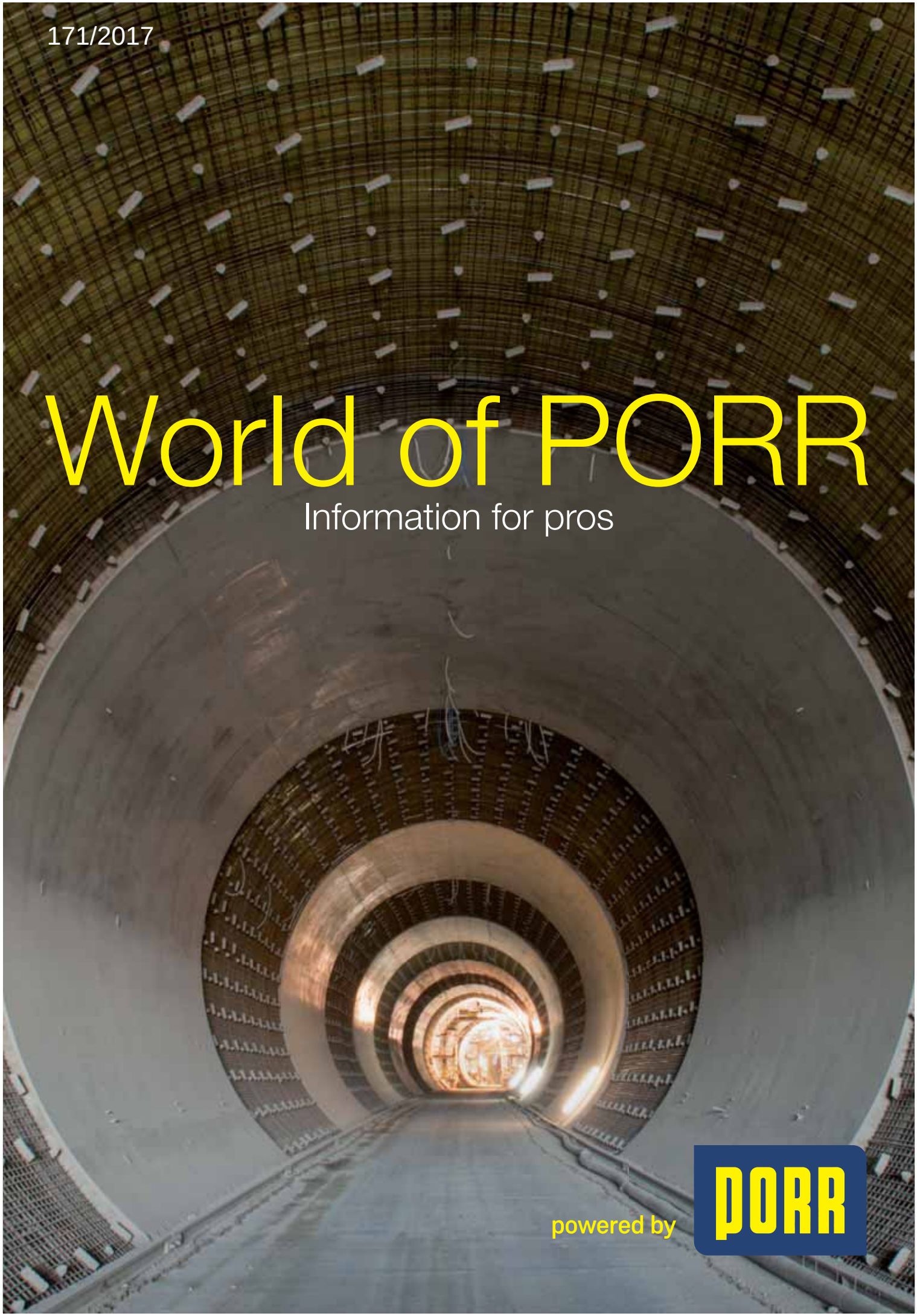
171/2017

# World of PORR

## Information for pros



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## Foreword



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# Karl-Heinz Strauss, CEO

Karl-Heinz Strauss, CEO
Image: PORR AG

**Dear ladies and gentlemen,**
**dear business partners,**

I would like to invite you on a journey through the world of PORR. In this edition, we will show you how our company is currently performing. Take a look behind our construction projects, and find out interesting information and fascinating facts from our experts.

After playing a major role in constructing Vienna's main railway station and the Belvedere Central quarter, PORR further enhanced the district with THE ICON VIENNA. Despite difficult conditions, the south-east tangent in Lower Austria was redeveloped in accordance with the required quality criteria. In Linz, PORR remediated contaminated sites at the coke plant. In Salzburg, the Puch senior citizens' home built by PORR seamlessly blends in with nature. The journey through the World of PORR continues to the Czech Republic, where PORR has completed the second stage in the construction of the Budweiser warehouse. Through the expansion of the Gurtnellen power plant in Switzerland, 7,000 households are now supplied with energy. "Verkehrsprojekt Deutsche Einheit Nr. 8", the largest rail project in Germany, uses PORR's patented slab track system, Slab Track Austria. When working on the Emscher sewage canal, PORR demonstrated its qualities in tunnelling and civil engineering in an extremely confined space. The next stop is Norway: at the Arctic Circle, PORR is undertaking a spectacular tunnel and road construction project on the western flank of Liafjellet Mountain.
In the updates section, you can read about the planned reconstruction of the St. Pölten University Hospital or the start of tunnelling in the west tube of the Boßlertunnel in Germany. Altogether, there are 28 exciting new projects – from residential to power plant construction to the placing of orders to groundbreaking and topping-out ceremonies.

We have also successfully and consistently continued the strategy of intelligent growth. With the acquisition of Oevermann GmbH, FRANKI Grundbau GmbH and Co. KG, H+E Haustechnik und Elektro GmbH, and the Hinteregger Group in 2017, we have expanded our position as a full service provider. The year 2018 will be marked by the integration of these companies. Successful development is already evident. Under the umbrella of PORR, the two subsidiaries FRANKI and Stump have implemented a pilot project to determine the load capacity of piles in special civil engineering. And in Stuttgart, the breakthrough of the Fildertunnel took place together with our colleagues from Hinteregger.

The intelligently growing world of PORR is thus enriched by numerous projects. This can be seen in the third quarter results. With an increase of 12.1% (over EUR 5.8 billion), the backlog of orders reached an all-time high. Incoming orders rose even more strongly – 28.2% above the previous year (over EUR 4.3 billion). Production output increased by 19.5% (to EUR 3.343 billion). For 2017, we expect earnings to be slightly below the previous year's level despite strong growth in production output. The reason for this is integration costs, which can be attributed to the rapid expansion of the market position in Germany and additional one-off logistics costs in Qatar. However, this year, we have further strengthened the basis for continued growth. PORR is thus optimally positioned for the coming years.

I wish you a pleasant journey through the World of PORR and all the best for the New Year.

Kind regards,
Karl-Heinz Strauss
CEO

# THE ICON VIENNA

## A new icon on the Viennese office market

Jürgen Feichtinger, Paul Möslinger, Roland Lehrner

### Project data

| | |
|---|---|
| Client | SIGNA |
| Contractor | PORR Bau GmbH, ALU-SOMMER GmbH |
| Project type | Specialist civil engineering . Temporary construction pit system, dewatering, foundation works<br>Building construction . Construction works<br>Façade . ALU glass façades |
| Gross floor area | 134,500 m² |
| Project scope | Construction of three office towers and a connecting mall |
| Start of construction | November 2015 |
| End of construction | Q2/2018 |
| Country | Austria |

### General information

A new business hotspot – THE ICON VIENNA – is currently being built right at Vienna Central Station. It has three office towers of different heights, creating an impressive view from afar. PORR Bau GmbH was contracted by SIGNA to provide the specialist civil engineering and construction services, while ALU-SOMMER was awarded the contract for the façades. The spatial constraints on the construction site and the complex architectural requirements meant that, in addition to a sophisticated concept for laying the foundations, new and innovative developments in designing the façade were also necessary.

THE ICON VIENNA at the new central station in Vienna.
Image: SIGNA

PORR used nearly 10,000 metric tonnes of steel in constructing 76,000 m³ of future office space.
Image: PORR AG

### Cut-and-cover construction pit solution for inner city construction projects

PORR was given the green light in November 2015, when the specialist civil engineering department was commissioned with the detailed planning and implementation of the temporary construction pit system and foundation works. The densely built-up surrounding area and the existing traffic infrastructure created the need for a sophisticated structural, technical and logistical concept. The solution was to construct a temporary construction pit system using diaphragm walls, with a total area of 8,700 m², a maximum excavation depth of up to 31 m and a thickness of 60 cm, not including the anchoring. The necessary bracing work was carried out at a depth of five floors underground, using the cut-and-cover method. This involves building "from the top down" – contrary to conventional construction methods. While the diaphragm wall was being constructed, foundation piles and auxiliary braces for mounting the future cover were produced, using one to three rotary drills. The total drilling length was 22,250 m, at a drilling depth of up to 37 m. All the diaphragm wall elements, most of the foundation and auxiliary piles, and the supporting area of the floor slab were also fitted with 75,000 heat absorber pipes for geothermic applications. The solution implemented for the construction pit represents an innovative, economical and sustainable solution that makes full use of the restricted space available in the inner city for this and future construction projects.

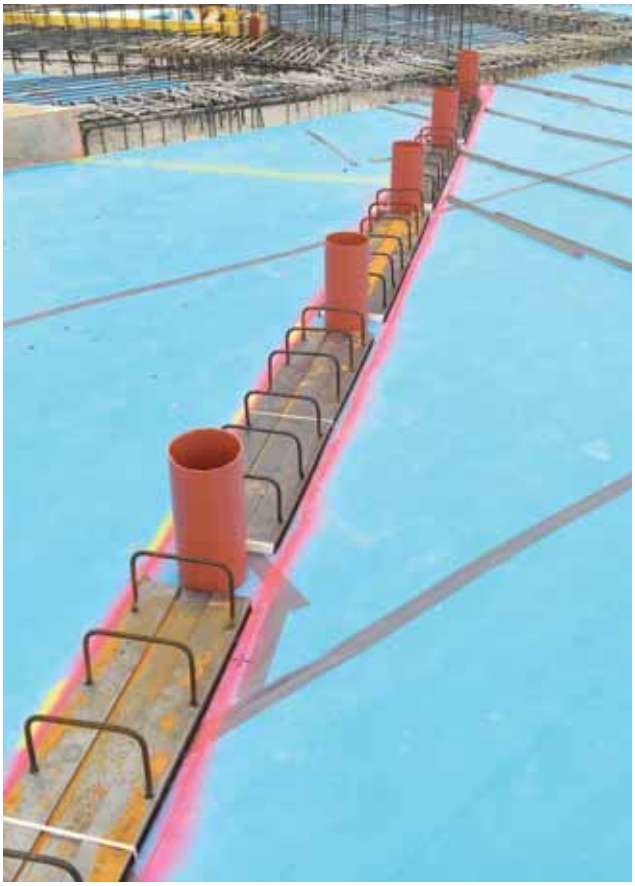

Up to three rotary drills were used to produce the foundation piles and auxiliary braces for mounting the future cover.
Image: PORR AG

### The building construction works

In January 2016, just two months after work on the foundations had begun, PORR . Building construction began work on the building construction. The contract comprises the structural works for a five-storey basement, a two-storey mall covering an area of around 8,000 m² and three office towers rising up out of the mall. The towers have a floor space of 2,000 m² per floor and a gross floor space of 134,000 m². They are 38.5 m to 88 m high, with 9, 17 and 24 storeys.

The basement was completed in late 2016. In line with the cut-and-cover method, the works began with the ceiling above the first basement floor. This consisted of a thick chequered mesh of girders built directly on top of the ground.

Producing the first cover, the ceiling above the first basement floor.
Image: PORR AG



Special feature of the cut-and-cover method: starter bars and filling holes for the subsequent construction of the walls below the first cover are taken into account.
Image: PORR AG

As the tower column grids do not correspond to the basement column grids, this solid ceiling level performs the function of absorbing the load via numerous girders, thereby redirecting them into the basement columns. In addition, in combination with the previously produced diaphragm walls and bored piles, the first cover can absorb the horizontal forces of the diaphragm walls, thereby acting as a brace for the construction pit. This guaranteed that construction operations could be carried out throughout the entire area below the first cover.

After this, the soil was excavated up to approximately 10 m below the first cover, where the second cover was then created. This cover was also secured to the bored piles and diaphragm walls to provide additional construction pit bracing. This meant that excavations could be carried out to a depth of up to 20 m, down to the foundation floor. Here, work began on constructing the foundations, followed by the "dismantling" of the basement.

First excavation below the second cover.
Image: PORR AG

The first and second covers with auxiliary piles.
Image: PORR AG

The construction of the remaining shell for the basement below the two existing covers presented the PORR specialists with a particular challenge: there were only three gaps in the covers – the future stairwells – for transporting machinery and materials into the floors below.

Building in confined spaces: the construction plot and the covers with the access openings.
Image: PORR AG

While the basement floors beneath the smallest tower had been dismantled by November 2016, dismantling the floors beneath the middle tower was not completed until March 2017.

March 2017: Progression of the construction works in Sections A and C, dismantling Section B.
Image: PORR AG

### One storey in less than two weeks

To create the towers, each tower was first divided into two concreting segments. The ceiling formwork was implemented using tableforms; the fitted bays were supplemented with conventional girder slab formwork. By working on both halves of the tower in overlapping shifts, the team were able to complete an entire storey in less than two weeks. Mobile concrete pumps were used up to a discharge head of approximately 50 m, and conventional crane buckets were used above this point.

Using a mobile pump to concrete the access opening for Tower A.
Image: PORR AG

To compensate for the resulting increase in the time required, the concreting sections were increased from two to six for each tower. Approximately 500 m² of bubbledeck were inserted into each ceiling to reduce its weight. The stairwell cores and the columns were constructed using panel formwork.
As a number of tubes had to be installed in the ceilings for the electrical system, sprinkler piping, and a cooling ceiling, the individual trades had to be constantly coordinated to ensure smooth operations.

Formwork for the mall ceiling; Tower A in the centre background, Tower B on the left, Tower C on the right.
Image: Michael Meixner

Efficient construction: while the upper storeys are being concreted, the distinctive exterior façade is already being installed below.
Image: Michael Meixner

### The aluminium and glass façade

A large part of THE ICON VIENNA's distinctive look is created by the aluminium and glass elements that cover the entire complex. SIGNA awarded the contract to the PORR subsidiary company ALU-SOMMER. New, complex designs were created for both the tower façades and the ceilings to strike a balance between the ideas of the client and the architect and the high demands placed by the structural and physical conditions. For example, the floor plan of the tower storey is shaped like an irregular trapezoid, whose corners are to be rounded off. The upper floors of all three towers rest on base constructions that are one to two storeys high and are set back from the upper floors at the adjoining public areas. This creates large covered areas which will be fitted with metal soffit panels. The mall, which links all the construction sections, will be fitted with expansive light roofs and portals.
Due to the project's high degree of complexity, ALU-SOMMER designed a number of samples during an intensive planning phase long before work on production began, all of which were successfully tested for noise protection and impermeability to heavy rain by independent test institutes.

Overview: on the right, the finished façade on Section C; in the middle, Section A with façade installed up to the 10th floor; and Section B on the left.
Image: ALU-SOMMER

The tower façades are double-skin element façades with safety glazing. The inner façade skin is heat insulated and fitted with triple insulation glazing. Casements have been set into the elements, which can be opened up to a maximum width of 11 cm by office users. The casements can be fully opened for cleaning and maintenance work. The intermediate façade cavity is 25 cm deep and is ventilated via ventilation slits placed at the side and top of each façade element. The cable-guided motorised Venetian blinds which provide protection from the sun are also placed here. The outer façade is fitted with buffer screens made of single glazing safety glass in varying strengths, depending on the respective wind load.

At the edges of the building, the outer skin is constructed using curved glass and curved façade profiles with different radiuses, in line with the architectural specifications.
The upper storeys of the tower are capped with a "paravent façade", which is placed on top of the two-skin façade at a height of up to 5.4 m as wind protection. It also consists of glazed façade elements, which are however not heat-insulated and which are held in place by a galvanised, powder-coated steel frame structure.

### High degree of prefabrication

Most of the façade elements are produced in the ALU-SOMMER factories Stoob and Sopron and delivered to the construction site. All the glass elements and sunshade systems for the tower façades are fitted in the factory. The largest elements measure 2.7 m x 5.4 m and weigh approximately 1,300 kg.

Section C façade with access opening.
Image: ALU-SOMMER

Once the elements have been delivered to the construction site, they are mounted onto previously installed anchor consoles – similar to the assembly of prefabricated components. A rotating tower crane is generally used to transport the elements to their installation points, in some cases while structural works are being carried out above. In those places where the elements cannot be mounted by crane due to the protruding ceiling forms, a rail system is set up around the entire building circumference as an alternative installation system. The façade elements are conveyed to their respective installation points by a motorised, radio-controlled lifting mechanism which transports them vertically and horizontally along this "monorail system". Thanks to this system, the installation can proceed without interruption and without having to use the construction cranes, which are already running at high capacity.

### Summary

Implementing a construction project under tight spatial constraints is always a logistical challenge and requires a high degree of organisational skill and a well-thought-out concept. THE ICON VIENNA demonstrates once again that PORR has successfully positioned itself as a full service provider. From the complex temporary pit construction system and foundation works to the architecturally challenging construction works and innovative façade construction – PORR Offers all of these services as a single provider: on schedule and to a high standard of quality. From the current perspective, there are no obstacles to completing the work as scheduled by July 2018.

Following major involvement in the construction of the Vienna Central Station and the Quartier Belvedere Central, THE ICON VIENNA constitutes another PORR project that makes a significant contribution to the development of the new urban quarter in Vienna's 10$^{th}$ district.

# Residential construction at Pfarrwiesengasse 23

## Luxurious living in an exclusive district of Vienna

Andreas Zeininger

### Project data

| | |
|---|---|
| Client | BUWOG Bauen und Wohnen GmbH |
| Contractors | PORR Bau GmbH |
| Project type | Building construction . Residential construction |
| Architect | Architekturbüro HNP – Heinz Neumann und Partner |
| Project scope | General contractor tasks for the construction of a total of 85 residential units |
| Gross floor area | 28,500 m² |
| Construction start | August 2015 |
| Construction end | April 2017 |
| Country | Austria |

Various forms of high-class modern living in Pfarrwiesengasse in Vienna's Döbling district.
Image: BUWOG Group/Stefan Huger

### General information

On the grounds of a former retirement home on Pfarrwiesengasse in Vienna Döbling, BUWOG and the architect's office HNP – Heinz Neumann und Partner have implemented the construction of 85 residential units. The objective of the project was to provide high-class modern living via design, functionality and facilities.
The construction project is located in the heart of Vienna's 19th district and is surrounded by the Vienna Woods and Grinzing, the city's most famous wine region, giving it a mixture of urban liveliness and rural charm. In July 2015, PORR Bau GmbH was awarded the contract for turnkey completion of the construction scheme.

### The project

BUWOG wanted its Pfarrwiesengasse project to benefit the widest possible range of people. Therefore, various different living arrangements were planned for in terms of size, location and amenities. In addition to the various residential options, the future residents could also choose between five different amenity categories, which differ mainly in terms of surfaces and furnishings. All apartments also have generous private open spaces. Those on the ground floor even have terraces and planted private gardens. For recreational activities, there are a variety of specialised areas for individual use, such as a spa fitness area, a pool, a home cinema, or a wine cellar.

### The result

The project was divided into a high-rise building with nine levels and a total of 78 residential units, ranging in size from 62 m² to 286 m². There are five "luxury town houses" with four floors and direct garage access, as well as two city villas with two storeys. A total of 75,000 m³ were converted to create a usable floor area of 10,200 m². The gross floor area amounts to 28,500 m².

### Construction works

On 20 August 2015, PORR started the excavation and temporary pit construction work. Two underground levels were constructed to house a total of 139 parking spaces. The temporary pit construction work was carried out using an inserted girder temporary support system, the execution of the two basement levels was performed with the requirement class "Completely dry" with additional injection options, rendering them entirely impermeable to water.

The underground car park will be developed via a 70 m ramp construction from Grinzinger-Allee, which will continue to serve for the development of the planned new district administration. The surfaces of the garage were smoothed and coated in accordance with ÖBV (Austrian Federal Insurance) guidelines under the supervision and monitoring of a certified testing centre.

For the outdoor overflow pool, deep foundations were established with ductile piles – to prevent any subsidence, no matter how small – in close collaboration with PORR's specialist civil engineering department.

PORR constructed the building's shell entirely in reinforced concrete.
Image: PORR AG

The complex building technology meant that it was necessary to consider and coordinate detailed planning for the following finishing services early on during the shell construction work. For example, the ventilation ducts and outlets of the heat-recovery ventilation system, as well as a large number of pipes for the subsequent KNX installation were already laid precisely in the shell construction due to the structural and acoustic requirements. The European Installation Bus (EIB), currently known as the KNX standard, describes how the sensors and actuators can be connected in an in-house installation. Due to the internal and external structure and the wealth of different building variants, PORR decided to construct the shell completely in reinforced concrete.

The completed shell.
Image: PORR AG

The entire sewage system was constructed as a separation system. Before discharge into the public sewers, a rainwater retention basin had to be built due to the large areas to be drained. Designed to cope with a 10-year rainfall event, the basin has a retention volume of 54,000 litres and an automatic throttle valve.

The entire building complex was built using low-energy construction methods – with energy efficiency class A+. The outer shell is a ventilated façade with processed large-format reflective panels and plastered cornice bands to represent the high quality standards in design and amenities. The individuality of the residential construction is emphasized by the exterior surfaces with WPC coatings and large-format panels, also with processed, diamond-brushed surfaces.

The client attached great importance to increased sound insulation – both indoors and within the outer shell. For example, a complex computer simulation ensured perfect positioning of the building technical elements located in the roof, such as the central ventilation units, as well as the necessary transparent sound insulation enclosures, in order to exclude any noise pollution on the top floor.

Due to the legal regulations governing the construction of high-rise buildings, significant parts of the window and door elements, as well as the glass and stainless steel railing constructions were implemented with tested fire protection elements and fire-resistant glazing. PORR also set up other safety-related equipment, such as a full protection fire alarm system, smoke extraction systems, pressurized ventilation systems for secured escape routes and fire-fighter lifts, as well as fire-fighting radio communications and wet fire extinguisher lines with hydrants.

The horizontal waterproofing and insulation were carried out based on the various requirements, including inverted roof, warm roof and duo roof implementations. Due to the limited altitudes and accessibility requirements, this was done in large part by using high-quality special insulation.

### Sophisticated building automation

At the core of every apartment is a KNX bus system that controls the individually relevant technical installations such as light, air conditioning, controlled ventilation or external sun protection. It is operated via a touch panel, which also functions as a video intercom and provides external information such as weather reports, property management information or bookings. There is also the option for remote access via smartphone or tablet.

The direct hot water supply, as well as the heat supply for underfloor heating and towel radiators is provided via decentralized internal stations, which are controlled on an apartment by apartment basis. The underfloor heating grid can be used in summer for additional cooling. This is enabled by diverting cold water (as cold as 16°C, depending on individual control) into the network from the chillers.

### Luxury communal areas

The luxurious character of the entire complex is apparent as soon as you enter the property. The air-conditioned two-storey foyer includes an open atrium with trees and a glass roof. The outside light makes the area seem even more spacious.

Residents are welcomed by a foyer with a light-flooded atrium and an in-house concierge service.
Image: BUWOG Group/Stefan Huger

Located at the entrance is a concierge service that provides owners with assistance in everyday matters. From the concierge desk, it is also possible to control the air conditioning in the communal and specialised areas. Next to the entrance, there is a goods receipt room with electronic transfer boxes that allow easy communication with all parcel and delivery service providers via the Internet, with no need for staff to be physically present.

All apartments have an in-house booking system for sole use of the specialised rooms. These include the spa & wellness area, the massage room with electronic massage table, the lounge & club room with fully-equipped kitchen, equipment and outdoor area, the entertainment room with professional Dolby Atmos system and the tasting room for wine tastings. This is connected to a wine cellar (maintained at a cool 12 degrees), containing a separate lockable wine storage area for each apartment.

One absolute highlight is the in-house wine cellar with tasting room.
Image: BUWOG Group/Stefan Huger

A fully-equipped fitness area, outdoor area and outdoor shower, a heated pool and a children's playground are also available for general use at all times.
Depending on usage, additional soundproofing and acoustic measures were needed for these specialised rooms, including soundproof ceilings and walls, acoustically-effective wall and ceiling coverings or sound-absorbing stage curtains.

**Summary**
With the Pfarrwiesengasse construction project, PORR has implemented a project that is extremely demanding in terms of its architectural and technical features and execution. Every day, PORR demonstrated the high level of flexibility that was essential for the high demands and ongoing adaptations required by this project. The construction project was completed on schedule on 14 April 2017.

In summer, people can enjoy a heated pool and relax and cool off in the surrounding open spaces.
Image: BUWOG Group/Stefan Huger

# Senior citizens' residence in Puch bei Hallein

## Nature as a model

Reinhold Kocher

### Project data

| | |
|---|---|
| Employer | Municipality of Puch bei Hallein - Mayor Helmut Klose |
| Contractor | PORR Bau GmbH |
| Project type | Building construction . Special structures |
| Architect | Stadtbaumeister Ing. Mag. Voglreiter GmbH |
| Anthroposophical concept | Christian Hitsch |
| Project scope | General contractor tasks for the construction of a three-storey senior citizens' residence |
| Construction start | September 2016 |
| Construction end | April 2018 |
| Country | Austria |

### General information

The municipality of Puch bei Hallein is building a senior citizens' residence with a total of 71 nursing beds distributed over 67 single and 2 double rooms. This building with a basement, ground floor and upper floor was built following anthroposophical principles – a type of architecture heavily modelled on forms found in nature. The project was preceded by a multistage competition, which was decided in favour of PORR Bau GmbH, not least thanks to the construction simulation created by PORR Design & Engineering using Building Information Modelling (BIM). In September 2016, PORR was commissioned with all general contractor facts including planning.


Ground floor plan
Image: PORR AG

Aerial view of the carcass work at the new senior citizen's residence south-west of downtown Puch.
Image: PORR AG

### The project

The new building is located directly next to the existing senior citizen's residence in the municipality of Puch and is divided into three floors. A hairdresser’s studio, a chapel and the administrative offices are located in the basement. Access to the building is through the ground floor, the rooms on the ground and upper floor are split into an east and west wing. The individual floors are accessed via three stairwells and three lift systems.

The outdoor facilities include 53 parking spaces, four barrier-free parking spaces and 22 covered parking spaces. There are also several e-charging stations for cars and bicycles. Supplies to the senior citizen's residence are delivered via a delivery ramp at the southern side.

Thanks to the gentle curves, the building harmonises perfectly with the surrounding landscape.
Image: PORR AG

### The architectural work

The senior citizen's residence was constructed fully in line with anthroposophical principles under the management of Christian Hitsch. His ideas run through the entire building like a golden thread and can be seen in the colours and shapes, all of which are modelled on nature. As such, the

building complex is gently curved and fits perfectly into the surrounding landscape.

At first glance, the façade design appears to take some getting used to, yet it too has been thought out down to the finest detail so as to place the central focus on human beings. The corridors in the building are very long due to the size of the senior citizen's residence, but are not perceived as such thanks to the special design. The view is obstructed by bends and the curves give an impression of shortened paths.

The colour concept imparts a character of its own to every single room. Strong colours in the interior provide older people with the feeling of having reached their destination. Different gradations and niches produce different shades of light.
The main roof has a three-dimensional curvature and sits on top of the building like a hat. The outdoor grounds are traversed by paths which surround the building in concentric circles.

South view of the senior citizen's residence based on Christian Hitsch's concept.
Image: PORR AG

### Short time required for carcass work

Excavation work began on the 20 September 2016. Due to the complex geometry of the building, PORR had already decided before starting the project to use a prefabricated construction system for all components in order to be able to keep to a short period of about seven months for the carcass work. The foundations for the entire building could be laid after the sand lenses were partially replaced with a conventional floor plate of 30 cm. During the planning phase, the floor level on the ground floor was laid about 1.80 m above the adjacent original lay of the land, thereby enabling the entire sewer system to be connected to the municipal sewer system without using pumping equipment. The ground-water level was reached at the bottom of three lift shaft pits.

The concrete double walls in the basement were also coated with a nine millimetre bitumen seal, because the highest measured ground-water level is about 1.20 m above the floor of the basement. The reinforced concrete floors are made from semi-finished parts throughout the entire building. In total, 4,800 m³ of concrete and 500 t of steel were used.
PORR had the load-bearing walls on the ground and upper floor prefabricated in a modular design using woodchip-concrete blocks. All corners were bonded together to fit exactly in the module work to save valuable time during assembly on-site.

Both prefabricated and semi-finished parts are used due to the short time scheduled for the carcass work and the complex geometry of the building.
Image: PORR AG

The curved three-dimensional roof surfaces that twist into each other posed a great challenge. Prefabricated nogging piece walls were used in the construction due to the high number of height differences at the gable ends. Achieving the elevation in the middle of the field required several framed structures at different heights. The roof elements were in turn then moved into place as prefabricated part elements. The planning of the complex roof form was achieved as with the entire project using BIM. Altogether, the different wood components installed amounted to nearly 7000. Without BIM this would not have been possible in such a short time. The soffit of the roof surface that projected by up to 8 m in places was suspended by means of 300 romenades. Each romenade has its own radius due to the nearly 70 building corners and the different projections.

Elevation of the roof truss with prefabricated wood nogging piece walls.
Image: PORR AG

### Summary

Despite the complex geometry specified by the anthroposophic design principles, PORR has created an unique senior citizens residence thanks to a high degree of know-how and a confident approach. Not least because of the comprehensive use of BIM and the high degree of prefabricated parts, there is nothing standing in the way of a ready-to-use on-schedule handover in spring 2018.

# General refurbishment Bundesschulzentrum in Weiz

## PORR builds with class

Markus Schlacher

### Project data

| | |
|---|---|
| Client | Bundesimmobiliengesellschaft m.b.H |
| Contractors | PORR Bau GmbH |
| Project type | Building construction . Revitalisation |
| Gross floor area | 36,000 m² |
| Project scope | Sole contractor commission for the general refurbishment of the Bundesschulzentrum (Federal School Centre) in Weiz |
| Construction start | June 2015 |
| Construction end | November 2017 |
| Country | Austria |

The general refurbishment of the Bundesschulzentrum in Weiz comprised interior and exterior work, including full renovation of the inner courtyard.
Image: PORR AG/Harry Schiffer

### General information

In May 2015, within the framework of an investment model, PORR Bau GmbH received the sole contractor commission for the general refurbishment of the Bundesschulzentrum in Weiz (BSSOG Weiz). This also includes various new and supplementary constructions, as well as a structural and technical improvement of the fire protection system. A five-stage construction phase concept (a joint development with the Ministry of Education as the client, the employer Bundesimmobiliengesellschaft m.b.H. (BIG) and the user) ensured that the work was carried out under the strictest safety conditions during ongoing school operations.

The implementation concept for the new Bundesschulzentrum in Weiz.
Image: Bundesimmobiliengesellschaft m.b.H.

### Background

The Bundesschulzentrum in Weiz is one of the largest federal school centres of its kind in Styria, accommodating three different vocational schools: a technical college, a commercial college, and a secondary college for economics. The building contains classrooms for around 2,100 pupils and 200 teachers and school staff, numerous computer, chemistry and physics rooms, a gymnasium, several teaching kitchens and a dining hall, as well as a storeroom and a large number of workshops and laboratories.

In addition to many typical school rooms such as computer rooms, physics labs and a gymnasium, the Weiz school centre also has workshops and laboratories.
Image: PORR AG/Harry Schiffer

### Project scope

In addition to extensive refurbishments, PORR also carried out various new and supplementary construction work, such as the construction of a paint shop, the addition of new storey to a stairwell, as well as the construction of a new, roofed rubbish collection area. Based on existing assessments, measures were taken to improve the building's structural and technical fire protection system. A gross floor area of 36,000 m² had to be renovated over a period of approximately 30 months.

### Project implementation

A fundamental requirement on the part of the client was that the general refurbishment had to be performed during

ongoing school operations. However, only those refurbishment measures that had no significant impact on day-to-day operations could be carried out during regular school hours. And even then, a clear separation between construction and school operations had to be ensured. The five-stage construction phase concept stipulated that three main phases of construction would take place during the summer holidays from 2015 to 2017, but also that strict safety-relevant requirements had to be complied with. It was possible to perform the refurbishment work during ongoing school operations with a specially-developed logistics concept to the complete satisfaction of all participants. The concept relied on a compact and specially-designed alternative area for containers, as well as on relocations of classes within the school.

### Comprehensive refurbishment work

During the project, PORR encountered a number of time-critical and technically and logistically challenging refurbishment tasks. Immediately after receiving the contract in May 2015, the refurbishment of large parts of the commercial college and the secondary college for economics began during the summer holidays. Existing sanitary units were demolished and rebuilt from scratch, classrooms and corridor areas were fitted with new drywall ceilings, floor coverings were partially demolished and newly laid. In addition, wall coatings were renewed, and existing door systems were repaired or replaced with new ones. Finally, all the electrical installations including lighting components had to be renovated.

The summer holidays in 2016 were followed, among other works, by the complete renovation of the gymnasium including the spectators' gallery, with a total area of 1,600 m². The floor and wall coverings were partially renewed. The suspended ceiling was completely demolished and replaced with a new acoustic ceiling, including LED lighting and ceiling heating.

During the 2016 summer holidays, PORR carried out the complete refurbishment of the gymnasium, among other works.
Image: PORR AG/Harry Schiffer

The same summer saw the complete demolition of two outdated teaching kitchens, the dining hall and the associated office and sanitary areas down to the foundations and outer walls, followed by their rebuilding according to current standards.

For the renovation of the 2,600 m² workshop and laboratory areas during the 2016 summer holidays, experts from the construction company first had to disassemble all the machines, such as the lathes and milling machines, load them onto trucks and transport them to external halls for temporary storage. When the refurbishment was completed, the machines were returned, reinstalled and put into operation.

The outdated teaching kitchens were also demolished and rebuilt according to the latest standards.
Image: PORR AG/Harry Schiffer

### Measures for ensuring the new fire protection concept

Another important aspect of the refurbishment was to improve the level of protection in the building. For this purpose, a fire protection and escape route concept adapted to the property was created and coordinated with the relevant authorities. Surveillance measures in the building as set out in the concept are now at "full protection" level. Many other fire safety measures were also implemented, including the construction of two additional escape staircases, the construction of further emergency exits in the area of the gymnasium and the addition of an escape staircase in the area of the commercial college and the secondary college for economics.

PORR built two additional escape staircases as part of the improvements to the fire protection levels.
Image: PORR AG/Harry Schiffer

### Thermal renovation of the buildings' outer shell

During the thermal renovation works, 3,200 m² aluminium windows including the associated shading, all exterior portals and exterior doors as well as the existing post and beam façades (850 m²), were renewed in the stairwell area. In addition, extensive new construction of the existing hot and cold roofs was necessary over an area of 9,500 m².

### Outdoor facilities and redesign of the inner courtyard

The refurbishment measures extended beyond the walls of the school centre building. PORR also had various outdoor activities to carry out, including the construction of defined roads with a 1,500 m² asphalt surface. The existing sewer system, measuring just under 2,000 m in length, was subjected to an extensive inventory including an associated leak test. Defective areas were either refurbished by means of an underground process, the so-called inliner system, or completely renovated in open construction.

The 400 m² inner courtyard was also completely redesigned by PORR. This involved various material manipulations for the demolition work, 180 metric tonnes of excavated earth and demolished concrete, as well as for the new construction, 250 metric tonnes of antifrost layers and 65 metric tonnes of precast concrete parts for benches, all of which were carried out exclusively with a specially-designed 120 tonne mobile crane.

### Summary

Thanks to long-term, forward-looking preparations, the entire construction process as well as the clear separation between the construction operations and school operations desired by both the client and the employer were exemplary and, above all, accident-free.
The partnership, solution-oriented cooperation, and excellent consensus reached between the client, the employer, the user and PORR during the construction period were particularly noteworthy.

# Remediation of contaminated site O76 “Linz Coke Plant”

## A five-year success story continues

Georg Steibl, Friedrich Budde

### Project data

| | |
|---|---|
| Client | voestalpine Stahl GmbH |
| Contractors | PORR Umwelttechnik GmbH, PORR Bau GmbH |
| Project type | Environmental clean-up . Remediation of contaminated site |
| Project scope | Funnel & gate system for preventing groundwater flow-off; partial clearance of the unsaturated soil zone in the highly contaminated areas, including ex-situ soil washing; subsurface air suction in the unsaturated soil zone; phased dewatering in the saturated soil zone |
| Construction start | July 2012 |
| Construction end | 2020 |
| Country | Austria |

Aerial photo of the site with the main areas of contamination highlighted in green.
Image: voestalpine

### General information

Since 2012, PORR Bau GmbH has been working with PORR Umwelttechnik GmbH on the comprehensive remediation of voestalpine Stahl GmbH’s contaminated coking plant site in Linz. A detailed variant study taking into account ecological and economic criteria concluded that a mix of four different measures is the best solution for securing and cleaning up the contaminated site.

### Background

The coke plant in Linz has been there since 1942. After extensive destruction during World War II, it resumed operations after the end of the war. The wartime destruction resulted in massive tar oil and aromatic hydrocarbons contamination, concentrated in multiple underground areas across the site. A significant amount of contaminant has entered the groundwater from these underground concentrations. As a result, the groundwater has developed a contaminant plume that is several hundred metres long.
From 2003 to 2008, detailed underground inspections were carried out. Based on the results of these inspections, the Austrian Federal Environment Agency performed a risk assessment for the suspected contaminated site. This resulted in certification of the 350,000 m² area as a priority 1 contaminated site.

### A mixed approach to the clean-up

On 15 October 2012, the official launch ceremony for remediation of the contaminated site was held in the main hall of Stahl GmbH, with a live link to the construction site, where a crawler crane with a PORR diaphragm wall grabber carried out the initial groundbreaking.

The highlight of the groundbreaking ceremony: the live transmission of the diaphragm wall grabber at the construction site.
Image: voestalpine

The remediation of the contaminated site is based on a

comprehensive assessment of the alternative approaches, taking into account ecological and economic criteria. The assessment settled on a mixed approach using a funnel & gate system to prevent groundwater flow-off, a partial clearance of the unsaturated soil zone in highly contaminated areas, subsurface air suction in the unsaturated soil zone and phased dewatering in the saturated soil zone.
For PORR, this remediation of a contaminated site is another excellent reference as a full service provider. The wide range of different methods used are covered easily by the different PORR departments. PORR Bau GmbH, represented by the civil engineering subsidiary in upper Austria and the specialist civil engineering department will implement the wide range of construction measures during the remediation work. PORR Umwelttechnik GmbH (environmental engineering) is responsible for remediation of contaminated sites, material processing and waste disposal activities. This means that PORR is responsible for almost every activity in this wide-ranging remediation project.

### Funnel & gate system – partial enclosure and reactive filter elements

The first measure carried out in 2012 and 2013 was to construct a 1,500 m-long cut-off wall as a two-phase diaphragm wall. This cut-off wall prevents the unsecured and uncontrolled flow-off of groundwater from the contaminated site. 41 filter elements are integrated at 12 points in this diaphragm wall. These filter elements are the only way the groundwater can leave the contaminated site. They contain around 2,000 m³ of activated carbon which absorbs contaminants from the groundwater as it flows through them. Depending on the level of contamination in the groundwater flowing through the filters, they will need to be changed every one to ten years. This measure ensures that, in future, no contaminated water will leave the contaminated site.

Funnel & gate system: red indicates the flow of the groundwater, blue indicates the diaphragm wall with the filter elements.
Image: voestalpine

The filter elements are prefabricated reinforced concrete parts with a heavy-duty grate, through which the groundwater flows. The approximately 350 prefabricated parts were produced at the contaminated site in a purpose-built PORR field factory.

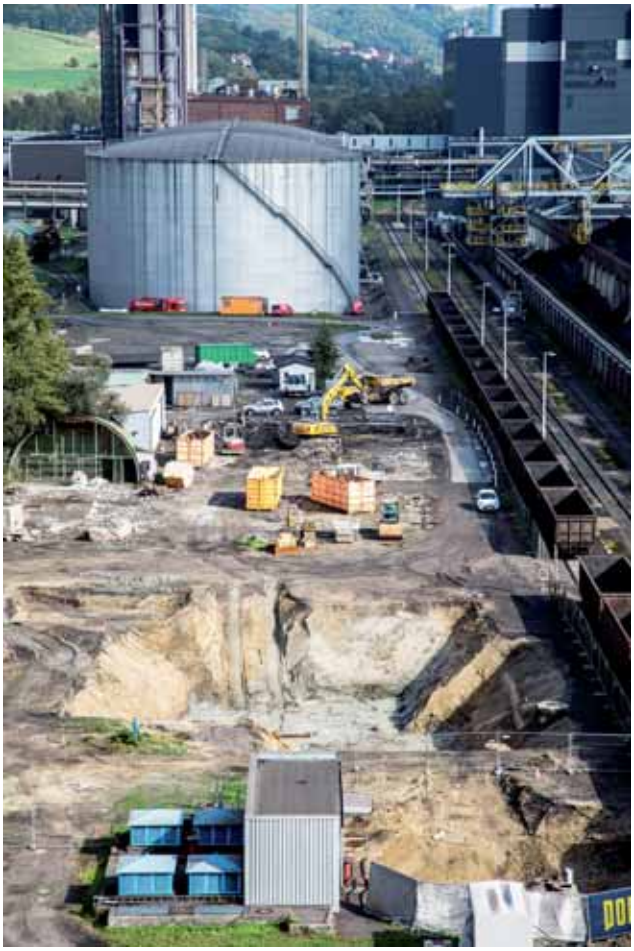
Field factory for production of prefabricated reinforced concrete parts.
Image: voestalpine

The prefabricated parts were lowered into the construction pit with fivefold chording, secured with sheet-pile walls and installed on the groundwater cut-off wall.

Construction pit with the installed reinforced concrete prefabricated parts from the field factory.
Image: voestalpine

### Ex-situ soil washing

During ex-situ soil washing, the most contaminated soil material in the unsaturated soil zone is excavated and washed in the wet soil separation plant before being used extensively to refill the excavations. Only those fractions that cannot be handled by the plant and the contaminant residues from the treatment are treated/disposed of externally.
Hotspot clean-up of area 6a is currently starting. In 2017 and 2018, around 170,000 t will be excavated over an area of 46,500 m².



Excavation of the hotspot areas in the area 6a.
Image: voestalpine

### Subsurface air suction

In some areas of the contaminated site, underground contamination is so high that hotspot clean-up would only be possible with breathing protection and special equipment. To avoid this from an employee safety and cost reduction perspective, the subsurface air is vacuumed up, cleaned and burned, along with the contaminants. This is done using suction level and suction lines that lead to a central subsurface air cleaning plant. When this measure is complete, these areas will also be excavated and treated in the wet soil separation plant.

### Phased dewatering

The contamination is not just in the unsaturated soil zone, but has also diffused into the groundwater. Therefore, different wells and special pumps are used to remove contaminated groundwater and cleaned in a central cleaning system until it can be diverted into the sewage network.

### Summary

The main measures undertaken during the remediation of the contamination should be completed by 2020.
Operation of the safety facilities such as the funnel & gate system will continue for several decades, however.
As a full service provider, PORR considers the extremely varied, demanding and uniquely complex solutions to this remediation project as the perfect opportunity to present its wide range of services.

Wet soil separation plant with storage for highly contaminated fractions.
Image: voestalpine

# Construction of new bridge in Mutters

## Railway bridge over the Mühlbachgraben

Daniel Sebö

### Project data

| | |
|---|---|
| Client | Innsbrucker Verkehrsbetriebe und Stubaitalbahn GmbH |
| Contractors | PORR Bau GmbH |
| Project type | Infrastructure . Bridge construction |
| Project scope | Construction of the new steel composite bridge including renewal of the entire track superstructure and track substructure in the construction project |
| Construction start | September 2016 |
| Construction end | November 2017 |
| Country | Austria |

Visualisation of the new bridge across the Mühlbachgraben in Tyrol.
Image: IVB Innsbruck

Aerial photo of the bridge construction shortly before completion in the middle of the image. Behind it is the old bridge, which will still be used by pedestrians and cyclists.
Image: PORR AG

### General information

In the autumn of 2016, following a public tender by the Innsbrucker Verkehrsbetriebe und Stubaitalbahn GmbH, PORR Bau GmbH was awarded the contract as general contractor for the construction of the new Mutters bridge over the Mühlbachgraben. Narrow access roads and very little space were among the biggest challenges of the project. The location of the construction site in a stream bed did not make matters easier for the PORR specialists.

### Background

The Stubaitalbahn railway was opened in 1904 and leads from Innsbruck to Fulpmes. The single-track branch line with a gauge of 1,000 mm has a total length of 18 km and runs along a gravel bed with wooden sleepers. The maximum longitudinal inclination of the track is 55 ‰, the smallest arc radius is 35 m.
The client decided on the construction of a new Mühlbachgraben bridge in Mutters, because refurbishment of the area in the immediate vicinity of the 100-year-old listed bridge and the pending refurbishment of the Mutter tunnel immediately adjacent to the bridge would have been just as expensive but less efficient.
The new bridge is approximately 153 m long and 43 m high and passes across the Mühlbachgraben in front of the Mutters Tunnel with a slight left turn. The old bridge will be preserved and used in future as a pedestrian and bicycle bridge.

### The project

The new construction also changes the course of the Stubaitalbahn railway. The new route is straightened and shortened, it deviates from the existing route at the 7,927 km route mark and returns to the existing track route at the 8,151 km route mark. Subsequently, the track will be adapted over a length of about 261 m. The narrow existing radii of the left and the right arc in the track section will both be widened, resulting in a slight deviation from the existing track. The height progression of the new railway track is designed with a constant gradient of 50.03 ‰. This necessitated cutting through existing terrain for the Fulpmes-side abutment. The new track in this area passes over a reinforced concrete tub construction, which merges with a supporting construction to the right and left of the track.

### Foundation work and substructure

For the deep foundation of the bridge piers, an incision had to be made into the steep terrain and secured with jetcrete and IBO anchors. Due to the spatial circumstances, the erected jetcrete shell was up to 10.0 m high.

Bored pile foundation, pier 2
Image: PORR AG

The foundations of the bridge structure were formed using 36 large bored piles with a diameter of 1.2 m and a length of 25.0 m, which were anchored up to 2.0 m deep into the rock. The bored piles were incorporated into two pile caps with a total cubage of 681 m³. The larger of the two pier foundations is 14.0 m long, 11.0 m wide, and 2.45 m high. The 31 m piers are a special feature of the steel composite bridge. Their elliptical shape made the production of the formwork a special challenge. In order to produce the formwork with the tie hole layout in accordance with the tendering conditions, PORR, in cooperation with Doka, developed a special formwork solution with matrix formwork in exposed concrete grade SB3.

Each pier was built in six concrete sections at a height of 5.40 m. Only the last pier section is 2.70 m high. In this section, the insert for the rigid connection was installed in the steel superstructure. Due to the height of the piers, a 250 metric tonne crane was deployed to move the 11 metric tonne insert. Due to the forces of the bridge acting on the insert, the reinforcement content was greatest in the last section, at about 260 kg/m³. For this reason, in the connection area of the insert, the reinforcement was guided in two rows with a double layer of reinforcing steel with a diameter of 26 mm. As a result, placing the steel insert with 1,200 shear studs was a big challenge for the fitters.

### Abutment

For the foundation of the bridge's bearing bank, GEWI anchors with a diameter of 63 mm were used for the deep foundations. The topographically difficult terrain placed severe limits on accessibility, so provisional earth deposits had to be made on the existing steep forest floor. This was the only way that the required construction equipment could be delivered and access the site for production of the Innsbruck abutment.

### Construction – steel bridge construction – composite panel

The 152.6 m steel superstructure is a three-layer composite construction in the shape of a torsionally rigid hollow box and consists of twelve individual pile sections and two end cross girders. These were manufactured in Carinthia and delivered to the construction site via special transports. The unique features of the bridge superstructure are the longitudinal gradient of 5 % and the radius of 88.0 m. The spans are 41.10 m, 48.50 m and 63.05 m. The superstructure also has a super-elevation of 150 mm at the centre of the main field.

The steel pile sections were assembled using a 750 metric tonne crawler crane, which was transported to the construction site in pieces in a total of 52 lorry journeys. This 100 m high Liebherr LR 1750 lattice boom crane has a maximum lifting capacity of 600 metric tonnes and was an imposing presence on the site. To create a sufficiently large footprint for the crawler crane, the Mühlgrabenbach was provisionally filled in here too.

Beneath the bridge, three steel piles were always pre-assembled, combined and then moved by the crawler crane. The entire superstructure was then lifted up to 35 m in five hoists. The lifting weight varied from 77 metric tonnes with a payload length of 73.5 m to 183 metric tonnes with a payload length of 40.0 m.

Hoist no. 3 with steel construction piles 3, 4 and 5 at 182.6 metric tonnes.
Image: PORR AG

Hoist no. 3 with steel construction piles 3, 4 and 5 at 182.6 metric tonnes.
Image: PORR AG

Hoist no. 4 with steel construction pile 6 and 7 at 63 metric tonnes. The steel piles were assembled using a 100 m high lattice boom crane.
Image: PORR AG

Steel superstructure before production of the composite panel.
Image: PORR AG

Only 10 % of the individual lifting loads were diverted to the connecting structures (piles and abutments). The superstructure was only welded after it had been assembled with down-to-the-millimetre accuracy. The steel construction work was completed with the welding of the construction site joints of the steel box, especially the technically-demanding gap closure between the two piers.

It was possible to start the formwork and reinforcement work while the last steel segments of the superstructure were being combined. The formwork system "ParaTopsystem" from Doka was used for this task. The 7.0 m-wide composite in-situ concrete slab was produced in five concrete sections with a total cubage of 374 m³.

Production of the composite panel of the bridge superstructure.
Image: PORR AG

Hoist no. 4 with steel construction piles 6 and 7 at 63 metric tonnes.
Image: PORR AG


Production of the composite panel of the bridge superstructure.
Image: PORR AG

## A window of eight weeks

All work on the open track and the completion / finishing work on the bridge superstructure and the trough structure connecting to the Fulpmes-side abutment had to be carried out over the course of an eight-week track possession period. In addition, a retaining wall was erected with a length of 67.50 m and a mean height of 3.50 m in exposed concrete grade SB2 with formwork matrices in a natural stone look and the entire substructure and the track itself were renewed in the construction project. The track construction work was carried out within the group by the Bahnbau/Gleisbau (railway construction/track construction) department.

## Summary

This project enabled PORR to demonstrate its impressive experience and competence in infrastructure and bridge construction. The biggest challenges in the construction of the new bridge were the confined space, the topographical location of the construction site in a stream gulley and the difficult access. Nevertheless, all the work was carried out successfully due to excellent cooperation between all project participants and completed on time in autumn 2017.

Construction progress of bridge and trough in September 2017.
Image: PORR AG

Aerial image of bridge and trough in September 2017.
Image: PORR AG

## Facts and figures

| | |
|---|---|
| Project length | 575.6 m |
| Bridge surface | 1,100 m² |
| Bridge length | 153 m |
| Steel construction | 510 metric tonnes |
| Concrete cubage | 4,106 m³ |
| Reinforced concrete | 515 metric tonnes |
| Large bored piles dm | 120 cm 925 m |
| Jetcrete surface | 1,011 m² |
| IBO anchors | 4,505 m |
| Micro-piles | 1,160 m |
| Earth excavated/moved | 8,750 m³ |

# Renovation of the Südosttangente

## Collaborative work on the A 23 Stadlau / Hirschstetten

Adolf Aichinger, Thomas Jantschitsch

### Project data

| | |
|---|---|
| Client | ASFINAG Baumanagement GmbH |
| Contractor | Consortium A 23 Tunnelsanierung with PORR Bau GmbH playing a leading role |
| Project type | Civil engineering . Concrete and civil engineering |
| Project scope | Repair works of the Stadlau and Hirschstetten tunnel structures and service areas as well as broadening measures at the Hirschstetten junction |
| Construction start | February 2016 |
| Construction end | August 2017 |
| Country | Austria |

### General information

In the summer of 2015, the general contractor "ARGE A 23 Tunnelsanierung" was awarded the contract for the "renovation of the Stadlau / Hirschstetten tunnel + Hirschstetten junction" consortium project. The technical management was undertaken by PORR. Construction work in tightly confined spaces and ongoing traffic were a major challenge for the consortium members. In addition, there was an unusually high number of service deviations. The pronounced willingness to cooperate among all participants made it possible, despite all the difficulties, to successfully implement the complex construction project.

### Background and construction phases

The Südosttangente is nearly 18 km long and although it is the shortest motorway in Austria, it's also the busiest road in the country, with an average of 170,000 vehicles per day. In order to influence the daily traffic as little as possible, two lanes had to be usable throughout the day during the entire construction period.

The construction project was implemented in two construction phases. In 2016, the consortium began with the renovation of the lane in the direction of Kaisermühlen, in 2017 the consortium switched lanes and took care of the opposite lane in the direction of Gänserndorf. The works began with the repair of the dividing wall, followed by the exterior wall and road restoration. The contractually stipulated deadlines for the renovation phases had been coordinated with the transport authority and had to be complied with due to the very strained traffic situation and the enormous public interest.

### First-time use

The structures to be renovated were built in 1993 and had to undergo a general renovation due to the extraordinarily high volume of traffic. The site-specific conditions posed a particular challenge. These included, above all, the continuous 24-hour operations from Monday through Friday, which was extended to Monday through Sunday during the execution period, the limited scheduling possibilities and the low number of entry and exit points. In addition, the work had to be carried out during ongoing traffic, there was also an unusually high number of service deviations due to the – in some cases – severe damage to the existing structures and the spatial conditions were highly constrained.

Generally during the day shift, a maximum workplace width of 1.7 m was available, which could be extended to around 4.6 m at night. Because the daily transfer of the 3 km long concrete safety barrier would not have been economically viable with conventional measures, the consortium opted for the so-called QuickChange Moveable Barrier System, or QMB System which was used for the first time in Central Europe. This specially designed "Road Zipper" places itself in the flow of traffic and rearranges the concrete elements in such a way as to allow an additional lane to be opened or closed again, without obstructing traffic flow. The transfer of the concrete elements on the 3 km stretch took only 30 minutes with the QMB.


The "Road Zipper" picks up the concrete barrier segments at the front, shifts them on the inside and "spits" them – transposed – back out the rear end.
Image: ARGE A23

### Creativity in the daily construction routine

The use of frost thawing agents had contaminated the tunnel structures with chlorides during their 23-year existence. Due to the severe damage to the reinforcements caused by pitting corrosion, the heavily contaminated concrete cover was removed and replaced by a new one. With a concrete cutter, this removal could be controlled down to the centimetre. In addition, it was necessary to remove material in the spray zone behind the reinforcement layer. This was done using a high-pressure

water jet robot with a pressure of up to 3,000 bar, which not only separated the concrete layers, but also removed the existing rust from the reinforcements.

The high-pressure water jet separated the concrete layers and removed the rust from the reinforcements.
Image: ARGE A23

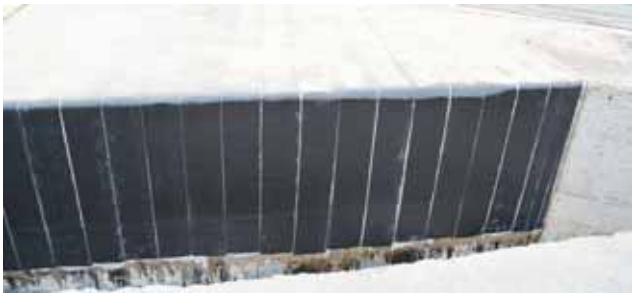
New solutions and ideas were also required for the formwork due to the limited space available and the tight schedule. Therefore, a system was developed in which the formwork was suspended from the ceiling and guided longitudinally by means of a rolling system. This involved a single-sided formwork system that was retrofitted using a rock anchor system specially developed by the project team in conjunction with a conical anchor.

In the adjacent facing formwork, the consortium opted for fibre-reinforced white concrete in order to achieve both the prescribed fire resistance and the required brightness without additional coating measures. Several test areas were prepared in advance, in which the compatibility of the formwork release agents with the white concrete and the hydrophobisation layer was tested. A suitable supplier was then selected. The hydrophobisation layer gives the concrete a water-repellent effect and thus significantly reduces the rate of corrosion of the reinforcements by chlorides and carbonation.

The requirement of a "bright surface" for best possible visibility without additional light and energy costs applied to the tunnel walls and ceilings as well as the asphalt surface. For this, bright aggregates (quartzite) and shot blasting were used. The high fire safety requirements (SN3) required cladding the tunnel ceilings over a total area of 27,000 m² with 35 mm thick fire-protection panels.

Completion of the tunnel from Hirschstetten in the direction of Kaisermühlen.
Image: ARGE A23

As part of the widening of the Hirschstetten junction, the existing bridges were strengthened by applying four-ply carbon fibre reinforced plastic panels, so-called CFK sheets, on both sides of the support area. Finally, a cyclist underpass was constructed under the A 23.



Carbon fibre reinforced plastic panels strengthen the existing bridges.
Image: ARGE A23

### Close cooperation

Despite carrying out proper preliminary investigations, the consortium found unexpected damage to the existing structure at the very beginning of the construction work. This necessitated additional services and resulted in a significant disruption of the entire construction process. The consortium therefore took all possible measures to comply with the contractually agreed deadlines. Due to the numerous deviations in services and their time-critical effects on the construction process and to the tight deadline, the client and the contractor unanimously decided to document all deviations in services together as soon as they arose. The initial scepticism towards this unorthodox approach quickly faded as it proved to significantly reduce the potential for discussion and conflict in regard to the disruption of services.

Both the asphalt surface and the tunnel walls and ceilings are much brighter after completion of the renovation work.
Image: Stefan Riedler, Tecton-Consult Baumanagement

### Principal dimensions of the construction project

#### Tunnel and outdoor areas

| | |
|---|---|
| Asphalt surface | 75.000 m² |
| Milled material | 10.000 m³ |
| Concrete removal with special milling machine | 30.000 m² |
| Concrete demolition | 3.000 m³ |
| Fire protection panels (ceiling) | 27.000 m² |
| Noise protection panels | 9.000 m² |
| Single-sided wall formwork | 30.000 m² |
| Inner shell concrete | 4.500 m³ |
| Concrete barriers | 16 km |
| Overhead signs | 13 Pcs |

#### Bridge area Ast-Hirschstetten

| | |
|---|---|
| CFK sheets 4-ply | 2.500 m² |
| Wall formwork | 8.000 m² |
| Reinforcements | 550 to |
| Concrete | 7.000 m³ |
| Pylons | 6 Pcs |

### Summary

The construction project – with its challenging constraints, extremely high media attention and numerous service deviations – was successfully implemented thanks to the continuously sustained motivation of the on-site staff. All quality criteria and deadlines required by the client were met. The joint cooperation between the contracting parties was particularly noteworthy. A big thank you goes to the workforce, who worked hard day and night.

# Expansion of Gurtnellen power plant

## Power for over 7,000 households

Edwin Gisler, Michaela Gisler

### Project data

| | |
|---|---|
| Client | KW Gurtnellen AG, c/o Elektrizitätswerk Altdorf AG |
| Contractors | PORR SUISSE AG |
| Project type | Civil engineering . Infrastructure, Civil engineering and hydraulic engineering |
| Project scope | Dismantling of old pressure pipeline, excavation and laying of new pressure lines, as well as refurbishment and expansion of the water catchment and the power plant control centre |
| Construction start | October 2015 |
| Construction end | October 2017 |
| Country | Switzerland |

Spectacular excavation work in steep terrain.
Image: PORR AG

### General information

Electricity has been produced in Gurtnellen in Switzerland since 1900. The power plant now needed to be renovated and expanded. PORR SUISSE AG was responsible for construction of the new pressure lines and the renovation and expansion of the water catchment and the power plant control centre. The topography of the area was the greatest challenge.

### Background

In 1899, Granitwerke Gurtnellen AG first received the concession to exploit the hydro-electric power of the Gornernbach in Gurtnellen in the Swiss canton of Uri. The power plant was commissioned in 1900. Over the years, the plant was renovated several times and new machinery was added. With the installation of a second machine group in 1942, output was increased to six megawatts. After 116 years of operation, the power plant has now been shut down for further expansion.

Working on a steep slope.
Image: PORR AG

### Topographical characteristics and a historic building

The expansion of the power plant soon proved to be a technical and logistical challenge. The difference in altitude between the power plant in Gurtnellen-Wiler and the Grueben water catchment in the Gorneralp mountains is almost 600 m. The power plant's pressure line, embedded behind a dry-stone wall and built in the 19th century, runs along a very steep and narrow historic footpath. PORR removed the existing pressure line and, after the introduction of the new pressure pipe by a subcontractor, backfilled the trench and restored the surface.

The power plant control centre, which was renovated and expanded during the project, was constructed using local natural granite masonry. The client attached particular importance to the preservation of the existing building fabric and care for the environment. For example, the "Ästige Mondraute", an extremely rare plant that has currently only been found in six locations in Switzerland, had to be carefully removed from the old pressure pipe and relocated to the new pressure pipe.

### Complex logistics

To transport building materials at over 1,300 m above sea level, PORR built a material cableway with a payload of up to 5 metric tonnes. Using a mobile rock crushing plant, the rock material excavated on the mountain was prepared directly for the line bedding. Concrete gravel and cement were transported to the construction site via the cableway and processed into concrete on-site. The aim was to avoid removing rock material from the mountain and to move as little material as possible onto the mountain.

The material cableway from Gurtnellen has a payload of 5 metric tonnes.
Image: PORR AG

The 1,748 m pressure line between the Grueben water catchment and the power plant control centre in Gurtnellen was constructed by PORR in several stages, with the exception of the laying of the pipes. In the control centre itself, the power plant equipment had to be dismantled before work could start on the excavations to a depth of 6 m, and the concrete works for the new power plant turbines.

Concrete works for the expansion of power plant control centres.
Image: PORR AG

## Structural details

### Main cubic volumes

| | |
|---|---|
| Excavation of loose material | 2,800 m³ |
| Rock excavation | 3,500 m³ |
| Dismantled pipeline | 1,400 m |
| Dismantled fixed points | 550 m³ |
| New pipeline | 1,710 m |
| Concrete gravel | 1,800 m³ |
| Filling | 4,850 m³ |
| Concrete | 1,900 m³ |

### Completion and commissioning

Despite the adverse weather conditions at the beginning of 2017, all work was completed on schedule. The Gurtnellen power plant went online in August 2017 for the first time. It will produce 31.5 million kilowatt hours of electricity at full capacity and supply energy to around 7,000 households. Ongoing recultivation work is taking place in the area of the water catchment, pressure line and power plant control centre. The material cableway will be dismantled after all systems have been successfully commissioned.

### Summary

The client described PORR’s employees as "consummate professionals" not only because of the demanding alpine surroundings. The logistical challenge and the careful treatment of the natural environment required special solutions that made this project unique. Full operations will commence at the end of this year.

Water catchment today, view from the rear.
Image: PORR AG

# Second stage of the distribution warehouse expansion for Budweiser brewery

## For modern brewery logistics

Eliška Korešová

### Project data

| | |
|---|---|
| Client | Budweiser Budvar, National Corporation |
| Contractor | PORR a.s. |
| Project type | Building construction . Industrial construction . Bridge construction and civil engineering. |
| Scope of performance | Construction and expansion of storage and traffic areas, administration buildings and a pallet conveyor system |
| Start of construction | November 2016 |
| End of construction | December 2017 |
| Country | Czech Republic |

Visualisation of the new distribution warehouse. After the works have been completed, a bridge and a pallet conveyor system will connect the two Budweiser warehousing sites.
Image: Atelier EIS

### General information

Budweiser is a very well-known brand of beer and PORR a.s. has been a very close partner of the famous brewery since 2008. Several joint projects have been carried out in the Czech Republic since that time. PORR is currently part of a consortium working on the second stage of the warehouse expansion project in České Budějovice. Some of the works included in this project are the construction of a pallet conveyor system, a new fully automated high-bay warehouse and a road bridge across a public road that currently separates the two warehousing sites.

### Background

By expanding the distribution warehouse, which consists of two sites in the north of České Budějovice, Budweiser hopes to modernise its warehouse management and optimise its logistics. The expansion project comprises a number of new constructions and extensions. The construction measures focus on the comprehensive expansion of a warehouse built in 2012 and a fully automatic elevated pallet conveyor system that runs across Kněžskodvorská Street to connect the two distribution warehouse sites. A tower with a goods lift and a smaller structure for checking the quality of the pallets will be built at the point where the conveyor system turns a curve. Other works will include the construction of a staff car park and the restructuring of the existing entrance and exit driveways to the distribution site, which will also feature a new gatehouse. Finally, a bridge will be built as a traffic link between the two warehousing sites to reduce traffic on Kněžskodvorská Street.
All the new constructions and extensions are in line with the planning concept for the entire site. For example, at its tallest point, the high-bay warehouse will be higher than the adjacent structures but higher than the main building of the brewery. The industrial structures were designed as urban civil structures to contribute to the visual revitalisation of the industrial zone. The existing building located at the newly designed entrance and exit driveways to the site was partially refurbished and visually modified in line with its surroundings by adding an entry portal.

### Complete urban planning and architectural concept

Despite the different appearance of the newly constructed buildings, the façades followed a uniform design. Individual elements of the basic composition constantly reoccur. The colours used also match the company's corporate design. The dominant colour is white, supplemented by grey plinths and sun louvres, and the tertiary colour red. Depending on the materials used for the claddings of the individual buildings, the uniform shade of white was applied either as a top coat or as plasterwork. The same principle was also applied to the main body of the road bridge. The cladding for the entry portal, the gatehouse and the in-site road bridge for lorry traffic across Kněžskodvorská Street will be made of red painted sheet metal. The building plinths, the sun louvres protecting the glass façades and windows and the supporting walls of the road bridges will be a shade of grey. The company logo will also be installed on individual façades.

### High-bay warehouse and administration area

After the demolition works had been completed, the terrain prepared, and the site set up, work began on the fully automated high-bay warehouse. This is a self-supporting steel shelf structure embedded in a solid supporting slab of reinforced concrete. At the same time, these steel shelves provide the supporting structure for the warehouse cladding.

The fully automated high-bay warehouse is a self-supporting steel shelf structure.
Image: PORR AG

The completed fully automated high-bay warehouse.
Image: PORR AG

The consortium group constructed a four-story building with staff rooms as a prefabricated reinforced concrete skeleton structure directly adjacent to the warehouse. With the exception of offices and communal areas for the lorry drivers, the ground floor consists of a large dispatch zone which is directly connected to the high-bay warehouse, separated only by a wire mesh dividing wall. The upper floors house further offices and administration areas, communal areas and ancillary engineering rooms. The floors are connected via three staircases; the middle one is a steel emergency staircase constructed outside the building. In addition, a passenger lift and two goods lifts to service the storage areas will be installed on the north façade.

Operational building with large dispatch zone and many staff rooms.
Image: PORR AG

### The pallet conveyor system

The new pallet conveyor system connects the two warehousing sites across Kněžskodvorská Street at a height of 12 m. The system itself is 7 m wide and 5.5 m high. The conveyor system consists of two rails, allowing goods to be conveyed in both directions at the same time. This means that pallets with empty packing can be transported in one direction, while pallets with finished products are simultaneously transported in the other direction. The tower with the goods lifts was erected in the curve of the conveyor system, with the small building for checking the quality of the pallets next to it.

The new bi-directional pallet conveyor system transports empty packing and finished products at the same time.
Image: PORR AG

### Expanding the existing warehouse

The final stopping point of the pallet conveyor system will be built as an extension to the existing warehouse. The construction measures comprise both goods lifts and staircases. A new shelving concept will also be created. This will double the cool storage space for the beer kegs in the western region. The need for a new shelving concept arose due to the installation of the cylinder conveyor system in the existing warehouse, which will be installed between the pallet conveyor system and the fully automated high-bay warehouse.

The new cylinder conveyor system in the existing warehouse created the need for an entirely new shelving concept...
Image: PORR AG

### Expanding the gatehouse

The existing gatehouse has two storeys; the supporting structure is a skeleton structure made of prefabricated components with brick exterior walls. Besides a garage, the gatehouse also contains an engineering room, offices and a doctor's office. The gatehouse expansion will include a new entryway directly accessing the upper floor. In addition, all the windows throughout the entire building will be replaced and the façade will be repaired and covered with a thermal insulation system.
The new entrance portal will be a light steel structure with sheet metal cladding, constructed on top of the supporting elements of the pallet conveyor system and other components. The entire area will be roofed over and some of the adjoining buildings will also be equipped with sheet metal cladding.

Visualisation of the expanded gatehouse with newly designed entrance and exit driveways.
Image: Atelier EIS

... and the implementation.
Image: PORR AG

Visualisation of the conveyor system connecting the two sites.
Image: Atelier EIS

### Traffic connection between the two sites

In addition to designing the entrance and exit areas and modifying Kněžskodvorská Street, PORR will also construct a road bridge connecting the two sites across Kněžskodvorská Street. As heavy goods traffic will also be conducted across this bridge, its construction was planned in line with the load-bearing requirements of norm ČSN EN 1991-2 and for a projected usage period of 100 years.

Visualisation of the connecting bridge.
Image: Atelier EIS

### Summary

The second stage of the distribution warehouse expansion marks another milestone in the successful partnership between PORR and Budweiser Budvar, which began in 2008, in the Czech Republic. PORR was once again able to demonstrate its comprehensive expertise with a large number of different construction and expansion projects, ranging from bridge construction to warehouse construction.

# 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

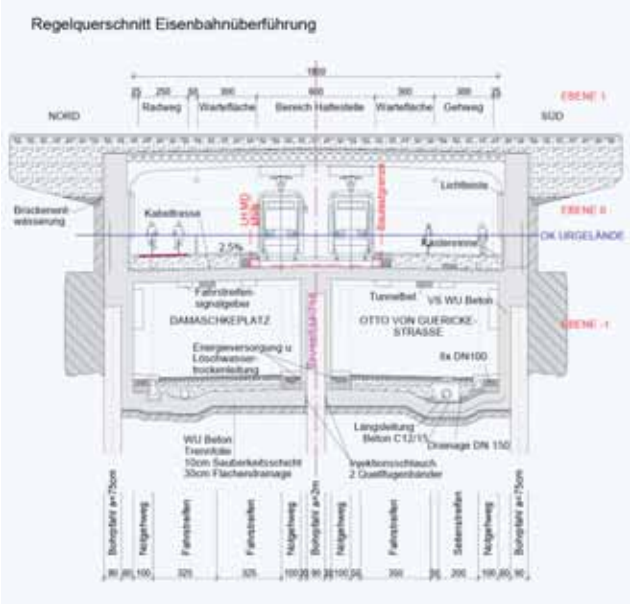
The total "Railway overpass Ernst-Reuter-Allee" project is divided into six specialist sub-lots, with five different clients. The main clients are DB Netz AG and the City of Magdeburg. PORR is renewing the railway overpasses, reinforcing the existing retaining walls and constructing stairways to the 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

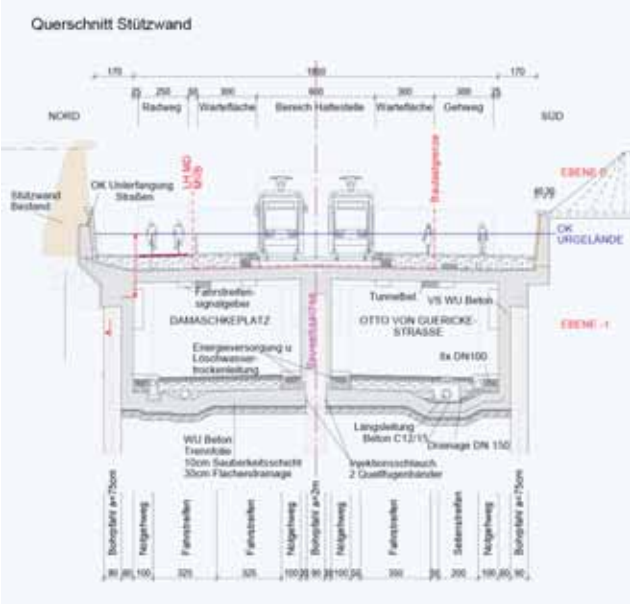
The project will distribute the various road users over a total of three levels. In the future, the lower level will house private motor vehicles, while trams, pedestrians and cyclists will share the middle level. The upper level will continue to be reserved exclusively for DB Netz AG rail traffic. On 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

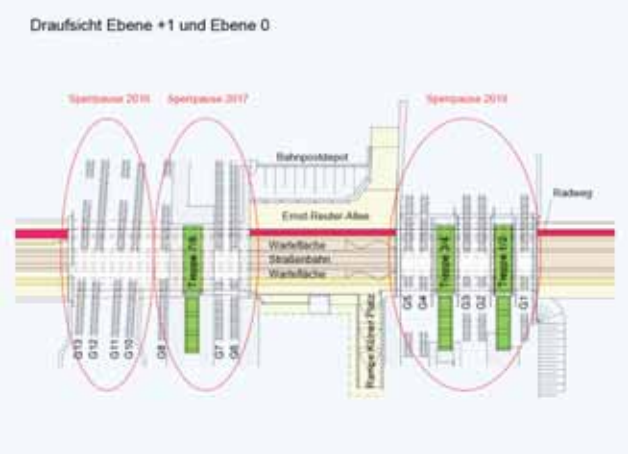
As Magdeburg suffered extensive bombing by the Allied Forces during World War II, the salvaging of unexploded ordnance is particularly important. For this reason, ordnance detection surveys must be carried out not only in the open-air construction areas and the pile areas, but also in the regions below 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 created to produce 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.

Damaschkeplatz with the drilling equipment – BG40 and BG36H.
Image: PORR AG

## 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.

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

Concreting the tunnel ceiling.
Image: PORR AG

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.

Installing the prefabricated prestressed concrete components.
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

### Dimensions

| | |
|---|---|
| Concrete used, excluding the bored piles | 38,000 m³ |
| Reinforcement, excluding the bored piles | 6,000 metric tonnes |
| Concrete for bored piles | 30,000 m³ (approx. 2,000 bored piles) |
| Bored pile reinforcement | 3,000 metric tonnes |
| Jet grouted structures | 6,000 m³ |
| Construction pit excavation | 120,000 m³ |
| Track extension | approx. 2,000 m |

### 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.

# Hammer Straße railway crossing

## FRANKI defeats groundwater and tight deadlines

Karsten Kegelbein, Uwe Häusser, Sören Beilke

### Project data

| | |
|---|---|
| Client | Freie und Hansestadt Hamburg; Landesbetrieb Straßen, Brücken und Gewässer (LSBG) |
| Contractors | Consortium Ingenieurbauwerke Hammer Straße Aug. Prien und FRANKI Grundbau GmbH |
| Project type | Civil engineering . Specialist civil engineering |
| Project scope | Construction of the complete construction pit |
| Construction start | July 2015 |
| Construction end | December 2018 |
| Country | Germany |

Aerial view of the FRANKI construction site in Hamburg. The plan is to construct an underpass consisting of a trough structure integrated with two frame structures.
Image: FRANKI Grundbau

### General information

In Hamburg's Hammer Straße, two gated level crossings are to be replaced by an underpass. This will require a 360 m long trough construction. FRANKI Grundbau is responsible for the implementation of the complete construction pit. Because of the highly inhomogeneous subgrade, FRANKI developed a special solution for this project. Finally, due to a shortage of time, some quick and successful improvisation was required.

Visualisation of the finished construction site.
Image: Winking . Froh Architekten BDA

### Background

In the past, the barriers on the two-track Hamburg-Lübeck main line were closed up to ten times an hour for a total of around 30 minutes. This was extremely disruptive for car traffic, cyclists and pedestrians. Therefore, Hamburg's Landesbetrieb Straßen, Brücken und Gewässer (LSBG) decided to replace this and another gated level crossing of a regional railway route on Hammer Straße with a joint underpass.

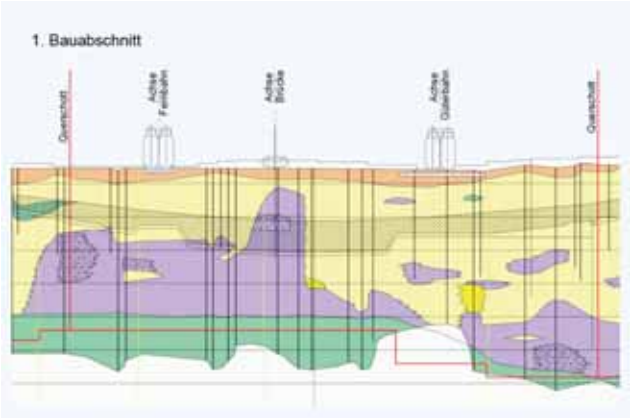
### The construction task

As a road underpass, a buoyancy-proof trough structure is planned, into which two frame structures will be integrated to enable the overpass for the two railway lines. The middle trough section is located between the frame structures. The total length of the structure is around 360 m. With a width of 18 m, two lanes, two cycle paths and two walkways are provided.


In Hamburg's Hammer Straße, a new underpass under two gated level crossings should significantly improve the flow of traffic.
Image: Google Maps

The construction approval plans provided for the construction of a secant bored pile wall for the entire area of the trough structure.

Since the groundwater in the construction field is already 1.50 m below the top level of the terrain, but the excavation depth in the middle trough area was up to 15 m, it was necessary to create watertight shoring walls. The planned secant bored pile wall will be sunk into the mica clay at a depth of approximately 20-30 m. This can serve as a natural dam and seal the excavation from below. Due to the large excavation depth, five tie positions were planned to support the retaining walls.




The longitudinal section of the subgrade shows that the creation of watertight shoring walls was required due to the high groundwater level.
Image: Steinfeld und Partner GbR

Preparatory work for drilling the second tie position.
Image: FRANKI Grundbau

Together with Ingenieurservice Grundbau isg, FRANKI developed a concept in which the bored pile walls outside the railway areas are replaced by sealing walls with set sheet piles or steel girders. These sealing walls can be very easily adapted to changing subgrade conditions during production. In addition, during execution of the diaphragm wall, it is easy to identify whether the sealing boulder clay has been reached. The construction of the sealing walls is quiet and vibration-free.


The FRANKI shoring concept was convincing, thanks in no small part to comprehensive 3D planning of the trough structure.
Image: Ingenieurservice Grundbau GmbH (isg)

A useful side effect of this concept was that it allowed the design to be optimised by using four tie points instead of five. Soldier pile walls were planned in the area of the ramps above groundwater level.
To better illustrate the entire construction pit concept and to avoid a collision of the anchors, especially in the corner areas, isg created a 3D plan with Revit Structure.
At the end of 2014, the consortium Aug. Prien and FRANKI Grundbau were awarded the contract to create the trough construction using this concept. FRANKI's task was to construct the entire construction pit.

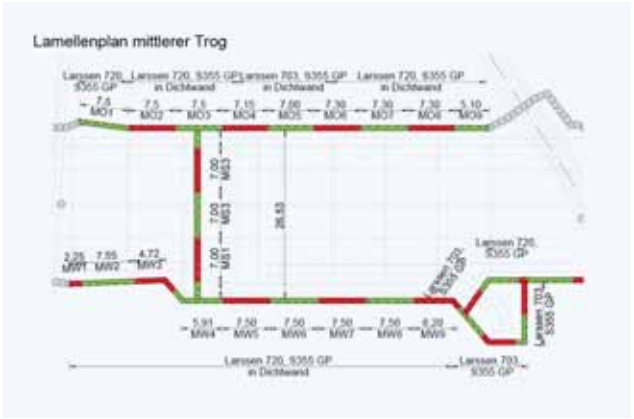
Earthworks in the trough.
Image: FRANKI Grundbau

### Redesign on diaphragm walls

The work in the area of the railway tracks represented a particular challenge, as it was only possible to work during strictly-timed track possessions that were severely limited in number and length. However, careful planning and large-scale personnel and equipment deployments were required in order to meet the tight deadlines. The sealing walls were produced according to plan, partly directly next to the railway tracks while the train service was still running.

Due to the tight schedule, sealing wall production had to be carried out in part while the train service was still running.
Image: FRANKI Grundbau

During execution, however, it turned out that there was no longer enough time left to manufacture the bored pile walls in the area of the double track. For this last section, a track possession period of 76 hours was approved, but the area covered by the east and west sides of the trough was about 750 m² at a depth of up to 30 m.




Section diagram of the middle trough.
Image: FRANKI Grundbau

FRANKI and isg then started looking for a solution that would make it possible to execute the construction in the remaining time available. In the end, they opted for the execution of the shoring as a cast in-situ concrete diaphragm wall. As isg and FRANKI have a lot of experience in planning and execution, they were confident that they would be able to solve the problem in this way. The new concept with the design as a diaphragm wall was presented to the client as a supplement and explained. It was then approved by the client after further adjustments.

Several rotary drilling rigs were used in the track area.
Image: FRANKI Grundbau

### Testing the diaphragm walls

The concept change posed a further challenge to FRANKI's project management. The DB Netz AG (railway infrastructure provider) inspection deadlines for engineering structures are usually defined at around 20 weeks. With the support of the client and constructive discussions with DB Netz AG, the new plan was reviewed and approved within a time frame of just 3.5 weeks – including over Christmas and New Year.

### Execution of the diaphragm walls

Large numbers of personnel and equipment had to be deployed to produce almost 800 m² of cast in-situ concrete diaphragm walls in the area of the double track during the final 76-hour possession period.
At the beginning of January 2016, the time had finally come: the railway closed off the main Hamburg-Lübeck route and the consortium had a specialist company dismantle the tracks. The time for removing and reinstalling the tracks had already been deducted from the 76 hours and was no longer available for the diaphragm wall production.

For the diaphragm wall work, two units were used in multi-shift operation. In addition to the two cable excavators, a rotary drilling rig, two service excavators, two hydraulic excavators, a dumper truck, and two two-way excavators for road and rail were also deployed. This required a team of around 30 workers.

The ready-mixed concrete came from two different plants and had to be preheated due to the low temperatures. Both factories had obtained travel permits for night driving and transportation on Sunday.
The diaphragm walls were successfully produced as planned and it was possible to hand over the construction site to the track construction companies on a just-in-time basis.

### Services provided

| | |
|---|---|
| Sealing wall, thickness = 60 cm, with sheet-pile wall and steel girders | 22,000 m² |
| Cast in-situ concrete diaphragm wall, thickness = 80 cm, up to 30 m deep | 760 m² |
| Secant bored pile wall, thickness = 120 cm | 1,450 m² |
| Steel tube piles, thickness = 81 cm, length approx. 24 m, for holding the DB provisional bridge | 4 |
| Steel tube piles, thickness = 91 cm, length approx. 27 m, for holding the DB provisional bridges | 2 |
| Temporary strand anchors, Zk ≤ 750 kN, L ≤ 20 m | 900 |
| Soldier pile wall | 400 m² |
| Excavated earth | 70,000 m³ |

### Summary

With suitable subgrade conditions, sealing and in-situ concrete diaphragm walls provide the builder and planner with great advantages compared to bored pile walls. The slot depths can be adjusted to the ground during production. The large grabs ensure especially fast construction progress. Also, the seal of the diaphragm shoring is better because the joint proportion is lower due to the large slats. Particularly good results are achieved when the flat joint elements for sealing the slats are equipped with two joint rubbers. Cast in-situ concrete diaphragm walls are also very deformation resistant and can also accommodate vertical loads.

# Determining pile load capacity in geotechnical and special foundation engineering

## Re-measuring the world

Arne Kindler

### Project data

| | |
|---|---|
| Client | Ingenieurservice Grundbau GmbH |
| Contractor | Stump Spezialtiefbau GmbH |
| Project type | Civil engineering . Special civil engineering |
| Scope of performance | Static and dynamic load capacity measurements for FRANKI piles NG (registered trademark) and ATLAS piles |
| Start of project | April 2017 |
| End of project | July 2017 |
| Country | Germany |

Abutment constructed for static pile load testing by Ingenieurservice Grundbau (isg).
Image: Stump Spezialtiefbau GmbH

### General information

Stump Spezialtiefbau GmbH in cooperation with FRANKI Grundbau GmbH conducted a pilot test series to calculate the load-bearing capacity of various pile types used as foundation for bridge abutment in challenging subsoil conditions. A test field was created for FRANKI piles NG (registered trademark) and ATLAS piles diameter 46/56 for this purpose. In order to evaluate the piles' load capacity, Ingenieurservice Grundbau GmbH (isg) planned and performed a series of static and dynamic pile load tests.

### Measuring concept

For the first pile load test, isg implemented a measuring concept which - due to the conditions imposed by the system – did not provide separate measurements for pile toe and pile skin friction forces. The load concept was devised in line with the recommendations issued by the "Piles" working committee at the German Geotechnical Society.
The goal was to allow pile toe and pile skin friction forces to be recorded separately, with minimal effort and at a low cost. The research and development department of Stump Spezialtiefbau (sister company of FRANKI) introduced the possibility of using Distributed Strain Sensing for FRANKI piles NG (R) and ATLAS piles diameter 46/56. The advantage of Distributed Strain Sensing is that it uses a sensor to detect strain variations in different locations, from the pile shaft to the pile toe, permitting a differentiated evaluation of pile toe and pile skin friction forces.

### A new measurement technique in special foundation engineering

Distributed Sensing is a fibre optic measurement technique that uses fibre optic sensors distributed across different locations to measure and record mechanical quantities. Unlike most common electronic sensor systems, fibre optic sensors have an impressively compact design and can bridge large distances to the measuring point.

Fibre optic measuring systems consist of an active monitoring unit and a passive sensor fibre. The monitoring unit transmits a light signal into the glass fibre, records the reflected light signal, and analyses the changes between the two.
Distributed Sensing yields an unusually high spatial resolution. It can detect strain variations only millimetres apart over a maximum length of 75 m or centimetres apart over a maximum length of 40 km. The highest possible sampling rates are around 16 kHz.

Important milestones in the work with fibre optic measurements completed to date include the development of a new anchor monitoring system by Stump Spezialtiefbau, the installation of measuring instruments on an energy pile at a testing site provided by the Municipal Council of the City of Vienna, and the cooperation with the Department for Environmental Protection in optimising the energy field designed for the PORR office building in Linz. Thanks to their previous experience in using distributed sensing technology in measuring strain, temperature and moisture in the field of special foundation engineering, Stump have become the leading expert in the application and knowledge transfer of this new glass fibre sensor technology in special foundation engineering.

Instrumentation of the energy pile toe prior to placing the reinforcement cage in the borehole.
Image: Stump Spezialtiefbau GmbH

### Installing the instruments for the pile load test

A FRANKI pile NG (R) and an ATLAS pile diameter 46/56 were instrumented with fibre optic sensor cables for Distributed Strain Sensing in order to conduct static pile load tests as part of the pilot test series. A FRANKI pile NG (R) was also fitted with instrumentation for integrity testing via temperature measurements. By recording the hydration-generated heat inside the pile during the hardening process, Stump were able to demonstrate its integrity. And finally, in the course of the ongoing development process, an additional FRANKI pile NG (R) was fitted with newly designed impulse sensors with four chains of 16 sensors each to conduct dynamic measurements during the dynamic pile load testing process.

Fibre optic sensor cables installed at the foot of the reinforcement cage for Distributed Strain Sensing (DSS) along the shaft of an ATLAS-pile diameter 46/56.
Image: Stump Spezialtiefbau GmbH

### Quality assurance and functionality

One of the greatest challenges in using fibre optic sensors is ensuring the quality and functionality of the entire measurement system. The boundary conditions that prevail in special foundation engineering are far less favourable than in the energy, aviation and automotive industries, where Distributed Sensing technologies originated. Moisture, mud and wet concrete are a constant accompanying factor.
Despite this, the functionality of the fibre optic sensor cables, which have a diameter of up to 2.30 mm, must be assured in order to ensure quality. The company's own quality control procedures stipulate testing the functionality of the fibre optic cables before, during and after installation to prevent a total systems failure, and documenting the results. This is why Stump equip the connector plugs with particularly strong protection from mechanical and chemical forces. Functionality testing is performed at every stage of production using Optical Time Domain Reflectometry (OTDR).

Using Optical Time Domain Reflectometry to measure attenuation in the fibre optic fibres as part of the fibre optic sensor cable quality control procedures.
Image: Stump Spezialtiefbau GmbH

### Results of the pile load tests

The Distributed Strain Sensing measurements involved recording the force lines along the pile shaft down to the pile toe for individual pile test loads, while taking characteristic strains and changes to the cross section caused by a cladding tube (7.20 m) in the upper region of the pile shaft into account. The distance between measurement points was 5 cm. The curve progressions from 0 to approx. 7.20 m are characterised by the composite effects of the cladding tube and the concrete and can only be used to evaluate load-bearing characteristics if composite action is taken into account. It became evident that no forces were diverted in the cladding tube region in an organic soil. The pile cross section tapered significantly from 90 cm to 56 cm at about 7.20 m.

The first step of the dynamic pile load tests with a FRANKI pile NG (R) involved comparing the results yielded by the fibre optic impulse sensor developed especially for this purpose with those of the conventional strain gauge. This comparison showed a sufficiently accurate match between the progression of strain over time as measured by the impulse sensor and by the conventional extension gauge.

This proved that the functionality of the impulse sensors designed for this purpose was both given and plausible. Strain progressions were recorded for all 16 individual impulse sensors for test chain 4. The pulse created by the drop weight becomes apparent in a pressure wave within the time interval of 61.15 to 61.20 seconds. The negative pressure wave reflected by the pile toe in the opposite direction can be identified at around 61.20 to 61.25 seconds. This is followed by another pressure wave at around 61.30 seconds, caused by the drop weight "springing back". In the following time period, the impulse sensors are “run through” by a variety of reflections.
As the measurement system used for the dynamic measurements is still under development, the resulting data has not yet been evaluated in its entirety. But its enormous potential for evaluations performed under dynamic conditions is already apparent. The evaluation results will be presented at the International DFI Conference in Rome in the summer of 2018.

### Summary of the fibre optic measurement results

Summary of the fibre optic measurement results
The measurement results obtained by using Distributed Strain Sensing allowed recording of the progression of strain and determination of force lines separately for the pile shaft and the pile toe during static pile load testing, with relative small effort. They confirm the results on the load-bearing capacity of FRANKI and ATLAS piles presented in the recommendations issued by the "Piles" working committee et al. In addition, it was demonstrated that it is also possible to use fibre optic measurement techniques in complex technical production processes. In the course of evaluating the results, it was demonstrated that, in the region where the cross section become narrower, a significant portion of the load is induced directly into the surrounding subsoil.

On the basis of these findings, the load transfer of a pile system can be modified in line with the system's intended effect.
In a further step, the dynamic fibre optic measurement results will be used for a modification of the numeric model (CAPWAP). The results obtained in this way reflect the effective load transfer along the entire length of the pile more accurately, thereby facilitating an assessment of the results of the dynamic pile load testing in relation to the corresponding modelling process (CAPWAP).

Moisture, mud and wet concrete – the difficult but common boundary conditions that prevail in the field of special foundation engineering – Pile head of an ATLAS pile diameter 46/56 after pile construction.
Image: Stump Spezialtiefbau GmbH)

**Summary**

On the basis of the numerous measurements conducted with the aid of Distributed Sensing, it could be demonstrated that this measurement technology is more than suitable for monitoring processes in geotechnical and special foundation engineering. Future areas of application in the field of special foundation engineering include short-term and continuous monitoring of large bored piles and micro-piles, diaphragm walls, locating leaks, measuring anchors and braces, general deformation measurements, pile and anchor integrity testing, determining the cross sections of jet piles and proactive convergence measurements in tunnel construction.

The new glass fibre sensor technology can also potentially be used to introduce economic continuous monitoring for Damage Category 4 bridge structures, to facilitate temperature measurements and leak detection in the field of power plant construction, to conduct underground deformation measurements in the fields of track and road construction and to locate leaks in flood protection facilities in the field of hydraulic engineering. A comprehensive early warning system for avalanches is also a possibility.

The benefits of Distributed Strain Sensing are self-evident: With the aid of the new glass fibre sensor technology and company-owned measurement devices, it is now possible for the first time to economically conduct distributed, high-resolution and highly precise measurements of strain, temperature and moisture variations within a millimetre range.

The experience gathered in this field and the corresponding expertise already allows the Research and Development Department of Stump Spezialtiefbau GmbH to support engineering firms in Canada, South Africa, Great Britain, Austria, Italy and Germany in working with Distributed Strain Sensing in geotechnical and special foundation engineering.

# German Unification Transport Project Nr. 8

## Cutting-edge Concept for the Deutsche Bahn

Ivana Avramovic

### Project data

| | |
|---|---|
| Client | DB Netz AG |
| Contractor | PORR Bau GmbH |
| Project type | Infrastructure . Railway. Design & Build |
| Scope | New construction of 320 km of high speed line with Slab Track Austria system |
| Construction start | June 2012 |
| Construction End | December 2017 |
| Country | Germany |

VDE 8.2 has been in operation since December 2015.
Image: PORR AG

### General information

In 1991 the German federal government decided to build the German Unification Transport Project Nr. 8, VDE 8 for short, in order to improve transport links between the old and the new German federal states with a total of 17 projects. PORR BAU GmbH in Vienna was tasked with construction of three lots of the largest railway project in Germany, VDE 8.
In 2011, DB Netz AG, a subsidiary of Deutsche Bahn AG, awarded the contract in the form of a "Design & Build" contract. More than 320 km of the PORR patented slab track system, also known as Slab Track Austria, were installed, which can be driven on at a speed of up to 300 km/h. This allows a reduction in travel time between Munich and Berlin from six to about four hours. The last section of the high speed line will start operation in December 2017.

### Background

The "German Unity Transport Project" was decided in the course of reunification to improve the overall German transport network. The largest rail project VDE 8 covers the new construction and upgrade of railway lines with a total length of 515 km between Nuremberg, Erfurt, Halle, Leipzig/Halle and Berlin. In addition, the new high speed line has another purpose: closing the gap in the European high speed rail network. In the future it will be possible to travel from south to north Europe without changing locomotives, train stops or changing the train control system.

### Design and construction

Three of the total of four new construction lots were awarded to PORR. Specifically, these were the sections Coburg - Illmenau (VDE 8.1.2), Bad Staffelstein - Coburg (VDE 8.1.3) and Erfurt – Leipzig / Halle (VDE 8.2). The PORR slab track system was used on all the lines.
The contract included detailed design, construction, coordination of third parties, support for the high-speed test drives, as well as for the commissioning, and was associated with an enormous planning effort. Over 8,000 plans were prepared for the railway superstructure, the noise barriers and the railway technology, as well as 74 company-internal approvals and technical notifications obtained. In addition, seven approvals for operational testing were applied for and granted.

PORR was also commissioned to design and build noise and wind protection barriers for the operating speed of up to 300 km/h.
Image: PORR AG

### Slab Track Austria

Slab Track Austria (STA) system, a joint development of ÖBB and PORR, was installed in all three construction lots. The main element of the system is an elastically supported slab. Some of the greatest advantages include maximum availability and ride comfort, integrated structure-borne noise protection, short construction phases due to a high degree of prefabrication and low maintenance. The system was first implemented in 1989

and has since been in operation without maintenance necessary.
Overall, PORR produced some 60,000 track slabs for the construction of the line. Starting in 2012, 75 of these track slabs were produced per day in a production facility set near the construction site for this purpose.

The high degree of prefabrication in the factory allows quick installation and little rework on site.
Image: PORR AG

### Complex logistics concept

Logistics played a central role on this project due to the long linear construction site. In particular, the timely transport of all STA track slabs and in-situ concrete had to work smoothly, regardless of whether it was built on bridges, earthworks or tunnels along the line. PORR developed its own logistics concept for this purpose.

Well fleshed out logistics concepts for long linear construction sites were of the utmost importance for the successful implementation of a total of around 320 km of PORR slab track.
Image: PORR AG

### Further developments and innovations

The construction measures included not only the superstructure work, but also the railway technology (VDE 8.2), the construction of noise and wind protection walls, foundations for overhead line masts and the "accessibility of the slab track". For this purpose, a test section was built in advance and a new accessibility plate was developed. Thus, tunnel and bridge areas are easily accessible and can be driven on by tire-wheeled emergency vehicles in case of emergency. A dual function – accessibility with guide rail function – was implemented in the southern sections VDE 8.1.2 and VDE 8.1.3

PORR's Slab Track Austria system was implemented on a total of three sections of the new VDE 8 high-speed line.
Image: PORR AG

Accessibility for emergency vehicles with a guide rail function is a new development of the PORR slab track system.
Image: PORR AG

PORR has developed and installed track slabs with special support points for the bridge joint area. The bridge movements can be absorbed without damage and the required highly precise track position can be ensured using these special slabs.

In addition, the newly developed PORR slab track turnouts, which are also suitable for high-speed traffic, were installed in the construction lot VDE 8.1.3 for the first time. With this system extension, PORR has been able to build its system for all track areas with its elastically supported track slabs. Due to the high quality of prefabrication, cracks in concrete can be avoided. The advantages of the elastically supported slab also come into play here.


Installation of the PORR slabs in tight areas.
Image: PORR AG

### Full service provider

PORR was responsible for coordination of the design, construction, and commissioning, as well as the documentation of several railway engineering systems during the construction of this standard gauge, double-track, electrified railway line.

### Project data VDE 8.2

| | |
|---|---|
| Design speed | 300 km/h |
| Total length of the Slab Track Austria (ÖBB-PORR) system | 179,352 km |
| Ballast track | 11 km |
| Turnouts in slab track | 42 |
| Turnouts in ballasted track | 20 |
| Tunnels | 3 |
| Total length of slab track in tunnel | 31 km |
| Bridges | 6 |
| Total length of slab track on bridges | 29 km |
| Total length of slab track in open section | 121 km |
| Noise and wind protection walls with foundations | 22 km |
| Foundation for overhead lines | 60 km |
| Accessibility of the slab track for tire-wheeled vehicles | 31 km |

PORR also designed and constructed electrical systems and telecommunication facilities such as emergency call, emergency lighting and energy supply in several tunnel sections with a total length of about 31 km on the construction lot VDE 8.2:

- 50-Hz-systems and telecommunications equipment such as the tunnel emergency call and the tunnel security lighting.
- 50-Hz- transformer stations and 50 Hz tunnel power supply for the low voltage cable system and intruder detection system / fire alarm system.

The concept, design, construction, production and installation of the fire doors in the tunnels was also the responsibility of PORR:

- 60 pieces of double-wing swing doors T-30, 8 of which in the Osterberg Tunnel; 26 pieces in the Bibra Tunnel and 26 pieces in the Finne Tunnel
- 6 pieces of single-wing tunnel – fire protection closures T-120 in Finne Tunnel
- 47 pieces single-wing fire protection doors T-90, of which 4 pieces in Osterberg Tunnel; 37 pieces in Bibra Tunnel and 6 pieces in Finne Tunnel were installed.
- 7 pieces of double-wing swing door T-30 without pressure. 2 of them were installed in Finne Tunnel and 5 pieces in Osterberg Tunnel.

### Project data VDE 8.1.2

| | |
|---|---|
| Design speed | 300 km/h |
| Total length of the Slab Track Austria (ÖBB-PORR) system | 87,860 km |
| Ballast track | 2,360 km |
| Turnouts in slab track | 18 |
| Turnouts in ballasted track | 4 |
| Tunnels | 12 |
| Total length of slab track in tunnel | 55,458 km |
| Bridges | 17 |
| Total length of slab track on bridges | 12,524 km |
| Total length of slab track in open section | 19,878 km |
| Noise and wind protection walls with foundations | 13 km |
| Foundation for overhead lines | 39,8 km |
| Accessibility of the slab track for tire-wheeled vehicles | 54 km |

### Project data VDE 8.1.3

| | |
|---|---|
| Design speed | 300 km/h |
| Total length of the Slab Track Austria (ÖBB-PORR) system | 46,075 km |
| Ballast track | 2,148 km |
| Turnouts in slab track | 9 |
| Turnouts in ballasted track | 5 |
| Tunnels | 7 |
| Total length of slab track in tunnel | 19,027 km |
| Bridges | 6 |
| Total length of slab track on bridges | 5,734 km |
| Total length of slab track in open section | 20,470 km |
| Noise and wind protection walls with foundations | 10,7 km |
| Foundation for overhead lines | 41 km |
| Accessibility of the slab track for tire-wheeled vehicles | 10.8 |

### Summary

Since the commissioning of the 90 km section VDE 8.2 in December 2015, passengers and freight trains have been driving on the PORR slab track. For all three construction lots, detailed test drives were carried out before commissioning with a gradual increase in driving speed up to 330 km/h. Full operation will start at speeds of up to 300 km / h over the entire VDE 8 route in December 2017.

# Emscher Sewer, Construction Stage 40

## In a class of its own

Irina Melzer

### Project data

| | |
|---|---|
| Employer | Emschergenossenschaft (Emscher Water Board) |
| Contractor | Consortium Emscher BA 40 (Emscher Construction Stage 40) – PORR Bau GmbH. Infrastructure Tunnel Construction and PORR Germany GmbH. |
| Project type | Tunneling . Civil Engineering |
| Project scope | Mechanised Tunnelling, Civil Engineering, Pipe Jacking, Specialist Civil Engineering |
| Construction Start Date | December 2013 |
| Construction End Date | April 2018 |
| Country | Germany |

In the course of restoring the Emscher to its natural state, a system of sewers totalling 51 km in length will be constructed.
Image: PORR AG

### General information

In 2013, PORR Bau GmbH. Infrastructure Tunnel Construction, together with PORR Deutschland GmbH, won the contract to build construction stage 40 of the new Emscher sewer. This 10 km long section consists of two parallel tunnel bores, constructed by the segmented method. The tunnelling employed two earth pressure balance shields, and was completed in June 2017. In addition to the tunnel boring, the PORR consortium is constructing fourteen shafts, and fitting out twelve of these for the operation of the sewer. This involves building complicated underground civil engineering structures in these construction pits, which are up to 45 m in depth.

### Background

The Emscher is an approximately 85 km long tributary of the Rhine river which, as a result of the historical development of the Ruhr region, came to be used as an open sewer. In the course of restoring the river to its natural state, a 51 km long system of sewers is being constructed to carry the wastewater of approximately 2.2 million residents. The waters of the Emscher and its tributaries will thus be restored to as near their natural state as possible. The future Emscher sewer (Abwasserkanal Emscher, AKE) will run from Dortmund to Dinslaken, and carry wastewater to the sewage treatment plants at Bottrop and the mouth of the Emscher.
In construction stage 40 (Bauabschnitt 40, BA 40), the sewer will be constructed in a twin bore configuration for a length of circa 10 km. In addition, nine main and five secondary shaft structures will be constructed, and four secondary inlets will be excavated by means of pipe jacking.

### Part 1: Tunnel construction

Unlike many other projects, the challenge in this tunnelling project lay not in the ground in which it was to be built, which despite exploratory drilling always remains an unknown element, but in the small diameter of the tunnel bores. At 2.6 m, these are at the lower limit of what is possible with segmented tunnel construction. The resulting spatial constraints had massive implications for the overall mechanical engineering, the design of the tunnel segments, the logistics of the excavation, and safety during the works.

### Technical challenges

The most difficult task in setting up the tunnelling equipment was arranging the components without compromising functionality or safety considerations. Components such as conveyor belt bearings, switch cabinets and pumps had to be easily accessible and could not be blocked by other components, in order to allow maintenance and repair works to be completed quickly and effectively. A two-floor arrangement, as is usual with larger shield machines, was not possible due to the limited height of 2.6 m. Therefore, all components had to be constructed one behind the other.

Although some components in a small-diameter machine can also be made smaller, other components cannot be changed in proportion to this. For instance, the length of the auger in an earth pressure balance shield depends largely on the required operating pressure. This decreases along the length of the auger, and should reach atmospheric pressure at the exit of the auger, in order to make sluice-free jacking possible. The theoretically estimated pressure for this project was 3.6 bar. This resulted in an auger length of 8.8 m. The shield casing of the boring machine was already nearly 15 m long, about five times as large as the diameter of the cutting wheel.

The total length of the machine, including all the trailers, reached 90 m. For comparison, the largest earth pressure balance shield machine in the world, with a diameter of 15.5 m, is 130 m long.

## Tunnel segment design

The narrow diameter of the tunnel also had an impact on the design of the tunnel segments. As in all tunnelling machines, the width of the segments, and therefore the jacking length, is dependent on the width of the trailer structure, which in this case was 1.3 m. After deducting tolerance dimensions, the width of the segments was chosen as 1.18 m. The specifications of the machine also had to be considered in dividing the rings. A division of the rings into only four pieces would have required a larger height clearance for the segment feeder in the first trailer. That would not have been possible with the steering position for the machine operator and the conveyor belts lying directly above. Due to these and other geometric requirements, each ring was made in six equally sized segments with a thickness of 25 cm and a weight of 1.1 t.

The segments were to be installed by conventional means, with a vacuum segment erector. However, in the process of qualifying the vacuum plate, it became apparent that because of the small surface area of the segments and their relatively heavy weight, it was not possible to produce a sufficient vacuum for safe installation. The same was true for the segment crane, which is why the segments without openings and depressions desired by the client were not feasible.
The segments were therefore produced with a plastic sleeve, into which a steel bolt was screwed for unloading the segments onto the segment feeder, and for the ring construction. To this, a mechanical erector plate was clamped. This construction also required a change in the installation procedure; now every segment had a steel bolt screwed into it, which had to be removed after the ring construction, and every plastic sleeve then closed with a plastic cap. Sealing the sleeves, which was necessary in the case of this particular project due to the eventual use of the tunnel as a sewer, could probably have been avoided with the use of a vacuum erector.

View from the pilot tunnel in the direction of the segment-lined tunnel
Image: PORR AG

## Logistics

In such a long and narrow tunnel, smoothly functioning logistics are of great importance. Downtime due to missing material deliveries had to be avoided at all costs. As the trailer of the tunnelling equipment didn't provide any storage space, only a small amount of material could be stockpiled. A lot had to be delivered "just in time". Since waiting times would have been unavoidable for a distance of 10 km, the route was divided into three tunnelling sections, and the entire starting shaft installation, including the tunnelling logistics, rebuilt twice. In this way, continuous supply to the shield machine could be guaranteed.

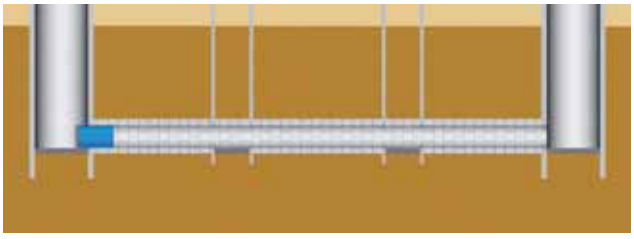
Route of construction stage 40 of the sewer, showing the three tunnelling sections.
Image: PORR AG

The pressure on the logistics was further relieved by the use, for the first time in Germany, of a two- component mortar for the gaps between the rings. Rather than the usual method of carrying the mortar in a mortar tank on the machine, in this case it is pumped via a transfer line from the mortar mixing equipment directly to the mortar tank on the tunnelling machine. To avoid the mortar hardening in the transfer line, it is separated into two components. The so-called "A-components" consist of water, cement, powdered rock, bentonite and a stabiliser. With this composition, the mortar is very fluid and can be pumped easily. During the tunnelling process, the mortar is pumped to the end of the line in the shield tail, where the B-components are added as it passes through the so-called grout injection line into the annular space. The B-components consist of soluble alkali silicates and serve as an accelerant, so that the liquid mortar hardens quickly, guaranteeing the necessary ballast for the segment ring. In order to avoid segregation of the A-components and resultant blockages in the mortar transfer line, as high a flowrate as possible in the small cross section had to be achieved. The usual pressure in the mortar transfer line was circa 10 bar at a flow of some 3 m³ per hour. With increasing lengths of up to 4,100 m, the pressure increased significantly, and the installed system nearly reached the limits of its performance capacity.

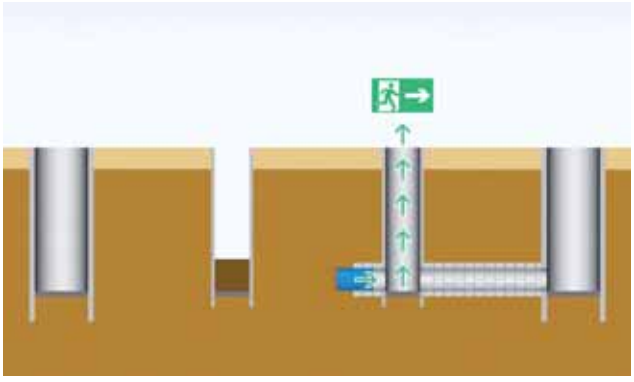
## Workplace health and safety

Safety is a particular concern in all tunnelling operations. After all, there is always only one escape route, and the length of the escape or rescue route increases with every drive forwards. In the case of BA 40, the small internal diameters brought further difficulties.
The fire protection and rescue plans originally envisaged starting the three tunnelling sections each as one piece, so that the maximum escape and rescue route corresponded

to the longest section at 4,100 m. The other shafts along the route were to be driven through in an unexcavated state, and only be excavated and fitted out after the tunnelling works were completed. In order to ensure a speedy rescue despite the long rescue route, a team of paramedics would be contracted to accompany the tunnelling works. With the help of technical rescue equipment, victims of accidents in the tunnelling machine could be rescued within a short time frame, transported to the shaft, and there transferred to the local fire brigade. However, before the start of the tunnelling work, a revision of the fire protection and rescue plans was requested by the responsible fire brigade. The escape and rescue routes were deemed too long considering the small cross section of the tunnel, and the construction process had to be significantly modified. The intermediate shafts were now to be converted into rescue shafts immediately after the equipment had passed through. This meant that, first of all, the shafts had to be excavated and the floor slabs installed, before the tunnelling machine could enter. The shafts were then filled with “liquid soil”, a type of lean concrete, so that the tunnelling machine could drive through the shaft. After the machine, including all the trailers, had driven through the shaft, the tunnelling work was paused, and the shaft excavated once more. The segment rings were subsequently removed from the shaft, and the shaft was converted into a rescue shaft. This included, for example, a rescue stair tower, as well as an electrically driven lift with emergency back-up power. Only after the rescue shaft was commissioned could the tunnelling work continue. This rebuilding phase took place for every intermediate shaft.



The originally planned construction process...
Image: Emschergenossenschaft



...had to be changed due to a reworking of the fire protection and rescue plans.
Image: Emschergenossenschaft

In addition to these measures, a variety of safety technologies were employed. PORR installed an employee tracking system, fire alarms and extinguishing systems, smoke bulkheads to stop the spread of smoke in case of fire, and a communication system. Furthermore, intensive training and instruction were provided, and regular rescue drills were performed in order to familiarise all parties concerned with the special circumstances, and to ensure things would run smoothly in case of an emergency. Apart from the special requirements for the fire protection and rescue plans, even regular operation was a borderline case from a workplace health and safety perspective. The height clearance in the trailer area was around 1.6 m, whilst the passage height on the catwalk was just 1.2 m. This meant that a person of average height could only stand upright behind the last trailer, or in the area of the shield tail. Upright movement was impossible for those employed in the tunnelling operation.

Because of the extremely cramped conditions, the number of employees in the tunnel was kept to a minimum.
Image: PORR AG

It was impossible to walk upright in the tunnel.
Image: PORR AG

A container to serve as a break room, which is usual on larger machines, could not be included because of the geometric conditions. Even the installation of a construction site toilet was impossible given the small cross section.
Therefore, since neither the tunnel cross section nor the size of the tunnelling machine could be changed, other measures had to be taken to reduce the physical toll of the work. First and foremost, the number of employees in the tunnel was kept to a minimum. Only a shield driver, a ring builder and a post-drive metalworker stayed permanently on the tunnelling machine. In order to keep working times within an eight-hour limit, the work was conducted in three shifts, instead of the two-shift schedule usually used in tunnel construction.
As after the first few weeks of tunnelling it became clear that employees with normal hard hats regularly hit their heads, the helmets worn in the tunnel were replaced with impact caps, after consultation with the responsible authorities. As a further measure, all employees were put through several weeks of a “construction fitness” programme. Here, a sports scientist intensively followed the tunnelling work in particular, and gave the employees advice on working movements, in order to prevent damage to the musculoskeletal system.

## Facts and figures

| | |
|---|---|
| Tunnel Length | 2 x 10 km |
| Tunnelling Technology | Earth pressure balance shield with segmented construction |
| Inner Diameter | 2,600 mm |
| Cutting Wheel Outer Diameter | 3,396 mm |
| Number of | 14 |
| Number of fully fitted out shafts | 12 |
| Depth | 25 to 45 m |
| Geology | Mainly marl, one sandy fault zone |

## Part 2: Civil engineering

As with the tunnelling work, the current shaft construction is also taking place under special conditions. Both the spatial limitations and the complexity of the construction works pose a number of challenges. Although the shafts are quite wide, with an inner diameter of 12.5 m, the space required for the formwork and auxiliary construction such as falsework and work platforms is so great that these must be planned precisely, so that the works do not impede each other, and safe working conditions can be maintained.

## Technical challenges

Basically, one outer wall and two separating or partition walls must be built in each shaft construction pit. Additionally, in some shafts, one or even two swirl chambers must also be built. Once in operation, the wastewater from the inlets above will flow through these down to the main sewer. When in use, the shaft structures may be subject to increased acid attack, so the shafts are constructed from acid-resistant concrete. Shafts into which the wastewater will flow via a swirl chamber must be clad in polyethylene slabs in addition to acid-resistant concrete. For the formworking of the outside walls, PORR relies on climbing and sliding methods. In these approaches, the formwork is hoisted by means of a special lifting apparatus. Fabrication by the climbing formwork method proceeds in sections; every section is individually reinforced, and then concreted. This has the advantage of allowing every section to be manufactured in a controlled manner, and no time pressure arises. The disadvantage is that a construction joint must be made after every section. In the sliding method, a construction-joint-free construction is achieved, as the reinforcement and concreting work runs continuously in 24-hour operation. The disadvantage here is that the work cannot be interrupted. This places high demands on the supply of concrete, the general logistics, as well as the organisation of the works. The advantage of the sliding method is fast completion. For comparison: the fabrication of a shaft by the sliding method takes around nine days, but by the climbing method would require around 28 days.

The structure of the climbing formwork shows the different working levels and the lifting apparatus.
Image: PORR AG

The civil engineering works of the project involve three different types of shaft. In most shafts, the outside wall of the shaft is concreted against the existing diaphragm wall. In this case, a dimpled drainage layer must be installed first. Because of the large depth of the shafts, this is conducted from a work basket, as the construction and deconstruction of scaffolding would incur long lead times. Therefore, the reinforcements are brought in piecewise. The installation of the reinforcements is clearly complicated by the limited accessibility, since the rear rows of reinforcement must be installed over the reinforcement joint at the front. In the shafts where cladding with polyethylene slabs is not necessary, the sliding method is used. Shafts with polyethylene cladding can only be fabricated by the climbing method, since this step can not be incorporated in the sliding approach for one-sided formwork. If polyethylene panels are to be installed, they must be subsequently welded together, in order to provide the necessary water tightness. To do this, work platforms from which the welding work can take place are mounted underneath the climbing formwork. Thus the work takes place on two levels above the platform; whilst the next section is being concreted above, the polyethylene slabs for the previous section are being welded on the level below.

A shaft inside a shaft.
Image: PORR AG

The fabrication of the outer walls of the starting shafts also requires a different approach. In order for these shafts to be used as starting shafts and logistics shafts for the tunnelling, they were manufactured with a larger diameter than necessary for the subsequent operation of the sewer. In this case, the existing diaphragm wall is not concreted, but the outer walls of the shaft are instead fabricated by means of two-sided formwork. Unlike the single-sided formwork, this is accessible from both sides. Therefore, in this case, the formwork can proceed by the sliding method, even though polyethylene slabs must also be incorporated.

Construction of the two-sided formwork of the starting and logistics shafts.
Image: PORR AG

After the outer walls, the fabrication continues with the inner walls, also clad with polyethylene slabs, including the swirl chambers. For this, a support structure is necessary; this will later be modified to create the support structure for the ceiling formwork. Because of the complicated construction of the swirl chambers and space limitations, it is not technically feasible to fabricate all the inner walls at the same time. Therefore, the walls comprising the swirl chamber are “tightened up”, or finished off, later.

Construction of the inner walls.
Image: PORR AG

The next steps of the work involve the construction of the ceiling, including superstructures and the assembly of various built-in elements, and the building of gutters and clinker brickwork in the shaft. The clinker bricklaying and

installation of all the built-in elements are particularly complex and very time consuming. Many of these works take place at different heights, so again support scaffolding will be needed. The built-in elements can also differ from shaft to shaft, and must therefore be fabricated and installed accordingly.
The many different construction processes and subsections require precise organisation and planning of the works. Also, high demands are placed on the quality of the work – not only in the terms of the contract. Reworking defects would entail a heavy work load and long delays. For example, a work platform would have to be set up for the retrospective welding of polyethylene slabs in the upper section. To reduce the occurrence of any such faults in the construction, the site management employees carry out regular checks and maintain thorough documentation.
Furthermore, the location of the shaft construction works complicates the organisation of the construction process. Twelve shafts are to be fitted out, each one currently in a different stage of construction, spaced along the 10 km route. Driving from the first shaft to the last can take up to 45 minutes in rush hour traffic. Therefore, the works must be well organised, with the timings and assignment of employees carefully worked out, so that as few extra journeys as possible are required. Also, since failure of construction equipment can lead to long waiting times and accompanying delays, regular testing and maintenance of the equipment is essential.

### Workplace health and safety

As in the tunnelling works, workplace safety is also top priority in the construction of the shafts. Since the access routes to individual work areas change regularly as the construction progresses, it is important, particularly during the fabrication of the external walls, to adapt these access routes in the course of the works. That is why PORR moved and rebuilt the stair towers over the course of the works to ensure safe access routes in every phase. After the work on the outer wall, work progresses on several subsections at the same time; good coordination of subcontractors is essential to guarantee workplace safety, as up to 20 people can be working in a shaft at one time. Employees take part in regular courses and are given frequent instruction in the correct usage of personal protective equipment.

An exhaust duct in the secondary shaft.
Image: PORR AG

A gutter in the secondary shaft.
Image: PORR AG

A swirl chamber in the main shaft.
Image: PORR AG

### Summary

The Emscher sewer is in a class of its own. Currently, there is no comparable project in the whole of Europe. The engineering, logistics and, last but not least, workplace safety, posed enormous challenges for PORR.
In the tunnelling work, the small inside diameter of just 2.6 m is particularly noteworthy. This is right at the limit of what is possible not just technically, but also in terms of workplace health and safety.
The civil engineering works are characterised by their high degree of complexity and stringent quality demands. Because of the many different subsections and procedures involved, the works require precise planning and coordination.
It is thanks to the technical and organisational know-how of PORR that the tunnel construction work could be successfully completed in June 2017, and also that the ongoing shaft construction is running to plan.

# Fylkesveg 17 Liafjellet

## Building close to the Arctic Circle

Norbert Hörlein

### Project data

| | |
|---|---|
| Client | Statens Vegvesen / Nordland Fylkeskommune |
| Contractor | PORR Nordic Construction – Norge AS |
| Project type | Tunnel construction/infrastructure . Road and tunnel construction |
| Scope of performance | Construction of two new tunnels and a 5.5 km road section |
| Start of construction | September 2016 |
| End of construction | August 2019 |
| Country | Norway |

PORR are constructing two tunnels and a 5.5 km long road section 10 km south of the Arctic Circle.
Image: PORR AG

### General information

Fylkesveg 17 is an approximately 630 km long county road linking the cities of Steinkjier and Bodø. The road narrows to one lane along a three-kilometre bottleneck near the village of Bratland. In the winter months, avalanches pose an additional risk to traffic on the western side of the Liafjellet mountain. For this reason, the municipal road authorities began plans to expand this bottleneck in late 2011. In September 2016, PORR Nordic Construction – Norge AS (PNC Norge AS) – a 100% PORR subsidiary based in Oslo – was awarded the tender for constructing this section.

### Background

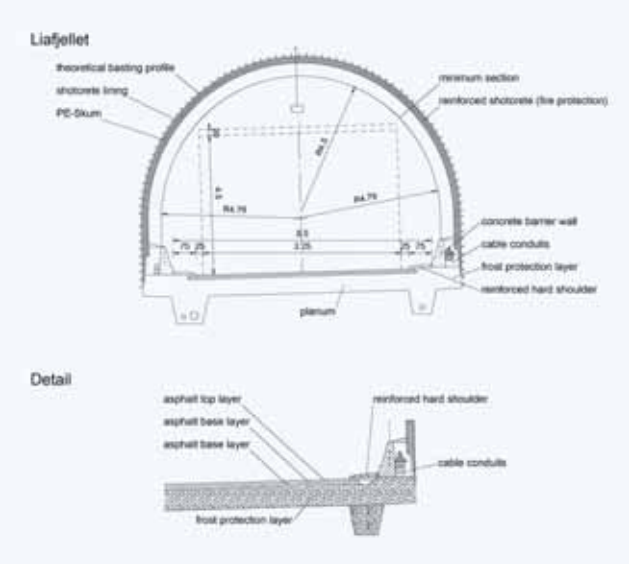
Project Fylkesveg 17 Liafjellet – Olvikvatnet is located in the Norwegian province of Nordland, around 10 km south of the Arctic Circle on the European North Sea coast. The job entails the construction of two road tunnels with an excavation profile of around 69 m² and a total length of 2.2 km, and a 2.8 km section of two-lane highway. Over 300,000 m³ of rock will have to be removed for this purpose. Most of it will then be used in a causeway for the road as it crosses Lake Olvikvatnet.

### Geological conditions

The project site consists predominantly of various metamorphic rocks such as gneiss and schist, as well as igneous rocks such as granite. The granite has rock strength properties ranging above 160 N/mm². This facilitates tunnelling up to a longitudinal excavation depth of five metres. The hydrological conditions are dry to pit-moist for the most part, but PNC do expect isolated influxes of mountain water.
The projected road will cross Lake Olvikvatnet, which is 0.61 km² wide and the bottom of which is covered with a one-metre layer of sediment and silt. These sediments must be removed before the filling works begin to ensure a high-quality supporting surface for the causeway.

### Boring the tunnel

The project includes the construction of two road tunnels. The Bakliholtan tunnel in the north is 443 m long, while the Liafjellet tunnel located in the south is 2,005 m long. Both tunnels have the same cross-section profile: the Norwegian standard profile T 8.5.




Standard cross section of the tunnel
Image: PORR AG

The lanes are 3.5 m wide in both directions, including a 25 cm border strip. Breakdown lay-bys will be created every 500 m in the Liafjellet tunnel, as well as three engineering rooms to house the necessary electronic equipment and traffic control systems.
PNC uses a representative of the latest generation of three-boom Sandvik tunnelling jumbos to bore the tunnel. This machine can drill blasting holes of an average length of 5 m into the mountain in a fully automated process. The tunnelling engineers use a special computer programme to create the blasting plans, which are then transmitted to the drilling machine via Wi-Fi. The driver then pulls up the

current drilling plan and is guided to the respective drilling locations that have been determined beforehand. If geological conditions are homogeneous, this can also be carried out by the machine autonomously.

The Sandvik three-boom tunnelling jumbo can create blasting holes in a fully automated process.
Image: PORR AG

### A premiere for Norway

The rocks are secured with steel-fibre-reinforced jetcrete and anchor systems. PNC systematically uses electronic blasting detonators, a first for Norway. Each detonator is individually programmed beforehand with its own delay time. Using electronic detonators not only leads to improved blasting results, it can also reduce the environmental impact. For example, the plastic hoses used in non-electronic detonator systems and which were tipped into the sea along with the tunnel excavation material, have been found in whales' stomachs. The wires used in electronic detonators, on the other hand, remain in the underwater disposal sites.

The debris removal works are carried out with the aid of a wheel loader and articulated dump trucks with a load volume of 25 cubic metres.
Image: PORR AG

When an increased influx of water was identified while boring the Liafjellet tunnel in July 2017, PNC responded by systematically injecting cement into the mountain. In line with the client's specifications, 24 m long holes were drilled and then filled with a cement suspension. Up to 40 of these drilled holes create an injection screen which significantly reduces the influx of mountain water, allowing tunnelling works to continue. These injection screens were created every 10 to 15 metres, depending on the water influx.

PNC responds to increased water influx by creating injection screens, consisting of up to 40 drilled holes filled with a cement suspension.
Image: PORR AG

### Constructing the tunnel

Once the tunnelling works have been completed, both tunnels are lined with a material called PE-Skum.
This construction method is prevalent in Scandinavia and differs significantly from the method commonly used in Central Europe. An inner tunnel shell is created out of polythene slabs, which are attached to anchors in the mountain rock face. Structural steel lattice mats are then placed on top and covered with an 8 cm layer of jetcrete. The mountain water drains off into the cavity between the rock face and the outer edges of the polythene slabs, where it is then conducted into the bottom drainage system.
In a final step, both tunnels will be equipped with an asphalt road surface and the corresponding traffic guidance and safety systems.

### On the open road

The planned overground road section is divided into two main segments. The works on the segment between the two tunnels will mainly involve filling operations and adapting the terrain. Extensive blasting works will, however, be necessary at the north end of the construction site.
Most of these rock masses will be used to build the causeway supporting the road across Lake Olvikvatnet. A large part of the tunnel excavation material will also be used for this lake crossing.
Prior to these works, approximately 50,000 m³ of silt and mud had to be excavated from depths of up to 30 m to ensure a solid contact surface for the filling operations. The works in the lake were carried out from floating work platforms, known as barges. Hopper barges were also used. 3D underwater scans and remote-controlled mobile cameras were used to monitor the quality of these works.
The final steps of the overground works will involve covering the road with an asphalt surface, installing traffic guidance systems, and constructing a small, 30 m long bridge in the lake to avoid disrupting the natural water currents.

Floating work platforms and hopper barges were used for the works in the lake.
Image: PORR AG

### Summary and outlook

The construction site's isolated location, combined with the challenging weather conditions near the Arctic Circle, represent the most noteworthy features of this project. Thanks to the excellent cooperation between everyone involved, the works were implemented to a high standard and to the client's complete satisfaction. The construction works are currently going ahead satisfactorily, and the construction project is to be handed over to the client in September 2019, as contractually agreed.

The PNC Arctic Circle team is made up of no less than seven different nationalities.
Image: PORR AG

# Reconstruction of the Jiul underpass in Timişoara

## Using "Box Jacking" as an unusual method

Harald Metzinger

### Project data

| | |
|---|---|
| Client | The City of Timişoara |
| Contractor | PORR Construct SRL |
| Project type | Infrastructure . Bridge construction |
| Scope of performance | Replacement and extension of an underpass including the supporting bridge superstructures |
| Start of construction | June 2016 |
| End of construction | November 2017 |
| Country | Rumania |

The Jiul passage in the centre of the city of Timişoara.
Image: PORR AG

### General information

The Jiul passage is one of the main traffic junctions in the western part of Timişoara city centre. As the existing rail bridge proved too small for the amount of traffic, the Timişoara city administration resolved to replace and extend both the underpass and the supporting bridge superstructures. In order to maintain rail and road traffic operations, the client stipulated that the works were to be carried out using the "Box Jacking" method. The tender was awarded to PORR Construct SRL on 31 March 2016.

Rail traffic operations had to be maintained throughout the entire construction period.
Image: PORR AG

### The existing bridge

The existing structure was a 12.6 m long steel bridge which formed part of the railway line between the east and north railway stations in Timişoara. The bridge consisted of three separate superstructures, two of which were constructed in 1957 and a third added in 1972 in the course of widening the railway line to include three tracks.

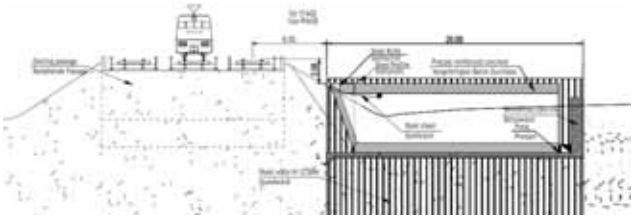
### The new construction

One of the existing abutments was to be used for the new bridge, and so it was reinforced and refurbished. 35 micro-piles were produced for this purpose and 350 anchor points were bored to ensure a friction-locked connection between the new retaining wall and the abutment. The second abutment was designed as a passage for cyclists and pedestrians and was inserted next to the old abutment.
Like the old bridge, the 19 m long new bridge consists of three separate superstructures, which are however constructed as steel-composite trough bridges. All the superstructures were constructed next to the old bridge and then hoisted into their final positions. In a final step, the roads were adapted to the new conditions.

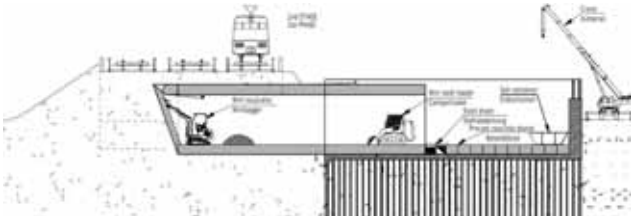
Completing the trough bridge superstructures at the construction site.
Image: PORR AG

### The "Box Jacking" method

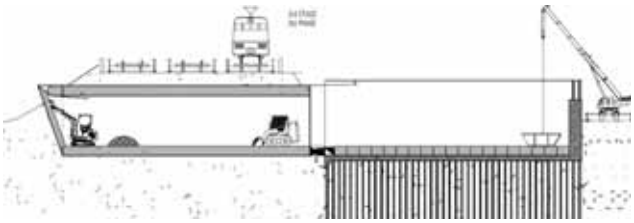
The second abutment was designed as a passage and was constructed using a special process: the "Box Jacking" method. This refers to shunting a completed reinforced concrete passage horizontally underneath an existing road or railway to avoid traffic disruptions.
The client's decision to use this method, which is rarely implemented in practice, was due to the existing switches in the immediate vicinity of the new abutment, which prevented the construction of provisional bridges.



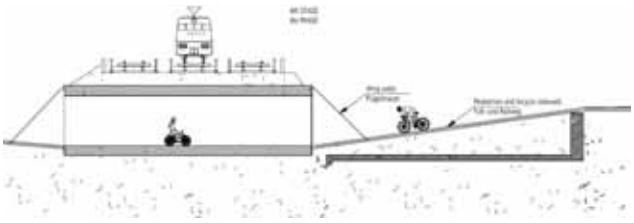
Box Jacking stage 1: Completing the passage including the shield.
Image: PORR AG



Box Jacking stage 2: Jacking the passage and excavation.
Image: PORR AG



Box Jacking stage 3: Jacking the passage into its final position.
Image: PORR AG



Box Jacking stage 4: Final works.
Image: PORR AG

### Constructing the passage

In order to construct the passage or abutment, the excavation pit was enclosed using sheet piles and then excavated to the required depth. A launch pad was then constructed in reinforced concrete to form the basis for the passage.
The completed passage, measuring 5.85 x 4.3 x 16.5 m and weighing 550 metric tonnes, was additionally pre-stressed in all directions. A steel and concrete shield was constructed at the front end of the structure to protect it from loads from above and to reduce friction during the jacking process. Eight hydraulic jacks at the rear of the structure provided a total compression force of 24,000 kN for the jacking process.
To minimise friction on the surface of the passage, steel bands were fitted to isolate the passage from the ground.

### Inserting the passage

Inserting the passage or abutment itself took only 10 days; the works were carried out night and day. The propulsion length per jack stroke was approximately 15 cm. After each stroke, the outcropping soil was loosened with a mini-excavator, driven out of the passage with a compact loader and lifted out of the construction pit by a vehicle mounted crane. At a total propulsion length of approximately one metre, prefabricated concrete blocks were hoisted in to bridge the gap between the jacks and the supporting wall.

### Removing the old superstructure and preparing the abutment

Once the passage had reached its final position, the preparatory works for hoisting in the bridge elements could commence. As one track was always in operation during these works, particular attention had to be paid to the workers' safety.
After the old bridge superstructure had been hoisted out during a brief total track possession period, PORR constructed the new bridge bearing and removed the old abutment.

### Hoisting in the new supporting bridge superstructures

The three new bridge superstructures are composite bridges and were prefabricated on the construction site. After the abutments had been completed, a new bridge superstructure, weighing a total of 115 metric tonnes was hoisted in by a crane during another three-hour possession period. A new track was then constructed and opened for railway traffic, and works on the next abutment could commence.

### A roadway heating system for the underpass road

Another special feature of this project is a roadway heating system installed in the underpass section to ensure that the road is free of snow and ice, even during the winter months. The system was originally to have been installed under asphalt. Due to their lack of long-term experience with asphalt roadway heating systems, PORR was able to persuade the client to switch from asphalt to concrete.

The installed roadway heating system prior to being concreted.
Image: PORR AG

### Main dimensions

| | |
|---|---|
| Bridge length | 19 m |
| Bridge width | 15 m |
| Composite steel bridge | 3 x 115 metric tonnes |
| Newly built road | 14,800 m² |
| Construction site enclosure | 600 m² |
| Micro-piles | 250 m |
| Track construction | 120 m |
| Snowmelt system | 1,200 m² |
| Pumping station | 1 |

### Summary

PORR was once again able to demonstrate their technical expertise in this challenging project. A special thanks is due to the PORR project management team on site, who were responsible for the successful implementation of this project.

Final Opening in November 2017
Image: PORR AG

# PORR . Building constructions in high demand in Vienna

## The new orders at a glance

Alfred Vandrovec

Project See See in Aspern lake town
Image: BUWOG Group

PORR Bau GmbH . Building constructions currently have plenty of work to do in the Austrian capital. The building company has been entrusted with the implementation of several exciting new projects.

### Project See See Aspern lake town

PORR was commissioned by the BUWOG Group to implement three connected projects in Aspen lake town as the general contractor. The projects See See Tower, See See Living and See See Home will be created on three adjacent construction plots. The order volume is approximately EUR 38.0 million (net). Construction began in late August 2017. The deciding factor for awarding the contract to PORR was its high-quality construction, as demonstrated by various projects including the Pfarrwiesengasse project.

### Project at the Nordbahnhof

The housing company Österreichisches Volkswohnungswerk awarded PORR the contract for another residential / office project at the Nordbahnhof, as general contractor. The order volume is approximately EUR 25.7 million (net). The office construction will be carried out separately. Once again, the deciding factor for this contract was the perfect implementation of an ongoing contract on Traviatagasse.

### Beeresgasse Campus

A PPP project was secured jointly with PBM and PORREAL at the Beeresgasse Campus. The construction order volume is around EUR 43 million (net) and includes not only the general contractor services, but also execution planning, which will be carried out by PORR Design & Engineering, a PORR group subsidiary company.

### Boehringer industrial construction project

This summer, PORR secured another partial contract in the industrial construction project Boehringer Ingelheim Wien. Following the infrastructure services, excavation enclosure and deep foundations including ground plates and cover plates, the construction company was also awarded the contract for the master building work for the basement. The order volume for this project is EUR 5.1 million (net). In the meantime, the master building works for the project LSCC (Large Scale Cell Culture), with an order volume of roughly EUR 32 million (net), and the general contractor works for the Quality Center, with an order volume of EUR 25 million (net) have also been awarded to PORR.

### KIBB residential building at the Nordbahnhof

PORR secured the order for a KIBB residential project; also located at Vienna Nordbahnhof. The order volume is approximately EUR 15.5 million (net).

### "Neues Leben" in Vienna 22

Furthermore, PORR was awarded two more residential construction projects by regular client "Neues Leben": one in Esslinger Hauptstraße with an order volume of EUR 13.5 million (net) and the other in Mühlgrundgasse with an order volume of EUR 18 million (net). The quality of the last projects was a decisive factor in awarding the contract to PORR.

### Major project MGC Erdberg

The housing association Win4Wien-Bauträger also chose PORR for an ambitious major project: construction works for the project MGC Erdberg are scheduled to start on 13 November 2017, the order volume is nearly EUR 50 million (net).

### Revitalisation IBC Hetzendorf

The construction group also managed to land a notable contract in the revitalisation sector: the contract for renovating the facilities at the IBC Hetzendorf school in Hetzendorferstraße was awarded to the bidding consortium PORR/P&B. Construction will start shortly. The order volume is EUR 23 million (net).

### Building renovations at the Flötzersteig

Last but not least, the housing association gebös has awarded PORR a EUR 4.5 million (net) contract to renovate a building at the Flötzersteig.

# BMW Freimann office building

## Automobile company trusts in PORR's experience

Alfred Zehetgruber

Visualisation of the new BMW office building
Image: PORR AG

### Project data

| | |
|---|---|
| Client | BMW AG |
| Contractor | PORR Bau GmbH; PORR Deutschland GmbH |
| Project type | Building construction . Office |
| Architect | PORR Design & Engineering GmbH |
| Scope of performance | General contracting services for the construction of an office building in Munich |
| Gross floor area | 74,000 m² |
| Start of construction | July 2017 |
| End of construction | Early 2019 |
| Country | Germany |

BMW AG has awarded PORR Bau GmbH the last and most important part of the contract as main contractor for consultancy services, planning and construction of an office building in the Munich district of Freimann. The project is to be fully equipped with all modern amenities and will fulfil sustainability criteria.

Several factors contributed to PORR's lead in the bidding for this major contract: intensive consulting services that began during the planning stage, a high quantity of suggestions and improvements, and consistent use of LEAN management principles.

### Cross-departmental teamwork as a factor for success

Ultimately, the deciding factor was the fact that the project is handled by PORR Design & Engineering, PORR Major projects . Building Construction and PORR Deutschland GmbH Munich in a cross-departmental team. This ensures that, from the very outset, the planning team and the team carrying out the construction can combine their expertise on the project. The preliminary draft and small sections of the early design planning stages were created by the Munich-based office Obermeyer Planen und Beraten GmbH.

The construction of the 74,000 m² building is jointly implemented by the PORR Major projects . Building Construction department and PORR Deutschland GmbH Munich. The raw construction works are already well underway and LEAN management principles are used consistently in the operational management of the construction site. The entire project is scheduled for completion at the beginning of 2019.

# Baltyk Tower

## The new symbol of Poznań

Magdalena Sojka- Kobrzyńska

The Baltyk Tower – a building with many faces
Image: PORR AG

### Project data

| | |
|---|---|
| Client | Sophia (Garvest i Voelkel) |
| Contractors | PORR S.A. |
| Project type | Building construction . Office |
| Architect | Design studio MVRDV |
| Scope of services | General contractor services for the construction of an office building with 16 upper floors and three basement floors with parking garages and engineering rooms |
| Gross floor space | 30,650 m² |
| Construction start | November 2015 |
| Construction end | June 2017 |
| Country | Poland |

The centre of the city of Poznań in Poland has a new landmark: the Baltyk Tower. With 16 upper floors for offices and businesses and three basement floors with parking garages and engineering rooms, the building has a gross floor area of 30,650 m².
After 30 months of construction, the building was officially opened on 2 June 2017. The general contractor for the project was PORR S.A.

### Central meeting point

The Baltyk building is located in the most attractive square in Poznań: at the city's central transportation hub, near Poznań's International Conference Centre and the main train station. The site was formerly the location of the Baltyk Cinema, which had been a meeting place for local residents of all generations from 1929 to 2002. For this reason, the name Baltyk was retained for the new building.

### Unique design

The Netherlands-based design studio MVRDV is responsible for the architecture. It is one of the best architecture offices in the world and this project represents its début in Poland. MVRDV is known for its unconventional and modern ideas, which can also be seen in the Baltyk Tower. The irregular building design merges with the specified construction line. The cascade-like observation decks on the south and the sloping surfaces at other points make the building look different from every angle. The main entrance is accentuated by an undercut in the building structure.

# AUSTRIA CAMPUS

## New development in Vienna Leopoldstadt

Harald Schön

Visualisation of the new office complex in Vienna Leopoldstadt
Image: comm.ag Communication Agency GmbH

### Project data

| | |
|---|---|
| Client | AOC Fünf Immobilien GmbH & Co OG, AOC Sechs Immobilien GmbH & Co OG, AOC Sieben Immobilien GmbH & Co OG, AOC Acht Immobilien GmbH & Co OG, AOC Neununddreißig Immobilien GmbH & Co OG |
| Contractors | Consortium AUSTRIA CAMPUS 2017/2018 with PORR Bau GmbH and STRABAG AG |
| Project type | Infrastructure . Road construction |
| Scope of services | Road construction and installation of utility lines, as well as landscaping for the AUSTRIA CAMPUS office complex |
| Construction start | May 2017 |
| Construction end | June 2018 |
| Country | Austria |

With a gross floor space of approximately 303,000 m², the AUSTRIA CAMPUS office complex is being constructed in one of the most attractive business locations in Vienna, perfectly situated in Vienna's Second district. As part of a consortium, PORR has been commissioned with the road construction and laying of the utility lines, as well as the landscaping for the site. The order volume is EUR 10.65 million (net).

### Building details

- Road construction/outdoor installations:
- 20,000 m³ embankment
- 30,000 m² concrete paving slabs
- 10,000 m³ light granulate filling
- 370 trees planted
- 3 km granite kerb demarcation
- 3.5 km Corten steel kerb demarcation

**Utility lines:**

- 4.5 km pipe ducts
- 5.5 km cable conduits
- 80 light masts

### Bringing new value to the district

Over the coming three years, five modern and sustainable office complexes will be built on the site with their own infrastructure and perfect connections to the public transportation network.
The value of the project will be compounded as useful synergies are established in the immediate neighbourhood with the nearby conference centre and the campus of the Vienna University of Economics and Business Administration.

The implementation of this project will make a significant contribution to Vienna's urban development. The AUSTRIA CAMPUS is also very important for the overall development of the district. There are plans for gastronomic businesses, as well as retail spaces, a hotel, a medical centre, as well as a spacious kindergarten. The expansive, tree-planted green areas create a pleasant atmosphere in the inner courtyards of the AUSTRIA CAMPUS. The planned end date for the project is June 2018.

Visualisation of the inner courtyard.
Image: comm.ag Communication Agency GmbH

Visualisation of the inner courtyard.
Image: comm.ag Communication Agency GmbH

# Office complex Spreespeicher Berlin-Kreuzberg

## Major project for PORR in Berlin

Jürgen Maikisch

A new office complex will be built on the banks of the Spree in Berlin within the next two years.
Image: Cuvrystraße 50-51 Berlin GmbH

### Project data

| | |
|---|---|
| Client | Cuvrystraße 50-51 Berlin GmbH |
| Contractor | PORR Großprojekte Hochbau BU1 [Major projects . Building construction] under the management of PORR Deutschland GmbH |
| Project type | Building construction . Office |
| Architect | nps tchoban voss GmbH & Co KG |
| Scope of performance | General contractor services for the construction of four buildings with office and commercial spaces and the construction of an underground parking garage with 163 parking spaces |
| Gross floor area | 31,659 m² |
| Start of construction | January 2018 |
| End of construction | January 2020 |
| Country | Germany |

The PORR Major projects . Building construction department, under the management of PORR Deutschland GmbH, has been awarded another contract in Berlin: The "Neue Spreespeicher" project in the district of Kreuzberg will comprise six buildings with office and retail spaces.

The contract was awarded by Cuvrystraße 50-51 Berlin GmbH and includes general contractor services and execution planning. The services contracted to date include four buildings and an underground parking garage with 163 parking spaces extending across the entire site. The order volume for this project is currently around EUR 46 million (net).

A decision will be made regarding the construction of the two other buildings as soon as the company has received planning permission, which will probably be in January 2018. If PORR is awarded this contract as well, plus the contract for the interior finishing works, the project will have a net order volume of EUR 80 million (net).

The 24-month implementation period requires tight logistics and a well-thought-out site setup. The buildings will be adapted to their historic surroundings – a sensitive area on the banks of the Spree – and a tenant has already been found for them.

# BFI Lower Austria, construction section III:

## Groundbreaking ceremony

Dieter Haderer


Left to right: Mayor Josef Panis, 2nd Deputy Mayor Horst Karas, CEO of BFI Lower Austria Peter Beierl, 1st Deputy Mayor Dr. Christian Stocker, President of the AKNÖ and Chairman of the Lower Austrian Trade Union Federation CC Markus Wieser, National Secretary of the Austrian Trade Union Federation CC Christian Farthofer, Commissioner Dieter Haderer, CEO of BFI Lower Austria Michael Johnach M. A.
Image: PORR AG

### Project data

| | |
|---|---|
| Client | Berufsförderungsinstitut (BFI) Lower Austria |
| Contractor | PORR Bau GmbH |
| Project type | Building construction . Office and training building |
| Architect | Planning for construction section 3: Baumeister Josef Panis GesmbH & Co KG |
| Scope of performance | Expansion of the Josef Staudinger training academy by 9,000m² as general contractor for construction section 3. |
| Gross floor area | Construction section 3: 2,473m² |
| Start of construction | June 2017 |
| End of construction | May 2018 |
| Country | Austria |

PORR Bau GmbH was awarded the contract for the expansion of the Josef Staudinger training academy. The groundbreaking ceremony took place on 29 June in Wiener Neustadt with Markus Wieser, President of the Lower Austrian Chamber of Labour, and Peter Beierl, CEO of the vocational training institute BFI for Lower Austria, in attendance.

Having already been responsible for the construction of sections 1 and 2, PORR is now also the general contractor for construction section 3. The 9,000 m² expansion will provide room for 260 additional students and 14 seminar rooms. The building houses 520 students over a total area of 21,000 m².

The BFI site, located in the commercial district of Nova City, has been operating since 2012. The site houses both the national headquarters and the Wiener Neustadt service centre. The Josef Staudinger training academy is already one of Lower Austria's most modern training locations.

# University Hospital of St. Pölten

## PORR responsible for conversion, new construction and expansion

Johann Aigner

Site plan for the University Hospital of St Pölten: D block will be reconstructed, A Block will be demolished and relocated to the new development .
Image: PORR AG

### Project data

| | |
|---|---|
| Employer | St Pölten University Hospital Facility |
| Contractor | PORR Bau GmbH in an consortium |
| Project type | Building construction . Health care facility |
| Architect | Working partnership Pfaffenbichler – FCP |
| Project scope | Conversion and expansion of the University Hospital of St Pölten, plus new construction with room for 380 beds. |
| Gross floor area | approx. 53,000m² |
| Construction start | Mid-2018 |
| Construction end | End of 2023 |
| Country | Austria |

On the 17 May 2017, PORR Bau GmbH's Lower Austrian branch office, as part of a consortium with VAMED AG, was awarded the contract for the conversion and completion of the University Hospital of St. Pölten. Plans include the complete reconstruction of D Block and the Psychiatry building as well as conversion of B Block and the necessary connections to neighbouring buildings. The contract has a total value of around 190 million EUR (net).

The contract, which was awarded via a negotiation process with prior notification of the upper limit, was announced throughout Europe on 19 June 2015. After submission of the initial offer in July 2015, an intensive negotiation process ensued, from which PORR emerged victorious.

### Main contract in St. Pölten

The contract covers the development and optimisation of the entire project, lead design and turn-key construction. This also encompasses the outfitting of the new and converted buildings including all outdoor facilities in the planning area and all necessary demolition and relocation works for what is currently the last major section of the University Hospital of St. Pölten.

### Conversion – new construction – demolition

With work on the company's organisational planning and preliminary design already underway, the next step is to obtain construction permits and legal clearance for the sanitation facilities. The conversion of B block will begin in mid-2018. One year later work will commence on the reconstruction of D Block, with a net floor area of around 22,000 m², along with all necessary connections to existing buildings. The block will have room for 380 beds. The beginning of the planning phase for the reconstruction of the Psychiatry building is set for mid-2019.

Completion is expected in 2023, after which A block – originally built during the 1970s – will be evacuated and subsequently demolished. The whole project, including demolition, will be completed by the end of 2023.

# Vaillant in Remscheid

## PORR is building a new research and development centre

Nicole Stiegler

The Düsseldorf Building Construction subsidiary of PORR Deutschland is building the new R&D centre for heating technology company Vaillant. Image: RKW

### Project data

| | |
|---|---|
| Client | Vaillant |
| Contractor | PORR Deutschland GmbH |
| Project type | Building construction . Office and commercial building |
| Architect | RKW Architektur + , Düsseldorf |
| Scope of performance | General contractor services for the construction of a research and development centre |
| Gross floor area | 25,200 m² |
| Start of construction | May 2017 |
| End of construction | End of 2018 |
| Country | Germany |

With around 12,000 employees worldwide, Vaillant is one of the market and technology leaders in the heating technology sector. With a new research and development centre consisting of two office blocks and a test centre, the company is concentrating on environmentally friendly, resource-conserving technologies. Vaillant has awarded the Düsseldorf Building Construction subsidiary of PORR Deutschland GmbH the contract for constructing the extension at the Remscheid headquarters. Construction began in May 2017 and is expected to be completed by the end of 2018. The order volume is around EUR 22 million (net), not including technical facilities.

The new R&D centre is situated directly beside the existing factory area and will be connected to the existing building by a glass atrium. In total, a testing centre with a floor area of 9,000 m² and two office blocks with a total floor area of 14,500 m² will be constructed. 200 car-parking spaces and six electric charging points will also be created on the site.

### Modern, flexible workspaces

Around 570 employees from every department involved in the product creation process will move into the two new office blocks. The office space concept was designed in coordination with the Fraunhofer Institute for Industrial Engineering and can be flexibly adapted to the requirements of the interdisciplinary teams and projects.

### The focal point of the research and development centre

The test centre will house around 90 employees. The structure has a reinforced concrete frame with a 7.50 m x 7.50 m grid, ensuring spacious rooms and a flexible layout. It will house over 230 testing benches, including 40 heat pump testing benches, 21 environmental chambers, a drop-test laboratory and a wind-test laboratory. The layout design must be as open as possible in order to meet the special requirements for individual testing benches. To this end, three of the four staircases will be located outside. Only individual wall slabs will be used for static bracing.

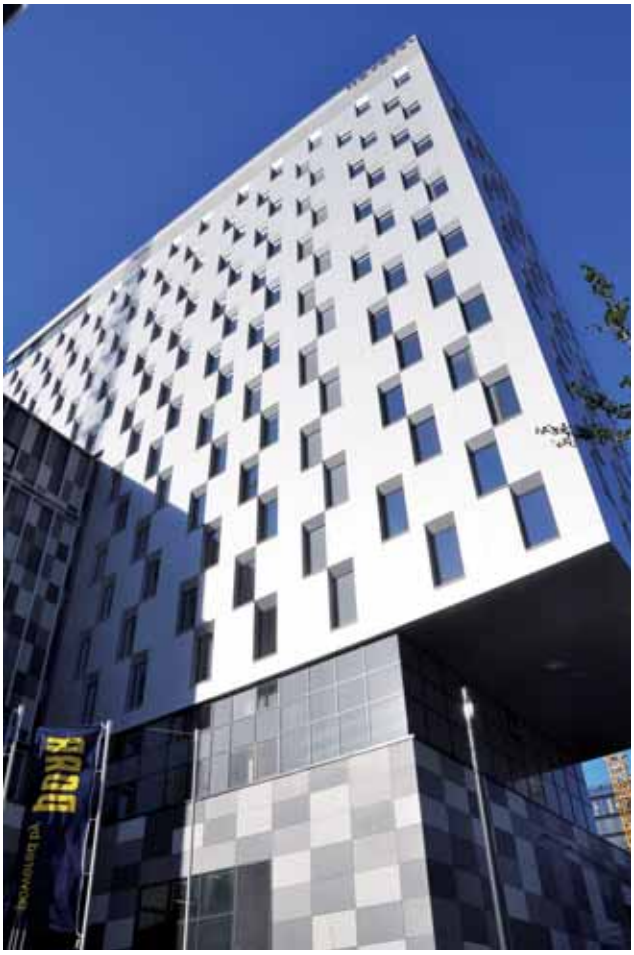
Another special feature is the 9-m-high EMC chamber for testing the products' and devices' electro-magnetic compatibility, located on the second floor; there is also a 6-m-high acoustic chamber on the ground floor.

Waste heat from the testing benches will be used to heat the R&D centre, which meets high sustainability standards overall. As one heads towards the atrium, the test centre façade changes from a closed porous concrete façade to a transparent glazed façade. This allows the testing benches to be seen from outside.

# Quartier Belvedere Central (QBC5)

## First construction phase completed according to plan

Hubertus Kröll



QBC5: Exterior view of the Novotel at Vienna Central Station.
Image: PORR AG

### Project data

| | |
|---|---|
| Client | STRAUSS & PARTNER Development GmbH |
| Contractor | PORR Bau GmbH |
| Project type | Building construction . Hotel |
| Architect | Neumann + Partner |
| Scope of performance | General contracting services for the construction of a 63-metre high building with a total of 577 rooms |
| Gross floor area | approx. 27,000 m² |
| Start of construction | May 2015 |
| End of construction | May 2017 |
| Country | Austria |

The first construction section of the Quartier Belvedere Central (QBC5) in Vienna, located right next to the central railway station, has been completed. In May 2017, PORR Major construction projects . Building construction, Vienna handed over the 63 m building to the building contractor STRAUSS & PARTNER and subsequently to the hotel operator Accor Hotelbetriebsges.b.H.

144,000 work hours during the skeleton construction stage, 29,000 m³ of concrete, 3,800 metric tonnes of steel, 3.5 km of threaded pipe and 19 finished storeys: After barely two years of construction, the AccorHotels Group welcomes the addition of two new buildings. A total of 577 rooms are available at the 3* hotel ibis and the 4* hotel Novotel. The opening ceremony for both hotels took place in July 2017.

The client emphasised and praised the outstanding achievements of the workers and the exemplary cooperation between everyone involved in the project.

Not just one, but two hotels were opened in July.
Image: AnnABlaU

# Forestry Training Centre in Traunkirchen

## New training wing built in record construction time

Stefan Doler

Visualisation of the new training centre.
Image: Hinterwirth Architekten ZT OG

Visualisation of the centre from a bird's eye view.
Image: Hinterwirth Architekten ZT OG

### Project data

| | |
|---|---|
| Employer | Gemeinnützige Wohnungs- und Siedlungsgesellschaft Austria Draht GmbH Bruck an der Mur |
| Contractor | PORR Bau GmbH |
| Project type | Building construction . Training building |
| Architect | Hinterwirth Architekten Ziviltechniker OG |
| Project scope | General contractor services incl. execution planning for the construction of a forestry training centre |
| Gross surface area | 18,752 m² |
| Construction start | June 2017 |
| Construction end | August 2018 |
| Country | Austria |

After a possibly record-breaking construction time of only five months for the carcam, the topping out ceremony for the Forstliche Bildungszentrum in Traunkirchen – a forestry training centre – took place on the 16 November 2017. This contract for PORR Bau GmbH as general contractor was awarded by the non-profit residential and housing association Austria Draht GmbH. The project team consists of both the Upper Austrian and Styrian PORR branch offices.

The building is divided into three wings, existing of administrative, training and residential wing. The work will include the complete renovation of a heritage listed nineteenth-century villa, a newly built training wing including kitchen, canteen and multi-purpose hall, and a new residential wing with 70 bedrooms, underground car park and several workshops.

### Sustainable construction

The building is divided into three wings, intended for administration, training and residential use. Wooden construction will be used throughout the upper floors. In addition, all conditions for the Gold "klima:aktiv" award must be met for this project.

After a construction period of 15 months, the campus, with its focus on forestry and silviculture, will train around 120 students and 8,000 short-course participants every year.

# Residential construction Erdberger Lände 26 Nord 2

## Topping-out ceremony for the "Laendyard" project

Michael Binder, Michael Teggan

### Project data

| | |
|---|---|
| Client | CA Immo and JP Immobilien |
| Contractors | PORR Bau GmbH |
| Project type | Building construction . Residential construction |
| Architect | BEHF, Malek Herbst |
| Project scope | General contractor tasks for the construction of a total of 270 residential units |
| Gross floor area | approx. 28.000 m² |
| Construction start | August 2016 |
| Construction end | May 2018 |
| Country | Austria |

PORR Bau GmbH . Building construction Vienna is the main contractor carrying out the Erdberger Lände 26 Nord 2 project, a residential complex with 270 investment apartments and condominiums, along with 1,350 m² of commercial space. Completion is scheduled for May 2018.

The topping out ceremony took place on 29 August on the site. Along with with our clients CA Immo and JP Immobilien, 400 guests were in attendance including workers, purchasers and commercial and political representatives.

Construction started on 16 August 2016 and the structural work was completed in July 2017. This was built as a reinforced concrete construction using prefabricated components. Four building sections stand on a construction area of 6,300 m², linked by a shared underground garage. As well as 270 apartments, the site will include 1,350 m² of commercial space.

The buildings stand out thanks to their high-quality facilities and elaborate façades. In building sections 1 and 4, these latter will consist of AluCobond and plaster façades. In building section 3, a combination of metal pilasters with sheet metal cladding and concrete reinforcements will be used.


A building tradition: the youngest worker recites the time-honoured verse to mark the topping out ceremony.
Image: PORR AG

On the roof of the shell construction.
Image: PORR AG

# Apartments in the former Naumannsche Brewery building

## PORR is building 226 apartments in Leipzig

Anke Dimmer

Modern apartments are to be constructed in the existing Naumannsche Brewery building, the heritage listed former brewhouse.
Image: Mann & Schott Architekten

### Project data

| | |
|---|---|
| Employer | ImmVest Wolf GmbH |
| Contractor | PORR Deutschland GmbH |
| Project type | Building construction . Residential building |
| Design architect | Architectural firm of Mann & Schott Leipzig |
| Project scope | Main contractor works comprising the construction of 226 apartments and 6 commercial units in 15 detached buildings in addition to 3 underground car parks with 215 spaces |
| Gross floor area | 29,500 m² |
| Construction start | March 2017 |
| Construction end | December 2018 |
| Country | Germany |

In early 2017, ImmVest Wolf GmbH awarded the Thuringia-Saxony branch of PORR Deutschland GmbH the contract to construct 226 flats and six commercial units in 15 detached buildings, as well as building three underground car parks with 215 parking spaces. The existing heritage listed building, part of a former brewery, will be integrated into the new construction. The contract has a total value of around EUR 33 million (net). Completion is expected by the end of 2018.

The construction project is located on the site of the former Naumannsche Brewery in the Plagwitz borough of Leipzig. The district, with its typical old industrial architecture, has become a popular residential area in recent years as well as becoming the focal point of the artistic scene in the Saxon city.

### Change of use

Carl Wilhelm Naumann, after whom the brewery is named, was an energetic businessman who left his mark on many parts of Leipzig. He purchased what is now the construction site, between Zschocherscher-Straße and Erich-Zeigner-Allee, in 1857. He initially had a storage cellar built on the site and later added a steam brewery. After a short period of privatisation, the operation was finally wound up in 1992. The premises have been standing empty for years, but now an expansive residential project for rental properties is being created, based on a design by architectural firm Mann & Schott Leipzig. The original buildings remaining on the site, the former brewhouse and ice cellar, are heritage listed and will be converted into residences and integrated into the redevelopment.

### Construction activities already underway

The comprehensive earthworks and demolition were carried out in March 2017. The greatest challenge lay in removing the labyrinthine underground cellar facilities from beneath metres of backfill. Now that these artefacts from the previous century have been removed, structural work is now well underway.

# Schlossquartier Kiel

## Structural works completed

Sabine Hansen


The internal joint venture, involving PORR Deutschland GmbH, regional branch Hamburg Hochbau and PORR Bau GmbH Großprojekte Hochbau Vienna, is proud of having achieved this milestone.
Image: H. Hurt

### Project data

| | |
|---|---|
| Employer | Allgemeine Baubetreuungsgesellschaft mbH (ABG), Norddeutsche Grundstücksentwicklungsgesellschaft (NGEG) |
| Contractor | PORR Deutschland GmbH |
| Project type | Building construction . Residential building and commercial |
| Design architect | AAG BBP-Schnittger |
| Project scope | Main contracting works for the planning and construction of a total of 213 residential units and commercial spaces |
| Gross floor area | 31,358 m² |
| Construction start | Beginning of 2016 |
| Construction end | Spring 2018 |
| Country | Germany |

The 7,560 m² Schlossquartier is located right in the centre of Kiel, between the Church of Sankt-Nikolai, the Schlossplatz and the Kieler Förde. In mid-2015, Allgemeine Baubetreuungsgesellschaft mbH (ABG) and the Norddeutsche Grundstücksentwicklungsgesellschaft (NGEG) awarded PORR Deutschland GmbH the contract for the turn-key construction of 213 residential units, comprising 130 freehold and 83 rental apartments, as well as office and commercial spaces.

The Schlossquartier consists of a block building with two tenement houses, three freehold apartments and a single tower, also containing freehold units. Plans also include an underground garage with 165 parking spaces. The residential units will be constructed in compliance with energy efficiency standard Effizienzhaus 70.

On the 6 July 2017, just a year after the foundation stone was laid, the roofing ceremony took place on the Kiel Schlossplatz. At the ceremony, the Lord Mayor of Kiel, Dr. Ulf Kämpfer, stated that the project was located on historic ground, and thanked the clients for investing in Kiel.

Ceremonial hoisting of the roof crown
Image: S. Hansen

Once the project is complete, in the spring of 2018, the new occupants will be able to enjoy the hustle and bustle of the old town and their proximity to the water from the comfort of their elegant apartments. At the same time, a 60s-era development which brought high volumes of vehicle traffic into the town centre will be reversed, making the heart of Kiel a residential area once more.

# Gleisarena and Gleistribüne

## Groundbreaking ceremony at Zurich Central Station

Paul Gilli

Official groundbreaking ceremony at the border between the Gleisarena and Gleistribüne sites.
Image: SBB AG

### Project data

| | |
|---|---|
| Client | Schweizerische Bundesbahnen SBB, limited company established by its own act of parliament and based in Berne, represented by SBB Immobilien Development |
| Contractor | PORR SUISSE AG |
| Project type | Building construction . Residential, office and commercial |
| Architect | Gleisarena: Made in Sàrl<br>Gleistribüne: Esch Sintzel Architekten |
| Project Scope | General contractor services for the construction of an office block (Gleisarena) and a residential complex (Gleistribüne) with 139 rental apartments and a retail area for businesses, retailers and restaurants |
| Gross floor area | Gleisarena: 7,371 m²; Gleistribüne: 20,874 m² |
| Start of construction | Gleisarena: May 2017; Gleistribüne: March 2017 |
| End of construction | Gleisarena: February 2020; Gleistribüne: August 2019 |
| Country | Switzerland |

In addition to the major contract for the "Europaallee" overbuild construction project, which comprises the three construction segments B, D and F, PORR SUISSE AG has been awarded two more contracts at Zurich Central Station: the Gleisarena and, on the other side of the railway tracks, the Gleistribüne. This means that PORR will play a significant part in shaping the view of the city from trains arriving at Zurich Central Station.

The official start of construction was marked by the groundbreaking ceremony on 10 July at the boundary between the Gleisarena and Gleistribüne sites, which was attended by representatives of the government and SBB Immobilien, as well as by urban planners and other stakeholders involved in the project.

### The Gleisarena

The Gleisarena, with a site area of 3,177 m² (not including the partially covered platform area of 1,019 m²) will be built above the Museumsstraße underground station, right next to Platform 18, in the heart of Switzerland's most vibrant economic region. To the south, the overbuild construction site borders the track and platform system of Zurich Central Station. Commercial spaces and a restaurant are planned for the ground floor, as well as service spaces in the upper floors. The building shell will be handed over to the client on 28 February 2020. The contract for the tenant fit out, which is expected to be in mid-2020, has not been awarded yet.

Building close to the railway, frequent night shifts, and the requirements under the MINERGIE-P-Eco (no certificate) and DGNB (SGNI) gold label standards are expected to constitute the main challenges of the project. The net contract volume is approximately CHF 40 million (around EUR 34.4 million).

### The Gleistribüne

The Zurich Gleistribüne site covers an area of 6,360 m² and is located north of the tracks, around 250 m from Zurich Central Station, and borders directly on the Gleisarena project.

In addition to 139 rental apartments, retail and food service spaces will also be built over a gross floor area of 20,874 m². A new south-facing neighbourhood square, the "Louis-Favre-Platz", will be built at the junction between Hafnerstrasse and Zollstrasse. The Gleistribüne will be ready for occupation from autumn 2019.

The net contract volume for the Zurich Gleistribüne is approximately CHF 60 million (around EUR 51.7 million). The Gleisarena and the Gleistribüne will be connected via a shared basement.

# Local rail line U5 Frankfurt

## Turf-cutting ceremony in the Europa-Allee

Anja Herud

L. to r.: Reinhard Bünker (GF Stump GmbH), Michael Rüffer, Mayor Peter Feldmann, State Minister Tarek Al-Wazir, Florian Habersack, Wendelin Friedel, Hischam Fouad (GL PORR Deutschland GmbH)
Image: Klaus Helbig

### Project data

| | |
|---|---|
| Client | SBEV-Stadtbahn Europaviertel Projektbaugesellschaft mbH |
| Contractor | PORR Deutschland GmbH in consortium with Stump Spezialtiefbau GmbH |
| Project type | Specialist civil engineering . Tunnel construction and civil engineering |
| Project scope | Planning and construction of a 1,160 m long underground section of local railway line U5, including the Güterplatz station |
| Construction start | January 2017 |
| Construction end | September 2022 |
| Country | Germany |

On 21 September, in Frankfurt's Europa Allee, PORR Deutschland GmbH celebrated the start of construction for the U5 local railway line extension.

### The “Europa Quarter” emerges

Following signing of the contract between SBEV-Stadtbahn Europaviertel Projektbaugesellschaft mbH and PORR Deutschland GmbH on 19 January 2017, an intensive construction site planning and set-up process began. The construction project involves an underground section 1,160 m long, beginning at the Platz der Republik and emerging at ground level just before the Emser Bridge. Construction of the Güterplatz underground station also forms part of the contract.

The “Europa Quarter” has space for around 30,000 people. The new transport link seals the status for this district in Frankfurt's city centre as a quarter with excellent quality of life and state-of-the-art infrastructure.

### The construction work

The construction work will be carried out by PORR's internal U5 Europaviertel consortium, which comprises PORR Deutschland GmbH and PORR subsidiary Stump Spezialtiefbau GmbH. The order volume exceeds EUR 120 million (net).

Construction work has begun at the level of Stockholm Straße, starting with the diaphragm walls for the initial construction pit. From here, tunnelling will proceed towards the Platz der Republik. Until the tunnel and ramp have been created – using an open-cut method – the area up to the Emser Bridge will serve as a storage and transport area. It will take around five years to complete all structural works.

In the future location of the new underground station “Güterplatz”, diaphragm walls are likewise being erected for the construction pit. Once the two tunnels have been bored, the construction pit can be lifted out of the station. It is planned that the two tunnels will be bored one after the other in approximately twelve months’ time. This does not take into account the assembly times and withdrawal of the tunnel boring machine.

Completion of the entire construction project is scheduled for autumn 2022.

# Railway line no. 354

## Renovation of railway lines from Poznań to Piła

Siegfried Weindok

PORR looks back on years of railway construction experience with challenging projects at home and abroad.
Image: PORR AG

### Project data

| | |
|---|---|
| Employer | Polish State Railways (PKP PLK) |
| Contractor | PORR S.A. |
| Project type | Infrastructure . Railway construction |
| Project description | Modernisation of railway line no. 354 Poznań Główny POD – Chodzież – Piła Główna |
| Construction start | May 2017 |
| Construction end | April 2020 |
| Contract value | 485 million PLN (114 million EUR) |
| Country | Poland |

The modernisation of the existing railway line no. 354 from Poznań to Pila will see travel times reduced from the current two hours to just 40 minutes. PORR S.A. and PKP PLK S.A. signed the contract for this major project on the 24 April. At a value of around EUR 114 million (net) (PLN 485 million), this contract is one of the largest so far for PORR in Polish railway construction.
In the last five years the Polish team hasve repeatedly demonstrated their expertise in railway construction. An important factor in the decision to award the contract was PORR's plan to optimise construction schedules and reduce track closures. This will keep interruptions to the railway system during works to a minimum, which is a matter of great importance to railway customers. The Polish team, with their prior experience and use of the most modern technology and logistics, are sure to rise to the challenge.

### 142 km of track and more

The modernisation works involve 142 km of track, the renovation of 91 turnout systems and partial renovation of the overhead lines. This includes 12 bridges, four underpasses and 91 waterways. A further 76 level crossings, 37 platforms and various buildings will either be renovated or rebuilt from the ground up. Facilities for control, communication and safety systems will also be updated, including the construction of two new electronic signal boxes.

Trains currently travel along this section of line at speeds of 50 to 100 km/h, but in the future passenger trains will be able to reach speeds of up to 120 km/h and goods trains up to 80 km/h. These measures will result not only in substantial reductions in transit time, but also increased capacity for line no. 354 and improved comfort levels for all passengers.

# A fourth contract on the LK4 central artery

## PORR is awarded another railway construction contract in Poland

Siegfried Weindok

Installing the switches in Biała Rawska.
Image: PORR AG

### Project data

| | |
|---|---|
| Client | Polish railway (PKP PLK) |
| Contractor | PORR S.A. |
| Project type | Infrastructure . Railway construction |
| Scope of performance | Supplementing track ballast, tamping works, regulating the overhead lines along 160 km of track + 16 switches |
| Start of construction | August 2017 |
| End of construction | November 2017 |
| Country | Poland |

On 18 August, the Polish railway company PKP PLK awarded PORR another contract – the fourth so far – on the prestigious LK4 line, a central artery connecting Warsaw with the Katowice metropolitan region in the south of Poland.

### One contract follows the next

In March 2016, the first construction contract, comprising the installation of four high-speed EW1200 switches and the construction of a new electronic signal box at the Biała Rawska station, was signed. The work was carried out extremely successfully, with the switches installed during a 6-day closure of the LK4.

In December 2016, PORR received the second contract for this line. This time, a new diamond crossover consisting of four high-speed EW1200 switches, and an electronic signal box were constructed in Pilichowice. The switch assembly took place in the last week of July and the remaining services were all completed by the end of September 2017.

The third construction contract on the LK4 was signed in May 2017. This contract involved replacing 16 switches – including 12 high-speed EW1200 switches – in the Opoczno station and 5 km of tracks, and constructing a new electronic signal box. In addition to this, the overhead lines are to be upgraded, and a new platform and pedestrian underpass built. This "Design & Build"-project is currently still in the planning stage. The construction work will be carried out next year.

The current order, with a value of PLN 15 millon (net) approximately EUR 3.5 million is particularly important for the full-capacity operation of the machine pool (tamping technology). Approximately 55,000 metric tonnes of track ballast are to be supplemented, 160 km of track and 16 switches tamped, and 160 km of overhead lines regulated on the 80-km section between Grodzisk Mazowiecki and Idzikowice. Logistically, the construction project presented a major challenge, since all the work had to be carried out exclusively during eight-hour overnight closure periods from 28 August to 7 November 2017 (72 days).

The four contracts have a total net value of PLN 103 million (net) approximately EUR 24 million.

# Modernisation of the E30 railway line

## PORR receives another railway construction contract in the south of Poland

Siegfried Weindok

The PORR railway construction team in Poland scored high with its technical solution which makes it possible to minimise track possession periods.
Image: PORR AG

### Project data

| | |
|---|---|
| Client | PKP PLK S.A. |
| Contractor | PORR S.A. |
| Project type | Infrastructure . Railway construction |
| Scope of performance | Works on section Kędzierzyn Koźle – Opole Zachodnie of railway line E30, from km -0.206 to km 37.511 of line no. 136 and from km 94.281 to km 97.210 of line no. 132, including upgrades to 49 engineering structures. |
| Start of construction | September 2017 |
| End of construction | November 2021 |
| Country | Poland |

In September 2017, PORR S.A. and the Polish railway company PKP PLK S.A. signed a contract for the modernisation of the Kędzierzyn Koźle – Opole Zachodnie section of railway line E30. PORR was commissioned to plan and carry out the construction works. The order volume is approximately EUR 97 million (net) (PLN 412 million).

### Twice the speed, increased capacity

The railway along the 40-km section of the line is the most popular form of public transport in the region. The projected modernisation will make an important contribution to regional mobility: the current speed limit of 60 km/h to a maximum of 100 km/h will increase to up to 160 km/h, which will significantly increase the line capacity for the transportation of persons and goods.

### Polish railway prioritises experience

Two criteria played an especially crucial role in the decision to award the contract: the price, but also the technical solution. In addition, the track possession periods have to be kept as short as possible. The PORR railway construction team in Poland scored high in terms of expertise and a solution that involves upgrading the tracks mechanically, using specialised railway construction machinery.

### The construction works

In the course of this project, PORR will replace 91 km of tracks, including the overhead lines and 112 signals. Furthermore, 49 engineering structures - nine bridges, five overpasses, three underpasses and 32 passages in total - and 22 railway crossings will be upgraded. In addition, the technical control and safety facilities will be modernised, and 15 signal boxes will be overhauled. The railway stations will also be upgraded to improve the comfort of the passengers. New platforms are planned at heights of 55 cm and 76 cm, which will make boarding the trains significantly easier. The platforms will also be equipped with new roofing, benches and new lights.

# Revitalisation of railway lines in Upper Silesia

## PORR lands another railway contract in Poland

Siegfried Weindok

### Project data

| | |
|---|---|
| Employer | PKP PLK S.A. |
| Contractor | PORR S.A. |
| Project type | Infrastructure . Railway construction |
| Project scope | Works on railway line nos. 153, 199, 681, 682 and 872 - Section Toszek Północ - Rudziniec Gliwicki - Stare Koźle |
| Construction start | October 2017 |
| Construction end | November 2019 |
| Country | Poland |

In October 2017, PORR S.A. and PKP PLK S.A. signed a contract for the modernisation of a section of railway line in Upper Silesia, Poland. PORR will be carrying out this project alone, both planning and implementing construction works on the section Toszek Północ – Rudziniec Gliwice – Stare Koźle. The revitalisation of the 44 km section will result in shorter travel times and increased line capacity. The project should be completed by 2019. The contract is worth around EUR 43 million (net) (PLN 182 million). The planned modernisation of this section will improve comfort levels for all travellers. The project will also allow the maximum speed limits of goods trains on the individual sections to be increased significantly – from 60 to 90 km/h between Toszek Północ and Rudziniec Gliwicki and from 50 to 80 km/h between Gliwice and Kędzierzyn Koźle.

With the works on the E30 railway line between Kedzierzyn Kozle and Opole Zachodnie, this is the company's second contract for the modernisation of a Polish railway line in just a few weeks. The two projects are located right next to each other, and together they comprise the 80 km total section Toszek – Kedzierzyn – Opole, with a total contract value of around (net) 140 million EUR (PLN 600 million). This proximity affords significant advantages and synergetic effects, such as maintaining the current personnel and equipment potential while reducing transport costs.

Construction works on the railway section Toszek Północ – Rudziniec Gliwice – Stare Koźle will take around two years. PORR is responsible for the renewal of railway tracks and overhead lines over 44 kms, and the replacement of 32 points. In the course of the project PORR will also be reconstructing 51 engineering structures - a total of 17 overpasses, five bridges, one pedestrian crossing under the tracks and 28 culverts. In addition, plans include the renovation of nine level crossings and ten signal boxes as well as the modernisation of control and communications systems and safety facilities.

The PORR railway construction team in Poland have already demonstrated their competence and team strength on numerous railway construction projects.
Image: PORR AG

# Bridge construction in Norway

## Important milestones reached on three projects

Bettina Gerti Groß

From the final section in July to the handover on 16 November – the PNC Norge team is connecting the inhabitants of Larvik via the Farris Bridge. Image: PORR AG

The bridge team of PNC Norge AS – a subsidiary of PORR – has reached three important milestones on three bridge projects in Norway almost simultaneously. In early July, the final steel component was hoisted into place in the Farris Bridge in Larvik on the south coast of Norway. The final concrete section subsequently filled the last gap in the 570 m long bridge at the end of July. The same success was recorded with the Loftesnes Bridge in Sognefjord in central Norway one week later: the final section was concreted on 3 August 2017 and traffic has been flowing across the new Loftesnes Bridge since early December. The old bridge is currently being demolished.

PORR also marked an important milestone with the Varrod Bridge on the south coast of Norway. Bridges there are built in the water, on top of massive foundations, otherwise known as caissons or cofferdams. PORR manufactured three of these caissons in a dry dock, which was flooded on 9 August in order to transport the floating caissons across the sea to their destination.

Other projects are already in the pipeline. PORR is about to start on the construction of a further 13 bridges and six culverts in Norway.

The PORR Group is represented in Norway with its companies PNC Norge AS and PNC Norge Infrastructure NUF, which carry out the projects jointly. PNC stands for PORR Nordic Construction.

The final section of the Loftesnes Bridge was concreted in place in August. Image: PORR AG

The flooding of the caissons for the Varrod Bridge proceeded smoothly. Image: PORR AG

# Bridge construction project Remisenstraße Zurich

## Exceptional project successfully handed over to the client

Dani Camenzind

The highest degree of precision was required to position the 170 tonne slabs.
Image: PORR AG

### Project data

| | |
|---|---|
| Client | SBB AG (Swiss Rail) |
| Contractor | PORR SUISSE AG |
| Project type | Infrastructure . Bridge construction |
| Scope of performance | Construction of the bridge without disrupting road and rail traffic |
| Start of construction | April 2016 |
| End of construction | May 2017 |
| Country | Switzerland |

Staying in motion: this was the motto of the first exceptional bridge construction project to be implemented by PORR SUISSE AG. The project was successfully handed over to the client SBB in May 2017.

### A special challenge

The construction site was located right in the middle of Remisenstraße in the city of Zurich. Besides the preliminary works and the construction of a provisional bridge, the project's focus lay in the demolition of the existing bridge and the construction of the new one. To maintain road and rail traffic throughout, the company decided to use the retroactive relocation method. This meant that the bridge slabs were prefabricated and prepared on the installation site beforehand to allow the changeover to take place overnight from 16 to 17 December 2016.

### A superlative bridge construction

The two slabs, each weighing 170 metric tons, were relocated individually using one the largest crawler cranes in all of Switzerland, and positioned with millimetre precision. The two slabs were then concreted together with quick-setting concrete in the same night. Thanks to the tireless efforts of everyone involved, the railway tracks under the bridge were opened for rail service on Sunday.

The finishing works and the removal of the provisional bridge were then carried out in the spring of 2017 to complete the entire project. PORR and the client SBB both look back on an extremely successful project and PORR intends to keep moving with other bridge construction projects.

The prefabricated bridge structure...
Image: PORR AG

... was hoisted into place overnight.
Image: PORR AG

# The Marzahn combined-cycle CHP

## PORR Deutschland constructs engineering structure for Siemens AG

Frank Thiel

Rendering of the combined-cycle CHP in Marzahn, Berlin.
Image: PORR AG

### Project data

| | |
|---|---|
| Client | Siemens AG, Power and Gas Division, Energy Solutions |
| Contractor | PORR Deutschland GmbH |
| Project type | Infrastructure . Structural engineering |
| Scope of performance | Construction of the combined-cycle combined heat and power plant in Marzahn |
| Start of construction | September 2017 |
| End of construction | September 2019 |
| Country | Germany |

At the beginning of August, PORR Deutschland GmbH . Civil engineering and infrastructure in Munich was awarded the contract to construct the Marzahn combined-cycle CHP in Berlin.
The client is Siemens AG, Power and Gas Division, Energy Solutions, based in Erlangen. PORR will carry out the structural and concrete works with the respective PORR group departments.

The new plant will cover an area of around 30,200 m² and is to be constructed on the current site of the Marzahn CHP. The new construction will be built on the open space to the north-east of the plant area. It will consist of several building sections. The largest complex consists of the following buildings: the steam turbine powerhouse, gas turbine powerhouse, boiler house with chimney, feed water house, and the switchboard station with staircase towers.

The buildings range in height from 25 m to 39 m. The highest staircase tower will have a projected height of 43.75 m and the chimney will be approximately 67 m high. The remaining auxiliary buildings will be 5.65 m to 15 m high. The buildings do not have cellars. The foundations will be embedded at depths of 0.8 m to 4 m below the surface.

The majority of the building foundations are to be laid on floor slabs with thicknesses of 0.80 m to 1.70 m or constructed as pile foundations using bored piles with diameters of 630 mm and 750 mm at a depth of 14.50 m.

An additional building complex will be constructed as a comprehensive solution, including the interior fittings, to house the control room, engineering room, administrative building, storage and staff facilities.

The total construction time for the main and auxiliary services will be 24 months from the start of construction in September 2017.

# Lubelska traffic junction

## PORR constructs a two-level traffic intersection in central Poland

Piotr.Kledzik@porr.pl

After the successful construction of various motorways in Poland, including the S7, PORR S.A. is tackling another exciting project with the Lubelska traffic junction.
Image: PORR AG

### Project data

| | |
|---|---|
| Employer | Generalna Dyrekcja Dróg Krajowych i Autostrad [Directorate General for National Roads and Motorways] |
| Contractor | PORR S.A. |
| Project type | Infrastructure . Road construction |
| Project scope | Planning and construction of the "Lubelska" traffic junction on the intersection of the S17 and S2 highways with the A2 motorway including technical infrastructure, construction works and facilities |
| Construction start | November 2018 |
| Construction end | September 2020 |
| Country | Poland |

A traffic junction of great importance to the road networks in central Poland is about to be constructed: PORR S.A. signed the contract in July with the Polish Directorate General for National Roads and Motorways (GDDKiA). The contract includes, among other things, the planning and execution of a two-level traffic junction at Lubelska on the intersection of the existing DK 17 highway with the newly-planned S2, A2 and S17. The contract has a net worth of PLN 190 million (EUR 45 million). This capital expenditure will result in the connection of the southern bypass from Warsaw (S2) with the eastern bypass (S17) and the A2 motorway. Completion is scheduled for September 2020.

The Lubelska traffic junction is a significant intersection in the road network around Warsaw.
The S2 highway, the southern bypass from Warsaw, will connect the two intersections of Konotopa – west of Warsaw – and Warszawa-Lubelska at the A2 motorway. The already completed sections of the S2 have had considerable influence on the development of the road infrastructure in the area around the city. It is important that all the relevant sections and the Lubelska transport junction are completed at around the same time in 2020.

Within the scope of this project, PORR is also responsible for works on waterways/canals, telecommunications and elements of electronic infrastructure. PORR is constructing the nearly two kilometre long road and bridge system with a concrete road surface, similar to the surfaces of the A2, S2 and S17.

### Road sections collision-free

The two-level intersection will be free from collisions, because the traffic lanes do not overlap and turns are made by entering, leaving and changing traffic streams. Bringing the various sections of road together into a functional whole is an enormous challenge for all companies involved with this road construction project. The touchstone for all those involved will not just be the completion date, but also the timely provision of necessary labour, construction materials and equipment.

# Construction section 16 of the A100 in Berlin

## PORR completes the structural trough floors

Ronny Spielberg

Underwater concreting: A reliable method of placing underwater concrete is the so called contractor method. Concrete is pumped with a concrete pump through a vertical pipe. This reaches approximately 1 m into the new concrete under water.
Image: HeidelbergCement Group

### Project data

| | |
|---|---|
| Client | Senate Department for the Environment, Transport and Climate Protection, Berlin |
| Contractor | PORR Deutschland GmbH |
| Project type | Civil engineering. Structural engineering |
| Project scope | Construction of a 550 m segment of construction section 16 of the A100, including specialist civil engineering services and construction of the civil engineering structures. |
| Start of construction | September 2015 |
| End of construction | November 2019 |
| Country | Germany |

The A100 federal autobahn is one of the main thoroughfares in the long-distance, regional and urban road networks of the German capital of Berlin. The addition of construction section 16 will extend it by another 3.2 km. It runs from the three-way interchange Neukölln to the Am Treptower Park motorway junction, and has a total of three junctions. The route runs through 386 m of tunnel (Grenzallee) and continues along a trough of up to seven metres depth for approximately 2.3 km.

Completion of the A100 will improve traffic links between the eastern districts of Berlin, the middle ring road and the A113. This will make the Berlin Brandenburg Airport and the research site Adlershof significantly more accessible and improve long-distance traffic connections to Dresden, Cottbus and Frankfurt/Oder.

### Joint venture with Stump

Construction section 16 of the A100 is part of the middle ring road in the federal state of Berlin. The newly constructed extension of the A100 ring road, construction section 16, will extend from the Neukölln three-way interchange (Autobahndreieck AD) to the Am Treptower Park junction (Anschlussstelle AS). The planning section A 100, construction section 16 is divided lengthwise into seven lots.

On 28 September 2015, PORR Deutschland . Civil engineering and infrastructure in Berlin was awarded the contract for lot 5, which extends from km 22 + 465 to km 23 + 015 over a length of 550 m. The order volume is currently approximately EUR 40 m (net). The project will be implemented in a joint venture with Stump Spezialtiefbau GmbH. For the projected new motorway construction, the urban road Kiefholzstraße and all the civil engineering structures had to be constructed. This includes trough floors and walls, rainwater pumping station, congestion management, gantries, light masts and a two-span bridge.

The construction pits were constructed dock by dock in lengths of up to 120 m and sealed vertically via sheet pile or diaphragm wall structures. The tender called for the horizontal construction pit seal to be provided by underwater concrete floors. In a variant solution submitted after the tender had been awarded, it was proposed to the client that the horizontal seal in four of the five construction docks be constructed using jet grouting (jet grouted floors). These were produced at deep and medium levels using buoyancy control piles (GEWI piles). The technology stipulated in the contract was retained in dock 22 via wet excavation and concrete underwater floors and only the temporary construction pit system was optimised in line with static analysis calculations. Employees worked on this dock in night and day shifts over the past months to complete approximately 57,000 m³ of underwater excavations, 450 buoyancy control piles at lengths of up to 30 m and roughly 7,500 m³ of underwater concreting. Following its completion, the construction pit was drained and the structural trough floors were produced in individual concreting works using up to 4,000 m³ of concrete and up to 600 metric tonnes of reinforcing steel per component.

This represents a major milestone for the PORR construction site team, as they can now spend the next few months working intensively on the rising structures (rainwater pumping plant, congestion management, the Kiefholzstraße bridge), for which contractual handover deadlines exist.

# Filder Tunnel breakthrough in Stuttgart

## Another milestone reached

Andreas Rath

Breakthrough of the second tunnel stage in Stuttgart
Image: ATCOST21 / imagocura

### Project data

| | |
|---|---|
| Client | Deutsche Bahn |
| Contractor | PORR Deutschland GmbH in a consortium |
| Project type | Civil Engineering . tunnel construction |
| Project scope | Construction of the 9.5 km long Filder Tunnel in Stuttgart |
| Construction start | July 2011 |
| Construction end | 2022 |
| Country | Germany |

During the construction of the 9.5 km long Filder Tunnel in Stuttgart on 4 July, a good three months after the first tunnel breakthrough into the neighbouring construction lot, another milestone was reached: The consortium ATCOST 21, under the leadership of PORR, celebrated the breakthrough of the tunnel boring machine (TBM) "SUSE" from the "Upper Filder Tunnel" into the "Middle Filder Tunnel", which is being blast excavated.

An impressive and emotional event for everyone present: a TBM breakthrough in the middle of the mountain, over 4 km from the nearest portal and about 110 m below the surface. Two aspects have especially contributed to this: on the one hand, the shotcrete reinforcement withstood the TBM's very sparingly applied force for longer than originally expected, resulting in the breakthrough lasting almost three hours instead of the originally estimated 45 minutes. On the other hand, the team on the TBM was supported by PORR's Managing Director Alfred Sebl-Litzlbauer and Mr. Leger, Managing Director of DB-PSU, the two of whom gave the breakthrough a special, personal touch by climbing through the cutter wheel together.

The tunnel boring machine has thereby completed the approximately 8 km of the two tubes of the "Upper Filder Tunnel". In the summer, the TBM was adapted for the two remaining 3.3 km long shield machine drives of the "Lower Filder Tunnel" inside the mountain and then pushed about 1.1 km to the new Andreh station through the shotcrete section. The third shield machine drive started in early November, the next breakthrough is expected around Easter 2018.

Tunnelling is always a big challenge. In the Filder Tunnel too, the different rock strata pose a number of challenges for both humans and machines. In any case, the PORR project team is confident that they will progress with the excavation of the second half of the Filder Tunnel as planned.

# Boßler Tunnel – West Tube

## Last stage of the large-scale project: Stuttgart/Ulm Albaufstieg tunnel

Kurt Joham

Caption: Assembling the tunnel boring machine "Käthchen" in front of the Boßler Tunnel – West Tube.
Image: Arnim Kilgus

### Project data

| | |
|---|---|
| Client | DB project Stuttgart Ulm GMBH (DB-PSU GMBH) |
| Contractors | Consortium Tunnel Albaufstieg (ATA) with PORR Deutschland GmbH, Hinteregger, Östu/Stettin & Swietelsky |
| Project type | Civil engineering . Tunnel construction |
| Project scope | Construction of an 8,806m-long twin-tube railroad tunnel |
| Tunnel construction | 17,612 m tunnel tubes with 17 connecting structures |
| Construction start | 2012 |
| Construction end | 2019 |
| Country | Germany |

The consortium Tunnel Albaufstieg (ATA) set a milestone with the construction of the Boßler tunnel in Stuttgart: After the breakthrough of the 8.806m-long east tube on 6 November 2016, the tunnel boring machine "Käthchen" withdrew and was reassembled at the north entrance at Aichelberg. On 11 April 2017, a farewell celebration for the tunnel boring machine was held in the west tube, with an impressive firework display – the final stage of the Albaufstieg route.

The removal and reinstallation of the tunnel boring machine went according to plan, allowing boring to start on the west tube on 18 April 2017. Käthchen – which is 110 m long and weighs 2,480 metric tonnes – will construct around 4,400 tunnel rings made of 30,800 prefabricated concrete parts. At the end of 2017, after 8 months of boring, over 5,000 meters of the Boßler west tube have already been excavated. The tunnelling route is impressive – on a record-breaking scale. It illustrates the effort and excellent teamwork that has gone into the Albaufstieg project since 2012. The last breakthrough is planned for mid-2018. The tunnel boring machine will then see daylight again above the Filstal valley near Mühlhausen im Täle.

# Steinbühl tunnel at the Albaufstieg Project

## Inner concrete shell completed

Kurt Joham

Completed inner concrete shell of the railway tunnel
Image: ARGE Tunnel Albaufstieg – M. Kaltenböck

### Project data

| | |
|---|---|
| Client | DB Projekt-Stuttgart Ulm GMBH (DB-PSU GMBH) |
| Contractor | Consortium Tunnel Albaufstieg (ATA) with PORR Deutschland GmbH, Hinteregger, Östu/Stettin & Swietelsky |
| Project type | Civil engineering . Tunnel construction |
| Project scope | Construction of a twin-bore railway tunnel 4,847 m long |
| Inner concrete shell | 9,694 m tunnel bore with 9 connecting structures |
| Construction start | Construction start 2012 – start concrete system 1.6.2015 |
| Construction end | Construction end 2019 – Completion of concrete system 17.11.2017 |
| Country | Germany |

The consortium Tunnel Albaufstieg (ATA) has good cause for celebration: on 17 November 2017, at its Steinbühltunnel project in Stuttgart, the final concreting for the tunnel lining at the tunnel's south entrance was completed. In just 900 days, the ATA team had constructed a total of 1,574 bedding and annular concrete blocks, along with the shells of nine connecting structures – all in top quality. This means that for each calendar day, about two of the concrete sections (12.5 m long) were manufactured inside the tunnel bores.

### Single track and twin bore

On the boundary of Mühlhausen im Täle, in the Hohenstadt direction, you will find the 4,847-metre-long twin-bore railway tunnel for the new Wendlingen-Ulm route currently under construction. Like the Boßler tunnel, the Steinbühl tunnel has a longitudinal incline of around 25 ‰. The east and west tunnels are both single track and run parallel to each other. The two main bores are linked together every 500 m with connecting structures. In this way, one bore can act as an emergency route in case of incident.

### Central part of the east-west axis

The north-west portal of the Steinbühl tunnel is directly connected to the Fistal bridge. This is also the connecting link with the neighbouring Boßler tunnel. Altogether, 2.8 million m³ of material has been excavated from the two tunnels. The completion of the Stuttgart-Ulm railway project will further expand the central European rail corridor Paris-Budapest. The total route length is around 60 km, with around 31 km of this in tunnels. The longest tunnel, at 8,806 m, is the Boßler tunnel.

In November 2017, the final concreting for the tunnel inner shell was completed.
Image: ARGE Tunnel Albaufstieg – M. Kaltenböck

# Voitsberg power station site

## Demolition works completely finished

Gregor Scherleitner

The levelled site, the foundation of the future of the Voitsberg location.
Image: PORR AG

### Project data

| | |
|---|---|
| Employer | PORR Umwelttechnik GmbH |
| Contractor | PORR Deutschland GmbH in working partnership with Scholz Austria GmbH |
| Project type | Environmental engineering . Urban mining, industrial demolition, pollutant clean-up |
| Project scope | Main contractor services for the demolition of the Voitsberg power station including reclamation works |
| Construction start | 2013 |
| Construction end | August 2016 - maintenance as per notification requirements until December 2016 |
| Site handover to client | June 2017 – to VGI Grundstücksverwertungs GmbH |
| Country | Austria |

At the end of 2016, PORR Umwelttechnik and their working partner completed the final stages of demolition work on the Voitsberg power station. The ceremonial handover to VGI Grundstücksverwertungs GmbH, a company run by the municipality together with a private investor, was attended by Deputy Governor Michael Schickhofer, Mayor Ernst Meixner and PORR CEO Karl-Heinz Strauss. Numerous honoured guests including regional political dignitaries and industry representatives were also in attendance.

The municipality had a clear vision for the future of the site: The Mayor of Voitsberg promised an economic revival with the establishment of new businesses and clear additional benefits to the region.

For PORR the project has come full circle: the Voitsberg power station was the largest contemporary industrial demolition project in Austria. When it was first built, it was one of the largest construction schemes. In both cases, PORR was responsible for the work. The project took several years to complete. The construction process was very significant from a workplace safety perspective: it was, happily, completed without accident.

### A sophisticated demolition concept with history

Many years of experience with individual projects in urban mining and in the contaminated sites sector meant that PORR was the only company in Austria able to manage a project like the demolition of the Voitsberg power station singlehandedly, from design and preparation right through to site reclamation. Only when it came to blasting did the company, due to public interest and the dimensions of the project, employ external specialists.

The location and technical execution of the existing installations and buildings called for a sophisticated demolition concept for the dismantling of the 100 m high cooling tower, and PORR had developed just such a concept: the "cable pull method", in which no blasting at all is used. The main focus of the demolition process was the correct sorting of materials. In the course of the reclamation-oriented demolition process, more than 90 % of the materials were able to be recycled and reused in the commercial cycle as secondary raw materials. Around one and a half years of planning went into this demolition project. The working partners were intent on involving local partners in the project: almost three quarters of the commissioned activities were contracted out to partners in Voitsberg and surrounding parts of Styria.

After the demolition of the three power plant units from 2013-2016, PORR completed the final reclamation works on the site as per construction and water authority rulings. One of the requirements for the sale and handover of the site was the construction of flood control measures along the adjacent Kainach river. These works were also performed by PORR, who emerged victorious as the best bidder from a public call for tenders process.

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