THE EFFECTIVENESS OF GEOSYNTHETIC TO PREVENT SLOPE EROSION

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ABSTRACT

Slope failure or landslide always related to the slope works at the hilly area. One of the factors that contribute to this problem when slope surface is exposes to the rainfall or surface run-off that eroded particle from slope surface. Suitable protected layer and types of vegetation is important in this final year project. This final year project was carried out to determine the actual value of sedimentation when using protected layer compared to unprotected layer or bare control slope, also carried out the soil classification at the case study. Geogrid were selected to be used in this study and two types of grass were selected as earth cover is *Signal grass* and *Japanese millet.* From the shear strength test of soil at Bukit Gambang, the average of shear strength is 183.17 kPa with angle of friction 37.1°. From the soil classification test, this soil is sand soil with absence of fine gravel and little silt and clay. To ensure the successfully of this study, four (4) slope model were develop to determine the sedimentation value of the slope surface. Actual values of sedimentation were determined by using total suspended solid method. This study conclude that slope surface that contain *Japanese millet* not effective either control or protected slope model. Slope surface that protected with Geogrid shows effectiveness where can reduce sedimentation up to 6.98×10^{-4} g/mL per m^2. Side analysis form this study shows that *Signal grass* have effectiveness to protect slope surface by reducing 2.72×10^{-3} g/mL per m^2 sedimentation. The usage of Geogrid with *Signal grass* totally shows the effectiveness to solve slope surface erosion problem that can reduce sedimentation up to 3.86×10^{-3} g/mL per m^2.

ABSTRAK

Kerja-kerja membuat cerun di lereng-lereng bukit sentiasa dikaitkan dengan punca kegagalan cerun. Salah satu faktor yang menyumbang kepada ketidakstabilan cerun adalah permukaan cerun yang terdedah dengan air yang menyebabkan hakisan permukaan cerun. Kajian terhadap lapisan dan tanaman tutup bumi menjadi perkara penting didalam kajian projek sarjana muda ini. Tujuan kajian ini dijalankan adalah untuk mendapatkan nilai sebenar hakisan dan membezakan dengan permukaan cerun yang tidak diberi perlindungan serta mengklasifikasikan jenis tanah di tapak kajian. Lapisan yang digunakan didalam kajian ini ialah lapisan geogrid dan terdapat dua jenis tanaman tutup bumi yang telah dikenal pasti sesuai digunakan iaitu *Signal grass* dan *Japanese millet*. Ujian kekuatan ricih tanah di Bukit Gambang mendapati purata kekuatan ricih tanah ialah 183.17 kPa dengan satah kegagalan sebanyak 37.1^{o}. Dari ujian pengeklasan tanah, tanah ini dikelaskan sebagai tanah pasir yang mengandungi batu kelikir halus, sedikit kelodak dan tanah liat. Bagi memastikan kajian ini berjaya, empat (4) buah model cerun dibina khas untuk mendapatkan nilai hakisan terhadap permukaan cerun tersebut. Nilai sebenar hakisan dapat ditentukan dengan menggunakan kaedah pepejal terampai. Kesimpulan kajian ini mendapati permukaan cerun yang menggunakan rumput *Japanese millet* tidak berkesan samada dengan Geogrid atau tidak. Permukaan cerun yang dilindungi dengan Geogrid adalah lebih baik dengan mengurangkan kesan hakisan sebanyak $6.98\text{x}10^{-4}$ g/mL per m^2. Kajian selingan mendapati *Signal grass* juga mempunyai keberkesanan dengan mengurangkan hakisan sebanyak $2.72\text{x}10^{-3}$ g/mL per m^2. Penggunaan Geogrid dengan *Signal grass* sememangnya berkesan bagi menangani masalah hakisan permukaan cerun dengan mengurangkan hakisan sebanyak $3.86\text{x}10^{-3}$ g/mL per m^2.

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A	-	Area
BH	-	Bore hole
C	-	Cohesion
C_u	-	Undrained shear strength
C'	-	Effective cohesion
C	-	Clay
CL	-	Low plastic clay
GCLs	-	Geosynthetic clay liners
Gs	-	Specific gravity
I_L	-	Liquidity index
I_P	-	Plasticity index
I	-	Rainfall intensity
LI	-	Liquidity index
LL	-	Liquid limit
M	-	Silt
PI	-	Plasticity index
PL	-	Plastic limit
UU	-	Undrained unconsolidated
UV	-	Ultraviolet
OMC	-	Optimum moisture content
S	-	Sand
SP	-	Poorly sand
w	-	Natural moisture content
w_L	-	Liquid limit
w_P	-	Plastic limit

w_S	-	Shrinkage limit
Q	-	Flow rate
z	-	Depth
σ	-	Stress
σ'	-	Effective stress
σ_3	-	Confining pressure
σ_v	-	Overburden pressure
ρ	-	Density
γ	-	Bulk unit weight
γ_{dry}	-	Dry unit weight
Φ	-	Internal angle of friction
Φ'	-	Effective angle of friction
τ_f	-	Stress at failure
^oF	-	Degree Fahrenheit
^oC	-	Degree Celsius
θ	-	Degree

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Highlands's area is a beautiful place to serve as travel, entertainment or as a residence for people who like beautiful scenery, fresh air and away from the bustling city. Highland areas in Malaysia including Cameron Highland, Genting Highland, Fraser's Hill and Bukit Tinggi often become tourist attractions from within and outside the country. Nowadays, highland areas in Malaysia are becoming more sought-after the settlers who want to open the forest highlands. With activities such as the development is expected to increase revenue, but instead have happened.

Malaysia has received a drastic current modernization began early 80s, where there are many infrastructure development ahead run in the city or village. Not exempt development on high ground and the slope of the hill-slope. Since developing, many buildings can be built higher and also due to modernization, many residential areas built in the hills because of the financial status changes dramatically. At that time and now, housing in the area of land represents a high status to the buyer, but buyers are not realizing the danger living in hilly area.

November 1993, Malaysia shocked by landslides against the Highland Tower which has claimed many lives. The event was a great impact for Malaysia where the effects of modernization has been shown to respond to the community. Since the incident, the government has taken various measures to prevent landslides from happening again, but the result disappointed. Since 1993, there are many cases follow-up occurred after the landslide and also involves death and property loss.

While Malaysia can be categorized as a country that is safe from natural disasters such as earthquakes, hurricanes and tsunamis, but Malaysia is not free from landslides caused by climatic conditions and form of the hilly terrain. Malaysia generally has a mountainous terrain in the middle of the country from north Malaysia to the west coast. Titiwangsa Mountains range is the oldest in Malaysia which there are many hills around. Mountainous also is an obstacle to the transport system to get to the east coast and northern Malaysia. Normally the way to go to the north and the east coast, the road were be built on the hillside of the work involves cutting and trim hill.

Malaysia's position is located in the middle of the equator line to receive hot and humid weather throughout the year also located in a circle of Pacific Ring of Fire that shows in Figure 1.1. A climatic condition such as this is a major contributor to landslides where the weathering process that occurs at very high line is the equator. Malaysia also received high rainfall throughout the year starting from early October until late January next year because of changes in the northeast monsoon winds. Even though Malaysia is safe from earth quake, but Malaysia still can have the effect form that activity and there is still no evident that says Malaysia are not suffer from earth quake activity or massive movement of earth crust.

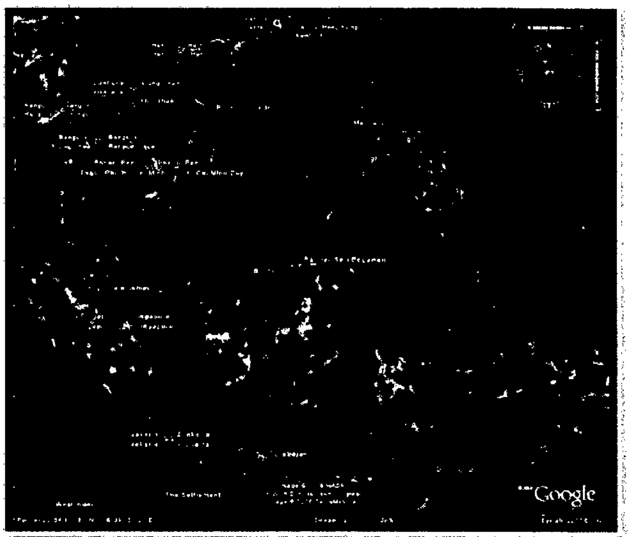

Figure 1.1: Pacific ring of fire at equator line

Source: Google earth

Water is a dangerous agent compared to wind, water not only can dissolve, but it's scraping and drifting the soil particle. A part form factor land and climatic conditions, there are several additional factors, such as less monitoring and maintenance and the attitude not to know about the circumstances surrounding highlands contribute to landslides. High land clearing activity not controlled can also affect the geological origin of the region. Until now, there are many projects actively carried out in the highlands, for example the construction of such roads in the Simpang Pulai-Gua Musang-Lojing the recorded cases of concern.

Development in the hills that are not managed and controlled to give worst impact to the country, when there is landslide occurs especially to the victim family or community. Because landslides occur blinking of an eye and people who live on high ground are not prepared, always is a victim of landslides. Effects of landslides not only claimed lives and property, even harming the economy of the country as the issue had to spend big to repair the destruction and damages. Also, there are some people who suffer emotional disturbances because of past landslides.

1.2 Problem Statements

Development on high ground indeed invites the problem of landslides. Generally, plateau areas are places where rain water catchment's supplying water in lowland areas. When the occurrence of development activities carried out, cutting of forests in the highlands can disrupt the original ecology of the area. With activities that also, it changed the pattern of water flow at the top of the hill. Time when it rained, the water can easily infiltrate into the soil pores and loosen the bonds of soil and the occurrence of landslides.

Landslides can occur in two ways, first by nature, and the second with the man-made. However, as a result of man-made landslide that makes this worse compare than nature. As an example, construction of roads in the hillside, cut and trim work involves hills and the result is there is a slope failure along the road. Unfortunately, due to the progress of an area, work like this should be done. However, it must be carefully planned and reviewed, also supervision and maintenance that must be implemented consistently.

Slope failure is the main enemy really is water, because in Malaysia, the rainfall for each year is quite high. Safe and well construction on slope can siphon water out well from the slope. Certainly the increasingly steep slope, the speed of water flow rate and increasingly dangerous conditions the slope. With the right techniques must be adopted when the design of a slope. Most of the problems of landslides or other words slope failure occurred due to poor technique and lack of maintenance. This is because of slope failure cannot be predicting when it happen when and where, so the design of a slope should first ensure its effectiveness.

Pattern of slope failure are many ways, including erosion slope. When the occurrence of erosion slopes, the mountain has been lost from the water layer of defence. Thus, water is easy to infiltrate into the hills and help to collapse. The main factor is the occurrence of slope erosion processes of weathering, where hot and cold conditions cause cracks in the surface and rain which came down to help eliminate the particle of the soil. For problems like this, usually require in-depth study to determine where the appropriate conditions are used to prevent erosion problems on the surface slope.

Normally, the surface slope erosion solved by providing a special layer to prevent soil movement from top to bottom. To prevent the erosion rate is by planting grass on the surface of the slope to slow water runoff in surface slope. Surface slope maintenance is important to ensure the safety of slopes. This is because the surface slope acts as a barrier from water absorbed into the surface. This is important, because surface slopes are low maintenance compared to the costs when a landslide occurrence. So on the surface treatment is indeed important to guarantee the safety of slopes.

With the existence of problems such as this, a study should be conducted to investigate the effectiveness of the layer to treat this slope erosion problem. Consistent with the title of this study, expected a new discovery or improvement on how to prevent this problem. The appropriate parameters must be studied in order get good results and thus solve the puzzle about this problem.

1.3 Objective

The objectives of this study are:

1. To determine the soil properties at the Bukit Gambang area.
2. To analyze the effectiveness of Geosynthetic due to different types of vegetation.

1.4 Scope of works

Studies that were implemented are related to the slope erosion involving the study of soil properties and methods to prevent erosion. To implement this study, the study of slope should be done, but it is difficult for outside research takes a long time and uncertain circumstances. As solutions, this study was implemented to model slope outside, which is smaller but still similar to the conditions outside. To ensure the success of this study, there are three processes to be carried out, the first study the situation of soil properties in Bukit Gambang. Second, develop four slope models as tool for this study. Finally, is comparing the effectiveness of Geosynthetic layer between protected and control model and also due to different types of vegetation.

To studying soil properties in Bukit Gambang, soil usually be taken at the surface slope. This soil are taken in Bukit Gambang and then brought back to the laboratory for more in-depth study for soil classification. For research that utilizes Geosynthetic, there are four soil specimens should be develop, two of it is the control model are fertilized with two different types of grass and the other two are protected model which protect by Geosynthetic material also fertilized with two different types of grass. All of the slope models were using the same soil that taken from Bukit Gambang.

There is two types of grass were planted for this study, first is Signal grass where it is low-growing decumbent perennial, with trailing stems that root at the nodes. It forms a dense soil cover, with a canopy usually under 40 cm when grazed and Figure 1.2 shows a photo of Signal grass. The second grass is ordinary corps field grass that suitable to adapt in wet soils and requires no soil preparation or care called Japanese Millet grass. Figure 1.3 shows a photo of Japanese Millet grass.

Figure 1.2: Signal grass in specimen box

Figure 1.3: Japanese millet grass in specimen box

Specimen box were develop specifically for this study and specimen box has dimensions measure 500 mm wide x 1000 mm long x 356 mm high (1 foot). Figure 1.4 shows the illustration of the slope surface in specimen box. There are many types of Geosynthetic, and Geogrid were used for this study. Geogrids is only one of Geosynthetic material can let grass grows on it and there is a standard size in the market. In this study, Geogrids with a biaxial strength of 60 kN/m horizontally and 60 kN/m vertically were used and Figure 1.5 shows a photo of Geogrids.

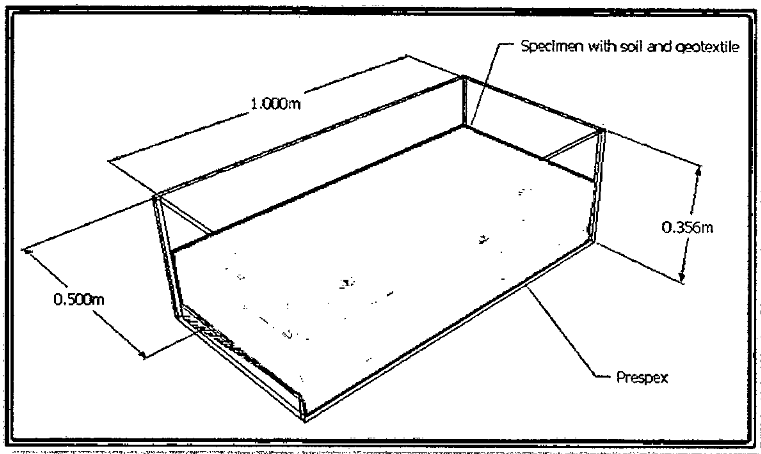

Figure 1.4: Slope surface in specimen box

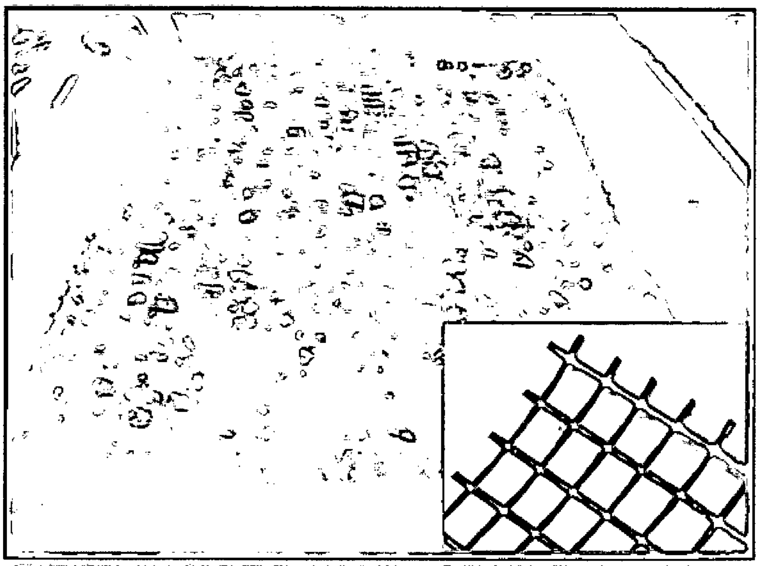

Figure 1.5: Geogrids KG 60/60

Slope model were also developed specially for the purpose of this study, it is used to replicate the original slope. Slope model are constructed with a dimension of 1000 mm length x 500 mm wide x 1000 mm high. Specimen box were placed on the top of slope model, where the soil are tested with various slope angles. The top of the slope model can be rotated until 50° maximum. Slope surface in specimen box were rotate for every 10° each starting from 0° until 50°. Therefore, the study required 6 types of angles of rotation and 24 data of the erosion rate were collected.

To study the erosion rate, rain simulators were constructed to resemble the actual rain or other words to make the process of weathering with the actual situation. This study is implemented in open areas and rainfall simulator were accordance with Malaysia average heavy rainfall with intensity 83.3 mm/hr. Rainfall simulations were carried out for 1 hour for each specimen at a certain slope angle. To determine the rate of erosion, the water runoff are collected and determine using the total suspended solid apparatus, to knowing the particles of the soil has been eroded every hour. Figure 1.6 shows the slope model and rain simulator illustration.

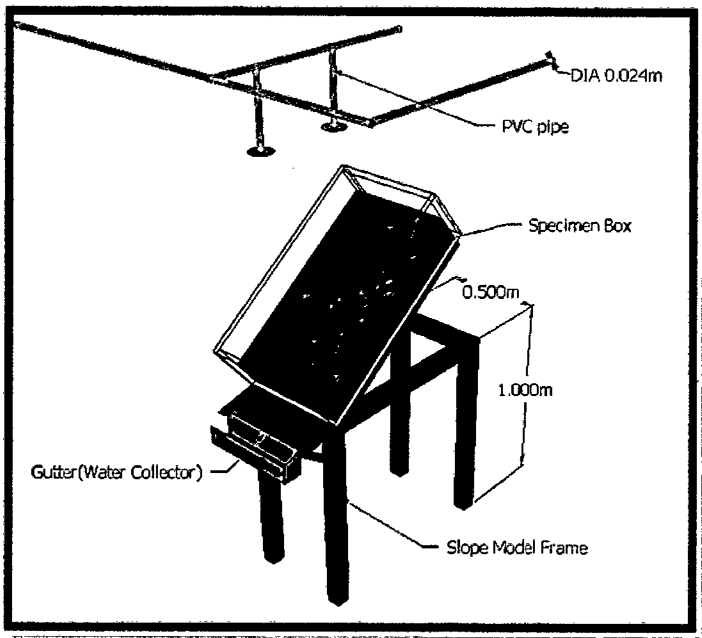

Figure 1.6: Slope model with rain simulator