Abstract

This thesis is concerned with the development of a three-dimensional finite element simulation model for shield tunnelling, which takes into account all relevant components and processes and realistically models the step-by-step process of the tunnel advance. This model can be used for the prediction of the tunnelling induced surface settlements and the loading and deformation of the tunnel lining. Furthermore, the complex interactions between the soil, the shield machine, the tunnel lining, the hydraulic jacks and the grouting of the tail void can be analysed in detail.

The soil and the tail void grout are modelled as saturated, porous materials using a two-field finite element formulation in order to allow for the simulation of tunnel advances below the ground water table and to allow for an adequate representation of slurry face support and the grouting of the tail void. The tail void grout is modelled in a simplified manner as an elastic material. Its hydration is considered by means of a time-dependent stiffness and permeability. An elasto-plastic Cam-Clay model is used to describe the material behaviour of soft, cohesive soils. The simulation procedure has been automated by means of a supplementary program in order to allow for a user-friendly, automatic simulation of arbitrarily long, also curved tunnelling sections.

By means of a prototype simulation of a shallow, hydroshield-driven tunnel advance in homogeneous, soft, cohesive soil the prognosis capabilities of the model are tested and the results of the model are verified by comparison with measurement data. Starting from the analysed situation, extensive and systematic parametric studies are performed in order to investigate the qualitative and quantitative influence of the different parameters especially on the surface settlements and the loading of the tunnel lining.