

Fire behavior of tunnels

Henco Burggraaf[†], Ton van Overbeek[†] and Adri Vervuurt[†]

[†]TNO Built Environment and Geosciences

Van Mourik Broekmanweg 6, PO Box 49, 2600 AA Delft, The Netherlands

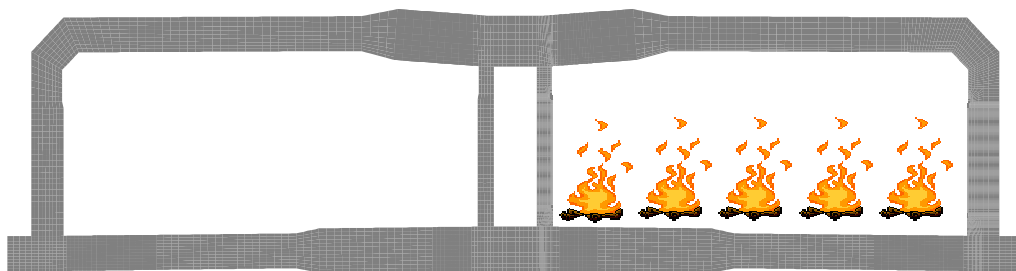
henco.burggraaf@tno.nl

ABSTRACT

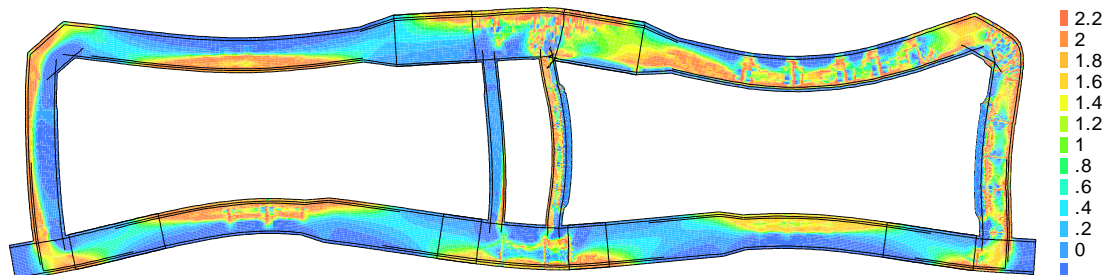
The European economy relies heavily upon a sustainable transportation system, in which tunnels are a key element. The accidents in recent years have drawn widespread attention to the risks of fires in tunnels. The main object of the project is to study tunnels damaged by fire, in order to estimate the structural safety in time. The project team consists of the Dutch Ministry of Transport, Public Works and Water Management and TNO Built Environment and Geosciences.

The project started some years ago by studying the structural fire behavior of the Wijkertunnel in the Netherlands. The Wijkertunnel is a double box, immersed tunnel which was built between 1993 and 1996. The fire protection of the tunnel consists of 27 mm thick Promatect-H isolation boards. In DIANA the tunnel is loaded by dead weight, ground pressure and water pressure. One box of the tunnel is exposed to the RWS-fire curve. The potential flow analysis was performed with a dense mesh of Q4HT-flow elements for taking into account the large temperature gradient. The calculated temperatures were used as input for the stress analysis, which was performed by modeling the tunnel with CL18B-beam elements. Because of the large temperatures and consequently the large stress gradient, a model consisting of beam elements appeared not to be the most accurate approach.

Therefore, recently the project was continued by modeling the tunnel with CQ40S-curved shell elements and performing a coupled flow-stress analysis. The results show the appearance of cracks at the outside of the tunnel. The poor accessibility of these cracks has a negative influence on reparability and durability. Moreover it is unknown what the effect on the cracks is when the structure cools down. The main object for the project in 2008 is the development of a User Supplied Subroutine for modeling the cooling down phase of concrete and study the effect on the estimated crack widths.



Geometry of the Wijkertunnel and the location of the fire



Principal stresses [MPa] after 2 hours exposure to the RWS-fire curve (100x real deformations)