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Numerical simulation of self-healing process and its mechanical regain in cementitious materials

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The research project presented in this paper aims at a thorough characterization of the self-healing capacity of the cementitious composites, i.e. their capacity to completely or partially re-seal cracks and, in case, also exhibit recovery of mechanical properties. This subject will be investigated with reference an ordinary concrete under different types of environmental exposure, including accelerated temperature cycles at constant relative humidity, climate chamber, air exposure and water immersion. The effects of proprietary additives to engineer the self-healing capacity will also be investigated. With reference to three-point-bending tests performed up to controlled crack opening and up to failure, respectively before and after exposure/conditioning recovery of stiffness and stress bearing capacity will be evaluated to assess the self-healing capacity.
The Solidification-Microprestress-Microplane (SMM) model [1] for concrete, which makes use of the microplane model M4 and the solidification-microprestress theory, is able to reproduce, as deeply demonstrated, all the prominent behaviors of concrete, such as creep, shrinkage, thermal deformation, aging, and damage/cracking starting from the initial stages of its maturing up to the age of several years. This model uses the moisture and heat fields, as well as, the hydration degree, which are obtained from the solution of a hygro-thermal-chemical problem [2]. This model is extended for incorporating the self-healing effects. In particular, the delayed cement hydration and/or the action of particular additives, which are the main cause of the self-healing, are modelled, as well as the effects of cracking on the diffusivity.
Numerical examples will be presented to validate the computational model developed and to show its capabilities. The numerical simulations will deal with the analysis of concrete specimens described above. The numerical examples will show that the proposed model properly describes the self-healing regain of mechanical strength under hygro-thermal different conditions and it can be a useful tool for the analysis of concrete structures and their durability.

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