The Performance of Stabilized Road Base Material with Oil Palm Fruit Ash (OPFASH) as Additive

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Abstract

. Nowadays, volume of the traffic as well as the load of the vehicles are becoming higher and heavier. That situation of course re uires more strength of the base of the pavement. Some efforts have been done by road designers to improve the strength of the pavement especially on the base layer. Most improvement which has been done is stabilizing this layer with sand, cement, lime and even with asphalt. This paper presents laboratory evaluation on stabilizing of road base of the pavement using Oil Palm Fruit Ash (OPFASH), a waste material of palm oil industry. Using OPFASH is intended to reduce of using original portland cement (cement), the material most use for base stabilization, as stabilizing agent since the increasing of cement price. 1 to 4 with interval 1 by weight of both cement and OPFASH are added to the road base material. Laboratory experiments show that compressive strength of the road base using 2 cement and 2 OPFASH as well as 1 cement and 3 OPFASH almost have the same result as if using 4 cement and 0 OPFASH. This can be concluded that OPFASH can be used as road base material stabilization in road construction.

Keywords: opfash, stabilize, road base, strength, pavement

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1. Introduction

Base layer is one of the most important structural layers of flexible pavement and one of the classical design criteria is the fatigue in this layer due to over stress or lack of its strength. Suitable base material to fulfill the specification requirement is often not finding in the site of the road project, therefore stabilization to improve its strength is needed. Many types of material like sand, portland cement, and lime can be used to stabilized base material but original portland cement (hereinafter just called cement) is used most often since have pozzolanic properties which enable the reaction between base material and stabilizing agent and the process of stabilization faster.

Yet, the problem comes up with increasing the price of cement. To solve this problem, oil palm fruit ash (OPFASH) is added to the cement as stabilizing agent of base material.

Principally stabilization the pavement material is improving its density. Laboratory experiment show that OPFASH can be successfully used as Cement additive for stabilizing agent, but can not be successfully used for stabilizing agent without other material. The result of laboratory experiment shown by using of 1% Cement + 3% OPFASH (by weight of base material) have almost the same dry density as if using of 4% Cement + 0% OPFASH as stabilizing agent. Dry density 4% Cement + 0% OPFASH is 2.188 and 1% Cement + 3% OPFASH is 2.112. The same result also shown in the compressive strength value, 1% Cement + 3% OPFASH have compressive strength 4.26 N/mm^2, while the compressive strength for 4% Cement + 0% OPFASH is 4.76 N/mm^2.

The base material used for this study was crushed aggregate obtained from site of upgrading project in km 220.5 Yong Peng – Pagoh Malaysia, a Project of Lebuhraya Utara – Selatan (PLUS). Study on samples containing 4%, 3%, 2% and 1% for both Cement and OPFASH. The samples were tested through compaction test to get the optimum moisture content (OMC) and finally through compressive strength test to get the compressive strength value to be compared.

2. aboratory xperiments

In order to quantify the strength of Cement-OPFASH stabilized road base material, laboratory

experiments were carried out in the Road Research and Transportation Laboratory of the Civil Engineering Faculty of the University Technology of Malaysia. The following tests were carried out:

- Sieve analysis
- Dry density test
- Compressive strength test

Four different mixes of Cement and OPFASH, 4% + 0%, 3% + 1%, 2% + 2%, and 0% 4% of Cement + OPFASH respectively were added to stabilize the base material and tested.

2.1. Sieve analysis

Material for sieve analysis was selected using manual quartering. The purpose of sieve analysis was to check the grading after intense pulverization of original road base material with Wirtgen WR2500 recycler. The grading was compared to the Jabatan Kerja Raya (JKR, Malaysian Public Works Office) standard for Type 1 and Type 2.

The size of OPFASH being used was passing 600µm and for Cement was passing 75µm.

2.2. Dry Density Test

Dry Density was determined in accordance with BS 1377:1990. Optimum moisture contents were determined using maximum dry densities from samples. Randomly, water contents were selected first with increment of 2% to find optimum moisture content and maximum dry densities. The samples contents are as follows:

Table 1 Cement and OPFASH contents in the sample.

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

2.3. Compressive Strength Tests

100 mm cube moulds were selected for sample preparation. Three curing durations were chosen which 24 hours, 7 days and 14 days are. Optimum moisture contents obtained in dry density test were used to cast samples. Samples were covered by wet sacks during the curing period.

3. Results and Analysis

3.1. Sieve Analysis

Figure 1 shows the results of sieve analysis of base material obtained from site. The material was identified as Type 2 based on JKR standard. From this figure shows that gradation of the material is fulfill the gradation requirement and only slightly disturbed by the pulverization process.

3.2. Dry Density

Figure 2 shows the results of dry densities with different sample and water contents. Legends show the various sample contents. These results gave the optimum moisture content in casting process.

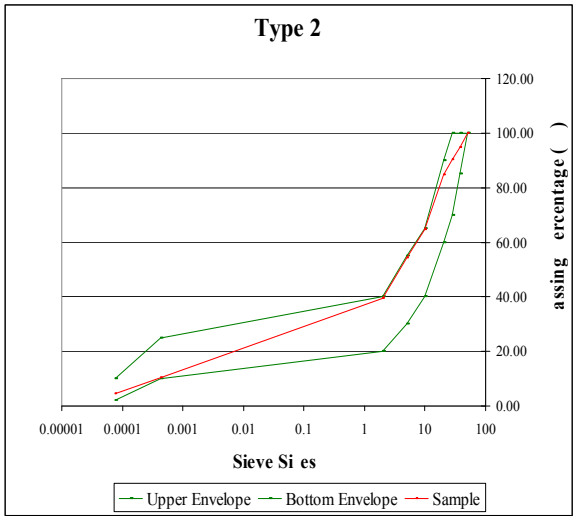

Figure 1 Sieve Analysis

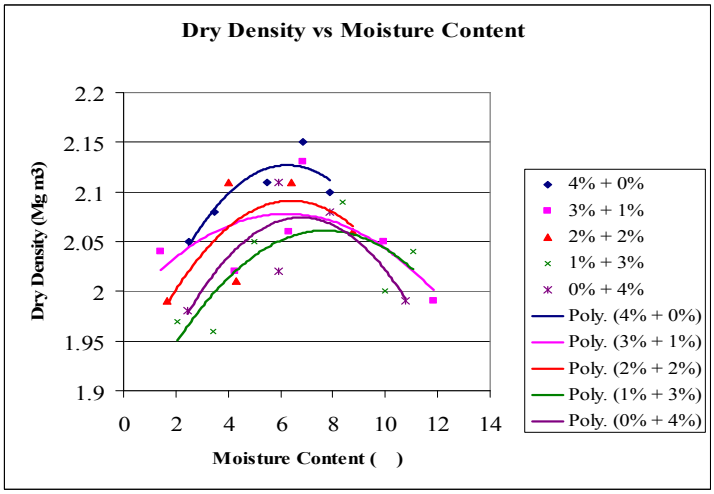

Figure 2 Dry Densities versus Moisture Content.

Table 2 indicates that optimum moisture contents were increased when the contents of Cement were reduced; this was due to the size and weight of the particles. While the value of maximum dry density almost same for all samples. OPFASH is lighter than

Cement and absorbed more water compared to Cement.

Table 2 the Value of Maximum Dry Density and the Optimum Water Content.

Sample (Cement + OPFASH)	Max. Dry Density (Mg/m^3)	Optimum Water Content (%)
4% + 0%	2.188	6
3% + 1%	2.132	6
2% + 2%	2.144	6.4
1% + 3%	2.112	8
0% + 4%	2.128	7

3.3. Compressive Strength

Table 3 shows the results of compressive strength after the curing period. The sample containing 4% OPFSH with 0% Cement was crumbled during the mould opening after 24 hours casting. This suggests that OPFASH does not have significant amount of cementations property.

The data in this table shows that the strength increased with increasing amount of Cement and also the increasing of curing period. Besides that, the values do not much differ between each sample. From the previous study, the strength of OPFASH increased in course of time and it took longer time than Cement due to pozzolanic reactivity.

Table 3 Results of compressive strength (N/mm^2).

Curing time → Sample (Cement O FAS)	**24 hours**	**7 days**	**14 days**
4% + 0%	4.55	4.55	4.76
3% + 1%	3.97	4.46	4.57
2% + 2%	4.18	4.62	4.46
1% + 3%	3.79	4.09	4.26
0% + 4%	-	-	-

4. Conclusions and Recommendations

Based on this study, following conclusions can be drawn:

1. OPFASH can be used as the stabilizing agent together with Cement
2. OPFASH does not react to the material as fast as Cement which is with in 24 hours
3. Combination of OPFASH and Cement as stabilizing agents gave slightly different value of compressive strength compared to sample containing Cement only
4. Combination of 2% Cement and 2% OPFASH is recommended based on the economical cost and a slight different of compressive strength value from 4% Cement

Based on the findings and the conclusions, this study recommends some future research for base material stabilization using OPFASH:

1. This study found out that combination of Cement and OPFASH as stabilizing agents is possible. By extending the curing to certain period, the increasing of compressive strength value can be identified
2. The smaller size of OPFASH particles is recommended which is passing 75μm to make it easy to react with Cement and the base material

5. References

[1] A.Hilmi Lav, M. Aysen Lav, dan A. Burak Goktepe (2006), "*Analysis and Design of a Stabilized Fly Ash as a Pavement Base Material* , Turkey.

[2] Irfan Khan Jhatial (2006), "*Evaluation of Properties of Cold In Place Recycling Material* , Universiti Teknologi Malaysia.

[3] Selia Selenggara Selatan Sdn. Bhd. (2007), "*Penswastaan Penyelenggaraan Jalan-jalan Persekutuan di Semenanjung Malaysia (on Selatan)* .

[4] Weerachart Tangchirapat, Tirasit Saeting, Chai Jaturapittakul, Kraiwood Kiattikomol, Anek Siripanichgorn (2006), *Use of waste ash from palm oil industry in concrete* .