EGU General Assembly 2024

EGU24-2980, updated on 19 Jan 2025
https://doi.org/10.5194/egusphere-egu24-2980
EGU General Assembly 2024


# Study on methodology and efficiency of microbially induced carbonate precipitation on improvement of marine silty sand

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The demand for ground improvement of marine sediments has been risen in construction of offshore infrastructures, including wharves, embankments and breakwaters. In recent years, microbially induced carbonate precipitation (MICP) has developed rapidly and become an alternative technology for increasing soil strength and limiting soil erosion. Silty sand is widely distributed in offshore areas throughout the world. The high salinity of seawater may have an impact on the bacterial activity, while the fine particles in silty sand would affect the transportation of cementation solution and the formation of carbonate precipitation. In this study, attentions are paid to the application of MICP on improvement of marine silty sand properties, as well as the factors influencing the hydraulic conductivity and strength of the bio-cemented soil. Multi-gradient domestication tests on *Sporosacina pasteurii* were carried out to ensure the bacterial and urease activities in seawater environment. It was found that the bacterial concentration and urease activity after five-gradient domestication in seawater reached 98.5% and 92.8% of those in the deionized water environment, respectively. The permeability, unconfined compressive strength (UCS) and content of carbonate precipitation of bio-cemented specimens were measured. The MICP treatment on silty sand with seawater resulted in an increase of UCS to 700 kPa and a reduction of permeability by an order of magnitude, corresponding to a carbonate content of 8%. X-ray diffraction (XRD) and scanning electron microscopy (SEM) were performed to investigate the types and distributions of carbonate crystals. The results indicated the formation of calcium carbonate and magnesium carbonate crystals due to the interaction between carbonate ions and calcium and magnesium ions in seawater. The precipitations were distributed on the surfaces of soil particles and near particle contact points, affecting the soil microstructure and thus the strength and permeability. The influences of concentration and injection rate of cementation solution on the efficiency of MICP were demonstrated and the recommended values were given. This study may provide a possible solution for improvement of engineering properties of marine silty sand foundations.