Marbach valley bridge

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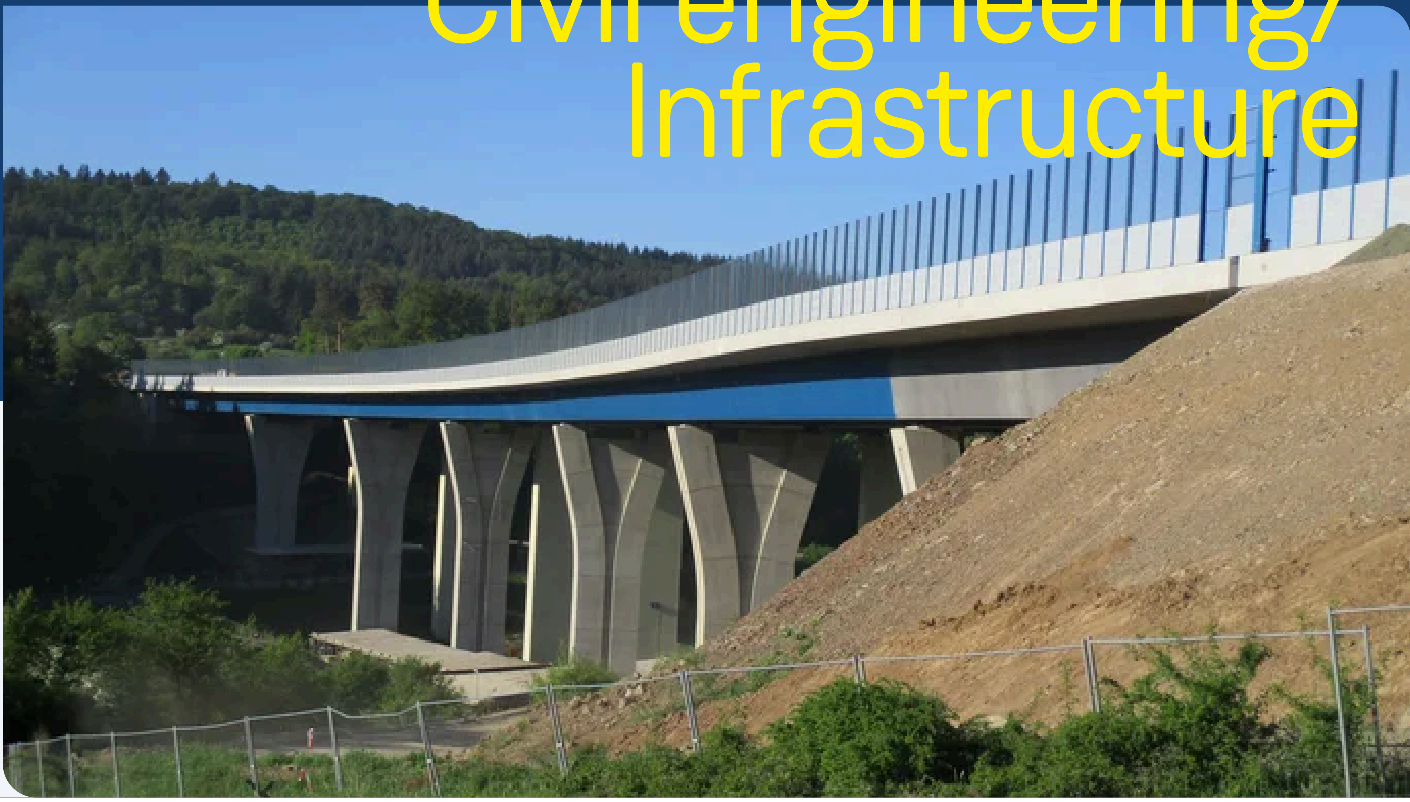
Civil engineering/ Infrastructure



Factbox

Client: Hessen Mobil Straßen- und Verkehrsmanagement

Contractor: PORR Deutschland GmbH

Project Type: Infrastructure, Bridge building

Scope: Demolition and new construction of the Marbach valley bridge, BAB A 45

Contract Volume: EUR 36.4 million

Construction Start: 09/2014

Construction End: 06/2020

Location: Dillenburg

At the edge of Dillenburg, PORR Deutschland GmbH is constructing a 388m long bridge over the valley which will completely replace the existing bridge.

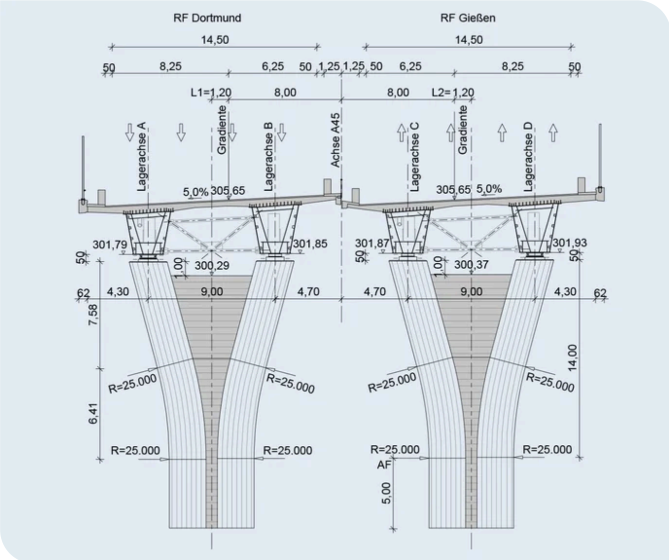
The bridge leads above the Marbach, passing country and service roads. Challenges are the dismantling of the existing structure, the geometry of the composite steel superstructure and the logistics of the construction site in a restricted construction area.

The A45 national motorway is an important north-south link, connecting the Greater Dortmund and Greater Frankfurt areas. Following the sharp increase in traffic volume over recent years, the entire four-lane section is being widened into six lanes. Calculations made back in 2008 on the two partial structures that make up the old bridge indicated that the structure – built in 1967 – was already exhibiting significant deficiencies in terms of load-bearing capacity and was no longer suited to the current traffic loads – and thus certainly not for future requirements. Due to the poor state of the structure, immediate measures were taken with an emergency overhaul of the Frankfurt-bound side in 2011. In 2014, PORR began demolition work and construction of the new bridge. Once all traffic had been transferred to the existing Frankfurt-bound partial structure, the Dortmound-bound bridge was demolished and replaced by the new partial structure. On completion of the new structure, traffic was transferred over to it, so that the old bridge could be demolished and the second new structure created. Once this is complete and a temporary carriageway alteration on the northern side of the bridge has been reverted, traffic can begin circulating using the planned lanes. The contract also includes manufacture of a rainwater retention basin, the corresponding drainage channels, noise barriers, the access roads and the A45 road construction.

A demanding and complex bridge construction on a confined construction site - we have the expertise and the experience.

Enrico Haußner
Senior Site Manager, PORR Deutschland GmbH

The project



The steel composite construction in cross-section. Image: PORR AG

The new construction of the viaduct is to be realised as a 7-span structure in two parallel substructures. On five of the eight axes of the substructures, the load transfer of the structure is carried out via large bored piles up to 16 metres long as deep foundations. On three axes, shallow foundations will be constructed directly on the rock using reinforced concrete foundations. Each superstructure rests on six piers and two abutments. The individual support spans of the steel composite cross-section are between 45.7 metres and 69 metres. The superstructure cross-section consists of two single-cell steel box girders in each direction of travel and a loosely reinforced carriageway slab.

Demolition of the existing buildings

The demolition work was carried out using an excavator. Image: PORR AG

For the dismantling of the existing structures, a detailed demolition concept was specified by the higher state authority Hessen Mobil, which, among other things, provided for the demolition of the superstructure in sections on a demolition scaffold. The individual demolition sections of 45 metres in length were decoupled from the remaining superstructure by means of a separating cut. In order to ensure the even load distribution of the respective superstructure section to be demolished into the demolition scaffolding, a complex hydraulic system with 48 adjusting ring presses and three hydraulic pumps had to be installed in the scaffolding below the demolition floor.

This had to be adjusted several times a day to the new demolition conditions. The demolition was carried out from the carriageway slab using an excavator. A lateral demolition formwork prevented demolition material from falling downwards. After dismantling each section, the demolition scaffolding was separated in the centre and positioned longitudinally in the next bay. This meant that the old prestressed concrete superstructure was demolished in the exact opposite direction to the new construction at the time.

Foundations and substructures

The new bridge piers, axis 50 and 60, are between 15.5 m and 35 m high and were concreted in individual sections of 5 m each. Image: PORR AG

The foundations of the new structure were laid in or on rock - partly as shallow foundations and partly as deep foundations using large bored piles with a diameter of 150 cm. Due to small-scale changes in the subsoil conditions, the solid rock was encountered at different levels, in different rock types and even with larger fissures and cavities. The construction of the pile foundation was correspondingly difficult. The new bridge piers have a full cross-section of around 14.5 m² with a height of around 15.5 m to 35 m including the pier head. They were concreted in individual sections, each 5 metres high. The heads of the piers widen significantly over the height of 14 metres and are almost twice as wide at the upper edge (around 11.5 metres) as at the pier shaft. The construction of the pier heads was correspondingly complex due to the widening. The abutments have a cubic volume of up to 600 m³ and a concreting height of up to 9.50 m in the first section up to the support bench.

Steel composite superstructure

The steel structure was assembled behind the abutments from individual components around 30 m long and weighing up to 100 tonnes, welded together and moved in individual sections. This took place in the approximately 90 m long and 5 m deep cycle cellars. The components were transported at night over a distance of 400 km from the factory to the construction site.

The adjacent box girders in the intermittent cellar were linked by cross bracing, which was arranged at 20 m intervals as planned. The assembly and shunting took place one after the other from both the south and the north. The resulting centre joint was subsequently aligned and connected directly in the final position. The geometry of the superstructure itself is very challenging, as it is inclined northwards by around 2.5% in the longitudinal direction of the bridge and consists of a curve with a radius of 700 m followed by a slight counter-curve, with the steel structure following a straight line in the second section. This means that the composite slab no longer runs parallel to the steel structure from the centre of the bridge, which resulted in a change in the cantilever arm lengths and posed a major challenge in the construction of the carriageway slab. The formwork construction of the cantilever arms on the formwork carriage had to be modified several times accordingly.

This was mainly because the carriageway slab was produced using the pilgrim step method and not only had to be moved forwards, but also back again and again. In this context, the confined space conditions to the neighbouring substructure required special solutions for the connection reinforcement of the bridge cap and a great deal of skill when moving the formwork carriage. The solution for moving the centre section of the formwork carriage was equally challenging. Due to the limited space between the upper edge of the cross bracing and the lower edge of the carriageway slab - the distance is only 60 to 80 cm - the scaffolding on the formwork had to be modified each time the carriage was moved. Despite this, three sections of the carriageway slab, each 29 metres long, were completed before the gap in the steel structure was closed at the beginning of June 2017.

Another special feature of the structure is that there is a change in gradient on the bridge, which means that the transverse gradient changes from 5% to the east to 3.7% to the west. The design solution for this was a change to the steel structure, which required the heights of the box girders to be adjusted. The initially high box girder on one side of the bridge becomes a lower box girder at the end of the bridge and the initially low box girder is higher at the end. The heights of the steel structure vary from around 2.90 metres to 3.60 metres.

Gallery




Completion of substructure 1

The remaining corrosion protection work, which had to be stopped in November 2017 due to the weather, has been carried out since April 2018. The next goal of the project was achieved with the construction of the bridge waterproofing and the completion of the structure with the safety equipment and the noise barrier. With the completion of the first

With the completion of the first section of the structure and the associated roadworks on the A45 motorway in May 2018, traffic was rerouted so that PORR can begin with the demolition and construction of the second section in July 2018. The demolition scaffolding for the second section of the structure is already in position and only needs to be completed.

Technical data

Brückenlänge	388,4 m
Aushub	80.000 m³
Verbauter Stahl	8.640 t
Projektlänge	1.450 m
Brückenfläche	14.160 m²
Konstruktionsstahl	4.600 t
Verbauter Beton	22.500 m³
Bewehrungsstahl	4.040 t
Großbohrpfähle 150 cm	950 m
Trägerbohlverbau	1.400 m²
Spritzbetonfläche	1.300 m²
Betonabbruch	12.400 m³

Conclusion

Despite the very challenging and complex design and the cramped construction site, PORR completed the first section of the structure in accordance with the contract. The disruptions caused to a large extent by changes and additional services were well compensated for by the continuous operation of the works since April 2017.

This was achieved thanks to the great commitment and expertise of everyone involved in the project. PORR will use the experience gained from the first section to realise the second part of the project quickly and professionally from July 2018.