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# Capillary water absorption of unstabilized and stabilized earth materials: anomalous time scaling behaviour

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## ABSTRACT

Building materials based on natural earth bear important environmental advantages and, so, are becoming widely used all over the world. However, their behaviour as construction materials for walls (rammed earth, adobe) or in mortars (plasters and renders, repair or bedding mortars) is still poorly understood and usually addressed at a purely technological level.

To improve their mechanical resistance and reduce clay swelling, earth-based materials are often stabilized with small amounts of lime or cement.

Here, we present a set of one-directional capillary water absorption experiments [1] performed with four types of earth. Indeed, water is involved in most decay processes and, as evidenced by practice, can be particularly harmful for earth-based materials. To understand the hydric behaviour is, therefore, essential for this type of material.

One of the earth materials is a commercial earth. The other three were collected from the walls of unstabilized rammed earth buildings located in Alentejo region, in south Portugal. The four materials are fully characterized elsewhere [2, 3]. The commercial earth was tested after stabilization with dry hydrated air lime, natural hydraulic lime, Portland cement or natural cement, as well as unstabilized.

The results showed that the unstabilized materials have anomalous capillary suction behavior, evidenced by nonlinear (exponential) $t^{1/2}$ dependence during the first minutes. The irregularity is especially significant for the commercial earth, but disappears with the addition of even the smallest amounts of binder (5% weight).

The anomaly is probably due to the volume increase of the clay particles as they contact with water, reducing the pore size and, thus, increasing the amount of capillary pores. The use of stabilizers eliminates clay swelling, thereby enabling linear $t^{1/2}$ dependence in the capillary suction tests.

Despite the regularization of the suction behavior, the stabilizers can hardly be considered to have improved the hydric performance of the earth materials. In fact, they increased the capillary suction and the maximum amount of water absorbed, i.e., the capillary porosity of the material. These effects were more relevant for the air lime and, above all, for Portland cement, but they were also obvious for the higher contents of hydraulic lime and of natural cement. Alike results were obtained for the case of cement stabilization in a previous study [4]. The present results show that other hydraulic binders and also air lime can have similar effect, suggesting that all of them can significantly increase the quantity of capillary pore space in the earth material.

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