ANALYSIS OF SLOPE STABILITY BY USING OASYS SLOPE VERSION 18.1 SOFTWARE

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ABSTRACT

A fill slope with two different angles and fill slope by extend the toe of the fill slope were proposed to stabilize the permanent fill slope at KM 47.9 of Tamparuli – Ranau Highway, Sabah. In this study, software Oasys Slope version 18.1 was used to analysis the possibility failure of the existing fill slope. Bishop Method with Variably Inclined Interslice Forces was used for the analysis. Two method of proposed fill slope were analyzed. The result showed that the factor of safety for the existing slopes close to factor of safety 1. The existing slopes tend to fail. For the proposed slope, the factor of safety increased after application of the proposed fill slope.

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ABSTRAK

Cerun timbus dengan dua sudut yang berlainan dan cerun timbus dengan memanjangkan kaki cerun telah dicadangkan untuk menstabilkan cerus timbus tetap di KM 47.9 Tamparuli-Ranau Highway, Sabah. Dalam kajian ini, perisian Oasys Slope versi 18.1 telah digunakan untuk menganalisakan kemungkinan gagal cerun yang sedia ada. Cara Bishop dengan Variably Inclined Interslice Forces telah digunakan untuk analisa. Dua cara cerun timbus yang dicadangkan telah dianakiskan. Keputusan telah menunjukkan bahawa factor selamat untuk cerun yang sedia ada telah mendekati factor selamat 1. Cerun yang sedia ada boleh gagal. Untuk cerun yang dicadangkan, factor selamat akan meningkat selepas cerun timbus yang dicadangkan telah digunakan.

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CHAPTER 1

INTRODUCTION

1.0 Overview

In Malaysia, there has been a tremendous increase in construction of residential buildings on hill-sites over the last 15 years especially due to depleting flat land and other influencing factors like beautiful scenery, fresh air, exclusiveness, etc. Often hill site development is related to landslides, and safety of buildings on hill-sites is often a topic of discussion among engineers and the public. The truth is hill-site development can be safe with proper planning, design, construction and maintenance.

Safety of buildings and slopes on hill-sites is often a topic of discussion among engineers and the public. The discussions intensify each time a landslide is highlighted by media and this usually happens during the monsoon seasons. The collapse of Block 1 of Highland Towers in 1993, landslides at Bukit Antarabangsa in 1999, and landslide at Taman Hillview in November 2002 have worried the public particularly those who are staying on a hill site or planning to purchase a unit on one.

Hills can have considerable development potential because of the views and attractive setting they provide. Historically, development on hills had been conceived on short term benefits with the rights of the individual prevailing. However, there are rising community expectations concerning the maintenance of visual values, natural habitat and biodiversity around urban and growth centres. Hill slopes are prone to

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environmental hazards such as soil erosion and landslide as is evident from past incidences, resulting in loss of lives and property.

Development in these areas can compound such hazards and render them highly visible and costly to deal with. To ensure a safety for public from slope failure hazard, many kind of the slope stability techniques have been developed such as cut slope, fill slope, gabion wall, gravity retaining wall, crib wall, soil nailing, anchored sheet piles wall, anchored bored piles wall and so on.

Slope failure from time to time without prior indication and sometimes, due to interface of man. On of the factors that lead to the landslide is the weakness in managing the rock slope through effective stabilization method, maintenance and monitoring. Suitable stabilization method is required for the unstable slope that has low factor of safety and the process of selecting and deciding the appropriate methods are at critical stage.

Sometimes stable slope also may also fail due to the natural process such as weathering. Therefore, the understanding of the natural of slope, mode of slope failure, stabilization technique as well as maintenance is very important aspect when designing a slope.

1.1 Problem Statement

A comprehensive understanding of slope behavior and its failure mechanism is essential in designing and installation of appropriate stabilization system. The selection of proper stabilization method for slope stability depends on the failure

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mode. The economic aspect should also be considered to avoid over design and consequently burden the client.

1.2 Objective of Study

The objectives of this study are identification and mapping of landslide prone areas in Kota Kinabalu.

1.3 Scope of Study

The study will be carried out at Tamparuli-Ranau Highway (KM 47.9) of Sabah.

a. Studying the possibility of failure of the selective slope by using geotechnical software Oasys SLOPE version 18.0
b. Suggesting the proper slope remedial works to improve the selective practices.

1.4 Significance of the Study

The significance of the study is the presentation of case study of different kind of slope stability techniques used in Sabah. The landslide is a natural hazard that has been threatening man for centuries. With the development of the technology, the impact of the hazard can be minimized through effective stabilization method. However, different mode of failure needs different technique of stabilization. Sometimes a slope failure is treated with combination of several support methods. How to select an appropriate and effective treatment for stabilizing a slope failure, which perform various mode of failure become questionable. There, knowledge on

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the cause of failure and the relevant treatment are important in ensuring slope stability and subsequently maintenance.

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CHAPTER 2

LITERATURE REVIEW

2.0 Definition of Hill Site in Malaysia

There is no legal definition of hill site development. Some agencies have proposed various classification systems to suit their own usage. The most common ones are based on altitude or slope gradient of the original topography before development. According to the Ministry of Housing and Local Governments of Malaysia (KPKT 1997), hill-sites will be classified as high risk if the lands have natural or original gradient of the slopes of 25 degrees and steeper.

In the Economic Planning Unit (EPU) 2002 report prepared by WWF, it was stated that a consistent classification of highlands should be adopted throughout the country and classification of risk of landslide on hill site development shown as below Table 2.1. Hence it gives the proposed definition based on altitude as follows:

- 0m - 150m = Low Land
- 150m - 300m = Hill Land
- 300m - 1000m = Highland
- Above 1000m = Mountain

Table 2.1 Classification of risk of landslide on hill site development. (after IEM, 2000)

Class	Description
(Low risk)	For slopes either natural or man made, in the site or

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	adjacent to the site not belonging to Class 2 or Class 3.
(Medium risk)	For slopes either natural or man made, in the site or adjacent to the site where : · $6m \leq H_T \leq 15m$ and $\alpha_G \geq 27^o$ or · $6m \leq H_T \leq 15m$ and $\alpha_L \geq 30^o$ with $H_L \geq 3m$ or · $H_T \leq 6m$ and $\alpha_L \geq 34^o$ with $H_L \geq 3m$ or · $H_T \geq 15m$ and $19^o \leq \alpha_G \leq 27^o$ or $27^o \leq \alpha_L \leq 30^o$ with HL $\geq 3m$
(Higher risk)	Excluding bungalow (detached unit) not higher than 2-storey. For slopes either natural or man made, in the site or adjacent to the site where : · $H_T \geq 15m$ and $\alpha_G \geq 27^o$ or · $H_T \geq 15m$ and $\alpha_L \geq 30^o$ · with $H_L \geq 3m$

H = Total height of slopes

= Total height of natural slopes & man made slopes at site and immediately adjacent to the site which has potential influence on the site. It is the difference between the Lowest Level and the Highest Level at the site including adjacent site.

H_L = Height of Localised Slope which Angle of Slope, α_L is measured.

α_G = Global Angle of Slopes (Slopes contributing to H_T).

α_L = Localise Angle of Slopes either single and multiple height intervals.

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2.1 Geology in Relation to Landslides of Sabah

The geology of Sabah is dominated by sedimentary formations. About 70 per cent of this underlying geology is made of sedimentary rocks with about 10 per cent of rock types being Terrace and Recent deposits. The remainder of the geology is intrusive and extrusive igneous and metamorphic rocks.

The sedimentary formations comprise of a variety of rocks including interbedded sandstone and mudstone, shale, siltstone, limestone, calcareous sandstone, chert, tuffite and slump breccia. They are in varying degrees of consolidation. The sedimentary rocks which form the mountain and hill ranges along the west coast of Sabah belong to the Crocker and Trusmadi Formations; the rocks are strongly folded, faulted and fractured. The sedimentary rocks composing the east coast of Sabah are poorly consolidated, gently folded and tilted. Some of the formations consist predominantly of mudstone.

Terrace deposits are found in the Pinosuk Plateau, the Keningau-Sook Plain and along thecoastal areas. These consist of gravel, sand, silt and mud. The Pinosuk deposits are of glacial origin, poorly sorted and consolidated and consist of blocks as much as a few metres across.

Intrusive igneous rocks form mountains and hills in the Kinabalu and Segama areas, including the Mount Kinabalu. Volcanic rocks are mainly found in the Semporna Peninsula where they form mountainous country along the spine of the Peninsula; associated with these volcanic rocks are some intrusive rocks.

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Weathering of the sedimentary formations is frequently severe, often reaching a depth of 30m. A completely weathered zone of 1 to 10m thick has developed in most formations. The erodibility of soils developed from the weathering of these sedimentary formations depends on soil texture, aggregate stability, shear strength, infiltration capacity and organic and chemical content. Soils with high silt content are highly erodible.

Instability and landslides are recurrent problems associated with hillslope development affecting excavation for building sites and road cuts, particularly on the hilly terrain underlain by sedimentary rocks along the west coast, Kundasang and Sandakan areas. Landslides are also common in steep terrain underlain by igneous intrusive rocks, particularly the ultrabasic rocks, in the Lahad Datu and Telupid areas. The landslides may occur both in bedrock and in overburden. Slides may also occur in fill material. A tabulated major landslides in Sabah provided by EIA for as a guideline for the construction on hill in Sabah shown as below in Table 2.2.

Bedrock slides are most common where planes of structural weakness such as bedding or major joint planes dip towards the cut. Overburden slides occur mainly on semi-hemispherical slip surface.

Table 2.2 Major landslides in Sabah (EIA Guideline for Construction on Hill Slope of Sabah)

Date	**Locality**	**Loss or Life / Injury**	**Property**	**Remarks**
8 Feb 1999	Kg. Gelam, 2km from	17 dead, 2 injured	4 houses destroyed	-

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