Development of In-situ Triaxial Test for Discontinuous Rock Masses

Background

Conventional in-situ test methods based on standards or guidelines of scientific societies are performed for determining the mechanical properties of foundations of nuclear power plant and dam sites. They have several problems in which deformation and strength characteristics are investigated separately, test results are significantly affected by disturbance of the loading surfaces and so on. A new field test method (in-situ triaxial test for rock masses) was developed to provide the solution to the above the problems. Proof tests were carried out at sites of homogeneous soft rock and inhomogeneous rudaceous rock. However the application of the test method at site of discontinuous rock was a very difficult problem because self-supporting large cylindrical specimens were not made easily for the site.

Objectives

The purpose of this study is to develop a new effective method of making large cylindrical specimens, improve the in-situ triaxial test equipment, and then investigate the applicability of the test method to discontinuous rock masses.

Principal Results

(1) Cylindrical specimens of weathered discontinuous sandstone were successfully made by a new drilling equipment developed in CRIEPI. The size of the specimen is about 38cm in diameter and about 100cm high. In the drilling, the drilling rate and the amount of drilling water were controlled based on the results of the measured bit weight, torque and so on. After the drilling, a triaxial cell was inserted into the slit and hydraulic pressure was provided to the cell while lifting a core pack made of acrylic. As a consequence, the making of the cylindrical specimen for the in-situ triaxial test could be possible for discontinuous rock for which the making of one has so far been difficult (Figure 1, Figure2).

(2) In-situ triaxial compression tests were carried out under four confining pressures with the in-situ triaxial test equipment which has been improved in the strain measuring system. All the specimens were retrieved to the ground surface after the tests so that the validity of the test results was ascertained from any information as to discontinuity, shear bands and so on. Consequently, the high-precision measurement of stress-strain relationship and Poisson's ratio could be possible for discontinuous rock for which the measurement has so far been difficult (Figure 3).

(3) The dependency of deformation modulus and Poisson's ratio on shear stress level, and the dependency of deformation modulus on confining pressure were quantitatively-measured from the result of in-situ triaxial test for the weathered discontinuous sandstone. As a result, the investigation of detailed mechanical property which has not been investigated before was possible (Figure 4).

The development of the testing equipment was carried out in CRIEPI and the application for in-situ rock mass was carried out as a funded research with Kyushu Electric Power Company.

Future Developments

In order to put this test method to practical use, further examinations are needed to enhance applicability to discontinuous rocks, and thus it is important to improve the in-situ triaxial test equipment to investigate the dynamic mechanical properties and tensile strength characteristics for discontinuous rock masses.

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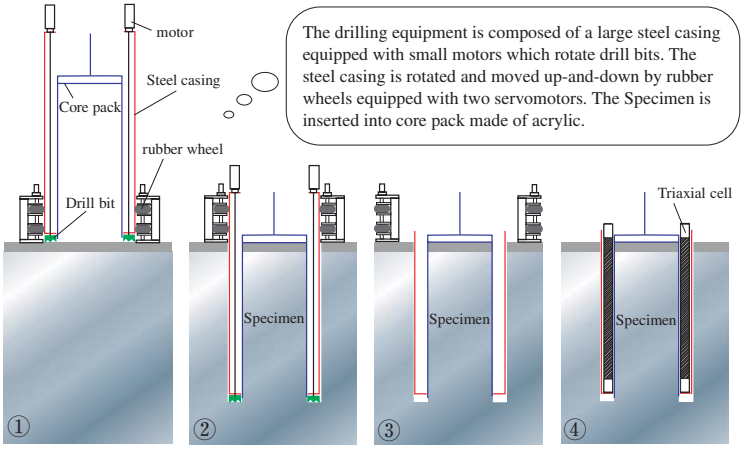
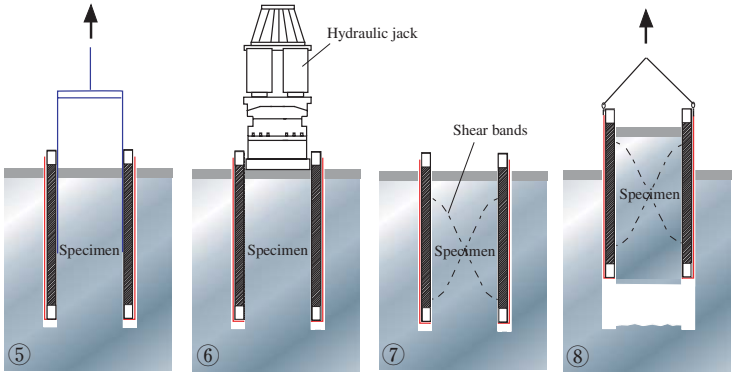
Reference

T. Okada, et.al., 2008, “Applicability of in-situ triaxial test for discontinuous rock masses - A case of discontinuous sandstone -”, CRIEPI Report N07513 (in Japanese)



①The drilling equipment is prepared on the ground surface.
②The specimen is made by drilling with a suitable width and then is covered with core pack.
③The rubber wheels and the upper part of the drilling equipment is taken away.
④The triaxial cell is inserted into the slit.



⑤Hydraulic pressure is provided to the cell while lifting a core pack.
⑥The cap equipped with a load cell and the hydraulic jack are placed on the top of the specimen. Triaxial test is conducted in the field.
⑦After the test, the cap and the hydraulic jack are removed.
⑧The specimen is cut at its bottom and lifted to the ground surface for further observation.

Fig.1 Test procedure of in-situ triaxial test

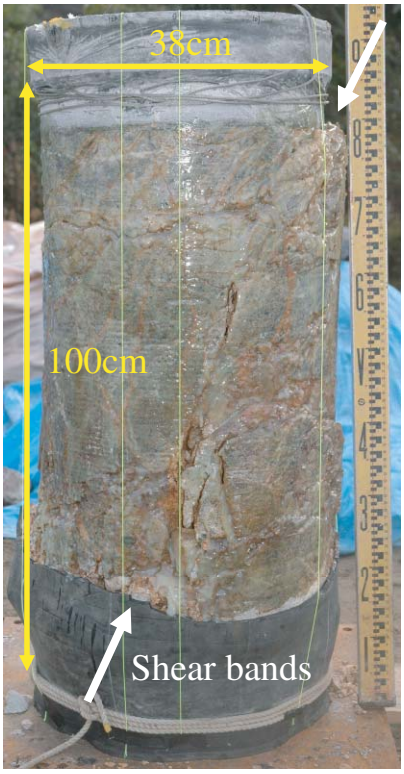


Fig.2 Specimen retrieved after tests
The specimen exhibited several shear planes mainly along the discontinuities. The brown lines in the photograph show the discontinuities.

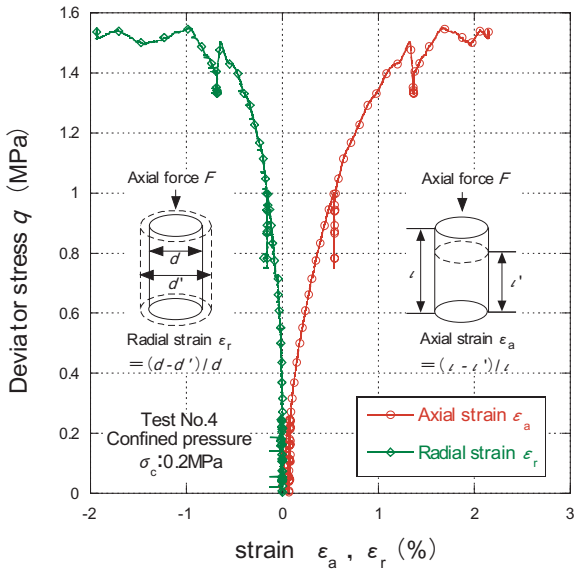


Fig.3 Relationship between stress and strain
Stress-strain relationship of discontinuous rock is obtained accurately under confined pressure.

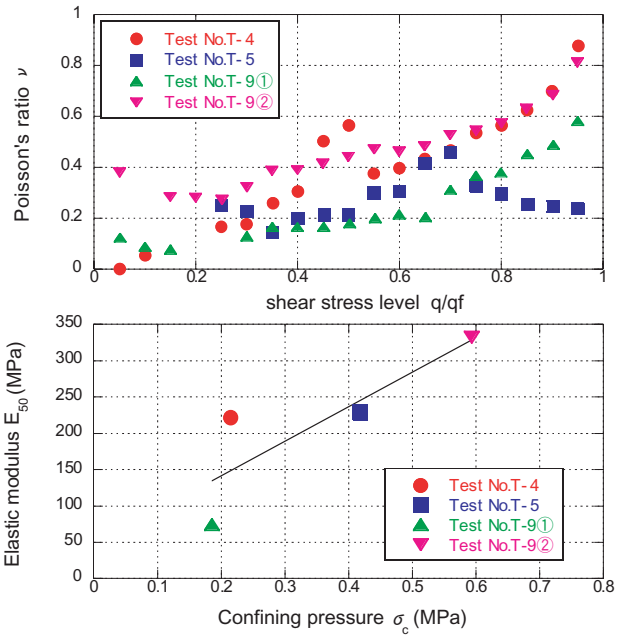


Fig.4 Mechanical properties of the site
The dependency of Poisson's ratio on shear stress level (top figure) and elastic modulus on confining pressure (bottom figure) which has not investigated before were measured from the result of the test .