Preliminary Ventilation and Cooling during the Construction of the Brenner Base Tunnel

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Content

1. Introduction Brenner Base Tunnel
2. Design objectives preliminary ventilation / cooling
3. Base data
4. Methodology ventilation / cooling design
5. Concepts preliminary ventilation / cooling
6. Specification / performance data
7. Conclusions
1. Introduction Brenner Base Tunnel

Brenner Base Tunnel:

- key element of European high performance railway network
- amongst world’s longest traffic tunnels (64 km)
- construction (5 main construction lots) underway
- increased rock temperatures expected
2. Design objectives ventilation / cooling

**General objectives:**

- provision of decent tunnel climate during normal operation
- support of rescue and intervention in case of emergency
- smallest possible restriction of construction progress
- high flexibility regarding changes of construction
3. Base data

Essential base data of ventilation / cooling design:

- construction schedule (interaction of activities)
- construction method (TBM, drill & blast)
- logistics (transport properties, mucking)
4. Methodology ventilation / cooling design

**Thresholds**
OCCUPATIONAL MEDICINE
(fresh air requirements, max. temperatures, etc.)

**Definition**
REQUIRED FRESH AIR AMOUNT AT WORK SITES

**Concept**
PRELIMINARY TUNNEL LOGISTICS
(construction schedule, required staff/machinery, available space, etc.)

**Pre-Settings**
TUNNEL LOGISTICS

**Specification**
PRELIMINARY VENTILATION SYSTEM

**Concept**
PRELIMINARY COOLING

**Specification**
PRELIMINARY COOLING SYSTEM

**Definition**
REQUIRED COOLING POWER AT WORK SITES

**Definition**
REQUIRED FRESH AIR AMOUNT AT WORK SITES
5. Concepts preliminary ventilation

General characteristics:

- individual concept for each construction phase
- focus on peak construction performance
- every portal used for air supply / removal.
- fresh air requirements achieved
- no substantial obstruction of tunnel construction
5. Concepts preliminary cooling

Main principles:

- local heat removal with air cooling machines at work sites
- heat transport via cooling water in pipes
- heat disposal to the ambient with cooling towers
- low impact on the ambient
- flexible / nearly fail safe operation
6. Specification / performance data

Preliminary ventilation:

- specification of fans and air ducts based on concept and calculations
- outline: 56 main fans, 16 auxiliary fans, 200 km air duct, 172 air barriers, 8 air locks
- performance: total power demand 25 MW, fresh air supply 2'100 m$^3$/s
- to be verified in execution
6. Specification / performance data

Preliminary cooling:

- specification of air cooling machines, pipes, water pumps and cooling towers based on tunnel climate simulations (BAUKLIMA)
- outline: 6 cooling towers, 94 pumps, 300 km pipe, 228 air cooling machines
- performance: demand 50 MW, cooling 70 MW
- to be verified in execution
7. Conclusions

- Intense tunnelling requires a great deal of fresh air challenged by limited accessibility.
- Concepts only call for minor additional excavation (no additional shafts and tunnels).
- Diligent analysis of construction phases ensures uninterrupted ventilation/cooling.
- Ventilation/cooling design are mainly based on occupational medicine and tunnel logistics.
- In order to specify and verify preliminary ventilation/cooling adequate simulation tools must be used (e.g. the code BAUKLIMA) particularly considering interaction of ventilation and cooling.
- A module based design of ventilation and cooling rather allows for changes in construction schedule (e.g. can be adapted easier) than a fixed or centralised solution.
- Changes of tunnel logistics relating to preliminary ventilation and cooling must be continuously checked.
Thank you for your attention!