**2. TEXTUAL DOCUMENTATION**

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**2.1. Technical description – the bridge construction**

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### General data on the object

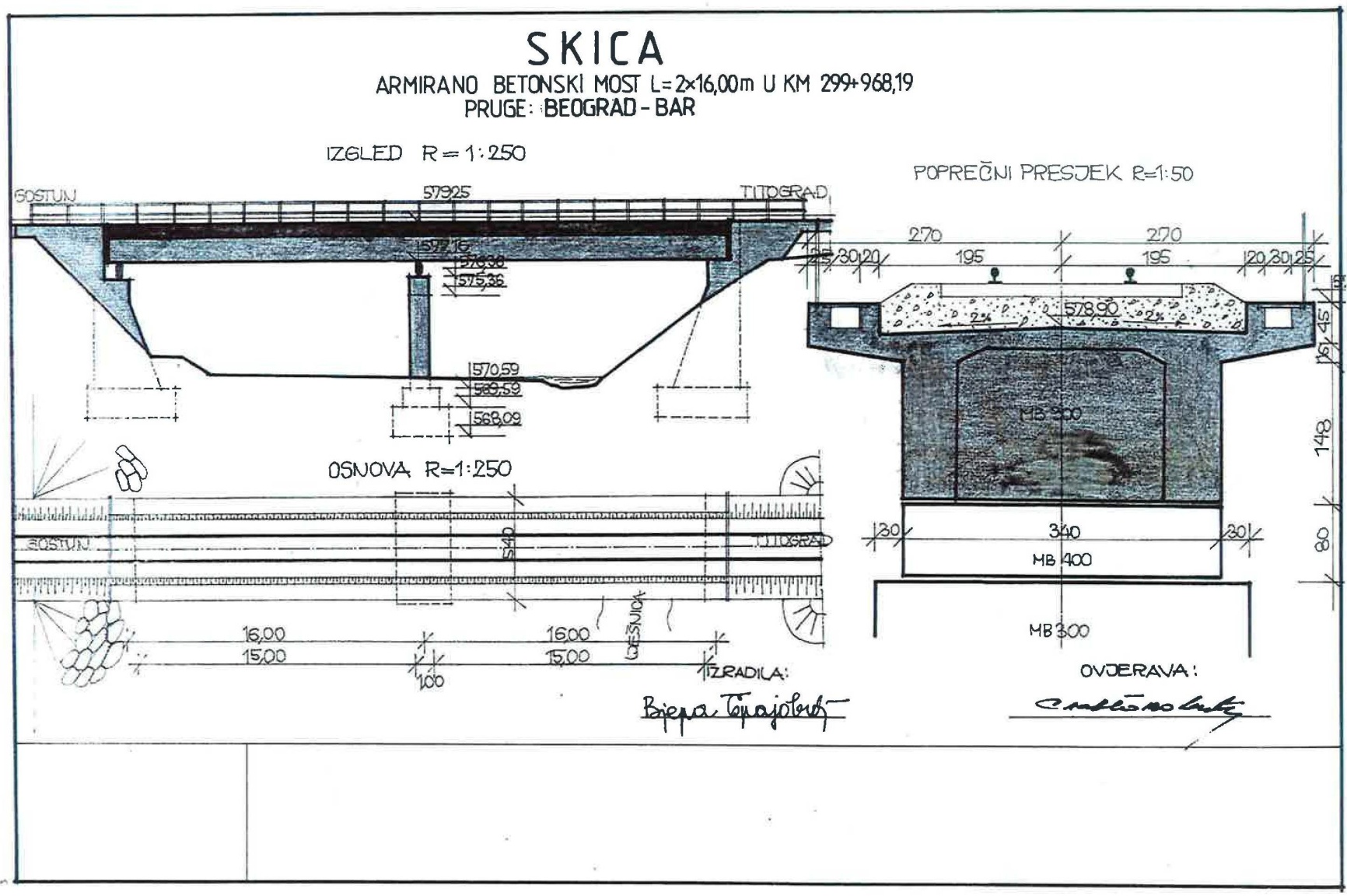
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| --- | --- |
| EMPLOYER: | European Investment Bank |
| BENEFICIARY: | Željeznička infrastruktura Crne Gore AD Podgorica |
| STRUCTURE: | BRIDGE no. 9, at km 299+968.19 |
| PROJECT: | MAIN DESIGN FOR REHABILITATION OF BRIDGE  at km.299+968,19 |
| SECTION: | Vrbnica - Bar |
| CHAINAGE: | 299+968.19 |
| PROJECT STAGE: | Main design |
| NAME AND DESIGNATION OF PROJECT SECTION: | VOLUME II – STRUCTURAL DESIGN  Bridge no .9, at km 299+968.19 |
| PROJECT ORGANIZATION RESPONSIBLE FOR DRAFTING BRIDGE STRUCTURAL DESIGN: | Cestra d.o.o. Beograd  Južni Bulevar 1a, Beograd 11118 |

### Description of route location and alignment

The bridge is located at chainage km 299+968.19 on the Vrbnica-Bar railway line. The track is in a circular curve (R=1600m), the bridge is in a straight line, and the level line is lowered 0.632%. Bridge is a continuous beam structure with spans of 16+16m. The bridge extends over the Lješnica River in its first span, whereas its second span extends over the non-categorized road with a clear height of 4m over it. The track structure is that of the continuous welded rail.

### Attachment 1 – Bridge layout plan from the ŽICG archives

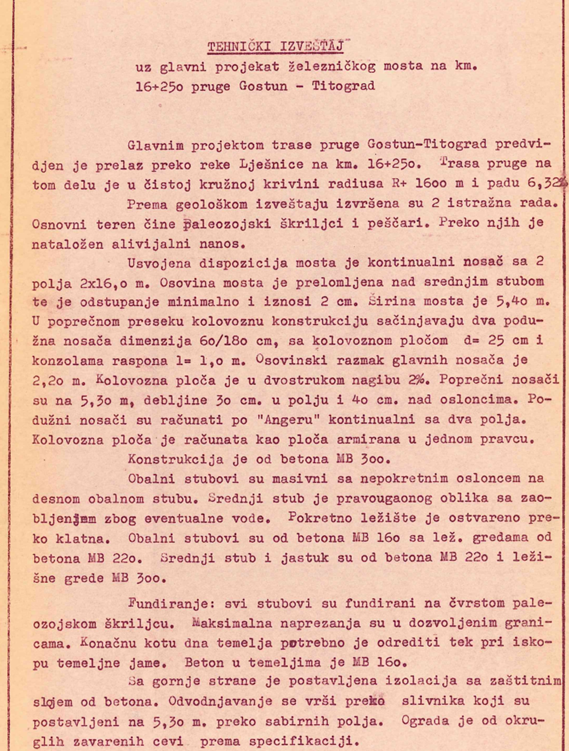
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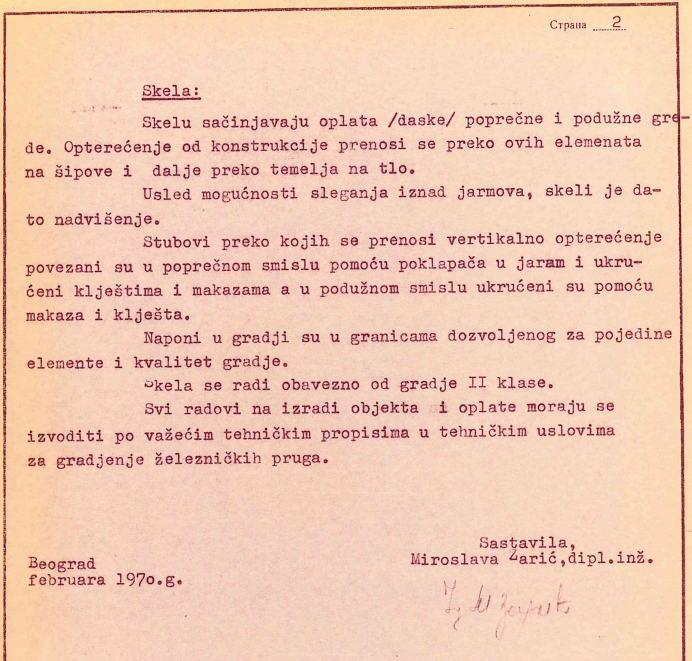


### Attachment 2 – Technical Report from the original design

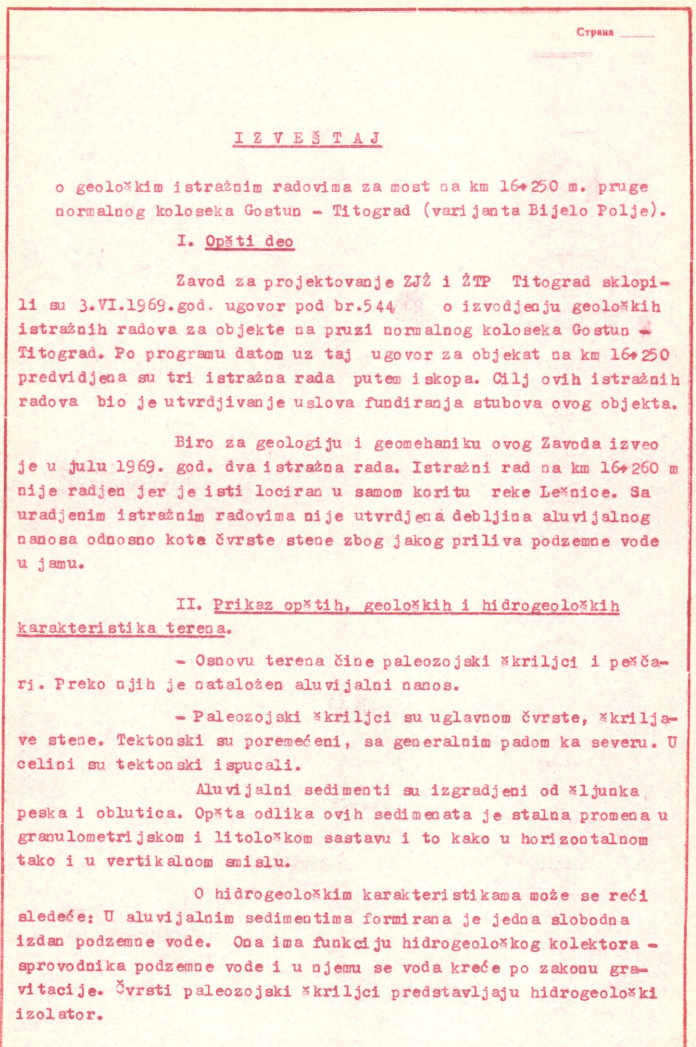
The main structural design was done by the Association of Yugoslav Railways, Designing Institute, Belgrade, 1970. The structure was redesigned in 1970.

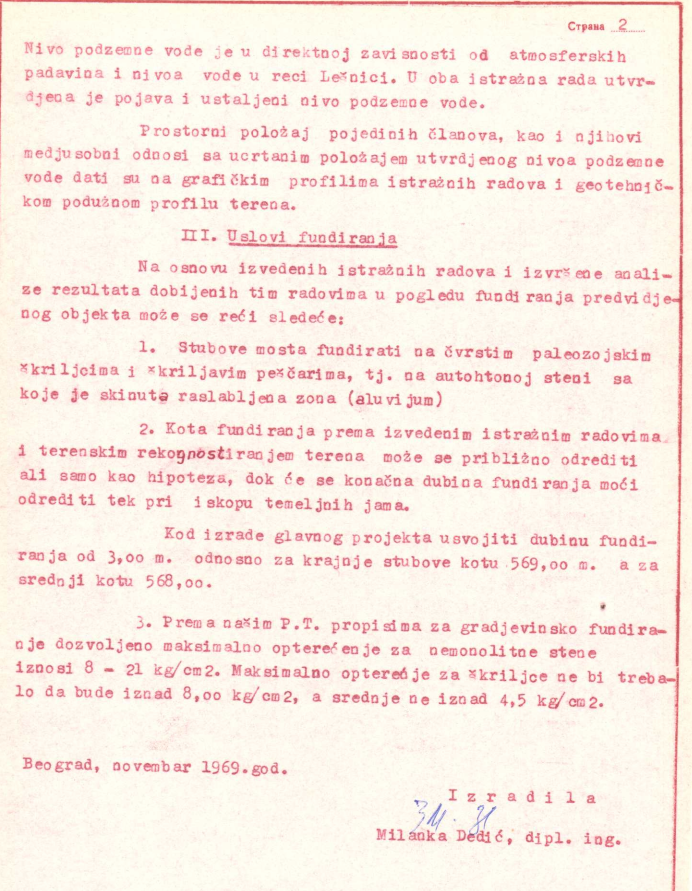
The main design dates back to 1970.





Report on geological investigation works dated 1969





### Attachment 3 – Assessment of bridge condition with proposed measures (Bridge inspection report 2014)

Taken from „*The report on the state of the bridge: the bridge at km 299+968,19 the railway line Vrbnica – Bar” from 2014.*

General observation about the state of the bridge:

Measuring the dimensions of the structural elements and comparing with the dimensions given in layout sketches from "Report about the current state of bridges on the Vrbnica-Bar railway line" it was observed:

* dimensions of the bridge are in compliance with the dimensions from the "Report about the current state of bridges on the Vrbnica-Bar railway line",
* after removing the track ballast and measuring of all necessary dimensions, thickness of the RC slab was determined indirectly and it was found to be 36 cm (with a protective coating and waterproofing) in the middle of the slab.

Railway track on the bridge is in good condition. After removing the track ballast in the sleeper zone,thickness of the track ballast below the lower edge of sleeper was found to be 30 cm (in the axis of the railway track).

Damages that could reduce the capacity and stability of the bridge structure were not found during the detailed visual inspection of the bridge.

However, lack of rehabilitation of damaged RC pendulums as well as upper zone of the pier S2 and progression of those damages can lead to reduced capacity of the bridge structure. Also,in accordance to threatened stability of abutment S1 it is necessary to do rehabilitation of unstable retaining walls of channel profile in section between piers S1-S2.

The observed damages and deficiencies of the structure which negatively affect the durability and functionality of the structure are the following:

* damages of the concrete in the upper part of RC pendulums on middle pier S2 – degradation of concrete and deep corrosion of reinforcement,
* degradation of concrete with exposed and corroded reinforcement of the cap beam on the middle pier S2,
* scour and erosion of the ground beneath retaining walls of channel profile which results in unstability of retaining walls in span S1-S2,
* expansion joints are out of function in the zone of cantilevers (or even does not exists), and that results in inflow of the water from the railway track to the backwalls, cap beams, abutmens and structure in the zone of the abutmens,
* inadequately drainage system with gullies that are to close to the main girders which results in uncontrolled inflow of the water on the main girders and sidewalk cantilevers. The same applies for inadequate repair of initial holes for drainage system,
* the absence of the drip edges on the sidewalk cantilevers that leads to the inflow of the water on the cantilevers and main girders,
* damages of the waterproofing in the zone of pier S2 (that is most likely related to observed cracks in RC slab and sidewalk cantilevers) which results in inflow of the water through concrete on the cantilever connection with main girders which jeopardize stability of the cantilever and damages concrete surface of main girders,
* lack of drainage of the installation channels,
* the absence of the protective barriers above the road which impacts on the safety of the traffic beneath the bridge.

## Proposed measures from the aspect of the bridge structure durability and functionality

* rehabilitation of concrete of RC pendulum and cap beam on the middle pier S2,
* rehabilitation of the ground and retaining wall of channel profile in the span S1-S2 to make it stabile,
* installation of the watertight expansion joints between sidewalk cantilevers and abutments backwalls,
* rehabilitation of drainage system – gullies,
* make drip edges on the both sidewalk cantilevers,
* make additional structural design for the cross-section of RC slab in the axis of pier S2 to determine the cause of cracks appearance in tensile zone. In accordance to results of these calculation,eventually foresee additional reinforcement before replacing the damaged waterproofing in that area,
* replacement of the damaged waterproofing of RC slab in the zone of pier S2,
* provide drainage of the installation channels,
* installation of protective barriers above the road.

### Damage on the bridge and the possible causes of its occurrence

A detailed overview of the damage with possible causes of occurrence was given in the previous phase of the project:

“*The Bridge Condition Report: Bridge at km 299+968.19, Vrbnica - Bar railway line from 2014, made by the company Pro-Inženjering Ltd. from Belgrade*.

A graphic display of the damage observed during the bridge inspection is given in the graphic documentation of the project in the drawing – The damage picture.

Based on "The Bridge Condition Report: Bridge at km *299+968.19,* Vrbnica - Bar railway line“ from 2014, the scope of damage as well as the manner of its rehabilitation are examined. The scope of the works and the investment value are based on the review carried out in 2014.

### Description of bridge structure – current condition

The bridge structure is a system of continuous beams on two spans of 2×16.0m in the vicinity of Bijelo Polje. The bridge extends over the Lješnica River. The track is in a circular curve R=1600m, while the axis of the bridge structure breaks above the middle pier. The total width of the bridge is 5.40m, with 75 cm wide footpaths on each side of the bridge. Deviation of bridge axis from the track axis is 2cm.

The bridge structure comprises two reinforced concrete beams with a T-section and the axial distance between them is 2.80m. The total height of girders is 1.83m, and the slab is 25cm thick in the middle. The bridge deck is haunched on the underside and designed in a dual slope of 2%. Cantilevers of footpaths are 1.0m and are haunched with maximum thickness of 32 cm.Longitudinal girder are 60cm thick. Girders are connected with cross members designed on the thirds of longitudinal girder spans. Intermediate cross girders are 30 cm thick, whereas the end and intermediate supports are 40 cm thick. In terms of static, the structure is a continuous beam supported on the movable supports on the piers S1 and S2, while on the pier S3 there is a fixed support.

Girders, bridge deck, cross girders and the bearing beam on the pier were made using the MB 300 concrete grade, whereas pendulums were made of MB400 concrete.Bearing beams on abutments, pier and the footing pillow of the pier were made of MB220, and abutments and foundations were made using MB 160. Rebar was made of Č-0200 (Č-37) steel grade.

The middle pier S2 has a rounded basis that measures b×d=1.0×4.0m. Abutments basis measure b×d=3.40×4.0m – pier S1 and b×d=4.26×4.0m – pier S3. Piers were founded on a layer of gravel and sand with pebbles and blocks of prphyric rock and limestone. All the piers were founded on footings.

Structure layout

Longitudinal section



Structure base



##### Current condition:

The track on the bridge is located in a transition curve and was produced as a CWR. The track is a closed one with a crushed stone ballast on the bridge deck. Damp-proofing was placed on the upper deck with a concrete cover of 5 cm.

At the ends of the bridge deck, there are footpaths 75 cm wide. There are cable ducts on footpaths covered with prefabricated RC covers that form the footpath floor. Drainage on the RC structure is handled using a slope of the bridge deck and gullies installed on both sides as part of footpaths. The handrail on the bridge structure was made with welded pipe sections. The handrail is 1100mm high.

existing cross-section



***Newly designed condition:***

The rehabilitation design provides for damp-proofing replacement on the bridge deck, reconstruction of the drainage system and reconstruction of footpaths.

Due to damp-proofing replacement, removal of crushed stone and the the existing damp-proofing cover, traffic closure is planned in the course of such works. Before damp-proofing placement, and if necessary, the bridge deck should be fixed using repair mortar. The new damp-proofing is a spray-type waterproofing.

The existing gullies shall be replaced by new ones. Gullies will be extended up to the bottom edge of the girder and are supported against girder webs in all aspects as per details given in Graphic Documents and the scale with Drainage Design.

Footpaths shall be reconstructed by adding prefabricated cornices, replacing the existing prefabricated slabs with new ones and repairing inner surfaces of the cable ducts. Damp-proofing and duct filling in the footpath is also planned. The filling for the footpath shall be made of sand placed in two layers with cable ducts. New footpath details are given in Graphic documents. The exiting drainage outlets in cable ducts on footpaths shall be closed and new drain tubes installed as per new layout in all things according to the details given in Graphic documents. Terrain development plans for the demolition of the existing retaining wall and the construction of a new one next to the abutment S1.

In addition, the footpath handrail and expansions joints should also be replaced.

newly designed cross-section



***Superficial damage repair***

Superficial damage repair on outer girder surfaces in the form of crack repair by injection and repair of damaged covers. Following superficial damage repair works, it is necessary to protect all the outer girder surfaces with protective coatings.

The planned intervention areas for superficial damage repair are shown in Graphic documents.

***Interventions on the bridge during exploitation***

According to the existing documents obtained from ŽICG, we established that no changes occurred in the course of bridge exploitation.

### Static calculation – summary

### Tehnology of work execution and rehabilitation works

The construction site provides:

* storage space for the tools and equipment;
* storage space for the material;
* enclosed and secured space for combustible materials and fuels;
* office space for the Contractor and the Engineer;
* compounds for the workers;
* area for the machines;
* other.

Given that each structure has different conditions for the transport of personnel, equipment, machinery and materials, the following principles were adopted:

1. The construction site is formed in the area of the structure in case:

* there is an asphalt road or a good macadam road;
* there is free space for construction site capacities.

1. The construction site is formed in the area of the nearest railway station and in that case the following applies:

* transport of personnel and material to the bridge is carried out using railway rolling stock during the whole time of works as per established procedures and possible time slots;
* providing a building for the security personnel, a building for workers' accommodation and the tool warehouse at the bridge location.

The following was adopted for bridge M9:

* the bridge is in Bijelo Polje
* asphalt pavement goes under the bridge, clearance height Hs = 4,0 m
* construction site can be set out at the bridge location
* transport of personnel, equipment, machinery and material to the bridge can be carried out the asphalt pavement.

1. Superstructure

The items of works for which technology of execution is described in detail are as follows:

* 1. Placement of new damp-proofing under the track prism

Removal of a cover (fine-grained concrete) and removal of existing damp-proofing, sandblasting of concrete surfacing, applying repair mortar, producing new spray damp-proofing with a cover made of prefabricated sheets of extruded polystyrene.

* 1. Placement of new gullies

Disassembly of existing gullies, treatment of the area with repair mortar, applying damp-proofing and installation of new gullies.

* 1. Placement of new bridge expansion joints

Disassembly of existing expansions, treatment of concrete surfaces, fitting new expansion joints.

* 1. Repairing cable ducts

Removing sand from the ducts, local dislocation of SS and TT cables, sandblasting of concrete surfaces, applying repair mortar, installation of drain tubes and applying spray damp-proofing.

* 1. Repair of cornices on footpaths

Machine removal of the top and lateral surface of concrete cornices, sandblasting the concrete and rebar, producing new section of a cornice with a drip cap.

* 1. Placement of new handrail on footpaths

Removal of existing handrail on footpaths, placement of new handrail onto previously repaired cornices.

It is essential execute new damp-proofing, new expansion joints and new gullies in a high-quality manner so as to eliminate harmful effect of water on the structure long term. Placement of damp-proofing and the repair mortar coating must be done adhering to the temperature, humidity and hardening times. It is also important to avoid frequent resumption of works when damp-proofing as much as possible.

The above-mentioned items of works are executed under special railway traffic management schemes as follows:

1. items 1 and 2 in bridges with gullies at the structure axis are executed under traffic closure and voltage shut-down for a maximum period of time;
2. items 2 and 3 are executed under “railway closure for construction works” scheme in the day-time slots (e.g. 1130 to 1630 ) with or without power shutdown;
3. items 4, 5 and 6 are executed under low-speed traffic scheme (30 km/h) without power shutdown.

Works defined under items 2 through 6 may be executed under railway traffic scheme a) or b) if this does not interfere with the works defined under item 1 in the Description of works.

1. Track works (the bridge and the bridge area)

For the execution of works under items 1, 2 and 3, it is necessary to remove the rails, sleepers and crushed stone ballast all the way to the damp-proofing layer.

Here is the description of items of track works that need to be executed.

1. Works to be executed before traffic closure:

* assembly and disassembly of rail anchors in the track area after abutments;
* assembly and disassembly of sleeper anchors in the track area after abutments;
* cutting rails in the embankment at 10m from abutments and at every 22.5m on the bridge with rail drilling and fitting of rail connectors.

1. Works executed under traffic closure and power shutdown:

* track disassembly (rails, check rails, sleepers, ballast prism) in the track length as per dynamic plan.
* assembling the track using existing rails, the new crushed stone ballast, new wooden sleepers and new rail fasteners.

1. Works executed after construction works in the track area:

* welding rails as CWR, placement of check rails;
* regulating the track by direction and the level line according to current condition elements.

1. Substructure

1) Strenghtening works

* Mechanical or manual excavation in cascades with shoring to the level necessary for the disassembly of the existing supporting construction;
* demolition of the existing retaining wall
* erecting a new retaining wall next to the abutment S1.

The above mentioned works are executed in dry conditions.

2) Repair works on concrete pier surfaces

Repair works on concrete pier surfaces including crack injection works:

* Identifying and marking cracks larger or equal to 0.2mm;
* Cleaning the marked concrete surfaces;
* Sealing cracks with appropriate epoxy gel;
* Injecting cracks with epoxy resin;
* Cleaning the treated concrete surfaces;
* All works are performed in line with the relevant Technical Specifications.

Repair works on concrete pier surfaces with cover degradation:

* Identifying and marking the surfaces to be repaired;
* Removing damaged and unbound parts of concrete pier surfaces;
* Cleaning the exposed and corroded reinforcement;
* Cleaning and degreasing the prepared concrete surfaces;
* Applying repair mortar;
* Treating repaired surfaces so that they are aligned with the surface of the existing concrete;
* Curing repair mortars/concretes;
* All works are performed in line with the relevant Technical Specifications.

The preparation of protective cement-based coating for the protection of concrete surfaces (vertical pier surfaces, bearing beams, pendulums, wing walls) in line with Technical Specifications.

The above mentioned works are executed in dry conditions.

1. Conclusion
2. The prerequisite for quality execution of damp-proofing works, gullies and expansion joints is to adhere to installation requirements and work carefully without any unreasonable demands to shorten the time required for such works.
3. With good preparation and good management of work train traffic, sufficient number of construction machinery and experienced and qualified workforce, it is possible to repair damp-proofing on the deck at 15m of the bridge under one-day continuous closure (24h) and go to low-speed traffic afterwards.

This applies to the Vrbnica-Podgorica railway section for the period May-September and the Podgorica-Bar section for the period April-October.

1. The Contractor shall, as per design recommendations and his technical and technological capacities determine which period of railway closures are necessary and submit a timely request to ŽICG for railway closures longer than the approved single-day closures.
2. To the extent possible, traffic closures should be employed simultaneously on two or more bridges which are at the same inter-station distance.

In bridges with spans over 15m, repeated use of long closures is necessary, although it is acceptable to employ such closures with breaks in between closures that are not longer than 2 days.

### The list of templates used for the creation of technical documentation

The design engineer used the following documents for the creation of the rehabilitation project:

* The original design - Main design of viaduct at km 16+250 of railway line Gostun - Titograd (developed by Institute for designing ZJŽ Belgrade, 1970.)
* Bridge condition report: Bridge in km. 299+968.19 of railway line Vrbnica - Bar (developed by Pro-inženjering, 2014.)
* Geotechnical elaborate (2018.)
* Geodetic survey (2018.)

### List of applied regulations

LAWS AND RULEBOOKS REGARDING THE CONTENTS OF THE TECHNICAL DOCUMENTATION

* Railway law. Official Gazette of RMN, N° 27/2013;
* Law on safety, organization and efficiency of rail transport of Montenegro of 27/12/2013, in force since January 2014;
* Law on spatial development and construction of structures. Official Gazette of RMN, N°51/08, 40/10, 34/11, 47/11, 35713, 39/13;
* Law on construction products N° 18/2014;
* Law on geological researches. Official Gazette of RMN, N° 28/93, 27/94, 42/94, 26/07;
* Law on occupational safety. Official Gazette of RMN, N° 34/2014;
* The Rulebook on content and production of technical documentation - Official Gazette of RMN, N° 23/14, 32/15, 75/15;

RULEBOOKS FOR THE DESIGN

* (316) Rulebook on technical standards for determining the size of the load and categorization of railway bridges, culverts and other structures on railway lines. Edition 1992

EN STANDARDS

* MEST EN 1990:2013-Eurocode - Basis of structural design.
* MEST EN 1990:2013/NA:2013- Eurocode - Basis of structural design - National Annex.
* MEST EN 1991-1-1:2017/NA:2017- Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings - National Annex
* MEST EN 1991-1-3:2017-Eurocode 1 - Actions on structures - Part 1-3: General actions - Snow loads.
* MEST EN 1991-1-3:2017/NA:2017- Eurocode 1 - Actions on structures - Part 1-3: General actions - Snow loads - National Annex
* MEST EN 1991-1-4:2016-Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions.
* MEST EN 1991-1-4:2016/NA:2016- Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions - National Annex.
* MEST EN 1991-1-5:2017/NA:2017- Eurocode 1: Actions on structures - Part 1-5: General actions - Thermal actions - National Annex
* MEST EN 1992-1-1:2017/NA:2017 - Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings - National Annex
* MEST EN 1997-1:2017- Eurocode 7: Geotechnical design - Part 1: General rules - National Annex;
* MEST EN 1997-1:2017- Geotechnical design - Part 1: General rules;
* MEST EN 1998-1:2015 - Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings.
* MEST EN 1998-1:2015/NA:2015 - Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings - National Annex
* SRPS EN 1991-1-5:2012 - Eurocode 1: Actions on structures - Part 1-5
* SRPS EN 1991-1-1:2012 - Eurocode 1: Actions on structures -Part 1-1
* SRPS EN 1991-1-3:2012 - Eurocode 1: Actions on structures -Part 1-3
* SRPS EN 1992-1-1:2015 - Eurocode 2: Design of concrete structures: Part 1-1
* SRPS EN 1997-1:2004 - Eurocode 7: Geotechnical design - Part 1
* HRN EN 1991-1-7:2012 - Eurocode 1: Actions on structures - Part 1-7
* HRN EN 1991-1-7:2012/Cor.1:2015 - Eurocode 1: Action on structures -Part 1-7
* HRN EN 1991-1-7:2012/A1:2015 - Eurocode 1: Action on structures -Part 1-7
* HRN EN 1991-2:2012 - Eurocode 1: Action on structures -Part 2
* HRN EN 1992-2:2013 - Eurocode 2: Design of concrete structures -Part 2
* HRN EN 1998-2:2011 - Eurocode 8: Design of structures for earthquake resistance - Part 2
* HRN EN 1998-3:2011 - Eurokod 8: Design of structures for earthquake resistance -Part 3
* HRN EN 1998-3:2011/Cor.1:2014 - Eurokod 8: Design of structures for earthquake resistance -Part 3
* HRN EN 1998-5:2011 - Eurokod 8: Design of structures for earthquake resistace - Part 5

**2.2. Technical description – the superstructure**

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**2.2.1 GENERAL**

Within the Main Design for the rehabilitation of the bridge no. 9, works on the track superstructure in the function of bridge rehabilitation were planned. Technical documents for the bridge no. 9 deal with track section 52.00m long, which includes the total bridge length and 10.00m before and after the bridge.

Based on the Conclusion of the Inspection Report on the bridge no. 9 superstructure condition, and establishing the current condition in the drafting period of the relevant technical documents, works to be done on the bridge track superstructure were defined. The tracks on the bridge are in a curve (R=1600m L=40m) and are welded as CWR.

Measures were adopted to be taken on the bridge track superstructure with the drafting of Priced BoQ, Technical Specifications, Superstructure Static Calculation and Track development on the bridge.

Total value of superstructure works for the bridge no. 9 is 40,417.80 €.

**2.2.2 REQUIRED MEASURES AND SEQUENCE OF WORKS ON SUPERSTRUCTURE WHEN**

**EXECUTING BRIDGE REHABILITATION WORKS**

For the execution of rehabilitation works (placing new damp-proofing under the ballast prism, installation of new gullies and expansion joints) the following works on the superstructure were planned, where the bridge length and the length on the embankment of 10 m from abutments, before and after the bridge are taken into account:

* arresting CWR before and after the bridge with the installation of rail anchors;
* disassembly of the existing tracks in segments up to 22.5m with the track and checkrail removal, whereby it is necessary to cut the existing track and drill rails for the connections at the joint, perform any disassembly of fasteners and sleepers as per technology of track and check rail removal;
* removal of the current crushed stone ballast all the way to the damp-proofing protective layer;
* installation of the track and check rails in segments up to 22.5m with new crushed stone, new sleepers and new fasteners, with a fitting of connectors and the necessary fasteners for joining running rails and check rails;
* regulating the track by direction and the level line as per elements of current condition;
* disassembly of rail joints on running rails before welding;
* welding the track as CWR;
* disassembly of rail anchors, installed for the purpose of arresting CWR, both before and after the bridge, while keeping the rail anchors in the area after the bridge, in accordance with the existing number and position of rail anchors;
* final track regulation.

Bridge superstructure works on bridge rehabilitation, particularly the disassembly and the assembly of the existing track are executed under traffic closure while low-speed traffic scheme should be employed on the bridge section during rehabilitation works.

**2.2.3 STATIC CALCULATION - SUMMARY**

The basic elements of the superstructure used in the calculation of track stresses and stability are as follows:

- 49 E1 rails, grade R260 (900A)

- wooden sleepers L=260cm, at axial spacing of 60cm

- "K"-type fasteners.

The bridge structure is made of reinforced concrete, with a girder cross-section, and it terms of statics it is a continuous beam with the span of L=2x16.00m. Girders are supported by RC pendulums on piers S1 and S2, whereas the immovability was achieved on pilar S3 with the use of anchors and direct leaning. The track on the bridge is in a curve (R=1600m L=40m), welded as CWR.

Having in mind the regulations from the Rulebook on the maintenance of the railway tracks superstructure (“Official Gazette of Montenegro, no. 42/2016“ published on 11/7/2016), as well as the valid EN standards and the UIC Announcements, and in addition to the stance that there is no relative displacement between the bridge and the LRT (“Study of various methods adopted by world railways to continue LWR over bridges“) the calculations and analyses are done for the temperatural change impacts on the rails without any impact of the bridges on the rail (just like on open tracks, that is, as if the tracks were practically observed on the embankment).

***Characteristic results***

a) For the LRT of 49E1 rails, the maximum compressive force is:

**N= -661.50kN**

b) For the LRT of 49E1 rails, the maximum tensile force is:

**N= 817.14kN**

c) The inspection of track stability against buckling in the curve with a radius R=1600m on the bridge in extreme summer temperatures employing the Mischenko energy model was made.

Crtitical lateral resistances were obtained q= **78.68 N/cm <90 N/cm** for which it is not necessary to install sleeper anchors, that is, a well tamped ballast provides stability against track buckling.

d) Inspection of crack size on rail cracking in winter was made, and it was determined that, on rail cracking, the crack size will be 2.52cm<10cm, i.e. traffic safety shall not be at risk in case of rail cracking.

**2.2.4 TRACK DEVELOPMENT**

Based on the performed analysis and the obtained calculation results, the track should be developed in the following way meeting the following requirements:

1. The substructure before and after the bridge must be completely and appropriately executed (cross-section, drainage, stabilization)
2. Crushed stone ballast before, after and on the bridge must be uncontaminated, having the adequate quality and grain size distribution, with a ballast prism intended for CWR. On sections where rail anchors are placed, additional tamping of ballast prism should be performed.
3. Before welding, the track (on the bridge and outside the bridge) must be completely regulated by direction and the level line as per the elements of the current condition.
4. The calculation was made under the condition that both the railway line and the track on the bridge are welded as CWR.
5. The required temperature for CWR tempering is +230C ± 30C.
6. Before the arresting of CWR, 74 pieces of rail anchors are fitted at about 50m of the track before and after the bridge which are to be disassembled after the final welding. However, devices against lateral track movement shall remain in the track area after the bridge, in accordance with the existing number and position of those devices.
7. Installing devices against lateral track movement is not necessary, that is, the track in a curve with R=1600m with a well tamped ballast provides stability against track buckling.
8. Permanent labels for monitoring CWR longitudinal and transversal displacement (in the bridge area) should be put in the following places:

- at the first sleeper after the bridge

- at the first sleeper before the bridge.

Labels are buried at both sides of the track on stable soil.

Labels are placed before completing CWR formation, and are calibrated immediately after CWR tempering in the presence of the Supervisor.

Chainage labels can be used as permanent labels for CWR monitoring, provided they are in the immediate vicinity (within 3 m) of the places where labels are placed. Permanent labels are not included in the Priced Bill of Quantities.

1. As check rails, the exiting rails already laid on the bridge shall be used, which are interconnected at its end with an oak key, whereby the new fasteners are installed on the sleeper connection with the running rails and check rails, which connection is made at each sleeper, in addition to new fasteners for bridge ends and new additional fasteners for check rail joints.
2. All the necessary track maintenance works should be done on time, in a quality manner and within the allowed temperature ranges. It is also necessary to ensure enhanced supervision on the section at extreme rail temperatures (below -10°C and over +35°C).