Hydro-mechanical modeling of the dome plug

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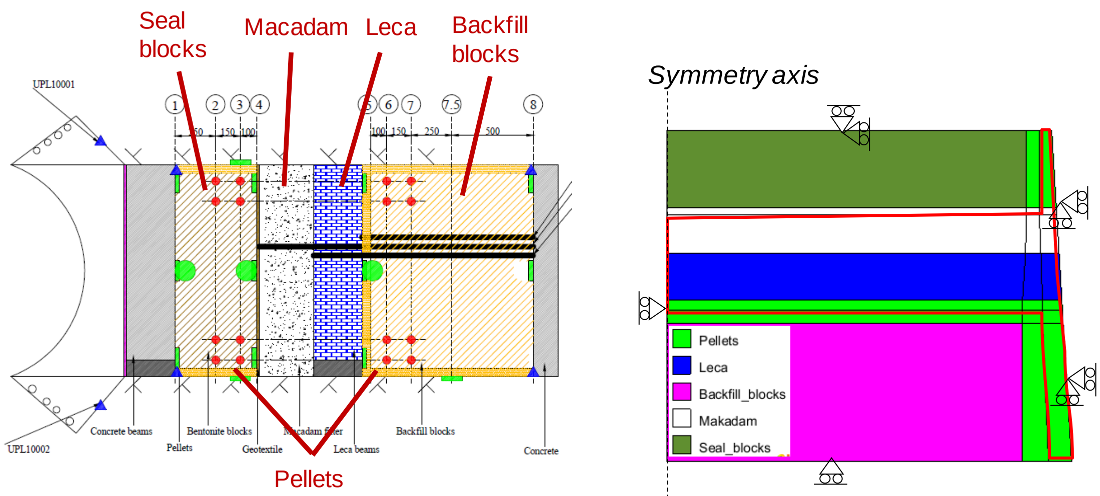

Figure 1 Design of field tests (left) and geometry of hydro-mechanical model (right).

Background and objective: The KBS-3 tunnels are planned to be sealed with dome plugs after the emplacement of the canisters, the buffer and the backfill. The system design of the plug is currently investigated in a field experiment at Äspö HRL. The processes in this test were predicted through hydro-mechanical modelling with the Code_Bright finite element code. This work was part of the SKB project Systems design of plugs – DP1 – Laboratory tests and modelling.

General description: The dome plug was represented with a two-dimensional axisymmetric geometry (Figure 1) and consisted of several components: i) the bentonite seal blocks, located at the front and surrounded by pellets (all behind the concrete plug and beams which were excluded from the model); ii) the filter, consisting of a macadam filling and Leca blocks; iii) the backfill blocks, located at the inner part of the tunnel and surrounded by pellets, including a pellets-filled slot between the Leca and the backfill blocks. Water-uptake was enabled through a hydraulic surface boundary in the filter materials and the pellets-fillings. Internal radial displacements were allowed, whereas the outer boundaries were confined.

The water transport was modelled with Darcy's law for unsaturated conditions with adopted parameter values for the intrinsic and the relative permeability, as well as for the water retention curve. The mechanical processes were modelled with elasto-plastic constitutive laws which are based on the Barcelona Basic Model. In addition, these laws were modified by Clay Technology through incorporating a void ratio dependent swelling pressure relation into the pressure dependence of the used swelling modulus (SKB TR-10-44).

Main results: The model results can be evaluated as evolutions of different variables at different locations. Evolutions of axial stresses and axial displacements along the central axis at interfaces between different materials are shown in Figure 2. The axial stresses displayed a steady increase and indicated that 1 MPa would be reached after approximately two years.

The displacements in the seal and the filter materials were directed inward, whereas the corresponding displacements in the backfill blocks were directed outwards. This was due to the large compressive strains in the pellets-filled slot between the Leca and the backfill blocks. The largest displacements were found at the interface between the seal blocks and the macadam filling, and after two years this displacement would be 4 – 5 cm.

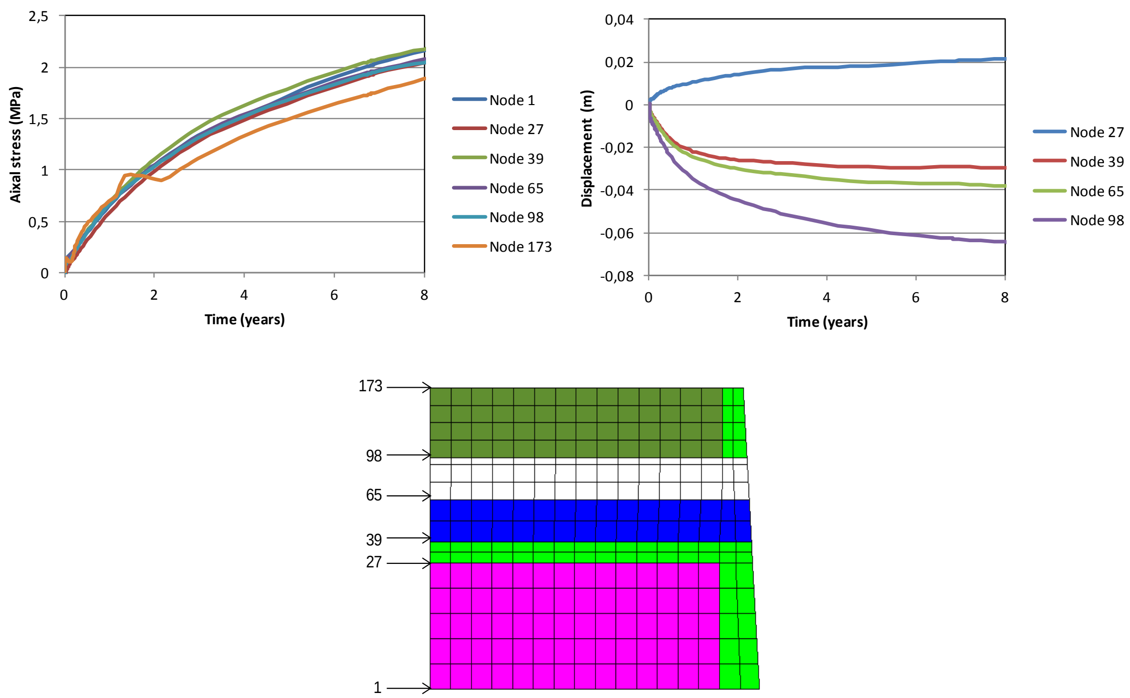

Figure 2 Model evolutions of axial stress and displacement at different nodes along model axis.