

THE EFFECT OF COCONUT SHELL CHARCOAL POWDER WASTE AS A FINE AGGREGATE SUBSTITUTION IN ASPHALT CONCRETE WEARING COURSE MIXTURE

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ABSTRACT

Laston, commonly known as AC (Asphalt Concrete) in Indonesia, is a type of asphalt concrete with continuous gradation designed to handle large traffic volumes. According to Waani (2013), stability is the main characteristic that makes laston a vital component. This study examines the use of coconut shell charcoal, previously considered waste, as an environmentally friendly additive. Coconut shells and rock ash are used as fillers in asphalt mixtures. It is important to test asphalt containing coconut shell charcoal to evaluate changes in its properties. The performance of asphalt mixtures, including flow, stability, VIM, VMA, Marshall Quotient, VFA, and durability values are expected to increase with the addition of coconut shell charcoal. The results of the Marshall characteristic analysis of the AC-WC mixture with a filler variation of 25% substituted with coconut shell charcoal powder are 2487 kg for stability, 36.51% for VMA, 3.35 mm for flow, 26.19% for VIM, and 742 kg/mm for MQ, all of which have met the specifications. However, the 2018 Bina Marga standard was not met by the VFB value of 28.27%. On the other hand, the variation of 50% coconut shell charcoal powder produced a stability value of 2568 kg, an MQ value of 756 kg/mm, a VMA value of 37.31%, a flow value of 3.4 mm, and a VIM value of 27.12%, all of which were still within the acceptable range. However, the VFB value of 27.31% did not meet the 2018 Bina Marga requirements. The findings of the mixture design presentation for cement filler are as follows: 17% for hot bin I, 45% for hot bin II, 32% for hot bin III, 6% for cement filler, and 6% for asphalt.

Keywordss: Asphalt Concrete Wearing Course, Coconut Shell, Charcoal, Waste.

INTRODUCTION

Laston, commonly known as AC (Asphalt Concrete) in Indonesia, is a type of asphalt concrete with continuous gradation designed to handle large traffic volumes. According to Waani (2013), stability is the main characteristic that makes laston a vital component. This study examines the use of coconut shell charcoal, previously considered waste, as an environmentally friendly additive. Coconut shells and rock ash are used as fillers in asphalt mixtures. It is important to test asphalt containing coconut shell charcoal to evaluate changes in its properties. The performance of asphalt mixtures, including flow, stability, VIM, VMA, Marshall Quotient, VFA, and durability values are expected to improve with the addition of coconut shell charcoal.

METHODS

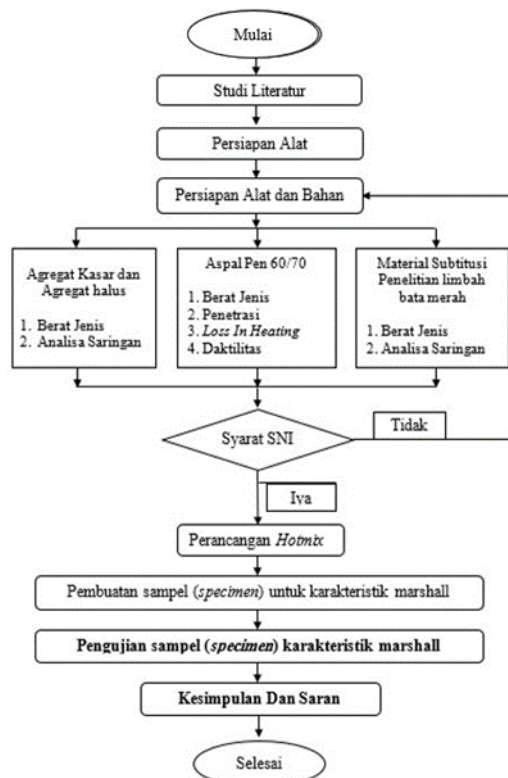


Figure 1. Research Flowchart

This research was conducted from May to June 2024 at the Asphalt Laboratory, Civil Engineering Department, Faculty of Engineering, Krisnadwipayana University in Jakarta. This study tested the asphalt concrete wearing course with variations in the use of coconut shell charcoal as a filler. The filler applied must be free from contaminants and able to pass sieve No. 200. The filler material must be non-lumpy and dry. In this study, the filler used has successfully passed sieve No. 200. In this study, the equipment used included a digital scale, digital sieve, oven with a temperature of $110 \pm 5^{\circ}$ Celsius, standard sieve, asphalt ductility tester, pycnometer, thermometer, stopwatch, soaking tub, electric stove, mold, extruder, marshall tester, compactor hammer, and instruments to measure specific gravity and absorption in coarse aggregate.



Figure 2. Specific Gravity & Absorption Of Coarse Aggregate



Figure 3. Digital Filter



Figure 4. Soaking Tank



Figure 5. Pycnometer

RESULTS AND DISCUSSION

The asphalt test analysis conducted at the Krisnadwipayana University Asphalt Laboratory based on the 2018 Bina Marga General Specifications is shown in table 5 below:

Table 5. Recap of Total Results of Pertamina Pen 60/70 Asphalt Tests

Pengujian	Satuan	Metode	Syarat	Hasil	Keterangan
Penetrasi	mm	SNI 06-2456-1991	60-70	63,5	Memenuhi
Berat Jenis	1	SNI 06-2488-1991	Min 1	1,029	Memenuhi
Kehilangan Berat	%	SNI 06-2441-1991	Maks. 0,8	0,33%	Memenuhi
Daktilitas	cm	SNI 06-2432-1991	Min 100 cm	126,8	Memenuhi

Asphalt hardness testing is carried out using a penetrometer, which measures the penetration depth of a 1 mm needle weighing 100 grams for 5 seconds, at a standard temperature of 25°C

Table 6. Penetration Analysis Test of Pertamina Pen 60/70 Asphalt

Penetrasi Aspal Pertamina AC Pen 60/70	
Penetrasi pada suhu 25 °C 500 gr, 5 Detik	
Percobaan I	Percobaan II
62	65
Rata-rata (mm) 63,5 mm	
Pengujian ini sesuai dengan Spesifikasi Umum Bina Marga 2018 yang merujuk dari SNI 06-2456-1991	

Table 7. Asphalt Ductility Analysis Test

Pengujian	I	II	III
Pengamatan setelah 5 menit (cm)	20,5	20,5	20,5
Pengamatan setelah 10 menit (cm)	45,0	45,0	45,0
Pengamatan setelah 15 menit (cm)	69,5	69,5	69,5
Pengamatan setelah 20 menit (cm)	85,8	93,8	93,8
Pengamatan setelah 25 menit (cm)	-	118,2	115,2
Daktilitas (cm)	-	138,4	115,2
Selisih maximum dari pengujian (cm)	-	23,2	
Daktilitas rata-rata (cm)	126,8		
Pengujian ini sesuai dengan Spesifikasi Umum Bina Marga 2018 yang merujuk dari SNI 06-2432-1991			

The AC-WC asphalt concrete layer is the top pavement layer that acts as a wearing layer. This study utilizes coconut shell charcoal powder as a substitute for sand in the asphalt concrete mixture. To ensure the quality of the material, asphalt composition testing and examination were carried out. This discussion will present the results of material testing and asphalt concrete stability using the Marshall method. Based on the test results, the specific gravity of asphalt in this study was 1.03 gr/cm³. The results of this specific gravity have met the established standards, so this asphalt is suitable for use as a laston forming component.

Table 8. Asphalt Specific Gravity Analysis Test

Temperatur Ruangan : 31° C		Air : 25° C	Oven : 105° C	Kelembaban : 55° C	
Contoh :					
1	Nomor Pemeriksaan		I	II	
2	Berat <u>Picometer</u> (W1) (CC)		28,28	<u>Gr</u>	27,00 <u>gr</u>
3	Berat <u>Picometer</u> + Contoh (W2) (CC)		44,23	<u>Gr</u>	42,92 <u>gr</u>
4	Berat <u>Pic</u> + Contoh + Air (W3) (CC)		52,78	<u>Gr</u>	53,08 <u>gr</u>
5	Berat <u>Pic</u> + Air (W4) (CC)		52,32	<u>Gr</u>	52,58 <u>gr</u>
6	$\frac{W_2 - W_1}{W_3 - W_1} \times \frac{W_4 - W_1}{W_2 - W_1}$		1,030	<u>Gr</u>	1,032 <u>gr</u>
7	Selisih Hasil Pengujian		0,002 <u>gr</u>		
8	Hasil Rata-Rata		1,03 <u>gr</u>		

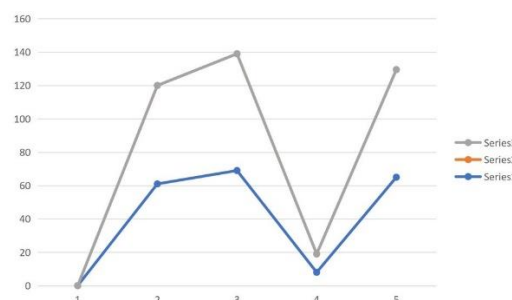


Figure 6. Asphalt Penetration Analysis Test Graph

The composition of the asphalt mixture plan in the Laboratory of the Faculty of Civil Engineering, Krisnadwipayana University includes hot bin I 42%, hot bin II 37%, hot bin III 20%, cement filler 1%, and asphalt content 5.7%.

Table 9. Cement Filler Design Results

Material		Kadar	
Kadar Aspal Optimum		6	%
Berat Sampel		1200	Gram
Berat Kadar Aspal Optimum		7,200	Gram
Berat Agregat Kasar	(Hot Bin I) : 17%	204	Gram
Berat Agregat Sedang	(Hot Bin II) : 45%	540	Gram
Berat Agregat Halus	(Hot Bin III) : 32%	384.0	Gram
Filler Semen	: 6%	72	Gram
Filler (Serbuk arang batok kelapa)	: 0%	0	Gram
Total :		1,200	Gram

Table 10 Results of 25% Coconut Shell Charcoal Powder Filler Design

Material		Kadar	
Kadar Aspal Optimum		6	%
Berat Sampel		1200	Gram
Berat Kadar Aspal Optimum		7,200	Gram
Berat Agregat Kasar	(Hot Bin I) : 17%	204	Gram
Berat Agregat Sedang	(Hot Bin II) : 45%	540	Gram
Berat Agregat Halus	(Hot Bin III) : 32%	384.0	Gram
Berat Filler Total	: 6%	72.0	Gram
Filler (Semen) dari Berat Total Filler	: 60%	43.20	Gram
Filler (Serbuk arang batok kelapa) dari Berat Total Filler	: 25%	28.80	Gram
Total :		1,200	Gram

Table 11 Results of 50% Coconut Shell Charcoal Powder Filler Design

Material		Kadar	
Kadar Aspal Optimum		66	%
Berat Sampel		1200	Gram
Berat Kadar Aspal Optimum		79,200	Gram
Berat Agregat Kasar	(Hot Bin I) : 17%	204	Gram
Berat Agregat Sedang	(Hot Bin II) : 45%	540	Gram
Berat Agregat Halus	(Hot Bin III) : 32%	384.0	Gram
Berat Filler Total	: 6%	72.0	Gram
Filler (Semen) dari Berat Total Filler	: 20%	14.4	Gram
Filler (Serbuk arang batok kelapa) dari Berat Total Filler	: 50%	57.6	Gram
Total :		1,200	Gram

CONCLUSIONS

The results of the Marshall characteristic analysis of the AC-WC mixture with a filler variation of 25% substituted with coconut shell charcoal powder are 2487 kg for stability, 36.51% for VMA, 3.35 mm for flow, 26.19% for VIM, and 742 kg/mm for MQ, all of which have met the specifications.

However, the 2018 Bina Marga standard is not met by the VFB value of 28.27%. On the other hand, the variation of 50% coconut shell charcoal powder produces a stability value of 2568 kg, an MQ value of 756 kg/mm, a VMA value of 37.31%, a flow value of 3.4 mm, and a VIM value of 27.12%, all of which are still within the acceptable range.

However, the VFB value of 27.31% does not meet the requirements of Bina Marga 2018. The findings of the mix design presentation for cement filler are as follows: 17% for hot bin I, 45% for hot bin II, 32% for hot bin III, 6% for cement filler, and 6% for asphalt.

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