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CONSOLIDATION OF LAYERED SOIL USING VERTICAL DRAIN

AINI SAKINAH BINTI ESA

A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Civil – Geotechnics)

Faculty of Civil Engineering
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JULY 2011

I declare that this project report entitled "*Consolidation of Layered Soil Using Vertical Drain*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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To my beloved parents and loved ones.

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ABSTRACT

Vertical drains are usually installed in the weak subsoil that consists of several layers. However, most of the existing solutions for the consolidation process are not applicable for multilayered soil. In addition, only few available studies for layered soil take account of the well resistance and the smear action. Therefore, a parametric study for consolidation of layered soil considering smear effect and well resistance using finite element solution will be compared and discussed. This study also will adopt the comparison of degree of the consolidation in terms of excess pore water pressure with various ratio of permeability, drain spacing using finite element method. The problem is analyzed under two dimensional plane strain conditions. It is shown that smear effect and well resistance has significant effect on the rate of consolidation in layered soils. Besides, permeability ratio in layered soil and drain spacing also influences the rate of consolidation.

ABSTRAK

Saliran tegak kebiasaannya digunapakai pada tanah lembut yang mengandungi beberapa lapisan.Namun, kaedah yang sedia ada untuk proses enapan tidak boleh diaplikasikan untuk tanah yg berlapis. Malah, kajian mengenai tanah yang berlapis yang mengambil kira faktor kesan lumuran dan rintangan kolam adalah sangat kurang.Oleh itu, kajian parametrik bagi enapan untuk tanah berlapis dengan mengambil kira kesan lumuran dan rintangan kolam menggunakan kaedah penyelesaian unsur tak terhingga akan dibandingkan dan dibincangkan. Kajian ini juga mengandungi perbandingan antara nilai enapan dari segi pengeluaran air yang berlebihan dengan pelbagai nisbah kebolehtelapan tanah pelbagai lapisan dan jarak saliran dengan kaedah unsur tak terhingga. Masalah ini dianalisis dengan menggunakan keadaan dua dimensi terikan satah. Kesan lumuran dan rintangan kolam didapati mengandungi kesan signifikan pada kadar enapan dalam tanah berlapis. Selain itu, nisbah kebolehtelapan pada tanah berlapis dan jarak saliran juga mempengaruhi kadar enapan.

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a	-	permeability ratio
c'	-	cohesion
D_e	-	diameter of equivalent soil cylinder of vertical drain
d_s	-	diameter of smeared zone
d_w	-	Equivalent drain diameter
E	-	elastic modulus
H	-	thickness of soil model
h_1	-	thickness of layer 1
h_2	-	thickness of layer 2
k_h	-	horizontal hydraulic conductivity
k_s	-	smeared hydraulic conductivity
k_v	-	vertical hydraulic conductivity
k_{ve}	-	equivalent vertical hydraulic conductivity
l	-	drainage length
S	-	vertical drain spacing
q_w	-	discharge capacity
v	-	Poisson ratio
φ'	-	soil plasticity
ψ	-	angle of dilantacy

CHAPTER 1

INTRODUCTION

1.1 Background of the Problem

Rapid urbanization and increase in development activities have resulted in the reclamation of coastal zones and the utilization of the poorest of soil formation for construction has become inevitable. The use of vertical drains with preloading to stabilize and improve the engineering properties of the underlying soft soil deposits has become a common and successful technique prior to construction. Whereas preloading increases the pore water pressure, the installation of vertical drain in the soft soil helps reduce the length of the drainage path and shorten the time for consolidation process to complete. Other than facilitate the natural drainage of the soil, vertical drains are also effective in laminated or layered anisotropic soil, provided the loaded area is considerably large. Finite element method offers analysis that capable to predict especially the deformation and the degree of consolidation of the layered soil that incorporates with the vertical drain.

1.2 Problem Statement

Vertical drains are usually installed in the weak subsoil that consists of several layers. However, most of the existing solutions and analysis for the consolidation process are not applicable for multilayered soil. In addition, only few available solutions for layered soil take account of the well resistance and the smear action. Therefore, the accuracy of other researchers' procedures and findings related with the consolidation of layered soil solution will be discussed. This study also will adopt the comparison of degree of the consolidation between the existing analytical solutions for layered soil with the present numerical solution using finite element method.

1.3 Objective of the Study

The aim of this study is to simulate the consolidation behavior of layered soft ground improved by prefabricated vertical drain. The objectives to reach the aim of the study this study are as following:

1. To analyze the consolidation process in the multi layered soil with vertical drain using finite element method.
2. To determine the effects of different permeability ratio in the layered soils on the magnitude and rate of consolidation in finite element analysis.
3. To predict the influence of various parameters in vertical drain to the rate of excess pore water pressure dissipation of the layered soil by finite element method.

1.4 Scope of the Study

In this study, the main focus is on the analysis of the layered soil consolidation process as the soil is rarely heterogeneous and to predict the excess pore water dissipation by using finite element method.

1.5 Significant of the Study

By analyzing the consolidation of layered soil with vertical drain with finite element method (FEM) by using PLAXIS, we can verify the methods used by the previous researchers. Furthermore, by using both FEM interactive methods, we will compare the differences among the results especially the rate of consolidation and the distribution of excess pore pressure along the layered soil.