Sustainability of Enzyme-Mediated Calcite Precipitation Method as an Environmental-Friendly Soil Improvement Technique

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ABSTRACT

This study discussed the applicability of enzyme-mediated calcite precipitation (EMCP) as an environmental-friendly soil improvement technique. The natural zeolite of mordenite was added to the prepared grouting materials composed urea-urease to remove the produced ammonium ions. The effects of the utilization of mordenite on the EMCP parameters such as amount, pH, the mineralogical substance of the precipitated minerals, and the improvement in the strength of treated soil were also evaluated. The ammonium ion measurements showed that the use of 10 g/L of zeolite with a 2-hr mixing time could reduce the concentration of ammonium ions by 43% of the maximum theoretical concentration in urea concentrations of 1.0 mol/L. UCS tests results showed that the grouting solutions brought about a significant improvement in the soil strength. A precipitated material of 9% of the sand mass was produced by three PV injections of grouting materials, which showed a sufficient unconfined compressive strength of 0.3 MPa. The results of this study have confirmed that the application of natural zeolite of mordenite to the EMCP technique may be an alternative environmental-friendly soil improvement technique.

Keywords: EMCP, Calcite, Zeolite, Ammonium, UCS, Environmental-friendly soil improvement

1. INTRODUCTION

Enzyme-mediated calcite precipitation (EMCP) techniques have been confirmed as the potential method for improving the engineering properties of soil [1], [2]. The strength of improved sand ranging from 200 kPa to 1.6 MPa, depending upon the amount of precipitated calcite can be achieved, and the permeability of the treated samples can be reduced by more than one order of magnitude [1], [3]. In this technique, an enzyme of urease is employed to dissociate the urea into ammonium and carbonate.