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学 位 論 文 内 容 の 要 旨

DISSERTATION ABSTRACT

博士の専攻分野の名称　博士（工学）　氏名　Anjula Buddhika Nayomi Dassanayake

学 位 論 文 題 名

Title of dissertation submitted for the degree

Effective Stress Coefficient of Rocks for Peak and Residual Strengths

(ピークおよび残留強度における岩石の有効応力係数)

To determine the effective stress coefficient for peak and residual strengths (α-peak and α-residual) of rocks, Modified Failure Envelope Method (MFEM) was proposed incorporating the results of triaxial compression tests based on the failure envelope method. The effective stress coefficients for intact and fractured rock (α-Biot's and α-fractured) were also evaluated using conventional methods, and the data were compared with the coefficient values obtained by MFEM for the peak and residual strengths. The types of rock considered were Kimachi sandstone and Bibai sandstone as medium-hard clastic rocks, Inada granite as a hard crystalline rock and Shikotsu welded tuff as a soft pyroclastic rock, to cover wide range of physical properties of rock under confining pressures of 1-15 MPa at 295 K. Based on the results of rock types, an equation to obtain the effective stress coefficient from total confining pressure and pore pressure, and a method to choose the coefficients for elastic stress analyses and failure evaluations for intact rock structures or structures in rock mass were also proposed. Main findings are as follows.

For Kimachi sandstone, the effective stress coefficients for the peak strength, α-peak decreased with increasing effective confining pressure and was in the range 0.8 > α-peak > 0.4, under both single and multi stage MFEMs. For residual strength, α-residual was almost constant under single stage MFEM. But it shows slight decrease with increasing effective confining pressure in both approaches of multistage MFEM. In Multistage MFEM-descending Pc approach, stress data related to small Pp magnitude; 3 MPa and 5 MPa caused large errors in α value. Compaction effect of sample under multistage descending Pc approach could also cause to this larger deviate of α from constant trend under higher Pp magnitudes. In the drained hydrostatic compression test α-Biot's decreased with increasing confining pressure, and was in the range 1 > α-Biot's > 0.8. The effective stress coefficients by hydrostatic tests for fractured rock, α-fractured were larger than those for intact rock α-Biot's and were close to unity.

For Bibai sandstone, the effective stress coefficients for the peak strength, α-peak decreased with increasing effective confining pressure and was in the range 0.9 > α-peak > 0.4, under both single and multi stage MFEMs. For residual strength, α-residual was almost constant under single stage MFEM and slightly fluctuate in the range of 0.8 > α-residual > 0.7. But it shows slight decrease with increasing effective confining pressure in both approaches of multistage MFEM. However in both single stage and multistage MFEMs, α-Residual shows almost constant value and slightly fluctuate in the range of 0.9 > α-residual > 0.7. In the drained hydrostatic compression test α-Biot's decreased with

increasing confining pressure, and was in the range $1 > \alpha$-Biot's > 0.5. The effective stress coefficients by hydrostatic tests for fractured rock, α-fractured were larger than those for intact rock α-Biot's and were close to unity.

For Inada granite, α value for peak strengths under the single-stage MFEM were scattered around 1. In the multistage triaxial tests, effective stress coefficient for peak strength decreased with effective confining pressure and were in the range $0.8 > \alpha$-peak > 0.2. The behavior of α for residual strength as a function of the effective confining pressure was similar to that of the peak strength. In the drained hydrostatic compression tests, the effective stress coefficient decreased with confining pressure and was in the range $0.9 > \alpha$-Biot's > 0.7. These results exhibited rather large variations in α, which was attributed to the small strain. The effective stress coefficients by hydrostatic tests for fractured rock, α-fractured were larger than those for intact rock α-Biot's and were close to unity.

For Shikotsu welded tuff, the MFEM could not be used to determine the effective stress coefficients for the peak strength in single stage or multistage triaxial tests. In many cases, the strength with non-zero pore pressures was larger than that with zero pore pressure. This may be due to an end-cap like failure surface at higher stresses because of pore collapse, due to crushing of the rock matrix, which consisted of volcanic glass. The decrease in α for residual strength with increasing effective confining pressure shows the progress of the pore collapse. Therefore, poroelasticity theory could not be applied to this condition. In the drained hydrostatic compression tests, the effective stress coefficient slightly decreased with confining pressure and was in the range $0.95 > \alpha$-Biot's > 0.90. The effective stress coefficients by the hydrostatic tests for fractured rock, α-fractured were larger than those for intact rock, and were close to unity.