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Performance of Mini-Triaxial Test and Its Practical Applications to Soil Investigation

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ABSTRACT

The authors have developed a mini-triaxial compression apparatus. In the mini-triaxial test, a small specimen 22.5 mm in diameter and 45 mm in height is used, which is much smaller than the conventional triaxial specimen. The mini-triaxial test has two main advantages compared to the conventional triaxial test: A limited amount of sample can provide more specimens, and the consolidation time can be shortened because of shorter drainage distance. The size effect of triaxial specimens is first discussed through comparison of the consolidated undrained triaxial ($C\bar{U}$) tests of three different size specimens for undisturbed Alluvial and Pleistocene clays, showing that specimen size does not affect triaxial test results for clays regardless of soil plasticity. Then, practical applications of the mini-triaxial test to soil investigation are demonstrated successfully.

INTRODUCTION

The mechanical behavior of Pleistocene clays becomes important in geotechnical engineering, as applied pressures increase with increasing scale of structures. Because Pleistocene clay layers are located deeper than Alluvial clay, it may be difficult and expensive to take a large amount of undisturbed clay samples. Therefore, the mechanical behavior of Pleistocene clays has not fully been understood so far. Moreover, even in an Alluvial clay layer a few meters thick, the sedimentary environment could have been changed because of a long geological sedimentary period. This means that such physical properties of Alluvial clay as particle size distribution and consistency limits could vary even within the same clay layer, together with a change in mechanical characteristics. To elucidate vertical variation of mechanical characteristics of undisturbed clays in a layer through triaxial tests, several identical undisturbed clay specimens are required at a deep position. To overcome the above-mentioned difficulties, the authors have developed a mini-triaxial compression apparatus, in which a small size specimen 22.5 mm in diameter and 45 mm in height is used.

In this paper, the advantages of a small specimen are discussed, focusing on providing more specimens from a limited sample and shortening consolidation time. Then, the size effect of a triaxial test specimen is experimentally examined for undisturbed Alluvial and Pleistocene clays. Finally, as successful examples which are difficult to perform by the conventional triaxial test, two examples of practical applications of the mini-triaxial test to soil investigation are demonstrated.

MINI-TRIAXIAL COMPRESSION APPARATUS

The newly developed mini-triaxial compression apparatus consists of 4 main units: Axial loading facilities, triaxial cell, pneumatic pressure control instruments and measuring instruments. Notable points on these equipments are described below.

Axial Loading Facilities

Photo 1 shows the axial loading facilities, triaxial cell and measuring instruments. The axial loading facilities can be used both for displacement control and stress control. In the CU tests, the displacement rate is controlled by DC motor (displacement controlled tests). The maximum load is 490 kN and the displacement rate can be changed in a range of 0.005~0.5 mm/min. In the undrained creep tests, the axial load is applied by a double acting bellofram cylinder (stress controlled tests).

Triaxial Cell

An acrylic cell is used for under 700 kPa and an aluminum cell is used for from 700 to 900 kPa. The “leaking air system” (Chan, 1975) is adopted in order to reduce the effect of shaft friction on axial load and the gap between piston rod and rod support is 0.012 mm.

Pneumatic Pressure Control Instruments

Fig. 1 illustrates the line system of the mini-triaxial test apparatus. Pneumatic pressure is supplied by the air compressor, which

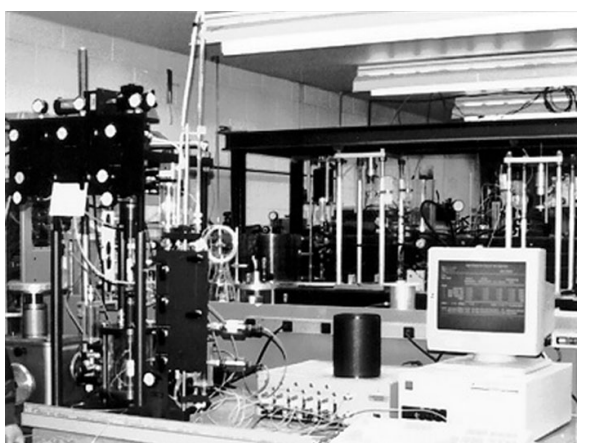

Photo 1 Mini-triaxial compression apparatus

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KEY WORDS: Mechanical properties, mini-triaxial test apparatus, size effect, small size specimen, soil investigation, undisturbed clay.