

CHEMO-HYDRO-MECHANICAL BEHAVIOUR OF UNSATURATED CLAYS

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Understanding of the chemical effects on clays is essential for many problems ranging from pollution studies and waste-containment. Several studies examined the effect of changes in pore fluid composition on the mechanical and hydraulic properties (e.g. Barbour and Yang, 1993). Volume changes (contraction/expansion) have been measured on clay specimens upon exposure to salt solutions (Di Maio, 1996) or permeation with organic liquids (Fernandez and Quigley, 1991). Moreover, it was shown that permeation of clay with brine induces an increase of the shear strength (e.g. Barbour and Yang, 1993). In addition, several models have been proposed to describe the chemo-mechanical behaviour of saturated clays under saturated conditions (e.g. Hueckel, 1997).

A new chemo-hydro-mechanical model for unsaturated clays is under development. The chemo-mechanical effects are described within an elasto-plastic framework using the concept that chemical effects act on the plastic properties by increasing or decreasing the preconsolidation stress. The model is based on the distinction within the material of a microstructural and a macrostructural levels. Chemical loading has a significant effect on the microstructure. The negative pressure associated with the capillary water plays its role in the interconnected macro pores. By adopting simple assumptions concerning the coupling between the two levels it is intended to reproduce the features of the behaviour of unsaturated clays when there is a change in pore fluid composition (increase or decrease of concentration). A yield surface which defines the set of yield preconsolidation stress values, for each associated capillary suction and concentration of pore fluid should be defined. In addition, the behaviour of clays under unsaturated condition and the behaviour at full saturation under chemical loading represent two limiting cases of the framework.

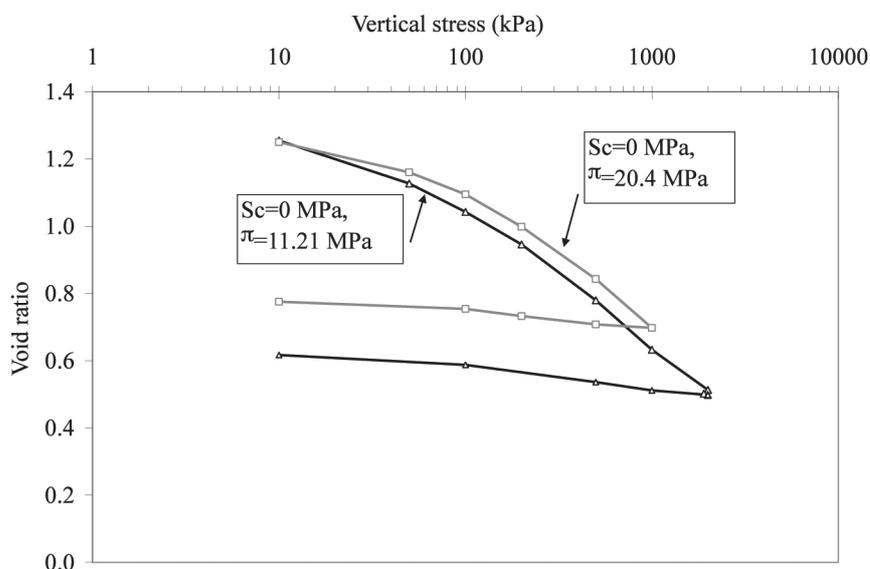


Figure 1: Comparison of consolidation of two specimens prepared with sodium nitrate solution with different concentrations. S_c : capillary suction. π : osmotic suction.

Studies on the compatibility of Boom Clay with large amounts of nitrate-bearing bituminized radioactive waste have recently raised a particular interest on the influence of chemical loading on this reference

formation in Belgium. To map out the chemo-hydro-mechanical behaviour of the Boom Clay a series of oedometric tests under saturated and unsaturated conditions are being performed. The experiments are being conducted on reconstituted specimens prepared by mixing the powdered clay with sodium nitrate solution to slurry at about the liquid limit.

Figure 1 shows the influence of increasing the concentration of pore water on the mechanical behaviour of the studied clay.

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