

**Title : Settlement risk assessment for the North/Southline**

**Speaker** R.P. Roggeveld MSc (Structural Engineer / Speaker)  
**Co-Authors** F.J. Kaalberg MSc / W.H.N.C. van Empel MSc  
**Firm** Witteveen+Bos, The Netherlands

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). The centre of Amsterdam is known for its old and monumental buildings. Various analyses have been undertaken to predict tunnel boring induced settlements, based on which the alignment has been optimised and compensation grouting locations have been chosen.

The bored tunnels of the North-Southline predominantly follow the existing street pattern of the city. However in the south part of the project the tunnels are projected underneath existing building blocks. In the process of assessing the damage potential to these existing building blocks and determining the necessity of active settlement control (compensation grouting) a detailed 3D coupled analysis has been performed in order to assess the impact of settlements on these building blocks.

The used 3D model consists of a masonry building block combined with a full volumetric 3D model of the layered soil in which the tunnels have been projected. The impact of tunnelboring has been simulated by applying supporting (grout) pressures around the perimeter of the tunnel. By means of this integral model the effects of soil structure interaction have been quantified. The behaviour of less extensive 2D models have been compared with the 3D model, based on which it was concluded that soil structure interaction is heavily overestimated by the 2D models. The masonry building block has been modelled by a non-linear cracking model, therefore realistically taking into account the behaviour of the building.

Compared to more conventional 2D models and analytical approaches the performed phased 3D settlement risk assessment has not only provided some fundamental insights but also the basis of the decisions regarding the necessity of active settlement control by compensation grouting.

**figure 1. Model showing both tunnel, soil and building**

