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Sulfate Resistance of Blended Cements (Limestone Illite Calcined Clay) Exposed Without Previous Curing

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1 Introduction

This paper presents a comparison of the performance of blended cements with filler and two different illite calcined clays against sulfate attack without the previous curing prescribed by the standards (Ikumi *et al,* 2017) to evaluate sulfate resistance when supplementary materials are used. For this, pastes and mortars was molded to evaluate the mineralogical changes and the evolution of physical and mechanical properties during the external sulfate attack (ESA).

2 Materials and Methods

CEM I 52.5 R with high C3A-content (8.2%), limestone filler (LF) and two different illitic calcined clays (ICC) from Olavarria, Buenos Aires Province (Argentine) were used. For these two ICCs, the Frattini test was positive after 14 days (Lemma *et al,* 2015). The SCM replacement in all binders was set to 30% by cement weight: a binary filler cement (C30F), a binary illitic red calcined clay cement (C30CCR), a binary illitic orange calcined clay cement (C30CCO), a ternary red illitic blended cement (C15F15CCR) and a ternary orange blended cement (C15F15CCO). Mortar prisms and cement paste cubes were fabricated and exposed to a sodium sulfate solution after 2 days. Comparison of sulfate resistance was based on the expansion, mass variation, visual appearance and compressive strength. Furthermore, the evolution of microstructure of blended cements exposed to sodium sulfate solution was characterized by XRD tests on the external surface and the core of cement-blended pastes.

3 Results and Conclusions

Expansions of mortar bars in sulfate solution are shown in Fig. 1. C30F mortar reaches the limit of 0.10% at 38 days. C30CCR reaches the limit of 0.05% at 252 days, which is after the threshold of 6 months established by the ASTM standard to be considered as a sulfate resistant cement. Compressive strength on mortars is shown in Fig. 2. At 90 days, C30F cured in sulfates has practically lost its compressive strength, indicating severe degradation caused by ESA. Compositions with the 30 % ICC replacement present a significant increase of the compressive strength during the 28 - 90 days period in aggressive conditions. At 90 days, the strengths obtained even reach higher values than the ones obtained in non-aggressive conditions.

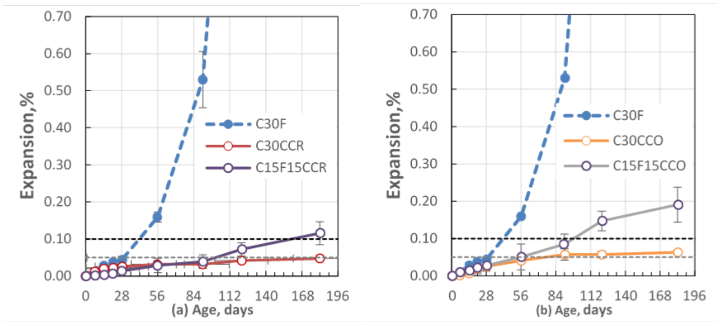

Figure 1. Expansion on sodium sulfate of mortar following ASTM 1012. (a) Blended cements with ICCR and (b) blended cements with ICCN.

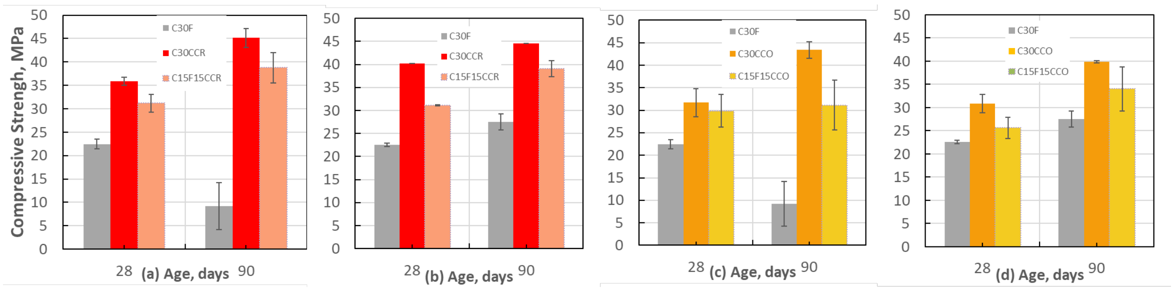

Figure 2. Compressive Strength of mortars, (a) C30CCR, C15F15CCR cured in sulfate, (b) C30CCR, C15F15CCR cured in water, (c) C30CCO, C15F15CCO cured in sulfate, (d) C30CCO, C15F15CCO cured in water.

The results of this studies shows that the pozzolanic reaction of calcined clay in mortars is similarly developed in aggressive and non-aggressive curing conditions, consuming the CH and blocking the sulfate ingress due to pore size refinement. The AFm phases formed during hydration in water were converted to ettringite when pastes are exposed to sulfate solution, but the mortar shows no expansion and retains the compressive strength at 6 months. These experiences show that despite the lack of curing prior to sulfate exposure, cement with the replacement of 30% of an illitic calcined clay shows great resistance to ESA, while limestone cements presented a worse performance.

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