EFFECT OF MINERAL ADDITIONS ON THE OPTIMUM DOSAGE OF SUPERPLASTICISERS IN GROUTS

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The use of mineral admixtures such as limestone powder or filler (LSP) or ground granulated blast furnace slag (GGBS) affects the interaction between superplasticiser (SP) and cement. At the same time, the interaction between LSP and/or GGBS and cement is also modified by the type and SP dosage. This research has applied a new approach to analyse Marsh cone test results and to explore the compatibility between two particular mineral admixtures (LSP and GGBS) and two SPs (SP1 and SP2).

In this research, the water/solids ratio was kept at 0.40 for cement grouts with different percentages of GGBS and/or LSP. Grouts with different SP1 or SP2 dosages have been produced and their flowability has been evaluated through the Marsh cone 7-min flow time, according to the standard EN 445: the time it takes for 1.2 litres of grout to pass the 10 mm opening of the cone has been measured for all grouts after 7 minutes mixing.

For each solids combination, exponential curves have been fitted to the experimental results by means of nonlinear regression to obtained the so-called flow curve: flow times vs SP dosage.

The saturation point, or optimum dosage, of a superplasticiser is the point beyond which additional superplasticiser is of no benefit. This point is often determined visually, and there are a number of definitions based on the slope of the flow curve. The authors have introduced a new definition based on the efficiency of increasing amounts of superplasticiser: the saturation point or optimum SP dosage has been defined as the point beyond which no time reduction higher than 10 seconds is possible by adding 1% o/binder of superplasticiser.

By testing 100% cement grouts, it has been concluded that SP1 is more efficient than SP2, and this has been shown to modify the way LSP or GGBS affect grouts flowability.

Previous studies concluded that LSP at contents higher than 20% improves the dispersion of all solid particles and enhances compatibility between cement and SP. The results of this are coherent with previous findings: using LSP implies a general reduction of flow times. This reduction is especially important when the superplasticiser used is SP2, which has been identified as the less performant. Therefore, the addition of LSP is positive not only from the point of view of the grout fluidity but can also counterbalance a possible lack of efficiency of the superplasticiser.

Replacing cement with GGBS has a negative impact on grout flowability, implying a general increase of flow times, especially when the superplasticiser used is SP2, which is the less performant: this causes a severe loss of compatibility between cement and superplasticiser SP2. There are several aspects that can explain the negative impact of GGBS

on flow times reported here. First, the flaky shape of GGBS particles might be increasing the friction close to the cone orifice when the grout is flowing out of the Marsh cone. Second, the size distribution of GGBS is rather narrow when compared to that of the LSP: this can mean an inefficient lubricating role of GGBS particles. Third, it is possible that differences between SP1 and SP2 include the fact that some fraction of SP2 is adsorbed onto the GGBS particles while this does not happens with SP1. This could be a consequence of the different composition of SP1 and SP2 and needs to be further explored, for instance by looking for possible changes in the zeta potential. And fourth, having only 50% of cement in the grout increases the average interparticle distance between cement particles and SP molecules. All these aspects may be at operation together.

Since the use of LSP implies a general decrease of flow times, while the use of GGBS has proved to have a contrary effect, it would be reasonable to expect that these effects are someway counterbalanced when both mineral admixtures are used simultaneously. However, this is not the case. There is a general reduction in flow times when both mineral additions are used together, regardless of the superplasticiser used. Therefore, it can be concluded that the effect of these mineral additions on flow times is not simple: they not only interact with the cement and superplasticiser but also between themselves. This interaction has turned out to be advantageous for the flowability of the grout.

However, the problem is not trivial and cannot be generalised, since there are many conflicting cases that can be found in previous literature. It is therefore of paramount importance to carry out preliminary tests to study the compatibility between mineral admixtures and superplasticiser rather than relying in general assumptions.

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