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Investigating and comparing the resistance characteristics of sandy soils with change in percentage of moisture and fine-grained characteristics

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Abstract
In nature, sandy soils are rarely clean and often contain some clay and silt. These fines grain have a significant effect on the resistance and dilation behavior of sandy soils. Therefore, in this study, resistance and dilation behavior of sand mixture with fine grains such as silt and clay using a small scale direct shear test have been studied. Tests are conducted on specimens of sand with various fine content ranging from 0 to 40%, density of 30, 60 and 90 percent and the samples are subjected to three normal stresses 0.5, 1.0 and 1.5 kg/cm^2 with two percent of optimum and saturation moisture. The test results show with increase in percentage of fine grains, the shear strength of sandy soil decrease and with increase in percentage of clay the shear strength decreases further. Also, dilation angle and angle of friction decreases with increase fine grains content and cohesion parameter increases with increase fine grains, Of course, it more increases with increase clay content and the rate of change of the cohesive parameter increases with increasing fine-grained percentage.

Keywords: *Direct shear test, Clay and silt, Shear strength, Internal friction angle, Dilation*

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Extended Abstract:

1. Introduction

Natural sand is usually not completely clean and contains significant amounts of fine-grained that include silt or clay. Numerous experiments have shown that the increment of fine-grained to the granular soil reduces the shear strength and porosity ratio of the soil, but this reduction in strength occurs to a certain extent from the amount of fine-grained and then, with increasing fine-grained, the soil strength increases. The amount of fine-grained to change the soil behavior is called the "amount of transitional fine-grained." In general, the amount of transitional fine-grained is the amount of fine-grained material that in lesser amounts of which, the behavior of the soil is controlled by the coarse-grained part of the soil, and in larger quantities, the soil behavior is controlled by the fine-grained part of the soil (Thevanayagam et al., 2000, Thevanayagam, 2000, Mitchell and Soga, 2005, Kenny, 1977). Shear strength of the sandy soils contains fine grains is one of the most important issues in geotechnical designs, and given that the behavior of materials is a function of several variables that none of them cannot be ignored, so mechanical tests under different conditions seem necessary. In this research, the effect of fine-grained and its type on sandy soil has been investigated using a small-scale direct shear test in different conditions and the shear strength of the mixtures and the parameters of internal friction angle and cohesion and dilation angle in different relative densities and under different overheads as well as with 2% of optimum and saturation moisture have been discussed.

2. Materials and methods

The materials used in this research are a dual mixture of coarse and fine grains. The coarse-grained part consists of sand and the fine-grained part consists of silt and clay.

In this research, soil samples with four different percent of fine-grains of 10, 20, 30 and 40 with two types of silt and clay fine-grains in three relative densities of 30, 60 and 90% were made under normal stress of 0.5, 1 and 1.5 kg/cm^2.

3. Results and Discussion

To determine the parameters of shear strength and angle of soil dilation in this study, a small scale direct shear test was used. Direct shear tests were performed with different amounts of fine-grained percentage and relative density with two types of silt and clay fine-grained and 2% of optimum moisture and saturation. Maximum shear strength and maximum friction angle and cohesive along with the dilation angle was calculated for the samples. The maximum tolerable shear stress was selected by the samples as the maximum shear strength. The internal friction angle is also obtained by plotting the maximum shear stress values for three different normal stresses.

Figure 1 shows the effect of fine-grained include silt and clay on the dilation angle at 60 and 90% densities for different normal stresses. As the percentage of fine-grains, both silt and clay, increases, the dilation angle of the samples decreases.

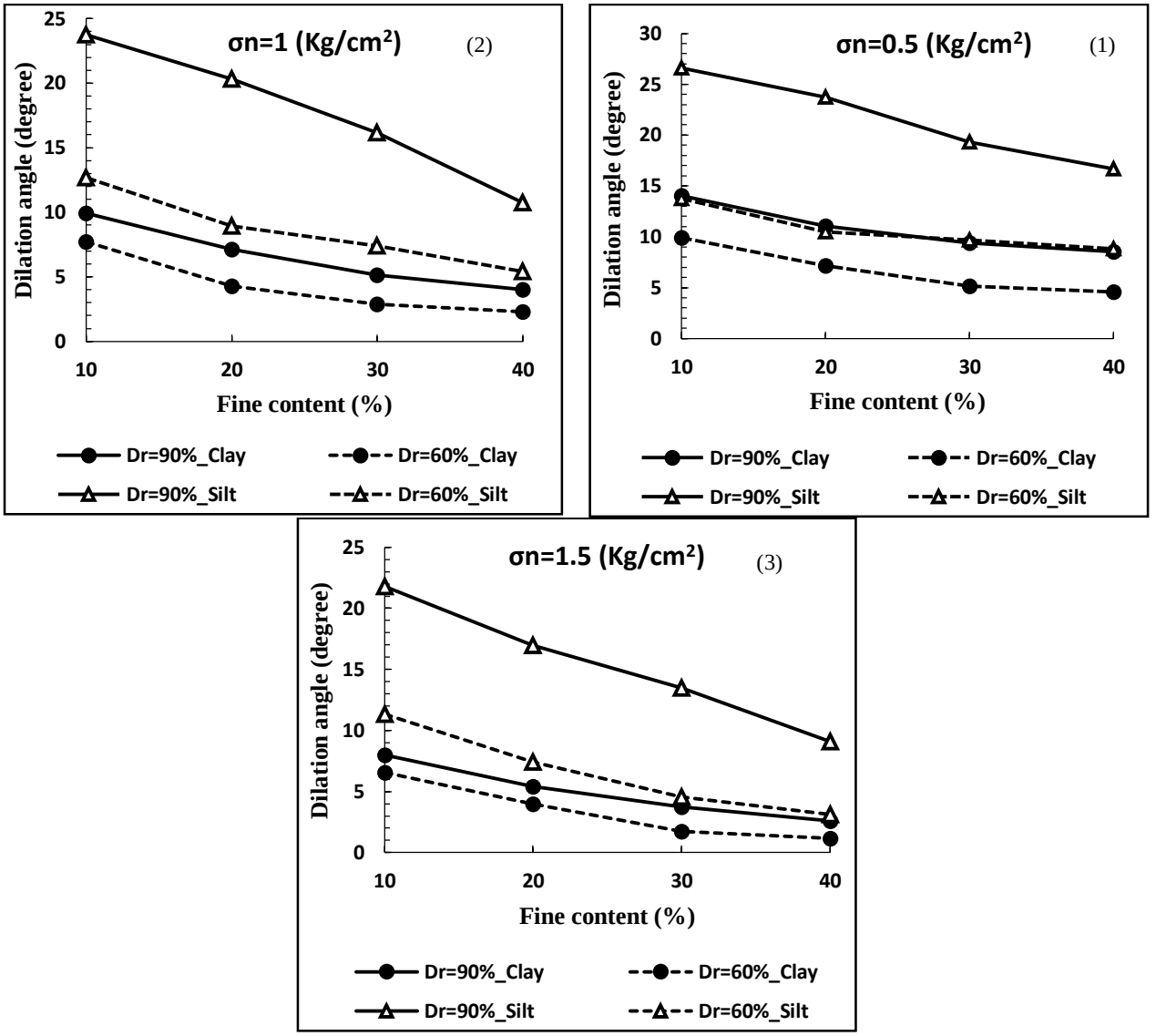

Fig.1. Comparison of the effect of fine-grained include silt and clay on the dilation angle in normal stresses (1): 0.5 kg /cm^2, (2): 1 kg /cm^2, (3): 1.5 kg /cm^2

According to the results of this study, in both types of mixed soils, the internal friction angle of the soil decreases with increasing fine-graines of both silt and clay. Figure 2 shows the graph of the effect of silt and clay on the maximum internal friction angle against the percentage of fine-grained for different relative densities.

Figure 3 also shows the graph of the cohesive parameter against the amount of fine-grained for the percentage of different relative densities of sandy soil combined with silt and clay. In both types of mixtures, the cohesive parameter increases with increasing fine-grained.

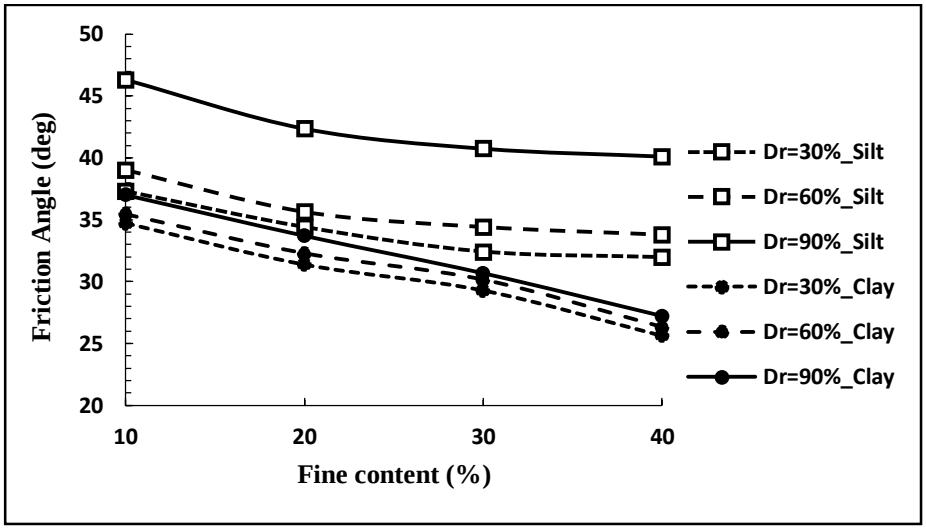

Fig. 2. Friction angle changes with different silt and clay percentages and relative densities

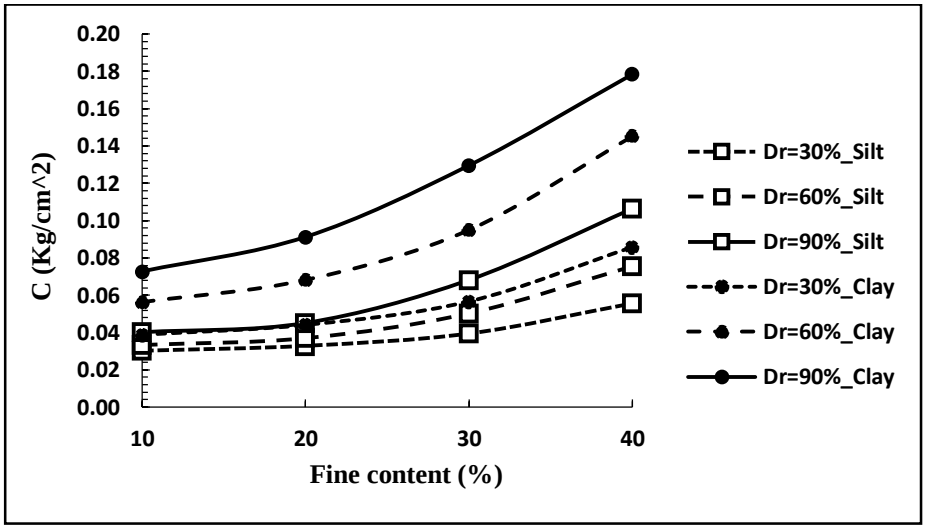

Fig. 3. Cohesive parameter changes with different silt and clay percentages and relative densities

4. Conclusion

In this research, small-scale direct shear tests were performed on sandy soils combined with two amounts of silt and clay in different density and moisture content to investigate the effect of type and amount of fine grains on sandy soil behavior. Finally, the results are as follows:

-In both types of mixed soils, with increasing both fine-grained include silt and clay, the internal friction angle of the soil decreases and in general the values of the friction angle of the clayey sand mixture are lower than the silty sand mixture.

-As the percentage of fine-grained, both silt and clay, increases, the dilation angle of the samples decreases.

-In both types of mixtures, with increasing fine-grained, the cohesive parameter increases and the cohesive values of clay samples are higher than silt samples. It should be noted that the moisture content is very important and effective in clay samples.

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