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DESIGN OF COLOURED SELF-COMPACTING CONCRETE MADE WITH CRUSHED VULCANIC AGGREGATES

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ABSTRACT

The main goal of this research work was to design coloured self-compacting concrete (SCC) compositions produced from materials available in the Autonomous Region of Madeira (RAM). One of the main problems associated with concrete industry in RAM is the unavailability of natural rolled aggregates. In fact, all the aggregates available in the RAM are crushed aggregates and come from volcanic origin. Furthermore, additions (limestone filler, metakaolin, silica fume, blast furnace slag, etc.) considered as essential constituents in the production of SCCs are difficulty of access with competitive price. Thus, this paper addresses the difficulties of designing SCC compositions in the RAM and the problem of incorporating liquid pigments to produce coloured SCCs. To ensure self-compacting properties of the concrete a third generation superplasticizer and fly ash were used.

This paper reports the most important results of experimental work carried out at the laboratory of the company 'Cimentos Madeira'. SCC compositions were designed considering volumetric ratios of the constituent materials. The introduction of pigments and superplasticizer was performed by substitution of equal volume of water. Pastes, mortars and concrete tests were carried out in order to evaluate the effect of some of the constituent materials on the self-compacting properties, the dosages of superplasticizer and effect of incorporating pigments composition being emphasised.

Keywords: fresh properties, self-compacting concrete, coloured concrete, liquid pigments.

PRELIMINARY RESULTS

The experimental work started with the study of pastes in order to analyse the effect of the fly ash and the superplasticizer. Subsequently, it was concluded by testing pastes that an incorporation of fly ash decrease the water content necessary to obtain a given flowability (Gp - Fig. 1) or to obtain a given viscosity (Marsh funnel time - Fig. 2). As expected, a similar effect was observed for the superplasticizer content: the higher superplasticizer content the higher flowability and the lower Marsh funnel time (valid for Sp/p<~5%, in fact the use of superplasticizer in high amounts - above the saturation dosage - did not produce major changes in terms of viscosity and flowability. Contrary, as can be seen in Fig. 3, all pigments produced the effect of decreasing the flowability. It is also observed that the yellow and orange pigments produced a more dramatic effect.

At the level of mortar, a reference composition was designed with self-compacting properties, i.e. with ~250 mm of flow diameter and ~10 s of V-funnel time [1, 2]. Then, it was needed to

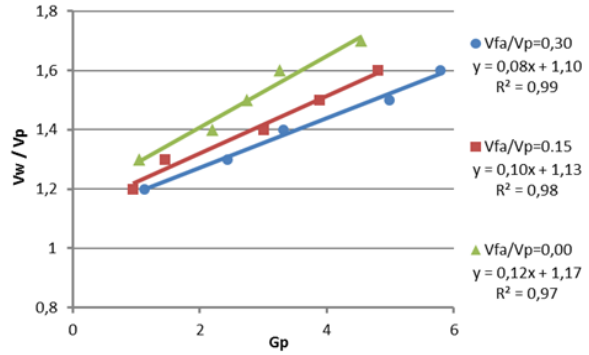

Fig. 1 - Determination of the βp in pastes Vfa/Vp = 0, 0,15 and 0,30

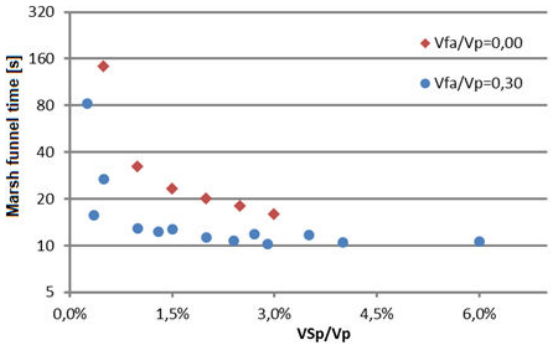

Fig. 2 - Effect of the superplasticizer content on the flow time of the Marsh funnel test

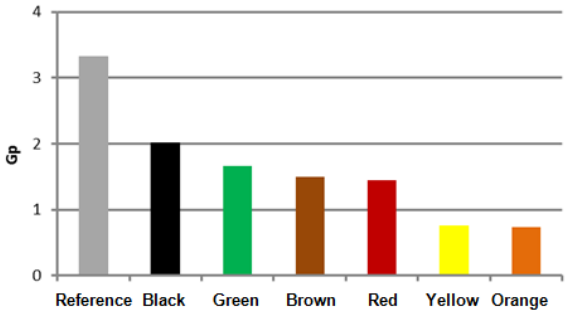

Fig. 3 - Effect of the pigment on the Gp: V_{pig}/V_p=10%, V_w/V_p=1,4, V_{fa}/V_p=0,30

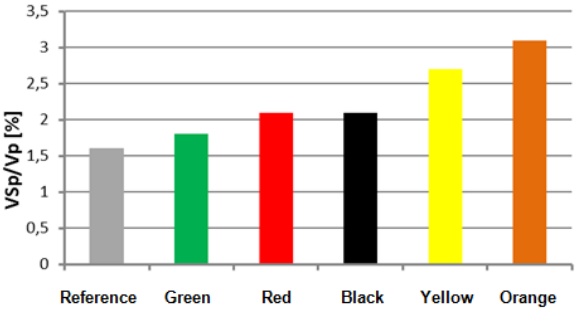

Fig. 4 - Superplasticizer content needed to obtain self-compacting properties in coloured mortars

adjust the superplasticizer content in the coloured mortars (to ensure self-compacting properties). Analysing Fig. 4 one observes that results are in agreement with Fig. 3 because the orange and yellow pigments needed more superplasticizer. With the results previously obtained in pastes and mortars, a concrete composition was defined as a reference. Then, coloured SCC compositions were produced (V_{pig}/V_p=10%), the superplasticizer being adjusted by comparison with Fig. 4. Finally, the slum-flow, V-funnel, L-box and the segregation tests [1] were performed to characterize fresh properties of the coloured SCCs.

FINAL REMARKS

It was possible to produce SCCs with materials available in RAM (crushed gravels and sands from volcanic origin and without limestone fillers, etc.). Moreover it was possible to produce coloured SCCs by incorporating liquid pigments. However, the incorporation pigments substantially reduced the concrete self-compacting properties.

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