

Analysis and Improvement of Compressive Strength in Self-Healing Concrete by Using Bacteria

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This research focuses on the impact of bacterial activity, specifically the direct addition of *Bacillus subtilis*, *Bacillus megaterium*, and their combination, on the compressive strength of self-healing concrete, to address the issue of concrete's inherent micro-cracks, which can lead to structural degradation and the infiltration of harmful substances. This causes steel corrosion, carbonation, chloride ion erosion, and sulfate erosion, resulting in structural deterioration. Previous researchers have introduced urease-producing bacteria and added a calcium source to the concrete mix, resulting in calcite precipitation. This bacterial biomineralization by utilizing *Bacillus* bacteria can prevent and repair micro-cracks in concrete structures. This study aims to develop sustainable self-healing concrete by controlling micro-cracks using *Bacillus* bacteria by analyzing the mechanisms of which *Bacillus* bacteria enhance compressive strength, microstructural changes, CaCO₃ precipitation, and bacterial growth impact. The compressive strength test, SEM analysis, and water absorption test were conducted to investigate the natural ability of *Bacillus* bacteria to produce CaCO₃ and heal concrete cracks. The results show that *Bacillus subtilis* concrete exhibits the highest increase in compressive strength at 25%, followed by the combination of bacterial concrete with a 23.4% improvement, and *Bacillus megaterium* concrete with a 16.2% increase in compressive strength compared to conventional concrete. Additionally, bacterial concrete exhibited low water absorptivity, indicating a high healing capability compared to conventional concrete. In the combination bacterial concrete, SEM analysis indicates that extending the curing duration enhances the healing efficiency. The combination bacterial concrete exhibited slightly lower compressive strength and healing efficiency compared to *Bacillus subtilis* alone but higher than *Bacillus megaterium* alone and significant improvements compared to conventional concrete. Therefore, the combination bacterial concrete appears to strike a balance between compressive strength enhancement and healing capabilities. This can be used in high-strength concrete structures to reduce the costs and challenges associated with external intervention in harsh environments.

Keywords: Self-healing concrete, Compressive strength, *Bacillus subtilis*, *Bacillus megaterium*, Healing efficiency