Influence of temperature on the rheology of pastes and selfcompacting mortars with sustainable binders

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ABSTRACT

The use of ternary cements, is one of the strategies investigated to improve sustainability in construction. However, in construction sites, concrete and mortars with ternary cements and high dosages of admixtures show a high variability in rheological properties, especially with temperature changes. Supplementary materials have an effect in the hydration rate of ternary cements, and curing temperature has proved to be a key parameter in the rheological evolution since directly influences the hydration process. For small increments of admixtures, temperature is also a key parameter on the stability of the mixes.

A better understanding of the temperature influence on the rheological properties and stability of cement pastes and mortars is the main objective of this work. A series of pastes and mortars with different dosages of PCE HRWR superplastizier were tested using Viskomat rheometer. SP dosage was selected in agreement with the w/b ratio (0-1.25% for 0.4 w/b; and 2-3.5% for w/r of 0.3) so samples had a similar initial slump of 300 mm (±50mm). The temperatures studied were 5ºC, 10ºC, 20ºC and 37ºC for the mortars, and 20ºC and 37ºC for cement pastes. The three cement types were a Portland cement used as a reference (R1) and two blended cements prepared in the laboratory (SF2 has 64% of R1, 26% of slag and 10% of fly ash; SL1 has 64% of R1, 30% of slag and 6% of limestone).

To estimate the rheological parameters several rheological models were checked (power, modified Bingham, Herchel-Bulkley). Before accepting a model, the physical correspondence to the type of behavior that is trying to predict was checked. Power model gives the best fitting for all experimental results with pastes, and power and Herchel-Bulkley models for experimental results with mortars.

Conclusions show that mortars with higher values of viscosity (lower w/b ratio and higher SP dosage) are more sensitive to temperature for small increments of PCE; this is consistent for the two PCE tested. Increment in temperature is positive for the structural building-up for blended cements mortars, while for the reference mortar there is a strong loss of workability.

At 20 ºC, fluidity index of pastes with R1 cement are less sensitive to the increment of the SP dosage than blended cements. However, the influence of the type of admixture is larger for pastes with cement R1 that for blended cements at any w/b ratio. This temperature dependency is most pronounced for pastes with cement R1 and SF2.

REFERENCES

[1] A. Hallal; Kadri,; E.H. Ezziane; A. Kadri; H. Khelafi. "Combined effect of mineral admixtures with superplasticizers on the fluidity of the blended cement paste", *Construction and Building Materials*, 24, pp. 1418–1423, (2010).

[2] M. Nehdi; S. A. Marini. "Estimating time and temperature dependent yield stress of cement paste using oscillatory rheology and genetic algorithms", *Cement and Concrete Research*, 39, pp. 1007-1016, (2009).