SOIL SLOPE STABILITY IN ROAD CONSTRUCTION ON SOFT GROUND

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DEDICATION

This thesis is dedicated to my father and my mother, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Slope stability assessment is a fundamental step in evaluating the safe design of structures and infrastructures especially for road construction. This is very crucial to ensure the slope can effectively function to protect earth soil from landslide and in addition, to allow for vehicle passing through the road safely. In the routine of geotechnical analysis, the use of limit equilibrium (LE) methods with a Mohr-Coulomb are criterion is the preferred option to examine the factor of safety for slopes. This is usually done by using a 2D approximation that corresponds as closely as possible to the good credible scenario. Various commercial software up to date can be used today for the purpose and in this study, SLOPE/W software is used to analyse the slope stability. In addition, analytical analysis also carried out via elastic and consolidation analysis to obtain the settlement condition. In this study, a selected case study of a new proposed road construction approximately 5.0 km in length is located between the state road route of M131, (Hutan Percha – Gemencheh) and state road route of M19, (Tebong – Ayer Pasir), Alor Gajah, Melaka) is presented. A parametric analyses of different height of embankment is carried out to investigate the outcome of factor of safety (FOS) and settlement. Results show that for the selected critical case study area, the slope model with height proposed embankment of height of 14 m lead to factor of safety less than 1.3 with certain value of settlement. .

ABSTRAK

Penilaian kestabilan cerun adalah langkah asas dalam menilai reka bentuk struktur dan infrastruktur yang selamat terutamanya untuk pembinaan jalan raya. Ini sangat penting untuk memastikan cerun dapat berfungsi dengan berkesan untuk melindungi tanah dari berlakunya keruntuhan dan untuk kenderaan melalui laluan jalan dengan selamat. Dalam rutin analisis geoteknikal, penggunaan kaedah keseimbangan had (LE) dengan Mohr-Coulomb adalah kriteria pemilihan yang lebih baik untuk mengkaji faktor keselamatan untuk cerun. Ia kebiasanya dilakukan dengan menggunakan pendekatan 2D yang sesuai sedekat mungkin dengan senario yang boleh dipercayai. Pelbagai perisian komersial terkini dapat digunakan pada hari ini untuk tujuan tersebut dan dalam kajian ini, perisian SLOPE / W digunakan untuk menganalisis kestabilan cerun. Selain itu, analisis juga dilakukan terhadap enapann melalui pengiraan analisis elastik dan pengukuhan untuk mendapatkan keadaan enapan tanah. Dalam kajian ini, satu kajian kes terpilih yang merupakan cadangan pembinaan jalan baru dengan panjang kira-kira 5.0 km terletak di antara jalan raya negeri M131, (Hutan Percha - Gemencheh) dan jalan raya negeri M19, (Tebong - Ayer Pasir), Alor Gajah, Melaka) dibentangkan. Analisis parametrik ketinggian penambakkan yang berbeza untuk memahami hasil faktor keselamatan (FOS) dan pengenapan tanah. Hasil kajian menunjukkan bahawa untuk kawasan kajian kes kritikal yang dipilih, model cerun dengan ketinggian 14 m) memberikan faktor keselamatan kurang dari 1.3 dengan kadar pengenapan tanah yang tertentu.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

FOS	-	Factor Of Safety
FE	-	Finite Element
LE	-	Limit Equilibrium
CSS	-	Circular Slope Stability
CBR	-	California Bearing Ratio
TM	-	Terzaghi Method
UTM	-	Universiti Teknologi Malaysia
JM	-	Janbu Method
SPT	-	Soil Penetration Test
BM	-	Bishop Method
CH	-	Chainage
M-P	-	Morgenstern and Price

LIST OF SYMBOLS

Se	-	Elastic Settlement
Sc	-	Consolidation Settlement
St	-	Total Settlement
F	-	Force
$q0$	-	net applied pressure on the foundation
P	-	Pressure
μ	-	Poisson's ratio of soil
Es	-	average modulus of elasticity of the soil under the foundation, measured from depth z = 0 to about z = 4B
B'	-	B/2 for center of the foundation and B for corner of the foundation
Is	-	shape factor
Su	-	undrained shear strength
qu	-	compressive strength
$\sigma'v$	-	effective vertical stress
τff	-	maximum shear stress
q_u	-	compressive strength
$F\varphi$	-	friction
Cr	-	recompression index
Cc	-	Compression index
eo	-	initial void ratio
H	-	soil layer height
$\sigma'o$	-	in-situ vertical effective stress at rest
σp	-	Pre consolidation pressure
$\Delta\sigma'$	-	stress increase in the soil mass due to embankment loading
cv	-	coefficient of consolidation
Tv	-	time
uh	-	average excess pore pressure between t2 and t1
Δt	-	elapsed time between t1 and t2

Δt	-	elapsed time between t1 and t2
$\sigma v1$	-	applied axial stress at time t1
$\sigma v2$	-	applied axial stress at time t2
Ip	-	Non dimensional influence factor
H	-	average specimen height between t1 and t2

CHAPTER 1

INTRODUCTION

1.1 Overview of the Topic

Slope stability is a geotechnical problem that deals with the balance of naturally occurring or manmade slopes and requires an understanding of the earth's materials and its engineering properties. Slope stability analysis is conducted to evaluate the stability of slopes, analysing the stability of a slope provides ways of determining, performing a great the suitable height of embankment, shall achieve a certain factor of safety against slope stability failure. It is one of the most important and critical problems and geotechnical engineering projects such as dams, embankments, earth dams, landfills, and highways. Unsuccessful significances of slope collapse necessitate better tools for predicting their occurrences. Such hazards are responsible for heavy devastations of public/private property, interruptions of traffic, and loss of human lives every year (Sah *et al*., 1994; Shi *et al*., 2010; Hoang and Pham, 2016; Basahel and Mitri, 2018).

In order to construct a new proposed embankment road, the geotechnical part must be taken especially to analyse the stability of slope. To define either the slope is stability or instability, the major part is challenging in prediction/interpretation of the slope stability in road construction embankment, especially for the site that involving the soft soil. In addition, for a settlement analysis, the influence of the general geology and soil conditions is discussed in relation to the site investigation works and the establishing of soil. The fundamentals of preloading techniques with calculation for get settlement total (St) including elastic settlement (Se for sand) addition with consolidation settlement (Sc for clay) as ground improvement measures are also included. The observational approach in evaluating calculation performance and settlement estimations is then made residual settlements. Strongly depend on stress

with both vertical and horizontal together when sand stiffness is increases with depth stress occurs for certain height embankment. Then, for thus know that the soft soil shear strength is low, as engineer, generally to design to make the increase in the stress relatively small and the total stress in the ground will be on your doorstep to the preconsolidation pressure. Therefore, importance in estimating the settlement is depend the value effective stress occur each settlement on each various height proposed embankment and rate settlement on year.

1.2 Problem Statement

Slope instability is defined as the tendency of the slope to move, and it is known as a failure if it involves mass movement. In general, the forces that cause instability are the parameters associated with gravity and seepage. The resistance of these forces is the slope geometry (slope design) and the shear strength of the soil properties of the slope (Benda & Manager, 2014). A dissatisfaction directly above the street may be due to the interesting and interpretation of the supportive toe of the slope, whereas a catastrophe below the road could be due to a raising of the groundwater table and following pore water pressure surge (TNB, 2014). However, to fulfill one of the aims of the study, the LE based methods are compared based on the factor of safety (FOS) obtained for various methods of interpretation. Mainly based on complex slope geometry and expected input parameters. These LE methods are well well-known for many years, and thus some of them are still commonly used in practice for stability analysis. Simplicity and reasonably good results are the advantages of these methods". (Aryal, Krishna Prasad,2006)

1.3 Objectives

The aim of study is to carry out prediction of slope stability on road embankment on soft ground. The objectives of the study are:

(a) To determine the settlement occur each various height embankment in slope model for a respective case study

(b) To determine the factor of safety (FOS) computed by limit equilibrium method using simulation Geoslope (SLOPE /W)

The prediction will be compared and checked with the design criteria of embankment in areas of soft ground practices in Malaysia.

1.4 Scope of Work

The study is carried out based on the MS2038:2006: Site Investigation code of Practice and MS1056:2005 Soil for Civil Engineering The following limitation used in this study also listed as below:

a) The field subsurface of this study is generally founded by the intrusive rocks (acid intrusive).

b) The method of interpreting the slope stability is using Limit equilibrium based SOFTWARE (SLOPE/W)

c) The result for doing a comparison based on the various height of interpretation

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