Role of Microbially Mediated Mineralization in Healing the Cracks in Cementitious Materials

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Concrete is one of the most widely used construction materials on Earth and at the same time cracking is one of the most deleterious parameters for concrete durability. Although there are various approaches to heal the cracks, microbial healing approach, based on biomineralisation, is distinguished by its potential due to the efficient bonding capacity and compatibility with concrete compositions. Microbially induced calcium carbonate precipitation, a type of biomineralisation, is a promising way and widely researched in recent years in construction engineering to heal the cracks in cementitious materials. For this purpose, ureolytic bacterium such as *Bacillus cereus* or *Acinetobacter* sp. was introduced into artificial cracks created in cement mortars. The compressive strength, water absorption capacity, and porosity of those repaired mortars were tested in order to know the remediation efficiency.

The calcium carbonate precipitation induced by bacterial cells enhanced the compressive strength by 55-62% after treatment of cracked mortars compared to control repaired ones, while ureolytic process led to 40-45% reduction in water absorption in mortars after healing. The porosity of healed specimens was reduced significantly. The healed parts on cement mortars were visualized under scanning electron microscopy that depicted biominerals and crystal morphology alongwith rod-shaped bacterial cells. The responsible functional chemical groups in biominerals formation were elucidated by Fourier-transformed infrared spectroscopy. The biominerals were later identified (mainly as calcite) by X-ray diffraction.

The mechanism of crack healing in bacterial mortars occured through metabolic conversion of calcium source, used to grow bacterial cells, to biominerals (identified as calcium carbonate) that resulted in healing of cracks. This microbially mediated process can result in efficient sealing of sub-millimeter to millimeter sized cracks. There are many cultural heritage items made up of cementitious materials and results of this study can be implemented in repairing those structures as well.