Stránov Tunnel under Construction

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ABSTRACT: This paper presents the technical solution for the cut-and-cover Stránov Tunnel, which forms part of the Road I/16 realignment within the cadastral area of the municipality of Jizerní Vtelno near Mladá Boleslav. The text summarizes the basic parameters of the structure, the construction method, and selected findings from the current progress of the works.

1. INTRODUCTION

The municipality of Jizerní Vtelno is located in the Central Bohemian Region of the Czech Republic and is traversed by Road I/16, which connects to the D6 motorway near Řevničov, continues towards Mělník and terminates at the interchange with the D10 motorway south of Mladá Boleslav. Because the existing alignment of Road I/16 within the built-up area includes several horizontal curves with small radii, the passage of heavy vehicle combinations is markedly constrained and vehicles frequently encroach into the opposing lane when maneuvering, which adversely affects the surrounding development and simultaneously reduces both traffic flow and safety. The road administrator (ŘSD ČR) therefore initiated the Road I/16 realignment to divert transit traffic away from the village; upon completion, not only shorter travel times in the affected section are expected but also improved safety on Road I/16 and within the settlement itself. The Stránov Tunnel is being constructed within this project by Doprastav, a.s.

The proposed realignment is situated in the northern part of the municipality outside the buildable areas; in its western section it runs across agricultural land, then passes through the Stránov Tunnel, continues briefly over forest parcels, and finally ties back into the existing Road I/16 alignment. The entire realigned section lies within the cadastral territory of the municipality of Jizerní Vtelno (Fig. 1).

Figure 1: Project location (Amberg Engineering Slovakia, s.r.o. 2015)

The total length of the Road I/16 realignment is 1,285 m including the tunnel section, and the road is designed in category S9.5/80 or S9.5/70. In the chainage direction the route descends, and, within the tunnel, the longitudinal gradient reaches up to 8%; therefore, for operational reasons, an additional lane

3.5 m wide is designed in the section from km 0.472 to km 1.185. The tunnel section is located approximately between chainage km 0.68050 and km 0.950, and the carriageway is three-lane along its entire length, i.e., with one lane in the chainage direction and two lanes in the opposite direction.

2. STRÁNOV TUNNEL – GENERAL INFORMATION

The Stránov Tunnel is a cut-and-cover, bidirectional three-lane tunnel 270 m long, by which Road I/16 is routed through the rock mass beneath Stránov Castle; the structure is classified in category TD and is designed with a variable longitudinal gradient with a maximum of 8.0%.

The horizontal alignment within the tunnel consists of two opposing curves (Fig. 2); the tunnel is a cut-and-cover structure constructed in an open cutting, and the excavation will proceed from the western portal towards the eastern portal. The construction layout also allows a temporary stockpile area to be established at the start of the future road alignment, and because a substantial portion of the excavated material is suitable for reuse, it will subsequently be utilized for backfilling.

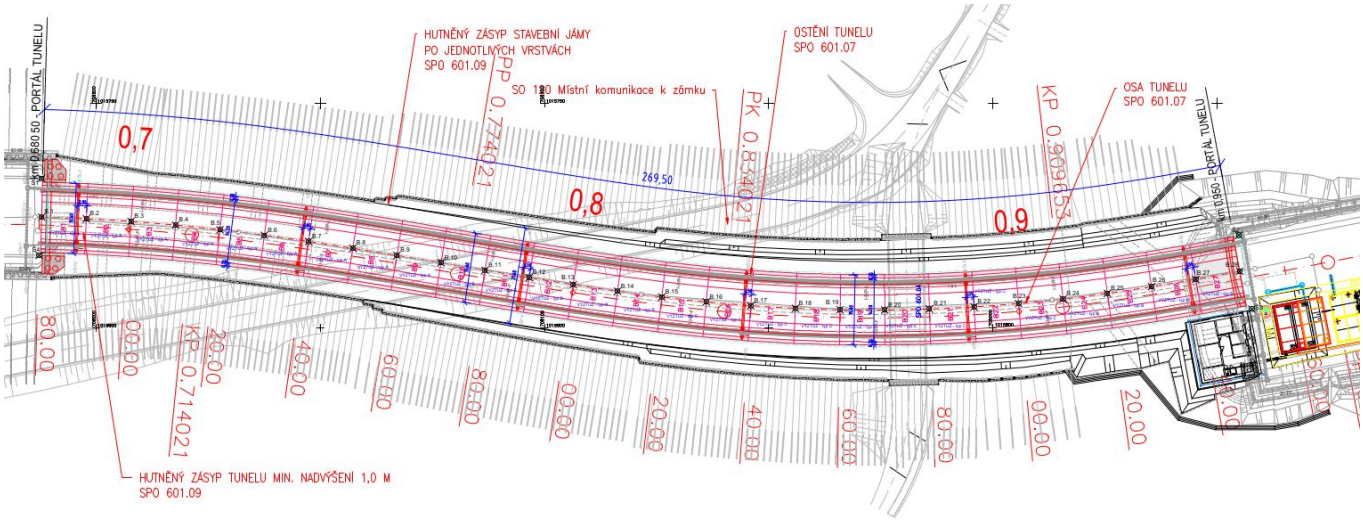

Figure 2: Tunnel layout (Amberg Engineering Slovakia, s.r.o. 2015)

Backfilling will be carried out concurrently and symmetrically from both sides of the tunnel, i.e., from the lower portal towards the upper portal, while concreting will be organized in an analogous manner, namely in stages until the structure reaches its final state.

The tunnel design complies with the requirements of ČSN 73 7507 (Design of road tunnels) and TP 98 (Technical equipment of road tunnels). The load-bearing structures are dimensioned for an assumed service life of 100 years; civil/architectural equipment is considered for at least 30 years and technical equipment (TVT) for at least 15 years.

The technological equipment is designed regarding the corrosive aggressiveness of the tunnel environment, which is classified as C4 ("high" aggressiveness) according to ČSN ISO 9223; the selection of materials and the proposed protective measures are adapted accordingly.

As part of preparatory works, affected utility lines crossing the tunnel alignment are being relocated, and the temporarily diverted lines will be supported on a temporary bridge structure. Prior to the start of earthworks, selected structures within the potential zone of influence were rehabilitated and preliminary geotechnical monitoring was carried out; in addition, a detailed survey of structures in the considered zone of influence was performed.

Tunnel construction is prepared in accordance with the principles of the observational method, including geotechnical monitoring focused primarily on continuous observation of excavation support during excavation and backfilling and, subsequently, during operation. The monitoring is designed and performed by an organization independent of the contractor and directly reporting to the client.

From the standpoint of project breakdown, the construction is divided into 17 separate sub-objects that cover the individual structures, including temporary works required for tunnel construction.

3. EXCAVATION SUPPORT

The excavation is secured by anchored pile shoring and by a cut into the rock subgrade; the stability of the cutting is enhanced by shotcrete and soil nailing (Fig. 3). The excavation support was also coordinated with a temporary bridge intended for utility relocation and for maintaining access to Stránov Castle through the construction site.

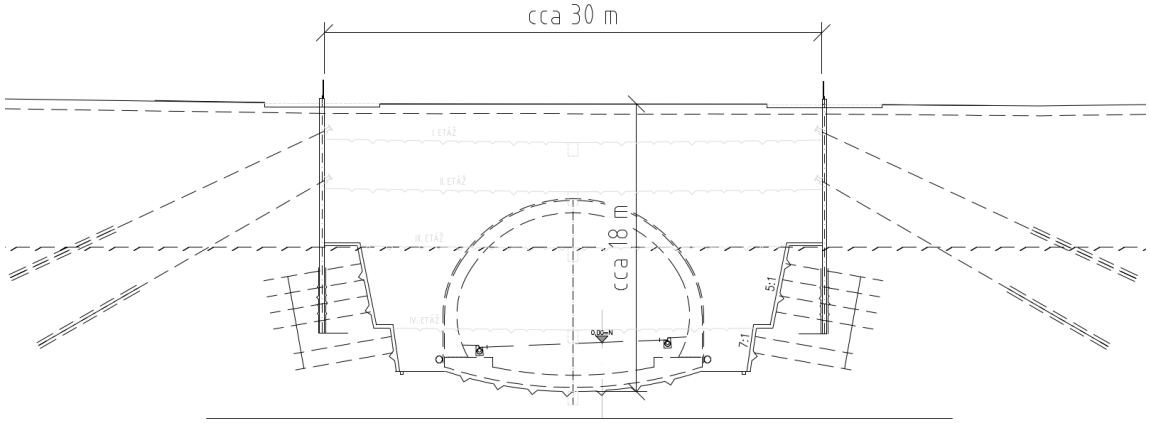

Figure 3: Cross-section through the excavation (Amberg Engineering Slovakia, s.r.o. 2015)

Excavation for the Stránov Tunnel is carried out in stages (benches) while the excavation walls are secured simultaneously, using a combination of pile shoring with timber lagging, reinforced shotcrete, temporary ground anchors and soil nails (Fig. 4).

Figure 4: Pile shoring in the initial construction phase

The excavated material is crushed and stockpiled; however, it is preferentially reused for levelling layers and as a replacement of the subgrade under the tunnel invert in areas affected by karst cavities. Material intended for the waterproofing layer and for backfill at the level of the aquifer is of suitable composition and is therefore stored separately.

Earthworks proceed continuously, albeit with due consideration of utility relocations and the construction of a temporary bridge used to carry these lines; this structure simultaneously maintains access to Stránov Castle, particularly from the western portal.

4. LOAD-BEARING STRUCTURE FOR TEMPORARY UTILITY DIVERSION AND ACCESS TO STRÁNOV CASTLE

During construction it is necessary to maintain the transport connection between the municipality of Jizerní Vtelno and Stránov Castle across the construction site area, because the works will temporarily interrupt the only access road in this part of the municipality and, at the same time, utilities crossing the tunnel alignment are being relocated. For this purpose, a temporary bridge deck MMT-100 is installed, located approximately 1.27 m above the original ground surface; on one side it enables pedestrian movement on a 0.75 m wide walkway, while on the other side, within a space of the same width, the diverted utility lines are routed. A single-lane roadway 5.5 m wide is arranged in the central part. The load-bearing structure of the temporary bridge is 33 m long, of which the bridge span itself is 31.2 m (Fig. 5); with a bridge rise of 18.2 m, its axis is aligned with the Road I/16 realignment. The temporary bridge is founded on piles, which in the vicinity of the temporary bridge replace the Pile shoring of the excavation (Fig. 6).

Figure 5: Temporary bridge foundation during construction

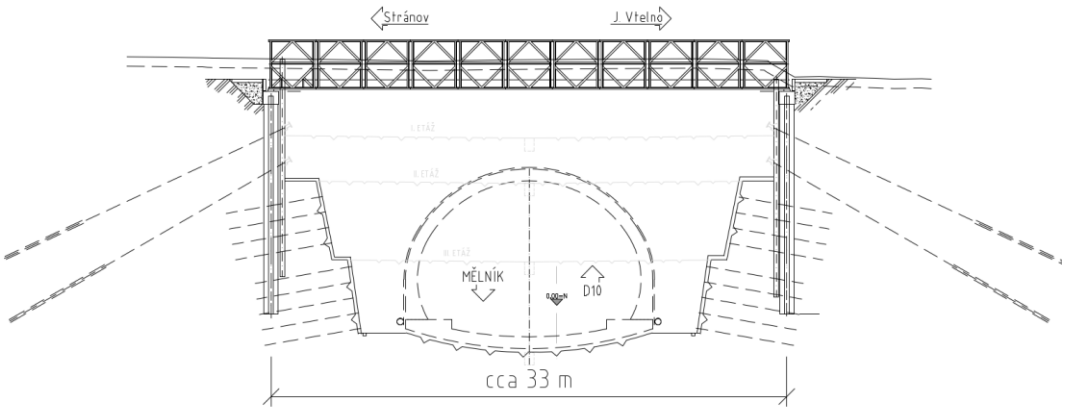

Figure 6: Cross-section through the excavation at the temporary bridge location (Amberg Engineering Slovakia, s.r.o. 2015)

5. STRÁNOV TUNNEL – STRUCTURE

The tunnel lining is designed as a reinforced-concrete arch structure with an invert and a membrane waterproofing system; along the outer perimeter of the structure, drainage is provided on both sides to collect and discharge water.

The reinforced-concrete structure will be constructed on a reinforced-concrete bottom invert (Figs. 7 and 8) and, longitudinally, the tunnel is divided into blocks with a maximum length of 10 m, resulting in a total of 27 blocks. The minimum thickness of both the bottom and top arches is 750 mm; for the bottom arch, concrete class C25/30 with resistance classes Xa2 is assumed, and for the top arch, concrete class C30/37 with resistance classes XD3 and XF4.

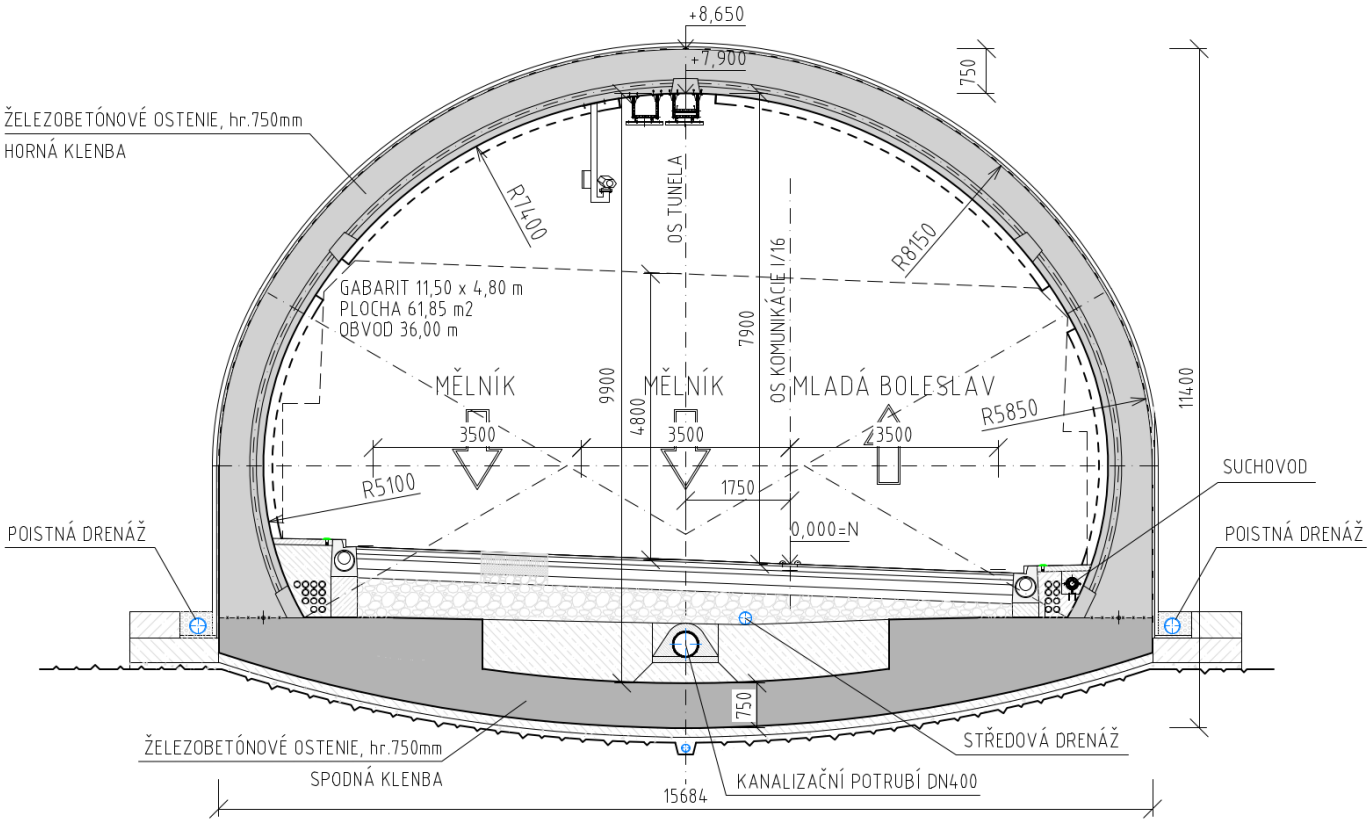

Figure 7: Typical cross-section of the cut-and-cover tunnel (Amberg Engineering Slovakia, s.r.o. 2015)

The cover (backfill) above the tunnel will be at least 1 m in the initial part up to a distance of 60 m from the start of the tunnel; in this section, the backfill crest will be above the level of the original ground surface. Further on, the backfill is gradually adjusted to the original ground level and, towards the crossing with the temporary bridge (approx. 200 m from the start), it reaches about 7.2 m, while behind the tunnel the elevation decreases smoothly and slightly below the tunnel crown at the portal block. Increased noise loading in the tunnel is assumed mainly during the passage of heavy traffic, which is related to the significant longitudinal gradient.

In a section approximately 50 m from each portal, the lining will be fitted with an acoustic cladding to reduce the risk of unfavourable noise levels in the surroundings due to traffic passing through the tunnel.

Although no niches are designed in the tunnel, the alignment includes a drainage system for Road I/16; in the sidewalks along the tunnel, cable routes for technological equipment will be installed and, on the right side, also a dry riser for the fire water main. At the eastern portal, tanks for supplying the fire water main and for tunnel maintenance are envisaged, as well as an oil separator, and a service building for tunnel equipment will also be in this area.

6. STRÁNOV TUNNEL – PORTAL SECTIONS

The cutting at the western portal is secured by an anchored bored pile wall on both sides of Road I/16; the pile wall has a length of 192 m on the left side and 43 m on the right side of the cutting. The pile diameter is 1.2 m. The maximum cover height in front of the pile wall is 7.3 m, and the pile wall height ranges between 5 and 14 m. The walls are anchored at one to two levels with permanent strand anchors with a maximum length of 25 m at an axial spacing of 3.6 m. The architectural finish is provided by facing units with a split-concrete surface.

The cutting at the eastern portal will be stabilized by reinforced-concrete gravity walls founded deeply on micropiles on both sides of Road I/16; the wall face on both sides will be clad with stone.

On the left side of the cutting, the retaining wall starts at the portal block at the location of maximum height, approximately 9.3 m above the foundation joint, and then its height gradually decreases over a length of about 50 m to the level of the existing terrain. A noise barrier wall made of reinforced-concrete panels with acoustic cladding is designed on top of the wall; it starts at the tunnel at a wall height of about 1.2 m (also serving as a fall protection barrier), then increases to 5.4 m at approximately two thirds of the wall length and, towards the end of the wall, decreases to about 3.7 m. Because the last approximately 11 m of the wall no longer serve as a foundation for the noise barrier, this part is clad with stone; in the lower part of the facing, a cable route supplying the public lighting in front of the tunnel portal is also routed.

On the right side, the retaining wall starts at the portal block with a height of about 6.5 m and its height decreases smoothly along the cutting, while it is carried across an existing stream. Approximately 16 m from the portal, the decrease continues. At the stated location, the wall rises again to about 10 m at its end, which is at about 60 m from the portal, and then it smoothly ties into the rock cutting of the existing Road I/16. At this location, the cutting will be further deepened and additionally protected by catch-fence steel nets against falling loosened stones. A railing is designed on the wall crest to prevent falls.

7. CONCLUSION

The aim of the presented Road I/16 realignment project is to stabilize and improve the traffic situation in the municipality of Jizerní Vtelno, where safety has long been reduced due to the unfavorable geometry of the existing road. Because the realignment diverts transit traffic outside the built-up area, it will have a favorable effect on the permeability of the section and will significantly increase safety on Road I/16 and in the municipality itself, as the need for heavy goods vehicles to pass through critical points will be eliminated and the traffic comfort of both transit and local traffic will improve. The quality of public space in the village center will also improve, because traffic will be carried on the newly built bypass section.

Together with the portal cuttings, the Stránov Tunnel will be the key technical element and dominant feature of the Road I/16 realignment, because without this structure it would not be possible to implement the realignment rationally given the complex morphological conditions of the area.

Figure 10: Grave of a three-member family

An archaeological investigation, carried out after stripping the topsoil and before starting the excavation for the tunnel, is also noteworthy. Within this survey, an extensive Bronze Age burial ground with approximately 60 graves was identified (Fig. 9); in addition, artifacts of everyday use were found and source areas for clay extraction for pottery production were identified (Fig. 10). Most of the finds were concentrated near the western portal of the Stránov Tunnel.

Figure 9: Source area for clay extraction for pottery production

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