BRIE WATER-UPTAKE TEST

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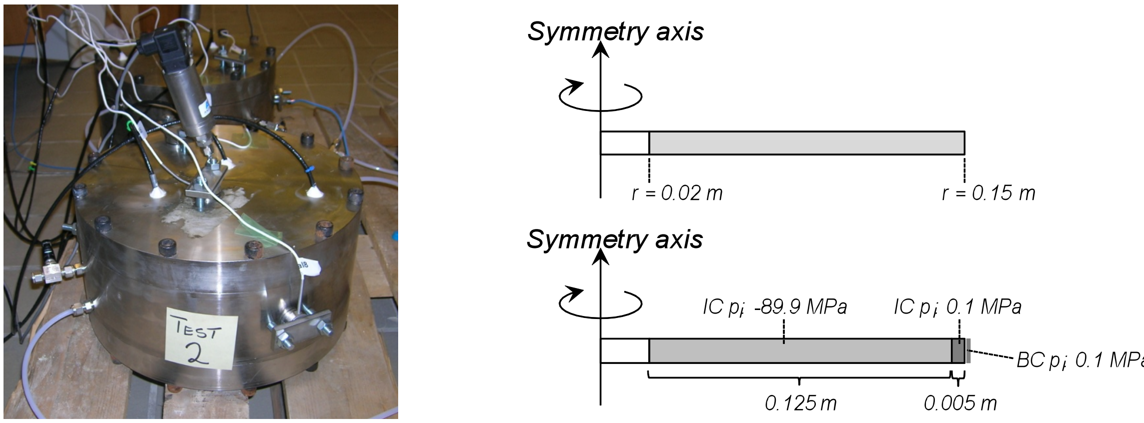

Figure 1. Test cylinder (left), model geometry (top right) and model initial and boundary conditions (bottom right).

Background and objective: The Bentonite Rock Interaction Experiment (BRIE) was a field experiment, performed at Äspö HRL which addresses the hydraulic interaction between the system components of compacted bentonite and near-field host rock composed of hard and fractured crystalline bedrock. The objective of BRIE is to enable: i) an enhanced understanding of the exchange of water across the bentonite-rock interface; ii) better predictions of the hydration of the bentonite buffer; and iii) better characterization methods of the deposition holes.

The BRIE water-uptake test was a laboratory test which was performed on bentonite blocks with the same MX-80 bentonite and the same radial dimensions, density and water content as in the field experiment. The objective of the test was to provide data from an experiment with radial water-uptake, which would give a clear-cut description of the hydraulic processes in the bentonite in the BRIE experiment.The hydraulic evaluation of this test resulted in a set of parameter values, which can be used for modeling of the field experiment. In addition, it has contributed to a general validation of the material model.

General description: The bentonite blocks were installed in steel cylinders, with steel lids mounted on the top and the bottom (Figure 1). A plastic filter was mounted on the inside of the cylinder which facilitated a free access of water along the circumference of the block. The cylinder and the top lid were equipped with sensors for measurement of total pressure and relative humidity. Three tests were performed: i) with free access of water during ~ 200 days; ii) with free access of water during ~ 100 days; and iii) with the access of water limited to an initial filling of the outer slot and left to equilibrate during ~ 100 days.

The tests have resulted in three major sets of experimental data: i) evolutions of the cumulative water uptake; ii) evolutions of the relative humidity and stresses; and iii) profiles of degree of saturation and void ratio (Figure 2). The tests results were evaluated through: i) the optimization of two saturation dependent moisture diffusivity functions, which either were based on the water-uptake data (i.e. inflows) or on the water saturation data (measured after dismantling); ii) the adoption of two in-situ retention curves (van Genuchten and square law type), which were based on initial and final data from RH sensors and measured degrees of saturation; and iii) the evaluation of saturation dependent permeability functions from the diffusivity functions and retention curves.

The water-uptake test was finally modelled with Code_Bright as a purely hydraulic problem with a 1D axisymmetric geometry, see Figure 1. The block was described as homogenized with a single constant porosity (44 %). The initial water filling of the outer slot was taken into account by applying water saturated conditions from the start in the outer 5 mm of the bentonite. The liquid pressure at the outer boundary was kept constant at an atmospheric level throughout the calculations (203 days). Four different model cases were analyzed.

Main results: The main experimental and model results regarding cumulative water-uptake, saturation profiles and RH evolution at sensor positions are shown in Figure 2.

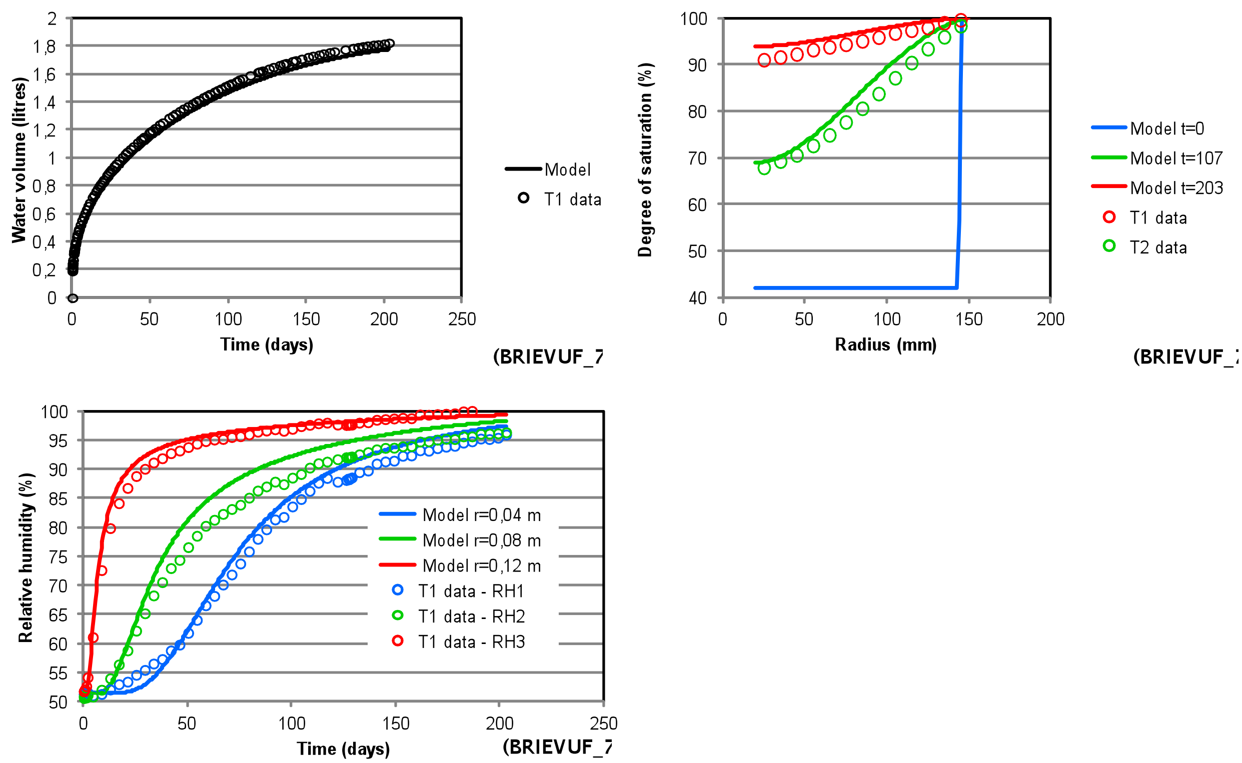

Figure 2 Experimental (symbols) and model results (lines) of cumulative water uptake (upper left), radial distribution of degree of saturation(upper right), and evolution of relative humidity (lower left).