Vapour equilibrium technique in oedometer tests. Measure, control and numerical simulation.

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The water retention curve is a fundamental parameter in unsaturated soils. There are some methods for its determination which can be divided in imposing suction and measuring suction (Delage et al. 2007, Blatz et al. 2008). The suction range of the swelling clays is quite large, so the vapour equilibrium technique seems to be the best when the suction ranges are higher than 10 MPa and can be used carefully for suctions lower than this value.

This paper presents an experimental work where the suction is imposed in oedometer cells forcing a flow of air with its relative humidity controlled by the porous stones. The reference clay is MX-80 (Dueck 2004). There are two types of tests under oedometric conditions (radial strains avoided). The first one on cells where it is avoided the vertical displacements and in some cases, the swelling pressure is measured (in wetting path). The second ones are oedometric paths (drying and wetting under constant vertical load).

The technique of impose the relative humidity in the sample under static conditions (without forced air flow) provides an exact value of the suction but it is quite slow (it takes some months). This is not admissible in engineering work, so the forced flow maybe a solution, which reach the steady state conditions in some days. This technique should be studied accurately because there are some dynamic equilibriums and the relative humidity in the sample in steady state conditions should be measured.

The relative humidity is controlled by saturated solutions. The type of solute gives the relative humidity imposed in the environment.

Solute	NaOH	LiCl	NaBr	NaCl	$(NH_4)_2SO_4$	KNO_3	K_2SO_4
RH (%)	6	11	58	75	81	92	97

Table 1. Relative humidity imposed at 25 C by different solutes

The equipment for measuring the relative humidity is a Vaisala model HMT 337. It is a hygrometer and the relative humidity of the different parts of the system can be measured. The cells have been modified for checking the relative humidity at the top and at the bottom of the sample before extract it from the cell.

The relative humidity in the pipes is measured as well. The measures in the first step are:

	Vacuum		Pressure		Flask	
NaOH	5.1 %	24.0 C	7.9 %	24.0 C	7.1 %	24.5 C
LiCl	7.2 %	24.6 C	10.7 %	26.3 C	11.5 %	25.0 C

Table 2. Relative humidity measured

The relative humidity is not the same in all path of the air flow, so it is very important to measure the final suction in the soil to obtain accurately the water retention curve, for this reason, the chilled-mirror dew point psycrometer WP4 from Decagon Devices, Inc. will be used for measure the suction as well.

The tests will be simulated with a numerical code where the different phenomena can be analyzed (Pintado et al 2009). The numerical code used is CODE_BRIGHT (COupled Deformation BRIne, Gas and Heat Transport). The numerical simulation allows to estimate the time for reaching the steady state conditions and the suction in the different parts of the sample. The numerical and the experimental results can be compared.

New approach to the evaporation coefficient can be done in order to have more accurately the time necessary to reach the steady state conditions.

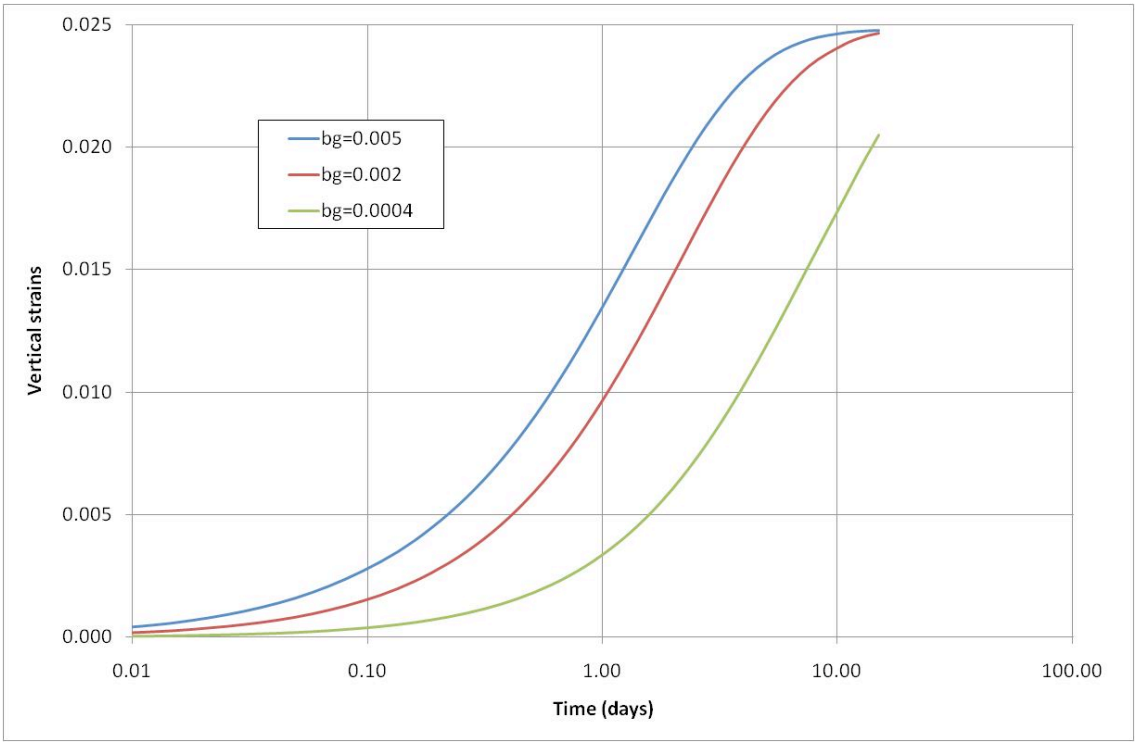

Figure 1. Vertical strains in suction controlled oedometer test

The scientific goal of this work is to study the conditions for that this technique can be used assuring the final state of the sample is correctly controlled and known.

References:

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