Ⅲ－121

# Small strain behaviour of stiff Suginami clay in TC

Mukabi, J and Tatsuoka, F.  IIS, University of Tokyo

## 1. INTRODUCTION

Most research based on the behaviour of soft clay has considered that stiff clay is more susceptible to the effects of sample disturbance. It has also been assumed that like in the case of soft clays, the effects of reconsolidation stress history (i.e., OC, LTC) are also pronounced on the behaviour of stiff clays reconsolidated in the laboratory. This study however, shows that the influence of stress history on stiff clays is very little and that carefully performed tests on high quality undisturbed samples can produce results that closely agree with the field values.

## 2. TESTING PROGRAM

Undisturbed samples were obtained from block sampling by hand carving from Pleistocene layers at depths of between 29～60m in Kandagawa, Tokyo. All the specimens tested were 12.5 cm in height and 5 cm in diameter with side drain. The specimens were saturated using the dry setting method to obtain B–values higher than 0.95. They were automatically at an axial strain rate of 0.001%/min. initially consolidated along a $K_c(=\sigma_c/\sigma_a)$ over–consolidated (OC) to; (a) a stress level beyond $\sigma_{ao}'$ but within the yield locus or (b) their estimated previous maximum pressure state (Fig. 1). Subsequently, they were rebounded under quasi–$K_0$ conditions with $(K_0)_{rebound}=(K_0)_{NC}\times OCR^m$, $m=\sin\phi'$, to their current in–situ pressure level $\sigma_{ao}'$. Small load/unload cycles were applied at prescribed stages during secondary consolidation prior to the final stage of undrained TC shearing at $\dot{\varepsilon}_a$=0.01%/min. Axial strains were measured using two proximity transducers (Gap Sensors, GSs) and a pair of LDTs (Local Deformation Transducers, Goto et. al., 1991).

## 3. TEST RESULTS AND DISCUSSIONS

### 3.1 Influence of OCR

Fig. 1 shows the effective stress paths during reconsolidation and undrained TC shear. The stress paths during shear show noticeably different trends possibly due to the different stress histories they underwent. The stress–external axial strain relation

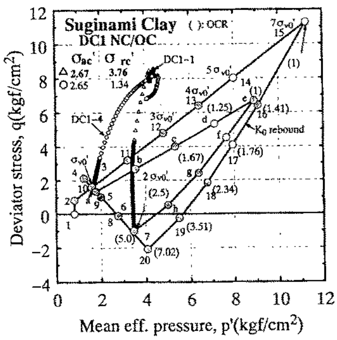


Fig. 1 Effective cons. and undrained

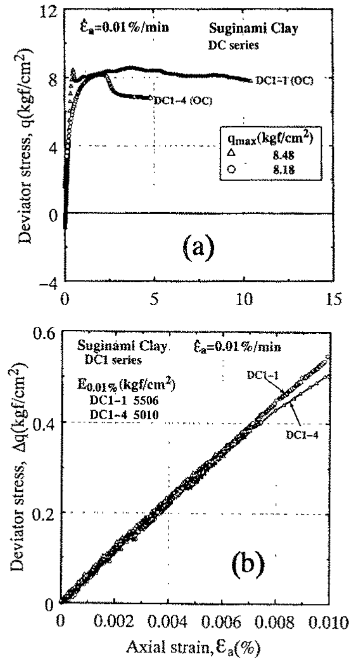


Fig. 2 Stress–strain relations

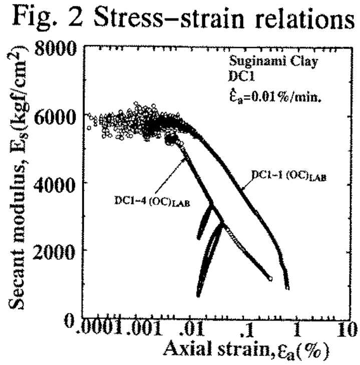


Fig. 3 Decay curves

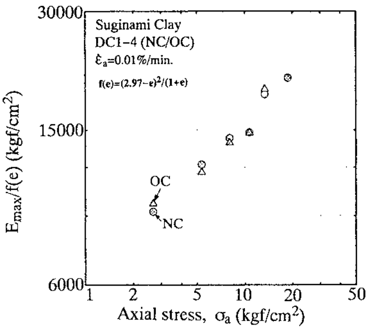


Fig. 4 $E_{max}/f(e)$ vs. axial stress relations

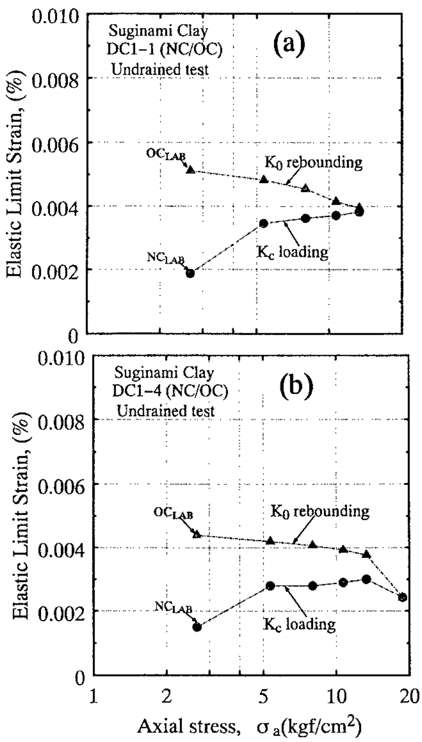


Fig. 5 Effect of stress level

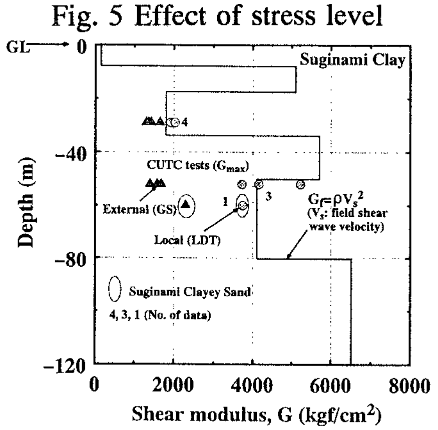


Fig. 6 Shear modulus vs. depth relations

over the whole range is depicted in Fig. 2(a). Again, although both the specimens have almost the same peak shear strength, they show fairly different pre-peak behaviour. The small stress-strain relations are shown in Fig. 2(b). In these strain regions, the DC1-1 specimen that was subjected to OC stress state along it's rebound stress path (ref. Fig. 1) exhibits less non-linear behaviour than the DC1-4. This point can also be noticed from the decay curves shown in Fig. 3. Figs. 4 shows $E_{max}/F(e) \sim \sigma_a'$ relations during $K_0$-consolidation and rebound determined from DC1-4 test. The void ratio function $F(e)=(2.973-e)^2/(1+e)\}$ after Hardin and Black (1969) was used. The ratio of F(e) between a pair of NC and OC specimens at $\sigma_{ac}'$ is only 0.98, due to small changes in e during consolidation. Virtually no effect of OC is seen from the test results in contrast to most of the test results reported on soft clays. Figs. 5(a) and (b) show the relationship between the elastic limit strain and axial stress $\{(\varepsilon)_{ELS} \sim \sigma_a'\}$ during $K_c$ loading and $K_0$ rebounding for DC1-1 and DC1-4 specimens respectively. It can be seen from both these figures that the linear elastic portion practically increases with consolidation time and particularly with $K_0$rebounding (ref. to Fig. 3).

3.2 Comparison of $G_{max}$ and $G_f$

Fig. 8 compared the $G_{max}$ and $G_f$ values for this clay. It is seen that these vaues are very similar to each other suggesting the least effects of sample disturbance.

4 CONCLUSIONS

For undisturbed Pleistocene stiff Suginami clay, the influence of stress history was seen to be very little. It was also observed that there was a good agreement between the laboratory $G_{max}$ values and the field $G_f$ values obtained from field sesmic surveys.

REFERENCES

[1] Goto, S., Tatsuoka, F., Shibuya, S., Kim, Y.S. and Sato, T. 1991. A simple gauge for local small strain measurements in the laboratory, S6F, 31-1, pp. 169-180.
[2] Hardin, B.O. and Black, W.L. (1969): "Vibrational modulus of normally consolidated clay"", Proc. of ASCE, Vol. 94, SM2, pp353-369.