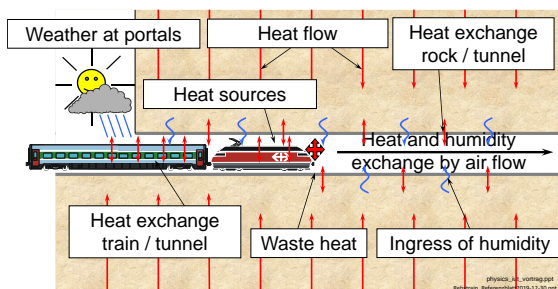
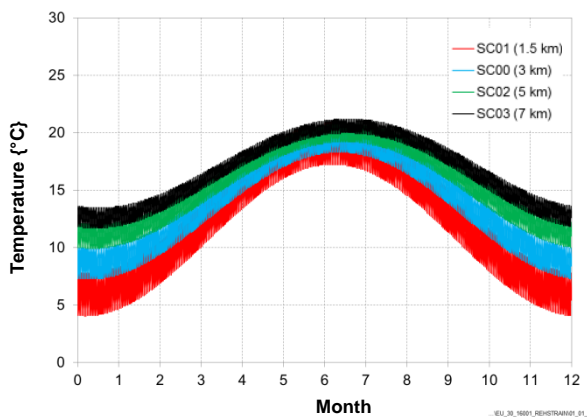


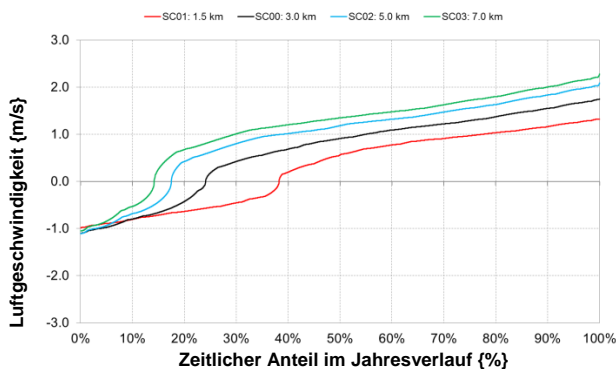
Natural thermal draft in a 3 km long tunnel with 4% inclination



Factors influencing the aero-thermal conditions in rail tunnels



Influence of tunnel length on average tunnel temperature during a year



Influence of tunnel length on frequency of up- and downwards directed thermal draft during a year

Description

The French-German research project "Resilience of the Franco-German High Speed Train Network" (REHSTRIN) investigated the vulnerability of high-speed rail infrastructure to terrorist threats and suitable countermeasures to improve their resilience. Resilience means the ability of the rail system to maintain central functions and system states even during and after exposure to hazards and to quickly restore disrupted functions.

A specific part of the research was to investigate the safety in tunnels in the event of explosions and fire events. The aero-thermal conditions and the influence of natural airflows on the appropriate evacuation and rescue procedures were clarified.

Services

The following services were performed by HBI Haerter Consulting Engineers in the context of the REHSTRIN project:

- Determine the typical properties of rail tunnels of the French and German high-speed network to investigate the natural airflows in inclined tunnels
- Define the reference tunnels, the train operation scenarios and the parameter variations to be investigated
- Develop the methodology for combination of short-term (tunnel aerodynamics) and long-term (tunnel environment) simulation tools
- Perform numerical calculations to determine the frequency distribution of up- and downwards directed draft flows during a year
- Simulate the near- and far-field of the propagation of smoke and hazardous gases in the tunnel with one- and three-dimensional calculation tools
- Compare one- and three-dimensional CFD fire simulations for tunnels with natural ventilation
- Show the possibilities of sudden changes of the propagation direction of smoke
- Conduct egress flow analysis for fire events in tunnels
- Recommend behavioural principles for safe evacuation and rescue in inclined tunnels