POST-CYCLIC CHARACTERISTICS OF UNDISTURBED ANISOTROPICALLY CONSOLIDATED ARIAKE SILTY CLAY

Saga University, S.MJSCE, L. Samang
Saga University, MJSCE, N. Miura
Saga University, S.MJSCE, S. Sasaki

INTRODUCTION

It is widely recognized that silty clay have an intermediate behaviour between clay and sand, generally exhibits a larger resistance to cyclic loading than sand does. The effects of cyclic loading on clay causes a reduction in both stiffness and shear strength on subsequent post-cyclic static loading (Matsui et al., 1992). This paper presents the effects of cyclic loading on the post-cyclic characteristics of an anisotropically consolidated silty clay.

EXPERIMENTAL METHODS

The undisturbed silty clay were obtained with shelby tubes at the depth up to 12 m from the access road site of Saga Airport project. The samples have an average value of natural water content = 85.74%, liquid limit = 85.95%, plasticity index = 46.60%, specific gravity = 2.66, and void ratio = 2.06 prior to cyclic loading. The coefficient of permiability = 1.56×10^{-6} cm/s, which is approximated 3 to 5 times of the generally value of Ariake clay.

All specimens were first normally consolidated hydrostatically under confining pressure of 0.5 kgf/cm^2 with a back pressure of 2.0 kgf/cm^2, point A in Fig.1. To simulate the in situ shear stress ratio Ko = 0.5, the additional axial stress of 0.5 kgf/cm^2 under drained conditions was applied at a stress rate of 0.025 kgf/cm^2 per hour, point B in Fig.1. The testing programme is schematically in Fig.1.

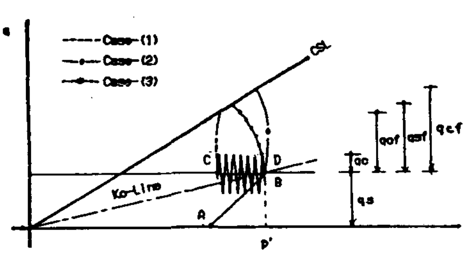

Fig.1 Testing programme and definitions

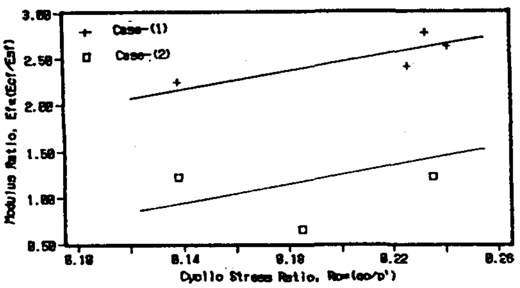

Fig.2a Post-cyclic characteristics of secant def. modulus

Cyclic loading was applied with a symmetric two-way sinusoidal deviatior stress pulse at a frequency of 0.1 Hz for each cyclic stress level and then terminated when a prescribed number of load cycles (about 70 load numbers) was developed before reaching cyclic failure. The distribution of cyclic-induced pore water pressure was ensured by leaving the specimen for a few minutes under initial aninsotropic stress condition, point C in Fig.1. During post-cyclic recompression case-(2), the drainage line was opened with measurement of drain volume changes and their time dependency. While, post-cyclic undrained static without drainage case-(1) and undrained static without cyclic loading case-(3) were done under stress controlled with the same previous stress rate.

RESULTS AND DISCUSSIONS

In generally, the undrained cyclic loading causes a reduction of mean effective pressure and this characteristics behaves in a similar way to the overconsolidated clay produced by unloading from point B to C in Fig.1. This hypothesis (Matsui et al., 1992) was taken into consideration to characterize the behaviour of post-cyclic recompression.

Fig.2a shows the cyclic loading with or and without recompression further degrades the secant deformation modulus ratio ($E_f=E_{cf}/E_{sf}$) with decreasing of the cyclic stress ratio ($R_0=q_c/p'$). Fig.2b shows that the failure ratio ($R_f=q_{cf}/q_{sf}$) after recompression increases proportionally with the cyclic stress ratio, due to decrease in void ratio silimar to the secondary compression behaviour of generally clay. If there is no recompression allowed after cyclic loading, the failure ratio will decrease with cyclic stress ratio due to the reorientation of soil skeleton during cyclic loading. It was observed that post-cyclic characteristics with drainage offers better resistance for both failure ratio and secant deformation modulus ratio.

The recompression volumetric strain is evaluated when the cyclic-induced pore water pressure (Δu) are completely dissipated from the value corresponding to the equivalent Over Consolidation Ratio (OCR_{eq}) by equation (1), where p' is the pre-cyclic mean effective stress.

$$OCR_{eq} = 1/(1-\Delta u/p') \qquad (1)$$

The post-cyclic recompression characteristics is presented together and comparing with Ariake clay published data (Yasuhara et al., 1992) as shown in Fig.3. It was found out that the critical value of OCReq is approximated of 1.9 for both of plotting data, this particularly true if the permiability ratio is considered.

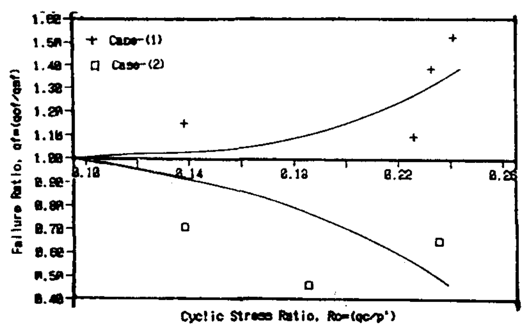

Fig.2b Post-cyclic characteristics of failure ratio

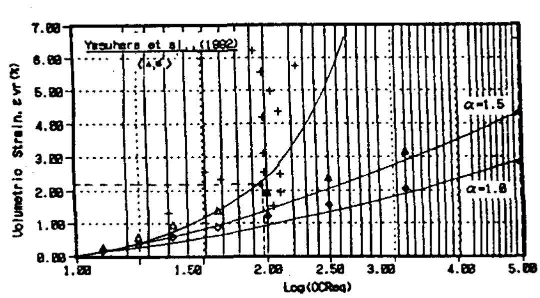

Fig.3 Post-cyclic characteristics of rec. volumetric strain

CONCLUSIONS

From this study the main conclusions can be summarized as follows: (1).The stiffness degradation is not so significant in this case for no reversal stress. (2). Post-cyclic characteristics with drainage offers better resistance for both failure ratio and secant deformation modulus ratio. (3). It was found out that the critical value of OCR_{eq} is approximated of 1.9 if the permiability ratio is considered.

REFFERENCES

Yasuhara, K. et al., (1992). Effects of cyclic loading on undrained strength and compressibility of clay, Soil and Foundations, Vol.32, No.1, pp. 100-116.

Matsui, T. et al., (1992). Prediction of shear characteristics of undisturbed clays after cyclic loading and consolidation, Proc. 10th World Conf. on Earthquake Engineering, Vol.3, Madrid, Spain.