

Expert assessment brief and scope

This contract brief and scope is for an independent Expert assessment of a railway project „Modernizace trati Praha-Výstaviště (mimo) – Praha-Veleslavín (mimo)“, section Dejvice – Veleslavín. This particular section of the project consists of 4km long railway tunnels in accordance with option R1spěš of the feasibility study „Studie proveditelnosti Železniční spojení Prahy, Letiště Ruzyně a Kladno, doplnění 2016“ [1].

In January 2020 the Designer of the project Metroprojekt Praha prepared a study „Porovnání variant tunelového řešení v úseku Praha-Dejvice – Praha-Veleslavín“ [2]. The aim of this study was to summarise and evaluate the feasible tunnel alignment options. The study considered 4 tunnel alignment options (option CUT AND COVER, mined option NORTH, mined option SOUTH and mined option CENTRAL) and for completeness, one additional SURFACE alignment option.

The scope of this Expert assessment is to assess and compare the 4 tunnel alignment options briefly described in the study [2] and further detailed in the below reference documents. The options are:

1) CUT AND COVER option

Alignment of this option runs underneath the existing railway track. It consists of a double track railway tunnel partly constructed as cut and cover, partly as top-down and partly it is mined conventionally (NATM). This option originates from a preliminary design stage process initiated in 2007 „Aktualizace přípravné dokumentace 03/2009 Modernizace trati Praha – Kladno s připojením na letiště Ruzyně, I. Etapa“ [3] and subsequent design update „Studie proveditelnosti“ [1], which deleted the train stop Dlouhý lán.

2) Mined option NORTH

This alignment option runs in two single track tunnels excavated by EPB-TBMs, away from the existing rail alignment. It passes north of the Institute of Physics of the Academy of Sciences. The west tunnel portal (Dejvice) is located adjacent to Bruska water storage and pumping facilities, the east tunnel portal (Veleslavín) is located adjacent to Veleslavín heating plant. This option originated from the preliminary design stage DUR 02/2019 [4].

3) Mined option SOUTH

This alignment option runs in two single track tunnels excavated by EPB-TBMs, away from the existing rail alignment. It passes south of the Institute of Physics of the Academy of Sciences. The west tunnel portal (Dejvice) is located in Hradčanská adjacent to intersection of streets Svatovítská and Milady Horákové, the east tunnel portal (Veleslavín) is located adjacent to Veleslavín heat plant. This option originated from the preliminary design stage DUR 11/2019 [5].

4) Mined option CENTRAL

This option is a modification of the option „SOUTH“. The difference is alignment routing in the Střešovice area, where the alignment is shifted north to follow streets Střešovická and Na Petřinách and minimises the extent of tunnelling underneath hospital “ÚVN Střešovice“. This option is documented in the study „Porovnání variant tunelového řešení v úseku Praha-Dejvice – Praha-Veleslavín“ [2]

The referenced preliminary design documents include tunnel design reports and drawings and preliminary Geotechnical interpretative reports (GIR), prepared according to Czech standard ČSN EN 1997-1 (Czech implementation of EC7). For the option CENTRAL there are two additional ground investigation boreholes underway and the preliminary GIR will be supplemented with the borehole information and testing results by June 2020. For the remainder of the tunnel alignment options the preliminary ground investigation stage is complete. Detail design ground investigation stage will commence after selection of the final alignment option, hence after this Expert assessment.

The main scope of this Expert assessment is to:

- 1) Assess the sufficiency of the preliminary ground investigation – evaluate whether the extent of the completed ground investigation is sufficient for the preliminary design stage and for the selection of the preferred tunnel alignment option and if it is in agreement with the general world good practice. If the preliminary geotechnical investigation is found insufficient, the Designer/Client will design and execute additional preliminary geotechnical investigation based on the recommendations of the Expert in a way, that the Expert will be able to recommend the most favourable tunnel alignment option upon receipt of the additional ground investigation data.
- 2) Independently recommend the most favourable tunnel alignment option based on:
 - a) Identification and assessment of the main risks (especially geotechnical) associated with the selected type of tunnelling method in these ground conditions (EPB-TBM for options NORTH, SOUTH, CENTRAL; cut and cover, top down and NATM construction for option CUT AND COVER) and the main risks associated with the location of portals for EPB-TBM excavation.
 - b) Assessment of the technical solution in terms of tunnelling technology for the expected ground conditions - qualitatively.
 - c) Assessment of the influence of the tunnel excavation and operation on the surrounding 3rd party assets - qualitatively (ground deformation, change of groundwater levels) and quantitatively (calculation of surface deformations in reference cross-sections).
- 3) Respond to Client's specific questions/areas of interest:
 - a) The risk of connecting two independent aquifers as a consequence of the TBM excavation, especially when excavating through a fault zone. Recommendations how to prevent this.
 - b) Options NORTH, SOUTH and CENTRAL have a ventilation shaft which will be excavated by NATM (with double shell lining). This shaft will cross both aquifers. The owner asks to recommend ways how to prevent connection of these two aquifers (permeation grouting is currently envisaged as the mitigation measure)
 - c) What specific ground parameters or characteristics should be obtained and gathered in the detailed-design-ground-investigation phase and should any specific laboratory testing be carried out to allow effective design of EPB-TBMs (excavation)?

- d) Do you consider satellite monitoring of ground deformation suitable for this project and why?
- e) Is there a possibility of the TBM excavation having some dynamic impact (vibrations) on the 3rd party assets?
- f) Describe features of EPB-TBM excavation which allow minimisation of the ground movement in these ground conditions including any monitoring. How can live monitoring data be considered in EPB-TBM operation to limit impact on 3rd party assets?

Based on assessment of the tunnel alignment options recommend the most suitable one(s). For the recommended option(s) summarise geotechnical risks in relation to impact on 3rd party assets including proposals how to mitigate these risks without compromising the project's budget (consider value for money). Recommend further steps for this design phase (preliminary design) and for the subsequent design stages that would lead to risk mitigation.

Note: Consider 3 critical cross sections for each alignment option and assess these in detail for ground deformation by calculations/modelling. Based on these selected profiles it should be possible to estimate greenfield surface deformation along the entire route of EPB-TBM tunnels. In coordination with the Designer, critical assets will be picked along the alignment route. The expected construction impact (so called Stage 1 damage assessment) on these structures will be characterized and more advanced damage assessment stages will be recommended where required. These structures include:

- Fyzikální ústav AV ČR – Cukrovarnická (Institute of Physics of the Czech Academy of Sciences, Cukrovarnická street),
- Ústřední vojenská nemocnice Střešovice, also called ÚVN Střešovice (Military University Hospital Prague),
- Vodojemy a přečerpávací stanice Bruska (Water storage and pumping facilities Bruska),
- Tunel MO Blanka (Road tunnel Blanka),
- Vozovna Střešovice (Tram depot Střešovice),
- Kostel sv. Norberta (Saint Norbert church),
- Evangelický kostel Střešovice (Evangelic church Střešovice),
- Teplárna Veveslavín (Heat plant Veveslavín),
- Památkově chráněné objekty v oblasti Proboštského Dvora (Heritage listed buildings in the area of Proboštský Dvůr),
- and others based on assessment with the Designer.

The following locations of cross sections are recommended for the ground settlement analysis:

- CUT AND COVER option - Proboštský Dvůr (NATM tunnel section), retaining wall of Teplárna Veveslavín (top down tunnel section), third suitable cross section to be selected by the Expert
- Mined option NORTH – Buštěhradská street (adjacent to west portal Dejvice), ÚVN Střešovice, third suitable cross section is to be selected by the Expert
- Mined option SOUTH – Pod Hradbami street, ÚVN Střešovice, third suitable cross section is to be selected by the Expert
- Mined option CENTRAL – Pod Hradbami street, ÚVN Střešovice, third suitable cross section is to be selected by the Expert

Deliverables and programme:

- 1) Assessor (Expert): Deliver technical note regarding point 1) of the scope (sufficiency of ground investigation) by 15th May 2020
- 2) Client: Provide Assessor (Expert) data from the two additional ground investigation boreholes for mined option CENTRAL by 15th June 2020
- 3) Assessor (Expert): Deliver draft of the Expert assessment for review by 15th June 2020
- 4) Assessor (Expert): Deliver final Expert assessment by 30th July 2020

Should deliverable 1) require any additional preliminary ground investigation, submission dates for deliverables 3) and 4) would be postponed to await completion of the additional preliminary ground investigation.

References:

[1] Studie proveditelnosti Železniční spojení Prahy, Letiště Ruzyně a Kladno, doplnění 2016, „Společnost MP+SUDOP – Praha-Ruzyně-Kladno“, 08/2019

(Feasibility study the railway connection Prague, Airport Ruzyně and Kladno, amendment 2016, “Company MP+SUDOP – Praha-Ruzyně-Kladno, 08/2019)

[2] Modernizace trati Praha-Výstaviště (mimo) – Praha-Veleslavín (mimo) - studie „Porovnání variant tunelového řešení v úseku Praha-Dejvice – Praha-Veleslavín“, METROPROJEKT Praha a. s., 02/2020

(Refurbishment of railway line Praha-Výstaviště (excluding the railway station Praha-Výstaviště) to Praha-Veleslavín (excluding the railway station Praha-Veleslavín) – study „Comparison of Tunnel route Variants in the Prague-Dejvice – Prague-Veleslavín section“, METROPROJEKT Praha a. s., 02/2020)

[3] Aktualizace přípravné dokumentace 03/2009 Modernizace trati Praha – Kladno s připojením na letiště Ruzyně, I. etapa, „Sdružení METROPROJEKT a SUDOP pro PRaK I. etapa“, 03/2009

(Amendment of the preliminary design 03/2009 Refurbishment of the railway line Prague – Kladno including connection to airport Ruzyně, 1st stage, “joint venture METROPROJEKT and SUDOP for PRaK 1st stage)

[4] Modernizace trati Praha-Výstaviště (mimo) – Praha-Veleslavín (mimo), dílčí plnění předkládající technické řešení a geotechnický průzkum pro variantu raženou SEVER, „Společnost MP+SP – Výstaviště-Veleslavín“, 02/2019

(Refurbishment of the railway line Praha-Výstaviště (excl.) to Praha-Veleslavín (excl.), partial submission related to preliminary design and ground investigation for mined tunnel option NORTH, „Company MP+SP – Výstaviště-Veleslavín“, 02/2019)

[5] Modernizace trati Praha-Výstaviště (mimo) – Praha-Veleslavín (mimo), dílčí plnění předkládající technické řešení a geotechnický průzkum pro variantu raženou JIH, „Společnost MP+SP – Výstaviště-Veleslavín“, 11/2019

(Refurbishment of the railway line Praha-Výstaviště (excl.) to Praha-Veleslavín (excl.), partial submission related to the preliminary design and ground investigation for mined tunnel option SOUTH, „Company MP+SP – Výstaviště-Veleslavín“, 11/2019)

[6] Geotechnical cross sections showing all four tunnel alignment options in the area of:

- Fyzikální ústav AV ČR (Institute of Physics of the Czech Academy of Sciences)
- Ventilation shaft Střešovice
- Ústřední vojenská nemocnice Střešovice (Military University Hospital Prague)

[7] Table summarising laboratory and field testing carried out in each of the boreholes.

[8] Designer's technical note regarding the possibility of encountering a fault zone running parallel to the tunnel alignment

[9] Hydrogeological description of the area