Railway overpass Ernst-Reuter-Allee, Magdeburg
Little space, little time

Jenny Reiske

Project data

| Clients | DB Netz AG; Building department of the State Capital of Magdeburg - Civil Engineering Office; Magdeburger Verkehrsbetriebe GmbH & Co.KG; Abwassergesellschaft Magdeburg mbH; Städtische Werke Magdeburg GmbH & Co.KG |
| Contractor | PORR Deutschland GmbH |
| Project type | Tunnelling . Traffic route construction |
| Scope of performance | Construction of an entirely new railway overpass, including refurbishment of traffic facilities, construction of two tram stops, and installation and rerouting of supply and waste disposal lines. |
| Start of construction | January 2015 |
| End of construction | June 2020 |
| Country | Germany |

View of the Ernst-Reuter-Allee railway overpass construction site from a rotary tower crane.
Image: PORR AG

General information
Within the scope of the project titled “Railway overpass Ernst-Reuter-Allee”, PORR Deutschland GmbH are constructing a 340-metre-long road tunnel between Damaschkeplatz and Otto-v.-Guericke-Strasse, near Magdeburg central station. The construction project is one of the city’s largest traffic projects since the Reunification and is designed to optimise operations at the station itself and improve traffic flow in the surrounding area. No less than five clients commissioned PORR to design and plan the project. Planning the shell, reinforcements and provisional structures all fall within the work assigned to PORR. The tight scheduling, which is defined by previously determined track possession periods, presents one of the main challenges of this project.

Background
The total “Railway overpass Ernst-Reuter-Allee” project is divided into six specialist sub-lots, with five different clients. The main clients are DB Netz AG and the City of Magdeburg. PORR is renewing the railway overpasses, reinforcing the existing retaining walls and constructing stairways to the platforms for the Deutsche Bahn subsidiary. The tunnel and road construction works are the responsibility of the city. The other clients are Magdeburger Verkehrsbetriebe GmbH, on behalf of whom the tramlines and corresponding stops are being constructed, and the waste water and utilities companies Abwassergesellschaft Magdeburg and Stadtwerke Magdeburg, for the extensive installation and rerouting of supply and waste disposal lines.

Project structure
The project will distribute the various road users over a total of three levels. In the future, the lower level will house private motor vehicles, while trams, pedestrians and cyclists will share the middle level. The upper level will continue to be reserved exclusively for DB Netz AG rail traffic. On this level, PORR will replace the old and dilapidated steel structures with prefabricated components made of prestressed concrete, which will be placed on the newly constructed abutments and joined together to form a framework in their final state. All the visible surfaces will consist of Class SB2 exposed concrete. The two upper levels will also be linked to the central station via covered stairwells to allow travellers to change trains regardless of weather conditions.

The entire construction site area is characterised by historic retaining walls, some of which are to be preserved and which are made of quarry stone masonry with a brickwork facing shell, and their foundations, which must be strengthened and reinforced with extensive masonry injections. The tunnel itself must be watertight, as it is located under the groundwater line in its entirety. During the construction works, the tunnel is sealed with secant bored pile walls and cement-soil structures produced underneath the existing structures using jet grouting. In its final state, the seal will be achieved by waterproof concrete tanking.
Standard cross section of the railway overpass: the blue line shows that the future street level will be approximately 80 cm below the existing street level. Image: PORR AG

Standard cross section of the retaining wall area: this part of the construction site is characterised by historic retaining walls, some of which are to be preserved, and which are made of quarry stone masonry with a brickwork facing shell, and their foundations, which must be strengthened and reinforced with extensive masonry injections. Image: PORR AG

Deep foundations

As Magdeburg suffered extensive bombing by the Allied Forces during World War II, the salvaging of unexploded ordnance is particularly important. For this reason, ordnance detection surveys must be carried out not only in the open-air construction areas and the pile areas, but also in the regions below and behind the existing retaining walls and abutments. Once they have received ordnance safety clearance, the PORR subsidiary Stump Spezialtiefbau GmbH will begin with the specialist civil engineering works. Secant bored pile walls are created using the Kelly drilling method. With this method, a non-reinforced pile is constructed to serve as the primary pile. Once the primary pile has reached the minimum compressive strength of concrete, part of the pile is cut away. Stump then concretes a reinforced pile into this gap as a secondary pile. This results in a watertight construction pit wall, which seals the pit and provides buoyancy control. In this case, it will also become an essential part of the supporting structure of the final tunnel. The tunnel construction pit is sealed and braced in the lower regions by integrating it into the bedrock. This function is provided by the tunnel ceiling in the upper regions. Once the concrete structure has been completed, the tunnel walls themselves will be responsible for sealing the tunnel off from the groundwater.

As the tunnel project is located close to a built-up area, exhaustive and sensitive monitoring will be necessary to ascertain the extent of the vibrations caused by the building works. For this purpose, numerous sensors and a total of 17 measurement systems will record the vibration emissions that may arise during e.g. the construction of the large bored piles, shoring works and sealing works. One major aspect of the works consists of improving the foundations of the existing retaining walls and abutments to facilitate vertical excavation. In addition, the construction pit produced to form the tunnel ceiling must be sealed from the top edge of the site to the top edge of the bored pile level to prevent the influx of groundwater from the outside. To achieve this Stump Spezialtiefbau have used jet grouting to construct a lateral seal for the construction pit above the bored piles, and underpinned the existing structures. A cement suspension is injected into the soil through a drilled hole, using one or more jets, at a pressure of over 400 bar. By continually twisting and pulling the drill piping, the suspension is blended into the surrounding soil creating underground cement-like structures. Any surplus soil and suspension escapes unpressurized from the mouth of the drilled hole and is disposed of.

An overview of the possession periods

Observance of the three scheduled track possession periods is crucial to the successful completion of the project. The demolition of the old bridges, the construction of the abutments and tunnel ceilings, and the insertion of the superstructures must all take place within these strictly defined time periods. Problems arose when it already became clear during the planning phase that it would be necessary to increase the diameters of the bored piles from the original 90 cm to 120 cm and to decrease the spaces between the bored piles, due to static requirements. This created project delays
which also posed a risk to the three possession periods. In order to ensure these deadlines could be met, PORR worked with the clients to create and implement expedited construction procedures. This allowed them to observe both Possession Period I in 2016 and Possession Period II in 2017 as originally planned.

Except from a simplified overview plan with the possession periods highlighted.
Image: PORR AG

1st possession period 2016

In February 2016, the original 120-year-old steel superstructures were demolished to clear the space for constructing the new abutments and superstructures. In order to meet the deadlines for the first possession period, all the bored pile works were carried out daily, around the clock. In late June of 2016, the citizens of Magdeburg witnessed a second steel superstructure of a temporary bridge being hoisted out.

Besides the temporal constraints, spatial constraints also presented a particular challenge. Approximately 100 employees were at work during the first possession period - several different trades often working on the site at once, necessitating strict coordination and planning. This was a real balancing act and - thanks to good preparation and the perfectly coordinated cooperation between all those involved - it was a success.

In August 2016, the future tunnel ceilings were constructed below the railway bridges that were yet to be built; in September, the prefabricated prestressed concrete components were placed on the new abutments. After the remaining supplementary concreting works on the superstructures had been completed and the seal had been constructed, the project was handed over to the client on schedule in October 2016.

Several trades were often working at the same time and in the same place. For example, the bored piles were chiselled off while the earthworks, engineering works and dewatering works were carried out close by.
Image: PORR AG

Installing the prefabricated prestressed concrete components.
Image: PORR AG

Concreting the tunnel ceiling.
Image: PORR AG
2nd possession period 2017

During the second possession period, in addition to continuing the work of the first possession period, the construction site team constructed a stairwell for the platforms to tracks 7 and 8. These works were successfully completed between April and September 2017, which meant that this milestone could also be handed over to DB Netz AG on schedule.

Reinforced stairwell and the tunnel ceiling
Image: PORR AG

A stairwell to the platforms was also constructed during the second possession period.
Image: PORR AG

Reinforced stairwell and the tunnel ceiling
Image: PORR AG

Dimensions

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete used, excluding the bored piles</td>
<td>38,000 m³</td>
</tr>
<tr>
<td>Reinforcement, excluding the bored piles</td>
<td>6,000 metric tonnes</td>
</tr>
<tr>
<td>Concrete for bored piles</td>
<td>30,000 m³ (approx. 2,000 bored piles)</td>
</tr>
<tr>
<td>Bored pile reinforcement</td>
<td>3,000 metric tonnes</td>
</tr>
<tr>
<td>Jet grouted structures</td>
<td>6,000 m³</td>
</tr>
<tr>
<td>Construction pit excavation</td>
<td>120,000 m³</td>
</tr>
<tr>
<td>Track extension</td>
<td>approx. 2,000 m</td>
</tr>
</tbody>
</table>

Summary

Five different clients, strict deadlines and tight restrictions on space at the construction site meant that this project presented a real challenge for everyone involved. The high flexibility demonstrated by PORR, combined with the very cooperative clients ensured that up to now, and despite unexpected obstacles, the works have been completed successfully and on schedule.