SOIL-ROOT INTERACTION AND EFFECT ON SLOPE STABILIZATION

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

Faculty of Civil Engineering
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NOVEMBER 2009

INTERAKSI TANAH-AKAR KESAN KEPADA KESTABILAN CERUN

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Fukulti Kejuruteraan Awam
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NOVEMBER 2009

Dedicated

To

Almighty GOD

To

My beloved father and mother, brother and sisters, friends

For your love and support

ACKNOWLEDGMENT

First of all, I want to give thanks to Almighty God who is my source of wisdom and my provider.

I want to thank my supervisor Dr. Nazri Bin Ali who has guided me so patiently in completing this project. Without his, this project would not be completed in time and smoothly. His dedication, patience and continues assistances have led me to strive for better achievement in this project.

Besides that, my sincere appreciation also extends to my family and friends specially and for their support and encouragements throughout my program and also in completing the writing of this project report.

Finally, the author wishes to thank all those who have contributed in one way or another in making this project a possible one.

ABSTRACT

The use of vegetation for preventing and controlling erosion for slope stabilization has being practiced throughout the world. This disciplines has recently gained a global recognition and was given a new entity “Ecological Engineering” defined as the design of sustainable ecosystem that integrate human society with its natural environment for the benefit of both. This soft approach of stabilizing slope confers numerous advantages, including high biodiversity, low maintenance, self-sustainability as well as being environmental-friendly.

There are various conventional methods used to improve stability of slope, they all have merit and demerit, but the use of vegetation has other advantages as mentioned above plus root do not corrode, they are self-repairing, regenerating and adaptive. This gives the motivation to carry out this research; so as to gain more understanding on its soil-root interaction and effects on slope stabilization. The mechanical and hydrological effect of vegetation would be combined and their overall effect on slope stability stabilization and analyses would be evaluated.

ABSTRAK

Penggunaan tumbuhan bagi mengatasi masalah tanah runtuh bagi cerun tanah dipraktikkan secara meluas di seluruh dunia. Disiplin ini telah diiktiraf dunia dan diberikan satu entity iaitu “kejuruteraan ekologi” yang membawa maksud keseimbangan ekosistem yang mengintegrasikan manusia dan alam semulajadi untuk kebaikan bersama. Kaedah ini memberikan banyak kebaikan antaranya biodiversiti yang rendah, pengekalan yang kendiri dan mesra alam.

Terdapat pelbagai kaedah bagi memperbaiki kestabilan cerun dan ianya mempunyai kebaikan dan keburukan yang tersendiri. Penggunaan tumbuhan memberi kebaikan seperti akarnya yang tidak mudah terhakis, penumbuhan yang kendiri dan fleksibel. Ini memberikan motivasi untuk menjalankan kajian ini dan untuk mengetahui interaksi tanah-akar dengan kesan kestabilan cerun. Kesan mekanikal dan hidrologi bagi tumbuhan akan digabungkan dan kesan secara keseluruhannya akan kestabilan akan dianalisis dan dinilai.

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Basic parameters and dimensions used in stability analysis by method of slices

B	-	width of slice (m)
c'	-	effective cohesion at base of slice (kN/m^2)
F	-	factor of safety (usually shear strength/shear force on slip plane)
F_f	-	factor of safety in terms of horizontal force equilibrium (ratio)
H	-	average height of slice (m)
h_w	-	average piezometer head at base of slice (m)
h_{w1}	-	height of free water surface at left-hand side of slice (m)
h_{w2}	-	height of free water surface at right-hand side of slice (m)
l	-	length (chord) along base of slice (m)
u	-	average water pressure on base of slice (kN/m^2)
U_1	-	water force on left-hand side of slice (kN)
U_2	-	water force on right-hand of slice (kN)
W	-	total weight of soil in slice (kN)
A	-	inclination of base of slice to horizontal (degree)
Γ	-	bulk unit weight of soil in slice (kN/m^3)
γ_w	-	unit weight of water (kn/m^3)
φ'	-	effective angle of friction at base of slice (degrees)

Vegetation, reinforcement and hydrological effect

c'_v	-	additional effective cohesion at base of slice (kN/m^2)
δh_w	-	increase in average piezometer head at base of slice (m)
δh_{w1}	-	increase in free water surface at left-hand side of slice (m)

δh_{w2}	-	increase in free water surface at right-hand side of slice (m)
δU_1	-	increase in water force on left-hand side of slice (kN)
δU_2	-	increase in water force on right-hand side of slice (kN)
δu_v	-	increase in average water pressure at base of slice (kN/m^2)
D_w	-	windthrow force (kN)
F_r	-	factor of safety applied to ultimate root force to reflect uncertainly in root distribution and assumptions made
T	-	tensile root or reinforcement force on base of slice (kN)
T_{rd}	-	available (design) root force per square meter of soil on a particular plane (kN/m^2)
T_{ru}	-	ultimate roof force per square meter of soil (kN/m^2)
W_v	-	increase on weight of slice due to vegetation (or surcharge) (kN)
B	-	angle between wind direction and horizontal (degrees)
Θ	-	angle between direction of T and base of slip surface (degrees)

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The use of vegetation for preventing and controlling erosion for slope stabilization has being practiced throughout the world (Normaniza et al, 2006). The importance of a vegetative cover is demonstrated by the effects of its removal as pointed out by Ziemer et al (1977), Ziemer (1978) and Wu at al (1979). This disciplines has recently gained a global recognition and was given a new entity "Ecological Engineering" defined as the design of sustainable ecosystem that integrate human society with its natural environment for the benefit of both. This soft approach of stabilizing slope confers numerous advantages, including high biodiversity, low maintenance, self-sustainability as well as being environmental-friendly (Normaniza et al, 2006).

There are various conventional methods used to improve stability of slope, they all have merit and demerit, but the use of vegetation has other advantages as mentioned above plus root do not corrode, they are self-repairing, regenerating and adaptive. This gives the motivation to carry out this research; so as to gain more understanding on is soil-root interaction and effects on slope stabilization. The

mechanical and hydrological effect of vegetation on slope stability stabilization and analyses would be evaluated.

There are Malaysian Publications as well as research papers from other parts of the world which would be used as primary source of theoretical literature on use of vegetation on slope stability and analysis.

1.2 Statement of Research Problems

Empirical data as regards to root characterization, soil moisture and orientations as well as other mechanical and hydrological effects of vegetation on slope are still far from sufficient. The important of vegetation in slope stabilization and surface erosion control is enormous. It is cheap, environmentally friendly, same plant exhibit different characteristic when growing in different environment because of their biodiversity. Hence, need to select native specie to investigate its mechanical and hydrological effects on the slopes. The mechanical and the hydrological effect would be combined and their overall effect on finite slope would be determined. The need for more work on bonding characteristics in soil-root interaction and effects on slope stabilization is inevitable.

1.3 Aim and Objectives

The research is aimed towards the determination of soil-root interaction and effects on slopes stabilization.

The following specific objectives are to be achieved:

1. To illustrate the effect of moisture and root on shear strength of soil.

2. To obtain the transpiration rate, root geometry, wind effect and weight of the tree.

3. To determine the failure mechanism of root during shear.

4. To assess overall the mechanical and simulate hydrological effects of root on finite slope.

5. To establish the contribution of root-reinforcement on finite slope using in SLIP4EX Programming.

1.4 Scope of the Research

The study will be carried out within the United Kingdom and its environs. It is located on longitude 8^0W 2'E and latitude 49^0 59'N with temperate climate with plentiful rainfall all year round.

The research will be limited to:

1. The plant to be use in this research is *mature lime tree* (Tilia), the transpiration rate, weight; root geometry of the tree shall be used.

2. Determination of mechanical properties of root using Greenwood (2004) in ECOSLOPE project.

3. Boulder clay soil would be used.

4. Mechanical effect of tree on finite slopes using SLIP4EX computer program.

1.5 Significant of Research

This research intent to bridge the gap existing on severe lack of empirical data on effects of vegetation on slope stabilization and analysis. The unique significant is the combination of mechanical and the hydrological effects of vegetation on slopes and its effects to slope stability, analysis and stabilization. The overall effects of vegetation both mechanical and hydrological on finite slope stability and analysis to stabilization would be quantified.