

PERMEABILITY ASSESSMENT OF THE DAMAGED ZONES AROUND A TUNNEL IN THE BURE SITE, FRANCE

Purpose(s): Evaluation through numerical discrete modeling of the geometry of the failed/damaged zones around a tunnel

Client: ANDRA

Dates: 2004 – 2005

Location: Bure Site (France)

Partners: None

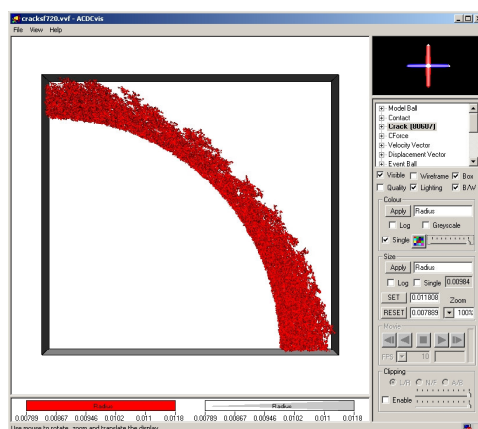
Project executive manager:
Fabian DEDECKER

Code(s) used: PFC^{3D} & 3FLO

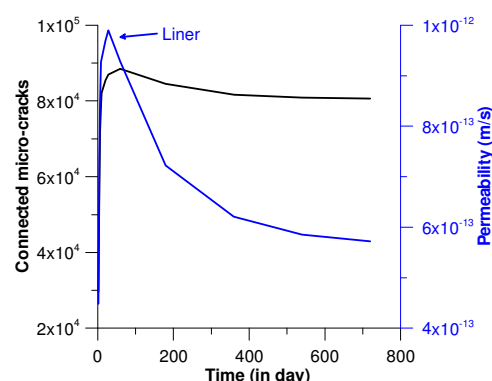
During **drilling** (shaft or drift), the surrounding rock mass is subjected to a fast unloading phase that can lead to local fracturing, or even the development of a major **damage zone** in the short or long term. When the drift is proposed for radioactive waste storage, it is necessary to foresee the **fracture network** as well as the **evolution of the permeability** caused by the induced fracture network in the rock mass.

In this framework, we have developed an innovative method by **coupling PFC^{3D}** (software modeling the movement and **interaction of spherical particles**) and **3FLO** (software **evaluating flow** in fractured media). By definition, **PFC^{3D}** models the micro-fractures network (damaged zone) around the drift, whereas **3FLO** estimates the **equivalent permeability of the fracture network**. The permeability is obtained by simulating a flow field inside the micro-fracture network.

Because much data were available from the Bure Site, France, we have validated this new method by modeling the behavior of the **Callovo-Oxfordien clay rock** over two years from its excavation.



View of connected micro-cracks 2 years after the drift opening



Number of micro-cracks connected and variation of permeability in the fractured zone versus time

KEYWORDS:

- Numerical discrete modeling
- AC/DC approach
- Parallel computing
- Callovo-Oxfordien argillites
- Damage
- Permeability

⇒ RESULTS:

- Assessing the permeability from the micro-crack network is a viable numerical concept.
- The "ring" of micro-cracks connected to the tunnel reaches a significant depth (more than 40 cm) during the first month after the opening of the shaft.
- A very quick localisation along the principal minor-stress direction can be observed.
- The use of a "square" relation between transmissivity and relative displacement (= aperture) is well-adapted to our case.
- The permeability obtained numerically is consistent with in-situ measurements.

REFERENCES:

- Billaux D., Dedecker F. and Cundall P., 2004, A novel approach to studying rock damage: the three dimensional Adaptive Continuum / Discontinuum Code, *EUROCK 2004 & 53rd Geomechanics Colloquim*, pp. 723-728, Ed. Schubert, 2004.
- Dedecker F., Cundall P., Billaux D., and Groeger T., 2006, Evaluation of damage-induced permeability using a three-dimensional Adaptive Continuum/Discontinuum Code (AC/DC), *Physics and Chemistry of Earth, Parts A/B/C*, in press.