WTC 2007
Prague – 6th May 2007

Shotcrete Activities in the Czech Republic

Dr. Matous Hilar
Czech WG12 leader
D2 Consult

Table of Contents:

1. NATM tunnelling in the Czech Republic

Completed NATM Road Tunnels

Tunnel	Total lenght of driven sections (m)	Profile (m2)	Overburden (m)	Deformations (mm)	Geology	Construct. period
Hřebeč	275	160	40	40	Rock	1995 - 1996
Valík	2 x 200	330	16	15	Rock	2004 - 2005
Panenská	2 x 2000	90	70	15	Rock	2003 - 2005
Libouchec	2 x 500	90	30	7	Rock	2005 - 2006
Klimkovice	2 x 850	115	20	20	Rock	2004 - 2006
Pisárecký	2 x 300	95	35	20	Rock	1995 - 1997
Mrázovka	2 x 1000	140 - 350	60		Rock	1999 - 2004
TOTAL	10 km	100 - 120 m^2	20 - 60 m	20 mm	Rock	

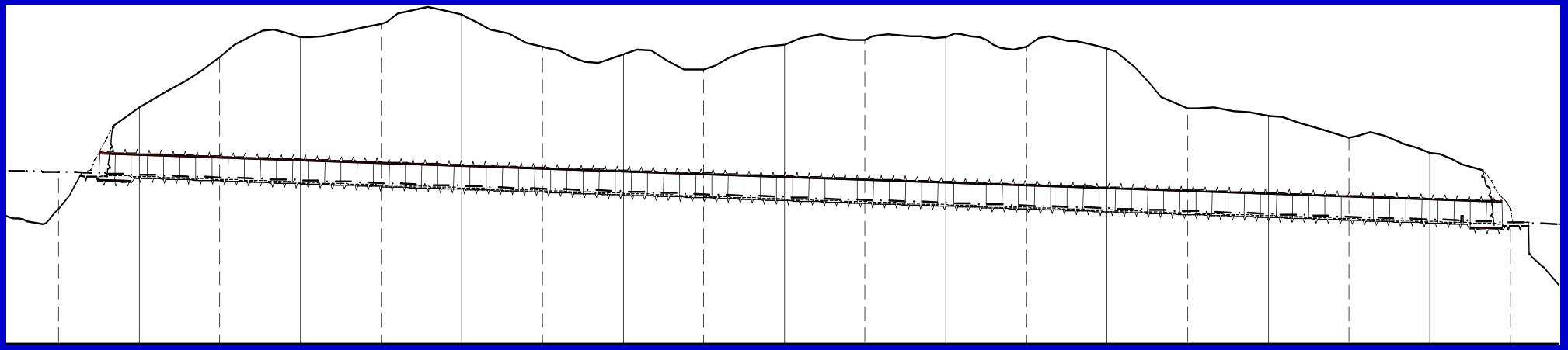
Czech NATM Highway Tunnels (recently completed)

Completed NATM Railway Tunnels

Tunnel	Total lenght of driven sections (m)	Profile (m2)	Overburden (m)	Deformations (mm)	Geology	Construct. period
Vepřek	272	112	30	20	Rock	2002 - 2003
Krasíkovský	1035	124	15	10	Rock	2002 - 2003
Tatenický	85	112	25	15	Rock	2002 - 2003
Malá Huba	300	117	20	15	Rock	2003 - 2004
Hněvkovský I.	130	117	15	15	Rock	2004 - 2005
Hněvkovský II.	432	104	15	15	Rock	2004 - 2005
Nové spojení	2 x 1200	100	50	15	Rock	2005 - 2006
Březno	1500	72	30		Soft ground	2002 - 2007
CELKEM	6 km	110 m2	20 – 50 m	15 mm	Rock	

Typical Czech NATM Tunnel

Tunnel overburden: 20 – 60 meters

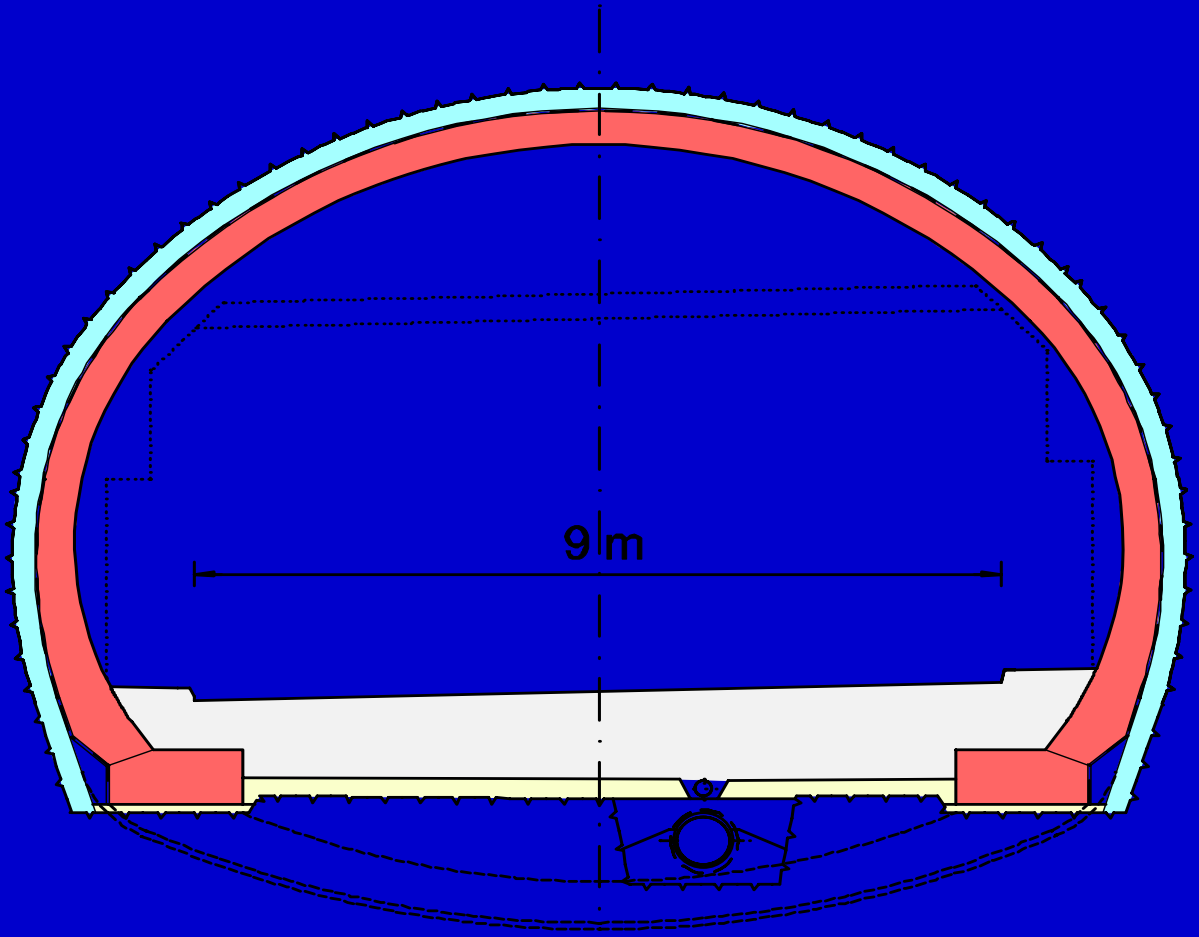


Tunnel lenght: 500 – 1500 m

Tunnel profile: 100 – 120 m²

Geology: Rock

Typical Czech NATM Road Tunnel
Two-lane twin tube



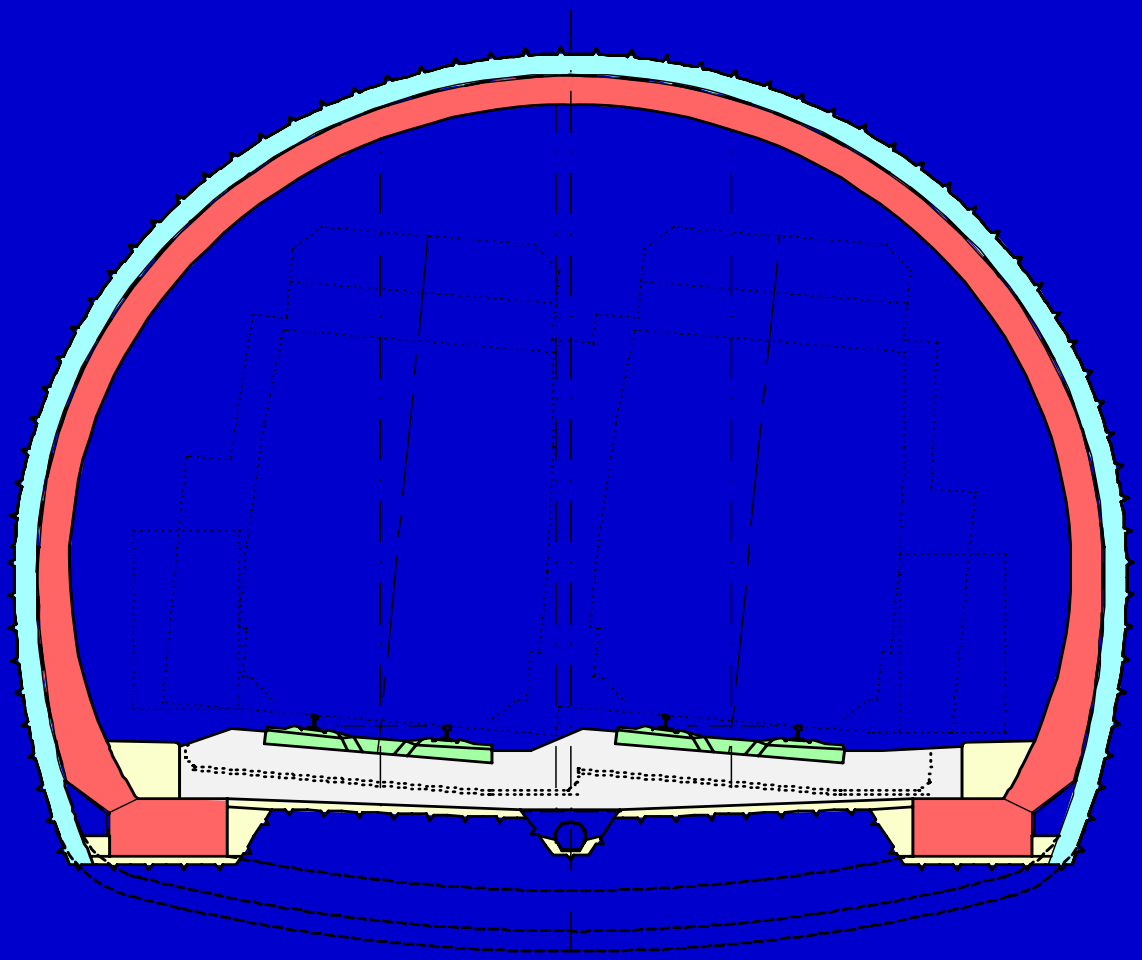
Czech NATM Road Tunnels

WTC 2007 – Czech WG12

D2 Consult

D2 CONSULT

Typical Czech NATM Railway Tunnel
Double track (single bore)



Czech NATM Railway Tunnels

WTC 2007 – Czech WG12

D2 Consult

D2 CONSULT

Planned Road Tunnels (2006 – 2015)

Tunnel	Total lenght of driven sections (m)	Profile (m2)	Overburden (m)	Geology	Construction period
SOKP 513	2 x 1900	110 - 160	50	Rock	2006 - 2008
SOKP 514	2 x 1650	110 - 160	50	Rock	2006 - 2008
SOKP 518	2 x 400	100	10	Rock	2008 - 2012
MO Myslbek	2 x 1000	160	15		2008 - 2015
MO Blanka	2 x 2500	110 - 160	40	Rock	2008 - 2015
MO Bílá skála	2 x 2000	110	50	Rock	2008 - 2015
MO other	2 x 2000	110	30	Rock	2008 - 2015
Radlická rad.	2 x 2000	110 - 160	70	Rock	2008 - 2015
Dobrovského	2 x 1000	125	25	Soft ground	2006 - 2009
D8 Radejčín	2 x 600	120	50	Rock	2010 - 2012
D8 Prackovice	2 x 300	120	50	Rock	2010 - 2012
D3	2 x 2000	100	50	Rock	2010 - 2015
R11	2 x 2000	?	100	Rock	2010 - 2015
TOTAL	**30 km**	**100 – 160 m2**	**20 – 60 m**	**Rock**	**2006 - 2015**

Planned Railway Tunnels (2008 – 2015)

Tunnel	Total lenght of driven sections (m)	Profile (m2)	Overburden (m)	Geology	Construction period
3rd railway corridor	Prague – Pilsner – Cheb - Germany				
Prague - Beroun	2 x 25000	do 110	180	Rock	2011 -2016
Homolka	2 x 4000	110 až 124	70	Rock	2008 -2013
Cheb	500	65	15	Soft ground	2008 -2013
4th railway corridor	Prague – Tábor – Czech Budwaiser - Austria				
Tomický	300	100	25	Rock	after 2010
Zahradnický	1000	100	50	Rock	after 2010
Olbramovický	500	100	20	Rock	after 2010
Votice	600	100	25	Rock	after 2010
Deboreč	600	100	50	Rock	after 2010
Mezno	800	100	20	Rock	after 2010
Sudoměřice	400	100	20	Rock	after 2010
Zvěrotice	372	100	6		
Sedlčany	300	100	5		
Janovský	876	100	11		
Hosín	1500	100	50	Various	after 2014
Nemanice	2300	100	60	Rock	after 2014
TOTAL	70 km	100 m2	20 - 60	Rock	after 2010

WTC 2007 – Czech WG12

D2 Consult

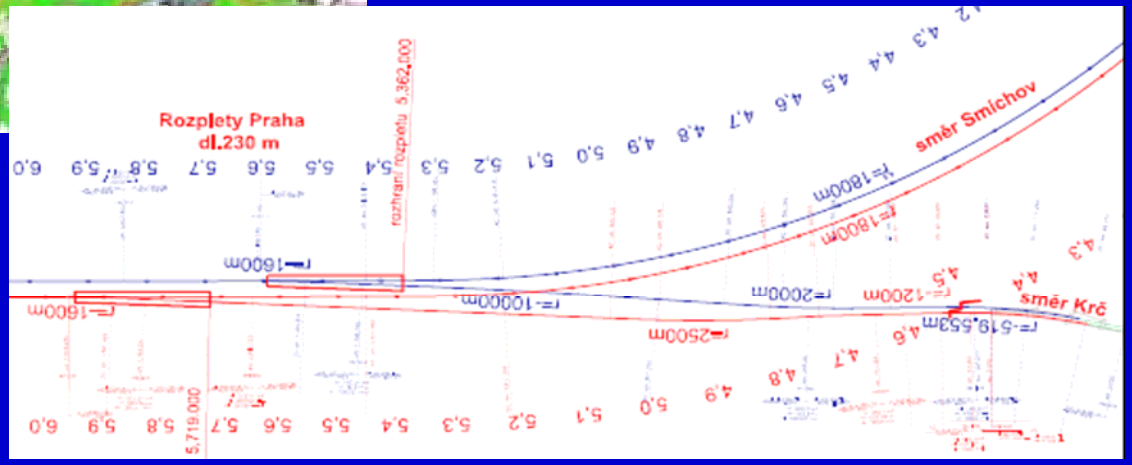
D2 CONSULT

Prague – Beroun
25km long high-speed railway tunnel

- Two tubes + XP
- Speed up to 300kph
- Majority TBM
- Partly NATM

  Expected construction:

  2011 - 2016



- Prague – bifurection

  (about 9km of NATM)

WTC 2007 – Czech WG12

D2 Consult

D2 CONSULT

NATM Tunnelling in the Czech Republic

+

NATM Technology (basic elements, design and construction)

Skills of labours (i.e. nozzlemen), quality of primary shotcrete lining

Geomonitoring (GTM)

Machinery optimalisation

Tunnel functionality, durability

-

Conservative design, resistance against new methods (permanent SCL, fibre reinforced SCL, etc.)

Excavation optimalisation (based on monitoring, geology, etc.)

Construction management – competencies, involvement of designer, risk management

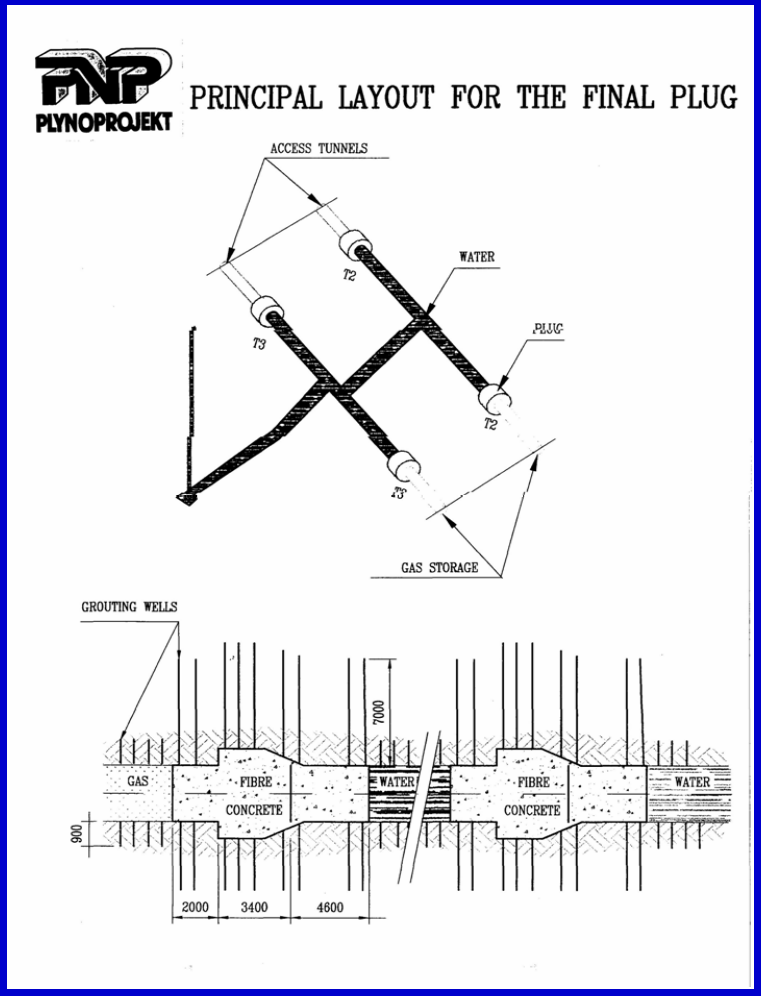
Construction cost

2. Shotcrete Trends in the Czech Republic

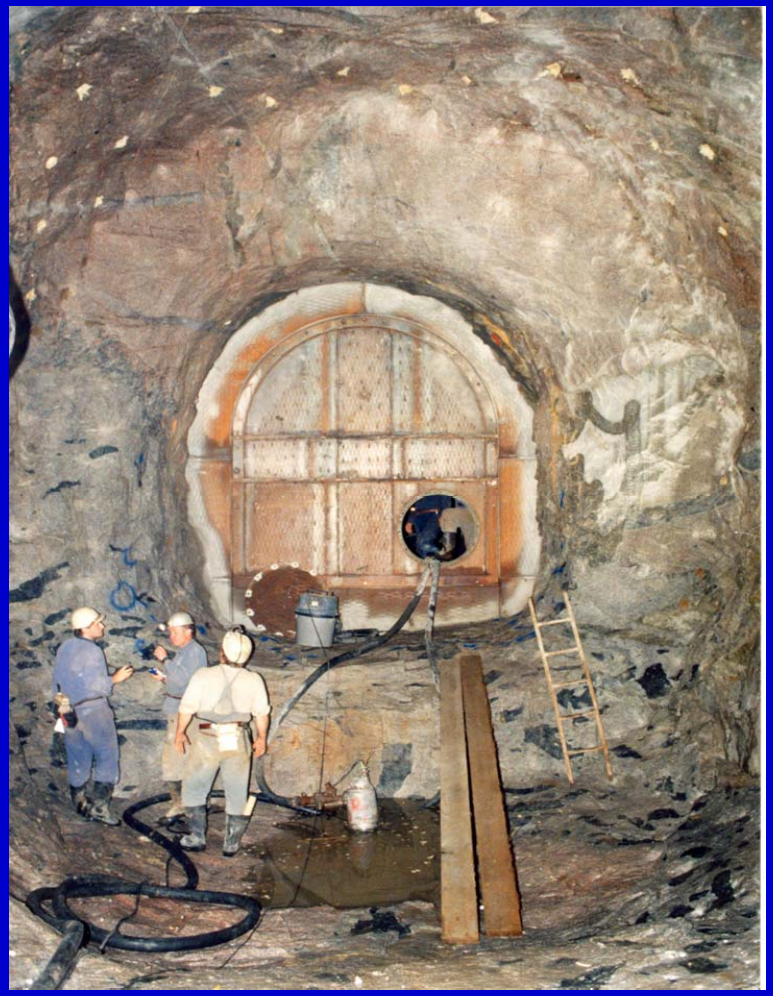
Steel Fibres Reinforced Shotcrete

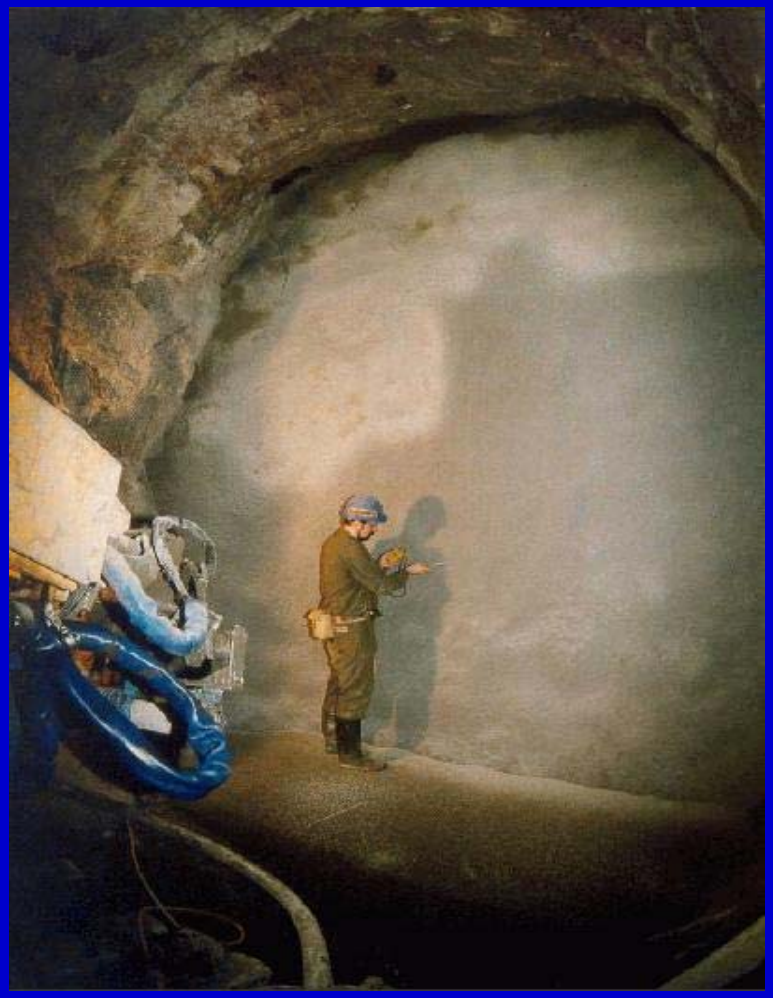
Plugs for underground gas reservoir Pribram

Number of plugs: 4
Length of one plug: 10 m
Total volume: 620,000 m3
Gas pressure: 2.0 – 9.5 (12.5) MPa
Gas capacity: 55 mil. m3 (82 mil. m3)
Overburden: 1000m
Fibre dosage: 90kg/m3
Shotcrete strenght: 40MPa
Completed: 1998
Required shotcrete watertightness was reached (pressure tests)



Plugs for underground gas reservoir Pribram

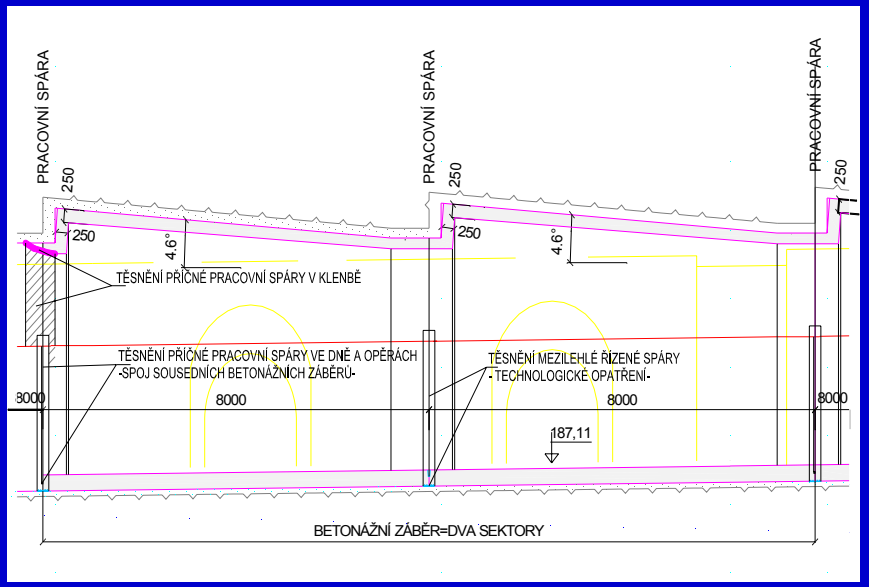


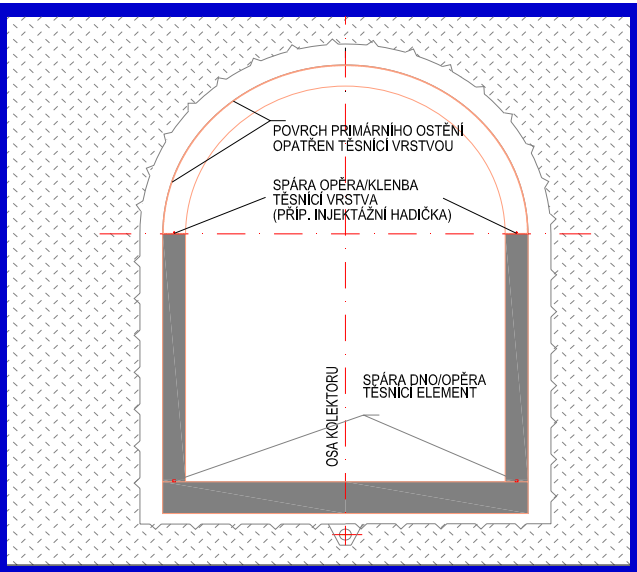


Permanent Sprayed Concrete Lining

Cable tunnels in Prague

- Geology: sands, gravels
- Support: grouted columns (grouted in advance from face)
- Varying tunnel profile
- Lenght of columns: 9,25m
- Primary lining: SCL
- No sheet membrane
- Secondary lining:
  - Invert: cast concrete
  - Vault: sprayed concrete





WTC 2007 – Czech WG12

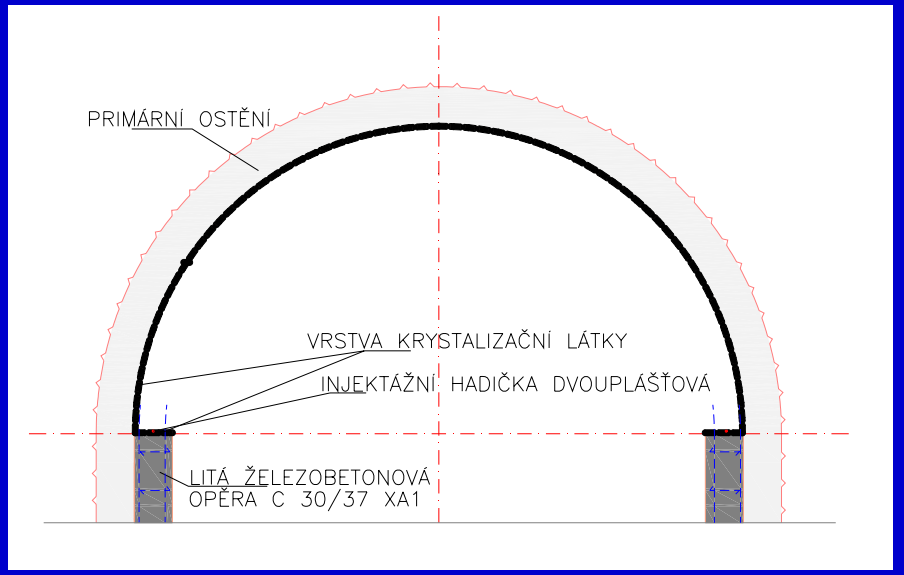
D2 Consult

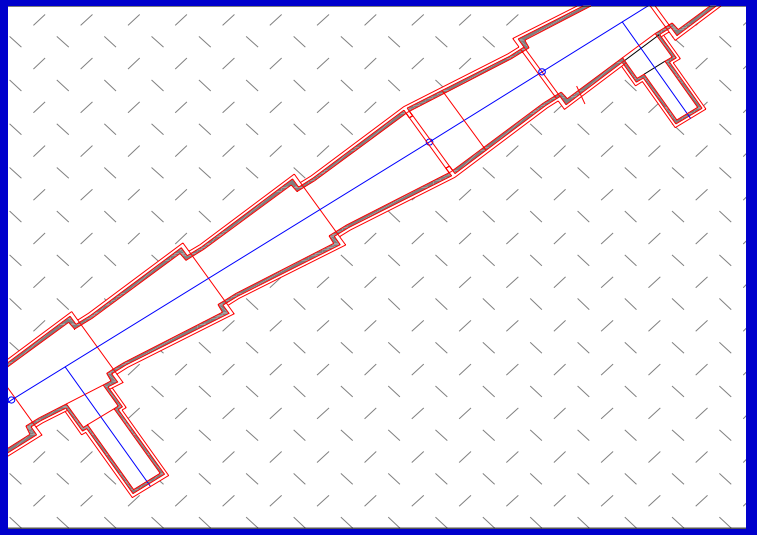
D2 CONSULT

Cable tunnels in Prague

Watertightness:

- Xypex layer (crystallic material)
- Shotcrete composition
- Hydrophilic gaskets



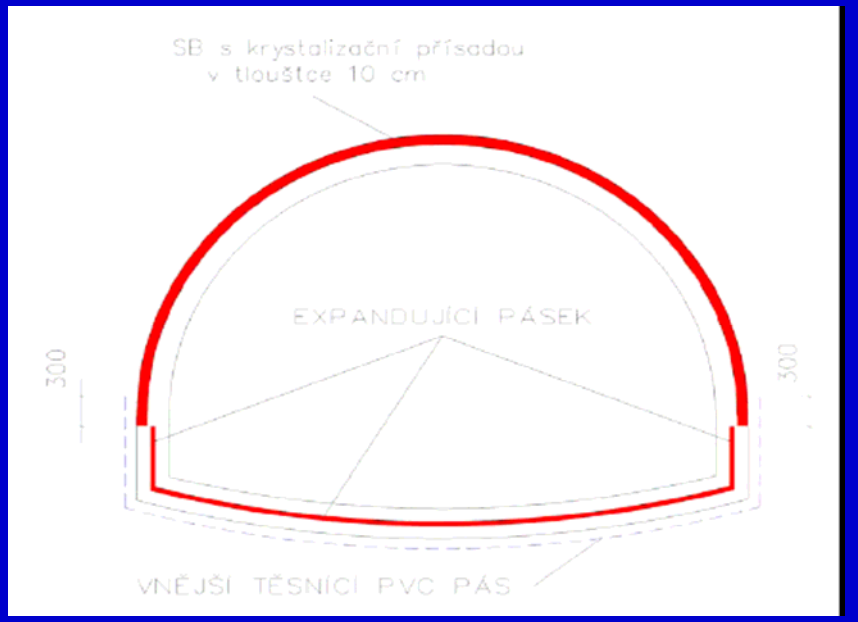


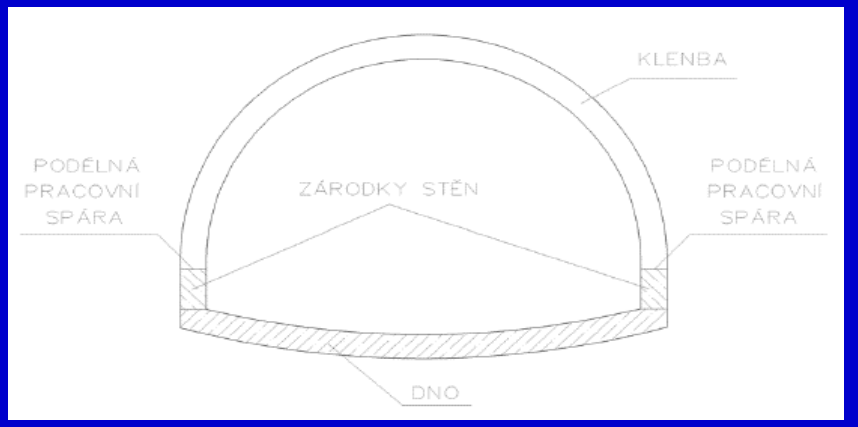
Permanent SCL – Motol adit

- Completed: 2007
- Primary lining: SCL
- No sheet membrane
- Secondary lining:
  - Invert: cast concrete
  - Vault: sprayed concrete

Watertightness:

- Xypex layer (crystallic material)
- Shotcrete composition
- Hydrophilic gaskets





Sprayed Membranes

Prague Metro

- Application: 2005 (first in CR)
- Reason: difficult geometry
- Structure: pumping station
- Material: Masterseal 345
- Sprayed area: 750 m2
- Consumption: 3000kg
- Good bond to sheet membrane
- Training of local contractors

- Problem: dust

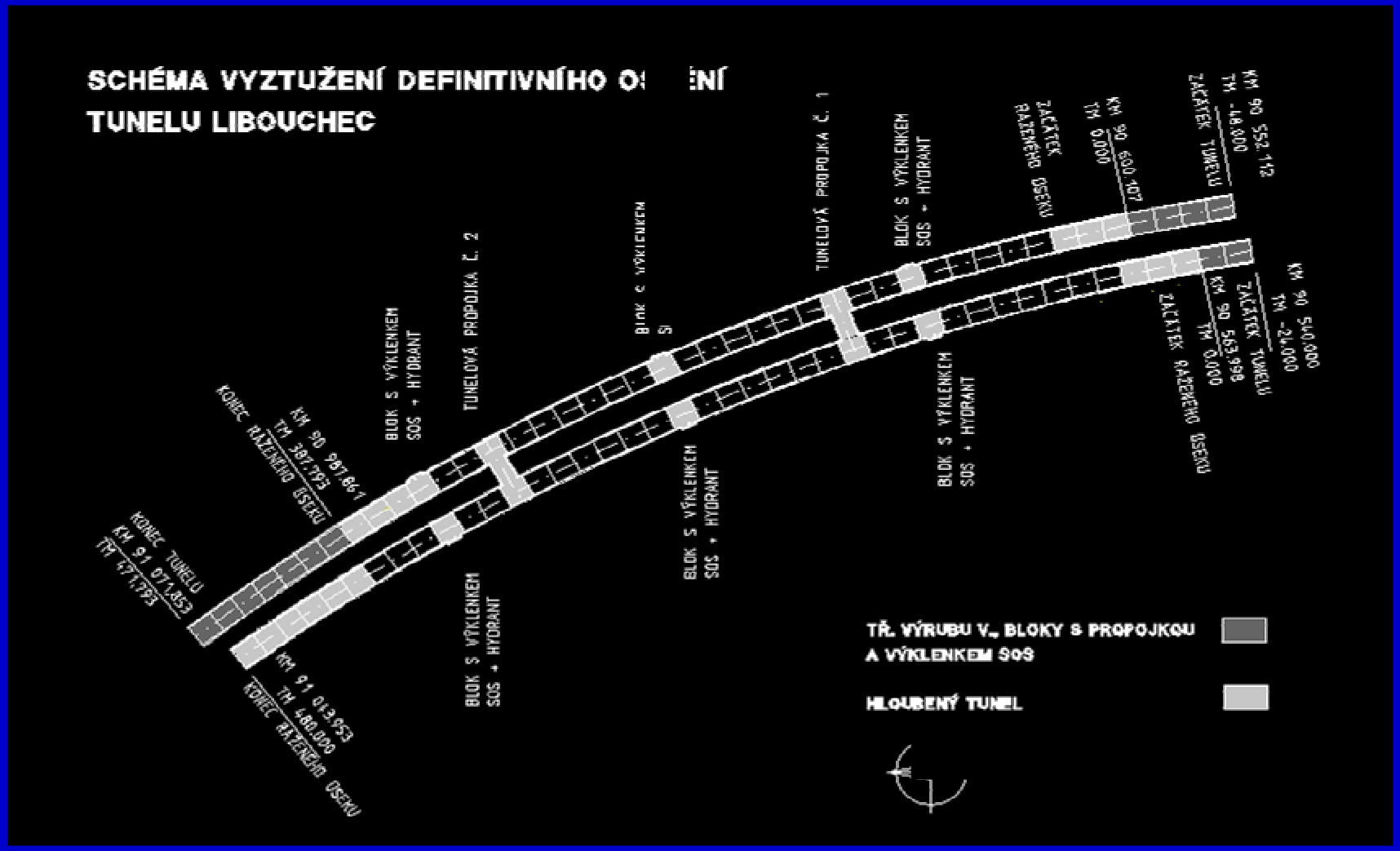
Prague Metro - Sprayed Membranes

Plain in-situ cast concrete for secondary lining

Libouchec Tunnel

- 2 x 2 lanes highway tunnel
- Length: 0.5km
- Secondary lining reinforced only in areas of portals and XP
- Allowed cracks: max. 0.8mm
- Calculation: Non-linear
- Steel weight reduction from original 700t to 150t
- Tunnel was opened in 2006

Libouchec secondary lining (reinforcement scheme)

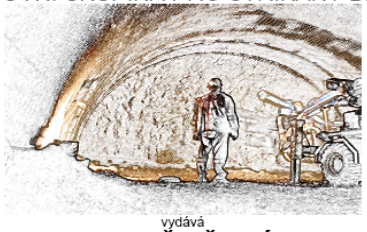


Certification of Shotcrete Nozzlemen

Documents for procedure

- Basic document about certification (reasons, examining board, management)
- Manual about SCL application (theoretical and practical information for labours)
- Forms for testing
- Certificates

PRACOVNÍ SKUPINA PRO STŘÍKANÝ BETON



vydává

OSVĚDČENÍ

profesní způsobilosti v oblasti: Aplikace stříkaného betonu pro definitivní konstrukce

č. 002-2007

Název činnosti:
NASTŘÍKÁVAČ

Příjmení, jméno: **Josef Kříž**

Datum narození: 18.2.1981

Toto Osvědčení vydává Pracovní skupina pro stříkaný beton podle pravidel vydaných k zavádění systému personální certifikace k ověření shody, že osoba splnila stanovená kriteria.
Profesní způsobilost byla posouzena v rámci 1. cyklu Certifikačního řízení konaného Na stavbě Vítkovského tunelu dne 7.6.2006:

Zkouškou z teoretických znalostí
Předvedením zkušebního nástřiku

viz Záznam O PRŮBĚHU CERTIFIKAČNÍHO ŘÍZENÍ PROFESE „NASTŘÍKÁVAČ" ze dne 13.11.2006

Na základě uvedeného se pracovní skupinou pro stříkaný beton potvrzuje způsobilost pro profesi „Nastříkávač" v kategorii stříkaných betonů používaných ke zhotovování konstrukcí s trvalou funkcí.

Osvědčení nabývá účinnosti dnem jeho vydání a platí po dobu 1. roku od nabytí účinnosti.

V Praze dne: 1.4.2007

Ing. Pavel Polák
vedoucí Pracovní skupiny pro stříkaný beton

Certificate

Programme of Certification

- Education
  - Sprayed concrete (composition, application, etc.)
  - Machinery (operation, maintainance, etc.)
- Practical tests (60%)
  - Tunnel lining spraying (top heading)
  - Test panels spraying
- Theoretical tests (40%)
- Evaluation (more than 70% required)

Certification of Nozzlemen

Conclusion:

1. **NATM tunnelling in the Czech Republic**
   - NATM – prevailing tunnelling method
   - Many ongoing and proposed NATM projects (highways, railways, utility tunnels, etc.)
   - Good experience with NATM
   - Czech sprayed concrete guidelines were published in 2003 (WG12)

2. **Shotcrete trends in the Czech Republic**
   - Conservative environment (resistance against new methods)
   - First applications of:
     - **permanent shotcrete lining**
     - **sprayed membranes**
     - **fibre reinforced shotcrete**
     - **plain secondary lining**
   - Shotcrete nozzlemen certification started in 2006 (WG12)


THANKS FOR
YOUR ATTENTION
MEYCO