

Distribution of toxic smoke and flue gas from a tunnel fire into the open

A fire in a tunnel is not only a danger for the passengers trapped in the tunnel but also for the public and the neighbours living or working around a smoke discharge shaft of the tunnel, in particular, if the exhaust shaft



is located in an urban area where it discharges the toxic smoke and hot gas in case of a fire directly into the open. This is not only the case with road tunnels but also with train tunnels or metro and sub-way tunnels. Reference is made to the fire of a sub-way train (see the photo on the left), which happened recently, on 18th of Feb. 2003, in the city of Daegu, Korea.

Therefore, it is necessary to know and predict the probable distribution and concentration of the toxic smoke and hot gas released from the fire in the endangered area in advance and as early as possible in order to make the right decision for the conceptual and basic design of the smoke exhaust system on basis of reliable data.

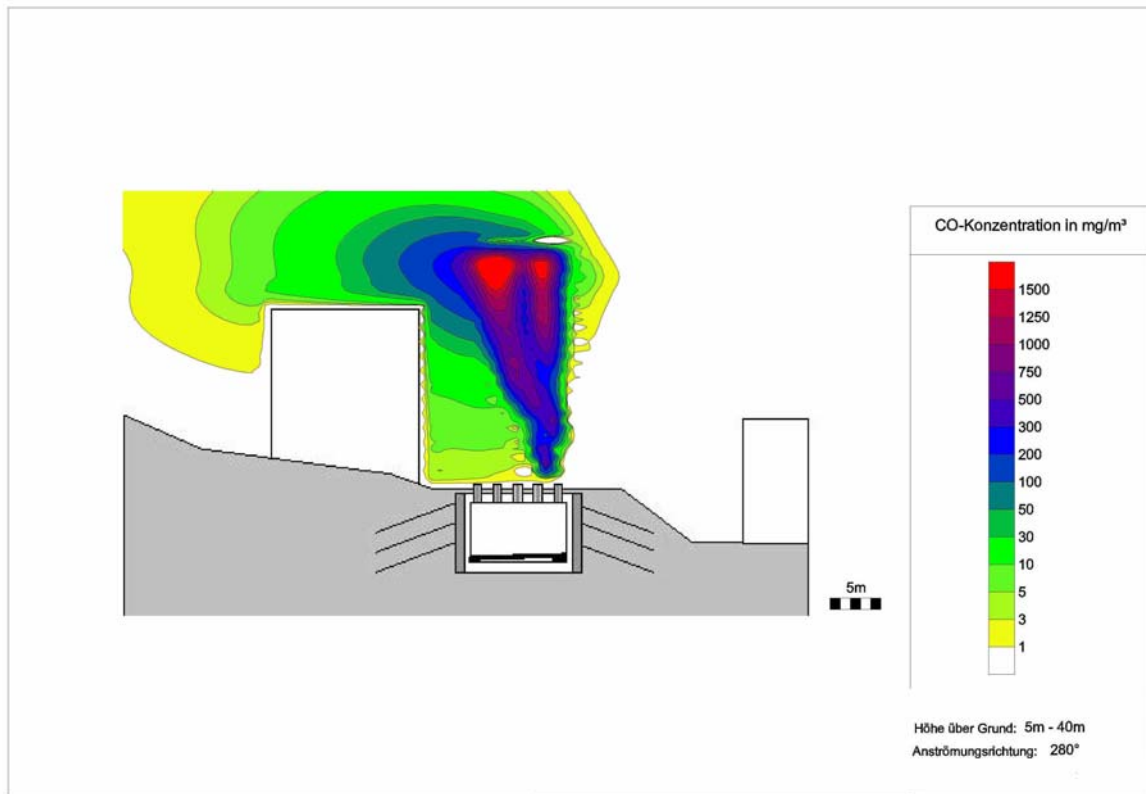
Therefore, the Lahmeyer International GmbH (a consulting and engineering company in Germany) developed a 3D simulation program (CFD-analysis)

based on the MISKAM-program module which is used for the numerical computer simulation of the concentration and impact of various air pollutants, as it is often the case at tunnel portals and ventilation shafts.

In this study, the distribution has been calculated mainly for the CO-gas concentration. The CO-gas was chosen as its density is comparable with the ambient air and as it represents the major toxic content of the smoke and gas inventory and therefore it can be seen as the characteristic value in the simulation: From this result, one can derive the concentration of the other toxic fractions carried with the smoke and hot gas, such as the CO₂, NO_x, HCN, hydrocarbon compounds and other aerosols and particles (PM10). The latter are not only the reason for the temporary loss of sight in the tunnel but also a danger to the respiration system of the human body as the aerosols and particles carry the toxic components of the smoke and flue gas.

From the result of the exemplary simulation it can be seen that the potential risk and danger at the ground level is lower than at the roof level of the next building, especially, if there is a penthouse on it. This is an important aspect to be considered for the rescue and evacuation planning by the rescue team or fire brigade. It could be proven for all instances, under all open wind directions and in each case that no one of the inhabitants in the surrounding buildings will be threatened or harmed by the smoke distribution released from the exhaust shaft in case of a truck burning in the tunnel at 30 MW HRR. This scenario considered the application and use of smoke extraction fans being installed in the exhaust shafts blowing the smoke and flue gas with 8m/s directly into the open. A sample result is shown on the next page.

Vertical section through the smoke and flue gas plume from a tunnel fire into the open



Horizontal smoke distribution at the 15m plane above the tunnel smoke exhausts shafts

