Size Effect on the Compressive Strength of Natural Hydraulic Lime Mortars

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ABSTRACT

A study has been carried out in order to determine the size effect on the compressive strength of lime mortars. This type of material is typically used in restoration of historical buildings, especially those made with masonry and earthen materials. The reason is mainly due to its lower stiffness in comparison with the substrate material, which makes them compatible. Owing to the usual structural role that lime mortars must undertake in such situations, it is required to properly know their mechanical properties.

Two different lime mortars were studied, one of dry consistency and one of fluid consistency, with water/lime ratios of 0.8 and 1.1, respectively. A full characterisation of these materials was performed [1], including compressive strength (f_c), tensile strength (f_t), elastic modulus (E) and fracture energy (G_F). The standard tests of the compressive strength for lime mortars (f_{c1}) are performed on prisms of 40×40×80 mm^3, by loading through two opposite square plates centred on the longest specimen side [2]. Additionally, compressive tests on cylinders (75 mm in diameter and 150 mm in height) were carried out (f_{c2}).

The notorious difference between f_{c1} and f_{c2} suggests the existence of size and geometry effects. This has been studied through a numerical model done with ATENA [3], a commercial finite-element programme that is able to simulate fracture of quasi-brittle materials through a crack band model. The model geometry reproduces the configuration of compressive tests with prisms but modelling the mortar with f_{c2} for the compressive strength.

The numerical maximum loads of both mortars fit very well the experimental ones which means that the measured f_{c1} is obtained. This implies that f_{c2} is very close to the real intrinsic strength (f_c) and f_{c1} is the result of a size effect. These two conclusions are confirmed by the size-effect law of both mortars, obtained each with the aid of two additional numerical analyses with specimen sizes of 80×80×160 mm^3 and 160×160×320 mm^3, respectively, by following the procedure described in [4].

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