UNIVERSITI TEKNOLOGI MARA

SMALL STRAIN STIFFNESS BEHAVIOUR OF UNDISTURBED AUCKLAND RESIDUAL CLAY UNDER MONOTONIC AND DYNAMIC LOADING

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Thesis submitted in fullfillment
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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Auckland residual soil is product of in-situ chemical weathering of Waitemata group sandstones and siltstones, which is the most abundant available construction material in the Auckland region. It is well known that Auckland is lying on the active volcanic and seismic region due to the fact New Zealand is located on the dynamic boundary of Pacific and Indo-Australian Plate. Therefore, seismic consideration in the design of foundations and soil structures is vital and thus extensive study on the dynamic properties is very important to be carried out of this particular soil. Investigation of dynamic properties of undisturbed Auckland residual soil in the laboratory using modified small strain triaxial apparatus, bender element and field seismic dilatometer test (sDMT) under the elastic range of strain. Improved small strain triaxial apparatus enables the investigation of non-linear stress-strain characteristics and maximum shear modulus at the very small strain, which is less than 0.0001% strain under the monotonic loading condition. Bender element system that is successfully integrated with existing small strain triaxial apparatus in this study provide a very valuable comparison data for maximum shear modulus (G_{max}) obtained under dynamic loading and monotonic loading from both bender element and small strain triaxial test. Moreover, a non-destructive bender elements test allows the same specimen to be used for both laboratory tests repectively, thus enables substantial homogeneity of results and appreciable cost saving especially when dealing with undisturbed soil samples. The field sDMT performed at the trial pit of the same sampling site provides a useful comparison set of data to validate the accuracy of the laboratory experimental data from both small strain triaxial and bender elements test. Furthermore, data from field and laboratory tests enable meaningful comparison of G_{max} and practical correlation with the soil properties. In addition of that, the simulation of the small strain triaxial test using PLAXIS software is carried out as it provides some advantages over limitation imposed by the physical triaxial test. Further investigation of Auckland residual soil behaviour under various conditions of stress and loading can be simulated and predicted satisfactorily by HS-small soil model in the software. Finally, the suitable prediction model, called normalized rotational multiple yield surface framework (NRMYSF) for small strain model of Auckland residual soil has been developed in order to analyse and investigate the significance features of the non-linearity at small strains. The NRMYSF enables excellent prediction of stress-strain curve of undisturbed Auckland residual soils. In conclusions the verification of maximum shear modulus values between laboratory bender element test and field sDMT shows excellent agreement, thus confirmed the reliability of the laboratory test. Furthermore, the exceptionally mathced of stress-strain curve between small strain traixial laboratory test data and predicted values using NRMYSF indicated the significant improvement of existing Rotational Multiple Yield Surface (RMYS) model in predicting small strain stiffness behaviour.

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