Description of Thermo-Hydro-Mechanical modeling of Bentonite clay performed by Clay Technology.

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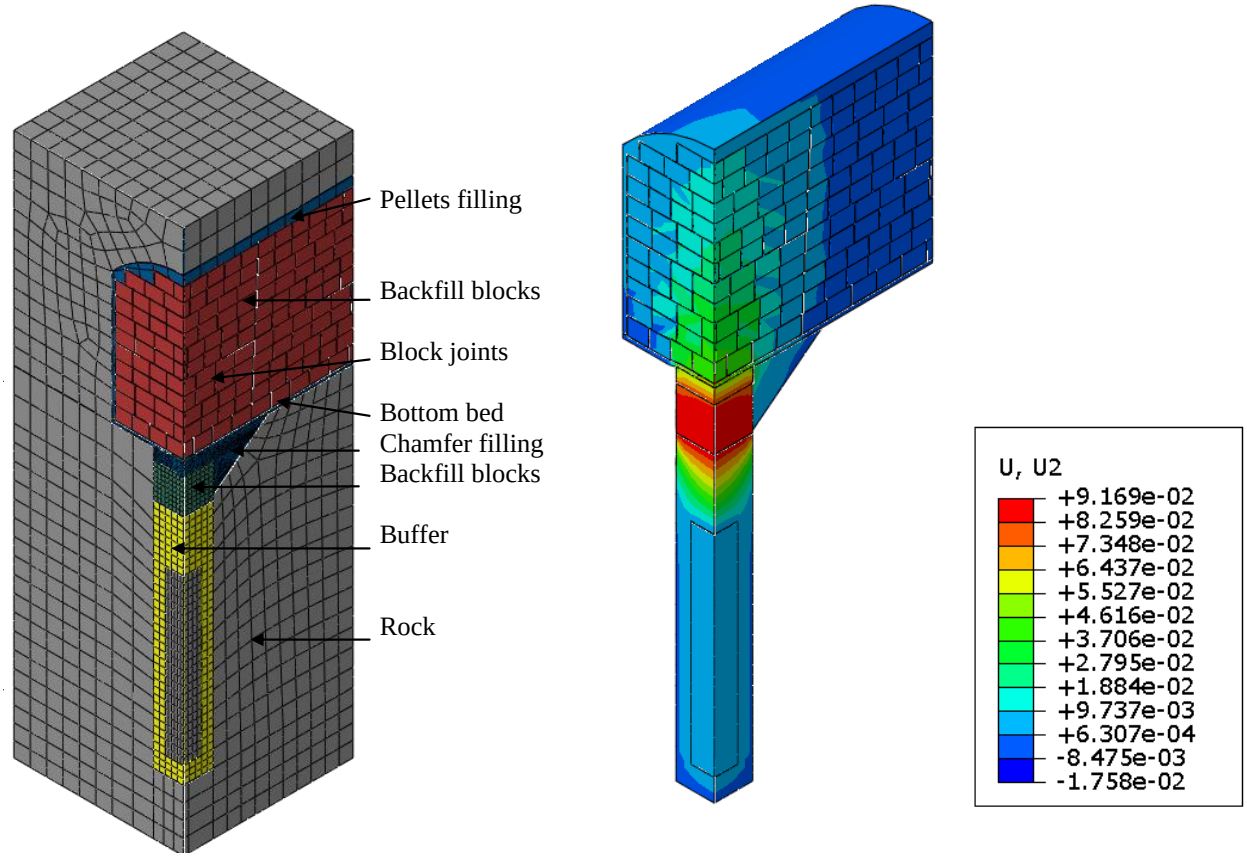

Example of modelling (Abaqus). Upwards swelling of bentonite buffer to the backfilled tunnel. Vertical displacements in meters.

Bentonite clay components are commonly used in engineered barrier systems. The swelling property of the clay when absorbing water is utilized to obtain a tight barrier which also acts as a mechanical protection. Also, in the systems we consider, the water transport may be affected by temperature. Therefore, in order to obtain representative simulations of engineered barrier systems, all three processes; thermal, hydraulic, and mechanical often have to be regarded. Furthermore, the processes are intimately coupled and may affect each other. This means that simulations have to be designed as to solve the equations with consideration of the couplings.

Clay Technology has for a long time been involved in projects including thermo-hydro-mechanical simulations of engineered barrier systems for the Swedish Nuclear Fuel and Waste Management Co.

(SKB). We therefore have extensive knowledge in conducting such analyses. Projects generally can be categorized as to belong to either "*Understanding the system*" or "*Predict the future of the system*". The projects in the first category aim at increasing our knowledge of the system, often so regarding a particular identified issue or an existing experiment. For some examples see references [1] – [12]. The projects within the second category typically are related to safety assessment of existing or future repositories, see references [13] – [24] for examples.

The analyses we perform range from back-of-the-envelope calculations to fully fledged coupled thermo-hydro-mechanical finite element (FE) simulations in 3D. Our numerical toolbox contains spreadsheet software, engineering calculation software (e.g. Mathcad), and currently two FE-solvers. The first FE-solver to be used by Clay Technology, Abaqus, is a general purpose thermo-mechanical code which has been equipped with user-defined features as to enable modeling of hydraulic processes as well. Code_Bright, the second FE-solver, developed at the Department of Geotechnical Engineering and Geo-Sciences at Universitat Politècnica de Catalunya, was specifically designed with geomechanical applications in mind where coupled thermo-hydro-mechanical processes are addressed.

Category 1 ("Understanding the system") references

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