EFFECT OF CLAY PARTICLE CONTENT ON LIQUEFACTION OF SOIL

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SUMMARY

This paper presents the results of experimental research and analysis of liquefaction characteristics of sand and silt. The Laboratory tests were conducted on reconstituted soil samples so as to obtain the main parameters which affect the liquefaction behaviour of sand and silt. Test results show that clay particle content is a main factor affecting the liquefaction characteristics of soil. The correlationship of cyclic stress ratio versus the variance of coarse fraction contents of remoulded samples on different time affecting conditions were also presented.

INTRODUCTION

Earthquake is a kind of natural calamity, which happens every year in the world. Engineer has known that the liquefaction of saturate sand due to earthquake causes seriously destroying of buildings. Thus, the liquefaction of saturate sand has become the important subject in soil dynamics (Finn, 1991). After the catastrophic 1976 Tangshan Earthquake, China, engineers found that not only granular soil but also soil containing large amount of plastic fines had experienced liquefaction. Therefore, geotechnical engineers become interesting in the liquefaction characteristics of silt soil under seismic loading .

The study of silt soil liquefaction has shown that the clay particle content is a very important factor affecting the soil liquefaction characteristics. But, there are still no accepted statement for design criterion.

EXPERIMENT DEVICE AND SAMPLE PRPARATION

The instrument used is cyclic triaxial device of stress controlled type designed and made in China. Its index properties are as follows,

1. Frequency: 0.1Hz – 1Hz
2. Maximum vertical pressure: 25KN
3. Maximum confining pressure: 1.0Mpa
4. Height of sample:10cm
5. Diameter of sample: 5.0cm

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All the samples were remoulded. The laboratory tests are divided into two groups. The first group includes sand with various coarse fraction and fine particle content and second one consists of silt samples with different fine particle contents and time effects.

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All the soils including sand, silt, and clay were taken from the bank of Feng River, Shanxi. Then, according to the calculated density, clay particle content, and coarse fraction content, the certain portions of various soils were mixed together to form the required remoulded samples. Some of them were set in a sand box to obtain remoulded samples in different time effects. Table 1 gives the sample numbers of testing.

Table 1

Clay particle cont.(%)		0	3	6	8	9	10	12	16
Medium sand		4	0	4	4	4	3	3	3
Fine sand		4	0	4	4	4	3	3	3
Silt	0 day	0	3	3	0	3	0	3	3
	60 days	0	3	3	0	3	0	3	3
	Plastic index		8.5	8.7		8.9		9.6	9.9

ANALYSIS OF TEST RESULTS

Since silt contains fine particles which resist dynamic pore pressure to reach confining pressure, the failure criterion for saturated silt soil is failure strain. Referred to Seed (1966), the failure criterion adopted at this study is the strain of double amplitude εd = 5%.

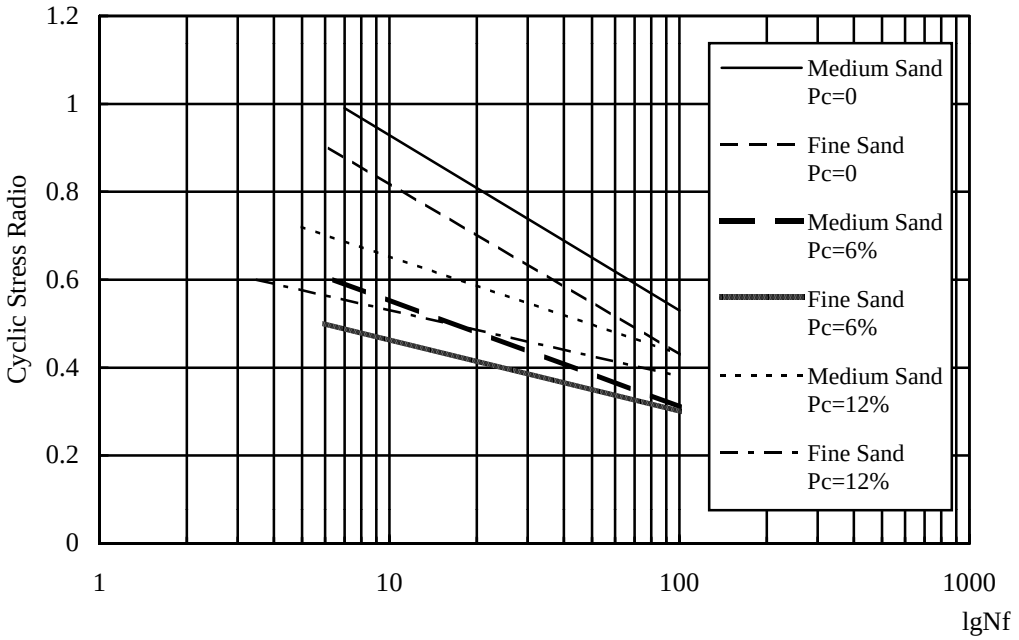

Fig.1 Cyclic Stress Ratio Versus Number of Cycles for Samples of Medium and Fine Sands

Analysis of Liquefaction Resistant Behaviour of Sand in Different Coarse Fraction

Authors conducted dynamic triaxial tests on the sand samples with different coarse fraction contents to investigate liquefaction resistant behaviours of sand contained natural clay particles.

Fig. 1 gives the correlationship of cyclic stress ratio versus number of cycles for samples with different coarse fraction contents. These laboratory curves show that the cyclic stress ratio of medium sand always is greater than that of fine sand at same clay particle content.

The Effect of Clay Particle Content on the Liquefaction Behaviour of Soil

It has been well known that the fine particle content is an important factor to affect the liquefaction of either sand or silt (Qiu et al. 1988). In order to evaluate the effect of clay particle content to cyclic stress ratio quantitatively, the authors performed laboratory dynamic triaxial tests on 8 groups of soil including 65 samples with different clay particle contents at no time effect conditions. The test results were shown in Figure 2.

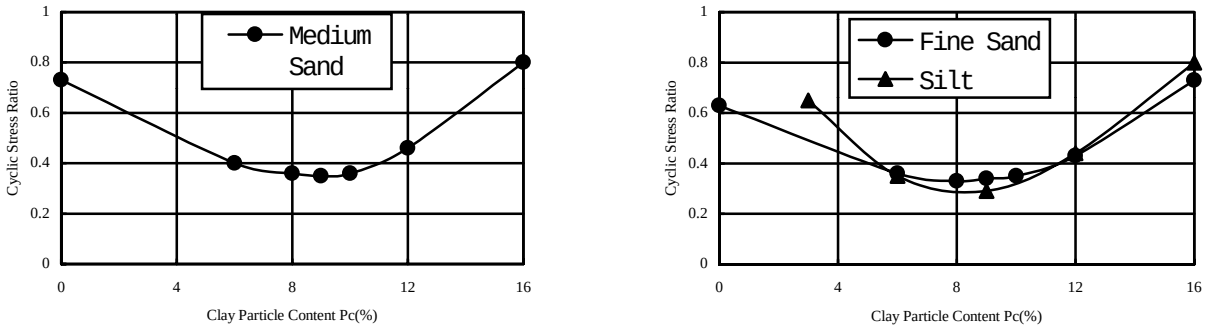

Fig.2 Correlationship Between Cyclic Stress Ratio and Clay Particle Content

It can be seen from the test results that following the increase of clay particle content, the cyclic stress ratio is not monotonously increased, but with a minimum value at Pc = 9 %, the cyclic stress ratio will increase following the increment of Pc and finally, we obtain the regression equation as following:

Medium sand: $y = 0.99 – 0.133Pc + 0.0074(Pc)2$

Fine sand: $y = 0.52 – 0.064Pc + 0.0048(Pc)2$

Silt: $y = 1.06 – 0.189Pc + 0.0115(Pc)2$

Time Effect of Liquefaction Resistant Behaviours of Silt

The soil structure has some effect to the liquefaction resistant behaviour of the soil. In order to investigation of the time effect to the liquefaction resistant behaviour of silt, the authors conducted tests on remoulded samples set in the sand box for 60 days. The comparative test curves are shown in Figures 3 and 4.

From Figure 4, it can be seen clearly that following the increase of clay particle contents, the cyclic stress ratio will increase after 60 days setting in sand box.

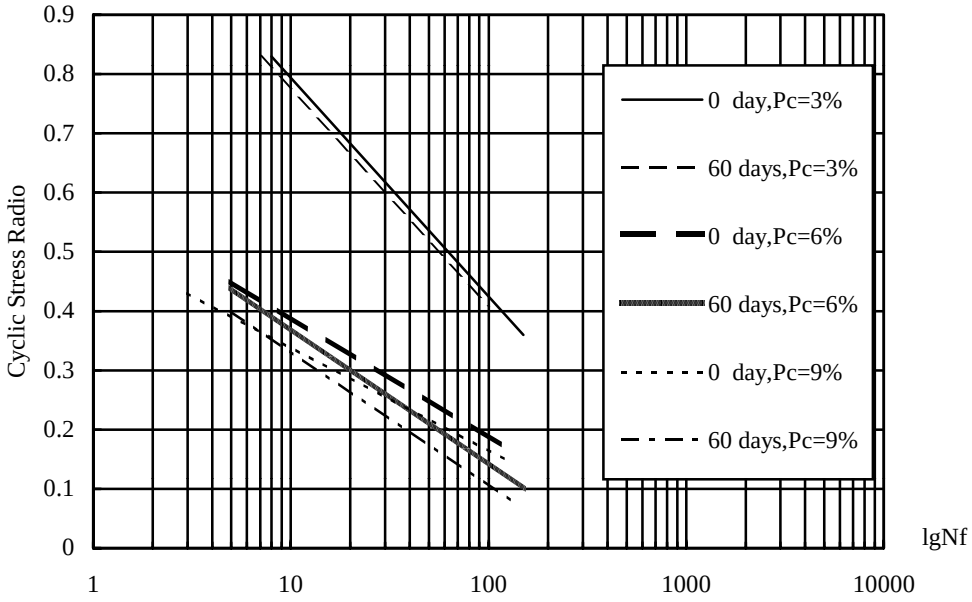

Fig. 3 Cyclic Stress Ratio Versus Number of Cycles for Silt Samples Setting for 0 Day and 60 Days

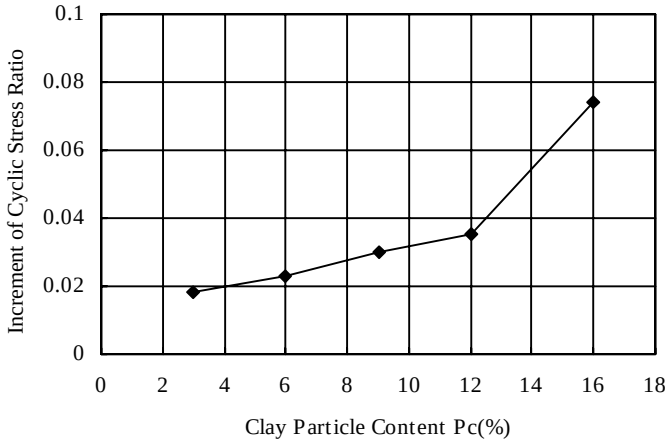

Fig.4 Correlationship Between Increment of Cyclic Stress Ratio

After 60 Days Setting and Clay Particle Content

CONCLUSIONS

It is found from the experimental test that the clay particle content is not in a linear relationship with the liquefaction resistant capacity but with minimum value at Pc = 9%.

Laboratory study of liquefaction shows that the cyclic shear strength of medium sand is higher than that of fine sand for same clay particle content, which proves that the coarse particles take an important part in sand to resist liquefaction.

Laboratory study of liquefaction shows also that the cyclic stress ratio of the remoulded silt samples after 60 days setting in sand box is higher than that of samples no setting. And, the increment of cyclic stress ratio increase with the increase of clay particle contents. It means that the time effect plays an important role for the silt to resist liquefaction.

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