World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:15, No:04, 2021

Wetting Induced Collapse Behavior of Loosely Compacted Kaolin Soil: A Microstructural Study

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Abstract : Collapsible soils undergo significant volume reduction upon wetting under the pre-existing mechanically applied normal stress (inundation pressure). These soils exhibit a very high strength in air-dried conditions and can carry up to a considerable magnitude of normal stress without undergoing significant volume change. The soil strength is, however, lost upon saturation and results in a sudden collapse of the soil structure under the existing mechanical stress condition. The intrusion of water into the dry deposits of such soil causes ground subsidence leading to damages in the overlying buildings/structures. A study on the wetting-induced volume change behavior of collapsible soils is essential in dealing with the ground subsidence problems in various geotechnical engineering practices. The collapse of loosely compacted Kaolin soil upon wetting under various inundation pressures has been reported in recent studies. The collapse in the Kaolin soil is attributed to the alteration in the soil particle-particle association (fabric) resulting due to the changes in the various inter-particle (microscale) forces induced by the water saturation. The inundation pressure plays a significant role in the fabric evolution during the wetting process, thus controls the collapse potential of the compacted soil. A microstructural study is useful to understand the collapse mechanisms at various pore-fabric levels under different inundation pressure. Kaolin soil compacted to a dry density of 1.25 g/cc was used in this work to study the wetting-induced volume change behavior under different inundation pressures in the range of 10-1600 kPa. The compacted specimen of Kaolin soil exhibited a consistent collapse under all the studied inundation pressure. The collapse potential was observed to be increasing with an increase in the inundation pressure up to a maximum value of 13.85% under 800 kPa and then decreased to 11.7% under 1600 kPa. Microstructural analysis was carried out based on the fabric images and the pore size distributions (PSDs) obtained from FESEM analysis and mercury intrusion porosimetry (MIP), respectively. The PSDs and the soil fabric images of ‘as-compacted’ specimen and post-collapse specimen under 400 kPa were analyzed to understand the changes in the soil fabric and pores due to wetting. The pore size density curve for the post-collapse specimen was found to be on the finer side with respect to the ‘as-compacted’ specimen, indicating the reduction of the larger pores during the collapse. The inter-aggregate pores in the range of 0.1-0.5μm were identified as the major contributing pore size classes to the macroscopic volume change. Wetting under an inundation pressure results in the reduction of these pore sizes and lead to an increase in the finer pore sizes. The magnitude of inundation pressure influences the amount of reduction of these pores during the wetting process. The collapse potential was directly related to the degree of reduction in the pore volume contributed by these pore sizes.

Keywords : collapse behavior, inundation pressure, kaolin, microstructure
Conference Title : ICUSSE 2021 : International Conference on Unsaturated Soils and Soil Engineering
Conference Location : Rome, Italy
Conference Dates : April 08-09, 2021

Open Science Index, Geotechnical and Geological Engineering Vol:15, No:04, 2021 publications.waset.org/abstracts/133193.pdf