Utilization of alkali-activated olivine in soil stabilization and the effect of carbonation on unconfined compressive strength and microstructure

ABSTRACT

This paper reports for the first time the stabilization of soil using olivine and the application of novel techniques utilizing alkaline activation and carbonation. A rigorous study addressed the effect of carbon dioxide pressure and alkali concentration (10-M sodium hydroxide soil additions from 5 to 20%) between 7 and 90 days. Microstructural and compositional changes were evaluated using microscopic, spectroscopic, and diffraction techniques. Results demonstrate the advantages of using olivine in the presence of NaOH and the associated increases in soil shear strength of up to 40% over 90 days. Samples subjected to carbonation for a further 7 days led to additional increases in soil strength of up to 60%. Microstructural investigations before and after carbonation attributed the strength development to the formation of Mg(OH)2, hydrated magnesium carbonates, and M─S─H, A─S─H gel phases. The impact of this work is far reaching and provides a new soil stabilization approach. Key advantages include significant improvements in soil strength with a lower carbon footprint compared with lime or cement stabilization.

Keyword: Olivine; Carbonation; Alkalies; Compressive strength; Stabilization; Soils; Microstructure