SETTLEMENTS ANALYSIS OF PVD INSTALLATION IN SOFT SOIL USING PLAXIS 3D

AHMED MOHAMMED HASAN ALLAWI

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

School of Civil Engineering
Faculty of Engineering
Universiti Teknologi Malaysia

JULY 2020

DEDICATION

This project is dedicated to my family

ACKNOWLEDGEMENT

First and foremost, all praises be to Allah S.W.T, the Almighty, for the blessings during the whole of my research work to complete the research successfully.

I would like to express my deep and sincere gratitude to my enthusiastic supervisor, Prof. Nazri Bin Ali. His dynamism, vision, sincerity and motivation have deeply inspired me. he taught me the methodology to carry out the research and to present the research works as clearly as possible. It was a great privilege and honor to work and study under his guidance .Without his leadership this project would not have been possible.

I am extremely grateful to my parents for their love, prayers, caring and sacrifices for educating and preparing me for my future. I am very much thankful to my friends for their support, understanding, sacrifices, prayers and continuing support to complete this project. Also I express my thanks to my sister for her support and valuable prayers.

ABSTRACT

Recent years, several of construction projects are built on soft soil. In accordance with the proprieties of soft soil, the construction on soft soil always leads to settlements. Vertical drain such as prefabricate vertical drain (PVD) has been successfully applied in many projects as soft soil ground improvement method. However, some of the solutions that existed to accelerate the consolidation process are not applicable for the multi-layered soft soil and optimum spacing and length of PVD has not been established due to limitation of 2D analysis. In this study, finite element analysis is applied to verify the efficiency of modelling of vertical drain in subsoil using computer software, PLAXIS 3D. This study will also analyses the effect of prefabricate vertical drain (PVD) at optimum horizontal spacing and length of (PVD) via different soil models those are Mohr Coulomb Model and Hardening Soil Model.

ABSTRAK

Sejak kebelakangan ini, beberapa projek pembinaan dibina di atas tanah lembut. Merujuk kepada sifat tanah lembut, pembinaan di atas tanah lembut selalu menyebabkan pemendapan tanah. Saliran menegak seperti prefabricated vertical drain (PVD) telah berjaya diterapkan dalam banyak projek sebagai kaedah penambahmbaikan/pengukuhan tanah lembut. Walau bagaimanapun, beberapa penyelesaian yang sedia ada untuk mempercepatkan proses pengukuhan tidak sesuai bagi tanah lembut berlapis-lapis dan jarak optimum serta panjang PVD juga belum dapat diwujudkan kerana keterbatasan analisis secara 2D. Dalam kajian ini, analisis unsur terhingga (finite element) diterapkan untuk mengesahkan kecekapan pemodelan prefabricated vertical drain (PVD) di tanah lembut dengan menggunakan perisian komputer, PLAXIS 3D. Kajian ini juga akan menganalisis kesan prefabricated vertical drain (PVD) pada jarak ufuk optimum dan panjang PVD dengan menggunakan model tanah yang berbeza seperti Mohr Coulomb Model dan Hardening Soil Model.

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LIST OF ABBREVIATIONS

PVD	prefabricated Vertical Drains
FEM	Finite Element Method
MC	Mohr Coulomb Model
HS	Hardening Soil model

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CHAPTER 1

INTROUDUCTION

1.1 Background of the problem

In general soil settlement due to changes in environmental and stress can cause change in volumetric of soil mass. When a soil has already been subjected to a load, the vertical effective stress will be increased. Vertical strain also will increase in the soil as a result of the stress and can move the ground downward, therefor settlement will happen. This settlement that supports the embankment in the subsoil will be placed during and after filling.

A weak soft soil under the constructed embankment always leads to settlement. Ground improvement is essential to avoid this kind of problem. There are many techniques to improve the soft soil and one of the familiar techniques is prefabricated Vertical Drains (PVD). The function of (PVD) is to decrease the drainage path from low permeable layer of the pore water pressure to the ore-installed drainage layer or to the free water surface; as a result, settlement progression might be more rapidly also the rate of main consolidation.

The installation of vertical drains increase the rate of settlement that could take place in the soil (Barron, 1948; Hansbo, 1981; Holtz et al, 1987; Holtz et al, 1991) and it will reduce the settlement of the post-construction. The structures that are sensitive to settlement and embankment normally we use preloading with surcharge as a technique to accelerate the settlement (Johnson, 1970a) and it is always connected with vertical drains (Johnson, 197Db).

To ensure stability of the embankment other techniques may have to be considered during construction. With the steep side slopes embankment can be constructed in stage construction (Jardine and Hight, 1987; Ladd, 1991; Leroueil et al, 1991). During construction the subsoil relies on the increasing in the undrained shear strength and therefore it will be more benefit when we use it with vertical drains. Tensile reinforcing material such as geogrids, geotextiles or steel reinforcement become more popular technique to use positioned at the base of the embankment (Bonaparte and Christopher, 1987). In the subsoil the bearing capacity effectively will increase from the lateral restrain that provides from the reinforcement.

1.2 Problem Statement

The number of project failures regarding with soil settlements and deformation of structure has been increased either locally or internationally. Some of the failures were caused by the low shear strength and high compressibility of soft soil. Settlement problem can be illustrated as a movement downward of the ground in the soil caused by applied stresses. The load carrying system will be changed as a result of soil settlement. A part of fill material will be floated if the ground water level is high which will affect the total surcharge loading and the strength of the soil. Stabilizing and improvement the engineering properties of the soft soil the use of vertical drains with preloading have become a common and successful technique for the construction. While preloading raises the pore water pressure, the vertical drain installation in soft soil will help to reduce the length of the drainage path and help to make the time of consolidation shorter to complete.

Numerical analysis by using PLAXIS software is the work focusing. For the geotechnical engineering the construction on the soft soil area is a great challenge in the field. The construction of embankments on the soft soil, compressible ground has being increased due to lack of appropriate land for infrastructure and other developments. Many engineering problems in the form of slope stability, bearing capacity failure or differential settlement could occur either during or after the construction time due to low shear strength and high compressibility of this soil.

Many type of ground improvements have being used to support embankments on soft ground to get economical and safe constructing. Many factors can affect the success of ground improvement from planning, investigation, analysis, design, specification of works construction and closed supervision by design consultants.

Before this, acceleration of the consolidation had been analyzed with and without vertical drain in 2D PLAXIS software. Hence we would like to analysis the effect of (PVD) vertical length and the effect of (PVD) at optimum horizontal spacing in PLAXIS 3D software by using different soil model which are Mohr-Coulomb model and Hardening Soil model.

The findings of this study will the benefit the society to understanding the effect of PVD installation as ground improvement. Thus, the engineers can apply or consider the finding as guideline in designing the PVD installation on soft ground.

1.3 Objective of the Study

The aim of this project is to study the effectiveness of (PVD) installation in the soft soil by using PLAXIS 3D for the settlements analysis. The objectives to reach the aim of this study are as following:

i) To analysis soil properties for consolidation;

ii) To analysis the effect of PVD at different spacing.

iii) To analysis the effect of PVD length at optimum PVD spacing.

1.4 Scope of the Study

This study will cover the analysis of soft soil consolidation using prefabricates vertical drains and preloading. In order to establish settlement design chart, numerical simulation will be perform using finite element analysis in PLAXIS 3D. The Plaxis software is used as the main indicator in analysing acceleration of consolidation of soft soil under preloading and prefabricates vertical drains. This study focuses on the use of ground improvement which is (PVD) for accelerate the consolidation of embankment over soft soil and to analyze the effect of (PVD) spacing and effect of (PVD) length. The soil parameters obtained were used on the modeling of embankment according to previous project. The figure 1.1 shows the trail embankment install with (PVD).

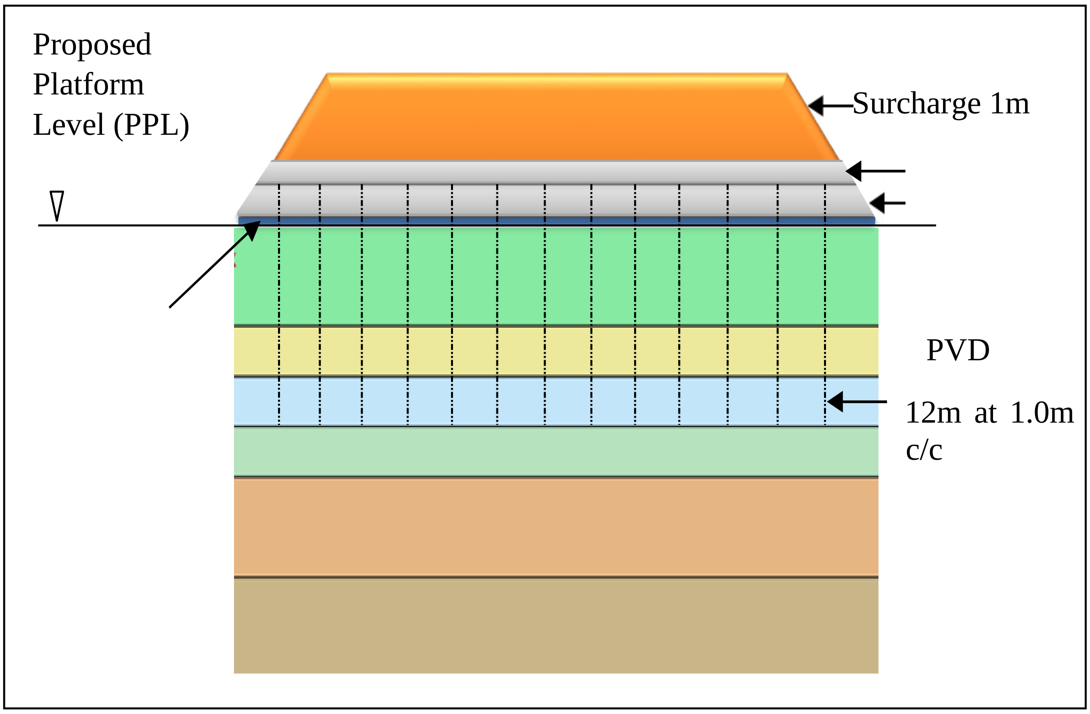

Figure 1.1: Cross section one of embankment install with PVD.

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