MICRO-MECHANICS OF COLLAPSE IN LOESS

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There are good reasons that 'collapse' is among the most crucial hazards to the built environment. The term 'collapse' belongs to a group of destructing soil problems that either instantly or progressively modifies the ground and in particular destructs inter-particle bonds responsible for much of soil's strength and stiffness. Bonding materials rearrange, leaving behind the soil's quartz skeleton vulnerable to contract to a degree, which is a factor of the operating external conditions.

Since the geochemistry of soil was not explicit enough to the geotechnical engineering community, engineers dread the riddle of collapse mechanism. As such, there is almost no treatment available to exclusively tackle the collapsibility. There are however the widely practiced densification techniques, which were made available over a century ago. These, nonetheless, have been occasionally reported not effective enough to combat the collapse problem.

Densification strategies do, on classic and fresh reading of the evidences, have the hallmarks of failure to fully mitigate the collapsibility, and to secure the minimum subsidence in compacted grounds over seasonal changes. These evidences include the restoration of the collapsing microfabric upon wetting-drying seasons in both calcareous and non-calcareous soils, continuous grain crush particularly in transient loading environments, and the complex structure of poly-mineral bonds with slim chances to break upon wetting or loading.

This inefficiency often stems from a lack of in-depth understanding of collapsing soils' geochemistry and structure. The derivation of ground improvement practice specific to collapse is not the only area of limited progression, since the fundamental understanding of collapse has been suffering oversimplification due to the missing links between geology and geotechnical engineering.

In other words, it is not as simple as the collapsing soils representing deposits with open-packed structures, the compression of which can fully remove the collapse potential. As such, this research work commenced in January 2010 with the principal aim of identifying the contribution of individual loess components in collapse. Loess was studied as an assemblage of clastic quartz grains bonded together with primary and secondary clay, water film, carbonate, amorphous silica, sulphate and chloride, each of a specific micro-morphology, which was inherited from a lab-scale simulated genesis background.

This project sought for a better understanding of these constituents, as individuals and pairs, which then proceeded to classification of fine-grained (<63um in size) soils (including Loess), derivation of the collapse mechanism in the framework of a modified form of the principle of effective stress, prediction of collapse, identification of constraints to the current collapse mitigation strategies, and modification of strategies to relax these constraints.

- Research poster available here