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Effect of Plastic Fines on Undrained Resistance of Anzali Sand

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ABSTRACT

In this regard, plastic fines have been added to Anzali sand with diverse proportions and then triaxial monotonic tests have been implemented to find that how these fine contents can affect the sand undrained shear behaviour. All the prepared samples had the same initial dry density and were subjected to two different confining pressures. The results show that, in comparison to the clean sand, increasing the content of plastic fines from 0 to 30% results in a decrease in the undrained shear resistance of the samples, wherease this trend is reversed for the values of fine contents greater than 30%. In addition, the effect of plastic fines on the pore pressure generation was studied in the saturated sands. The results reveal that the specimens having up to 30% plastic fine contents generated larger values of pore water pressure than clean sand specimens. And for the larger amounts of fine contents, the excess pore water pressure decreased comparing to the clean sand.

KEYWORDS

Plastic Fine, Clay, Triaxial Test, Undrained Shear Strength, Pore Water Pressure.

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1- INTRODUCTION

Numerous studies have been performed to examine the effects of fines on the undrained behavior and liquefaction potential of the sands. For non- plastic fines, Namely, mostly empirical correlations from in situ tests shows that the presence of fines increases the liquefaction resistance (Seed HB., Tokimatsu K., Harder LF., Chung RM.), while the majority of laboratory tests shows that increasing the non-plastic fines content in a sand will either increase the liquefaction resistance of the sand, decrease the liquefaction resistance of the sand, or decreases the liquefaction resistance until some limiting fines content is reached, and then increases its resistance. The result of these studies report that increasing the silt content in a sand will either increase the liquefaction resistance of the sand (Chang et al.,1982; Dezfulian, 1982), decrease the liquefaction resistance of the sand (Shen et al., 1977; Tronsco and Verdugo, 1985; Finn et al., 1994; and Vaid, 1994), or decrease the liquefaction resistance until some limiting silt content is reached, and then increase its resistance (Law and Ling, 1992; Koester, 1994).

And for the plastic fines, Field studies by Tokimatsu and Yoshimi, (1983), indicate that the sands with more than 20 percent clay will not be liquefied. Seed et al. (1983), reached a similar conclusion. Ishihara (1993), reports two Japanese studies that predict the soils with greater than 10 percent clay are non-liquefiable. Additionally, the laboratory studies by Ishihara and Koseki (1989), and Yasuda et al. (1994), found a strong correlation between an increased plasticity of the fines and increased cyclic resistance. Lee and Fitton (1968) concluded that the addition of clay fines may increase the cyclic resistance of a soil, considerably.

2- METHODOLOGY

In order to determine the effects of fines content on undrained shear resistance of sandy soils, monotonic triaxial tests were performed on the specimens formed from various mixtures of sand and clay. Anzali sand has been used for all tests presented in this research. The clay used for the plastic portion of the fine-grained material consisted of commercially available kaolinite. Two series of 20 undrained triaxial compression tests were performed at two different initial isotropic confining pressures of 150 and 300 kPa. Clay contents of the soil mixtures varied from 0 to 45 percent by weight.

All the specimens in this study were constructed by the dry deposition method, which is performed by compacting soil in layers to a selected percentage of the required dry unit density of the specimen. The specimens typically 50 mm in diameter and 100 mm in height, were compacted in five layers. All the specimens were prepared in an initial dry unit densities of 1.64 (gr/cm^3).

The specimens were saturated and had a Skempton B value in excess of 96%. To facilitate the saturation process, carbon dioxide (Co_2) was first percolated through the specimens and then deaired water was flushed into the specimens. Lastly, a back pressure of 210 kPa was incrementally applied to accelerate the saturation rate. The specimens were then isotropically consolidated under two different effective confining stresses of 150 and 300 kPa. Following consolidation, undrained triaxial tests were carried out under strain- controlled conditions.

One of the issues of concern in this study was to assess the effect of aggregate content on the shear strength during monotonic loading and the deviatoric stress q is defined as:

$$q = (\sigma'_1 - \sigma'_3) \qquad (1)$$

where $\acute{\sigma}_1$ and $\acute{\sigma}_3$ are the principal effective stresses. The mean effective stress, p', and the excess pore pressure ratio, r_u are also defined as:

$$p' = \left[\frac{\sigma'_1 + 2\sigma'_3}{3}\right] - \Delta u \qquad (2)$$

$$r_u = \left(\Delta u / p'_0\right) \qquad (3)$$

where $\acute{p}_0$ is the initial confining stress.

3- MAIN CONTRIBUTIONS

Fig. 1 and Fig. 2 present the peak normalized strengths and the maximum excess pore pressure ratios of the mixed samples versus fines content at 150 and 300 kPa confining pressures. It is clear that, as the clay content increases up to about 30%, the peak strength decreases and the maximum of excess pore pressure ratio increased. With further increase in the clay content, the maximum excess pore pressure ratio is decreased and the peak strength is increased, however, the strength of clayey sand is less than the clean sand. This means that the soil becomes weakened with an increase in the clay content up to 30% and then strengthened again.

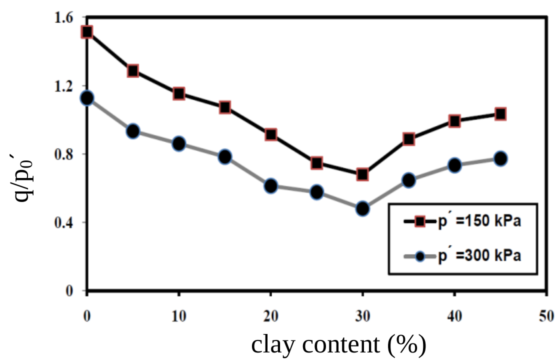

FIG 1. PEAK NORMILIZED STRENGTHS OF MIXED SAMPLES VERSUS FINE CONTENTS

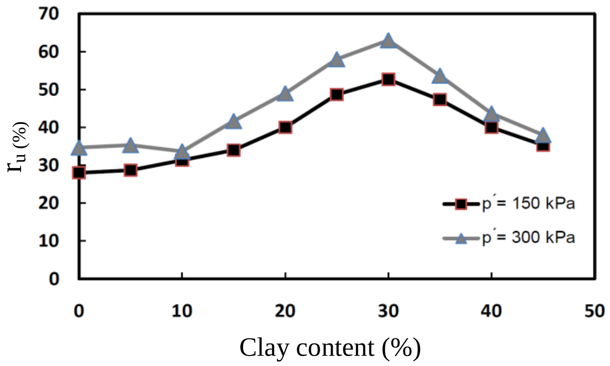

FIG 2. MAXIMUM EXECC PORE PRESSURE RATIOS OF MIXED SAMPLES VERSUS FINE CONTENTS

4- CONCLUSIONS

The sand from Anzali (North of Iran) is used to construct the specimens and to study the behavior of clayey sand over the range of 0–45% fines content, at almost the same void ratios and different confining pressures. Two series of 20 undrained triaxial compression tests were performed under the monotonic condition on samples are prepared with different fines content and two confining pressures of 150 and 300 kPa were used to consolidate the specimens during the tests.

The results show that, in comparison to the clean sand, increasing the content of plastic fines from 0 to 30% results in a decrease in the undrained shear resistance of the samples, wherease this trend is reversed for the values of fine contents greater than 30%.

In addition, the effect of plastic fines on the pore pressure generation was studied in the saturated sands. The results reveal that specimens having up to 30% plastic fine contents generated larger values of pore water pressure than the clean sand specimens. And for larger amounts of fine contents, the excess pore water pressure decreased comparing to the clean sand.

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