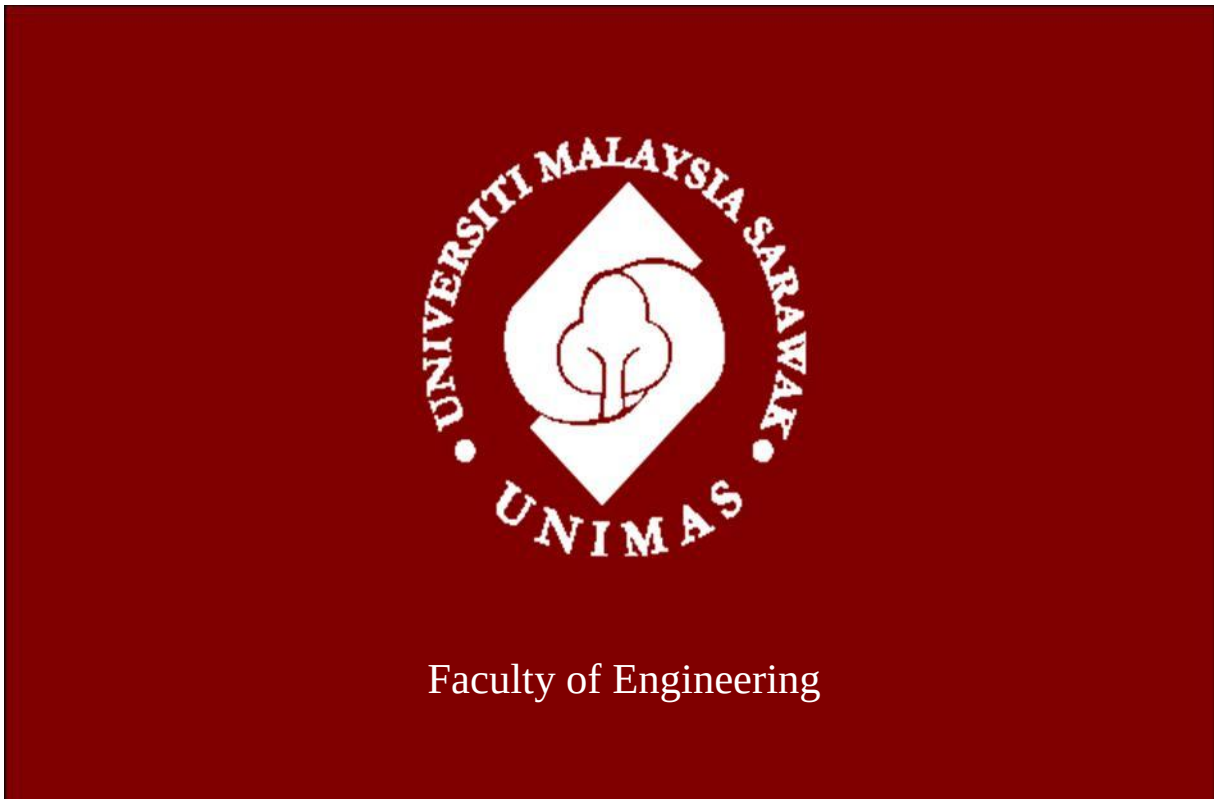

ANALYSIS OF SLOPE STABILITY USING FINITE ELEMENT METHOD

Mohd Yusri Bin Suratman

Bachelor of Engineering with Honours

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UNIVERSITI MALAYSIA SARAWAK

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ANALYSIS OF SLOPE STABILITY USING FINITE ELEMENT METHOD

MOHD YUSRI BIN SURATMAN

This thesis is submitted to

Faculty of Engineering, Universiti Malaysia Sarawak

in fulfillment of the requirements for the award of the degree of

Bachelor of Engineering with Honours

(Civil Engineering)

2009

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To my beloved mother and father

Thanks for everything

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ABSTRACT

Slope can be defined as an exposed ground surface that stands at an angle with the horizontal surface. There is several traditional limit equilibrium methods developed for checking safety factor of a slope. These methods, in general, require the soil mass to be divided into slices. The directions of the forces acting on each slice in the slope are assumed. This assumption is a key role in distinguishing one limit equilibrium method from another. Finite element method has been increasingly used in slope stability analysis nowadays. A finite element program namely PLAXIS has been chosen for this parametric study. Analysis was conducted using two-dimensional finite element program, PLAXIS. The safety factors are evaluated using gravity loading and phi-c reduction procedure. Mohr-Coulomb soil parameters and levels of global coarseness are examined to know its effect to the computed factor of safety. From the present parametric study, factor of safety remains unchanged with increasing Young's modulus and Poisson's ratio. Next, factor of safety is directly proportional with angle of internal friction and cohesion. Moreover, factor of safety changed with a given level of global coarseness.

ABSTRAK

Cerun merupakan permukaan yang berada dalam keadaan bersudut dengan permukaan garis mengufuk. Terdapat beberapa kaedah keseimbangan tradisional terhad yang dicipta untuk memeriksa faktor keselamatan bagi sesuatu cerun. Kaedah ini, secara amnya, memerlukan jisim tanah dibahagi kepada beberapa hirisan. Haluan bagi daya yang bertindak ke atas setiap hirisan diandaikan. Andaian ini merupakan kunci utama yang membezakan satu kaedah keseimbangan terhad daripada yang lain. Kaedah elemen terhad telah meningkat pengunaannya dalam analisis kestabilan cerun pada masa kini. Sebuah progam unsur terhingga dinamakan PLAXIS telah di pilih untuk kajian parametrik ini. Analisis telah dijalankan menggunakan program elemen terhad dua dimensi, PLAXIS. Faktor keselamatan diperolehi menggunakan kaedah beban graviti dan penggurangan phi-*c*. Parameter-parameter tanah Mohr-Coulomb dan tingkat kekasaran global dikaji untuk mengetahui kesannya terhadap pengiraan faktor keselamatan. Bagi kajian parametrik ini, faktor keselamatan tidak berubah dengan peningkatan *Young's modulus* dan *Poisson's ratio*. Kemudian, faktor keselamatan berkadar secara langsung dengan *angle of internal friction* dan *cohesion*. Tambahan, faktor keselamatan berubah dengan penggunaan setiap tingkat kekasaran global.

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	-	Angle of internal friction
c	-	Cohesion
ψ	-	Dilatancy angle
c'	-	Effective (drained) strength parameter
´	-	Effective (drained) strength parameter
σ	-	Normal stress
v	-	Poisson's ratio
τ	-	Shear strength of the soil
γ	-	Unit weight of soil
c_u	-	Undrained (total) strength parameter
$_u$	-	Undrained (total) strength parameter
H	-	Height of slope
Fs	-	Factor of safety
E	-	Young's modulus
K_0	-	Ratio of the horizontal and vertical effective stresses
N_r	-	Normal component of the reaction R
P_n	-	Normal force that act on the sides of the slices
T_n	-	Shearing force that act on the sides of the slices
T_r	-	Tangential component of reaction R

LIST OF SYMBOLS

a°	-	Inclination angle of slice at base
b	-	Width of slice
W_n	-	Weight of slice

CHAPTER I

INTRODUCTION

1.1 General

Malaysia has grown up with a rapid infrastructure development over the last few decades. As a result, slope stability issue has become one of the main problems in construction industry due to the nature of Malaysian topography. There has been a tremendous increase in construction on sloped area over the last 15 years due to reduction of available flat land. Nowadays, the requirements for housing, commercial and industrial building are still increasing and more sloped areas are being developed. Thus, the safety of building on hill site is often a topic of discussion among government authorities, engineers and public.

The collapse of Block 1 Highland Tower in 1993, loss of 20 lives in the tragedy of Genting Sempah Tunnel in 1995, collapsed bungalow in Taman Hillview, Ampang in November 2002 and the latest tragedy at Taman Bukit Mewah which lead to Bukit Antarabangsa landslide in Hulu Klang, Selangor in December 2008 was the evidence for the problems created by the slope's instability.

Gravitational forces are always acting on a mass of soil or rock beneath a slope. As long as the strength of the mass is equal to or greater than the gravitational forces, the forces are in balance and movement does not occur.

Before any construction works begin, proper site investigations have to be carried out to identify the characteristic of the soil prior to design. However, the stability of the slope cannot be determined perfectly because there are many factors that can influence its stability from time to time. Therefore, the stability of the slope should be analyzed with various approaches such as infinite slope analysis, planar surface analysis, circular surface analysis and finite element analysis, so that the most critical situation can be determined. The truth is hill site development is safe with proper planning, design, construction and maintenance. Engineers with good expertise on soil rock in slope and foundation stability design are usually engaged in construction projects. The main priority is to safeguard the safety of the public from landslide hazards.

There are lots of things that are related with slope. Civil engineers and geologists have to carry out an investigation and research about slope stability and followed with analysis of slope stability. They have found out the reasons that affect the slope stability most likely caused by different type of soils, properties of soil, and modelling error in implementing analytical methods. An understanding of geology, hydrology, and soil properties is central to applying slope stability principles properly. Analyses must be based upon a model that accurately represent site subsurface conditions, ground behavior, and applied loads. Judgments regarding acceptable risk or safety factors must be made to assess the result of analyses.

1.2 Problems statement

The stability analysis of slopes plays an important role in civil engineering. Slope stability analysis is used in the design of highways, railroads, canals, surface mining, earth embankments and dams, as well as many other human activities involving construction and excavations. The earlier researches have recognized a need for consistent understanding and application of slope stability analysis for construction and remediation projects. These analyses are generally carried out at the beginning, and sometimes throughout the life, of projects during planning, design, construction, improvement, rehabilitation and maintenance.