POROELASTIC WITH DAMAGE MODELLING OF A DEEP SPHERICAL CAVITY SUBMITTED TO VENTILATION

A. Blaisonneau [1 *], A. Giraud [1], F. Homand [1], D. Hoxha [1], P. Giraud [1], A. Courtois [2], T. Lassabatere [2]

1. **Laboratoire de Géomecanique, Ouvrages et Environnement, LaEGO-ENSG , Rue du Doyen Marcel Roubault, B.P. 40, 54501 Vandoeuvre-lès-Nancy**
2. **EDF/DRD/MMC, route de Sens, Ecuelles, Moret sur Loing Cedex, 77818 France**

* **actually at Laboratoire de Mécanique des Sols, Ecole Polytechnique Fédérale de Lausanne, Ecublens CH-1015 Suisse**

Variations of moisture in underground works involve hydro-mechanical coupling effects in the rock mass. Indeed, the ventilation of gallery induce extensive drying zone and tensile stress in the surrounding rock mass. In the context of radioactive waste storage in deep cavities, the determination of the perturbed area is of first importance in order to estimate the confining capacity of the rock mass.

The theoretical context of this study is the mechanics of partially saturated porous media framework [COU95] and the rheological model taken into account is linear [LASS94] and non linear isotropic poroelastic model with damage given by Blaisonneau [BLA02]. The connected porosity is saturated by a liquid *lq* and a gas mixture *gz* formed by the liquid vapour *vp* and dry air *da*, and considered as perfect gases. Phase changes between the liquid and the vapour are possible. Generalized Darcy's law is used to describe the conduction of liquid and gas mixture whereas the vapour diffusion in the gas mixture is describe by the Fick's law [MAI99]. Moreover the Kelvin relation translate the thermodynamic equilibrium between the water liquid and its vapour under isothermal conditions. By combining the transport equations with the water and dry air mass conservation, and after introducing the behavior law, a fully coupled system of field equations of diffusion is formulated and, with the mechanical equilibrium equation, allows to describe isothermal evolutions of the material (the unknows are the liquid pressure, the gas mixture pressure and the volumetric strain).

Semi-analytical solutions are presented for the behavior of a spherical cavity submitted to ventilation. This kind of solutions requires the linearization of the field equations system [THO99]. As analytical solutions can only be obtained on problems characterized by simple geometries and boundary conditions, such ones have been developped to solve more complex and realistic problems thanks to the development of symbolic computation. Because of their accuracy and their simplicity, semi-analytical solutions are usefull to validate numerical code and to perform parametric studies thanks to speed calculation.

A simple one-dimensional geometric model is taken into account. Material considered for the safe rock mass is a very low permeability rock, the Est's argilite which is the deep argillaceous rock of the French *URL* in the East Parisian basin [AND99]. The initial stress state is considered to be isotropic and the boundary conditions are such to simulate the excavation ($\sigma_r = 0$ at the cavity wall) and the ventilation (decrease of the relative moisture imposed at the cavity wall).

Because semi-analytical solutions are highly dependent on the linearization way, they must be considered as a first approach. Then, a comparison survey is presented between this solutions and FEM solutions with a non linear poroelastic with damage model [BLA02].

References

[AND99] ANDRA (1999) – Etude pour la faisabilité des stockages de déchets radioactifs, Actes des journées scientifiques ANDRA, Nancy , 7, 8 et 9 Décembre 1999.

[BLA02] Blaisonneau A. (2002) – Modélisations couplées hydro-mécaniques en milieux poreux partiellement saturés : Application à la ventilation de galeries profondes, Thèse, Ecole Nationale Supérieure de Géologie, Institut National Polytechnique de Lorraine.

[COU95] Coussy O. (1995) – Mechanics of porous continua. John Wiley and Sons.

[GIR00] Giraud A., Blaisonneau A. & Homand F. (2000) – Linear and non-linear poroelastic with damage modelling of the drying effects around deep cavities, Int. Workshop on Geomech. Hydromech. and Thermohydromech. Behavior of Deep Argillaceous Rocks : Theory and Experiment, 11 p.

[LAS94] Lassabatère T. (1994) – Couplages hydromécaniques en milieu poreux non saturé avec changement de phase. Application au retrait de dessication, Thèse de Doctorat de l'Ecole Nationale des ponts et Chaussées.

[MAI99] Mainguy M. (1999) – Modèles de diffusion non-linaires en milieux poreux, application à la dissolution et au séchage des matériaux cimentaires, Thèse, Ecole Nationale des Ponts et Chaussées.

[THO99] Thouvenin G. (1999) – Modélisations couplées thermo-hydro-mécaniques en milieux poreux partiellement saturés : solutions linéaires et non linéaires, Thèse, Ecole Nationale Supérieure de Géologie, Institut National Polytechnique de Lorraine.