Solutions for the Construction of steel bridges using the example of the Hochmoselübergang

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General Overview
Tender Project
Construction of the Superstructure
Preassembly
Sliding Technology
Statitical Calculations
Conclusions
Overview – Integration of the Hochmoselbridge in the existing road network
Overview – Visualisation of the bridge
Overview – Building consortium and volumina

Construction Joint Venture:

Eiffel Deutschland Stahltechnologie GmbH

Porr Deutschland GmbH

Eiffage Construction Metallique Frankreich

Contracted Services (net)
Steel Construction: 85,4 Mio.€
Reinforced Concrete: 22,7 Mio.€
Contracted Amount: 108,1 Mio.€

Tendered Quantities:
Superstructure:
Steel Structure: 24,950 to (S 355)
Coating Area: 130,000 m² (outer surface),
115,000 m² (inner surface)
Total Area: 51,000 m²

Substructures
Piles Ø 1,80 m: 2,550 lfd. m mit 325 to BSt 500 S
Concrete Volume: 29,540 m³
Reinforcing Steel: 3,758 to BSt 500 S
Tender project – View of the Hochmoselbridge

- Number of superstructure fields: 11
- Total length: 1702,35 m
- Max. height above valley: about 158 m
Tender project – Normal cross section

- Cross section: 2 x footway – 2 x road – median strip
- Nominal width: 28.50 m
- Bridge deck area: 48517 m²
Tender project – Substructures – Pier 8

**Substructures**
- 2 box shaped abutments
- 10 piers

**Piers**
- foundations with bored piles (diameters of 1.50 m to 2.00 m)
- single-celled hollow cross section
- pier head from 20.78 m up to 150.72 m
- shape defined by tapering
• Construction method: incremental launching method
• Steel construction is premounted behind the eastern abutment
• Use of pylon cables and an 80 m high pylon for reduction of bending moments
Construction project – Arrangement into shots

- Superstructure is divided into 82 shots
- Length of the shots: appr. 10 up to 25 m
- Below: example of arrangement for the first 3 fields
Construction project – Arrangement of components

- Superstructure is divided into 12 components (height exceeds 6,00 m)
- Height variation is realised by components 9.1 and 9.2
- Components weights varies between 20 and 100 tons
Construction project – Different systems of transversal elements

Cross frames (QR)

Cross frames bracings (QRV)

Transverse bracing (QV)

Pier transverse system (PS)
Assembly – Preassembly shots 1-3 and transport

Preassembly of orthotropic plate with web (component 4) in the manufacturing plant of EDS

Transport to the building site (component 6)
Assembly – Preassembly yard 2011 and 2014
Assembly – Preassembly of superstructure

Assembly of the hollow box in the preassembly yard and lying on edge
Assembly – Preassembly of components

Assembly of box web and parts of bottom and orthotropic plate

Erection of preassembled side walls with parts of bottom and orthotropic plate
Assembly – Preassembly of bottom part

Assembly of the bottom plate shot 3 in 2012
Assembly – Sliding of superstructure using an stationary, central drive

Horizontal forces due to friction on the sliding bearings on the piers →
Stability of the piers cannot be realised
Assembly – Sliding of superstructure with decentralised drive

Horizontal forces are „shorted“:
action force (by hydraulic press) = reaction force (friction on the sliding bearings)
Assembly – Sliding rocker with bridge sliding system 2011

Hydraulic presses

Sliding layer
mode of operation BVS 2011
mode of operation BVS 2011
mode of operation BVS 2011
mode of operation BVS 2011
mode of operation BVS 2011
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Bridge Sliding system 2011
Calculation – Modelling of overall system in final state and state of construction

- Superstructure and piers were modelled in the overall modell
- One-beam 3 D model with corresponding section properties in all directions
- This modelling has been chosen to meet the acceptable calculation duration
Calculation – Load assumptions – General

The following effects are considered for calculation:

• Permanent influences (dead loads and additional loads) according to DIN Technical Report 101
• Traffic influences (LM 1, LM 2, LM 3 according to DIN Technical Report 101)
• Subsoil movements
• Drifting loads as a result of the tilted position of the piers
• Wind effects
• Bearing friction and bearing replacement
• Subsequent removal and installation of asphalt
• Military traffic loads (MLC)
• Earthquake loads
Calculation – Wind load assumptions

The wind load on the superstructure consists of a horizontal, vertical and a torsional component.

The application of the wind load on the bridge is as follows:

Average velocity pressure $q_m$

Peak velocity pressure $q_b$
Calculation – Wind cover in shots 1 to 4

Due to the high wind load assumptions the stability is not given for
• superstructure in different sliding states and
• some free piers in intermediate construction conditions

Therefore must be arranged
• „cubes“ on the respective piers
• triangular wedges covered with sheet metal in the first 90 m of the cantilever end
Calculation – Distribution of bending moments during construction
Calculation – Maximum bending moments in the state of construction and final state
Calculation – Interaction of sliding rockers and superstructure

<table>
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<th>Spannung unter Gleichlast</th>
<th>Laststeigerungsfaktor (SF) neu</th>
<th>anzunehmende Bemessungsspannung in Prozent inkl. Sicherheitsfaktor</th>
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<td>Feld I</td>
<td>$t_{\text{Blech}} &lt; 40 \text{ mm}$</td>
<td>1,30</td>
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Calculation – Modelling of the transverse bracing and frames

Modeling Transverse bracing (QV)

Modeling Pier transverse system (PS)
Main Assumptions

• Calculation according to II. order theory with use of global imperfections H/500

• Load and boundary conditions according to global calculations of whole structure

• Submodelling used to detailed calculations of main parts of structure of pylon i.e. pylon head, pylon foot, joints, etc.

• Material: S235 (Pylon), S355 (pylon head, pylon foot, etc.)
Calculation – Modelling the Erection processes of the pylon

The Erection process carried out in two phases:
Phase 1 (angles 0-45°) – erection with use of additional pylon located at the foot of main pylon
Phase 2 (angles 45°-90°) – erection with use of tensioning station located at the bridge deck

Phase 1 (angles 0-45°)
Calculation – Modelling the Erection processes of the pylon

Phase 2 (angles 45°-90°)
Calculation – Results for the pylon

Main structure

Pylon head

Pylon joint

Pylon foot
Conclusions

Construction of Hochmosel bridge is associated with further developments concerning the erection technology and static construction solutions.

This includes:

- the patented sliding system BVS 2011
- the vertical manipulation of the auxiliary pylon for the variation of cable forces
- the shapes defined for the superstructure cantilever and pier heads as a result of wind tunnel investigations
- the concept of statical analysis for the global and functional subsystems
Sliding process
Sliding process
Thank you for your attention