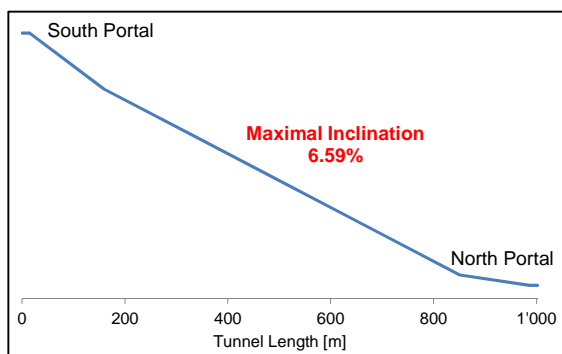
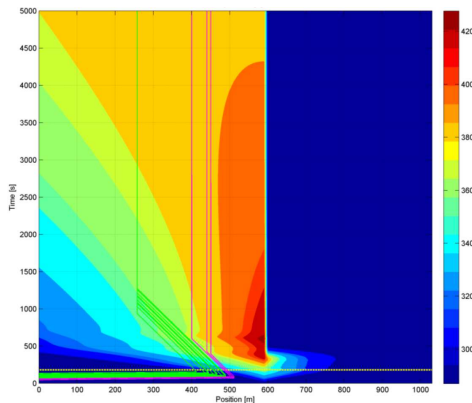




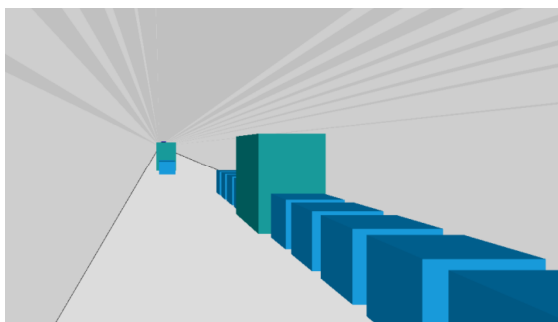
Tunnel Bärenburg on alpine location



Two-way traffic tunnel with a rather big inclination



Identification of the extent of loss of life due to smoke propagation and the formation of noxious gases with simulated personnel flow



Verification calculations by means of 3-dimensional CFD-simulations

## Description

The bidirectional Tunnel Bärenburg with an approximate length of 1 km is located on the N13 in the canton of Grisons in Switzerland. The tunnel is one of several tunnels on this important north-south route with an inclination of more than 5%. Thus, a more detailed examination by means of a risk analysis is required as per direction of the Federal Roads Office (FEDRO).

Presently, the tunnel is being longitudinally ventilated by jet fans. Within the scope of increasing the safety of the tunnel, these jet fans shall be replaced and the construction of a parallel escape tunnel is planned.

The risk analysis shall lay the foundation for the decision of the optimal number of emergency exits to the escape tunnel and also the most ideal emergency ventilation concept.

## Services

A quantitative risk analysis was performed for the Tunnel Bärenburg including the following services:

- Detailed description of the system and its boundaries to establish the reference case and 2 possible design options (3 options in total)
- Calculation of the smoke propagation with the software SPRINT for more than 300 cases per option
- Verification calculations of the smoke propagation by means of 3D-CFD-simulations for selected cases
- Definition of assumptions for the escape conditions
- Personnel flow analysis and egress modelling to identify the extent of loss of life by means of the software ODEM
- Development of the event trees for the scenarios "collision" and "fire (without dangerous goods according to ADR)"
- Application of the Swiss version of the OECD/PIARC model for the scenario "events with involvement or release of dangerous goods according to ADR"
- Calculation, illustration and interpretation of the risk for all the 3 scenarios
- Prove that the safety level of both the design options is in line with the regulations.
- The results are currently being implemented in the refurbishment project.