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**STRENGTH AND STIFFNESS
IMPROVEMENT OF BIO-CEMENTED
SYDNEY SAND**

By

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B.Eng. (Hons) (Civil Engineering), M.Sc. (Geotechnical and Geological Engineering)

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Doctor of Philosophy
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**THE UNIVERSITY OF
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ABSTRACT

This thesis explores the performance of small scale cemented soil columns produced using soil mixing with cement resulting from bacterially mediated reactions that precipitate calcium carbonate, a process often referred to as bio-cementation. Bio-cementation has received considerable research attention over the last decade as it has the potential to complement existing ground improvement techniques and mitigate environmental concerns with currently used materials. Previous research has concentrated on pumping and injection techniques because of concerns that bacteria will be unable to survive the stresses associated with industrial mixing processes, however it has been difficult to create uniform bio-cemented soil masses. In this thesis the ureolytic bacterium, *Bacillus Megaterium*, not previously reported in bio-cementation studies, has been investigated to determine its viability and efficiency as a microbe for mediating the calcite precipitation. It has been found that the highest hydrolysis rate is recorded when calcium concentrations are double the urea concentrations, and that significant amounts of calcite can be precipitated in a single mixing process. Unconfined compressive strength (UCS) tests and a series of triaxial tests have been conducted to quantify the effects of the bio-cementation on the mechanical response. Bender elements mounted in the triaxial cell have also been used to monitor the shear wave velocity during curing and shearing. The results of mechanical tests on the bio-cemented sand have been compared with tests on gypsum cemented and uncemented specimens. It has been found that bio-cementation by mixing produces homogeneous specimens with similar strengths and stiffnesses to the commonly used flushing or injection technique. To assess the performance of in-situ mixed, 38 mm diameter, bio-cemented sand columns a small scale in-situ mixing technique was used to create the model columns. Foundation tests have been performed at 1-g in a cylindrical tank with diameter of 600 mm. A significant improvement was observed in the response of foundations when placed on bio-cemented columns, and this was similar to the improvement from more conventional gypsum cements. These tests confirmed the feasibility of using an in-situ mixing technique with bio-cementation and provided valuable insight into the factors that must be considered in developing field applications.

This thesis also has demonstrated repair strategies and techniques to encourage healing and self-healing should damage occur in foundations. Results from tests performed to investigate the ability of biocement to repair cemented soil columns are reported.

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