Volumetric Characteristics of HRS-WC Mixed Using Petroleum Bitumen Grade 60/70 as Binder

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Volumetric Characteristics of HRS-WC Mixed Using Petroleum Bitumen Grade 60/70 as Binder

Irianto[1,*], M Tumpu[2] and H Parung[3]

[1]Lecturer, Civil Engineering Department, Yapis University, Jayapura, Indonesia
[2]Lecturer, Civil Engineering Department, Fajar University, Indonesia
[3]Professor, Graduate School of Hasanuddin University, Indonesia

*corresponding author: irian.anto@gmail.com

Abstract. This study aims to determine the volumetric values consisting of VIM, VMA and VFB on the binder layer mixture using HRS-WC gradation using petroleum bitumen as a binder. The method used in this research is experimental method in laboratory. In this study, variations of asphalt content used were 5.5%, 6.0%, 6.5%, 7.0% dan 7.5%. These variations were obtained from the calculation of effective asphalt level of 5.9%. The results show that the VIM values decreases along with the increase of bitumen content used. VIM values obtained were 6.69%, 5.82%, 5.18%, 4.42% and 3.34%, respectively. The VMA values obtained were 18.12%, 18.38%, 18.84%, 19.21% and 19.30% for each bitumen content. Besides that, the value of VFB is also taken into account and the values obtained for each quality of bitumen content are 63.10%, 68.41%, 72.57%, 76.99% and 82.71%.

1. Introduction

Domestic demand for oil asphalt is around 1.2 million tons per year. Domestic production of oil asphalt is only around 600 thousand tons, so the remaining 600 thousand tons must be met with imports of oil asphalt from overseas [1]. Indonesia has natural asphalt known as Asbuton, so named because the asphalt location is on the island of Buton, Southeast Sulawesi. Asbuton has quite a large deposit of around 600 million tons [2]. The Asbuton deposit is estimated to be equivalent to 24 million oil asphalt [3]. One of the efforts to reduce imports of oil asphalt is to use Indonesian Buton Asphalt (Asbuton-Indonesia) which is Indonesia's natural asphalt. Asphalt is expected to replace the role of oil asphalt partially or completely [4]. A number of studies on bitumen from Buton natural asphalt extraction show that the bitumen extracted from Buton natural asphalt has the suitability of physical properties with oil asphalt [5-7].

One type of processed Buton asphalt is modified Buton asphalt which is a semi-extracted product of natural Buton asphalt which can be used as a binder in asphalt mixtures. In this study using Asphalt 60/70 type Retona Blend 55. Refinery Buton asphalt (Retona) is Kabungka Asbuton or Lawele which has reduced the amount of minerals in it (by semi-extraction using chemicals) and mixed with oil asphalt. Furthermore, it is ready to be liquefied in the AMP asphalt tank with or without additional oil asphalt to be pumped into the pugmill that contains aggregate [8-10].

There have been many research results that state that by using Buton asphalt as a partial substitute for oil asphalt, besides being able to take advantage of Indonesia's natural resources, it can also increase the value of stability and can improve the performance of asphalt [1-12].

Some literature related to volumetric asphalt mixture consisting of cavity in the mixture (VIM), cavity in the aggregate (VMA) and cavity in bitumen (VFB) can be obtained through experimental testing in the laboratory which is included in the empirical test group with the Marshall test. Figure 1 shows a volumetric illustration (VIM, VMA and VFB) in an asphalt mixture [13-17].

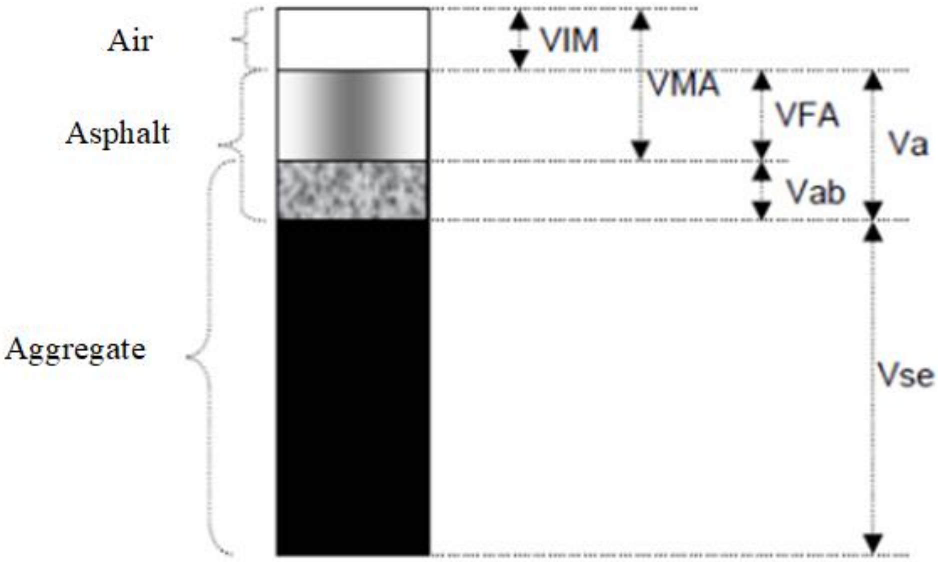

Figure 1. Volumetric illustration of asphalt mixture

Some important volumetric characteristics of asphalt, namely Void in Mix (VIM), Void Mineral Aggregate (VMA), Void Filled Bitumen (VFB) in asphalt mixtures need to be known to evaluate the performance of the mixed material before use and during service life. This study aims to analyze the volumetric value of the HRS-WC mixture using oil asphalt 60/70 as a binder.

2. Materials and Method

2.1. Location and Type of Research
The type of research used in this research is experimental study and literature review. This research was carried out at the Testing of Roads and Bridges Laboratory Satker Region V, West Papua Province. The research time was carried out for approximately 2 months.

2.2. Research Methods and Variation of Test Objects
The research that was carried out was structured systematically to examine in the laboratory the HRS-WC graded asphalt mixture using oil asphalt 60/70 as a binder. The hot asphalt mixture is produced in the laboratory using a modified Buton asphalt type Retona Blend 55 as the binder. Then carried out the study and volumetric testing of the asphalt mixture consisting of VIM, VMA and VFB with variations in asphalt content of 5.5%, 6.0%, 6.5%, 7.0% and 7.5%, respectively. This variation of asphalt content is obtained from the calculation of the effective asphalt content based on the rules of the 2010 Revision 3 Specifications, Bina Marga, Indonesia requirement.

2.3. Method of Collecting Data
Data collection in this study begins with testing the characteristics of each material used in the mixture to fulfill the required specifications, for this reason the proportion of the combined aggregate is made based on the trial and error method with reference to the required grading limits for the HRS-WC asphalt mixture on Specifications 2010 Revision 3 Bina Marga, Indonesia requirement. Then enter the required specification data from the grading limits into the table for determining the aggregate

proportion. After that, vary the percentage of each aggregate fraction that results in an amount of 100%, whose value is within the grading limit and the combined value is close to the ideal value. To ensure uniform grading of the aggregates in each briquette sample made, the aggregate and filler mixture for each briquette specimen is 1200 grams with the weight of each fraction calculated.

This research used a mixture of coarse aggregate, fine aggregate, filler and oil asphalt 60/70 with a total weight of 1200 grams for the Marshall specimen. Based on the research variables, 3 steps were carried out, namely, the calculation of the effective asphalt content based on the percentage of combined aggregate, the calculation of mix design based on variations in asphalt content and the manufacture of test objects based on the KAO obtained. After that, a volumetric test of asphalt mixture (VIM, VMA and VFB) was carried out based on the rules of the 2010 Revision of Specifications 3, Bina Marga.

The manufacture of test objects refers to SNI Marshall (SNI 06-2489-1991), begins with weighing the components of the mixture, namely aggregate (coarse aggregate and fine aggregate), modified Asbuton, and filler according to the mix design. Meanwhile, the volumetric test of asphalt mixture consisting of VIM, VMA and VFB due to the aging process also refers to SNI 06-2489-1991.

Coarse aggregate, fine aggregate and filler are mixed at room temperature and heated to a temperature of 110°C and the temperature of mixing with asphalt is 150° C based on the rules of the 2010 Revision 3 of Bina Marga Specification, Indonesia requirement. The next is, the mixture is put into a mold cylinder which has been coated with filter paper on both sides. Then the process of compaction of the mixture at room temperature is carried out using a pulverizer (weight 4.5 kg and falling height 45.7 cm) with the number of collisions 75 times for every field. The number of collisions is 75 for every field based on Marshall's standard testing assuming that 75 collisions signal heavy traffic. After that, the compacted specimen is removed from the mold using an ejector.

2.4. Data analysis method
Data collection in this study begins with testing the characteristics of the material (physical characteristics and chemical characteristics) used which consist of coarse aggregate, fine aggregate (rock ash and filler) and modified Asbuton. Next, make a mix design based on the variation of asphalt content obtained from the calculation of the effective asphalt content and manufacture of test objects based on SNI Marshall. After making the test objects, then the volumetric testing (VIM, VMA and VFB) is carried out based on the 2010 Revision 3 Specifications, Bina Marga. This collected data is then used to analyze the ability of the asphalt mixture using oil asphalt 60/70 as a binder.

3. Research Result

3.1. Material Characteristics
The test is carried out based on SNI, which tests the physical characteristics of coarse aggregate, rock ash, rock ash filler and binders for Asphalt oil 60/70. Coarse aggregate, fine aggregate and filler in this research were obtained from various sources, which are located in West Papua Province.

3.2. Aggregate physical characteristics
Table 1 shows the results of testing the characteristics of coarse aggregate, rock ash and filler that have been carried out. Tests are carried out with reference to the 2010 Revision 3 Specifications. Based on the results of testing the characteristics of coarse aggregate (crushed stone), rock ash, and filler shown, it can be seen that the aggregate used meets the Bina Marga specifications for the required road material, so all of these materials can be used for this research.

3.3. Characteristics of physical and chemical properties of modified Asbuton
Oil asphalt 60/70 is the binder used in this research. Table 2 shows the results of the examination of the physical and chemical characteristics of the minerals contained in Oil Asphalt 60/70 that has been carried out. The test results of the physical characteristics of Oil Asphalt 60/70 show that the material

fulfill the requirements for use as a binder in the asphalt mixture. The chemical characteristics of Oil Asphalt 60/70 were obtained through the X-Ray Flourence (XRF) test. The test results showed that the element content of SO_3, which is one of the constituent elements of minerals in oil Asphalt 60/70, is 69.137%, CaO is 22.174% and SiO_2 content is 4.281%. In addition, a number of other mineral constituent elements such as Cl, Fe_2O_3, V_2O_5, K_2O, NiO, Cr_2O_3 contains content were 1.778%, 1.196%, 1.049%, 0.258%, 0.097% and 0.030%, respectively.

Table 1. Physical characteristics of coarse aggregate, rock ash and filler

No.	Examination	Test Result	Spesification		Unit
			Min	Max	
	Water Absorption				
	Crushed Stone 0.5 - 1 cm	2.07	-	3.0	%
1	**Crushed Stone 1 - 2 cm**	2.08	-	3.0	%
	Rock Ash	2.79	-	3.0	
	Filler	2.28	-	3.0	
	Specific Gravity				
	Crushed Stone 0.5 - 1 cm				
	Bulk Specific Gravity	2.62	2.5	-	-
	SSD Specific Gravity	2.67	2.5	-	-
	Apparent Specific Gravity	2.77	2.5	-	-
	Crushed Stone 1 - 2 cm				
	Bulk Specific Gravity	2.62	2.5	-	-
	SSD Specific Gravity	2.68	2.5	-	-
2	Apparent Specific Gravity	2.77	2.5	-	-
	Rock Ash				
	Bulk Specific Gravity	2.45	2.5	-	-
	Ssd Specific Gravity	2.52	2.5	-	-
	Apparent Specific Gravity	2.63	2.5	-	-
	Filler				
	Bulk Specific Gravity	2.60	2.5	-	-
	SSD Specific Gravity	2.65	2.5	-	-
	Apparent Specific Gravity	2.76	2.5	-	-
	Flake Index				
3	**Crushed Stone 0.5 - 1 cm**	20.10	-	25	%
	Crushed Stone 1 - 2 cm	9.38	-	25	%
	Aggregate Wear				
4	**Crushed Stone 0.5 - 1 cm**	25.72	-	40	%
	Crushed Stone 1 - 2 cm	24.36	-	40	%
	Sand Equivalent				
5	**Rock Ash**	89.66	50	-	%
	Filler	69.57	50	-	%

Table 2. The results of the examination of the physical characteristics of the 60/70 oil asphalt and the chemical composition of the 60/70 oil asphalt mineral

Physical characteristics			Chemical characteristics of minerals		
No	Testing	Result	No	Compound	Content (%)
1	Penetration before losing weight (mm)	78.6	1	SO_3	69.137
2	Softening Point (°C)	52	2	CaO	22.174
3	Ductility at 25°C. 5cm/	114	3	SiO_2	4.281

	minute (cm)				
4	Flash point (°C)	280	4	Cl	1.778
5	Specific gravity	1.12	5	Fe_2O_3	1.196
6	Weight loss (%)	0.3	6	V_2O_5; K_2O	1.049; 0.258
7	Penetration After Losing Weight (mm)	86	7	NiO; Cr_2O_3	0.097; 0.030

3.4. Combined aggregate gradation

Figure 2 shows that the combined aggregate design or the combined aggregate gradation made is within the standard specification interval according to the 2010 General Specifications for Road Works by Bina Marga, Indonesia requirement and has met the requirements for surface coating so that an optimal mix design can be obtained. Furthermore. the combined aggregate gradation that has been obtained based on these specifications can be used to make the HRS-WC (Hot Rollet Sheet Wearing Course) mix design in this research.

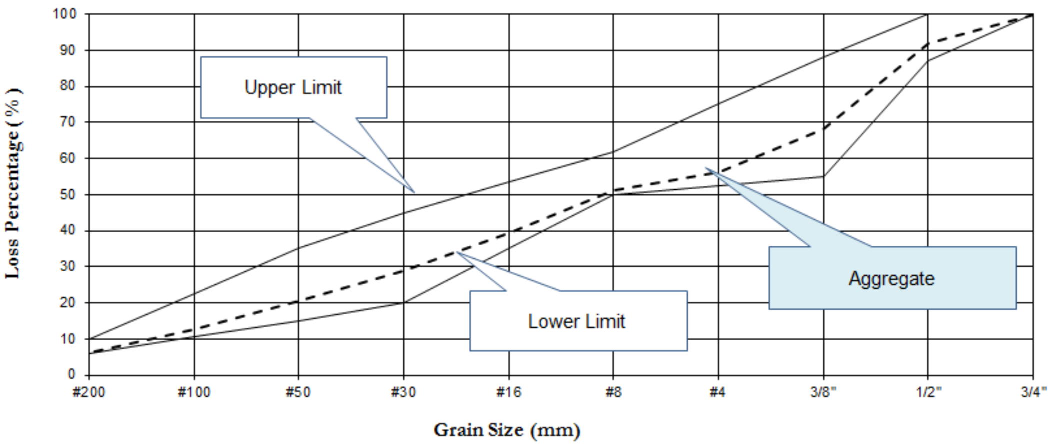

Figure 2. Gradient aggregate

3.5. Determination of variations in asphalt content based on estimated asphalt content

Before calculating the estimated asphalt content of the HRS-WC mixture in this study. First the calculation of the combined density of the aggregate consists of bulk density. apparent density. effective density and asphalt absorption. The results obtained based on theoretical calculations are 2.62 for bulk density. 2.73 for apparent density. 2.68 for effective density and 0.83% asphalt absorption. The method used for the design of the HRS-WC mixture is to first determine the aggregate gradation and then calculate the estimated asphalt content using the formula in the General Specifications 2010 Revision 3, Bina Marga, Indonesia requirement. The estimated asphalt content obtained is 5.9%. So that from the estimation of the asphalt content. The variation of the asphalt content for the AC-BC mixture is used 5.5%. 6.0%. 6.5%. 7.0% and 7.5%.

3.6. Volumetric HRS-WC mixture using Oil Asphalt 60/70 as binder

The mixed volumetric test consisting of VIM, VMA and VFB was carried out on the test object that was made according to Marshall's equipment with a weight of 1200 grams. Volumetric testing was carried out based on variations in asphalt content were 5.5%. 6.0%. 6.5%. 7.0 % and 7.5%. Table 3 shows the volumetric test results of the asphalt mixture using oil asphalt 60/70 as a binder which consists of VIM. VMA and VFB. The results showed that the VIM values obtained respectively 6.69%. 5.82%. 5.18%. 4.42% and 3.34%, respectively for the asphalt content used. Whereas the VMA and VFB values obtained at 5.5% asphalt content were 18.12% and 63.10%. At 6.0% asphalt content was 18.38% and 68.41%. At asphalt content 6.5% is equal to 18.84% and 72.57%. The asphalt content of 7.0% is 19.21% and 76.99% and the asphalt content of 7.5% is 19.30% and 82.71 %.

Table 3. Volumetric values of the mixture of variations in asphalt content

No	Oil Asphalt Content 60/70 (%)	VMA (%)	VIM (%)	VFB (%)
1	5.50	18.12	6.69	63.10
2	6.00	18.38	5.82	68.41
3	6.50	18.84	5.18	72.57
4	7.00	19.21	4.42	76.99
5	7.50	19.30	3.34	82.71
6	Specification	18% <	4-6%	68 % <

Based on the volumetric test results, the VIM values required by the 2010 General Specifications. revision 3 are 4% to 6%. It can be seen that the oil asphalt content are 60 / 705.5%. 6.0%. 6.5%. 7.0% and 7.5%. the VIM (Void in Mix) values are respectively 6.69%. 5. 82%. 5.18%. 4.42% and 3.34%. Based on the VIM value obtained. it can be seen that the VIM value that fulfill the 2010 specifications. Revision 3 is at the 60/70 oil asphalt content, which is 6.0%. 6.5% and 7.0% while the oil asphalt content 60/70 is 5.5 % and 7.5% not eligible specification 2010. Revision 3. The 2010 General Specification. Revision 3. Division 6 on Asphalt Pavement requires that the VMA value in the asphalt mixture is at least 18%. VMA indicates a cavity that occurs between the binding of the aggregate. where this parameter is one of the volumetric parameters. The VMA value at the oil asphalt content of 60/70 6.0% was 18.38% which was relatively higher than the VMA value for the oil asphalt content of 60/70 5.5% of 18.12%. Whereas at the oil asphalt content of 60/70 6.5%. 7.0% and 7.5%. the VMA values were respectively 18.84%. 19.21% and 19.30%. Therefore. all content of oil asphalt 60/70 used in this research is fulfill the specifications required by the General Specifications 2010. Revision 3. Division 6 concerning Asphalt Pavement Bina Marga. Indonesia requirement.

Based on the 2010 General Specifications, Revision 3, Division 6 on Asphalt Pavement. Bina Marga. Indonesia requirement the VFB requirement in asphalt mixtures is a minimum of 68%. The results of the volumetric test of asphalt mixture using oil asphalt 60/70 as a binder in the form of VFB parameters showed values of 63.10%. 68.41%. 72.57%. 76.99% and 82.71% for each oil asphalt content 60/70, namely 45.5%. 6.0%. 6.5%. 7.0% and 7.5%. Therefore, all used 60/70 oil Asphalt grades comply with the 2010 General Specification Revision 3 except at 5.5% Oil Asphalt content 60/70.

4. Conclusion

The use of oil asphalt 60/70 as a binder in the asphalt mixture is suitable for use as a hot asphalt mixture using the HRS-WC gradation. Volumetric values consisting of VIM (Void in Mix), VMA (Void Mineral Aggregate) and VFB (Void Filled Bitumen) Asphalt mixture can be used to determine the optimal asphalt content. The volumetric value that is very influential in the asphalt mixture is the VIM value which is the cavity in the mixture. The optimal asphalt content can be determined by the stability parameter and the volumetric parameter.

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