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Consequence Modelling of Gas Explosion Scenarios in Traffic Tunnels

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Abstract

In the Netherlands, future road and rail infrastructure is increasingly projected underground or covered in. In this respect, a particular problem shows up with regard to the transportation hazardous materials, witness the many recent severe accidents in European traffic tunnels.

Within the entire spectrum of risk of hazardous materials transportation, the probability of gas explosion in a tunnel may be relatively low but, on the other hand, the geometry of a tunnel constitutes optimum conditions for a gas explosion to develop devastating consequences. In the tunnel design an explosion scenario is not yet taken into account. Consequently, a gas explosion is mostly fatal for the tunnel structure as well as for all people present inside.

To be able to assess the social acceptability of hazardous materials transport through tunnels risk analysis is an appropriate technique. In order to be able to perform a sound hazard analysis, the TNO Prins Maurits Laboratory developed the proper tools:

- A screening tool set to determine quickly the consequences in a wide spectrum of scenarios. A one-dimensional gas dynamic model of a gas explosion computes the pressure loading. This model requires input in terms of flame propagation behaviour in tubes. Subsequently, damage criteria in pressure-impulse graphs determine the response of the tunnel structure.
- A tool set for detailed numerical simulation. A three-dimensional CFD gas explosion simulator is capable of computing the consequences of any gas explosion scenario as well as the effects of any possible mitigating measure in detail. The resulting blast loading serves as input to a FE-model that is able to simulate the dynamic response of the tunnel structure in any wanted detail.

Beside the performance of a sound hazard analysis, these tools also enable the definition of effective mitigation measures to realise a sufficient safety level. The gas explosion modelling is supported by an extensive data set of gas explosions developing in a small-scale (1:20) model of a traffic tunnel. This paper summarises the characteristics of the CFD gas explosion solver and the screening tool.