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# Experimental study on marshall stability and flow of Asphalt Concrete Wearing Course (AC-WC) mixture using Asbuton semi extracted as binder

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**Abstract.** This study is a part of an on going research program to optimize the utilization of the huge deposit of natural asphalt in several areas in Buton Island, Indonesia. In asphalt production processes it is important to think about energy savings and environmental benefits. Production of AC-WC mixture using Asbuton semi extracted bitumen is one of the efforts to reduce energy consumption. Asbuton modification is a semi extracted bitumen produced from Buton natural rock asphalt, it can be used as a binder material in asphalt mixture. This paper presents Marshall test that was performed on AC-WC mixture using Asbuton semi extracted as binder. The result of Marshall test shows the sufficient stability and resistance to deformation can be established by aggregate interlocking and cohesion which developed due to the Bitumen in Asbuton semi extracted.

## 1. Introduction

Asphalt mixtures, commonly called asphalt concrete in the United States, are composite materials commonly used in surface roads, parking lots, and airports. Asphalt concrete consists of aggregate and asphalt/bitumen laid in layers and then compacted. Bitumen acts as binder to bind the aggregates together.

In the southern area of Buton island, Indonesia posses a deposit of the sedimentary rock containing hydrocarbon substances. The natural rock asphalt resources are approximately 60,991,554,38 tons (24,352,833,07 barrel oil equivalent) [1]. Natural rock asphalt is composed of approximately 30% bitumen and 70% mineral. In recent years, the refining process has been developed to extract and recover the bitumen out of the rock to produce pure bitumen [2,3].

In this present paper, an asphalt concrete wearing course made with Asbuton semi extracted type Retona Blend 55 mixture production according to Bina Marga, Indonesia requirement. The objective of this paper is to study the influence of Asbuton modification mixtures containing petroleum bitumen and Asbuton semi extracted on the Marshall stability and flow.

## 2. Material and methods

### 2.1. Retona blend 55

Table 1 shows the characteristics of Asbuton modification, Retona Blend 55 used this research. The table shows the kind of testing including the penetration, softening point, ductility, flash, specific



gravity, weight loss, and penetration. The table is used to design the material mixture for each graded and mixture.

**Table 1.** Design of the HRS-WC mixture for Gap-graded and Half Gap-graded mixture.

No.	Kinds of Testing	Testing Result
1	Penetration before weight loss (mm)	78.6
2	Softening point (°C)	52
3	Ductility in 25°C, 5cm/menit (cm)	114
4	Flash point (°C)	280
5	Spesific gravity	1.12
6	Weight loss	0.5
7	Penetration after weight loss (mm)	86

### 2.2. Characteristics of aggregates

Two fractions of coarse aggregates derived from crushed river stone were used: one with aggregate diameter 5-10 mm and the other with crushed stone diameter 10-20 mm. River sand and stone dust obtained from the stone crushing process were used as fine aggregate and filler, respectively. The properties of coarse aggregates, fine aggregate and filler are shown in Table 2, Table 3 and Table 4, respectively. The aggregates used for material components in the cold mixture were collected from the Jeneberang river in Gowa.

**Table 2.** Properties of coarse aggregate.

Properties	(Crushed Stone)	
	0,5 - 1 (cm)	1 - 2 (cm)
Water absorption, %	2.071	2.08
Bulk specific gravity	2.622	2.627
Saturated surface dry specific gravity	2.677	2.682
Apparent specific gravity	2.773	2.779
Flakiness index, %	20.1	9.38
Abrasion aggregate, %	25.72	24.36

**Table 3.** Properties of coarse aggregate.

Water Absorption, %	2.792	
Sand Equivalent, %	89.66	
Bulk spesific gravity	Saturated surface dry specific grafity	Apparent specific gravity
2.449	2.518	2.629

**Table 4.** Properties of mineral filler.

Water Absorption, %	2.283	
Sand Equivalent, %	69.57	
Bulk spesific gravity	Saturated surface dry specific grafity	Apparent specific gravity
2.595	2.654	2.758

2.3. Combined aggregate gradation and mixtures design

The combined aggregate gradation is shown in Fig. 1. The combined aggregate gradation was kept. The mixtures were all prepared in the laboratory. The content of asphalt Retona Blend 55 was 5.0%, 5.5%, 6.0%, 6.5%, 7.0% and 7.5% of the total weight of the mixture. Table 5 shows the mixture by weight of AC-WC mixture. Retona Blend 55, aggregates and filler were mixed and compacted into the cylindrical mold with a capacity of 1,200 gram and diameter of 101.6 mm. In the laboratory, the aggregate and binder (Retona Blend 55) were respectively mixed and compacted at  $150 \pm 0.5^\circ\text{C}$ . The specimens were compacted with 75 blows each face by using Marshall compactor. After compaction, the specimens were removed from the molds and allowed to cool down. Mixing and compaction process was carried out in the laboratory at temperature room  $27^\circ\text{C}$ .

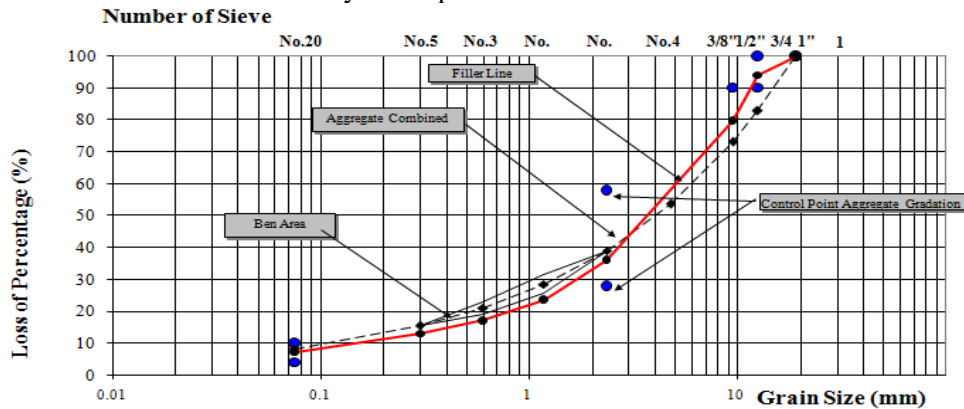


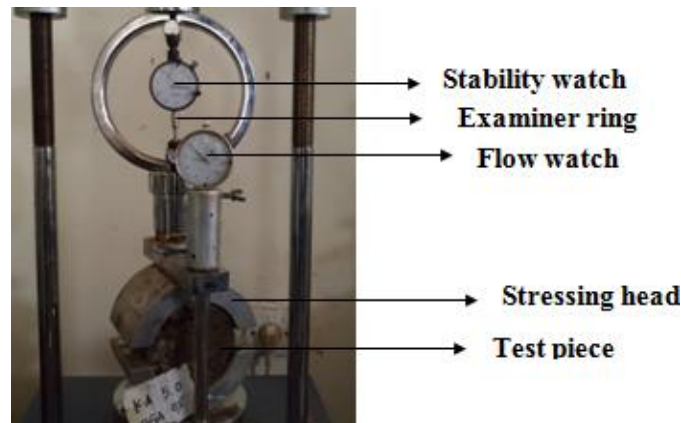
Figure 1. Combined aggregates gradation.

Table 5. Asphalt mixture by weight (1,200 gram)

No	Description	Unit	Asbuton Modification Content (%)							
			5.0	5.5	6.0	6.5	7.0	7.5		
A	Asbuton modification weight	gr	60	66	72	78	84	90		
B	Combined aggregates gradation		Weight of Aggregate by Number of Sieve							
	Number of sieves	% Loss	% Restrained							
1	3/4"	100.00	0.00	gr	-	-	-	-	-	
2	1/2"	96.00	4.00	gr	45.62	45.38	45.14	44.90	44.66	44.42
3	3/8"	86.93	9.07	gr	103.39	102.85	102.31	101.76	101.22	100.67
4	No. 4	63.90	2.03	gr	262.50	261.12	259.74	258.36	256.98	255.60
5	No. 8	43.56	20.34	gr	231.82	230.60	229.38	228.16	226.94	225.72
6	No. 16	28.62	14.94	gr	170.34	169.44	168.54	167.65	166.75	165.85
7	No. 30	20.75	7.87	gr	89.68	89.21	88.74	88.27	87.79	87.32
8	No. 50	15.59	5.16	gr	58.84	58.53	58.22	57.91	57.60	57.29
9	No. 200	8.42	7.17	gr	81.76	81.33	80.90	80.47	80.04	79.61
10	PAN	0.00	8.42	gr	96.03	95.53	95.02	94.52	94.01	93.51
	Total		<b>100.00</b>	gr	1,140	1,134	1,128	1,122	1,116	1,100
C	Total Weight of Test Piece	gr			1,200	1,200	1,200	1,200	1,200	1,200

**2.4. Stability test**

This study is based on laboratory experimental work. The samples were prepared using the Marshall Test method in accordance with SNI 06-2489-1991. In the stability test, the specimens were prepared with the specified temperature by immersing in a water bath at a temperature of  $60^{\circ}\text{C} \pm 1^{\circ}\text{C}$  for a period of 30 minutes. It was then placed in the Marshall Stability testing machine and loaded at a constant rate of deformation of 50.8 mm/minute until the maximum load was reached. Figure 2 shows the Marshall stability test equipment.

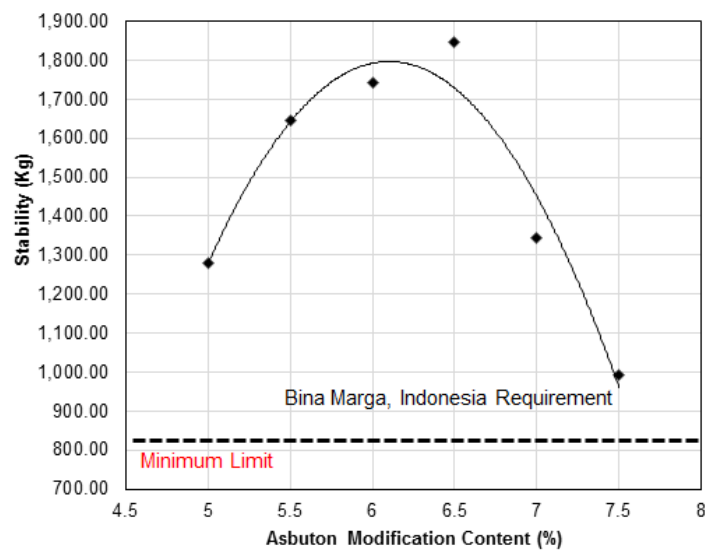


**Figure 2.** Marshall stability test equipment.

**3. Results and discussion**

**3.1. Relationship of Asbuton Modification Content With Stability**

Based on the results of the Marshall test, the relationship between modified Asbuton contents and stability values is shown in Figure 3. The test results show that when the bitumen content increases, the stability value also increases until it reaches an optimum value when the asphalt content is at the optimum content of asphalt content. The highest occurs in the mixture, and when the asphalt content passes through the optimum content of asphalt content, the stability value slowly decreases.



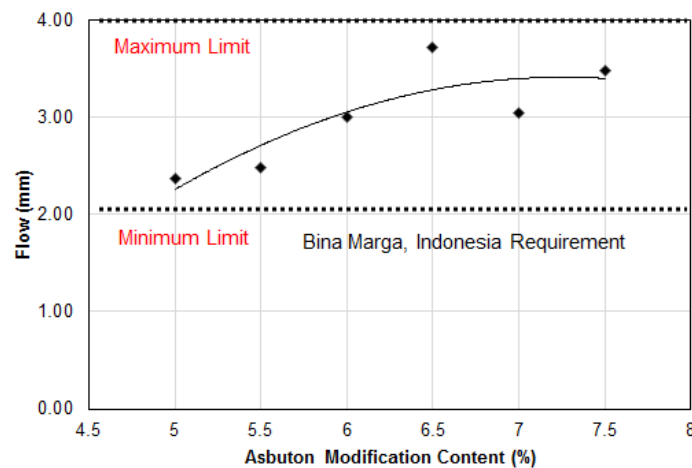
**Figure 3.** Relationship Asbuton Modification Content with Stability

The stability value obtained meets all specifications specified Bina Marga, Indonesia's requirement of asphalt mixture, which is  $\geq 800$  kg. The lowest stability value is in the mixture with modified 7.5% Asbuton content, with a stability value of 993.82 kg and the highest stability value in the mixture with

modified Asbuton content of 6.5% with a stability value of 1847.16 kg. The mixture with a modified content of 5.5% Asbuton content has a stability value of 1647 kg which is almost the same as the modified Asbuton content of 6.0% with a stability value of 1741.81 kg and a mixture with modified content of 5.0% Asbuton with a stability value of 1278.27 kg and a mixture with modified Asbuton content of 7.0% has the highest stability value of 1344.99 kg. Thus, we can know that the optimum content of modified Asbuton content is between the content of modified Asbuton levels of 6.0% and 6.5%.

### 3.2. Relationship of asbuton modification content with flow

Based on the results of the Marshall test, the relationship between modified Asbuton content and flow is shown in figure 4.



**Figure 4.** Relationship Asbuton Modification Content with Marshall Quotient.

Marshall quotient value obtained is in accordance with the specifications set by Bina Marga, Indonesia requirement which is a minimum of 250 kg/mm. The lowest quotient Marshall value is in the mixture with modified 7.5% Asbuton content of 362.33 kg/mm, and the highest quotient Marshall value in the mixture with a modified content of 5.5% Asbuton content of 674.01 kg/mm. Mixture with modified content of 6.5% Asbuton content has a Marshall quotient value of 516.85 kg/mm while modified Asbuton content is 6.0% with Marshall quotient value of 585.38 kg/mm and a mixture with modification content of 5.0% and 7% Asbuton 0% with Marshall quotient 544.86 kg/mm and 523.77 kg/mm.

The low value of Marshall Quotient mixture Modified asbuton due to the small stability and large flow and covered aggregates become thick and easy changes will eventually reduce the binding capacity between the aggregates in the mixture when loaded. The reduced bond between aggregates will reduce the stability of the mixture which leads to the value of the rising flow.

## 4. Conclusions

A good adhesion between bitumen and aggregate particle arose from a good cohesion between bitumen of BGA and petroleum bitumen as a droplet phase in the Asbuton modification. The bitumen of BGA contributed to the creation of a better aggregate and particle packing. As a result, AC-WC mixture used Asbuton semi extracted as binder had sufficient stability to bear the load with flexibility deformation.

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