CEMENT-PAL ... BILIZER

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ABSTRACT

A wide range of reinforcements have been used to improve soil performance to increase the soil strength. Soil stabilization can help in enhancing the soil by improving the soil properties. This research was carried out in order to determine the effectiveness of cement-palm oil fiber (POF) as the soil stabilization. The soil sample was taken at Pekan and the palm oil fiber was taken from a factory located in Lepar Hilir, Gambang, Pahang. The objective of this was to propose the optimum percentage of palm oil fiber to increase the soil engineering characteristics. The tests involved are sieve analysis, Atterberg limit test, standard proctor test, falling head test and unconfined compression test. From the sieve analysis test it is shown that the clay consisted of 24% clay and 76% silt which indicates the soft soil as a silty clay. From the obtained results in Atterberg limit test it is shown that with the presence of 25% palm oil fiber and 5% cement in the mixture it reduced the plasticity index value to 9.67%. Standard proctor test shows the highest value of 21.57kN/m^3 with the mixture of 15% fiber and 85% soft soil. While for the falling head test shows the lowest value for coefficient of permeability which is 5.08 x10^{-7}m/s for the mixture of 75% soft soil, 20% fiber and 5% cement. From the obtained result in unconfined compression test, the mixture of 75% soft soil, 20% fiber and 5% cement brings the highest value of unconfined compressive strength which is 140.67kPa. In overall, it is concluded that the effectiveness of POF can helps the soft soil in enhancing its soil properties and the objectives of this research was achieved.

ABSTRAK

Pelbagai tetulang telah digunakan untuk meningkatkan prestasi tanah dalam menambahkan kekuatan tanah. Penstabilan tanah boleh membantu dalam meningkatkan sifat-sifat tanah dan juga prestasi tanah. Kajian ini telah dijalankan untuk menentukan keberkesanan simen gentian minyak sawit (POF) sebagai penstabilan tanah. Sampel tanah telah diambil di Pekan dan serat kelapa sawit telah diambil dari sebuah kilang yang terletak di Lepar Hilir, Gambang, Pahang. Objektif projek ini adalah untuk mendapatkan peratusan optimum serat kelapa sawit dalam meningkatkan ciri-ciri kejuruteraan tanah. Ujian-ujian yang terlibat adalah ujian analisis ayakan, ujian had Atterberg, ujian Proctor Piawai, ujian meter telap turus menurun dan ujian mampatan tak terkurung. Dari ujian analisis ayakan ia menunjukkan bahawa kandungan sampel tanah liat yang diambil terdiri daripada 24% tanah liat dan 76% kelodak dan ianya diklasifikasikan sebagai tanah liat berkelodak. Daripada keputusan yang diperolehi dalam ujian had Atterberg ditunjukkan bahawa dengan kehadiran 25% serat kelapa sawit dan 55 simen di dalam campuran ia dapat mengurangkan nilai indeks keplastikan kepada 9.67%. Ujian Proctor Piawai menunjukkan nilai tertinggi 21.57kN/m^3 dengan campuran 15% serat dan 5% simen. Manakala bagi ujian meter telap turus menurun menunjukkan nilai terendah bagi pekali kebolehtelapan yang ialah 5.08 x10^{-7} m/s bagi campuran 75% tanah lembut, 20% gentian dan 5% simen. Daripada hasil keputusan yang diperolehi dalam ujian mampatan tak terkurung, campuran 75% tanah lembut, 20% gentian dan 5% simen memberi nilai tertinggi yang mepunyai kekuatan mampatan yang 140.67kPa. Pada keseluruhannya, ini dapat disimpulkan bahawa keberkesanan POF telah dapat membantu tanah lembut dalam meningkatkan sifat-sifat tanah dan objektif kajian ini telah dicapai.

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LIST OF ABBREVIATIONS

POF	-	Palm Oil Fiber
LL	-	Liquid Limit
PL	-	Plastic Limit
PI	-	Plastic Index
(S+F)	-	Mixture of soil and fiber
(S+F+C)	-	Mixture of soil, fiber and cement
(S+F)	-	Mixture of soil and fiber
(S)	-	Mixture of soil
EFB	-	Empty Fruit Bunch
(R&D)	-	Research & Development

LIST OF SYMBOLS

P_d	-	Dry Density Unit Weight
k	-	Coefficient of Permeability
%	-	Percentage
g	-	gram
cm	-	centimeter
ε	-	Strain
q_u	-	Unconfined Compressive Strength
A	-	Cross sectional area
H	-	Deformation
P	-	Wet Density
W	-	Moisture content
M	-	Mass of soil
V	-	Volume ($1000cm^3$)
t_1	-	Initial time for discharge in seconds
t_2	-	Final time for discharge in seconds
h_1	-	Initial height of water level in the pipe in cm
h_2	-	Final height of water level in the pipe in cm
L	-	Length of specimen in cm

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Malaysia has become one of the developed countries in this region. The developments and technologies have helped our country in order to achieve the goal for Malaysia to stand up together with other countries. In order to maintain our developments, all the projects involved which are related with civil engineering are important to be done in a proper way. In civil engineering sector, planning and analysis are the most important part before constructing any buildings. Construction of structures on soft soil like clay soil would be difficult without any soil improvement. Clay soil has poor in shear strength and high in compressibility. The soil also is high in settlement due to its soft soil texture. This will contribute to soil failure and lead to buildings collapse in the future. So, soil reinforcement or soil improvement is one of the methods applied years ago in construction in order to overcome those problems from occurred and lead to death.

Oil palm fiber is one of the industrial wastage which it can be used as a soil stabilizer. It was produced from the empty fruits bunch through an extraction process of oil palm fruits in our industry. The fiber had gone through several process which they are being shredded, separated, refined and dried in order to make it in such way. In this process, there will be no chemicals involved in order to provide a high quality oil palm fiber. So, here the end production can be used for various activities by the manufacturers such as mattress, furniture, landscaping and most important thing it can act as a soil stabilizer in civil engineering.

1.2 Problem Statement

Clay soil which is also known as expansive soil is one of the problematic soils which need to take into account when constructing buildings on it as a base soil. Expansive soils contain minerals such as smectite clays that are capable in absorbing water. When they absorb water they increase in volume. The more water they absorb the more their volume increases. This change in volume can exert enough force on a building or other structure to cause damage.

Cracked foundations, floors and basement walls are typical types of damage done by expansive soils. Damage to the upper floors of the building can occur when motion in the structure is significant.

Expansive soils will also shrink when they dry out. This shrinkage can remove support from buildings or other structures and result in damaging subsidence. Fissures in the soil can also develop. These fissures can facilitate the deep penetration of water when moist conditions or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures. Therefore, these are the problems attributed by the clay soils.

Meanwhile, the end production of palm oil fruits is one of the biggest industrial wastage which contaminates the environment. So here, the used of palm oil fiber as a soil stabilizer can help the environment in reducing the quantity of the wastage produced.

Besides that, it helps the clay soil to improve its characteristics. The effect of the stabilizer used can be analyze and determine through the stress path and stress-strain relation. Therefore, from the experimental data, we can know whether the used of the fiber contributes any effect to the soil test in term of their shear strength as well as compressibility and permeability.

1.3 Objectives of Study

The objective of this study are:

i. To determine the effectiveness of palm oil fibers as the soil stabilizer.

ii. To propose the optimum percentage of palm oil fiber to increase the soil engineering characteristics.

1.4 Scope of Study

The project covered the determination of soil properties in relation with the palm oil fibers as a medium of soil. So here, the clay soil was tested with several laboratory tests which are Atterberg Limit test, Standard Proctor test, Permeability test and the Unconfined Compression test. The Atterberg limit test was held with two categories of test which are the liquid limit test and plastic limit test in order to test the moisture content.

For the laboratory tests, the soft soil sample taken at Pekan in the area of low land that always hit flooded. Before starting the required test, the soil sample tested with the soil classification test in order to determine the type of the soil. Then, the sample tested with several percentage of palm oil fiber which is 5%, 10%, 15%, 20% and 25% by weight. Each percentage carries five samples.

1.5 Significant of Study

The contribution of this study is the engineering properties of clay at low land in Pekan can be improve and treated by using palm oil fiber as it soil stabilization. In the future, construction on Pekan area can be carried out by using the information from this research. On the other hand, this study is to help the environment by keep it clean from the contamination of the industrial wastage which is the palm oil fibers. This study also could help engineers in order for them to design their structures which consist of soft soils as their base.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The empty fruit bunch fiber (EFB) was identified as the first of the series of standards on palm oil fibers because of logistic reasons. The EFB has the highest fiber yield and is the only material commercially utilized for fiber extraction. The EFB fibers found to be strong and stable and could be processed easily into various dimensional grades to suit specific applications in mattress and cushion manufacture, soil stabilization or compaction for erosion control, landscaping and horticulture, ceramic and brick manufacture and flat fiber board manufacture (Hamzah, M.M. (2008)). Fig 2.1 shows the physical of palm oil fiber which is obtained after oil extraction process.

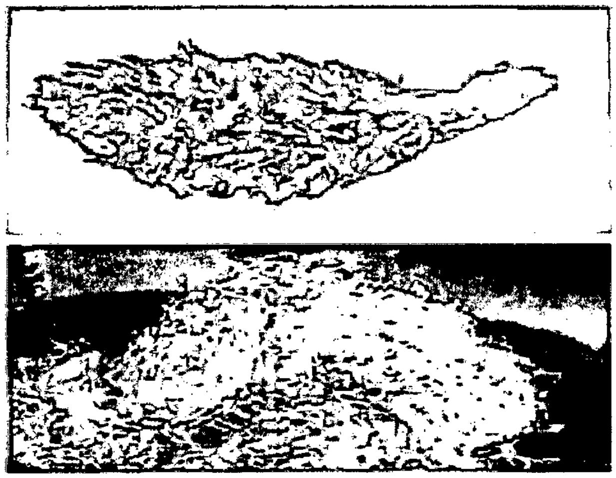

Photo 1. An empty fruit bunch (EFB, top) and its fibrous form (bottom).

Figure 2.1: Physical of palm oil fibre. (Abu, B. N. 2006)

Oil palm production is a major agricultural industry in Malaysia. It contributes about US$ 7.3 billion in export earnings each year, mostly from the export of palm oil. Currently, there are more than three million hectares of oil palm plantations. In total, about 90 million of renewable biomass (trunks, fronds, shells, palm press fiber and the empty fruit bunch) are produced each year (Kamarudin et al., 1997, cited by Hamzah, M. M. 2008).

The empty fruit bunches (EFB) represent about 9% of this total. They are the residue left after the fruit bunches are pressed to extract oil at oil mills. The oil mills are located near or in the plantation itself. EFB is a suitable raw material for recycling because it is produced in large quantities in localized areas (Hamzah, M.M. 2008).

2.2 Properties of Oil Palm

Oil palm is one of the most economical and very high-potential perennial oil crops. It belongs to the species Elaeisguineensis under the family Palmacea, and originated in the tropical forests of West Africa. Major industrial cultivation is in Southeast Asian countries such as Malaysia and Indonesia. Large-scale cultivation has come up in Latin America. In India, oil palm cultivation is coming up on a large-scale basis with a view to attaining self-sufficiency in oil production.

Oil palm fiber is non-hazardous biodegradable material extracted from oil palm's empty fruit bunch (EFB). Oil palm fiber is an important lignocellulose raw material. OPEFB fiber and oil palm mesocarpfiber are two types of fibrous materials left in the palm-oil mill.

Mesocarpfibers are left as a waste material after the oil extraction. These fibers must be cleaned of oily and dirty materials. The only current uses of this highly cellulosic material are as boiler fuel and in the preparation of potassium fertilizers. When left on the plantation floor, these waste materials create great environmental problems. Therefore, economic utilization of these fibers will be beneficial (Sreekala et al., 1997, cited by Bateni, F. 2009).

OPEFB fiber is obtained after the subtraction of oil seeds from fruit bunch for oil extraction. OPEFB fiber is extracted by the retting process of the EFB. Average yield of OPEFB fiber is about 400 g per bunch. Previous studies report the mechanical properties of OPEFB fibers. Table 2.1 shows the summary of oil palm fiber properties (Jacob et al., 2004; Sreekala et al., 2001; Sreekala et al., 1997, cited by Bateni, F. 2009).

2.3 Characteristic of Palm Oil Fiber

2.3.1 Fiber Morphology

The structure and properties of palm oil fiber have been investigated by several researchers (Abdul Khalil et al., 2006; Law et al., 2007, cited by Ismail, M.A.E 2009). The understanding of morphology and characteristic will not only help open up a new avenue for this fiber, but also emphasize the importance of this agriculture material.

Analysis of palm oil fiber was carried out by using scanning electronmicroscope (FESEM, Material Lab, Faculty of Mechanical, UTM). Figures 2.2 to 2.7 show the image of scanning electron micrographs of palm oil fiber respectively. Figure 2.2 shows the cross section the fiber.

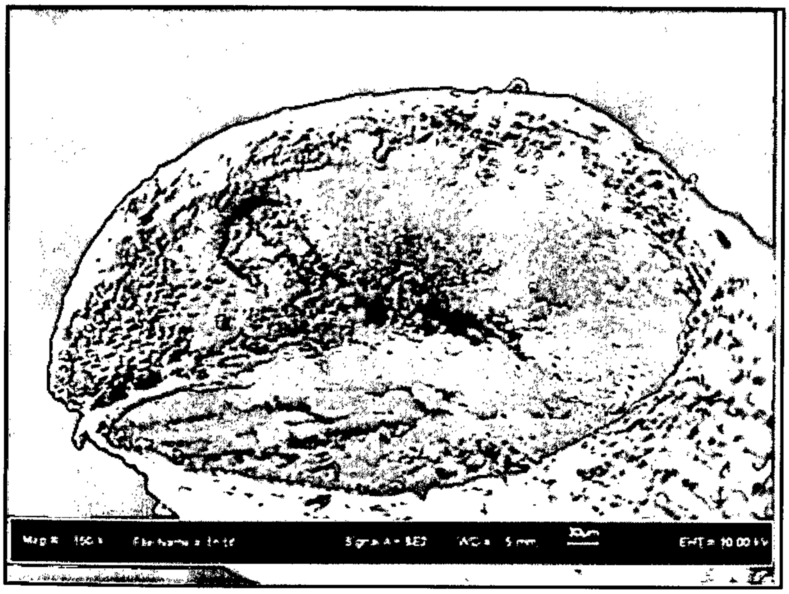

Figure 2.2: Cross section view of a fibrous strand (Ismail, M.A.E. 2009)

As can be seen in Figure 2.3, the cross section of POF is oval and fairly uniform in dimension. It contains various sizes of vascular bundle. The vascular bundles are widely imbedded in the thin-walled parenchymatous ground tissue. Each bundle is made up of a fibrous sheath, vessels, fibers, phloem, and parenchymatous tissues. (Abdul Khalil et al., 2006, cited by Ismail, M.A.E. 2009).

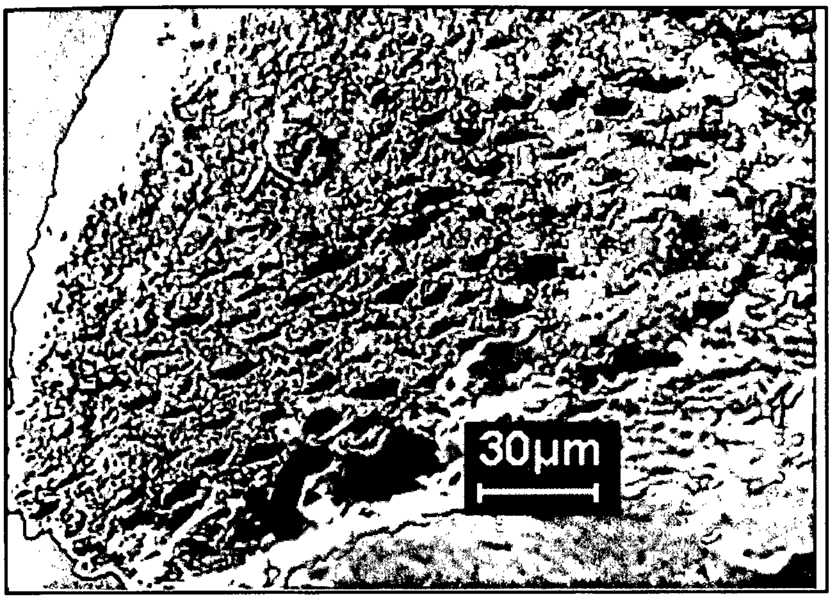

Figure 2.3: Cross section view of a fibrous strand. (Ismail, M.A.E. 2009)

Figure 2.4 and 2.5 shows the interior view of fibrous strand with two different magnification view. The electron microscopic observations were mainly to the walls of the fibers within vascular bundle.

Figure 2.4: Interior longitudinal view at magnificant 100x. (Ismail, M.A.E. 2009).

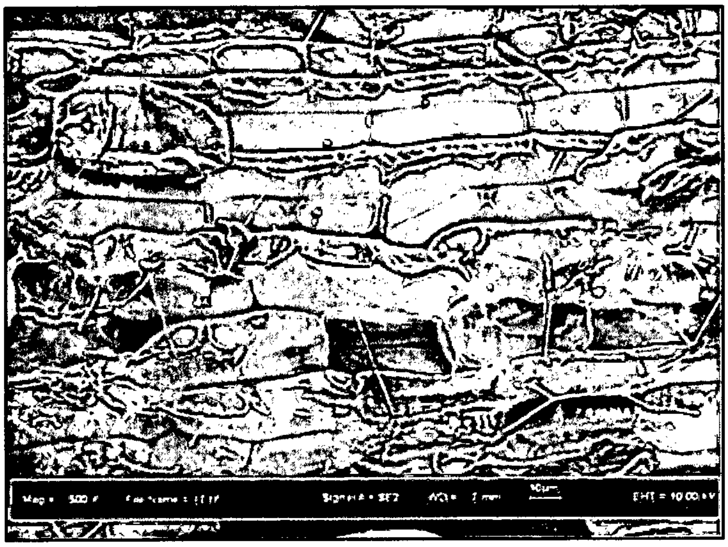

Figure 2.5: Interior longitudinal view at magnification 500x. (Ismail, M.A.E. 2009).

Figure 2.6 shows the longitudinal surface view at magnification 500x and Figure 2.7 shows closer and clearer view of surface POF. As can be seen, Silicabodiesare found in great numbers on POF strand. They seem to attach themselves to circular crater which spread relatively uniform over the strand's surface, (Law et al., 2007). The Silica-bodies looked like rounded-shape, are measured about 10-20 μm in diameter.

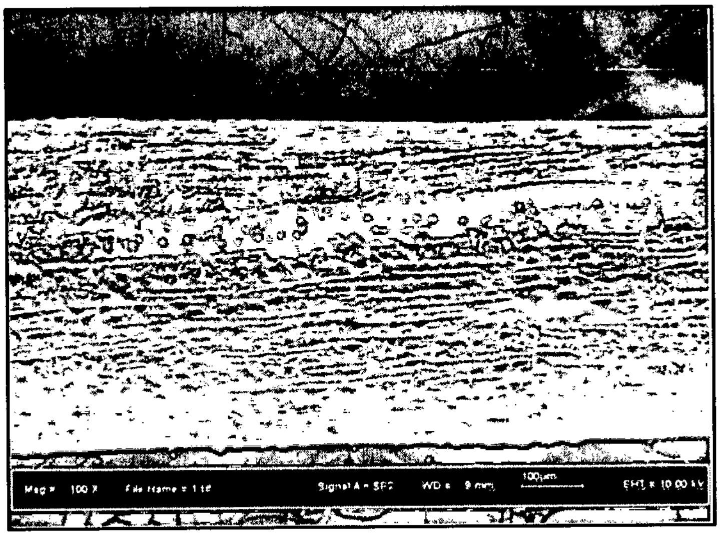

Figure 2.6: Longitudinal surface view at magnification 500x. (Ismail, M.A.E. 2009).

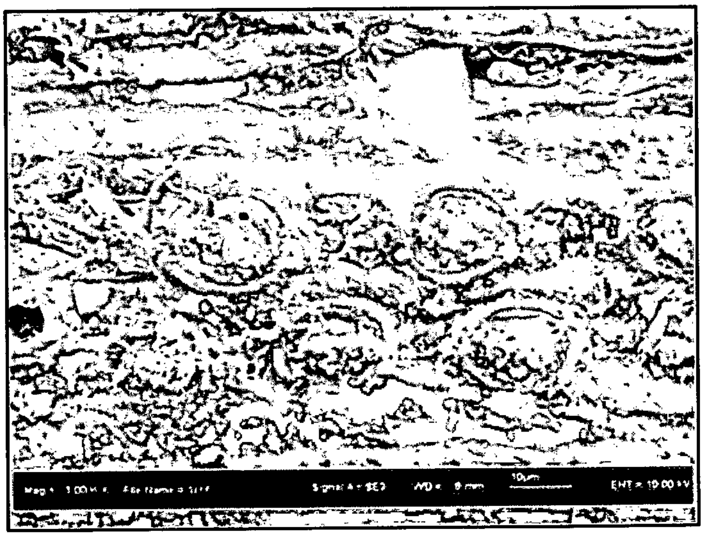

Figure 2.7: Longitudinal surface view at magnification 100x. (Ismail, M.A.E. 2009).