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Marshall properties of LASBUTAG asphalt mixes with pertalite as a modifier

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Abstract. LASBUTAG is one of the surface layers in road construction which consists of a mixture of Asbuton, coarse aggregate, fine aggregate and rejuvenating material, which is stirred, spread out and cold compacted. The modifier used 60/70 penetration petroleum bitumen which was cured for ± 3-5 days until dilute petroleum bitumen and lawele granular asbuton were cured with pertalite for ± 24 hours to remove the bitumen content. Variations in the asphalt content used are 1%, 1.5%, 2%, 2.5%, 3% and 3.5% with 3 x 6 test objects for standard marshall 18 pieces and 6 pieces for Marshall immersion so the total test objects made of 24 cylindrical pieces with a volume of 1200 grams. The results showed that all Marshall characteristics obtained had an effect on Marshall Stability, VMA and Marshall Quotient, but had less effect on (VIM), from variations of 1%, 1.5%, 2%, 2.5%, 3% and 3.5% used for stability. The marshall, VMA, VIM and marshall quotient tested all met the standards except for the variation of 3% and 3.5% which did not meet the VIM values for the standards used. And from the variations that meet the stability requirements, VMA, VIM and Marshall quotient are 1.75% variation (Optimum Asphalt Content) and Marshall immersion index (IP) of 95.66%.

1. Introduction

The road is a vital interest that must be fulfilled in this day and age. Along with the times, the need for roads is also growing. Seeing the development of traffic from year to year which is increasing, it requires the realization of a road that has a high level of service [1].

LASBUTAG (Aggregated Buton Asphalt Layer) is a mixture of asbuton, modifier and additional aggregate that can be used as a road pavement material. The main problem with cold mixed LASBUTAG is that the oil in the modifier has not completely evaporated from the mixture so that the LASBUTAG mixture is relatively soft with low Marshall stability. Therefore, it is necessary to find the composition of light oil, heavy oil and oil asphalt in order to achieve high quality road pavement for heavy traffic [2,3].

A modifier is a material that must be included in the LASBUTAG mixing process, considering that a modifier is a material used to rejuvenate and soften the bitumen in Asbuton. So far, the use of Asbuton for road construction has encountered several obstacles in the field, both in terms of the quality of the Asbuton produced, the use of the wrong type of modifier, as well as from the techniques used in the manufacture of asphalt mixtures with Asbuton [4,5].

This research focuses on marshall characteristics intend to obtain the best gradation of asphalt mixture using pertalite as a modifier on cold mixed LASBUTAG. The test object used was 1200 grams in volume with variations in asphalt oil content of 1%, 1.5%, 2%, 2.5%, 3% and 3.5%.

2. Methods

2.1. Physical Properties of Aggregate

Coarse aggregate used comes from crushed river stones were collected from the Jeneberang river located in Gowa with two types of aggregates with a diameter of 5 mm -10 mm and a diameter of 10 mm - 20 mm. Meanwhile, the fine aggregate used is river sand and filler using rock dust obtained from the stone crushing process. Tables 1, 2, and 3 show the characteristics and test results as well as the standard method carried out with coarse aggregate, fine aggregate, and filler.

Table 1 Properties of coarse aggregate and standard test method

Properties	Test results		Standard method
	5 - 10 (mm)	10 - 20 (mm)	
Water absorption, %	2.07	2.1	SNI 03-1969-1990
Bulk specific gravity	2.6	2.63	
Saturated surface dry specific gravity	2.7	2.68	
Apparent specific gravity	2.8	2.78	
Flatness index, %	20.12	94	SNI 03-4137-1996
Abrasion aggregate, %	25.7	24.4	SNI 03-2417-1991

Table 2 Properties of fine aggregate and standard test method

Properties	Test results	Standard method
Sand Equivalent, %	89.7	SNI 03-4428-1997
Water Absorption, %	2.8	SNI 03-1970-1990
Bulk specific gravity	2.45	
Saturated surface dry specific gravity	2.5	
Apparent specific gravity	2.63	

Table 3 Properties of mineral filler and standard test method

Properties	Test results	Standard method
Sand Equivalent, %	69.6	SNI 03-4428-1997
Water Absorption, %	2.3	SNI 15-2531-1991
Bulk specific gravity	2.6	
Saturated surface dry specific gravity	2.6	
Apparent specific gravity	2.7	

2.2. Modified Asbuton

The characteristics of the modified asbuton, retona blend 55 are shown in table 4.

Table 4 Characteristics of modified asbuton and standard test method

No.	Testing	Results	Standard method
1	Penetration before weight loss (mm)	78	SNI 06-2456-1991
2	Softening point (°C)	55	SNI 06-2434-1991
3	Ductility in 25°C, 5cm/min (cm)	113	SNI 06-2432-1991
4	Flash point (°C)	281	SNI 06-2433-1991
5	Specific gravity	1.14	SNI 06-2441-1991
6	Weight loss	0.6	SNI 06-2440-1991
7	Penetration after weight loss (mm)	85	SNI 06-2456-1991

2.3. Marshall Test

Marshall stability testing which was carried out referring to SNI 06-2489-1991 [6] used a Marshall test equipment as shown in Figure 1.

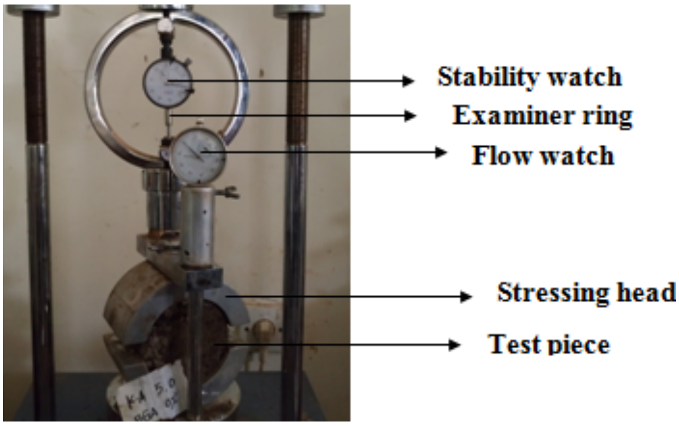

Figure 1 Marshall test equipment

3. Results and Discussion

3.1. Combined Aggregate Gradation and Mixtures Design

A sieve analysis was carried out to determine the gradation of the mixed aggregate used in the design of the solid graded asphalt mixture. Figure 2 shows the upper and lower limits of the design boundary and gradation requirements used in the study. The gradation and design used is the midpoint of the sieve analysis control limit. The composition of the mixture without Lawele granular prepared in the laboratory for this study is shown in table 5.

Two variations of the mixture without granular lawele and a mixture with granular lawele were mixed until homogeneous and then compacted into a cylindrical mould with a capacity of 1200 grams with a diameter of 101.6 mm. The compaction method used refers to the Marshall method with 50 compactions on each side for all specimens. The process of mixing until solidification of the mixture with or without granular lawele was carried out at room temperature of 27˚C. The sample was removed from the cylindrical mould after 24 hours of preservation. Put in the oven at 38˚C for up to 24 hours. Furthermore, the marshal stability test was carried out using the marshal test equipment to determine stability value and the characteristics of the marshal.

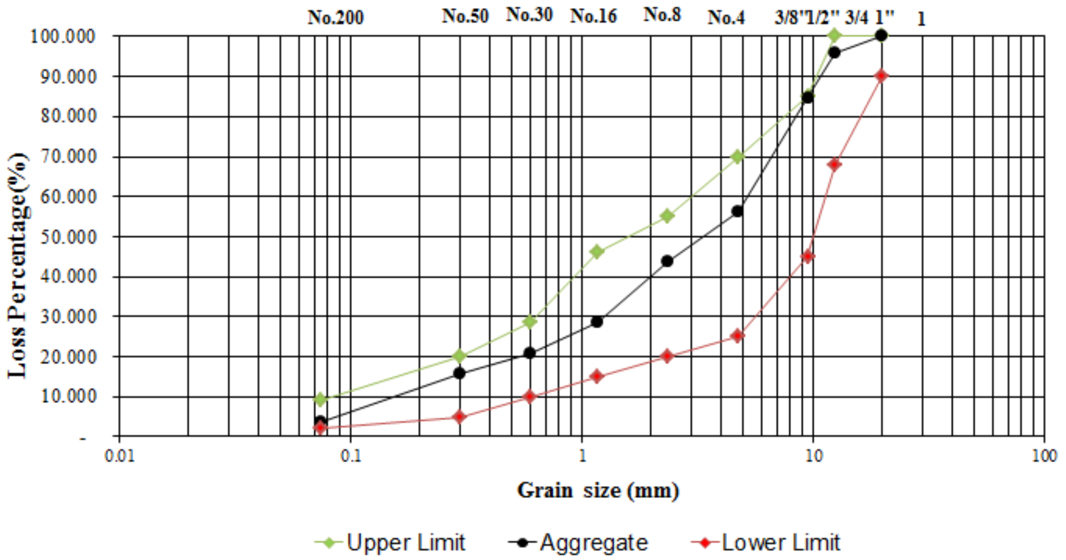

Figure 2 Combined aggregates gradation

Table 5 Composition of mixtures without Lawele granular (for 1,200 grams)

Asphalt content variation	Weight of aggregate (gr)	Weight of asphalt (gr)	Total
1%	1200	12	1212
1.5%	1200	18	1218
2%	1200	24	1224
2.5%	1200	30	1230
3%	1200	37	1237
3.5%	1200	43	1243

3.2. Marshall Characteristics

Table 6 shows the results of testing the Marshall characteristics of the LASBUTAG mixture using oil asphalt with percentages of 1.0%, 1.5%, 2.0%, 2.5%, 3.0% and 3.5%.

Table 6 Marshall characteristics of asphalt mixture

Asphalt content variation (%)	VMA	VIM	*Flow*	Stability	VFB
	(%)	(%)	(mm)	(kg)	(%)
1.0	19.05	4.52	3.07	702.42	76.29
1.5	19.15	3.19	3.13	750.41	83.35
2.0	19.93	3.10	3.10	770.88	84.44
2.5	20.75	3.07	3.23	782.24	85.21
3.0	21.11	2.48	3.17	799.43	88.25
3.5	21.88	2.41	3.30	805.88	89.04
Specification	Min. 14	3-5	2-4	Min. 750	Min. 75

The results of testing the characteristics of marshall using pertalite on cold mixed LASBUTAG are shown in table 6. In the Bina Marga specification for LASBUTAG mixture, the minimum marshall stability value is 750 kg. It can be seen in table 6 that the 1% asphalt content variation has a stability value less than the required value. However, the variation of 1.5%, 2%, 2.5%, 3%, and 3.5% met the requirements of Bina Marga and had an increased stability value with the addition of asphalt content. The greatest stability value is 805.88 kg with 3.5% asphalt content.

The specification required by Bina Marga for the VIM value in the LASBUTAG mixture is 3%-5%. The VIM value indicates the number of air voids in a mixture. The results of the marshall characteristic test using pertalite on cold mixed LASBUTAG with asphalt content of 1%, 1.5%, 2%, and 2.5% indicate that the value of the void in the mixture (VIM) is in accordance with the specifications. The addition of asphalt content makes the VIM value smaller it means that the more asphalt content fills the air voids in the mixture, making the asphalt mixture denser. However, the asphalt content of 3% and 3.5% is not according to specifications. This means that with the addition of 3% and 3.5% asphalt content, the voids in the mixture are very small which makes insufficient space available and bleeding can occur. The VIM values that are too low will be easier for plastic deformation to occur.

The VMA value in the marshall characteristic test of the use of pertalite in the LASBUTAG cold mixed as a whole follows the required value and increases with increasing asphalt content. The VMA value required in the Bina Marga specification for LASBUTAG mixtures is a minimum of 14%. If the results of the VMA value is greater, then the volume of pores filled in the aggregate in the mixture is large, so that the aggregate bond is stronger and the voids in the asphalt-concrete mixture are getting smaller.

Flow is the magnitude of deformation of the asphalt mixture due to the working load. The flow value in the marshall characteristic test using pertalite in the LASBUTAG cold mixed tends not to change much from the addition of 1% to 3.5% asphalt content but still accordance with the required value. The specification of the flow value in the LASBUTAG mixture required by Bina Marga is 2 mm – 4 mm [7].

The VFB value indicates the size of the void filled with bitumen. The value of VFB determines the level of durability of the mixture. The greater of VFB value means the voids filled with asphalt is getting bigger and the impermeability of mixture is getting bigger. The Bina Marga specification for the VFB value in the labutag mixture is a minimum of 75 mm. Overall, this research is accordance to the required value.

3.3. Marshall Immersion of Asphalt Mixture

Table 7 shows the results of the Marshall Immersion of asphalt mixture test. It can be seen that the results of the Marshall immersion test at 1.75% asphalt content with an immersion duration of 30 minutes and 24 hours are VIM values of 5.61% and 4.25%, respectively. The VFB values are 71.92% and 78.85%. VMA values are 19.97% and 20.03%. The stability values are 770.88 kg and 754.30 kg while the flow values are 3.20 mm and 3.10 mm.

Table 7 Marshall immersion of asphalt mixture

Asphalt content variation (%)	Duration of immersion	VIM (%)	VFB (%)	VMA (%)	Stability (kg)	Flow (mm)
1.75	30 min	5.61	71.92	19.97	770.88	3.20
1.75	24 hour	4.25	78.85	20.03	754.30	3.10

4. Conclusions

Based on the results of research conducted at the Civil Engineering Laboratory of the Indonesian Christian University, Toraja, it can be concluded that the effect of the use of pertalite modifier on the quality of Asbuton with a cold mix system, from the results of the Marshall characteristic test obtained, all of them have an effect on Marshall Stability, VMA and Marshall Quotient, but have little effect on (VIM), of the variations of 1%, 1.5%, 2%, 2.5%, 3% and 3.5% used in the marshall stability, VMA, VIM and the marshall quotient that were tested all met the standard except for variations of 3% and 3.5% which did not meet VIM value for the standard used. And from variations that meet the requirements based on the Department of Public Works, Directorate General of Highways, the use of asbuton (Book 5) is a mixture of cold asphalt with asbuton emulsifier grains for stability, flow, air voids, cavities in the mixture and the marshall quotient, namely variations of 1.75% (KAO) and Marshall immersion index (IP) is 95.66%.

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