Appendix 2.5 – CZECH REPUBLIC – Prague – Prague City ring – Mrázovka and Strahov

1. SUMMARY – MRÁZOVKA AND STRAHOV

This series of the tunnels is located on the Prague City ring (Czech Republic). The city of Prague has about 1.2 million inhabitants. The series of tunnels is on the western and northern part of the Prague City Ring and includes the underpass Zlíchov (ZAT), the Mrázovka (ATM) and Strahov (SAT) tunnels and the tunnel Complex Blanka (TKB) (**Figures 1 & 2**).

The tunnels on the Prague City Ring are owned by City of Prague and operated by the "Technical Road Authority" state founded institution of the City of Prague.

The SAT, ZAT and ATM tunnels were put into service in 1997, 2002and 2004 respectively. TKB will be opened in 2014.

All tunnels on the City Ring have two unidirectional tubes with two lanes in each. Exit and merging lanes enlarge two lane tunnels to three lanes over the required length. Exit and entrance ramps are one lane during normal operations and one and half or two lanes in the emergency situation.

Figure 1 – Prague City ring - situation

The total length of the western part of the City Ring from the South entrance portal of ATM to the exit North portal of the SAT tunnel is about 5 km. The length of ATM is 1.30 km; the length of SAT is 2.04 km.

ATM and SAT were designed according to Czech standards "Design of the road tunnels". However, the design does not comply with all requirements of the Czech Standard where there are entrance and exit ramps.

Two main construction methods have been used for the ATM and SAT:

- Drill & blast construction method: 1,040 m for ATM and 1,560 m for SAT,
- Cut & Cover construction method: 260 m for ATM and 476 m for SAT.

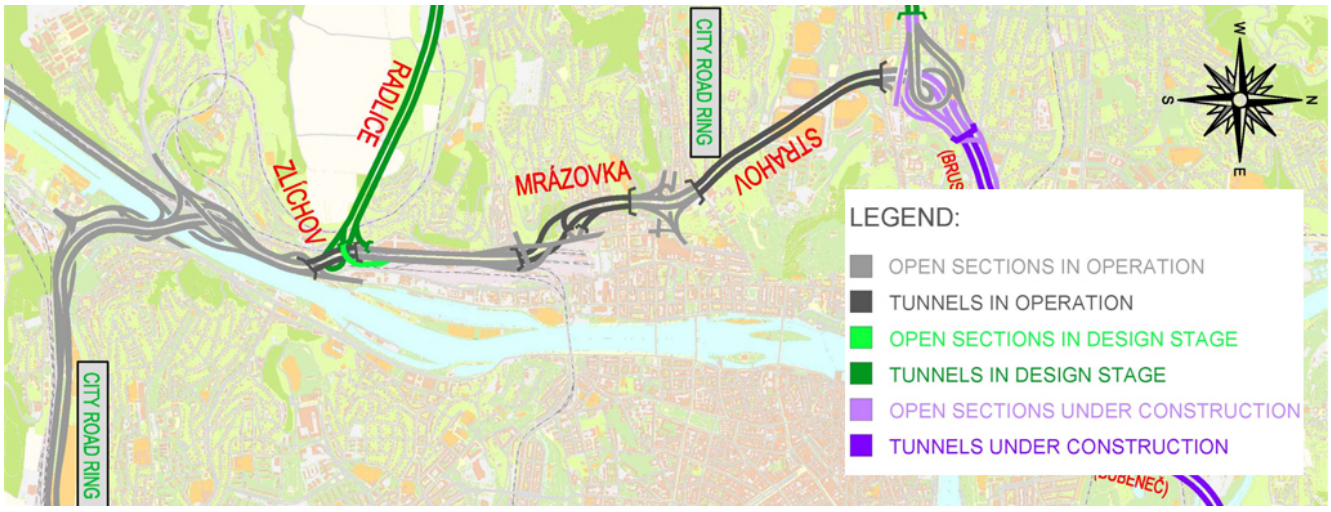

Figure 2 – situation of the Mrázovka and the Strahov tunnels

2. MAIN CHARACTERISTICS

2.1 GEOMETRY

2.1.1 Mrázovka tunnel (ATM)

- Tunnel length 1,300 m

- Horizontal alignment: minimum radius of the curve : 195 m
- Vertical alignment : maximum gradient of 4.5 % in tunnel and 6.0% for the ramps

2.1.2 Strahov (SAT)

- Tunnel length 2,042 m
- Horizontal alignment: straight
- Maximum gradient 4.6%

2.2 CROSS SECTION

2.2.1 ATM and SAT tunnels

- Lane width of 3.50 m (regardless of the number of lanes or type of construction),
- Vertical clearance 4.80 m,
- Sidewalk: 1.00 m width,
- HGV traffic is forbidden,

The cross sections are shown **figures n° 3 and 4**.

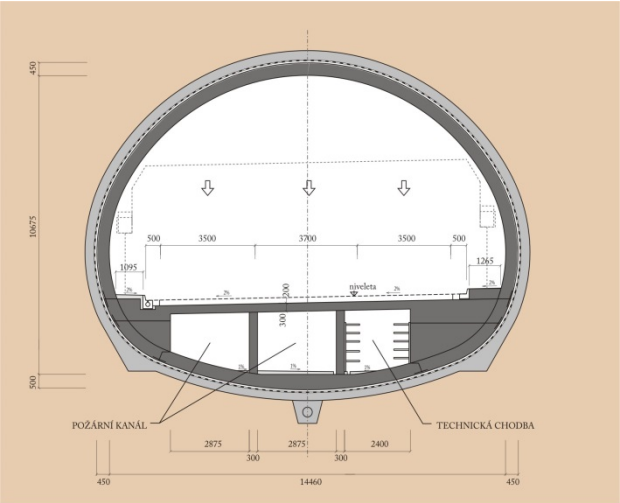

Figure 3 – ATM – cross section - drill & blast method

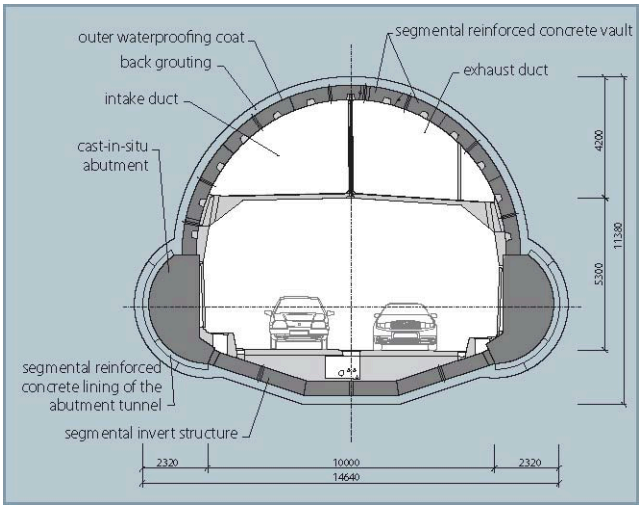

Figure 4 – SAT – cross section - drill & blast method

2.2.2 Escape route

ATM

- 5 cross passages between the two tubes, one of which is for firefighting vehicles, spacing max.250m
- Cross passages are closed by doors and are pressurised. Ventilation of escape routes is independent from the ventilation system for the traffic tunnel.

SAT

- 9 cross passages between the two tubes only for users, spacing max 200m
- Cross passages are closed by doors and are pressurised

2.3 TRAFFIC CONDITIONS – BREAKDOWNS AND ACCIDENTS

2.3.1 Traffic conditions

The AADT and HGV proportion of traffic for each tunnel is shown in the table below

- ZAT 77 400 veh. / day HGV 3%
- ATM 44 600 veh./day HGV 3%
- SAT 65 000 veh./day HGV 3%

The diurnal traffic variation is shown **Figure 5** below. The diagram represents an average working day for the Strahov tunnel (western and middle tunnel tubes) in the year 2008.

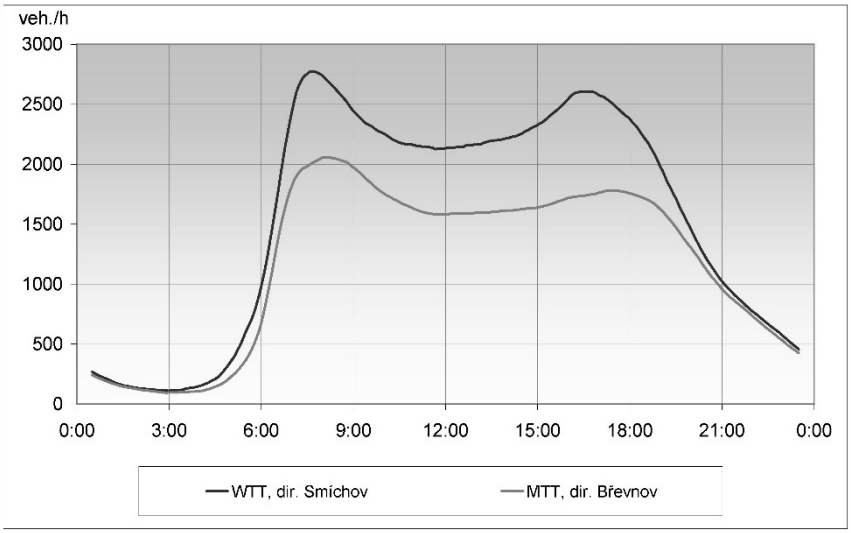

Figure 5 – hourly distribution of traffic volume

2.3.2 Breakdowns and accidents

The table below shows the average numbers of accidents, fatalities and injuries for the Mrázovka and Strahov tunnels for the years 2009 and 2010.

Accident rate 2009 - 2010	2009				2010			
	accidents	fatalities	severe injuries	minor injures	accidents	fatalities	severe injuries	minor injures
SAT	20	0	0	1	15	0	0	3
ATM	10	0	0	1	17	0	0	2

2.3.3 Road tunnels

- Speed limit 70 km/hour for the tunnels and 50 km/hour for the ramps,
- Prohibited for vehicles over 12 tonnes,
- According to the Technical regulation TP 98 "technological equipment of the road tunnels" it is required to control traffic in order to avoid congestion inside the tunnels.
- Traffic jams occur regularly in the morning between 7 and 10 on both ends of the "city ring tunnels series" due to the low capacity of the local network downstream of the city ring. The control system then automatically regulates, by traffic lights, the volume of traffic entering all the tunnels.

2.4 VENTILATION

The ventilation concept is shown in the table below.

tunnels	Length (km)	Type of ventilation systems in the main and secondary tubes	Normal ventilation strategy[1]	Emergency ventilation strategy for the main tubes[2]
Mrázovka (ATM)	1200 m	Longitudinal with extraction	Natural with transfer of polluted air to the other tube (for NO2); entrance ramps pressurised	Phase 1: air velocity >= 2 m/s Phase 2: air velocity > critical velocity Transverse extraction at 115m^3/s over 400 m
Strahov (SAT)	2042 m	Transverse	Natural ventilation and transverse extraction	Transverse extraction at 220 m^3/s over 2000 m

[1] No specific pollution and environmental control (like filtration, etc.)
[2] Note that ventilation of escapes routes is independent of tunnel ventilation

2.5 ENVIRONMENTAL ISSUES

2.5.1 Noise

Jet fans are equipped with noise attenuators. Passive noise reduction systems are installed inside the ventilation plant rooms.

2.5.2 Water quality

Water is not cleaned before discharge from the tunnels. In case of an accident with the spillage of dangerous substances, the operator is required to close the connection with sewerage system. Polluted water is removed to a water tank.

2.6 FACILITIES AND OPERATING EQUIPMENT

The tunnels are equipped with all the usual operation and safety equipment. Particular attention has been paid to communication with tunnel users, traffic management provisions and the safety and environmental conditions: monitors, CCTV, AID (automatic incident detection), loops, heat detection cables etc.

2.7 OPERATION

One organization (TSK) operates TCB and all the city tunnels.

There are two operation centres in Prague:

- The Technological centre operated by TSK. This centre operates, manages and supervises the equipment of all the tunnels,
- The Traffic centre operated by the Police of the Czech Republic. This centre manages all the road traffic of the city.

Communication between the two control rooms is by telephone. The two control rooms receive information from all monitoring and control systems and, in the case of the detection of an incident, they inform each other immediately.

In case of fire, emergency services and fire brigade teams are at the two portals in less than 10 minutes.

3. PICTURES (FIGURES N° 6 & 7)

Figure 6 – Southern portals of Strahov tunnel and the bridge leading to Mrázovka tunnel

Figure 7 – South-western portals of Mrázovka tunnel on the Radlická Street