Acta Polytechnica CTU Proceedings **56**:32–36, 2026
https://doi.org/10.14311/APP.2026.56.0032

SPECIAL FOUNDATION OF NEW BUILDINGS IN NOVÉ SADY STREET IN BRNO

Petr Svoboda

KELLER-speciální zakládání, spol. s r.o., office Brno, Vídeňská 120, 619 00 Brno, Czech Republic
correspondence: petr.svoboda@keller.com

Abstract. The construction of the TITANIUM building was started in 2008 near the main railway station in Brno, along the left side of Nové Sady Street. This was followed by the southern extension and expansion of the IN SADY building, then the northward extension of the TITANIUM X and CENTROPOLIS buildings. Various special foundation methods were used in the construction of the building pits and the actual foundation of the buildings. Responses to the realistic form of neogenic clay were also important.

Keywords: Piles, sheet piles, Neogene bedrock, groundwater.

1. Introduction

The location of the main railway station evokes many decades of discussion and controversy in Brno, both on the professional and the political level. The topic of relocation to a new location or reconstruction in the existing location is probably not a fundamental one for geotechnical engineering. However, brownfield and unused surrounding land has been undergoing significant transformation for years. An example of this is the construction of a modern multifunctional complex south of Hybešova Street, between Nové Sady Street and the southern part of the main railway station. It was started in 2008 by TITANIUM. This was followed by its southern and northern extensions (TITANIUM II and TITANIUM X) and, together with the currently constructed closely adjacent buildings IN SADY and CENTROPOLIS, it occupies a trapezoid area of approximately 210 m along Nové Sady Street and perpendicular to it for a minimum of 50 m and a maximum of approximately 110 m (see Figure 1). It offers into the future garages, offices of larger and smaller companies, restaurants, apartments and recreational areas including a large atrium with greenery and water reservoirs.

KELLER gradually established all of the abovementioned buildings, some of which required the provision of a construction pit. Different technologies and methods of special foundations were used, both classic and less common.

2. Geotechnical conditions

Prior to the start of construction, the site was unevenly developed with smaller buildings and areas and was used only sporadically for storage, parking and other low-intensity and low-demand production activities. As part of the redevelopment, it was not necessary to clear the subject areas of significant underground anthropogenic obstructions. Nevertheless, archaeological investigations were carried out here in stages, always on a large scale, in view of the historical importance of the site.

The surface of the original site was flat with an elevation of no more than a few tens of centimetres and an average elevation of approximately 200 to 201 m. The area is located in the floodplain of the Svratka River with a water level of 100 metres above the existing terrain.

Taking an engineering-geological point of view, under the layer of anthropogenic ballast (which was removed in the entire extent of the construction site both in terms of its extent and area), there is a layer of Holocene flood clay, sandy and clay-sandy soils as alluvial floodplains of the Svratka alluvium at a depth of about 1 to 3 metres. The consistency of these soils and their fill varies and ranges from soft to firm.

In some places, however, Holocene alluvium was completely absent, with the alluvium deposited directly on the surface of fluvial gravel and sand terraces of Pleistocene age. The latter is built up with sands and, in places, weakly clayey gravels. These incohesive soils are predominantly bedded. The terrace surface was recorded at depths of between 3.0 and 5.0 m below ground level.

Directly below the Quaternary cover are Neogene bedrock sediments, which are composed of calcareous highly plastic clays (till) and clayey sands of Lower Tortonian age, mostly of firm consistency. The surface of the Neogene is slightly inclined to the SE, but shallow deformation of its surface due to erosion by the Svratka River cannot be ruled out, and it was recorded at depths of 5 to 8 m below the ground surface. Its thickness in these places ranges from approximately 20 to several tens of metres. The bedrock has not been identified.

Groundwater here continuously aquifers the gravel terrace of the Svratka River and shallow and more permeable overlying sediments. Due to the very weak lateral inflows of groundwater infiltrating into the area of interest from the surrounding valley slopes, it is

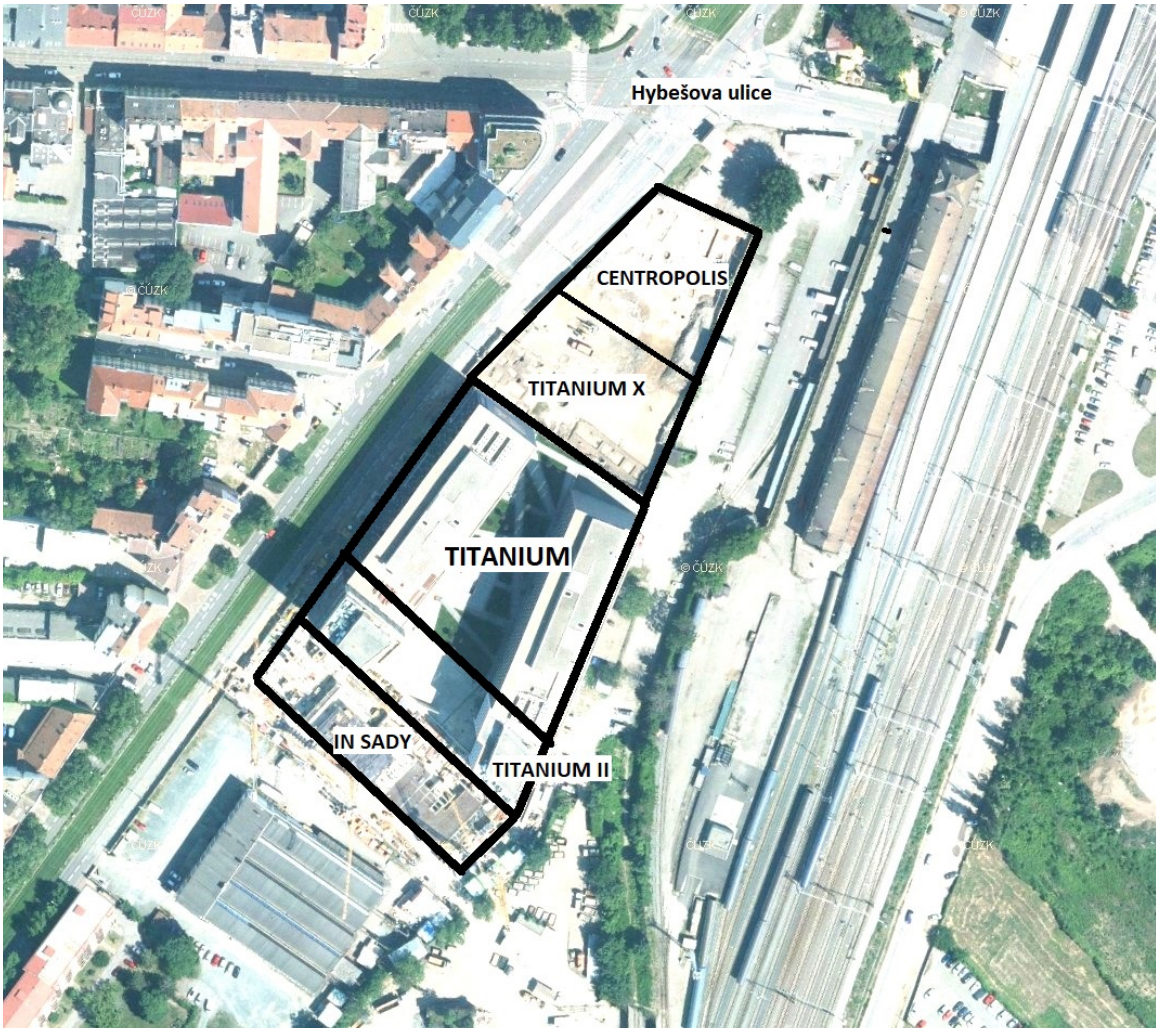

Figure 1. Situation of the location of individual objects.

mainly groundwater of a fluvial nature. The groundwater level is slightly stressed and slopes towards the Svratka River. The level of impacted HPV was observed at a depth of approximately 3 to 4 m below ground level and the level of steady HPV could be observed as low as 1 m above ground level.

The permeability of the aquifer environment, especially the river gravels, is relatively very high. It can be expressed in terms of a filtration coefficient in the range of about $1{\cdot}10^{-1}$ to $1{\cdot}10^{-3}\,\mathrm{m\,s^{-1}}$. The permeability of the overlying clays and alluvium, or the neogenic bedrock, is then considerably lower, which explains the groundwater stress.

3. Construction phasing

3.1. TITANIUM I

The oldest (main) part of the complex are two high-rise buildings with 8 floors above ground connected by one underground floor, which in the space between these high-rise buildings carries an outdoor atrium layout on its ceiling. The foundation joint is located at a depth of approximately 3.5 metres below the surrounding ground level, essentially at groundwater level. With a view to maximising use for car parking, the entire underground level is open, with only a column support system and cores with stairs and lifts. Reinforced concrete monolithic columns with a cross-section of 300×450 or 600 mm and perimeter walls with a thickness of 200 mm are connected to a reinforced concrete base-floor slab with a thickness of 400 mm.

The original design of the building foundation assumed classic drilled large-diameter piles. However, since KELLER had already had experience with the use of the Deep Soil Mixing (DSM) wet method with cement binder in “Brno geological conditions”, it decided to use it here as well. The construction conditions, represented by the rigid foundation slab, were also suitable. Thus, despite the higher loads in the skeleton columns (up to 4 MN), it was possible to transfer the load to a load-bearing gravel bench or a solid neogenic subsoil using blocks composed of four to eight pieces of 600 mm diameter DSM piers. The piers were stirred by a single column with paddles to a depth of 4 to 6 m. Above each DSM block, below the level of the foundation slab, a 400 to 600 mm thick spread footing of C16/20 grade concrete with a steel grid was still in place.

Unfortunately, the general contractor went bankrupt after the completion of the underground floor and it took more than 3 years to get the construction restarted. The final settlement that was measured on some selected skeleton columns did not reach the maximum values predicted by the calculation, i.e. 15 mm.

3.2. TITANIUM II

The second phase had to wait until 2019, when the TITANIUM II extension was initiated. It is an extension of the building to the south, but with a total floor area of ten storeys. Also it has only one underground floor, which is connected to the TITANIUM I section 3.1. For this extension, in view of the requirement for rapid construction, collision-free connection on all floors of both buildings and the significantly higher load in the columns of the skeleton of Part II (10+1 storeys), we chose a foundation on drilled reinforced concrete piles. This was due to concerns about the incomplete settlement of the DSM solids in the new section at the time of its construction completion, and therefore meeting the requirement for a collision-free connection between the two buildings. Therefore, reinforced concrete drilled piles of 620, 880 and 1 180 mm diameter and 4 to 20 m long were used. Their drilling was largely trouble-free, with only the quaternary positions needing to be drilled, and the neogenic bedrock could then be drilled without casing.

Even before the start of this stage, the client had agreed with the investor of the neighbouring IN SADY project to build a retaining wall on the boundary of their buildings. IN SADY was planned with one extra underground floor, and therefore it was logical to build the retaining wall under TITANIUM II in advance, rather than subsequently undermining the building. The wall was designed as a pile wall (620 mm diameter piles with an axial distance of 1 200 to 1 500 mm) with jet grouting.

3.3. IN SADY

The following stages were in quick succession. In 2021 there came the further expansion of the complex in the south direction with the IN SADY part, a building mainly with apartments. However, there was a major change in terms of special foundation, namely the requirement for two underground floors (see above) and also 12 floors above ground. The excavation of a construction pit up to 8 m deep with a groundwater level 3 m below the ground surface had to be solved both statically and hydrologically. Conflicting factors entered into the decision-making process, such as

(a) the availability of sufficient floor space on the construction site, which allowed the casing to be set up at a distance from the future building structure, or

(b) the very firm position of the neogenic clay, which is resistant to the conventional method of vibratory sheet piling.

After consideration and financial analysis of several options, we finally implemented the design of an anchored sheet pile wall with CFA piers, offset approximately 1.0 m from the face of the basement perimeter wall, sufficiently committed to the impermeable clay subgrade. Thus, we anticipated a very reliable sealing of the pit against groundwater and a simple, quick and inexpensive implementation. The connection to the casing-sealing wall in the section along the TITANIUM II building was also prepared in advance.

Pit wall anchorage and foundation piles were to be drilled from the lower levels of the pit excavation. Unfortunately, in the course of pre-drilling, installation of the pumping wells and actual pumping of groundwater from the pit area, it became apparent that the sheet piles in approximately half of the extent closer to Nové Sady Street were not committed to the impermeable clay subsoil, which was contrary to the information from the client's engineering geological survey. Six control core holes were quickly completed and confirmed that the pertinent involved area of the upper Neogene parts is not clay but sand. For this reason, our company proposed to the client to seal the base of the unbound part of the sheet pile wall with jet grouting slats and in order not to slow down the progress of the work too much, foundation reinforced concrete large-diameter piles were drilled already from a level just above the groundwater level, i.e. with a deaf drilling length of up to 5 m. Unfortunately, the IG survey also proved to be of poor quality when drilling the 620, 880 and 1 180 mm diameter piles, as it did not identify the neogenic sand positions with a tight water table, which then required borehole casing of up to 28 m in length.

Logically, these measures have resulted in an extension of the deadline and a significant increase in costs. However, the sealing of the construction pit was successful and the pumping of the negligible amount of groundwater was already under the control of the client. The anchoring of the sheet pile walls as well as the pile wall under TITANIUM II was then carried out using temporary prestressed cable anchors during the excavation of the pit, i.e. later than the plan to drill the piles from the bottom of the pit. Approximately 10 months after the completion of the pit construction, a sufficient mass of the actual building was constructed to counterbalance the groundwater uplift and the sheet piles could be removed.

3.4. TITANIUM X + CENTROPOLIS

The last stage of the construction of the complex in the northern direction was launched in autumn 2022. The TITANIUM I building is followed by an extension labeled TITANIUM X, which is connected to the CENTROPOLIS building of another developer by a garage basement. TITANIUM X corresponds to the existing

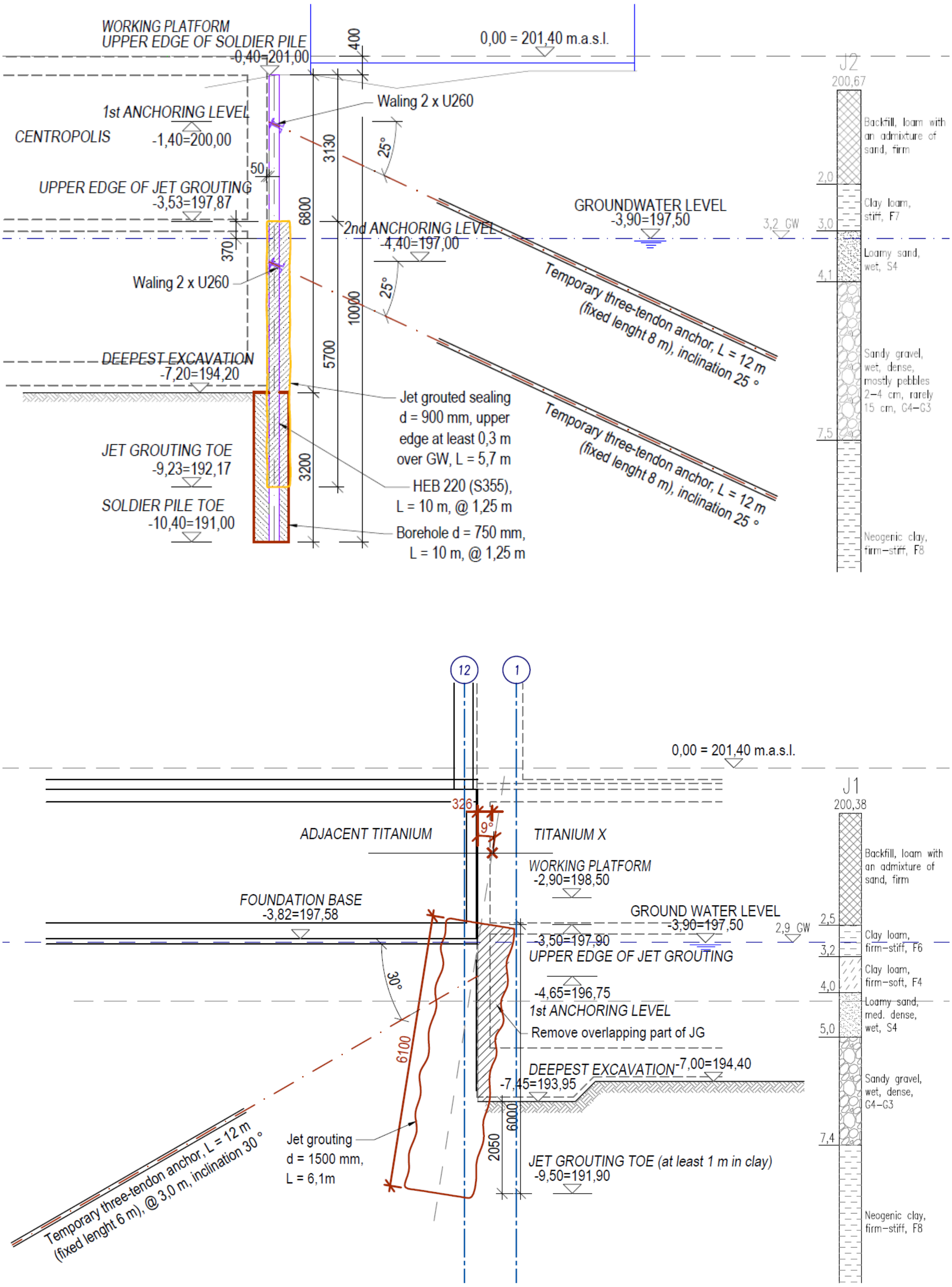

Figure 2. Examples of the TITANIUM X + CENTROPOLIS footings.

TITANIUM I in its above-ground construction and functional orientation (offices). CENTROPOLIS, on the other hand, will be an exclusively residential building with seven floors above ground. However, both buildings are realized from one common construction pit similarly conceived as the pit for the IN SADY section. Its depth is approximately 7.5 to 8.5 m and corresponds to the need for two underground floors for garage parking. Geotechnical and spatial conditions led our company and the investor to design and seal the pit from three sides in the spirit of the IN SADY section, i.e. using an anchored sheet pile wall. The adjacent existing TITANIUM I wall was then supported or sealed by jet grouting pillars with a diameter of 1 600 mm. The adjacent DSM walls were used to tie in and connect the jet grouting slats at the foundation support locations.

From the original terrain, the pit was first slightly above the groundwater level, i.e. about 3 m below the level of the original terrain. From there, sheet piling was installed, approximately 10 m in length, preceded by drilling in the centreline of the wall using the CFA system to the designed depth, or impermeable neogenic clay bedrock of firm consistency. In two short sections, the footing had to be designed as a lost formwork due to the impossibility of maintaining the distance from the future face of the basement wall and was implemented by means of a backstop with jet grouting or a separate wall made of jet grouting piers only. These sections were also bound in impermeable tertiary clay. All of the casing or seal structures were anchored with temporary cable prestressed anchors at one or two levels. The pit sealed reliably and did not require any modification or additions to the casing-seals. Examples of the construction in some sections of the pit casing are shown in Figure 2.

However, the drilling of large-diameter reinforced concrete piles with diameters of 620, 880 and 1 180 mm and lengths of up to 25 m for the foundation was again accompanied by the need to cut some boreholes down to the level of their base, although this was not at all obvious from the conclusions of the engineering geological survey. Some of the piles had to be dimensioned for the tensile effects of groundwater buoyancy. The final stage of the delivery will be the removal of the anchor steel lintels and the removal of the sheet piles this winter or next spring.

4. Conclusion

The city centre of Brno includes, among other things, original sites and land which have been significantly reconstructed or revitalised in recent years. Part of this is also the construction of a complex of buildings along the left side in the initial part of Nové Sady Street. It started in 2008 and is likely to be completed next year.

Geotechnically, this site is very interesting and offers opportunities to use modern technological methods of special foundation for the sealing of construction pits as well as the foundation of buildings. The successful accomplishments of KELLER within this new development prove this.

However, it should be noted that, as in many other cases, there is a significant deficit in the quality of geotechnical investigations. The area in question covers approximately 20 000 m^2 and a total of seven core drillings and two penetration probes were carried out in stages prior to construction or design work. Unfortunately, this was only to a maximum depth of 15 m, while the depths of the construction pits reached up to 8 m and the lengths of the piles from the bottom of the pits up to 25 m. It is therefore appropriate to recall that the myth that information given "where the surface of the Neogene bedrock is located and that it is the same from here on" is sufficient for purpose is reprehensible. We needed to know much more and if we do not know this in advance, we will still be setting up somewhat chaotic, rather slow and therefore unexpectedly more expensive than planned (designed) operations. Neogene bedrock is not simply and only impermeable clay of solid or hard consistency. . . !

It is therefore necessary to (patiently) convince investors and design planners that they must specify the requirement for a proper and sufficient geotechnical investigation. Its conception must be prepared by a geotechnical engineer who is familiar with the planned building, its foundation requirements or the technological context. The foundation designer should then be able to responsibly and humbly work with such documents with a minimum of contradiction.

Acknowledgements

I give my thanks on behalf of KELLER to all three principals or investors for the complex under construction, the companies JRA Estate, a.s., TIPA Telekom Nové Sady s.r.o. and PROPERITY s.r.o., Brno, namely its representatives, Mr.Richard Kocman, Ing. Tomáš Přibyl and Ing. Tomáš Drozd for their kindness and the opportunity to participate in the projects, both in the phases of design and finally of implementation.