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Mechanical Characterization of Biocalcified Sand

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Extended Abstract

A new method of soil improvement has emerged during the last decade: the Microbial Induced Carbonate Precipitation (MICP). This technique enhances the resistance and stiffness of cohesionless soils by the precipitation of calcite through the control of bacterial activity and an optimization of pH [1]. The first step consists in injecting S. pasteurii simultaneously with an urea medium in the soil. After a certain period, the bacteria spread and grow uniformly. A cementation liquid composed of urea, ammonium chloride, nutriments, sodium bicarbonate and calcite chloride is then injected periodically at low flow into the soil until the desired degree of cementation is achieved.

This new method has been explored recently by many authors due to its high efficiency, low environmental impact and diversity of applications. DeJong, et al. [2], Montoya, et al. [3], Mortensen and DeJong [4], van Paassen [5] have conducted many researches on stiffness and strength enhancement and have demonstrated that the MICP is an effective remedial solution to poor soil stability and resistance. According to Suer, et al. [6], this method is less toxic than the jet-grouting (the most comparable method), requires less energy and can treat a soil along a larger radius of action. Finally, in 2005, an article written by almost all active researchers in this field have listed the potential applications based on four criteria: implementation, rate of success, cost/ viability and social acceptance [7]. Applications with the highest potential include structural repair, soil improvement, soil liquefaction mitigation, erosion control and shallow carbon sequestration.

Most of the publications on the subject documented the potential of this technique, the biological process, the methods of injection (percolation or injection) and optimization possibilities. The objective of the present research project was to study the mechanical behavior of a biocalcified soil and to develop a constitutive law suitable to this new geomaterial. To this end, the research was performed in three stages:

1. First, a series of CIU (undrained shear stress) tests were conducted on various samples. The objective was to evaluate the maximum shear stress and the rigidity under the variation of two conditions, the amount of calcite precipitate and the consolidation pressure.
2. Secondly a constitutive model was developed, based on the previous data and the critical state concept.
3. Finally, the constitutive law developed in the second phase was implemented in a finite element model of a CIU test. The objective was to reproduce the behavior obtained in laboratory tests in terms of forces and interstitial fluid pressures.

The presentation will deal with the results and model obtained in the stage one and two.

References

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