior to plugging.
Measurement per piece.

12.5.03.17, 12.5.04.16 PLUGGING OF Ø110 MM PIPE

Description
The pipes shall be closed with specified plugs according to the relevant ZJPTT regulations. Take account of preventing penetration of water, earth and rodents prior to plugging.
Measurement per piece.

12.5.01.23, 12.5.02.22 STRAIGHT CABLE JOINT ON OPTIC CABLE IN THE TRENCH

Description
Straight cable joint (in trench) shall be made according to the relevant ZJPTT regulations. Cable joint location shall be georeferenced and entered into the As-built design.
Measurement per piece.

12.5.01.27, 12.5.02.28, 12.5.03.21, 12.5.04.20, 12.5.05.21, 12.5.06.17, 12.5.07.20
GEODETIC SURVEY AND MAPPING

Description
Geodetic survey shall be performed according to ZJPTT regulations and professional rules. Survey shall be verified and approved by TELEKOM SRBIJA a.d. Company.
Measurement per meter of length.

12.05.01.26, 12.5.02.27, 12.5.03.20, 12.5.04.19, 12.5.05.20, 12.5.06.16, 12.5.07.19
PREPARATION OF AS-BUILT TECHNICAL DOCUMENTATION

Description
Preparation of as-built technical documentation.
Preparation per set.

12.5.02.24 CONECTING OF NEW RE PIPES Ø40 AND THE EXISTING ONES

Description
Connecting of the planned RE pipes ø40 and the existing ones. All required works and small instalation material included.
Measurement per meter.

12.5.02.23 DISMANTLING OF UNDERGROUND CABLE

Description
Dismanling of the existing telecommunication cable and disposal of dismantled material to the safe place and commisioning to the Employer.
Measurement per meter.

12.5.02.14, 12.5.03.14, 12.5.04.13, 12.5.05.13, 12.5.07.13,
PLACING COMBS INSIDE THE TRENCH

Description
Combs shall be placed according to ZJPTT regulations. Special attention shall be paid to levelling and stability.
Measurement per piece.

12.5.05.17   Positions does not contain any additional description

DESIGN OF OCS RECONSTRUCTION AND OVERPASS EARTHING

1. This Technical specification governs the execution, inspection and take over of the works needed to install 25 kV, 50 Hz single phase overhead contact line equipment together with internal inspection, testing and trial operation.
2. The works include civil and installation works to erect and mount equipment and materials and supply of necessary equipment and materials apart from those to be provided by the Employer, transport, insurance and other works listed in the General conditions and in the itemized descriptions. This Specification governs both civil works and installation unless stated that it refers to one class of works only.
3. As this specification mainly refers to OCS reconstruction the Contractor shall get familiar with the existing structures and the equipment purchased and prepare a detailed time schedule in conjunction with the user. These actions shall be approved by the Engineer.

4. OCS erection shall start as soon as the construction permit based on the technical documentation is obtained and shall be carried out in accordance with the Provisional technical instructions for design and construction of single phase 25 kV, 50 Hz overhead contact line on YR (TPE-KM1) General construction rules and this Technical Specification.
Whenever the Railways of Serbia are exempt from enforcing a general regulation, then only those provisions of the regulation which are not in conflict with the railway regulations shall apply.
5. Inspection described herein means the awareness of the Engineer that the works have been done in accordance with the contract documents which will not release the Contractor from his responsibility for the technical accuracy of the executed works.
6. Acceptance in this Specification means take-over of the works and the incorporated equipment and materials by quality and quantity for the sake of the settlement of accounts and payment.
7. Internal inspection of civil works shall be done after their completion and prior to erection.
Final internal inspection shall follow completion of OCS erection and precede an invitation to a relevant authority to perform inspection in accordance with the general regulations.
8. Testing of completed OCS envisaged in this specification shall be partly done at the time of the final internal inspection Section 0.7 hereof and partly when the OCS is put under voltage and during the trial operation.
9. The trial operation according to this Specification may start after a technical inspection, elimination of defects detected during technical inspection and live tests, i.e. upon receipt of the use permit.

12.6.01 DISMANTLING WORKS

Description of works

OCS fittings to be dismantled either permanently or temporarily as provided by the design shall be disassembled into parts by the Contractor (if their condition allows this), sorted out and handed over to the User or Employer in their store. Dismantling, transport within the distance of 5 km and storage shall be careful so that some fittings can, after repair be reused for maintenance. The Contractor, the Engineer, the Employer and the User shall jointly identify the condition of the fittings for dismantling as well as the way and place of storage, its further treatment and status.
It will be important to keep dismantled equipment in order and never threaten safety of people and goods or impair the structural stability.
OCS fittings may be dismantled only after suspension of traffic and power turning off on the OCS section concerned.
12.6.01.01 Payment per kg of dismantled mast. The Item includes breaking the foundation if an abandoned foundation may interfere.
12.6.01.02 The existing catenary system consisting of a catenary, a contact wire, and droppers shall be transferred to new cantilevers on OCS masts. Care shall be taken to keep the OCS fittings undamaged during the transfer. Tolerances of adjusted stagger and pull-off in curves shall not exceed □ 50 mm and □ 10 mm in overlaps.
12.6.01.03 Wherever tension length is changed, droppers shall have to be replaced. Permissible contact wire heights above high rail level at support points and dropper points shall be for:
- contact wire heights except minimum ones not less than 5020 mm- □ 15 mm
- minimum contact wire height /5020 mm/ - + 10 mm, - 0 mm.

12.6.01.04 Payment per each dismantled single cantilever and bracket assembly,
12.6.01.05 Payment per each dismantled mast earthing bonded to rail.

12.6.02 EARTHWORKS

12.6.02.01 Marking foundations for masts, portals and anchor ties, removal and replacement of crushed stone for ballast prism

Description of works
Mast centre lines shall be marked by the Contractor in the following way: by drawing one vertical and two horizontal lines on rail head and mast serial number on rail web in special paint (one rail only) and by pegging the track centre line and portal mast centre line.
Pits for foundations shall be marked by the Contractor based on pegged mast locations and high rail level (Local abbr. GIŠ) fully as designed. The setting out accuracy shall be certified by the Works manager and the Engineer and an entry shall be made in the construction log book
Prior to foundation setting-out the Contractor shall check the spacing of support points, distances between mast centre line to track centre line and the track side at which a mast shall be erected. In case of any discrepancy he shall inform the Engineer immediately.
Tolerances in foundation setting out compared to the designed ones are :
- mast centre to centre line distance ±100mm
- tension length ±500mm
- distance from track centre line to mast centre line +50mm - 0 mm

Measurement and Payment
Payment will be done per each marked foundation pit at each mast location.

12.6.02.02 Excavation of foundation pits for masts, portals and anchor ties, 0-2 m deep without struting in cat. II-III ground

Description of works
Excavation of foundation pits shall be careful, true to designed dimensions, without damage inflicted to underground installations and threat to personal safety. Excavation shall be done by hand. Pit sides shall be perpendicular down to the depth required, and the bottom shall be well levelled and horizontal.
Pits shall be safe from the beginning of excavation until concreting. Pit sides for cantilever masts shall be parallel i.e. at the right angle to the nearer rail while pit sides for portal masts shall be perpendicular, i.e. parallel to the portal centre line unless otherwise specified by the design.
If major trouble is encountered during excavation of pits because of underground installations excavation shall be stopped, the pit shall be made safe and either the Designer or the Engineer shall be invited. Data shall be daily recorded in the construction log book and every such entry shall be signed by the Employer's Engineer who shall thus confirm acceptance of foundation pits.
Dimensions and depth of pits, their positions in relation to track centre line, bottom evenness, safety against ground collapse shall be checked and the soil bearing capacity determined to check its compliance with the designed value. In case the designed bearing capacity differs from the actual one, foundations shall be modified by the Engineer in conjunction with the Designer.
In special cases foundation pits in hard ground need not be timbered if the Engineer approves it.

Measurement and Payment
Payment will be done per m3 of excavated foundation pit at support point.

12.6.02.03 Backfilling and compaction of earth around foundations together with spreading

Description of works
If foundation is planned to be backfilled from above, excavated earth will be used. Backfilling shall be in 20 cm thick layers together with compacting.

Measurement and Payment

Payment will be done per m3 of earth to be used for foundation backfilling.

12.6.02.04 Haulage of spoil of all categories with loading and unloading within 5-20m distance

Description of works
Spoil apart from the quantity needed for backfilling around a finished foundation shall be hauled away. Embankment slopes, ballast and drains shall be cleaned. Spoil shall not be deposited at track side and shall by no means be thrown over and mixed with crushed stone ballast. Drains must not be clogged with spoil either.

Measurement and Payment
Payment will be done per m3 removed spoil.

12.06.03 CONCRETE WORKS

12.6.03.01 Concreting of mast foundations, portals and anchors through the use of concrete, class MB15. Mechanical mixing and compaction by pre-vibrator.

Description of works
Foundation pit dimensions shall be checked prior to concreting, pit shall be cleaned well and made safe against ground collapse. Concrete shall be, as a rule mixed mechanically and vibrated.
Concrete mass for foundations can be mixed at a central point and transported to the point of placing in mixers, dumpers, rail cars or working train provided mix homogeneity is ensured by constant agitation and the mass is placed before cement starts to set. Concrete may be mixed in special trains which will serve for both mixing and transport of concrete.
Test cubes shall be taken at each 100 m3 of placed concrete.
Concreting shall proceed without interruption. Cylinders for holding down bolts shall be placed as shown on drawings of typical or special solutions. Minor collapses of pit walls shall be filled with normal concrete mix without strutting. Concrete class will be MB15.
The quality of concrete and its constituents (cement, gravel, water) shall meet the following rules and standards:
a) Technical Code for Plain and Reinforced Concrete
b) Serbian standards (hereinafter SRPS).
Foundation tops will be related to railway line benchmarks.
Permissible tolerances for precast and cast in place plain and reinforced concrete foundations of designed dimensions are as follows:

- Cracks	not permitted
- Holding down bolts	vertical, straight with protected threads
- Openings for mast planting	± 10 mm by width
- Openings for planting of masts	± 10 mm by depth
- Cross fall and deviation of holding down bolts from a horizontal line towards the side opposite to main load direction	not more than 1:100
- Cross fall of foundation top and deviation of holding down bolts from a horizontal line towards main load direction	not permitted
- Foundation centre-to-track centre distance	+ 50 mm, - 0 mm
- Top foundation surface level	± 20 mm
- Rotation from a plane perpendicular to track centre line and around vertical axis to both sides	to 1 o

Masts can be fixed to foundations after the above inspection.

Measurement and Payment
Payment per m3 of concrete mix MB15 used for mast foundations.

12.6.03.02 Increased costs due to strutting

Description of works
The foundation parts protruding above the ground shall be concreted in strutting. The strutting shall accurately follow the shape and position of each foundation. Its striking can take place only when concrete achieves the necessary strength that will preserve concrete surface and edges from damage during strutting removal, but not earlier than 24 hours after concreting. Foundations may be loaded when concrete reaches 70% of its designed strength. After striking of strutting surface damages may be repaired if permitted by the Engineer pursuant to civil engineering rules.

Measurement and Payment
Per m2 of area of the strutting used for foundation construction.

12.6.03.03 Finishing visible faces of foundation with 1:3 cement mortar, 2 cm thick in average

Description of works

Visible faces of foundations shall be finished with cement mortar. Finished foundation tops shall enable water runoff and shall contain a groove for earthing wire.

Measurement and Payment
Per m2 of area of the strutting used for foundation face finishing.

12.6.03.04 Delivery and fixing of M 36/830 mm holding down bolts for masts with base plates

Description of works

Masts with base plates shall be fixed to foundation with holding down bolts M36, 830mm long, thread length 150 mm, with pits at bottom of steel Č0461, hot dip galvanized according to OCS Catalogue, No. 151100.
Holding down bolts shall be secured with nuts in a template. They shall remain strictly vertical during concrete placing and the distances to timbering shall be constantly monitored. Free bolt sections shall be greased and protected with suitable caps of tar paper or wrapped with paper and wire. Threads on bolts shall

be inspected after removal of the above protection. If necessary threads shall be cleaned and finished with appropriate tool. Bolt accuracy shall be checked by tightening nuts to ends of threads. This done, fixing of masts may start.
Such free bolt sections shall be black and/or galvanized depending on the type of protection of the supporting structure to be fixed onto them.

Measurement and Payment
Per each delivered and fitted holding down bolt M36/830 mm and three nuts and two base plates.

12.6.04 MASTS AND PORTALS

12.6.04.01 Delivery and erection

Description of works
OCS masts shall be standard, of twin channel steel sections with steel rod bracing. They are available in several types, of standard height of high mast (V identification). Masts shall be selected to suit the OCS design. Anti-corrosive protection shall be in form of hot dip galvanizing. OCS masts shall fully conform to standard drawing TR1-501 in the Catalogue of 25kV, 50 Hz overhead catenary system.
Masts shall be erected fully as designed.
The following tolerances of designed dimensions are allowed for erected masts:

- Rotation of mast around its vertical axis to one or other side from a plane perpendicular to track axis, 1 o
- Distance from inner face of mast to track centre line + 50 mm- 0 mm
- Rake of mast axis to all directions from designed axial position not more than 0.2 % of free mast height

Each mast inserted in foundation opening shall be temporarily made safe with wooden wedges and raked away from track while in the station areas each mast between tracks shall be temporarily raked in the direction of track axis or be strictly vertical.
When a mast is to be fixed onto holding down bolts each of its legs shall be secured with at least one nut. Pads can also be used for its vertical adjustment but more than three pads shall not be left on on one bolt 10 mm thick altogether.
If protective zinc coat on a supporting structure or its parts is damaged they shall not be erected until damages are repaired. Anti-corrosive coat shall be carefully applied to such damaged spots

Measurement and Payment
Payment will be done per kg of delivered and erected OCS mast.

12.6.04.02 Impressing TOR, mast number and distance of mast inner face to track centre line on mast

Description of works
Each mast shall bear a serial number, danger sign for 25 kV high voltage, distance of mast inner face to track centre line and TOR sign, too. The signs shall be legible, indelible and inerasable. The sign shall be installed at the height of 1.5 m measured from the TOR.

Measurement and Payment
Payment will be done per each marked OCS mast.

12.6.05 ELECTRICAL INSTALLATIONS

12.6.05.01 Single cantilever assembly with brackets for twin channel masts or drop arms on portals

Description of works
Cantilevers for catenary system suspension shall be delivered according to standard designs in 25kV, 50Hz OCS Catalogue TR2-501 to TR2-522, and possibly in special designs shown on the relevant drawings. Cantilever brackets for masts shall be made of hot dip galvanized steel. Brackets shall be selected from among standard designs given in 25kV, 50Hz OCS Catalogue.
Bracket position may deviate from the designed one by □ 10 mm.
Cantilevers shall be assembled in the Contractor's workshop and together with other suspension assemblies transported so that no part suffers any damage. Openings in suspension tubes shall be safely plugged to prevent humidity getting in.
Suspension assemblies shall be provisionally fixed to supporting structures until wires are pulled out so that they do not move, suffer damage or foul clear track profile

Measurement and Payment
Payment will be done per delivered, fixed standard or special cantilever assemble with bracket for mast.

12.6.06 RETURN CONDUCTOR AND EARTHING

12.6.06.01 Delivery and installation of bonds made of bare 35 mm2 copper strand

Description of works
Metallic structures near an electrified railway line shall be earthed as designed. Unconnected structural parts shall have bonds of 35 mm2 copper strand as shown on design drawings, cat. No. 651110 Catalogue of 25kV, 50Hz OCS on the understanding that strand insulation shall be cut out and thrown away.
The points where an earth wire is bonded to rails and structures earthed shall be accessible for inspection. Each strand shall be welded to structure by AL-thermal method, CADWELD.

Measurement and Payment
Payment will be done per each delivered and fitted bond of 35 mm2,copper wire, 220 mm long.

12.6.06.02 Delivery and fixing of a full spark gap assembly for metalwork earthing

Description of works
The metalwork usually not bonded to rails shall be earthed via spark gaps. A spark gap shall be bonded to the rail foot inside as provided in the design. Spark gap characteristics shall be:

- Alternating response voltage - 220V;
- Max withstand voltage – 430V,
- 100% - impact response voltage – 1000V
- Apex value of short time withstand impact current - 8000A

Measurement and Payment
Payment will be done per each delivered and fitted spark gap and bracket.

12.6.06.03 Delivery and fixing bare galvanized steel strand, 95mm2 on post supports for bonding metalwork to earth

Description of works
Metalwork shall be earthed by means of a galvanized earth wire, 95 mm2, Cat.No.656200 with bonding material. On a concrete surface the wire shall be placed on posts at 1m spacing, Cat. No. 656300 while it shall be fixed to structure by means of Al-thermal welding method CADWELD.

Measurement and Payment
Payment will be done per piece and m of delivered, fixed and bonded earth wire FeZn 95 mm2, with bonding material and posts on structure.

12.6.06.4 Delivery and installation of earthing assembly of bare galvanized steel strand, 95mm2 buried in track formation and bonded to rail for supporting structures or other metalwork outside tunnels

Description of works
OCS supporting structures shall be earthen to rail with 95 mm2 galvanized steel strand, standard design TR6-551 Catalogue of 25kV, 50Hz OCS, screwed to a plate on mast and welded to the rail outer side by Al-thermal CADWELD method. It shall be fixed with brackets to wooden sleeper (cat.No.650400) or concrete (cat.No.650500). For protection purposes it shall be buried 20 cm deep in the formation.

Measurement and Payment
Payment will be done per each delivered and fitted earthing wire, 3500 mm or 5000 mm long on average with brackets and fastenings.

12.6.06.05 Delivery and fixing of mechanical barrier of 50 x 50 x 1600 mm angles

Description of works
Earth wire shall be protected against mechanical damage at the point where it penetrates into soil with hot dip galvanized angles 50x50x1600mm, in strict accordance with Cat. No. 656600, 25kV, 50Hz, OCS Catalogue.

Measurement and Payment
Payment will be done per each delivered and fixed mechanical barrier for earth wire protection fixed to adjacent structure.

12.6.06.06 Delivery and fixing of danger warning plate Cat. JŽ 951101

Description of works
Danger warning plates shall be fixed on overbridge fences crossing an electrified line, Cat. No. 951101, Catalogue of 25kV, 50Hz OCS.

Measurement and Payment
Payment will be per each delivered and fixed warning plate with fittings, fixed to a structure next to it.

12.6.07 MISCELLANEOUS WORKS

12.6.07.01 OCS inspection, testing and energizing

Description of works
OCS internal inspection shall start as soon as the relevant OCS system is fully completed. The final internal inspection shall be performed by a commission whose members shall be:
- The Employer's representative
- The Contractor's representative
- The Engineer for civil works
- The Engineer for erection of OCS system
- Chief Site Engineer for civil works
- Chief Site Engineer for erection of OCS system .

Prior to the final internal inspection of completed OCS the Contractor shall submit to the Engineer one copy of the design technical documentation containing modifications up to that date as well as who performed them and who permitted them .
The results of final internal inspection and possible comments shall be entered in the construction log book.
The following shall be checked:
- Whether the OCS is mounted in strict accordance with the design,
- Whether the equipment and materials comply with the design,
- Whether the work are of good quality and comply with this Technical Specification and engineering practice.

A check of compliance of OCS with the technical documentation shall include checks of :
- OCS sectioning
- Wire and conductor cross sectional areas
- Locations and positions of disconnecting switches
- Clear profile in all cross sections
- Safety clearances particularly on platforms, road-rail level crossings, in tunnels, on overbridges
- Accuracy of basic OCS dimensions
- Stagger and position of contact wire in the middle of span from a static pantograph centre line particularly in circle and transition curves
- Method and quality of bonds and connections, electrical and mechanical
- Return conductor and earthing
- Adjustment of overhead contact line equipment to suit the tables and drawings.

A check of equipment and material shall include checks of:
- Anti-corrosive protection of equipment
- The state of the erected and fitted equipment and materials provided by the Employer
- Quality of return conductor and earthing and protective measures
- Quality of works and of fitted equipment and materials provided by the Contractor

A check of workmanship shall include checks of:
- Method and fixing quality of suspension, tensioning and electrical sectioning assemblies,
- Reliability of wire splices and connections of the fittings
- Accurate positioning of wires between equipment and insulators
- Functionality of hand isolator drives, contact making, lubricated bases and friction faces and cleanliness of isolators and their contacts
- Treatment of wire ends
- Quality of repairs if any damages were inflicted in the course of installation.

The Commission shall set a date by which the Contractor shall repair and remedy the works according to comments given in the Minutes.

The Contractor shall act upon the comments given and invite the commission to repeat the checking procedure and check only the equipment to which the comments referred.
When the Commission confirm that the Contractor has incorporated the comments, the members shall sign the minutes on the final internal inspection of the installed OCS and the completed overhead contact line shall be ready for testing, technical inspection, energizing and trial operation.

TESTING

Testing means inspecting and testing OCS equipment prior to putting it under voltage and subsequent testing.
Prior to energizing, the OCS equipment shall be tested for :
- Mechanical properties,
- Earthing resistance measurements,
- Insulation resistance measurement.

Mechanical properties shall be tested at different running speeds under normal pressure and at reduced speeds under increased pressure exerted by a specified pantograph over points/ turnouts.
Earthing measurement shall be done not earlier than two days after rain. Measured value shall be smaller or equal to the designed one. Measurement of earth resistance shall strictly follow the method given in the design.
Measurement of insulation resistance of all OCS wires shall be done with 1000V megaOhm metre. Measured resistance value shall not be below 1 megaOhm for one feeding section.
After energizing the following shall be done:
- A check of voltage,
- Running of a special inspection car or an electrical locomotive
- Measurement of touch and step voltages

Voltages shall be checked against readings from the respective instruments.
A special inspection car or electrical locomotive will be used to monitor OCS performance at various running speeds up to maximum one at which current collection will be free from arcing between contact wire and pantograph. The following characteristic values shall be checked from an inspection car – running speed, variations of pantograph pressure on contact wire, variations of contact wire height, interrupted voltage at suspension points, stagger of contact wire, etc.
OCS performance shall be checked by a maximum specified number of locomotives coupled at the head of a freight train with only one pantograph raised on each locomotive. The maximum speed shall be as provided in the design.
Touch and step voltages shall be measured in normal operating conditions and at short circuit (artificial) longitudinally along the track, and crosswise

TRIAL OPERATION

General

OCS equipment may be put under voltage and into trial operation only when all prerequisites for proper OCS performance on a track section are satisfied.

Minimum OCS length on which a trial operation may start is one section.

Putting under voltage
A prerequisite to energizing OCS equipment will be the completion of all civil and fitting works, testing according to these Conditions and sending workers away from the site. The Contractor shall confirm to the Employer in writing that workers have left the site.
Prior to putting the OCS equipment under voltage all isolators shall be in OFF position and all temporary earthing removed.
The OCS equipment shall be put under voltage by the Employer and attended by the Contractor.

Tasks during a trial operation
The tests listed in this specification shall be undertaken during the trial operation.
Operation of disconnecting switches and section insulators shall be checked.
Touch and step voltage values shall be measured.
Systematic records of faults shall be kept. Causes of faults shall be traced and removed

Measurement and Payment
Payment will be done upon completion of all works stated in the Item.

12.6.07.02 Works on 25 kV network and site safety

Description of works
Power in OCS shall be temporarily turned off prior to work on 25 kV catenary system. Power shall be turned off by opening disconnectors in OCS or circuit breakers in substations. Each site shall be made safe with rods placed along its limits and earthing rods, Instructions 227 on electrical safety on electrified railway lines JŽ (ZJŽ No.287-8/78), Rulebook 227a on safety measures on single phase 25kV, 50Hz OCS JŽ (ZJŽ No.300-7), and Rulebook 228 for works on YR tracks electrified with 25kV, 50Hz. single phase system.

Measurement and Payment
Payment will be done upon completion of all works stated in the Item.

DESIGN FOR DISPLACEMENT AND PROTECTION OF THE EXISTING WATER PIPES

12.7/7.03.00. INSTALLATION WORKS

12.7/7.03.01. PROCUREMENT, TRANSPORT AND ASSEMBLY OF PIPES

Description of works
Procurement, transport, distribution along trench and laying of water pipes into trench as designed. Pipes shall be carefully laid on a sand bed and aligned to designed line and grades. Work shall proceed fully as specified in the technical regulations for this type of pipes, drawings and the Engineer’s instructions.
The price shall cover material, waste, distribution of pipes along trench, inspection of each pipe and joint, lowering on sand bed and joining.

Material
- Pipes for low pressure of 10 bar.
- Ø90 mm (DN90) (HDPE-100)

Measurement and Payment

Payment will be done per m’ of completely assembled pipes.

12.7/7.03.02. CAST IRON PIPE FITTINGS

Description of works
Cast iron pipe fittings for low pressure of 10 bars. Procurement, transport, distribution along and installation of pipe fittings into trench. Installation shall be made according to installation plan (for nodes). All flange joints out of manholes shall be coated with bitumen after completion of trial pressure test.

Measurement and Payment
Payment will be done per kg of completely installed pipe fitting.

12.7/7.03.03. POLYETHYLENE PIPE FITTINGS

Description of works
Polyethylene pipe fitting for low pressure of 10 bars. Procurement, transport, distribution along and installation of pipe fittings into trench. Installation shall be made according to installation plan (for nodes). All flange joints out of manholes shall be coated with bitumen after completion of trial pressure test.

Material
PEHD PE100

Measurement and Payment
Payment will be done per one completely installed pipe fitting.

12.7/7.03.04. EURO 20 VALVES

Description of works
EURO 20 valves (type 21). Procurement, transport and installation of wheel valves in manhole and valves with set of accessories out of manhole for operation pressure of 10 bars. After installation the valves shall be controlled and properly tested. All works shall be performed according to design documentation, current regulations for this type of works and the Engineer instructions.

Material
- EURO 20 Ø 80 mm

Measurement and Payment
Payment will be done per one completely installed valve.

12.7/7.03.05. CAST IRON LIDS

Description of works
Cast iron lids. Procurement, transport and fitting of cast iron lids for manholes of 625 mm, SRPS M.J6.226. Installation shall be performed according to design documentation and the Engineer’s instructions.

Measurement and Payment
Payment will be done per one installed lid.

12.7/7.03.06. CAST IRON RUNGS

Description of works
Procurement, transport and installation of cast iron rungs, SRPS M.J6.285.

Measurement and Payment
Payment will be done per one installed rung.

12.7/7.04.00. PLAIN AND REINFORCED CONCRETE WORKS

For plain and reinforced concrete mentioned in this part of documentation the following will apply:

Material
The following applies to all items: works on concrete and reinforcement shall be performed fully in accordance with design documentation, structural analysis and current codes.
Concrete will be mixed, transported, placed and tested on test sample according to provisions of the Code of Technical Standards for Plain and Reinforced Concrete - PBAB 87 – Official Gazette of the SFRY, No. 11/87. Concrete mix will consist of aggregates and cement certified according to the current Serbian regulations. Concrete shall be mixed mechanically and compacted by vibration. The price of concrete includes formwork and scaffold. Measurement includes all works, materials, auxiliary tool, placing and curing of concrete and other company’s costs and income.
Payment of fully completed work per m³ of placed concrete. Reinforcing bars shall be paid separately. The bars shall be free from rust and dirt, bent and fixed according to reinforcement drawings. Unit price of reinforcing bars includes placing of pads to achieve specified covers and proper position of reinforcing bars in the structure. All distribution steel and stirrups shall be firmly fixed to the main reinforcement to secure their proper position.
The Contractor is responsible for a quality of fixed reinforcing bars. Payment per kg of fixed bars regardless of complexity and reinforcing bar diameter according to tabulated weights.

12.7/7.04.01. LEAN CONCRETE BEDDING

Description of works
Lean concrete, class MB15, 10 cm thick, under the bottom plate of manholes and inspection shafts.

Measurement and Payment
Payment will be done per m³ of placed concrete, class MB15.

12.7/7.05.00. SUNDRY WORKS

12.7/7.05.04. GEODETIC SURVEY

Description of works
As-built survey. After laying of water pipes and prior to backfilling, pipelines, hydrants, manholes, house drains and other facilities in the network shall be surveyed.
After completion of survey, the As-built report shall be prepared and delivered to the Employer.
Payment per m’ of surveyed pipeline.

Measurement and Payment
Payment will be done per m’ of surveyed pipeline.

CIVIL ENGINEERING DESIGN OF TELECOMMUNICATION CABLE CONDUIT, Book 12, Volume 8

INTRODUCTION
The Technical specifications describe in detail particular parts of the design, requirements for the execution of works and quality of performed works.
If this Technical specification does not cover some work, or does not define quality, testing of materials, safety or health and hygiene provisions, then relevant laws, rules, regulations, and standards shall apply. All works shall be performed in compliance with technical specifications, reviewed and verified designs and here mentioned laws, rules and standards.
These technical specifications will be applied to all civil works. General and special provisions given with the Bill of Quantities are integral part of these Technical specifications.

08.02.01.01.02 Positions does not contain any additional description

08.02.01.04.01. BRICKWORK

Building shall be carried out by qualified workers fully as stated in the current technical regulations and the Code of practices in civil engineering.
Brickwork shall exactly follow the plans; bricks shall be properly bonded in horizontal rows without pieces smaller than 1/4 of brick and such pieces shall not be laid one next to the other in a wall.
Vertical and horizontal joints shall be filled with mortar free of voids. Mortar in joints shall not be thicker than 10 - 12 mm. Outer joints shall be left empty by 15-20 mm to allow good bond during wall rendering.
Mortar escaping from joints still fresh shall be removed with trowel and wiped with hessian cloth.
Care shall be taken during wall building of the following:
- To align designed bonds in brickwork consistently and accurately over the whole wall area,
- To cut bricks with a machine, if necessary,
- To make joint strictly horizontal and/or vertical and continuous in width.

Measurement per m2 or m3, which will be defined in the Bill of Quantities.

08.02.01.05. MISCELLANEOUS

Waterproofing of concrete faces in contact with earth shall be meticulously and accurately done according to the design requirements, bill of quantities and detailed drawings.
Used materials shall conform to the current standards and regulations, shall be accompanied with test certificates of accredited institutions, verified in use, durable same as the structure itself or designed to be replaceable.
Measurement per m2 of coated area with all consumed quantities of materials, transport and labor. Unit price shall be as described above in this item per m2.

08.02.01.05.01. WATERPROOFING

General provisions

The work shall be of good quality strictly according to designed detail. Waterproofing shall be done by qualified manpower with appropriate tools and materials, properly procured and stored complying to technical regulations, codes of practices and SRPS standards. The works only that will be executed properly and have the quality specified, requested or commonly expected in the regulations and design shall be measured.
Prior to the commencement of works the Contractor shall submit test certificates to the Employer for all materials he intends to purchase and use. Test certificates shall be issued by accredited institutions for this kind of works and shall not be older than one year counting from the date of their issue to the date of commencement of the works by the Contractor.
The contracted waterproofing items shall be performed according to the design drawings based on which the Contractor will prepare construction details and method statement for the whole structure or certain phases of the works, to be inspected by the Supervising Engineer and Designer. The Contractor shall be fully professionally and legally responsible for the above if the Designer or the Employer accepts his proposal as a better one than the design concept. The Waterproofing Contractor is particularly warned to pay full consideration to the following:
- Waterproofing may be done only in accordance with technically correct details, relevant regulations, instructions and by a verified, proper and usual method of work at the weather suiting them or with adequate protection in case of sudden weather changes or storm.
- Civil, finishing and other works preceding application of waterproofing layers or phases and either associated with them or in any other way depending on them technologically, and those works whose synchronized or later execution may cause damage to waterproofing shall be done in advance of the above, namely in an appropriate sequence agreed and approved.
- Performance of the civil, finishing and other works that may affect the quality, safety and durability of waterproofing shall be checked before it is commenced. The Waterproofing Contractor shall duly inform in writing the Main Contractor about his needs and the latter shall submit this report to the Supervising Engineer to inspect it together with other relevant procedures in the technology of works that usually precede waterproofing.
- All materials to be used shall be sound in every respect.
- Unsound materials (damaged, stuck together or failing to be of appropriate specified quality) shall not be stored, kept on site or placed.
- Waterproofing shall be done in the way that its segments and layers as well as finished items fully conform to use, quality requirements, safety and durability.

Prior to starting any contracted waterproofing item, the base surface shall be dedusted and carefully and well cleaned from all dirt, loose dust particles, possible stains of oil, grease, acids etc. If these are not cleaned and removed they may form an interim layer between base and waterproofing and prevent a good bond. The base shall be if possible blown with compressed air and washed with a solution of caustic soda and water and some other efficient and approved agent.

08.02.01.05.02. FITTING OF LIDS

The following lids are used to cover manholes of telecommunication cable conduit:
- Light (~130 kg) for manholes in pavement and grassland
- Heavy (~280 kg) for manholes in pavement

The lids enable easy access to the manhole, more favorable bending diameter of telecommunication cables and manhole inspection. The lid shall prevent penetration of water and dirt into a cable conduit in case of precipitation and street washing.
The lids consist of the following elements:

Light lid:	- frame
	- plate (cover)
	- rubber seal
Heavy lid:	- frame
	- outer plate (cover)
	- plate (cover)
	- rubber seal

A frame shall be made of gray cast iron which quality shall comply to SRPS C J2.020/73.
A frame shall be even without any distortion, rectangular, with clean edges and grooves so that all plates uniformly rest on the frame without rocking. A groove with a rubber seal shall be conical, of uniform depth and width.
Lid plates shall be made of grey cast iron which quality shall comply to SRPS C J2.020/73. The plates shall be square without any distortion, with clean edges and appropriate number of adequately located ribs on the bottom side. Top plates shall withstand live load without any damage as follows:
- 12.5 t for plates in grassland and sidewalk
- 25 t for plates in pavement

To prevent slipping, the plate top surface shall have checkered-relief pattern. Sealing rubber shall be without neoprene-based textile insert.
The manufacturer shall complement, sort out and test a quantity prepared for delivery in accordance with these technical specifications and make a test book. The manufacturer shall have a test certificate issued by the authorized institution for tests which cannot be performed in the factory. Fabrication and dimensions shall be checked visually and by measuring dimensions according to documentation and with testing plate seat in the frame and the way plate opens and seals.
Cast iron lid shall be fitted to each manhole – light lid for manhole in sidewalks and heavy lid for manholes in pavement. The lid shall be mounted at height of 0.5 cm above the sidewalk and pavement level but in case of earth surface it will be mounted at height of 1 cm above the ground level. The lid seat shall be concreted with 1:4 mix of cement and gravel.

08.02.01.05.03. FUNNEL-LIKE OPENINGS

Funnel-like openings for pipes in the manhole wall shall be made for whole pipe profile with canted sides. All pipes shall be of same length i.e. aligned for easy mortaring.

08.02.01.05.04. MOUNTING OF CABLE AND CANTILEVER SUPPORTS

Cable supports shall be mounted on walls in telephone manholes and galleries to support cables which are laid there. The supports shall enable easy mounting and safe support of cables and joints. The cable supports consist of one or more components.
Simple support consists of a cantilever and shoe. The cantilever shall be made of appropriate steel section (pipes, Ø section, L section, T section, U section) of specified quality to support cables in manholes and galleries. One cantilever end shall have suitable shape to be mounted directly on the wall or fixed and/or screwed into seat previously placed onto wall. The other cantilever end shall be suitable finished with rounded edges to prevent cable damage of worker injury. Cantilever seat shall be made of steel sheet or casting and have suitable shape to fix or screw the corresponding cantilever. A shoe shall be flexibly mounted to ensure cable laying along the as large as possible surface. A base shall be made of a steel section of specified shape and quality and to enable easy mounting, fixing or screwing of cantilevers.
The manufacture shall complement and test a quantity of cable supports prepared for delivery and make a test book. Fabrication shall be checked by visually inspection of surfaces, complementing and marking while dimensions will be gauged in the appropriate way. The quality of used materials shall be controlled by insight into the factory test certificates and if they are not available, then by laboratory tests.
The lowest row of supports shall be mounted at height of 0.3 m above the ground level while the highest row can be at 0.3 m below the manhole ceiling. Spacing between rows can be 0.3 – 0.5 m. Spacing between supports depends on number and design of cables and can be 0.8 – 1.2 m.

DESIGN FOR DISPLACEMENT AND PROTECTION OF LINESIDE CABLES, Book 12, Volume 9

The missing technical specifications for items of the Bill of Quantities

12.09.01.02.18, 12.09.01.02.19, 12.09.01.02.20, 12.09.01.02.21, 12.09.01.02.22, 12.09.02.02.17, 12.09.02.02.18, 12.09.02.02.19 12.09.02.02.20 12.09.02.02.21 12.09.03.02.14, 12.09.03.02.15 12.09.03.02.16, 12.09.05.02.17 12.09.05.02.18 12.09.05.02.19 12.09.05.02.20, 12.09.05.02.21, 12.09.06.02.16 12.09.06.02.17 12.09.06.02.18 12.09.06.02.19

COPPER CABLE SPLICING IN A TRENCH

Description
Copper wires in cables shall be spliced by twisting. 0.8 mm diameter and thicker wires shall be soldered. The splices shall be insulated with small paper tubes Splices in the form of single or multiple wire connectors and multiple modules will be permitted only if explicitly envisaged in the Technical description or specifically directed by the Engineer
Capacitive coupling shall be made for the purpose of crosstalk attenuation in low frequency range as described in the Technical description. Loading coils shall be inserted to reduce pair attenuation in low frequency range

12.09.05.01.09, 12.09.05.02.13, 12.09.05.02.22, 12.09.05.02.23, 12.09.05.02.24, 12.09.05.02.25, 12.09.05.02.26, 12.09.05.02.27, 12.09.05.02.28, 12.09.05.02.29, 12.09.05.02.30, 12.09.05.02.36, 12.09.05.02.37, 12.09.06.02.15, 12.09.06.02.20, 12.09.06.02.21, 12.09.06.02.22, 12.09.06.02.23, 12.09.06.02.24, 12.09.06.02.25, 12.09.06.02.26, 12.09.06.02.27, 12.09.06.02.28, 12.09.06.02.35, 12.09.06.02.36. Technical specifications for above mentioned Items are given in BoQ.

LANDSCAPING DESIGN

GENERAL SPECIFICATIONS FOR LANDSCAPING

14.01.01. 14.01.02. 14.01.03. 14.01.04. 14.01.05. 14.01.06. LANDSCAPING WORKS

Description of works
Seedlings shall be planted in autumn when growing period is completed or in spring before the start of growing period.
Planting material shall be cultivated in the nursery-garden and properly developed with undamaged root system and aerial part without any entomological or phytopathological disease.
Planting material shall be picked from the nursery-garden and transported immediately prior to planting in permanent place.

If planting is not possible on the spot, planting material transported without baled turfs shall be stored in a clamp at once.
Fertilization with humus-peat fertilizer or well burned two-year manure shall be performed in the following way: at first, specific fertilizer quantity shall be mixed with humus earth and spread around and over the root system at the time of planting.
At the time of planting, seedlings shall be oriented toward marked cardinal point (north) to be at same position as in the nursery-garden thus enabling proper further growing.
Seedlings of deciduous trees shall be fixed by rubber clips with raffia strings or figure-of-eight rope to a stick of specified height with rounded top placed vertically to dominant wind direction prior to covering up the turfs in order to avoid root system damage.
Planting depth and/or position of root tip shall be by 2-3 cm below the level at which a seedling was during cultivation in the nursery-garden. It is expected that earth will be settled to a level of the root neck after planting and watering.
A seedling shall be permanently fixed to a stick 2-3 days after planting and/or settling of earth around the planted seedling.
Coniferous trees shall be anchored in three directions with pegs, wire and rubber clips placed around the tree.
After planting, the ground around seedlings of all vegetation categories shall be adequately prepared to ensure proper watering.
Each planting pit shall be cylinder-shaped with different diameter and depth depending on category:

High conifers	1.0 x 1.0 m2
Middle-high and low conifers	0.8 x 0.8 m2
High deciduous trees	1.0 x 1.0 m2
Middle-high and low deciduous trees	0.8 x 0.8 m2
Shrubs and climbing plants	0.4 x 0.4 m2

For different categories of planting material, each pit requires the following quantities of peat fertilizer:

For high conifers	20 kg
For middle-high and low conifers	10 kg
For high deciduous trees	25 kg
For middle-high and low deciduous trees	15 kg
For shrubs and climbing plants	3-5 kg

Measurement
Measurement will be done per one seedling.

14.02.01. MAINTENANCE OF VEGETATION

Description of works
After complete cultivation of green areas they shall be intensively nurtured and maintained in order to facilitate adaptation of seedlings to the new environment and ensure quick growth and biologically strong vegetation.
In order to meet seedling needs and achieve the above-mentioned, the following shall be performed:
- Pruning the hedge
- Hoeing the seedlings of trees, shrubs, roses and hedge
- Grassland weeding out
- Grassland mowing, raking and rolling
- Watering of grassland and seedlings
- Nutrition and landscaping of flower gardens, change of seasonal flowers, weeding, hoeing, watering, etc.

Vegetation maintenance value is about 20% of landscaping amount for 1 (one) calendar year. Maintenance shall start from the day of technical inspection. Planted material shall be maintained from the very beginning and the above stated percent serves for provision of financial resources for maintenance till acceptance of works.
During the defect liability period the Contractor shall eliminate at his expense all defects caused by unprofessionally performed works or planting of low-quality vegetation.

Measurement
About 20 % of the landscaping investment value shall be measured.

ENVIRONMENTAL MANAGEMENT PLAN
& CHECK LIST

TABLE OF CONTENTS

APPENDICES

ABBREVIATIONS AND ACRONYMS

EIB	European Investment Bank
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study / Environmental Impact Statement
EMP	Environmental Management Plan
HSE	Health, Safety and Environment
INP	Institute for Nature Protection of the Republic of Serbia
IPCM	Institute for Protection of Cultural Monuments of the Republic of Serbia
KS	Koridori Srbije Drustvo sa Ogranicenom Odgovornoscu (“Corridors of Serbia”)
MOESP	Ministry of Environment and Spatial Planning
NCA	Natural Cultural Assets
PAP	Project Affected Person
PEPS	Public Enterprise “Putevi Srbije” (Roads of Serbia)
PMC	Project Management Consultant
SSIP	Site Specific Implementation Plan
WB	The World Bank Group
WMP	Waste Management Plan

INTRODUCTION

Corridor X is one of the ten pan-European corridors and Serbia's main transport route. It provides vital links to Bulgaria in the east, FYR Macedonia and Greece in the south and to Croatia, Hungary and Western Europe in the north. The construction of the E-75 motorway, running from Nis to the Border of FYR Macedonia, will allow Serbia to capitalize further on its location as a transit country for international transport.

The second section of the E-75 motorway, from Nis to Grabovnica, has already been built. The missing Corridor Xd highway section from Grabovnica to Levosoje is approximately 74 km long. The ending point in Levosoje corresponds to the starting point of the 22 km long, already constructed highway section, finished with domestic budget support. The EIB funds together with loans from the World Bank and the HIPERB will be used to finance the construction of the remaining sections of the new four lane motorway.

The EIB has been approached by the "Corridors of Serbia" (former Corridor 10 Company) for a long term senior loan to co-finance the construction of E-75 and E-80 motorway, which forms part of the larger Trans-European Corridor X project in Serbia. Other co-financing sources include the World Bank (WB) and the European Bank for Reconstruction and Development (EBRD). Specifically, the E-75 is a new 4-lane motorway, that will link Nis, located in south east Serbia, to the border with FYR Macedonia.

Republic of Serbia intends using the proceeds of a loan from the EIB (the Bank) for a project "Corridor X Motorway Project". The proposed Project's Objective is to facilitate sustainable economic development and ensure that the country capitalizes on its geographical position to continue its development as a key transit country on the Trans-European Network as well as to increase transport efficiency and improve traffic safety on sections of Corridor X, and to improve road management and road safety in Serbia.

The Project will be carried out by the Project Implementing Entity: "Corridors of Serbia" Limited Liability Company (KS).

Civil works on construction of motorway from Nis to border of FYRM on Corridor X, E-75, with the EIB financing covering:

o Section 2 from Grdelica (Gornje Polje) to Caricina Dolina (cca 11.8km) and

o Section 3 from Caricina Dolina to Vladicin Han (cca 14.1km)

Contracts to be financed with the proceeds of a loan from the Bank are subject to the Bank's Procurement Policies and Rules and will be open to firms from any country.

This Environmental Management Plan (EMP) is related to 11.8 km long E-75 Motorway section from Grdelica (Gornje Polje) to Caricina Dolina.

1. PROJECT DESCRIPTION

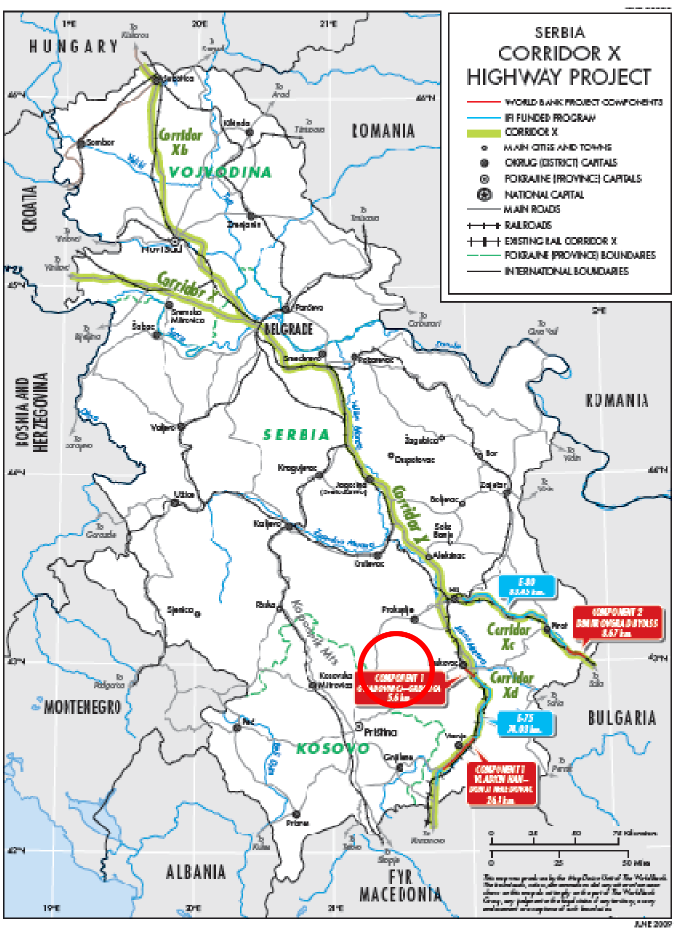
The subject of this Environmental Management Plan (EMP) is 11.8 km long E-75 motorway section from Grdelica (Gornje Polje) to Caricina Dolina. This motorway section consists of two sub-sections:

LOT 1 - Road and bridges from Grdelica to tunnel Predejane, approximately 6.1 km

LOT 2 - Road and bridges from tunnel Predejane to Caricina Dolina, approximately 4.7 km

Commencement of the motorway section is on km 873+720, close to settlement named Gornje Polje. End of the Section is located on km 885+523, close to settlement Susevlje in Caricina Valley. This component involves the construction of cca 11.8 km of new motorway, bridges and one long tunnel ("Predejane") which is divided into two separated tunnel tubes (1110 m long right tube and 865 m long left tube).

Motorway will be tolled and be part of the closed system encompassing the whole Serbian motorway network.



Picture 1: Corridor Xd Highway Project with marked Grdelica – Caricina Dolinahighway section

According to the Bank Environmental Policy, this project is classified as Category "A" because the project could result in potentially significant adverse future environmental impacts.

Picture 2: Grdelica (Gornje Polje) – Caricina DolinaHighwaysection

Just after the new constructed bridge over Southern Morava river (chainage km 874+286) , motorway alignment enter the Grdelica gorge and take completely new alignment, leaving egzisting M-1 arterial road to serve as a alternative road for local transport. On one part of the alignment (km 883+800.00 to km 884+400.00), egsisting road will be moved on separate alignment, close to the railway and S.Morava river.

Based on above facts, during motorway construction, all local transport will be enabled by using existing M-1 road. After completing works, M-1 road will stay as non-comercial, alternative road for local transport.

The studied area is located in the basin of the Southern Morava and its tributaries, which more or less flow directly into it (Palojska River, Licindolska River and Predejanska River). The remaining smaller flows and streams are oriented towards these waterways and all together belong to the Black SeaBasin. In the observed area there are no registered water supply wells.

Two forms of relief are characteristic, conditioning use of appropriate elements of horizontal and vertical projection. The highway route on this section passes through two types of different topographic characteristics. flat – highway route is located on the Southern Morava river draft; Hilly – mountainous – with the route located in a cut or deep cut with steep slopes on the left bank of the Southern Morava.

With the beginning of the section, the route enters into Grdelica Gorge and follows the railroad Nis – Skopje, main road M-1 and regional road R-214 in a parallel manner.Grdelica gorge is one of the biggest gorges in Serbia (30 km long and 550 m wide). Due to topographic and infrastructure constraints the route follows the valley and crosses the river Southern Morava for seven times, by means of structures of different lengths. In the zone of Predejane, the highway route is located in a tunnel due to the hilly terrain in the area.

The expanded area of the analyzed corridor encompasses rural settlements. The cadaster parcels which are covered by the belt of expropriation for the construction of the highway are: CM Bojisna, CM Graovo, CM Bocevica, CM Palojce, CM Licin Do, CM Koracevac, CM Predejane Varos, CM Bricevlje and CM Susevlje.

EIA procedure prescribed by the Serbian Law on EIA (“Official Gazette of RS” No. 135/2004, 36/2009) is completed. Public Consultation and Public Disclosure for the Draft Environmental Impact Study (EIS)is finished (see chapter 7 –

Public Consultations). The Technical Commission evaluated the EIS, together with the systematized report on the consultations of the authorities, organisations and the public concerned and the report on the completed impact assessment procedure, and evaluated the suitability of the measures envisaged to prevent, reduce or eliminate the likely harmful effects of the project on the environment.

Final Environmental Approval for E-75 Highway section from Gornje Polje to Caricina Dolina is obtained from the Ministry of Environment and Spatial Planning.

Final environmental approval of the EIS set out specifically the conditions and measures, which should be undertaken to prevent, reduce or eliminate the adverse effects on the environment. All conditions and measures are presented in this EMP.

Additionally, for all five E-75 Highway sub-sections between Grabovnica and Levosoje existing section specific EIS were integrated into the Corridor level EIA Report for section E-75 covering the proposed highway alignment. The Corridor level EIA Report for section E-75 can be found at the following web sites:

- The EIB web site:

http://www.eib.org/projects/pipeline/2008/20080546.htm

- KS web site:

http://www.koridor10.rs/doc/33/WB,_E-80,_REVISED_CLEIA,_20101110,_ENG.pdf

Impacts for each component of the biophysical and social environment were identified and assessed. For each impact that cannot be avoided, mitigation measures have been developed and a detailed action plan, including responsibilities for implementation and monitoring indicators, is presented as part of the publicly available Corridor Level EIA.

Finally, as a part of Project documentation, PEPS has prepared a detailed design of environmental protection for Grdelica (Gornje Polje) – Caricina Dolina, as a regulatory instrument in Serbian law. This document is one of the basic documents which are used in process of preparation of this EMP and can be obtained in the PEPS main office, Belgrade, Bulevar kralja Aleksandra 282.

The Corridor Level EIA and detailed design of environmental protection for Grdelica (Gornje Polje) – Caricina Dolina Project provides a platform, on which Site-Specific Environmental Management Plan (EMP) and Checklist, for this sub-section, are prepared. Detailed design of environmental protection contains concrete mitigations and monitoring measures which are relevant to this Project. This EMP reflects the additional baseline refinement data work required prior to works commencing, such as data contained in site-specific implementation plan, prepared by the contractors and approved prior to commencing works. This EMP and Checklist should be a part of the bidding documents, to ensure the contractors are aware and meet their formal obligations in this respect. The bidders are obliged to prepare their own site specific implementation plan (SSIP), to be approved by KS, containing the detailed information on meeting the requirements detailed in this EMP. The SSIP will be highly site-specific and be compiled as part of the construction planning for aspects such as fuel stores, plant selection and performance and material sourcing and sub-contracting.

EMP and Check List are produced to point at the essential environmental requirements during the construction of cca 11.8 km of motorway on a section of the corridor between Gornje Polje and Caricina Dolina and guide the potential bidders in preparation of SSIP in order to eliminate, offset, or reduce potentially adverse environmental impacts to acceptable levels. Description of mitigation measures and Description of monitoring program are key parts of this document.

For the purpose of drafting the preliminary design of the E-75 Highway, Nis–FYR Macedonian border, section Gornje Polje - Caricina Dolina, preliminary works were carried out in the established corridor of the highway.

The elements of the highway cross-section have been dimensioned for a calculated speed of 100 km/h (total width of the plane 26.1 m) and an AADT for 2021 amounting to 10,715 vehicles every 24 hours on average.

In accordance with the TOR, a concept of water drainage has been adopted. The principle of an open system for water drainage is characterized by the free (uncontrolled) flow of water from the highway down the slope of the embankment. The main hydrographic characteristic of the region in which the analyzed section of the highway is located is the Southern Morava River. From the very beginning of the section of the E-75 Highway, the Southern Morava follows along within the direct vicinity of the alignment. All tributaries more or less flow directly into the Southern Morava and for the most part are of a stream-like character with spacious proluvial fans at the confluence into the main recipient.

In the observed area there are no registered water supply wells.

On the alignment of the analyzed section of the highway there are several engineered structures which may be significant in the sense of defining certain effects from the domain of the environment. On the analyzed section, there are 13 bridges, 2 galleries, 9 culverts, 1 overpass.

Tunel "Predejane" is designedwith sepatated tunnel tubes. Lenghth of the left tube is 943.92m (km 879+895 to km 880+835).Lenghth of the right tube is 1112.41m (km 879+789.31 to km 880+903.84).

„Predejane“ Interchange on km 883+250 is part of this motorway section too.

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1. Relevant Institutions

During the construction and operation of motorways in the Republic of Serbia, the issue of environmental protection is managed by mutual cooperation of the several statutory government institutions. The Ministry for Environment and Spatial Planning is the key institution in Serbia responsible for formulation and implementation of environmental policy matters. The Ministry is responsible for the protection against noise and vibration, hazardous and toxic material, air pollution, ionic and non-ionic radiation, nature protection and international co-operation. The other aspects of natural resources management related to issues of construction and operation of motorways in the Republic of Serbia, are dealt with several other institutions, among which are the Ministry of Economy and Regional Development; the Ministry of Infrastructure; the Ministry of Agriculture, Forestry and Water management; the Ministry of Culture; the Public Enterprise ‘Putevi Srbije’ (PEPS); the Institute for Nature Protection of Serbia (INP); the Institute for Protection of Cultural Monuments of the Republic of Serbia (IPCM), and KS.

2.2. Existing Serbian legislation

Environmental protection in Serbia is regulated by many republic and municipal laws and by-laws. The environmental legislation in force in Serbia is summarized in Appendix III.

2.3. Main steps of national procedure on EIA in the Republic of Serbia

In the juridical system of the Republic of Serbia, the Environmental Impact Assessment procedure is regulated by the Law on Environmental Impact Assessment, along with appropriate sublegal enactments which determine particular issues within the Impact Assessment procedure in more detail. One of the significant elements in the procedure itself is public involvement (see chapter 7.) and the duty of forming the Technical Committee. Environmental Impact Assessments are required for the projects which are being planned and conducted, technology improvements, reconstructions, capacity expansion, work termination and removal of projects which significantly influence the environment.

The procedure of Environmental Impact Assessment consists of three phases (depending on the List containing a certain project, there can be one, two or more phases):
- Phase I: Decision-making on the necessity of Environmental Impact Assessment of the project
- Phase II: Specification of scope and contents of the EIS – Screening Phase
- Phase III: EIS

Entities which have participated in this Environmental Impact Assessment procedure are the following: Project contractor (PEPS), relevant authority (Ministry for Environment and Spatial Planning), and elaborators of the study, interested authorities, organizations and general public.
According to the Law on EIA (“Official Gazette of RS”, 135/04, 36/09), KS may not commence the project implementation without having previously completed the impact assessment procedure and obtained the approval of the EIS from the competent authority (MOESP).

2.4. Relevant EIB and European environmental policy

E-75 Motorway section from Gornje Polje to Caricina Dolina is financed from the EIB Loan.

The EIB’s policy towards the formal process commonly known as “Environmental Impact Assessment” (EIA) is summarized in its Environmental Statement (2004). The EIA Directive outlines which project categories shall require an EIA, which procedure shall be followed and the content of the assessment. Article 5(1) of the Directive requires the project promoter to provide information to the competent authority relating to the environmental impact of the project. Also, this EMP document is composed by respecting the EIB Statement of Environmental and Social Principles and Standards (2008).The requirements of the Statement are translated into the operations of the Bank through sector lending policies, such as those for energy, transport, water, waste, and research, development and innovation.

The EIB requires that all projects, irrespective of location, comply with the requirements (principles and practices) of the European Union’s EIA Directive in terms of the requirements for and scope and form of a formal EIA.

Also, according to the SOURCEBOOK ON EU ENVIRONMENTAL LAW (prepared by Institute for European Environmental Policy for the EPE Banks), the construction of motorways and (express) roads is subject to the EIA requirements of Directive on the assessment of the effects of certain public and private projects on the environment Directive (85/337/EC as amended by 97/11/EC and 2003/35/EC3), is one of the items of EU environmental legislation with the most wide-ranging implications for project developers. It requires a systematic assessment of the likely environmental impacts of projects in a wide range of sectors.

The construction of motorways and express roads is listed under Annex I of the EIA Directive and consequently an EIA must always be undertaken as part of the consent procedure for the planned development. This holds too for the construction of a new road of four or more lanes, or realignment and/or widening of an existing road of two lanes or less so as to provide four or more lanes, where such new road, or realigned and/or widened section of road, would be 10 km or more in a continuous length.

The EIA process mandated by the Directive seeks to help ensure that project development and planning decisions take environmental impacts into account by incorporating adequate measures to avoid or reduce and if possible offset potential impacts from the planning stage; selecting lower impact projects and rejecting projects whose likely impacts are considered unacceptable by the competent national authorities.

Public Disclosure

Public participation within the EIA procedure launched for this motorway project is also ensured by respecting EIB Public Disclosure Policy (Principles, Rules, and Procedures, 17 July 2007).

Obligations with respect to nature conservation

The construction of roads may lead to habitat fragmentation and therefore any such infrastructure projects need to be planned with due regard to the relevant provisions of Directives 79/409/EEC and 92/43/EEC.

Other relevant books

EIB ENVIRONMENTAL AND SOCIAL PRACTICES HANDBOOK, Environment and Social Office Projects Directorate Version 2 of 24/02/2010

3. BASELINE CONDITIONS ASSESSED DURING ALIGNMENT SURVEY

3.1. Geology and soil

For the studied area of the section Gornje Polje - Caricina Dolina, E – 75 Highway Belgrade - Nis–FYR Macedonian border there are no available data on the presence of polluting material in the soil. Empirically, it can be expected that the intensification of traffic and agricultural activities may lead to excessive pollution of the environment, including the soil.

<u>Recent Exodynamic Processes and Phenomena</u>

Surface erosion and line erosion processes are especially obvious in the Grdelica gorge.

Ravines are the most common in the area of the Grdelica gorge, where 200 of them have been registered. They are partly repaired by dykes after catastrophic torrents.

Landslides have been registered in the valley of the South Morava river in the valleys of rivers, brooks and ravines which flow into it and along their very banks, whereas sliding terrain away from the waterways do not occur so frequently. The most common are the old, currently calmed Landslides, and special attention has to be given to sliding area Susevlje.

3.2. Surface and ground water

In order to define the existing condition of the quality of surface waters, more specifically the rivers in the corridor of the future highway (Southern Morava River, Palojska River, Licindolska River and Predejanska River), data was used from the Republic Hydro-meteorological Bureau (hydrological yearbook - 2005) and that only for the Southern Morava River, with consideration for the fact that measurements are not taken for the remaining waterways in the studied area.

In the observed area there are no registered water supply wells.

Main water bodies on proposed motorway section are:

1. Creek Vasiljkovac km 874+120
2. Cerje km 875+750
3. Terzinci km 876+760
4. Palojska river km 877+380
5. Licindolska river km 878+300
6. Crnogorski creek km 878+600
7. Predejanska river km 882+630
8. Creek Bratez km 882+630
9. Creek Planiste km 884+500
10. Creek Caricina dolina km 885+590

A review of the existing condition of water of the Southern Morava River indicates a low level of quality. By analyzing the data on measurements of the concentration of the physical-chemical parameters in the waters of the aforementioned river collected at the measurement stations, it can be concluded that there is a deviation from Maximum PermittedConcentrations (MDK) for second class waterways, which the Southern Morava belongs to according to the Regulation on Categorization of Waterways (Official Gazette RS, No. 5/68).

The value of dissolved O_2 as well as the percentage of oxygen saturated water occasionally corresponded to class III, class IV and VK condition of water quality. Furthermore, the measured values of suspended materials at all locations corresponded to class III. By reviewing the results of the conducted analysis, one can notice that in one case there was the occurrence of excess values of ammonium nitrate (class III/IV).

Of dangerous and harmful materials there were individual cases at individual locations of excess concentrations of manganese (Mn) and hexavalent chromium (C_r^{6+}).

A study of the quality of surface waters in the sense of a more detailed definition of the existing condition in the corridor of the planned section of the highway was performed for the Southern Morava River. Data on the quality of water of the Southern Morava River is displayed in table T 3.2.

T 3.2 Results of the analysis of the quality of water for the Southern Morava River

No.	Dangerous material	MDK for class II	S. Morava
1	BPK5	4	19.01
2	HPK	12	25.44
3	Suspended material	30	24.80
4	Dissolvable material	1000	154.59
5	Ammonia	0.1	0.65
6	Nitrites	0.05	0.039
7	Nitrates	10	3.22
8	Phenol	0.001	0.009
9	Detergents	0.4	0.37
10	Mineral oil	0.05	0.00
11	Iron	0.3	0.07
12	Chromium (Cr^{+6})	0.1	0.00
13	Zinc	0.2	0.00
14	Copper	0.1	0.07
15	Sulphides	0.00	0.01
16	Cadmium	0.005	0.00
17	Nickel	0.05	0.002
18	Chromium (Cr^{+3})	0.1	0.00
19	Cyanide	0.1	0.01

3.3. Air

Within the corridor of the future highway section between Gornje Polje and Caricina Dolina there are no significant non-point or point sources of air pollution. The major road M-1, as well as the regional road R-214, islinear sources which could potentially cause an increased concentration of air pollutants. Due to no industrial structures being marked within the studied area which could cause increased levels of concentrations of pollutants in the atmosphere, It can be justifiably assumed that the quality of the air is at a satisfactory level.

Data on the measured values of air pollution in the observed corridor were not available. It is presumed that the planned section of the highway will become the dominant linear air polluter within the observed area.

3.4. Climate factors

The entire area along the planned alignment of the highway is characterized by a mild - continental climate. It is especially evident in the valley of the Southern Morava and along its banks, characterized by mild summers, cold winters with heavy precipitation and clearly defined transitional seasons of which autumn is exceptionally long. There is a relatively small volume of precipitation during the summer, but there are strong wind currents. The annual mean air temperature for the period of 1931 - 1970 at meteorological station Predejane is 10.8° C. The annual mean temperature amplitude is 20.8° C. Average precipitation is 693.3mm.

The Grdelica gorge has a climate which is somewhere between moderately continental and Mediterranean climate, with certain peculiarities conditioned by its geographic position, and especially its orographic (topographically induced rain) and hydrographic characteristics.

3.5. Ecosystems (Flora and Fauna)

Preconditions obtained from INP, related to whole E-80 Motorway from Nis to Bulgarian border, including motorway section Gornje Polje - Caricina Dolina, and are given in the document No 03-853/2 from 29.06.2006, andNo 03-237/2 from 27.02.2008 (see Annex IV).

The key comments from INP noted: There is no statutory protected natural resources along the motorway route between Gornje Polje and Caricina Dolina.

However, one section of the E-75 highway passes through the Grdelica Gorge, which while not a formally protected area is a refugium for tertiary flora, rare endangered herbal species and mixed relic vegetation and thus its preserve which is found in Derven Gorge, is included in The Red Data Book of Flora of Serbia I. Since this plant grows on ploughlands near roads, assumptions are that this plant could be found in Grdelica Gorge itself (on the highway section Caricina Dolina - Vladicin Han). In case of continued negative impacts, these habitats would become ecologically unstable and vulnerable. The Grdelica Gorge contains some endangered and protected birds of prey, such as golden eagle *Aquila chrysaetos* and The Peregrine Falcon *Falco peregrinus*. These two species were identified by the Institute for Nature Protection as are highly sensitive, and it will be necessary to protect them from excessive anthropogenic impacts during construction and operation of the Highway. Further studies are required during detailed design to identify specific habitat areas and resources required by the birds which should not be disturbed.

Besides these, other characteristic species of haemophilic, rocky habitats in this area should be also mentioned. Other notable species include Eurasian Eagle Owl *Bubo Bubo,* Rock Partridge *Alectoris graeca,* The Rufous-tailed Rock Thrush *Monticola saxatilis*, The Black-eared Wheatear

Oenanthe hispanica, Red Rumped Swallow *Hirundo daurica.*. Specific recommendations of the INP include the need for conservation of agro-ecosystems along the Southern Morava and remains of habitats that are used as foraging areas for birds, and the positioning of culverts and other underpasses to serve as animal crossings.

INP checked final EIS and confirmed that Study incorporated all nature protection requests prescribed within the preconditions No 03-853/2 from 29.06.2006, andNo 03-237/2 from 27.02.2008 (see Annex IV for details).

Within the area of Gornje Polje - Caricina DolinaHighway section, the diversity of plants is above all conditioned by the presence of waterways. They further influence the regime of moisture in the ground and as such also the composition of phytocoenosis which find more or less suitable conditions for life. Various plant communities can be found in the waterways and that being in the form of free floating or submerged hygrophilous species. They are mutually characterized by various needs for sunlight and content of mineral and organic components which are dissolved in the water.

Full list of animal and plant species which habitats are located within the area of E-75 Highway section betweenGornje Polje and Caricina Dolina is presented within the EISfor proposed Highway section.

None of aforementioned plant or animal species are rare, vulnerable, endangered or protected.

3.6. Inhabitants

The territory which belongs to the Gornje Polje– Caricina DolinaHighway section encompasses 4 settlements which belong to the municipality of Leskovac. A majority of those are rural settlements. Data which relates to the basic characteristics of the inhabitants and their activities is displayed in table T3.6.

T 3.6.Comparison of inhabitants' characteristics

Settlement	Year of census	No. of residents
Bojisna	1991. 2002.	265 245
Bocevica	1991. 2002.	193 151
Bricevlje	1991. 2002.	231 241
Palojce	1991. 2002.	512 502
Predejane (town)	1991. 2002.	1396 1222
Graovo	1991. 2002.	356 277
Koracevac	1991. 2002.	199 192
Licin Dol	1991. 2002.	198 139
Predejane (village)	1991. 2002.	456 495
Susevlje	1991. 2002.	258 228
Garinje	1991. 2002.	530 554

3.7. Immovable cultural assets

Preconditions obtained from IPCM, related to E-75Highway section from Gornje Polje to Caricina Dolina are given in the document No 10/2233 from 24thSeptember 2008. This document is available in Appendix IV of this EMP Document, and recorded cultural assets in the zone of proposed highway section are listed within the Table T 3.7..
Table T 3.7. Recorded cultural assets

Place	Name of locality
Bocevci	Latin Graveyard
Bocevci	Seliste
Predejane	Old Graveyard
Predejane	Seliste
Predejane	Gradac
Susevlje	Latin Graveyard

No statutorily protected archaeological sites will be directly affected by the construction works.

At all locations **is not necessary** to carry out preliminary archeological excavation.

At all locations **is necessary** to carry out archaeological supervision during earthworks.

Before beginning any kind of earthworks on the aforementioned locations, it is necessary to inform the Institute for the Protection of Cultural Monuments of Serbia – Belgrade.

In case of chance finds, The Contractor is required to immediately, without delay, halt works and inform the authorized Institution for Protection of Cultural Monuments and to undertake measures to ensure the findings are not destroyed or damaged and to protect the area and position in which they are discovered.

Assetsmay be vulnerable to indirect impacts such as vibrations and air pollution. In some cases the precise locations and boundaries are not known (e.g. Bocevci and Predejane). Overall, the knowledge regarding these sites is very limited.

3.8. Landscape

The most remarkable morphological form in the relief of the analyzed area is the Grdelicagorge whose creation was related to the influence of many different factors through a longperiod of time.

During the lake phase in the basins, the Grdelica gorge did not have the form it has today. Inthat period, above the today gorge, there was a kind of strait connecting Vranjsko andLeskovacko lakes.

The relief forms which were created in the Grdelica gorge through the erosion of the abovesaid strait, and through a subsequent outlet of the lake and finally the South Morava river existin the form of terraces, capes and terraced flooded soil.

Above the Grdelica gorge (1100 - 1200 mas) a large valley of the «lake straits» is located.There are river terraces in the gorge which correspond to the lake terraces of the basin.Fans of flooded terraces are situated on the confluences of big tributaries, and the SouthMorava river has carved terraces tall more than 10 meters in them, and the tributariesthemselves carved in terraces in their flooded grounds.

4. SUMMARY OF ENVIRONMENTAL IMPACTS

The environmental impact which will be caused by the construction, operation and maintenance of the section Gornje Polje - Caricina Dolina of the highway Beograd - Nis - FYR Macedonian border indicate qualitative and quantitative changes in the environment during the construction phase, and the subsequent opening to traffic, as well asthe additional exceptional risks engendered byan accident.

4.1. Geology and soils

The construction of the E–75 highwaycould lead to soil degradation due to the opening of borrow pits or formation of dump sites along the alignment.On theGornje Polje-Caricina Dolina section, the proposed alignmentdoes not requirehigh cuts and side cuts, and thus anydeficit in the required materials for embankments may be met fromexisting borrow pits in the immediate vicinity of the highwayalignment (at the distance of up to 30 km), rather than the opening of new ones.

4.1.1. Construction Phase

Pollution of the soil in this phase may be caused as a result of improper manipulation of petroleum and petroleum derivatives which are used for construction machinery and other devices during construction, cleaning of vehicles and machinery outside of the prescribed and arranged areas, inadequate arrangement of the construction site and other activities which are not carried out according to recommended technical mitigation measures during construction.

Pollution of soil during construction is an aspect which affects the soil, as a factor of the environment, which may be reduced to a minimum or be completely eliminated by adhering to the technical mitigation measures which are stated in a special chapter which describes the measure for reducing the effects of the project.

Works on clearing away the existing soil, vegetation and structures, and then removal of the surface layer of earth commence construction works on the new highway. During the carrying out of those works, the greatest changes to the topography occur.

The process of road construction itself is characterized by extensive mechanical stabilization in the corridor of the roadbed and in places where temporary access roads are formed, which, in individual sensitive sections, could have an influence on the entire system of parameters of soil, primarily in the sense of its water permeability, air content, etc.

4.1.2. Operational Phase

During the phase of operation of the road, pollution of soil will mostly be the consequence of the following processes:

- pollution from atmospheric waters from the highway;
- settling of exhaust gases;,
- discarding organic and non-organic rubbish;
- spilling of loads;
- settling of atmospheric particles carried by wind; and
- dispersal due to movement of vehicles.

The catchment area of the South Morava River in the sector of Grdelica gorge is one of the best known erosive areas in Serbia. Erosive processes in the catchment areas of torrential tributaries of the South Morava River on the given motorway section are mainly within the range of medium and high erosion. All tributaries of the South Morava River in the given sector are of extremely torrential character. The basic characteristic of the hydrological regime of water courses are torrential waves with sudden onset and of short duration. These waves bring the major part (70 - 80 %) of total annual production of erosion deposit.

The dynamics of torrential processes in the catchment areas of these water courses is very marked. After intensive precipitation in the catchment areas, torrential waves are formed, bringing large amounts of erosion deposit.

Taking into consideration the concept of drainage (open system) of atmospheric waters on the analyzed section of the newly planned highway, it can be concluded that the most significant level of soil pollution occurs in the area 5.0 to 10.0 m from a road with a heavy traffic load. The greatest effect of cadmium is in the zones of 1.0 to a maximum of 5.0 m along the length of the road, which is within the protective belt of the road.

Soil pollution which may appear as a consequence of the destruction of hazardous loads also is relevant considering the characteristics of the soil in the analyzed area. An analysis of a case of accidental pollution will be analyzed in a separate chapter.

The engineering-geological and hydrological characteristics of the soil, as well as the planned earthworks on the position of the overpasses create the conditions for the occurrence of settling of the road bed which could in certain circumstances reflect in the permeability of the soil. Regardless of settling of soil below the embankment, and with consideration for the local hydrogeological characteristics and time lapse of consolidation, negative effects are not expected.

Degradation of soil which may occur by forming dumping areas and borrow pits for construction material in the specific conditions is limited by the category of the borrow pits, being that the planned carriageway is planned on an embankment. For forming the embankment, the necessary quantity of material shall be provided from the alluvial deposits (but not from the river bed) and local borrow pits.

Table T 4.1.2. Expected content of heavy metals in soil(ppm)

Element	MPC*	min	max
Ag	50	91	136
B		136	181
Ba		363	408
Be		54	91
V		135	181

Element	MPC*	min	max
Ga		45	64
Co		27	45
Cu	100	181	227
Cr	100	227	272
Mn		136	181
Ni	50	103	136
Sc		45	73
Zn	300	163	181
Zr		Zr	227
Sr		Sr	227
Y		118	163

*Defined in the Rules on permissible quantities of dangerous and harmful substances in soil and irrigation water, and methods for their testing (Official Gazette of RS, No.23/94)

4.2. Air quality

4.2.1. Construction Phase

The carrying out of construction works, according to its nature, represents a significant source of pollution to the atmosphere due to the use of construction machinery which uses mostly fossil fuels for propulsion. The moving of large earth masses during construction of the road (cut, embankment) also results in large quantities of dust being lifted into the atmosphere which may trigger negative consequences in the populace and vegetation. The operation of asphalt bases, as well as the placement of asphalt masses in the road bed, carries with it the emission of volatile organic compounds (VOC), of which asignificant percentage are polycyclic aromatic hydrocarbons (PAH) which are proven carcinogens, i.e. have been confirmed to cause cancer in humans.

In this case, the space in which construction works are to be executed is at more than 100m
distance from the populated area and thus no negative effects on health of the population are expected. The asphalt plants will be located outside the project impact zone.

4.2.2. Operational Phase

The calculation of concentrations of air pollutants for characteristic cross-sections of the planned highway was done using an advanced computer program based on the procedures of modeling defined in the directives for calculation of air pollution on roads (Merkblat über Luftverunreinigungen an Strassen, MLuS-90).

Based on data on wind frequency, speed, and directions, from the meteorological station Predejane, the average wind speed of 3.0 m/s, north by direction, was derived. For these meteorological conditions, concentrations of pollutants were calculated for AADT in 2021 as the final year of operation period, and for the traffic flow speed of 80 km/h.

Based on the data obtained from the analysis of characteristic conditions and the limit values defined by the Rulebook on Limit Values, Methods of Measuring Emissions, and Criteria for Setting Up Measuring Locations and Recording Data (Official Gazette RS 54/92), the following conclusions were made:

- in conditions of a dominant wind (N), the concentrations of all polluting materials, except for NO_2max, are below the limit values of emissions;
- generally, during a dominant wind (N), concentrations of polluting materials in the air are greater on the right side of the section of the highway;
- the limit for exceeding values of LVE for NO_2max is 5.5 m on the left and 18 m on the right side of the road, measured from the edge of the highway; and
- in periods without wind, the LVE for all polluting materials are exceeded as follows: carbon monoxide at 6 m for the mean and 10 m for the maximum values, nitrogen dioxide 45 m for the mean and 68 m for the maximum values, sulfur dioxide 35 m for the mean and 14 m for the maximum values and solid particles 6 m for the maximum values.

4.3. Noise

4.3.1. Construction Phase

The sources of noise during the construction are heavy construction machines and their traffic in connection with the execution of works. The organization of the construction of a linear structure, such as a road, is characterized by the arrangement of construction machines over a relatively large area, which makes it more difficult to intervene with regard to the protection of environment from elevated noise levels in this phase. Exposure to these impacts is limited both in time andnature and as such it is considered in the mitigation measures during the construction phase.

4.3.2. Operational Phase

During the operational phase, Road traffic plays a dominant role if compared with other types of traffic and is predicted to continue to grow. This results in an increase in the level of noise in the zones around roads.

The noise impact analysis impliesthe definition of the parameters of traffic noise on a spatially and functionally defined road. Thestatus which is defined in this way is compared with current legal regulations with regard to themaximum permissible levels for particular facilities. Exceeding the permissible levels implies the need for additional protection measures.

For the concrete calculation of the authoritative level at any point of a section, special computer programs were used which were developed on the basis of the instructions titled: "Richtlinien für den Larmschutz and StrassenRLS-90" (ref. 15).

On the basis of the numerical data obtained through the calculation of traffic noise in the planned period at the characteristic cross-sections which are presented in the corresponding tables, it can be concluded that excessive levels of noise are expected to be present.

The obtained authoritative levels indicate that in the planned period the levels of noise expected at the referenced distance of 25 m, during the day should stay around 76 dB(A) and during the night around 70 dB(A). The difference between levels at individual places is a consequence of physical restrictions in the cross-section which cause the reduction in level. If the limit value of a permitted level of 55 dB(A) is adopted for nighttime conditions, which applies to structures along major highways, under the conditions of free distance of sound, this value would be reached at the closest distance of around 100 m and at the furthest distance of around 280 m from the axis of the planned highway.

Being that along the planned highway there are structures which could be analyzed for negative effects, the previously obtained values serve as the criteria for identification of those residential structures which are potentially in danger of being affected by noise from the highway.

Based on the numerical data obtained by calculation and the relevant levels defined by law, a conclusion may be drawn that limit noise levels are exceeded in the several zones in which the registered structures are located and appropriate mitigation measures are planned by using noise protection barriers (see chapter 5 – Description of mitigation measures).

4.4. Flora, Fauna and visual impact

4.4.1. Impact on flora

Based on theanalyzed impacts of the planned alignment in the sphere of air and water pollution, and soilpollution, occupancy of surfaces and division of space, it is possible to derive conclusions inrespect of possible impacts on ecosystems of areas across which the road alignment shall pass. It isalso essential to pay particular attention to the comments and requirements of the INP, whoprovided detailed comments on the individual road sections.

Preconditions obtained from INP, related to E-75 Highway section from Gornje Polje to Caricina Dolina are given in the document No 03-853/2 from 29.06.2006 and No 03-237/2 from 27.02.2008. This document is available in Appendix IV of this EMP and also as a part of EIA for Gornje Polje – Caricina DolinaHighway section.

INP commentsincluded notes on the conservation status of ecosystems and species of flora and fauna, generalmitigation measures and the need to undertake additional investigations during the detailed design stage, so as to minimize potential adverse impacts. For this reason an allowance for such studies has been made in the EMP.

The facts which have been introduced within the framework of the existing conditions indicate that, with consideration for local conditions and plant diversity of the area, especially negative effects should not be expected.

The effect of air pollution on plant life is spatially limited to a narrow belt along the road itself being that the concentrations which are permitted by the limit values, with consideration for the possible negative effects, are reached only at the edge of the road for a majority of components. This is a consequence, as was also concluded in the chapter on air pollution, of traffic load and the conditions of transmission of pollutants on roads located outside of cities.

Another important fact which must be highlighted is that the spatial and operational elements of the planned carriageway do not contribute significant possible negative effects because this concerns with a relatively low traffic load and modest width, with no fencing which would affect the spatial division.

4.4.2. Impacts on fauna

<u>Construction Phase</u>

Impacts on fauna in the given area are related to the occupancy of land, since this iswhen some habitats, breeding ponds, and refugia are destroyed, and traditional animal paths arecut off. Any pollution of soil, ground and surface waters can negatively impact fauna in the studyarea. In the course of highway construction, the area will be modified through the alteration ofphysical characteristics of the space, transformation of land by the highway construction andpreparation of the ground, and there are also certain forms of pollution. The modification of the area reflects through the modification of habitats (change in geometry, floors, mosaic like nature, and general conditions of refuge and food chain), the removal of soil cover (the removal, erosion, or destruction of top layers of rock and soil), the change in hydrological regimes (changes in thecomposition and structure of habitats, so as to affect soil moisture of the area), noise andvibrations.

Studies of the terrain covered by the corridor of the planned section of the highway which was carried out for the purpose of defining the possible negative effects on wildlife have indicated that for the most part exceptional negative effects should not be expected because there is simply no significant wildlife elements registered in the area.

By reviewing the official register for the analyzed area which is the subject of the study, it has been confirmed that there are no registered habitats of rare or protected species so possible effects within these categories are not expected.

Operational Phase

Modern linear traffic infrastructure facilities, such as highway and railway lines, have a multiple negative impact on the living world. This negative impact shows up directly. The intensity and consequences of unfavorable impacts are specific, to some extent, for each animal group particularly, while the general effects most often show through:

- Direct devastation of habitats,
- Degradation of quality of habitats along the road,
- Fragmentation of habitats, alteration of their form and geometry,
- Intersection of ecological corridors and traditional migratory paths,
- Hindered access to vital parts of habitats,
- Fragmentation of population due to the effect of road barrier, and impossibility of constant and unobstructed communication,
- Higher hunting and poaching pressure due to an easier access,
- Higher mortality rate of animals due to running over,
- Disturbed regime of surface and ground waters,
- Accumulation of liquid, solid, chemical and other waste
- Intensified light and noise pollution of the area around the road.

Most of the fauna will temporarily migrate out of the highway corridor during construction. The newly designed road may destroy a habitat, if its remaining parts are not self-sustainable. Consequences of such effects are: a disturbed normal life cycle of animal species, behavioral changes, reduced ecological stability, and disappearance of local populations, changes in composition and structure of animal habitats due to avoidance of the road by some species, all of which has, as the final result, a substantially impoverished bio-diversity on all levels (genetic, species, eco-system).
Since the road alignment passes through the river alluvium in some places, it is assumed that new structures will have the highest impact on animals that depend on water as eco-system. Since the project envisages river control, it is necessary to avoid this type of works in the period of fish spawning. This will be elaborated in the site-specific EMPs.

On-site investigations for the highway corridor, conducted in terms of identifying possible negative impacts on fauna, showed that salient negative impacts should not be expected in most of the area, simply because no significant faunal elements were registered. Potential impacts on fauna which are present will be reduced by implementation of the conditions provided by the INP.

In order to allow free movement of animals from one to another side of the motorway, 20 box culverts and bridges will be constructed as underpasses for big animals too. Longest distance between two neighbor passes is 2685m.

4.4.3. Visual impact

The problems of visual pollution have been considered on two basic levels: The first level implies the problems of spatial relations of the alignment itself and elements of the homogeneity of its projection are encompassed in the concept of so-called geometric shaping. The second level encompasses the relation of the alignment, as a construction, towards the space in the sense of defining the effect on the landscape.

For quantification of the relations of the transit construction towards the landscape, the methodology of breaking things down into individual components has been used (morphology, vegetation, surface water, structures and general appearance). For the characteristics of the planned highway and local conditions, the only component which has an effect on the landscape characteristics is the morphological characteristics.

The zone of altered landscape characteristics can be defined on the basis of the medical threshold of visibility accepting the visible angle of 10° as the measure for reviewing the maximum height difference in the section of the line perpendicular to the line of the terrain. This kind of relation entails that the width of the zone of possibly jeopardized landscape is 700H (H is the maximum height difference in the transversal profile). The largest multi-level sections in the cross section (overpass across railway line and roads) would be realized with a distance of 5.5 kilometers. Based on the aforementioned consideration, it is possible to conclude that in the specific conditions, grade-separated interchanges have the dominant shape which gives the fundamental morphological form to the entire area.

In the morphological sense, the alignment of the planned highway does not excessively burden the landscape. Local effects are present in the zone of overpasses over the existing regional road R-214 and railway line and in the zone of multi-level junctions.

Finally, it can be considered that the spatial entirety which the planned highway belongs to is predominantly characterized by cultivated landscape without especially significant forms and that the dominant form is represented by future grade-separated interchange structures.

4.5. Surface and ground water

Construction Phase

Pollution during the construction phase is of a temporary character, and is limited in both volume and intensity, but individual cases of damage could lead to serious consequences.

We separate two aspects of effects which are caused by construction of the transit structure:
- Pollution of the water; and
- Changes to the regime of surface and underground waters.

Changes in the physical and chemical characteristics of water, under the condition that the organization of the construction site and procedures during works follow the environmental protection conditions prescribed by this study, can be triggered by accidental pollution from leakage of dangerous and hazardous materials into open flows. For that reason, it is necessary to provide a controlled access of machinery to the waterways and other surface waters
Changes in the circulation speed and flow of surface water occurs due to changes in the morphology of the terrain when carrying out earthworks and during construction of bridges and culverts.

During the construction phase, surface water may be seriously endangered by pollution or physical destruction of the river bank.

The effects on the regime of surface waters (waterways), on the section Gornje Polje - Caricina Dolina of the newly planned alignment of the highway, are not directly conditioned by construction of the section, except in the part which is related to restricting highway construction works around the river regulation structures.

The justification of works on arrangement of the riverbeds lies in the prevention of landslides and erosion, but on the other hand those same works may have a negative effect on the environment, most of all on plants and wildlife in and around those waterways.

Conflicts may arise with aquatic plants and wildlife due to increased retention of sediments as a result of construction works. Destroying the bank and vegetation of the bank will significantly diminish the value of these areas in the sense of plants and wildlife.

Changes in the regime of underground water could occur as a result of construction of columns for bridges, settling of soil underneath high embankments and in parts of the section of the highway where a limited regulation of the flow of the Southern Morava River has been envisaged.Changes in the regime of underground water could occur as a result of construction of bridge columns, settling of soil underneath high embankments, etc. Construction of engineered structures will require the level of underground water to be temporarily lowered. As a consequence of lowering underground water through draining, effects on vegetation could arise. All of these changes to the regime of underground water and effects on vegetation will be of a temporary character.

Operational Phase

The main sources of pollutants during operation of the observed section are: vehicles, precipitation and dust.

During the phase of operation of the road, pollution of water will mostly be the consequence of the following processes:settling of exhaust gases,wearing of tires,spilling of loads,discarding organic and non-organic waste,settling from atmosphere,carrying by wind,dispersal due to passing vehicles, etc.

Pollution as a consequence of the aforementioned processes, according the characteristics of its duration, may be constant, seasonal and incidental (accidental).

A series of harmful materials are present in the water which runs off from the surface of the highway. This mostly concerns the components of fuel such as hydrocarbons, organic and non-organic carbon, and nitrogen compounds (nitrates, nitrites, ammonia).

A special group of elements is composed of heavy metals such ascadmium, copper, zinc, mercury, iron, nickel and many different fuel additives. A significant portion is also made up of solid materials of varying structures and characteristics which appear in the form of settled, suspended or dissolved particles. It is also possible to register materials which are the consequence of using corrosion protection substances. Another group of very carcinogenic materials is polyaromatic hydrocarbons (benzopyrene, fluoranthene) which are the product of the uncompleted combustion of fuel and used motor oil.
For indication of present pollutants which appear in dissolved or undisolved form, there is a series of macro indicators such as: pH, electrical conductivity, suspended and sediment materials, COD, BOD, grease and oil, etc.

In accordance with the stated positions, and based on foreign experiences acquired from 20-year studies, an estimation has been done for emissions of polluting materials which appear during operation of the observed section for the traffic load in the planned period, the results are displayed in the table 4.5.

Table 4.5 Quantity of polluting materials, by unit of surface area, which forecasted traffic emits during one year

Polluting materials	(kg/ha/yr)
Suspended particles	178.33
total organic carbon	52.87
Nitrates	1.205
total phosphorus	0.27
oil and grease	2.77
Copper	0.01
Iron	5.28
Zinc	0.097

The concept of water removal for the analyzed sections of the highway represents a significant element from the viewpoint of possible influences in the sense of both water and soil pollution.

Water removal is realized through free flow over the shoulder and slope of the embankment where it is freely dispersed across the terrain. On parts of the section with smaller radii, water collected along the median is drained through a closed system to natural recipients outside of the road base.

The terrain on which the alignment is located is water permeable, partially-permeable, partially-impermeable and impermeable.

The problem of accidental pollution is impossible to quantify in this way because it primarily concerns individual cases spread out according to location and time.

Bridges represent a significant risk for the issue of waterway pollution, especially in cases of accidents. When damages have already occurred, the possibilities of rehabilitation are very small. Such locations on the observed section Gornje Polje - Caricina Dolina, E-75 HighwayBelgrade - Nis - FYR Macedonian border are bridges crossing rivers and streams at chainages:

- km 874+286, bridge across S.Morava river, 138m
- km 874+075, overpass
- km 875+423, bridge across S.Morava river, 227m
- km 876+319, viaduct, creek, 164m
- km 876+973, bridge across S.Morava river, 428m
- km 877+386, bridge across Palojska river, 350m
- km 878+394, bridge across S.Morava river, 143m
- km 881+705, bridge across S.Morava river, 106m
- km 0+085, most, Predejane interchange, 124m
- km 0+702,594 DIZ, 0+079,202 LUL, S.Morava, interchange Predejane, 127m
- km 881+930, bridge across S.Morava river, 203m
- km 883+305, bridge across S.Morava river, railway, 495m
- km 883+576, most, creek, 11m
- km 884+958, most, creek, 11m
- km 885+445, most, creek, 11m
- km 885+335, viaduct, creek, 139m
- km 878+778, gallery, 80m
- km 882+605, galery, 190m
- km 876+527, slab culvert, creek Terzinci, 6m
- km 877+460, slab culvert, underpass, 6m
- km 884+090, slab culvert, creek, 6m
- km 884+567, slab culvert, creek, 6m
- km 885+020, slab culvert, creek, 6m
- km 885+550,slab culvert, creek, 6m
- km 885+649, slab culvert, creek, 6m
- km 885+020, slab culvert, creek, 6m
- km 885+649, slab culvert, 6m

4.6. Impacts on social /cultural environment

4.6.1. Impact on population

The impact of the planned motorway E–75 Nis – FYRM Border on the health of the population includes the impact on the population in settlements along the motorway as well as on drivers and other participants in the traffic (assistant drivers, passengers, pedestrians). These impacts include exposure to noise, vibrations and air pollution (oil combustion and exhaust fumes).

The construction of the Gornje Polje - Caricina DolinaHighway section, as a part of E–75 Nis - FYRM border highway, will have a stimulating effect on a better traffic and economic connection of the Republic of Serbia with its surroundings, as well as on faster development of the region served by this corridor.

From the perspective of the interests of certain social groups as users of the space and the structures within that space, the construction of the highway may have a twofold effect on the socio-economic and commercial development of the specific area.

Two basic populations of interest stand out for the section of the highway Gornje Polje - Caricina Dolina. The first group is made up of users of the highway, while the second is owners of the land on which the analyzed section is built. With the construction of the planned highway, the conditions for travel are improved while simultaneously decreasing expenses and increasing the safety of users from the aforementioned first group.

However, the construction of the road may lead to worsened living conditions in a particular settlement and its zones. These negative effects appear in the case when the corridor of the road cuts off (divides) development of parts of settlements.

Comparing the effects of construction, positive and negative, in both cases leads to the conclusion that the benefits to social circumstances in the case of construction of the planned section of the highway are much greater than the damage which also occurs as a consequence of construction.

4.6.2. Impact on cultural monuments

Preconditions obtained from IPCM, related to E-75 Highway section from Gornje Polje to Caricina Dolina are given in the document No 10/2233 from 24th September 2008. This document is available in Appendix IV of this EMP Document. No statutorily protected archaeological sites will be directly affected by the construction works. On the marked highway section, during systematic archeological reconnaissance carried out in 2003, the following archeological findings were recorded:

Table 4.6.2. Recorded cultural assets

Place	Name of locality
Bocevci	Latin Graveyard
Bocevci	Seliste
Predejane	Old Graveyard
Predejane	Seliste
Predejane	Gradac
Susevlje	Latin Graveyard

No statutorily protected archaeological sites will be directly affected by the construction works.

The Law on Cultural Resources requires that the investor and contractor, in the case of the discovery of new, unrecorded locations, must enable and provide for archeological intervention. That consists of the momentary halting of works and informing the authorized IPCM of the discovery. This of course requires occasional archeological monitoring during construction. The investor is required to provide the financial means for all envisaged works - occasional archeological monitoring, protective archeological interventions, etc.

The Contractor willprepare action plan as a part of the bidding document, and update it periodically in accordance with the new findings (if any). The initial plan will consider the whole section (Gornje Polje - Caricina DolinaHighway section) to be subject of actions relevant to chance finds, in addition to specific measures to deal with above mentioned sites/locations. The updated action plans will be subject to obtaining consent from the IPCM and any other relevant authority, as may be instructed by the KS.

In case of locations that may be of interest (chance finds), KSwill provide funds for – occasional archaeological supervision, protection of the archaeological intervention, etc. The effective protection measures in case of chance finds will include immediate stop of all works in progress around the new finds, adequate fencing to prevent unauthorized access and immediate notification of IPCM.

The preconditions of the IPCM are summarized as:

No excavation, demolition, alteration or any works that may harm the properties of thecultural monument may be carried out. IPCM and authorized expert must be timelynotified of the commencement of earth and other works at the archaeological site or in itsimmediate vicinity, in order to timely perform all the necessary preparations until thearchaeological exploration license is obtained.Identified sites must be marked and secured (with a protective railing or other means ofprotection) to avoid damage in the course of road construction.

4.6.3. Impact on natural resources

According to the preconditions obtained from INP (No 03-853/2 from 29.06.2006, andNo 03-237/2 from 27.02.2008 (see Annex IV), none of plant or animal species which habitats belong to the zone of the E-75 Highway section from Gornje Polje to Caricina Dolina are rare, vulnerable, endangered or protected.

Upon reviewing the registry of protected natural resources, it was established that within the analyzed area there are no registered locations which fall under this category. The fact is however that within the analysis of the existing condition, spatial units stand out for which there are proposals regarding their arrangement and placement under special protection.

4.7. Construction camps

The nature and extent of the construction works will require establishment of a number of Construction Camps, which will house workers, equipment, machinery, fuels and materials. The number, size and location of camps are not currently known and can and will only be determined following mobilization of Contractors to country.

From the environmental and social viewpoint, construction camps pose potentially adverse impacts, due to: Additional land requirement; Storage and use of hazardous material, fuels and oils; The need for services including water, electricity, sanitation and wastewater; Potential interference with community harmony and/or community tension resulting from the presence of large numbers of workers, particularly from an influx of foreign workers, who may also be a source of sexually transmitted infections (STIs) or HIV.

As the number, size and location of camps are not known at this stage, the most effective way to address the potentially adverse impacts is through contractor's adoption of the guidelines as contractual requirements. These are presented in the EMP in Appendix I of this report. The Contractor's SSIP - Camp Management Plan should contain, but not be limited to, procedures for establishing and operating construction camps in order to safeguard nearby communities and environmental resources.

Work camps will be required to conform to international Health, Safety and Environment (HSE) standards and will thus be furnished with sanitary and wastewater collection and disposal/treatment facilities and will operate fully compliant waste systems, involving storage of waste by waste category. These requirements will be included within the contracts for construction, which should ensure that contractors include sufficient budget for effective HSE management Contractors teams will reflect these provisions, by including HSE staff and independent environmental specialists to provide advice and to undertake monitoring and auditing.

4.8. Cumulative impacts

The existence of other structures in the study area as well as possible construction and operationof new facilities may exacerbate impacts when combined with those resulting from operation of theproposed highway. In such circumstances it may be possible for the combined impacts to exceedenvironmental limits or standards. Therefore, as part of the fieldwork for the EIAs, data on thepossibility of occurrence of these cumulative impacts were collected by noting the presence ofthese structures within the impact zone of the road.

Due to the terrain for most of the alignment from Gornje Polje to Caricina Dolina the existing road andcommunication infrastructure is confined in a corridor and thus the highway is locatedroughly parallel to the existing main railroad Nis – Skopje, at a distance of 50 – 300 m. This type ofmutual positioning results in cumulative noise impacts. This fact was taken into considerationduring the EIA modeling of noise levels in the impact zone.

Emissions of gases and dust due to excavation and grinding of stone aggregate, together with emissions of pollutants from traffic operation in the air, represent a cumulative impact that may be mitigated by appliance of stricter regulations in relation to operation of the stone quarry. Construction of highway maintenance centers is envisaged for zone of the Grdelica interchange. There is a possibility that cumulative impacts of these facilities and the road exceed thepermitted values of pollutants concentrations in the air as well as noise limits, which will be testedthrough EIAs prepared for these structures.

Major new induced development along the alignment of the highway *per se* is not anticipated, as newhighway accesses to only existing facilities and connecting roads will be constructed as part of theProject. The Project highway aims, *inter alia,* to stimulate economic development and improvecommunication both regionally and internationally.

However, the majority of the areas throughwhich the highway is alignmentis predominantly rural in nature and continues to suffer from out-migration, as people move to the larger cities and towns in search of work etc. The socio-economic studies to be undertaken in the context of preparing RAPs will explore this issue further, but it is not expected that the improved highway connection resulting from the project will have a significant impact on this overall demographic trend, such as stimulating large in-migrationsor substantial new development.

5. DESCRIPTION OF MITIGATION MEASURES

5.1. Site-specific mitigation measures

5.1.1. Soil

Construction phase

- Strict protection of all areas outside the immediate zone of the agreed work sites, such that no additional areas may be used as a permanent or temporary disposal sites for materials, as borrow pits, or for machine parking or repair;
- Removal, storage and handling of topsoil in such a manner that it can be used in final reinstatement, bio-restoration and stabilization of slopes;
- Storage and handling of fuels, oils and other hydrocarbons in a controlled process, involving measures to prevent soil and water contamination. Work camps should include storage on sealed surfaces and within secondary containment; refueling of all plants, vehicles and machinery should not be allowed within 50m of any watercourse, drain or channel leading to a water course.
- Forbidding any opening of non-controlled access roads to any part of the construction sites;
- Temporary storage of construction waste will be limited to within the site, and within areas approved by the Engineer.
- The Contractor shall not dispose of any waste and/or construction debris by burning, or by burying. All waste shall be disposed of offsite at an approved landfill site.
- The Contractor will be responsible to remove and transport all waste material off site to an approved landfill.
- The Contractor is advised that cement and concrete will be regarded as materials that are potentially damaging to the natural environment on account of the very high pH of the material, and the chemicals contained therein. The Contractor shall ensure that all operations that involve the use of cement and concrete are carefully controlled.
- Concrete mixing, in the purpose of pre-stress girders, shall only take place in the construction camp or in dedicated plateau. Water and slurry from concrete mixing operations shall be contained to prevent pollution of the ground surrounding the mixing points. Old cement bags shall be placed in wind and spill proof containers as soon as they are empty. The Contractor shall not allow closed, open or empty bags to lie around the site.
- All unsuitable and surplus spoil rock shall be removed from the site to an alternative recycling opportunity. Last alternative is to transport it to a dumping site or sites where it shall be dumped, spread and leveled.
- No dumpsite shall be used without the prior written approval of the Contractor and the owner of the property.
- No spoil material shall be stockpiled in violation of any legal requirement or to obstruct any watercourse or drainage channel.
- Concrete remains will be crashed into pieces of cca 20cm diameter and will be used for the backfilling.
- All visible remains of excess concrete shall be physically removed immediately and disposed of as waste. Washing the visible signs into the ground is not acceptable. All excess aggregate shall also be removed.
- The process of separating rock material into acceptable grades for backfilling and layer works material will result in noise and dust. The Contractor shall suppress dust caused by the screening process. The screening process shall be positioned so as not to cause any disturbance-to surrounding villages.
- Waste steel will be sent to steel recycling facility, which will provide transport service;
- Wastewater from the WWTF facilities and sedimentation ponds/tanks on site wilt is reused for dust suppression and vehicle wash down as a priority over discharging the water to stormwater or creek.
- The Contractor shall dispose of all refuse generated by his staff and Sub-Contractors on a weekly basis at a registered Domestic Waste Disposal Site. Contractor will engage specialized utility company for removal and disposal of domestic waste.
- In a purpose of temporary waste disposal, Contractor will ensure scavenger, water and windproof containers, for collected waste until disposed of.
- The Contractor shall supply waste bins/skips throughout the site at locations where construction personnel are working. The bins shall be provided with lids and an external closing mechanism to prevent their contents blowing out and shall be scavenger-proof to prevent baboons and other animals that may be attracted to the waste.
- The Contractor shall ensure that all personnel immediately deposit all waste in the waste bins for removal by the Contractor. Bins shall be emptied on a daily basis at waste containers.
- No waste to be buried or burnt onsite and litter and gross pollutants to be removed as part of ongoing maintenance operations;
- The bins shall not be used for any purposes other than domestic waste collection.
- All hazard materials have to be storage at the fenced and secured area. All hazardous and danger material will be undertaken
- Liquid hazard materials have to be kept on the waterproof surface, supplied with WWTF.
- All areas used as storage of the liquid hazard materials, must be supplied with the adsorbent, such is prefabricated peat, sand or cutting, which has to be used in the accidents to collect liquid.

- Collected liquid hazardous waste will be kept in specialized liquid waste containers, which will be carried out by the licensed company engaged by the Contractor.
- All content from the separator and coalescent filters are dangerous waste and handling requires well-trained persons. Extracting and temporary storage will be done using specialized liquid waste containers.
- Used tires, or other rubber parts of equipment will also be treated as hazardous waste.
- The Contractor shall ensure that he is familiar with the requirements for the safe storage, handling and disposal of petroleum, chemical, harmful and hazardous materials.
- The Contractor Shall is responsible for establishing an emergency procedure for dealing with spills of release of these substances. He shall also ensure that the relevant construction personnel are familiar with these emergency procedures.
- Petroleum, fuel and oil throughout the site shall be stored in enclosed separated areas at reservoirs with double shield, at the location of which shall be determined on site in conjunction with the Engineer. The enclosed areas shall be clearly marked.
- Usage of oil and fuel will be 'allowed only to the training persons, who will be nominated by the Contractor. All activates with fuel and oils will be at the dedicated areas.
- Special care will be taken during deliveries, especially when fuels and hazardous materials a being handled. A responsible person, who will check storage tank levels, before delivery to prevent overfilling, supervises all deliveries and that the product is delivered to the correct tank.
- Tanks containing fuels shall have lids and shall remain firmly shut. Only empty and externally clean tanks *may* be stored on the bare ground. All empty but externally dirty tanks shall be stored on an area where the ground is protected (e.g. concrete slab, covered store house, etc.).
- Fuel stores shall be placed on a concrete, or similar, base surrounded by a brick bund. The bund shall have a volume of 10% of the volume of the largest tank in the storage area plus 10% of the volume of all other tanks. The slab shall be sloped towards a sump to enable any spilled fuel and water to be removed. Any wastewater collected at the sump shall be disposed of as hazardous waste.
- Gas and liquid fuel shall not be stored in the same storage area.
- The Contractor shall take all the necessary precautions to prevent fires or spills at the fuel stores. No smoking shall be allowed inside the stores and within 3m of a bund.
- The Contractor shall ensure that there is adequate fire-fighting equipment at the fuel stores.
- Lubricants will be stored in drums or tins that are either sealed or have tightly fitting caps. All containers must be closed unless in use. Decanting of lubricants must be carried out in a specific area that has been previously identified and suitably protected.
- The floor of any storage of decanting area shall be impervious (such as concrete) to lubricants and kept clean at all times. The floor shall slope towards a central sump, all liquids collected in the sump shall be disposed of as hazardous waste.
- Lubricants shall be stored under cover in a no smoking area.
- All lubricant impregnated cotton waste and rags shall be promptly disposed of and handled as hazardous waste.
- The Contractor shall ensure that all servicing and/or refueling of vehicles and equipment takes place within the construction camp. The ground under the servicing and refueling areas shall be protected against pollution caused by spills and/or tank overfills. The method of protecting the ground shall be identified by the Contractor and approved by Engineer;
- All waste shall be collected, contained on site and stored in water-tight containers prior to disposal off-site as hazardous waste at approved site. All equipment that leaks shall be repaired immediately or removed from the site;
- The Contractor shall only change oil or lubricants at agreed and designated locations, except if there is a breakdown or an emergency repair. In such instances, the Contractor, shall ensure that he has sorbent (sand, cutting or Similar) and/or drip trays available to collect any oil or fluid. The only permitted method of refueling and refilling lubricants is by means of a pump;
- In the purpose of smaller interventions for re-fueling it will be used small fuel delivery vehicle. It will be supplied with Spill-Kit equipment.
- Parking of machines and equipment only at designated sites, which should be provided with specific measures for protection against soil pollution with fuel, oil, or oil derivatives. In the event that soil is contaminated by spillage, the affected layer should be removed and disposed of at approved dump sites, in accordance with the Contractors waste management plans (WMP);
- Systematic collection of solid waste during construction (including food and material packaging, and other types of waste) should be undertaken and should be disposed of two agreed licensed facilities, in accordance with the WMP (se Appendix I);
- Cleaning equipment and vehicles will only be allowed in dedicated facilities, designed to avoid ground and water pollution. Similarly, washing out of concrete mixers and uncontrolled removal of remaining concrete should be a controlled operation; the use of „slush pits (lined pits) or tanks should be employed for washing out concrete contaminated equipment following concrete pours. The resultant set concrete can then be disposed of as inert solid waste or reused in bulk fill areas, as appropriate;
- Upon completion of material extraction, all borrow pits and waste disposal sites should be reinstated to reduce the visual effect and re-establish natural vegetation. Limitations to this will occur, especially where material is

extracted from currently operating, licensed quarries, in which Project influences are restricted, as will be the case for licensed waste disposal facilities.

- Since the project envisages river control works, it is necessary to avoid this type of works in the period of fish spawning.
- Organizing the construction within the minimum amount of space needed for its functioning, and during selection of the location, ensuring that it is not an area with developed plant and wildlife characteristics in order to avoid unnecessary loss of biotope.
- Collecting humus material and storing it in an organized storage area so that it may be used during finishing works for recultivation and biological protection;
- Carrying out all activities with petroleum and its derivatives during construction or the filling of vehicles in a specially defined place with the maximum mitigation measures to ensure that spilling does not occur. Collecting all packaging for oil and other petroleum derivatives and taking them to a controlled storage area;
- If damage occurs to a vehicle with dangerous liquid materials, traffic must be stopped as in the previous case and transferred to a parallel carriageway. In the meantime the authorized service at the level of the municipality shall be informed and the specialized team for sanitizing damage shall be deployed. The spilled material is removed from the highway using special sorbents. If the liquid reaches outside of the profile and pollutes the soil, sanitization shall be done by removing the soil. All materials which are collected in this way are treated according to the special procedures of regeneration or are stored in the storage area envisaged for such materials.

<u>Operation phase</u>

No specific measures to be implemented, except applying good engineering practice.
General mitigation measures are:

- Provide suitable road markings, signs and signals for the section
- Draw up operational plans for winter maintenance procedures, taking into account environmental protection;
- Slopes of embankments need to be landscaped and planted both to improve the visual effect and reduce potential for surface erosion;
- Provide a road protection zone that will not be used as an arable zone. Considering the expected concentrations of the pollutants, this belt should not spread beyond 5 meters from the edge of the road right of way. The grass obtained by the maintenance of green surfaces in the vicinity of the road shall not be used as cattle feed. It will be important to inform and educate local communities regarding the dangers of using this vegetation. According to the law, PEPS is responsible to perform all sampling, measuring and other monitoring activities during the operation phase, by following all recommendations given within the monitoring plans (component of site specific EIA and this EMP). All the monitoring results are to be provided to the Serbian Environmental Protection Agency. PEPS will also inform local communities about monitoring results, including on potential pollution of land nearby the motorway. No herbicides shall be used for elimination of weeds;
- Substitute the use of sodium chloride with by other substances with a similar or higher defrosting effect in order to minimize the effects of salinization of soil in the vicinity of motorway resulting from the winter maintenance. Where sodium chloride is used in the maintenance process, precise planning of time distribution and quantities is of critical importance;
- Ensure that other support and other service facilities along the route are designed and erected in after the appropriate EIA and/or studies are made and approved by the relevant national institutions;
- All possible accompanying content along the planned highway must be designed and built in harmony with the fundamental function of this road with a prior Environmental Impact Assessment study;
- The complexes of accompanying content must be supplied with special containers for collection of solid waste so that pollution of soil in the zone of the road is avoided during operation. The containers must be emptied by the authorized company and solid waste must be stored at the proper dump area.

5.1.2. Surface and ground water

The mitigation measures for underground and surface waters encompass all procedures which are necessary for bringing quantified negative effects to within the allowed limits, as well as procedures for minimizing the effects of the phase of construction and phase of operation.

<u>Construction phase</u>

Contractor should carefully plan potentially sensitive operations such as in-river works. Typical procedures will include:

- No construction materials or pollutants, such as cement shall be allowed to fall/flow into water features. All storage of spilling material will be covered to avoid possible emissions with wind blow. Nearby watercourses site will be fenced.
- Extreme caution shall be taken during construction owing to the high erosion potential of the river embankments. The EM shall assess any preventable damage caused by the Contractor and prescribe rehabilitation measures to be completed.

- Construction in the river bed will take place during low water level period;
- No washing of equipment or vehicles will be allowed in the vicinity of watercourses;
- The river banks in the studied area must be protected by barriers during the construction phase for the purpose of preventing negative effects which could be caused by driving and unloading material in the vicinity of the same.
- Driving of machinery within rivers, streams or on their banks should be prevented except in cases when it is impossible to avoid due to construction of a certain structure or building.
- Excavation and construction of foundations for shoreline columns, support walls, and other structures which are located on or in the vicinity of bodies of water, are carried out during periods of low water level (July - September), in order to reduce the negative effects on the rivers and their shorelines to a minimum.
- Maintaining, refueling and cleaning construction machinery shall be carried out at locations which are far from waterways and which will be defined before the works are begun.
- In the direct vicinity of rivers, spillage of any kind of dangerous substances must be avoided. In that sense, the contractor will be required to use biodegradable compounds for lubricating machinery as well as biodegradable transmission fluid in order to reduce pollution down to a minimum during the carrying out of works.
- Providing training to machine operators regarding the sensitivities and working procedures to be followed;
- Checking all machines and equipment for leaks prior to use;
- Preparing site specific emergency plans to respond to any incidents or spillages of hazardous material;
- Storing all fuels at a safe distance from the watercourse;
- Preventing re-fuelling near the watercourse and/or taking precautionary measures to prevent spillage.
- Construction of foundations for bridge piers, retaining walls, and structures located at or in the vicinity of rivers should take place in the period of low water levels (July - September) so as to minimize negative impacts on rivers, their banks and river ecology;
- Storage and handling of fuels, oils and other hydrocarbons through a controlled process, involving measures to prevent soil and water contamination. Those should include fuel and oil storage on sealed surfaces and within secondary containment; refueling of all plant, vehicles and machinery at minimum 50m of any watercourse, drain or channel leading to a water course.
- Similar measures for storage of fuels and re-fuelling of equipment should be put in place in floodplains to prevent groundwater pollution. No storage of fuels and oils will be allowed in floodplains where the potential for washout exists.
- All sites near rivers will be protected by fencing and other means to prevent loss of construction materials, particularly hazardous materials.
- Prevent the movement of machines inside rivers, streams, or on their banks, except when it is unavoidable due to the construction of a structure or construction.
- The Contractor shall construct and operate the necessary collection facilities to prevent pollution.
- The Contractor shall dispose/discharge of collected wastewater in a manner in accordance with Water Protection Conditions.
- Each parking, service, or cleaning and washing plateau will be equipped with Waste water treatment facilities (WWTF) in the manner of sedimentation tank and grease and oil separator. All these WNTF will be temporary objects.
- Contractor will consider in detail all recommended locations of the coalescent filters, described in the EMPC as construction site facilities, and prepare detail plan of their usage in the purpose of works. Moreover, working progress schedule will have influence on facilities installation.
- All washing of plant/equipment/concreting equipment etc. shall take place within the construction camp. Water from washing operations shall be collected in a sedimentation tank, then to be purified through grease and oil separator. Recycled water will be discharged into natural recipient, The Contractor is encouraged to recycle dirty wash water to avoid obligation of removing it off-site.
- Trucks delivering concrete shall not wash the trucks or the chutes on the site or anywhere outside site boundary. All washing operations shall take place at a dedicated location where wastewater can be collected, purified, and discharged of in an acceptable manner.
- All construction camps will be equipped with sanitation. Sanitation facilities contain temporary sewage and disposal tank (sump), which will be discharged in a necessary period by the licensed company.
- Adequate chemical latrines/toilets shall be provided for all staff near the alignment. They shall be emptied I serviced on a regular basis to prevent overflowing by the licensed company;
- All latrines provided by the Contractor shall be efficient, sanitary and non-offensive. A minimum of one toilet shall be provided per 20 persons at each working area and the construction site.
- Strom Water is clean run-off water from the up-slope areas, mostly it will be catch on the perimeter of the site, and discharged into the recipients;
- During construction. the Contractor will ensure that erosion control structures - either permanent or temporary - are installed prior to commencement of construction.
- Any erosion channels developing during the construction period or during the operational and maintenance period shall be backfilled and consolidated immediately and the area restored to the proper condition. All erosion damage shall be repaired as soon as possible. Displaced topsoil will be replaced from approved topsoil.
- Up-slope ditches will be constructed and used during construction phase to divert away from areas of exposed soil to prevent the contamination of clean runoff. .

- Side ditches will be installed down-slope of all erodible stockpiles and upslope protection measures will be used to divert runoff in the event of rain;
- Sandbags will also be placed around storm water inlets/grates, throughout the site to prevent sediment entering piped storm water system.
- All vehicles and plants shall be well maintained to ensure that there are no oil or fuel leakages.
- The Contractor will provide a dished concrete plateau to prevent infiltration of hydrocarbon products.
- Drip trays will be utilized during servicing,
- Drainage from the service area will be channeled into a grease and oil-skimming tank, where it shall be treated to remove old hydrocarbons. Drainage from the washing platform will firstly be channeled into the skimming tank before being released by drain to the sedimentation pond.
- Soil contaminated by oil, fuel or chemicals shall be removed and disposed of at a registered Hazardous Waste Disposal Site or rehabilitated in-situ,
- The Contractor shall educate workers on the appropriate methods for workshop maintenance and fuel points to prevent fuel and oil being washed out of containment areas.
- Toxins and oil must be recovered from the system at least once a week, and if necessary the Engineer should require a higher frequency;
- Toxins and oil recovered must be stored in sealed drums on a covered, bounded area and removed from site either for recycling or disposal at a registered waste disposal Site.
- All spillage of oil onto concrete surfaces shall be controlled by the use of an accepted absorbent material.
- The servicing of equipment and vehicles will only be allowed in the Construction Camp within the dedicated areas.
- The Contractor shall provide grease and oil separation tanks at all areas where oil spillage or collection will occur, i.e. workshops, oil storage, vehicle wash areas and fuel points.
- The Contractor shall provide a method for oil recovery. Recovered oil shall be collected in waterproof drums for recycling or disposed of at a registered Waste Disposal Site. These drums will be stored on site only on a covered, bounded area,
- The Contractor will test effluent discharged from the oil separator tanks for Conformity with relevant effluent conditions if requested to do so by the Engineer when pollution is suspected.
- In the closure to the local water intake area it is forbidden to organize any activates with liquid hazardous material, such a fuel, oil, cleaning and washing waste water, etc.;
- The Contractor must demarcate each location, and all staff will be informed about water intake presence.
- It is forbidden to open any new well in the water intake protected area.
- The Contractor is to ensure that the quality of the water discharged is compliant with the Water Protection Conditions, with respect to the receiving environment.

<u>Operation phase</u>

- The obligation of cleaning water runoff from the highway is based on the application of the Law on Bodies of Water (Official Gazette RS No. 46/91), the Regulation on Classification of Water (Official Gazette RS No. 5/68) and the Plan on Protection of Water (Official Gazette RS No. 6/91). According to legal regulations, atmospheric water which is released into waterways, canals or other water surfaces must be cleaned at least to the quality which corresponds to the class of water in the recipient waterway.
- Removal of water from the highway on the subject section is achieved by free flow over the shoulder and slope of the embankment and on parts of the section with smaller radii, water collected along the median is drained through a closed system to natural recipients outside of the road base.
- Considering that contamination is present in water runoff from the highway in the first 10-15 minutes of rainfall which is of a high enough intensity to move a majority of particles deposited on the highway (tables 6.2.4 - 02 to 6.2.4 - 05), as a measure for preventing infiltration of pollutants into lower layers of soil and underground water or surface water, the already envisaged humus layer can be used on slopes of embankments which has filtering characteristics in the sense of retaining polluting material during vertical permeation into the soil. This can also be used in zones of cuts by laying humus in the collateral drainage ditches. The capacity of a humus layer depends on the intensity of traffic and the relation between drained surfaces of the road and surface infiltration.
- On bridge structures, along the protective barriers and raised curbs, bridge collections areas have been planned by which all atmospheric water from the surface of the bridge and the elastic connections will be collected, guided into the appropriate drainage pipe, hung on the bridge cantilever or proper support, which must be defined in the main design.
- Within the framework of the internal system, surface water removal must be resolved for all accompanying content (rest stops, tollgates, loops, including disconnected sections as well as other operational surfaces) and all structures (viaducts, bridges) on the alignment of the newly planned section of the highway.
- The continuous cleaning of components is necessary for the functioning of the water drainage system. A very important item in a series of other items aimed at ensuring the regular and efficient maintaining of the functions of the system is checking over the condition of the retention basin and cleaning the device during the operation phase. In that way the appropriate protection from pollution of the surrounding soil will be provided considering that over time pollutants become concentrated in the areas of retention basins.

5.1.3. Air quality

No specific measures to be implemented, except applying good engineering practice. Use existing asphalt plant, which is located outside project impact zone.

General mitigation measures during construction phase are:

- o The Contractor acts appropriately to minimize the generation of dust caused by construction works. Such measures include frequent watering during dry periods or by comparable means approved by the Engineer.
- o Speed limits must be enforced in all areas, including public roads and private property to limit the levels of dust pollution;
- o Dust must be suppressed on access roads and overall construction sites during dry periods y the regular application of water. Water used for this purpose must be used in quantities that will not result in the generation of run-off.
- o Water trucks dampen haul roads and exposed surfaces to minimize dust generation and utilize dust suppressant products to assist in binding fine surface dust, improve water infiltration and reduce water usage;
- o Dust dispersion from construction activities, roads, spoil dumps and other construction locations shall be limited and suppressed to the maximum extent practical.
- o Spoil dumps shall be positioned such that they are not vulnerable to wind erosion.
- o An appropriate freeboard shall be maintained in trucks hauling dirt, sand, soil and other loose material when leaving the road reserve.

5.1.4. Noise

Construction phase

If measurements taken as a part of planed monitoring activities (see Appendix II) show increased noise levels, contractor is obliged to take appropriate mitigation measures which are predefined within the Appendix I – Mitigation plan.

Contractor should also perform following activities:

- o Raising workers awareness that noisy activities should be minimized;
- o Adjusting the working hours in line with local conditions;
- o Use of modern equipment and machines with noise suppressors when working in the vicinity of populated areas;
- o Regular maintenance of construction vehicles and equipment in view of the elimination of unnecessary sources of noise;
- o Avoiding the concomitant operation of several noisy machines, when possible;
- o Switching-off the machines when out of use;
- o Using natural acoustic barriers or screens for protection against the noise round the machines;
- o Regular maintenance of access and temporary roads and limiting the speed of vehicles on unpaved roads for transportation of materials.

Operation phase

On the observed section, it is necessary to carry out measures for protection from noise.

The most important measure of protection from noise is construction of noise protection walls. This mitigation measure will be applied in places where the most endangered groups of structures are located. During the selection of the type of wall, attention must be given to the conditions which need to be fulfilled, those are:

- resistance to weather conditions,
- rationality of structure,
- visual effect,
- possibility of pre-cast construction,
- possibility of upgrading,
- spatial conformity,
- ease of maintenance.

With consideration of the level of noise from traffic in the planned period which was obtained through the calculation of authoritative levels defined by law, it is necessary to envisage a structure for protection from noise in places where the alignment is located within the vicinity of settled areas. The analyses on traffic noise which were carried out within the framework of the analyses on possible effects indicate that the limit values of permitted levels for urban areas along major highways are reached at distances of around 80 to around 250 meters from the newly planned highway. The spatial position and maximum heights of noise protection structures are provided in table T 5.1.3.

Table T 5.1.3. Spatial position and lengths of noise protection structures

Chainage (km)	Position	Length (m)
873+879 – 874+110	left	224
877+565 – 878+164	left	604
881+077 – 881+328	left	244
881+451 – 881+614	left	164
885+133 – 885+400	left	264

5.1.5. Impacts on cultural environment

- Contractor is responsible for following national requirements with respect to “chance finds” which may emerge during construction.
- Before beginning any kind of earthworks on the aforementioned locations, it is necessary to inform the Institute for the Protection of Cultural Monuments of Serbia - Belgrade so that they may carry out an archeological study;
- If at any time during construction archeological findings or archeological objects are uncovered, The Contractor is required to immediately, without delay, halt works and inform the authorized Institution for Protection of Cultural Monuments and to undertake measures to ensure the findings are not destroyed or damaged and to protect the area and position in which they are discovered.
- Contractor is not allowed to perform excavation, demolition, alteration or any works that may harm the properties of the cultural monument.
- KS will timely inform the IPCM and authorized expert about the commencement of earth and other works at the archaeological site or in its immediate vicinity, in order to timely perform all the necessary preparations until the archaeological exploration license is obtained. This aspect has been included in the EMP and a costing allowance has been made to cover archaeological watching brief and any subsequent investigations.
- In case of chance finds, Contractor shall mark and secure new identified sites (with a protective railing or other means of protection) to avoid damage in the course of road construction and immediately notify the relevant IPCM.
- KS is obliged to provide for and ensure archaeological intervention in the case they come across new finds. This involves the immediate discontinuation of works and notifying the competent IPCM about the discovery. Carrying out the above activities will require occasional archaeological supervision during construction.

KS will finance producing new documentation and ensure conservation of physical cultural resources. Prior to work, Employer will engage IPCM to do permanent supervision of works at the whole motorway section.

Regarding that there is possibility to find new cultural resources, Contractor will apply followingmethodology to rescue all excavated material:

- New localities require the presence of archaeological - conservation authority in the executionphase.
- Depending on the character of the findings, possibilities and methods of protection andconservation will be considered and some of the following proposed measures will be applied:conservation of the findings by backfilling; allocation of the findings; and partial allocation of thefindings with the conservation of the remainder of locality by backfilling.

According to mentioned facts, the protection of possible localities will be realized in three steps, whichwill be in accordance to the actual circumstances follow each other. Realization steps are:

- Execute exploratory boreholes for archaeological investigation on the identified sites so as to determine theexact cultural belonging of the sites, stratification of archaeological layers, chronologicaldetermination, and preservation of the archaeological layers and the remainders of the architecture ifthere is any. Investigation in this phase would have to be completed before the commencementof the works on the site.

- On the basis of the archaeological research results in the phase one, new archaeologicalresearches would be planned on special parts of the site that would be endangered by construction. In case that in the course on research in the phase one it happens thatthe culturallayer on the localities is not preserved or that the line of the communication is avoided, the second-phase research will not be carried out.

- Monitoring by the authorities, i.e. the control while execution of earth works near the alignment.with mandatory protection of archaeological excavation if any new archaeological sites arediscovered while execution of work.

5.1.6. Flora, Fauna and visual impact

Flora

The following mitigation measures are necessary:

- Clearing up and removal of vegetation should be minimized to the extent necessary for the execution of works.
- Natural vegetation shall be kept in as undisturbed a state as possible. Special attention shall be paid to preserve trees and plant communities such as wetlands or montage forests, strictly according to the preconditions obtained

from INP (see appendix IV). Vegetation removals as part of the development requirements - such as along the proposed scarp road - are excluded.
- Based on the detailed design for this project, and locations marked as a ground under high and excessive erosion, The Contractor is obliged to prepare his own plan (Re-foresting Plan) for re-foresting those areas and to perform re-foresting activities according to this plan.

Fauna

The protection of fauna will be ensured by undertaking the following measures:

- Erection of a protective fence along the road, as a measure to prevent domestic and wild animals straying onto the road and being killed. Protective fence should be with the variable density, starting from higher density in a zone of 50cm above the ground and ending with a standard density for regular protective fence.
- Ensure that the protective fence ends at the bridge base, so as to direct wild animals toward the passage under the bridge. Execute the bank revetments with rough, coarse surface to prevent animals from slipping into water.

One of the more significant consequences of construction of the highway is the phenomenon of fragmentation of the habitats which in this case hits amphibians the hardest. The reason can be found in the existence of the waterways which are necessary for their life cycle. For the purpose of protecting biodiversity and undisturbed movement, multi-functional passages can be built along the waterways, viz. in those places where the construction of bridges has been envisaged. Bridges can be their own ecological corridors with a little revamping so that the bank of the waterway takes up a third of the passage under the road. The sides of the bank must be coarse in order to prevent the sliding of animals into the waterway and in order to enable easier exit from the waterway. The area before and after the passage must be covered in an identical type of soil and vegetation.
Along the aforementioned passages, it would also be suitable to use the envisaged slab, tubular and vaulted culverts for movement of wild animals. As there are no larger wild animals in the region in question, these passages represent a suitable place for the crossing of small wild animals. In the following table, a display is provided of the types of culverts, chainages and their sizes.

T 5.1.6. Culverts suitable for the passage of animals on the section Gornje Polje – Caricina Dolina

Type of culvert	Chainage (km)	Length - diameter (m)
Slab culverts	876+527	6
	877+460	6
	884+090	6
	884+567	6
	885+020	6
	885+550	6
	885+649	6
	885+020	6
	885+649	6

Visual Impact

This issue is solved during design phase and there is no additional, site-specific mitigation measures related with the visual impact of the project. Generally, all visual impact during construction works can be divided into two groups:

1. Temporary disturbance of visual characteristics during construction works due to presence of site equipment and mechanization.
2. Space occupation, which can be improved by site organization in accordance with Detailed Design of environmental protection

5.1.7. Construction Camps

The Contractor shall submit a locality and site plan of all construction camps indicating the location of fuel supplies, stockpile sites, offices and the construction area for approval by the Engineer to be approved prior to establishing any camps. The Contractor shall submit a locality and site plan of all construction camps indicating the location of fuel supplies, stockpile sites, offices and the construction area for approval by the Engineer prior to establishing any camps. If there is a need to put any equipment or facilities outside the expropriation boundary it will be done in the agreement of the owner and under Engineer approval.

- No one of the Camps will be in the area of influence on the water bodies (watercourse, water intake, etc.), Storage of hazardous materials will be afar of watercourse, and under specific conditions.
- Site facilities and offices will 00 selected in the manner to ensure that there is a minimal impact on the environment. All facilities will follow international health and safety standards furnished with power and telecommunication installations, fresh water supply, sanitary and wastewater collecting and treatment installations, solid waste collecting by category and hazardous waste collecting eco-receptacle;
- All Camps will be placed within an existing disturbed area, as far as possible. There will be no Contractor's objects, structures, parking, services, nor material storage in sensitive areas, such as wetlands or erosion potential land;
- All site buildings are containers and other temporary structures. No permanent structures will be built. All objects will be sound-proofing built, and will not pose a danger to personnel and surrounding environment.
- With the decommissioning of the structures all compacted platforms and slab foundations must be ripped and removed.
- Welding, gas cutting or cutting of metal will only be permitted in a specialized protected area inside the Construction site.
- No fires are allowed in or outside the Construction Camp. Adequate and well-maintained firefighting equipment-according to the fire hazard strategies - must be maintained on site during the construction period.
- The Contractor shall be liable for any costs related to extinguishing fires started by the Contractor's employees or subcontractors. Additional penalties for infringements will also be imposed by the EM
- The boundaries of the site shall be demarcated prior to any work commencing on the site. The site boundary demarcation shall be removed when the site is disestablished.
- The Contractor shall demarcate the boundaries of inner limits of the site. Site boundary is defined by expropriation line, and can be changed only in agreement with neighbor landowners. The Contractor shall maintain the demarcation line /
- The method of demarcating the boundaries shall be determined by the Contractor and agree to by the Engineer prior to any work being undertaken. The method of demarcation consists of steel droppers placed at regular intervals, with nylon rope between the markers where this prove to be safe, but where any unauthorized person move closely pass construction work, netting should be provided preventing building material from falling into these paths.
- The Contractor shall ensure that a/l his plant. equipment and materials remain within the boundaries of the site, unless otherwise agreed with Engineer.
- Contractor will ensure that materials used for construction on the site do not blow on or move outside the Site and environs, or pose a threat to animals in the area. Failure to do so may result in the Engineer requiring the Contractor to fence the boundaries of the site with wire mesh, prepare covering material etc., at his own expense to the satisfaction of the Engineer.
- Wire mash fences will be constructed around heritage resources. to prevent access into such areas during construction.
- Fencing shall be kept neat at all times. The Contractor shall be responsible for the maintenance of all fences. Breaches in the fencing must be repaired immediately.
- If fencing is removed temporarily for the execution of work, the Contractor shall reinstate it as soon as practicable. Until re-instatement, the contractor shall demarcate the working area by surrounding it with danger-tape marking.
- Demarcating/Fencing of the construction site shall be suitable to allow access by livestock and local fauna to their natural routes. The purpose of the fenced areas is to control construction and personnel activity within the designated areas, and limit unauthorized access.
- No unauthorized pedestrian or vehicular access shall be allowed into demarcated off-limit areas.
- All vehicles and equipment will be allocated a dedicated parking area in the Camp site;
- No storage of equipment and vehicles will be allowed outside of the designated area:
- All parking, service, cleaning and washing areas will be made of waterproof structure with equipment for collecting spillage. All parking areas will be equipped with WNTF;
- Existing roads (arterial road M-1.12, regional road R-121 and local road network) will be used, as far as possible. No temporary access roads will be permitted, unless, otherwise is accepted by the Engineer, and under agreement with affected landowners.
- In the purpose of the Project, if any existing local road need extension or reinforcement to carry out Contractor's heavy machinery it will be done in accordance with local standards, and approved by the Engineer prior to use;
- If any, temporary roads required Shall be decommissioned by the Contractor and rehabilitated using stockpiled topsoil. Topsoil shall be removed as described under 'Clearing and Grubbing' prior to the construction of the road.
- Access roads shall be regularly brushed or scraped and kept free from dust and mud deposits. In dry weather dust suppression measures may be required.
- The accommodation of traffic is an important aspect on the roads identified for upgrade / maintenance. Where required, temporary works to facilitate the accommodation of traffic during construction, should be completed first as road closures will be avoided as far as possible.

- Adequate and appropriate traffic warning signage will be placed along the route to be used by the construction vehicles from the Camp.
- Adequate and appropriate traffic warning signage will be placed along the route to warn public of construction work and heavy vehicle traffic.
- Transporters of fine materials must ensure that their operation does not pose a nuisance through the spillage of material or the creation of dust.
- All trucks and vehicles removing spoil from the site shall have the load areas covered by a tarpaulin to prevent rocks and spoil from falling onto the road surfaces, or causing a nuisance to persons in the vicinity.
- Deliveries shall be scheduled for off-peak hour traffic time schedules, as far as possible.

5.2. Requirements of site specific implementation plansduring construction phase

General environmental protection will be contractually provided for in the organization and planning of the work and operations on work site. Each Contractor should build upon the mitigation measures described in the EIA and EMP and should prepare his own site specific implementation plan (SSIP), to include *inter alia*

- Waste and wastewater management plan
- Traffic Management Plan
- Oil and fuel storage management plan
- In-river works management plan
- Camp management plan
- Emergency response plan
- Re-foresting plan
- Grievance mechanism

Minimum requirements for each of above plans are shown in Appendix I – Mitigation Plan.

Each Contractor should include HSE staff as part of his workforce and they should report to the HSE staff of the Project Management Consultant advising KS. In addition, the Project is to include Independent Environmental Consultants to provide informal advice and undertake monitoring and auditing activities.

All construction sites should be managed in accordance with national legislation on construction and HSE, such as the Law on Occupational Safety and the Law on Occupational Health and Safety and the Regulation on Occupational Safety for Construction Works (Official Gazette of RS, No. 53/97).

5.3. Check List – Mitigation Plan

Phasing, issues and mitigation measures are covered in Appendix I.

6. DESCRIPTION OF MONITORING PROGRAM

Monitoring of the effects of the Project will commence <u>during the construction phase</u> and will continue <u>during the operation of the highway</u>. This EMP sets out the basic parameters to be monitored in order to determine that mitigation measures identified above are being implemented effectively.

Following award of contracts for construction, the individual Contractors will work with KS to develop a detailed monitoring program with specified targets for each indicator, which will be tailored to the requirements of each road sub-section and the elements of The Contractor’s Environmental Management System (EMS) and site-specific EMP. Each Contractor will develop a written monitoring program that will be evaluated by the independent environmental consultants and Project stakeholders, including national statutory agencies. The Contractor will cover the cost of implementing the relevant monitoring program in areas of his responsibility.

The monitoring results will be compared to data on current conditions

Compliance with EMP will be monitored by the independent contractor/supervisor, KS and the WB staff.

6.1. Construction Phase

Shortly after mobilization to country The Contractor will develop the monitoring plan in conjunction with the Project Management Consultants (PMC) and relevant statutory authorities. The parameters in the monitoring plan are expected to focus on potential soil and water pollution, especially in areas of higher sensitivity, such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), suspended solids, oils and greases to represent potential impact due to construction of the highway, based on the nature of the site activity.

Parameters which require measuring along the highway alignment<u>during operation</u> should be based on the potential for environmental impact and thus focus on water, air, soil and noise pollution, both <u>during construction</u> and <u>operation</u>.

6.1.1. Noise

Noise exposure levels are specified under the Regulation on Allowed Environment Noise Levels (Official Gazette RS, No.54/92). Noise measuring equipment will be used to establish a background or baseline and then during construction to establish increases in level and hence compliance to the standards. It is recognized that the best approach to noise control during construction works is require the use of equipment which conforms to noise standards, and then monitor the issue on an ongoing basis, including reacting to any nuisance complaints by local residences or businesses. If acceptable noise levels are exceeded, implementing mitigation such as temporary screening or re-arranging work sites this will be the responsibility of the Contractors environmental and construction site staff.

During construction the level of noise increases due to the transport of loads by heavy freight vehicles (removal and delivery of materials) and the use of the construction machinery. These sources of noise are of a temporary character and last until the completion of construction works.

During the phase when works are being carried out, the level of noise must be controlled when necessary, meaning upon the occasion of a complaint being filed for an excess level of noise while works are being carried out. The Rulebook on Allowed Levels of Noise in the Environment defines the methods of measurement, selection of measurement location and the time intervals of measurement.

Within the framework of monitoring noise during the carrying out of works, the following is required:

- measurement of the zero point,
- measurement of the highest levels (peaks) of noise during construction,
- If during the course of works the limits of allowed levels of noise are significantly exceeded, in agreement with the owner of the structure, necessary mitigation measures are undertaken.

The Contractor is responsible for all consequences which arise from excess levels of noise during the phase of construction.

6.1.2. Air Pollution

Constant monitoring has been envisaged for when there are residential buildings located closer than 400 m. In the case of a complaint from a local resident, monitoring of the effects may be organized at that time.

6.1.3. Water

Monitoring of water during the phase of construction of the highway includes determining the effects on the quality of water while construction works are being carried out in the vicinity of waterways or water collectors.

For surface water, the program includes the following parameters: pH, concentration of dissolved oxygen in the water, waste materials, murkiness, concentration of organic compounds and mineral oil.

Limit Values for Serbian water class standard is in according to Serbian Legislation (“Official Gazette of SRS” No. 05/68, 31/82). Documents are presented within the app III of this document.

Monitoring responsibility lies on Serbian road management company (currently “Corridors of Serbia”)

The taking of samples is done on a part of a surface waterway downstream from the construction site. The monitoring program is administered in such a way that it can be used to establish which construction works affect the quality of surface waterways. Samples must be taken before the commencement of works, at the time when humus is being removed and when excavation or the building of embankments from earth material is being carried out. Sampling is done in monthly intervals.

In the situation when the measurement results and analysis indicate an increase of negative effects, it is necessary to determine the cause of the deteriorating condition and undertake the necessary mitigation measures. Until the cause of the deteriorating condition is determined, only works which do not have an influence on pollution of surface waters may be carried out.

All measurements begin one month before the beginning of preparatory works. The parameters which are the subject of monitoring are divided into the groups geological-hydrological, physical-chemical and chemical. Measurement of the basic and indicative parameters of underground waters should be done at least four times a year with an interval of at least two months. Measurements of the chemical and physical-chemical parameters are done quarterly. The days when samples are taken will depend on the level of underground water, precipitation and other geological and hydrological relations.

6.1.4. Soil

Relevant parameters for soil impact assessment are: pH, concentration of heavy metals, oils and organic substances. Soils near roads having a high frequency of traffic, as in this case, should be tested for hazardous substances, such as typical heavy metals which may have accumulated from vehicle exhausts.

The program for monitoring soil during the construction phase includes parameters which are authoritative for determining the level of endangerment of the same. There is a wide spectrum of pollutants which have been categorized into the following two groups: heavy metals and greases and oils (remains of uncombusted fuel, lubricants and motor oil, antifreeze, hydraulic fluid, etc.).

Samples must be taken before the commencement of works, at the time when humus is being removed and when excavation or the building of embankments of earth material is being carried out.

In the situation when the measurement results and analysis indicate an increase of negative effects, it is necessary to determine the cause of the deteriorating condition and undertake the necessary mitigation measures. Until the cause of the deteriorating condition is determined, only works which do not have an influence on pollution of soil may be carried out.

6.2. Operational Phase

During operation of the highway the relevant environmental aspects will be monitored and will include noise, air, and water and soil quality. The results obtained will determine if additional environmental protection measures are necessary, such as provision of additional noise attenuation structures, landscaping or modifications to carriageway drainage or treatment.

6.2.1. Noise

During operation, within the defect notification period, noise must be controlled with the goal of controlling the effectiveness of envisaged noise protection measures. Measurement of the level of noise must be carried out in intervals of five years and in cases of complaints from adjacent inhabitants.

Residential object which will be monitored related to noise problems are located on the following chainages

Chainage (km)	Position
873+879 – 874+110	left
877+565 – 878+164	left
881+077 – 881+328	left
881+451 – 881+614	left
885+133 – 885+400	left

6.2.2. Air

For measuring the content of pollutants in the air which are emitted by motor vehicles during the phase of operation of the future E-75 Highway, it is necessary for all measuring stations to be placed in the same manner because only in that way can the proper dispersion model be formed, based on which adequately reliable data on the spatial distribution of air pollution in the affected zone can be obtained.

In the first phase of monitoring which must last 5 years, it is necessary to carry out periodic monitoring of the air quality (1 month in a season), because in order to establish trends of air pollution it is necessary for measurement data to be obtained for at least five consecutive years.

Only in the case where the results of periodic measurement indicate the necessity for further monitoring of air quality would it be necessary to carry out permanent monitoring of air quality, viz. enacting the second phase of monitoring.

6.2.3. Water

The monitoring program for surface waters during the operation includes monitoring of the following parameters: pH, concentration of dissolved oxygen in the water, waste materials, murkiness, concentration of organic compounds and mineral oil, then temperature, color and odor.

Domestic legal regulations which relate to the method of controlling the quantity and quality of waste water (effluent) before it is released into a recipient cannot be applied to the control of the quality of cleaned atmospheric waste water. Depending on the climatic factors, scope and structure of traffic, the composition of effluent varies during one hydrological year. Besides that, as opposed to a majority of European countries, in Serbia there are no prescribed emissions standards. That is why in this specific case it is only possible to monitor the effect of operation of the future highway on the quality of water of the recipient through emissions standards.

Measuring the quality of water of the recipients (Southern Morava River with its tributaries) is aimed at understanding the effects of runoff waste water on the quality of water in the recipient.

The TOR envisages the water removal system to be an open type system. With that in mind, monitoring of surface water during operation of the project should be carried out at a place downstream from where the water removal canals empty into the recipient Southern Morava.

Purpose of the monitoring is to comply with Serbian legislation. Within the Article 73 of Law on Environmental Protection (“Official Gazette of RS” No. 135/2004, 36/2009, 72/2009) is stated that polluters are obliged to submit the data on monitoring to the Environmental Protection Agency in a way prescribed by regulations.

"Koridori Srbije" needs to ensure that quality of the water which enters the recipient river does comply with the Serbian water class standard for specific river recipient.

It is necessary for the measurement and processing of data to be carried out continuously every four months. This means taking samples in January, April, July and October, which covers all periods of low and high water levels within the function of rain and drought. In that manner, possible concentrations of pollutants in runoff water will be controlled and with that also the condition of the class of the waterways in the studied area.

The monitoring plan for underground waters was done in accordance with the requirements of the TOR as well as in accordance with the basic characteristics of construction of the subject section of the highway.

Within the framework of the geological-hydrological studies on the characteristics of underground waters, a map of the levels of underground waters was drafted which covers the area of the analyzed section. The hydraulic parameters of underground water are determined in each testing which implies the determination of the coefficient of water permeability and its comparison with previously obtained data. Based on these results the hydraulic conditions of each bore hole are determined.

The testing program encompasses the parameters which can be used to evaluate the current condition of the quality of underground water and the degree to which it is polluted with polluting substances from the subject section. The testing program includes the following measurements:

- Terrain measurements: temperature of air and water, pH, electrical conductivity, oxidation/reduction potential,
- Basic parameters: color, dissolved materials, total organic carbon, nitrogen, nitrates, sulfates, chlorides, chemical and biological consumption of oxygen,
- Indicative parameters: microelements, phenols, mineral oil, polycyclic aromatic hydrocarbons, aromatic hydrocarbons, pesticides.

6.2.4. Soil

Monitoring of soil during the operation of the highway, viz. monitoring the effects of operation of the future E-75 Highway, section Gornje Polje - Caricina Dolina, on the quality of soil, must be carried out at the edge of the "buffer zone" of highway.

The Contractor will ensure a preliminary testing ("zero monitoring") of soil pollutants according to the Monitoring Plan of this EMP document. In the preliminary testing, the locations where sampling is done must be selected randomly and be small in number. The first and most important step in the analysis of the quality of soil is the taking of samples. It is not only quality of the measurement results that depends on the manner in which the samples are taken, but also the conclusions which relate to the quality of the analyzed soil. Any particular sample of soil can rarely be reproduced in the sense of its physical and chemical characteristics. For example, the second sample, taken from the same sampling point, won't necessarily be identical to the first sample. The depth of sampling depends on the use of the land, as well as on the effects which are present on that land. From cultivated land, samples are taken form a depth of 0-30 cm and from land which is used for growing fruits, samples are taken from two depths- from 0-30 cm and from 30-60 cm. Individual samples are then placed into a PCV container, mixed up and stones and plant remains are removed. The prepared sample is then put into a PVC bag, marked and transported to the laboratory for analysis.

Following the preliminary testing a plan for further testing is created. For this purpose the place of sampling is defined first. The number of samples depends on the preliminary testing and is related to the structure being tested.

Parallel to the control of the quality of soil, the quality of underground water must also be monitored. The quality of underground water requires the monitoring of pollutants which are present in the soil and for the purpose of determining the effects of soil pollution on the pollution of underground water. Sampling of underground water is done using the piezometer.

6.3. Check List – Monitoring Plan

Details related to the monitoring program are tabulated in Appendix II.

7. PUBLIC CONSULTATION

7.1. Public Consultations on EIS

In respect to environmental safeguard issues, the Client (PEPS) has already prepared subsection EIS on preliminary/ feasibility design of E-75 Highway section between Gornje Polje and Caricina Dolina, in accordance with Serbian legislation. The national disclosure process encompassed four rounds of public consultations for each sub-section (on TOR for environmental consultant, on scope of environmental assessment, on draft EIS and on draft final EIS) and were carried out in period from 2006 to 2009.

The national EIA procedure in respect to E-75 highway section from Gornje Polje to Caricina Dolinastarted at Jan26, 2006, when PEPS (former Serbian Road Directorate) submitted the Request to the Ministry for environmental protection (MOE) in order to receive document determining scope and content of EIS. According to the Serbian Law on EIA ("Official Gazette of RS" No. 135/2004, 36/2009), this step was announced in daily newspaper "Politika" (Feb15, 2006), and interested parties were invited to participate in process of defining the scope and content of EIS. At Mar 10, 2006, the Ministry provided the Terms of Reference and that information was made public in daily newspaper "Politika" (Mar23, 2006). The CIP Institute, Belgrade prepared draft EIS, which was submitted to MOE for its approval (Aug 05, 2008). At the same time PEPS announced this step in daily newspaper "Politika" (Sep12, 2008), when public and other interested parties and organizations were invited to participate in process of public consultation on draft EIS for E-75 Highway Project, section Gornje Polje - Caricina Dolina.

Public Consultation was held in Leskovac, on Oct09, 2008, and there were no major complains on prepared draft EIS. The sub-section EIS has been approved by the Serbian Ministry of Environment and Spatial Planning (former MOE) on Jun 18, 2009 (No 353-02-236/2008-02).

7.2. Public Consultations on Corridor Level EIA report

In accordance with OP/BP 4.01 the Borrower has engaged an independent consultant to prepareCorridor Level EIAfor E-75 Highway from Grabovnica to Levosoje, which include highway sub-section from Gornje Polje to Caricina Dolina. Besides consolidating the sub-sectionEIA, the Corridor Level EIA also addressed the cumulative, induced, indirect and transboundary impacts. The draft EIS has been received by the Bank and commented upon. The Client subsequently updated the Corridor Level EISand prepared a final version of the document.

The in-country disclosure of draft Corridor Level EIS was carried out in the period from February25 (when the documents were made publicly available on site and at the Client's web site) to March12th(when the public meetings were held in Vranje). Public announcements inSerbian and English were published in the daily newspaper Politika, inviting the public, authoritiesand relevant institutions to have an insight into the EIS for the Project. Prior to announcement in thenewspapers, the EIS was delivered to the Municipality of Vranje and published on the KS and PE "Roads ofSerbia" web site.

Public Consultations were concluded on March 12, 2009, from 12 to 02 PM (local time), bypresentation of the subject EIA on the premises of the Municipality of Vranje.

Presentation of the EIA for the E-75 Highway Project, Nis – FYRM Border, Section Grabovnica –FYRM Border, was attended by representatives of the Municipality of Vranje, EIA Author, WBrepresentative, representatives of the PE "Roads of Serbia" and the interested public. List ofparticipants is included in this Report.

During the public consultations, there were no significant remarks in regards to environmentalprotection issues related to Gornje Polje - Caricina DolinaHighway section.

8. INSTITUTIONAL ARRANGEMENTS

KS is responsible for the overall implementation of the Project, including management of environmental and social issues under the Project.

The EIS for E-75 Gornje Polje – Caricina Dolinahighway section, Corridor Level EIA and Detailed Design of Environmental Protection for E-75 Gornje Polje – Caricina Dolina highway section provides the base for the preparation of this site specific EMP. As part of the detailed design stage for this section, KS has prepared this site-specific EMP and Checklists. The site-specific EMP and Checklist are included as part of the bidding documents to ensure the contractors are aware and meet their formal obligations in the area of the environmental protection. After contract signing, The Contractor will prepare his implementation plan, to be approved by the KS ("Corridors of Serbia")'s Supervision Consultant, containing the detailed information on meeting the requirements detailed in this EMP.

During project implementation, a firm of independent consultants, who will report directly to KS, will monitor whether and how well contractor complies with the measures as outlined in the EMP. Any non-compliance with the EMP or any other safeguards will require immediate remediation. Contractors *vis-a-vi* the borrower, and the borrower *vis-a-vis* the Bank will need to present reasons for noncompliance, propose a detailed and time-bound action plan to achieve compliance, and obtain the no objection of the Bank for the action plan. The cost of proposed corrective measures will be borne by the responsible contractor.

9. IMPLEMENTATION SCHEDULE AND REPORTING PROCEDURES

Prior to the commencement of works KS will submit to the Bank for its approval: this section specific Environmental Management Plan and Checklist.

The Contractor will prepare his compliance reports in respect to this EMP and his SSIP at regular intervals as instructed by KS.

The Contractor will submit reports in both Serbian and English language in hard copy and electronic versions.

Separate independent environmental and social supervision will directly reporting to KS for the implementation of the project,

Project progress reports, including monitoring indicators and reporting on the implementation of the requirements set forth in the Environmental Impact Assessments and the Resettlement Policy Framework, will be prepared by KS on a quarterly basis and submitted for Bank review. The Bank will review the reports and verify their contents through periodic site visits.

The Contractor will provide “Zero monitoring” results prior to commencement of earth works, during its own mobilization phase.

Semi-annual reviews will be carried out each year, jointly by the Borrower and the Bank together with other participating IFIs and bilateral donors, to measure progress made in implementing the Project. The semi-annual reviews shall cover, *inter alia:* (a) progress made in meeting the Project objectives; and (b) overall Project performance against Project monitoring indicators.

10. REFERENCE

1 Detailed site-specific EIA for E-75Highway Nis – Border of FYRM, section Gornje Polje - Caricina Dolina, CIP Institute Belgrade, 2008

2 Corridor X level EIA Report for E-75 Nis – Border of FYRMHighway, PEPS, 2009

3 Environmental Assessment Sourcebook No 25, Environmental Management Plans, The World Bank Environment Department, January 1999

4 Roads and the environment: A Handbook, The World Bank Environment Department

5 Project Appraisal Document (PAD) to the Republic of Serbia Corridor X Highway Project, Report No: 47069-YF, June 12th, 2009

Appendix I

CHECK LIST

MITIGATION PLAN

Phase, location	Issue	Mitigation	Institutional responsibility		Notes
			Install	Operate	
Highway Construction	Relocation of services	Effective co-ordination with utility companies during relocation.	Contractor, KS	Contractor, KS	
	Noise impact on affected residents, km 873+879 to km 874+110, left side	Noise protection construction, L=230m	Contractor	Contractor	
	Noise impact on affected residents, km 877+565 to km 878+164, left side	Noise protection construction, L=600m	Contractor	Contractor	
	Noise impact on affected residents, km 881+077 to km 881+328, left side	Noise protection construction, L=250m	Contractor	Contractor	
	Noise impact on affected residents, km 881+451 to km 881+614, left side	Noise protection construction, L=163m	Contractor	Contractor	
	Noise impact on affected residents, km 885+133 to km 885+400, left side	Noise protection construction, L=267m	Contractor	Contractor	
	Inadequate prevention of construction-related noise from vehicles, asphalt plants, crushing and batch plants and equipment	The plants and equipment used for construction will strictly conform to noise standards.	Contractor	Contractor	
	Noise Impact - Disturbance to residents	Working hours/activities will be adjusted to reduce noise disturbance and working time restricted to 0630 to 1930hrs, or as otherwise agreed locally. Maintain dialogue or use grievance mechanism to allow residents to contact Project staff to make representations.	Contractor	Contractor	
	Noise impact - Protection of workers H&S	Noise standards will be strictly enforced to protect construction workers from noise impacts, in accordance with international HSE procedures. All Project works will adhere to international H&S standards, including minimum PPE standards, e.g. hard hat, safety boots, ear defenders and noise exposure limited to 85 dB(A).	Contractor	Contractor	
	Construction waste.	Heavy metals are separated and should be removed and disposed of at approved dump sites, in accordance with The Contractors waste management plans (WMP).	Contractor	Contractor	
	Potential contamination of soil and water resources.	Each parking, service, or cleaning and washing plateau will be equipped with waste water treatment facilities which will be temporary objects	Contractor	Contractor	
	Maintaining animal mobility through culverts and bridges	Use of designed culverts and bridges as animal crossing points.	Contractor	Contractor	
	Emission from construction vehicles and machinery	All vehicles, equipment and machinery used for construction will be regularly maintained and inspected/certificated to ensure that the pollution emission levels conform to the standards prescribed.	Contractor	Contractor	
	New borrow pits damaging agricultural, archaeological or ecological resources	Contractor have to use the Borrow pits on a specific locations which are predefined within the Detailed design	Contractor	Contractor	
	Asphalt plant-dust, fumes, workers health and safety, ecosystem disturbance	Contractual requirement-use existing asphalt plants; requirement for official approval or valid operating license or new plants require certification and approval.	Contractor	Contractor	
	Stone quarry	Contractual requirement-use existing quarries; requirement for official approval or valid operating license.	Contractor	Contractor	

Phase, location	Issue	Mitigation	Institutional responsibility		Notes
			Install	Operate	
	Sand and gravel borrow pit-disturbance of river bed, water quality, ecosystem disturbance	Contractor has to use the Borrow pits on specific locations which are predefined within the Detailed design . It is allowed to use existing borrow pits or buy material at licensed facilities; no borrowing from rivers. Or use new pits which require approval and licensing.	Contractor	Contractor	
	Construction related dust, from movement of vehicles at site and to sites from borrow pits and quarry sites, etc.	Dust suppression will be used on unsealed road surfaces, asphalt mixing sites and temporary service areas. Water truck bowser with spray bar will be used.	Contractor	Contractor	
	Vehicles hauling materials will generate dust nuisance	Vehicles delivering material will be covered.	Contractor	Contractor	
	Failure to properly manage/store topsoil, leading to degraded and substandard site reclamation and re-vegetation	Cleary defined topsoil storage and handling in contract specification and management plan and follow up with regular inspection & monitoring and reporting.	Contractor	Contractor	
	Flora - vegetation protection	Clearing up and removal of vegetation should be minimized to the extent necessary for the execution of works	Contractor	Contractor	
	Preventingdomestic and wild animals straying onto the road and being killed	Erection of a protective fence along the road, as a measure to prevent domestic and wild animals straying onto the road and being killed. Protective fence should be built with the variable density	Contractor	Contractor	
	Landscape impact, soil erosion	Develop and implement landscape planting; Re-forest ground of classes 6 and 7 under high and excessive erosion	Contractor, KS	Contractor, KS	
	Damage to agricultural lands, including drainage and irrigation infrastructure	Liaise effectively with PAPs before start of construction, maintain dialogue, develop a grievance procedure, strictly control machinery and vehicle access and reinstate all affected areas.	Contractor	Contractor	
	Livestock resources damaged by machinery and vehicles	Liaise effectively with PAPs before start of construction, maintain dialogue, develop a grievance procedure, strictly control machinery and vehicle access, and consider fencing for protection.	Contractor	Contractor	
	Contamination of soil or water resources	Storage and handling of fuels, oils and other hydrocarbons will be a controlled process, involving measures to prevent soil and water contamination. Designs will include storage on sealed surfaces and within secondary containment and refueling of all plant, vehicles and machinery will not be allowed within 50 m of any watercourse, drain or channel leading to a water course.	Contractor	Contractor	
	Damage to aquatic ecosystems	Prevent the movement of machines inside rivers, streams, or on their banks, except when it is unavoidable due to the construction of a structure or construction.	Contractor	Contractor	
	Contamination of soil or water resources	All sites near rivers shall be protected by fencing and other means to prevent loss of construction materials, particularly hazardous materials.	Contractor	Contractor	
	Traffic disruption to residents and longer distance travelers	Develop Traffic Management Plan in conjunction with road authorities to manage all temporary accesses, delivery of material and machinery.	Contractor	Contractor	
	Residents injured by construction traffic and machinery	Conduct safety awareness campaigns, focusing on schools and children.	Contractor	Contractor	
	Workers injured during construction	Implement international HSE standards in all contracts.	Contractor	Contractor	

Phase, location	Issue	Mitigation	Institutional responsibility		Notes
			Install	Operate	
	Illegal or excessive borrowing may damage archaeological or land resources	No earth borrowed from unauthorized locations.	Contractor	Contractor	
	Reduced land or property values	Establish and maintain dialogue with PAPs to reduce adverse effects as part of ongoing design and construction.	Contractor, KS	Contractor	
	Contamination of soil or water resources	Contaminated or hazardous waste such as bitumen waste to be disposed of in selected areas approved by the Ministry of Environment. All waste disposal to comply with a Waste Management Plan, to be developed at the start of construction.	Contractor	Contractor	
	Pollution of groundwater and soils during demolition of properties	Develop working method statement to include effective management of materials.	Contractor	Contractor	
	Damage to water resources	All abstractions and any formalized discharges must be licensed/ approved by relevant authorities.	Contractor	Contractor	
	Damage to aquatic habitats and fish	All in-river works will be conducted outside of the fish spawning season and Contractors will prepare management plans for such works as a part of their Construction Method Statements.	Contractor	Contractor	
	Damage to river morphology	Digging and making the foundations for bridge piers, retaining walls, and structures located at, or in the vicinity of, surface water bodies, will take place in the period of low water levels (July-September) so as to minimize negative impacts on rivers and their banks.	Contractor	Contractor	
	Soil and water pollution	Construction vehicles and equipment will be maintained and refueled at protected refueling stations. Fuel storage and handling sites located away from drainage channels and important water bodies in accordance with Management Plan.	Contractor	Contractor	
	Soil and water pollution	Develop plans for cement and wash-water management.	Contractor	Contractor	
	Water pollution	Develop monitoring program for sensitive water courses, such as major river crossings and reporting, feedback and remedial action procedures. This should be linked to the Management Plans to be developed by The Contractors.	Contractor	Contractor	
	Temporary access-vegetation removed, soil compacted, landscape and vegetation impacted	Remove topsoil layer initially and afterwards de-compact alignments and reinstate topsoil andperform re-vegetation	Contractor	Contractor	
	impact on fish and other animals that depend on water as eco-system	Avoid river control works in theperiod of fish spawning. All in-river works will be conducted outside of the fish spawning season and Contractors will prepare management plans for such works as a part of their Construction Method Statements.	Contractor	Contractor	
	Land resources damaged	Identify work areas with contractor(s) and describe system approvals for extensions and fines for violations.	Contractor	Contractor, KS	
Construction camps	Community tension and disruption	Locations for camps are predefined within the Detailed Design of the Project. Contractor should prepare Camp Management Plan	Contractor	Contractor	
	HSE Standards	Work camps are required to conform to international Health, Safety and Environment (HSE) standards	Contractor	Contractor	

Phase, location	Issue	Mitigation	Institutional responsibility		Notes
			Install	Operate	
	Wastewater collection and disposal/treatment	Camps should be furnished with sanitary and wastewater collection and disposal/treatment facilities and should operate fully compliant waste systems, involving storage of waste by waste category.	Contractor	Contractor	
	Contamination of soil or water resources	Storage of fuels and re-fuelling of equipment will be controlled in floodplains to prevent groundwater pollution. No storage of fuels and oils will be allowed in floodplains where the potential for washout exists.	Contractor	Contractor	
	Spread of disease, including STIs	Conduct awareness campaigns for camp workers and if relevant nearby communities.	Contractor	Contractor	
	Water and soil pollution	The sewage system for such camps will be properly designed and built so that no water pollution takes place. Such facilities will be decommissioned at end of the construction period.	Contractor	Contractor	

Prior to initiating works, the Contractors will be required to prepare and submit for approval Site-Specific Implementation Plans (SSIP) consisting of:

Waste andwastewatermanagement plan

The Contractor's SSIPshould cover all aspects of waste management, including implementation of practice standards such as reduce, re-use and recycle. It should specify final disposal alignments for all waste and demonstrate compliance to national legislation and best practice procedures on waste management.
The WMP will, as a minimum, include details of temporary waste storage, waste transfer and pre-treatment prior to final disposal or recycling. Licensed/approved facilities for solid and liquid waste disposal must be used and a duty of care and chain of custody for all waste leaving the site will be followed. As part of the plan Contractors will be expected to produce waste handling forms for chain of custody, which will be used to control waste leaving site. Thus the waste controller will keep a copy of the form and the driver will always carry a copy and will ensure that the load is signed for at the final disposal site. All records will be kept by The Contractor for audit purposes and to demonstrate that the project is complying with best practice and applicable legislation.

Oil and fuel storagemanagement plan

The Contractor's SSIP should cover all procedures for storage, transportation and usage of oils and fuels, refueling of plant and machinery and procedures for minimizing the risk of ground and water contamination. All oils and fuels will be required to be stored within secondary containment of 110 % capacity and all spillages shall be cleaned up immediately. Re-fuelling vehicles will carry Spill Kits to enable spillages to be cleaned up as soon as possible. All categories of spillage will be reported in accordance with the Plan to be developed by The Contractor. Toolbox Talks would be expected to be delivered on an ongoing basis as „continued training" and following any significant incident.

In-river worksmanagement plan

The Contractor's SSIP should cover procedures and plans for safeguarding aquatic habitats and fish during in-river construction work and will complement the Construction Method Statements.

Campmanagement plan

The Contractor's SSIP should contain procedures for establishing and operating construction camps in order to safeguard nearby communities and environmental resources.

Re-foresting plan

In accordance with the preconditions obtained from INP, The Contractor will prepare plan for reforesting areas which were destroyed during construction phase.

Emergencyresponse plan

The Contractor's SSIP should contain procedures for emergency response in the event of accidents or major incidents, in order to safeguard people, property and environmental resources.

Appendix II

CHECK LIST

MONITORING PLAN

Phase, item	What parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored?/ type of monitoring equipment	When is the parameter to be monitored? (frequency of measurement or continuous)	Why is the parameter to be monitored? (optional)	Install and operate
Construction						
Contamination of surface water during construction	suspended solids, organic compounds, lubricants, fuel, solvents, heavy metals, pH value, mineral oils	On a part of a surface waterway downstream from the construction site.	Water quality analysis	before the commencement of works, at the time when humus is being removed and when excavation or the building of embankments from earth material is being carried out. During construction sampling will be done on monthly basis	EIA compliance	Contractor
Contamination of underground water during construction	suspended solids, organic compounds, lubricants, fuel, solvents, heavy metals, pH value, mineral oils	On the basis of the program prescribed within the main design of environmental protection	Water quality analysis	One month before the commencement of works. During construction sampling will be done quarterly.	EIA compliance	Contractor
Contamination of soilduring construction	Heavy metals and greases and oils	On the basis of the program prescribed within the main design of environmental protection	Soil quality analysis	One month before the commencement of works. During construction sampling will be done quarterly.	EIA compliance	Contractor
Noise	Noise Levels	km 873+879 to km 874+110	Noise meter	Every month	Settlement potentially affected with the noise	Contractor
Noise	Noise Levels	km 877+565 to km 878+164	Noise meter	Every month	Settlement potentially affected with the noise	Contractor
Noise	Noise Levels	km 881+077, to km 881+328	Noise meter	Every month	Settlement potentially affected with the noise	Contractor
Noise	Noise Levels	km 881+451, to km 881+614	Noise meter	Every month	Settlement potentially affected with the noise	Contractor
Noise	Noise Levels	km 885+133, to km 885+400	Noise meter	Every month	Settlement potentially affected with the noise	Contractor
	Damage to irrigation and Drainage infrastructure	Agricultural lands	Visual observations, discussions with PAPs	weekly	Compliance to EIA and social commitments	Contractor e.g. Environmental staff
	Dust	At construction sites	Visual monitoring	Regularly site visits	Check environment and H&S requirements	Contractor
	Waste water from construction camps and portable sites	At construction camps and portable facilities at work sites	Monitoring of appropriate installation and operation of wastewater units, latrines and septic tanks	Regularly site visits	Check environment requirements are being maintained	Contractor
	Community tension and disruption.	Construction sites	Observation	Regularly site visits	EIA compliance	Contractor

Phase, item	What parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored?/ type of monitoring equipment	When is the parameter to be monitored? (frequency of measurement or continuous)	Why is the parameter to be monitored? (optional)	Install and operate
Air Quality	Measuring carbon monoxide (CO) and nitrogen dioxide (NO2) is recommendable in stage one. If the measurement results show exceeded allowable concentration values, the list of pollutants should be extended by measuring the concentrations of nitrogen monoxide (NO), sulphur dioxide (SO2), hydrocarbon (CXHY), and solids/particulates (PM10).	Characteristic profiles according to the monitoring program produced by Contractor and approved by KS	Laboratory equipment	Two times during Construction works	Settlement potentially affected with the air pollution	Contractor
	Asphalt plant - possession of official approval or valid operating license	asphalt plants	Supervision inspection	before work begins	Ensure plant compliance with environment, health and safety standards	Plant Operator, contractor
	Stone quarry - possession of official approval or valid operating license	stone quarry	Supervision inspection	before work begins	Ensure compliance with EIA	Quarry Operator, contractor
	Sand and gravel borrow pit - possession of official approval or valid operating license	sand and gravel borrow pit	Supervision inspection	before work begins	Ensure compliance with EIA	Quarry Operator, contractor
	Asphalt, dusty, bulk materials - truck load covered and/or wetted	job site	Supervision inspection	Regular inspections during work	Ensure compliance of performance with environment, health and	Contractor
	Traffic management - hours and alignments selected	job site	Supervision inspection	Regular inspections during work	Ensure compliance with EIA	Contractor
Construction site						
Vibration	Vibration levels	job site	Supervision, observations	Regular inspections during work and on complain	Ensure compliance to EMP	Contractor
Noise disturbance to human and animal population	noise levels; equipment	job site; nearest homes	Mobile noise meter	once per week and on any complaint	assure compliance to EMP	Contractor
Traffic disruption	existence of traffic management plan; traffic congestion	at and near job site, local roads	inspection; observation	before works start; once per week at peak periods	assure compliance to EMP	
Workers safety	Protective equipment; organization of bypassing traffic	job site	inspection	Regular inspections during work	Ensure compliance to EMP and H&S standards.	Contractor

Phase, item	What parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored?/ type of monitoring equipment	When is the parameter to be monitored? (frequency of measurement or continuous)	Why is the parameter to be monitored? (optional)	Install and operate
Operation						
Contamination of soil during highway operation	Heavy metals and greases and oils	On the basis of the program prescribed within the main design of environmental protection	Soil quality analysis	Quarterly, at least 5 years during operational phase of highway section	EIA compliance	Contractor
Contamination of soil or water resources.	Concentration of dissolved oxygen, waste materials, oil, suspended solids, organic compounds, lubricants, fuel, solvents, heavy metals, pH value, color and odor	On river Southern Morava,Characteristic profiles according to the monitoring program produced by Contractor and approved by KS	it is necessary for the measurement and processing of data to be carried out continuously every four months. (January, April, July and October)	Monthly, at least 5 years during operational phase of highway section	EIA compliance	PEPS
Maintenance						
Noise disturbance residents, workers	noise levels	job site; nearest homes	Noise meter	Regularly	Ensure compliance to HSE Standards.	Maintenance Contractor
Possible air, water and soil pollution	air, water and soil quality (suspended solids, organic compounds, lubricants, fuel, solvents, heavy metals, pH value, water conductivity	job site; material storage areas; wash down areas for equipment; equipment maint. facilities	laboratory with necessary equipment	Regular inspections during maintenance activities and on complain	Ensure compliance to HSE Standards.	Maintenance Contractor
Vibrations	limited time of activities	job site	supervision	Regular inspections during maintenance activities and on any complaint		Maintenance Contractor
Workers safety	Protective equipment; organization of bypassing traffic	job site	inspection	Regular inspections during maintenance activities and on any complaint		Maintenance Contractor
Road safety						
Increased vehicle speed	condition of traffic signs; vehicle speed	roadsectionincluded in project	visual observation; speed detectors	during maintenance activities; unannounced	a)-b) enable safe and economical traffic flow	Traffic Police
Erosion, rockfall, hazardous conditions	condition of hazard signs	road section included in project	visual observation	during maintenance activities	Maintenance Contractor	Traffic Police, Supervision Contractor

Appendix III

LEGISLATION

<u>MAIN SERBIAN LEGISLATION:</u>

The main laws and regulations currently in force in Republic of Serbia which are relevant to the environmental protection during planning, design, construction and operating of this Project are listed below:

- Law on planning and construction ("Official Gazette of RS" No. 72/2009, 81/2009)
- Law on nature protection ("Official Gazette of RS", 36/09)
- Law on environmental protection ("Official Gazette of RS" No. 135/04, 36/09, 72/09)
- Law on EIA ("Official Gazette of RS" No. 135/2004, 36/2009)
- Law on Strategic EIA ("Official Gazette of RS" No. 135/2004)
- Law on waste management ("Official Gazette of RS", 36/09)
- Law on noise protection ("Official Gazette of RS", 36/09)
- Law on water ("Official Gazette of RS", 46/91, 53/93, 67/93, 48/94, 54/96, 101/05)
- Law on forest ("Official Gazette of RS", 46/91, 83/92, 54/93, 60/93, 53/93, 67/93, 48/94, 54/96, 101/05)
- Law on air protection ("Official Gazette of RS", 36/09)

Regulations established on the basis of the Law on EIA include the following:

- Decree on establishing the List of Projects for which the Impact Assessment is mandatory and the List of projects for which the EIA can be requested ("Official Gazette of RS" No. 114/08)
- Rulebook on the contents of requests for the necessity of Impact Assessment and on the contents of requests for specification of scope and contents of the EIS ("Official Gazette of RS" No. 69/05)
- Rulebook on the contents of the EIS ("Official Gazette of RS" No. 69/05)
- Rulebook on the procedure of public inspection, presentation and public consultation about the EIS ("Official Gazette of RS" No. 69/05)
- Rulebook on the work of the Technical Committee for the EIS ("Official Gazette of RS" No. 69/05)
- Regulations on permitted noise level in the environment ("Official Gazette of RS" No. 54/92)
- Decree on establishing class of water bodies ("Official Gazette of SRS" No. 5/68)
- Regulations on dangers pollutants in waters ("Official Gazette of SRS" No. 31/82)

Other relevant Serbian legislation

- Law on confirmation of convention on information disclosure, public involvement in process of decision making and legal protection in the environmental area ("Official Gazette of RS", 38/09)
- Law on public roads ("Official Gazette of RS" No. 101/2005, 123/07)

Appendix IV

PRECONDISIONS FROM THE RELEVANT INSTITUTIONS

1. PRECONDITIONS OBTAINED FROM INP

ЗАВОД ЗА ЗАШТИТУ ПРИРОДЕ СРБИЈЕ

СЕДИШТЕ • 11070 Н. Београд, Др Ивана Рибара 91 • тел: 011/2093-800, 2093-801 • факс: 011/2093-867 • beograd@natureprotection.org.yu

датум 29. 06. 2006.

број 03 – 853 / 2

САОБРАЋАЈНИ ИНСТИТУТ ЦИП - БЕОГРАД
Б Е О Г Р А Д
Примљено: 12 JUL 2006
566-381/97

САОБРАЋАЈНИ ИНСТИТУТ ЦИП Д.О.О.
Немањина 6
11000 БЕОГРАД

УСЛОВИ ЗАШТИТЕ ПРИРОДЕ И ЖИВОТНЕ СРЕДИНЕ ЗА ПОТРЕБЕ ИЗРАДЕ ИДЕЈНОГ ПРОЈЕКТА АУТОПУТА Е-75, БЕОГРАД – НИШ – ГРАНИЦА БЈР МАКЕДОНИЈА, ДЕОНИЦА ГОРЊЕ ПОЉЕ – ЦАРИЧИНА ДОЛИНА ОД km 873+714.86 ДО km 886+050.91

Саобраћајни институт ЦИП д.о.о. поднео је захтев за издавање услова који су од значаја за израду Идејног пројекта аутопута Е-75, Београд – Ниш – Граница БЈР Македонија, деоница Горње Поље – Царичина долина од km 873+714.86 до km 886+050.91 (бр. 566-329/97 од 19. 05. 2006.).

На основу достављене документације и увида у Регистар заштићених природних добара у Републици Србији, Завод за заштиту природе Србије констатује, да се на траси Идејног пројекта аутопута Е-75, Београд – Ниш – Граница БЈР Македонија, деоница Горње Поље – Царичина долина, не налазе посебно заштићена природна добара те Обрађивач Идејног пројекта нема посебних обавеза према чл. 51. и 61. Закона о заштити животне средине („Службени гласник РС", бр. 66/91).

Међутим, Обрађивач Идејног пројекта је обавезан да према релевантној законској регулативи изврши валоризацију и утврди начине, мере и услове заштите природе и животне средине, односно адекватно коришћење и уређење простора у складу са наменом, највише у вези са чињеницом да је због своје угрожености флора и фауна на читавој територији Србије под одређеним видом заштите (Уредба о заштити природних реткости «Службени гласник Републике Србије» бр. 50/93; Уредба о стављању под контролу коришћења и промета дивље флоре и фауне «Службени гласник Републике Србије» бр. 31/2005). Са тим у вези

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потребно је у што већој мери очувати сва станишта на току Јужне Мораве и у њеној плавној зони.

Надаље, већи део предметне деонице аутопута Е-75 пролази кроз Грделичку клисуру која представља рефугијуми терцијерне флоре, ретких угрожених биљних врста и мешовите реликтне вегетације, те су њено очување и заштита од изузетног значаја. Овде се могу наћи врсте које су у Србији постале ретке или су сасвим ишчезле. Такве су ендемичне балканске врсте, *Comsolida uechtritziana* (Pančić ex Huth), Soo (ихтрицхов жаворњак), чије се станиште налази у непосредној близини деонице (Царичина долина) у клисури Дервен. Наиме, овај таксом је уврштен у Црвену књигу флоре Србије I. Обзиром да сва врста расте на ораницама поред путева, претпоставка је да и у самој Грделичкој клисури (на деоници аутопута Царичина долина - Владичин Хан), има станишта на којима би се могла пронаћи. У случају да се негативни утицаји наставе ова станишта би постала еколошки лабилна и рањива.

Takoђе, клисура представља и један од коридора којим се поједини представници херпетофауне шире од југа према северу. Овај коридор је уједно и најкраћи пут између Врањске и Лесковачке котлине. Врсте који користе овај коридор су Степски гуштер *Podarcis tauricus*, као и Балкански зидни гуштер *Podarcis eħardii*. Очување овог дела коридора је изузетно значајно ако се има у виду да се рубни ареала ових врста налазе на управо поменутим просторима.

Фауну птица Грделичке клисуре карактерише већи број заштићених и угрожених врста. То су пре свега грабљивице, као што су сури орао *Aquila chrysaetos* и сиви соко *Falco peregrinus*. Популације ове две врсте су у неповољном положају, зависе од заштите, па је неопходно смањење или елиминисање негативног антропогеног утицаја. Поред њих, не треба занемарити остале, карактеристичне врсте термофилних, каменитих станишта овог подручја, као што су велика ушара *Bubo bubo*, јаребица камењарка *Alectoris graeca*, планински кос *Monticola saxatilis*, медитеранска белка *Oenanthe hispanica*, даурска ласта *Hirundo daurica*.

ЕКОЛОШКИ КОРИДОРИ

Изградњом аутопута врши се фрагментација станишта биљних и животињских врста и ствара се непропустљива баријера за највећи (или велики) број животињских врста. Ради очувања биодиверзитета региона неопходно је обезбедити слободно кретање јединки између очуваних субпопулација природних станишта. Због тога је неопходна изградња еколошких коридора, који повезују просторне јединице изолованих природних станишта. Очување проходности ових еколошких коридора је од приоритетног значаја за очување биодиверзитета региона, како врста Законом заштићених као природне реткости, тако и значајних ловних врста. У ту сврху потребно је током пројектовања и изградње аутопута планирати и изградњу пролаза за ситне и крупне животиње, изнад или испод аутопута, зависно од потребе и карактеристике терена како би се негативни ефекти саобраћајнице што више ублажили.

Користећи нека досадашња позитивна инострана искуства, сматрамо да су се мултифункционални пролази за ситне и крупне животиње, превасходно сисаре, показали као једина решења овог проблема:

- Предвиђени прелази (мостови) преко водотока такође се могу искористити као својеврсни еколошки коридори, уз мале преправке. Корито водотока треба да заузима највише једну трећину пролаза испод пута;
- Димензије пролаза пројектовати тако да испуне овај услов;
- Профил корита унутар пролаза треба да има нагиб мањи од 45° (оптимално 30°);
- Странице обалоутврда водотока унутар пролаза треба да буду грубо храпаве (нпр. прављењем хоризонталних ребара), чиме би се спречило клизање животиња у воду, и омогућио њихов лакши излазак из воде;
- Простор испред и иза пролаза треба да буде прекривен истоветним типом земљишта на датом локалитету, и природном вегетацијом околине;
- Као пролазе за водоземце и неке друге врсте животиња које преферирају влажна станишта и живе у близини воде, могуће је искористити већ пројектоване цеви за дренажу тла.

ПОЗАЈМИШТА

Позајмишта песка и земљишта имају вишеструки негативни утицај на биодиверзитет. У случају стварања отвореног воденог окна фреатске издани на позајмишту, долази до загађивања фреатске издани. Отворено фреатско окно својим испаравањем негативно утиче на природни режим околних влажних станишта. После напуштања позајмишта, обновљена природна вегетација и водена површина привлачи животињске врсте, које могу да страдају на аутопуту. Дугорочно посматрано овакво станиште функционише као клопка за многе врсте. Највише су угрожене популације птица, водоземаца и гмизаваца.

Услови:
- Позајмишта не могу да се копају дубље од максималног нивоа подземне воде, да би се спречила појава отвореног фреатског окна;
- Позајмишта код прелаза за дивљач треба да садрже очуване делове плодног земљишта оригиналне структуре (обезбедити потребну количину плодног земљишта) ради формирања ремиза;
- Приликом ревитализације обновити вегетацију која је карактеристична за дату област. Избегавати озелењавање дрвенастим врстама и врстама са привлачним плодовима да би се спречавало привлачење птичјих врста и њихово страдање уз аутопут.

УТИЦАЈ АУТОПУТА НА ЗЕМЉИШТЕ

Изградња и експлоатација аутопута утичу на земљиште на коме сем флоре и фауне обитава и људска популација, па је неопходно дефинисати ужу и ширу зону утицаја изградње и функционисања објекта аутопута на животну средину (посебно са аспекта очувања пољопривредног земљишта и производње хране одговарајућег квалитета). С тим у вези треба предвидети зоне утицаја и количине загађивача који спирањем са коловоза аутопута доспевају у земљиште и воду, те на основу тога утврдити мере и препоруке за коришћење земљишта.

На површинама и зонама где су концентрације тешких метала и других загађивача веће од дозвољених мора се утврдити таква намена површина којом ће се избећи културе које служе за исхрану људи и стоке (земљиште поред аутопута може се користити у пољопривредне сврхе на удаљености 30 м од ивице коловоза). На површинама за које се утврди да су у таквој зони утицаја аутопута најсврсисходније је предвидети пошумљавање, односно културе засада дрвета или других индустријских биљака.

Осим наведених мера које се односе на заштиту флоре, фауне, и земљишта, Идејним пројектом аутопута Е-75, Београд – Ниш – Граница БЈР Македонија, деоница Горње Поље – Царичина долина обезбедиће се услови за изградњу саобраћајних површина, инфраструктурних мрежа и објеката, као и уређење простора, те са тим у вези морају бити испуњени и следећи услови:

1. Обрађивач Идејног пројекта аутопута Е-75 је дужан да, у складу са Законом о процени утицаја на животну средину („Службени гласник РС", бр. 135/04), код надлежног органа покрене поступак процене утицаја планираних радова на животну средину.

2. Приликом израде идејног пројекта аутопута Е-75 на предметној локацији посебну пажњу обратити на подручја значајна са аспекта заштите природе. Ово се посебно односи на шумске комплексе, водотокове и њихова приобаља, барске и мочварне површине, ливаде и сл. Иако се ради о мањим површинама, окруженим насељима и пољопривредним земљиштем, оне представљају посебне остатке природних станишта флоре и фауне. Стога треба настојати да траса аутопута буде тако дефинисана да се планираним радовима не униште потпуно, односно уништење постојеће флоре и фауне свести на најмању могућу меру, а по завршетку радова обавезно је успоставити биљни покривач (култивисати терен) на свим угроженим местима, применом одговарајуће флоре и таквих врста које су биолошки постојане у датим климатским условима, отпорније на штетне утицаје (издувне гасове и сл.) као и да је избор врста усклађен са околним простором и његовом наменом.

3. Предвидети формирање зелених појасева уз аутопут, као и заштитних конструкција различитих апсорпционих својстава, у функцији заштите од буке и умањења негативних ефеката загађења ваздуха. Ове заштитне појасеве треба лоцирати нарочито на оним деоницама где траса аутопута тангира рурална и урбана насеља.

4. Идејним пројектом утврдити начин организације градилишта аутопута са јасно прецизираним локацијама за објекте, паркинге и путеве проласка тешке механизације, као и позајмишта, односно депоније материјала, те начин и мере санације и уређења путног појаса, односно стављања простора у намену утврђену пројектном документацијом.

5. Посебну пажњу посветити заштити и уређењу простора, односно локалитета где су смештене базе за одржавање пута. Мере заштите треба да спрече негативне ефекте на животну средину које ови објекти, са машинама и пратећим садржајима, могу изазвати.

6. Начин транспортовања, утовар, истовар и депоновање грађевинског материјала одредити посебно за сваку деоницу аутопута, тј. градилиште.

7. Забрањено је сервисирање и одржавање возила, грађевинских машина и сл. дуж трасе пута. Уколико дође до хаваријског изливања уља или горива неопходно је извршити санацију локације.

8. Текуће одржавање возила, грађевинских машина и сл. вршити на прописно изграђеном каналу. Инвеститор је у обавези да обезбеди сакупљање отпадних материја при сервисирању, и њихово одлагање у складу са законом.

9. Забрањено је депоновање шута, земље и осталог отпада у зони трасе пута и непосредно уз њу, током и по завршетку радова, осим на локацијама које ће се пројектом организације градилишта утврдити као привремене или трајне депоније.

10. Хумус који ће бити коришћен за радове на санацији терена засебно депоновати и заштити од спирања.

11. Строго је забрањено бацање комуналног и другог отпада у водотоке и земљиште.

12. Комунални отпад се може привремено депоновати дуж трасе аутопута на одговарајући начин постављањем одговарајућих специјалних судова за његово прикупљање. Током извођења радова, инвеститор је обавезан да у оквиру простора одржава максимални ниво комуналне хигијене.

13. Посебно предвидети заштиту водотока и земљишта, од пробоја загађења у случају акцидентних ситуација, нарочито код превоза

опасних материја. У случају акцидента и изливања загађујућих материја (горива, моторног уља и др.) како у водотоке, тако и у земљиште, неопходно је загађено место евакуисати под условима надлежне комуналне службе, а локацију санирати.

14. При пројектовању система одвођења атмосферских вода применити таква решења која ће спречити директно изливање штетних материја са коловоза, у водотоке и земљиште

15. Такође, евентуалне усеке и насипе пројектовати тако да прате и да се уклапају у природни облик терена, односно применити био-инжењерске мере заштите терена од ерозије.
Приликом покривања шкарпи вегетацијом, треба имати у виду да постоји природни, максимални степен нагиба до кога се вегетација може одржати без помоћи техничких мера. Земљиште доста стрмих шкарпи треба учврстити жичаном мрежом испод које се сади трава и аутохтоно шибље.

16. Сва позајмишта по завршетку радова треба довести у одговарајуће функционално стање усаглашено са непосредном околином. Позајмишта рекултивисати тако што се земљиште прво насипа хумусом, а затим се пошумљава – озелењава одговарајућим аутохтоним врстама флоре.

17. На свим ризичним пунктовима трасе аутопута обезбедити одговарајуће противпожарне мере заштите, посебно шума, људства, технике на градилишту и др.

18. Уколико се приликом извођења грађевинских радова на траси аутопута јави потреба за уређењем водотокова, обавезна је примена тзв. „натуралног уређења", применом природних материјала, вегетације и сл., из самог окружења истих. Забрањује се бетонирање обала и корита водотокова, те је обавезно њихово максимално очување, посебно обала и корита реке Јужне Мораве, а све у циљу заштите и очувања станишта аутохтоне водене, и приобалне флоре и фауне тога подручја.
У случају да је неопходно измештање корита водотокова, потребно је то чинити у што мањем обиму, и то само колико је неопходно за изградњу аутопута. При формирању новог корита и обала, водити рачуна да се њихов изворни и аутентични изглед и намена очува.
Такође, уколико се јави потреба пресецања корита водотокова, неопходно је обезбедити одређене пропусте за несметан ток воде, а самим тим и несметан живот и развој водене флоре и фауне.

19. Идејним пројектом обавезно предвидети да, уколико се у припреми локација планираних за изградњу аутопута, односно свих објеката везаних за исти, открије природно добро које је геолошко – палеонтолошкогн или минеролошко – петрографског порекла, а могло би да има својства природног споменика, извођач радова има обавезу

да о томе обавести Завод за заштиту природе Србије и да предузме све мере како се природно добро не би оштетило до доласка овлашћеног лица.

20. По усвајању пројекта, молимо вас да нас повратно информишете о реализованом концепту, посебно за сегмент који се односи на заштиту природе и животне средине, како би смо сличне, прихватљиве варијанте и даље примењивали у пракси (нпр. ефикасност постојања одређених прелаза и пролаза за животиње, њихово одржавање, економичност за сам пројекат итд.).

21. Обрађивач је дужан да поштује и све друге одредбе заштите утврђене Законом о заштити животне средине, другим прописима, као и важећим планским актима вишег реда.

О б р а з л о ж е њ е

Одредбом члана 33. и 34. Закона о заштити животне средине („Службени гласник РС", бр.135/04) и члана 51. и 61. Закона о заштити животне средине („Службени гласник РС", бр. 66/91), одређено је да организација за заштиту природе, тј. Завод за заштиту природе Србије утврђује услове заштите и даје податке о заштићеним природним добрима у поступку израде просторних и других планова, односно основа (шумских, водопривредних, ловних, риболовних и др.) и друге инвестиционо – техничке документације.

У складу са наведеном законском одредбом, САОБРАЋАЈНИ ИНСТИТУТ ЦИП д.о.о., поднео је захтев бр. 566-329/97 од 19. 05. 2006. године за издавање услова заштите природе и животне средине за потребе израде Идејног пројекта Е-75, Београд – Ниш - Граница БЈР Македонија, деоница Горње Поље – Царичина долина од km 873+714.86 до km 886+050.91.

Достављено:

- Насловy
- Министарству науке и заштите животне средине
  Управа за заштиту животне средине
- Архиви

Директор Завода,

Проф. др Лидија Амиџић

ЗАВОД ЗА ЗАШТИТУ ПРИРОДЕ СРБИЈЕ
СЕДИШТЕ ♦ 11070 Н. Београд, Др Ивана Рибара 91 ♦ тел: 011/2093-800, 2093-801 ♦ факс: 011/2093-867 ♦ beograd@natureprotection.org.yu

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САОБРАЋАЈНИ ИНСТИТУТ – ЦИП д.о.о. БЕОГРАД
Примљено: 29. FEB. 2008
Орг. јед. | Број | Прилог
Ц | 566-369/07 |

САОБРАЋАЈНИ ИНСТИТУТ ЦИП д.о.о.
Немањина 6/IV
11000 БЕОГРАД

Предмет: **Допуна и измена Услова заштите природе и животне средине за потребе израде Идејног пројекта аутопута Е-75, Београд – Ниш - Граница БЈР Македонија, деоница Горње Поље – Царичина долина од km 873+714.86 до km 885+726.739**

Саобраћајни институт ЦИП д.о.о., поднео је захтев за допуну и измену Услова заштите природе и животне средине бр. 03 – 853/2 , издатих 29. 06. 2006. године, за изградњу и експлоатацију планираних објеката, са предлогом евентуалних мера заштите за подручје које обухвата зону утицаја аутопута Е-75, Београд – Ниш - Граница БЈР Македонија, деоница Горње Поље – Царичина долина.

Допуна и измена наведених услова је потребна због измене дела Идејног пројекта (промена трасе аутопута од km 878+960.41 до km 881+819.43). Траса аутопута се поред насеља Предејане „помера" у брдо и пролази тунелом дужине 1000 m.

Увидом у достављену документацију и Регистар заштићених природних добара у Републици Србији, Завод за заштиту природе Србије констатује, да се на траси аутопута Е-75, Београд – Ниш – Граница БЈР Македонија, деоница Горње Поље – Царичина долина, од km 878+960.41 до km 881+819.43, која обухвата предметни тунел, не налазе посебно заштићена природна добара те Обрађивач Идејног пројекта нема посебних обавеза према чл. 51. и 61. Закона о заштити животне средине („Службени гласник РС", бр. 66/91).

На основу наведеног, Завод за заштиту природе Србије потврђује Услове заштите природе и животне средине за потребе израде Идејног пројекта Е-75, Београд – Ниш - Граница БЈР Македонија, деоница Горње Поље – Царичина, издате под бројем 03 - 853/2, дана 29. 06. 2006. године.

Такође, осим већ утврђених Услова, у вези израде Идејног пројекта аутопута Е-75, Београд – Ниш – Граница БЈР Македонија, деоница Грдње Поље – Царичина, на делу трасе аутопута на којој се налази планирани тунел, Завод исте допуњује следећим мерама и условима:

1.Планску и техничку документацију новопројектованог тунела, на траси аутопута Е-75, потребно је ускладити са најновијим знањима технике пројектовања и изградње тунела, са захтевима безбедности саобраћаја, са економским начелима и мерилима за оцену оправданости његове изградње и са прописима о заштити животне средине, тако да штетни утицаји на природу, због очекиваног утицаја на исту, буду што мањи.

2.Потребно је настојати да се радовима на изградњи тунела уништење постојеће флоре и фауне, око планираних излазних, односно улазних портала, леве и десне тунелске цеви, као и на падинама које засвођују тунелске цеви, сведе на најмању могућу меру, јер ће исте послужити као ефикасни прелази за различите животињске врсте, односно за њихово одржање на овом простору.

3.Идејним пројектом је предвиђено да планирани тунел у дужини од 1000 m прође кроз стенски комплекс шкриљаца. С тим у вези потребно је водити рачуна да је при неповољним морфолошким, хидролошким, хидрогеолошким и вегетационим условима, овај материјал подложан клизању, дубоком јаружењу и површинском спирању. Ове појаве су управо најинтензивније на појединим теренима у сливу Јужне Мораве, пре свега у пределу Грделичке клисуре, те је обзиром на наведено, потребно кроз Пројекат предвидети мере и решења која ће омогућити успостављање стабилности терена, односно који ће онемогућити евентуална обрушавања истог.

4.Утврдити и начин организације градилишта тунела са јасно прецизираним локацијама за објекте, паркинге и путеве проласка тешке механизације, као и позајмишта, односно депоније материјала, те начин и мере санације и уређења путног појаса, односно стављања простора у намену утврђену пројектном документацијом.

5.Радови на минирању, при изградњи предметног тунела, морају се планирати и изводити по шеми строго контролисаног минирања и са квалификованим лицима за ту врсту посла. Допрему експлозива и иницијалних средства планирати из одговарајућег овлашћеног магацина, а њихово допремање вршити возилима за ту намену.

6.Забрањено је депоновање ископаног стенског материјала, земље и сл. у зони око тунелских улазних портала и непосредно уз њих, те у обалној зони Јужне Мораве, током и по завршетку радова. Исти депоновати на локацијама које ће се пројектом организације градилишта утврдити као привремене или трајне депоније.

7.На одговарајућим пунктовима у склопу тунела планирати потребне системе сигнализације, вентилације, евентуални видео надзор, одговарајуће противпожарне мере заштите и сл.

8.Након изградње тунела неопходно је уклонити сву механизацију, грађевински материјал, контејнере, резервне делове и др., са трасе пута.

9.По завршетку радова обавезно је успоставити биљни покривач (култивисати терен) на свим угроженим местима, применом одговарајуће вегетације.

10.Идејним пројектом обавезно предвидети да, уколико се у припреми локација планираних за изградњу тунела, односно свих објеката везаних за исти, открије природно добро које је геолошко – палеонтолошког или минеролошко – петрографског порекла, а могло би да има својства природног споменика, извођач радова има обавезу да о томе обавести Завод за заштиту природе Србије и да предузме све мере како се природно добро не би оштетило до доласка овлашћеног лица.

О б р а з л о ж е њ е

Одредбом члана 33. и 34. Закона о заштити животне средине („Службени гласник РС", бр.135/04) и члана 51. и 61. Закона о заштити животне средине („Службени гласник РС", бр. 66/91), одређено је да организација за заштиту природе, тј. Завод за заштиту природе Србије утврђује услове заштите животне средине и даје податке о заштићеним природним добрима у поступку израде просторних и других планова, односно основа (шумских, водопривредних, ловних, риболовних и др.) и друге инвестиционо – техничке документације.

У складу са наведеном законском одредбом, САОБРАЋАЈНИ ИНСТИТУТ ЦИП д.о.о., поднео је захтев бр. 566-369/97 од 29. 01. 2008. године за допуну и измену Услова заштите природе и животне средине бр. 03 – 853/2 , издатих 29. 06. 2006. године, за потребе израде Идејног пројекта Е-75, Београд – Ниш - Граница БЈР Македонија, деоница Горње Поље – Царичина долина од km 873+714.86 до km 885+726.739.

Достављено:
- Наслову
- Министарству заштите животне средине
- Министарству за инфраструктуру
- Архиви

Директор Завода

Проф. др Лидија Амицић

ЗАВОД ЗА ЗАШТИТУ ПРИРОДЕ СРБИЈЕ

[illegible] 03-2356/2
[illegible] 08.10.2010

КОРИДОР 10 доо
БЕОГРАД
Бр. [illegible]
[illegible] 20__ год.

КОРИДОР 10 д.о.о.

11000 БЕОГРАД
Влајковићева 19а

Предмет: Мишљење о Студији о процени утицаја пројекта ауто-пута Е-75 Ниш - граница БЈРМ, деоница Горње поље - Царичина долина на животну средину

Дописом бр. 1294/10 доставили сте Заводу за заштиту природе Србије захтев за издавање мишљења о Студији о процени утицаја пројекта ауто-пута Е-75 Ниш - граница БЈРМ, деоница Горње поље - Царичина долина на животну средину.

Студију је обрадио Саобраћајни институт - ЦИП д.о.о. из Београда.

Инвеститор је Јавно предузеће „Путеви Србије" из Београда.

Студија је обрађена на 115 страна и садржи већи број рефералних карата, прилога, табела и других прилога.

У претходном поступку обрађивач Студије је обезбедио одговарајуће услове заштите природе од Завода за потребе израде пројектне и друге документације.

Након разматрања Студије, констатовано је да су мере заштите природе и животне средине које је прописао Завод, доследно уграђене у Студију.

У том смислу, предметна Студија о процени утицаја се може позитивно оценити.

С поштовањем,

Директор Завода

Проф. др Ненад Ставретовић

Достављено:
- Архиви

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PRECONDITIONS OBTAINED FROM IPCM

РЕПУБЛИЧКИ ЗАВОД ЗА ЗАШТИТУ СПОМЕНИКА КУЛТУРЕ
Бр. 10/2233
24. 09. 2008. год.

БЕОГРАД
Примљено: 26.09.2008
566-436/97

МБ/ЈБ

Републички завод за заштиту споменика културе - Београд, на основу чл. 99. став 2. тачка 1, 100. став 1., 109., 110. и 104. Закона о културним добрима («Службени гласник РС», број 71/94) и члана 131. Закона о општем управном поступку («Службени лист СРЈ», бр. 33/97 и 31/01), на захтев Саобраћајног института CIP из Београда, улица Немањина бр. 6, доноси

Р Е Ш Е Њ Е

I Мере техничке заштите за израду Идејног пројекта Е-75 Београд – Ниш – Граница БЈРМ деоница Горње поље – Царичина долина, могу се предузети према следећим условима:

- на траси Ауто пута Е-75 Ниш – Граница БРЈМ, деоница Горње поље – Царичина долина од км 873+714,86 до км 886+050,91 регистровани су бројни археолошки локалитети;
- не може се са сигурношћу тврдити да су градњом пута на овој деоници угрожени археолошки локалитети;
- како је у непосредној близини трасе ауто пута током 2002. године регистровано пет археолошких налазишта, за која не можемо са сигурношћу тврдити да ли ће бити девастирана градњом трасе ауто пута, неопходно је стално присуство археолога Републичког завода за заштиту споменика културе – Београд током земљаних радова;
- у случају да, у току радова, открије до сада нерегистровани локалитет или његов део, инвеститор је у обавези да о томе, без одлагања, обавести Републички завод за заштиту споменика културе - Београд;
- инвеститор је дужан да обезбеди средства за истраживање, археолошки надзор, заштиту, чување, публиковање и излагање добара која уживају претходну заштиту, а која се открију приликом извођења радова.

II Подносилац захтева дужан је да изради пројекат у свему у складу са издатим условима из тачке I.. овог решења.

III По изради пројекта у складу са овим условима, подносилац захтева је дужан да на исти прибави сагласност Републичког завода за заштиту споменика културе.

IV Ово решење не ослобађа подносиоца захтева обавезе прибављања и других услова, дозвола и сагласности предвиђених прописима о планирању и изградњи.

V Ово решење важи годину дана од дана издавања.

VI Жалба не одлаже извршење овог решења.

О б р а з л о ж е њ е

Овом Заводу се Саобраћајни институт CIP из Београда, улица Немањина бр. 6, захтевом за утврђивање услова за предузимање мера техничке заштите за израду Идејног пројекта Е-75 Београд – Ниш – Граница БЈРМ деоница Горње поље – Царичина долина.

Археолошки локалитети регистровани на предметној деоници ауто пута јесу непокретна добра која уживају претходну заштиту, у складу са одредбама Закона о културним добрима.

По захтеву је, применом одредаба чл. 99. став 2. тачка 1, 100. став 1., 109. и 110. Закона о културним добрима, решено као у диспозитиву.

На основу члана 104. став 3. Закона о културним добрима, жалба не одлаже извршење решења.

ПОУКА О ПРАВНОМ ЛЕКУ: Против овог решења дозвољена је жалба Министарству културе у року од 15 дана од дана достављања решења. Жалба се подноси преко доносиоца овог решења, а на основу члана 16. Закона о културним добрима, ослобођена је плаћања републичке административне таксе.

Директор

Вера Павловић Лончарски

Доставити:
- Подносиоцу
- Архиви