The Effect of Filler Adding Palm Kernel Shell Ash on Durability and the Marshall Values Properties of Asphalt Concrete Mix

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Abstract

Lampung Province is one of the palm oil producers, especially in Way Kanan Regency. Way Kanan Regency has two palm oil-producing mills, namely PT. Sawit Indo Mas which is located in Kampung Tanjung Raja Sakti Blambangan Umpu and PT PLP which is located in Kampung Bumi Agung, Bahuga District. The two factories duce thousands of tons of Crude Palm Oil (CPO) vegetable oil daily produced from palm fruit plants (Elaeis Guineensis Jacq, Arecaceae). From oil management, it is undeniable that it can create a lot of solid waste from the palm shell. Meanwhile, the government has not made much effort to use the waste from the waste. When managing palm fruit, palm shells cannot be processed into oil because they have a hard texture, so the shells are discarded and become waste. Then we use the shell for research material as a filler. Palm shell ash has a silicon dioxide (SiO2) content which is also contained in Portland cement, so this content can allow the acquisition of a good asphalt mixture on the AC-BC layer. This study aims to see the effect of the effectiveness of adding shell ash fillers from palm shell waste in Marshall test tests and value the resulting durability. The addition of fillers with percentages of 20%, 30%, 40%, 50%and 60%. From the results obtained from the test results in the laboratory that the addition of shell ash fillers of 40% gets better performance compared to shell ash with percentages of 20%, 30%, and 60%, with a higher state value of 1225 kg shown. In Marshall testing, using palm shell ash fillers can increase the value of KAO. So that from the Marshall test, the durability value of the sample immersion at the IRS value of 0% was 98.4% greater than the 40%, which was 91.13%. Overall, using palm shell ash fillers meets the minimum requirements of Indonesia Bureau for Construction Bina Marga as an asphalt mixture. The degree of weather change in immersion durability affects the strength level of the Marshall test.

Keywords: *durability, palm shell ash, filler, Marshall test, asphalt concrete.*

I. INTRODUCTION

LAMPUNG Province is one of the palm oil producers, especially in Way Kanan Regency. Way Kanan Regency has two palm oil-producing mills, namely PT. Sawit Indo Mas which is located in Kampung Tanjung Raja Sakti Blambangan Umpu and

PT PLP which is located in Kampung Bumi Agung, Bahuga District. The two factories produce thousands of tons of Crude Palm Oil (CPO) vegetable oil daily from palm fruit plants (*Elaeis Guineensis Jacq, Arecaceae*). From oil management, it is undeniable that it can produce a lot of solid waste from the palm shell. Meanwhile, from the trash, the government has not made many efforts to use the litter.

This shell waste has a hard texture and is the deepest part of the oil palm fruit. Therefore, when processing palm fruit, the shell cannot be processed into oil but only waste or factory waste. Judging from the many benefits that can be taken and a reasonably large amount, palm shell ash was used in the study.

Palm shell ash has a silicon dioxide (SiO2) content which is also contained in Portland cement, so with this content, it can be possible to obtain a good asphalt mixture, especially in AC-BC layers. Previously, a study was carried out using a 50% variation in palm shell waste ash in the AC-WC mixture. As a result, the stability value obtained in the interpretation has the highest stability value (Fajri, 2019).

Road pavement is a mixture of asphalt and aggregate that can play a role in providing transportation services so that during its use, it is expected that no fatal damage will occur. To achieve the desired pavement quality, it is necessary to understand the nature and quality of the road pavement constituent materials that will be needed later (Silvia Sukirman, 2003).

Flexible pavement construction is a construction that makes asphalt a binding material (Sukirman, 2003). The pavement layer carries the load and distributes it to the base soil, which consists of several parts, namely the base soil (subgrade), the lower foundation layer (subbase course), the upper foundation layer (base course), the foundation layer (base), the intermediate layer (binder course) and the wear layer.

Also, Salma Alwi et al. (2020), in their study using palm shell ash as a filler, showed that the variation of the mixture of 5% shell ash obtained the highest stability value, which was obtained by 1940kg, and the KAO value of 5.19%.

This study aims to determine the effectiveness of palm shell ash waste as filler and Portland cement on the Marshall test characteristics of AC-BC concrete asphalt mixture and the resulting durability value. This research is expected so that later this palm shell ash can be used as a filler for the AC-BC layer asphalt mixture so that it has better performance.

The problem was obtained, namely determining Kao Marshall's value for the AC-BC mixture. Then, the palm shell ash fillers were added with proportions of 20%, 30%, 40%, 50%, and 60% of the total number of fillers and how the effect of the activity of adding palm shell ash fillers on the durability and Marshall test.

The value of KAO Marshall for a mixture of AC-BC asphalt with palm shell ash fillers in the proportions of 20%, 30%, 40%, 50%, and 60% of the total fillers will be determined. Also, the effect of adding palm shell ash fillers on the durability value and Marshall test. This study may take advantage of the use of palm shell waste wasted from oil management results can be used as a filler for a mixture of AC-BC concrete asphalt.

II. Materials and Methods

A. Material Preparation

Asphalt Concrete is a road pavement composed of asphalt mix and aggregates using additional materials. In ac-BC, pavement layers generally have a minimum thickness of 6 cm, as in Fig. 1. The material used was shell ash waste, which is then carried out the combustion and is made into a filler of asphalt mixture.

Figure 1. (a) Test Objects, (b) Marshall Tests

The combined aggregate gradation expressed by percentage of aggregate weight and filler weight must be within the specified specification limits. This study used a gradation of the middle value of the AC-BC specification, as in Tables 1 and 2.

Table 1. Aggregate Testing Specifications

Test			Test Method	Score
Conservation of aggregate form in solution		Natrium Sulfate	SNI 3407:2008	Max. 12%
		Magnesium Sulfate		Max 18%
Abrasion with LA machine -1	Mixed AC Modification and SMA	100 round	SNI 2417:2008	Max. 6%
		500 round		Max. 30%
	All kinds of other graded asphalt mixes	100 round		Max. 8%
		500 round		Max. 40%
Aggregate adhesion to asphalt			SNI 2439:2011	Min. 95%
Cracked grains in coarse aggregate		SMA	SNI 7619:2012	100/90*)
		other		95/90**)
		SMA	ASTM D 4792-10 Comparis	Mx. 5%
		other		Mx. 10%

			on 1: 5	
Material passes the sieve no. 200			SNI ASTM C 117:2011	Max. 1%

Source: General Specifications of Bina Marga 2018 Division 6 Asphalt Pavement

Table 2. Combined Aggregate Gradation for Paved Mixes

Sieve size		% Weight that passes to the total aggregate
ASTM	**(mm)**	**Laston AC-BC**
1"	25	100
¾"	19	90-100
½"	12,5	75-90
3/8"	9,5	66-82
No. 4	4,75	46-64
No. 8	2,36	30-49
No. 16	1,18	18-38
No. 30	0,600	12-28
No. 50	0,300	7-20
No.100	0,150	5-13
No.200	0,075	4-8

B. Material Preparation

Testing of materials in the form of aggregates, asphalt, and fillers. The aggregate testing included:

1. The specific gravity of absorption of fine and coarse aggregates determines the particular gravity of SSD condition, pseudo-specific gravity, and absorption (absorption). The sum used is passed through a 9.5 mm sieve and retained by a 4.76 mm sieve totaling 5000 grams
2. The selector index was carried out to determine the percent of the number of elliptical grains and flat grains present in one sample of the test object and then compared to the total weight. The sample used was 4000 grams that had been evened and taken randomly.
3. The aggregate wear test to find out the strength of the aggregate against wear with the Los Angeles engine is guided by SNI 2417:2008. The sample used in the amount of 5000 grams, i.e., passed a sieve of 12.7 mm with a sieve of 4.76 mm expressed in the ratio between the weight of the worn aggregate gave sieve No. 12 of the importance of the initial aggregate defined by a percentage, then
4. Sieve analysis.

Also, the asphalt testing includes:

1. Penetration test that carried out to determine the penetration of hard or mushy bitumen by inserting a needle in a sample of a specific size, time, and load.
2. Flashpoint and burn. The asphalt flash point is carried out to get a flash point from oil sparks during maximum heat conditions. Then for the asphalt burn point, which is the exit of fire when the asphalt is heated to a specific temperature after obtaining the flash point.
3. The mushy Point is to know the magnitude of the temperature when the asphalt gains a degree of softening (melting).
4. Daktilitas. The flexibility value of the asphalt is measured from the longest distance and pulled using a ductility device at a speed of 50mm/min at a temperature of 25°C.
5. The specific gravity of asphalt with water along with the same contents. Then finally, the filler testing includes specific gravity and the Atterberg test and analysis.

C. Manufacture of test objects

Manufacture of test objects with the proportion of palm shell ash *fillers* and Portland cement (0%, 20%, 30%, 40%, and 60%) with the Bina Marga method in 2018. Then, manufacturing test objects on filler variations and KAO is optimal in the Marshall tests.

The Marshall Testing and Durability was carried out on a test object given a filler proportion at the optimum KAO level. In addition, immersion in the test sample carried out a Marshall value and durability test. Also, the mixture of test objects and the number of test objects was to determine the properties of the mix and the level of asphalt mixture was on table 3.

Table 3. The test object to determine KAO with Portland Cement filler and AC-BC layer Laston palm shell ash

Palm Shell Ash (%)	Asphalt Content (%)	Sum Test Objects	Total Test Objects
0	(-1%, -0,5%, Pb, +0,5%, 1%)	3	15
20		3	15
30		3	15
40		3	15
50		3	15
60		3	15
Sum			90
KAO optimum		3	9
		3	
		3	
Total Number			99

Table 4. Sample Requirement on IRS Testing 0% shell ash (soak duration 4 hours and 24 hours + 2 hours temperatures 60°C and 25°C)

No	Soaking time	Number of test objects
1	24 hours + 2 hours	3
2	4 hours	3
	Total	6

Table 5. Sample Requirement on IRS Testing 40% shell ash (soaking time 4 hours and 24 hours + 2 hours temperature 60°C and 25°C)

No	Soaking time	Number of test

		objects
1	24 hours + 2 hours	3
2	4 hours	3
	Total	6

III. Results and Discussions

3.1 *Asphalt* test results

The test results of the physical properties of the 60/70 shell pen asphalt include testing of asphalt-specific gravity, penetration, mushy Point, weight loss, and flexibility.

Table 6. Test Results of The Physical Properties of Asphalt

No	Types of Asphalt Testing	Result	Condition	Acceptance
1	Penetration 25°C (mm)	61,97	60-70	Meet
2	Specific Gravity	1,036	≥ 1	Meet
3	Mushy Point (°C)	49	≥ 48	Meet
4	Dactylitis (cm)	110,6	≥ 100	Meet
5	Flash Point	324°C	≥ 232	Meet

3.2 *Aggregate test* results

The aggregate test results aim to determine the physical properties or characteristics of aggregates derived from the Tanjungan area. The test is carried out on coarse and fine aggregates, namely, the aggregate gradation, specific gravity, absorption of fine and coarse aggregates, the alignment, and the wear value or abrasion.

Table 7. Aggregate Test Results

Testing	Result		Condition	Acceptance
	Coarse Aggregates	Fine Aggregates		
Abrasion Test (%)	17,27%		Max 40%	Meet
Alignment and oblong indices (%)	13,62%		Max 25%	Meet
Specific Gravity:				
1. Bulk	2,630	2,642	Min. 2.5%	Meet
2. SSD	2,670	2,656	Min. 2.5%	Meet
3. Apparent	2,720	2,750	Min. 2.5%	Meet
4. % Absorption	2,250	1,100	Max 3% Coarse aggregate	Meet
			Max 5% Fine aggregate	Meet

3.3 *Filler test* results

The test results of asphalt, aggregate, and filler show that the aggregate used has met General Bina Marga 2018 specification in table 6.

Table 8. Filler Test Results

Types of Filler Testing	Result	Condition	Acceptance
BJ Portland Cement	3,15	SNI 03-2460-1991	Meet
BJ Palm Shell Ash	2,611	-	-

Based on the results of filler testing on the specific gravity of the two samples used as a mixture, namely Portland cement and palm shell ash, in the SNI requirements, the particular gravity of Portland cement meets the mix requirements.

Table 9. Laston AC-BC Aggregate Gradation Result Data

Sieve No. (mm)	Central Boundary	% Restrained
25	100	
19	95	5
12,5	82	12,5
9,5	74	8,5
4,75	55	19
2,36	39,5	15,5
1,18	28	11,5
0,6	20	8
0,3	13,5	6,5
0,15	9	4,5
0,075	6	3
0,035	0	6

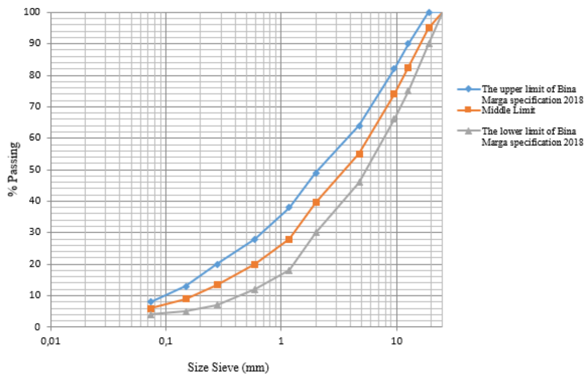

Figure 2. Laston AC-BC Mixed Aggregate Graph

3.4 The result of the calculation of asphalt content (Pb)

After obtaining the previous aggregate percentage, namely the CA gradation of 60.5%, FA of 33.5%, and FF of 6%. The grade of draft asphalt can be calculated using the following equation:

$$Pb = 0.035(\%CA) + 0.045(\%FA) + 0.18(\%FF) + K$$
$$= 0{,}035(60{,}5\%) + 0{,}045(33{,}5\%) + 0{,}18(6\%) + 0{,}75$$
$$= 5{,}455\,\% \approx 5{,}5\%$$

Thus, the variations in asphalt content used for the manufacture of test objects are by taking two ranges of asphalt levels above plan asphalt levels (Pb) and two ranges of asphalt levels below plan asphalt levels (Pb) with a difference of ± 0.5 which can be seen in Table 10.

Table 10. Laston AC-BC Aggregate Gradation Result Data

Asphalt Content (Pb)	Pb - 1%	Pb-0,5%	Pb	Pb+0,5%	Pb+1%
	4,5	5	5,5	6	6,5

3.5The calculation of the manufacture of test sample objects

The aggregate content in the Laston mixture for each asphalt grade is determined from the percentage of aggregate retained on the sieve multiplied by the total weight obtained at each asphalt grade. The aggregate requirement for the Laston mixture using portland cement filler and palm shell ash is as follows.

Table 11. Aggregate Requirement of Laston Filler Mixture 0% Shell Ash

Sieves		%Passing	%Retained	KA 4,5%	KA 5%	KA 5,5%	KA 6%	KA 6,5 %
(Inchi)	(mm)							
				1240,064	1224,367	1208,903	1193,666	1178,652
1"	25,4	100	0	0	0	0	0	0
3/4"	19	95	5	62,003	61,218	60,445	59,683	58,933
1/2"	12,7	82	12,5	155,008	153,046	151,113	149,208	147,331
3/8"	9,5	73	8,5	105,405	104,071	102,757	101,462	100,185
# 4	4,75	55,5	19	235,612	232,630	229,692	226,797	223,944
# 8	2,36	41,8	15,5	192,210	189,777	187,380	185,018	182,691
# 16	1,18	33,15	11,5	142,607	140,802	139,024	137,272	135,545
# 30	0,6	24,35	8	99,205	97,949	96,712	95,493	94,292
# 50	0,3	16,85	6,5	80,604	79,584	78,579	77,588	76,612
# 100	0,15	8,5	4,5	55,803	55,097	54,401	53,715	53,039
# 200	0,075	6	3	37,202	36,731	36,267	35,810	35,360
Pan		0	6	74,404	73,462	72,534	71,620	70,719
0% shell ash				1240,064	1224,367	1208,903	1193,666	1178,652

Table 12. Aggregate Requirement of Laston Filler Mixture 20% Shell Ash

Sieves		%Passing	%Retained	KA 4,5%	KA 5%	KA 5,5%	KA 6%	KA 6,5 %
(Inchi)	(mm)							
1"	25,4	100	0	0	0	0	0	0
3/4"	19	95	5	62,003	61,218	60,445	59,683	58,933
1/2"	12,7	82	12,5	155,008	153,046	151,113	149,208	147,331
3/8"	9,5	73	8,5	105,405	104,071	102,757	101,462	100,185
# 4	4,75	55,5	19	235,612	232,630	229,692	226,797	223,944
# 8	2,36	41,8	15,5	192,210	189,777	187,380	185,018	182,691
# 16	1,18	33,15	11,5	142,607	140,802	139,024	137,272	135,545
# 30	0,6	24,35	8	99,205	97,949	96,712	95,493	94,292
# 50	0,3	16,85	6,5	80,604	79,584	78,579	77,588	76,612
# 100	0,15	8,5	4,5	55,803	55,097	54,401	53,715	53,039
# 200	0,075	6	3	37,202	36,731	36,267	35,810	35,360
Pan		0	6	74,404	73,462	72,534	71,620	70,719
20% shell ash				12,3345	12,17837	12,024557	11,873	11,723658
80% portland cement				59,52308	58,76964	58,027354	57,29599	56,575295

Table 13. Aggregate Needs of Laston Filler Mixture 30% Shell Ash

Sieves		%Passing	%Retained	KA 4,5%	KA 5%	KA 5,5%	KA 6%	KA 6,5 %
(Inchi)	(mm)							
1"	25,4	100	0	0	0	0	0	0
3/4"	19	95	5	62,003	61,218	60,445	59,683	58,933
1/2"	12,7	82	12,5	155,008	153,046	151,113	149,208	147,331
3/8"	9,5	73	8,5	105,405	104,071	102,757	101,462	100,185
# 4	4,75	55,5	19	235,612	232,630	229,692	226,797	223,944
# 8	2,36	41,8	15,5	192,210	189,777	187,380	185,018	182,691
# 16	1,18	33,15	11,5	142,607	140,802	139,024	137,272	135,545
# 30	0,6	24,35	8	99,205	97,949	96,712	95,493	94,292
# 50	0,3	16,85	6,5	80,604	79,584	78,579	77,588	76,612
# 100	0,15	8,5	4,5	55,803	55,097	54,401	53,715	53,039
# 200	0,075	6	3	37,202	36,731	36,267	35,810	35,360
Pan		0	6	74,404	73,462	72,534	71,620	70,719
30% Shell ash				18,50176	18,26756	18,036836	17,8095	17,585488
70% Portland Cement				52,08269	51,42343	50,773935	50,13399	49,503383

Table 14. Aggregate Requirement of Laston Filler Mixture 40% Shell Ash

Sieves		%Passing	%Retained	KA 4,5%	KA 5%	KA 5,5%	KA 6%	KA 6,5 %
(Inchi)	(mm)							
1"	25,4	100	0	0	0	0	0	0
3/4"	19	95	5	62,003	61,218	60,445	59,683	58,933
1/2"	12,7	82	12,5	155,008	153,046	151,113	149,208	147,331
3/8"	9,5	73	8,5	105,405	104,071	102,757	101,462	100,185
# 4	4,75	55,5	19	235,612	232,630	229,692	226,797	223,944
# 8	2,36	41,8	15,5	192,210	189,777	187,380	185,018	182,691
# 16	1,18	33,15	11,5	142,607	140,802	139,024	137,272	135,545
# 30	0,6	24,35	8	99,205	97,949	96,712	95,493	94,292
# 50	0,3	16,85	6,5	80,604	79,584	78,579	77,588	76,612
# 100	0,15	8,5	4,5	55,803	55,097	54,401	53,715	53,039
# 200	0,075	6	3	37,202	36,731	36,267	35,810	35,360
Pan		0	6	74,404	73,462	72,534	71,620	70,719
40% Shell ash				24,67	24,36	24,05	23,75	23,45
60% portland cement				44,64	44,08	43,52	42,97	42,43

Table 15. Aggregate Requirement of Laston Filler Mixture 50% Shell Ash

Sieves		%Passing	%Retained	KA 4,5%	KA 5%	KA 5,5%	KA 6%	KA 6,5 %
(Inchi)	(mm)							
1"	25,4	100	0	0	0	0	0	0
3/4"	19	95	5	62,003	61,218	60,445	59,683	58,933
1/2"	12,7	82	12,5	155,008	153,046	151,113	149,208	147,331
3/8"	9,5	73	8,5	105,405	104,071	102,757	101,462	100,185
# 4	4,75	55,5	19	235,612	232,630	229,692	226,797	223,944
# 8	2,36	41,8	15,5	192,210	189,777	187,380	185,018	182,691
# 16	1,18	33,15	11,5	142,607	140,802	139,024	137,272	135,545
# 30	0,6	24,35	8	99,205	97,949	96,712	95,493	94,292
# 50	0,3	16,85	6,5	80,604	79,584	78,579	77,588	76,612
# 100	0,15	8,5	4,5	55,803	55,097	54,401	53,715	53,039
# 200	0,075	6	3	37,202	36,731	36,267	35,810	35,360
Pan		0	6	74,404	73,462	72,534	71,620	70,719
50% Shell ash				30,84	30,45	30,06	29,68	29,31
50% portland cement				37,20	36,73	36,27	35,81	35,36

Table 16. Aggregate Requirement of Laston Filler Mixture 60% Shell Ash

Sieves		%Passing	%Retained	KA 4,5%	KA 5%	KA 5,5%	KA 6%	KA 6,5 %
(Inchi)	(mm)							
1"	25,4	100	0	0	0	0	0	0
3/4"	19	95	5	62,003	61,218	60,445	59,683	58,933
1/2"	12,7	82	12,5	155,008	153,046	151,113	149,208	147,331
3/8"	9,5	73	8,5	105,405	104,071	102,757	101,462	100,185
# 4	4,75	55,5	19	235,612	232,630	229,692	226,797	223,944
# 8	2,36	41,8	15,5	192,210	189,777	187,380	185,018	182,691
# 16	1,18	33,15	11,5	142,607	140,802	139,024	137,272	135,545
# 30	0,6	24,35	8	99,205	97,949	96,712	95,493	94,292
# 50	0,3	16,85	6,5	80,604	79,584	78,579	77,588	76,612
# 100	0,15	8,5	4,5	55,803	55,097	54,401	53,715	53,039
# 200	0,075	6	3	37,202	36,731	36,267	35,810	35,360
Pan		0	6	74,404	73,462	72,534	71,620	70,719
0% Shell ash				1240,064	1224,367	1208,903	1193,666	1178,652
60% Shell ash				24,67	24,36	24,05	23,75	23,45
40% Portland cement				44,64	44,08	43,52	42,97	42,43

3.6Analysis of the Effect of Marshall Test on Palm Shell Ash as a Filler

In the Marshall test analysis, using palm shell ash dramatically affects the value of KAO. The more use of palm shell ash as a filler substitution, the higher the optimum asphalt content value. From the calculation results, it was found that the KAO value increased with every addition of shell ash percent, KAO obtained at a 0% filler variation of 5.65 increased by 0.88% to 5.7 at a filler content of 20%, increased by 0.44% to 5.725 at a filler content of 30%, increased by 0.436% to 5.75 at a filler content of 40%, increased by 4.3% to 6 at a filler content of 50% and increased by 1.67% to 6.1 at a filler content of 60%. Therefore, the best stability value was obtained at %shell ash filler with 40% shell ash content with a KAO value of 5.75%, which will be used to determine the optimum KAO value through Marshall testing. The following can be seen in figure 3 that the filler content (%) affects the value of its stability.

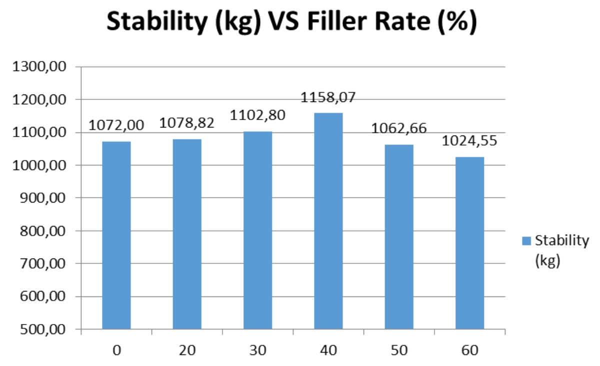

Figure 3. Graph of the Relationship Between Palm Shell Ash and Stability Values

From the test results obtained the relationship between shell ash and Marshall stability value, the graph above shows the Marshall stability value with six variations of palm shell ash filler getting stability value results exceeding specifications, namely min. 800 kg. At filler levels of 0% to 40%, the stability value increases, then at filler levels of 50% and 60% decreases. From the chart above, it can be seen that the highest stability value occurs at a filler content of 40%.

3.7 Comparison of Test Results Using Palm Shell Ash Against Previous Studies

Based on the results of tests that previous studies have carried out by Salma Alwi et al. (2020), for the optimum asphalt content value produced by previous studies and the author does not much different name in the previous research, the KAO was 5.19 while the author was 5.75 following the specifications of Bina Marga in 2018, as on the following table.

Table 17. Previous Research Results and Authors

Marshall Characteristics	Previous Research	Author's Research
Optimum Asphalt Content (%)	5,19	5,75
Up to Elephants (%)	2, 3, 4, 5, 6	0, 20, 30, 40, 50, 60
Stability (kg)	1940	1225
VIM (%)3,80	3,80	3,51
VMA (%)	14,80	16,42
VFA (%)73	73	75,77
MQ (kg/mm)	560	340
Flow (mm)	3,5	3,38
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Flow (mm)	3,5	3,38

Furthermore, using different filler levels (%), both still produce stability values that are not much different. Thus, the previous study and the authors for the stability value met the specification standards determined by Bina Marga in 2018, namely a minimum of 800 kg.

3.8 Index of Retained Strength (IRS) Test Results on Filler Variations of 0% and 40% Palm Shell Ash

Durability is the ability of pavements to withstand traffic loads without damage and wear and tear due to weather and climate influences such as water, air, and temperature. The 0% content was carried out in the IRS test using a KAO value of 5.6%. Therefore, for IRS test results can be seen in table 18.

Table 18. IRS Test Results filler content of 0% palm shell ash

Asphalt Content	Test Object Number	Length of Soaking	Immersion Temperature	Stability (Kg)	IRS results (%)
5,6%	1	4 hours	25°C	1290,94	98,43
	2	4 hours		1548,96	
	3	4 hours		1526,25	
	Average			1455,39	
	4	24 hours + 2 hrs.	60°C + 25°C	1315,38	
	5	24 hours + 2 hrs.		1329,54	
	6	24 hours + 2 hrs.		1652,67	
	Average			1432,53	

Based on the results of the Index *of Retained Strength* (IRS) research test, it was obtained 98.43%, so this value is still included in the Y2018 of Bina Marga specification value, which is determined by a minimum limit value of 90%.

IV. Conclusions

From the results of the study, it was concluded that the results of tests conducted using palm shell ash as a filler could increase the value of KAO at 0% KAO shell ash 5.6%, 20% KAO shell ash 5.7%, 30% KAO shell ash 5.725%, 40% KAO shell ash 5.75%, 50% KAO shell ash 6%, and 60% KAO shell ash 6.1%. This shows that asphalt mixture using palm shell ash requires high levels of asphalt to meet Marshall's characteristics. In addition, although the results of the soaking test conducted obtained the results of the IRS value on 0% shell ash with a value of 98.43% greater than 40% shell ash, which is 91.13%, this result as a whole shows that the use of palm shell ash in asphalt mixture still meets the minimum requirements of Bina Marga 2018, which is 90%.

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