

EXPLORATORY ADIT FOR THE BÍLÁ SKÁLA TUNNEL ON THE ROUTE OF PRAGUE CITY RING ROAD

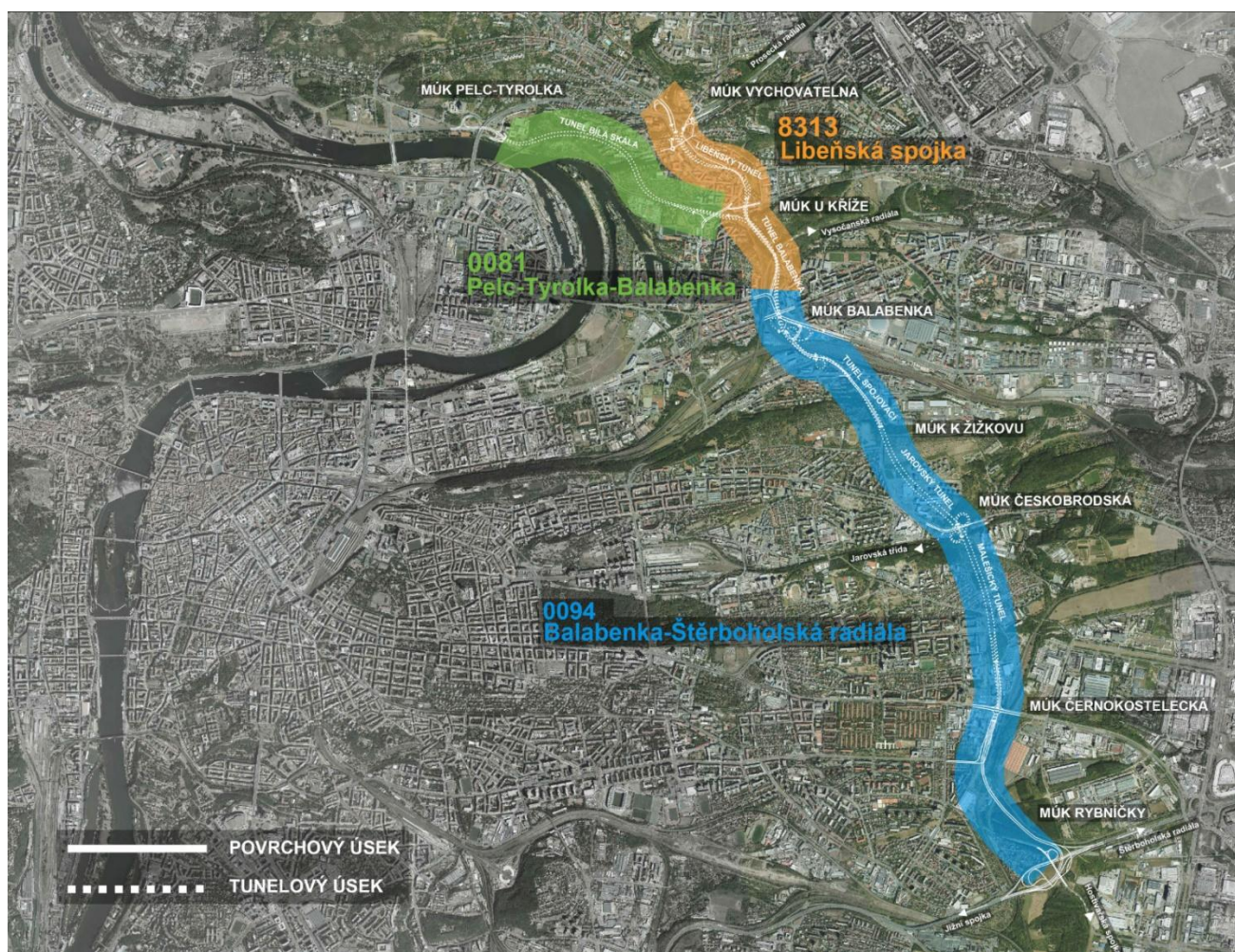
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ABSTRACT: The Bílá Skála road tunnel is part of the initial section of the remaining unrealized part of the Prague City Ring Road in the direction from the Blanka tunnel complex. Documentation for the zoning decision has been prepared for the entire project. This paper follows up on an article from the previous Underground Structures Prague 2023 conference and deals with the technical design of a 1,133 m long exploratory adit for the Bílá Skála tunnel. The exploratory adit is proposed as part of a detailed geotechnical survey of the project and runs within the profile of one of the two tubes of the future road tunnel.

1. INTRODUCTION

The Blanka Tunnel Complex, which was put into operation in 2015, is followed by a set of three new sections with a total length of approximately 10.5 km, which will complete the entire City Ring Road. These sections meet at the U Kříže - Balabenka traffic junction and complement each other. The joint project consists of MO No.0081 section Pelc Tyrolka – Balabenka, MO No.0094 section Balabenka - Rybníčky and the related LS No.8313 section U Kříže - Vychovatelna (Fig. 1). The Bílá Skála tunnel is



mostly part of construction MO 0081, cut-and-cover section of the northern tunnel tube is extended into LS 8313.

Tunnel proposal was described in detail in the article "Prepared Bílá Skála tunnel on the route of Prague City Ring Road" from the previous Underground Structures Prague 2023 conference (Korejčík et al., 2023). The conclusion of the article mentioned the need to carry out a detailed geotechnical survey for this demanding construction project, including a design of an exploratory adit for the bored part of the tunnel. The following text will familiarize you with the technical proposal of this exploratory project. At the time of writing, the tender documentation for the detailed geotechnical survey of all three of the above-mentioned project sections is being finalized.

2. GEOTECHNICAL SURVEY PHASES

A search of available geological data was prepared for the first phase of the design works. The area of interest is relatively well explored in terms of the number of archive probes. However, the probes are mostly shallow and in many cases have very brief descriptions. The number of usable boreholes with good descriptions that extend sufficiently below the design road level, in the case of tunnel sections below the bottom of the excavation, is an order of magnitude lower.

A preliminary geotechnical survey (SGG-PUDIS, 2021) was carried out in parallel with the design in order to establish the geotechnical basis for the preliminary design, already with regard to the specific alignment of the route. The survey consisted of exploratory core drilling, supplemented by pressiometric tests. Some of the boreholes were equipped to carry out hydrodynamic measurements and tests to complete the hydrogeological survey. In addition, geophysical and corrosion surveys, chemical analyses of water and soils, and laboratory testing of soil and rock samples collected during drilling were carried out.

The results of the survey carried out showed that the ground and geotechnical conditions are complex and need to be further refined in the next phase of preparation. The construction represents a highly demanding engineering task, which requires close cooperation between the designer, client, geologist, geotechnical engineer, and hydrogeologist in the subsequent phases of preparation.

For the next design stage, a detailed geotechnical survey was proposed, aimed at refining the results obtained along the entire route, with an emphasis on the bored sections, which represent the most demanding parts of the tunnel construction with several critical points. The first of these is the western portal of the bored tunnel, where landslide occurred in the past during the construction of a railway tunnel nearby. In the underpass beneath the Bulovka Hospital complex, it is also necessary to verify the course and nature of the location of the Řevnice quartzites, locate tectonic faults along the route, and verify the impact of excavation on the surface. Another critical location is the underpass of the sharply cut valley under Bulovka Street, where it is necessary to verify the extent and nature of weathering and tectonic faults and to specify the hydrogeological conditions.

For these reasons, a detailed geotechnical survey proposed an exploratory adit along almost the entire length of the southern tunnel tube of the future bored tunnel. Three additional exploratory boreholes were drilled to determine the optimal location of the adit portal and the access ramp support. Further exploratory work is expected to be carried out underground during the excavation of the adit.

A detailed surface drilling survey was designed for the above-ground and cut-and-cover tunnel sections and technological objects. The cut-and-cover tunnel sections will also affect the natural flow of groundwater due to their elevation, and at the same time they will be affected by groundwater. For this reason, long-term monitoring of existing and new hydrogeological boreholes and wells in the vicinity of the future construction has been proposed. It is necessary to supplement and update information on hydrogeological conditions, which are complex and often change within the city limits, mainly as a result of construction activities. The results of the survey will be used to determine the size of expected inflows, groundwater flow directions, and an overall assessment of the impact of the tunnel construction on the natural hydrogeological regime in the area.

3. GROUND CONDITIONS

The area of interest is located on the north-western flank of the Barrandien brachysynclinal, so the dominant dip of the strata is expected to be SSE. The pre-Quaternary bedrock in the area is exclusively Ordovician rocks of the Prague Basin. An overview of the longitudinal geological profile is shown in Figure 2, the colours of the individual geotypes are indicated in the text below.

The construction site area and the excavated access ramp to the tunnel portal are located in an environment of fill consisting mainly of silty-sandy sediments which abruptly transition into strongly to slightly weathered clayey shales of the Dobrotivá Formation.

Driven exploratory adit follows, for the first few hundred meters in weathered, then weathered to healthy Dobrotivá clayey shales (green). After about 70-90 m of weathered to healthy Řevnice quartzites (orange), followed by weathered to healthy clayey-dusty shales of the Libeň Formation (again green) ended by a geophysically predicted tectonic zone, followed by weathered to healthy dusty-sandy shales with interbedded fine-grained quartzites of the Letná Formation (brown). The end of the adit will be located in the weathered Letná shale. Archival searches have defined 6 distinct fault zones in the Bílá skála area. The predicted width of the fault zones ranges from 2 to 7 m, corresponding to a thickness of 1.5 to 5 m.

The entire exploratory adit will be excavated below the groundwater table. The groundwater will be aggressive to concrete in the range of XA1-XA2. In the vicinity of aquifers connected to the Ordovician strata, the transmissivity is mainly in the order of $10^{-6} \text{ m}^2 \cdot \text{s}^{-1}$ and can be considered very low, only occasionally values approach or exceed $10^{-5} \text{ m}^2 \cdot \text{s}^{-1}$.

In a quartzite environment, it is necessary to take into account the difficulty of separating highly solid rock with probable increased groundwater inflow and reduced stability of the excavation, all under the premises of the Bulovka Hospital.

The Libeň shale is slightly tectonically disturbed and weathered almost to the top of the future tunnel vault in the underpass of the historical water depression in Bulovka Street. At the same time, the lowest rock overburden is located in this section. This place therefore represents one of the risk areas for tunnelling, which will require great attention not only to ensure the stability of the tunnel excavation but also to minimise the impact of tunnelling on existing surface structures.

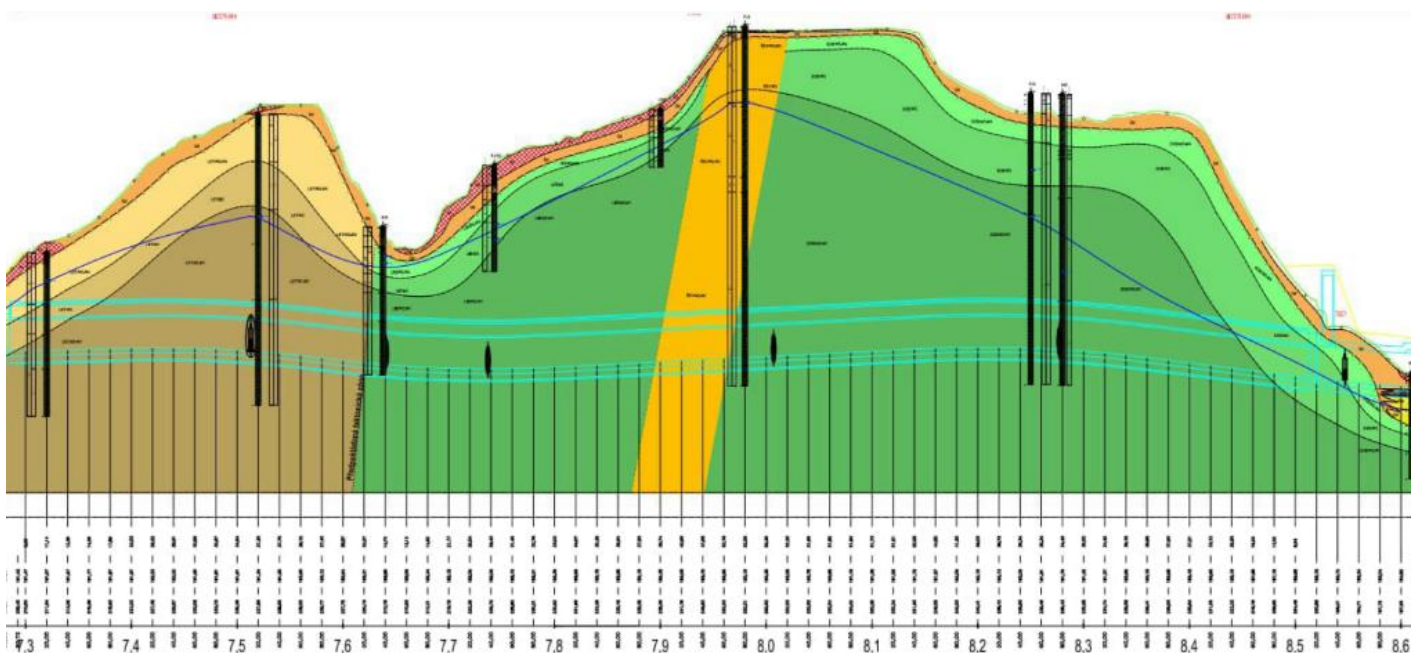


Figure 2: Longitudinal profile with geology in the east-west direction; adit portal on the right (description in text)

4. TECHNICAL DESIGN OF EXPLORATORY ADIT

4.1 BASIC DESCRIPTION

As already mentioned, as part of a detailed geotechnical survey for future tunnels on the Prague Ring Road, and specifically for the design of the Bílá Skála road tunnel, a 1,133 m long exploratory adit is proposed. It will be constructed conventionally using the New Austrian Tunneling Method (NATM). The profile of the adit is located inside the profile of the southern tube of the future bored road tunnel.

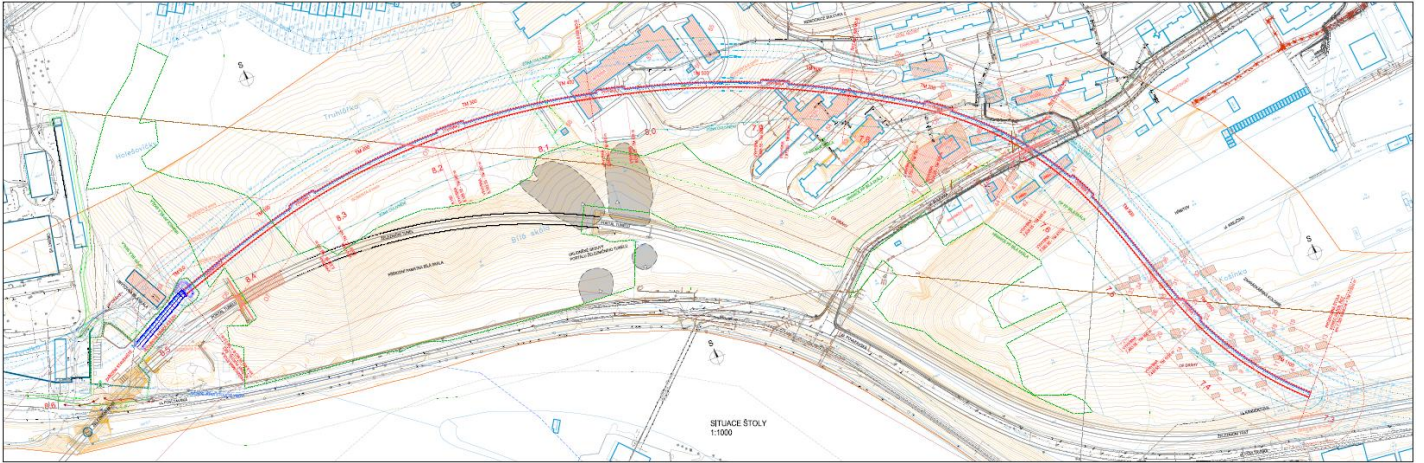


Figure 3: Layout of the exploratory adit; construction site and adit portal on the left

The adit alignment corresponds to the alignment of the future tunnel (Figures 2, 3). The adit cannot be designed with a uniform slope that would allow gravity drainage of groundwater seepage. The construction site is located near the university campus in the Pelc-Tyrolka area, in the vicinity of the future cut-and-cover road tunnels. From there, the adit will be excavated under the Bílá skála hill and the Bulovka Hospital complex, followed by an underpass of the terrain depression in Bulovka Street, after which the terrain rises again and the tunnel passes under the hill on which the Libeň cemetery and gardening community district are located. The adit ends under Kandertova Street near the future portal of the bored road tunnel.

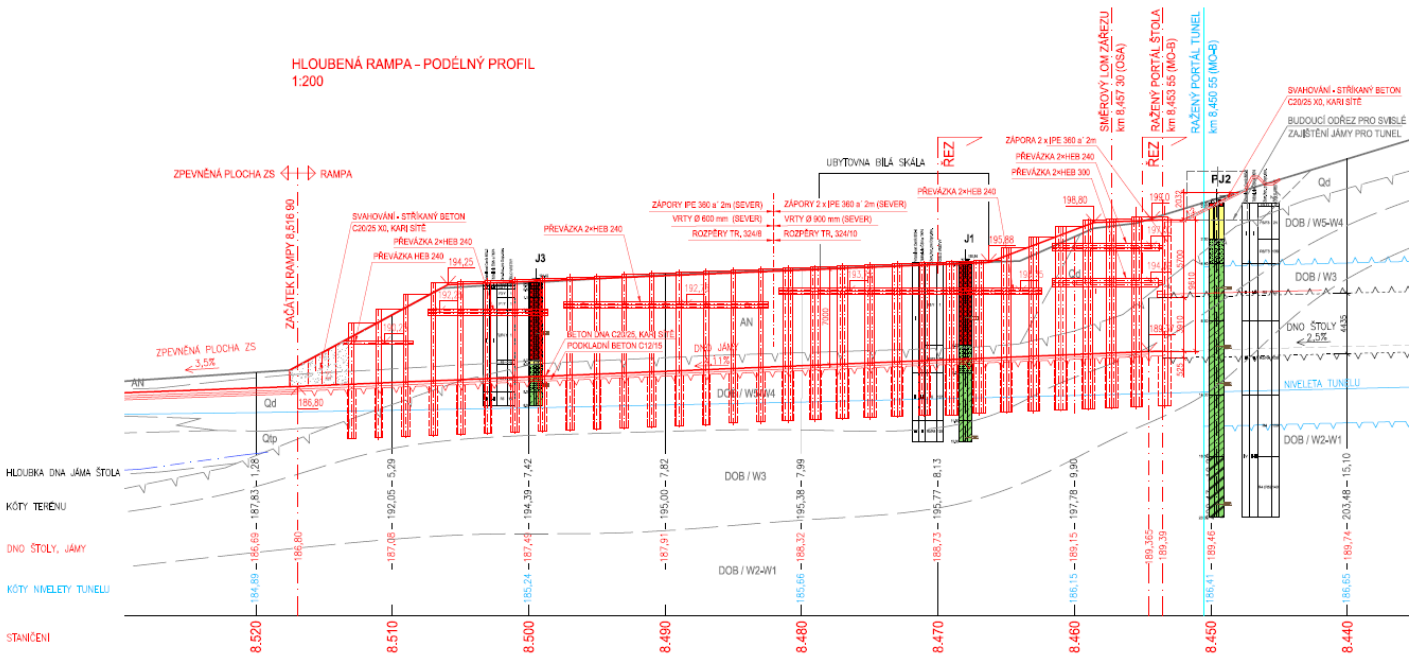


Figure 4: Longitudinal profile of the access cut to the adit portal

4.2 EXPLORATORY ADIT PORTAL

All tunnelling work will be carried out from the western portal. The construction site facilities are placed at the former construction site of the nearby railway tunnel, approximately at the level of Povltavská Street, to which it is directly connected.

Access for machinery from the construction site to the adit portal and the excavation itself will be provided by means of a cut with a clear width of 6 m and a length of approx. 63.5 m, rising slightly towards the portal (Figure 4). The maximum depth of the cut is approximately 10 m. The vertical walls of the cut will be supported by soldier pile walls with piles made of rolled IPE steel beams. Piles are strengthened by walers made of HEB steel beams and steel pipes bracing struts.

To commence excavation, a protective micropile steel umbrella with reinforced concrete arch beam will be installed above the future excavation face, the steel walers will be reinforced, and the portal wall will be additionally supported using shotcrete with reinforcing steel mesh and bolts. The sloped areas of the cut will be stabilized with shotcrete and steel mesh.

4.3 BORED EXPLORATORY ADIT

The exploratory adit is located inside the profile of the future southern road tunnel (Figure 5). The adit is horseshoe-shaped, with a width of approximately 4.4 m and a maximum height of approximately 4.5m. The excavation area is approximately 15.5 m². To ensure logistics and sufficient space for exploratory drilling from underground, a total of seven semicircular sidings will be placed in the adit. The 25-meter-long sidings widen the adit profile on the left in the direction of excavation to 23.2 m².

The lining of the tunnel is single shell throughout the entire length, with a concrete bottom and no waterproofing. The primary lining is designed from reinforced shotcrete SB C20/25 with steel reinforcement meshes. Reinforcing lattice girders, rockbolts, pre-drilled steel spiles, and other reinforcing elements will also be used. Excavation is planned to use blasting works or mechanized excavation. The use of excavation classes 3, 4, and 5a is expected. The individual excavation classes differ in terms of the length of the excavation step (max. 1.5, 1.3, 1.0 m), the thickness of the lining (150, 200, 250 mm), and the extent of support elements of the excavation.

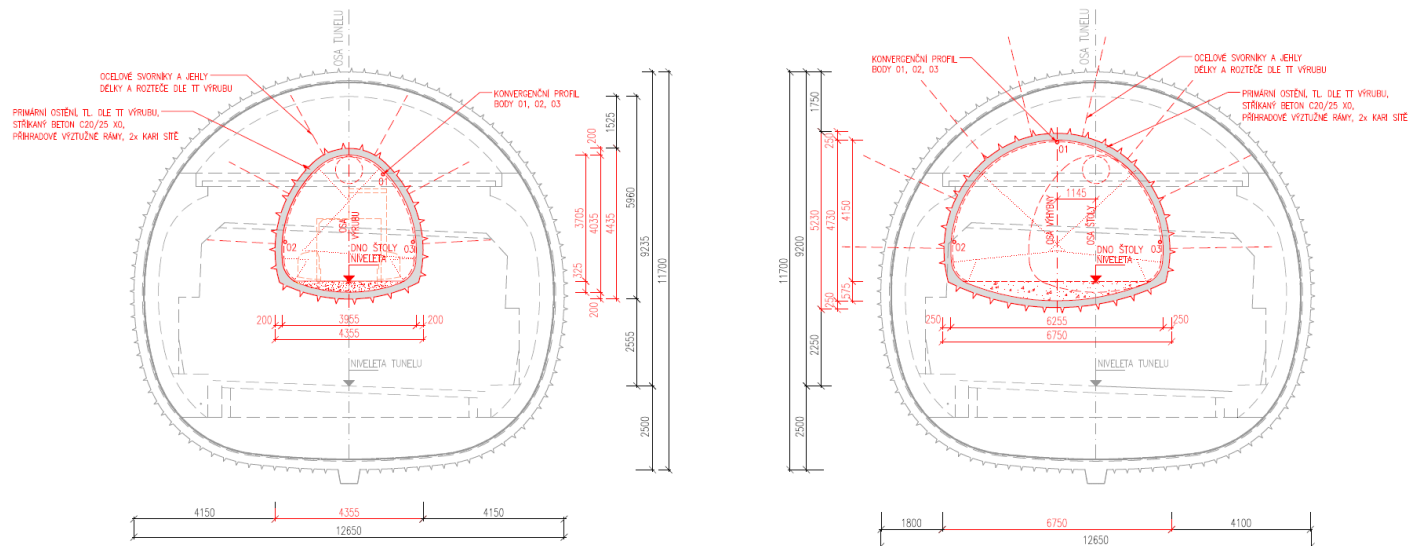


Figure 5: Location of the exploratory adit and siding in the future tunnel

5. GEOMONITORING AND SURVEY OF STRUCTURES

The exploratory adit excavation will be carried out using mining methods. In the area of possible negative induced effects of excavation work (area affected by subsidence and blasting), geotechnical monitoring

will be carried out in accordance with applicable regulations, as well as the building condition survey, as is common practice in the Czech Republic during the construction of excavated structures.

To minimize the negative impact of the construction on the surface, surrounding buildings, underground structures, and utilities, geotechnical monitoring, measurement, observation, and evaluation of the affected structures will be carried out. As part of geomonitoring, it is proposed to measure terrain surface deformations using geodetic levelling and trigonometric measurements. Similarly, above-ground buildings and the most important pipe utilities will be measured. In addition, measurements of deformations and faults in structures will be added. Another very important measurement will be the monitoring of the dynamic effects of blasting and noise measurements. During excavation, geotechnical evaluation of the rock mass and convergence measurements in the exploration adit will be performed regularly. Extensometric and inclinometric measurements are proposed to refine the behavior of the rock mass. Hydrogeological measurements will monitor the groundwater level in the vicinity of the excavations.

Before construction work begins, an inventory and detailed condition survey of buildings and structures in potential impact must be carried out. If necessary, a structural survey and static assessment of the load-bearing capacity of above-ground structures will also be carried out. During construction, the condition survey may be supplemented or updated. After completion of construction work, a final condition survey will be carried out. The final condition of the structure will be compared with the original one, including an assessment of any negative effects of the construction activity.

6. CONCLUSION

The exploratory adit for the future Bílá Skála road tunnel on the Prague City Ring Road is essentially ready in terms of design. All that remains is to wish it good luck for its implementation and hope that it will be reborn in the form of a new road tunnel that will serve drivers well and at the same time calm traffic in the surrounding area.

LITERATURE

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