KUANTAN CLAY SUBGRADE [illegible] USING OIL PALM EMTY FRUIT BRUNCHES (OPEFB) ASH MIXED WITH PORTLAND CEMENT AS STABILIZER.

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ABSTRACT

Stabilization is the process of blending and mixing materials with a soil to improve certain properties of the soil. This research is to study the relationship of Oil Palm Empty Fruit Brunches (OPEFB) ash mixed with Portland cements. The mixed additives between OPEFB ash and Portland cement according to ratio 2:1 (3, 6 and 9 percent of OPEFB ash and mixed with 1.5, 3 and 4.5 percent Portland cement) for every of soil sample preparation. Clay soils are taken from Kuantan area (coordinate N 03'36.604' E 103' 19.322'). This thesis covered the engineering properties of soil sample such as sieve analysis, specific gravity, moisture content, Atterberg limit and standard proctor test. Meanwhile, for strength of soil it was covered by the California Bearing Ratio (CBR) test. The Kuantan clay soils can be classified as a kind of soils are highly compressible and have low strength. Maximum moisture content found in every percent of soil in Proctor test had used to prepare for California Bearing Ratio (CBR) test. The laboratory result show that the strength gain in stabilization mainly depends on two additives content and molding water content.

ABSTRAK

Penstabilan tanah merupakan satu proses dimana campuran antara beberapa bahan hasilan produk dengan tanah untuk meningkat serta menguatkan keupayaan tanah. Di dalam kajian ini akan menentukan hubungan antara debu hangus hasilan daripada tandan kosong kelapa sawit dicampur dengan simen. Nisbah penyediaan antara kedua-dua bahan ini ialah 2:1 (3, 6 dan 9 peratus debu hangus hasilan daripada tandan kosong kelapa sawit dan dicampur dengan 1.5, 3 dan 4.5 peratus simen) untuk setiap satu sampel. Tanah liat yang digunakan ini diperolehi dari kawasan sekitar Kuantan (koordinat N03'36.604' E 103'19.322'). Kajian ini merangkumi cara untuk mengetahui keadaan jenis tanah seperti *Seive analysis, specific gravity, moisture content, plastic and liquid limit* dan *Standard proctor test.* manakala pula, untuk mengetahui kekuatan tanah, eksperiment seperti *California Bearing Ratio (CBR)* test akan digunakan. Tanah liat kuantan dapat dikelaskan sebagai tanah yang mudah untuk dimampatkan dan mempunyai kekuatan yang agak lemah. Kandungan air yang tinggi diperolehi daripadan eksperiment *Proctor test* digunakan untuk penyediaan kajian California Bearing Ratio (CBR) test. Keputusan makmal menunjukan bahawa kekuatan tanah meningkat apabila dikaitkan dengan tambahan bahan dan juga kandungan air.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

SYMBOLS	
OPEFB	Oil Palm Empty Fruit Brunches
ASTM	American Standard Testing Method
LL	Liquid limit
PL	Plastic Limit
PI	Plastic Index
Gs	Specific Gravity
M_0	weight of sample of oven-dry soil in gram
M_A	weight of density bottle filled with water
M_B	weight of density bottle filled with water and soil.
CBR	California Bearing Ratio

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Kuantan is a state capital of Pahang. There still have a lot projects need to be built here in the future. Thus, it very important to know the condition of clay to avoid any problems encountered during the construction phase. Clay with low shear strength can be strengthened economically for building or road purposes through the process of soil stabilization using the by-product material such as Oil Palm Empty Fruit Bunch (OPEFB) ash [1]. Soils can be stabilized by mixing the correct proportion of additives. Oil palm empty fruit brunch (OPEFB) is one of the lignocellulose materials, which has great relevance to Malaysia, as a large quantity of the biomass is generated by oil palm industries [4]. The fresh oil palm fruit bunch contains about 21% palm oil, 6-7% palm kernel, 14-15% fibre, 6-7% shell and 23% empty fruit bunch [5]. The incorporation of empty fruit bunch (EFB) into polymers to obtain cost reduction has been reported by various workers [6].

In the other hands, to make sure the strength of clay strong enough to support the loads, there will be other additive is added such as Portland cement. Meanwhile, scientific techniques of soil stabilization have been introduced in recent year and use Portland cement as stabilizer is quite common. [7]. Pozzolanic stabilizers can bind soil particles together and reduce water absorbtion by clay paritcles. The potential for using indusrial by-products for stabilization of clayey soils is promising and has been investigated [8].

1.2 PROBLEMS STATEMENT

Clay exhibit generally undesirable engineering properties. They tend to have low shear strengths and to lose shear strength further upon wetting or other physical disturbances [9]. They can be plastic and compressible and they expand when wetted and shrink when dried. Cohesive soils can creep over time under constant load, especially when the shear stress is approaching its shear strength, making them prone to sliding. They develop large lateral pressures. For this reasons, clays are generally poor materials for foundations.

Besides, the annual cost of damage done to non-military engineering structures constructed on expansive soils is estimated at $220 million in the United Kingdom and many billions of dollars worldwide[10]. This was due to the unstable strength of the soil.

1.3 OBJECTIVES

i) To identify the engineering properties of Kuantan clay subgrade.

ii) To determine the optimum content of stabilizer those give the maximum strength.

iii) To demonstrate the stabilized of Kuantan Clay by using oil palm empty fruit brunch ash and Portland cement

1.4 SCOPE OF STUDY

Clay subgrade used in the research randomly collects from Kuantan area. Materials used in the research are Oil Palm Empty Fruit Brunches (OPEFB) ash and Portland cement. The grading size of coarse aggregate is 20mm whereas for the fine aggregate the grading size is below 5mm.The testing involves specific gravity, moisture content, water absorption, deleterious material, sieve analysis, chemical composition, aggregate crushing value, ten percent fines value, and impact value. The testing involves in the engineering properties and strength such as Sieve Analysis, water content, Atterberg Limit, Shrinkage Limit, Specific Gravity and California Bearing Ratio (CBR), , Compaction Proctor tests based on BS 1377-4 1990 [11].Stabilized soil specimens will prepares at 3, 6, 9% OPEFB ash content (on dry weight basis of clay soil). For every specimen, there will be 3 different tests conducted (mixed with Portland and OPEFB ash only).

1.5 EXPECTED RESULT

After done with this research, hopefully I can improve the fact that relate with the properties of Kuantan clay subgrade. Furthermore, I hope can get the optimum additive value for Kuantan clay subgrade with different type of additives. Last but not least, hopefully this research can increase the strength of Kuantan clay subgrade.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

According to the online dictionary subgrade refers to the prepared earth surface on which a pavement or the ballast of railroad track is placed or upon which the foundation of a structure is built. Meanwhile, stabilization, refer to the act process of stabilizing or the state of being stabilized. Thus, it can be emphasized here that subgrade stabilization (formation level) very important to avoid any failure base on our project after everything had been done. Commonly, soil stabilization can be divided into two type's mechanical and additive stabilization.

2.1 Mechanical Stabilization

Mechanical soil stabilization refers to either compaction or the introduction of fibrous and other non-biodegradable reinforcement to the soil. This practice does not require chemical change of the soil, although it is common to ues both mechanical and chemical means to achieve specified stabilization. There are several methods used to achieve mechanical stabilization:

2.1.1 Compaction

Compaction typically employs a heavy weight to increase soil density by applying pressure from above. Machines are often used for this purpose; large soil compactors with vibrating steel drums efficiently apply pressure to the soil, increasing its density to meet engineering requirements. Operators of the machines must be careful not to over-compact the soil, for too much pressure can result in crushed aggregates that lose their engineering properties.

Figure 2.1: Crawlers Dynamic Compaction Machine

2.1.2 Vibroflotation

Vibroflotation involves the use of vibrating probe that can penetrate granular soil to depths of over 100 feet [24]. The vibrations of the probe cause the grain structure to collapse thereby densifying the soil surrounding the probe and Figure 2.1 is shown the vibroflotation. To treat an area of potentially liquefiable soil, the vibroflot is raised and lowered in a grid pattern. Vibro replacement is a combination of vibroflotation with a gravel backfill resulting in stone columns, which not only increases the amount of densification, but provided a degree of reinforcement and a potentially effective means of drainage. The vibroflotation process consists of flotation of the soil particles as result of vibration which then allows for rearrangement of particles into denser state.

Figure 2.2 Vibro-compaction

2.1.3 Soil Reinforcement

Soil problem are sometimes remedied by utilizing engineered or non-engineered mechanical solutions. Geo-textiles and engineered plastic mesh are designed to trap soils and help control erosion, moisture conditions and soil permeability. Larger aggregates, such as gravel, stones and boulders are often employed where additional mass and rigidity can prevent unwanted soil migration or improve load-bearing properties.

2.2 Additive Stabilization

A common method of improving the engineering characteristics of a soil is to add certain aggregates that lend desirable attributes to the soil, such as increased strength or decreased plasticity. This method provides material economy, improves support capabilities of the subgrade, and furnishes a working platform for the remaining structure. Additive stabilization is achieved by the addition of proper percentages of Portland cement, oil palm empty fruit brunches (OPEFB) ash. The selection of type and determination of the percentage of additive to be used is dependent upon the soil classification and the degree of improvement in soil quality desired. Smaller amounts of additives are required when it is simply to modify soil properties such as gradation, workability and plasticity. Larger quantities of additive are used when it is to improve the strength and durability significantly. After the additive has been mixed with the soil, spreading and compaction are achieved by conventional means [15].

2.2.1 Oil Palm Empty Fruit Brunches (OPEFB) ash.

Oil palm is the highest yielding edible oil crop in the world. It is cultivated in 42 countries in 11 million ha worldwide [12] West Africa, South east Asian countries like Malaysia and Indonesia, Latin American countries and India are the major oil palm cultivating countries [13]. 1 ha oil palm plantation annually produces about 55 ton of dry matter in the form of fibrous biomass while yielding 5.5 ton of oil [14]. Thus, there is no such a problem to find the main source materials for this research.

Soil stabilization by using by-product method provides material economy, improves support capabilities of the subgrade, and furnishes a working platform for the remaining structure. Additive stabilization is achieved by the addition of proper percentages of Portland cement, lime, oil palm empty fruit brunches (OPEFB). The selection of type and determination of the percentage of additive to be used is dependent upon the soil classification and the degree of improvement in soil quality desired. Smaller amounts of additives are required when it is simply to modify soil properties such as gradation, workability and plasticity. Larger quantities of additive are used when it is to improve the strength and durability significantly. After the additive has been mixed with the soil, spreading and compaction are achieved by conventional means. [15]

Many researchers have studied the use of agro-waste ashes as constituents in soil. Their results have revealed that these agro-waste ashes contain high amount of silica in amorphous form and could be used as a pozzolanic material [26]. Utilization of Oil Palm Empty Fruit Brunches (OPEFB) is minimal and unmanageable. To solve the energy problems, solid wastes from palm oil residue are used as fuel to produce steam for electricity generation. After burning, an ash by-product is produced. As a solution to the disposal problem of the ash derived from palm oil, research studies have been carried out to examine the feasibility of using the ash as additive material. [27].

2.2.2 Portland cement stabilization

Another additive that will be experiment in this research is Portland cement. According to the PCA (Portland Cement Association), CTB (Cement-Treated Base) has provided economical, long-lasting pavement foundations for over seventy years. These structures have combined soil and aggregate with cement and water which is then compacted to high density. The advantages of cement stabilization are several:

1) Cement stabilization increases base material strength and stiffness, which reduce deflections due to traffic loads. This delays surface distress such as fatigue cracking and extends pavement structure life.

2) Cement stabilization provided uniform, strong support, which results in reduced stresses to the sub-grade. Testing indicates a thinner cement-stabilized layer can reduce stresses more effectively than a thicker un-stabilized layer of aggregate. This reduces sub-grade failure, pothole formation and rough pavement surfaces.

3) Cement stabilized bases have greater moisture resistance to keep water out; this maintains higher strength for the structure.

4) Cement stabilization reduces the potential for pumping of subgrade fines.

5) Cement stabilized base spreads loads and reduces sub-grade stress.

According to the Portland Cement Association, Cement Modified Soil is a soil material that has been treated with a relatively low proportion of Portland cement. In general, the volume of cement is less than required for soil cement. The objective Cement modified soil is to mitigatethe undesirable properties of materials that are sub-standard in quality or engineering value so that they can be made suitable for construction. The amount of improvement that can be expected is dependent upon the quantity and quality of cement used as well as the type of soil being treated. The engineering properties that can be improved include the following:

1) The soil's Plasticity Index can be reduced.

2) . The soil's CBR (California Bearing Ratio) can be increased.

3) Material shearing strength can be increased.

4) Shrinkage or swelling characteristics for the soil can be decreased.

5) The amount of fine-grained material particles (silt and clay) can be reduced.

Cement-stabilized soils have been widely used as base, sub base and/or subgrade materials in pavement structure applications due to the effectiveness in improving their engineering properties as construction materials. Soil cement especially has been used as a \beneficial substitute for conventional base materials. The use of soil cement base/subbase can prevent pumping of fine subgrade soils under saturation and heavy traffic load and can provide a strong support for asphalt or concrete pavement structures [17].

With cement stabilization, the cement already contains the silica without needing to break down the clay mineral. Thus, cement stabilization is fairly independent of the soil properties; the only requirement is that the soil contains some water for the hydration process to begin. Carbonation can also occur when using cement stabilization. When cement is exposed to air, the cement will react with carbon dioxide from the atmosphere to produce a relatively insoluble calcium carbonate. Thus, proper handling methods and expedited construction procedures should be employed to avoid premature carbonation of cement through exposure to air.

[18,19,20] reported that the behavior of the cement-clay with lower cement content is similar to an over consolidated soil, and the cement clay with higher cement content behaves like a soft rock.

2.3 Current condition of Kuantan clay soils.

Most of clay sample were high plasticity. These soils cannot be used as embankment material or have to avoid. If the used of soils cannot reasonably avoided, such material shall be used only on bottom portion of embankment. The engineering properties of these soils could be improved by stabilizer. [25]

The chemical element of kuantan clay soil tested by integrated electron microscope and engery dispersive x-ray spectroscopy (SEM-EDS) was given in table