

Can Self-Healing Mechanism Helps Concrete Structures Sustainable?

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Abstract

Concrete is quasi-brittle material making it prone to cracking under external and/or imposed tensile or shear stress. In case of continuous network of crack is formed, concrete structure becomes permeable and embedded rebar may be exposed to ambient air, hence escalating the risk of material degradation. For retaining structures, crack endangers the liquid tightness and diminishes its functionality. This crack may jeopardize the integrity and durability of concrete structures as well as hamper its service life.

On the other side, concrete infrastructures industry is facing pressing sustainability issues. Concrete production consumes high amount of energy and produces large amount of CO₂ emission. The scale of the problem is even greater in the event of many concrete structure premature failure which consumes more raw material for rebuilding. Designing new infrastructures for longer service life by improving concrete (materials and structure) durability is one solution to overcome the dilemma. One promising concept is by incorporating self-healing mechanism found in nature into cement-based materials / concrete structural element.

This paper presents inherent autogeneous healing which occur due to its heterogeneous nature of concrete. This contribution also demonstrates some laboratory proven bio-inspired techniques that makes concrete materials and/or structural element self-healing autonomously. It involved diverse methods of embedding (micro)capsules and installing brittle tube, both containing healing agents. The Porous Network Concrete which mimic bone morphology and healing mechanism is elaborated as well in this article. Using chemical-based, cement-based, and alkaliphilic bacteria-based healing agent this bone-like concrete was able to self-heal by the mechanism of feedback loop. The methods designed have demonstrated to have a good prospect in making concrete structural element self-healing. Finally the paper concludes with the claim that If unavoidable cracks due to inherent brittleness in concrete could be self-sealed/healed/repared, concrete structure will certainly serve longer service life, making it more durable, therefore sustainable.

Keyword: Self-healing concrete, bacteria-based healing agent, Porous Network Concrete, Bio-inspired engineering.