Modelling the chemo-hydro-mechanical response of clay-based materials

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ABSTRACT

In the context of geotechnical engineering, clays and clay-based materials are often used for the containment or isolation from the surrounding environment of waste products, i.e. to minimize the transport of liquids and/or gases in the underground. Clays are used as barrier materials in several geo-environmental applications, such as nuclear waste disposal facilities, clay liners and slurry cutoff walls. Transport of contaminants through clay barriers and possible physico-chemical reactions are multi-physics and strongly coupled processes. In this contribution, attention is paid to the relevant effects of pore fluid composition on the hydro-mechanical behaviour of compacted clays and on its modelling.

Compacted clays are cast in place in unsaturated conditions and the chemical composition and species concentration of their compaction pore fluid can be very different from the one of the surrounding groundwater. The contribution of both matric and osmotic suction is thus fundamental to properly characterize the energy state of pore water. Experimental evidences at the microstructural scale, including ESEM microphotographs and Mercury Intrusion Porosimetry data, are firstly presented, focusing on the role of both water content and chemical composition of the pore fluid on the fabric of compacted clays. This information is then exploited to provide an interpretation of the phenomenological hydraulic response of these materials and to develop a conceptual double –porosity water retention framework capable of reproducing the evolution of hydraulic properties of compacted clays exposed to fluids whose chemical composition is different from the one of preparation [1]. Finally, a double-structure chemo-hydro-mechanical model is described and used to simulate the results of salinization–desalinization tests [2,3], during which both displacements of the soil mass and concentrations of contaminant were recorded at the boundary of the specimens. Adopting a double porosity formulation allows the reproduction of important aspects of both the transport processes (since mass can be exchanged between the two structural levels) and of the mechanical behaviour (since the overall observed deformation depends on the mechanical behaviour at the two scales and on the interaction between them).

REFERENCES

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