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Feasibility study on the use of microalgae as an external crack healing agent for cement mortar rehabilitation

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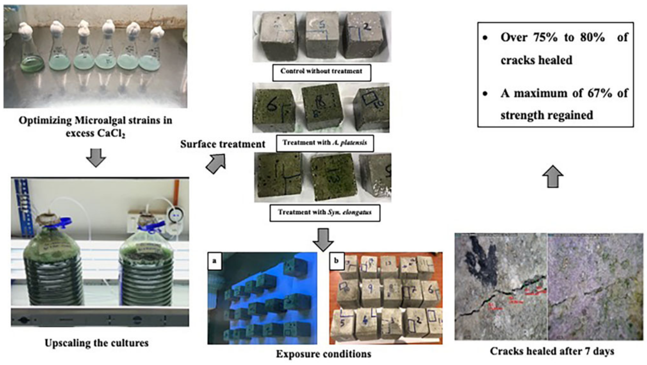
As conventional concrete repairs have shortcomings and impact the environment, multiple attempts exist to find alternative sustainable measures to address this issue. Microbial-induced carbonate precipitation (MICP) using microalgae is one of the proven methods that can heal microcracks. In this study, the method used in repairing microcracks is by spraying microalgae species, namely, *Arthrospira platensis* and *Synechococcus elongatus*, cultured in a high calcium-based medium onto the surface of the cement mortar. The crack healing was evaluated for 14 days after the cracks were induced by applying 65–70% of the maximum threshold load. The results show that the microalgal-treated specimens exhibited a higher strength recovery, crack closure, and less water absorption than the control specimen. It is also observed that over 75–80% (0.26 mm, approx.) of the cracks can be healed within the span of 14 days sustainably using microalgae.

Graphical abstract



HIGHLIGHTS

- This research investigated the healing capacity of cracked cement mortar by applying a microalgal solution on the surface externally.
- The study proves that microalgae are a better and more eco-friendly way than other external chemical agents to crack repair.
- A maximum of 67% strength was regained in 14 days of treatment with *Arthrospira platensis*.
- Over 75–80% of cracks can heal after spraying microalgae.
- Comparing SEM and XRD polymorphs, $CaCO_3$ precipitation was identified as Vaterite and Calcite.

Keywords: MICP; *Arthrospira platensis*; *Synechococcus elongatus*; bio-coating; blue-green microalgae; crack restoration

1. Introduction

Concrete has been widely used in bridges, roads, buildings, etc. The number of existing concrete structures is enormous and rapidly increasing as the world develops. The expeditious urbanization over the past few decades has increased the use of concrete and played an essential role in the remarkable economic prosperity of the world [1]. More than 7 billion cubic meters of concrete are used in the world on a global average, which is predicted to reach four times the level [2].

The rapid increase in the use of concrete is a concern for the present and future environment due to its high carbon dioxide emissions. Ordinary Portland Cement (OPC) is the most prevalent precursor material used as a binder in concrete [3]. The OPC produces about 6% of the global anthropogenic CO_2 emissions [4–6]. In the current global setting, building construction and operation result in 50% of all CO_2 emissions worldwide. The fact that the cement is produced about 3.5 billion tonnes are produced annually, and China uses about 57.3% of it [4,7]. There are

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