KUANTAN CLAY SUBGRADE STABILIZATION BY USING CARPET FIBERS AS STABILIZER.

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ABSTRACT

The use of carpet fiber as stabilizer for soil stabilization is attractive approach with such low cost material and reduced needs for landfilling. The main objective of the study is the utilization of carpet fibers to improve soil subgrade for highway construction. The research conducts various contents of carpet fibres to clay soils from Kampung Ubai, Kuantan-Pekan. The compaction tests and California Bearing Ratio (CBR) tests we applied in soil samples to estimate the optimum mixture design. The samples were set up by mixing soil samples with various content of carpet fibers at different water content in compaction test to obtain optimum dry unit weight and optimum water contents. The optimum water contents were used in CBR test s of mixtures of soil samples-carpet fibers. The accomplishment of subgrade stabilization depends on the engineering properties of soils and the content of carpet fibers. The performance analysis of carpet fiber should be based on the laboratory tests such as engineering properties of soil and CBR tests of specified site in Kuantan. The strength gain in stabilization mainly depends on two factors: carpet fiber content and molding water content. The optimum carpet fibers that give the optimum strength is 9%. The variation content of carpet fibers were 3%, 6% and 9% by total weight.

ABSTRAK

Penggunaan fiber karpet sebagai penstabil bagi menstabilkan tanah adalah satu pendekatan yang menarik kerana melibatkan kos yang rendah dan mengurangkan bahan buangan di tempat pembuangan sampah. Objektif utama kajian ini adalah penggunaan fiber karpet sebagai penstabil subgred bagi pembinaan jalan raya. Penyelidik menjalankan penyelidikan terhadap tanah liat dari Kampung Ubai, Kuantan-Pekan dengan mencampurkan kandungan fiber karpet yang berbeza pada tanah bagi menstabilkan tanah liat tersebut sebagai subgred. Ujian Pemadatan dan ujian CBR diaplikasikan untuk menyelidik sampel tanah bagi menganggarkan kandungan fiber karpet yang paling optimum bagi reka bentuk subgred. Sampel tanah telah dicampurkan dengan kandungan fiber karpet yang berbeza pada kandungan kelembapan yang berbeza untuk ujian pemadatan bagi mendapatkan kandungan kelembapan yang optimum serta unit berat kering tanah yang optimum. Kemudian, kandungan kelembapan yang optimum digunakan dalam ujian CBR bagi tanah yang telah dicampurkan dengan fiber karpet atau distabilkan. Pencapaian penstabilan subgred brgantung pada sifat-sifat kejuruteraan tanah dan kandungan fiber karpet yang digunakan untuk menstabilkan tanah. Analisis terhadap prestasi fiber karpet terhadap tanah yang telah dispecifikkan di Kuantan seperti sifat kejuruteraan tanah dan ujian CBR mestilah berdasarkan ujian makmal. Peningkatan kekuatan tanah yang distabilkan bergantung kepada dua faktor iaitu kandungan fiber karpet dan kandungan air yang digunakan untuk penstabilan. Kandungan fiber karpet yang memberi kekuatan yang paling optimum adalah 9%. Kandungan berbeza fiber karpet yang digunakan adalah 3%, 6% dan 9% dari jumlah berat tanah.

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LIST OF SYMBOLS

mg	Milligram
%	Percentage
mm	Milimeter
Kg/m^3	Kilogram per meter cube
µm	Micro meter
kg	Kilogram
in	inches
Kpa	Kilo Pascal
kN/m^3	Kilo Newton per meter cube
°C	Degree Celcius

LIST OF ABBRIVIATIONS

CBR	California Bearing Ratio
AASHTO	American Association of State Highway and Transportation Officials
PL	Plastic Limit
LL	Liquid Limit
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
JKR	Jabatan Kerja Raya
UMP	Universiti Malaysia Pahang
CIDB	Construction Industrial Development Board

CHAPTER 1

INTRODUCTION

1.1 Research background

The growth of the population has created a need for better and economical vehicular operation which requires good highway having proper geometric design, pavement condition and maintenance. The highways have to be maintained so that comfort, convenience and safety are provided to the travelling public. As commonly known, construction of roadways over soft subgrade is one of the most frequent problems for highway construction in many parts of the world. These problems are also frequently encountered.

The usual approach to soft subgrades stabilization is removes the soft soil, and replaces it with stronger materials likes crushed rock. The high cost of replacement caused highway contractors to assess alternative methods of highway construction on soft subgrades. One approach is to use recycling material to stabilize the soft sub grade. Instead of using recycling material such is one of the residues that offer more economical alternatives for a wide range of soil stabilization application. A sustainable highway have to implement: planned or replaced, financed, designed, constructed, inspected, operated and maintained in a way that provides sustainable

benefits related to Environmental, and Economic. Innovative highway industry uses for recycling materials and by products as stabilizer in subgrade stabilization, rather than on more commonly followed practices were discussed in this paper.

Recycling material used as stabilizer for clay from Kuantan, Malaysia. Engineering properties, strength and CBR values improvement for soil stabilized were investigated. This method needs to review carefully before being applied in this problem.

1.2 Problem statement

A soft subgrade in construction of roadways is one of the most frequent problems for highway construction in many part of the world. These problems also occur at the proposed place to investigate, Kuantan-Pekan region. There is clay subgrade. The usual approach when soft subgrade soil encountered is removes the soft soil and replaces it with stronger materials likes crushed rock. The high cost of replacement causes highway contractors to explore alternatives methods of highway construction on soft subgrade. The engineering properties of some Kuantan Clay soils were high plasticity material, classified as A-7-6 AASHTO Classification System.

In this research the approach to make soil improvement is by using recycling material such as carpet fibers as stabilizer. Instead of using carpet fiber may offer more economical alternatives for a wide range application of soil stabilization. Soil stabilization using recycle material besides to improve the engineering characteristic also performance of a soil and preservation with goal of eliminating the environmental concerns is a serious matter (Tuncer B. Edil et al, 2007) .

This research demonstrates the results of laboratory investigation on carpet fiber-soil mixture for stabilization which is want to ensure the improvement in strength of Kuantan clay subgrade.

1.3 Objectives of the research

i. To investigate the engineering properties of Kuantan soil.
ii. To demonstrate the stabilized of Kuantan Clay by using carpet fibers.
iii. To determine the optimum content of stabilizer those give the maximum strength.

1.4 Scope of research

Scopes of this research include the following procedures:

i. Collect soil sample from some part of Kuantan city and stabilizer material from some part of Malaysia.
ii. Engineering properties and strength test for original soil sample and stabilizer material.
iii. Design for stabilized soil and test the strength.
iv. Test result data coding and analyze follow the AASTHO and or Malaysian specification and support by computer and software.
v. Produce the report.

1.5 Expected result

i. Utilization of engineering properties of Kuantan Clay and stabilized of Kuantan Clay by using carpet fibers.

ii. Basic engineering data for developing reseacrh in ground stabilization.

iii. Optimum content of stabilizers for subgrade stabilization.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Soil is the basic construction material. It supports the substructure of any structure and it is the subgrade which supports the subbase/base in the pavement. The existing soil at a particular location may not be suitable for the construction due to poor bearing capacity and higher compressibility or even sometimes excessive swelling in case of expansive soils.

Soil stabilization has been widely recommended for developing countries for the construction of various elements of the pavements. The reasons usually put forward are that the use of locally available materials will lead to lower costs. An understanding of local conditions is of paramount importance while developing any soil stabilizing technique for a given country. Climatic conditions can affect the behaviour of stabilized soil materials as well as construction procedures. By using the recycling material as stabilizer of soil, it is can reduces the cost and improve the soil strength (A.K. Choudhary, J.N. Jha and K.S. Gill).

The Engineering properties and strength properties of Kuantan clay and Kuantan clay stabilized with stabilizer have to utilize to improve the road structure quality, decrease thickness and decrease cost of construction in Kuantan state significantly. One of the solutions is to improve the characteristics at site and make soil capable of carrying load and to increase the shear strength decrease the compressibility of the soil. Soil Stabilization was one of the well-known methods in ground improvement.

Clay soil can be stabilized by addition small percentage of stabilizer such bottom ash,fly ash and other chemical agent. The objective of the soil stabilization is improving engineering properties quality and in increases the soil strength (Fauzi. Achmad, 2011).

The engineering properties quality improvement and increase of strength reported by many researchers. The addition of lime in certain percentage increased in optimum water content and decreases their maximum dry density, as well as enhanced California Bearing Ratio (CBR) (F.G. Bell 1996). Lime stabilization of Kuantan Clay creates a number of important engineering properties in soils such as improved workability, providing a working platform for subsequent construction, reducing plasticity to meet specifications, conditioning the soil for further treatment but until decreased CBR when content of lime more than 4 percentage. (Fauzi. Achmad, 2011).

In the investigation done by S A Naeini and S M Sadjadi,(2008) ,the waste polymer materials has been chosen as the reinforcement material and it was randomly included in to the clayey soils with different plasticity indexes at five different percentages of fiber content (0%, 1%,2%, 3%, 4%) by weight of raw soil. CBR tests are conducted by Behzad Kalantari, Bujang B.K. Huat and Arun Prasad, (2010) and their experimental findings are analysed with the point of view of use of waste plastic fibers in soil reinforcement.

The Engineering properties and strength properties of Kuantan clay and Kuantan clay stabilized with stabilizer have to utilized to improve the road structure quality, decrease thickness and decrease cost of construction in Kuantan state significantly (Fauzi. Achmad, 2011).

The use of waste byproducts in lieu of virgin materials for instance, would relieve some of the burden associated with disposal and may provide an inexpensive and advantageous construction product. Current research on the beneficial use of waste byproducts as highway construction materials has identified several promising uses for these materials (Robin L. Schroeder, 2010).

2.2 Clay

Clay minerals are typically formed over long periods of time by the gradual chemical weathering of rocks (usually silicate-bearing) by low concentration of carbonic acid and other diluted solvent. Soft Clay has particle sizes less than about 0.002mm or easily break down to this sixe (Liu & Evett,2005). According to Brand & Brenner (1981), soft clay is defined as clay with shear strength less than 25kPa. The strength of clay is low by comparing with other type of soils.

2.3 Stabilization

Stabilization of soil is the process of blending and mixing materials with a soil to improve certain properties of the soil. The process may include the blending of soils to achieve a desired gradation or the mixing of commercially available

additives that mayalter the gradation, texture or plasticity, or act as a binder for cementation of the soil. (Gordon R. Sullivan, 1994)

2.4 Carpet fibers

The carpet waste generated each year and accumulated in landfills represents an abundance of useful resources, as it may be converted into various useful products. The amount of carpet waste, including production waste and postconsumer carpet, is estimated at over 2 million tons per year. Because of the high cost of developing and managing landfills, waste disposal in landfills has become increasingly difficult.

A carpet typically consists of two layers of backing (usually fabrics from polypropylene tape yarns), joined by CaC03-filled styrene-butadiene latex rubber (SBR), and face fibers (majority being nylon 6 and nylon 66 textured yarns) tufted into the primary backing. The SBR adhesive is a thermoset rnaterial, which cannot be remelted or reshaped. Some waste is generated before the application of SBR. Such waste is termed so waste, and most of it is reused as a filling material or as nonwoven mats. The waste containing the SBR (termed *hard waste)* has not found significant uses and it forms the major part of the waste going into the landfills.

The use of carpet waste for soil reinforcement was shown to increase the triaxial compressive strength and residual strength of soil. Field trials showed that shredded carpet waste fibers (to 70 mm long) can be blended into soil with conventional equipment, and they confirmed other advantages such as improved durability for certain types of soil. Studies are still underway to achieve a better understanding of the reinforcement mechanisms.(Youjiang Wang).

Major physical behavior of the used fibers in carpets, that is to say, nylon and polypropylene are summarized in Table 2.1.

Table 2.1: Waste carpet fibers properties (Vilkner *et al.*,2010)

Property Unit Weight (gr/cm3)	Nylon 1.13-1.15	Polypropylene 0.9-0.91
Reaction with water	Suck up water	Hydrophobic
Tensile strength (kg/cm2)	83-100	35-46
Extension at break (%)	15-300	100-600
Fusing point (°C)	265	175
Thermal conductivity (w/M/k)	0.24	0.12

Table2.2: The effect of fiber content on MDD and OMC (Ramesh *et al.*, 2010)

Fiber Content (%)	Fiber length (mm)	Optimum Moister Content (%)	Maximum Dry Density (Kg/m3)
1.0	40	32	1430
	60	30.5	1425
	80	32	1360
	100	35.5	1360
1.5	40	31.5	1360
	60	36.5	1425
	80	36.5	1440
	100	37	1370
2.0	40	34	1420
	60	32	1380
	80	32.5	1360
	100	37	1360
2.5	40	35	1330
	60	31.5	1340
	80	35	1340
	100	36	1340

Increasing of fiber has some effect on increasing the Unconfined Compressive Strength (UCS) of Soil. Some quantities of fibers with 1.0, 1.5, 2.0 and 2.5 percents are mixed with soil, and then their UCS has been tested. These materials are been used in embankments along the road and reliability .The UCS of soil without adding fiber is equal to 90 kg, but by adding 1% of fiber to soil, its UCS grows up to 120 kg. To determine what length of fiber is suitable, diagram of strength of soil containing fiber against fiber length is drawn and shown in Figire 2.1. It's noted that by having 1.5% of fiber, its best lengths is 40 mm. Figure 2.1 shows the effect of performed tests on different contain of fiber on soil. When the content of

fibers in soil increase, the soil strength increase too, and when the content of waste carpet fibers of soil is 2.0 %, the soil strength increase up to 200 %.

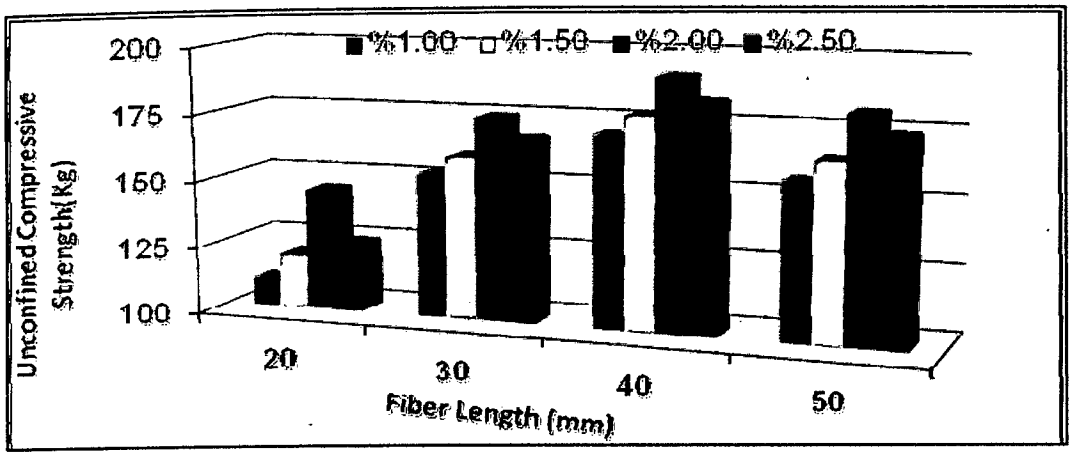

Figure 2.1: The effect of fiber length and fiber content on soil strength

The use of fiber in subgrade materials leads to increase in soil Unconfined Compressive Strength and consequently its modulus of elasticity increase, so, the pavement performance will improve.

2.5 California Bearing Ratio (CBR) Test

The main application of California Bearing Ratio (CBR) is to evaluate the stiffness modulus and shear strength of subgrade. Generally, the subgrade soil cannot bear the construction and commercial traffic without any distress, therefore; a layer of rigid or flexible pavement is required to be laid on top of the subgrade to carry the traffic load. The determination of the thickness of the pavement layer is governed by the strength of subgrade, thus the information on the stiffness modulus and shear strength of subgrade are required before any pavement design is carried out (Mak Wai Kin, 2002).

CHAPTER 3

METHODOLOGY

3.1 This research is qualitative research and does by experiment in laboratory. The method of research:

- Desk study: gather information, collect secondary data, gather paper and journal with relation to this research, clay subgrade stabilization by using carpet fibers as stabilizer and review those information and data.
- Writing research proposal: write research proposal as require by UMP Authority
- Soil and material sampling: collect soil sample from some part of Kuantan-Pekan road in Kampung Ubai, Figure 3.1 and stabilizer material (carpet fibers) from some part of Kuantan, Malaysia. The carpet will choose randomly and cut in small size. Then separate the carpet fibers. The carpet fibers are shown in Figure 3.2.
- Soil and material testing: Engineering properties and strength test for original soil sample.
- Soil stabilization design and testing: design for stabilized soil and test the engineering properties and strength.

- Coding and analyze data: test result data coding and analyze follow the AASTHO and or Malaysian specification and support by computer and soft ware
- Discussion: for the result validity, I have to discuss with the supervisor and other specialist person .Writing Report: produce the report is the aim of the research. Report writing follows the UMP format or International standard format for writing report or journal or paper.
- Close by report submission as shown on flowchart below.

Figure 3.1: Clay Soil

Figure 3.2: Carpet Fiber

3.2 Chart flow