Numerical simulation of autogenous reactions in self-healing concrete

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ABSTRACT

Self-repair of small cracks in concrete can be achieved by the synergetic action of different mechanisms, ranging from the naturally occurring hydration and carbonation reactions to the engineered incorporation of super absorbent polymers and encapsulated bacteria within the concrete matrix [1]. This work focuses on the study of the course of autogenous hydration and carbonation reactions, activated by the ingress of moisture and carbon dioxide across the crack surface and which results in the precipitation of solid phases at the crack. Despite this mechanism can repair moderate crack widths (<300 µm), the chemical reactions taking place are relevant to both other self-healing mechanisms and to the assessment of material durability.

With that goal in mind, a multi-component flow model in a porous material is considered, in which the reaction kinetics of the different compounds are taken into account [2]. A mixed finite element formulation is implemented to guarantee local mass conservation and flow continuity across elements [3].

Results of the numerical simulation this model provide the spatio-temporal evolution of critical compounds such as portlandite, calcite, carbon dioxide and moisture. This information allows to build estimates of the healing capacity of the system, as well as to obtain indicators of changes in the pH that directly couple with the corrosion risk in reinforced concrete.

REFERENCES