Ⅲ－B349 Influence of weathering on the physico-mechanical characteristics of the Hiroshima decomposed granite

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1. INTRODUCTION

The paper comparatively describes the results of field investigation on two decomposed granite sites, situated in the vicinity of Hiroshima city. The field investigations were performed in July and November 1995 and July 1996 respectively and consisted of measurements of in-situ moisture content, total and dry densities by the radio-isotope method, plate loading tests, seismic refraction tests and block sampling for further laboratory investigation. Also, pressuremeter tests were performed, but due to the limited space they are not presented here. It was found that the weathering degrees of the two sites are DL and DH, this fact affecting the physico-mechanical properties of the soils. The study herein is part of a vast program, which has been carrying on at the Hiroshima University, devoted to the research of the behavior of the decomposed granite.

2. IN-SITU MEASUREMENTS BY RADIO-ISOTOPE METHOD TESTS

The radio-isotope tests offer the advantage of a rapid measurements of the in-situ moisture content, total and dry densities. At the first site, in July 1995 the RI tests were performed in 12 locations covering an area of 72 m^2, whereas at the second site, in July 1996 they involved 15 locations over an area of 127 m^2. The measurements revealed different physical properties indicating that the site investigated in July 1995 is DL weathering type while the site investigated in 1996 has DH degree of weathering. The mean values of the measured data, together with the calculated values of the void ratio and degree of saturation, are presented in Table 1.

3. SEISMIC REFRACTION TESTS

The in-situ velocities of the primary and shear elastic waves were determined by the seismic refraction method, along two parallel alignments. The energy source was provided by a sledge hammer which struck a metal plate. A multichannel seismograph recorded the signals from twelve geophones installed along a length of 16.50 m at 1.50 m intervals. Due to the fact that the values of the shear strains involved by the seismic refraction technique are in the range of 10^{-5}- 10^{-3} %, the waves that are generated are elastic, therefore the in-situ elastic soil properties, like the Poisson's ratio, shear and Young's moduli can be calculated.
In Table 2 are presented the mean values of the seismic refraction test results (V_p and V_s) and the calculated elastic properties of the investigated sites.
Correlating the results of the seismic refraction tests with those of the radio-isotope measurements, one can classify the decomposed granite sites, according to Honshu-Shikoku Bridge Authority (1977), within DH and DL categories of weathering.

Table 1 Results of the radio-isotope measurements

Type of soil	DH decomposed granite	DL decomposed granite
Moisture content, w (%)	1.71	13.1
Total density, ρ_t (kg/m^3)	2170	1760
Dry density, ρ_d (kg/m^3)	2130	1560
Void ratio, e	0.260	0.710
Degree of saturation, S_r (%)	17.64	49.10

Table 2 Results of the seismic refraction tests

Type of soil	DH decomposed granite	DL decomposed granite
Velocity of primary wave (m/s)	1720	380
Velocity of shear wave(m/s)	1180	190
Poisson's ratio, ν	0.055	0.33
Shear modulus, G (kN/m^2)	3.06E+06	6.48E+04
Young's modulus, E (kN/m^2)	6.46E+06	1.73E+05

4. PLATE LOADING TESTS

Plate loading tests were carried out on three different diameter steel plates, 100 mm, 200 mm and 300 mm. The loading force was applied incrementally in three loading-unloading cycles, by means of a hydraulic jack, while the reaction was undertaken by a 60 tf bulldozer. The load force was measured by a 50 tf capacity load cell and the settlements of the plate and the surrounding ground were monitored by twelve dial gauges. The load force, the plate settlements and the soil surface deflection in the vicinity of the loaded plate were recorded by a data logger. After all the tests were completed, the ground was excavated into a vertical section passing through the center of each plate with the aim to examine the appearance of the underground below the plates.

In Table 3, the values of the coefficient of vertical subgrade reaction and Young's modulus, are given for both types of masado soil, for the initial stage of loading and the first unload-reload cycle. The values of the Young's modulus are calculated under the assumption of a rigid footing on an elastic medium. The Poisson's coefficient is considered 0.30. It strikes out that the

Key words: weathering degree, field test, particle crushing, bearing capacity
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Table 3 Young's modulus and the coefficient of subgrade reaction from plate loading tests

Plate diameter (mm)	DL masado		DH masado	
	k_v (kN/m^3)	E (kN/m^2)	k_v (kN/m^3)	E (kN/m^2)
100 mm	9.832E+4	7.068E+3	8.015E+5	5.762E+4
	6.420E+5	4.615E+4	5.259E+6	3.781E+5
200 mm	5.646E+4	8.118E+3	3.808E+5	5.475E+4
	3.157E+5	4.539E+4	2.166E+6	3.114E+5
300 mm	4.649E+4	1.003E+4	4.045E+5	8.723E+4
	1.942E+5	4.189E+4	1.581E+6	3.410E+5

stiffness characteristics of the DL masado represent 11-14% from those of the DH masado. This important reduction is attributed to the advanced weathering of the DL masado.

In Fig. 1 the log-log graphs of load-settlement intensities were plotted to better indicate possible yield points. From the plotted curves it is difficult to indicate such a threshold in their shape. In the case of stiffer DH masado it appears that the bearing stress is far from reaching the ultimate bearing capacity. However, for the DL masado the maximum settlements are greater than one-fifth of the plates' diameter and still no clear yield points can be identified. It is believed that this pattern is given by the particular failure mechanism of this type of soils, which involves besides the shear process an important amount of particle breakage. Optical microscope examinations of thin sections of material before and after the plate loading test were done and they prove this assumption. Moreover, the amount of breakage increases with the degree of weathering. Typical microscope photographs of DL and DH masado soil samples after the plate loading test are shown in Fig. 2, as an evidence to the above statement.

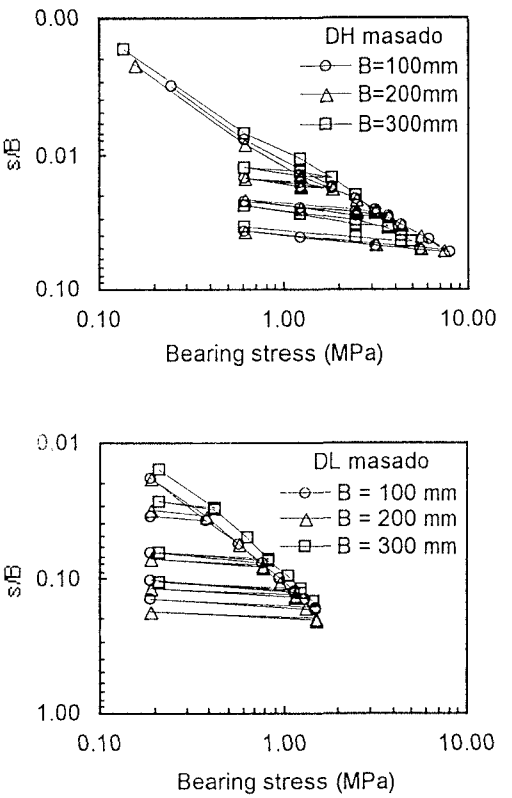

Fig.1 Load-settlement curves from plate loading tests for DH and DL masado

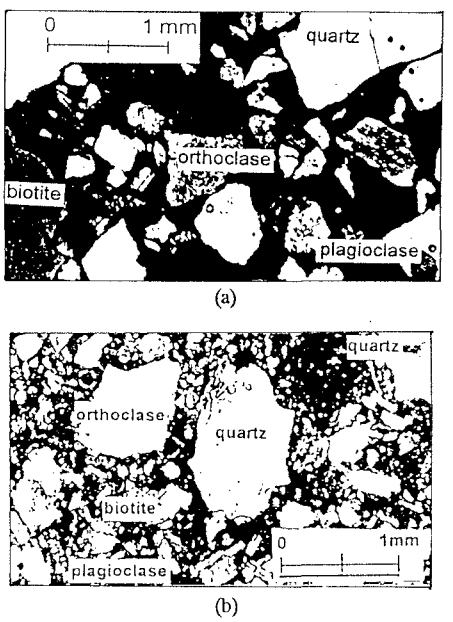

Fig. 2 Microscope photographs after the plate loading test for (a) DH masado (b) DL masado

5. CONCLUSIONS

The physico-mechanical characteristics of two decomposed granite sites were investigated by means of various field tests. The main conclusions can be summarized as following:

- according to the field investigation results, the both sites consist of decomposed granite soil with DL and DH degrees of weathering
- the plate loading tests show a reduction of the stiffness parameters from 7 to 9 times, when the degree of weathering varies from DH to DL
- the load-settlement curves do not indicate a clear yield point, probably due to the particular mechanism of failure of this type of soils, where shearing is combined with particle crushing. The amount of breakage increases with the degree of weathering. This observations are sustained by the microscope examination of soil samples with different degree of weathering, before and after the plate loading tests

REFERENCES

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