Investigating the Engineering Properties of Kerman Soils and Factors Controlling their Collapsibility

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Extended Abstract

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Introduction

The problematic collapsible soils are deposits with wind origin that constitute about 10% of the total area of the earth. Several countries, including China, Russia, the United States, France, Germany, New Zealand, and Argentina have vast areas of collapsible soils. These deposits usually form a semi-stable honeycomb structure and are highly susceptible to sudden changes in the volume reduction due to becoming humid. Collapsibility and other related issues such as different subsidences, land cracks and landfalls seriously damage the infrastructures constructed on these soils.

By the growing rate of urbanization in different parts of the world, the probability of construction on these soils and consequently water availability for these soils will increase; as a result, humidity increases and the collapse of these soils may occur. Therefore, studying the behavior of these types of soils is very important. Over the past six decades, many researchers have studied the collapse mechanism of collapsible soils due to becoming humid. Discussions on this subject are summarized in three categories: traditional methods, soil structure studies, and soil mechanics-based methods. In the present work, collapsibility and its controlling factors in the soils of Kerman city are investigated.

Material and methods

To determine engineering properties of Kerman deposits in this research, the geotechnical information was gathered and 50 core samples were extracted from different parts of the city. The sampling points were selected such that they could have a high overlap. X-ray diffraction (XRD) was applied to determine the mineral type and soil structures while scanning electron microscopy (SEM) was used to study grain arrangement.

Results and discussion

Geotechnical characteristics of the samples collected from Kerman plain deposits include their physical and mechanical properties. Based on the obtained results, this fine-grained sediment generally includes two CL and CL-ML groups. The mineralogy studies of Kerman city soils show that the minerals in these deposits are mainly illite, chlorite, illite-smectite, calcite, quartz, and gypsum. In order to study the collapsibility level of the soils in Kerman through the field studies, samples were taken from different parts of the city and the tests were carried out to determine the physical properties, collapsibility index, and structural studies. Through the SEM analyses, samples related to Haft Bagh area, Motahhari Town, and Pedar Town revealed an open structure and intergranular pores and thus a high level of collapsibility. On the other hand, in the majority of samples taken from the central part of the city, such as Esteghlal Street, Azadi Square, Bahmaniyar Street, and Hafez Street, the soil aggregates generally have corner-to-corner connectivity, with no specific order in their structure, and the arrangement of the particles is random and irregular. The orientation of the particles mostly shows no sharp pattern. In addition to soil particles, they have shown random and disorientated cavities with small sizes, suggesting the density and compactness of the soil indicating a low to moderate collapsibility. In some areas (e.g., Pedar Township and Motahhari Township), crystalline salt and gypsum crystals are clearly seen. It is expected that by increasing the amount of water, these salts dissolve and their effects can be observed as dissolution cavities.

The dissolution of soluble crystals can also reduce the strength of the soil structure and ultimately lead to soil degradation. Calcite crystals are

also found in some places in the form of calcite cement among the grains, sometimes as single crystals, and sometimes as lime nodules within the soils of Kerman city. Among the stated criteria in this research, Denisov, Holtz, and Hill criteria, the Russian regulations and ASTM standards were employed to assess the potential of the studied soil collapsing. Based on the criterion of the construction regulations of Russia, it was found that the deposits of the city of Kerman are mainly collapsible (L>-0.1).

Moreover, based on the Denisov criterion (if e/eL>1.5 the soil is non-collapsible, if it is between 0.75 and 1.5, the soil is prone to collapsing, and if it is between 0.5 and 0.75, the soil is severely collapsible), soils of Kerman are within the range of collapse-prone soils. Finally, based on the ASTM criterion, in some areas of the city like Motahhari Town, Pedar Town, and Haft bagh, soils show a high collapsibility. In comparison, in the central parts of the city, the values of this criterion vary between 0.15 and 11, suggesting the presence of soils with a moderate collapsibility. Comparing the results obtained using these criteria it is seen that areas with a collapsible behavior are relatively similar collapsibility results are obtained.

Conclusion

Based on the achieved results, fine-grained sediments of Kerman city are mainly composed of CL and CL-ML groups. Mineralogy results indicate that the minerals in these deposits are mainly illite, chlorite, illite-smectite, calcite, quartz, and gypsum. SEM results for the central part of Kerman city confirm the compressed and densely compact form of soil particles. The results obtained, using the construction regulations of Russia show that the soils in the study area are collapsible. According to the Denisov criterion, they were found to be prone to collapse. Finally, based on the ASTM results for the central parts of the city, soils exhibit a low to moderate collapsibility. However, in some areas of the city, such as Motahhari and Haft bagh, soils show a complete collapsibility behavior.

Keywords: Collapsible Soil, Loess, Scanning Electron Microscopy images, Kerman

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