

THE EFFECT OF GREEN SHELL POWDER WASTE AS A SUBSTITUTE FOR FINE AGGREGATE IN ASPHALT CONCRETE WEARING COURSE MIXTURE

Daniel Simatupang¹, Sahat Martua Sihombing², Achmad Pahrul Rodji³

^{1,2,3}Department of Civil Engineering, Krisnadwipayana University
Email : daniel.togatorop15@gmail.com

ABSTRACT

Waste, the residue of production that has lost its primary purpose, including garbage and wastewater, is a global problem due to its potential for contamination and the spread of disease. In Indonesia, it is estimated that around 21.88 million tons of waste will be produced in 2021. To address this problem, it is important to find ways to reduce waste, such as using it in asphalt production. In an effort to create a more durable road pavement, researchers have experimented with mussel waste as an additive to improve asphalt quality. This study examined the use of mussel waste to replace fine aggregate in asphalt concrete layers, in the hope of extending the life of the road. When mussel waste powder was substituted for 25% filler in the Asphalt Concrete-Wearing Concrete mixture, Marshall characteristic analysis resulted in a stability value of 2487 kg, VMA 36.51%, flow 3.35 mm, VIM 26.19%, and MQ 742 kg/mm, all of which met the requirements. However, the VFB value of 28.27% does not meet the requirements of Bina Marga 2018. The combination produces a stability value of 2568 kg, VMA 37.31%, flow 3.4 mm, VIM 27.12%, and MQ 756 kg/mm in the variation of green mussel powder waste 50%, all of which meet the requirements. However, the VFB value of 27.31% does not meet the requirements of Bina Marga 2018. The mixture design with the results of the cement filler presentation shows the following composition: 17% for hot bin I, 45% for hot bin II, 32% for hot bin III, 6% for cement filler, and 6% for asphalt.

Keywords: Asphalt Concrete Wearing Course, Green Mussel Shells, Waste.

INTRODUCTION

Waste, the residue of production that has lost its original purpose, including garbage and wastewater, is a global problem due to its potential for contamination and the spread of disease. In Indonesia, it is estimated that around 21.88 million tons of waste will be produced in 2021. To address this problem, it is important to find ways to reduce waste, such as using it in asphalt production. In an effort to create more durable road pavements, researchers have experimented with mussel waste as an additive to improve asphalt quality. The study examined the use of mussel waste to replace fine aggregate in asphalt concrete layers, in the hope of extending the life of the road.

METHODS

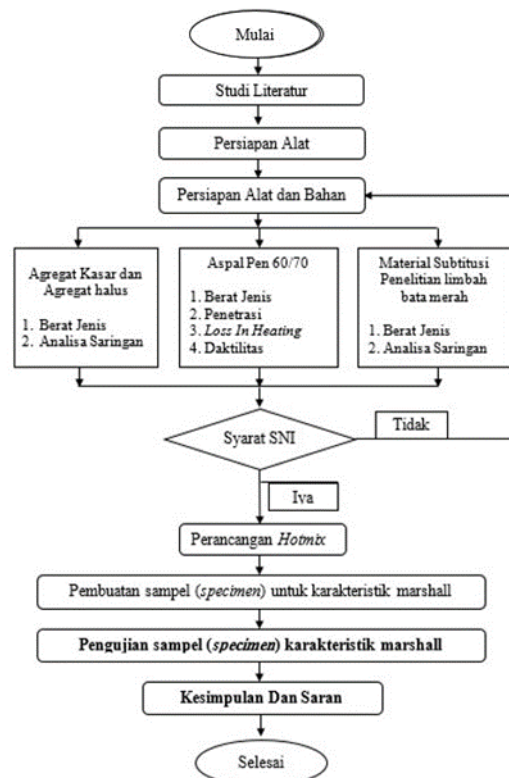


Figure 1. Research Flowchart

This research was conducted from May to June 2024 at the Asphalt Laboratory, Civil Engineering Department, Faculty of Engineering, Krisnadwipayana University, Jakarta. This study tested the asphalt concrete wearing course with variations in the use of fish bone powder waste as a filler. The filler used must be free from unwanted materials and must be able to pass through sieve No. 200. Furthermore, the filler used must be non-muddy and in dry condition. In this study, the filler used successfully passed through sieve No. 200. The specifications of the filler have been described in accordance with SNI 1994 and are presented in Table 4 below:

Table 4. Mineral Requirements for Filler Materials

No.	Karakteristik	StandarPengujian	Satuan	Spesifikasi	
	Filler			Min.	Maks.
1	Material yang lolos saringanNo.200	SK SNIM-02-1994-03	%	70	-
2	Berat Jenis	AASHTO T-85 -81		-	-

In this study, the equipment used included digital scales, digital sieves, ovens with a temperature of $110\pm 5^{\circ}\text{C}$, standard sieves, asphalt ductility testers, pycnometers, thermometers, stopwatches, soaking tubs, electric stoves, molds, extruders, Marshall testers, compaction hammers, and instruments for measuring specific gravity and absorption in coarse aggregates.



Figure 2. Specific Gravity & Absorption Of Coarse Aggregate



Figure 3. Digital Filter



Figure 4. Soaking Tank

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. Recapitulation of Pertamina Pen 60/70 Asphalt Test Results

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 Testing 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 Testing

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			

Table 8. Composition of AC-WC Asphalt Samples

Material	Berat (gram)	Persentase (%)	Berat (gram)	Berat (gram)
Sampel	1200			
Kadar Aspal 6%		6%	72	72
Agregat Kasar 40%		40%	480	480
Agregat Halus 52%		52%	624	624
Filler Semen 2%		2%	24	24
100%				1200

Kadar Aspal 6%				
			Berat (gram)	Kumulatif (gram)
Agregat Kasar 40%		Agregat Kasar	72,00	72,0
Agregat Halus 52%		Agregat Halus	480,00	552,0
Filler Semen 2%		Filler Semen	624,00	1176,0
		Aspal	24,00	1200

Table 9. Composition of AC-WC Asphalt Samples, Variation 1, Mixture of Green Mussel Shell Waste 30% of Fine Aggregate Weight

Material	Berat (gram)	Persentase (%)	Berat (gram)	Berat (gram)
Sampel	1200			
Kadar Aspal 6%		6%	72	72
Agregat Kasar 40%		40%	480	480
Agregat Halus 52%		36%	436,8	436,8
Filler Semen 2%		2%	24	24
Variasi 1 (CKH) 30% (AH)		16%	187,2	187,2
				1200

Kadar Aspal 6%				
			Berat (gram)	Kumulatif (gram)
Agregat Kasar 40%		Agregat Kasar	480,00	480,0
Agregat Halus 36%		Agregat Halus	436,80	916,8
Filler Semen 2%		Filler Semen	24,00	940,8
Variasi 1 (CKH) 16%		Variasi 1 (CKH)	187,20	1128
		Aspal	72	1200

Table 10. Composition of AC-WC Asphalt Samples, Variation 2, Mixture of Green Mussel Shell Waste 60% of Fine Aggregate Weight

Material	Berat (gram)	Persentase (%)	Berat (gram)	Berat (gram)
Sampel	1200			
Kadar Aspal 6%		6%	72	72
Agregat Kasar 40%		40%	480	480
Agregat Halus 52%		21%	249,6	249,6
Filler Semen 2%		2%	24	24
Variasi 2 (CKH) 60% (AH)		31%	374,4	374,4
				1200

Kadar Aspal 6%				
			Berat (gram)	Kumulatif (gram)
Agregat Kasar 40%		Agregat Kasar	480,00	480,0
Agregat Halus 21%		Agregat Halus	249,60	729,6
Filler Semen 2%		Filler Semen	24,00	753,6
Variasi 2 (CKH) 31%		Variasi 2 (CKH)	374,40	1128
		Aspal	72	1200

Table 11. Composition of AC-WC Asphalt Samples, Variation 3, Mixture of Green Mussel Shell Waste 90% of Fine Aggregate Weight

Material	Berat (gram)	Persentase (%)	Berat (gram)	Berat (gram)
Sampel	1200			
Kadar Aspal 6%		6%	72	72
Agregat Kasar 40%		40%	480	480
Agregat Halus 52%		5%	62,4	62,4
Filler Semen 2%		2%	24	24
Variasi 3 (CKH) 90% (AH)		47%	561,6	561,6
				1200

Kadar Aspal 6%				
			Berat (gram)	Kumulatif (gram)
Agregat Kasar 40%		Agregat Kasar	480,00	480,0
Agregat Halus 5%		Agregat Halus	62,40	542,4
Filler Semen 2%		Filler Semen	24,00	566,4
Variasi 3 (CKH) 47%		Variasi 3 (CKH)	561,60	1128
		Aspal	72	1200

Table 12. AC-WC Research Results on Asphalt Content

Tabel Hasil Penelitian AC-WC Kadar Aspal 5%, 6%, dan 7% Limbah Cangkang Kerang Hijau Varian 0%, 30%, 60%, dan 90%				
Kadar Aspal	Normal	30% Cangkang Kerang Hijau	60% Cangkang Kerang Hijau	90% Cangkang Kerang Hijau
6%	Stability = 1676,7 kg	Stability = 1360,2 kg	Stability = 1076,4 kg	Stability = 1076,4 kg
	Flow = 3,3 mm	Flow = 4,6 mm	Flow = 5,3 mm	Flow = 5,6 mm
	VIM = 4,46%	VIM = 31,88%	VIM = 34,15%	VIM = 30,86%
	VMA = 15,72%	VMA = 6,20%	VMA = 9,32%	VMA = 4,79%
	VFA = 71,92%	VFA = 104,1%	VFA = 102,7%	VFA = 105,44%
	MQ = 205,06 kg/mm	MQ = 278,79 kg/mm	MQ = 205,06 kg/mm	MQ = 191,61 kg/mm

CONCLUSIONS

When green mussel powder waste is substituted for 25% filler in the Asphalt Concrete-Wearing Concrete mixture, Marshall characteristic analysis produces a stability value of 2487 kg, VMA 36.51%, flow 3.35 mm, VIM 26.19%, and MQ 742 kg/mm, all of which meet the requirements. However, the VFB value of 28.27% does not meet the requirements of Bina Marga 2018. The combination produces a stability value of 2568 kg, VMA 37.31%, flow 3.4 mm, VIM 27.12%, and MQ 756 kg/mm in the variation of 50% green mussel powder waste, all of which meet the requirements. However, the VFB value of 27.31% does not meet the requirements of Bina Marga 2018. The mixture design with the results of the cement filler presentation shows the following composition: 17% for hot bin I, 45% for hot bin II, 32% for hot bin III, 6% for cement filler, and 6% for asphalt.

REFERENCES

- Sihombing, S., Rodji, A. P., & Akbar, J. A. (2019, July). Analisis Penggunaan Serbuk Batu Karang sebagai Filler pada Campuran Asphalt Concrete-Wearing Course (AC-WC). In *Prosiding Seminar Nasional Teknologi Universitas Krisnadwipayana* (pp. 368-375).
- Rumbyarso, Y. P. A., & Ulum, R. B. (2021). Analisis Pengaruh Penggunaan Cangkang Telur Bebek Ras Petelur Sebagai Filler Pada Campuran Aspal Beton. *Jurnal Teknologika*, 11(2), 115-124.