III－197 Small strain behaviour in triaxial compression of lightly over-consolidated Kaolin

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

1 INTRODUCTION

It has been shown for normally consolidated (NC) Kaolin that the effect of strain rate on the initial stiffness at strains less than about 0.001% is very small, whereas it increases as the strain increases exceeding the elastic limit (Mukabi et. al. 1991b). However, It is not known whether it is also the case with over-consolidated clays.
In this paper, therefore, while comparing with that of normally consolidated specimens of the same Kaolin, the small strain behaviour of lightly over-consolidated Kaolin (OCR=1.2) sheared under three different strain rates is studied.

2 TESTING PROGRAM

The specimens were prepared by one-dimensional consolidation of a slurry Kaolin (LL=84.2, PI=43.6 and G_s=2.65) under a pressure of 1.5 kgf/cm^2. The dry setting method was used for saturating the specimens to B-values higher than 0.98.

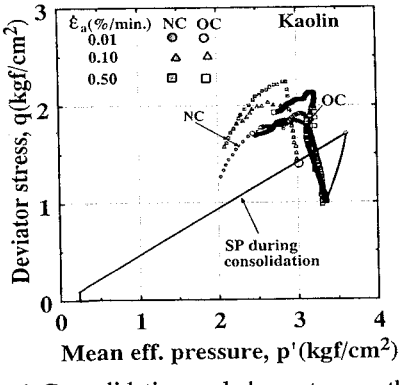

Fig. 1 Consolidation and shear stress paths

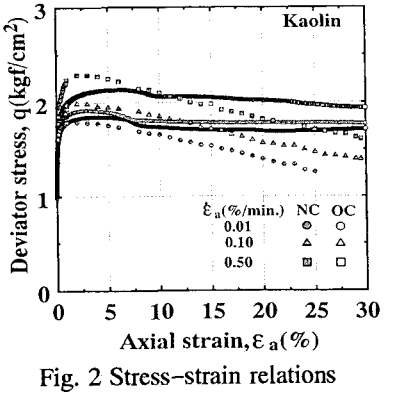

Fig. 2 Stress-strain relations

All specimens were automatically consolidated along a stress path of K=0.64 at a constant strain rate of $\dot{\varepsilon}_a$=0.01%/min. The K_0 rebound was simulated by $(K_0)_{rebound}=(K_0)_{NC}\times OCR^{\sin\phi}$ (Fig. 1). All the specimens were sheared under undrained conditions at constant rates of $\dot{\varepsilon}_a$ =0.01, 0.1 and 0.5%/min.

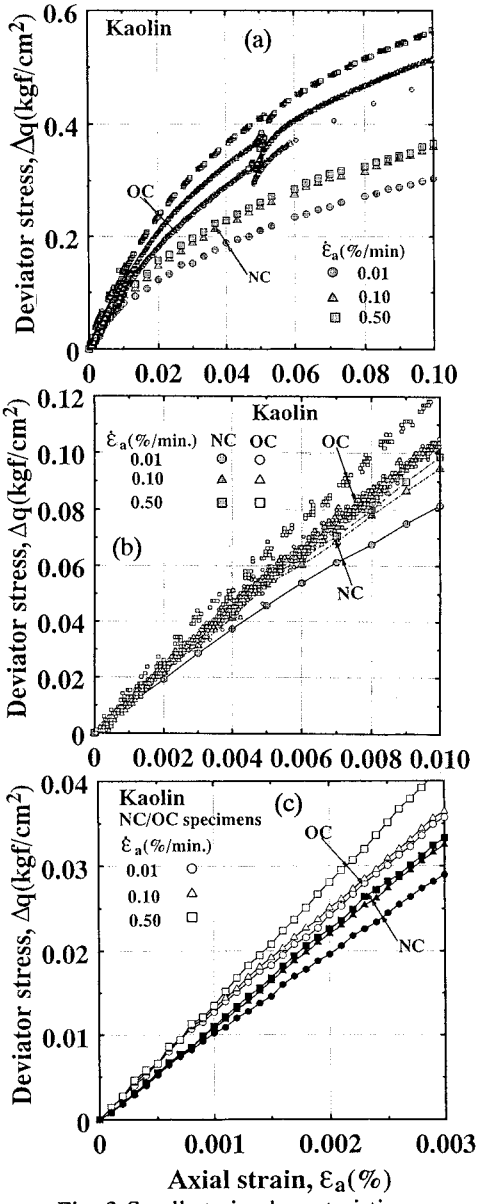

Fig. 3 Small strain characteristics

3 TEST RESULTS AND DISCUSSIONS

Fig. 2 shows the overall stress-strain curves of both the NC and OC specimens. A gain in the shear strength with increasing strain rate can be observed. The small strain characteristics are represented in Figs. 3a ～ 3c. It can be seen that for both the NC and OC specimens, a linear elastic range exists at very small strains, the size of which increases with increasing strain rate.
It is also seen that for the same strain rate, the elastic limit strain is larger for OC specimens than for NC ones (about 2.5 times). This trend is clearly noted also in Fig. 4. A similar effect was also observed for aged clay (Mukabi et. al 1993b).

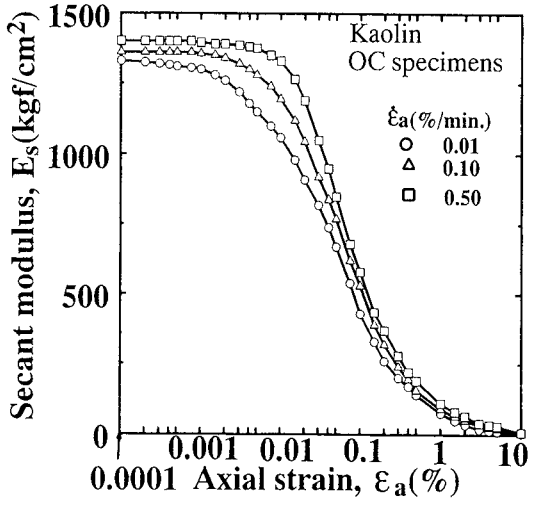

Fig. 4 Strain level dependency of stiffness

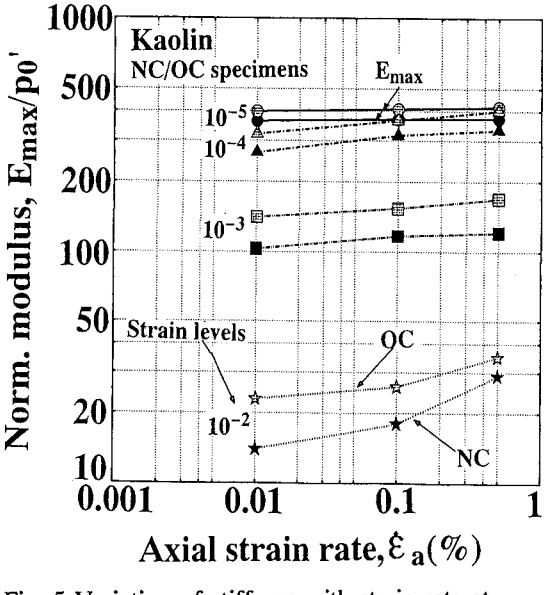

Fig. 5 Variation of stiffness with strain rate at different strain levels

Fig. 5 summarizes the relationship between $E_{sec}=\Delta q/\Delta \varepsilon_a$, normalized by the consolidation effective mean principal stress p_0', and the axial strain rate. The following points can be observed:
1) $E_{max}(=E_{sec}$ at $\varepsilon_a=10^{-5})/p_0'$ increases slightly by OC.
2) E_{max} is not sensitive to the strain rate for both NC and OC specimens.
3) The effects of strain rate in terms of the slope in this log-log plot increases as the axial strain increases exceeding 10^{-5} for both NC and OC specimens.
4) As the strain increases, the effect of strain rate becomes larger for NC than OC specimens. This point is seen also from Fig. 6. The reason for this is a topic to be studied.

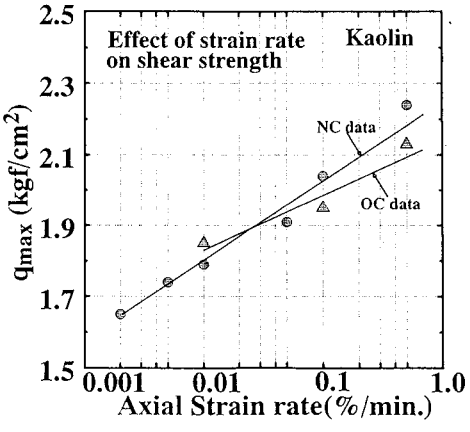

Fig. 6 Effect of strain rate on q_{max}

4 CONCLUSIONS

From the above discussions, the following conclusions may be drawn.
1) For both normally and lightly over-consolidated Kaolin, the effect of strain rate is insignificant in the region of small elastic strains, while the effect increases as the strain increases exceeding the elastic limit strain.
2) The linear elastic range increases with strain rate and is larger for OC than for NC specimens.
3) The maximum shear strength was seen to increase with increasing strain rate at a larger rate for the NC specimens than for the OC specimens.

REFERENCES

Mukabi,J.N., Tatsuoka,F. and Hirose, K. (1991b). Effect of strain rate on small strain stiffness of Kaolin in CU triaxial compression, Proc. 26th Japan National Conf. on SMFE, Nagano, pp. 659-662.
Mukabi,J.N.,Tatsuoka,F. and Tsuchida,T. (1993b). Field and laboratory measurements of small strain stiffness for Osaka Bay Clay. Proc. of 26th annual meeting of JSCE in Sendai, Ⅲ: 46-47.