Abstract

The objective of this experimental work is to study shrinkage in self compacting concrete (SCC) in which part of the fines limestone aggregates have been replaced by granulated slag of blast furnace (GBFS). The consumption of natural resources is reduced by using slag as aggregate, allowing a more sustainable construction. Nevertheless the use GBFS could modify the mechanical properties of concrete and also the microstructure and the hydration process.

In order to analyse the influence in the shrinkage of replaced aggregates by GBFS seven types of SCC are manufactured with a water/binder relationship of 0.55. Different content of slag (0%, 10%, 20%, 30%, 40%, 50% and 60%) is used. This work also includes the study mechanical properties, microstructure and porosity.

The results show that replacement fines aggregates by slag sand produces mixtures with a greater volume of pores and slightly finer pore structure. At an early age SCC with higher content of slag tend to obtain compressive strength lower due to a bad aggregates packing, although the strength increases with time due to the reactivity of the slag. In fact, at the age of 365 days, mortars produce with 50% of GBFS instead of cement achieve a similar compressive strength than mortar manufactured with 100% of the cement. The consumption of calcium hydroxide during the hydration of the GBFS and also the formation of CSH improve the mechanical properties of interface slag-paste.

When GBFS mortars is analysed using scanning electron microscopy is observed a concentration of Al and Mg atoms in the interface slag-

paste, so spread of slag to paste components is happen. The highest concentrations are reached in a strip of 5μm around the GBFS.

Using QNM (Quantitative Nano-mechanical) tests, is observed that the deformation modules are similar in pastes made of siliceous aggregate inert and those made with GBFS. Nevertheless in a thin strip of 5μm slightly increase in the modulus of elasticity (between 5 and 10 GPa) is observed in the GBFS pastes.

By the other hand, autogenous shrinkage and drying shrinkage increases as the increase the percentage of fines aggregates replace by slag. This is due to several reasons: the higher deformability of concrete (greater porosity); the largest self- desiccation due to the hydration of clinker; and the chemical shrinkage produced by the reactivity of the slag. In fact, total shrink of GBFS concrete is an 4% higher than the pattern concrete, when the fine aggregates is replace by a 10% of slag, and 44% higher for a 60 % of sand replaced.