DESIGN PREPARATION FOR THE HLOUBĚTÍN TUNNEL ON PRŮMYSLOVÝ POLOOKRUH (INDUSTRIAL HALF-RING ROAD) IN PRAGUE

L. Grünwald & P. Šourek & M. Laloušek
SATRA, spol. s r. o., Praha, Czech Republic

ABSTRACT: The Hloubětín Tunnel project is a key part of the planned modernization and opening of the so-called Průmyslový polookruh (Industrial Half-Ring Road) (PPO) in the northeastern part of Prague. Preparation for the construction project is currently in the planning permission phase in accordance with the new Building Act No. 283/2021 Sb. (Collection of Laws). The project addresses the transfer of a significant section of the existing surface road network of the City of Prague underground with the aim of eliminating existing traffic congestion, significantly reducing the negative impacts of transit traffic on adjacent residential and recreational areas, increasing traffic safety and flow, and enabling the urban transformation of surface roads into an urban boulevard with preference given to public transport, cyclists, and pedestrians. The implementation of the project, together with other measures, is conditional on the completion of the eastern section of Městský okruh (Inner City Ring Road) (MO) in Prague, as the PPO represents a by-pass route for the period of construction of the MO in the areas of Spojovací street, Balabenka, and Čuprova street.

The tunnel section is designed as a classic cut-and-cover, twin-tube tunnel with one-way traffic in each tube, approximately 670 m long, under Kbelská street. The total length of the PPO section under consideration is almost 2 km. The tunnel passes under two major traffic light-controlled intersections (Poděbradská × Průmyslová × Kbelská and Kolbenova × Kbelská). Above the tunnel, an urban boulevard will be created with dedicated lanes for public transport, emergency services, and cyclists, complemented by urban greenery and new pedestrian and bicycle connections.

The construction project is defined as a public benefit construction project according to the valid municipal plan of the City of Prague. No significant negative impact on the environment has been identified; the project is not subject to assessment under Act No. 100/2001 Sb. (Collection of Laws).

The design preparation work was significantly affected by complex urban planning, geotechnical, and engineering conditions. The area is heavily urbanized, in close proximity to residential buildings, sports facilities, protected natural sites (Pražský zlom, Smetanka Nature Park), and important infrastructure (metro line B, railway, tram line). The geotechnical investigation classified the route as geotechnical category III according to ČSN EN 1997, mainly due to variable geology, high groundwater levels, and complex interaction with surrounding buildings and operated structures.

The design respects the requirements for the protection of surrounding buildings and areas (underground (metro), above-ground structures, natural parks, and landscape features), including their securing and monitoring through geotechnical monitoring during construction. It also provides protection against stray currents and extreme rainfall using storm-water retention reservoirs and high-capacity pumping systems.

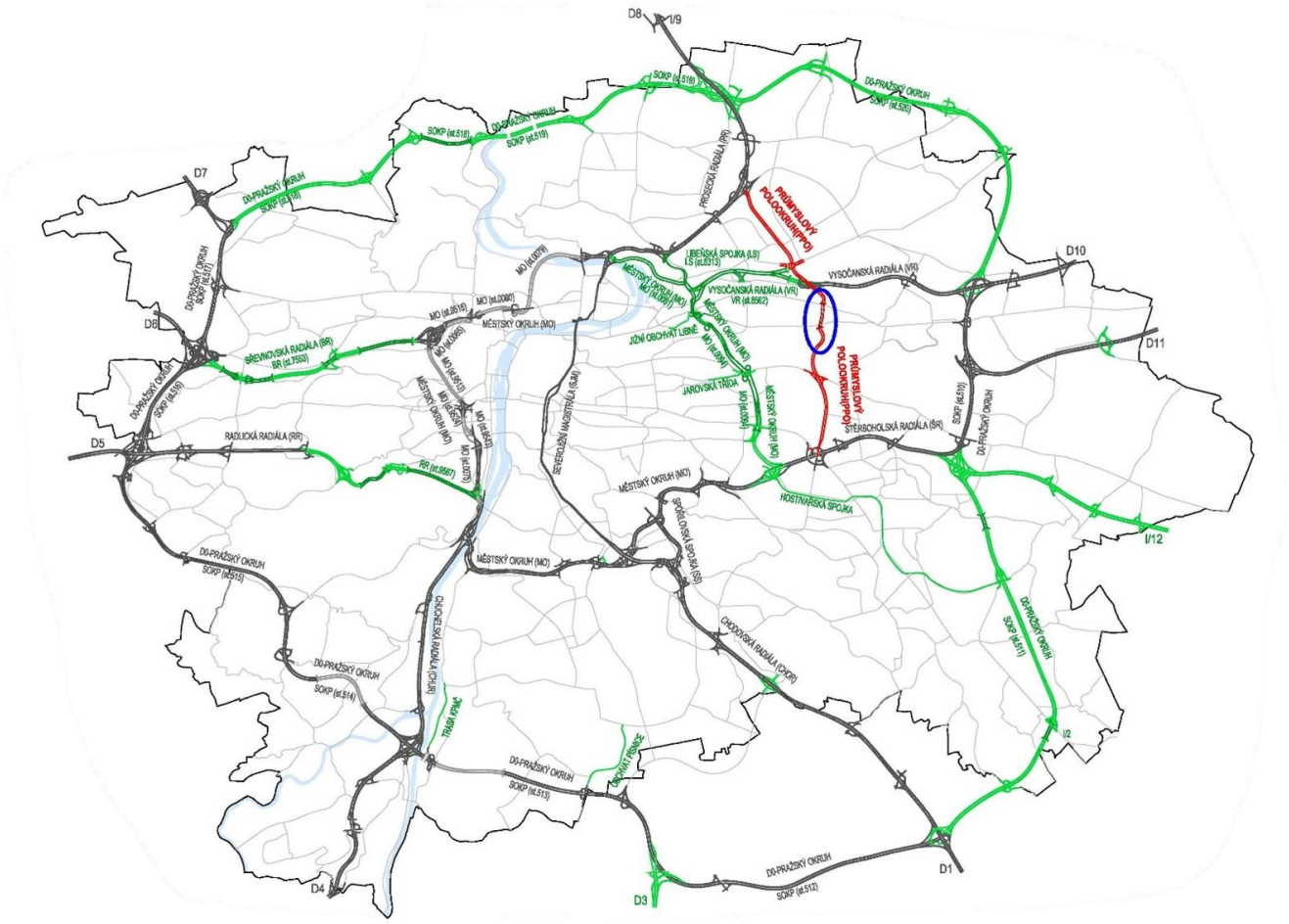
The project includes extensive relocation of utility lines, new water management facilities, noise reduction measures, and landscaping in line with the principles of blue-green infrastructure and rainwater management according to Prague-wide methodology.

The paper will present the main principles of design preparation work, key technical parameters of the tunnel, solutions for connection to technical infrastructure, principles of construction organization that significantly influence the structural layout of the tunnel, and measures to minimize the impact on the surrounding area. Special attention will be paid to integrating the tunnel into the urban transport system, coordinating with other investments, and drawing on experience gained from preparations in densely built-up urban environments.

1. INTRODUCTION

Průmyslový polookruh (Industrial Half-Ring Road) (PPO), approximately 8.75 km long, runs along Průmyslová and Kbelská streets and is one of the busiest traffic arteries in Prague. Currently, it effectively serves as a substitute for the Prague Ring Road and the City Ring Road, which is reflected in high traffic volumes (approx. 36,000–88,000 vehicles per day), including a significant proportion of heavy goods vehicles. The problematic nature of the road is exacerbated by the fact that in some sections it passes through residential areas, particularly in Hloubětín, thus generating negative impacts on the surrounding environment.

The subject of the project is to address the central section of the PPO between the bridge flyover over the Rokytka river valley and the grade-separated junction (MÚK) with Novopacká street (Vysočanská radial road I). In the section passing through the built-up area of Hloubětín, it is proposed to transfer part of the route into a tunnel. The main objective is to reduce the negative impact of traffic on the adjacent residential area and eliminate regular congestion at the Poděbradská × Průmyslová × Kbelská and Kolbenova × Kbelská intersections.



Key:

D0-PRAŽSKÝ OKRUH	D0-PRAGUE RING ROAD
SOKP (st. 519)	PRAGUE RING ROAD (construction project 519)
PROSECKÁ RADIÁLA (PR)	PROSEK RADIAL ROAD (PR)
VYSOČANSKÁ RADIÁLA (VR)	VYSOČANY RADIAL ROAD (VR)
PRŮMYSLOVÝ POLOOKRUH (PPO)	INDUSTRIAL HALF-RING ROAD (PPO)
HOSTIVAŘSKÁ SPOJKA	HOSTIVAŘ CONNECTION ROAD
CHODOVSKÁ RADIÁLA (CHOR)	CHODOV RADIAL ROAD (CHOR)
MĚSTSKÝ OKRUH	CITY RING ROAD
BŘEVNOVSKÁ RADIÁLA (BR)	BŘEVNOV RADIAL ROAD (BR)
BR (st. 7553)	BR (construction project 7553)
MO (st. 0079)	MO (construction project 0079)
LIBEŇSKÁ SPOJKA (LS)	LIBEŇ CONNECTION ROAD (LS)
LS (st. 8313)	LS (construction project 8313)
ŠTĚRBOHOLSKÁ RADIÁLA (ŠR)	ŠTĚRBOHOLY RADIAL ROAD (ŠR)
OBCHVAT PÍSNICE	PÍSNICE BYPASS ROAD
TRASA KPMČ	KPMČ (ROAD CONNECTION BETWEEN MUNICIPAL DISTRICTS) ROUTE
CHUCHELSKÁ RADIÁLA	CHUCHLE RADIAL ROAD
JAROVSKÁ TŘÍDA	JAROVSKÁ STREET

Fig. 1 General Traffic Context

2. INITIAL SITUATION AND REASONS FOR BUILDING THE ROAD IN A TUNNEL

The central section of the PPO between the Českobrodská and Novopacká grade separated junctions has long been the most problematic section in terms of traffic. The key problem is the level crossings with Poděbradská and Kolbenova streets, which cause significant traffic congestion in both directions. In combination with the closely adjacent residential buildings, there is a need for a solution that will simultaneously improve traffic flow and reduce its negative impact on the surroundings.

For this reason, it is proposed to build the PPO route in a tunnel section running under the existing Kbelská street. The separate tunnel section is designed as a classic cut-and-cover tunnel under Kbelská street. The tunnel section is designed in connection with the reconstruction of junction points so that the existing traffic light-controlled level crossings can be replaced with a grade-separated solution.

3. DEVELOPMENT OF THE PROJECT AND LEGISLATIVE PROCEDURE

Numerous studies have been prepared on parts of the PPO in the past. The last and most comprehensive study was a transport and urban planning study from November 2021 (SATRA s.r.o., JK Architekti s.r.o.), which addressed the entire length of the PPO route and proposed measures to increase the flow and safety of all traffic participants and to add cross connections for pedestrians and cyclists.

Due to the complexity of the proposed measures in the central part of the PPO, including the tunnel section of the route in the Hloubětín area, and also in relation to the planned completion of the City Ring Road (the PPO forms a detour route for the construction of the central part of the City Ring Road), a decision was made to prepare this section as a separate investment project. The Investment Department of the Prague City Hall, Transport Construction Department II, was tasked with preparing the project.

Based on this decision, a technical study of the central section was commissioned and completed in January 2022. The study became the basis for documents for the screening and scoping proceedings pursuant to Act No. 100/2001 Coll. and for the subsequent stage of project preparation – documentation for project approval.

On May 5, 2025, the conclusion of the screening and scoping was issued, stating that the project cannot have a significant impact on the environment and is not subject to assessment under the aforementioned law. The decision became final on June 6, 2025. In the second half of 2024, exploratory work and follow-up design work began on the documents for the project permit, prepared by "Satra - Pragoprojekt – Valbek - Hloubětínský tunel". From mid-2025 to the present (03/2026), engineering activities are underway to obtain the statements and opinions necessary to initiate the project permit application process. The process is expected to commence in the second quarter of 2026.

The project is identified in the zoning and planning documents in areas and corridors of public benefit structures and is listed in the VPS (public benefit structures) register, which confirms its importance in terms of public infrastructure.

4. CHARACTERISTICS OF THE AREA AND BASIC TRANSPORT SOLUTION

The area of interest is located in the eastern part of Prague, in the municipal districts of Prague 9 and Prague 14, in the cadastral areas of Vysočany and Hloubětín. The route passes through a densely built-up area in the central part and follows the existing road network – Průmyslová and Kbelská streets – including intersections with Poděbradská (southern section) and Kolbenova (northern section) streets.

The construction scope of the project is designed to be 1.992 km long. The horizontal alignment in the southern section is modified, among other things, to create space for parallel traffic route for pedestrians and cyclists along the eastern roadway.

Further route adjustments are proposed with a view to minimizing construction work and temporary land occupation in the southern section in front of the tunnel portal in specially protected areas and

nature parks (Smetanka Nature Park, Prague Fault Natural Monument), including the Rokytka watercourse.

A fundamental change is the proposal for two grade-separated junctions: Poděbradská grade-separated junction and Kolbenova grade-separated junction. Both are designed as grade-separated intersections with inner on-ramps and off-ramps, allowing for a compact arrangement of traffic light-controlled intersections of the off-ramps and on-ramps with Poděbradská street to the south and Kolbenova street to the north. An exception is the on-ramp from Kolbenova street to Kbelská street in the direction to Prosek within the Kolbenova grade-separated junction, which, due to limited space, is routed and connected to the PPO route from the outside.

Key:

KOLBENOVA	KOLBENOVA street
směr ČERNÝ MOST	direction to ČERNÝ MOST
PODĚBRADSKÁ UL.	PODĚBRADSKÁ street
směr ČERNÝ MOST	direction to ČERNÝ MOST
PRŮMYSLOVÁ UL.	PRŮMYSLOVÁ street
směr Hostivař	direction to Hostivař
KBELSKÁ UL.	KBELSKÁ street
směr Prosek, D8	direction to Prosek, D8 motorway
KOLBENOVA UL.	KOLBENOVA street
směr CENTRUM	direction to CITY CENTRE
PODĚBRADSKÁ UL.	PODĚBRADSKÁ street
směr CENTRUM	direction to CITY CENTRE

Fig. 2 Visualization of the Scope of Surface Layout

The tunnel section begins on Průmyslová street immediately (south) before the intersection with Poděbradská street and ends on Kbelská street immediately (north) after the intersection with Kolbenova street. The route is designed to follow the existing PPO road, with only minor adjustments, such as creating space for a parallel path for pedestrians and cyclists and modifying both existing intersections in this section of the PPO (with Poděbradská and Kolbenova streets). The construction project includes comprehensive modification of the surface areas of the section in question. Above the tunnel, there are plans to build an urban boulevard with dedicated lanes for public transport, emergency services, and cyclists, supplemented with vegetation. Furthermore, the project includes adding missing longitudinal and transverse connections for pedestrian and bicycle traffic, both in the section above the tunnel and along the connecting sections of the PPO.

A significant territorial impact of the project is the change in the vertical alignment of Kolbenova street. In connection with the intersection with tunnel structures, the final elevation of Kolbenova street will be increased by up to approx. 4 m. The solution includes terrain modelling in open areas along the road and the construction of retaining walls in connection with existing facilities, in particular the Hloubětín Depot of the Prague Public Transport Company and the Klima-Classic company premises.

Fig. 3 Intersection of the PPO and Poděbradská street – current situation

Fig. 4 Intersection of the PPO and Poděbradská street – design

Fig. 5 Intersection of the PPO and Kolbenova street – current situation

Fig. 6 Intersection of the PPO and Kolbenova street – design

4.1 GEOMORPHOLOGICAL AND GEOLOGICAL CONDITIONS

The area of interest is located on the border of two units, the Prague Plateau, represented by the Říčany Plateau, and the Český Brod Plateau unit, which includes the Čakovice Plateau. The terrain directly in the area of interest within the construction site slopes down from approximately 222 m above sea level in a

southerly direction to approximately 202 m above sea level. The Vltava River valley and its tributaries are deeply carved into the peneplain landscape. The Rokytka tributary is significant for the area of interest, as it has strongly eroded the treeless landscape and in places is deeply cut into shale and Ordovician sandstones.

The geological structure in the area of interest is quite complex. From a regional geological point of view, the area belongs to the Ordovician sedimentary Prague Basin. The current relatively rugged terrain is the result of selective erosion and denudation of the original peneplain. Through erosion, watercourses have created depressions in areas of less resistant rock and ridges in areas where solid quartzite and sandstone occur. The pre-Quaternary substrate consists of a set of rough and tectonically broken dusty and sandy rocks of Ordovician age. Quaternary deluvial and deluvio-fluvial sediments, alluvial deposits and terrace sediments of the Rokytka River, and anthropogenic made-up ground are deposited on the bedrock.

4.1.1 Pre-Quaternary Substrate

The bedrock consists of Ordovician sedimentary rocks of the Prague Basin belonging to the Zahořany Formation and partly also to the Bohdalec Formation. North of the area of interest, there are overlying Cretaceous sedimentary rocks.

The pre-Quaternary bedrock in the tunnel area consists of Proterozoic rocks of Ordovician age, mainly dusty shales, with quartzites at the edges. In the surface layer, the shales are completely decomposed at the interface between soils and semi-rocks R6/CI, R6/F6Cl. Their bedrock consists of completely weathered rocks, fragmentary crumbling shales R6. The total thickness of this surface layer reaches 0.6-6.0 m. Beneath this surface layer is heavily weathered, fragmentary R5 shale, which transitions into weathered R5/R4 shale at greater depths. In some places, weathered quartzites R5/R4 are found. The total thickness of this layer is 0.5-12.0 m. Deeper boreholes have verified a layer of slightly weathered, relatively solid shales R4/R3 to R3 in the bedrock beneath these weathered rocks.

4.1.2 Tectonics

The bedrock is significantly affected by tectonic activity. The main line of the first order in this area is Pražský zlom (Prague Fault). Along this fault, the northern crust was pushed under the southern crust by at least 900 m. This shift resulted in direct contact between the younger Zahořany shales and the older Skalka quartzites and Dobrotivá shales. Near the fault, the rocks are tectonically crushed, especially the solid quartzites. The fault occurs approximately between Nademlejnská street and Hloubětín Chateau, i.e., in the area outside the tunnel route itself, south of its southern portal. The fault is originally very steeply inclined. The rocks, especially in the Prague Fault area, are heavily tectonically broken by numerous tectonic faults, which, in addition to crushing and a higher degree of weathering, have also caused vertical shifts in some rock blocks.

4.1.3 Quaternary Cover

The Quaternary cover in the area of interest is formed by a varied sequence of deluvial, fluvial, deluvio-fluvial, and anthropogenic sediments. The total thickness of the Quaternary cover varies depending on the terrain morphology. The total thickness of these sediments reaches 0.4–12.8 m in the area of the planned tunnel construction.

The made-up ground is found in extensive thicknesses in the uppermost surface layer in the area of interest. Here, they are mostly used for landscaping and terrain modelling, forming railway embankments, structural layers of roads, and gaps between individual buildings. In the planned section of the tunnel, the upper layers consist mainly of heterogeneous made-up ground of highly variable composition with a thickness of 0.2–4.6 m.

4.2 HYDROGEOLOGICAL CONDITIONS

The location under assessment is part of the Vltava River basin, and the area of interest is also part of the Rokytka river sub-basin. The area of interest is drained by the Rokytka river to its confluence with the Vltava river. The groundwater level depends on atmospheric precipitation from the wider surrounding area. There are two hydrogeological units in the area, namely an environment of less permeable rock

formations (mainly permeable fissure environment) and a relatively well-permeable environment of Quaternary cover formations, both of which are hydraulically dependent.

For classification according to ČSN EN 206+A2, which defines groups of aggressiveness on structural concrete, groundwater, regarding the mineralogical composition of the rock environment, shows predominantly weak sulphate aggressiveness, and in places also carbonate aggressiveness on structural concrete.

The general direction of groundwater flow is south to southwest towards the Rokytka stream. The groundwater level is at a variable depth. During the exploratory work, a stabilized level was verified at a depth of 1.9–9.0 below ground surface level, mainly in loose sandy sediments of the Quaternary cover. The groundwater level is above the tunnel route level throughout the length of the tunnel.

4.3 FOUNDATION CONDITIONS

The foundation conditions are assessed as complex, corresponding to the conditions for geotechnical category 3 according to ČSN EN 1997. The rock environment varies significantly along the length of the tunnel, and groundwater will affect the foundation of the structure throughout the length of the tunnel.

The southern portal of the tunnel is in a cut approximately 13.4 m deep. The foundation base will contain weathered Ordovician shale rock. In the overlying formation there are pre-Quaternary cover rocks from a depth of 9.1 m, overlain by medium to well-compacted sands with intercalations of stiff to firm clays. The overlying formation consists of made-up ground of a stiff to solid consistency, and the surface consists of the structural layer of roadways. The groundwater level is 4.5 m below ground level.

In the tunnel section, the foundation base is located in a variable environment of transition between Ordovician Pre-Quaternary rocks and Quaternary sediments. From south to north, in connection with the rising level of the route, the foundation base reaches shallower areas, mainly of Quaternary sediments. The groundwater level is located at variable depths of 2.0–6.5 m below ground level.

In the northern portal section of the tunnel, the foundation base at a depth of 3.0–3.3 m will consist of sandy clay of a solid consistency with a total thickness of 1.2–1.5 m. The surface layer with a thickness of 1.8–2.1 m consists of made-up ground, and the surface consists of the structural layer of the roadways. The groundwater level is located at a depth of 4.2–4.6 m below ground level. The pre-Quaternary bedrock is located at a depth of approximately 5 to 7 m below ground level.

4.3.1 Corrosion Investigation and Contamination Investigation

A corrosion investigation was conducted with regard to the high density of roads, residential and industrial buildings. A total of 12 corrosion points were surveyed and evaluated. According to TP124, level 5 protective measures will need to be applied throughout the entire area due to the crossing of the route with metro line B, tram lines, and railway tracks.

As part of the investigation, the degree of soil contamination was determined and the possibility of its disposal during construction was assessed in accordance with Decree 273/2021 Sb. (Collection of Laws). A total of 9 mixed samples were collected along the entire length of the profile from 36 exploratory boreholes. The investigation results show that only 3 out of 9 mixed samples meet the requirements of the Decree and the materials can be used for backfilling.

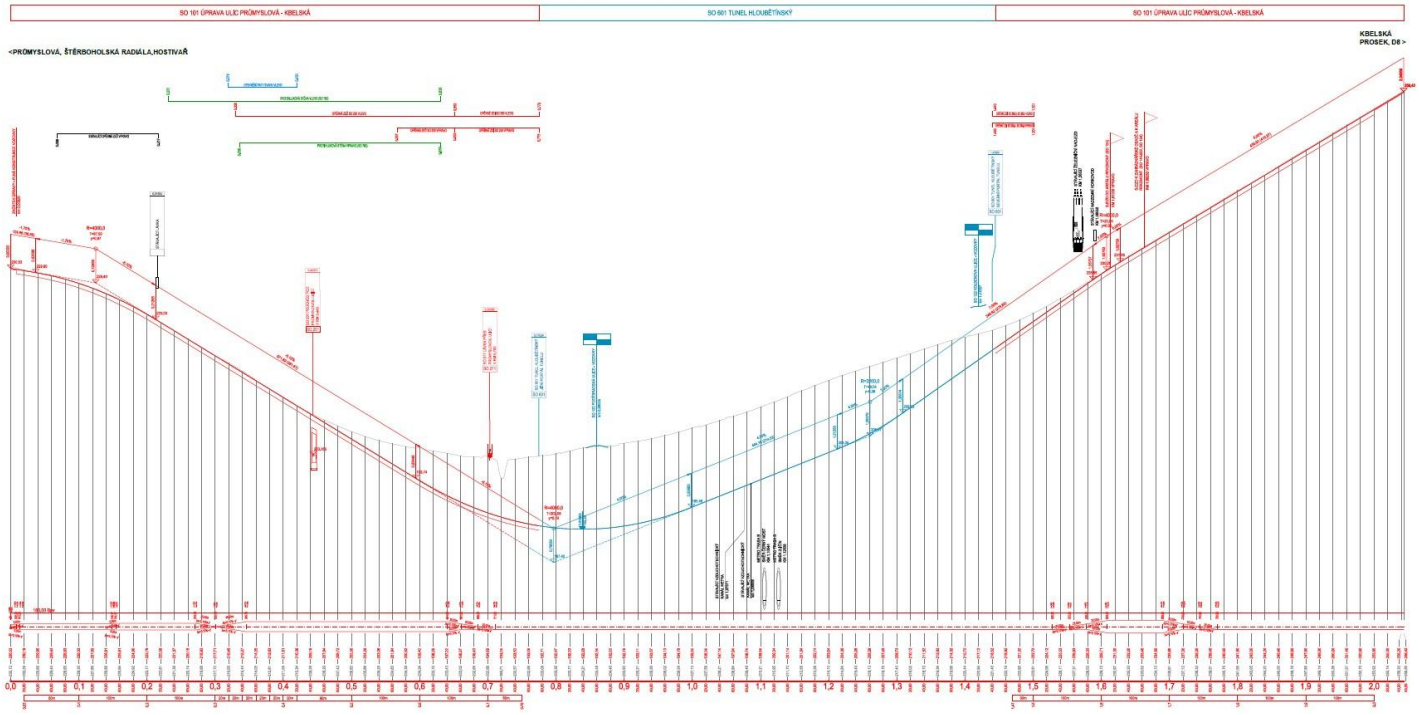
5. DESIGN PARAMETERS OF THE ROAD

The PPO Road category remains unchanged at the beginning of the solution, i.e., a 2+2 configuration in the MS4d 18/70 category with a design speed of 70 km/h.

In the final third of the PPO surface route, the eastern (ascending) lane in the direction of Prosek is widened by one lane. This creates the structural preparation for the continuous routing of two lanes in the direction of the D8 motorway. This modification is followed by a recommendation from a 2021 transport and urban planning study to extend the connecting section of the PPO between the Novopacká and Mladoboleslavská grade-separated junctions by one lane to ensure the continuity of two lanes in the direction of the D8 motorway in this section as well. A similar recommendation is the current

reconstruction of the elevated road (bridge) over the Rokytka river valley before the start of the section in question.

The modification of the PPO route elevation to achieve sufficient depth in the residential area and its transfer to a tunnel is mainly influenced in the southern part by the location of existing major sewers in Poděbradská street. In the northern part of the underground section, the design is mainly influenced by the connection to Kolbenova street and the possibility of connecting it with on-ramps before the existing railway overpass. The current width configuration of the railway overpass also limits the width of the PPO route.



Key:

SO 101 ÚPRAVA ULIC PRŮMYSLOVÁ -KBELSKÁ	SO 101 MODIFICATION OF PRŮMYSLOVÁ - KBELSKÁ STREETS
SO 601 TUNEL HLOUBĚTÍNSKÝ	SO 601 HLOUBĚTÍN TUNNEL

Fig. 7 Elevation adjustment of part of the PPO route

6. HLOUBĚTÍN TUNNEL – STRUCTURAL DESIGN AND BASIC PARAMETERS

The tunnel section is designed to be approximately 670 m long. Given the local conditions, i.e., the shallow route combined with the geological structure of the area and the morphology of the terrain, which do not allow the use of tunnel boring technology, the tunnel is designed as a classic cut-and-cover tunnel. The height of the overlying formation ranges up to a maximum of 5.0 m at the crossing with Poděbradská street, taking into account the tram line and utility lines being relocated.

6.1 TUNNEL CATEGORY AND BASIC TECHNICAL PARAMETERS

The proposed tunnel is a twin-tube tunnel with one-way traffic in each tunnel tube. In view of the possibility of congestion in the tunnel and based on the conclusions of the safety documents and the required lengths of escape routes, seven cross passages with a maximum spacing of 153 m are proposed as part of the tunnel. Two of them are located in front of the tunnel portals and are not considered escape routes (southern one passable with vehicles, northern one passable for pedestrians); they serve as access to the tunnel's technical facilities and can also be used as an emergency route for emergency services. Inside the tunnel, there is one cross passage for vehicle traffic and four cross passages for pedestrians serving as escape routes.

Length of the cut-and-cover tunnel, western tunnel tube:	676.21 m
Length of the cut-and-cover tunnel, eastern tunnel tube:	665.12 m
Tunnel width category (according to ČSN 73 7507):	T- 8.0 (two lanes)

Tunnel safety category (according to ČSN 73 7507):	TA
Design speed in the tunnels:	70 km/h
Permitted speed in the tunnels:	50 km/h
Longitudinal gradient:	max. 7.0% (north portal), standard 4.0%
Tunnel category according to length (according to ČSN 73 7507):	Medium
Clearance height (according to ČSN 73 6201):	4.50 m (vertical clearance 4.65 m)
Design service life of main load-bearing structures:	100 years
Required fire resistance of load-bearing structures:	REI 180 DP1

Horizontal layout of the tunnel, T-8.0 (two lanes) with the following dimensions:

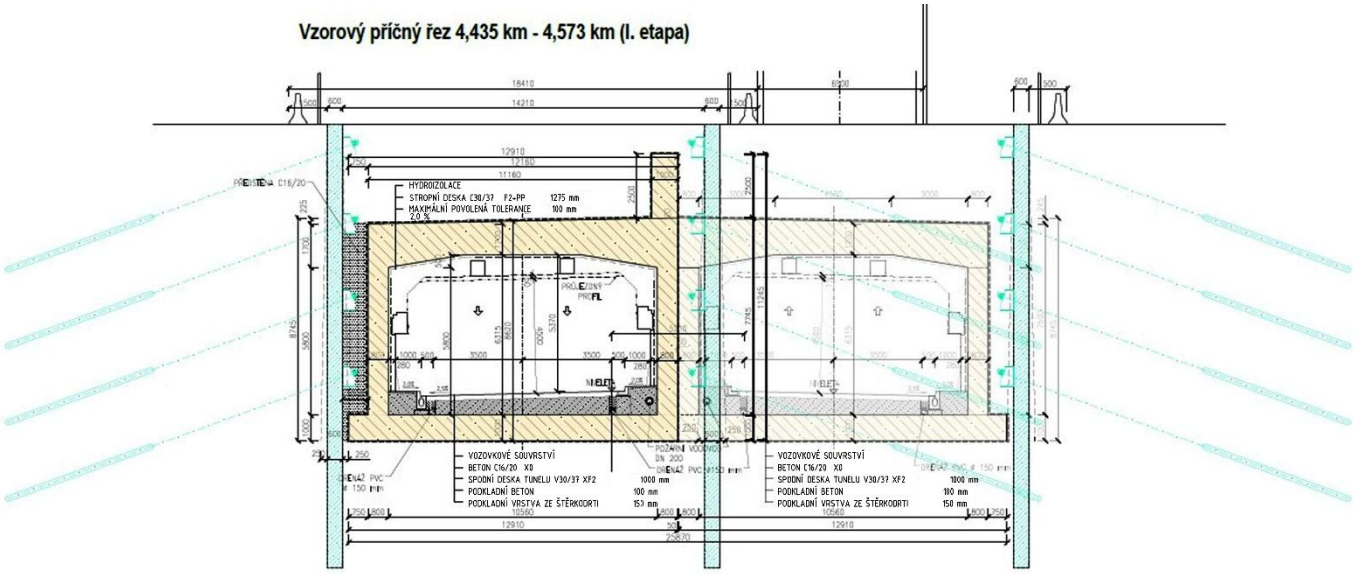
Edge lines	2 x 0.50 m
Lanes	2 x 3.50 m
Emergency walkways	2 x 1.00 m
Height of the kerb	120 mm

6.1.1 Directional and Elevation Situation of the Tunnel

In terms of direction, along the chainage of the main route, the tunnel connects from the south to the open section of the main route, which descends below ground level in the portal area with the height difference being secured by means of L-shaped retaining walls. The Hloubětín Tunnel begins with an approach section of supporting structures with entrance area cross passage No. 0, which provides a service connection in the portal area between the spaced tunnel tubes, between which the intermediate ramps of the surface sections of the Poděbradská x Průmyslová intersection begin. The route begins here with a right-hand curve with a radius of R = 360 m, continues with a 70 m transition curve into a connecting straight section 115 m long, where the tunnel tubes run close together. The route then continues with a 70 m transition section, followed by a 76 m left-hand curve with a radius of 1247 m. After another 70 m transition curve, the axis of the route becomes straight, where the tubes diverge again and the route continues to the northern tunnel portal and the approach area walls with entrance service cross passage No. 7.

In terms of elevation, the tunnel route begins in the direction of the chainage from the south with a valley line curve R = 4000 m, in which it transitions from a 6.1% descent to a 4.0% ascent. The lowest point of the route is located in a tunnel near tunnel cross passage No. 1 at the crossing with Poděbradská street. In the 4.0% ascent, the route continues northward to another valley line curve with a radius of 3,200 m, from which it heads northward in 7.0 % ascent, passes under Kolbenova Street, and emerges into the surface section at the northern portal.

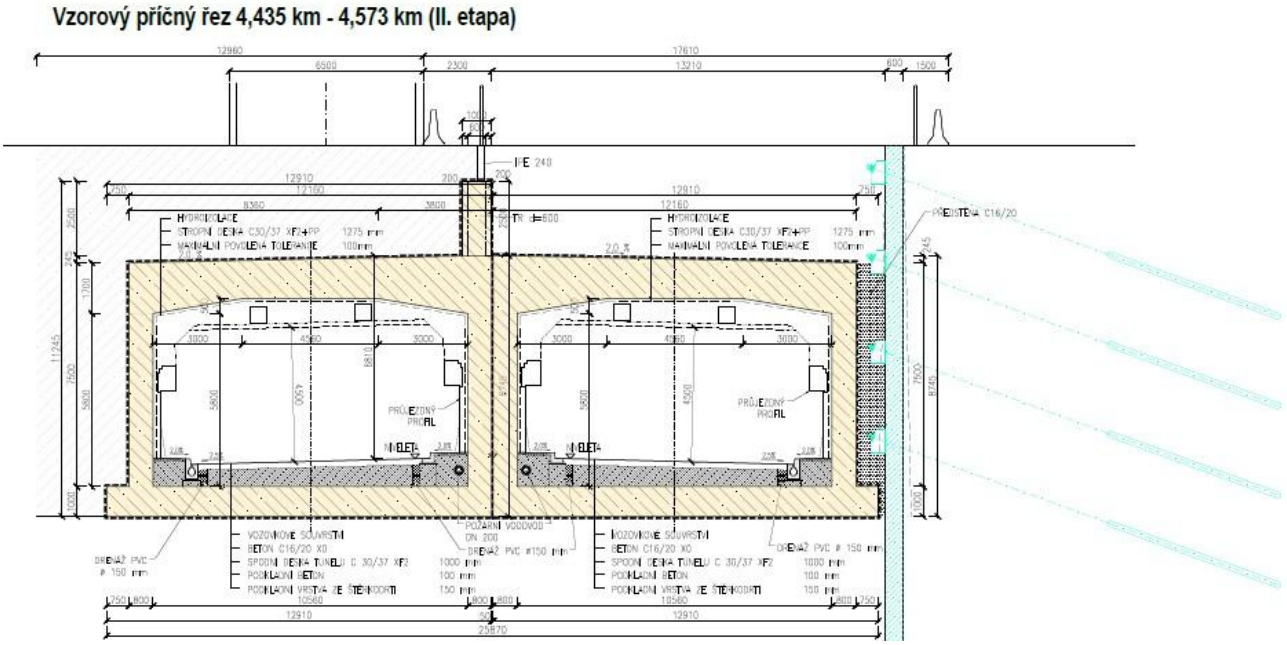
The crossfall of the roadway is envisaged to be roof-shaped, i.e., in both tunnels with a one-sided camber of 2.5%.



Key:

Vzorový příčný řez 4,435 km – 4,573 km (I. etapa)	Sample cross-section 4.435 km – 4.573 km (Stage I)
PŘEDSTĚNA	TEMPORARY FRONT WALL
HYDROIZOLACE	WATERPROOFING
STROPNÍ DESKA	TOP SLAB
MAXIMÁLNÍ POVOLENÁ TOLERANCE	MAXIMUM PERMISSIBLE TOLERANCE
PRŮJEZDNÝ PROFIL	CLEARANCE
DRENÁŽ PVC	PVC DRAINAGE PIPE
VOZOVKOVÉ SOUVRSTVÍ	PAVEMENT STRUCTURE
BETON	CONCRETE
SPODNÍ DESKA TUNELU	TUNNEL BOTTOM SLAB
PODKLADNÍ BETON	BLINDING CONCRETE
PODKLADNÍ VRSTVA ZE ŠTĚRKODRTI	CRUSHED AGGREGATE BASE COURSE
POŽÁRNÍ VODOVOD	FIREFIGHTING WATER MAIN

Fig. 8 Cross-section of the tunnel – construction of the western tunnel tube



Key:

Vzorový příčný řez 4,435 km – 4,573 km (II. etapa)	Sample cross-section 4.435 km – 4.573 km (Stage II)
PŘEDSTĚNA	TEMPORARY FRONT WALL
HYDROIZOLACE	WATERPROOFING
STROPNÍ DESKA	TOP SLAB
MAXIMÁLNÍ POVOLENÁ TOLERANCE	MAXIMUM PERMISSIBLE TOLERANCE
PRŮJEZDNÝ PROFIL	CLEARANCE
DRENÁŽ PVC	PVC DRAINAGE PIPE
VOZOVKOVÉ SOUVRSTVÍ	PAVEMENT STRUCTURE
BETON	CONCRETE
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PODKLADNÍ BETON	BLINDING CONCRETE
PODKLADNÍ VRSTVA ZE ŠTĚRKODRTI	CRUSHED AGGREGATE BASE COURSE
POŽÁRNÍ VODOVOD	FIREFIGHTING WATER MAIN

Fig. 9 Cross-section of the tunnel – construction of the eastern tunnel tube

6.2 SPATIAL ARRANGEMENT OF THE TUNNEL

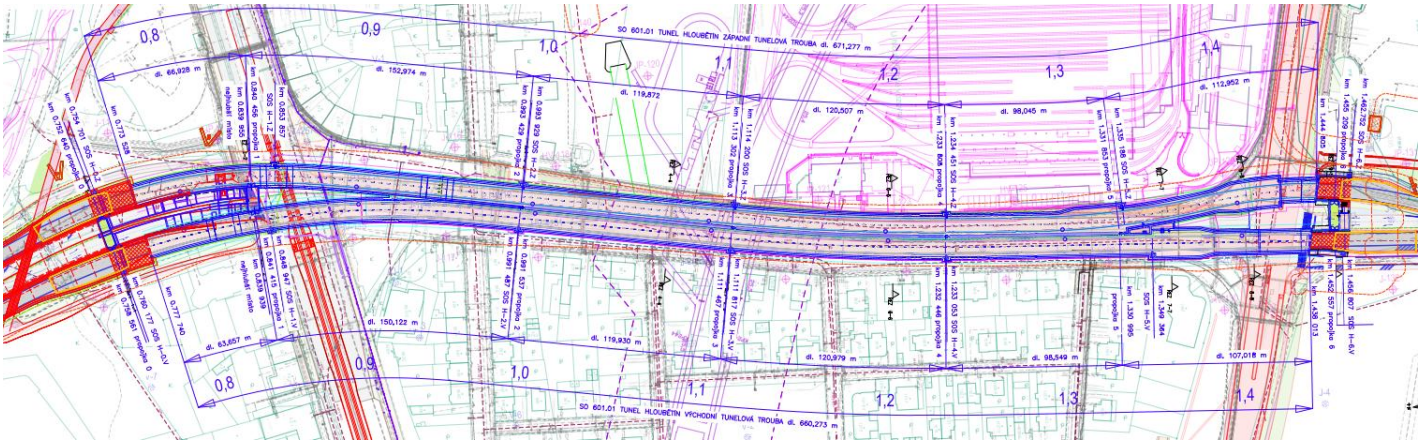
In the direction of the chainage, considering the construction phasing requirements, the Hloubětín Tunnel consists of two structurally separate one-way tunnel tubes passing under Poděbradská street (traffic light-controlled intersection of Poděbradská and Průmyslová streets), the surface section of Kbelská street, and Kolbenova street (traffic light-controlled intersection of Kolbenova and Kbelská streets).

The tunnels on the main route are designed as longitudinally ventilated throughout the entire length of the Hloubětín Tunnel within the main traffic area.

Given the local conditions (elevation of the route, terrain morphology, geological conditions), the tunnels are envisaged as conventional cut-and-cover tunnels constructed in open excavation pits, respecting the prevailing geology and based on the results of a detailed geotechnical investigation, taking into account the variable engineering-geological conditions and geotechnical conditions along the route.

In terms of layout, the tunnels consist of two physically separate two-lane tunnel tubes. In the portal areas, the tunnel tubes are spaced apart and the junction branches of the aforementioned Kbelská – Poděbradská and Kbelská – Kolbenova junctions join and depart the main route at the surface from the left by way of intermediate location.

The tunnel technology centre (TGC) is located between the separated tunnel tubes at the south portal, providing support for its operating and technological equipment.



Key:

SO 601.01 TUNEL HLOUBĚTÍN ZÁPADNÍ TUNELOVÁ TROUBA dl. 671,277 m	SO 601.01 HLOUBĚTÍN TUNNEL, WEST TUNNEL TUBE with length 671.277 m
nejhlubší místo	deepest point
propojka	cross passage

Fig. 10 Tunnel floor plan

6.3 TECHNICAL DESIGN

Conventional cut-and-cover tunnels are frame structures consisting of walls and a horizontal ceiling envisaged with shallow foundation on a base slab.

The tunnel layout consists of two tunnel tubes designed as a two-lane profile, divided directionally, with possible increased height in places where jet fans are located. Given that in the northern part of the area, where the frame structure protrudes above the existing ground surface, it is not possible to place the fans above the clearance profile, the fans will be placed next to the clearance profile. In these places, the tunnel will be partially widened on both sides by approximately 2.3 m.

The eastern tunnel tube and the western tunnel tube will be built separately, taking into account the construction phases.

The cut-and-cover eastern tunnel tube and western tunnel tube are connected by escape cross passages at maximum intervals of 153m. Two cross passages (No. 0 and No. 6) are designed primarily for tunnel maintenance (access to technical areas), but their parameters also allow for response by emergency services, with the southern cross passage No. 0 designed as passable for vehicles for transporting technical equipment to the TGC facility. North cross passage No. 6 provides access to the electrical cabinet

and underground automatic pressure station for pressurizing the fire water mains. It is also accessible from the surface via an entrance structure with an access service and emergency staircase.

Cross passages No. 1-5 constitute escape routes to the adjacent tube in the event of an emergency, such as a fire in the tunnel. Cross passage No. 1 is designed as a passable for vehicles, functionally connected to the TGC traffic corridor. Cross passages 2-5 are passable for pedestrian traffic.

North of cross passage No. 5 are the tunnel substations, each accessible from one of the tunnel tubes. These areas are ventilated by forced ventilation and air-conditioned with fresh air supplied at the surface (HVAC chimney within the Kbelská street SDP) and waste heat discharged into the tunnel.

Opposite the tunnel cross passages, there are always emergency niches, which are located so that the distance between them is always max. 150 m, in accordance with the requirements of ČSN 73 7507.

The construction process will consist of concreting the bottom foundation slab, walls, and ceiling. The thickness of the structure's ranges from 800 mm for walls to approx. 1,200 mm for top slabs (up to 1,700 mm in haunches). The thickness of the base slab is envisaged to be 1000 mm. The construction of the cut-and-cover tunnel tube is designed using C 35/45 - XF4, XD3 concrete, with nominal reinforcement cover of 50 mm and 65 mm, respectively, with PP fibres.

The plan is to use a closed waterproofing system based on sheet-based full-coverage waterproofing and size the lining for full hydrostatic load. Conceptually, the plan is to use a sufficiently tight waterproofing envelope with the possibility of immediate and multiple additional sealing. The construction joints of the tunnel lining will be sealed several times as standard using joint sealing plates. The joint sealing solution will always include grouting tubes for additional grouting.

In the longitudinal direction, the cast-in-place constructed tunnel tubes will be structurally divided into blocks of approximately 12 m in length, separated by construction joints. Expansion joints will be envisaged at a maximum distance of 40 m. Construction will proceed in stages using system formwork elements.

The tunnel design includes filler and gradient layers for tunnel maintenance walkways and roads, including the final surfaces of maintenance walkways. In accordance with standard practice in Prague, the road surfaces in the tunnel will be asphalt with a waterproof membrane.

With regard to the location of the construction project in the area, level 5 protection measures are specified for the tunnel structures, breast walls, and other related structures to protect the main tunnel structure crossing the metro route and located near the tram depot with a substation and within the range of the electrified railway line. A set of protective measures is proposed at the level of primary and secondary protection and structural measures, including the prescribed nominal concrete cover, welding of reinforcement of structures to protect against stray currents, and a non-destructive corrosion diagnosis system for reinforcement proposed for the most corrosion-exposed parts of the tunnel. The system of welded reinforcement in the tunnel foundations and breast walls will also serve as a grounding system for the tunnel technology and accessories on the breast walls.

The interior surface of the tunnel and ramp tube linings will be finished with ceramic tiles up to a height of 3.5 m to ensure long-term durability. Above this finish, the lining will be treated only with a washable protective coating system. The interior surfaces of escape routes and utility rooms will be coated only with a washable protective coating system.

Backfill consists of compacted soil, using local excavated material to the greatest extent possible.

6.3.1 Technology Centre

The tunnel technology centre (TGC) is located between the separated tunnel tubes at the south portal, providing support for its operating and technological equipment. The structure interacts statically with the tunnel structure and includes entrance area cross passage No. 0.

The TGC facility is designed as a three-storey underground structure with one above-ground floor. The facility is located between spaced tunnel tubes. The facility is accessible from the entrance area cross passage and the first tunnel cross passage at the level of the main route roads, as well as via a connecting staircase from the single-storey above-ground entrance house located south of the Poděbradská and Průmyslová intersection, which also includes intake shafts for the facility's air conditioning and

ventilation, as well as two PREdistribuce substations providing a separate entrance for manager staff. A large-capacity storage reservoir with a pumping station for the tunnel's operational drainage system, located below roadway level, will be incorporated into the TGC.

Technical rooms housing equipment (including substations) are located in such a way as not to impede natural drainage, i.e., they will be situated above roadway level.

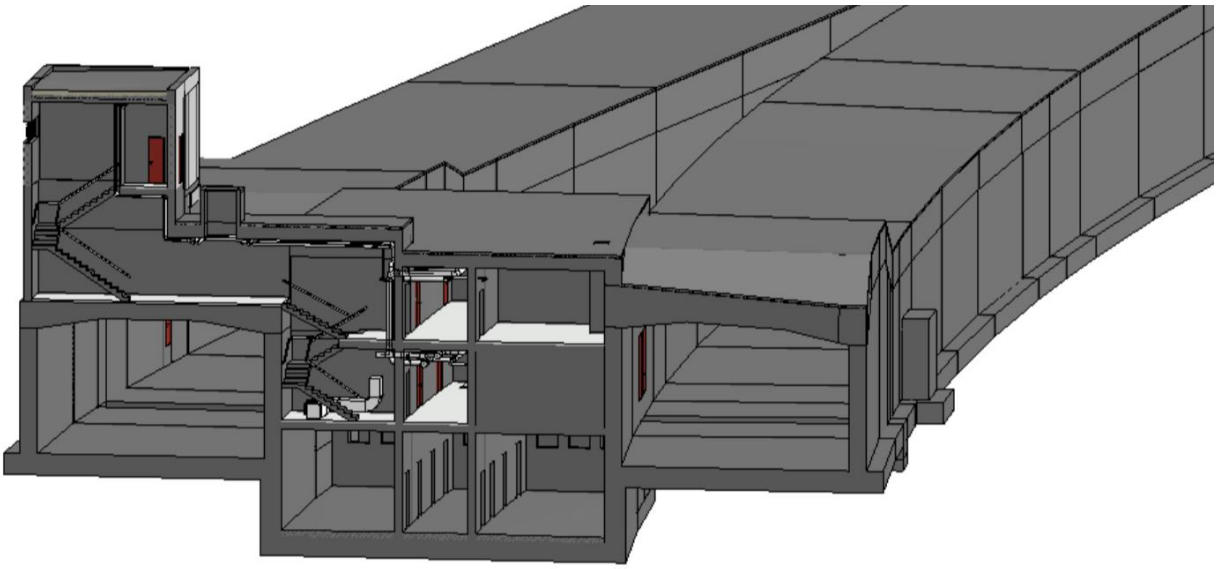


Fig. 11 Cross-section of the 3D model of the TGC facility and tunnel structures

6.3.2 Excavation Support

The tunnel will be constructed from the surface down into an open excavation pit. In the southern and central sections, the work will be carried out below the water table. For this reason, the perimeter walls of the excavation pit are designed to be impermeable. The excavation pit will be designed primarily as a sealed structure using a combination of fixed diaphragm walls 600 mm thick, drilled-in pile walls with a diameter of 600–800 mm made of C25/30 concrete, reinforced with B500B steel reinforcement cages and fixed with temporary five-strand cable anchors at 3–4 anchor levels. Outside the area requiring sealing of the excavation pit (the northern part of the pit and the central retaining wall), the pit will be secured with IPE360 braced timbering with wooden struts, anchored by temporary five-strand cable anchors at two levels.

The excavation pit follows the natural north-south flow of groundwater in the area toward the Rokytka river. Only in the southern part of the area (specifically in the sections where the route cuts through the surface) does the flow direction change to southwest, considering the Rokytka river corridor. Once construction is complete, the groundwater flow will be restored by installing drainage corridors of gravel-filled seepage cut-offs beneath the approach area support structures, thereby connecting the aquifers in the eastern and western sections.

6.3.3 Tunnel Drainage

The design minimizes the inflow of rainwater into the tunnel from the road surface as much as possible. However, given the morphology of the terrain, these options are limited. In the areas in front of the portals, measures have been taken to grade the main route's roadways to minimize the extent of drainage flowing into the tunnel, install cross-drainage elements with sufficient capacity, create seepage points in the gravel bed beneath the roadways, etc. At the same time, the TGC design includes a sufficiently large storage reservoir with a volume of 1,500 m^3 and a high-capacity pumping system for the operational drainage of the tunnel and the main route, which collects water that, due to the terrain's morphology, cannot be drained from the tunnel by gravity.

Road drainage is provided by a slotted gutter with a curb. This water flows by gravity into the contaminated water collection sump located within the area for the underground storage reservoir of the TGC facility and its pumping station at the lowest points of the section. From there, the water is

pumped into the municipal sewer system. The standard cross-slope of the roadway is 2.5%. Along the sidewalks, there is also a longitudinal drainage system made of Ø150 mm PVC pipes running beneath the roadway, which directs any seepage water to the roadway drainage pumping stations. The contaminated water sump is used to collect water from tunnel cleaning, liquids from unforeseen accidents or leaks in the tunnel, and to store water in the event of a firefighting operation. Under normal conditions, the sump will be open-flow; it will be closed by an electrically operated gate valve linked to an emergency detection system, which will trigger the closure. The contaminated water will be pumped out of the storage tank and transported away for disposal.

In the northern section of the road, upstream of the tunnel's northern portal, a large drainage basin (approx. 80 ha) is drained into the area of the railroad underpass. The area in front of the north portal will be drained via a high-capacity DN1200 sewer leading to a storage reservoir with a capacity of 5,350 m^3. The reservoir will be located west of the tunnel's northern portal. In front of the portal itself, large-capacity longitudinal and transverse slotted gutters and inlets will be installed to divert part of the water directly through the storm sewer system into the storm drain or the Rokytka river. This design provides the maximum technically feasible protection against flooding in the tunnel.

The proposed drainage system provides partial protection for the tunnel but is not capable of handling extreme above-design rainfall events. The TGC technical floor itself is elevated by approximately 1 meter above the roadway to better protect the equipment from tunnel flooding. The tunnel is thus protected against extreme rainfall. However, the tunnel's structure and technical equipment are not designed to withstand all types of extreme rainfall, particularly heavy, frequent downpours of long duration. In the most extreme cases, the runoff volume from the catchment area exceeds 15,000 m^3. For this volume, the proposed technical measures would no longer be cost-effective in relation to the potential damage.

6.3.4 Firefighting Water Supply to the Tunnel

A firefighting water tank with a minimum usable capacity of 108 m^3 will be installed in the ramp area of the tunnel's northern portal, in accordance with the requirements of ČSN 73 7507. It will be located immediately adjacent to the room housing the automatic pressure station, which connects to entrance area cross passage No. 6. The automatic pressure station will pressurize the permanently filled fire water mains. The fire water mains are located in the left sidewalk of the tunnel tube in the direction of travel. The pipe diameter is 200 mm. The piping is insulated. Alternatively, it is heated in the portal areas of tunnels. Fire hydrants are typically located in recesses in the tunnel lining opposite the emergency niches, spaced up to 150 meters apart near tunnel cross passages, in accordance with the requirements of ČSN 73 7507. The hydrant's drainage is routed above the roadway surface and connected to a slotted drainage channel.

7. SERVICE AND TECHNICAL EQUIPMENT, VENTILATION, AND DRAINAGE

From a safety perspective, according to the documents, the tunnel is classified in safety category TA and is fully equipped with technical systems. The technical facilities are located in the TGC. The TGC houses the main components of the technical infrastructure, including but not limited to electrical substations, transformer stations, a control room, and storage areas.

The tunnel's technical equipment includes, in particular, mechanical equipment, variable traffic signs, an information system, SOS boxes, ventilation systems, automated traffic control, pollutant detection (NOx, smoke, opacity), fire alarm systems, security systems, CCTV surveillance, antenna system, power supply, tunnel lighting, fire water mains, and tunnel drainage systems, including pumping stations.

In both emergency tunnel walkways, cable routes are planned solely for the tunnel's emergency lighting. If conditions permit, it is preferable to install cable routes above the roadway; all other cable runs are therefore planned to be routed through cable trays on the walls within the main traffic area of the tunnel (to be addressed by the relevant operational unit). The protective tubes in the emergency walkways will be constructed with a uniform slope and made watertight. Local cable manholes in front of the tunnel portals will be equipped with a drainage system that discharges into the roadway drainage system (into the storage reservoir in the TGC).

During normal operation, the tunnel's traffic area will be naturally ventilated by the airflow generated by passing vehicles traveling in the direction of traffic, with exhaust air venting through the tunnel exit portals. The ventilation rate is high, as the longitudinal airflow velocity in the tunnel exceeds 5 m/s. In 24 hours, more than 18 million cubic metres of outside air passes through each tube from one side to the other. To provide forced ventilation for the traffic area, the tunnel will be equipped with a longitudinal ventilation system consisting of jet fans installed within the tunnel.

The specifications for the tunnel construction equipment have been designed in accordance with the applicable regulations TP 98 and ČSN 73 7507.

8. RELATED SURFACE IMPROVEMENTS AND NON-MOTORIZED TRANSPORTATION

The plan also includes a comprehensive redesign of the surface layout with the aim of reducing the barrier effect of the road and adding both cross-street and through connections for non-motorized traffic in the wider area.

Fig. 12 Schematic model of the surface layout – Průmyslová–Poděbradská grade-separated junction area

In the southern section of the layout, in front of the Poděbradská grade-separated junction, a new shared-use path for pedestrians and cyclists is proposed on the east side, a replacement of the existing underpass with a new one and the addition of a new footbridge for pedestrians and cyclists. Plans are also being considered to extend the connections toward the Starý Hloubětín tram balloon loop and to link up with the main cycling route via the bridge over Poděbradská street.

The new surface section of Kbelská street on top of the tunnel PPO route is designed as an urban boulevard, reflecting the reduction in traffic volume resulting from the diversion of through traffic into the tunnel. At the same time, provision is made for the possibility of temporarily rerouting traffic to the surface section of Kbelská street in the event of an emergency in the tunnel. The proposed layout includes one traffic lane and one dedicated lane for bicycles and buses in both directions, with a wide, landscaped median strip. The layout includes new paths and sidewalks on both sides of Kbelská street, including green belts, the restoration of cross-street connections, parking bays, and landscaping.

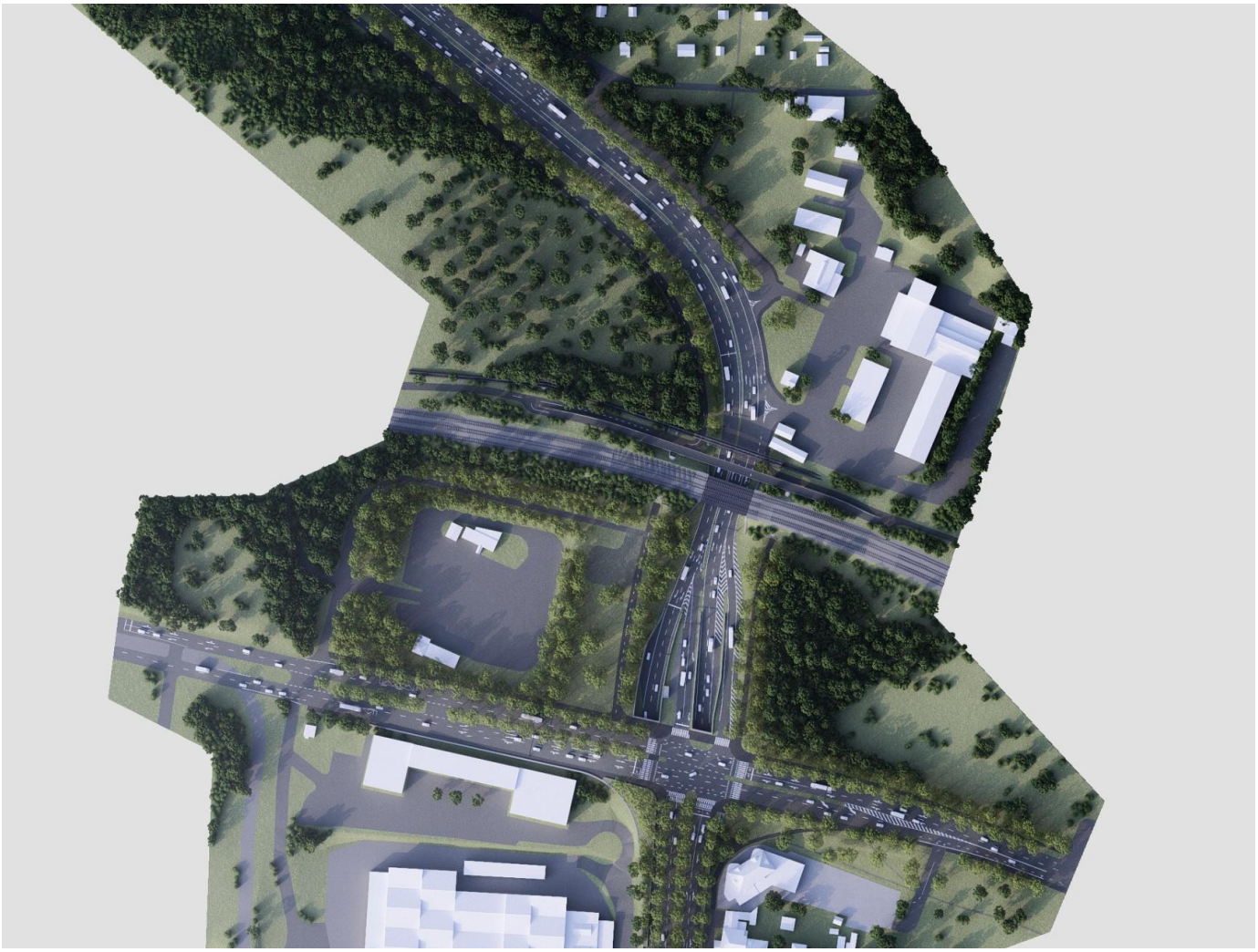


Fig. 13 Schematic model of the surface layout – Kbelská – Kolbenova grade-separated junction area

In the northern section of the project, i.e., from the Kolbenova grade-separated junction, longitudinal bicycle and pedestrian routes toward Prosek have been improved, considering the existing underpasses beneath the railroad tracks. A new footbridge for pedestrians and cyclists is proposed as a preliminary step toward the construction of a connecting bike path along the north side of the Prague–Lysá nad Labem railway line. In the area of the Kolbenova grade-separated junction, a service road is also proposed that connects to the PPO route from the west, allowing emergency vehicles to access the northern tunnel portal in the event of an emergency.

The project includes extensive landscaping and planting, with an emphasis on creating optimal conditions for the rooting of newly planted trees and the application of blue-green infrastructure principles and storm-water management in accordance with the standards of the City of Prague.

9. CROSSING WITH THE METRO LINE, UTILITY LINE RELOCATIONS, DEMOLITION WORK

Regarding the relationship to underground structures, the non-intersecting crossing of the tunnel route with the Metro B line, which the tunnel route crosses over, was evaluated. At the crossing, the highest point of the metro tunnel structure is located 11.0 m to 11.9 m below the level of the Hloubětín Tunnel's base slab.

Extensive construction activity in the area is affecting virtually all types of utility networks. This primarily involves the relocation of water mains, sewer lines, gas lines, and communication and power cables. Most of the relocations are planned in multiple phases, with temporary routes established according to the construction phases, in conjunction with the gradual opening of excavation pits and the rerouting of surface traffic in the area.

A section of the retaining wall located within the Hloubětín depot grounds along its eastern boundary is designed for demolition due to a conflict with the excavation pit support. In addition, the buildings on the Gallo brothers' site north of Kbelská street will be demolished due to the raised final ground level of Kolbenova street, the conflict with the route of the temporary detour for Kolbenova street, and the location of the stormwater storage reservoir on Kbelská street. In the Rekomont complex area north of the tunnel, the existing water management structures of the DUN reservoir—including the distribution shaft and the on-site well—will be demolished. The existing garage buildings adjacent to Kbelská street on the east side will be completely demolished. Advertising structures, particularly tall, illuminated billboards, will be removed from the affected areas without compensation. The demolition also includes the buildings housing the PREdistribuce substations that are to be relocated. In addition, the existing noise barriers on Kbelská street and the pedestrian underpass at Poděbradská street will be demolished.

10. CONSTRUCTION MANAGEMENT AND TRAFFIC ARRANGEMENTS DURING THE IMPLEMENTATION

The construction process consists of a total of eight basic phases, defined by the location of the section of the tunnel under construction and the routing of the detour roads. The total construction period is set at four years, with major traffic restrictions expected to last approximately 3.5 years.

Throughout the construction period, all traffic connections at the Kbelská × Kolbenova and Kbelská × Poděbradská × Průmyslová junctions are expected to remain in place, although they may be temporarily relocated as excavation pits are gradually opened up.

There are plans to permanently maintain at least one through lane in each direction of the PPO on Průmyslová and Kbelská streets. In the southern section of the approach area, a temporary eastern route terminating at Poděbradská street has been proposed to expedite construction of the underground section.

The basic principle of the construction management is to restrict traffic to only one radial direction at a time, i.e., either Poděbradská street or Kolbenova street. During the construction of the tunnel in the area of Poděbradská street, tram service from the city centre is expected to be temporarily terminated at the Hloubětín balloon loop. The designated alternative public transportation route is Metro Line B and a substitute bus service from the Hloubětín balloon loop (or the Starý Hloubětín stop) to Lehovec.

During the construction of the eastern tunnel tube, traffic connections from Kbelská street to the residential area east of it will be interrupted. Access to the area will be provided by a temporary access road connected to the existing street network and to the main road network of Poděbradská and Kbelská streets. Traffic patterns on certain local roads will also be temporarily adjusted.

Pedestrian and bicycle routes through the construction site will be maintained to an extent commensurate with the current conditions, particularly in the vicinity of the intersections.

More broadly, it is expected that the D0 511 project will be completed and operational by the time the Hloubětín Tunnel is built. The Štěrboholská radial road, the D0 motorway, and the Vysočanská radial road are being considered as primary detour routes. The temporary traffic configuration on Kbelská

street at the junction with the Vysočany radial road will resolve the congestion problem at the point where the road narrows to a single lane. Where necessary, traffic signs restricting the entry of freight and transit traffic will be installed in the surrounding area.

Given the traffic restrictions along the Průmyslová and Kbelská streets corridor during construction, it is advisable to simultaneously carry out the construction work outlined in the PPO feasibility study along the entire route of the Průmyslový polookruh (Industrial Half-Ring Road), particularly the reconstruction of the bridge over the Rokytka river valley and modifications to the Novopacká grade-separated junction. These projects are separate investment initiatives, and their scheduling and technical coordination are essential to minimize traffic disruptions.

The planned construction will affect neither Metro Line B service between Kolbenova and Hloubětín nor rail service between Praha-Vysočany and Praha-Rajská zahrada. Detour routes will be established for heavy freight transit traffic.

11. GEOTECHNICAL MONITORING

Given the nature of the project, the solution includes extensive geotechnical monitoring of the area concerned.

This section provides only a list of the specific types of measurements and monitored parameters, both before the start of construction, during construction, and after the completion of the tunnel. The proposed scope of GTM measurements is only general and advisory in nature, corresponding to the proposed solution, which is based on the level (scope) of knowledge regarding the rock environment along the tunnel route at the DPZ (Documents for Planning Permit) stage. The detailed monitoring plan itself will be part of the PDPS (Construction Drawings/Documents) and ZDS (tender specification) documents (in accordance with TP 237).

12. CONCLUSION

The Hloubětín Tunnel project addresses the need to mitigate the impacts of heavy traffic on the PPO and to eliminate the urban planning issue posed by the existing PPO route passing through a residential area. The proposed solution diverts the majority of through traffic into an approximately 670-metre-long cut-and-cover, directionally separated tunnel, while also modifying the surface layout to reduce the road's barrier effect and strengthen both longitudinal and cross-street connections for pedestrians and cyclists. The Poděbradská and Kolbenova junctions are designed as grade-separated structures, which aims to eliminate recurring congestion and improve traffic flow in the busiest section of the PPO.

In terms of preparation, the project has received a final decision from the screening and scoping process pursuant to Act No. 100/2001 Sb. (Collection of Laws) and has prepared the necessary Documents for Planning Permit (DPZ). Currently (January 2026), engineering work is underway to obtain the opinions required to initiate the planning permit proceedings for the project. These proceedings are expected to begin in the second quarter of 2026. The project is thus entering a crucial phase of the permitting process, with clearly defined parameters for the route, the tunnel, surface layout modifications, and the resulting relocations of transportation and utility infrastructure.

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Ing. Lukáš Grünwald
Office: SATRA spol. s r.o., Praha, Czech Republic
E-mail address: lukas.grunwald@satra.cz

Ing. Pavel Šourek
Office: SATRA spol. s r.o., Praha, Czech Republic
E-mail address: pavel.sourek@satra.cz

Ing. Martin Laloušek
Office: SATRA spol. s r.o., Praha, Czech Republic.
E-mail address: martin.lalousek@satra.cz