

**THE EFFECTIVENESS OF
TIRES CHIPS IN GABION WALL
FOR SLOPE PROTECTION**

HAFIZ ASHRAWI BIN BAHARUN

B. ENG (HONS.) CIVIL ENGINEERING

UNIVERSITI MALAYSIA PAHANG



STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

(Student's Signature)

Full Name : HAFIZ ASHRAWI BIN BAHARUN

ID Number : AA15019

Date : 31 May 2019

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HAFIZ ASHRAWI BIN BAHARUN

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ABSTRAK

Tayar sisa di Malaysia tidak dikategorikan sebagai sisa pepejal atau sisa berbahaya. Ia biasanya dianggap sebagai sisa perniagaan atau perdagangan, oleh itu pada masa ini tidak ada undang-undang atau peraturan khusus, yang mengawal pengurusan pembuangan sisa tayar. Kajian tesis ini mengenai keberkesanan cip tayar untuk digunakan sebagai bahan mentah di dalam dinding gabion sebagai perlindungan cerun. Objektif utama kajian ini adalah untuk menggantikan kerikil di dinding gabion dengan cip tayar. Kajian ini menganalisis kestabilan cerun menggunakan sudut cerun yang bervariasi (30° , 45° dan 60°), untuk mencari sudut kritikal akibat kesan hujan. Kajian ini juga menganalisis keberkesanan rawatan cerun menggunakan dinding gabion yang diisi dengan pelbagai variasi 0%, 20% dan 50% daripada cip tayar dari segi jumlah isipadu. Model simulator cerun dalam skala 1:20 telah dibina dan dinding gabion digunakan untuk mengekalkan model cerun yang terdiri daripada tanah dengan sudut 60° kritikal. Keamatan hujan sederhana ($13\text{mm} / \text{jam}$) tertakluk kepada bacaan cerun dan bacaan transduser yang merekodkan pergerakan dinding gabion telah diambil. Hasilnya menunjukkan bahawa pergerakan anjakan yang direkodkan oleh dinding gabion dengan 20% cip tayar dan 100% kerikil mempunyai perbezaan yang sangat besar dalam menahan cerun. Kerana itu, cip tayar tidak berkesan untuk digunakan sebagai bahan alternatif untuk kerikil dalam pembinaan tembok gabion kerana perbezaan pergerakan cerun yang besar dan perbezaan besar spesifik graviti untuk kerikil. Oleh itu, kajian lanjut perlu dibina untuk mengkaji potensi cip tayar untuk digunakan di dinding gabion pada masa akan datang.

ABSTRACT

Waste tire in Malaysia are neither categorized as solid waste or hazardous waste. It is generally consider as business or trade waste, hence currently there is no specific law or regulation, which govern waste tire management. This thesis study about the effectiveness of tire chips to use as raw material in gabion wall as slope protection. The main objective of this study is to replace the gravel in gabion wall with tire chips. This study analyzed the slope stability using various slope angle (30° , 45° and 60°), to find the critical angle due to effect of precipitation. This study also analyse the effectiveness of slope treatment using gabion filled with various proportion of 0%, 20% and 50% of tires chips in term of volume. Slope simulator model in scale 1:20 have been constructed and gabion wall were used to sustain the slope model consist of soil with 60° of critical angle. Moderate rain intensity (13mm/hour) was subjected on the slope and transducer reading that recording the displacement of gabion wall was taken. The result shows that the displacement recorded by gabion wall with 20% of tire chips and 100% gravel has a huge difference in resisting slope. Therefore, tire chips is not effective to use as alternative material for gravel in constructing of gabion wall due the large difference of displacement slope and the huge difference of specific gravity for gravel. Therefore, further study need to be constructed to studies the potential of the tire chips to be utilize in gabion wall in future.

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LIST OF SYMBOLS

c	Cohesion
G_s	Specific gravity
kPa	Kilo Pascal
mm	Millimeter
mm/h	Millimeter per hour
μm	Micrometer
%	Percent
$^\circ$	Degree
ϕ	Angle of friction
m	Meter
cm	Centimeter
C	Celsius
km	Kilometer
μ	Mu
μW	Microwatt
kg	Kilogramme
g	Gram
C_u	Coefficient of uniformity
C_c	Coefficient of curvature
k	Coefficient of permeability
sec	Seconds

LIST OF ABBREVIATIONS

JKR	Jabatan Kerja Raya
UMP	Universiti Malaysia Pahang
ASTM	American Standard Testing Material
FOS	Factor of Safety
US NASA	United States National Aeronautics Space Administration
PWD	Public Works Department
FELCRA	Federal Land Consolidation and Rehabilitation Authority
RC	Reinforced Concrete
USCS	Unified Soil Classification System
LL	Liquid Limit
PL	Plastic Limit
PI	Plasticity Index
G	Gravel
TC	Tire Chips

CHAPTER 1

INTRODUCTION

1.1 Background of study

Landslide are one of major disaster occurring frequently in Malaysia. They are responsible for both compensatory and non-compensatory losses. Besides damaging infrastructure, they cause loss of life, environmental degradation and interrupt the economic activity. For example, at 25 October 2018 tragedy of slope failure in Georgetown, Penang at Bukit Kukus which killed 9 construction worker and injure 4 people in one of the disasters that caused by slope failure. This disaster caused by three main factors including failure to control surface water run-off at the site. Besides that, inadequate measures to control soil movement, inadequate drainage system to control surface water run-off and inadequate measures to control water seepage at the side are the three component lead to slope failure.

Besides of that factor, there are another factor that contributed to slope failure such as topography (Malaysia in mountainous terrain), geological condition (soil characteristic and strength), weather condition (attributed to frequent and prolonged rainfall, in many cases associated with monsoon rainfalls) and external loading (surcharge, nearby structure, vibration).

According to guidelines for slope design JKR (2010) retaining wall is one of the solution to overcome slope failure. Since slope failure will result to losses of life, damages of structure and infrastructure as well as it involved huge money spending to restore the slope, therefore slope protection has become an urgent issue to take attention. Gabion wall is one type of the retaining wall that commonly been used to protect slopes

in Malaysia. Conventional gabion wall was made from purely rock fills that contributed to the self-weight of the retaining wall. This research study the potential of other material to replace rock fills / gravel as the material to made gabion type retaining wall. The suitable method has to be determine based on characteristic of slope and type of soil. Current gabion wall utilized 100% gravel as the material to filled up the gabion wall. But the problem is, the gravel material is a non-renewable resource (which may be limited in the future). Therefore, it is crucial to study on other potential material to replace the gravel in gabion type retaining wall.

1.2 Problem statement

According Kumar (2006), there is a steady increase in the motorcar waste tire generated annually in Malaysia . The number of motorcar waste tires generated annually in the country was estimated to be 8.2 million or approximately 57,391 tonnes. About 60% of the waste tire are disposed via unknown routes. Waste tire in Malaysia are neither categorized as solid waste or hazardous waste. It generally considered as business or trade waste, hence currently there is no specific law or regulation, which govern waste tire management. As a result of this matter, leads to environmental pollution where unused tire are dumped without proper management thus creating pollution. Uncontrolled dumping of waste tire especially in landfill, will increase the potential of health problem because the tires tend to be a breeding area for mosquitoes and rats.

Despite of the fact that, the biggest problem that the highest demand for conventional construction materials such as concrete, bricks, hollow blocks, solid blocks, precast wall, pavement blocks and gabion wall in construction industry has led towards a rapid decrease in natural sources such as gravel, thus causing ecological imbalance. In the case of gravel, the extensive use of concrete has lead high consumption of this material. According to the UNEP (2014), Malaysia uses more than 20 billion tonnes of gravel in a year. Continuous usage of this non-renewable resource would cause the depletion of this natural aggregate for the use of future generation.

1.3 Project Aims and Objectives

The aim of this project is to study the effectiveness of tire chips in gabion wall for slope protection. The specific objectives are as follows:

- i. To investigate the basic properties of the materials such as soil, gravel and tire chips.
- ii. To determine the critical angle of unprotected slope.
- iii. To examine the effectiveness of tire chips in replacing gravel as material to make gabion wall.

1.4 Scope of study

This research consists of two phases which involves material testing and slope model testing. Material testing was conducted in Geotechnical Laboratory UMP Gombang. Material testing was conducted to obtain basic properties of soil, gravel and tire chips. The laboratory testing was conducted based on American Standard Testing Material (ASTM). The test that had been conducted are particle size distribution test, specific gravity test, standard Proctor test, Atterberg limit test and direct shear test. The basic properties of tire chips and gravel are compared in terms of their suitability be used in gabion wall.

Slope model testing were consists of two phases which are, testing upon unprotected slope with various angle of 30°, 45° and 60°. The purpose of conducting this test was to find the critical angle due effect of precipitation. While phase two consists of testing upon protected slope with gabion wall followed JKR standard. Gabion wall was formed based on JKR specification gabion size which is 1m x 1m x1m. However, for laboratory model testing purposes, the size was down scaled to 1:20 (5cm x 5cm x 5cm). Proportion of gabion wall mixture had been set up with various proportion gravel and tire chips mixture of 0%, 20% and 50% by volume. Constant rain intensity of 13mm/hour (which classified as moderate rainfall intensity) based on Gombang's annually

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