Development of In-situ Triaxial Test for Inhomogeneous Rock Mass

Background

Conventional in-situ test methods 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) which provides the solution to the above the problems was developed. A trial series of tests were successfully conduced at a site of homogeneous soft rock. However, the tests of the soft rock were an only example. In order to put this test method to practical use, further examination is needed to enhance applicability to inhomogeneous rocks and discontinuous rock, and thus it is important to raise the measurement precision and the reliability of the measurement system (Figure 1).

Objectives

The measurement system of in-situ triaxial test is improved and the applicability of the test method to inhomogeneous rock masses of rudaceous rock is investigated.

Principal Results

1. Improvement of measurement system

The following results were obtained from the improvement of measurement system of in-situ triaxial test;

(1) The measurement precision was improved and both axial and lateral strains could be measured in the center hole and outer slit of hollow cylindrical specimens. As a consequence, the reliability of the measurement system largely increased (Figure 2).

(2) Not only triaxial compression test but also triaxial extension test and cyclic triaxial test could be carried out. As a consequence, the shear strength under low normal stress condition, the tensile strength and the strength and deformation characteristics under dynamic loading conditions in earthquake could be evaluated by in-situ test (Figure 3 & Figure 4).

2. Applicability for inhomogeneous rock mass

The following results were obtained from the investigaton of the in-situ triaxial test at a site of inhomogeneous rock mass.

(1) From the result of in-situ triaxial test, axial and lateral strains measured in the center hole agreed approximately with the corresponding values measured in the outer slit. The results proved that the test method was successful to measure average stress-strain relationships of rock specimens (Figure 5).

(2) The shear strengths evaluated by laboratory triaxial test on retrieved samples and by in-situ rock shear test were in reasonable agreement with those by in-situ triaxial test (Figure 6).

It should be concluded that the in-situ triaxial test can be applied to inhomogeneous rocks and substitute conventional in-situ test for rock ground investigation.

This research was supported by nine Japanese power companies and Japan Atomic Power Co. and Electric Power Development Co. Ltd. through the grant for a Joint Research Program.

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 drilling method of the specimen.

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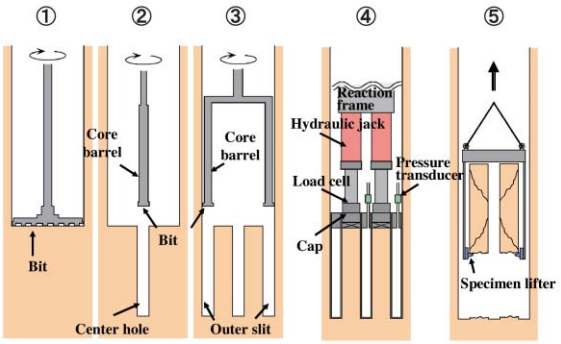
Reference

T. Okada, et.al., 2006, "Development of in-situ triaxial test for rock masses (Part2)", CRIEPI Report N05049 (in Japanese)



①The bottom of the drill-hole is prepared as a flat surface.
②The center hole is drilled. A drilled core can be obtained.
③The outer slit is drilled.
④The inner cell and outer cell are inserted respectively.
⑤The specimen is cut at its bottom and lifted to the ground surface for the observation.

Fig.1 Test procedure of in-situ triaxial test

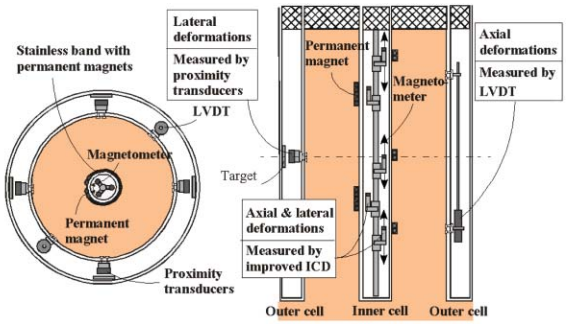


Fig.2 Improved measurement system

Axial and lateral strains can be measured in the center hole and outer slit of hollow cylindrical specimens.

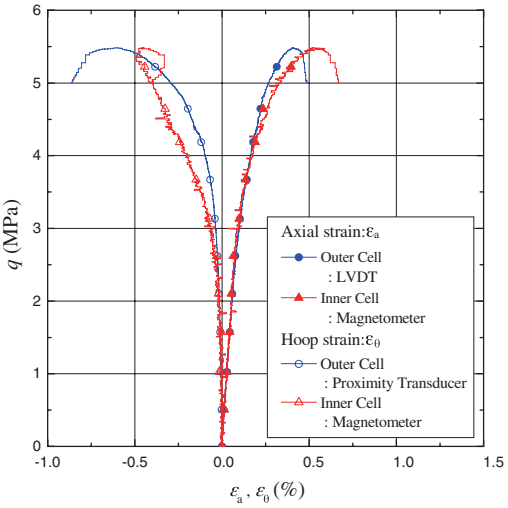


Fig.5 Relationship between stress and strain for C-2

Axial and lateral strains measured in the inner cell agreed approximately with the corresponding values measured in the outer cell.

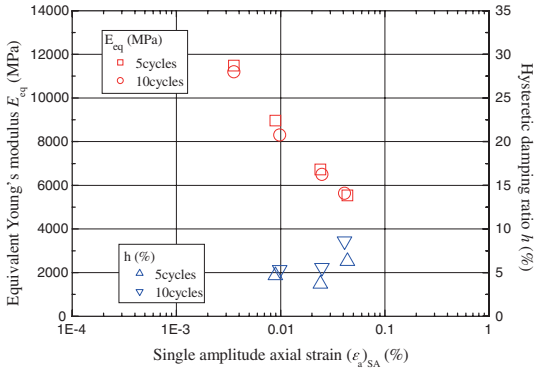


Fig.3 Dynamic deformation characteristics

In-situ cyclic triaxial test was successful to measure dynamic deformation characteristics for rock masses.

Fig.4 Specimen retrieved after tests

Left : triaxial compression, Right : triaxial extension

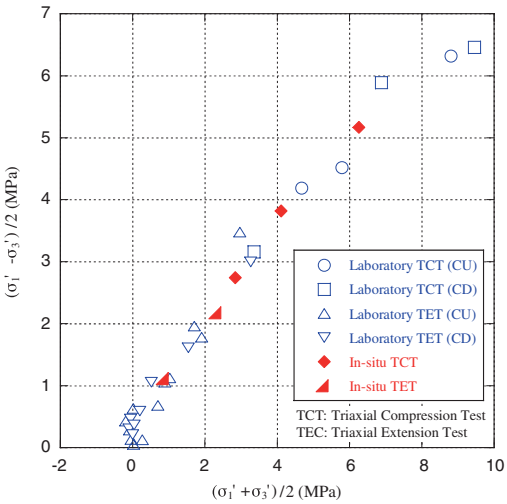


Fig.6 Results of laboratory and in-situ triaxial test

The strengths of the in-situ and laboratory triaxial tests were in reasonable agreement with each other.