CHALLENGES AT THE START OF CONSTRUCTION OF THE OPEVNĚNÍ AND POŘÍČÍ TUNNELS ON THE D11 MOTORWAY

J. Štetiar & V. Boltnar

V-CON, s.r.o., Prague, Czech Republic

J. Faltýnek

Subterra a. s., Prague, Czech Republic

V. Ruchkivskyi

VALBEK UA, Kyiv, Ukraine

ABSTRACT: This paper addresses the current status of the (as yet unfinished) Implementation Documentation (RDS) and summarises preparations for the commencement of excavation works for the Opevnění and Poříčí tunnels, which form part of the D11 motorway project in the 1109 Trutnov – CZ/PL national border section. The contribution presents both the contractor's perspective and that of the RDS designer, and it consolidates experience gained during the pre-construction and documentation phase. The text outlines schedule adjustments and their implications for overall construction logistics and coordination. It further reports selected technical constraints that had to be resolved during RDS preparation—e.g., the design and execution of portal construction pits in close proximity to very high voltage power lines. Finally, the paper discusses readiness for excavation start and the expected course of the forthcoming construction season, including the identification of principal technical and organisational challenges that will govern the subsequent progress of both tunnels.

1. INTRODUCTION

The D1109 section is the final segment of the D11 motorway (Fig. 1) prior to the national border between the Czech Republic and Poland. Together with the construction of section 1108—the last missing section of the D11—this project will complete an international connection within the TEN-T network and establish continuity to the Polish S3 high-speed communication corridor. The anticipated outcome is the diversion of transit traffic away from residential areas in the Trutnov–Královec region, with corresponding improvements in safety, continuity of traffic flow, and regional accessibility. In addition to underground works, the D1109 section is characterised by a high share of bridge structures: 28 bridges in total, including several exceptionally complex and long flyovers (ŘSD ČR).

The total length of the section is 21.175km (VALBEK). The contractor is an association of companies MI Roads a.s., Doprastav, a.s., Metrostav TBR a.s., Subterra a.s., and Duna Aszfalt Zrt. The complete RDS, comprising 176 building structures, is being prepared by Valbek, spol. s r.o. The RDS for the Poříčí and Opevnění tunnels, which are the focus of this paper, is being prepared by the design agency V-CON, s.r.o., while the tunnel contractor is an association of Subterra a.s. and Metrostav TBR a.s. The project owner is the Road and Motorway Directorate, SOE, and geotechnical monitoring for the section is provided by the "Trutnovský drak GTM" consortium.

2. BASIC CHARACTERISTICS OF THE TUNNELS

The D11 1109 Trutnov – CZ/PL national border project includes two tunnels: Poříčí (SO 601) and Opevnění (SO 602). The Poříčí tunnel comprises two separate, directionally segregated tubes: the left tunnel tube (LTT) is 540m long and the right tunnel tube (RTT) is 576m long. At both portals, cut-and-cover sections of identical lengths are designed (24m at the northern portal and 12m at the southern portal). Between these cut-and-cover sections, the excavated sections are 504m (LTT) and 540m (RTT), respectively. The tubes are interconnected by two excavated cross-passages.

Figure 1: Situation of D1109 section

The Opevnění tunnel consists of two tubes of equal length, 492m each. Each tube includes a 24m cut-and-cover section at the southern portal, followed by a 444m excavated section, and a 24m cut-and-cover section at the northern portal. One excavated cross-passage is designed at mid-length. Both tunnels are designed in the T 8.0 width category (Fig. 2), including both horizontal and vertical alignment curves. The clearance profile height is 4.8m. The Poříčí tunnel complies with safety category TC, whereas the Opevnění tunnel falls under category TB.

The design speed is 100km/h. The distance between the two tunnels is approximately 4.5km (measured along the main route (VALBEK, V–CON & Mott MacDonald CZ)).

The Poříčí tunnel is named after the Poříčí Ridge through which it is driven, while the Opevnění tunnel derives its name from a strip of former military infantry blockhouses located in its immediate vicinity.

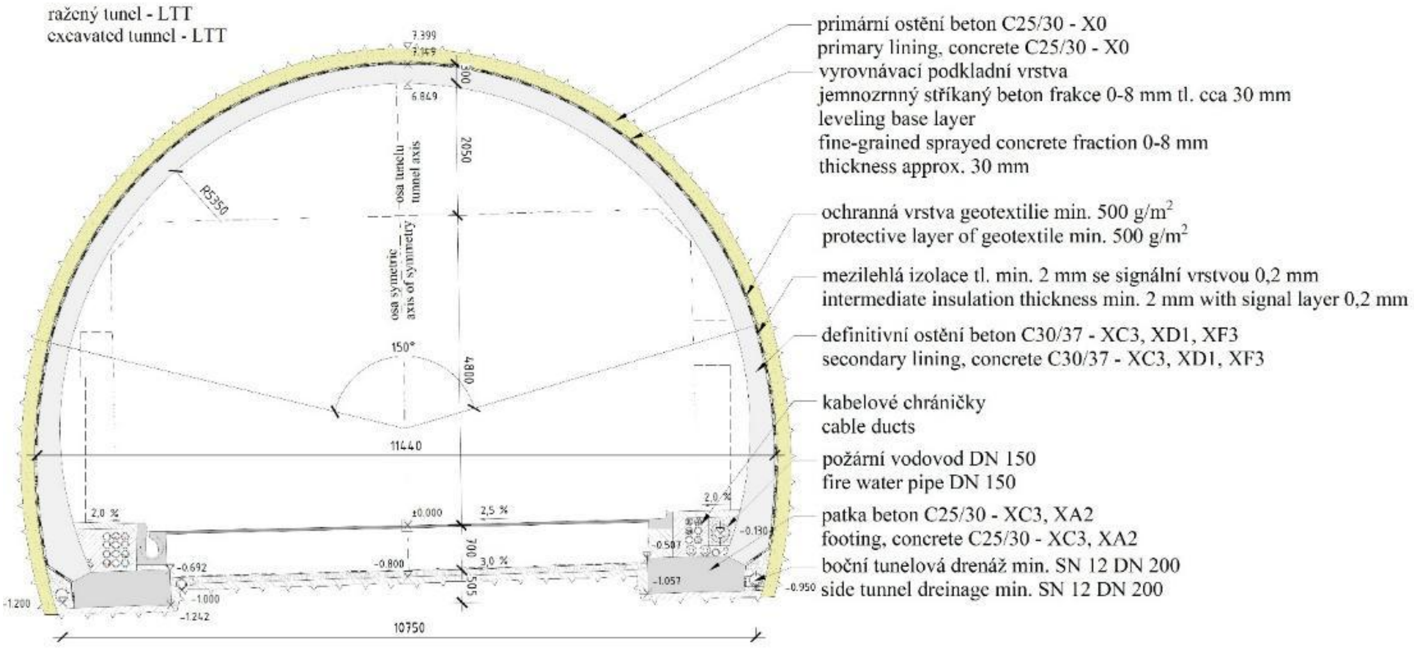


Figure 2: Exemplary cross-section of the tunnel traffic tube

Given the relatively favourable overburden and rock mass quality, both tunnels are designed for excavation by NATM with horizontal face sequencing, using excavation technological classes (TTV) 3, 4, and 5a. The excavation cross-sectional area reaches 90m^2. The secondary lining is designed as a two-pass system with strip footings and intermediate umbrella-type foil waterproofing. The vault of the secondary lining is supported on strip footings. Under the most adverse geotechnical conditions, the secondary lining at the crown is designed as 300mm thick unreinforced concrete. The cut-and-cover sections (arch on strip footings) are constructed within open, sloped portal pits secured by rock nails; following completion, they will be largely backfilled.

1. GEOLOGICAL CONDITIONS OF THE LOCATION

With respect to local geology, the Poříčí tunnel will be excavated predominantly in Antracolithic sandstones and siltstones (locally more competent), with a comparatively low intensity of discontinuities. From a hydrogeological perspective and in terms of permeability, the environment is fissured; groundwater occurrence is primarily associated with fractures and tectonic faults, which may locally intersect the excavation zone. A significant influx of groundwater is not anticipated during tunnel construction (GEOTEC-GS, 2019).

The Opevnění tunnel is excavated in sandstones and conglomerates with interbedded volcanoclastic rocks (rhyolite and pyroclastic rocks). The rock mass is affected by numerous fissures, increasing the risk of local block falls and groundwater inflows within fault zones. Groundwater levels are linked to the weathered rock mantle and may fluctuate with precipitation. Likewise, no high groundwater inflows into the Opevnění tunnel excavation are expected (GEOTEC-GS, 2019).

These rock mass conditions are reflected in the selection of NATM technological excavation classes, including the prescribed spacing between faces of the two tubes and the portal pre-support measures. Maximum emphasis will be placed on applying the observational method.

2. CHANGE OF CONSTRUCTION SCHEDULE

The construction site was handed over to the contractor on 08/10/2024. Preparation of the implementation documentation commenced immediately thereafter, in accordance with the initial construction schedule. During preparatory works in May 2025, a fly ash sludge lagoon was identified in the vicinity of the southern and northern portals of the Poříčí tunnel, necessitating adjustments to both the design and the planned construction sequence.

The identified material likely originated from historical operation of a nearby coal power plant, which previously used Radvanice coal characterised by a higher content of naturally occurring radionuclides. The potential for complications associated with excavation and disposal of historic fly ash deposits near the Poříčí tunnel, and the consequent risk to the planned schedule, led the project owner to revise the construction sequence of the two tunnels. Accordingly, in September 2025 the execution order for the Opevnění and Poříčí tunnels was reorganised to enable the required earthworks for removal of the fly ash sludge lagoon to be carried out in the interim, thereby minimising the potential overall delay to the project.

3. TRENCHING AND SECURING OF CONSTRUCTION PITS

Following the change in construction organisation, works commenced at the southern portal of the Opevnění tunnel. This portal presented demanding constraints from the standpoint of design, preparation, and execution. Under the original schedule, excavation of the Opevnění tunnel was intended to be completed at this portal; however, the revised sequence required that an area adjacent to the southern portal be prepared for site facilities and connected to essential utilities (Fig. 3). The dominant limiting factor was the presence of very high voltage (110kV) overhead power lines located in close proximity to the crest of the portal pit. The conductors intruded into the construction pit footprint (Fig.

4), and their spatial arrangement further constrained works in the vertical direction, as the lines rise upslope towards the portal (Fig. 5).

Figure 3: Construction site facilities near the southern portal of the Opevnění tunnel.

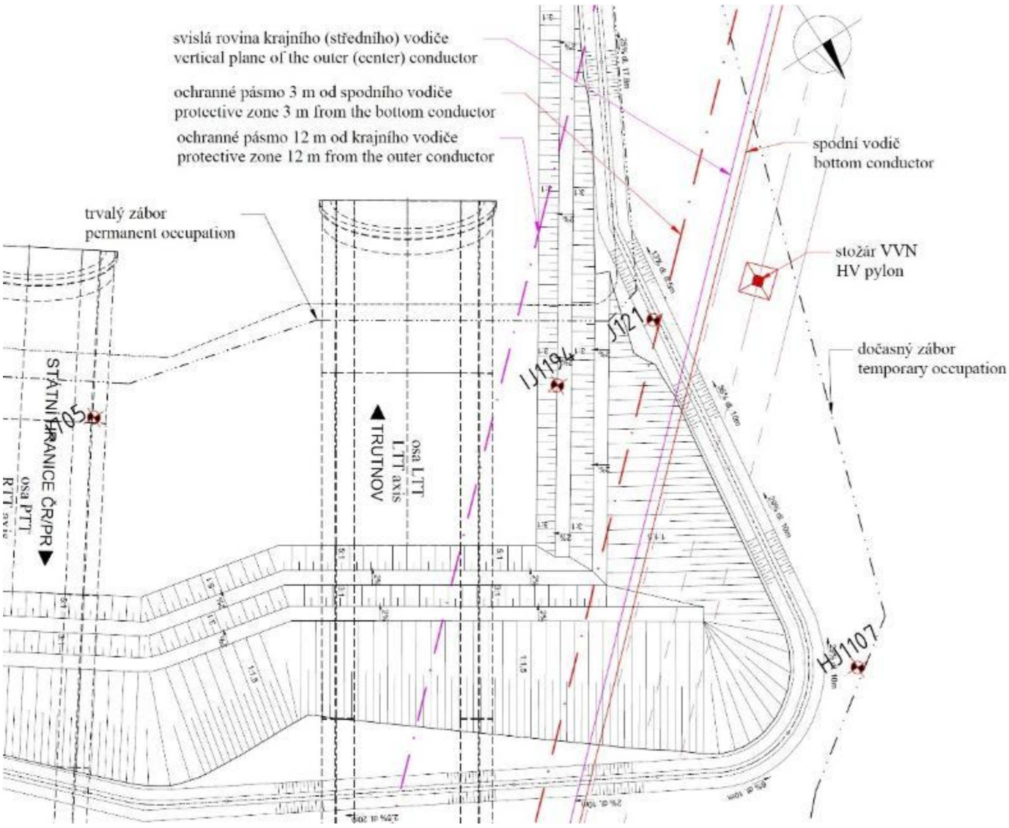


Figure 4: Cutout of a plan view of the construction pit with highlighted VHV protective zones

Figure 5: View of the VHV pylon from the crest of the excavation slope

Due to their importance, the overhead lines could not be diverted. This required the implementation of specific technical and organisational measures during construction. In cooperation with the distribution network operator, continuous monitoring of the pylon was ensured. All activities within the protective zone were carried out under the supervision of an authorised representative of the network operator, and construction procedures with the lowest risk to the overhead system were selected (Fig. 6).

Figure 6: Use of protective mats as a measure during blasting works

The northern portal of the Opevnění tunnel (Fig. 7) also required design revisions during the preparation of the implementation documentation. Based on more detailed geological inputs, coordination with the contractor, and updated calculations for the construction pit support in the area of the future retaining wall (left corner of the portal when looking against the chainage), the originally designed temporary anchoring with spacing corresponding to permanent anchors (3.0m) was replaced by an alternative solution using double-headed rock nails (Fig. 8). This arrangement enables activation in the temporary state via the first head, effectively densifying the support grid. The second head is then utilised during retaining wall concreting as the anchorage level for permanent slope stabilisation. The modification also required changing the nail type from SN rods to IBO rods, primarily due to the need for a longer threaded length to accommodate double anchorage heads. The double-headed rock nail solution therefore improves adaptability to less favourable geotechnical conditions on the left side of the portal while simplifying the transition from temporary to permanent works without the need for additional anchoring elements.

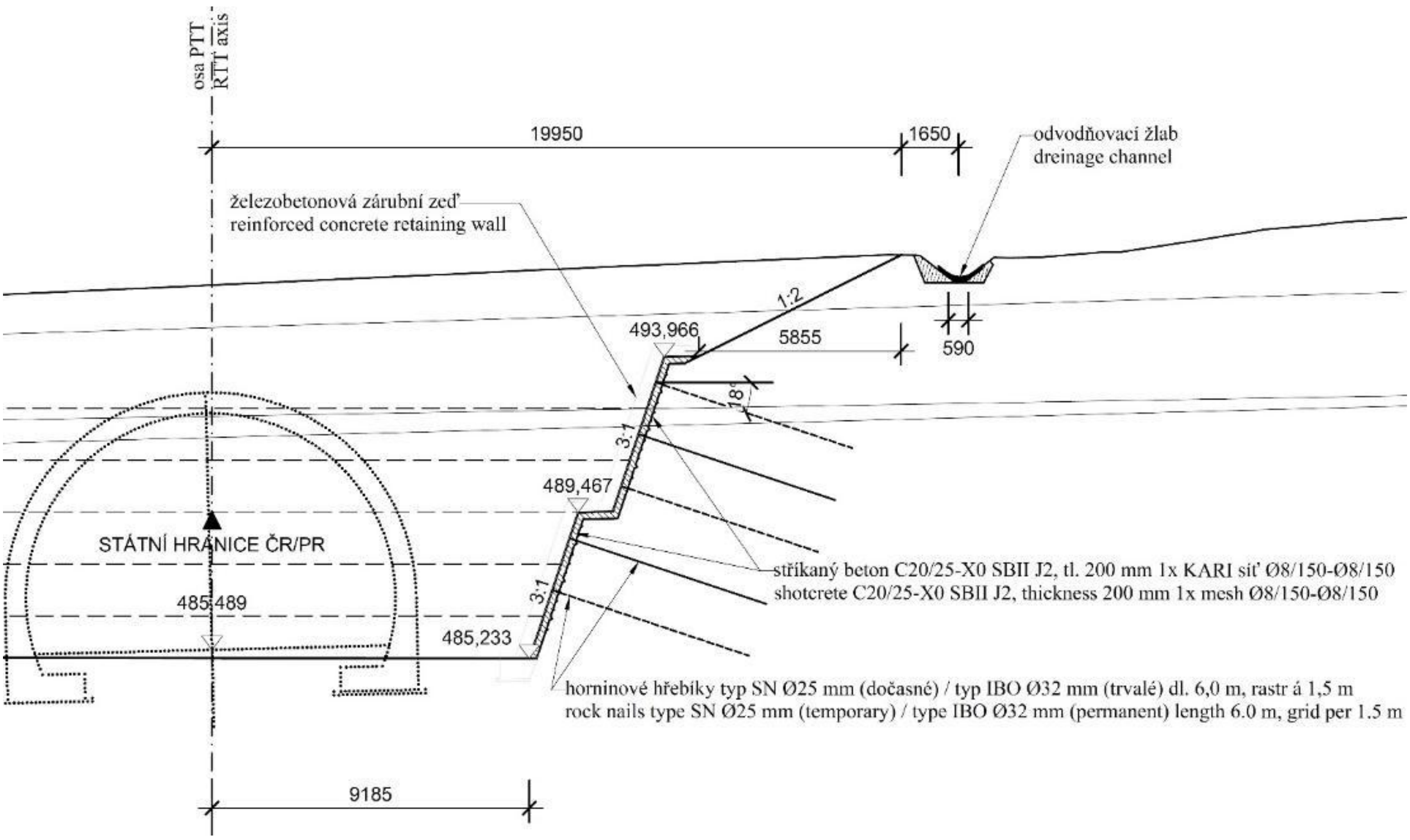


Figure 7: Cutout of a cross-section of construction pit support at the northern portal of the Opevnění tunnel.

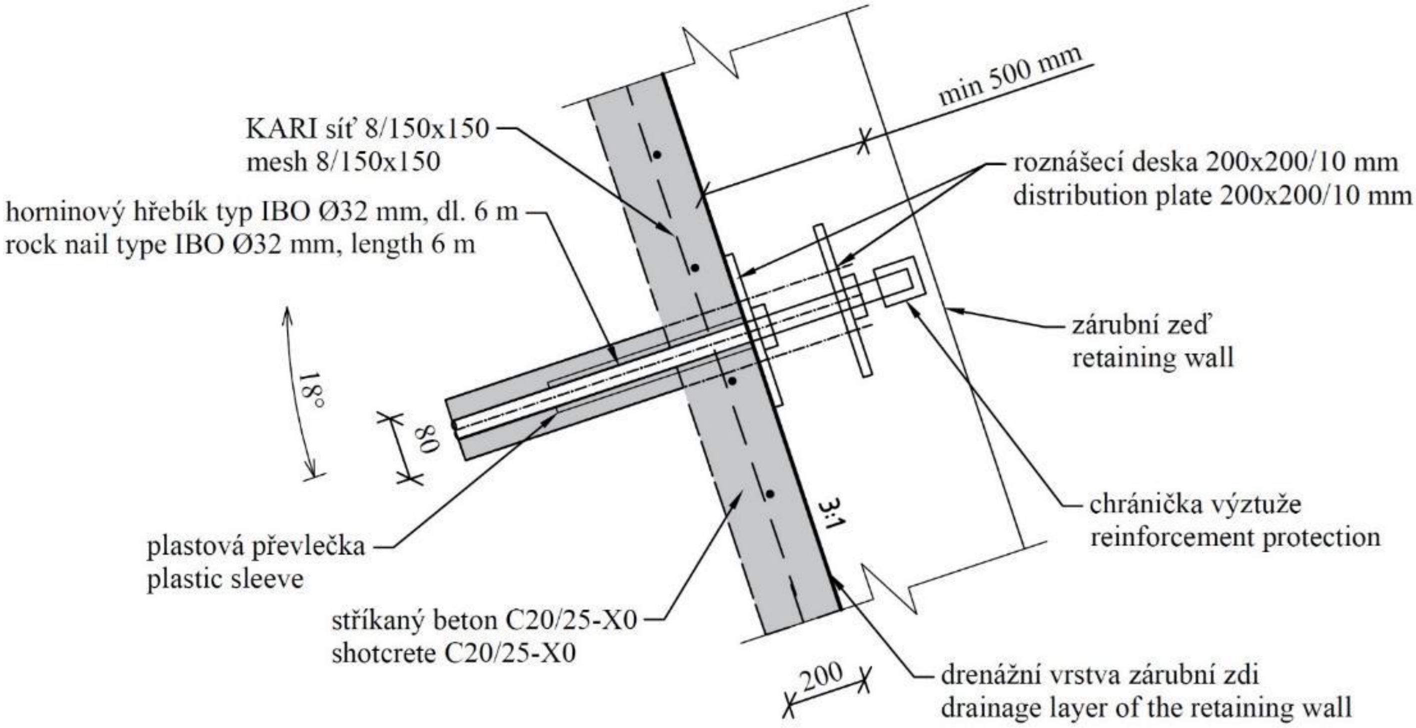


Figure 8: Modified detail of the rock nail head at the northern portal structure of the Opevnění tunnel.

4. CONCEPT OF EXCAVATIONS

4.1 SO 601 POŘÍČÍ TUNNEL

Excavation will be carried out as a down-grade heading from the southern portal using NATM with horizontal face sequencing into top heading, bench, and invert. Drill-and-blast will be used for rock breakage. Basic excavation parameters for both tunnels are summarised in Tab. 1, and primary support is specified in Tab. 2. Excavation will commence beneath a protective tunnel pre-shield and a spile umbrella canopy. Face spacing is defined conservatively: the minimum distance between the top heading and the bench in the first tube is 12m, and the opening of the second tube top heading will be at least 60m behind the bench of the first tube.

Most of the tunnel length is expected to be excavated in TTV3; portal sections and fault zones are anticipated in TTV4 and only rarely in TTV5a. The Antracolithic sandstones and siltstones generally allow predominantly dry excavation conditions. Localised inflows are associated with tectonic zones and typically diminish over time. A specific feature is the “fly ash” zone at the southern portal, which primarily affects portal pit organisation and drainage rather than the excavated section.

4.2 SO 602 OPEVNĚNÍ TUNNEL

The Opevnění tunnel will follow the same fundamental approach as the Poříčí tunnel: excavation by NATM, with excavation start supported by a pre-shield and a spile umbrella canopy. The face spacing is set to 12m between the top heading and the bench of the left tube and 60m between the bench of the left tube and the top heading of the right tube. Continuous assignment of the excavation to TTV classes will be performed in accordance with encountered engineering-geological conditions and based on geomonitoring results (Fig. 9).

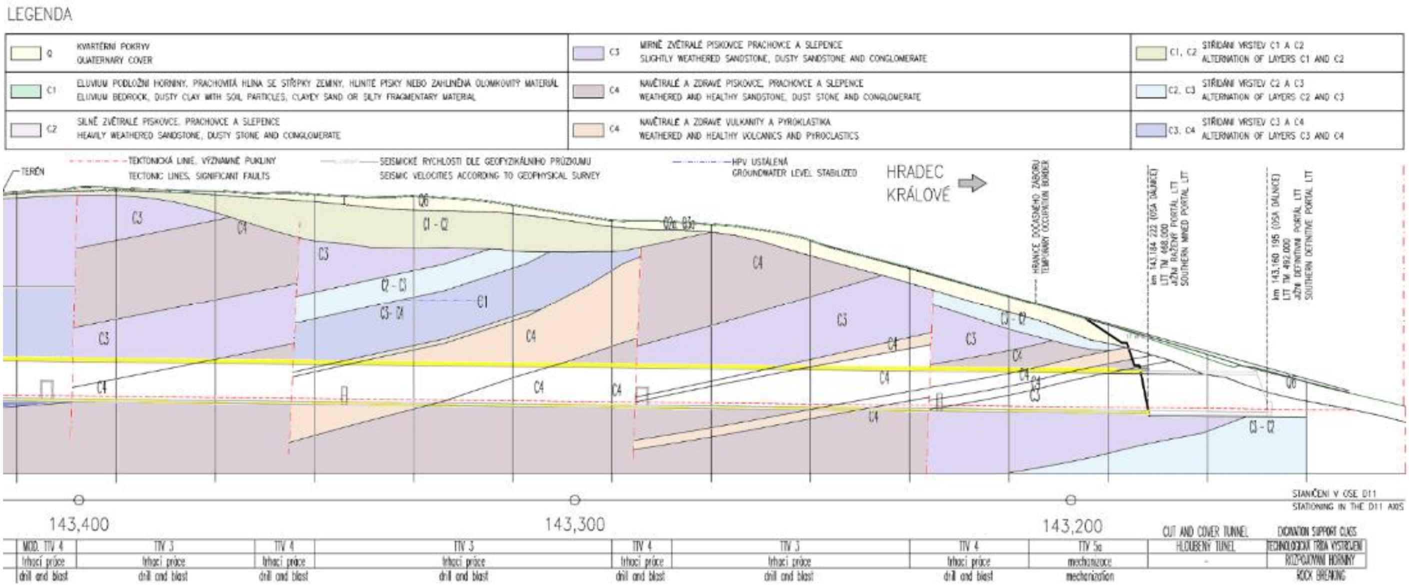


Figure 9: Cutout of a longitudinal geological profile.

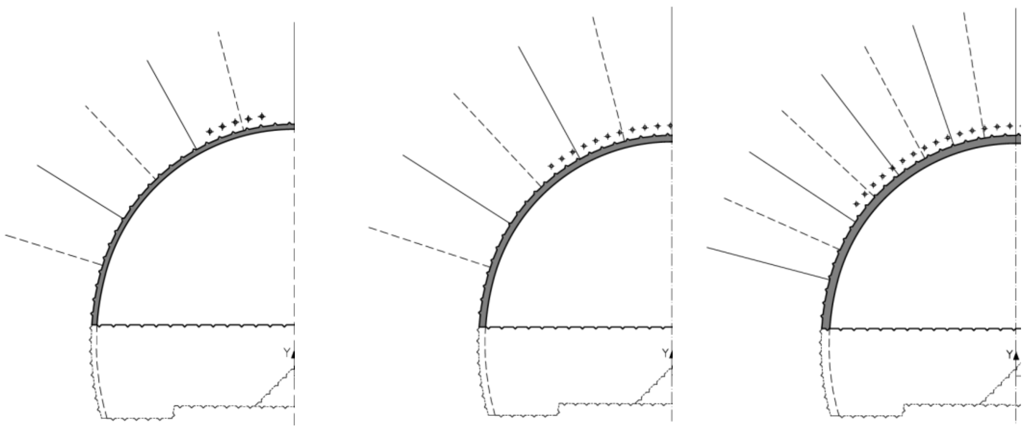
In the baseline scenario, TTV3 is expected, locally increasing to TTV4 and up to TTV5a near portals and in fault zones. Anticipated groundwater inflow is considered manageable using lateral (underside) drainage. During excavation of both tunnels, seismic effects of blasting will be monitored and surface deformations will be surveyed. For the Opevnění tunnel, a primary concern is the presence of three VHV 110kV pylons within the zone of influence; deformation of their isolated footings will therefore be included in monitoring. In practice, this entails careful blast design, convergence measurements, geodetic surveying, and clearly defined monitoring alert thresholds to enable timely adjustment of the excavation process. For both tunnels, the objective is to maintain a stable excavation advance and minimise unplanned reinforcement interventions.

Given the favourable predicted geotechnical parameters of the rock environment in both tunnels, the contractor plans to use pumped emulsion explosives for blasting works, drawing on the design team’s experience from Scandinavia and aiming to increase operational efficiency. A schematic comparison of individual excavation technological classes is provided in Tab. 2.

Table 1: Comparison of excavation parameters of both tunnels

Tunnel	Tunnel tube	Cut-and-cover section [m]	Excavated section [m]	No. of cross passages	Assumed TTV [m]		
					TTV 3	TTV 4 (+modification)	TTV 5a
SO 601 Poříčí	LTT	12 (J) + 24 (S)	504	2	312	120	72
	PTT	12 (J) + 24 (S)	540		336	132	72
SO 602 Opevnění	LTT	24 (J) + 24 (S)	444	1	264	120	60
	PTT	24 (J) + 24 (S)	444		276	120	48

Table 2: Schematic comparison of individual TTV classes



TTV	3	4	5a
Advance length [m]	1.5 to 3.0	1.2 to 1.5	0.8 to 1.2
Primary lining	C20/25 X0 thickness 150 mm + 1x KARI ⌀6/150	C20/25 X0 thickness 200 mm + 2xKARI ⌀6/150	C20/25 X0 thickness 250 mm + 2xKARI ⌀6/150
Radial rock bolts	Length 3.0 m, grid 3.0x3.0 m	Length 4.0 m, grid 3.0x1.5 m	Length 4.0 m, grid 2.0x1.2 m
Face support	10% of face: shotcrete (SB) C20/25 X0, thickness 50 mm + SN/IBO spiles Ø25 mm, length 6.0 m (depending on encountered engineering-geological conditions)	20% of face: shotcrete (SB) C20/25 X0, thickness 50 mm + SN/IBO spiles Ø25 mm, length 4.0 m (depending on encountered engineering-geological conditions)	50% of face: shotcrete (SB) C20/25 X0, thickness 50 mm + SN/IBO spiles Ø25 mm, length 4.0 m at 400 mm in every second advance

5. CONCLUSION

The proposed execution strategy for both tunnels is founded on rational design and the continuous optimisation of excavation support based on GTM results. Reorganisation of the construction sequence, adjustments to portal pit support, and the definition of NATM boundary conditions constitute an integrated response to local constraints, enabling schedule compliance without extraordinary changes to the overall construction concept.

From the contractor's perspective, the most demanding challenge will be the coordination of multiple concurrent activities across both tunnel structures. Given the relatively short, excavated lengths and the intent to achieve high production rates, it is likely that, in the following year, excavation in the second tunnel will run simultaneously with works in the terminal portal pit. As in the first tunnel, secondary lining works will proceed concurrently with other associated structures. This concurrency imposes stringent requirements on construction logistics and on the entire design team, including RDS designers, who must progress with the design of secondary lining and service ducts already at this early stage.

A further complication is associated with the site location. The Trutnov region forms a foothill area of the Krkonoše Mountains with challenging weather conditions and highly dissected terrain, which complicates access to individual parts of the construction site.

Overall, the proposed concept represents a robust yet sufficiently flexible framework for managing geotechnical risks during construction of both tunnels. A critical prerequisite for successful delivery is efficient cooperation between the contractor, designer, technical supervision, and geotechnical supervision, particularly when evaluating monitoring data within the monitoring council and continuously refining the geotechnical model throughout construction.

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Ing. Juraj Štetiar, MSc., MBA
V-CON, s.r.o.
juraj.stetiar@v-con.cz

Bc. Ing. Vojtěch Boltnar
V-CON, s.r.o.
vojtech.boltnar@v-con.cz

Ing. Jan Faltýnek, Ph.D., MBA, FEng., EUR ING
Subterra a.s.
JFaltynek@subterra.cz

Ing. Vitalii Ruchkivskyi, CSc.
VALBEK UA
vitalii.ruchkivskyi@valbek.ua