Bio-Engineered Concrete: A Sustainable Self-Healing Material

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Environmental pollution occurs as landscape mutilation, carbon dioxide emission, and energy consumption due to mass-scale concrete production. Cracked concrete has a reduced strength, reduced service life, and can ingress corrosive materials that bring the need for maintenance, repair, and replacement. With the investigation of a self-healing mortar to heal and bond a broken beam through the metabolic precipitation of calcite (limestone) by bacteria, the performance and lifespan could be improved, which would reduce the aforementioned pollution. To test the capabilities of the bacteria, Bacillus magaterium, in a mortar mix, bacteria concentration and fly ash percentage (to make the mix environmentally friendly) were manipulated. Beams, cubes, and brick stacks were constructed to test for tensile, compression, and bond strength, respectively. After testing, several cubes and beams were placed in a water-calcium lactate solution to attempt to reactivate the bacteria to stimulate self-healing processes through precipitation of limestone. The composition of 15% fly ash and lower concentration of bacteria was, on average, the most effective mix, although statistically, it insignificantly performed better. This was attributed to not having the proper curing time for fly ash, the inconsistent nature of unreinforced concrete, and the small number of samples tested. Most notably, the bacteria were reactivated and the precipitation of limestone by bacteria was viable. This precipitation increased the bond strength and the limestone filled and covered some cracks: meeting the project goal to produce a self-healing mortar that could heal a crack to allow for the reusing and recycling of concrete beams.

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