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Stabilization of Sub-grade Soil by Using of Oil Palm Fruit Ash (OPFASH)

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Abstract

This paper presents laboratory evaluation on stabilizing of sub-grade soil using Oil Palm Fruit Ash (OPFASH). A study was conducted in the laboratory to investigate the suitability of OPFASH in stabilizing the soil. The study involves the engineering characteristics of soil before mixing with the stabilizer and compressive strength of the soil after mixing with OPFASH and original portland cement (in this paper called Cement). The sample was prepared with different percentage of OPFASH starting with 0, 2, 4, 6 and mixture of 2 OPFASH and 2 Cement. The Unconfined Compression Test (UCT) was done to determine the compressive strength of the sample after curing period of 0, 7, 14 and 28 days. The results indicated that the sample with 2 OPFASH and 2 Cement performed better than the sample with just OPFASH.

1. Introduction

The sub-grade is the foundation layer, the structure that must eventually support all the loads that come onto the pavement. In some cases this layer will simply be the natural earth surface. Therefore, it is essential to make sure that the layer is stable and have sufficient shearing strength to withstand the stresses imposed on it by traffic loads in all kinds of weather without excessive deformation.

Many methods have been used to stabilize soil which are mechanically, physically and chemical reaction. Besides that, there are few types of soil stabilization. There are bituminous materials, Portland cement, lime and various other chemicals and stabilizers.

OPFASH is a waste product obtained in the form of ash on burning of palm oil husk and palm kernel shells as fuel in the palm oil mill boiler. This material has been reported to have very high pozzolanic reaction which is reaction between a siliceous or siliceous and aluminous material, and calcium hydroxide in the presence of moisture to form compounds possessing cementations properties. OPFASH is used as a cement replacement material in soil stabilization so that the cost of construction can be decrease relatively. The objective of this paper is to determine the suitability of OPFASH in providing sufficient strength to the soil sample so that the percentage of cement in the stabilization process can be reduced.

2. aboratory xperiments

Laboratory testing was conducted to first classify the soil that been used in the study. The laboratory tests was started by sieve analysis and followed by Atterberg Limit test to determine the plasticity index that obtained from plastic and liquid limit test. Samples were prepared using the optimum moisture content and maximum dry density that was gained from the compaction test.

The samples were prepared in cylinder shape with diameter 50mm and 100mm height and were cured with different period which are 0, 7, 14 and 28 days in the PVC pipe. After each period of curing, the samples were tested using the Unconfined Compression Test (UCT) machine which is computerized to obtain all the data and results. The results were then been analyzed to determine the compressive strength of the each sample and consequently verify the suitability of OPFASH in stabilizing soil. Table 1 shows the types of samples with different percentage of OPFASH and Cement.

Table 1 Types of sample

Sample	O FAS ( )	Cement ( )
1	0	0
2	2	0
3	4	0
4	6	0
5	2	2

3. Results and Analysis

3.1. Atteberg Limit

The Plasticity Index (PI) of the soil sample is obtained at this level, and two parameters which are Liquid Limit (LL) and Plastic Limit (PL) are needed to compute the PI. Table 2 shows the results of Atterberg Limit test.

Table 2 The Results of Atterberg Limit Test.

Test	Result
Liquid Limit (LL)	43.3%
Plastic Limit (PL)	29.5%
Plasticity Index (PI) = LL - PL	= 43.3% - 29.5% = 13.8%

3.2. Soil Classification

The soil is classified using two systems of soil classification i.e. the Unified Soil Classification (USC) and American Association of State Highway and Transportation Officials (AASHTO). Table 3 shows the classification of control sample using the USC system, while table 4 shows the classification of control sample using AASHTO system.

Table 3 the soil classification by using of USC

Characteristics	Control Sample
Liquid Limit	43.3%
Plasticity Index	13.8%
Soil Classification	Silt with sand (ML)

Table 4 the soil classification by using of AASHTO

Characteristics	Control Sample
Percent passing 0.075mm, F	10.7%
Liquid Limit	43.3%
Plasticity Index	13.8%
Group Index	0
Soil Classification	Group A-2-7 (0)

3.3. Compaction test

The compaction test was conducted to determine the value of Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) so that the sample for the UCT can be prepared. The value of OMC is obtained from the graph that plotted based on the result of the test. Hence, the value of MDD will be obtained from the value of OMC. The highest value of OMC is 17.8% which recorded by the 4% OPFASH sample. Meanwhile, the lowest value of OMC is 14.8% for the control sample. Figure 1 and Figure 2 shows the OMC and MDD respectively according to the percentage of OPFASH.

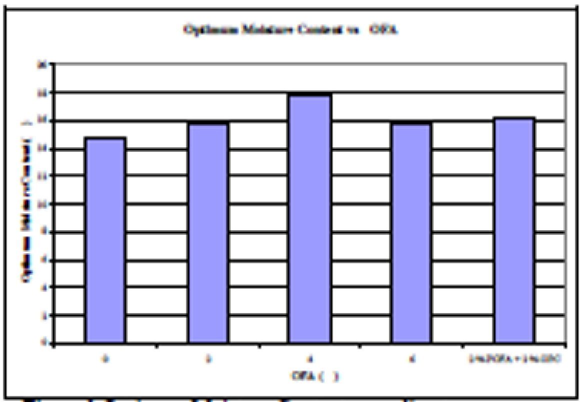

Figure 1 Optimum Moisture Content according to percentage of OPFASH.

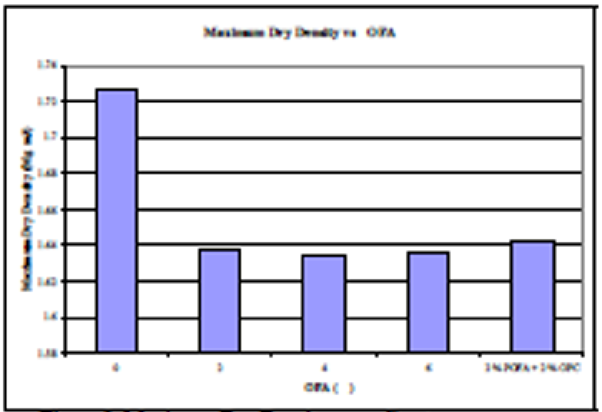

Figure 2 Maximum Dry Density according to percentage of OPFASH.

3.4. Unconfined Compression Test

The test was carried out to estimate the compressive strength of the sample. After certain period of curing, each sample was set up to the machine and the test was running under rate of displacement 2mm/sec. The results that obtained from the test were interpreted in the bar chart using the average value of two specimens.

Figure 3 compares the value of stress with the percentage of OPFASH within the specific curing period. The chart shows that there are no prominent changes of stresses at percentage of OPFASH 0, 2 and 4% comparing to the value of stresses at 6% and mixture of 2% OPFASH and 2% Cement. However, these values of stresses do not show constant increase or decrease related to the curing period. For example, the highest value of stress for 6% OPFASH is 200kPa without curing (0 day). Meanwhile, the highest value of stress for mixture of OPFASH and Cement is 482kPa after 28 days of curing.

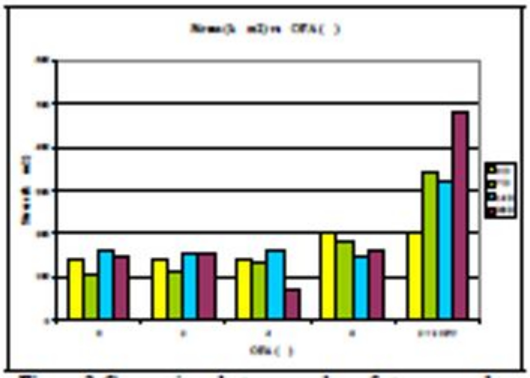

Figure 3 Comparison between value of stresses and percentage of Opfash at different curing period

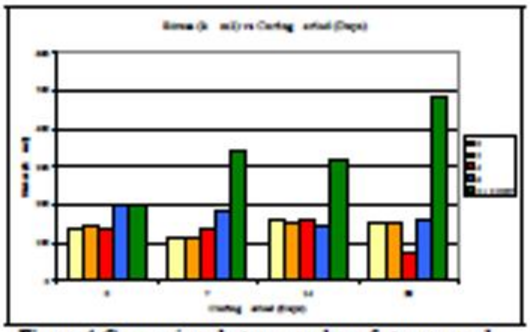

Figure 4 Comparison between value of stresses and curing period at different percentage of OPFASH

Figure 4 above shows the comparison value of stresses with the curing period at different percentage of OPFASH. For all curing period which are 0, 7, 14, and 28 days, the highest value of stresses was recorded by the mixture of 2% OPFASH and 2% Cement. Without curing, the highest value of stress is 201kPa. This followed by the highest value for 7 days curing which is 345kPa. However, there is slightly decrease in the highest value of stress after 14 days of curing which is 320kPa. On the other hand, the highest value of stress at 28 days curing increase with 482kPa.

4. Conclusions

The study showed that the use of OPFASH did not improve the strength significantly. However, stabilized soil with OPFASH and cement indicated satisfying strength which is nearly two times compared to sample that only composed of OPFASH. Sample with 2% OPFASH and 2% OPC showed the most composition in stabilizing the soil sample.

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