UNIVERSITI TEKNOLOGI MARA

MODELLING OF COLLAPSE SETTLEMENT BY EFFECTIVE STRESS AND SHEAR STRENGTH INTERACTION FOR GRANITE RESIDUAL SOIL

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Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Civil Engineering

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AUTHOR'S DECLARATION

I declare that the work in this dissertation 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 topic 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

Over the years, consolidation settlement has always been associated with effective stress increase. However, in unsaturated soils, volume change behaviour of soils due to wetting is always complex due to changes of the soil when it is inundated. The main objectives of this research are to evaluate the simulation of foundations on unsaturated soil using various soil models incorporating loading and wetting collapse of the soil and to verify the settlement behaviour through physical model and laboratory shear strength test on unsaturated soil samples. The double wall triaxial apparatus was used to determine the unsaturated shear strength of the soil following Curved Surface Envelope Soil Shear Strength Model. The Modified Rowe's cell apparatus was used to model the loading and wetting collapse behaviour of the soil, hence simulate using the Rotational Multiple Yield Surface Framework. The proposed shear strength equation and model for saturated and unsaturated conditions are in good agreements with the Kuala Kubu Baharu granite residual soil, which proves that the Curved Surface Envelope Soil Shear Strength Model is applicable to gravels and granite residual soil with 30 % fines. Hence, the prediction of the stress strain response for every specimen can be established during initial shearing of the specimen producing a general unique relationship between minimum mobilised friction angle, $\phi_{\min_{mob}}$ against axial strain, ε_a. The unique relationship curve follows the true behaviour of soil since the stiffness is related to the resisting strength parameters, which are $\phi'_{\min_{mob}}$ and ε_a. A settlement comparison was made between the simulated settlement values and the laboratory modelling showing that the simulation is almost similar to the laboratory modelling and is in good agreements to the laboratory modelling for unsaturated Kuala Kubu Baharu granite residual soil. This showed that significant settlements occurred when the soil is nearly saturated. In conclusion, the shear strength of granite residual soil predicted from the simulation using Curved Surface Envelope Soil Shear Strength Model is in good agreements with the triaxial test results and the wetting collapse settlement can be explained from the simulation and validation using Rotational Multiple Yield Surface Framework. In fact, the experimental results agreed with the simulation and formulation produced from this model and framework, hence, the complex wetting collapse behaviour of unsaturated soil can be explained and predicted with this fundamental approach.

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