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Laboratory Study of the Performance of Assphal with Assbuton using Liquid Asbuton - Oil Asphalt as a Binder

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Abstract

Porous asphalt is an asphalt mixture with low sand rate to get high cavity rate and is road concreting type design to channel water is the surface road to substratum so that not happened pond on the surface of road vertically and also horizontal, besides axis asphalt design to increase the coefficient of friction at paving surfaces. This research is done in a laboratory and is not done field study. Sampling Method; Harsh aggregate material and filler have taken away from river Bili-Bili district of Parangloe result of stone crusher PT. Cisco Sinar Jaya South Sulawesi province. Oil asphalt and liquid Asbuton taken away from technological examination area laboratory and expansion on duty Bina Marga South Sulawesi Province. The result of inferential research as follows: the result of the examination of asphalt axis mixture characteristic indicates that usage of mixture liquid Asbuton 50% and pin oil asphalt 60/70 50% using gradation open-graded shows good quality since have already fulfilled specification. Mixture liquid Asbuton and pin oil asphalt 60/70 of the result of penetrating examination with value 60/80 indicating that the asphalt mixture is including asphalt that is is too not firm. Gradation porosity 1 smaller than gradation 2, Binder drain-down stays under the maximum condition that is 0,3%. From the result of the graph the relation of some parameters mix design asphalt porus that is porosity, stability Marshall, Cantabro, flaw, Marshall Quotient, permeability and examination of binder drain-down, got optimum asphalt rate value of gradation 1 that is 6,9% and gradation 2 that is 6,775%.

Keyword: *Porous asphalt, mixture liquid Asbuton, and oil asphalt*

Introduction

In line with the increasing demand for asphalt in the country that has to import up to 650,000 tons per year and the occurrence of premature damage to the paving work is predicted due to increasingly heavy traffic loads and high pavement temperatures, as well as high rainfall and hot sun throughout the year. utilize in asphalt mixtures, hot mixtures, and warm mixtures which are used according to their designation, have good technical properties which can also save the use of oil asphalt (hard) and aggregates used.

One alternative that can be considered to reduce imports of oil asphalt and at the same time improve the performance of the asphalt mixture is to use Asbuton liquid. The utilization of natural asphalt found on the island of Buton which is commonly called Asbuton (Asbuton Rock), which is now starting to be processed into Asbuton liquid, is sought to be utilized as much as possible in the road infrastructure development program in Indonesia so that it can be an economical and efficient choice for road construction and maintenance. because besides the price is cheaper and has better workability than other Buton asphalt types.

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Porus asphalt is a mixture of asphalt with a low sand content to obtain a high cavity content and is a type of road paving designed to channel water on the road surface to the bottom layer so that there is no puddle on the road surface vertically or horizontally, besides that the asphalt shaft is designed to increase the coefficient of friction on the hardening surface. The mixture is dominated by the coarse aggregate, to get high enough pores to obtain high porous asphalt permeability, where the permeability is used for the sub-surface drain.

The properties of the porous asphalt are determined by the aggregate gradation, besides also depending on the properties of the porous asphalt forming material itself. Grading selection is a difficult process in determining the desired properties of porous asphalt, almost every research institute in various countries has specific aggregate gradations based on available recipes, and these gradations are not always compatible when used with materials and production methods. different.

Literature Review

Asphalt

Asphalt is defined as a black or dark brown material, at a temperature that is solid to slightly dense when heated to a certain temperature. Asphalt can become soft/liquid so that it can wrap the aggregate particles at the time of making asphalt concrete or can enter into the pores that are on spraying/watering on macadam or smelting pavements. If the temperature starts to drop, the asphalt will harden and bind the aggregate in place (Sukirman, 1990) Porous asphalt has been used as a surface coating in pedestrian areas such as pedestrian walkways in parks, sidewalks and for light vehicles (light vehicle)). Japan, the Netherlands, and several other countries have used hollow asphalt as the main road. In addition to its mechanical properties, microstructure, bonding between materials and permeability are important characteristics of porous asphalt used to reduce traffic noise, improve road slip resistance and permeability. used to pass water into the ground so that it can be used to control and regulate rainwater runoff.

Liquid Asbuton

Asphalt Buton (liquid Asbuton) as natural asphalt must be maximally utilized in road infrastructure development programs in Indonesia. Buton asphalt has various advantages compared to oil asphalt, whose price is currently increasing in line with the increase in world oil prices. Liquid Asbuton has very low penetration, making it very difficult to use without mixing with other ingredients, in general, it contains 60% to 75% bitumen content, the rest are minerals 25% -40% as natural fillers, bitumen is mostly formed by asphaltene and low levels of maltene and high stability levels of matter, which consists of polyaromatics resins (with aromatic and naphthenic structures) can improve the stability of the asphalt mixture. The high bitumen content in liquid asbuton causes a reduction in penetration or an increase in the viscosity of the asphalt and the softening point of the asphalt. Can be used as an additive to the asphalt mixture modifier that is used to modify the asphalt.

One of the modified ingredients for oil asphalt is liquid asbuton from natural asphalt from Buton Island. Liquid Asbuton is produced in the Makassar Industrial Estate by a national company that is domiciled in Makassar.

Liquid Asbuton is produced and Buton Rock Asphalt (BRA) is in the form of chunks, then the size is reduced through a crusher to a maximum size of 1 inch, then put into a dryer for drying and moisture content and heated to a temperature of 90 ° C, then entered into a kettle and heated 130 ° C, then until the mixer and heated again with a temperature of 180 ° C so that all the asphalt content in the rock comes out, then filtered with a 2-4 mm sieve size. The filtered liquid asbuton is put into the asphalt drum and ready for use.

Porus Asphalt

The porous asphalt mixture was created to have the ability to drain water over the surface into the impermeable layer and drain the water to the side channels. In Europe, the porous asphalt mixture was re-modified so that the air cavities were connected. Porous asphalt is a special coating when used as a wear layer. The porous asphalt gradation is obtained by mixing open-graded crushed stone with a polymer modifier binder and contains a high air cavity during compaction. Modify the air cavity according to the specifications, namely 15-25% so that it can drain water into the watertight layer and drain it into the side channel of the road. Applications of porous asphalt mixtures have long been practiced in the United States and Europe. In Malaysia, the use of porous asphalt mixtures was still in its infancy, which was around the 1990s. (Cahirul Abrar B Ali Ramdan).

According to Setyawan A. Sanusi, the porous asphalt mixture is a new generation in the flexible pavement, which allows water to penetrate the top layer (wearing course) vertically and horizontally. This layer uses an open-graded, which is spread over a waterproof asphalt layer. This porous asphalt layer can effectively provide a higher level of safety, especially during rainy days so that aquaplaning does not occur, resulting in rougher surface roughness, and can reduce noise (noise reduction). Porus asphalt consists of a larger amount of coarse aggregate, generally 75-85%, 4-7% binder, and 2-4% filler with a design having 15-25% air voids.

Coarse Aggregate

Coarse aggregate used for porous asphalt must meet the following physical and mechanical qualities.

1. The weight loss after testing the Los Angeles machine is <25%, based on ASTM C-131 or SNI 03-2417-1991.
2. The average weight loss after a magnesium sulfate test for soundness <18%, according to AASHTO T-104 or SNI 03-3407-1994.
3. Flatness index, when tested, <25%, based on MS-30 or RSNI T-01-2005.
4. Water absorption <2% based on MS-30 or AASHTO T85 - 81 testing

Fine Aggregate

Fine aggregate consists of non-plastic materials and must be free from silt, clay, organic matter. The fine aggregate used for porous asphalt must meet the following physical and mechanical qualities:

1. Aggregate fraction equivalent to sand that passes sieve no. 4 (4.75 mm)> 45%, based on ASTM D 2419.
2. Fine aggregate angularity> 45% when tested based on ASTM C1252.
3. The average weight loss on the magnesium sulfate soundness test (five rounds) is <20%, based on AASHTO T 104 or SNI 03-3407-1994.
4. Water absorption <2%, based on MS 30 or AASHTO T 85-81 tests.

Method

The experimental method used in this research is to conduct experimental activities in the laboratory. Porous asphalt is produced using the same type of direct aggregate from a stone crusher and bitumen, but with a different type of grading. For each type of gradation, then observations are made on the characteristic value to determine the optimum value of its bitumen content. Furthermore, with this optimum value, other observations can be made to determine the value of Marshall stability, pressure strength (UCT), and the value of the wear test (Cantabrian Test). Based on the best values of the three properties, it is then used to determine the best type of gradation using local materials. To obtain data as the main material in this study, two data collection methods were used as follows:

a. Literature study, to obtain secondary data by reading some books as a theoretical basis for the perfection of this research.
b. Sample examination is carried out in the laboratory to obtain primary data that will be used in analyzing the results of the research carried out.

Sample

a. Coarse aggregate and filler materials were taken from the Bili-Bili River, Parangloe District, the result of the stone crusher of PT. Cisco Sinar Jaya, South Sulawesi Province.
b. Asbuton liquid asphalt was taken from the Laboratory for Testing and Technology Development at the Highways Service Office of South Sulawesi Province.

Design

The methodology used in this research is as follows:

Material Properties Testing

The materials used in the porous asphalt mixture are tested for the characteristics of each material, both coarse aggregate, fine aggregate, and testing of Asbuton liquid asphalt where the test method refers to SNI, and this test is carried out in the laboratory. The initial stage of research carried

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out in the laboratory is to check the quality of the asphalt material and the quality of the aggregate that will be used in the mixed experiment.

Making Test Objects

After the material used is tested and meets the specified specifications for the porous asphalt mixture, the composition of the mixture is made for the manufacture of the test object. The composition of the mixture used in this study is the composition of the mixture using open-graded gradations, where the gradations meet the specifications of the type of gradation with asphalt mixing, namely 50% using Asbuton liquid and 50% oil asphalt.

Testing of test objects

In testing Porus asphalt specimens, there are four types of testing, namely:

1. Testing the stability of the test object is carried out using the Marshall Test tool where this experiment refers to SNI-06-2489-1991.
2. Cantabro test where test is intended to determine the weight loss of the test object after an aberration test is carried out with a Los Angeles machine where this experiment refers to ASTM C-131.
3. The Drain-Down Binder Test where this test aims to determine the amount of drain-down that occurs in the asphalt mixture that has not been compacted which refers to AASHTO T 305.
4. Permeabiliias Hatch, where this test refers to the modification of ASTMD2166-66.

Result and Discussion

Physical Characteristics of Aggregates and Rock Ash

The results of testing the physical properties of aggregate and rock dust are shown in Table 1 to Table 3.

Table 1. Characteristics of coarse aggregate materials (chipping 1: 2)

Type of Testing	Testing Method	Unit	Result	Specs
Bulk Specific Gravity (Bulk)	SNI-03-1969-1990	-	2,56	≥ 2,5
SSD Specific Gravity	SNI-03-1969-1990	-	2,60	-
Artificial Specific Gravity	SNI-03-1969-1990	%	2,66	-
Water Absorption	SNI-03-1969-1990	%	1,38	≤ 3,0
Aggregate Wear	SNI-03-2417-1991	%	23,97	≤ 40
Flake Index	SNI-M-25-1991-03	%	18,39	≤ 25

Source: Test Results and Lab Calculations. Transportation Engineering UNHAS

Table 2. Characteristics of coarse aggregate materials (chipping 0.5: 1)

Type of Testing	Testing Method	Unit	Result	Specs
Bulk Specific Gravity (Bulk)	SNI-03-1969-1990	-	2,72	≥ 2,5
SSD Specific Gravity	SNI-03-1969-1990	-	2,77	-
Artificial Specific Gravity	SNI-03-1969-1990	%	2,87	-
Water Absorption	SNI-03-1969-1990	%	1,87	≤ 3,0
Aggregate Wear	SNI-03-2417-1991	%	23,97	≤ 40
Flake Index	SNI-M-25-1991-03	%	18,39	≤ 25

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Table 3. Characteristics of fillers

Type of Testing	Testing Method	Unit	Result	Specs
Bulk Specific Gravity (Bulk)	SNI-03-1969-1991	-	2,58	≥ 2,5
SSD Specific Gravity	SNI-03-1969-1990	-	2,65	-
Artificial Specific Gravity	SNI-03-1969-1990	-	2,77	-
Water Absorption	SNI-03-1969-1990	%	2,62	≤ 3,0

Source: Test Results and Lab Calculations. Transportation Engineering UNHAS

Determination of Mixed Gradation

Cracked stone (∅1cm - ∅2cm), (∅0.5cm- ∅1cm), and rock ash are 70%, 15%, and 15% (gradation 1), and 75%, 15%, respectively. 10% (gradation 2) of the aggregate weight. The aggregate used is designed and made based on open-graded with the composition shown in Table 4 to Table 5.

Table 4. Gradiation of combined aggregates 70%, 15%, 15% (gradation 1)

TYPES OF MATERIAL	OPEN GRADED GRADATION					
	in	3/4	1/2	3/8	No.4	No.200
	mm	19,5	13,2	9,5	4,75	0,075
Crushed stone 1: 2	% PASS	100,00	55,28	21,75	1,35	0,00
70%	% PASS	70,000	38,6982	15,227	0,947	0,00
0.5: 1 crushed stone	% PASS	100,00	100,00	100,00	7,26	0,22
15%	% PASS	15,00	15,00	15,00	1,088	0,032
Stone ash	% PASS	100,00	100,00	100,00	100,00	17,255
15%	% PASS	15,00	15,00	15,00	15,00	2,588
TOTAL PASSING (%)		100,00	68,698	45,227	17,035	2,62
SPEC. GRADING		100	50-70	30-50	10-25	1-5

Source: Lab test results and calculations. Transportation Engineering UNHAS

Table 5. Grade of combined aggregate 75%, 15%, 10% (gradation 2)

TYPES OF MATERIAL	OPEN GRADED GRADATION					
	in	3/4	1/2	3/8	No.4	No.200
	mm	19,5	13,2	9,5	4,75	0,075
Crushed stone 1: 2	% PASS	100,00	55,28	21,75	1,35	0,00
75%	% PASS	75,000	41,4624	16,3141	1,0143	0,00
0.5: 1 crushed stone	% PASS	100,00	100,00	100,00	7,26	0,22
15%	% PASS	15,00	15,00	15,00	1,0883	0,0328
Stone ash	% PASS	100,00	100,00	100,00	100,00	17,255
10%	% PASS	10,00	10,00	10,00	10,00	1,7255
TOTAL PASSING (%)		100,00	66,4624	41,3141	12,1026	1,7583
SPEC. GRADING		100	50-70	30-50	10-25	1-5

Source: Lab test results and calculations. Transportation Engineering UNHAS

Table 6. Characteristics of liquid Asbuton 50% + Asphalt Oil 60/70 50%

Type of Testing	Testing Method	Unit	Result	Specs
Penetration (25o C, 5 sec, 100 gr)	SNI.06 – 2456-1991	0,1 mm	67,47	Max.79
Penetration After Losing Weight	SNI.06 – 2434-1991	% semula	84,08	-
Flashpoint	SNI.06 – 2433-1991	^{o}C	250	Min.225
Softening Point	SNI.06 – 2434-1991	^{o}C	55	Min.55
Specific gravity (250 C)	SNI.06 – 2441-1991	gr/cc	1,19	Min.1
Weight Loss (163o C, 5 hours)	SNI.06 – 2440-1991	% berat	0,320	-
Viscosity 170 Cst (Temp. Compaction)	SNI.06 – 6721-1991	^{o}C	140	-
Ductility (25o C, 5 cm / min)	SNI.06 – 2432-1991	cm	50,35	Min.50

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Laboratory Permeability Test Data

Table 7 of the results of the permeability test for grading (1) and grading (2) shows that the properties of the combined aggregate before mixing asphalt produce a permeability coefficient value of 0.01 cm / s. This proves that there are many cavities in the test object (porus) that can easily drain water.

Table 7. Permeability of mixed aggregates

Type of Testing	Testing Method	Unit	Result	Specs
Permeability (*constant head)* Gradation (1)	ASTMD2166-66	cm/det	0,01	
Permeability (*constant head)* Gradation (2)	ASTMD2166-66	cm/det	0,01	> 10^{-1} (gravel)

Source: Test Results and Lab Calculations. UNHAS Soil Mechanics

Porous Asphalt Porosity Test Data

Figure 1 shows that at a 75% chipping 1: 2 gradation, 15% chipping 0.5: 1, 10% rock dust (2), the porosity value decreases with increasing bitumen content, this is because asphalt is thermoplastic so that at certain hot temperatures it has properties like a liquid, which will occupy the space / 'cavity in the mixture to minimize the cavities in the mixture. Whereas in a gradation of 70% chipping 1: 2, 15% chipping 0.5: 1, 15% rock dust (1) The porosity value decreased until the asphalt content was 6%, then there was an increase in the bitumen content of 7% and 7.5%, although the increase does not exceed the asphalt content of 5% and 5.5%. There is a difference in the porosity value between gradation (1) and gradation (2), where the porosity value of the gradient (1) is smaller than the gradient (2), this is because there is a difference in the percentage of chipping weight 1: 2 and rock dust, where the percentage of chipping weight 1: 2 has more gradations (2) than gradations (1), while the weight percentage of rock dust has more gradations (1) than gradations (2), so asphalt and rock dust fill the voids between the aggregates.

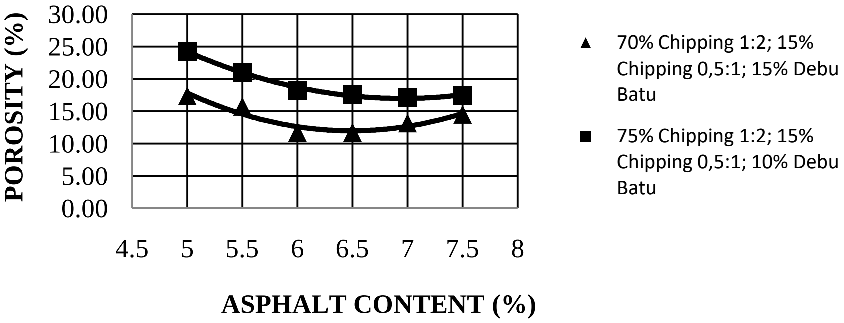

Figure 1. The relationship between asphalt content and porosity

Permeability Test Data

Figure 2 shows the permeability value of gradation 1 is smaller than gradation 2, this is because in gradation 1 the weight percentage of rock dust is more than gradation 2, so the asphalt and rock dust cover the volume of cavities inside the test object. the relationship between asphalt content and permeability coefficient where the function line of the relationship will decrease with increasing

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asphalt content. This is because, with the increase in the asphalt content, the volume of the cavity inside the test object decreases due to the closure of the cavity by the bitumen so that the time to drain water from the surface will be longer.

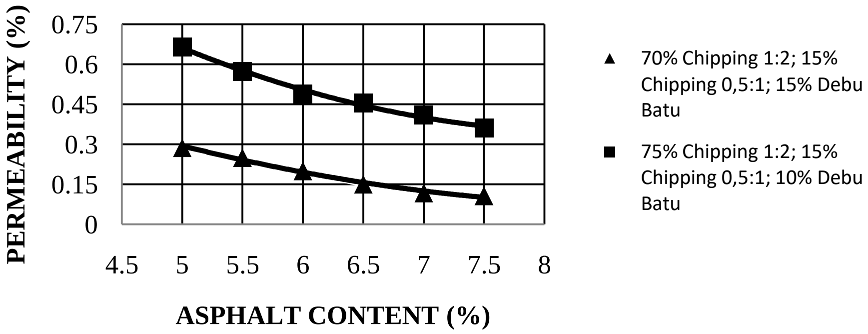

Figure 2. The relationship between asphalt content and permeability

Relationship between Asphalt Content and Stability

Figure 3 shows the relationship between asphalt content and stability, where the stability value of porous asphalt increases with increasing asphalt content. This is because the high bitumen content will bind the aggregate tighter so that the aggregate will be firm in its position. The increase in the value of gradient stability 2 is not like gradation 1, from the graph it appears that the increase in the stability value of gradation 2 tends to form a straight line, on visual observations after the Marshall test on the destruction pattern shows that the test object is damaged on asphalt bitumen and coarse aggregate, the results show that bitumen and aggregate is a monolithic unit in accepting loads so that cracks occur in both materials. From the graph, it can be seen that the stability in gradation 1 is greater than gradation 2, this is because in gradation 1 the porosity value is small so that the bitumen content (50% liquid + 50% oil asphalt) can bind the aggregate stronger. The stability value of gradation 1 and gradation 2 meets the stability standard for high traffic, namely 800 kg.

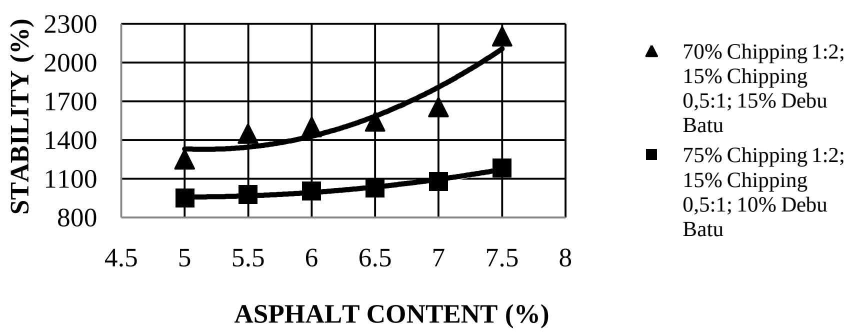

Figure 3. The relationship between asphalt content and stability

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Relationship between Asphalt Levels and Fatigue (Flow)

Figure 4 shows the relationship between asphalt content and flow, the flow value in gradation 1 is smaller than gradation 2, from the graph shown, the value of flow gradation 1 forms a straight line, meaning that there is no change in flow value for each increase in asphalt content, this is due to the percentage of chipping weight 0.5: 1 and rock dust alike. In contrast to gradation 1, the value of flow gradient 2 forms a parabola. Asphalt content 5% to asphalt content of 6.5% decreased, then increased until asphalt content of 7.5%. Visual observation after the pounding of the mixture in the mold, there is a similar pattern between the asphalt content of 5% to 6.5%, experiencing changes in asphalt content of 7% to 7.5%. The value of flow gradation 1 for asphalt content is 5.0%; 5.5%; 6.0%; 6.5%; 7.0%; and 7.5% resulted in a flow value of 2.88 mm; 2.68 mm; 2.77 mm; 2.65 mm; 2.80 mm; 2.85 mm. The value of flow gradation 2 for asphalt content is 5.0%; 5.5%; 6.0%; 6.5%; 7.0%; 7.5% produces a flow value of 3.80 mm; 2.97 mm; 2.88 mm; 2.88 mm; 3.13 mm; 3.5 mm.

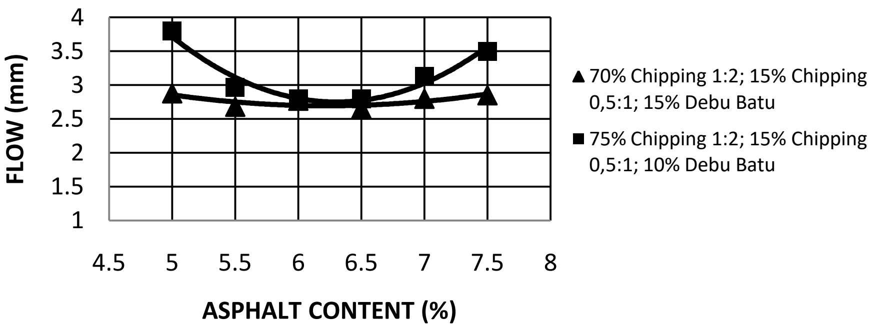

Figure 4. The relationship between asphalt content and flow

Relationship between Asphalt Levels and Weight Loss (Cantabro)

The Cantabro test shows the resistance of a test object. The less weight loss that occurs, the more durable the specimen is. Figure 5 shows that the smallest weight loss in gradation 1 occurred in the test object with the largest asphalt content of 7.5%, namely 4.14%, while the largest weight loss occurred at the smallest asphalt content of 5.0%, namely 76.44%. The smallest weight loss in gradation 2 occurred in the test object with the largest asphalt content of 7.5%, namely 5.62%, while the largest weight loss occurred in the test object with the smallest asphalt content, namely 64.76%. From the picture, it can be seen that gradation 1 and gradation 2 specimens with asphalt content of 6.5% to asphalt content of 7.5% by specifications while 5.0% - 6.0% are not included in the weight loss specification, namely at least 15% initial weight before Cantabro testing with Los Angles machines.

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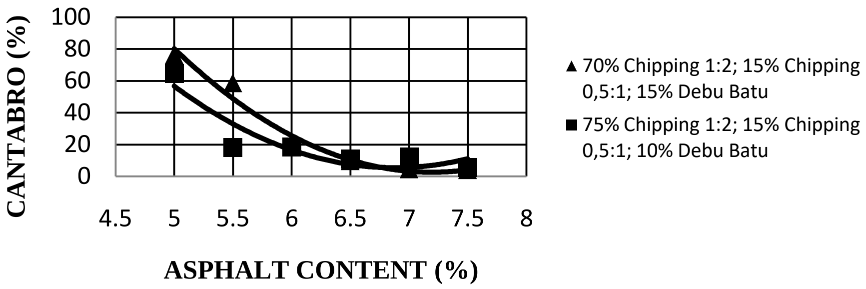

Figure 5. The relationship between asphalt content and weight loss

Conclusion

Based on the data analysis carried out in this study, it can be concluded as follows:

1. The results of testing the characteristics of the porous asphalt mixture show that the use of a mixture of 50% Asbuton liquid and 60/70 50% pen oil asphalt using open-graded gradations shows good quality because it meets specifications.
2. The mixture of liquid Asbuton and Oil Asphalt from the results of the penetration test with a value of 60/80 shows that the asphalt mixture includes bitumen that is not too hard. In the ductility test, the low level of plasticity was evidenced by the ductility value of only up to 50.35 cm which resulted in the high asphalt content in the Cantabro test which only met specifications. This is due to the low plasticity of the asphalt so that the binding power between the aggregates is less. The characteristics of porous asphalt obtained using a mixture of 50% Asbuton liquid and 50% oil asphalt with open-graded gradations are:
   a. The porosity of gradation 1 is smaller than gradient 2.
   b. The Drain-down binder, gradation 1 and gradation 2, is still below the maximum requirement of 0.3%.
   c. Losing weight through the Cantabro test with gradation 1 and gradation 2 and a half asphalt content from the test results passing the maximum requirement, namely 15%. This shows a mixture of 50% liquid Asbuton and 50% oil asphalt.
3. From the results of the graph of the relationship between several parameters of the porous asphalt mix design, namely porosity, Marshall stability, Cantabro, flow, Marshall Quotient, permeability, and binder drain-down testing, the optimum asphalt content value for gradation 1 is 6.9% and gradation 2 is 6.775. %.

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