UNIVERSITI TEKNOLOGI MARA

PREDICTION OF SOFT CLAY SOIL SETTLEMENT USING NORMALIZED ROTATIONAL MULTIPLE YIELD SURFACE FRAMEWORK (NRMYSF)

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Thesis submitted in fulfilment
of the requirements for the degree of
Master of Science
(Civil Engineering)

College of Engineering

August 2023

ABSTRACT

The prediction of soil settlement in geotechnical engineering can be challenging, primarily due to the influence of moisture content on soil shear strength. A reduction in shear strength can lead to increased soil settlement. In this research, the Normalized Rotational Multiple Yield Surface Framework (NRMYSF) is employed to predict settlement in soft clay soil. To achieve the objective of this research, the consolidated-drained (CD) triaxial tests were conducted. In this study, the Rotational Multiple Yield Surface Framework (RMYSF) is utilized to forecast the stress-strain curves of four sets of samples namely CD-A, CD-B, CD-C, and CD-D, at effective stresses of 50 kPa, 100 kPa, and 200 kPa. The percentage errors for these samples are 6.42%, 2.10%, 2.57%, and 1.78% respectively. To enhance accuracy, the NRMYSF is introduced, resulting in improved predictions. The NRMYSF exhibits lower percentage errors of 4.72%, 1.34%, 1.23%, and 0.67% for samples CD-A, CD-B, CD-C, and CD-D respectively. These lower error values indicate better agreement between predictions and laboratory results. The NRMYSF is extended to predict soil settlement based on shear strength stress-strain curves. Using 1D consolidation analysis, Normalized Rotational Multiple Yield Surface Framework (NRMYSF), and Settle 3D modelling software, the total settlement of soft clay soil is predicted to be 0.2048 meters, 0.1994 meters, and 0.1942 meters respectively. A comparison is made between the NRMYSF and other methods such as 1D consolidation analysis and Settle 3D software modelling, revealing difference errors of 2.7081% and 2.6078% respectively. Based on these findings, it can be concluded that the Normalized Rotational Multiple Yield Surface Framework (NRMYSF) is a viable and practical approach for predicting soil settlement in soft clay soil.

ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my Master and for completing this long and challenging journey successfully. My gratitude and thanks go to my supervisor Ts. Dr. Rohaya Binti Alias, and my ex-supervisor Assoc. Prof. Dr. Mohd. Jamaludin Md. Noor. Thank you for the support, patience and ideas in assisting me with this project.

My appreciation goes to the staff of University Technology MARA (UiTM) especially to my lecturers such as Asmidar Binti Alias and Farah Wahida Binti Mohd Latib who assisted me during my study. Special thanks to my colleagues and friends for helping me with this project.

I am very grateful to the University Technology MARA (UiTM) for giving me an opportunity to do a Master as research assistant and providing me with scholarship during the study.

Finally, this thesis is dedicated to the loving memory of my father and my very dear late mother for the vision and determination to educate me. This piece of victory is dedicated to both of you. Alhamdulillah.

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CHAPTER 1
INTRODUCTION

1.1 Overview

Geotechnical engineering has long been focused on understanding soil settlements, but accurately predicting the settlement of soil poses challenges due to variations in soil compressibility parameters and real-world soil conditions. The inability to properly assess soil stiffness and the lack of suitable design methods hinder geotechnical engineers in accurately forecasting soil settlement.

Soft clay soil is commonly regarded as a challenging soil type due to its inherent characteristics, characterized by low strength and significant compressibility. These characteristics make soft clays prone to extensive settlement under prolonged loading conditions. To avoid catastrophic failure, the design engineer may need to resort more expensive techniques such as deep foundations and ground improvement. While engineers strive to find precise methods for predicting soil behaviour, obtaining accurate input data is an expensive process. Settlement predictions have been improved by the development of various methods and models. Despite the development of various methods and models that have enhanced settlement predictions, accurately forecasting settlements remains a persistent challenge.

1.2 Problem Statement

Terzaghi's theory of soil consolidation, proposed in 1943, has been widely accepted as a method for predicting soil settlement in clay soils. This theory relies on the principles of effective stress to forecast soil settlement. In geotechnical engineering, engineers often employ a simplified approach to calculating consolidation settlements. This is done by assuming 1D deformation and relying on limited information obtained from standard oedometer tests. In spite of its simplicity and ability to capture various parameters such as compressibility coefficient and pre-consolidation pressure, the theory is often impractical due to uncertainty and constant parameters (Asaoka, 1978; Zhang, 2017 & Kim et al., 2020). Some disadvantages of 1D consolidation tests are time-consuming and do not take