

TECHNOLOGIES FOR CONSTRUCTION OF CONCRETE TUNNEL LININGS USED IN CZECHIA

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Contents

- Introduction
- Mined tunnels using NATM
- Mined tunnels using TBM
- Cate and cover tunnels
- Launched immersed tunnel
- Conclusions

First railway – České Budějovice – Linz Horse railway 1832 no tunnel
Railway Olomouc – Ceska Trebova – Tatenicky tunnel 146 m long



Tatenický tunnel
Construction 1842 – 1845 in open pit
Widening and repair in 1928
End of operation 2004

Vinohradsky tunnel in Prague now 3 tubes each for 2 tracks ~1150 m

1. Tube 1869 – 1871 original sandstone lining replaced in 1945-48 by granit lining

2. Tube 1940 – 1944

3. Tube 1940 – 1944 (290 m only), completed 1983 – 1989 2-tracks tunnel split into 2 tubes – 1-track tunnels

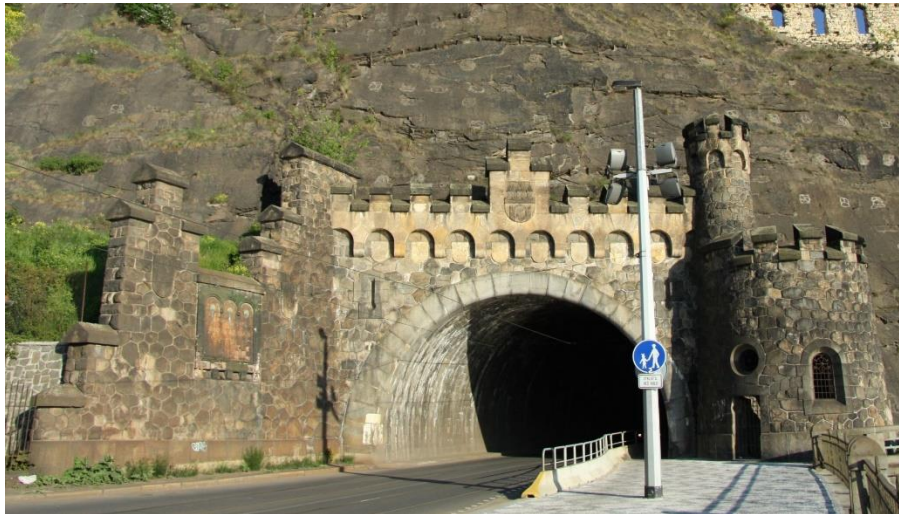


Vinohradsky tunnel – Prague centre

MAÚT 30 Introduction

Railway network 169 tunnels total length 55.9 km (in 2022)
10 tunnels longer than 1000 m
The longest: Ejpovicky (2018) – 4 150 m

Road network 29 tunnels in operation
The oldest: Vysehradsky (1904) – 35 m
The longest: Tunnel complex Blanka (2015) – 5 502 m



NATM (New Austrian Tunnelling Method)

Principle:

1. After excavation Primary (temporary) lining made of shotcrete is installed
2. The Secondary (definitive) lining is installed



The first road tunnel – Tunnel Hřebeč 3 lanes – 357 m long (1997)

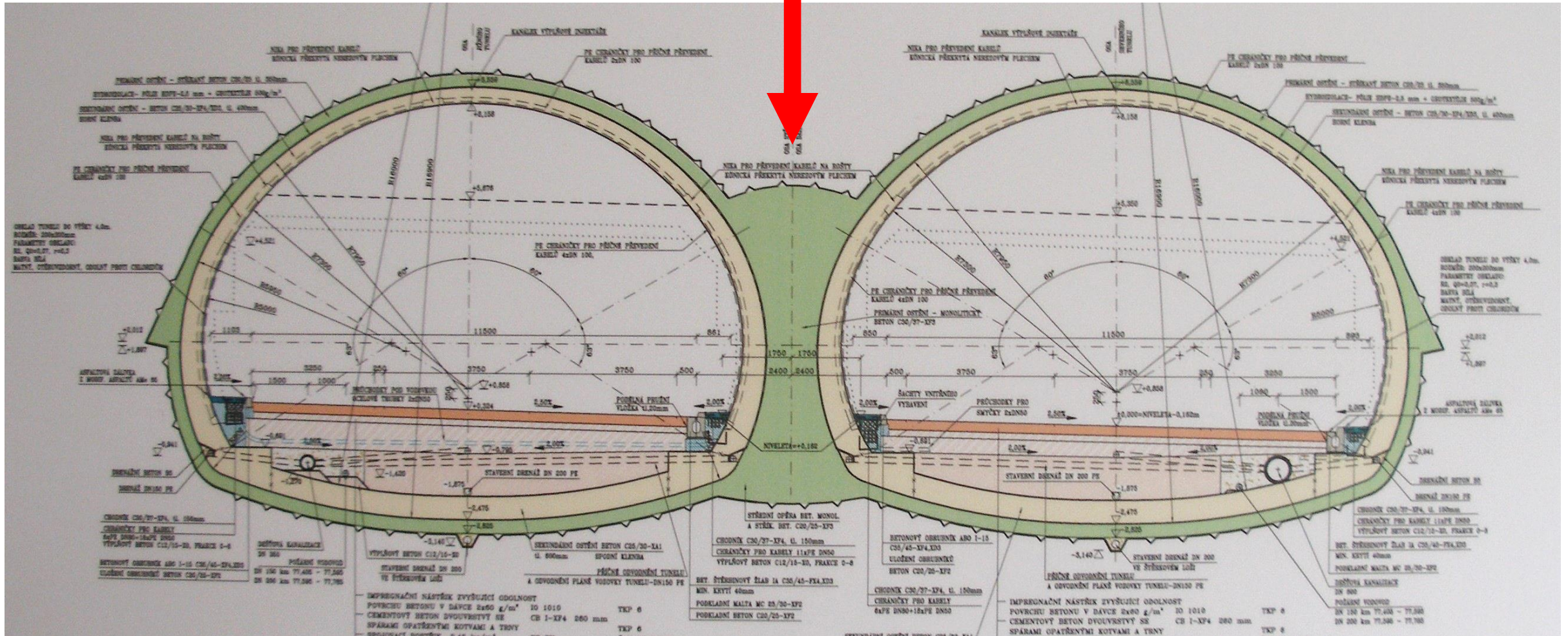


Highway tunnels – usually a wide soil pillar between the tubes

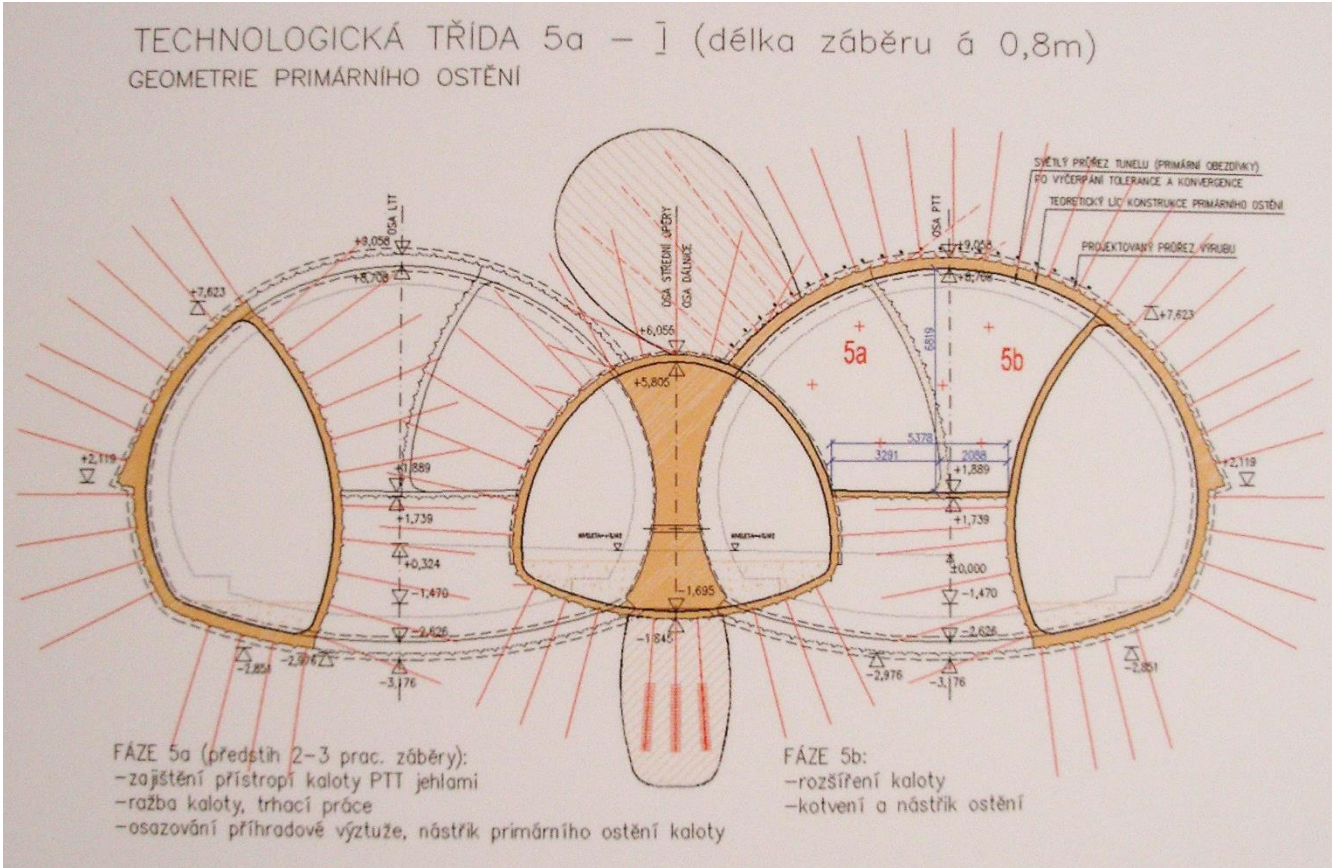


Prackovice tunnel D8
(Prague – Dresden)
260 m (R), 270 m (L) (2016)

Tunnel Valik – D5 (Prague – Nurnberg) 380 m (L) 390 m (R) (2006)



Tunnel Valík – D5 (Prague – Nurnberg) 380 m (L) 390 m (R) (2006)



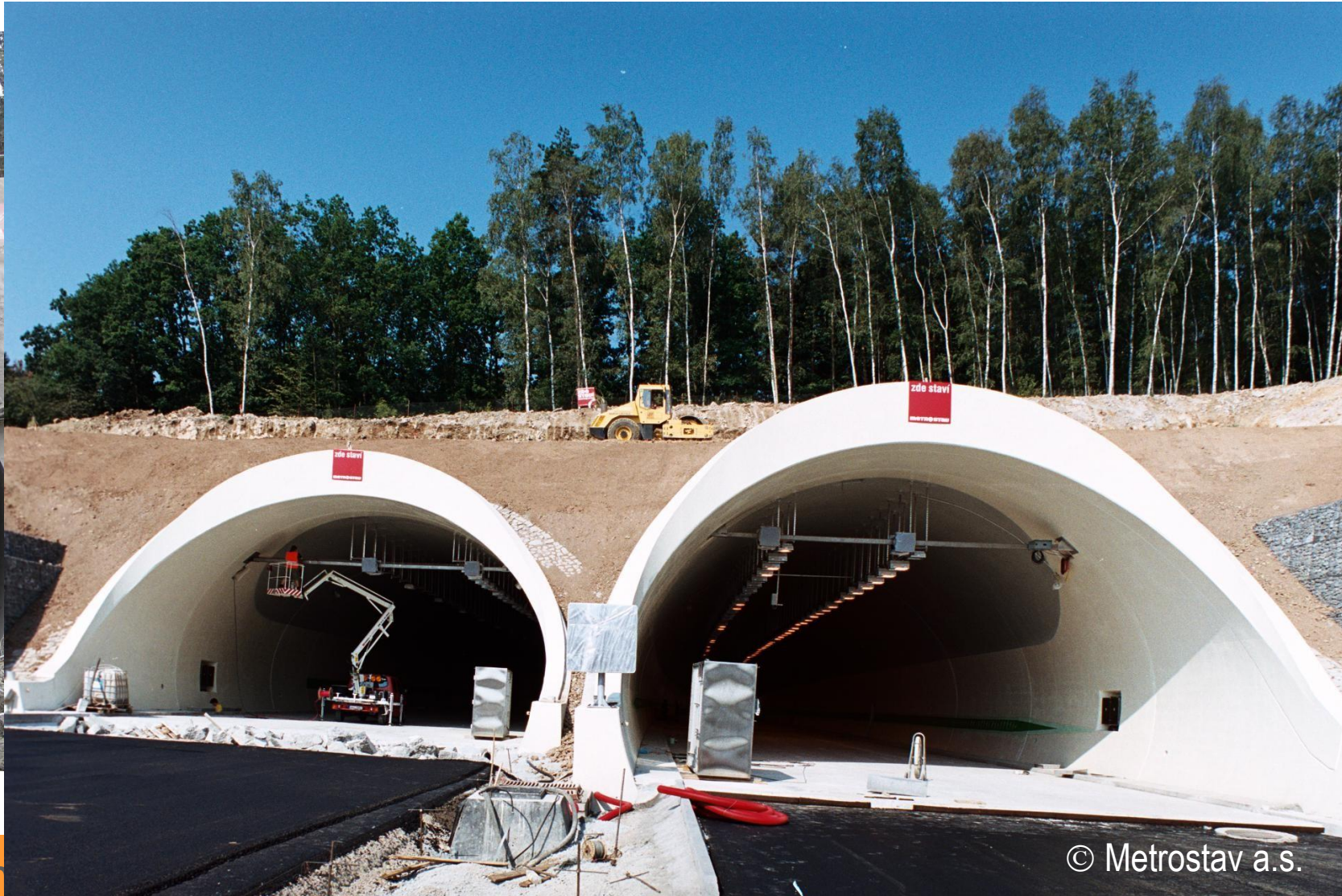
Tunnel Valik – D5 (Prague – Nurnberg) 380 m (L) 390 m (R) (2006)



MAÚT 30 Mined tunnels using NATM



Tunnel Valik – D5 (Prague – Nurnberg) 380 m (L) 390 m (R) (2006)



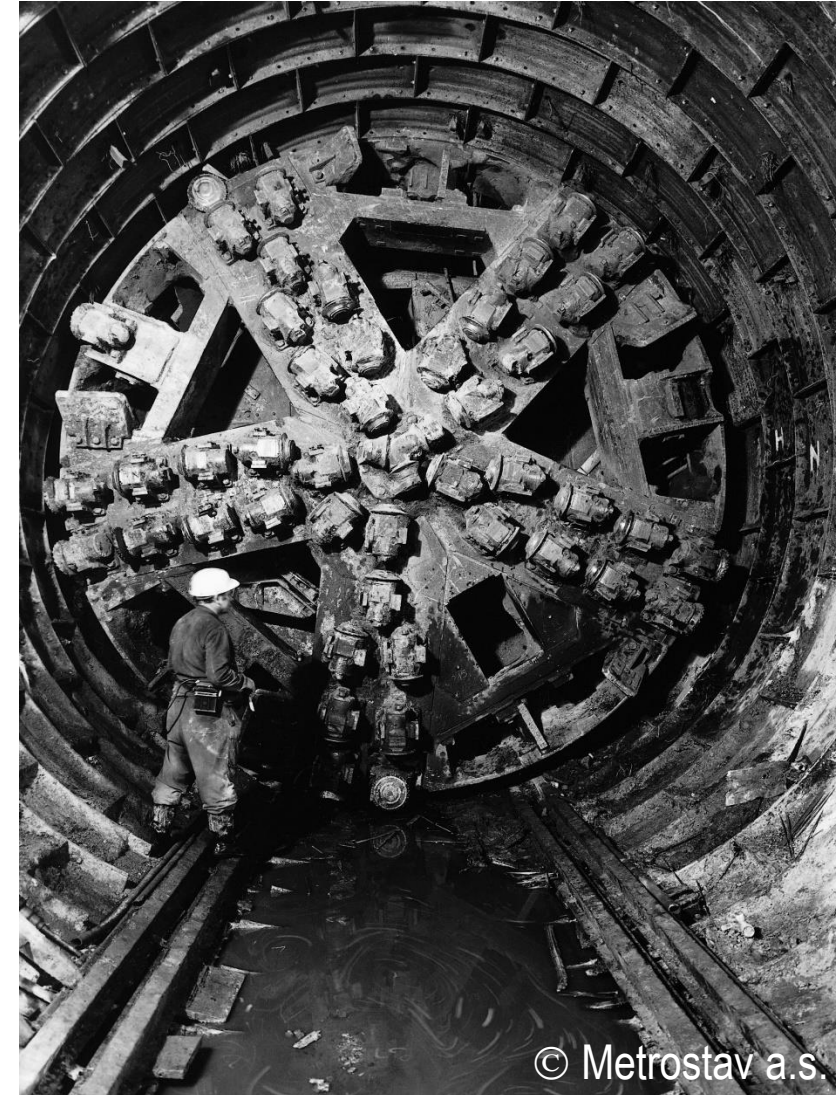
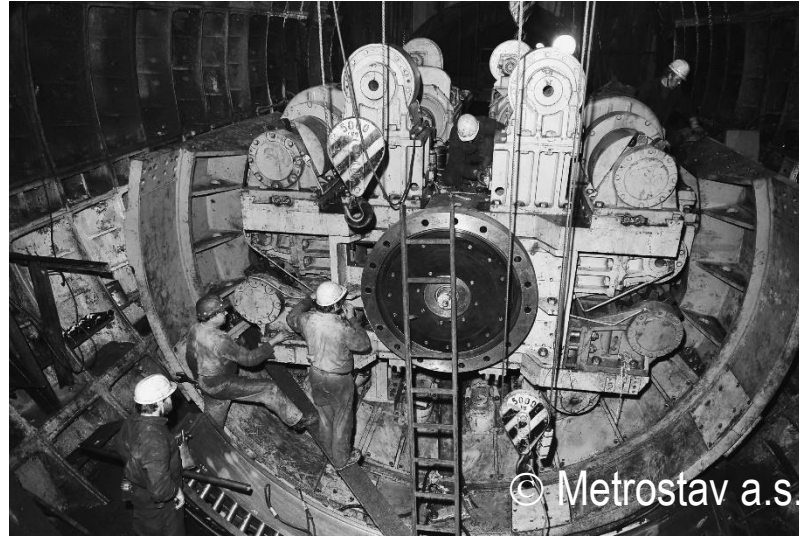
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TBM (Tunnel Boring Machine)

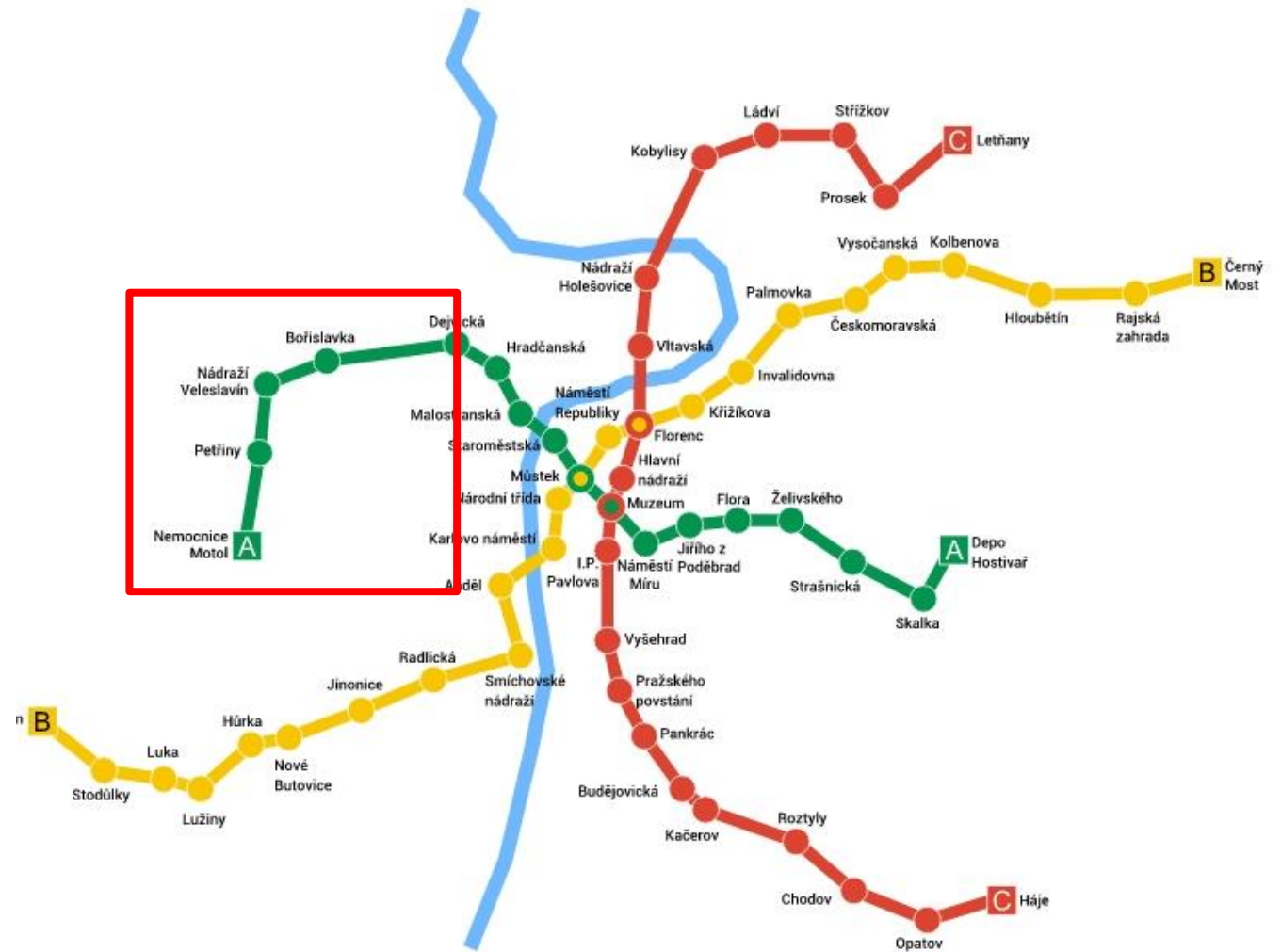
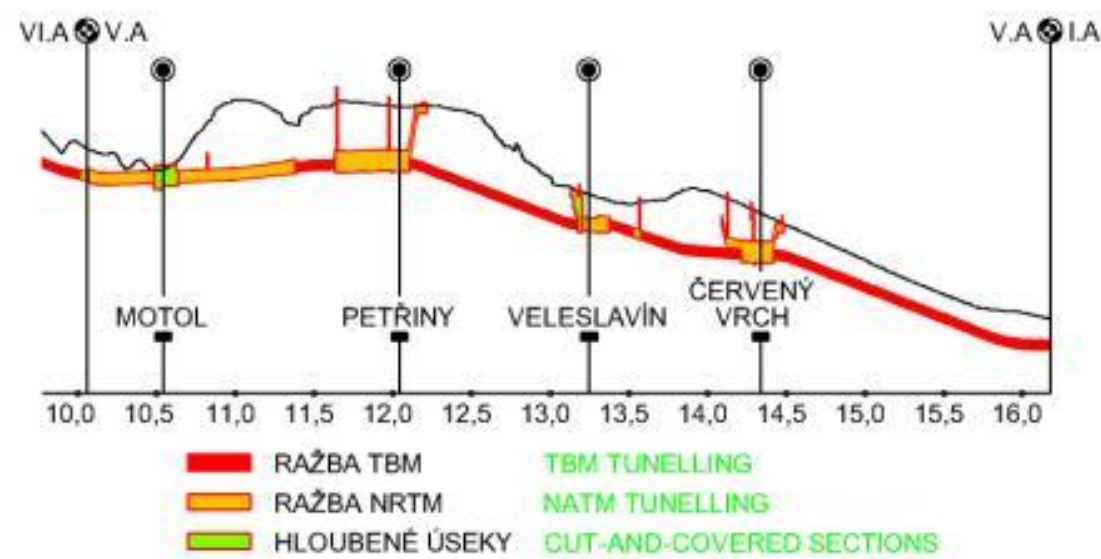
Projects:

- Metro lines 1970 - 1990



Projects:

- Metro line A (extension V.)
- 6 134 m, constr. time 2010 - 2014



Projects:

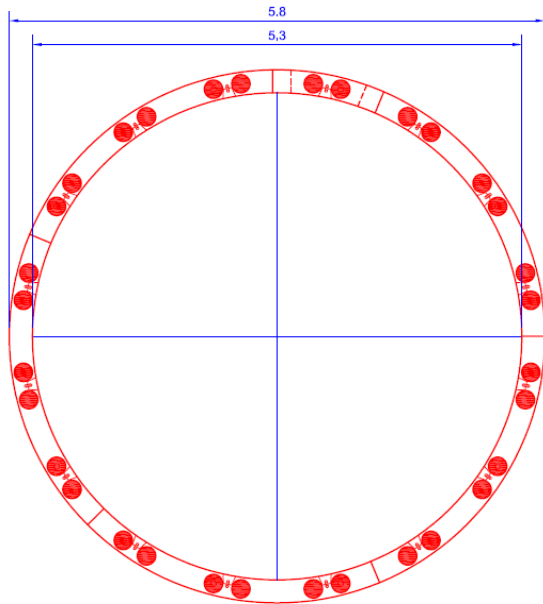
- Metro line A (extension V.)
- TBM – profile 6 m (outer), thickness of the reinforced concrete lining 250 mm



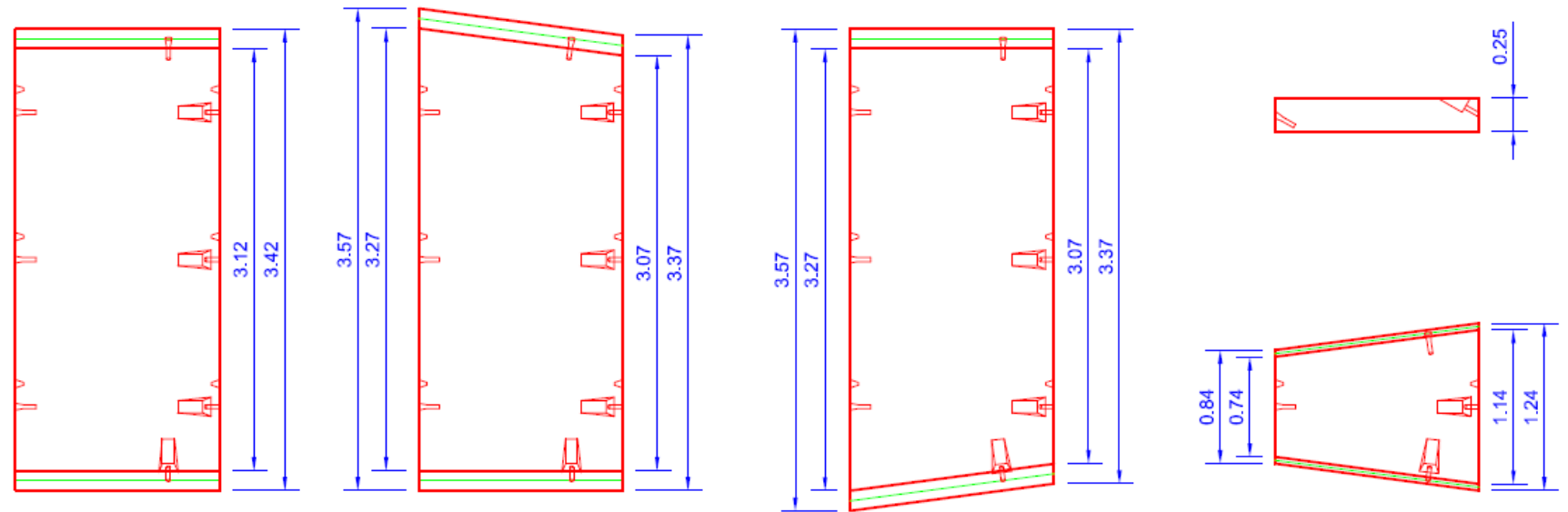
Metro line A (extension V.)

- Tunnel segments – Reinforced Concrete C50/60, outer diameter 5.8 m, width 1.5 m
 length ~ 3.4 m, thickness 250 mm. Ring 5+1, 2 machines installed 5 565 rings = 8 347.5 m

16 cylinder twins, 5 + 1 segments



Unfolded view, 5 + 1 segments



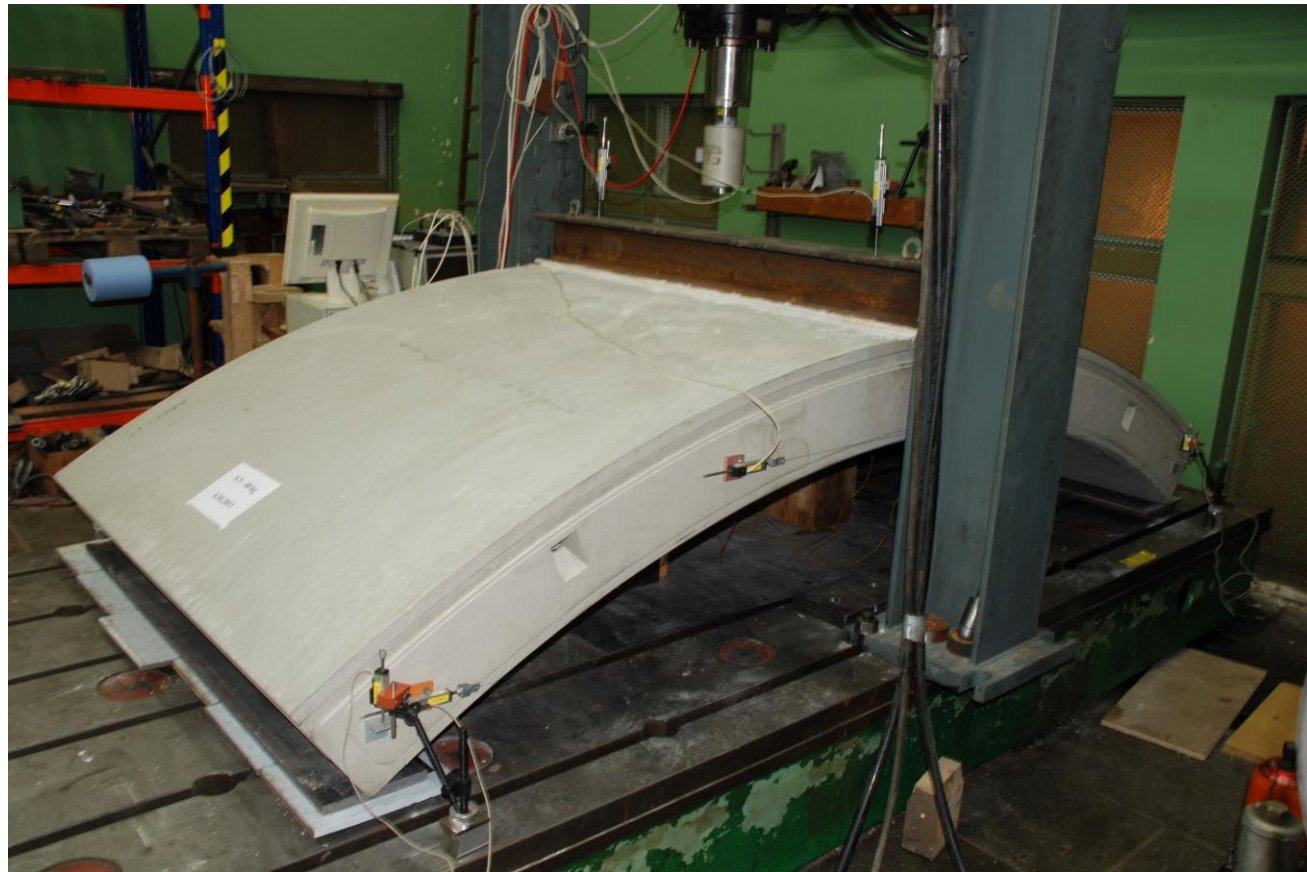
Metro line A (extension V.)

- Production of RC segments in Senec (Slovakia)



Experimental work

- Segments made of Steel fibre reinforced concrete (40 and 50 kg fibres / m³)



Tunnel Ejpovice

- Railway tunnel in western Bohemia 2 tubes, 4 150 m long
- Construction time 2013 – 2018
- Diameter of the tunnel: 10 m



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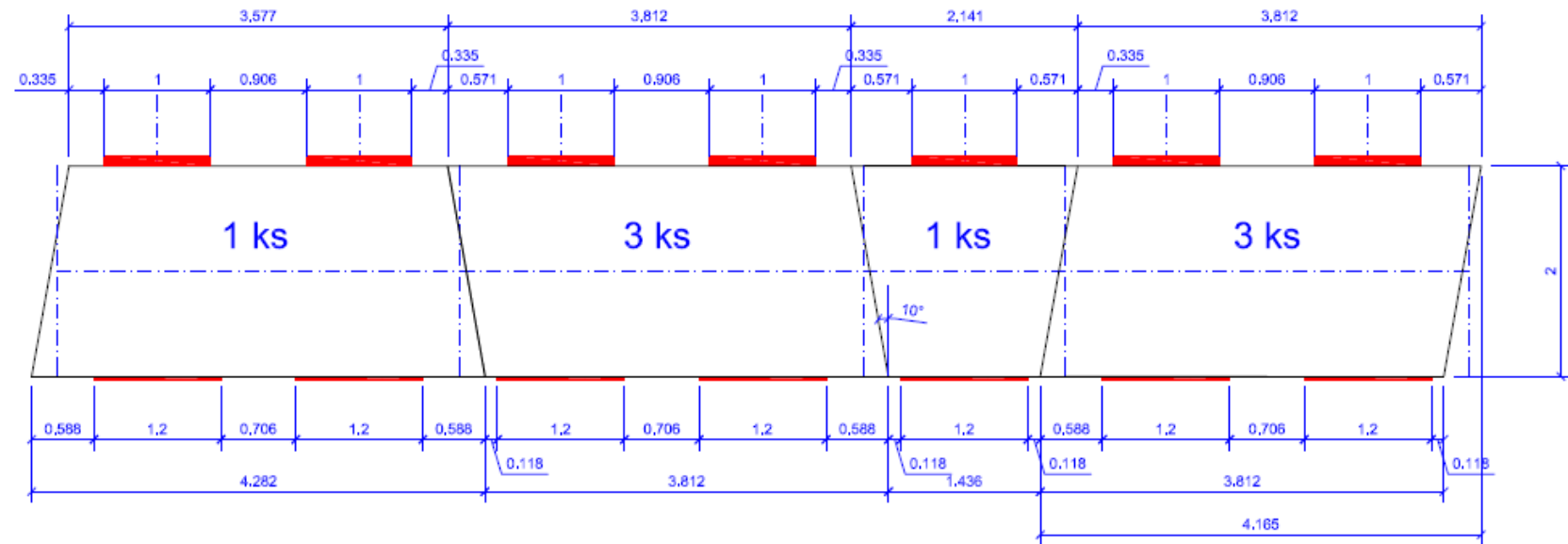
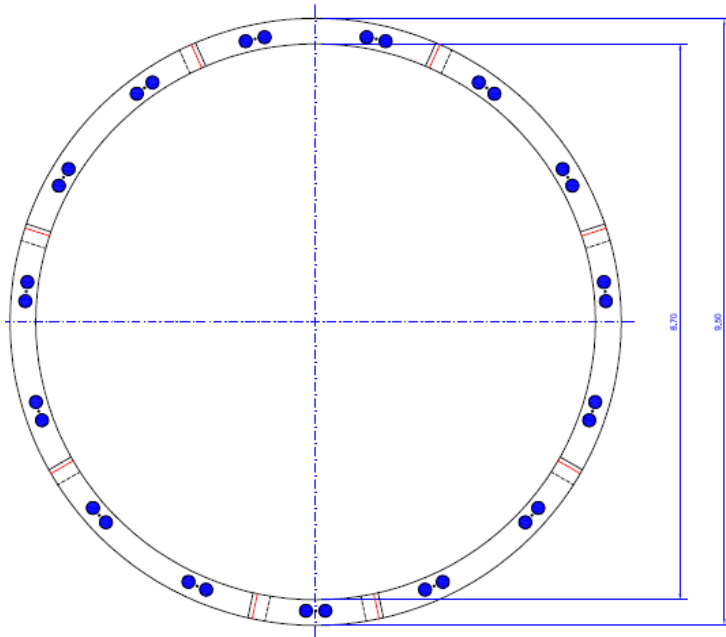


Tunnel Ejpovice



Tunnel Ejpovice

- Tunnel segments 7 + 1, t = 400 mm, w = 2.0 m, L = 3.8 – 4.2 m, $\varnothing = 9.5$ m (outer)
- FRC C45/55, steel fibres 60/1 mm, 40 kg/m³



Tunnel Ejpovice

- Tunnel segments production



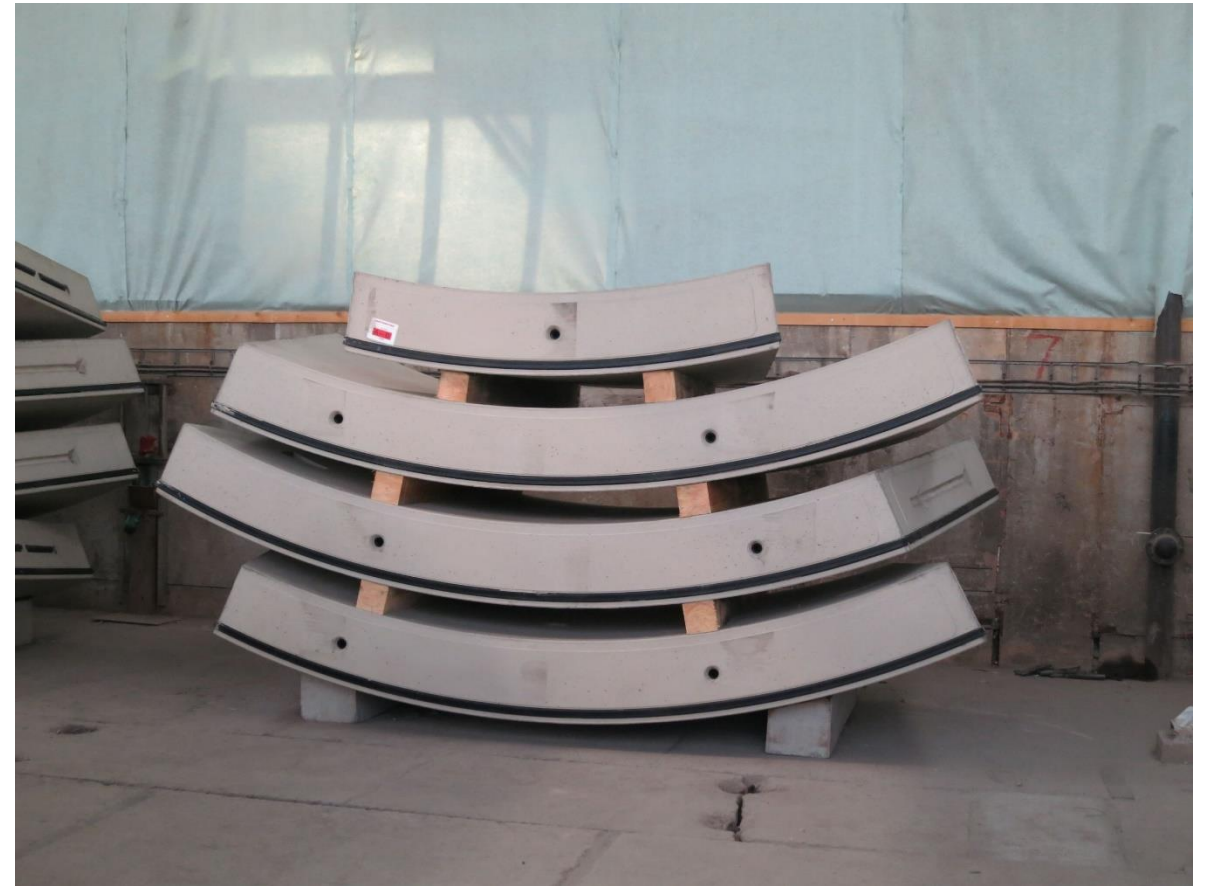
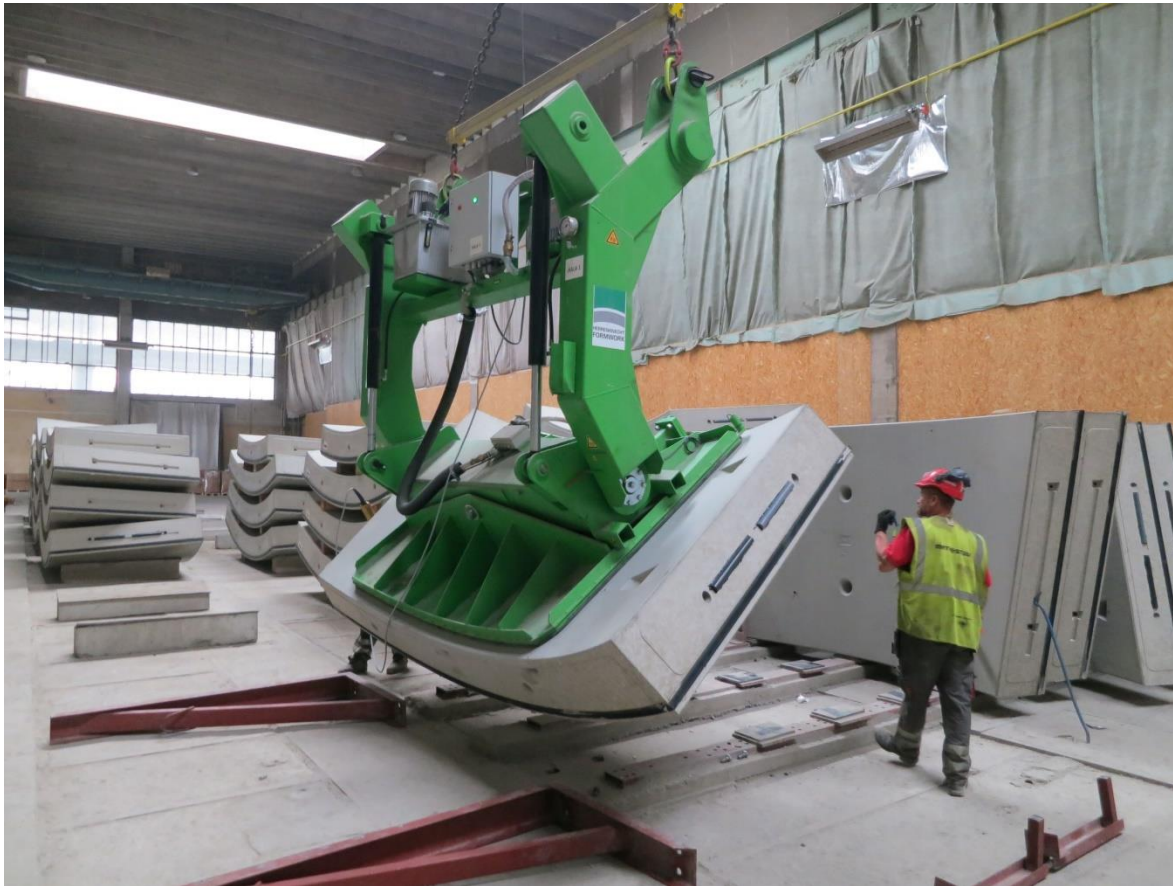
Tunnel Ejpovice

- Tunnel segments production



Tunnel Ejpovice

- Tunnel segments production



Tunnel Ejpovice

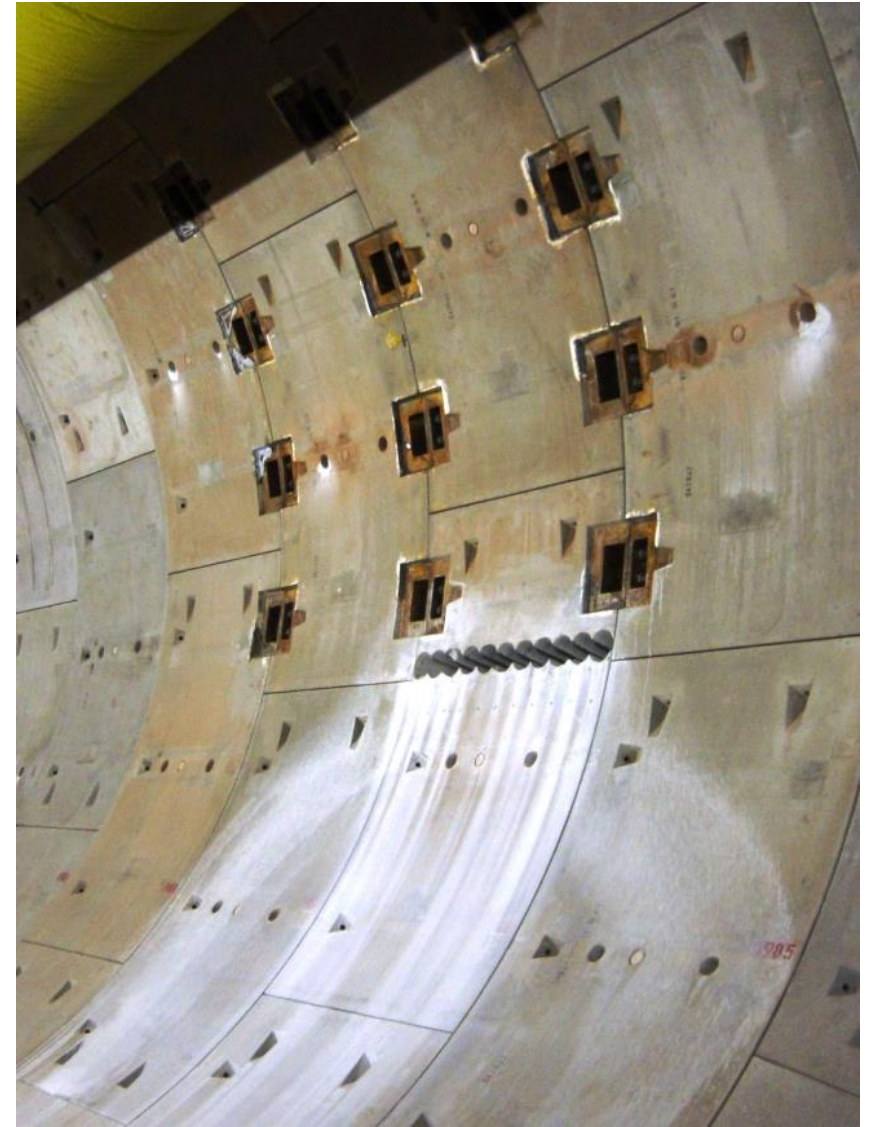
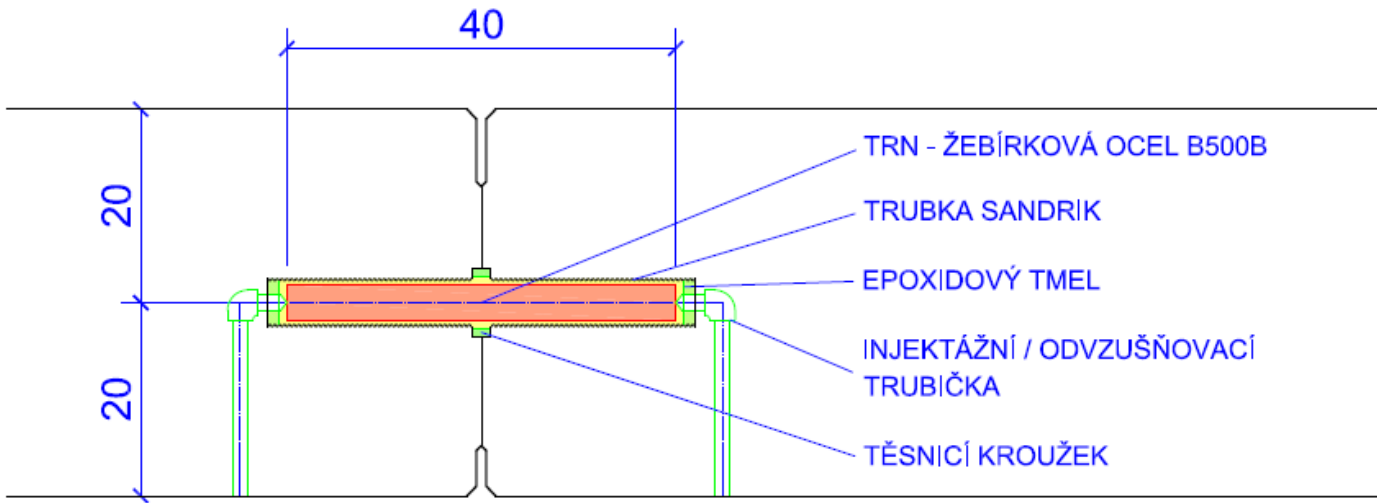
- Tunnel segments production



Tunnel Ejpovice



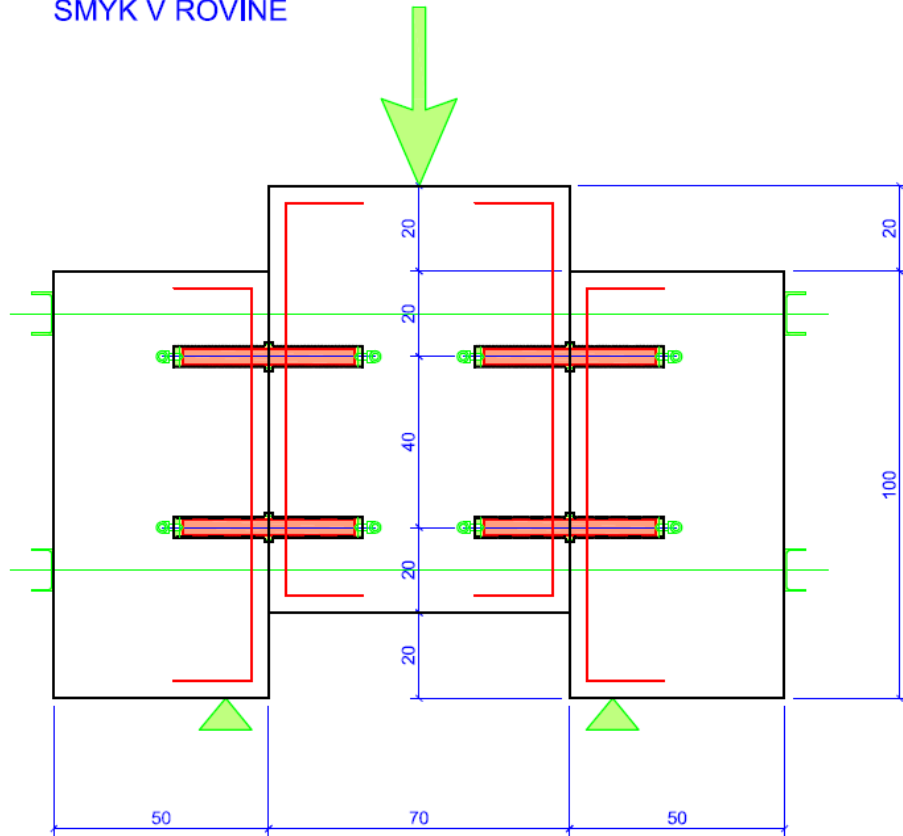
Tunnel Ejpovice – connecting galleries



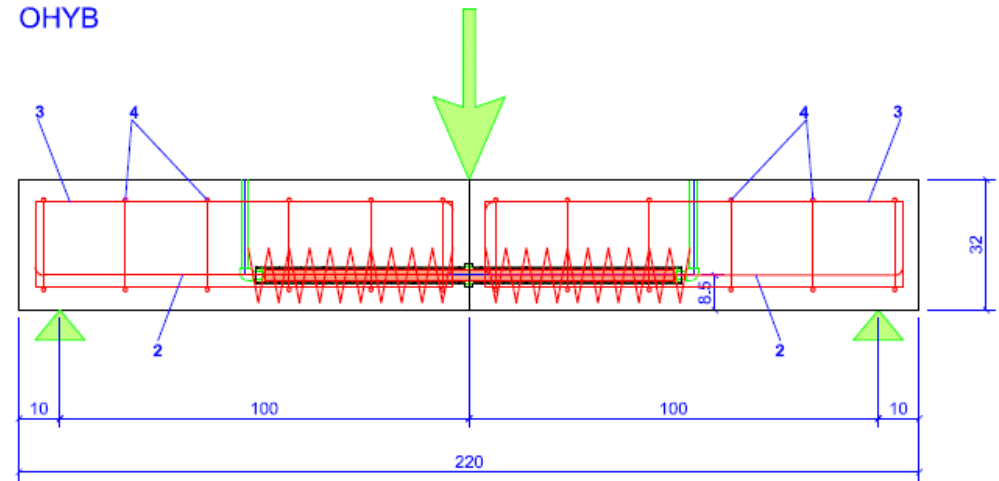
Tunnel Ejpovice

- Tunnel segments – testing of joints

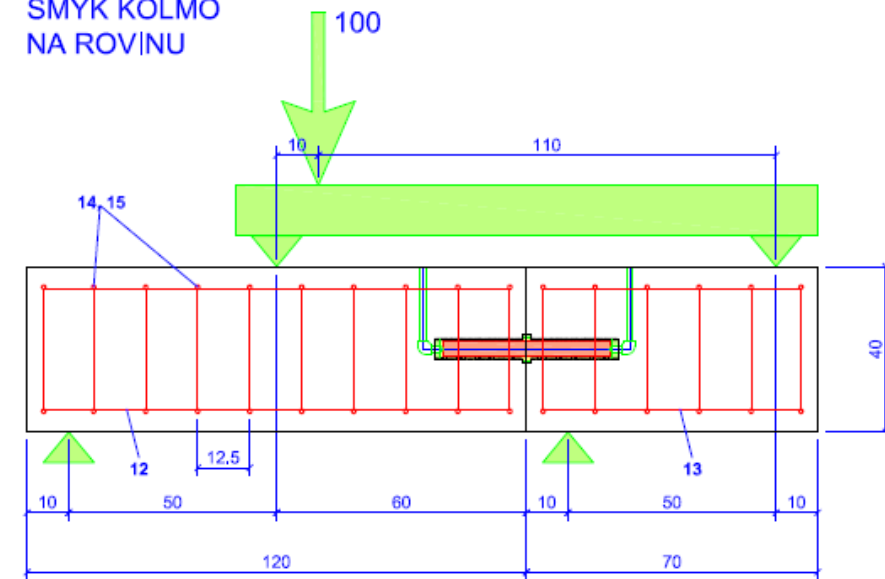
SMYK V ROVINĚ



OHYB



SMYK KOLMO NA ROVINU



Tunnel Ejpovice - Tunnel segments testing of joints



Tunnel Ejpovice – reinforcement of segments around the connecting gallery



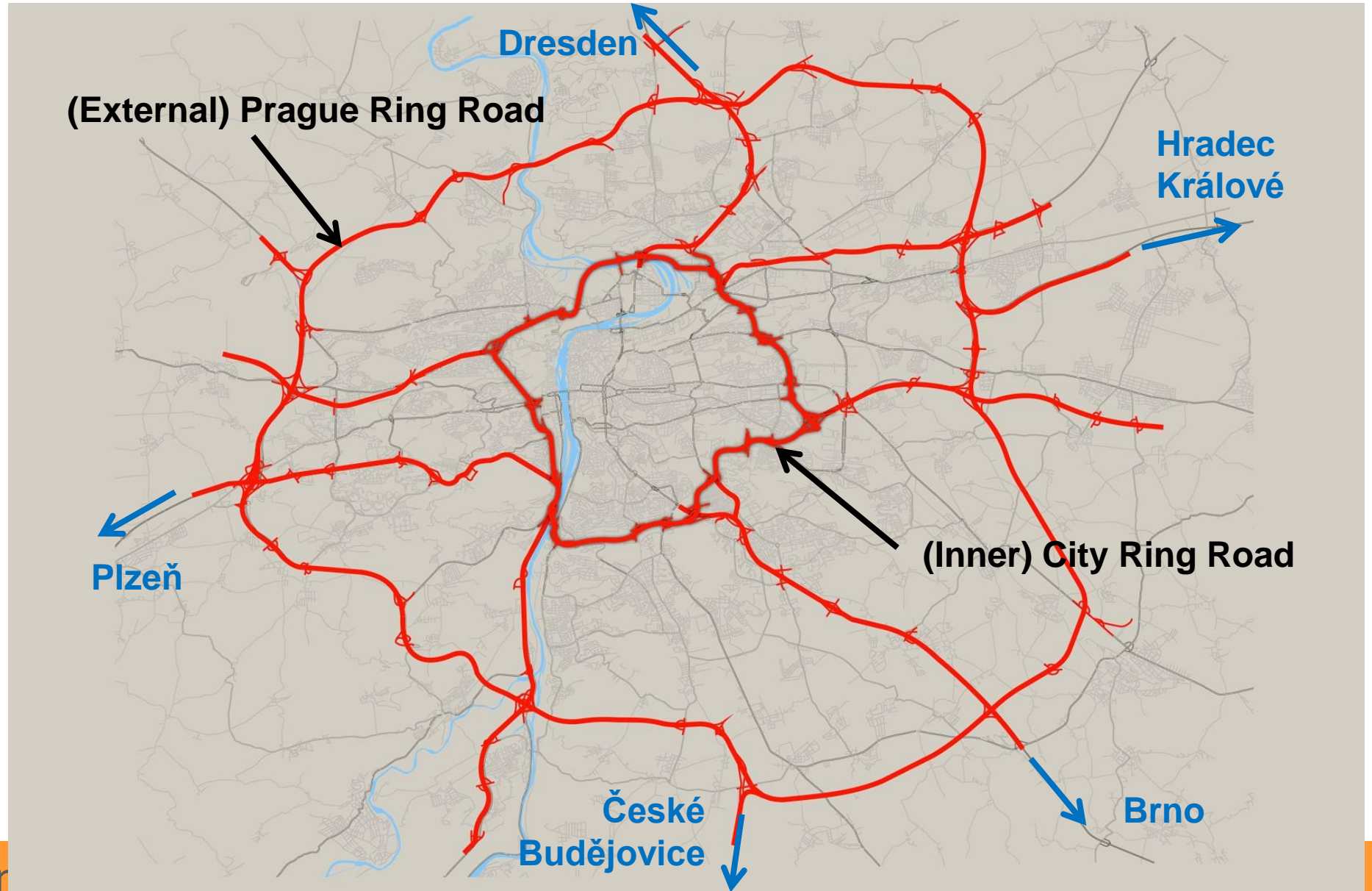
Tunnel Ejpovice – reinforcement of segments around the connecting gallery



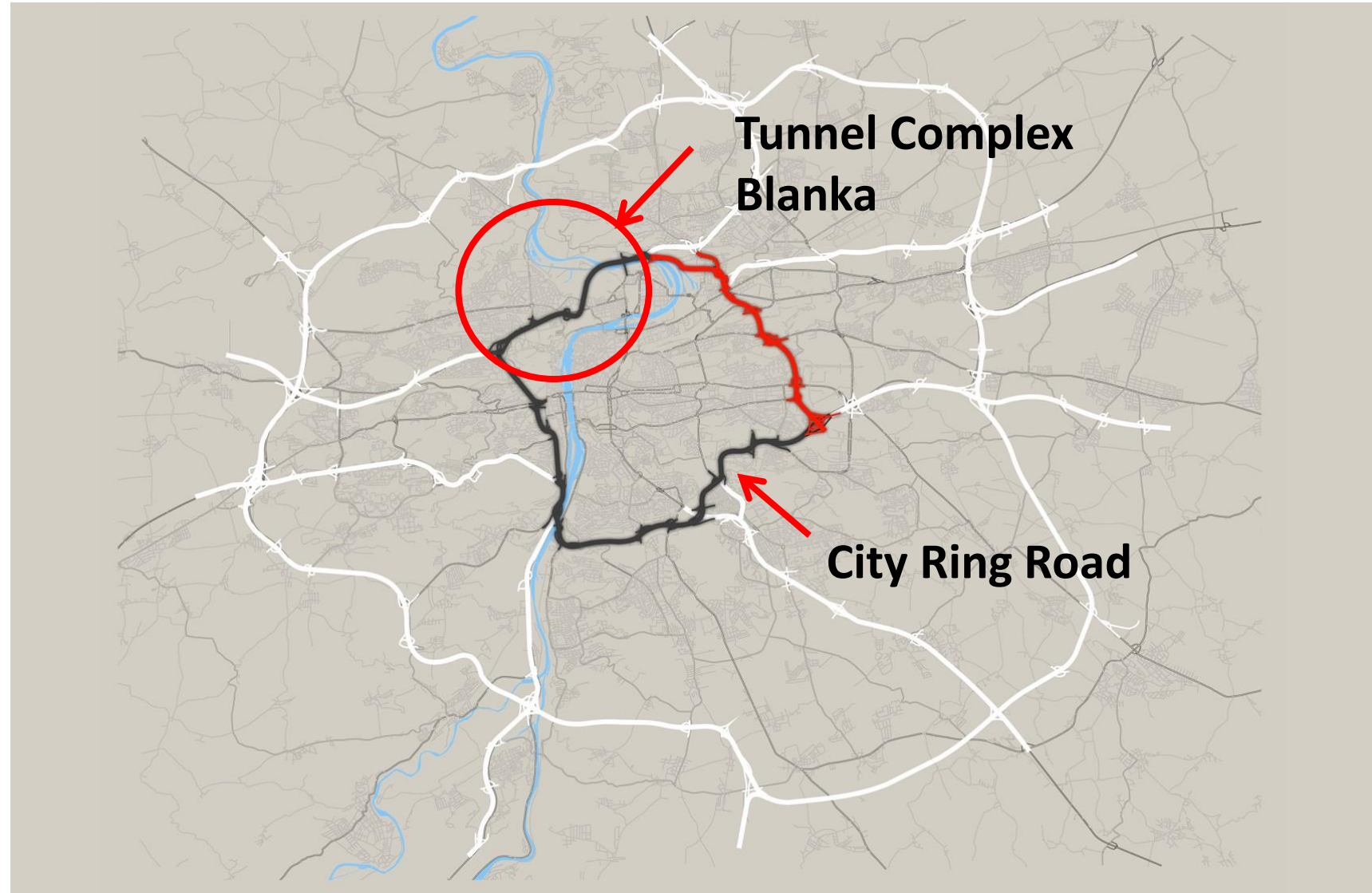
Tunnel Ejpvovice – breakthrough of the second tunnel



Road transportation system in Prague

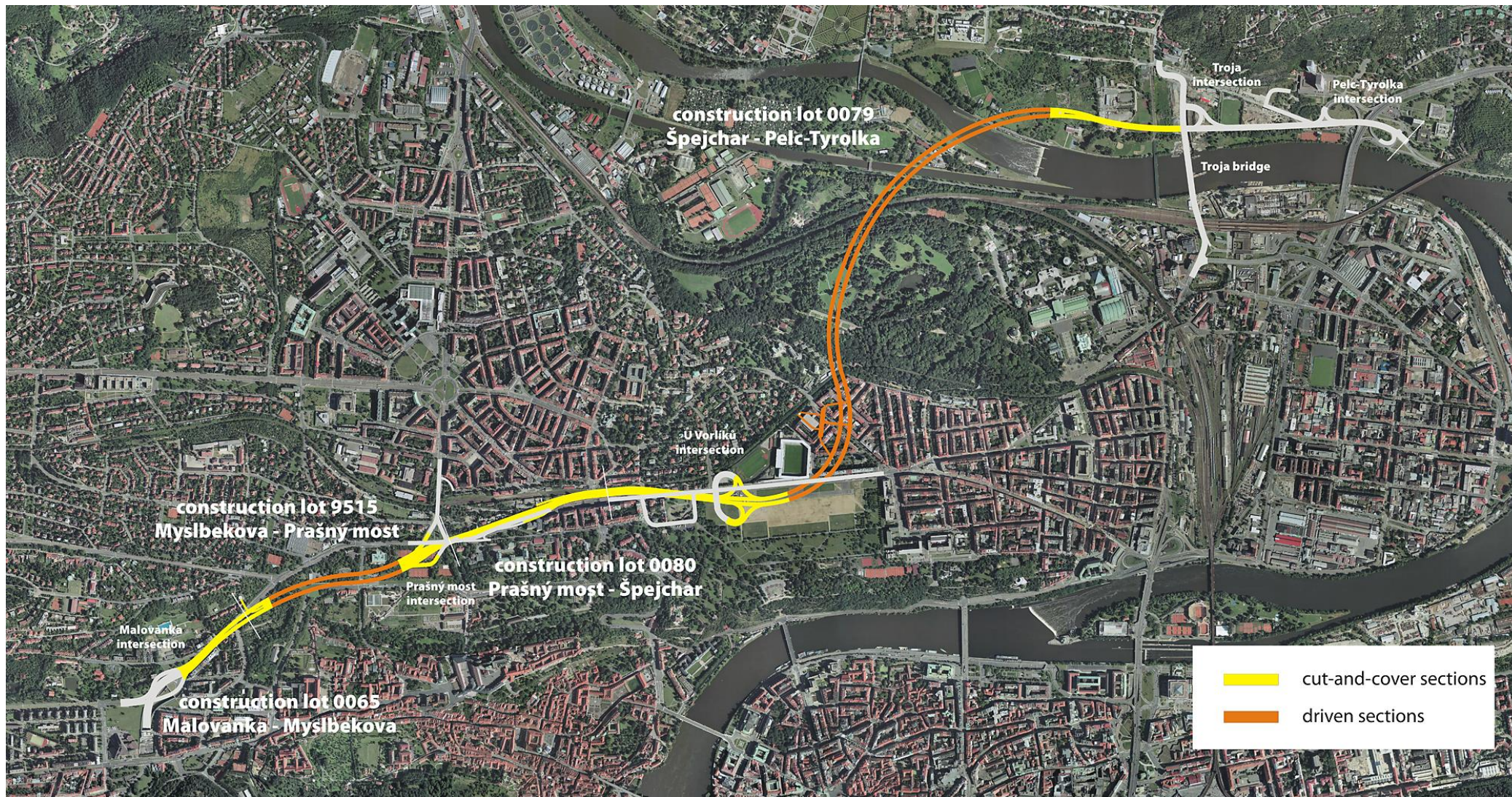


Road transportation system in Prague





Tunnel
Complex
Blanka



Tunnel Complex Blanka – Construction 2007 – 2015

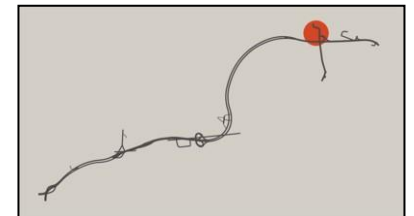
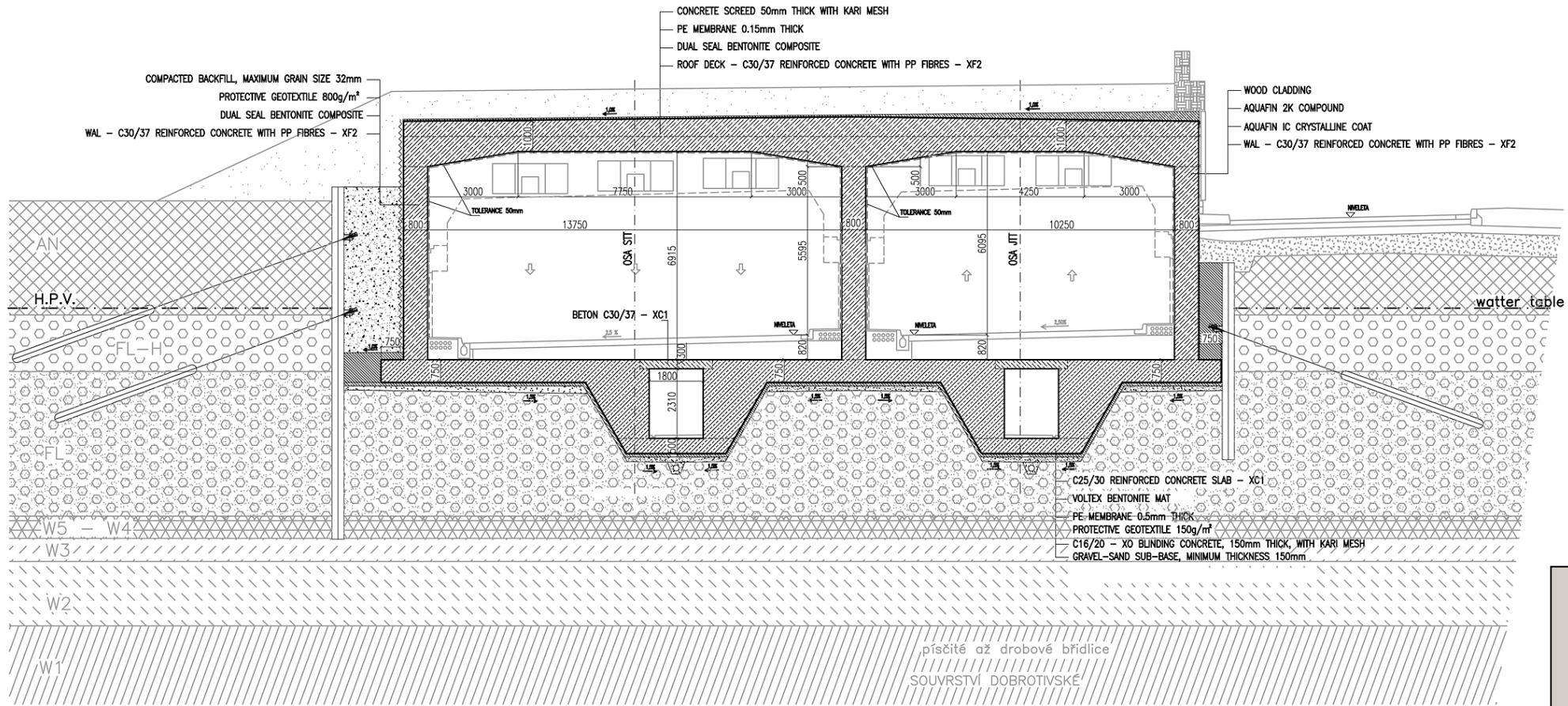
3 tunnels (2 lane and 3 lane)

Bubenečský	3 091 m
Dejvický	1 007 m
Brusnický	1 405 m
Total	5 503 m

The longest road tunnel in Czechia, the longest city tunnel in Europe

Cut and cover tunnels	1 334 m
Cover and cut tunnels (Top and down Method)	1 304 m

Tunnel Complex Blanka – Construction 2007 – 2015



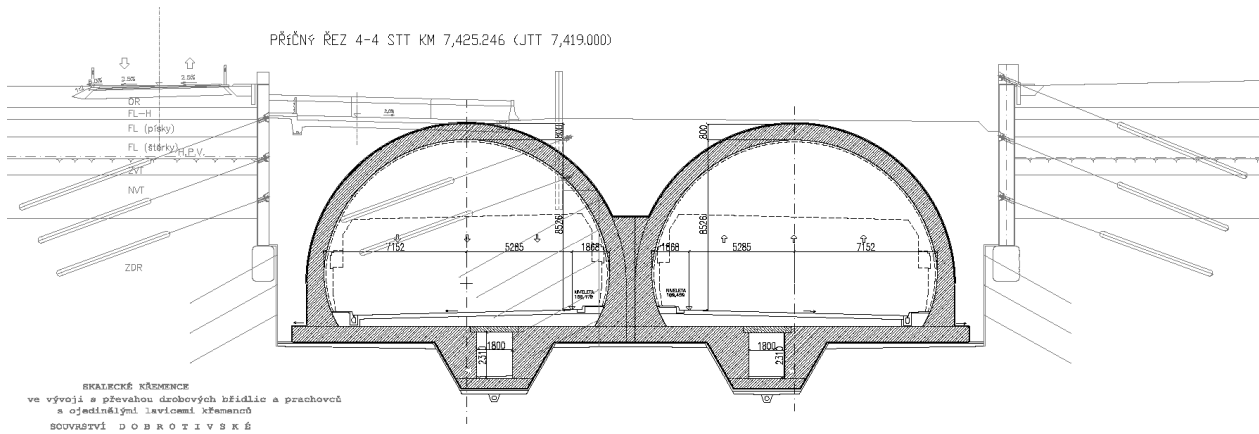
Tunnel Complex Blanka – Construction 2007 – 2015



Tunnel Complex Blanka – Construction 2007 – 2015



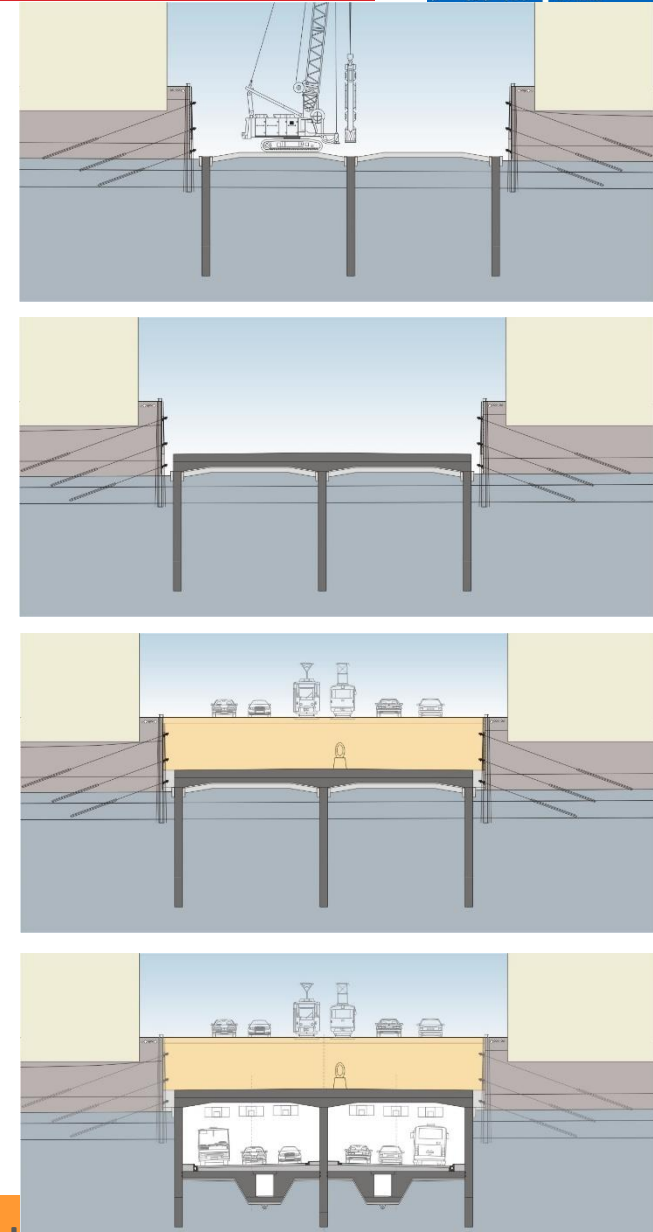
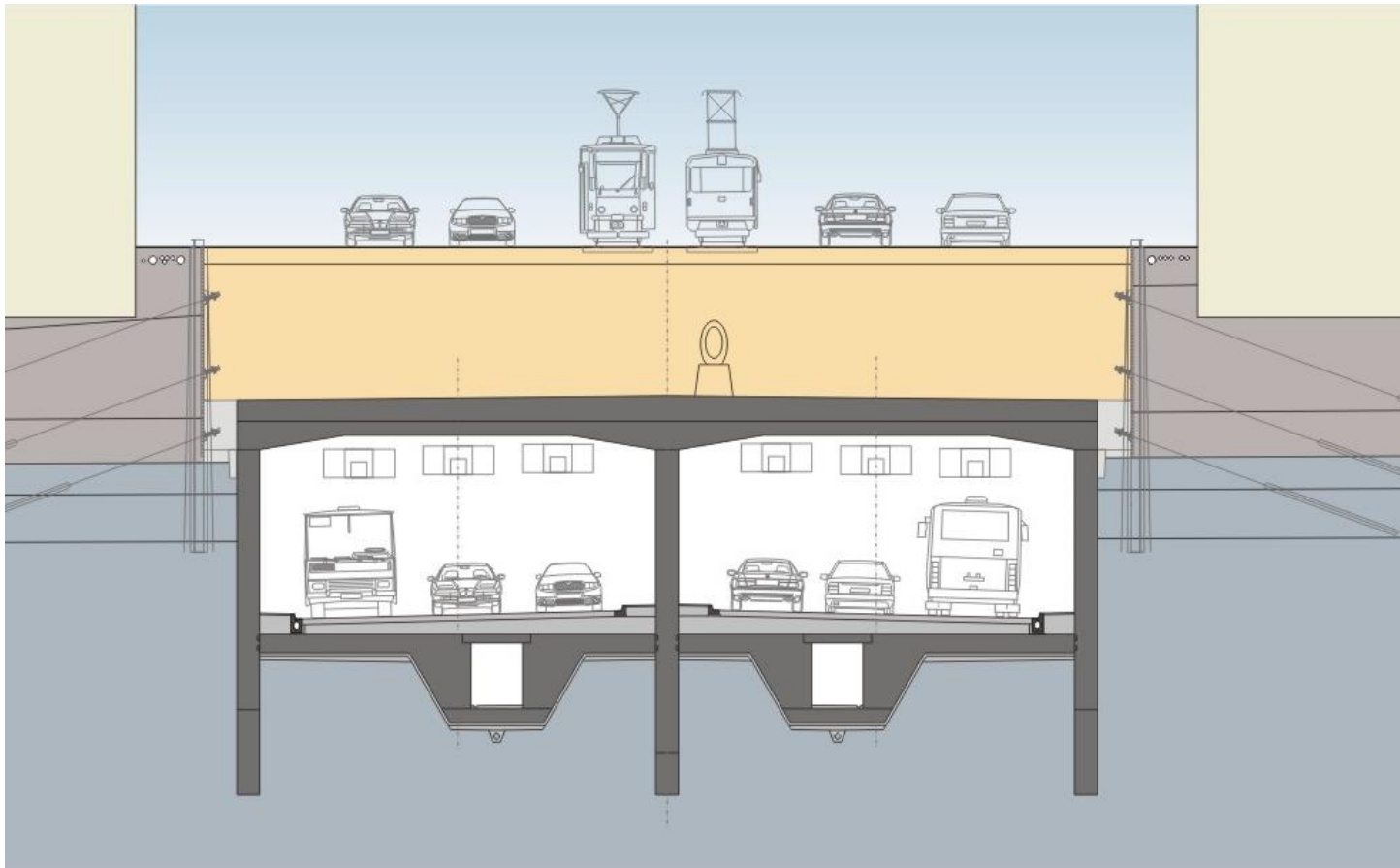
Tunnel Complex Blanka – Construction 2007 – 2015



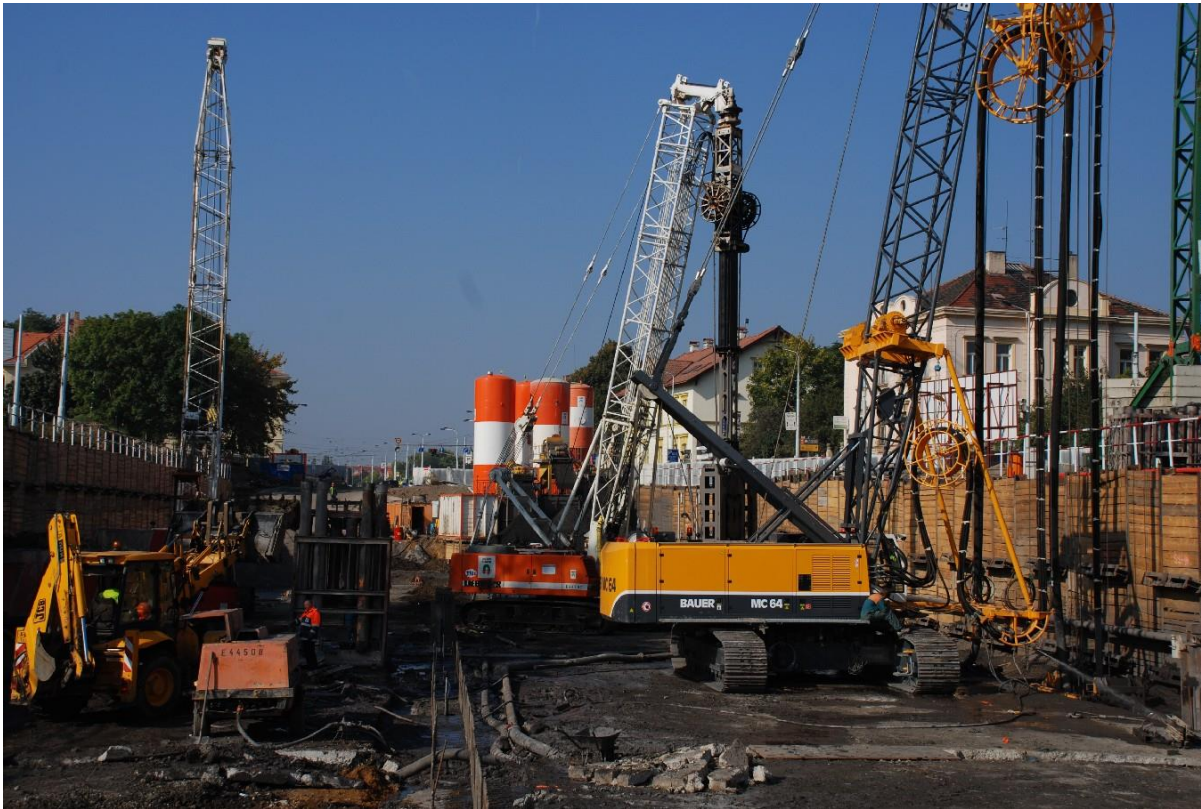
Tunnel Complex Blanka – Construction 2007 – 2015



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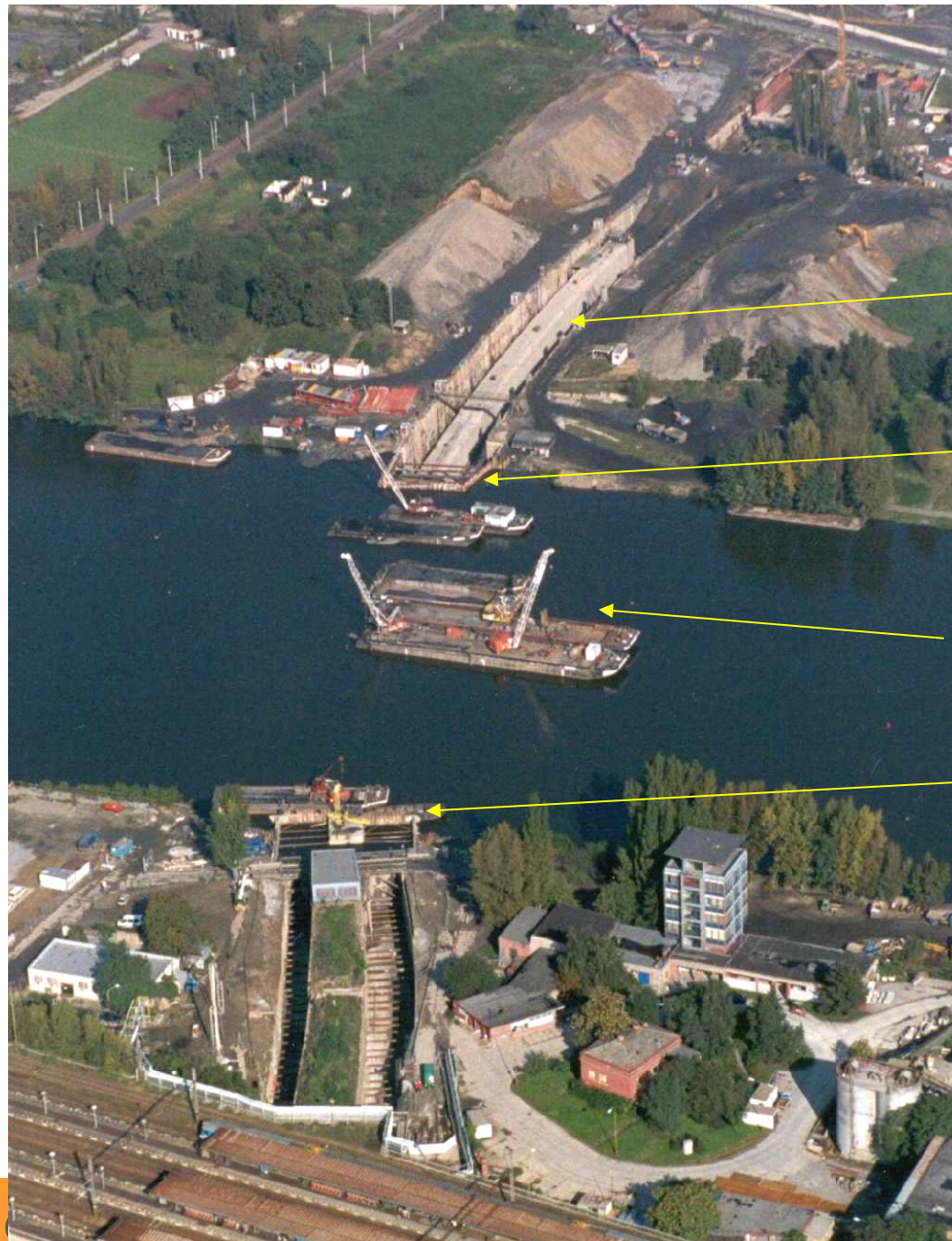


Metro Line C ext.
to the north
2000 - 2004



Launched
immersed tunnels

Metro Line C ext.
to the north
2000 - 2004



Troja

Dry dock and the
tunnel

Trója cofferdam

Excavation

Holešovice
cofferdam

Holešovice

Metro Line C ext. to the north 2000 - 2004

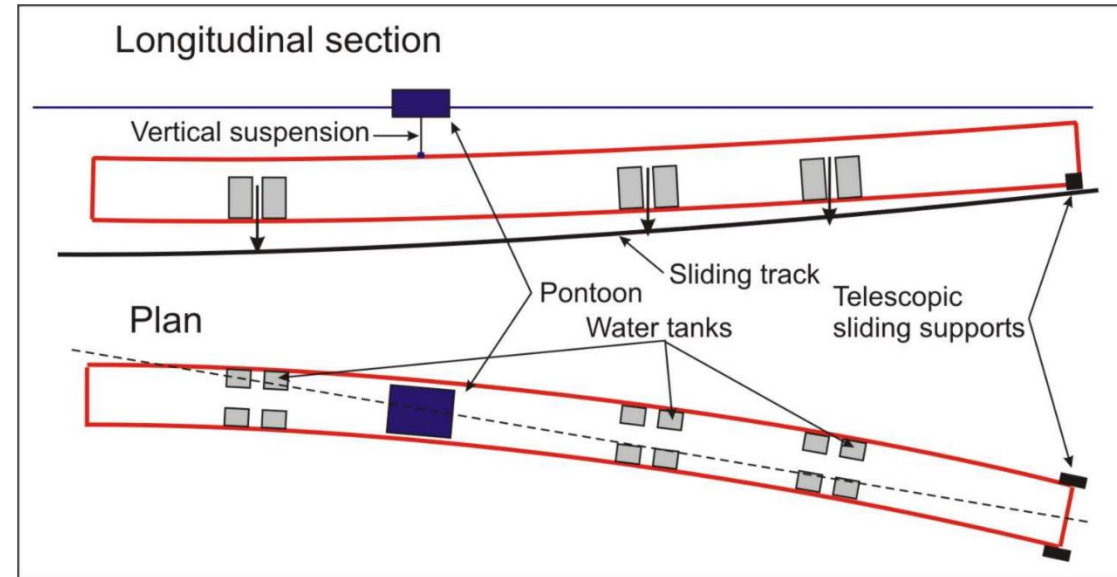


Metro Line C ext. to the north 2000 - 2004



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Direction of launching

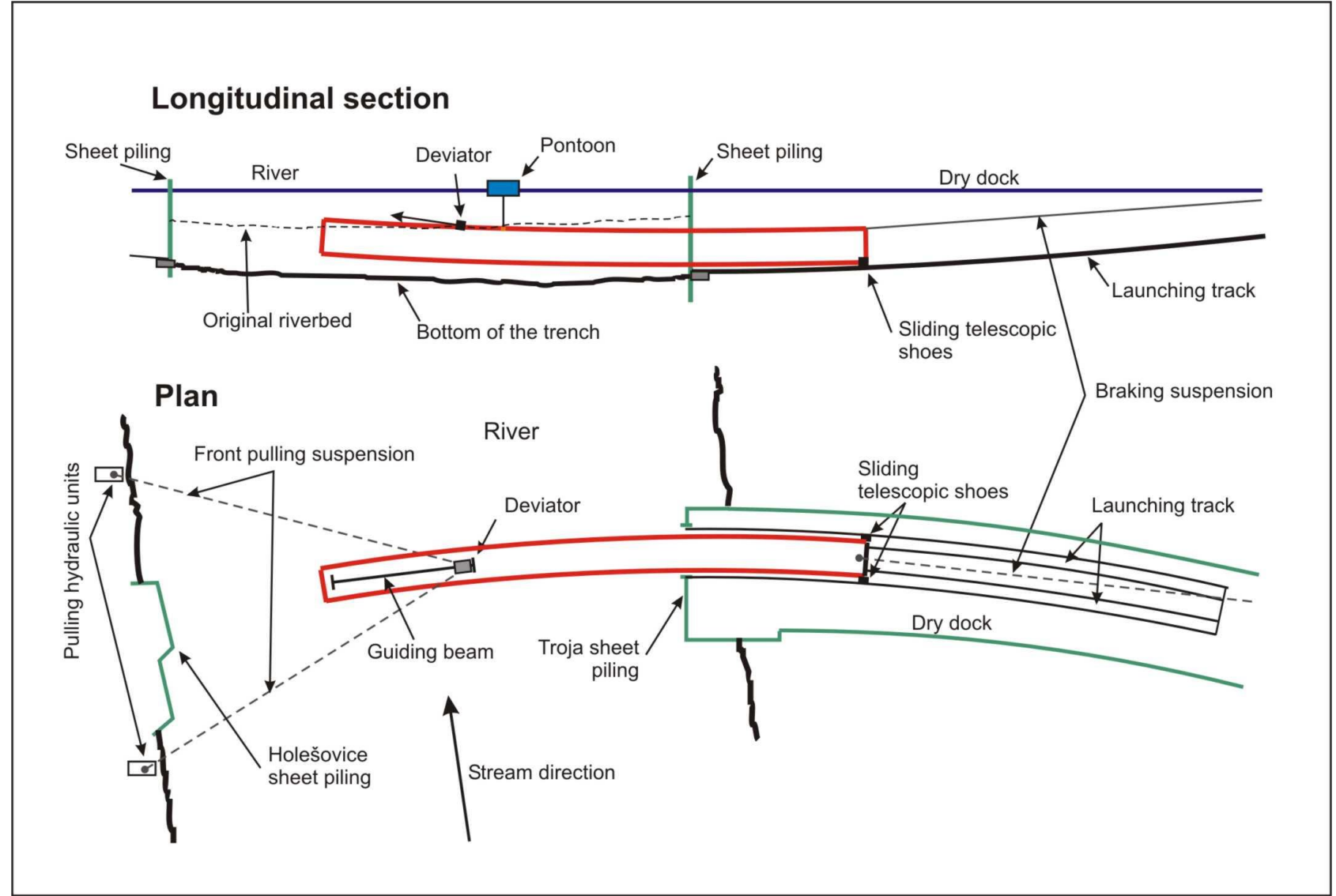


Weight = 6700 t = 100% Bouyancy = 99%

Weight in the water = 1% RT = 70t, LT = 57t

Metro Line C ext. to the north 2000 – 2004

Scheme of launching



Metro Line C ext. to the north 2000 – 2004



Metro Line C ext. to the north
2000 – 2004

1st tube launched Sept. 2001

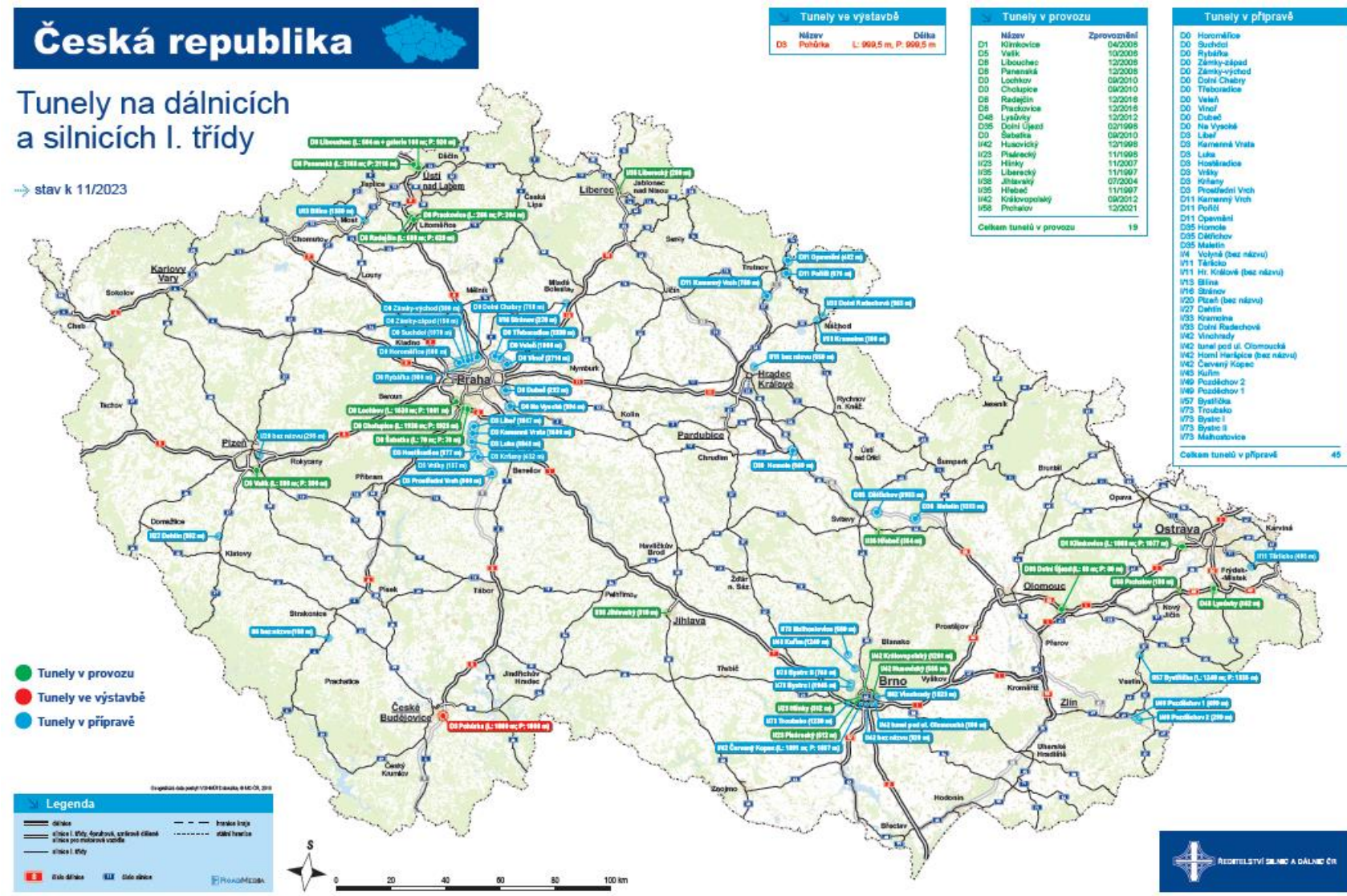
2nd tube launched July 2002

Metro in operation since 2004



Road tunnels
(Only motorways and I. class roads) 11/2023

Green: In operation 19
Red: Under construction 1
Blue: In preparation 45



Conclusions

- Czechia is a country with a limited number of tunnels
- Czech engineers try to do their best and follow the experience from abroad
- Different technologies are used
- Complex and variable geological conditions typical for Czechia require a thorough survey before the construction
- The development of infrastructure will require construction of many tunnels (Road and railway incl. high speed railways)

Thank you for your kind attention