Exploring a basic estimation approach for permeability of lime mortars: a comparison of experimental results and empirical formulations

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ABSTRACT

Mortars are frequently used in built heritage interventions, for repointing and remodeling of lost parts. They are used as a filling material in stone or masonry work, where both old mortar and building blocks have their preferential moisture transport pathways. Moisture may not stay trapped in the original material, since this can lead to severe deterioration [1]. One of the most important issues in these interventions is thus the ease of moisture transport through the new mortar compared to the original materials.

At present, repair mortars are mainly developed based on experience and only after a curing period of several months, the actual permeability of the mortar can be assessed. Mortar development is therefore costly and time consuming. It is thus favorable to be able to estimate the permeability of mortars before they are made. This can be done using properties of the known mortar ingredients such as the sand grain size or the Blaine surface area of the binder. In order to have a widespread use of this estimation technique for mortars, more accessible empirical formulations were chosen over more complex models for this research.

In the presented study, estimation formulas from related fields (concrete research, petrology) are used for lime mortars [2–4]. The estimated values from the formulations are compared with actual measurements of saturated and unsaturated permeability. Saturated values are based on helium gas permeability measurements. Helium gas permeability measurements on this type of lime mortars show values in the range of 10-15 m^2, an order of magnitude that could not be approached by using any of the empirical formulations. However, some of the formulations approached the permeability measurements by one or two orders of magnitude. Unsaturated values are calculated from transient moisture profiles derived from X-ray radiographs acquired during imbibition [5, 6]. A good estimation of both saturated and unsaturated permeability is essential to predict the moisture distribution in built heritage using analytical or numerical models for moisture transfer.

The authors believe that this study is a promising starting point for further research into the estimation of permeability for lime mortars, and for the assessment of potential moisture entrapment when applying them as repair mortars. The validation and improvement of empirical formulations for permeability will allow a more cost and time effective mortar development. The authors will research the subject profoundly, using multiple binder types, varying grain sizes and varying recipes.

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