Finite elements in geotechnical engineering

The LMR has its own finite element calculation code, EFEMER, adapted to stability computations in the domain of geotechnical engineering, particularly for underground structures and excavations. Initially written in Karlsruhe in 1969 by H. Malina as a doctoral thesis, this programme undergoes continual development at the LMR.

EFEMER permits the treatment of two dimensional problems in plain strain, plain stress or axisymmetrical conditions with surface elements (which simulate the ground), bars and beams (which model the support structures). The surface elements have elastic-plastic behaviour which may be anisotropic either in the elastic (orthotropic) or failure domains (directions of cracking), with or without strength softening (decrease in cohesion). The possible failure criteria are: Mohr-Coulomb, Hoek-Brown and Drucker-Prager.

The project phases can be truly represented, from the application of in situ stresses in the underground, followed by stress relaxation, then the excavation and support of each partial section by deactivating certain mesh elements. Loads are applied as nodal forces, prescribed nodal displacements, surface loads or temperature variations.

Numerous graphical output possibilities give the opportunity to fully visualise the results, i.e. the mesh, displacement fields, principal stresses (see figure) and strains, failed zones with the direction of cracks formed and safety with respect to failure for elements which are still elastic, the solicitations on the support structure (bending moments, normal and shear forces), isovalues of all displacement, stress and deformation components, as well as the safety coefficient.

Publications