PARTIAL REPLACEMENT OF NORMAL SAND WITH GARNET WASTE FOR BEDDING SAND LAYER OF CONCRETE BLOCK PAVEMENT

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ABSTRACT

Highway construction use river sand as a part of the materials. Due to fast developments, normal sand demand is increase and over exploited in construction. The increase in rate leads to increase in demand for raw materials which in turn leads to price hike of raw materials. Therefore this research aims to investigate the suitability of garnet waste to replace sand partially or fully as bedding materials. The objectives of the research are to determine the California Bearing Ratio (CBR) value at various content of sand-garnet ratio to be applied as bedding sand layer of concrete block pavement (CBP). Samples are labelled as 10S, 9S1G, 8S2G, 7S3G, 6S4G and 10G to differentiate the garnet waste content. Sieve analysis was carried out accordance to BS 882. Optimum moisture content (OMC) of sample was determined using compaction proctor test that refers to BS1377-2. Then the OMC used to determine CBR value of samples that accordance to BS1377-4. Experimental sieve analysis, OMC at maximum dry density (MDD) and CBR value were analysed and compared to the requirements to be applied as bedding sand layer. CBR value of sample type 10S, 9S1G, 8S2G, 7S3G, 6S4G and 10G were calculated 24.85%, 38.92%, 41.26%, 49.5% 47.83% and 42.67% respectively. Sample type 7S3G showed the highest CBR value of samples. However, only sample type 9S1G and 8S2G meet the requirements as materials for bedding sand layer application. Even all samples achieve acceptable CBR value for fine grained soil, but only sample type 9S1G and 8S2G meet the requirements of BS882 grading curve for bedding sand layer materials. Therefore, this research proposes the usage of 20% garnet waste for bedding sand layer application.

ABSTRAK

Pembinaan lebuh raya menggunakan pasir sungai sebagai sebahagian daripada bahan-bahan. Perkembangan yang pesat menyebabkan, permintaan pasir meningkat dan dieksploitasi secara berlebihan. Peningkatan permintaan bermaksud permintaan untuk bahan-bahan mentah akan meningkat yang seterusnya membawa kepada kenaikan harga bahan mentah. Oleh itu kajian ini bertujuan untuk mengkaji kesesuaian garnet terbuang untuk menggantikan sebahagian atau sepenuhnya pasir sebagai bahan lapisan dasar turapan blok konkrit (CBP). Objektif kajian ini adalah untuk menentukan nilai Nisbah Galas California (CBR) pada kandungan pelbagai nisbah pasir garnet terbuang yang akan digunakan sebagai lapisan dasar CBP. Sampel dilabel sebagai 10S, 9S1G, 8S2G, 7S3G, 6S4G dan 10G untuk membezakan kandungan garnet. Analisis ayak telah dijalankan mengikut BS 882. kandungan lembapan optimum (OMC) sampel telah ditentukan dengan menggunakan ujian pemadatan proctor yang merujuk kepada BS1377-2. Kemudian OMC digunakan untuk menentukan nilai CBR sampel yang mengikut BS1377-4. Data eksperimen analisis ayakan, OMC pada kepadatan kering maksimum (MDD) dan nilai CBR telah dianalisis dan dibandingkan dengan syarat-syarat untuk digunakan sebagai bahan lapisan dasar CBP. Nilai CBR bagi jenis sampel 10S, 9S1G, 8S2G, 7S3G, 6S4G dan 10G masing-masing 24.85%, 38,92%, 41,26%, 49.5% 47.83% dan 42.67%. Sampel 7S3G menunjukkan nilai CBR tertinggi. Walau bagaimanapun, hanya sampel 9S1G dan 8S2G memenuhi keperluan sebagai bahan untuk lapisan dasar CBP. Walaupun semua sampel mencapai nilai CBR boleh diterima bagi tanah berbutir halus, namun hanya sampel 9S1G dan 8S2G memenuhi keperluan penggredan BS882 sebagai bahan lapisan dasar CBP. Oleh itu, kajian ini mencadangkan kadar 20% garnet terbuang digunakan untuk lapisan dasar turapan.

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LIST OF ABREVIATIONS

AASHTO	-	American Association of State Highway and Transportation Officials
ASTM	-	American Standard for Testing and Material
Ave.	-	Average
BS	-	British Standard
CBR	-	California Bearing Ratio
COV	-	Coefficient of Variant
Dia.	-	Diameter
JKR	-	Jabatan Kerja Raya
Max.	-	Maximum
Min.	-	Minimum
MDD	-	Maximum Dry Density
OMC	-	Optimum Moisture Content
PI	-	Plasticity Index
Std. Dev.	-	Standard Deviation
SPJ	-	Spesifikasi Pembinaan Jalan
USCS	-	Unified Soil Classification System

LIST OF SYMBOLS

%	-	Percent
γ	-	Moist Unit Weight
W_t	-	Weight of compacted sample in the mould
V_m	-	Volume of the mould ($1000cm^3$)
γ_d	-	Dry Unit Weight
$W_{\%}$	-	Percentage of moisture content
k	-	Fineness Modulus,

CHAPTER 1

INTRODUCTION

1.1 Introduction

Currently, river sand has been used as a material in highway construction. Due to rapid developments, river sand is over exploited in construction. Many researchers suggest to using alternatives materials replacing normal sand fully or partially in construction.

1.2 Background of Study

Nowadays, the use of normal sand for construction industry has increased rapidly due to increase in number of construction industries. The increase in rate leads to increase in demand for raw materials which in turn leads to price hike of raw materials. Also this demand may be due to scarcity in availability of raw materials mostly the river sand. This problem of importing river sand from other places at a higher price has brought the idea of using the locally available natural material in the

place of this river sand. So, by using the garnet waste for the road construction, much of the economy of construction could be saved. So, by using waste materials to replace sand will save our earth for a sustainable environment. It also helps to save much of our river sand from being deployed for construction. In this research garnet will replace sand partially or fully as bedding materials.

1.3 Problem of Statement

Nowadays developers have neglected the use of waste materials. Garnet is a waste materials exist in marine industry. Abrasive garnet used as a cleaning ships body. However, used garnet then become abundant without appropriate disposal.

Replacement of normal sand has been commercialized in building construction to reduce the construction cost. Numerous of study has been conducted to replace normal sand in construction. If garnet waste can replace sand in many applications it also can be more economical in highway construction. Furthermore, garnet waste is environmental friendly since it is a waste material in marine industry. Reducing sand demand is main idea of this study because over exploited of mining sand will harm our environment and the use waste materials will make our environment more sustainable. Besides, there are possibilities of cost increase in the future cause by limited sources and increasing demand. Therefore, a study about effect of garnet to replace sand partially in bedding sand layers for Concrete Block Pavement (CBP) must be conducted.

1.4 Aim and Objectives

The aim of this study is to investigate the suitability of garnet waste partially replacement of normal sand for bedding sand application in CBP.

The objectives of this study are

i. To determine the optimum moisture contents at maximum dry density of bedding sand layer mix with different sand-garnet ratio.

ii. To determine the California Bearing Ratio (CBR) values of bedding sand layer mix with different sand-garnet ratio.

iii. To propose the percentage of garnet waste as bedding sand layer for CBP.

1.5 Scope of Study

For this research, basically to study the effect of garnet as bedding sand layer using different percentage of garnet content. The garnet that is being used is actually from the waste materials that used to clean ships body at Kemaman Port, Terengganu. Garnet was added partially as the replacement to the sand act as a bedding layer for CBP. The percentage of garnet varies from 10% to 40%, with 10% increment and also 100% garnet. The size of the samples to be prepared is according to the standard size of bedding sand specified in JKR standards which passing 5mm sieve and well graded. The total number of samples to be prepared is 25 samples; 5 samples for each percentage of garnet content. Each samples of garnet content will

have different moisture content to determine its optimum moisture content at maximum dry density. Test is conducts using compaction and California Bearing Ratio (CBR) test. CBR test is required to determine CBR value at 95% of maximum dry density. The result is to be analyse and will come out with significant conclusion. The entire tests conducted are in accordance to the standard including the performance of the application for the bedding layers. Scope of study has been summarizing in Table 1.1 below.

Table 1.1: Scope of Study

Description	Limitation
Material for bedding materials	River Sand and Garnet
Garnet proportion	0%, 10%, 20%, 30 %, 40%, 100%
Preparation for Materials	Sieve analysis, moisture content, Dry Density
Method of drying	Oven dried at 100 ^{o}C ±5 ^{o}C/ Open dried
Compaction	100% sand, partial replacement, 100% Garnet
CBR	100% sand, partial replacement, 100% Garnet

1.6 Significance of Study

As used abrasives garnet is waste material, hopefully this study will contribute to the construction industry to realize the advantages of using Garnet as replacement material to river sand functions. In future, developers will likely to use these materials widely. Then, cost of construction assuming can be reduced and at the same time the construction industry can be more sustainable with less pollution to the environment.

1.7 Thesis Organization

This thesis divided into five chapters that are introduction, literature review, methodology, result and analysis and conclusions and recommendations. Brief of each chapter are explain below:

CHAPTER 1: This is introduction chapter that presents the background of the development of garnet as alternative material to replace fully or partially san function in construction industry. It consist the problem statement, objectives, and scope of study and the significance of study.

CHAPTER 2: This chapter will reviews the pavement especially concrete block pavement layers. The requirements of bedding sand layer and properties of garnet also reviewed in this chapter.

CHAPTER 3: This chapter discusses laboratory methodology used in this research. It consist standard procedure and equipment in conducting necessary testing to obtain data.

CHAPTER 4: This chapter discusses the result analysis from the test data. The results were analysed and presented in this chapter.

CHAPTER 5: This chapter answered the research objectives as conclusions. It also consist recommendations for further research.

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