The Evaluation of use of Palm Shell Ash Waste to Polymer Modified Asphalt Mixture

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Rindu Twidi Bethary[1], Dwi Esti Intari[1], Woelandari Fathonah[1], Solehan Andika[1]

[1] Department of Civil Engineering, Sultan Ageng Tirtayasa University, Cilegon, Banten

Abstract. The ~~development of the palm oil industry~~palm oil industry's development has a strategic role in Indonesia's economy because Indonesia is the largest country and the largest exporter of palm oil ~~in the world, o~~globally. On the other hand, a new problem arises from increasing palm oil ash waste. This has encouraged the use of palm oil ash as filler mix asphalt~~, so i~~. In this study, an evaluation of the ~~performance of the asphalt mixtur~~asphalt mixture's performance on the surface layer (AC-WC) will be carried out by utilizing palm ash waste as a filler using Starbit E-55 polymer asphalt. Testing the ~~performance of the asphalt mixtur~~asphalt mixture's performance using the Marshall method with asphalt content of 6% ± 0.5 and variations in the percentage of palm ash filler used, namely 3~~%~~, 4~~%~~, 5~~%~~, and 6%. Samples are prepared and tested to obtain the stability and volumetric values of the mixture. Based on the results, it was found that the addition of palm ash waste as a filler could increase the stability performance at 3% filler content but there was a decrease in the filler content of 4~~%~~, 5~~%~~, and 6%~~,~~ in the test object without the addition of palm ash filler, the highest stability was obtained, namely 2358, 4 kg while the test object with the addition of 3% palm ash filler has a stability of 2503.03 kg at each asphalt content of 6.5%. The flow parameter in the test object continues to decrease along with the increase in the addition of oil palm ash filler, this is in line with the increase in the Marshall Quotient parameter which causes the mixture to become stiffness, this indicates that the mixture can withstand deformation due to traffic loads and shows that this oil palm ash potentially ~~good~~ suitable for use as a filler in asphalt mixtures.

Keywords: asphalt, p~~P~~alm o~~O~~il a~~A~~sh, M~~M~~arshall, f~~F~~iller, waste

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1. Introduction

Indonesia is one of the largest palm oil producing countries ~~in the world~~globally, contributing 59% of world palm oil production [1], especially in the last 25 years, where we can find oil palm plantations in almost all parts of Indonesia. But on the other hand, a lot of waste in the form of liquid and solid is produced from palm oil mills that have the potential to pollute the environment, so there is a need for better waste utilization in addition to environmental improvement and its positive impact on the economy [2]. Palm oil processing only produces 10% palm oil while the remaining 90% remains in the form of biomass or waste is still untapped for industry, with higher yields and increasing production in the world can produce more than 295 million tonnes of waste every year [3].

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The development of road infrastructure is one of the important needs in the development of the transportation system in Indonesia, a good transportation network will have an impact on the development of activities in a region [4]. A good material is a requirement for asphalt mixture as a pavement layer, one of which is filler the use of alternative materials in road construction has been developed for the use of aggregates and cement, including fly ash, slag, glass waste, and palm ash shells, where the use of palm shells in road construction widely used as a filler material [5-8]. The use of waste materials to replace the aggregate composition leads to asphalt pavement~~ which is,~~ a green, sustainable, and environmentally friendly construction, which ultimately conserves nature by reducing the need for materials from natural sources [9].

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The use of palm shell ash as an alternative to filler in asphalt mixtures ~~is because it~~ contains silicon dioxide (SiO_2), where silicon dioxide is the most abundant chemical element in portland cement and is suitable as a binder. The silicon dioxide content allows it to bind asphalt and aggregates ~~so that a stronger asphalt mixture is obtained~~to obtain a stronger asphalt mixture [10].

The use of oil palm ash waste with a percentage of 1 to 5% based on the test results has resistance to permanent deformation and lower moisture susceptibility with an optimum percentage of 3% [11], while for stability testing using the Marshall method, resilient modulus, static creep test and dynamic then the fatigue test showed different results with filler percentages of 0, 1, 3, 5, 7% showing different levels of performance but resistant to permanent deformation compared to the control mixture can achieve up to 5% filler replacement without disturbing the performance of the asphalt mixture [5]. Based on this, research on pavement technology development was carried out using palm ash as a filler and polymer modified bitumen Starbit E-55 in asphalt concrete - wearing course mixture (AC-WC).

2. Material and Methods

The materials used in this study were~~are~~ ~~aggregates~~ aggregated from several aggregate fractions such as ¾ ", ½",3/8" fractions, and dust from Cilegon Banten, Starbit E-55 polymer asphalt from PT. Bintang Djaja and palm shell ash, for the testing tool are used Marshall. In determining the proportion of the mixed aggregate, first a sieve analysis test is carried out to obtain the percentage data passed from each fraction used in the mixture, the results of the combined aggregate design are displayed in a graph that contains specification limitations for the asphalt concrete -wearing course mix type. From the results of mixed grading, the percentage for the aggregate weight of each aggregate fraction is obtained, namely split 1-2 by 15%, screening by 24%, and stone ash by 61%, can be seen in Figure 1.

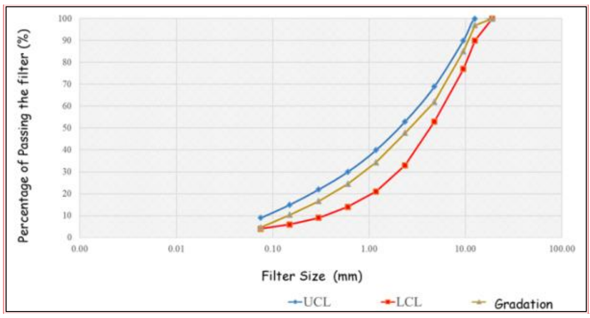

Figure 1. Gradation asphalt concrete -wearing course mixture (AC-WC).

The methodology in this study starts from material preparation, testing of physical properties of materials such as aggregate inspection, namely aggregate density and absorption, aggregate wear, sieve analysis, for asphalt inspection such as asphalt penetration, asphalt density, ductility, and checking for oil palm shell ash such as prepare the material to be filtered with a sieve no.200 for the added material for the asphalt mixture, after that the variations in the ash content of the oil palm shell are 0%, 3%, 4%, 5%, and 6% then all the ingredients are mixed for the test object manufacturing stage, testing the test object using Marshall and the final part will be presented data processing and analysis. More details can be seen in Figure 2.

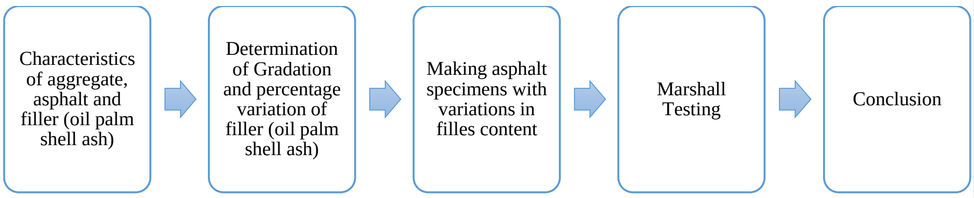

Figure 2. Research Methodology

3. Data Analysis

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Based on the results of tests performed on the material used in this study, ~~then do further analysis to be used in testing~~do further analysis to test the Marshall method.

3.1 Material testing

The coarse aggregates tested in this study were split 1-2, and the screening was held at sieve No. 4 or 4.75 mm sieve, while the fine aggregate used is rock ash that passes through sieve No. 4 or 4.75 mm sieve originating from Merak, Banten. The test results can be seen in Table 1.

Table 1. Aggregate Properties Test Results

No	Checking type	Results	Testing Specifications	
			Minimal	Maximal
I Coarse Aggregate				
1	BJ Bulk	2,63	-	-
2	BJ Apparent	2,71	-	-
3	BJ SSD	2,67	2,5	-
4	Absorption (%)	1,11	-	3
5	Abrasion Testing (%)	18,2	-	40
II Coarse Aggregate (Screening)				
1	BJ Bulk	2,68	-	-
2	BJ Apparent	2,73	-	-
3	BJ SSD	2,70	2,5	-
4	Absorption (%)	0,72	-	3
III Fine Aggregate				
1	BJ Bulk	2,47	-	-
2	BJ Apparent	2,49	-	-
3	BJ SSD	2,5	2,5	-
4	Absorption(%)	0,3	-	3

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e.g. Spesific Gravity (SG) or in Indonesian Heavy Type (BJ)

Based on the aggregate test, the results show that the bulk density, apparent density, surface dry saturated bulk density (SSD) meets SNI 1970-2008 with minimum requirements of 2.5 and absorption meets the maximum value of water absorption required that is 3%. The wear test with the Los Angeles machine shows that coarse aggregate is resistant to abrasion, which can be seen from the average wear value obtained is 20.05% with a maximum requirement of 40% for the asphalt concrete mixture [12].

The next material used in this research is polymer modified asphalt with the brand Starbit E-55, where polymer modified asphalt is a material produced from modification between natural polymers or synthetic polymers with ~~levels of 2-6%~~2-6% levels. ~~Testing of asphalt is carried out by Bina Marga standards~~Bina Marga standards carry out testing of asphalt (Standard ???~~-~~.. State the standard) with the provisions of type II hard asphalt, namely modified asphalt for synthetic elastomers. They ~~and~~ must meet the requirements ~~given~~ to be used as a binder in the pavement mixture. Several laboratory tests carried out on the properties of asphalt can be seen in Table 2.

Table 2. Testing Results of Asphalt Properties

No	Type of Testing	Test result	Testing Method
1	Penetration 25°C, 100gr, 5 seconds; 0.1 mm	63,7	SNI 06-2456-1991
2	Specific gravity	1,075	SNI 06-2441-1991
3	Penetration difference after weight loss; % original	0,35	SNI 06-2456-1991

In the penetration testing of polymer modified asphalt, Starbit E-55 meets the required specifications where the penetration of modified asphalt is a minimum of 40 mm (state the standard). The penetration value obtained shows that the asphalt is a low-penetration asphalt suitable for use in areas with hot weather or high volume traffic. Examination of the density of research asphalt shows a value of 1.075 or above the requirements~~, and t~~. The value of the weight ~~lost~~ loss is the difference between the penetration value before and after heating, which shows that the asphalt is sensitive to weather and temperature~~, obtained a value of 0.36% with a maximum requirement of 0.8%, so that the~~ and obtained a value of 0.36% with a maximum requirement of 0.8% weight loss test meets the requirements.

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3.2 Palm Shell Ash

The processing of oil palm fruit into palm oil extract produces a large amount of solid waste in ~~the form of~~ fiber, shells, and empty fruit bunches. Then the sell used again as fuel to produce steam in the palm oil mill. Burning in a steam boiler using oil palm shells will produce oil palm ashes with ~~a~~ very fine grain size. The results of the chemical element composition test of oil palm shell ash [13] can be seen in Table 3.

Table 3. Testing Results of Asphalt Properties

Chemical Elements	Percentage (%)
Silikon Dioksida (SiO_2)	58,02
Aluminium Oksida (Al_2O_3)	8,70
Besi Oksida (Fe_2O_3)	2,60
Kalsium Oksida (CaO)	12,65
Magnesium Oksida (MgO)	4,23

With the addition of materials containing silica as an alternative filler, it is hoped that the optimum filler content will be obtained with the optimum bitumen content to increase the stability value of the asphalt concrete -wearing course (AC-WC).

3.3 Marshall Testing Using Palm Shell Ash

Tests using the Marshall method on a mixture of wear-coated concrete asphalt (AC-WC) with the addition of palm shell ash as a substitute for filler with the percentage of 0~~%~~, 3~~%~~, 4~~%~~, 5~~%~~, and 6%. The results of the mixed volumetric test, stability, and flow are shown in Figure 3. The volumetric results from testing using the Marshall method can be seen for the void in the aggregate (VMA) of the four levels of the test object tends to increase along with the increase in the added filler content, this indicates that the filler provides a greater percentage of void or empty space so that the ability of the asphalt mixture in filling the reduced void aggregate. The value of VMA on the asphalt indicates a small percentage of void filled with asphalt.

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The asphalt concrete wearing course specimen using polymer modified asphalt for each filler content ~~has a requirement with~~requires a minimum value of void in the mixture (VIM) of 3% and a maximum of 5%. The addition of oil palm shell ash filler to the AC-WC mixture resulted in increased VIM value, which could reduce the a~~bility of the asphalt~~sphalt's ability to fill the existing void so that it became less dense. However, the VIM value will continue to decrease with increasing asphalt content, this is due to the asphalt filling more void in the mixture, where the VIM value is too high ~~t~~. This can cause the asphalt is not watertight, the appearance of premature cracks, raveling, and stripping.

The addition of oil palm shell ash filler resulted in a decrease in a void in the asphalt (VFA) because the filler could not be fully covered with asphalt, where the VFA value increased with the increase in asphalt content but required an asphalt content of 6.5% to 7% to make the mixture meet the requirements. The results of the stability test decreased with the increase in the percentage of oil palm shell ash filler content, where the maximum stability occurred at the addition of 3% filler, indicating that the mixture of asphalt with oil palm shell ash filler ~~has the ability to~~can withstand deformation due to traffic loads.

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The effect of using palm shell ash filler in the AC-WC mixture resulted in lower flow values compared to the asphalt concrete mixture without the addition of palm ash filler. This indicates that the filler makes the asphalt less flexible so that the asphalt concrete mixture becomes more brittle. The value of the Marshall Quotient (MQ) increases with increasing ~~levels of palm ash filler~~palm ash filler levels, causing the mixture to become stiffer and brittle. The advantage of adding palm ash filler can ~~increase~~ improve the stability value of the asphalt concrete wearing mixture (AC-WC) by adding a limited amount of filler and using asphalt content from 6.5% to 7%. Meanwhile, the disadvantages of adding palm ash filler are that it causes the asphalt concrete mixture to become very brittle and stiff, reduces the impermeable level and flexibility to a decrease in the value of stability at the added content of more than 3%.

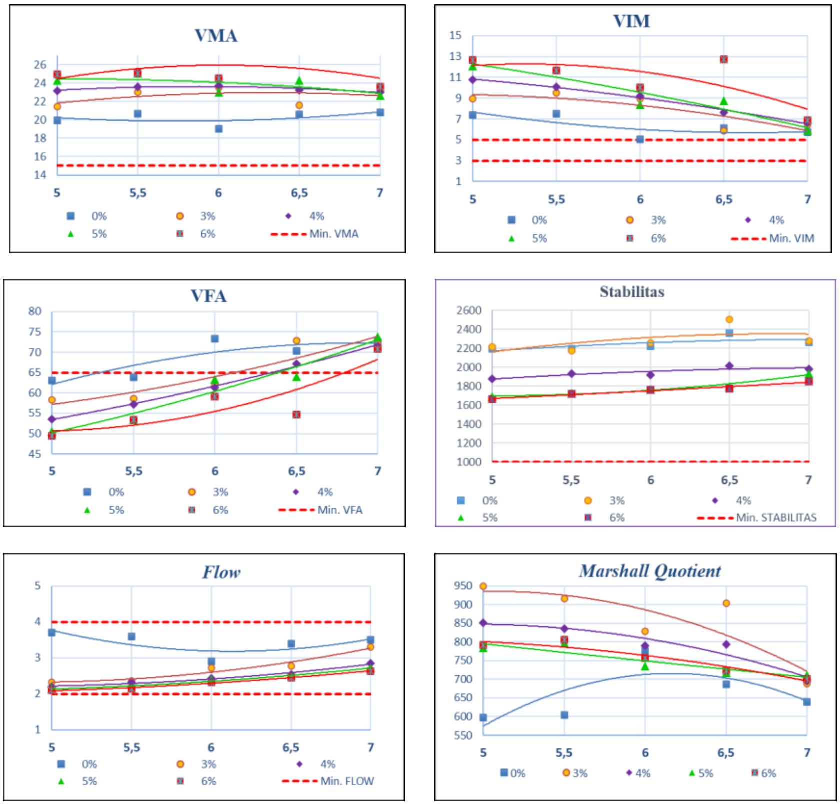

Figure 3. AC-WC Mix Test

Conclusion

Based on the results of research and discussion of the effect of adding palm shell ash filler to the polymer asphalt mixture, the following conclusions were obtained:

1. The ~~characteristics of the aggregate and asphalt test~~aggregate and asphalt test characteristics fulfill the requirements set out in the Ministry of General Affairs specification revision 3 of 2010. Chemical elements of oil palm shell ash the biggest silikon dioksida (SiO2) it can be provitable for ashalt mixture
2. The volumetric characteristics of the AC-WC asphalt mixture, with the addition of the percentage of oil palm shell ash filler, resulted in an increase in the value of the void in the aggregate (VMA) and the void in the mixture (VIM) which indicated a decrease in the void in the asphalt (VFA). Void in the asphalt (VFA) value ~~that~~ continues to decline due to the addition of palm ash filler and fulfill the requirements with asphalt content of 6.5% and 7%. Experienced an increase in stability at 3% filler content, then continued to decrease at 4%, 5%, and 6% levels but fulfill the requirements. The flow value in the addition of filler 3%, 4%, 5%, 6% continues to decrease along with the increase in filler content.
3. Addition of oil palm shell ash filler by 3% with a VMA value of 21.63%, a VIM value of 5.88%, a VFA value of 72.83%, a stability value of 2503.03 kg, and a flow value of 2.1 mm. This results in the AC-WC asphalt mixture becoming stiffer this indicates that the mixture can withstand deformation due to traffic loads.

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