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Efficacy of Crystalline Admixtures in Self-Healing Capacity of Fibre Reinforced Concrete

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Abstract : The purpose of this paper is the characterization of the effects of crystalline admixtures on concrete. Crystallites, aided by the presence of humidity, form idiomorphic crystals that block cracks and pores resulting in reduced porosity. In this project, two types of crystallines have been employed. The hydrophilic nature of crystalline admixtures helps the components to react with water and cement particles in the concrete to form calcium silicate hydrates and pore-blocking precipitates in the existing micro-cracks and capillaries. The underlying mechanism relies on the formation of calcium silicate hydrates and the resulting deposits of these crystals become integrally bound with the hydrated cement paste. The crystalline admixtures continue to activate throughout the life of the composite material when in the presence of moisture entering the concrete through hairline cracks, sealing additional gaps. The resulting concrete exhibits significantly increased resistance to water penetration under stress. Admixtures of calcium aluminates can also contribute to this healing mechanism in the same manner. However, this contribution is negligible compared to the calcium silicate hydrates due to the abundance of the latter. These crystalline deposits occur throughout the concrete volume and are a permanent part of the concrete mass. High-performance fibre reinforced cementitious composite (HPFRCC) were produced in the laboratory. The specimens were exposed in three healing conditions: water immersion until testing at 15 °C, sea water immersion until testing at 15 °C, and wet/dry cycles (immersion in tap water for 3 days and drying for 4 days). Specimens were pre-cracked at 28 days, and the achieved cracks width were in the range of 0.10–0.50 mm. Furthermore, microstructure observations and Ultrasonic Pulse Velocity tests have been conducted. Based on the outcomes, self-healing related indicators have also been defined. The results show almost perfect healing capability for specimens healed under seawater, better than for specimens healed in water while inadequate for the wet/dry exposure in both of the crystalline types.

Keywords : autogenous self-healing, concrete, crystalline admixtures, ultrasonic pulse velocity test
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