Optimization of Enzyme-Mediated Calcite Precipitation as a Soil-Improvement Technique: The Effect of Aragonite and Gypsum on the Mechanical Properties of Treated Sand

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The effectiveness of magnesium as a substitute material in enzyme-mediated calcite precipitation was evaluated. Magnesium sulfate was added to the injecting solution composed of urea, urease, and calcium chloride. The effect of the substitution on the amount of precipitated materials was evaluated through precipitation tests. X-ray powder diffraction and scanning electron microscopy analyses were conducted to examine the mineralogical morphology of the precipitated minerals and to determine the effect of magnesium on the composition of the precipitated materials. In addition to calcite, aragonite and gypsum were formed as the precipitated materials. The effect of the presence of aragonite and gypsum, in addition to calcite, as a soil-improvement technique was evaluated through unconfined compressive strength tests. Soil specimens were prepared in polyvinyl chloride cylinders and treated with concentration-controlled solutions, which produced calcite, aragonite, and gypsum. The mineralogical analysis revealed that the low and high concentrations of magnesium sulfate effectively promoted the formation of aragonite and gypsum, respectively. The injecting solutions which produced aragonite and calcite brought about a significant improvement in soil strength. The presence of the precipitated materials, comprising 10% of the soil mass within treated sand, generated a strength of 0.6 MPa.

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