ENHANCING STABILITY OF SLOPE USING SOIL NAILING

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To my husband.

Muhammad Naim Rahim

To my parents.

Johari Sabani

Siti Hamimah Selamat

My teachers.

My siblings.

My friends.

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ABSTRACT

Slope stability issue becomes one of the main problems in construction industry due to nature of the topography and the weather conditions in Malaysia. Various of technique can be applied for slope strengthening. One of the effectiveness and economic system is application of soil nail in slope surface. The objectives of the study were; i) to determine the effect of shear strength parameters and groundwater table on slope stability, ii) to determine the effect of soil nailing on slope stability, iii) to determine the optimum angle of nail inclination and slope degree with higher FOS, iv) to install/apply soil nail for slope stability improvement in the case study. Various simulation modeling and various parametric study were applied in this study such as slope angles, Ø cohesion, *c* internal angle of friction, ϕ and groundwater level. Then, various inclinations of soil nailing were applied in order to find optimum angle of soil nailing for strengthening slopes. Slope/W software was used in the slope stability analysis. All the results then were tabulated and recorded in the report. Based on the analysis, it shows that the shear strength parameters affect the stability of slopes by given a highest factor of safety. Soil nailing also will enhance the stability of slope by increasing in factor of safety. The soil nailing would produce highest factor safety when an optimum inclination angle of nails is applied.

ABSTRAK

Isu kestabilan cerun menjadi salah satu masalah utama dalam industri pembinaan kerana sifat topografi dan keadaan cuaca di Malaysia. Pelbagai teknik boleh digunakan untuk pengukuhan cerun. Salah satu keberkesanan dan sistem ekonomi adalah pengukuhan tanah di permukaan cerun. Objektif kajian ini ialah; i) untuk menentukan kesan parameter kekuatan ricih dan air tanah terhadap kestabilan cerun, ii) untuk menentukan kesan *soil nailing* terhadap kestabilan cerun, iii) untuk menentukan sudut optimum kecerunan *soil nail* dan darjah cerun dengan FOS lebih tinggi, iv) memasang / *soil nailing* untuk penambahbaikan kestabilan cerun dalam kajian kes. Pelbagai model simulasi dan pelbagai kajian parametrik telah digunakan dalam kajian ini seperti sudut cerun, Ø kejelekitan tanah, c sudut geseran dalaman, ϕ dan paras air bawah tanah. Kemudian, pelbagai sudut kecerunan *soil nailing* telah digunakan untuk mencari sudut optimum *soil nailing* untuk mengukuhkan cerun. Slope/W perisian telah digunakan dalam analisis kestabilan cerun. Semua keputusan kemudian telah dijadualkan dan direkodkan dalam laporan itu. Berdasarkan analisis, ia menunjukkan bahawa parameter kekuatan ricih mempengaruhi kestabilan cerun dengan memberikan faktor keselamatan (FOS) tertinggi. Kaedah *soil nailing* juga akan meningkatkan kestabilan cerun dengan meningkatkan dalam faktor keselamatan (FOS). Kaedah *soil nailing* ini juga akan menghasilkan faktor keselamatan (FOS) tertinggi apabila sudut kecerunan optimum *soil nailing* digunakan.

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Ø	-	Nail inclination
Φ	-	Angle of internal friction
ß	-	Slope Angle
c	-	Cohesion
FOS	-	Factor of safety
γ	-	Unit weight
τf	-	Shear strength
τ	-	Shear stress
m, n	-	Stability coefficient
	-	

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CHAPTER 1

INTRODUCTION

1.1 Background Of Study

Slope stability issue becomes one of the main problems in construction industry due to nature of the topography and the weather conditions in Malaysia. Slope failure has been acknowledged as one of the most frequent natural disaster that can lead to great loss in property and life.

In Malaysia, the collapse of Block 1 of Highland Towers in 1993, slope failure at Taman Hillview in November 2002 and the tragic landslide at Bukit Lanjan in 2003 had prompted our government and public to concern about the stability of slope and the risk involve in such circumstance. The most recent tragedy of slope failure in Bukit Antarabangsa, Kuala Lumpur which killed 5 people is one of the disasters that caused by slope failure. Since then, numerous landslide incidents had occurred and the latest one was at Hulu Langat which 16 people had been killed.

These occurrences were related to the importance of the slope stability technique. There are many methods of slope stability such as soil anchor, subsurface

drainage, shear piles and stone columns. The selection of the method to be applied should base on many factors that related to the types of slopes and the soil properties. This study is focusing on the soil nailing as the one of the methods in for stabilizing slopes. This method has been used widely in many countries especially in Malaysia.

Hence, the analysis of slope stability is very important in order to protect the slopes from fail and minimize the likelihood of slope failure. There are several techniques to analyze slope stability in order to prevent slope stability, for example, using method of slices. The method of slices is one of a technique that has been widely used to analyze the slope stability in two dimensions. The sliding mass above the failure surface is separated into a number of slices. The forces acting on each slice are obtained by considering the mechanical equilibrium for the slices.

1.2 Problem Statement

Soil nailing is commonly used in Malaysian slopes either as a stabilization measure for distressed slopes or for a very steep cut slopes. The selection of soil nailing is due to its technical suitability as an effective slope stabilization method, easy in construction and it is relatively maintenance free. As a result, many slope in Malaysia that up to 25m in height is being used by using soil nailing as slope stabilization. Therefore, a proper and systematic design procedures based on sound fundamentals and confirmed by extensive research is necessary, in order to ensure the soil nail slope performs satisfactory and to prevent repetition of tragedy highland tower. For ensuring the problem can be overcome, software “Slope/W” was used to study the effect of soil nailing for improvement and reinforcement of stability of the slope.

1.3 Objectives of Study

The objectives of this study are:

i. To determine the effect of shear strength parameters and groundwater table on slope stability
ii. To determine the optimum angle of nail inclination and slope degree with higher FOS and the effect of soil nailing on slope stability.
iii. To verify effectiveness of soil nailing for soil slope in case study

1.4 Scope of Study

The study is limited to the problems involving:

i. To determine the most appropriate slope inclination angle of the soil nailing on slope stability.
ii. To study the effect of shear strength parameters and groundwater level on the slope stability.
iii. Various slope inclinations; Ø, cohesion; c, internal angle of friction; ϕ , and groundwater table were applied in the parametric study.
iv. All the analysis and result were obtained by using Slope/W 2007.

1.5 Significance of Study

The significances of the study are important to determine the effect of the shear strength parameters in the slope stability. By doing this study, the efficiency of

soil nailing system can be proved to improve the slope stability. It also can help the designer to determine the optimum of the nail inclination for improving the stability of slope.

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