Stabilization of silty sand using bentonite-magnesium-alkalinization : Mechanical, physicochemical and microstructural characterization

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ABSTRACT

This paper investigates the mechanical, physicochemical, and microstructural characterization of treated silty sand using a novel additive. The additive from a mixture of bentonite, magnesium chloride, and alkaline solution was introduced for stabilization of soil. Atterberg limits, compaction, pH, and unconfined compressive strength (UCS) tests were used to assess the mechanical and physicochemical properties of the stabilized soil. Further investigation results on the optimum designed sample are discussed based on microstructural analysis using X-ray powder diffraction (XRD), field emission scanning electron microscopy (FESEM), Energy Dispersive Spectroscopy (EDS), and Fourier transform infrared spectroscopy (FTIR). Two curing types: unheated and heated at 60 °C for 24 h, were observed at 7, 14, 28 and 60 days in ambient temperature. Overall, it was found that the chemical additive improved the compressive strength of the soil and the heated curing tests showed significant strength improvement. The mechanical and physicochemical results revealed an optimum mix to improve silty sand strength using the addition of 40% bentonite with an alkaline activator (SS/SH) ratio of 0.5, an alkaline activator-to-$MgCl_2$ (L/S) ratio of 0.7, and 3% $MgCl_2$ by dry weight of the soil under heat curing condition at 60 °C for 24 h. The microstructure analysis confirmed the formation of the cementitious products, such as calcium aluminium silicate hydrate (C-(A)-S-H) and magnesium silicate hydrate (M-S-H) in the treated sample.

KEYWORDS

Calcium bentonite; Magnesium chloride; Chemical stabilization; Silty sand Heat curing; XRD

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