

STABILITY ANALYSIS FOR SLOPE REHABILITATION WORKS AT
KM424.80 SOUTH BOUND, NORTH SOUTH EXPRESSWAY

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DEDICATION

This thesis is dedicated to my late father, who taught me of how important an education to one's life. It is also dedicated to my mother, who taught me to be strong in facing difficult times in life.

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ABSTRACT

Slope failures are major natural hazards that constantly occurred along the North South Expressway. Every year, hundreds of slope failed especially during raining seasons and causing major disruption to the network. One of them is located at slope KM424.80 South Bound. This paper is mainly to study the relationship between rainfall and slope failure at KM424.80 South Bound and the effect of rainfall toward the stability of the slope, at initial and after rehabilitation works. Site investigation works and software application developed by Geostudio, SEEP/W and SLOPE/W is used to carry out the research. The analysis method used is based on Bishop and Morgenstern-Price theory of equilibrium and entry and exit as point mode of failure. There are four types of simulations being experimented ie, FOS without any rainfall, rainfall intensity of 119mm/hour, rainfall of various intensity and FOS of using transient technique. Based on the results of the simulation, it is concluded that rain can contribute to slope failure events. However, it is not the intensity of rain that plays a role but a period of rain that contributes to slope instability. The longer the slope is exposed to the rain, the higher the risk of the slope to fail.

ABSTRAK

Kegagalan cerun adalah bahaya semulajadi yang sentiasa berlaku sepanjang Lebuhraya Utara Selatan. Setiap tahun, beratus-ratus cerun gagal terutamanya semasa musim hujan dan menyebabkan gangguan besar ke rangkaian lebuhraya. Salah satunya terletak di cerun KM424.80 arah selatan. Kajian ini bertujuan mengkaji hubungan antara hujan dan kegagalan cerun di KM424.80 Bound Selatan dan kesan hujan ke arah kestabilan cerun, pada awal dan selepas kerja pembaikan. Kerja penyiataan tapak dan aplikasi perisian yang dibangunkan oleh Geostudio, SEEP / W dan SLOPE / W digunakan untuk menjalankan penyelidikan. Kaedah analisis yang digunakan adalah berdasarkan teori Bishop dan Morgenstern-Price teori keseimbangan dan kaedah '*entry and exit*' sebagai mod kegagalan. Terdapat empat jenis simulasi yang dijalankan iaitu FOS tanpa hujan, kelebatan hujan 119mm/jam, hujan pelbagai kelebatan dan FOS menggunakan teknik '*transient*'. Berdasarkan hasil simulasi, disimpulkan bahawa hujan boleh menyumbang kepada peristiwa kegagalan cerun. Walau bagaimanapun, ia bukanlah kelebatan hujan yang mainkan peranan tetapi tempoh hujan yang menyumbang kepada ketidakstabilan cerun. Semakin lama cerun terdedah kepada hujan, semakin tinggi risiko cerun untuk gagal.

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LIST OF ABBREVIATIONS

BH	-	Boreholes
CIU	-	Consolidated Undrained
FOS	-	Factor of Safety
SPT	-	Standard Penetration Test
bgl	-	Below Ground Level
GWL	-	Ground Water Level
UTM	-	Universiti Teknologi Malaysia
LL	-	Liquid Limit
PL	-	Plastic Limit
MP	-	Mackintosh Probes
WC	-	Water Content
SWCC	-	Soil Water Characteristic Curve

LIST OF SYMBOLS

Θ_r	-	Residual Water Content
Θ_s	-	Saturated Water Content
Ψ_b	-	Air Entry Pressure
τ_f	-	Shear Strength
σ	-	Stress
u_a	-	Air Pore Pressure
u_w	-	Water Pore Pressure
ϕ'	-	Effective Friction Angle
C	-	Cohesion
γ	-	Unit Weight
γ_d	-	Dry Unit Weight
ϕ_b	-	Phi B
γ_d	-	Dry Unit Weight

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

PLUS Expressways Berhad (PEB) is the largest highway concessionaire in Malaysia. It has 987 kilometer long expressway with slope and embankment built along the way to provide platform for the expressway. Over time, failures occur and therefore action has to be taken to remedy the failures.

PEB have spent millions of ringgit to rectify failed slopes every year to ensure it is properly being maintained so it would be safe to the expressway user. Each year there are more than 100 numbers of failed slopes shall be rectified and one of them is located at KM424.80 South Bound, Section C3 of the North South Expressway.

The existing cut slope was constructed more than twenty five years ago during the construction of the expressway. It is about 150 m long which comprises seven berms with a maximum height of approximately 30 m from the expressway level. The cut slope has gradients varies from 35° to 40°. Behind the cut slope is a forest reserved area and the ground is sloping upward.

Generally, the cut slope surface is densely vegetated and covered with fern and grass. The slope drainage system consists of interceptor trapezoidal drain on the top slope, V-shaped berm drains, cascade U-shaped block drains and trapezoidal toe drain. Most of the drains are still in good condition except at failed locations, cracks and broken drain were observed on the drain section due to soil movement.

The lithology of the slope is mainly argillaceous rock comprising quartz-mica schist, graphitic schist and phyllite of the Terolak Formation. The age of this formation is Middle Ordovician to perhaps Silurian.

1.2 Problem Statement

A report was lodged that some part of cut slope located at KM424.80 South Bound had failed during heavy downpour. On the following day, a foot inspection was carried out to assess the slope condition and the following were observed during the site assessment:

- i. A localised slope failure in between slope surface no. 1 and 3 which is approximately 40m length and 30m height
- ii. Displacement of berm drain at berm no. 1 and 2
- iii. Damaged to the existing stone pitching wall and cascaded drain of the slope due to soil movement
- iv. Barren area due to erosion at a few locations

1.3 Objectives

- i. To develop soil strata, carry out back analysis using SLOPE/W and propose the design of rehabilitation work.
- ii. To carry out parametric study of effect of rainfall intensity and soil suction using SEEP/W and SLOPE/W at initial condition and after rehabilitation works done.
- iii. To determine the duration of rainfall required using transient analysis technique before the slope reached its failed state.

1.4 Scope of Study

The scope of work of this paper is to investigate the relationship between rainfall intensity and slope failure event at KM424.80 South Bound and therefore proposing the appropriate design rehabilitation for this problem. Data collection is based on soil investigation program which consist of 3 boreholes, 1 number of hand auger, a few numbers of soil sampling and relevant soil testing. The findings of this study are only relevant only to the ground at the place where the soil investigations were carried out.

The analysis then was carried out by software application, SEEP/W and SLOPE/W. Based on topographical and cross sectional plan, only the most critical section at the failed slope will be selected for stability analysis. This is to ensure the design is safe for the entire condition of the slope failure. Figure 1.1 shows the overall view of slope KM424.80 South Bound.



Figure 1.1 Overall view of failed slope at KM424.80 South Bound

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