Campus Tower in HafenCity Hamburg

On plot 80 in the Baakenhafen harbour basin in the east of HafenCity Hamburg, Garbe Immobilien-Projekte GmbH is developing the 'Campus Tower'. The construction site of approximately 3800 m² directly overlooks the Elbe and is located at the mouth of the Baakenhafen and the exit of the HafenCity Universität station of the U4 U-Bahn line. The complex of buildings mainly consists of buildings for office and residential use above a shared two-level underground car park. The gross floor area (GFA) of the planned development is approximately 22 120 m².

The 16-storey tower building with a total height of 56 m and the adjacent 7-storey office block (ground floor including gallery level + six upper floors) has been designed by Delugan Meissl Associated Architects of Austria (fig. 2). The striking triangular layout of the high-rise has a clear structure and a clear grid-like glass façade.

In the south-side building, designed by the SOP architect firm from Düsseldorf, subsidised rental apartments and freehold apartments will be built directly by the water's edge. Large windows and continuous south-facing balcony strips create high-quality living conditions.

Both buildings will meet the highest sustainability standards and will achieve the Gold standard for the HafenCity environmental certificate. Schüßler-Plan is responsible for the structural planning (design and execution phases) for the entire complex of buildings and the design of the construction pit.

Construction pit

The base of the construction pit is 1.44 m above sea level. Compared to the highest point of the surrounding area, in the area of the abutment of the Baakenhafen Bridge, the maximum depth of the construction pit is approximately 8 m. In the area of lift pits, the excavation base is up to 2 m deeper.

The pit lining walls were constructed as rear anchored bored pile walls. The piles have a diameter of 750 mm an at a center to center distance of 1.55 m. The intermediate area is designed with shotconcrete. The upper 2.50 m of the pit lining will have to be removed as soon as the construction work is completed. Therefore in this area a soldier pile retaining wall consisting of I-beams inserted in the bored piles was realised.

The pit lining walls are planned as 'near rigid supported' foundation pit walls in accordance with EAB (recommendations of the working group excavation pits). According to the specifica-

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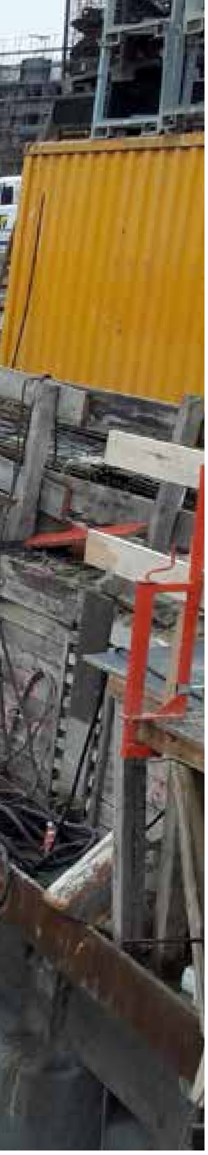
1 View of the pit lining situation on the north side
2 Tower building
credits: Delugan Meissl Associated Architects
3 Cross section view of the quay wall and the building pit



tions of the 'General conditions for licence areas' (Allgemeine Bedingungen für Gestattungsflächen) of HafenCity Hamburg GmbH, the horizontal deformations of the pit lining walls are limited to $v_h \leq 10$ mm [1].

Pit lining on the north side

On the north side of plot 80 a bored pile wall will be realised for the protection of the Versmannstraße, because a rear-anchored pit lining is not possible due to the nearby U4 line. The wall is reinforced with diagonal stays, which are supported against the partly completed base plate (photo 1). In the construction phase before the installation of the stays, the construction pit wall is supported by a berm. As a result, the required construction processes include interfaces with the building construction works, which had to be considered in advance in the planning.

Embankment and quay wall on the south side

Along the south side of the plot, the height difference between the bottom of the construction pit and the top edge of the adjacent quay wall (built in 1888) is approximately 3.50 m. The foundation pit has an incline here of between 45° and approximately 50°, and the surface is protected against erosion with shotcrete. This was necessary because the presence of existing quay makes the application of external anchorage impossible. Under the shotcrete, there is a drainage layer for effective water pressure release (fig. 3).

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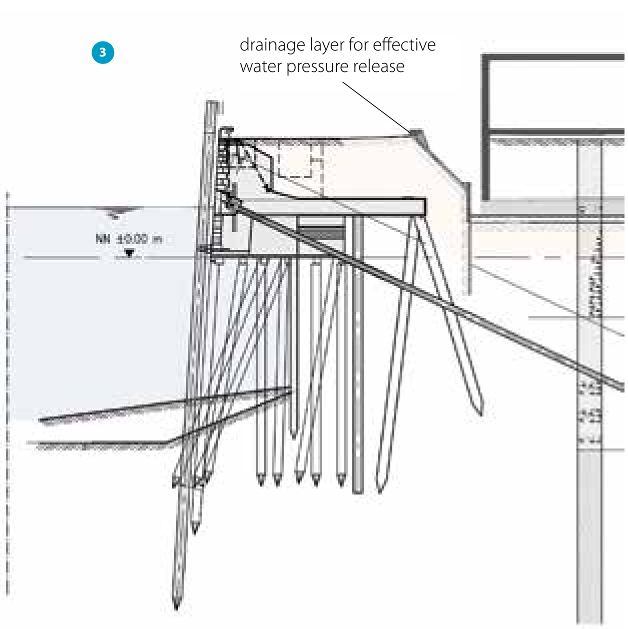

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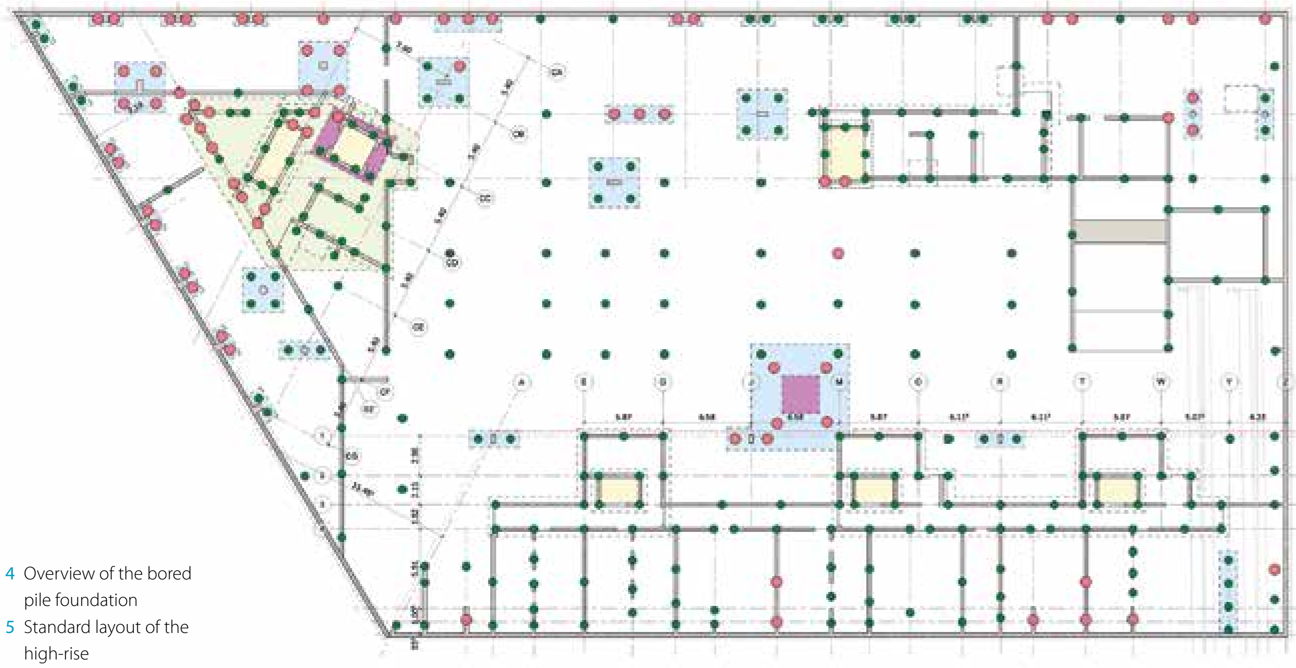
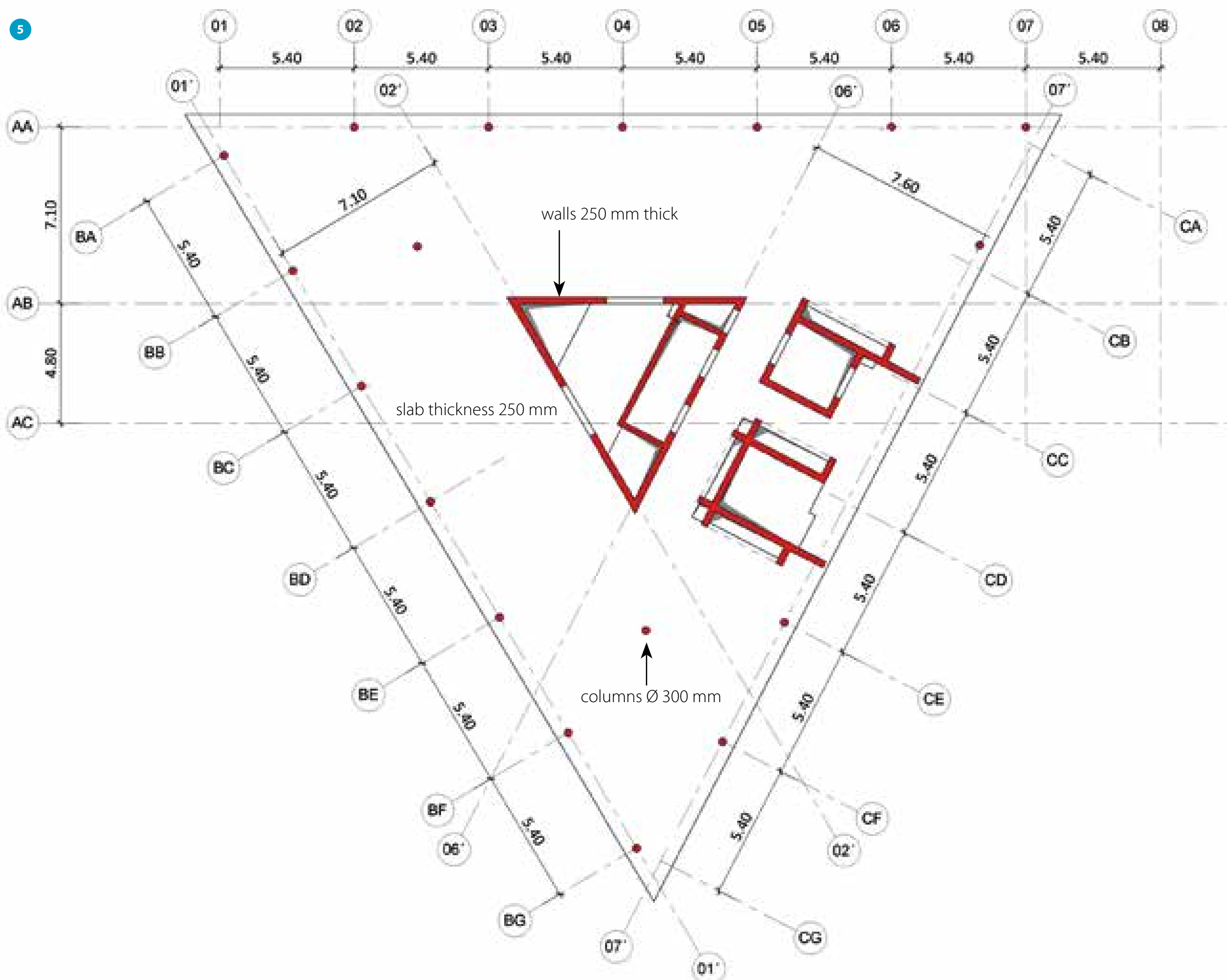
Foundation

In the investigation of underground conditions, in the first 3 m sandy fillings with soft layers (clay) were found. Next alternating layers of loosely layered sand and filled soft layers follow. Only after 8 m densely-packed sand, that is able to take a load, was found.
As the bottom edge of the structure is largely located in a filling, the load is transferred to the lower-lying sand that is able to take a load by a pile foundation. The piles are planned with diameters of Ø 600 mm and Ø 800 mm, and have a length of up to 25 m underneath the high-rise. In the calculation of the floor panel a spring stiffness of 240 MN/m (diameter 600 mm) and 340 MN/m (diameter 800) was applied. In the case of 9 m pile embedment into the load-bearing sands, a design load of R_d = 3400 kN was calculated for a 600 mm bored pile.

The vertical loads are diverted with point pressure and surface friction into the subsoil. Horizontal loads due to wind with short effect on the buildings and due to the sunk load cases (one-sided water pressure due to the draining-off of flood water) are transferred by areas through bedding and bending of the bored piles. For the horizontal bedding for the piles a bedding of k_h = 1.25 MN/m^2 was applied in the soft layer.
In addition to the usual load cases, the flood water load case with a flood level of +7,30 m above sea level and sunk load cases had to be considered: for the 0.65 m thick base plate this resulted in a maximum upward pressure of 55.50 kN/m^2. In total, there are approximately 340 bored piles spread across the





4 Overview of the bored pile foundation

5 Standard layout of the high-rise

entire construction site. Figure 4 shows the distribution of the bored piles (red: diameter 800 mm; green: diameter 600 mm).

The guideline 'Calculation models for flood protection walls, flood protection systems and waterfront structures in the area of the tidal Elbe of the Free and Hanseatic City of Hamburg' [3] and the 'Guideline for target heights and load assumptions for the HafenCity district' [4] are also taken into account in the structural calculations.

The arithmetically estimated pile resistances were reviewed with a static load test in accordance with 'EA – Pfähle' [5] (Recommendations of the Work Group 'Piles'). The load was applied centrically and axially with hydraulic presses. Steel trusses were used as abutments for the test load.

Structural design

High rise

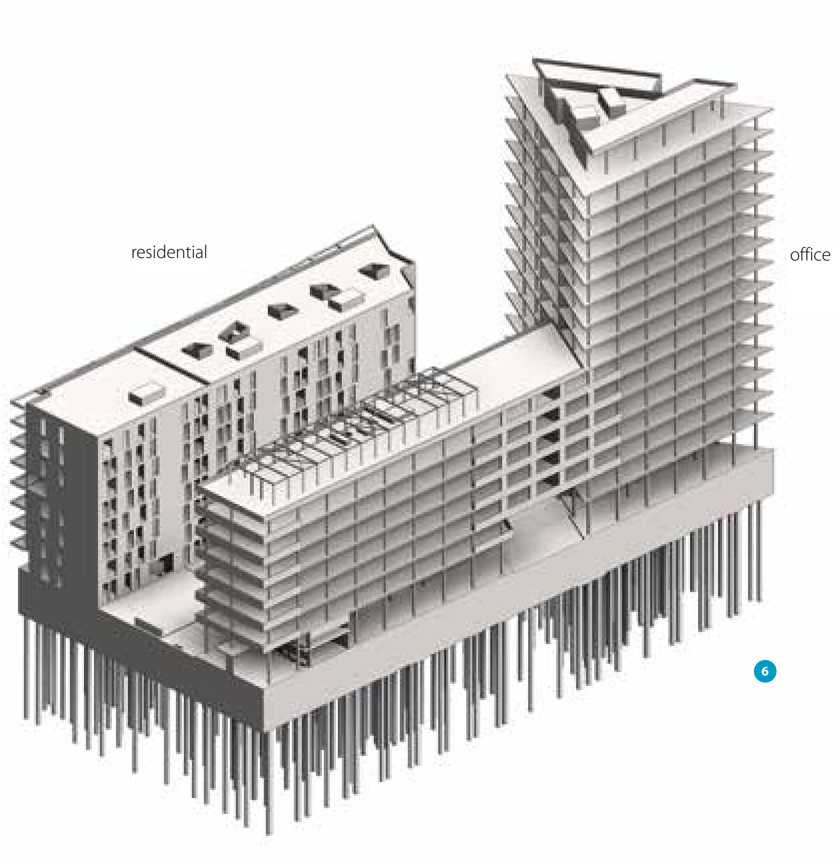
The 16-storey tower building and the adjacent office block extend along Versmannstrasse with a total length of 95 m. The standard layout of the high-rise has a clear structure with a support grid on the façade each 5.40 m with a total side length of L = 32.40 m (fig. 5). The distances to the reinforcing cores is L = 7.10 m.

The structural design is based on a reinforced concrete with 250 mm-thick flat slabs which are equipped with thermal component activation in the tower and the office block. The very slender supports in the high-rise are realised in high-strength concrete (C 80/95).

The building, which was examined holistically in a three-dimensional finite element model, is reinforced through the stairway cores and lift shafts. In the transition area between the tower and office building along Versmannstrasse, a 16.20 m wide passage to the inner courtyard is planned. This will be realised by a concrete structure in the area of the façade which will be formed over five floors as a Vierendeel truss (fig. 6).

Residential building

For the residential building, a design has been chosen which combines the efficiency and variability of the layouts: efficiency in terms of straight load transfer and flexibility in terms of the optimal arrangement of walls. In the transfer to the lower level, the loads were absorbed by roof beams and wall-like supports. The cantilever balconies in the area of the residential building are planned as prefabricated components and are fixed with Schöck Isokorb load-bearing elements in the 220 mm thick concrete slab.



6 3D model in REVIT

All plans produced by Schüßler-Plan are shown in a continuous, spatial 3D model in order to optimise the support structure, details and planning (fig. 6).
The building is currently being built and should be finished in spring 2018. ☒

REFERENCES

1 General conditions for licence areas (Version 06.05.2015), HafenCity Hamburg GmbH.
2 Geotechnical report, orienting contaminant investigation: Campus Tower, Hafencity Hamburg, Plot 80, IGB Ingenieurgesellschaft mbH, 29.07.2014.
3 Calculation models for flood protection walls, flood protection systems and waterfront structures in the area of the tidal Elbe of the Free and Hanseatic City of Hamburg; Free and Hanseatic City of Hamburg, Department for Roads, Bridges and Waterways.
4 Guideline for target heights and load assumptions for the HafenCity district; Free and Hanseatic City of Hamburg, Department for Roads, Bridges and Waterways.
5 EA – Pfähle, Recommendations of the Work Group 'Piles', German Geotechnical Society.