The influence of different hydro-mechanical paths on final properties of saturated MX80 bentonite samples

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Introduction

Compacted bentonite is considered to be used for deep geological nuclear waste disposal due to its isolation properties such as low permeability, solute retention and swelling pressure. To ensure that these properties will remain favourable throughout the long-term performance, understanding its physical behaviour in front of environmental variables is paramountThe study of expansive soils in geotechnics and geomechanics has been historically motivated because of the damage related to foundations during wetting and drying cycles. In recent decades, research has also been driven by the foreseen use of these materials, in particular bentonite, as buffers in nuclear waste disposal concepts. In this context the main behaviour to be predicted is the swelling pressure development, which will condition the microbial activity and the sealing.

The characterisation of material was done determining: the evolution of macroscopic parameters (such as axial strains, void ratio and, in case of isochoric saturation, swelling pressure) upon wetting; initial and final total suction; initial and final degree of saturation; as well as, by analysing the structure of bentonite in initial and final state on the base of XCT image data. Tests were conducted is such a way that the influence of possible side factors such as crushing the grains upon compaction of dry material and cracks evolution upon drying were avoided.

Material and methods

Samples were saturated in an oeodometric cell through liquid phase using water saturation pressure of 20kPa from downstream and upstream side. Two types of hydration paths were followed (Fig. 1). Path type A-B includes isochoric saturation (max axial displacement <0.6%). The properties Path A-C includes saturation in oedometric condition with radial displacement prevented and vertical loading of 20.78 kPa (the effective pressure during saturation is 0.78 kPa). Taking into account low value of effective pressure this wetting procedure is considered as free swelling saturation. The XCT analysis was conducted for three types of samples: type A – sample in as poured state, type B – sample saturated in isochoric conditions, type C – sample saturated in free swelling conditions. To prepare saturated samples for XCT analysis, the succoring procedure was conducted. The main properties of samples in as poured and as hydrated states are summarized in Table 1.

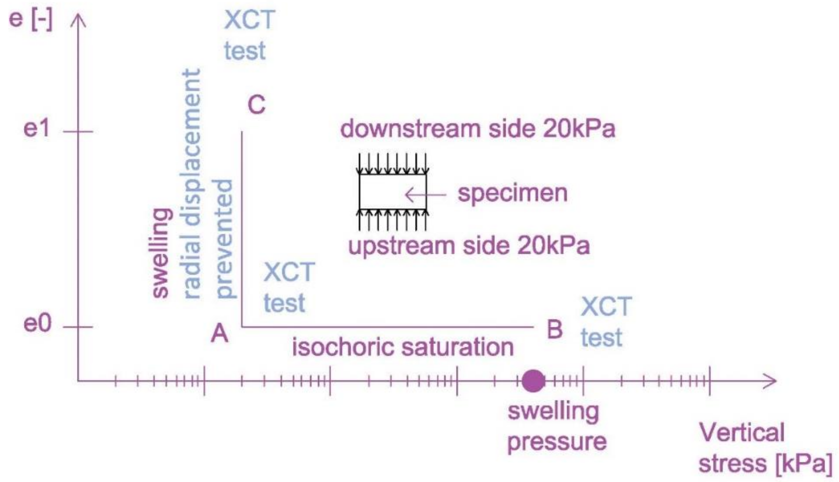

Figure 1. Hydration paths followed in test.

Table 1: Main properties of tested samples

Name of the granulation	As poured state	As saturated state (isochoric saturation)
GSDC C2	ρ_{d0}=1.3g/cm^3 w_0=hygroscopic (~0.06) **sample container:** plastic jar **sample dimensions:** d=215mm h=280mm	ρ_{dfinal} = ρ_{d0}±0.5% w_{final} ≥0.4 **sample container:** carbon cylinder + parafoil **sample dimensions:** d=10mm h=10mm
GSDC C3	ρ_{d0}=1.45g/cm^3 w_0=hygroscopic (~0.06) **sample container**: plastic jar **sample dimension:** d=215mm h=280mm	ρ_{dfinal} = ρ_{d0}±0.5% w_{final} ≥ 0.32 **sample container**: carbon cylinder + parafoil **sample dimension:** d=10mm h=10mm

Results

The characterisation of material was done determining: the evolution of macroscopic parameters (such as axial strains, void ratio and, in case of isochoric saturation, swelling pressure) upon wetting; initial and final total suction; initial and final degree of saturation; as well as, by analysing the structure of bentonite in initial and final state on the base of XCT image data. Tests were conducted is such a way that the influence of possible side factors such as crushing the grains upon compaction of dry material and cracks evolution upon drying were avoided.

Results of works presented herby reveal the evolution of homogenization process in bentonites during wetting, contributing to increase the understanding of this fundamental property of the material. Described experiments were conducted as part of the European project "Beacon" aiming to tackle key technical issues for the support of application of bentonites as sealing material of planned high-level radioactive waste geological disposal repositories.