World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:10, No:02, 2016

The Effect of Nanoclay on the Hydraulic Conductivity of Clayey Sand Soils

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Abstract : Soil structures have been frequently damaged during piping, earthquake and other types of failures. As far as adverse circumstances were developed subsequent to piping or other similar failure types, hydraulic parameters of soil such as hydraulic conductivity should be considered. As a result, acquiring an approach to diminish soil permeability is inevitable. There are many ground improvement methods to reduce seepage, which are classified under soil treatment and stabilization methods. Recently, one of the soil improvement methods is known as nanogeotechnology. This study aims to investigate the influence of Cloisite 30B nanoclay on permeability of compacted clayey sand soils. The samples are prepared by mixing two soil types, including Kaolin clay and Firouzkooh sand, in 1:9 and 1:5 clay:sand (by mass) proportions. In experimental procedure, initially, the optimum water content and maximum dry unit weight of each samples were obtained for compaction. Then, series of permeability tests were conducted by triaxial apparatus on prepared specimens with identical relative density of 95% of maximum dry density and water content of 1% wet of optimum for different weight percentages of nanoclay (1% to 4%). Therefore, in this paper, the effect of time on treated specimen was appraised, as well as two approaches of manual mixing and ball milling were compared to reveal the importance of dispersion issue. The results show that adding nanoclay up to 3%, as its optimum content, causes notable reduction in permeability (1.60e-03 to 5.51e-05 cm/s and 3.32e-04 to 8.44e-07 cm/s in samples with 1:9 and 1:5 mixture proportions, respectively). The hydraulic conductivity of treated clayey sand (1:5 mixture proportion with 3% nanoclay) decreases gradually from 8.44e-07 to 3.00e-07 cm/s within 90 days and then tends to be consistent. The influence of mixing method on permeability results shows that the utilization of ball mill mixing effectively leads to lower values than those of manual mixing, in other words, by adding 3% nanoclay, hydraulic conductivity of specimen declines from 8.44e-07 to 2.00e-07 cm/s. In order to evaluate the interaction between soil particles and, to ensure proper dispersion of nanoparticles through clayey sand mixture, they were magnified by means of scanning electron microscope (SEM). In conclusion, the nanoclay particles in vicinity of moisture can cause soil stabilization to prevent water penetration, which eventually result in lower usage of clay and operation costs.

Keywords : nanoclay, cloisite 30b, clayey sand, hydraulic conductivity
Conference Title : ICSMGE 2016 : International Conference on Soil Mechanics and Geotechnical Engineering
Conference Location : Paris, France
Conference Dates : February 22-23, 2016