

The rheological properties of low cost grouts

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Abstract

Grouting is the most used technique to consolidate the masonry heritage buildings. In general, the materials most used for consolidation are based on polymeric resins, some of them showed little compatibility and are irreversible. In Portugal, the majority of grout materials used is imported. Thus, the use of cement-based grouts with mineral admixtures contributes with a technical feasible low cost solution with double benefit for the environment: reducing wastes and consumption of natural resources.

The objective of this work was to verify the effect of different mineral admixtures on the cement-based grout rheological behaviour and evaluate the methods used to determine the rheological properties of fresh grout. The Marsh funnel test and rheometer test was applied to characterize the fresh properties of grouts produced with a Portland Cement 32.5 and different kinds of mineral admixture including: fine sand, metakaolin, limestone powder and silica fume. The grout mixtures have a constant water/binder ratio of 0.33 and a superplasticizer Sikacrete 3002 was used to attain the Marsh funnel flowing time of 22 ± 2 sec. The grout fresh water bleeding was measured and the hardened grout flexural and compressive strength was determined at the age of 28 days.

A group of binary grout mixture was prepared with Portland cement plus 10% and 5% of limestone powder (L10, L5), Portland cement plus 10% and 5% of fine sand (S10, S5) and Portland cement plus 10% and 5% of metakaolin (M10, M5). Ternary grout mixtures were composed of Portland cement plus 5% silica fume and 5% sand (SF5S5), Portland cement plus 5% silica fume and 5% limestone powder (SF5L5), Portland cement plus 5% silica fume and 5% metakaolin (SF5M5), Portland cement plus 5% sand and 5% limestone powder (S5L5) and Portland cement plus 5% metakaolin and 5% sand (M5S5).

The results shows that the mixtures M10, SF5S5 and SF5L5 required the maximum (3%) mass percentage of superplasticizer to attain the Marsh funnel required value, while the mixture M5 used the minimum (1.5%) mass percentage of superplasticizer. The highest values of water bleeding were observed in the mixtures where the sand was incorporated: S10, S5 and M5S5. Tixotropic behaviour was observed only on the SF5S5 and SF5L5 mixtures. The torque x speedy curves shows a nonlinear behaviour of grouts that is adequate represented by Herschel-Bulkley model. Summarising the rheological results, in general the grouts studied demands a very low initial torque and the lowest viscosity results of ternary mixtures was obtained with the grouts without silica fume, it was the case of M5L5 and S5L5.

The main conclusion is that the Marsh funnel test has a limited level of accuracy compared with the rheometer test, because it was observed different plastic viscosity values for a same Marsh funnel result. In addition, it was concluding that the silica fume incorporation increases the viscosity and the sand incorporation increases the water bleeding of grouts.