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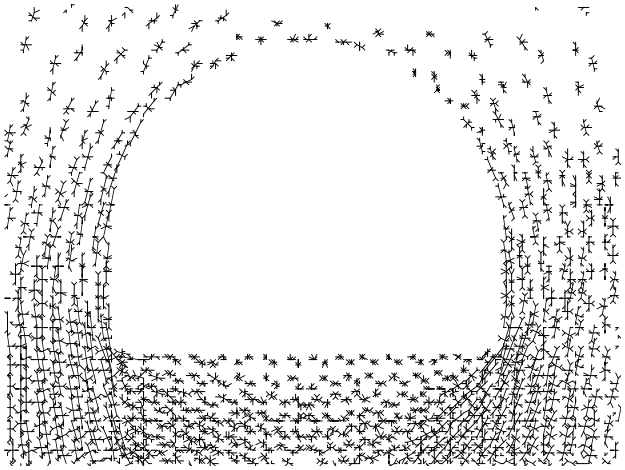
Finite elements in geotechnical engineering

The LMR has its own finite element calculation code, EFEMER, adapted to stability coputations 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 axisymetrical 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



Principal stresses around a shallow excavation

EFEMER is used by the LMR for teaching and research, but also for consulting, where its great flexibility of use allows the modelling of situations which are often newly conceived by the structural planners.

The new research direction for the development of the programme is the introduction of joint elements for the simulation of distinct cracks.

Publications

Dudt J-P. 1986-1995. EFEMER Méthode des éléments finis élasto-plastiques bi-dimensionnels avec fissures. *users manuel ISRF-LMR*.