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Study of Autogenous Self-Healing in Different Mortar Formulations

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1 Introduction

Autogenous self-healing of cement-based materials is a topic of current interest, and is the result of various chemical, physical and mechanical interactions (Kishi, Ahn, Hosoda, Suzuki, and Takaoka, 2007). This research analyzed the influence of constant hydration, environmental conditions and the incorporation of other elements such as binders and additions on the self- healing of longitudinal cracks. Their evolution has been evaluated measuring the water absorption by capillarity and by optical microscopy.

2 Experiment

2.1 Materials

This study used four types of mortars based on Portland Cement, one containing CEM II and the other three formulated with CEM I and different additions: fly-ash; nanosilica and hydraulic lime. The dimensions of the specimens were 100x100x40 mm and were reinforced with galvanized steel mesh (12.7 mm × 12.7 mm with Ø = 0.8 mm), which was embedded at the top and the bottom of the pieces. The longitudinal cracks were caused by a point load.

2.2 Environmental Exposure

The effect of the environmental conditions on the cracks repair has been evaluated. Factors such as humidity and temperature can affect self-healing (Suleiman and Nehdi, 2018). Specimens were exposed to 3 different environments: water immersion, curing chamber at 20 ± 2°C and 95 ± 5% of relative humidity (RH) and the laboratory at 25 ±5°C and 65% ± 5% RH.

2.3 Analysis of Self-Healing Products

The water absorption test was used to effectively evaluate the self-healing performance of cement-based materials (Park and Choi, 2018) and optical microscopy was used to observe the cracks surface (Homma, Mihashi, and Nishiwaki, 2009). In this research water absorption test by capillarity was performed according to UNE-EN 1925 and to observe the evolution of the cracks the Motic Stereoscopic Microscope was used. The tests were performed before cracking, upon cracking, and after exposing the specimens to the environmental conditions in

periods of 7, 15, 30 and 60 days.

3 Results and Discussion

The water absorption test by capillarity showed the variation of the absorption coefficient over time in the 3 environmental conditions to which the samples were exposed. In water immersion, the absorption coefficient diminished with timespecimens with cracks exhibited a lower with time. This confirmed the self-repair of the cracks and the formation of hydration products. These results were confirmed with optical microscopy, where the sectors analyzed showed a total repair after 60 days of water immersion. Fig 1.

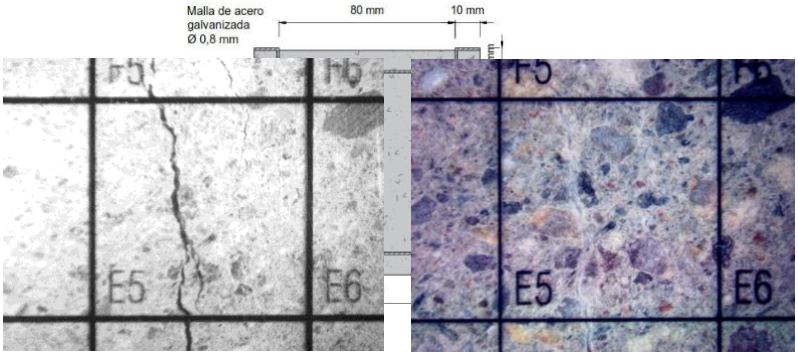

Figure 1. Sector before and after 60 days of water immersion.

4 Conclusions

The results obtained allow us to establish that constant hydration is an essential factor for the development of the self-healing mechanism. Under water immersion all the samples show self-healing of cracks, no matter the additions of the mortar formulation. Size of the crack is also an important factor to allow self-healing. The product formed during self-healing to fill the crack is mainly calcium carbonate.

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