SLOPE IMPROVEMENT TECHNIQUE USING 8R MAT SYSTEM

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by

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LIST OF ABBREVATIONS

2-8R	Two 8R sample
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ADR	Accord europeen sur le transport des marchandises dangereuses par route
ASTM	American Society for Testing and Materials
BS	British Standard
BD	Back Displacement
CFL	Connection-Failed Load
E1	Primary Extension
E2	Secondary Extension
Et	Total Extension
EL	Elongation at break
EPC	Earth Pressure Cell
FD	Front Displacement
F.S	Safety Factor
JKR	Jabatan Kerja Raya
M	Mean
MEL	Maximum Elongation
MFD	Maximum Front Displacement
MPF	Maximum Pull-out Force
MSt	Maximum Strain
MTL	Maximum Tensile Load

MTS	Maximum Tensile Strength
O	Round shape sample
PAHs	Polycyclic Aromatic Hydrocarbons
PAS	Publicly Available Specification
RMA	Rubber Manufacture Association
SD	Standard Deviation
SM	Silty Sand
SP	Settlement Plate
St	Strain
SW	Well Graded Sand
TM	Tilt Meter
UTM	Universal Tensile Machine
UU	Unconfined Undrained

LIST OF SYMBOLS

^{o}	Angle Degree
c	Cohesion
ϕ	Friction Angle
c_a	Apparent cohesion
σ_n	Normal stress
σ_1	Peak axial stress
τ_n	Shear stress
Θ	Central angle

TEKNIK PENAMBAHBAIKAN CERUN MENGUNAKAN SISTEM HAMPARAN 8R

ABSTRAK

Teknik penstabilan cerun telah menjadi satu subjek penting dalam bidang geoteknikal. Pada masa ini, terdapat beberapa kejadian tanah runtuh di serata dunia. Dalam usaha untuk meningkatkan kestabilan cerun, begitu banyak jenis tetulang cerun telah dihasilkan sejak kebelakangan ini. Antaranya, tayar sekerap telah menunjukkan beberapa ciri yang dikehendaki untuk teknik penstabilan cerun. Kerana jumlah tayar dihasilkan melebihi jumlah tayar sekerap dikitar semula setiap tahun, ia adalah satu peluang yang baik untuk menyelesaikan masalah alam sekitar ini pada masa yang sama meningkatkan kestabilan cerun apabila ia digunakan dalam bidang geoteknikal. Dalam kajian ini, cerun prototaip diperkukuhkan dengan system 8R telah dibina pada 15 Disember 2014 untuk mengkaji prestasinya. Hamparan 8R ini dihasilkan menggunakan tayar berbentuk lapan. Bagi tujuan analisis, ujian tegangan, tarik keluar dan paksi telah dijalankan ke atas tayar sekerap untuk menentukan sifatnya. Kekuatan tegangan sampel adalah lebih rendah pada sampel jalur membandingkan sampel 8R kerana keadaan wayar yang terganggu. Keputusan menunjukkan bahawa daya Tarik keluar dipengaruhi oleh bentuk, bilangan tetulang, saiz, beban tambahan dan juga bahan isian. Jeleketan ketara menunjukkan peningkatan dengan peningkatan nombor sambungan. Dari hasil analisis cerun, ia menunjukkan bahawa dengan memasang hamparan 8R kestabilan cerun telah bertambah baik. Dari hasil pemantauan, ia menunjukkan bahawa system hamparan 8R akan menghasilkan dinding penahan yang mempunyai pengaliran yg baik, kekuatan tinggi dan ringan. Oleh itu, dengan menggunakan sistem hamparan 8R sebagai struktur penahan akan menghasilkan

dinding penahan yang diingini dan pada masa yang sama membantu dalam mengurangkan jumlah tayar sekerap yang ada.

SLOPE IMPROVEMENT TECHNIQUE USING 8R MAT SYSTEM

ABSTRACT

Slope stabilization technique is become an important subject in the geotechnical field. Currently, there are a number of landslide occurrences around the world. In order to improve the slope stability, so many types of slope reinforcement had been produced lately. Among these, scrap tyre had been showing some desired properties for slope stabilization technique. Since the amount of generated tyre exceeded the amount of scrap tyre recycled annually, it is a good opportunity to solve this environmental problem at the same time enhancing the slope stability when it is used in geotechnical field. In this research, a prototype slope reinforced with 8R mat system was constructed on 15th December 2014 to study its performance. This 8R mat was produced using 8 shape tyre. For the analysis purposes, the tensile, pull-out and axial test were conducted on the scrap tyre to determine its properties. The tensile strength of the sample was lower on strip sample compared to 8R sample due to disturbed wire condition. The result shows that the pull-out force was influenced by the shape, number of reinforcement, size, overburden load and also the fill material. The apparent cohesion shows an increase with the increase of connection number. From the slope analysis result, it shows that by installing the 8R mat the slope stability had improved. From the monitoring results, it shows that the 8R mat system will provide a retaining wall that have better drainage, high strength and lightweight. Thus, by using the 8R mat system as a retaining structure will provide a desirable retaining wall at the same time help in reducing the amount of scrap tyre available.

CHAPTER ONE

INTRODUCTION

1.1 Background

Landslide is a natural phenomenon that is related to the movement of ground. Actually, landslide causes no harm to mankind, but if it happens near a road or residential area, this natural phenomenon can turn into a hazard. Some of the landslide activities occurred near the high-rise apartments had a high potential of threat to human life. For an example the tragic Highland Tower incident that had claimed the lives of 48 residences (Gue and Cheah, 2008). In recent year, the problem related to the landslide had increased in Malaysia. There had been so many cases that cause loss of life regarding the slopes that are unable to maintain its strength. Qasim et al., (2013) mentioned that about 49 cases of landslide that had happened, 88% of them were manmade slope. Other than that See-Sew and Tan (2007) also declare that along with poor designing, incompetency, casualness, raw input data are also contributing to this frequent fact of landslides. The main cause of the natural slope failure usually happens when there is a presence of extra water in soil, thus weakening the soil. Other than that, the changes of water table also had become the other factor that influences the soil strength. In order to cope with this problem, some preventive measures had been done to improve the slope stability.

There are so many methods that can be done in order to improve the slope stability. The most commonly used method for slope improvement is the gravity retaining wall. The gravity retaining wall is constructed using a reinforced concrete, are having a high strength that is able to maintain the slope stability. The main problem with this gravity retaining wall is that, the water from the soil behind the wall were unable to flow through it and will increase the pressure behind the retaining wall. Other than that, a method such as gabion had also been used to improve slope stability. Besides this conventional method, the researchers around the world had conducted so many studies on new material in order to invent a new method for the slope improvement technique. From the research done, tyres were having desirable are high in tensile strength, low deformation and high durability. There are several approaches for the use of scrap tyre in geotechnical field which are tyre shred/chip, tyre bale and whole tyre.

Shredded tyre shows some great properties such as lightweight, good thermal insulation and good drainage material (Humphrey 2009). They are also the cheapest alternative material compared to the conventional methods. From the test conducted in previous studies, the used of shredded tyre in construction showed a good result.

The use of whole tyre is most likely more preferable due to minimum processing that requires a lot of energy. Another aspect of using whole tyre refers to their ability to reduce the vertical deformation where it had been used as soil reinforcement.

Tyre bales use a significant amount of scrap tyre. This method should be the best way to cater the problem in discarding scrap tyre since it uses large amount of tyre just to produced 1 tyre bales. This tyre block shows good result when it is used for soft soil reinforcement for road base. The tyre block is very low in cost, low compressibility, high tensile strength and great durability (Winter et al., 2005)

From the study done on the scrap tyre by using different approaches, the scrap tyre can be used in many ways such as fill material, drainage material, retaining wall and much more. But the main consideration for the approaches use is the effect of the tyre to the surrounding area. In this study, the whole tyre approaches were used to reinforce the failed slope in order to optimize the used of scrap tyre.

1.2 Problem Statement

In order to reduce the amount of scrap tyre generated annually, it had been recycled and turn into something useful such as flower pot, decoration and much more. Even though it had been recycled, the amount of scrap tyres generated still exceed the amount of recycled scrap tyre. Because of its physical properties, geotechnical researcher had started to use it as slope reinforcement. This scrap tyre is used as slope reinforcement and work the same way as the conventional retaining wall. From the previous studies conducted by O'Shaughnessy and Garga (2000), it had shown that the use of tyre without sidewall had a lower settlement compare to whole tyre. But having a round shape tyre without sidewall would experience higher strain that is unfavourable for it to act as retaining wall. Safari (2012) had done some modifications by utilizing the 8 shape tyre to reduce deformation. The 8 shape tyre were used as the river bank reinforcement and shows a good result. The main concern in this study is to determine how this 8R mat system help to improve the slope stability. Other than that despite of many studies carried out on the field, most of them was conducted on river bank and embankment. It would be interesting to see the performance of the system when it been installed at a slope since the mechanism is different.

1.3 Objectives

The objectives of this study are: -

1. to characterize the properties of 8R mat material and soil conditions at the site,
2. to remediate a prototype field slope with 8R Mat as reinforcement and calculate the safety factor of reinforced slope; and
3. to monitor and evaluate the performance of the reinforced slope.

1.4 Scope of work

The study can be divided into two parts which are laboratory program and also field program. The laboratory program was done to obtain the properties of the material which are the tyre and also the soil on site. The tyre had undergone two test which are tensile test and also pull-out test. In order to evaluate the performance of the 8R mat in real slope condition, a slope at Jalan Junjong Kulim was selected for construction of the prototype slope. This site has been selected based on the discussion done between Universiti Sains Malaysia (USM) and District Engineer from Jabatan Kerja Raya (JKR) Kulim, Kedah. After presenting the work and finding the right place for this product, a site visit dated on the 25th June 2014 was carried out to confirm the selected site that requires attention for slope reinforcement. Plate 1.1 shows the failed slope.

Plate 1.1: Failed slope at Jalan Junjong, Kulim

During the site visit, it was observed that the slope condition was quite critical and some preventive measures needed to be done. The slope was suggested to be reinforced with the 8R mat system and the District Engineer agreed on this collaboration with the construction. The 8R Mat system was seen suited for the slope and all plans were scheduled with the team of JKR and USM.

1.5 Organization of Thesis

This thesis had been divided into five parts. Chapter 1 is the introduction on the background of the study, the problem statement, objectives of the study and also the scope of work.

Chapter 2, explains the origin of the scrap tyre used in geotechnical field. Other than that, the type of approaches and the method done in previous study had been discussed. The advantages and disadvantages using different approaches can be found in this chapter.

Chapter 3 gives the information about the method and test done on the material and soil. The production of 8R mat system and construction of the prototype slope had also been shown in this chapter.

The results from the study were discussed in the Chapter 4. The discussion about the properties of the material which are the tensile test and pull-out test had been done. Other than that, the result from slope monitoring had been analysed and the performance had been evaluated.

Lastly, Chapter 5 will conclude the research based on the result and proposed a recommendation for future study.