

論文の内容の要旨

論文題目 Elastic Wave Measurement and Evaluation of Mechanical Behavior of
Bound and Unbound Geomaterials
(非固結および固結した地盤材料の弾性波速度測定と力学特性の評価)

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Elastic wave propagation was employed in this study to investigate soil properties in the laboratory and field tests. In the laboratory, piezo-ceramic actuator for a trigger, accelerometer, and bender element were mainly used. In the field, suspension PS logging was conducted to investigate the soil profile of a construction site.

This study started from a comprehensive comparison on shear modulus obtained from various measurement techniques including different specimen sizes and densities, dry and saturated conditions, obtained from static and dynamic measurements, different researchers, and also triaxial compression and torsional apparatuses. As the outcomes, it was reported that results from cyclic loading on Triaxial Compression (TC) and Torsional Shear (TS) tests as static measurement, as well as Trigger Accelerometer (TA), Bender Element (BE), and Plate Transducer (PT) methods as dynamic measurement were compared in a log-log graph of normalized shear modulus ($G/f(e)$) versus stress parameter ($(\sigma_1 \sigma_3)^{0.5}$). For each method the values of $G/f(e)$ were plotted with the standard deviation values at largest of 5.0% and having coefficients on the stress-state dependency of 0.40 – 0.50. However, in average the values of shear modulus obtained with the TA with S and P wave methods resulted in about 30% higher than those with the BE method at stress parameter of about 30 kPa, while that in about 20% at stress parameter of about 400 kPa.

By employing coarser uniform graded geomaterials having mean diameter in the range of 1 to 4 mm, performance of BE method was studied. As the results, due to bedding error at the interface between the bender element and specimen especially in coarser geomaterials, soil stiffness measurement using BE method may lead to underestimate.

Furthermore, results of above study were also compared with those of round robin test using BE on

Toyoura sand that collecting data from 23 institutions of 11 countries organized by Japanese Domestic Committee for Technical Committee 29 (TC-29) in 2005. As the outcomes after plotting all the results in a graph at certain stress state, it seemed to that the scattering among data obtained from this study is plotted in very limited range as compared to those from round robin test.

Based on the finding from that comparison, the topic comes to a motivation to observe more in detail about TA method. By using large scale triaxial apparatus and employing four accelerometers placed inside the specimen, investigation on the wave propagation inside the specimen was performed. Two ways of accelerometer configuration for two aims were arranged, i.e. accelerometers placed in two different distances from the top cap for observing the wave travel time and those located on diametrical direction in the same distance for observing the cross sectional wave distribution. Simulating TA and BE methods in term of the presumption on generating wave propagation were also conducted with placing the trigger inside and outside the specimen, respectively. As the results, the values of shear modulus evaluated from the S and P waves captured by accelerometers placed inside and outside the specimen were compared. Wave front distribution inside the cylindrical specimen of S and P waves in term of velocity was reported. In addition to that, study on the combination of TA and BE method was also discussed.

After performing detailed study on elastic wave propagation using unbound geomaterials, this study went further to investigate the bound geomaterials. Undisturbed and reconstituted Chiba sands retrieved from construction site by block sample method were examined carefully both on small strain characteristics using static and dynamic measurements and also on strength characteristics. In this study, Chiba sand was classified as natural lightly-cemented sand.

Based on the comparison on the results from small strain measurements in the laboratory and suspension PS logging, no significant difference in the values of shear modulus were obtained, which imply to that degree on disturbance of the block sample is negligible. To compare between natural and artificial cemented sands, specimens of Toyoura sand mixed with Portland cement 1% and 5% were prepared. As the results, the existence and the destruction of cementation in the soil could be observed by employing elastic wave propagation. Furthermore, according to the state of cementation, the changing in tendency of degree on stress state dependency in small strain stiffness is observed.