UNIVERSITI TEKNOLOGI MARA

ANISOTROPIC VOLUME CHANGE BEHAVIOUR OF SOFT SOIL INCORPORATING SHEAR STRENGTH

JUHAIZAD BIN AHMAD

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy
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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.

Name of Student	:	Juhaizad bin Ahmad
Student I.D. No.	:	2016175823
Programme	:	Doctor of Philosophy (Civil Engineering) – EC950
Faculty	:	Civil Engineering
Thesis Title	:	Anisotropic Volume Change Behaviour of Soft Soil Incorporating Shear Strength
Signature of Student	:	……………………………………………..
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ABSTRACT

Volume change behaviour of soil is determined from the one-dimensional consolidation test. The weakness of the test is the lateral deformation is not permitted and the volume change is not well presenting the actual site condition. The real soil is exhibiting the anisotropic volume change behaviour based on the development of the shear strength during compression. This study is intended to determine the anisotropic volume change behaviour of soft soil by incorporating the shear strength via drained triaxial test. On top of that, the strain hardening and softening prediction is conducted on the stress-strain curve using graphical method. It is carried out from the mobilized shear strength envelope plot. The soil samples were collected from Kuala Terengganu, Alor Setar, Pasir Mas (Site A), Pasir Mas (Site B) and Butterworth, Malaysia. The consolidated drained (CD) triaxial test was conducted on the samples with various effective stresses (50, 100, 200 and 300kPa). The normalized method is applied in this study. It is based on the Rotational Multiple Yield Surface Framework (RMYSF). Currently, RMYSF is applied to predict the stress-strain curves for unsaturated soil and limited to strain hardening only. Extension work is conducted to the existing method by predicting the strain-softening phase for soft soil. The increase in mobilized shear strength is plotted for hardening prediction while the reduction of the mobilized shear strength envelope is used for strain softening prediction. Moreover, the preconsolidation stress is predicted from the shear strength characteristics. The preconsolidation stress is given by the transition of the curvilinear and linear mobilized shear strength envelope. The Mohr circle is plotted at this transition point and the preconsolidation stress is given by the value of the major principle stress value. Moreover, a novel method is proposed to determine the anisotropic volume change behavior of soft soil. RMYSF method is developed to from the stress-strain curves that representing the the initial stress condition at site. The volume change or settlement is given by the soil layer thickness times by the difference between final and initial axial strains. The comparison was made with Terzaghi's method and FEM. It can be concluded that the normalized method is successfully predicted the strain-softening phase and the anisotropic volume change behavior of the soil. Since the conventional method (Terzaghi method) is overpredicted the settlement, the proposed method is less conservative and can be used to estimate the anisotropic volume change behavior effectively. The settlement analysis using RMYSF and FEM is less 2.5% and 5.6%, respectively than Terzaghi's method. This result is accomplished without having to rely on assumptions and complicated phenomenological mathematical equations. This method is based on the inherent property of the soil. The main advantage of this method is that it can be applied to predict the soil strength parameter for various effective stresses without having to conduct many tests. The limitation of the model is that the consolidation settlement using RMYSF must be conducted for the topsoil with more than 4m. Otherwise, the initial effective stress cannot be determined. The recommendations for future works include the discretization of the axial strain increment of 0.5% for strain softening prediction, the preconsolidation stress prediction method should be verified with other types of soil, RMSYF should be verified with other types of test such as extension test and the shape of the mobilized shear strength envelope at higher stress level (more than 400kPa) is anticipated to be curvilinear. Hopefully, this method will help to cut the time and cost of testing successfully and help the geotechnical engineer to predict the soil behaviour successfully.

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TABLE OF CONTENT

Page