CHARACTERIZATION OF SOIL MIXED WITH GARNET WASTE FOR ROAD SHOULDER

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DEDICATION

Dedicated to Allah S.W.T

My lovely husband Mohd Hazree Bin Hashim

My princess Hanania Nur Sophea

My prince Hadith Nur Ayden

Priceless and Speechless of the time gave to Mummy

Abah Mama & Ibu Ayah

Mior Sani Bin Mior Mohamad Yusof & Selamah Binti Mohamed

and Hashim Bin Haron & Aznah Binti Amin

Terima kasih atas pengorbanan kalian untuk anakmu ini

~~~~~Love you all~~~~~

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ABSTRACT

This paper presents the finding of the characterization of soil mixed with garnet waste for road shoulder. Road shoulder at local road nowadays has insufficient compaction due to local settlement and further compaction by parked vehicles. Garnet waste is one the industrial waste that getting bulkier and it is the idea to reduce and reuse the waste. The research aims to determine the materials properties for soil and garnet waste, to determine the moisture content of materials and degree of compaction and also to propose the maximum percentage of mix proportion under California Bearing Ratio (CBR) test for road shoulder. Material properties testing are sieve analysis, Atterberg limit and chemical composition. Compaction test in the mixed proportion of 100% soil, 100% garnet waste, 2S8G, 4S6G, 6S4G and 8S2G were got the Optimum Moisture Content (OMC) between 8-20% and Maximum Dry Density (MDD) between 1.74-2.56 Mg/m^3. From OMC desired, CBR test was conducted and the optimum value of 40% added percentage of garnet waste can be used as the mix proportion for road shoulder construction. The addition of garnet waste content tends to increase MDD and the fineness modulus also influence the degree of compaction. The results obtained that garnet waste has a good potential as road shoulder in the percentage of 40% and above for mixed proportion with soil. The regression value of R^2 was 0.86 and 0.96 for CBR and MDD, respectively derived to predict the real CBR and MDD during real road construction using the garnet waste content.

ABSTRAK

Kajian ini membentangkan keputusan mengenai ciri-ciri penstabilan tanah bersama campuran sisa garnet sebagai bahu jalan. Bahu jalan di jalan tempatan kini dilihat mempunyai keupayaan mampatan yang lemah akibat daripada pemendapan semasa dan pemendapan daripada kenderaan yang memakir di bahu jalan. Sisa garnet merupakan salah satu sisa industri yang semakin banyak lambakan dan tercetus idea untuk mengurangkan dan menggunakan semula sisa ini. Tujuan utama kajian ini adalah untuk mengenalpasti ciri-ciri tanah dan sisa garnet, untuk mengenalpasti kandungan lembapan dan darjah pemadatan bahan campuran sebagai bahu jalan dan juga untuk mengenalpasti kandungan maksimum bahan campuran terhadap ujian Nisbah Galas California (NGC). Ciri-ciri bahan kajian ditentukan menggunakan ujian ayakan, ujian had Atterberg dan ujian komposisi kimia. Ujian mampatan bagi bahan campuran terdiri daripada 100% tanah, 100% sisa garnet, 2S8G, 4S6G, 6S4G dan 8S2G dimana kandungan lembapan optimum adalah 8-20% dan ketumpatan kering maksimum antara 1.74-2.56 Mg/m^3. Daripada nilai kandungan lembapan optimum, ujian NGC dijalankan dan hasil dapatan menunjukkan 40% campuran peratusan sisa garnet adalah sesuai digunakan sebagai pembinaan bahu jalan. Pertambahan nilai peratusan sisa garnet menunjukkan peningkatan dalam ketumpatan kering maksimum dan nilai modulus kehalusan antara faktor yang mempengaruhi darjah pemadatan. Hasil kajian menunjukkan sisa garnet mempunyai potensi sebagai bahu jalan bermula percampuran dengan tanah dan 40% ke atas peratus sisa garnet. Nilai regresi, R^2 adalah 0.86 dan 0.96 untuk nisbah galas California dan ketumpatan kering maksimum, masing-masing diperolehi menjangkakan nilai sebenar NGC dan ketumpatan kering maksimum semasa pembinaan jalan menggunakan kandungan peratus sisa garnet.

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LIST OF ABBREVIATION

SYMBOLS		TITLE
BS	-	British Standard Institution
CBR	-	California Bearing Ratio
COA	-	Certificate of Analysis
COV	-	Coefficient of Variation
CWM	-	Centre Waste Managament
DBKL	-	Dewan Bandaraya Kuala Lumpur
FA	-	Fly Ash
JKA	-	Civil Engineering Department
LL	-	Liquid Limit
LLNL	-	Lawrence Livermore National Laboratory
MDD	-	Maximum Dry Density
MSDS	-	Materials Safety Data Sheet
OMC	-	Optimum Moisture Content
PI	-	Plasitcity Index
PL	-	Plastic Limit
POFA	-	Palm Oil Fuel Ash
POLISAS	-	Politeknik Sultan Haji Ahmad Shah
R^2	-	Regression
RAP	-	Reclaimed Asphat Pavement
RHA	-	Rice Husk Ash
SD	-	Standard Deviation
UCS	-	Unconfined Compressive Strength
UMP	-	Universiti Malaysia Pahang

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Road shoulder is the portion of the roadways continuous with the pavement way for accommodation of stopped vehicle, for emergency use and for lateral support of the pavement layer. There are two main functions of road shoulder, the first is to provide the emergency stopping free of the traffic lane and the second is to provide the escape potential accidents and ways to reduce their severity. All road shoulders should be sloped sufficiently to rapidly drain surface water but not the extent that vehicular use would hazardous. For road shoulder to function effectively, it must be sufficiently stable to support occasional vehicle loads in all kind of weather without rutting.

Arahan Teknik (Jalan) 8/86 required that paved shoulders of the same strength and standard as the pavement should be followed the road standards. From the observation of Kuantan area, type of soil for examples peat soil, humic clay and silt soil for road shoulder are not suitable because of their characteristics such as poor grading, low strength, high elasticity and tendency to shrink and swell. By stabilizing such soil with appropriate agents will improve the engineering properties.

1.2 Background of Study

The construction of a highway over this unstabilized soil will take a high cost of replacement with a stronger material such as crushed rock or adding the agents such as sand. This research added the garnet waste in the percentage of proportion mix in order to minimize the usage of those costly materials and also to stabilized the road shoulder along the local road which always occurs the settlement. According to State of California, 1990 in section landfill waste classification and waste definition, garnet waste which is the wastes largely non-biodegradable, non-flammable and not chemically reactive is classified as an inert waste type.

The aim of this study is to investigate the effects of garnet waste addition on some of the geotechnical and engineering properties such as sieve analysis, Atterberg limits, Modified Proctor compaction characteristic and bearing capacity of the soil sample taken. All waste materials used, none of the research had done the garnet waste yet. This research will be determined the percentage of mixed proportion suitable for soil to provide good stopping lane and maintained stabilize for road shoulder.

1.3 Problem of Statement

Nowadays, Public Work Department, Malaysia had been issuing news on the damaged happened on local roads especially road shoulder at the rural area. The reasons behind that can be observed by layers of strength and thickness, mixture design, change in traffic load, etc. (Behiry, 2013). In addition, disposal problems from industrial are increasing with vast quantity of the waste material made.

i. Problem 1

Road shoulders must function effectively and be sufficiently stable to support vehicle loads. However. road shoulders at local road nowadays are suffering from insufficient compaction due to local settlement and further compaction by parked vehicles. Thus, this research was conducted to identify soil properties of road shoulder in the local area.

ii. Problem 2

Sources of sand is limited nowadays so the cost are increased as well as the demand to search for a new materials as stabilizer for road shoulder. Therefore, garnet waste was introduced in this research to partially or fully mixed with soil as replacement of sand. Metalic Polymer Coating and Services Sdn Bhd is encouraging outsiders to use garnet waste because the waste is getting bulkier and there are no proper storage to keep it except to pay the Kualiti Alam for disposal. This type of disposal is expensive, thus the ideas to reuse, recycle and reduce the garnet waste without jeopardizing the environmental.

1.4 Aim and Objectives

The overall objective of this research is to determine the percentage content of garnet waste as an agent of stabilizer to be mixed with laterite soil in the road shoulder. The specific objectives of this research are:

i. To determine the properties of soil and garnet waste.

ii. To determine the optimum moisture content of the materials and degree of compaction for road shoulder.

iii. To propose the maximum percentage of mix proportion under California Bearing Ratio (CBR) test for road shoulder.

1.5 Scope of Study

This study limits the scopes to several parameters as shown in Table 1.1. Table 1.1 shows the scope of study was conducted in a local road where the shoulder is a soil which need to be stabilized.

Table 1.1 : Scope of study

Description	Limitation
Material for road shoulder	Soil and Garnet waste
Testing for materials	Soil: Sieve analysis and Atterberg limit Garnet waste: Sieve analysis and chemical composition
Method of drying	Oven dried at 100 ^{o}C ±5 ^{o}C/ Open dried
Compaction	Fully replacement/partial replacement of garnet waste
CBR	Fully replacement/partial replacement of garnet waste Normal condition

1.6 Significance of Study

This research focuses on stabilization of soil using garnet waste as the agent stabilizer for road shoulder. The study intends to change engineering properties of soil which cause poor compaction and poor value of soil strength so as to make it suitable to stabilize with mix proportion of garnet waste. This study focused on increasing CBR value and load bearing ability of the soil by adding percentage of mix proportion of garnet waste. However, this research covered more on laboratory test for sieve analysis, Atterberg limit, compaction and CBR test.

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