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Characteristics Analysis of Modification *Asbuton* Granular B 50/30 with Asphalt Pen 60/70

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Abstract: In the framework of handling the bending pavement road, natural materials in the form of asphalt as a binding material in a hot paved blend are needed. One of the abundant natural asphaltic that has not been used to its fullest is *Asbuton*. The government through the Ministry of Public Works which is currently transformed into the Ministry of Public Works and Public Housing has issued Public Works Regulation No. 35 of 2006 on Increasing the Utilization of Buton Asphalt for Road Maintenance and Development. Because various things that cause permission to use 100% *Asbuton* in hot paved blends can not be issued, the use of *Asbuton* is still limited to improving the quality of asphalt Pen 60/70. This research aims to obtain an optimal composition in the use of *Asbuton* using the type of *Asbuton* Grain B 50/30. It is hoped that the results of the research can be an additional reference for *Asbuton* producers as well as a new insight for civil engineering students who explore the path of bending pavement. The results showed that *Asbuton* Granular B 50/30 can be used in improving the quality of Asphalt Pen 60/70 with an optimal composition of 25% *Asbuton* Granular B 50/30 and 75% Asphalt Pen 60/70.

Keywords: *asbuton* granular B 50/30, asphalt pen 60/70, *Spesifikasi Umum Bina Marga 2018*

INTRODUCTION

Roads are one of a variety of infrastructure built and maintained from year to year to support the economic rate of all regions in Indonesia. Along with the increasing number of activities on the highway, maintenance and repairs must continue to be implemented. Roads with flexible pavement in Indonesia mostly already use natural asphalt in the form of *Asbuton*. The use of *Asbuton* continues to be encouraged by the government because the Indonesian state is the largest producer of asphalt buton in the world located on Buton Island. Exploration and exploitation of *Asbuton* have been carried out since 1926 (Kramer, 1989 in Pravianto, 2013). Pravianto (2013) mentioned that many manufacturers of *Asbuton* processors became *Asbuton* Semi Extraction. But each of these processing manufacturers has *Asbuton* processed products with different qualities (Suaryana, 2016). But to date, permission to use 100% *Asbuton* in hot paved blends has not been issued.

To take advantage of this potential, research was conducted to modify *Asbuton* granular B 50/30 with Asphalt Pen 60/70 to improve the quality of asphalt pen 60/70, Asphalt Pen 60/70, and mixed variations between *Asbuton* Granular B 50/30 with Asphalt Pen 60/70 and find out the percentage of use of *Asbuton* Granular B 50/30 that can improve the physical properties of Asphalt Pen 60/70 by *Spesifikasi Umum Bina Marga 2018*.

Literature Review

1. Flexible Pavement Construction

- Using asphalt for binding material
- The nature of this pavement is to shoulder and spread a load of traffic to the ground.
- Its effect on load reps is the onset of rutting.
- Its effect on the decline of the ground, the bumpy road (following the ground).

The construction of the flexible pavement can be seen in figure 1.

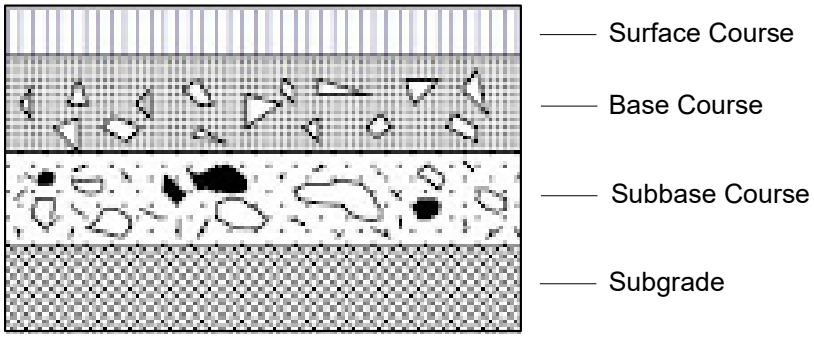

Figure 1. Component of the flexible pavement
(Source: kardinanawassa.blogspot.com/2013/04/sekilas-mengenai-perkerasan-jalan.html, 08/10/2021)

2. Material of the Flexible Pavement

1) Aggregates, according to Sukirman (1992) are pieces of broken stone, gravel, sand, or other minerals, both of natural and artificial origin in the form of solid minerals in the form of large or small sizes or fragments.
2) Asphalt, is a hydrocarbon material that contains little sulfur, oxygen, chlorine, and adhesive, is brownish-black, resistant to water, and viscoelastic (asphalt will be solid at room temperature and liquid when heated).
3) Fillers, serve to increase the viscosity of bitumen material and to reduce the susceptible properties to temperature. Another advantage of the presence of fillers is that it can increase the volume of bitumen because the filler material is widely absorbed in bitumen material.

3. Current Types of Asphalt

a) Natural Asphalt, one of which is *Asbuton* and which has been produced in fabrication and manual currently includes (Setiawan, 2011):
   1. *Asbuton* Granular, is the result of the processing of solid-shaped *Asbuton* that is broken down with a stone breaking tool (crusher) or other suitable breaking tools so that it has a certain grain size.
   2. Extraction *Asbuton* can be done in total to get pure *Asbuton* bitumen or to take advantage of the advantages of the mineral *Asbuton* as a filler, extraction is done until it reaches certain bitumen levels. *Asbuton* extraction products in paved mixtures can be used as asphalt additives or as binding materials as well as standard ready-made asphalt or hard asphalt equivalents.

b) Asphalt Oil (asphalt derived from petroleum), divided into 3 (three) types (Fang, et al, 2020):
   1. Asphalt Cement / AC, usually distinguished based on its penetration value, and Indonesia in general uses AC with penetration of 60/70.
   2. Cut Back Asphalt, asphalt produced by dissolving hard asphalt uses oil-based solvents, and is used in liquid and cold conditions.
   3. Emulsion Asphalt, asphalt produced from the process of the emulsion of hard asphalt. This process aims to separate hard asphalt particles and then disperse them into water-containing emulsifiers.

c) Modified asphalt, is a hard asphalt fraction that is improved in quality by adding added materials such as polymers, latex, bitumen *Asbuton* and others (*Spesifikasi Umum Bina Marga 2018*).

In this research, the road pavement materials tested and discussed the results were natural asphalt *Asbuton* Granular B 50/30, oil asphalt Pen 60/70, and Asphalt Modification between *Asbuton* Granular

B 50/30 with Asphalt Pen 60/70 with provisions as in Table 1 and Table 2.

Table 1. Specifications of *Asbuton* Granular B 50/30

No	Test item	Technical specifications
A	**Asphalt *Asbuton* Granular B 50/30**	
1	**Nature of Original Form**	
	The grain size of *Asbuton* granular	
	Escaped sieve 3/8" (9,5 mm); %	100
	Asbuton bitumen levels; %	Min. 20
	Water content; %	Maks. 4
2	**Properties of Bitumen Extraction Results and Recovery**	
	Solubility of Trichloroethylene; %	Min. 99
	Penetration of bitumen *Asbuton* at 25ºC, 100g, 5 sec; dmm	40 – 70
	Softening Point; ºC	Min. 48
	Ductility at 25ºC; cm	Min. 100
	Heating loss after TFOT; %	Maks. 2
	Penetration after TFOT, at 25ºC, 100g, 5 sec; (%)	Min. 54

Source: *Spesifikasi Umum Bina Marga, 2018*

Table 2. Specifications of Asphalt Pen 60/70

No	Test item	Technical specifications
1	Penetration at 25ºC (dmm)	60-70
2	Kinematic Viscosity at 135ºC (cSt)	≥ 300
3	Softening Point (ºC)	≥ 48
4	Ductility (cm)	≥ 100
5	Flash Point (ºC)	≥ 232
6	Solubility of Trichloroethylene (%)	≥ 99
7	Density (gr/ml)	≥ 1,0
	Thin-Film Oven Testing (TFOT)	
8	Heating loss (%)	≤ 0,8
9	Penetration at 25ºC (%)	≥ 54
10	Ductility at 25ºC (cm)	≥ 50

Source: *Spesifikasi Umum Bina Marga, 2018*

METHODOLOGY

The materials used to conduct this research include:

a. *Asbuton* Granular B 50/30.
b. Asphalt Pen 60/70.

This research uses two stages of testing, that's are:

1) Stages of material characteristic testing (*Asbuton* Granular B 50/30 and Asphalt Pen 60/70) with the following steps:
   a. Prepare the material.
   b. Testing the level of bitumen in *Asbuton* Granular B 50/30.
   c. Testing the physical properties of asphalt levels *Asbuton* Granular B 50/30.
   d. Testing the physical properties of the asphalt Pen 60/70.

2) Stage of asphalt blend variations testing with the following steps:
   a. Calculations of the composition material of asphalt mixed according to the test plan with code K1 - K5 for each test object.
   b. Manufacture of test objects with code K1 - K5.
   c. Testing the physical properties of asphalt Modification K1 – K5.
   d. Results and conclusions.

Some of the testing processes that have been done in the laboratory, among others:

1) Asphalt Penetration Testing, is done to get penetration numbers and is done on hard or flaccid asphalt where the results of this test can then be used to control the quality of hard asphalt used in the field.

   Formula:

   $\bar{X} = \overline{X_1} + \overline{X_2}$ ..... (1)

   Where: $\bar{X}$ = average penetration value
   $\overline{X_1}$ = average penetration value of 5 penetration points of test object 1
   $\overline{X_2}$ = average penetration value of 5 penetration points of test object 2

Figure 2. Penetration Data Capture
(Source: Author 2022)

2) Asphalt Viscosity testing, is done to find out the viscosity of asphalt at certain temperatures so that it can know the performance of asphalt under the desired conditions.

   Formula:

   $\bar{X} = \frac{X_1 + X_2}{2}$ ..... (2)

   Where: $\bar{X}$ = average viscosity value
   X_1 = viscosity value of test object 1
   X_2 = viscosity value of test object 2

Figure 3. Viscosity Data Capture
(Source: Autor 2022)

3) Asphalt Softening Point testing, conducted to find the number of soft spots of asphalt that range from 30ºC to 200ºC by way of ring and ball.

Formula:

$\bar{X} = \frac{X_1+X_2}{2}$ ..... (3)

Where: $\bar{X}$ = average value or temperature of softening point
X_1 = softening point value or temperature of test object 1
X_2 = softening point value or temperature of test object 2

Figure 4. Softening Point Data Capture
(Source: Autor 2022)

4) Asphalt ductility testing was performed to determine the fineness value of asphalt, measured from the longest distance, between two molds containing hard bitumen, pulled before breaking at 25oC and a speed of 50 mm/minute.

Formula:

% Elasticity = $\frac{10-\chi}{10} \times 100$ ..... (4)

Where: χ = Length after elasticity

Figure 5. Ductility Data Capture
(Source: Autor 2022)

5) Asphalt Flash Point testing was conducted to see the highest temperature where the asphalt lights up and starts to burn, this highest temperature is an indicator of asphalt safety on the ground in receiving heat from environmental conditions.

Formula:

$\bar{X} = \frac{X_1+X_2}{2}$ ..... (5)

Where: $\bar{X}$ = average value or temperature of the flashpoint
X_1 = value or temperature of the test object's flashpoint 1
X_2 = value or temperature of the test object's flashpoint 2

Figure 6. Flashpoint Data Capture
(Source: Autor 2022)

6) Asphalt solubility testing in Trichloroethylene, is done to determine the degree of solubility in trichloroethylene (TCE) in asphalt materials that contain no or little minerals.

Formula:

Insoluble materequal $\times 100\%$ ..... (6)

Soluble materials $= 100\% - \left(\frac{C-A}{B} \times 100\%\right)$ ..... (7)

Where: A = empty Gooch cup
B = weight of test objects
C = the weight of a Gooch cup with insoluble material

Figure 7. Solubility Data Capture in Trichloroethylene
(Source: Autor 2022)

7) Asphalt Density Testing, is done to determine the weight of the type of solid asphalt which can then be used in mixed planning work as well as road pavement quality control.

Formula:

$$\delta = \frac{(C-A)}{(B-A)-(D-C)} \quad \text{..... (8)}$$

Where: δ = Density of Asphalt
A = weight of the picnometer (with cover) (gram)
B = weight of a water-filled picnometer (gram)
C = weight of picnometer containing asphalt (gram)
D = weight of the picnometer contains asphalt and water (gram)

Figure 8. Density Data Capture
(Source: Autor 2022)

8) Weight Loss Testing (Thin-Film Oven Testing/TFOT), is done on the asphalt by looking for the amount of weight loss of oil and asphalt that is using a thin layer. Weight loss of oil and asphalt is the difference in weight before and after heating at a certain thickness at a certain temperature.

Formula:

$$\text{Weight loss} = \frac{A-B}{A} \times 100\% \quad \text{..... (9)}$$

Where: A = weight of the original test object
B = weight of test objects after heating

Figure 9. Weight Loss Data Capture (TFOT)
(Source: Autor 2022)

9) Penetration and Ductility testing after TFOT, is done to determine the percentage (%) of penetration values after TFOT against the testing value before TFOT and to find out the value of

ductility after TFOT.

RESULTS AND DISCUSSION

1) Results of Material characteristic testing (*Asbuton* Granular B 50/30 and Asphalt Pen 60/70).
   a. Testing of *Asbuton* Granular B 50/30 includes grain size, asphalt levels, moisture content, and solubility in trichloroethylene, penetration, softening point, ductility, heating loss after TFOT, and penetration after TFOT. Especially for *Asbuton* must first be done extraction and recovery asphalt produced by distillation. The results of the test on asphalt *Asbuton* Granular B 50/30 can be seen in Table 3.

Table 3. Results of Properties Testing *Asbuton* Granular B 50/30

No	Test item	Technical specifications	Test result
1	**Nature of Original Form**		
	- The grain size of *Asbuton* granular		
	Escaped sieve 3/8 inch (9,5 mm): %	100	100
	- *Asbuton* bitumen levels; %	Min. 20	21,83
	- Water Content; %	Maks. 4	-
2	**Properties of Bitumen Extraction Results and Recovery**		
	- Solubility of Trichloroethylene; %	Min 99	99,993
	- Penetration of bitumen *Asbuton* at 25ºC, 100g, 5 sec; dmm	40 – 70	54,50
	- Softening Point; ºC	Min. 48	56,40
	- Ductility at 25ºC; cm	Min. 100	136,5
	- Heating loss after TFOT; %	Maks. 2	0,283
	- Penetration after TFOT, at 25ºC, 100g, 5 sec; (%)	Min. 54	83,67

Source: Test results

   b. Testing of asphalt Pen 60/70 includes everything required by the Spesifikasi Umum Bina Marga 2018. But only 10 types of testing will be done, in Table 4 below is the result of asphalt pen 60/70 testing. In the table, it is seen that the asphalt Pen 60/70 used in this research meets the requirements of the Spesifikasi Umum Bina Marga 2018.

Table 4. Results of Properties Testing Asphalt Pen 60/70

No	Test item	Technical specifications	Test result
1	Penetration at 25ºC (dmm)	60-70	64,50
2	Kinematic Viscosity at 135ºC (cSt)	≥ 300	667,50
3	Softening Point (ºC)	≥ 48	48,10
4	Ductility (cm)	≥ 100	> 140
5	Flash Point (ºC)	≥ 232	292,5
6	Solubility of Trichloroethylene (%)	≥ 99	99,998
7	Dencity (gr/ml)	≥ 1,0	1,035
	Thin-Film Oven Testing (TFOT)		
8	Heating loss (%)	≤ 0,8	0,018
9	Penetration at 25ºC (%)	≥ 54	81,86

No	Test item	Technical specifications	Test result
10	Ductility at 25ºC (cm)	≥ 50	> 140

Source: Test results

2) Results of testing variations of asphalt blends modification.
Testing of variation asphalt blend between *Asbuton* Granular B 50/30 and Asphalt Pen 60/70 includes 10 types of testing required by the *Spesifikasi Umum Bina Marga 2018* and refers to the physical properties of asphalt Pen 60/70. Table 5 below is the result of testing the variation of the asphalt blend between Asphalt Granular B 50/30 with Asphalt Pen 60/70.

Table 5. Results of Properties Testing Variations of Asphalt Blend between Asphalt Granular B 50/30 with Asphalt Pen 60/70

No	Test item	Technical specifications of asphalt Pen 60/70	Test result				
			K1	K2	K3	K4	K5
1	Penetration at 25ºC (dmm)	60-70	62,60	62,00	61,30	58,80	58,30
2	Kinematic Viscosity at 135ºC (cSt)	≥ 300	717,50	792,50	830,00	852,50	897,50
3	Softening Point (ºC)	≥ 48	51,10	51,60	52,40	53,10	53,80
4	Ductility (cm)	≥ 100	137,5	131	122,25	111,5	97
5	Flash Point (ºC)	≥ 232	297	301,5	308	311,5	317
6	Solubility of Trichloroethylene (%)	≥ 99	92,707	88,698	84,606	80,750	76,794
7	Dencity (gr/ml)	≥ 1,0	1,047	1,081	1,118	1,124	1,182
	Thin-Film Oven Testing (TFOT)						
8	Heating loss (%)	≤ 0,8	0,021	0,127	0,170	0,200	0,281
9	Penetration at 25ºC (%)	≥ 54	81,94	82,75	83,36	83,84	84,39
10	Ductility at 25ºC (cm)	≥ 50	134,5	122,5	111,0	98,0	93,0

Source: Test results

From the results of the above test, it can be determined that the code of the K4 test object with a composition of 25% *Asbuton* Granular B 50/30 and 75% Asphalt Pen 60/70 is a modification of the most optimal blend variation in the use of Asphalt Granular B 50/30 as a material to improve the quality of Asphalt Pen 60/70. This determination is based on a ductility value of 112 cm and a softening point temperature of 53.1ºC that still meets the requirements. Where the value of ductility determines the elasticity of the asphalt material, so that if the asphalt when pulled is still above 100 cm based on the requirements of Asphalt Pen 60/70 is still declared flexible or not shaken so that the asphalt is still good to be used as a pavement connective material, as well as after the test of heating loss for code of K4 test objects when pulled the value of ductility is still above 50 cm based on Asphalt Pen 60/70 requirements. While the soft point value to determine the sensitivity of asphalt material to temperature changes, if the test temperature is still above 48ºC based on the requirements of Asphalt Pen 60/70 is still well expressed because sensitivity to temperature changes is still smaller than the requirements given.

CONCLUSION

Based on the tests that have been done, the material *Asbuton* Granular B 50/30 and Asphalt Pen 60/70 have asphalt properties by the requirements in the *Spesifikasi Umum Bina Marga 2018*. So that it can be continued for use in the manufacture of modification variations between *Asbuton* Granular B 50/30 and Asphalt Pen 60/70. The test results showed that asphalt modification with a code of K4 which

has a composition of 25% *Asbuton* Granular B 50/30 and 75% Asphalt Pen 60/70 is an optimal modification.

Based on the results of the research, the opportunity to increase the use of *Asbuton* is still very large, so more research is needed by using other types of *Asbuton* and if possibility coupled with other substances or materials so that asphalt modification using *Asbuton* can be further improved and a tool that can homogenize the blend so that the test results are better.

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