Numerical modelling of tunnel excavation in soft soil

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ABSTRACT
The development and extension of large cities creates a need of multiple shallow tunnels in the soft ground of built areas. Excavating a tunnel generates ground displacements and deformations which can affect existing buildings and services in urban sites and can lead to unacceptable damages. Prediction of the ground settlement caused by the tunnel excavation has been a major engineering challenge.

A numerical simulation using finite element method was implemented in the aim of developing a procedure for forecasting the movement induced by tunneling. This study describes the modelling procedure, comparing one procedure in a complete stages of modelling (called phases modelling) taking into account different phases simulating the different kinds of interaction between the tunnel and the soil (deconfinement, lining installation, pore pressure applied on the lining, and weight of the lining) and one in a simple way called `deconfinement modeling', simulating the excavation using a stress decrease vector exerted on the excavation boundary in the opposite to the initial ground stress described by a scalar parameter A. (the deconfinement rate).

A shallow lined tunnel is analyzed in a two dimensional analyses, and observations are made for the settlement at the surface and at the tunnel crown, the deformations of the tunnel opening, and the stress path around the tunnel. Comparison is conducted using two soil models : the Mohr-Coulomb model and the CJS model.

Observations of the results and comparison with the experimental data demonstrate that the deconfinement modeling is adequate for the analyses of settlement induced by tunneling only if a good modeling of the soil behavior is considered.