SLOPE ANALYSIS AND REMEDIAL WORK ON LANDSLIDE AT TAMAN SETIAWANGSA KUALA LUMPUR

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To my husband and my kids.

To my parents.

My teachers.

My siblings.

My friends.

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ABSTRACT

This study investigates the slope failure at Taman Setiawangsa, Kuala Lumpur by using back analysis approach. The catastrophic slope failure was triggered by a rainfall that occurred 2 days before the occurrence of slope failure. Site investigation that includes borehole sampling was conducted to obtain representative information for the study area. The slope can be divided into 3 layers namely Sandy SILT, decomposed of rock and bedrock. Due to the uncertainty about the actual cause of failure initiation, back analyses have been performed via Geostudio 2012 - *SLOPE/W* and Rocscience – *Slide* 6.0 for considering various probable mechanisms. In order to deal with the uncertainty and variability of the soil parameters, Limit Equilibrium Method was adopted in this study. Analysis results show that the slope failure is influenced by the shear strength parameter where the cohesion and friction angle at failure were 6 kPa and 33° respectively for a value of FOS is equal to 1.0. For remedial work design of new slope, several options were proposed with comparison on slope stability analyses. Analysis results using *SLOPE/W* found that the value of FOS obtained for analysis 'without' CBP wall is 1.2 and 'with' CBP wall is 1.5. In addition, for local stability value of FOS is checked for lower berm of the cut slope is 1.6 and at soil nail's berm is 2.0. Therefore, this study agreed that the best and recommended design's option of remedial work is using cut slope with CBP wall with highest FOS value achieved is 1.5.

ABSTRAK

Kajian ini menyiasat kegagalan cerun di Taman Setiawangsa, Kuala Lumpur dengan menggunakan pendekatan analisis terbalik. Kegagalan cerun adalah berpunca oleh hujan yang selama 2 hari sebelum berlakunya kegagalan cerun. Penyiasatan tapak telah dijalankan termasuk persampelan lubang gerudi untuk mendapatkan maklumat bagi kawasan kajian. Cerun ini terdidi daripada 3 lapisan iaitu *Sandy Silt*, *Decomposed Rock* dan batu. Oleh kerana ketidakpastian mengenai punca sebenar kegagalan cerun ini, analisis terbalik telah dijalankan menggunakan perincian *Geostudio 2012 - SLOPE/W* dan *Rocscience - SLIDE 6.0* untuk mengenalpasti pelbagai mekanisme kemungkinan. Dalam usaha untuk menangani ketidaktentuan dan kepelbagaian parameter tanah, Kaedah *Limit Equilibrium* telah digunakan dalam kajian ini. Keputusan analisis menunjukkan bahawa kegagalan cerun dipengaruhi oleh parameter kekuatan ricih di mana perpaduan dan sudut geseran pada kegagalan masing-masing 6kPa dan 33 ° untuk nilai *Factor of Safety (FOS)* adalah sama dengan 1.0. Untuk rekabentuk kerja-kerja pemulihan cerun baru, beberapa pilihan telah dicadangkan dengan perbandingan terhadap kestabilan cerun analisis. Keputusan dari *SLOPE/W* mendapati bahawa nilai *FOS* diperolehi untuk analisis 'tanpa' *CBP wall* adalah 1.2 dan 'dengan' *CBP wall* adalah 1.5. Di samping itu, untuk nilai kestabilan *FOS* diperiksa untuk *berm* bahagian cerun dibahagian bawah, adalah 1.6 dan pada berm di bahagian atas adalah 2.0. Oleh itu, kajian ini bersetuju bahawa pilihan terbaik dan disyorkan rekabentuk pemulihan cerun ini adalah menggunakan cerun dengan *CBP wall* iaitu nilai FOS tertinggi telah dicatat adalah 1.5.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Landslide or slope failures are known as one of the significant natural disasters in Malaysia. Their frequency and impacts, such as injuries, loss of lives and damage to property have been increasing over the years. The phenomenon is common especially in hilly area during monsoon season. Since 1969, several landslide disasters have occurred on hills with a high concentration of housing developments. One of the major disasters occurred in 1993, when the 12-floor Highland Tower Condominium collapsed due to a landslide Malaysia (Kamal et. al, 2010).

Generally, there are many factors and causes of the landslide such as soil erosion, water seepage and poor maintenance of the slope or additional load on top of the slope due to poor planning system on new development on the hillsides (Gue, 2008). Hilly and sloppy terrains are usually promised a high aesthetic view and high class of life style. Sometime, this exclusive area interact high-class people to own properties in these areas. This factor contributes of the property value increasing at the hillside areas. However, most of people especially to professionals involved in the construction industries tend to forgot that the hillside is the most high risk and very sensitive zone which are prone to natural disaster (Samah, 2003).

Based on this problem, a research is carry out for identifying the failure mechanism of the slope failure at a case study of anchored slope in Taman Setiawangsa, Kuala Lumpur. In order to identify the failure mechanism of the slope failure, back analysis approach is used to determine an insight of the underlying failure mechanism and improve the understanding regarding the factors controlling the stability of slopes. In addition, this study is aim to produce the most effective design using systematic approach for obtaining the soil parameters.

1.2 Research Background

There are many incident of landslide was occurred in Malaysia. One of the landslide events was happened on 28th December 2012. Landslides have occurred at midnight on the Anchored Slope of Puncak Setiawangsa, Taman Setiawangsa, Kuala Lumpur.

Figures 1.1 and 1.2 show the front view of the slope failure and the location of the site. This failure caused a residential house located at the top edge of the slope to partly collapse. The failure also caused one carriageway of the dual carriageway at the bottom of the slope to be closed. The slope contain of 11 berm of cut and steep slope strengthened by permanent ground anchors constructed in the period 1989 - 1991. Each berm has as average height of 5.0m with the horizontal spacing of the anchors was approximately 1.5m.

A geological map of the site is shown on Figure 1.3. The Map of the Bedrock Geology of Kuala Lumpur, New Series L08010, and Part of Sheet 94K, published by the Geological Survey Malaysia in 1993. The geology indicates that the site is located over the Hawthornden Schist Formation comprising of Schist and Phyllite of the Pre-middle Silurian Period. This formation is made up of metamorphosed rocks unit i.e. moderate to fine-grained quartz-mica-schist, quartz schist and graphitic schist.

In this study, subsurface investigation comprising of soil investigation work, geophysical survey and geological mapping were carried out on the failure slope to determine the stratigraphy, soil properties and the in-situ physical condition of the materials of the slope. Briefly from field data, the subsurface profile along the slope face generally consists of residual soils overlying decomposed schist followed by weathered Schist. Therefore, this study is carried out to determine the most effective design using systematic approach for obtaining the soil parameters i.e. cohesion, c and friction angle, φ.

Figure 1.1 Front view of the slope failure

Figure 1.2 Location of the slope failure and borehole in Puncak Setiawangsa

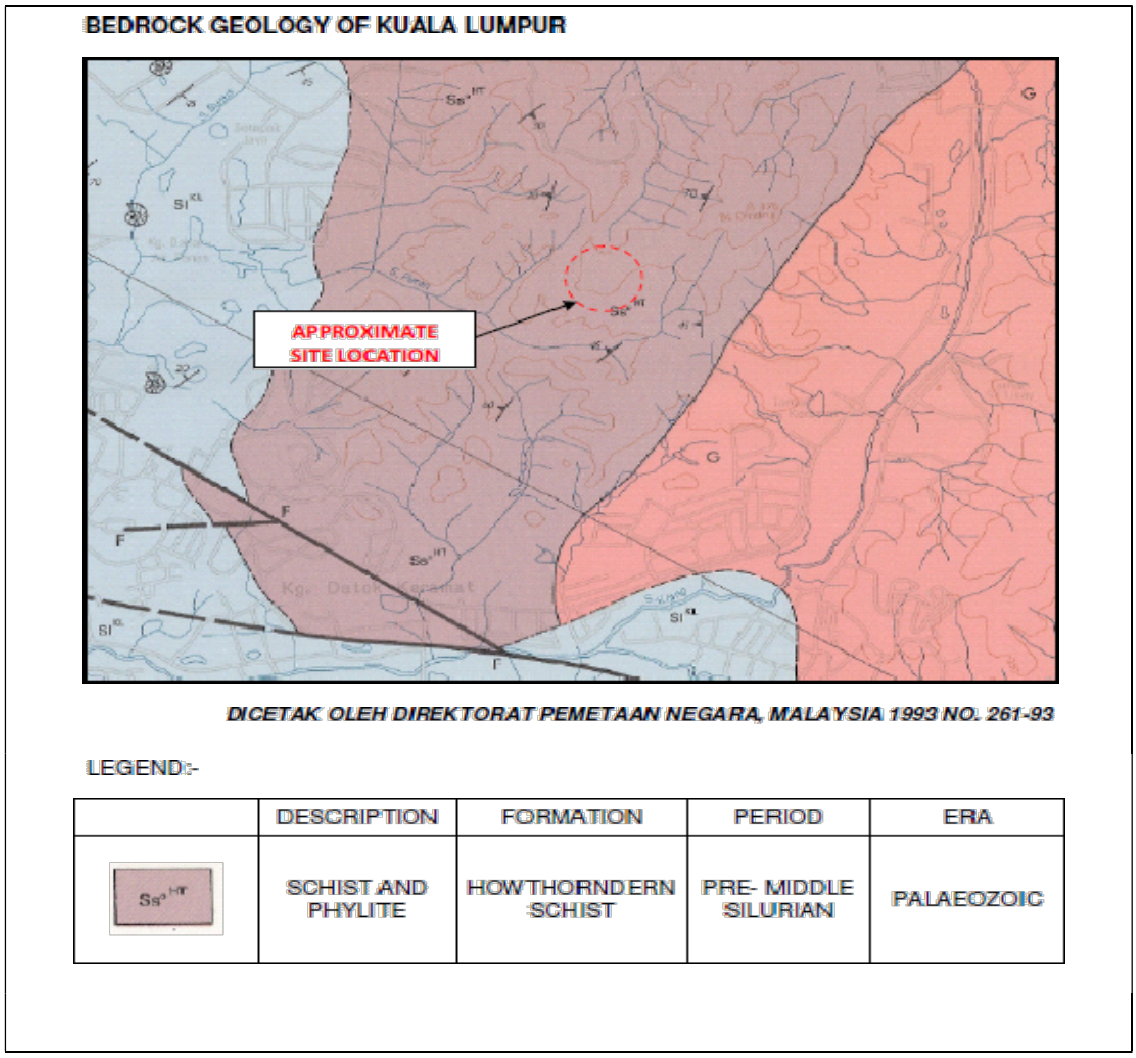

Figure 1.3 Geological maps of the site location

1.3 Problem Statement

Slope failure needs a comprehensive solution due to the constraint of residential houses area involved and also road disruption. The engineers need to come out with the new proposal with proper details analyses whether to repair or reconstruct with the new design of slope. Whatever the proposal will come out from the researchers and engineers, the most important thing is the parameter used in the design must be right and accurate.

In the previous research, the researchers had frequently evaluated in miniatures dimension and the outcomes then extrapolated and scaled up to life-sized construction. It is called prototype tests but they tend to be few and far between, owing to time and cost considerations (Seng, 2015).

However, this study will take the opportunity to carry out back analysis to identify the governing cause of the slope distress as well as to identify most accurate soil parameters. This will include the estimation of shear strengths, pore water pressure and other conditions prevailing at the time of failure.

1.4 Objectives

The aim of this study is to produce the most effective design using systematic approach for obtaining the soil parameters. To achieve the aim of this study, the following objectives will be carried out in this study:-

1. To identify the shear strength parameters of the failure slope using back analysis approach.
2. To propose suitable remedial work design of the failure slope.

1.5 Significance of study

Understanding on the general slope engineering practice in Malaysia are important to the entire process such as in planning, design, construction, maintenance and landslide preventive and recovery action in order to assist engineers to face the problem as a precaution and preparation in any working environment. The fundamental knowledge will help the engineers to make a better and quick decision and take a systematic approach to identify the accurate soil parameter by using back analysis approach and provide one effective solution for the remedial work design.

1.6 Scope of Study

The scopes of this study are detailed as follows:

a. All field investigation data of slope failure is obtained from site at Taman Setiawangsa, Kuala Lumpur.

b. Slope analysis will consider the following condition;
   - Soil properties i.e. unit weight, cohesion, friction angle
   - Ground water level based on Standpipe Piezometer data collection
   - Surcharge Load of 10kPa (Refer to Clause 3.2.4.1 of BS 8002:1994)

c. The analyses are based on two (2) computer softwares;
   - GeoStudio 2012 - SLOPE/W
   - Rocscience v. 6.0 - SLIDE

This study had decided to carry out back analysis of slope failure at Taman Setiawangsa to achieve the objectives of this study. Back analysis will perform on two (2) software applications i.e. Geostudio 2012 - *SLOPE/W* and Rocscience v.6.0 – *Slide*. Slope stability analyses were considered the available subsurface investigation work done by Kumpulan IKRAM Sdn Bhd. The range of soil parameter i.e. unit weight, cohesion, friction angle was interpreted by the subsurface investigation report as a main input of the analysis defining material. Ground water level was assigned based on the record of standpipe piezometer data from site. Appropriate design surcharge of 10kPa are considered in the analysis accordance to Clause 3.2.4.1 of BS 8002:1994 to be applied.

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