Numerical Simulation for tunnel design – Draft Programme

Objective

The objective of this training session is to provide an introduction to Numerical Simulation in Tunnelling. The seminar will provide a general overview of the different calculation methods, outlining the use, advantages and difficulties of numerical simulation, to be followed with more in-depth sessions on the numerical models and the associated parameters. Finally, examples of application will be given.

The first 2 days are aimed at professionals in tunnelling with prior knowledge in geomechanics. An optional third day is available giving technical details and practical advice when performing a numerical simulation. This third day is dedicated to engineers who conduct numerical simulation.

This course takes a more in-depth look into Numerical Simulation compared to the section on this issue proposed in the course entitled "Calculation methods for Tunnel Design".

Day 1

Session 1: Introduction and calculation methods

- Introduction : Importance of numerical simulation in tunnelling
- Overview of the different calculation methods
   Should be mentioned: Empirical method, convergence confinement method, Modulus reaction method, Numerical methods, face stability, block analysis
- Use and validation of the different methods
   Coherence between the different methods should be mentioned
   Highlight should be made between calculations performed:
     - *by researchers for very complex tunnel structures and for current tunnel projects*
     - *at the different stages of the project*

Session 2: Overview of the numerical methods for tunnelling

- Finite Element or finite difference method: FEM *(general principles + example of a project)*
- Distinct Elements method: DEM *(general principles + example of a project)*
- Simulation of construction stages
- Which model to use? (2D versus 3D, selection of the method….)

Session 3: Parameters for numerical modelling in tunnelling

- Constitutive models for ground (soil and rock) and concrete
   Presentation of most common models used in tunnelling for soil, rock and concrete. The purpose of this session is not to explain elastic and plastic theory.
- Choice of the parameters
   Awareness to the choice of constitutive models
- Modelling of the interface between ground and lining
- Sensitivity studies

Day 2

Session 4: Applications of numerical simulation in tunnelling

- Settlement and Buildings
- Segmental Lining
- Face Stability

- Ground improvement: ground freezing, grouting
- Ground support: sprayed concrete, bolts, steel arches…
- Ground and Water Transport

Session 5: Case studies
- Conventional tunnelling
- Mechanized tunnelling
  Both of them including stress and deformation analysis - Settlement analysis

Day 3 (optional)

Session 6: Numerical simulation tools
- Presentation of available software packages
  The purpose is to list available software frequently used in tunnelling. It is not to learn how to use them.

Session 7: How to set up a FEM model
- Geometry
- Node generation
- Element generation
- Meshing
- Boundary conditions
- Structuring the model into steps

Session 8: Post processing
- Vector plots
- Contour plots
- Evaluation of the results (benchmark tests, plausibility checks)