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The Effect of Fines on Threshold Shear Strain of Saturated Sands

S.M. Mir Mohammad Hosseini[1*], Mehdi Derakhshandi[2]

1- Professor, Department of Civil & Environmental Engineering, Amirkabir University of Technology, Tehran, Iran.
2-Assistant professor, Department of Civil Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran

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ABSTRACT

Threshold shear strain is one of the basic parameters of soil during cyclic loading condition. The threshold shear strain should be determined for evaluating pore water pressure generation due to earthquake, vibrating machine and all the cyclic loading which apply permanently or temporary on the soil. According to many scientific researches, the threshold shear strain is the strain, which there is no pore water pressure generation at the saturated soils and no volume changes at the dry conditions during cyclic loading. By increasing the shear strain more than threshold shear strain (γ_t), pore pressure increase is noticeable at the saturated soil and the soil microstructure starts to change. In this study, the effects of plastic and non-plastic fines on the threshold shear strain of saturated sands were evaluated by performing a number of cyclic triaxial tests with strain control method at small shear strain. All the specimens contained 0%, 10%, 20% and 30% plastic and non-plastic fines prepared by wet tamping undercompaction method. As a result, by increasing plastic fines more than 20%, threshold shear strain increased significantly. Moreover, by increasing non-plastic fines, threshold shear strain fluctuated. It first increased and then decreased.

KEYWORDS

Threshold Shear Strain, Saturated Sands, Plastic and Non-plastic Fines, Pore Pressure, Strain-controlled Cyclic Triaxial Test.

* Corresponding Author, Email: mirh53@yahoo.com

1- INTRODUCTION:

Pore water pressure is generated by the shear strain due to cyclic loading. Most of the previous fundamental studies of saturated sands have been concentrated on uniformly graded clean sands. However, the material sand deposits mostly contain fines and they are sometimes well graded. The fines can play an important role to initiate pore pressure generation during cyclic loading due to cyclic shear strain. To evaluate the threshold shear strain, in which pore pressure begins to build up, it is useful to study the effect of plastic and non-plastic fines content on the threshold shear strain of sand specimens. In this study, the effect of fines content on threshold shear strain of saturated sand were evaluated by performing a number of cyclic triaxial tests with strain control method at small shear strain.

2- METHODOLOGY, RESULTS and DISCUSSION,

All of the specimens contained Monterey # 0/30 sands with various content of plastic and none-plastic fines. The reconstituted specimens were constructed by moist tamping using the undercompaction technique at an initial relative density (DR) of 50%, saturated with a backpressure of about 80–90 kPa, and consolidated to an isotropic confining pressure of 100 kPa. Specimens were subjected to 50 sinusoidal cycles of axial strain at a loading rate of 0.1 Hz and pore pressure recorded during cyclic loading. The ranges of shear strain were 0.003% to 0.1%. All the specimens contained 0%, 10%, 20% and 30% plastic and non-plastic fines prepared by wet tamping undercompaction method.

Fig.1 shows the variation of excess pore pressure ratio versus shear strain after 10 cycles loading. As a result, by increasing plastic fines more than 20%, threshold shear strain increased significantly. Besides, by increasing non-plastic fines, threshold shear strain first increased then decreased. The effect of plastic fines on threshold shear strain of Monterey #0/30 is demonstrated in table 1.

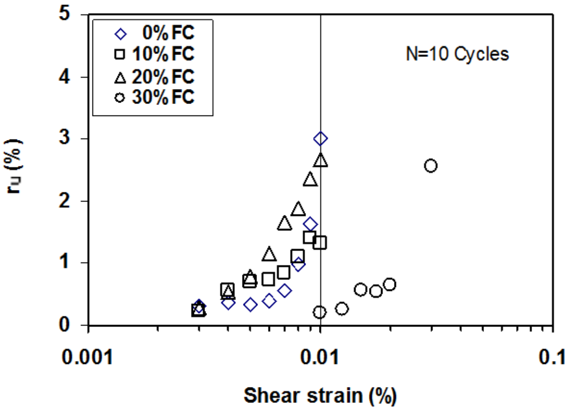

Fig.1. Excess pore pressure versus shear strain for the specimens contain Monterey #0/30 sand and variety of Kaolinite fines content

Table 1. Threshold shear strain and corresponding pore pressure for Monterey #0/30 sand containing plastic fines content

Fines contents (%)	0	10	20	30
Threshold shear strain (%)	0.008	0.006	0.006	0.025

3- CONCLUSION

In the saturated sands containing fines, pore pressure generation depends on types and quantity of fines during cyclic loading. In this research, threshold shear strain was defined as a shear strain in which the pore pressure ratio reaches to 1 percent. According to the results, for silty sand, threshold shear strain increased by increasing silt contents up to 10%. Subsequently, it gradually decreased by increasing silt contents more than 10%. For clayey sand the trend was reversed. By increasing plastic fines up to 10%, threshold shear strain decreased and for the specimens containing 10% to 30% plastic fines content, it increased so that threshold shear strain was determined 0.0125% for 30% plastic fine content. For 30% fine content, the plastic fines dominated the soil matrix and the soil responded more like clay.

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