EFFECT OF CONTENT OF FIBER MATERIAL AND SLURRY DENSITY ON TRIAXIAL SHEAR PROPERTY FOR LIQUEFIED STABILIZED SOIL

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1. INTRODUCTION

Since the Liquefied Stabilized Soil (LSS) is a cement treated soil classified as a slurry premixed soil, it has similar mechanical property as cement treated soil. With the increase of added amount of stabilizer, an increase in strength is observed while the seismic resistance might decrease due to its brittleness (Kohata, 2006). On the other hand, with the aim of reducing the overburden pressure when the LSS is used as a backfill soil for cut and cover tunnel etc., there is a concern about the use of the LSS prepared with a relatively lower slurry density instead of the normal slurry density with considering the strength reduction. In the past, in order to improve the brittle property of the LSS, a series of studies on the Liquefied Stabilized Soil mixed with newspaper prepared like cotton wool as the fiber material was carried out, and it was indicated that the brittle property after the peak is improved due to the reinforcing effect of the fiber. However, there are few study cases and still many unexplained parts about the LSS with reduced slurry density. In this study, the influence of changing in slurry density as well as added amount of fiber on the triaxial shearing characteristics of the LSS was discussed.

2. MATERIALS AND MIXING METHOD

In this study, NSF-CLAY was used as a homogenous base material, which was a commercially available cohesive soil with very clearly defined physical properties shown in Table 1. Geoset 200 provided by Taiheiyo Cement Co. was used as cement stabilizer, which was a cement-based solidifying agent for soft clay and problematic soil. Newspaper to be ground into like cotton wool by a food processor was used as fiber materials. In this study, the changing rate of slurry density $D\rho_f$ was defined as (Actual slurry density)/ (Basic slurry density) ×100 %.

Table 1 Physical parameter of NSF-CLAY

Particle density ρ_s (g/cm^3)	2.762
Liquid limit W_L (%)	60.15
Plastic limit W_P (%)	35.69
Plasticity index I_P	24.46

3. TEST METHOD

In this study, the measuring of axial strain was carried out by Local Deformation Transducer (LDT), which can measure the axial displacement from small strain level without the bedding error due to the compression of loose layers at the top and bottom ends of specimen or filter paper. Schematic figure of test apparatus was shown in Fig. 1.

The CUB tests were performed for both $D\rho_f$ = 95 % LSS and $D\rho_f$ = 100 % LSS specimens at curing time of 28 and 56 days. Specimens were saturated by the double vacuum method, which vacuum pressure was applied and the de-aired water flowed through specimen. After saturation, isotropic consolidation was conducted for about 16 hours under the effective confining pressure of 98 kPa. In order to unify with previous studies, small unloading/reloading loops during monotonic loading were applied before the peak of the stress-strain curve. The axial strain rate was 0.054 %/min overall.

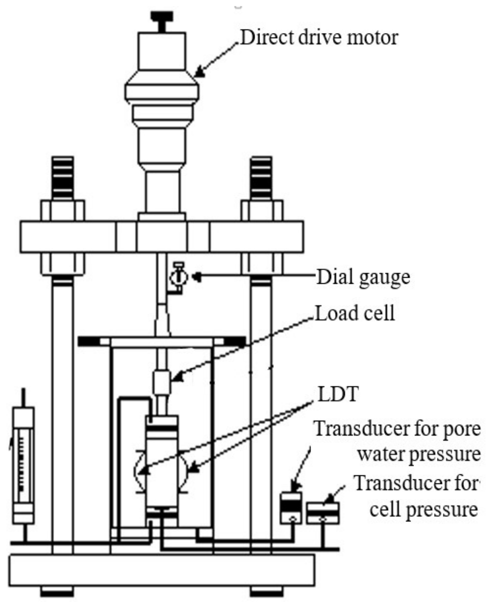

Fig. 1 Schematic figure of test apparatus

4. RESULTS AND DISCUSSIONS

Fig. 2 shows the relationship between deviator stress and axial strain in the cases where the added amount of fiber materials was 0 and 10 kg/m³ (Pc-0, Pc-10) combined with slurry density of 1.216 g/cm³ ($D\rho_f$ = 95 %) and 1.280g/cm³ ($D\rho_f$ = 100 %) of different curing time respectively. Both Fig. 2 (a) and Fig. 2 (b) show that the maximum deviator stress q_{max} were lower in the cases of $D\rho_f$ = 95 % for all different conditions of curing time and added amount of fiber materials respectively. It is also clearly shown in these figures that with the increase of curing time, only the strength of the condition with $D\rho_f$ = 100 %

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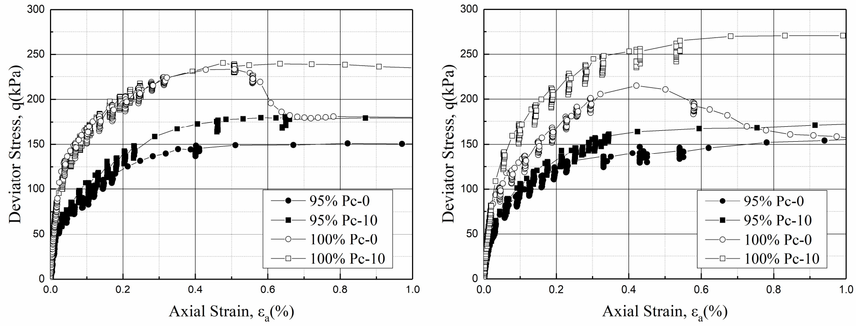
and Pc-10 tended to increase noticeably. Therefore, it can be mentioned that the strength of LSS mixed fiber was influenced by the changing of slurry density compared with that of curing time.

Fig. 3 is the zoom-up of q~ε_a relations up to ε_a = 0.1 % in Fig. 2. With the condition of curing time of 28 days, it can be seen that the q_{max} values of Pc-0 and Pc-10 were almost same in the case of $D\rho_f$ = 100 %, while the q_{max} value of Pc-10 was larger than that of Pc-0 in the case of $D\rho_f$ = 95 %. On the other hand, in the cases of longer curing time, influence of addition of fibers seemed to work in both cases of higher and lower slurry densities. In the case of $D\rho_f$ = 100 %, it is found that the brittle property of LSS in the q~ε_a relation was improved in the specimen of both the curing time.

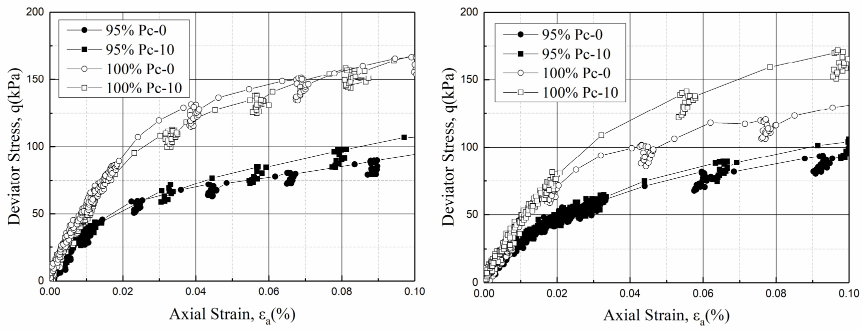
Fig. 4 shows the relationship between the tangent young's modulus normalized by the initial young's modulus (E_{tan}/E_0) and the deviator stress normalized by the maximum deviator stress (q/q_{max}). It can be noticed that even with the increase of curing time, the decreasing tendency of E_{tan}/E_0 was always large in the cases of lower slurry density as well as an increasing tendency of nonlinearity.

The equivalent young's modulus (obtained with small loops of unloading/reloading during CUB tests) normalized by the initial young's modulus (E_{eq}/E_0) were shown in Fig.5 with the horizontal axis of q/q_{max}. With all the cases of different curing time and added amount of fibers, E_{eq}/E_0 seemed to decrease earlier when the slurry densities were relatively lower. Therefore, the degree of damage with shear seemed to be larger in the case of lower slurry density, that tendency became large to be reduced with the addition of fiber materials.



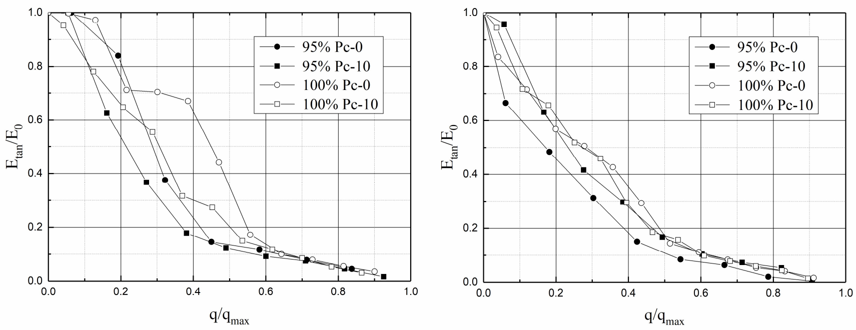
(a) 28 days (b) 56 days

Fig. 2 Relationship between deviator stress and axial strain up to ε_a = 1 %



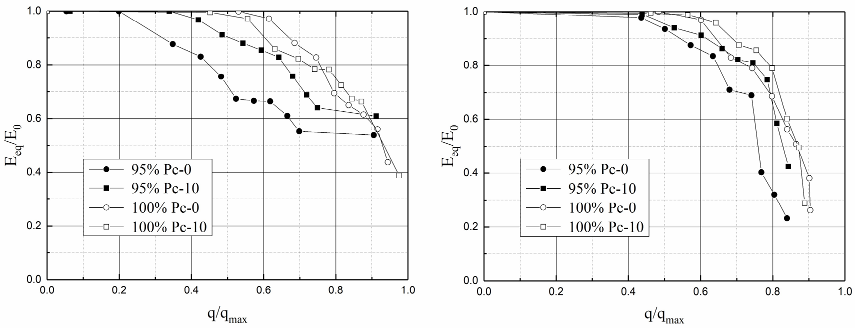
(a) 28 days (b) 56 days

Fig. 3 Relationship between deviator stress and axial strain up to ε_a = 0.1 %



(a) 28 days (b) 56 days

Fig. 4 Relationship between E_{tan}/E_0 and q/q_{max}



(a) 28 days (b) 56 days

Fig. 5 Relationship between E_{eq}/E_0 and q/q_{max}

5. CONCLUSIONS

1) The effect of slurry density on the strength and deformation property of LSS mixed fiber seems to be larger than the content of fiber material.

2) As slurry density was reduced, the nonlinearity of the q~ε_a relationship tended to increase.

3) It is considered that the degree of damage with shear tends to be reduced by the addition of fiber materials.

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