学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Experimental study for modeling unloading behavior of marine clays

(海成粘土における除荷挙動の実験研究とモデル化)

There is a rising demand for land reclamation in coastal cities with the economic and demographic growth in East and Southeast Asia. Marine clays play a critical role in these projects, as their deformation characteristics significantly impact subsoil quality. The long-term loading behavior of marine clays has been studied by many researchers. However, there are relatively few existing studies focusing on the unloading behavior after preloading, and strain rate dependency on the unloading behavior of marine clays remains unclear.

This study aims to accumulate experimental data on the unloading behavior of marine clays and develop a strain rate-based model for improving the prediction accuracy for marine clays' unloading behavior. The author conducted a series of Constant Rate of Strain (CRS) consolidation tests from loading to unloading, and Long-term unloading Oedometer Tests for marine clays to observe the unloading behavior. Controlling the preloading duration corresponding to different strain rates at the end of preloading to elucidate the stress history's effect.

Moreover, instead of a parameter σ'_p (preconsolidation pressure) for normal consolidation visco-plastic behavior, the author develop and propose a new visco-plastic model by introducing a concept of plastic rebound boundary and a new parameter R for swelling behavior in unloading. This parameter R represents the normalized distance from the current stress state to the plastic rebound boundary in logarithmic effective consolidation stress. Therefore, the visco-plastic model for behavior in the loading stage has been developed into the swelling visco-plastic behavior in the unloading stage of marine clay. Comparing the simulation and test results, the simplified visco-plastic swelling model shows great agreement with the test results.

This thesis provides a novel perspective on the unloading behavior of marine clays and experimentally validates the efficacy of a strain rate-based model in describing their swelling

behavior. The new model offers significant theoretical support for optimizing foundation design and prediction in future coastal land reclamation projects.

The thesis is composed of 7 chapters. Chapter 1 introduces the study's background, objectives, and the need for improvement in the accuracy of prediction for unloading behavior of marine clay. Chapter 2 provides a literature review of experimental research on loading and unloading behavior of marine clays, and some recent models for unloading behavior. Chapter 3 introduced the marine samples in this thesis. Chapter 4 describes the test methodology and results of the unloading CRS test. Chapter 5 describes the test methodology and results of the unloading Oedometer test. Chapter 6 develops a new visco-plastic model for the swelling behavior in unloading. Finally, Chapter 7 provides a further discussion of the new visco-plastic model, summarizes the study's findings, and provides some recommendations for further research.