THE EFFECTIVENESS OF COCONUT COIR BLANKET IN CONTROLLING SLOPE EROSION

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A thesis submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Civil Engineering

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DECEMBER 2010

ABSTRACT

A research to determine the effectiveness of coconut coir blanket in controlling slope erosion was conducted. There were two major division of testing made. One was the material analysis on the soil sample taken and the coconut coir blanket used and another was the simulation of rainfall pouring on sloped surface soil to analyze the erosion rate. Apparently, the division of material testing involved Soil Mechanics Engineering and Light Structure Engineering. Soil Mechanics Engineering assisted this research in soil analyzing in terms of the Soil Classification, Atterberg Limit, Specific Gravity, Shear Strength, Standard Proctor and Direct Shear testing. On the other hand, Light Structure Engineering focused on Tensile Strength of the coconut coir blanket. Generally, the major testing was the simulation of rainfall on the sloped surface soil. The soil sample which was taken from construction site in Bukit Gambang, Pahang was distributed into four cases. The parameters manipulated were the degree of slope, type of vegetation and the condition of the slope surface. The selected degree of slope were 0°, 10°, 20°, 30°, 40° and 50°. The vegetations planted were based on the norm slopes grasses used which were the Signal Grass and Japanese Millet. The conditions of the slope surface were divided into two. They were bare controlled case and protected slope case using coconut coir blanket. The main parameter which was the application of coconut coir blanket as the protection to the slope was proven effective. By comparing the bare controlled slope and the protected slope, the result showed that protected slope using the coconut coir blanket decreases the erosion rate by the Total Suspended Solids (TSS) test conducted. The bare controlled slope collected 0.014345 g/L amount of TSS while protected slope using coconut coir blanket collected only 0.001368 g/L. The difference of 0.012977 g/L TSS amount proved that coconut coir blanket was effective in controlling slope erosion assisted by the vegetation of Signal Grass which has longer leaves and gripping fibre roots in increasing the mode of slope strength.

ABSTRAK

Satu kajian untuk menentukan keberkesanan karpet sabut kelapa untuk mengawal hakisan cerun telah dijalankan. Terdapat dua bahagian bagi ujikaji yang dijalankan iaitu analisa ke atas sampel tanah diambil termasuklah sabut kelapa yang digunakan dan simulasi proses hujan ke atas cerun tanah untuk menganalisa hakisan cerun. Bahagian ujikaji untuk bahan yang digunakan merangkumi Kejuruteraan Mekanik Tanah dan Kejuruteraan Struktur Ringan. Kejuruteraan Mekanik Tanah membantu ujikaji ini dengan usaha menganalisa Pengelasan Tanah, Had Atterberg, Graviti Tentu, Kekuatan Ricih, Proktor Piawai and ujikaji Ricih Terus. Sebaliknya, Kejuruteraan Structur Ringan menumpukan kepada ujikaji Kekuatan Tegangan bagi bahan karpet sabut kelapa yang digunakan. Secara amnya, ujikaji utama adalah simulasi hujan ke atas cerun tanah. Sampel tanah yang diambil dari kawasan pembinaan di Bukit Gambang, Pahang dibahagikan kepada empat kes. Pembolehubah yang dimanipulasikan adalah darjah kecerunan, jenis tumbuhan dan keadaan cerun itu. Darjah kecerunan yang dipilih adalah 0°, 10°, 20°, 30°, 40° dan 50°. Tumbuhan yang ditanam merujuk kepada rumput yang biasa ditanam di kawasan cerun iaitu Signal Grass dan Japanese Millet. Keadaan cerun telah dibahagikan kepada dua iaitu kes tanah kosong yang dikawal dan kes cerun tanah yang dilindungi. Pembolehubah utama adalah aplikasi oleh karpet sabut kelapa sebagai pelindung cerun dibuktikan berkesan. Dengan membandingkan cerun kosong yang dikawal dengan cerun yang dilindungi, keputusan ujikaji menunjukkan cerun yang dilindungi mengurangkan hakisan tanahnya melalui ujikaji Sisa Pepejal Terampai yang telah dijalankan. Cerun yang kosong mengumpul 0.014345 g/L sisa pepejal terampai sementara cerun yang dilindungi menggunakan karpet sabut kelapa mengumpul hanya 0.001368 g/L. Perbezaannya adalah 0.012977 g/L yang membuktikan karpet sabut kelapa lebih berkesan dalam mengawal hakisan cerun yang ditanam dengan rumput Signal Grass dimana daunnya yang lebih panjang dan akar serabutnya yang kuat bagi meningkatkan mod kekuatan cerun.

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LIST OF SYMBOLS AND ABBREVIATIONS

A	-	Soil loss in tons/acre/year
R	-	Rain factor
K	-	Soil erodibility
LS	-	Topographic factor
C	-	Cover factor
P	-	Practice factor
c	-	Soil cohesion
E	-	Young's Modulus
v	-	Poisson's ratio
c'	-	Effective cohesion
Φ°	-	Effective friction angle
LL	-	Liquid limit
PL	-	Plastic limit
SL	-	Shrinkage limit
Su	-	Undrained shear strength
ΔL	-	Length deformation
L_o	-	Initial length
ε	-	Strain
Gs	-	Specific gravity
γ	-	Dry unit weight
Cu	-	Shear strength
%	-	Percentage
µm	-	Micrometer
o	-	Degree
mic	-	Micron

w%	-	Water content
M_o	-	Initial mass
σ	-	Stress
MD	-	Machine direction
CD	-	Cross direction
lbs	-	Pounds
in	-	Inch
ac	-	Acre
tan	-	Tangent
f	-	Internal friction
kPa	-	Kilo Pascal
^oC	-	Degree Celcius
ASTM	-	American Society for Testing and Materials
AASHTO	-	American Association of State Highway and Transportation Officials

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CHAPTER 1

INTRODUCTION

1.1 Background of Research

The surface of planet earth consists of mountains, flat grounds and water-filled sea. Each of these places needs to play roles in locating developments as the world has limited ground areas for all mankind to live in. As these places are built up to meet advanced civilization, the nature on their own is changing. The ground surface of earth basically is having crust movement as the planet rotates on its axis. The ambience which lives in the atmosphere too becomes the factors which lead to the adjustment of nature physically. Thereafter, the geological cycle of earth may be classified as disturbed.

Geologically, Malaysia is greatly disturbed by one of the major natural disaster which is landslide. Landslide occurs mostly at the surface of mountainous slopes that engaging danger to the residents. This alarming phenomenon can be predicted by geologists but on many cases, it happens unexpectedly leaving the residents in chaos. Lives are taken away and private properties are damaged which concurrently affect the residents spiritually and the country's economic sustainment. Many cases involved in the previous years and now seems like there is very minor improvement has been implemented in slope reinforcement due to the numerous agendas.

In Peninsular Malaysia, the states located in the region of north, west and south are having the gradual and evenly distributed rainfall season throughout the month of April to May and September to December. These states comprising of Kedah, Perak, Selangor and Johor are slightly affected to the landslide occurrence as a result from heavy rainfall. Based on climatology, these places basically have a dry season starting from January. Due to this, they are least in the dilemma of landslide. Out of jurisdiction, flooding may occur from time to time in the raining season.

Apparently, landslide which takes place due to human activities is normally because of major construction on the existing site. Construction works such as the cuts and excavations, removal of retaining wall or sheet piles and drawdown of water bodies can easily take leads to slope failure. Certain construction uses high technologies in order to cut hill slopes. Explosive are one of the major practice and most expensive method which being carried out. Any misleading of the explosion could simply produce unnecessary vibrations to the slope area.

Another example of human activities effects will be mining and quarrying process for the purpose of construction materials trading and entrepreneurship. Underprivileged monitoring of these activities might cause the area of site to be exposed for landslide. Additionally, the construction for tunnel without proper soil investigation and effective work may contribute in slope failure too. The hill that has been drilled may be subjected to undesired settlement. More to this construction industry, the building of a damn have a major risk in developing a landslide. Water which run underneath the ground level and water pressure against the wall of the dam may create a downfall.

Due to poor site investigation, a critical landslide may sweep off the entire construction area. This may happen too to completed projects for example in Malaysia itself, Jalan Semantan and Bukit Antarabangsa had landslide particularly in 2008 which killed a number of residents. Both projects are residential areas which stand aside to a retaining wall that protects the slope from settling down. These two cases were most likely the repetition of previous Highland Tower collapse back in 1985. It was a massive destruction as the whole tower fell to the side leaving few survivors. It is learnt that, construction within slope areas is still unsecured due to natural effects not human errors.

Though high technology and recognized philosophies had been practiced into the matter of slope protection, flaws seemed to rise and slowly engaging total disaster. Effort on improving of the reinforcement to slope have to be revised continuously as the analogy changes because of the transition made to the environment naturally or man-made. As the deformation keeps going on, slope erosion occurs because of the soil which eroded by water and wind factor. The slope erosion is one major reason why landslide phenomenon exists. The landslide proved that better technology is highly recommended for slope embankment and more protection is seriously needful in order to have a promising Factor of Safety.

1.2 Problem Statement

Soil erosion is one factor why landslide occurs. The erosion involved the human activities which development is engaged over the existing area. Due to uncontrollable scenario, the soil surface is exposed to wind and water. As the soil is being eroded, the changes made to the originality of the soil. Numerous elements are taken into discussion for the basic properties of the soil are altered. The soil will be losing nutrients and moisture, change in its structure and vegetation, and running through a salinization. Hence, the behaviour of the soil is deformed form its original state leaving it ineligible for many purposes.

Once an area of soil becomes degraded and eroded, the particular area shall be put up for sale as it cannot be used for farmland anymore. The elements of the soil which are altered made the soil become unsuitable for plantation to grow especially at highland grounds. The maintenance fee may go higher as the soil has to be modified in order to regain its natural behaviour. Unfortunately, the value of the soil too will decrease therefore the people farming it would be harvesting lesser or reducing stock and eventually end up poorer. Regarding to this, it can be assumed that erosion causes social, economic and political consequences to farm industries.

Whenever there is any presence of soil erosion, the existing ground is no longer safe for construction unless remedial measures are implemented. In residential divisions, high value residential nowadays favours the location of highland grounds that overlook scenic environment. However, the safety measures promised are vulnerable as any changes made by Mother Nature are unpredictable. Most cases that relates to residential happens when the slopes holding the houses overturn and slide resulting the houses to collapse. Lives were taken at stake. A home which is the safest area for people to live in becomes dangerous unexpectedly.

Other than residential area, high rise building such as offices, academic institutions, private organizations are too exposed to landslide caused by soil erosion. These multi-storeys building faces higher risk of destruction if the foundation of the structure is disrupted by the soil erosion scenario. The foundation which holds the main structure of the building may fail and bring down the whole building. Many cases have been highlighted in previous years as soil erosion keep on occurring after intense improvement on the slope reinforcement.

Most importantly, roadways which have been the network to human connections too seemed to be invaded by the severity of slope erosion. Highways which cut through a hill will be facing the dilemma of soil erosion by both sides of the excavated hill. The soil erosion which affects the roadway condition will be hazardous to the road users. Rocks, dust, and soil particles deposited by water certainly blocks the sight for the drivers. In a worsened scenario, the slope may fail thoroughly and engaging into landslide. Vehicles on the road during that particular moment may be having fatal accidents. If the destruction continues and the roadway itself collapses into lower ground, the structure of the main road is impaired. Road network is barred and transport connection is limited.

Seemingly, slope erosion by means of soil erosion leads to many difficulties to the nature and its surroundings. Most of the factor is withstood by the human activities themselves. The failure that damaging farmland, residential areas, high rise buildings and roadways are the major places involved. Lives are taken and properties are swept off each time a landslide occurs. As protecting slope is very important, this study leads to one of the many preventive measures by reinforcing the slope literally.

1.3 Objectives

The objectives of the study are:

1. To determine the strength and durability of coconut coir matting.
2. To determine the effectiveness of the coir blanket in controlling slope erosion.

1.4 Scope of Study

In the real world, the phenomenon of landslide cannot be forecasted of its time of occurring and how bad it is going to be. Many factors affected the movement of particles in the soil layers which were clearly subjective. The safety protections suggested and applied too were occasionally vulnerable due to the changes made by the Mother Nature. To gain such safety protections, many measures were taken into consideration. Due to this, testing was carried out based on the objectives of this study. The effectiveness of coconut coir in controlling slope erosion was determined by several testing.

The related laboratory testing in this study covers in two specific engineering division. It included both Geotechnical Engineering testing and Structural Engineering testing. These two majors were mainly for the soil sample analysis and the coconut coir properties assessment respectively. For Geotechnical Engineering testing, there were Soil Classification, Atterberg Limit, Specific Gravity, Standard Proctor, Shear Strength and Direct Shear tests. While Structural Engineering highlighted on the coconut coir blanket properties assessment based on the Tensile test.

In this study, a rainfall simulation model was built which contain a sloped surface of soil sample. An artificial rainfall was spurred all over the soil sample area, filtered into the layer of soil and the deposited amount of water was collected at the edge of the model. The rainfall water supplied came from a direct water supply from a water tab. The rainfall was designed to distribute the water uniformly over the soil sample area. Sprinklers were installed as to contribute in the distribution of the artificial rainfall thoroughly. Pressure gauge was connected to the main pipeline of the water supply for monitoring the water pressure so to alter the intensity of the rainfall as favoured in the testing. Each testing was gone for a one-hour raining session. The data accumulated were averaged out over 60 minutes.

One controlled condition of slope was to be tested with bare surface. The other condition was the sloped surfaces covered with coconut coir blanket. Both of the conditions were varied by the vegetations used which were the Signal Grass and Japanese Millet. The angles for the slope tested were 0°, 10°, 20°, 30°, 40° and 50°. Therefore, the total number of cases was 144. The soil sample was collected from a construction site in Bukit Gambang, Pahang. Soil which was altered extremely is most likely being disapproved as the originality of the soil content will be needed to assure the properties of natural soil.

1.5 Significant of Study

The phenomenon of landslide can be factored by many aspects. There are ground conditions, geomorphological processes, physical processes and man-made processes. One of the main factors is erosion that belongs in the category of geomorphological processes as it is a norm occurrence in Malaysia. Out of the many factors, erosion is chosen to be discussed in this study in a way that excessive rainfall season in Malaysia generates the soil particles movement settled in the slope area. It is without a doubt that the well-known relationship between heavy rainfall and landslides is the major contributions to slope erosion.

Remediation processes are highly important to slope failures. But practising such operation is not recognizable as prevention save lives and the human properties at the first place. Hence, remedial measures are the ones that need to be stressed out in controlling slope erosion. Geotextile proves that it is effective to reduce erosion in slopes. However, geosynthetic fibre is a new material which has better advantages than the polymerized geotextile already has. Coconut coir is the base material selected to be used in this study as it certainly belongs in eco-friendly element. A coconut coir based blanket is fully produced naturally. The raw material used is the coconut coir alone without any additives.