# BAUER
# Mixed-in-Place

# Content



**Offenbach, Germany**
The Mixed-in-Place method was used as cut-off wall encapsulation at the site of a former tar factory in Offenbach.

# Applications

The patented Bauer Mixed-in-Place method (MIP) has been successfully implemented for over 25 years for the construction of retaining structures, for foundation work and for flood protection.

**UpperNord Tower, Duesseldorf, Germany**
The watertight encompassment of the 13 m deep excavation pit of the UpperNord Tower skyscraper was carried out with approx. 6,000 m² of MIP wall. The drilling depth of up to 23.5 m proved to be particularly challenging. The ARAG skyscraper can be seen in the background, the excavation pit of which was also encompassed by Bauer with an MIP wall in 1998.


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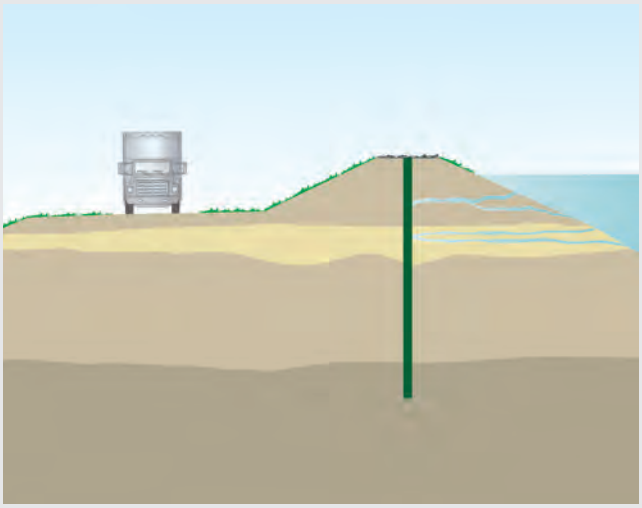
KLEMT

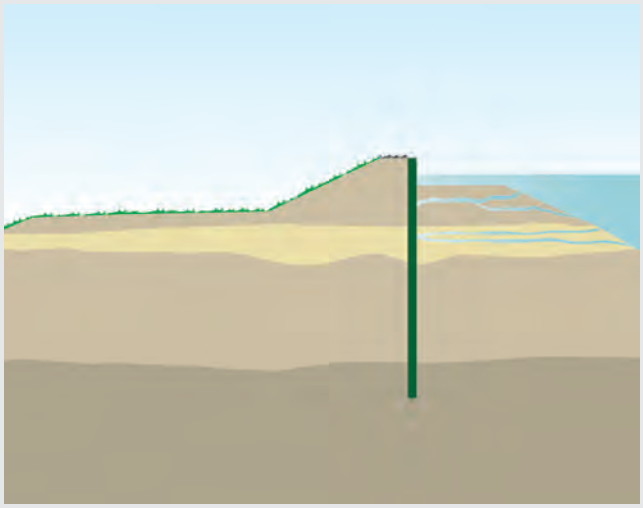
## Dikes without a structural function

Inner seals are inserted to reduce or prevent perfusion and thus to increase the stability of dikes without a structural function. These walls are generally constructed starting from the crest along the dike axis. They are either embedded into aquiclude layers or serve as an extension of the seepage path. The hardened cut-off wall materials must be able to withstand erosion and protect the dike against burrowing animals.

## Dikes with a structural function

If inner seals are exposed to structural load because of degradation on one side of the embankment due to natural forces, the Mixed-in-Place cut-off wall is to be designed for this load case. Reinforcement cages or girders will be installed to resist shear forces and bending moments resulting from earth and water pressure. The size and spacing of the load-bearing elements, as well as the compression strength required of the Mixed-in-Place materials are determined by the structural design.





**Dike renovation, Aramon, France**
A Mixed-in-Place cut-off wall was built to remediate a dike on the Rhône in Provence. For this purpose, the MIP elements were installed in the existing dike, along a length of 570 m and down to a maximum depth of 20 m.
A BAUER BG 40 was used for the works.

**Marchfeld embankment, Stopfenreuth, Austria**
For the renovation of the flood protection dam in Marchfeld an der Donau, a total of roughly 56,000 m² of cut-off wall, with a thickness of 500 mm was constructed.

**Dike renovation, Bittenbrunn, Germany**
West of Neuburg an der Donau, the dikes on the left and right bank of the Danube, in the reservoir area of the Bittenbrunn river power plant, were renovated with a total of roughly 27,000 m² of MIP cut-off wall. Since the kilometer-long construction site was partly located in a nature reserve, special regulations for the protection of bird life were observed.

**Aubecken, Dogern, Germany**
The sealing system of the “Aubecken am Rhein” pumped reservoir basin was renovated using 13,500 m² of MIP cut-off wall. The rocky soil and the required sealing with the adjacent rock proved to be especially challenging aspects. A test run whereby water impounding served to demonstrate the effectiveness of the up to 20.4 m deep inner seal.

## INFO

**Benefits of the MIP method**

- **Conservation of resources**
- **Low-vibration construction**
- **Higher degree of productivity**
- **Less noise and exhaust emissions**
- **Greater flexibility**
- **Cost-effective method**

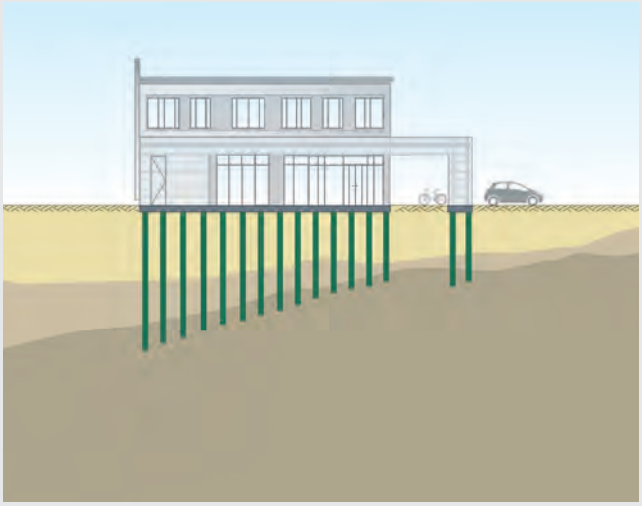
**Dike relocation project, Duisburg, Germany**
To extend the retention area on the Rheinbogen near Muendelheim and the associated relocation of the existing dike, roughly 28,000 m² of MIP wall over a length of 1.6 km and down to a depth of 20 m was constructed to seal the new three-zone dike subsoil.

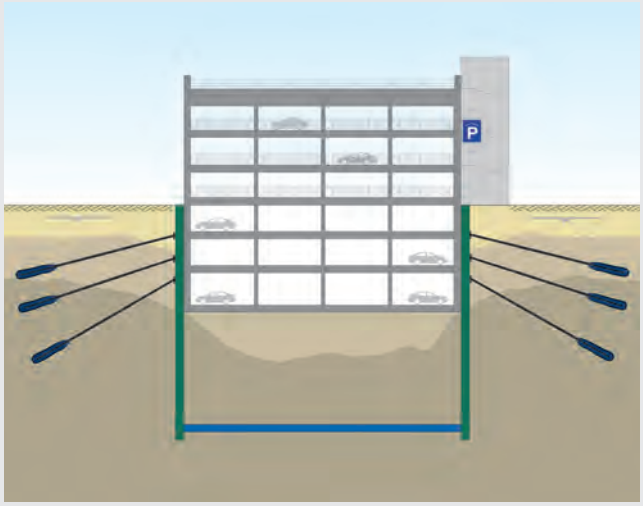
## Soil Improvement

For several years, the Mixed-in-Place method has been used for the production of foundation elements or for soil improvement. In addition to the triple auger, so-called “mono augers” or “single augers” are also often used for this. The Mixed-in-Place panels or piles can be arranged flexibly based on the structural requirements. Because the mixing effect of the single auger is less intensive than with the triple auger, a good knowledge of the in-situ subsurface conditions is necessary.

## Excavation Pits

An additional application for the MIP method is the encompassment of excavation pits. Particularly in inner-city areas, this method brings enormous benefits: the low level of vibration thanks to rotary drilling, the small amount of drill spoil created due to the use of the existing soil as aggregate and the inconvenience for the residents, due to the reduced need for transport and shorter construction times. In addition, small-scale retaining structures can be produced and worked close to existing buildings.






**Porto Novi Resort Village, Montenegro**
On a surface area of approximately 26 ha and along a coastline of about 3.5 km, a five-star hotel comprising five building complexes was built with a constructed surface of approximately 35,000 m². To fortify the subsoil beneath the building complex, approximately 240,000 m² Mixed-in-Place elements (individual elements as well as walls) were produced at depths up to 23 m and a wall thickness of 550 mm.

**Konstantinum, Leipzig, Germany**
Bauer was commissioned to carry out excavation work for a new building complex with barrier-free apartments and commercial space situated on a 3,800 m² corner lot in the city of Leipzig, in eastern Germany. The excavation pit was encompassed with over 4,000 m² of MIP shoring wall to a depth of 21 m, and a partial secant pile wall was constructed.

**Dreilaendergalerie, Weil am Rhein, Germany**
For the Dreilaendergalerie, a shopping center with shops, restaurants, an underground car park and a day care center in the geographical corner where France, Switzerland and Germany meet, Bauer was commissioned with digging out the excavation pit. The approximately 10,000 m² excavation pit was encompassed with MIP and pile walls and, with a depth of 18 m, was the deepest excavation pit ever dug by Bauer Spezialtiefbau using MIP walls. The walls were anchored in three layers and reinforced in various areas.

**Kleyerstrasse, Frankfurt am Main, Germany**
For a new building complex with several hundred apartments at the old industrial site of Gallus and in the immediate vicinity of the Adlerwerke, a tight retaining structure with approx. 7,000 m² of MIP wall was dug down to a depth of nearly 19 m.

## INFO

**Long-standing experience**

**The engineers of Bauer Spezialtiefbau can draw on years of experience. Since the start of the 1990s, Bauer has worked on over 650 construction sites with more than 2,600,000 m² of Mixed-in-Place walls.**

**Karlstrasse, Munich, Germany**
In Munich, for the first office building designed by the British architect David Chipperfield, the approximately 7,500 m² excavation pit was encompassed with MIP walls down to a depth of 15 m. For the “Karl” project, the MIP drilling rig along the Karlstrasse and Denisstrasse was equipped with a splash protection roller blind. A smaller part of the excavation pit was fortified with sheet pile walls.

# Methods

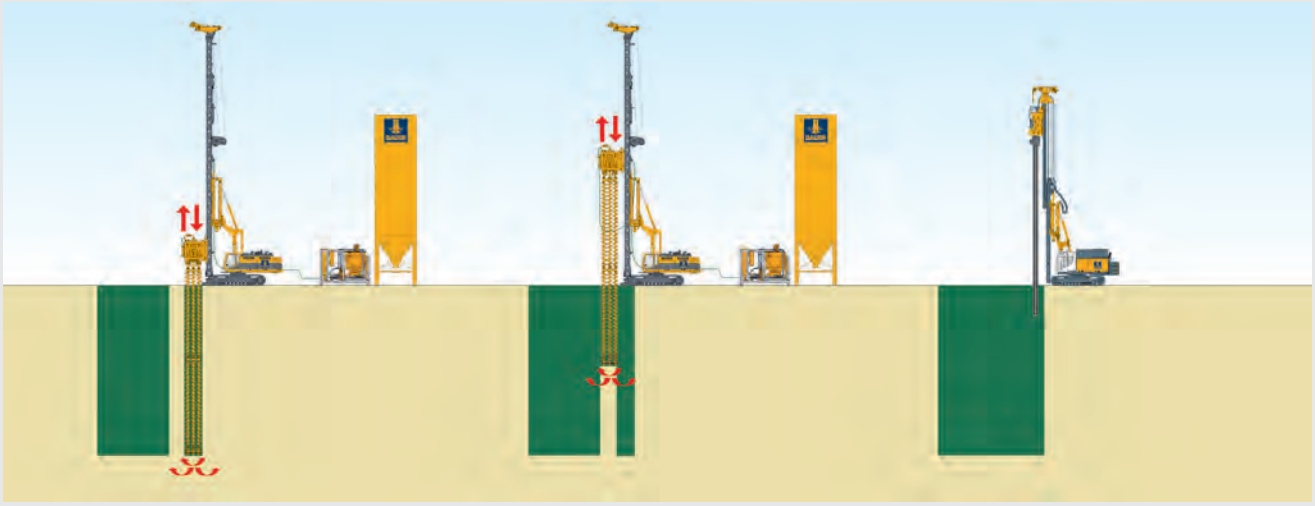
The key feature of the Mixed-in-Place method involves mixing the existing soil in-situ with a binding agent. The experience amassed by our highly-qualified team, as well as the continuous development of our drilling and mixing rigs, allows us to carry out the Mixed-in-Place method in virtually any soil condition.

**Aubecken, Dogern, Germany**
The Mixed-in-Place method was used to produce around 13,500 m² of cuf-off wall, over a length of 980 m.


RTG RG 25 S
RTG RG 25 S
BAUER

# Mixed-in-Place

“Mixed-in-Place” refers to mixing the existing soil in-situ with a binding agent. A triple auger is used to break up the soil and work in the binder slurry. The triple auger is drilled down to the final depth, with slurry being added. During the subsequent homogenization process, the direction of rotation of the individual augers is varied so that a circular material flow is produced in the trench. This vertical material flow is only made possible through the use of augers with continuous flights, which ensures the homogeneity of the soil binder and thus of the finished wall.

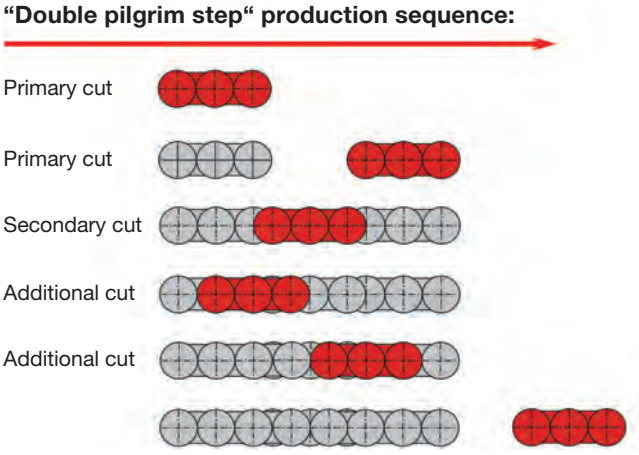


## INFO

### Quality

**To ensure the characteristics required of the Mixed-in-Place elements or walls, comprehensive monitoring of the construction process is conducted. In addition, aptitude tests are carried out in advance in our own building materials laboratory. The best binder formulation for each application is determined using soil and groundwater samples taken in situ. Installation volume and composition of the suspension are later adjusted to the local soil conditions during the execution.**

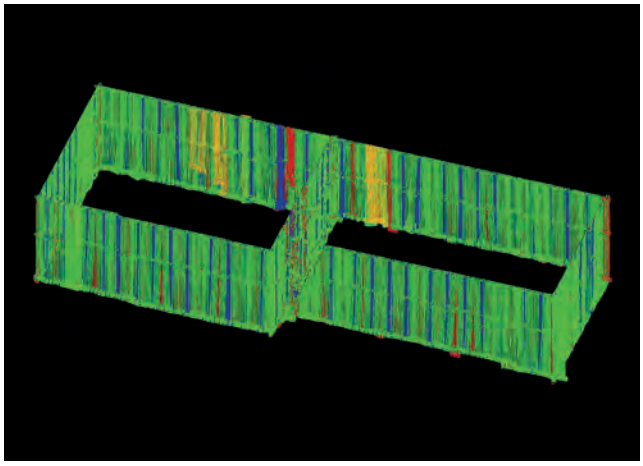
**“Double pilgrim step“ production sequence:**




**Work procedure**
To ensure that a solid, seamless wall is produced, MIP walls are constructed by the double pilgrim step method. This patented construction method is characterized by additional processing of the overlapping areas comprising primary and secondary cuts. This guarantees that the triple auger penetrates and processes each wall element at least twice.

**Production data monitoring**
All relevant production data, such as the amount of slurry added or the verticality of the augers, is visualized online for the machine operator and recorded in B-Tronic.


**GPS tracking**
The MIP drilling rigs are equipped with antennas for receiving position data (GPS, GLONASS, Galileo). Together with the verticality measurement in the triple auger, the position of the wall or of the individual elements is thus reliably detected.



**b-project**
The “b-project” data management software allows setpoint and actual production data to be automatically collected and processed. In order to better evaluate the data, various visualization options are available.

## INFO

### Sustainability

Unlike conventional special foundation techniques which involve soil removal, the MIP process involves the production of the building material on site and using the existing soil, which acts as the aggregate. This not only significantly reduces the need for the building materials to be transported, but also eliminates the necessity of removal of the excavated material from the construction site. Together with its high productivity, which results in comparatively short execution times, the MIP method can already be viewed as sustainable in terms of the Product Carbon Footprint (PCF), which can be gauged for a model construction site. The PCF provides the total amount of greenhouse gas emissions ($CO_2$ footprint) for the MIP method, taking into account emission factors from the production of building materials, construction machinery, fuel and on-site power consumption and all transport costs for building materials and personnel. The calculation for an exemplary construction site in Berlin shows about 25 % less greenhouse gases using the MIP method compared to a diaphragm wall with grab.

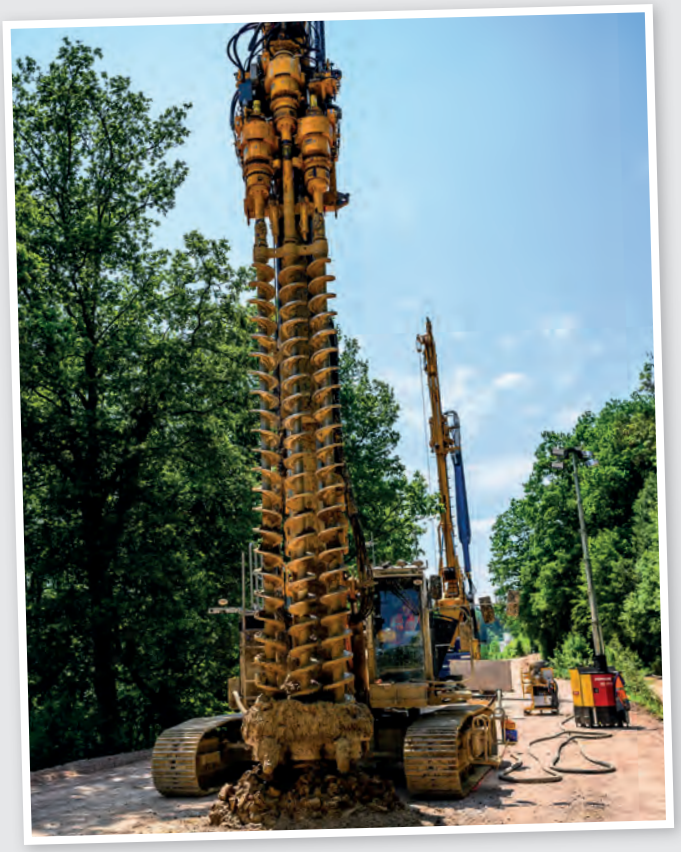
# Projects

Well over 2,6 million m² of Mixed-in-Place walls have been constructed to date. The Mixed-in-Place drilling rigs manufactured by Bauer can be deployed in the most confined urban construction sites, as well as in the largest dams and dikes.

**Frankfurt am Main, Germany**
Bauer constructed around 7,200 m² of MIP wall with a record depth of up to 23.8 m, for a hotel and residential construction project in the Rebstock district of Frankfurt. The project also included 1,300 m of anchors, 20,000 m³ of excavation as well as dewatering.

# Railway embankment renovation, Vilseck, Germany

In Neukirchen, the railway line 5060 branches off from the main line running from Nuremberg to Schwandorf and continues in the direction of Weiden. Since 2016, it could no longer be used with tilting technology or for freight trains. As part of a full closure of the railway line, around 42,000 m² of Mixed-in-Place panels were produced, as 2,700 individual elements, in six weeks and at three different railway embankments. In order to keep to the tight schedule and to get the line up and running again as soon as possible, drilling was carried out using a total of four MIP drilling rigs, during the day and night shifts. The site team also worked on public holidays and weekends. The Vilseck railway embankment renovation project was the first Bauer Spezialtiefbau project to receive approval by the German Federal Railway Authority, for operational testing of the Bauer-patented Mixed-in-Place method as the deep foundation for a railway track.



***It was the very first time that we were able to carry out the MIP method, which uses the existing soil as aggregate, on a railway embankment.***

Stefan Ferstl
Project manager

The work was carried out using an RTG RG 27 S, an RG 25 S and two RG 19 T's. A BAUER BG 24 was also used.

Due to the very cohesive soils, a special mixing auger was used, which intensified the homogenization process.

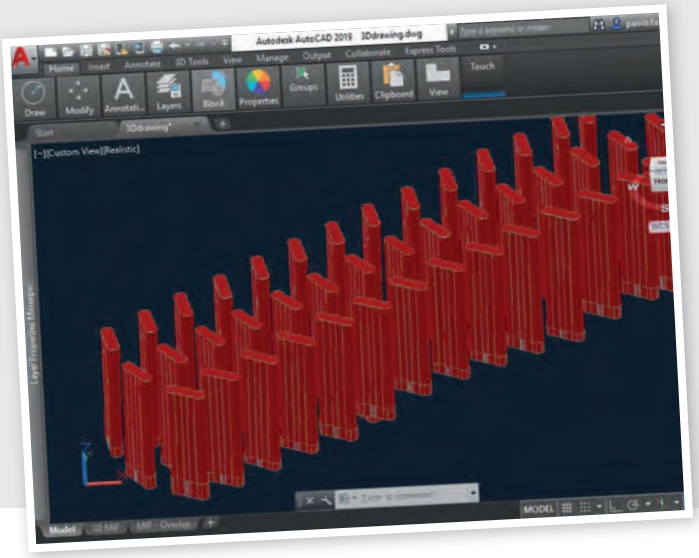
For the first time, an RG 27 S was used for the MIP method, whose Energy Efficient Power System (EEP) made it possible to reduce $CO^2$ and pollutant emissions thanks to less diesel consumption.

## INFO

**Six weeks‘ worth of construction time for...**

- **442,000 m² of Mixed-in-Place wall...**
- **... as 2,700 individual MIP panels**
- **50,000 m² of geogrid**
- **10,000 tons of cement**
- **900 samples**

To absorb tensile forces and for better load distribution among the MIP foundation elements, approx. 50,000 m² of geogrids were laid in two layers on the three dam sections.



The position of the individual MIP panels was determined by means of GPS positioning and their verticality was determined by means of inclinometers in the augers.

# QH Track, Berlin, Germany

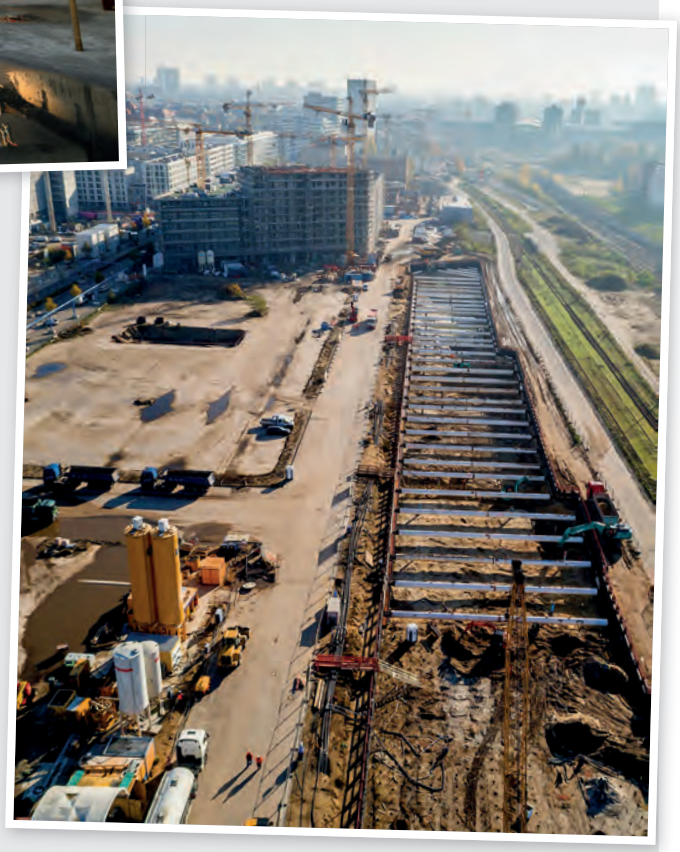
In the heart of Berlin's Moabit district, the new Heidestrasse district is being built in the immediate vicinity of the main train station. Divided into seven individual building complexes, the new district will provide space for residential and office buildings, commercial buildings, public streets and squares, as well as green spaces, cafes and restaurants. The planned district comprises an area of around 11.5 ha and is part of the Europacity urban development project. Within the framework of this large-scale project, BAUER Spezialtiefbau GmbH has been commissioned with various specialist foundation engineering works for the "QH Track" sub-project. Underground, the entire complex is connected by a two-storey underground car park, with the foundation slab of the second basement level located approximately 8.3 m below the ground level. The underground car park was built in a trough pit with walls 550 mm thick and using the Mixed-in-Place method. The approximately 23,000 m² of MIP wall was mainly braced using pipe struts.

***The required residual water flow rate of 1.5 l/s per 1,000 m² of wetted area for the entire system consisting of MIP walls and LWS base was, in some cases, significantly undercut.***

Klaus Wecker
Project manager

An RG 25 and an RG 16 were used to implement the Mixed-in-Place method.

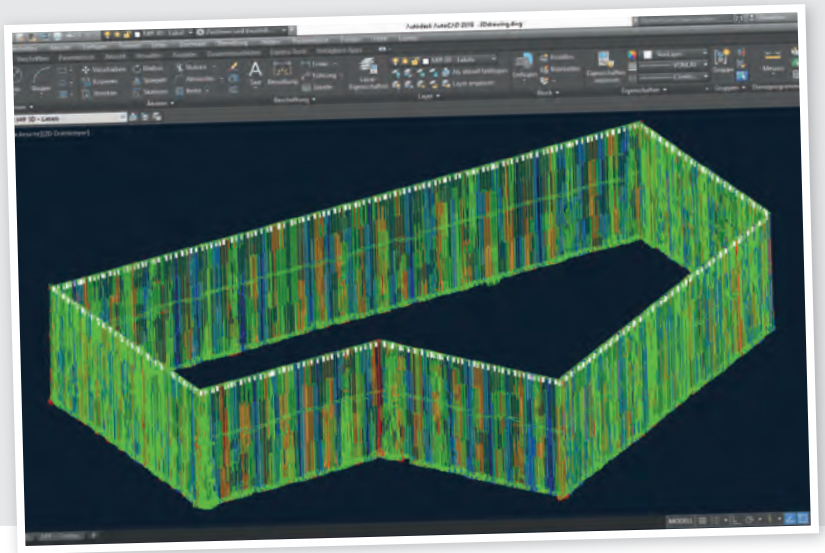
The excavation walls were mainly strutted against by each other, but were also partially anchored back.



## INFO

**Silicate gel base**

**The horizontal sealing of the approximately 16,000 m² excavation pit was carried out in the form of a silicate gel base (LWS base) using an RG 19 from RTG Rammtechnik GmbH at a depth of 16 m.**



Due to the exceptional size of the total excavation, a subdivision into nine smaller excavation pits was made. It was thus possible to successively hand over these individual troughs to the general contractor responsible for the concrete shell before completion.

The position and verticality of all MIP injection sites were recorded and visualized using the Bauer As-Built Generator (ABG). These representations, which were also available in 3D, served as the planning basis for the preparation of the LWS injection base.

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