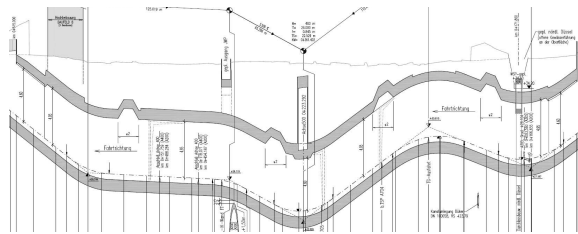
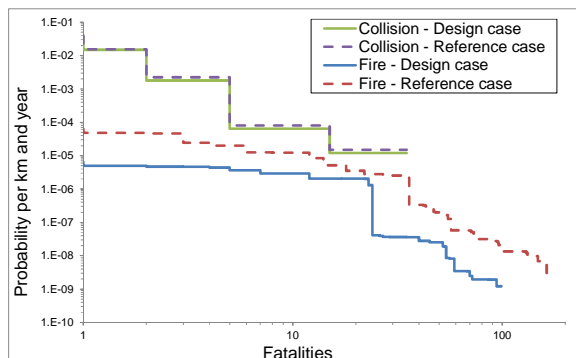


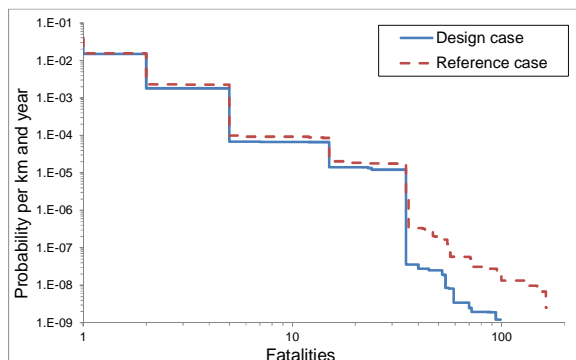
Tunnel system-overview Kö-Bogen (final stage)



Longitudinal section of the main southbound tunnel



Risk profiles for collision and fire



Summarized risk profile collision and fire

## Description

With the opening of the "Kö-Bogen" tunnel streets in the centre of Düsseldorf moved underground. The interconnected tunnels constitute a complex structure that includes three underground connections to new or existing underground parking lots.

The tunnels are used only for uni-directional traffic at a posted speed of 50 km / h in sections with up to three traffic lanes. There are strong changes of the longitudinal gradients up to 8%.

Tunnel ventilation in case of emergency is provided by mechanical longitudinal ventilation, which will be installed in all the tubes, despite their relatively short lengths.

In case of fire, the underground parking lots are isolated from the tunnels by fire doors. For rapid detection of fire events, smoke detection by the visual turbidity meters is supported by a video image detection system capable of recognizing stranded vehicles as well as fire.

## Services

For the tunnels of Kö-Bogen, a quantitative risk analysis was performed.

The following services were provided:

- System definition and description with establishing design case with additional measures and reference case
- Event trees for Collision and Fire
- Calculation of air flow conditions in the tunnel network
- Calculation of smoke propagation and pollution concentration
- Pedestrian flow analysis, egress model, establish event consequences
- Risk calculation and recommendation
- Documentation
- Review of system safety as a comparison between design case and reference case as defined by the German guideliner for the equipment and operation of road tunnels (RABT)