Title : Design of the cross-passages in the shield driven tunnels of the North/Southline

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At this moment the new metro line in Amsterdam (North/Southline) is under construction. The part of the new metro line beneath the old monumental city centre will be constructed using two Tunnel Boring Machines (TBM's). Every 300 meter of tunnel, for safety reasons, emergency exits will be constructed. In the first two tunnel stretches emergency exits will be constructed as cross-passages between both tunnels (three in total). In the last two tunnel stretches the tunnels will be connected with vertical emergency shafts (three in total).

The shield driven tunnels will consist of a segmented concrete lining. At the location of the cross-passages the tunnel will partly consist of steel tunnel segments in order to accommodate a passage to the emergency exits, which is made possible by removing a number of concrete segments. The creation of an opening in the tunnel and the subsequent excavation and construction of the cross-passage has a large structural impact on both the concrete and steel tunnellining.

During the design process a manageable 3D hybrid model has been used, consisting of a 3D shell model of the orthotropic steel segments connected to a 3D volumetric model of the tunnel around the cross-passage and a curved shell model for the tunnel at a larger distance to the cross passage. The detailed and local behaviour of the steel segments have therefore been taken realistically into account. The impact of excavation and construction of the cross passage on the tunnel has been assessed using a phased structural analysis.

By using a hybrid model both detailed and structurally correct model behaviour is attained in the steel segments while controlling the size of the model. Compared to a generalised orthotropic curved shell modelling for the steel segments the 3D shell approach provides a realistic insight in the behaviour of the steel segments. The 3D model therefore has proved to be a useful tool in the design process.

figure 1. Part of the model showing illustrative Von Mises stress [N/m^2] in steel frame