

Laboratory-scale model of carbon dioxide deposition for soil stabilisation

ABSTRACT

Olivine sand is a natural mineral, which, when added to soil, can improve the soil's mechanical properties while also sequester carbon dioxide (CO₂) from the surrounding environment. The originality of this paper stems from the novel two-stage approach. In the first stage, natural carbonation of olivine and carbonation of olivine treated soil under different CO₂ pressures and times were investigated. In this stage, the unconfined compression test was used as a tool to evaluate the strength performance. In the second stage, details of the installation and performance of carbonated olivine columns using a laboratory-scale model were investigated. In this respect, olivine was mixed with the natural soil using the auger and the columns were then carbonated with gaseous CO₂. The unconfined compressive strengths of soil in the first stage increased by up to 120% compared to those of the natural untreated soil. The strength development was found to be proportional to the CO₂ pressure and carbonation period. Microstructural analyses indicated the presence of magnesite on the surface of carbonated olivine-treated soil, demonstrating that modified physical properties provided a stronger and stiffer matrix. The performance of the carbonated olivine-soil columns, in terms of ultimate bearing capacity, showed that the carbonation procedure occurred rapidly and yielded a bearing capacity value of 120 kPa. Results of this study are of significance to the construction industry as the feasibility of carbonated olivine for strengthening and stabilizing soil is validated. Its applicability lies in a range of different geotechnical applications whilst also mitigates the global warming through the sequestration of CO₂.

Keyword: Olivine; Soil stabilisation; CO₂ deposition; Climate change; Unconfined compressive strength; Microstructure analysis