Elastoplastic modelling of a ventilation test in argillaceous rock

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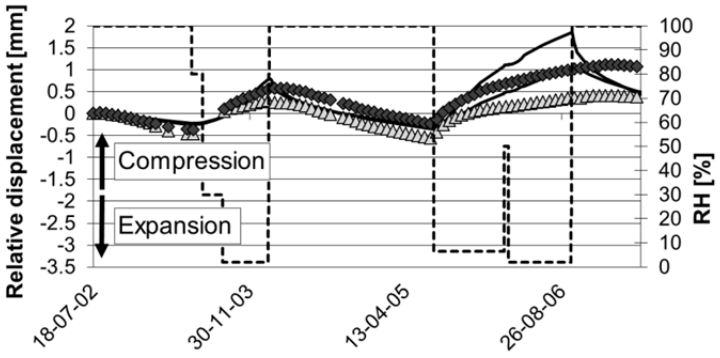
ABSTRACT

A full scale ventilation field test has been performed in a 10 m section of a 1.3m diameter unlined tunnel excavated in the Mont Terri underground laboratory. The tunnel has been excavated in Opalinus clay, a stiff strongly-bedded overconsolidated clay of Middle Jurassic age found in the Jura Mountains of Northern Switzerland. The test involved several stages of wetting and drying under controlled conditions and was fully instrumented with pore pressure, relative humidity and displacement sensors [1].

Coupled hydromechanical analyses have been performed taking into account the specific features of the test, especially the vapour migration phenomena and the conditions in the boundary between air and clay. The mechanical behaviour of the Opalinus clay has been simulated by an elastoplastic model in order to capture the potential irreversibility of deformations caused by ventilation.

The results of the calculations match quite closely the field test observations such as the existence of two different zones around the tunnel: a desaturation zone reaching only about 50 cm inside the clay and a larger zone, extending 2.5-3m from the tunnel wall, in which the Opalinus clay is under suction. Also, displacements close to the tunnel follow closely the changes of the relative humidity of the air in the tunnel; it compresses when ventilation involves dry air and it exhibits extension when wetting occurs. Although displacements are modest, it can be observed that the net effect of the full ventilation history is a net compression indicating a degree of irreversibility in the clay behaviour. Such irreversibility is well reproduced by the elasto-plastic coupled analysis (see Figure).



Relative displacements between the tunnel wall and an anchor point 2m inside the rock mass. Observed and computed results

REFERENCES

[1] J.C. Mayor and M. Velasco, *The Ventilation Experiment Phase II (Synthesis report)*. NF-PRO Project, Deliverable D 4.3.18 (F16W-CT-2003-02389) (2008).

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