

LABORATORY AND FIELD INVESTIGATION OF THE PERFORMANCE OF NOVEL MICROCAPSULE-BASED SELF-HEALING CONCRETE

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Abstract

Concrete, a composite material consisting of aggregates bound together with cement paste, is the most widely used construction material. Concrete is relatively cheap, very versatile and has excellent compressive strength. However, its tensile strength is limited and for this reason steel rebars are often added to create reinforced concrete (RC). Cracking inevitably occurs in all RC materials and associated structures due to a variety of mechanical and environmental actions. The generation of tiny microcracks within concrete facilitates the flow of potentially aggressive fluids that can corrode the embedded steel rebars and, in extreme cases, lead to premature structural failure.

Concrete, along with all cement-based materials, does possess some inherent self-healing capacity and is able to heal certain-size cracks autogenously. This self-healing capability is very limited and therefore researchers have attempted to improve upon it by using a variety of techniques. In particular, the use of engineered additions for autonomic self-healing has gained significant interest in the past two decades. An example is the addition of microcapsules that disperse throughout the hardened material subsequently providing reservoirs of healing agents. When cracks arise within the material, they rupture the embedded microcapsules causing a release of their contents into the crack volume. The released material then reacts to provide filling, sealing and healing of the crack.

The primary aim of this research project was to investigate the autonomic self-healing performance of concrete containing microencapsulated sodium silicate. The effect of microcapsule addition on the fresh, hardened and self-healing properties of cement, mortar and concrete were all explored. Self-healing was monitored using a variety of techniques and results reveal the increased self-healing ability of microcapsule-containing cementitious materials as well as the efficacy of sodium silicate as a healing agent. Furthermore, the self-healing concrete field trial displays the great potential for microcapsules to be incorporated into large-scale self-healing concrete applications.