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Analysis of Optimum Asphalt Content of Lasbutag Mixture (Buton Aggregate Asphalt Coating) Modified by Waste Oil and Diesel as Modifier

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ABSTRACT

Asbuton, a natural asphalt source on Buton Island in Southeast Sulawesi, is one of Indonesia's potential sources of natural wealth. As a road pavement material, LASBUTAG still has many weaknesses. This is especially true for cold LASBUTAG mixtures, which are only suitable for highways with light traffic. To mix Asbuton in cold conditions, a modifier is needed, the data of which is rare on the market, so other alternatives need to be considered as a modifier. In this research, we will try to use a mixture of waste oil and diesel as a modifier. The use of waste oil in this research is by looking at the development of the volume of waste oil. which continues to increase along with the increase in the number of motorized vehicles and motorized machines. The spread of oil waste is very widespread from big cities to rural areas throughout Indonesia. Waste from lubricating oil is included in B3 waste which needs special treatment in its processing. The aim of this research is to analyze the optimum asphalt content of cold Lasbutag mixtures with modifier materials from waste oil and diesel. From the results of this research, the Optimum Asphalt Content (KAO) in the Lasbutag Wearing Course (WC) mixture was 6.30% of the total mixture weight. Based on regression analysis, asphalt content can produce stability of 704.464 kg, flow of 3.078 mm, Vim of 4.467%, VMA of 17.077% and IKS of 78.763%. These values have met the requirements set out in the 2006 Special Lasbutag specifications.

Keywords: asbuton; cold asphalt; lasbutag; waste oil; modifiers.

INTRODUCTION

Asbuton, a natural asphalt source on Buton Island in Southeast Sulawesi, is one of Indonesia's potential sources of natural wealth. Natural asphalt reserves on Buton Island are very large, making it the largest natural asphalt deposit in the world (Amrin et al., 2017). According to the Mining and Energy Regional Division of Southeast Sulawesi Province in 1997, there were around 677.247 million tons of natural asphalt. Apart from having quite large reserves, Asbuton can also be processed in hot, warm and cold mixtures. Mixing warm and cold requires less energy than hot asphalt concrete mixtures, so this Asbuton mixture is considered more environmentally friendly (Amrin et al., 2017).

As a road pavement material, LASBUTAG still has many weaknesses. This is especially true for cold LASBUTAG mixtures, which are only suitable for highways with light traffic. To improve the quality of the mixture, additional ingredients are expected to improve the weaknesses of asbuton. (Ansyori Alamsyah et al., 2016). Several studies, most of which state that this type of pavement requires additional materials in the form of heavy oils such as MFO, Bunker Oil or Link Residue as a modifier. Currently, getting this modifier is rare on the market so it is necessary to consider other alternatives as a modifier material (Gusty & Tandi Paty, 2022). Apart from the several types of heavy oil above, there is another heavy oil ingredient that can be used to make Asbuton mixture modifier, namely Waste Oil from motor vehicles or other machines, which is quite plentiful and can be obtained more easily and at a cheaper price. In this research, we will try to use a mixture of waste oil and diesel as a modifier. The waste oil and diesel used as a modifier must meet the requirements of the heavy oil modifier from Bina Marga. It is hoped that the waste oil can replace the function of heavy oil as a modifier, and can produce a LASBUTAG pavement mixture of good quality and at a low price.

The use of waste oil in this research is based on the development of the volume of waste oil which continues to increase along with the increase in the number of motorized vehicles and motorized machines. Even in rural areas, you can find small workshops, one of the waste products is used oil. In other words, the spread of used oil is very widespread from big cities to rural areas throughout Indonesia. As the number of vehicles increases each year, the waste produced will also increase. Waste from lubricating oil is included in B3 waste which needs special treatment in its processing. (Azharuddin et al., 2020).

Asphalt flexible pavement is a type of road construction that uses asphalt as the main binding material, which is mixed with aggregate to form a strong and flexible road surface. The ideal mix for flexible asphalt pavement involves selecting the right ingredients, balanced proportions, and correct mixing and spreading methods (Artawan IP et.al, 2023; Paikun P et.al, 2023; Gusty S et.al, 2023). Asphalt as a binder is an important component in flexible pavement. The quality of the asphalt used must meet certain standards, such as proper viscosity and appropriate melting point, to ensure good adhesion between aggregate particles. Asphalt must be able to withstand changes in temperature and weather conditions, and have flexibility that allows the road to shift slightly without cracking when heavy traffic loads pass over it (Hakzah H et.al, 2023; Baggio EY et.al, 2023; Widodo S et.al, 2022).

RESEARCH METHODS

Materials

This research is quantitative research using experimental methods carried out in the laboratory. Attention is focused on laboratory tests on variations in asphalt content in cold mixed Lasbutags using a modifier in the form of a mixture of waste oil and diesel. Asphalt mixture testing is carried out using a Marshall test equipment.

The materials used in this research consisted of granular asphalt asphalt, modifier (waste oil and diesel), coarse aggregate and fine aggregate. Before making the test objects, these materials were tested with reference to the Indonesian National Standards (SNI) and General Bina Marga Specifications and Special Specifications for Las Butag. The asphalt used in this research was Asbuton Lawele Granural Asphalt (LGA) type B 50/30 in packaged form. The asbuton is first tested for bitumen content, gradation and water content. The aggregate material to be tested is standard, consisting of coarse aggregate and fine aggregate. The aggregate used in this research was taken from AMP from PT. Passokorang in quary Gentungan District. Mamuju, West Sulawesi. The modifier used in this research is a mixture of waste motor vehicle oil and diesel. Waste oil was obtained from a vehicle repair shop in the city of Mamuju, while diesel was Pertamina diesel obtained from a fuel filling station. For the modifier mixture ratio, refer to previous research with a ratio of waste oil: diesel fuel of 75:25 with a mixture content of 5.5%. The research flow can be seen in the following picture.

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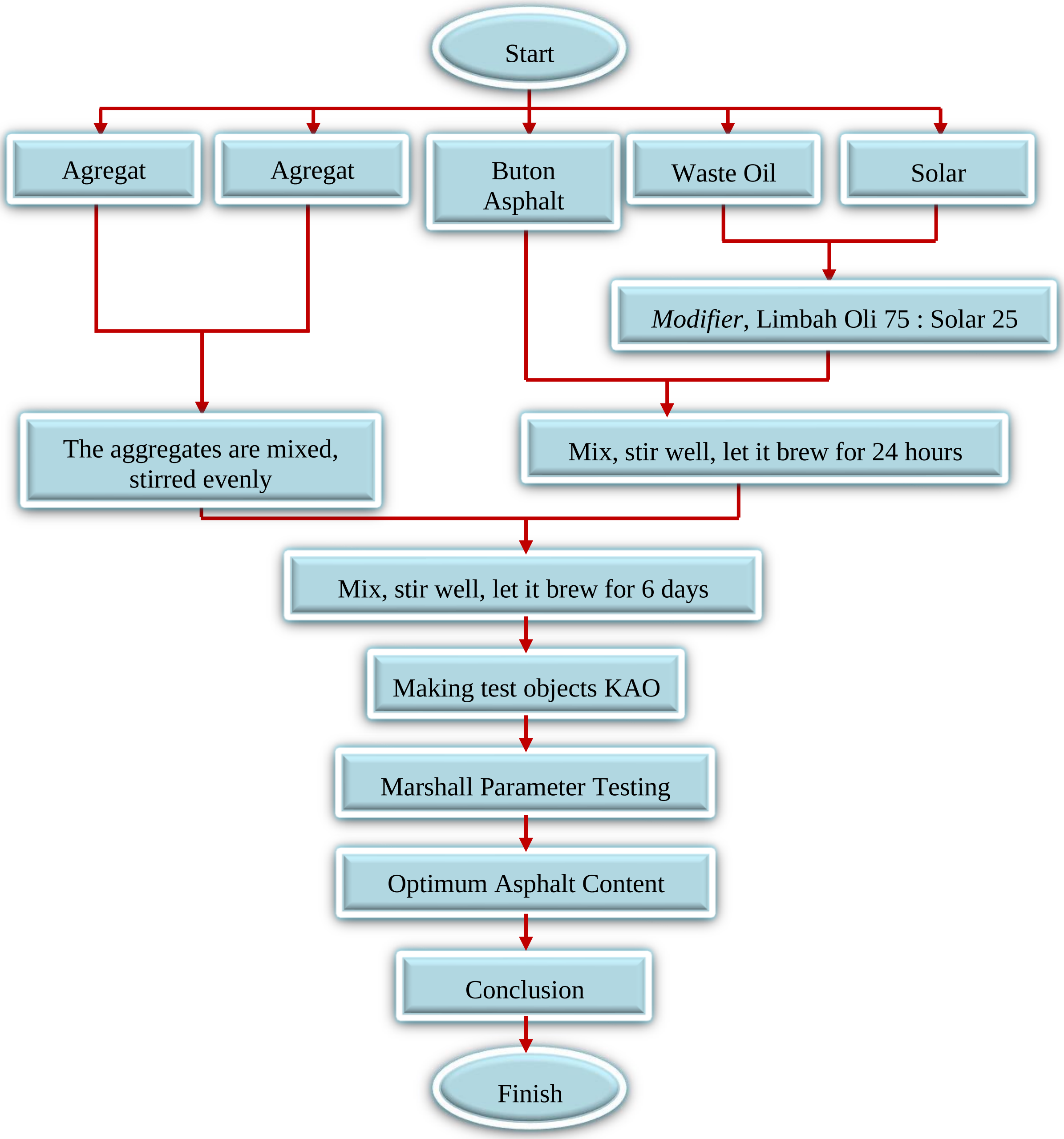

Figure 1. Research Flow Diagram

Methods

This research was conducted in Mamuju, West Sulawesi, in May September 2023. Samples in the form of briquettes were formed with varying asphalt content and mixed cold at the PT Road Laboratory. Pasokorang then carried out marshall and residual value tests referring to SNI 06-2489-1991.

Data collection techniques were carried out using experimental methods on several test objects tested in the laboratory. Primary data is data collected directly through a series of experimental activities carried out independently by referring to existing manual instructions, for example by conducting direct research/testing.

The sequence of research carried out in the laboratory consists of several stages as follows, starting from testing the material properties of pavement materials, making Marshall Test Objects with variations in asphalt content of 5.0%, 5.5%, 6.0%, 6.5% and 7 .0%. Followed by testing the Marshall Characteristics of the Lasbutag mixture, then analyzing, discussing and drawing conclusions from the test results

The equipment used in this research is laboratory equipment for testing road materials, including an oven with temperature control, a scale with an accuracy of 0.1 gr, a set of sieves of the appropriate size along with a sieve shaker, asphalt mixture briquette making equipment (which consists of a mold, compactor and hydraulic jack), Density, Specific Gravity and Porosity inspection tools (consisting of Vernier calipers and scales), Water Bath and Marshall test equipment (which consists of Beaking head, Proving Ring and Dial Flow).

Data Analysis

The analysis was carried out experimentally in the laboratory by comparing Marshall results in the form of density, voids in the mixture (VIM), voids in the aggregate (VMA), voids filled with asphalt (PFB), stability and flow using variations in asphalt content that were compared. with the values specified in the 2006 Lasbutag special specifications for wear-coated Lasbutag mixtures.

Data from the Marshall test results are then processed using regression and correlation analysis, where the regression equation can describe the behavior of the test results. Regression is a line that forms a function that connects points with the maximum possible closeness.

Correlation is a measure of the suitability of a regression model used as data. The magnitude of the correlation is symbolized by the letter R, which if R=0 means there is no relationship at all between the two data variables being analyzed. On the other hand, if R= ±1 then the two data variables being analyzed have a strong relationship. After the regression analysis is carried out, discussions and conclusions can be made on the Marshall characteristic values of the mixture

RESULTS AND DISCUSSION

From the results of this aggregate test, it was found that the physical properties or characteristics of the coarse aggregate and fine aggregate used in the mixture met the requirements of the 2006 Lasbutag special specifications and 2018 General Specifications. This can be seen from the results of the examination of the overall specific gravity of the aggregate, which ranges from 2.53 T. /m3 to 2.68 T/m3, these results are above the requirements set out in the specifications, namely a minimum of 2.5 T/m3. Absorption also still falls within the requirements set out in the specifications, namely a maximum of 3%, while the test results for Coarse Aggregate (1-2) were 1.17%, Coarse Aggregate (0.5-1) was 1.41% and Fine Aggregate (Batu Ash) of 2.25%. Specifically for coarse aggregates, aggregate abrasion or wear testing was carried out, the aggregate abrasion value resulting from the research was 26.11%, still below the value specified in the specifications, namely 40%.

Based on testing the properties of the original form of asbuton granules, it can be seen that the bitumen content of the asbuton samples used was 20.98%, still meeting the minimum requirements set out in the specifications, namely 20%. For type B50/30 asbuton grain size, it must pass a 3/8" filter. This has been fulfilled since the packaging process. Meanwhile, the specifications for water content require a maximum content of 4%, from the test results the sample used had a water content of 1.53%. So by looking at the parameters above, the Asbuton grain samples taken can meet the specifications and can be used for this research.

The modifier used refers to research conducted by Sumantri et al., the modifier formulation used is from waste oil and diesel with a ratio of 75: 25 with a modifier content in the mixture of 5.5% of the total mixture.

The combined aggregate gradation formulation is obtained using the trial and error method, carried out by multiplying the estimated composition by the percent passing each sieve until an ideal combined gradation result is obtained, which is between the minimum and maximum limits based on the specifications.

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Table 1. Gradation of Combined Aggregates

Filter Number		Coarse Aggregate (1-2)	Coarse Aggregate (0,5 – 1)	Fly ash	Mineral Asbuton	Combined Gradation	Lasbutag Special Specifications
		17,50 %	**45.00 %**	**14.91 %**	**22,59 %**		
¾ “	19,0	100,00	100,00	100,00	100,00	***100,00***	**100**
½ “	12,5	76,56	100,00	100,00	100,00	***95,69***	**90 – 100**
# 4	4,75	30,23	36,71	99,26	98,00	***58,76***	**45 – 70**
# 8	2,36	0,18	12,36	72,62	88,92	***36,51***	**25 – 55**
# 50	0,30	0,18	2,32	10,49	35,98	***10,77***	**5 – 20**
# 200	0,075	0,18	1,03	1,17	15,41	***4,15***	**2 – 9**

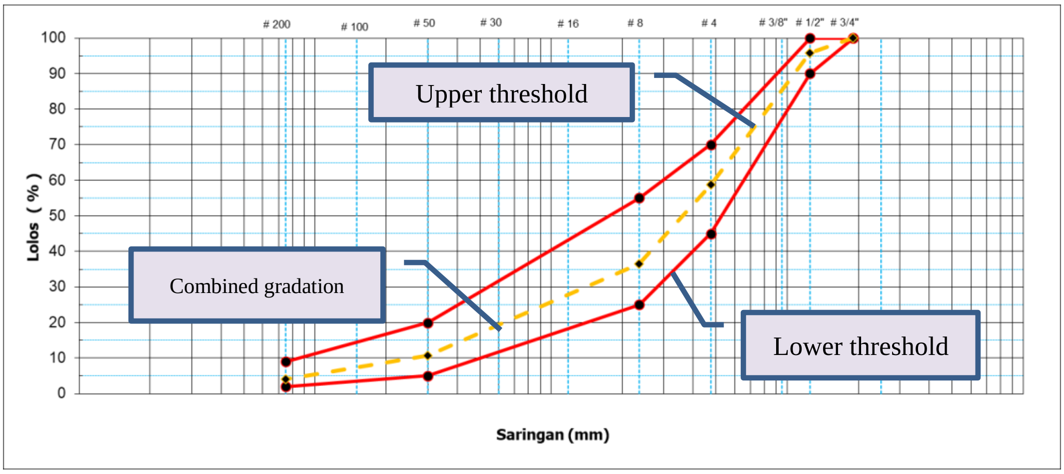

Figure 2. Combined Aggregate Gradation Graph

The combined aggregate formulation for asphalt content of 6.0% obtained a combined gradation graph as shown in table 1 and figure 2. To obtain the combined gradation combination in the graph above, the aggregate composition used was 17.50% Coarse Aggregate (1-2); 45.00 % Coarse Aggregate (0.5 -1); 14.91% Rock ash and 22.59% Asbuton mineral.

The total mixture of aggregate and asphalt for one test object weighs 1200 grams, consisting of coarse aggregate, fine aggregate and Asbuton. Three test specimens were made each, with variations in asphalt content of 5.0%, 5.5% 6.0% 6.5% and 7.0% with a modifier content of 5.5%.

Table 2. Aggregate Requirements

Fraction			Percentage to Aggregate (%)	Percentage to Mixture (%)	Weight per Fraction (gr)
Coarse Aggregate (1-2)			17,50	16,14	**193,72**
Fine Aggregate (0.5 – 1)			45,00	41,51	**498,14**
Batu Ash			14,91	13,75	**165,01**
Asbuton Granules	28,59 %	Mineral	22,59	28,59	**343,13**
		Bitumen	6,00		
Total				100	**1200,00**

The characteristics of the Lasbutag mixture are shown by fulfilling the requirements stated in the specifications related to Marshall parameter values and residual stability as follows.

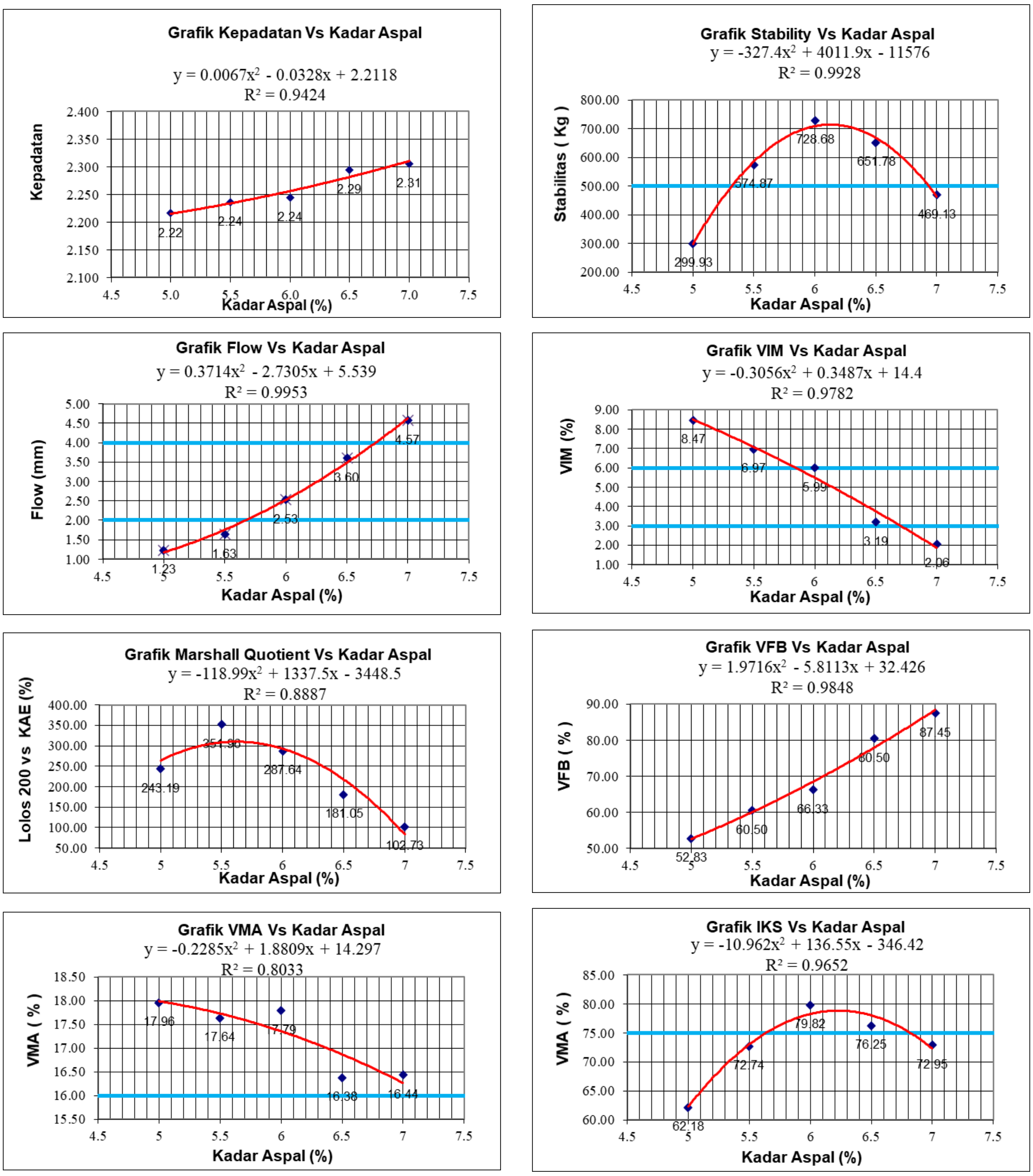

Figure 3. Marshall Characteristic Graph

The graph of the relationship between asphalt content and density shows that the higher the asphalt content, the higher the density of the mixture after compaction. The density value is influenced by several factors such as the gradation of the mixture, the type and quality of the constituent materials, the good compaction factor, the amount of compaction, the use of asphalt content in the mixture. From the graph, the relationship between stability and asphalt content shows that the stability value of a mixture with an asphalt content of 5.3% to 6.9% still meets the limits required in the Lasbutag special specifications, namely min 500 kg. From the graph of the relationship between flow/melting and asphalt content, it shows that the melting value (flow) for asphalt content of 5.7% to 6.7% still meets the limits required in the Lasbutag special specifications, namely 2 - 4 mm. From the graph of the relationship between VIM and asphalt content, it shows that the VIM value for asphalt content

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of 5.9% to 6.7% still meets the limits required in the Lasbutag special specifications, namely 3 - 6%. From the graph of the relationship between Marshal Quotient (MQ) and asphalt content, the relationship is obtained that the greater the asphalt content, the smaller the MQ value, the smaller the MQ value indicates a stiffer mixture. From the graph of the relationship between VFB and asphalt content, it can be seen that the higher the asphalt content in the mixture, the higher the VFB value in the sample. The VFB value can determine the stability, flexibility and durability of a mixture. The higher the VFB value means that there are more voids in the mixture, the higher the exposure to water and air, but a VFB value that is too high will result in bleeding. Meanwhile, the relationship between VMA and asphalt content shows that the higher the asphalt content used, the lower the VMA value obtained. Based on specifications that require the Lasbutag mixture to have a minimum VMA value of 16%. Thus, a mixture that meets these specifications uses asphalt content ranging from 5.9% to 6.7%.

The calculation results are then plotted in a bar chart system to determine the ideal percentage.

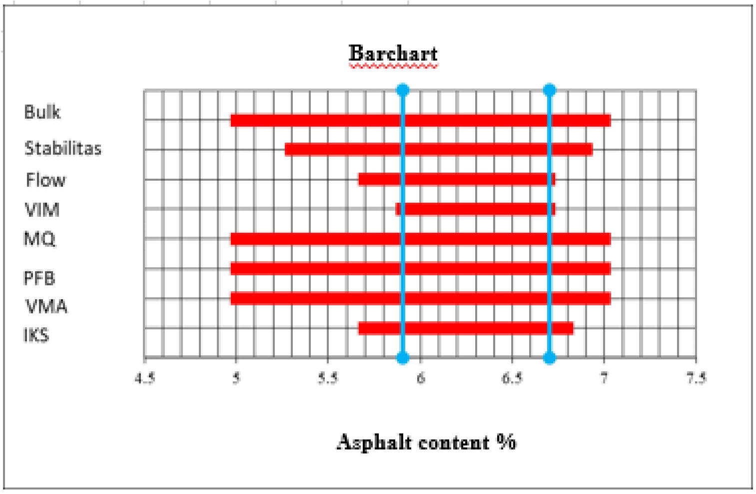

Figure 4. Barchart of optimum asphalt content

The ideal asphalt content is determined using interpolation techniques. The asphalt content is at a value of 5.9% - 6.7% so that the optimum asphalt content obtained is

$$\text{Optimum asphalt content} = \frac{(5,9 + 6,7)}{2} = 6,3\ \%$$

From the analysis, it was found that the Optimum Asphalt Content (KAO) was 6.30% with the formulation of coarse aggregate 1-2 = 17.50%, coarse aggregate 0.5-1 = 45.00%, fine aggregate/stone ash = 13.78% and usage Asbuton was 30.02%.

After obtaining the optimum asphalt content value, you can then find the magnitude of the mixture characteristics by analyzing the data from the optimum asphalt content that was previously obtained into a regression equation for each relationship between asphalt characteristics and asphalt content.

Table 3. Marshall parameter values for KAO based on the regression equation

Mixed properties	Equality	Value	Specification
Density, T/m3	y = 0.0067x2 - 0.0328x + 2.2118	2,271	-
Stability, Kg	y = -327.4x2 + 4011.9x - 11576	704,464	Min. 500
Flow, mm	y = 0.3714x2 - 2.7305x + 5.539	3,078	2 – 4
VIM, %	y = -0.3056x2 + 0.3487x + 14.4	4,467	3 – 6

Mixed properties	Equality	Value	Specification
MQ, %	y = -118.99x2 + 1337.5x - 3448.5	255,037	-
VFB, %	y = 1.9716x2 - 5.8113x + 32.426	74,068	-
VMA, %	y = -0.2285x2 + 1.8809x + 14.297	17,077	Min. 16
IKS, %	y = -10.962x2 + 136.55x - 346.42	78,763	Min 75

CONCLUSION

The Optimum Asphalt Content (KAO) in the Lasbutag Wearing Course (WC) mixture using material originating from the AMP location in the Gentungan Kalukku environment is 6.30% of the total weight of the mixture, with a Bitumen content in Asbuton of 20.98%, the use of asbuton in the mixture was 30.02%, while the use of coarse aggregate 1-2 was 17.50%, aggregate 0.5 – 1 was 45% and stone ash was 13.78%. Based on regression analysis, asphalt content can produce stability of 704.464 kg, flow of 3.078 mm, Vim of 4.467%, VMA of 17.077% and IKS of 78.763%. These values have met the requirements set out in the 2006 Special Lasbutag specifications.

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