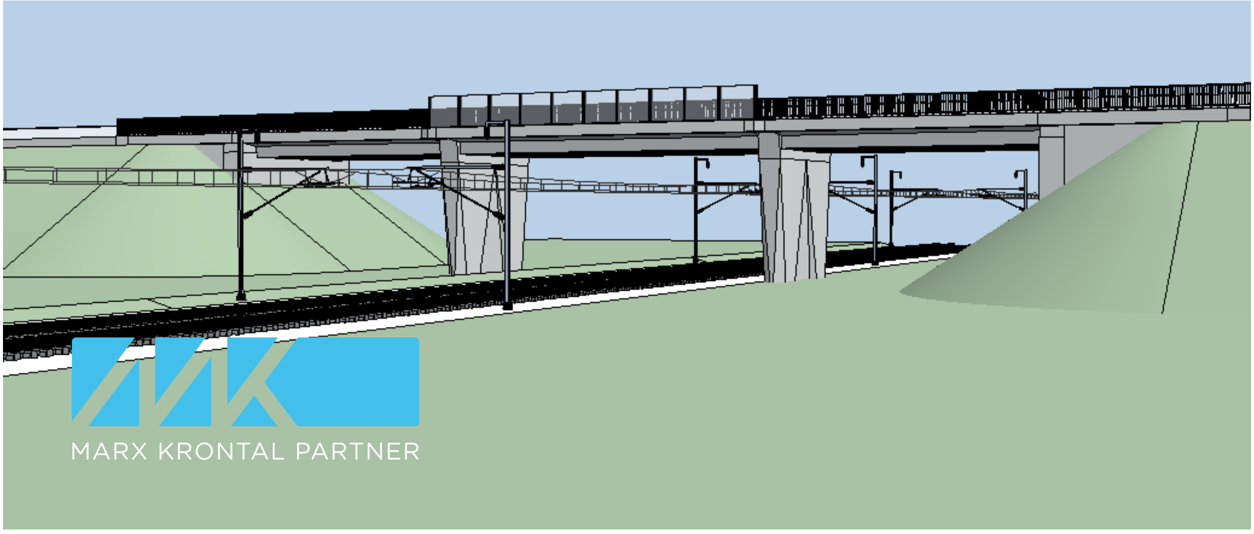

PROJECT	**Rail Baltica** SBS-Study
FINAL REPORT	**Development of preferred solution - Master Design**
CASE 4	**Justification Report Road Overpass**
PERFORMANCE PERIOD	07/2019 until 09/2019
PRINCIPAL	RB Rail AS Vasco Amaral; Rita Grigāne K. Valdemara 8-7 LV-1010 Riga Latvia
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PROJECT NUMBER INTERNAL	04119
EDITOR	Justine Bange, M.Sc
DATE	Hannover, 27.09.2019
INDEX	a

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Technical and additional documents

Basis of assignment

[U1] Assignment order (contract) No 8/2017-120-X/X for the provision of expert services, Riga

[U2] Mini competition_SBS-Cases-R0.2

[U3] Bridge Inventory; Rail Baltica; 02.04.2019

Project-specific documents

[U4] Rail Baltica Official Website

[U5] Design guidelines general requirements; Rail Baltica; 25.03.2019

Additional documents

[U6] Flue-Fluegelausbildung; Bundesanstalt für Straßenwesen bast; 12.2009

[U7] RiL804; DB Netz AG;01.11.2018

[U8] Was-Brückenentwässerung; Bundesanstalt für Straßenwesen bast; 12.2009

[U9] Dicht-Brückenabdichtung; Bundesanstalt für Straßenwesen bast; 2015

[U10] Übe-Fahrbahnübergangskonstruktionen; Bundesanstalt für Straßenwesen bast; 2012

Table of content

1 General

1.1 Necessity of measure, traffic routes, local boundary condition

The new high-speed railway line Rail Baltica will be crossed by roads. Depending on landscape situations Rail Baltica crosses either over or under road users. When the Rail Baltica line crosses under another route, this route has to be carried by a structure. This structure is termed road overpass.

According to Bridge Inventory of Rail Baltica project [U3] most of the needed bridges are road overpasses. Road overpasses enable motor vehicle, pedestrian and cyclist to cross Rail Baltica. Therefor a width of 12,00 m shall be provided. A vertical clearance of 6,70 m must be provided for high-speed trains. Typical occurring spans for Rail Baltica are between 20 – 30 m. [U2]

This justification report does not deal with a single building structure, but with a general solution for road overpasses. Each road overpass over railway line Rail Baltica has to be planned separately considering local boundary conditions, but this report shall give a design basis for such bridge types in a general, theoretical situation.

1.2 Load assumptions

This general planning of road overpasses does not include a static calculation, because it is depending on local boundary conditions (e.g. soil conditions) and geometric parameters of the bridge. Load assumptions for a static calculation of each bridge has to be made for local requirements and road types.

1.3 Construction design

The main overall design concept for railway bridges and road overpasses is a straight and clear language of design.

In this planning phase the superstructure is designed with a slenderness of about 16.5.

Straight abutments build the end of the bridge. It two axis pierwalls are arranged as shown in Figure 1. They are connected with superstructure via pierwallheads.

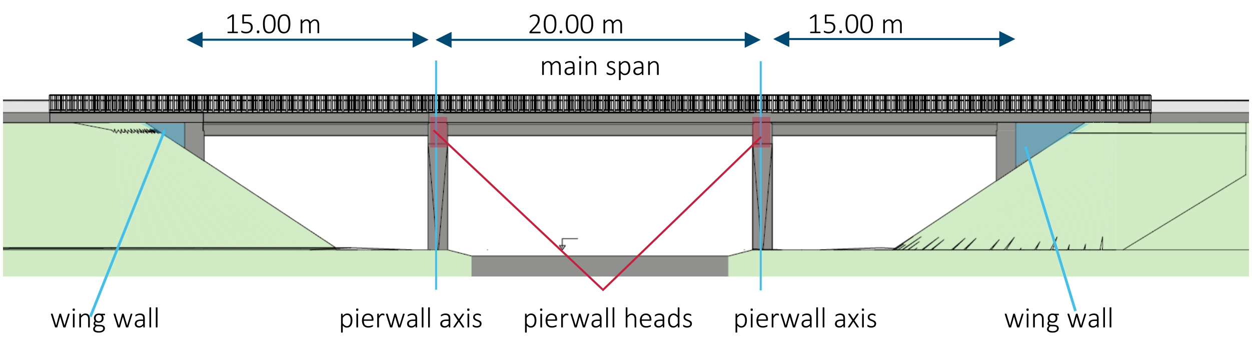


Figure 1: side view overpass

Considering rural local boundary conditions this solution is a very economical solution (as shown in MCA Annex 0_5). In urban situation another design could be more advantageous.

2 Soil conditions, foundation

2.1 Soil conditions

It is necessary to investigate soil conditions for each bridge. Soil investigation has to be made especially in foundation axis. For the general underpass planning, good soil conditions for spread footing are assumed.

2.2 Groundwater, water pumping

Depending on groundwater level, water pumping during construction phase might be necessary. Since Baltic states are very flat countries, water pumping is often necessary. Therefore, water pumping is calculated in estimation of costs with a lump sum of 10.000 € (see estimation of costs Annex 1_1). Depending on landscape a factor (factor of difficulty) to calculate the costs depending on the amount of water pumping can be added.

2.3 Footing

In this fictional design soil conditions for spread footing are assumed (Figure 2). Estimation of costs and quantities and construction planning are based on the idea of using spread footing.

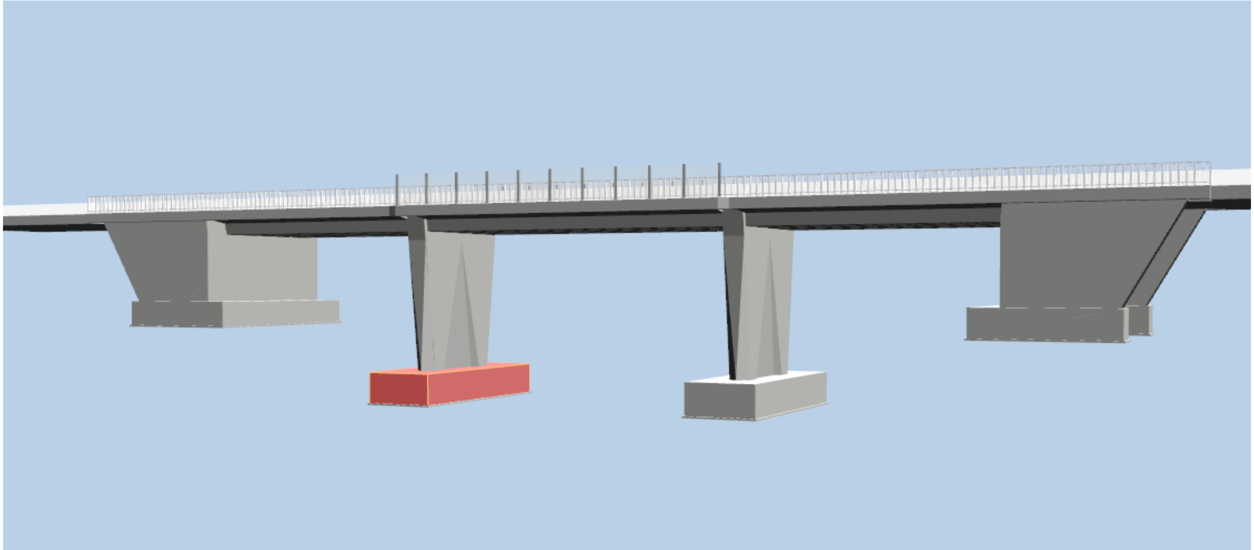


Figure 2: spread footing for road overpasses

For other soil conditions also spread footing with previous soil improvement or deep foundation, as shown in Figure 3, is thinkable.

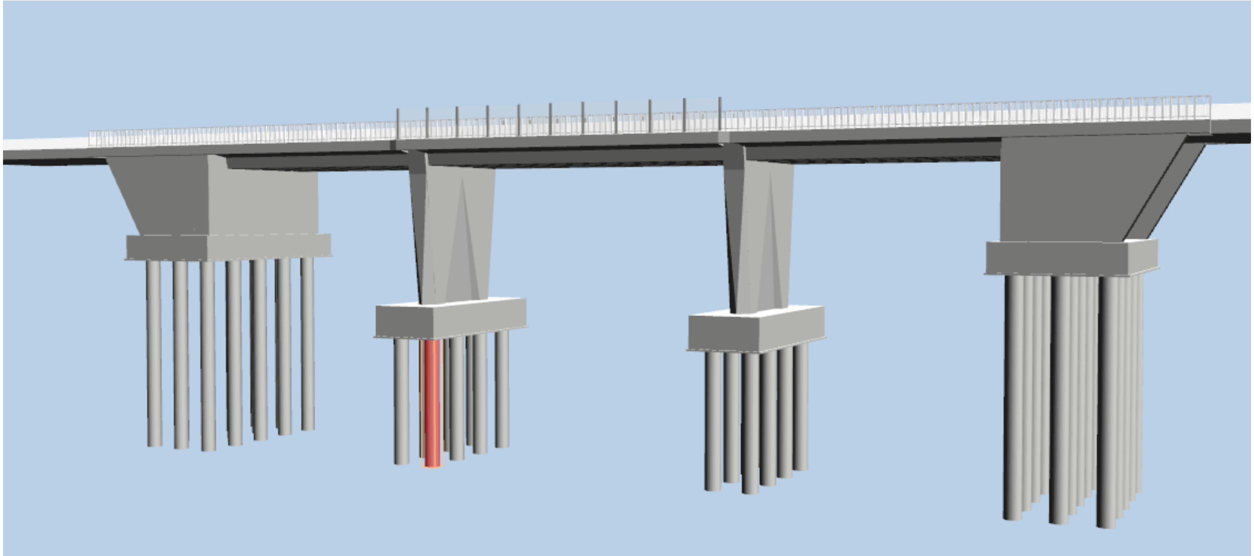


Figure 3: deep foundation for road overpasses

2.4 Investigation regarding contamination and explosive ordnance

For general road overpass planning no investigation regarding contamination and explosive ordnance are included in calculations. Depending on local boundary conditions the expense for these investigations has to be taken into account.

3 Substructure

3.1 Abutment, wing walls, backfill

Abutments and wing walls (east and west) are based on a 1.50 m thick spread footing which is set on a granular subbase.

Abutment and wing walls shall be constructed with concrete C 30/37. Reinforcing steel type B 500 B has to be used.

Wing walls have a constant thickness of 1.00 m and a length of about 7.30 m. They are designed according standard drawing by the German Federal Ministery of Transport, Building and Urban Development RiZ Flü 1 (Picture 1) [U6].

The angle of wing walls can differ depending on landscape situation. For road overpasses angle of wing walls does not have such a big influence on design and visual impact as for Underpasses.

There are three main kinds of wing walls.

- Angled wing walls: building more difficult, construction time is longer than parallel wing walls, most economical solution in comparison to parallel and perpendicular wing walls
- Parallel wing walls: easy to build, construction can be done in a short time, wing wall does not disturb existing embankment, but not most economical arrangement
- Perpendicular wing walls: building less difficult than angled wing walls, continuous alignment with bridge deck which can be used to support railings, disturb existing embankment

In this theoretical case perpendicular wing walls as shown in Figure 4 are chosen, because it is the best compromise considering all three components building difficulty, construction time and visual appearance. Depending on landscape also angled wing walls or parallel wing walls can be advantageous.

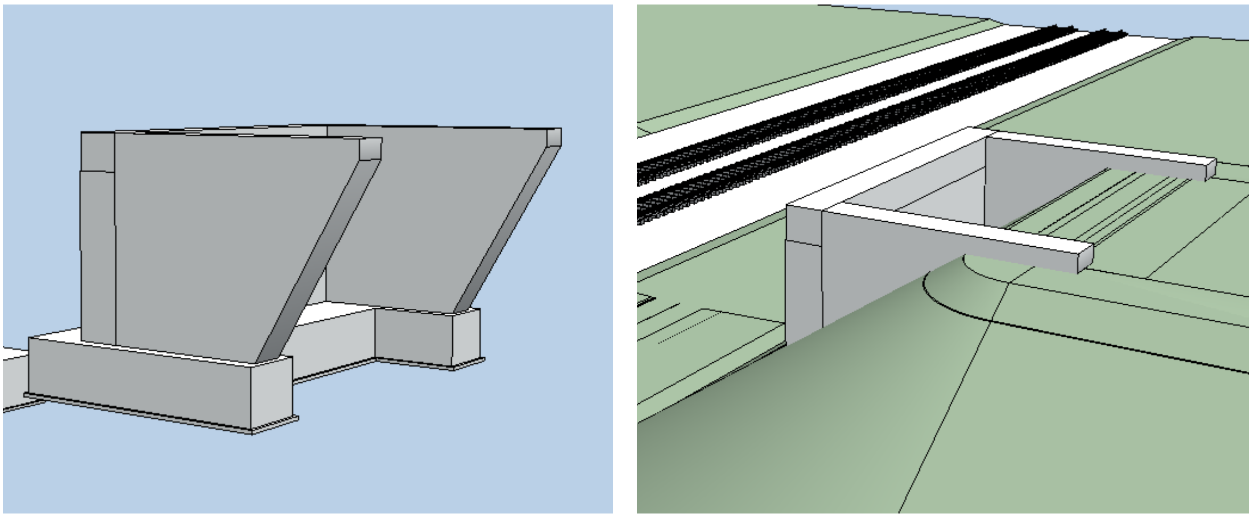


Figure 4: perpendicular wing walls for road overpass, basic model (left) integrated in landscape but without backfill (right)

3.2 Pierwalls

For road overpasses the substructure gets a higher impact load than for railway viaducts, because trains have other self-weight and speeds than cars or trucks. Therefore, pierwalls instead of single piers are planned as substructures. Pierwalls are more massive than piers for railway viaducts. Thus, they can handle better with high impact loads. Still the visual impact of substructure is a high identification factor. Therefore, a special pierwall form was invented to gain both: massive construction with a slender look.

As shown in Figure 5 the upper cross section of pierwalls differs from bottom cross section of pierwalls. Thus, diagonal edges occur. With diagonal edges the pierwalls do not seem to be too massive

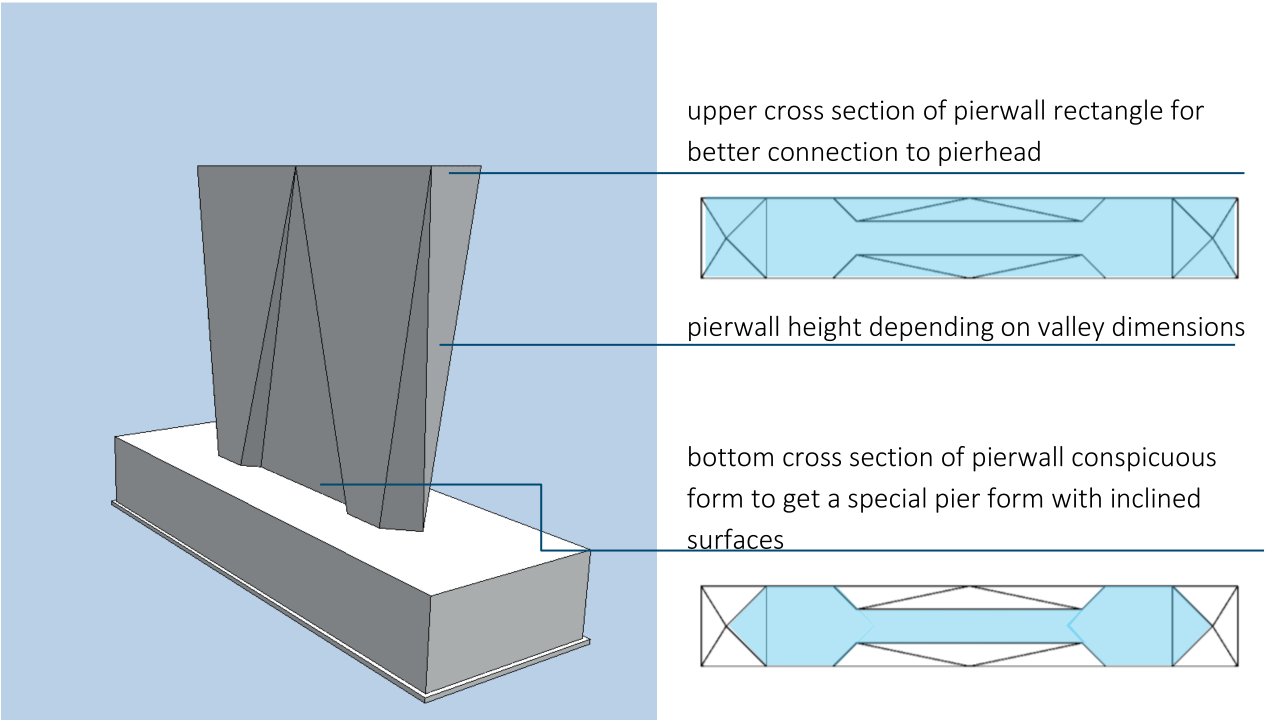


Figure 5: pierwall

3.3 Visible surfaces

For bridge design the interaction of surfaces is a big factor. Care should be taken for a good interaction between surfaces of superstructure and substructure. The visible surfaces of superstructure are mainly very smooth due to prefabricated surfaces. To contrast visible surfaces of substructure from the smooth superstructure surfaces different ways of formwork can be used:

- Formwork panels
- Planed planks
- Non-planed planks

Also, orientation of formwork can be used to produce a significant surface. We advise against colouring of concrete parts to get a contrast of surfaces. Concrete elements get an unnatural look. Furthermore, coloured surfaces may attract unauthorized graffiti artists. Additionally, costs per cubic metres concrete will increase about 10-20 %.

4 Superstructure

4.1 Load-bearing structure

Superstructure is a three-span plate construction. The plate construction is made out of two components: the prefabricated girders (+ prefabricated plates) and an in-situ concrete deck (see Figure 6). The prefabricated elements are U-profile girders. Span is 20.00 m with constant construction height of 1.20 m. Relation of span to height is l/h =16.6.

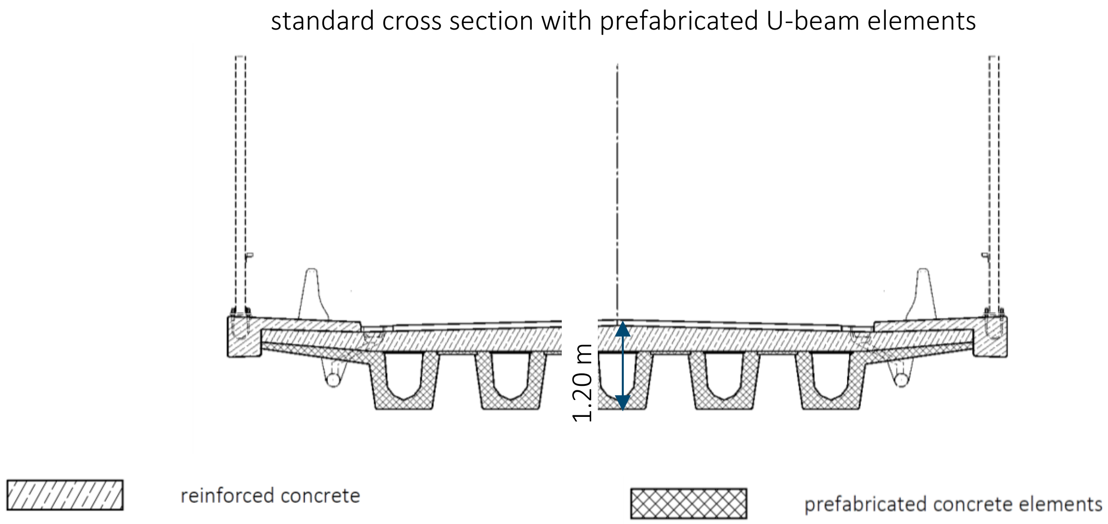


Figure 6: superstructure road overpass

Prefabricated girders which are pretensioned in prestressing bed are used. The advantage of prestressing bed method is that no anchor points are needed.

Superstructure materials are:

- Concrete

- Reinforcing steel

Minimum characteristic values of building materials for road overpasses are listed in drawing Annex 4_2_001. and 4_2_002.

Due to small bridge height accessibility for inspection is possible from below with lifting platform. Voids of U-beam girders can not be inspected. Surfaces of voids are not confronted with environmental influences, thus, no exposure.

4.2 Bearings, joints, expansion joints

In this example road overpasses are planned as integral bridges; thus, no bearings and joints are needed. Only dummy joints/ controlled crack joints in abutments according Annex 5_0_002 have to be planned.

For longer viaducts with bridge length > about 60 m semi-integral constructions are necessary. Therefore, bearings and joints are needed. For expansion joints standard drawing *Übe 1* by the German Federal Ministery of Transport, Building and Urban Development RiZ drawings [U10] can be used.

4.3 Waterproofing, covering

Detail for waterproofing and covering (see Figure 7) can be taken from Dicht 3 and Dicht 9 from standard drawing by the German Federal Ministery of Transport, Building and Urban Development RiZ drawings [U9].

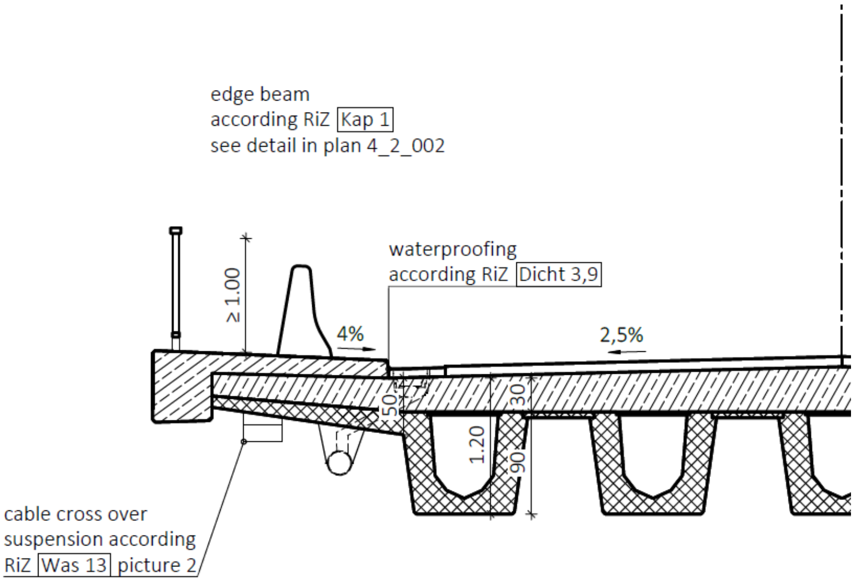


Figure 7: waterproofing road overpass

4.4 Corrosion protection, protection against environmental influences

Railings and other equipment parts made of steel (e.g. protection systems), need a coating system against corrosion.

5 Drainage system

5.1 Superstructure

Drainage pipes are installed under the edge beams of the bridge (see Figure 8). Water runs from deepest points of road surface through drain pipes in drainage pipes. For details we advise Was 1 and Was 13 from standard drawing by the German Federal Ministery of Transport, Building and Urban Development RiZ drawings [U8].

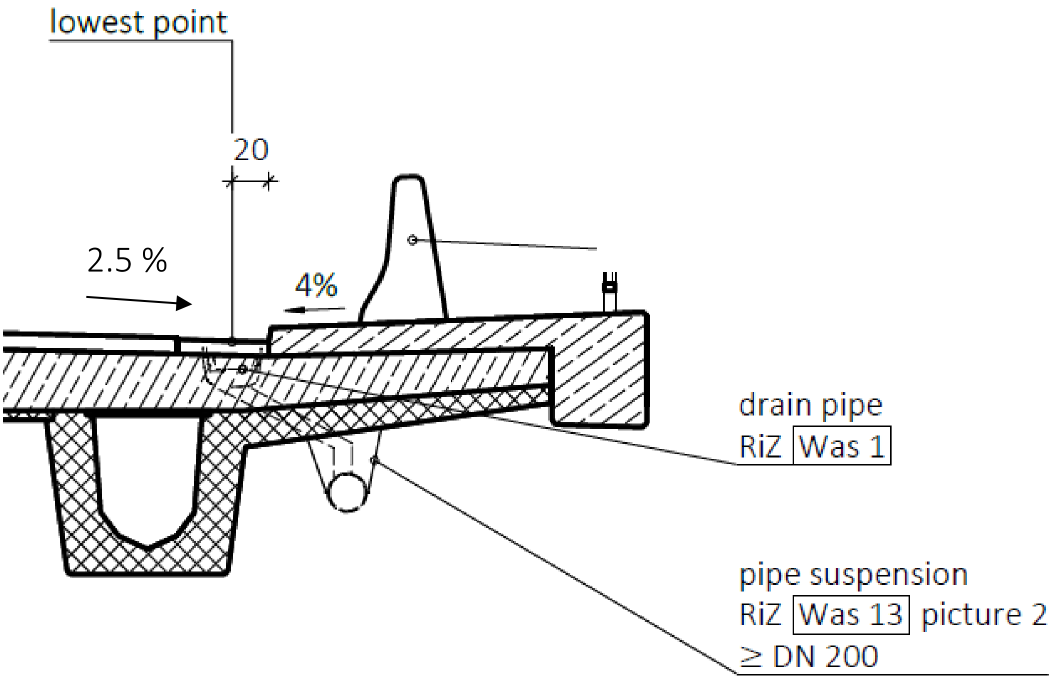
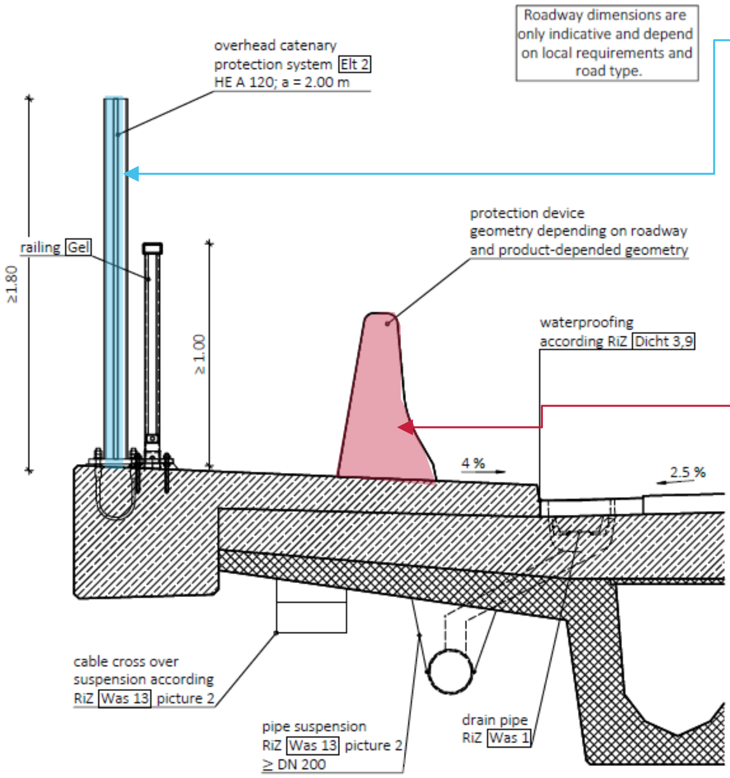


Figure 8: drainage system of superstructure

5.2 Abutments

Dewatering takes place in drainage walls along abutments. Therefore, drainage walls have to be included in drainage planning and have to be calculated.

6 Restraint and protection systems



Protection system/ protection parapet (Figure 9 blue) depends on requirements of Rail Baltica. We advise Elt 2 which is a detail for road overpasses from standard drawing by the German Federal Ministery of Transport, Building and Urban Development RiZ drawings.

Restraint system/ protection device (Figure 9 red) has to be chosen considering road type.

Figure 9: restaint and protection system

7 Accessibility

Accessibility for inspection is possible from below with lifting platform.

Accessorily via embankment stairs could be also possible. We advise against embankment stairs, because this enables unauthorized access from road bridge to railway line. If embankment stairs are wanted, we advise to include them in emergency escape route planning (stair width large enough etc.).

Voids of U-beam girders cannot be inspected. Surfaces of voids are not confronted with environmental influences, thus, no exposure.

8 Other equipment

Grounding

All solid construction components have to be equipped with an inner grounding. All steel construction components (noise protection wall, parapets, …) need grounding connections and need to be connected to railway earthing. For the connection to railway earthing see details of grounding in Annex 4_3_002.

Cable crossing

If a transfer of cables over road overpasses is necessary, we advise to install empty conduit package under the bridge with a suspension as for drain pipes. An example how this installation could look like is shown in Figure 10.

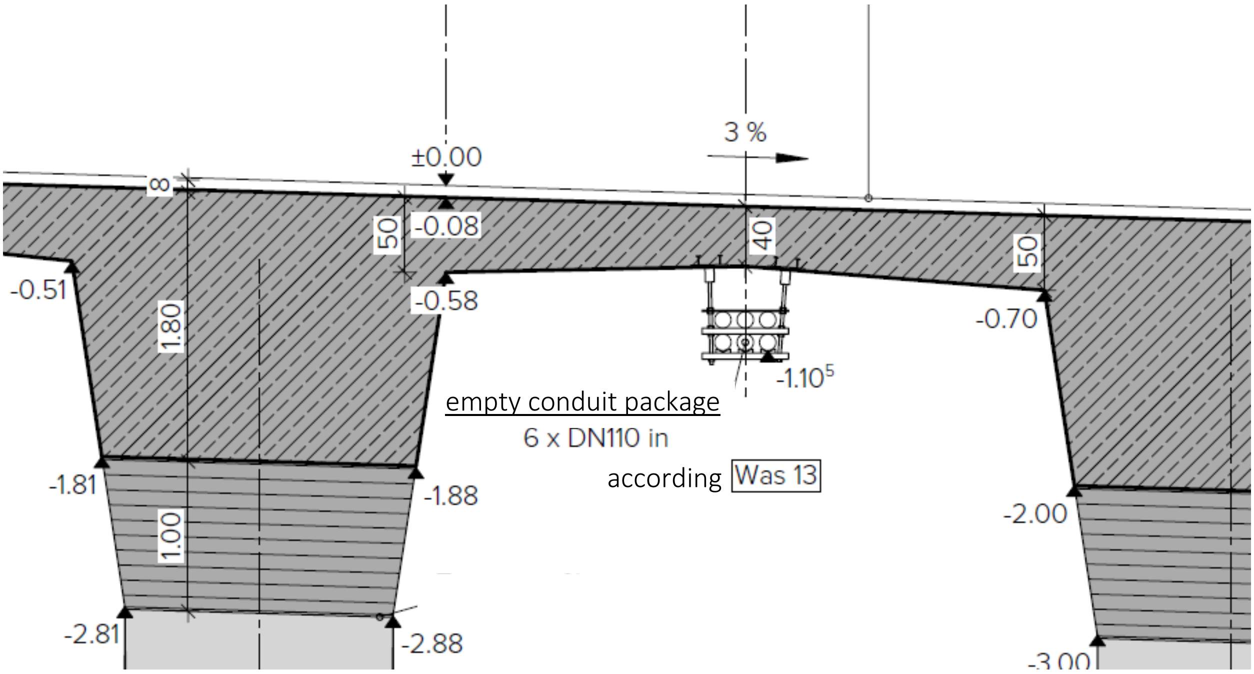


Figure 10: example for cable crossing

9 Construction, construction period

9.1 Construction process, construction period

Construction process	Duration	Comments
1 PREPARATORY WORKS	2-3 WEEKS	
Access/ access road to construction site		depending on region and landscape situation
If necessary, redirect “crossing partner”		depending on traffic situation
Set site area		
2 EARTHWORK		
Produce planum	1-6 WEEKS	depends strongly on landscape situation
Build embankment	1-6 WEEKS	depends strongly on landscape situation
Pit excavation for spread footing of abutments and pierwalls	incl. in founding	depending on local conditions either open excavation or sheeting
Backfill layer wise	incl. in abutment	layer thickness around 30 cm in a high-quality consolidation
3 FOUNDING FOR ABUTMENTS AND PIERWALLS	4-6 WEEKS PER FOUNDING AXIS INCL. PIT EXCAVATION DEPENDS ON TYPE OF FOUNDATION	
Abutment		
(pit excavation see earthwork)		
Granular subbase (abutment)		
Spread footing, foundation slab (abutment)		
- formwork		
- place reinforcement		incl. starter bars for abutment walls
- pouring concrete		
deep foundation as option instead of spread footing (abutment)	+ 2 WEEKS PER AXIS	
- insertion of foundation piles		depending on soil condition either bored piles, displacement piles, driven pile incl. starter bars for foundation slab
- formwork foundation slab		
- place reinforcement for foundation slab		incl. starter bars for abutment walls
- pouring concrete for foundation slab		
(Backfill layer wise, see earthwork)		
pierwalls		
(pit excavation see earthwork)		
Granular subbase (pierwalls)		

Spread footing (pierwalls)		
- formwork		
- place reinforcement		incl. starter bars for pierwalls
- pouring concrete		
deep foundation as option instead of spread footing (pierwalls)	+ 2 WEEKS PER AXIS	
- insertion of foundation piles		depending on soil condition either bored piles, displacement piles, driven pile incl. starter bars for foundation slab
- formwork		
- place reinforcement for foundation slab		
- pouring concrete for foundation slab		
4 SUBSTRUCTURE		
Abutment	5-7 WEEKS ABUTMENT AXIS INCL. BACKFILL	
Geometry as shown in Annex 4_2_001/002		in-situ concrete to ensure integral connection to superstructure, in this example perpendicular wing walls
abutment wall until construction joint		
- formwork		
- place reinforcement		incl. starter bars for abutment wing walls and superstructure connection
- pouring concrete		
abutment wing walls		
- formwork		
- place reinforcement		
- pouring concrete		
Pierwalls	1-2 WEEKS PER PIERWALL AXIS	
Geometry as shown in Annex 4_2_001/ 002		In-situ concrete to ensure integral connection to superstructure, pier head to ensure integral connection to superstructure
pierwalls		
- formwork		
- place reinforcement		incl. starter bars for pierhead
- pouring concrete		
pierheads		after superstructure elements are placed!
- formwork		

- place reinforcement		incl. starter bars for superstructure connection
- pouring concrete		
5 SUPERSTRUCTURE		
support structure	ABOUT 3 WEEKS	
- build support structure		if necessary, founding for support structure
- dismantling support structure		
superstructure		
prefabricated concrete elements	12-16 WEEKS incl. CURING TIME	
- produce prefabricated concrete elements		in precast factory
- transport prefabricated concrete elements to side		
- place prefabricated concrete elements		on support structure on support structure and on abutment walls
in-situ concrete for superstructure and connection area	4-5 WEEKS	
- formwork for connection area + waterproofing bridge end		connection area between superstructure and substructure, waterproofing bridge end
- place reinforcement for in-situ superstructure and connection area		
- pouring concrete		
- let concrete dry	+14 DAYS	
6 EQUIPMENT		
Waterproofing edge beam	8-9 DAYS	
- layer wise according RiZ drawings Dicht 3, Dicht 9		
Build in-situ concrete edge beams	4-5 WEEKS	with anchor for railing, overhead catenary protection system and protection barrier
- install temporary formwork consoles		
- formwork		
- place reinforcement		
- pouring concrete		
waterproofing superstructure between edge beams	2-3 WEEKS	
- layer wise according RiZ drawings Dicht 3, Dicht 9		
Drainage system abutment	1 WEEK PER ABUTMENT	
- principle following Detail E Annex 5_0_001		
Grounding, railing, joints, overhead catenary system, protection barrier	5-6 WEEKS	
- inner grounding		
- grounding of steel construction components to railway earthing		according principal of grounding annex 4_2_002

- railing - overhead catenary protection system - protection barrier - if necessary, joints		
construct roadway		indicative, depends on local requirements and road type
- build road in layers (subbase course, base course, surface course)		
7 LANDSCAPING	1-6 WEEKS	
Depending on local boundary conditions		
8 FINALIZING WORK	2-3 WEEKS	
Clearing construction site		

ALL INFORMATION ABOUT DURATION ARE ROUGH REFERENCE VALUES.
DURATION FOR PREPARATION, TRANSPORT AND LANDSCAPING DEPEND STRONGLY ON LANDSCAPE SITUATION.

9.2 Protective measures

Work for waterproofing might be problematical if ambient temperature is too low. Therefore, waterproofing either has to take place when it is not too cold for the waterproofing material (the manufacturer's details are to be observed) or a waterproofing material for the special ambient temperature while waterproofing apply phase has to be planned in detailed design for the specific structure. Waterproofing work can be started 2 weeks after concreting.

10 costs

The costs are roughly estimated. A list with costs and quantities can be seen in Annex 4_1.

Final leaf

Hannover, 27.09.2019