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Characteristics of AC-BC Asphalt Concrete Mix Using Oil Asphalt and LGA Asbuton as Binders

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ABSTRACT

Indonesia has natural asphalt located in Southeast Sulawesi Province, especially at Buton Island, called asbuton which can be utilized as a binder on road pavements to replace oil asphalt through an extraction process to separate the bitumen and asbuton minerals.

The aim of this study is to analyze the characteristics of asbuton asphalt that will be used in the AC-BC mixture and to analyze the characteristics of the asphalt mixture produced from a mixture of oil asphalt and asbuton LGA as a binder into the AC-BC asphalt mixture. The test results of the AC-BC asphalt mixture in the form of aggregate, 60-70 penetration bitumen, bitumen extracted from asbuton and gradation of the combined mixture showed results which corresponds to the requirements of Bina Marga. Characteristics of AC-BC asphalt mixture applied a test method with Marshall tool.

The mixture test result by adding LGA levels asbuton of 0%, 2%, 3,5%, and 5% as a substitute for penetration bitumen 60-70, the values of Stability, melting (flow), Marshall Quotient (MQ), and Voids Filled Bitumen (VFB) experienced an increase, while the Void in Mix (VIM) and the Voids in Mineral Aggregate (VMA) decreased and met the specifications set by Bina Marga. However, the 5% LGA level did not meet the specifications for melting (flow) values.

Keywords: *LGA Asbuton, AC-BC Mixture, Marshall Characteristics*

I. INTRODUCTION

More than 90% of all road lengths in Indonesia use flexible pavement technology or asphalt pavement. To meet the needs of asphalt pavement development and maintenance every year, asphalt must be imported, even though Indonesia has natural asphalt with very abundant deposits. Indonesia's national asphalt needs are around 1.2 million tons per year. Based on these needs, only 0.6 million tons can be met by PT. Pertamina while the rest is met through imports (Minister for Public Works and Human Settlements, 2016). Meanwhile, the availability of oil asphalt is increasingly limited and prices tend to continue to rise in line with world crude oil market prices.

To meet the needs of road construction and maintenance, of course, it is necessary to use other materials available domestically, including the use of natural asphalt found in Southeast Sulawesi province, especially on Buton Island which has natural asphalt known asbuton which is a deposit area. natural asphalt is about 650 million tons with the distribution of deposits located between Sampolawa bay and Lawele bay (Ministry of Public Works and Public Housing, 2016). One way to overcome the above problems, namely the use of asbuton as a substitute for oil asphalt through the extraction process. Utilization of asbuton is pursued through extraction technology so that asphalt from asbuton in asphalt mixtures will work effectively and utilization of asbuton material becomes efficient (Affandi, 2008 in Suaryana, et al, 2018).

As an opportunity, asbuton is a natural asphalt with the deposit being used as a binder on road pavements to replace oil asphalt. Along with the development of districts and cities, from day to day the length of roads in all regions in Indonesia is always increasing. The increase in the length of the road results in an increase in the need for binder materials, including asphalt, both for maintenance and for the construction of new roads.

The use of asbuton is expected to reduce the number of oil asphalt imports while at the same time being able to take advantage of the abundant domestic wealth through the use of Buton Asphalt as a flexible pavement construction material in the AC-BC asphalt concrete mixture so as to increase the ability of the pavement layer to accept traffic loads so that it will last for a long time. longer asphalt service.

II. LITERATURE REVIEW

Asphalt is defined as a black or dark brown material, at a temperature that is solid to slightly solid. If heated to a certain temperature asphalt can become soft/liquid so that it can enclose the aggregate particles at the time of making asphalt concrete or can enter the pores that exist in spraying/watering on various types of pavement or smelting. If the temperature starts to drop, the asphalt will harden and bind the aggregate in place (Sukirman, 1993 in Layuk, 2014). Asphalt used in road pavement construction serves as the binder provides a strong bond between the asphalt and the aggregate and between the asphalt itself, and Filler material between the aggregate grains and the existing pores of the aggregate it self.

Asphalt Buton (Asbuton) is natural asphalt contained in rock deposits from Buton Island, Southeast Sulawesi, consisting of 20-35% high quality asphalt, 65-80% limestone filler and an estimated deposit amount of 650 million tons (Ministry of Public Works and Public Housing, 2016). In the development of the use of Asbuton to date, it can be grouped into 4 types, namely: BGA (Buton Granular Asphalt) grain Asbuton, LGA (Lawele Granular Asphalt) grain Asbuton, semi-extracted Asbuton and fully extracted Asbuton (Ministry of Public Works and Public Housing, 2016).

Buton granular BGA (Buton Granular Asphalt) with grain size smaller than 1.18 mm, is divided into several types, namely: type 5/20, 15/20, 15/25 and 20/25. The main function of BGA grain Asbuton is to modify asphalt, so that its performance is getting better. As a substitute for asphalt oil, only 5 percent of the total mixture is used.
Asbuton grain LGA (Lawele Granular Asphalt), the grain size is smaller than 9.5 mm. classified as Asbuton grain type 50/30. The main function of Asbuton LGA grain is more directed to substitute oil asphalt, with pavement technology CPHMA (Cold Paving Hot Mix Asbuton), LPMA (Penetration Layer Macadam Asbuton) and Butur Seal. Asbuton LGA grains can substitute for asphalt oil up to 100 percent. However, its use is limited to roads with low traffic.

Semi-extracted Asbuton is Asbuton extracted to a purity of 50 percent or more. However, because the asphalt produced is relatively hard and still contains few minerals, it cannot be used directly as asphalt pavement material. In order to be used as a pavement material, oil asphalt must be added in a proportion (semi-extracted asphalt compared to oil asphalt) of about 20: 80. The main function of this semi-extracted asphalt is to modify oil asphalt so that it has better performance, is resistant to high temperatures and is resistant to high temperatures. heavy traffic.

Fully extracted Asbuton is a technology for extraction up to 100 percent purity. However, until now it is still in the research stage, especially in terms of processing efficiency or production costs. The binder course is part of the surface layer that lies between the base course and the wear course. The functions of the layers include:

1. Reducing stress/strain due to traffic loads and transmitting it to the layer below, must have sufficient thickness and stiffness.
2. Has a high strength on the pavement to withstand the highest loads due to traffic loads.

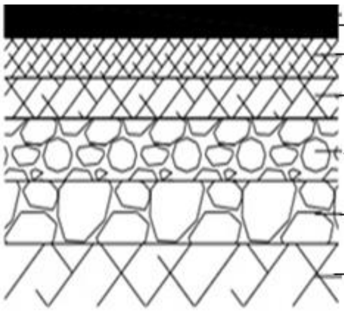

Figure 1. Asphalt Concrete Layer

Table 1. Provisions on the Properties of Hot Mixed Asphalt

Mixed Properties		Asphalt Concrete		
		Wear Layer (AC-WC)	Intermediate Layer (AC-BC)	Foundation (AC-Base)
Number of Collisions Per Field		75		112
Cavity In Mix (%)	Min	3,0		
	Max	5,0		
Cavity In Aggregate (VMA) (%)	Min	15	14	13
Asphalt Filled Cavity (%)	Min	65	65	65
Marshall Stability (Kg)	Min	800		1800
Melt (mm)	Min	2		3
	Max	4		6(1)

The performance of the asphalt-concrete mixture can be checked using a Marshall checker. The inspection is intended to determine the resistance (stability) to plastic melting (flow) of a mixture of asphalt and aggregate. Plastic yield is the change in deformation or strain of a mixture from no load to maximum load, expressed in millimeters or 0.01".

Suaryana, et al (2018) evaluated the performance of asphalt mixtures with bitumen fully extracted from asbuton and concluded that the characteristics of mixtures with pure asbuton had better performance in terms of the higher Marshall stability value of 1871 kg compared to 1100 kg in the AC-WC mixture, and 1241, 9 kg vs. 1094 kg in HRS-WC mixture. Layuk (2014) analyzed the AC-WC mixture using BGA-Asbuton as a binder and concluded that adding 3%, 4% and 5% Asbuton BGA to the mixture resulted in decreased stability compared to the absence of asbuton BGA addition.

Setiawan (2011) analyzed the use of granular asbuton on the characteristics of the marshall Asphaltic Concrete Wearing Course of warm mixed asbuton (AC-WC-ASB-H) and the results obtained were that it met the specifications for the grain asbutone content of 11.5% to 14.5% with a grade of the optimum grain asbuton selected 12.1%. Kamil, et al (2011) analyzed the performance of a worn-out asphalt concrete mix (AC-WC) using rice husk ash filler with the addition of asbuton in 60/70 asphalt pen and concluded that asphalt concrete mixtures using rice husk ash as a filler were able to compete with using rock dust filler, and therefore can be used as an alternative material for road pavement construction.

Affandi & Furqon (2006) analyzed a mixture of hot aggregate asphalt (AC-BC) with the addition of BGA (Buton Granular Asphalt) granulated asphalt by Marshall testing and concluded that asphalt containing bitumen asbutone has resistance to deformation and cracking at higher temperatures than hard asphalt without asbuton bitumen so that asphalt mixtures with asbuton bitumen content are more suitable for tropical areas.

III. RESEARCH METHODS

This research was conducted at the UPTD Laboratory of the Department of Water Resources and Highways of Southeast Sulawesi Province.

Table 2. Research Variables

No.	Variables	Parameter	Indicator
1.	Asbuton characteristics	Nature of Original Form	- Asbuton grain size passes of sieve ⅜" (9.5 mm); - Asbuton bitumen content
		Properties of the extracted bitumen	- Solubility in TCE - Penetration at 25ºC, 100g, 5seconds - Weight loss - Ductility - Melting point
2.	Characteristics of AC-BC mixture	Marshall Test	- Stability - Low - IM - VMA - VFB

The number of specimens in this study were 12 specimens to obtain the Marshall values for varying asphalt and asbuton content. LGA Asbuton used is LGA 50/30. Details of this research plan can be seen in Table 3.

Table 3. Variation and Number of Marshall Test Objects

No.	Asphalt Content Variations	Number of Test Items
1.	LGA 0 %	3
2.	LGA 2 %	3
3.	LGA 3.5 %	3
4.	LGA 5 %	3

For hot mix asphalt (AC) Binder course layer with gradation specifications according to the Directorate General of Highways in 2018. After obtaining the weight of each aggregate for each filter, the mixing process is carried out as follows:

- Aggregates were weighed in accordance with the percentage of the desired gradation target for each fraction with a mixture weight of approximately 1200 grams for a diameter of 4 inches, then the aggregate mixture was dried until the weight remained at a temperature of (110±5) ºC.
- Heating asphalt oil and asbuton grains for mixing at a temperature of 160 ± 1 C. So that the temperature of the mixture of aggregate and asphalt remains, the mixing is carried out on a heater and stirred until smooth.
- After the solidification temperature is reached, namely at a temperature of 150 ± 1 C, then the mixture is put into a mold that has been heated at a temperature of 100 to 160º and smeared with Vaseline first, and the bottom of the mold is given a piece of filter paper or waxed paper. has been cut according to the diameter of the mold while pricking with a spatula 15 times on the edges and 10 times in the middle.
- Standard compaction is carried out with the number of collisions 75 times on the top side then reversed and the bottom side is also pounded 75 times.
- The test object is removed from the tub and dried with a cloth on the surface so that the saturated surface dry (SSD) condition is then weighed.
- The test object is immersed in an immersion bath at a temperature of 60ºC for 30-40 minutes.
- The test object is tested with a Marshall tool.

IV. RESULTS AND DISCUSSION

A. Characteristics of Asphalt Buton

Table 3. Results of Examination of the Characteristics of Buton Asphalt Material Type 50/30

No.	Test	Test method	Test result	Terms
1.	Penetration at 25ºC (0.1mm)	SNI 2456:2011	54	40-70
2.	Ductility at 25ºC (cm)	SNI 2432:2011	119	≥100
3.	Melting point (ºC)	SNI 2434:2011	54.5	≥50
4.	Specific gravity	SNI 2441:2011	1.034	≥1.0
5.	Solubility in Trichlorethylene (%)	SNI 2438:2015	99.16	≥99
6.	Lost weight (%)	SNI 06-2441-1991	2.043	≤2

B. Marshall Test

Table 4. Marshall Test Results

Marshall Characteristics Paved Mix		Stability (kg)	Flow (mm)	MQ (kg/mm)	VIM (%)	VMA (%)	VFB (%)
Specification	Min.	800	2	-	3	14	65
	Maks.	-	4	-	5	-	-
LGA 0%		1117.6	3.2	349.3	4.6	16.8	72.6
		1297.5	3.4	381.6	4.8	17.0	71.6
		1039.7	3.5	297.0	4.8	17.0	71.6
Average		1151.6	3.4	342.6	4.8	16.9	72.0
LGA 2%		1403.5	3.4	412.8	4.3	16.5	74.2
		1195.6	3.6	332.1	4.5	16.7	73.0
		1117.6	3.4	328.7	4.1	16.4	74.9
Average		1238.9	3.5	357.9	4.3	16.5	74.0
LGA 3.5%		1432.6	4.0	358.2	3.9	16.2	75.8
		1481.5	3.7	400.4	3.9	16.2	76.0
		1324.5	3.8	348.6	3.7	16.0	76.7
Average		1412.9	3.8	369.0	3.9	16.2	76.2
LGA 5%		1784.0	4.1	440.5	3.3	15.6	79.1
		1486.7	4.1	364.4	3.7	16.0	76.8
		1273.6	4.0	316.8	3.9	16.2	75.9
Average		1514.8	4.1	373.9	3.6	16.0	77.2

C. Stability

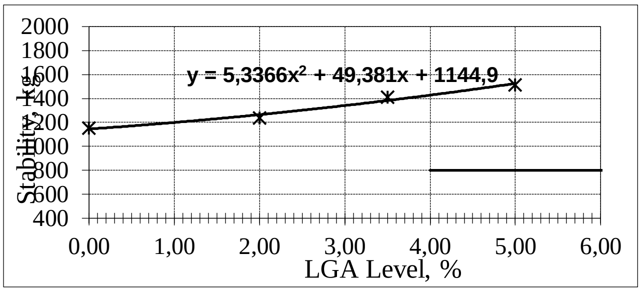

Figure 2. Graph of the Relationship between Stability and LGA Levels

Based on Figure 2, it can be seen that the addition of asbuton bitumen into the mixture affects the stability value. This can be seen from the increased stability value of 0% LGA with an average stability value of 1151.6 kg, LGA 2% with an average stability value of 1238.9 kg, LGA 3.5% with an average stability value of 1412.9, and 5% LGA with average stability value 1514.8 kg.

D. Flow

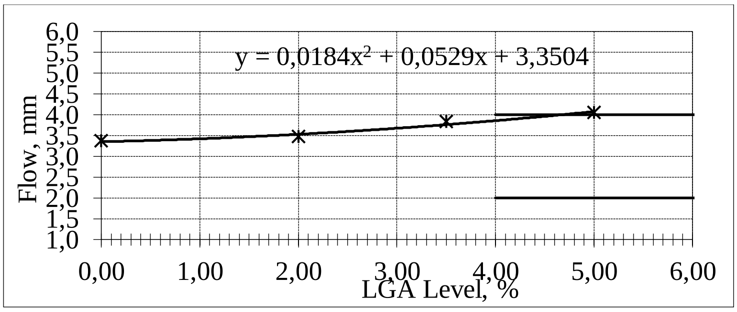

Figure 3. Graph of the Relationship between Melting and LGA Levels

Based on Figure 3, it can be seen that the addition of asbuton bitumen into the mixture affects the melting value. It can be seen that the melting value increases from the LGA level of 0% with an average melting value of 3.4 mm, LGA 2% with an average melting value of 3.5 mm, LGA 3.5% with an average melting value of 3.8 mm, and

LGA 5%. with an average melting value of 4.1 mm. The increase in the yield value indicates a stiff mixture so that it is easy to crack. Melting results, the 5% LGA content does not meet the specifications required by Highways.

E. Cavity in Mix (VIM)

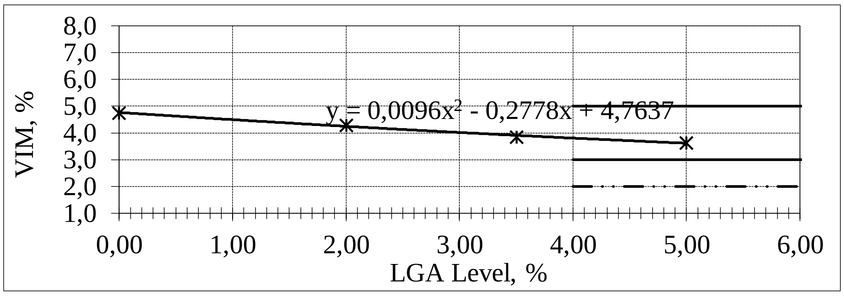

Figure 4. Graph of the Relationship of VIM and LGA Levels

Based on Figure 4, it can be seen that the addition of asbuton bitumen into the mixture affects the VIM value. It can be seen that the VIM value decreased from 0% LGA with an average VIM value of 4.8%, LGA 2% with an average VIM value of 4.3%, LGA 3.5% with an average VIM value of 3.9%, and LGA 5%. with an average VIM value of 3.6%. As the asphalt content increases, the amount of asphalt that fills the voids between the aggregate grains increases, so that the volume of the voids in the mixture decreases.

F. Cavities in Aggregate (VMA)

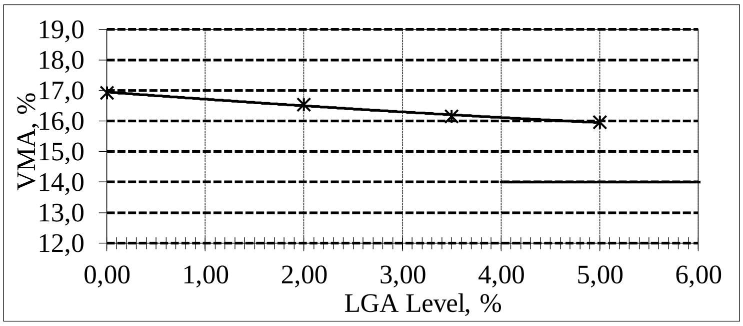

Figure 5. Graph of Relationship between VMA and LGA levels

Based on Figure 5, it can be seen that the addition of asbuton bitumen into the mixture affects the VMA value. It can be seen that the VMA value decreased from 0% LGA with an average VMA value of 16.9%, LGA 2% with an average VMA value of 16.5%, LGA 3.5% with an average VMA value of 16.2%, and LGA 5%. with an average VMA value of 16.0%. This shows that with the addition of asbuton bitumen content that replaces oil asphalt content, the mixture will be more economical to produce because the voids between the aggregates are decreasing.

G. Asphalt Filled Cavity (VFB)

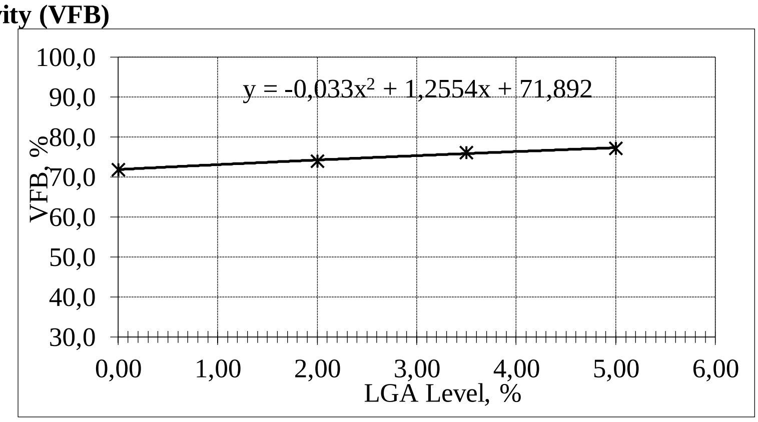

Figure **6.** Graph of Relationship between VFB and LGA levels

Based on Figure 6, it can be seen that the addition of asbuton bitumen into the mixture affects the VFB value. It can be seen that the VFB value increased from 0% LGA with an average VFB value of 72%, LGA 2% with an average VFB value of 74%, LGA 3.5% with an average VFB value of 76.2%, and LGA 5%. with an average VFB value of 77.2%. This shows that with the addition of asbuton bitumen content which replaces the asphalt oil content in the mixture, the mixture will be more durable. The value of VFB affects the impermeability of the mixture to water and air as well as the elasticity of the mixture.

H. Marshall Quotient (MQ)

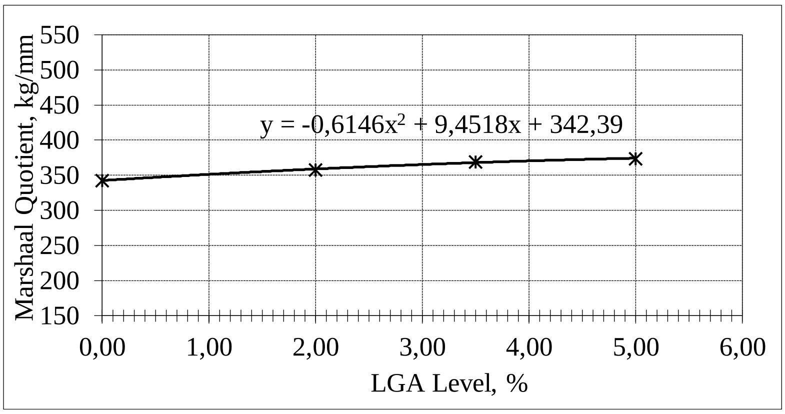

Figure 7. Graph of Relationship between MQ and LGA levels

Based on Figure 7, it can be seen that the Marshall Quotient value is increasing from 0% LGA with an average MQ value of 342.6 kg/mm, 2% LGA with an average MQ value of 357.9 kg/mm, LGA 3.5% with an average MQ value of 369.0 kg/mm, and 5% LGA with an average MQ value of 373.9 kg/mm. This shows that the more asbuton bitumen content is added to the mixture, the stiffer the mixture will be.

V. CONCLUSION

1. The test results of bitumen extracted from LGA Asbuton Type 50/30 have a penetration value of 5.4 mm, specific gravity of asphalt 1.034, weight loss of 2.034 %, solubility in Trichlorethylene (TCE) 99.16%, softening point 54.5 C, and ductility 119 cm and all meet specifications issued by Highways.
2. By adding 2%, 3.5%, and 5% LGA Asbuton as a substitute for 60-70 penetration asphalt, the stability, flow, Marshall Quotient (MQ) and asphalt-filled voids (VFB) are increased, while the voids are filled with asphalt. in the mixture (VIM) and voids in the aggregate (VMA) decreased and met the specifications determined by Highways. However, the 5% LGA content did not meet the specifications for the melt value (flow).

REFERENCES

Affandi., Furqon. 2006. Campuran aspal panas agregat (AC-BC) dengan tambahan aspal asbuton berbutir BGA (Buton Granular Asphalt) dengan pengujian Marshall. Litbang Jalan dan Jembatan, Bandung.

Kamil, dkk. 2011. The Performance of Asphalt-Concrete Wearingcourse (ACWC) Mixture by Using Rice Husk Ash As Filler With The Addition Of Asbuton In Asphalt Pen 60/70 As Binder. *Proceedings of The Annual International Conference,* Syiah Kuala University 2011, Banda Aceh.

Minister For Public Works and Human Settlements. 2016. Bahan Campuran Asbuton, BPSDM Pusat Pendidikan Dan Latihan Jalan, Perumahan, Permukiman, Dan Pengembangan Infrastruktur Wilayah. Bandung

Minister For Public Works and Human Settlements. 2018. Spesifikasi Umum 2018 Untuk Pekerjaan Konstruksi Jalan Dan Jembatan, Direktorat Jenderal Bina Marga. Jakarta.

Layuk, M. Paku. 2014. Studi Kinerja Campuran AC-WC Menggunakan BGA Asbuton Sebagai Bahan Pengikat. Skripsi Universitas Hasanuddin Makassar

Setiawan, Arief. 2011. Studi Penggunaan Asbuton Butir Terhadap Karakteristik Marshall Asphaltic Concrete Wearing Course Asbuton Campuran Hangat (AC-WC-ASB-H). *Jurnal Rekayasa dan Manajemen Transportasi,* Vol. 1(2), pp: 99-118.

Suaryana, dkk. 2018. Evaluasi Kinerja Campuran Beraspal Dengan Bitumen Hasil Ekstraksi Penuh Dari Asbuton. *Media Komunikasi Teknik Sipil*, Vol 24(1), pp: 62-70.