CS 119 Field and Laboratory measurements of small strain stiffness for Osaka Bay Clay

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1 Introduction

Strains in the ground under working load conditions are in many cases less than 0.1% [1]. However, in most field testing techniques, the range of strain in each method is very limited to either very small, $\epsilon_a < 0.001\%$*(seismic survey) or relatively large,* $\epsilon_a > 0.1\%$ *(in convetional Bore Hole Loading Tests(BHLTs)). Laboratory tests which can provide the stiffness values at strains covering strains mentioned above are therefore very valuable. The triaxial compression test results presented in this paper indicate a well defined elastic zone as well as a good consistency with in-situ tests.*

2 Method of Testing

Fourteen undisturbed specimens of Pleistocene taken from a depth of 98-210m below the sea bed of Osaka Bay were used in performing CUTC (Consolidated Undrained Triaxial Compression) tests. Axial strains were determined from the axial displacement of specimen cap. The normally consolidated(NC) specimens were consolidated to the in-situ overburden pressure along a stress path of K=0.5 by an automatically controlled triaxial testing system while the over consolidated(OC) specimens were consolidated under similar conditions but to a 1.2 times higher overburden pressure and then rebounded to the in-situ overburden pressure along a stress path of K=0.5 by an automatically controlled triaxial testing system while the over consolidated(OC) specimens were consolidated under similar conditions but to a 1.2 times higher overburden pressure and then rebounded to the in-situ overburden pressure as typically shown in Fig. 1. OCR=1.2 is an average value for this deposit obtained by conventional oedometer tests. The specimens were undrained sheared at the same constant axial strain rate.

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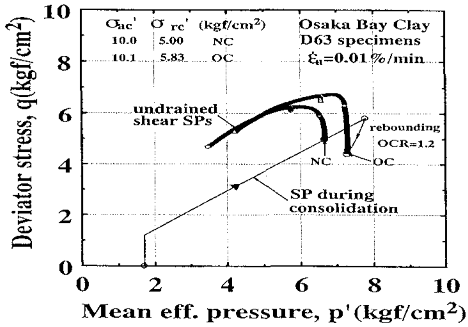

Fig. 1 Stress paths

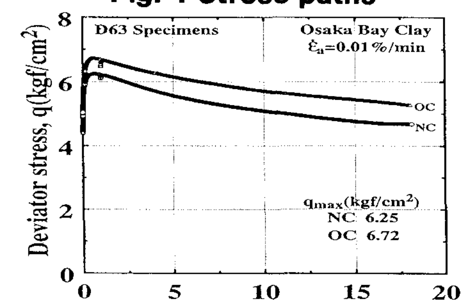

Fig. 2 Stress-strain curves

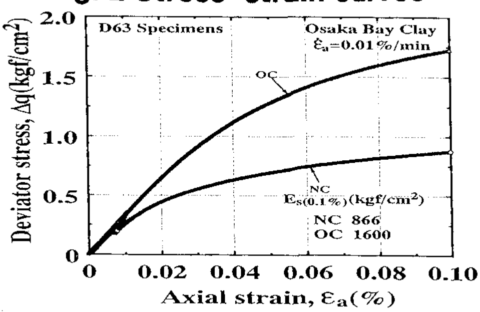

Fig. 3 Small strain characteristics

2 Results

Typical results shown in Fig. 2 indicate a slightly higher shear strength of the OC specimen. As can be seen in Fig. 3, even in the region of fairly small strains, the deformations are highly nonlinear and the difference in the stiffness between the NC and OC specimens is considerable. Figs. 4(a) and (b) show virtually linear and recoverable properties in the region of extremely small strains, $\epsilon_a < 0.001\%$ *with almost the same* E_{max} *between the NC and OC specimens. In Fig. 5, each value*

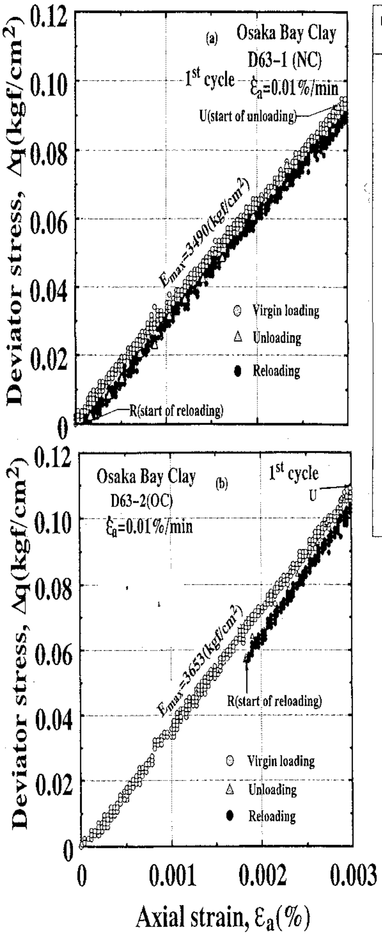

Fig. 4 Very small strains

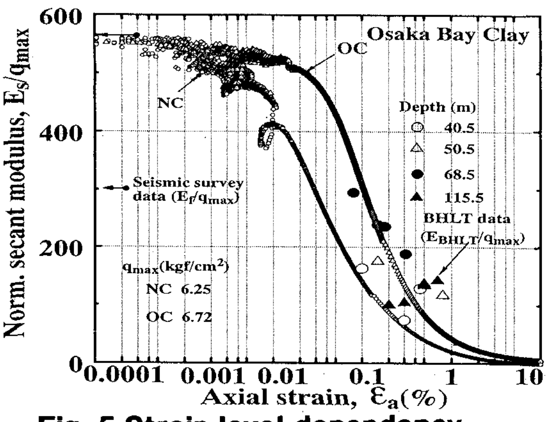

Fig. 5 Strain level dependency

of E_{BHLT} has been divided by the value of q_{max} estimated at the depth where the BHLT was performed from the q_{max}-depth relation, assuming q_{max}=0 at the sea bed (Fig. 7). Fig. 5 shows: 1) a good agreement between the lab. and field

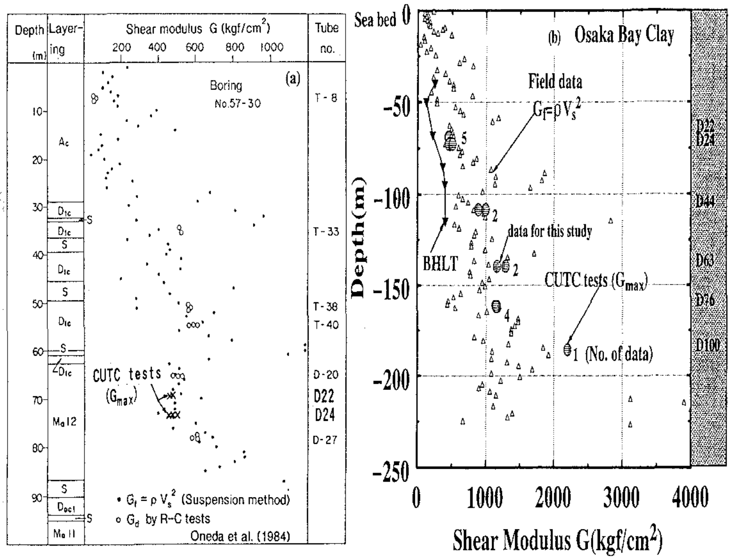

Fig. 6 G–depth relation

data at both small and large strain levels, see also Figs. 6(a) and (b) a better agreement between the E_{BHLT} and the E_{sec} of the OC specimen (Fig. 5) suggests that the OC specimen simulates the in-situ stiffness better than the NC one. 2) a clearly defined plateau(elastic zone). 3) a larger elastic zone for the OC specimen. 4) A very large drop in stiffness after the region, $\epsilon_a < 0.01\%$.

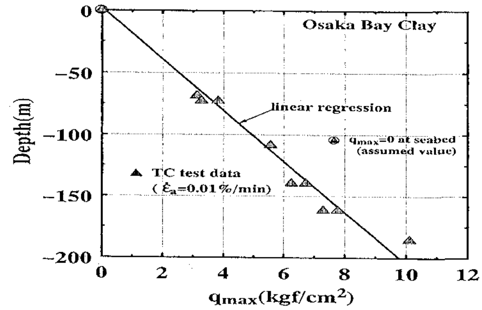

Fig. 7 q_{max}–depth relation

4 Conclusion

For Osaka Bay Pleistocene Clay, the stiffness values from lab. and field tests agreed very well when compared at the same strain level. It is suggested that a mechanical over-consolidation of OCR=1.2 simulates the field condition better.

References

[1] Burland, J. B (1989): Small is beautiful-the stiffness of soils at small strains, Ninth Laurits Bjerrum Memorial Lecture, Canadian Geotechnicla Jour. 26, pp499-516.

[2] Mukabi, J.N., Ampadu, S.K., Tatsuoka, F. and Hirose, K. (1991a): Small strain stiffness and elasticity of clays in monotonic loading triaxial compression, Proc. Sympo. on Triaxial Testing Methods, JSSMFE, Tokyo, pp257-264.