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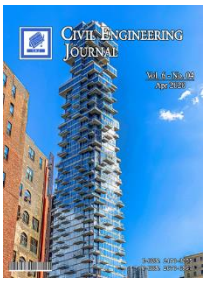

Healing of Generated Cracks in Cement Mortar Using MICP

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Abstract

This research is carried out to investigate pre-existing repair cracks in cement mortar using the microbiologically induced calcium carbonate precipitation (MICP) technology. In the study, 20-cylinder mortar samples (45 mm in diameter and 40 mm in length) were split to have cracked width of various sizes. Out of twenty cracked samples, sixteen samples of average crack width ranging from 0.12 to 1.3 mm were repaired using the MICP method, while four cracked samples, with an average crack width ranging from 0.16 to 1.55 mm were soaked under distilled water. The water permeability and split tensile strength (STS) of these repaired mortars were tested. The amount of $CaCO_3$ precipitated on the cracked mortar surfaces was evaluated. The results indicated that the MICP repair technique clearly reduced the water permeability of the cracked samples within the range of 73 to 84 %; while water-treated samples were too weak to undergo test. MICP-repaired samples had STS ranging from 29 to 380 kPa after 24 rounds of treatment. A relationship between the STS and percentage amount of $CaCO_3$ precipitated was observed for samples with an average crack width between 0.29 and 1.1 mm, which indicated that STS increased with percentage increase in $CaCO_3$ precipitated on the crack surfaces.

Keywords: MICP; Split Tensile Strength; Cement Mortar; Permeability.

1. Introduction

The generation of cracks in concrete is a natural phenomenon due to earthquakes, weathering or manmade activities which will adversely affect the life and durability of the structures. The measure cause of the crack is due to lower tensile strength and brittle nature of concrete. The harmful pollutants, chemicals, and water penetrate through the cracks which lead to deterioration of concrete. The present methods existing to repair such cracks are the use of chemicals, grout, or surface treatment which could be harmful to the end-users as well as to the environment. Eco-friendly, sustainable and new technique MICP as the new area of interest is a substitute to repair cracks [1]. MICP process depends on ureolytic non-pathogenic bacteria (*Bacillus pasteurii*) to hydrolyze urea in the presence of calcium ion which leads to calcite precipitation. Purified bacterial cells, containing the enzyme in high concentrations, were used to catalyse the hydrolysis of urea and produce ammonium and carbonate ions. Urease enzyme decomposes urea into ammonium (NH_4^+) and carbonate ions (CO_3^{2-}). The combination of this negative carbonate ions and positive Calcium ions (Ca^{2+}) available from cementing solution, result in the formation of Calcium Carbonate. The reactions involved are as follows:

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