Hydromechanical modelling of bentonite-based materials

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Most concepts of deep geological disposal for radioactive waste involve a multi-barrier system in which bentonite-based materials are used as engineered barriers. The objective is to create a zone of low permeability that is able to limit water flow around the excavated galleries, and thereby delay the release of radionuclides to the biosphere.

The behaviour of bentonite-based materials under *in situ* conditions is complex, owing to strong multiphysical and multiscale coupling taking place. Both hydraulic and mechanical behaviour are indeed strongly coupled, and the material exhibits important swelling upon hydration. In addition, the structure of bentonites is characterized by a bimodal pore size distribution created upon compaction. This structure evolves along hydromechanical stress paths and influences the material properties (hydraulic conductivity, retention capacities…).

In this paper, a hydromechanical model for compacted bentonites is developed. While developed at the macro-scale, the model includes important aspects of the material microstructure. More specifically, attention is paid on:

- The implementation of an elasto-plastic mechanical model able to reproduce the large strains observed in compacted bentonites upon wetting.
- The extension of the existing hydromechanical formulation to include coupling between
  - The water retention behaviour and the evolving material micro- and macrostructure (Della Vecchia et al. 2015);
  - The permeability and the material macrostructure.

The model is implemented in the finite element code LAGAMINE developed at the University of Liège (Dieudonne et al. 2014). The performance of the implementation is investigated through the modelling of laboratory infiltration tests. The importance of the various hydromechanical coupling is also highlighted.

Finally, the model is used to study the hydromechanical behaviour of a bentonite buffer submitted to hydration under *in situ* conditions. The investigated problem is directly related to the set of experiments PGZ2 developed in Andra's underground research laboratory.

References

Della Vecchia G., Dieudonne A.C., Jommi C. & Charlier R. (2015) Accounting for evolving pore size distribution in water retention models for compacted clays. *International Journal for Numerical and Analytical Methods in Geomechanics* 39(7), 702 – 723.

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