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Effect of Collision Variation towards the Index Retained Strength of Mixed Asphalt Concrete Wearing Course

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Abstract— *Compaction of Asphalt Concrete Wearing Course (AC-WC) is a compression process in order to obtain sufficient strength and stability and cavity in the asphalt mixture. The compaction process in the field is carried out using a tandem roller, whereas for the design of the mixture in the laboratory, the compaction process is simulated by weighing the mixture in the mold. Collision that does not meet the requirements can cause the density of the asphalt mixture to be uneven and easily cracked which will ultimately affect the performance of the asphalt mixture produced, both in terms of service life and in terms of comfort. This research will examine the effect of different amounts of collision during the compaction process on the characteristics of the AC-WC mixture by taking the number of collisions of 25x, 50x and 75x by varying the asphalt content of 5%, 5.50%, 6%, 6.50% and 7%. The results showed that using a mixture composition of 39.9% coarse aggregate, 46.8% fine aggregate, 6.30% filler and 7% asphalt and collision 25 collisions, 50 collisions, 75 collisions, AC-WC mixture was resistant to the effects of collisions and the effect of water immersion where the VFB value increases and the VMA value decreases. The Retained Strength Index shows all variations of collisions that meet the standard specifications.*

Keywords— *Collision, Retained Strength Index, Marsahll, AC-WC.*

I. INTRODUCTION

The flexible pavement in Indonesia is designed using the Marshall method whose mixed conditions and requirements are regulated in technical specifications issued by the Directorate General of Highways, the Ministry of Public Works and Public Housing [1]. But in its implementation it shows that the suitability of the results of quality control testing in the field with the control parameters required in these specifications is often not met. The average density of all Marshall specimens from compaction experiments in the Job Mix Formula (JMF) work mix formulation is a Job Standard Density (JSD) which must be the basis for comparing densities for all results of the asphalting work carried out [2]. The degree of density for the Asphalt Concrete Wearing Course (AC-WC) mixture should not be less than 98% JSD [1].

The compaction process in the field is carried out using a tandem roller, whereas for the design of the mixture in the laboratory, the compaction process is simulated by weighing the mixture in the mold.

Collision has an influence on the density of the mixture that depends on Void in Mix (VIM), Void in Mineral Aggregate (VMA), and Voids Filled with Bitumen (VFB) [3]. Collision that does not meet the requirements can cause the density of the asphalt mixture is uneven and easily cracked which will ultimately affect the performance of the asphalt mixture produced, both in terms of service life and in terms of comfort [4]. It is not always that increasing the amount of collision to the asphalt mixture produces the highest stability value, because the asphalt mixture has a deformation limit before experiencing failure due to repetitive static loading.

Several previous researchers who examined the compaction problem in AC-WC include Kurniawan et al. Who examined the issue of the Effect of Compaction Trajectory Speed on Dynamic Stability and Age of the Laston Lap Aus (AC-WC) Service [5], Sentosa, et al. Examined the effect of mixing temperature variations and compacting hot asphalt mixture using asphalt retona blend 55 [6]. Aschuri et al examined the optimum temperature problem in the compaction process for asphalt mixtures using modified plastic bitumen waste [7]. Fithra H., (2013),. Effect of Number of Collisions on the Latex Supplemental Asphalt Concrete Wearing Course (Ac-Wc) Mix on Marshall Properties {8}.

This research will examine the effect of differences in the number of collisions during the compaction process on the characteristics of the laston aus mixture (AC-WC) by taking the number of collisions of 25x, 50x and 75x with the asphalt content used asphalt content used is 5.00%, 5.50 %, 6.00%, 6.50% and 7.00% by analyzing the mixture characteristics (Conventional Marsahll and Marshal Imertion) and Retained Strength Index.

II. METHODOLOGY

A. Location

The study was conducted at the Road and Asphalt Laboratory of the Department of Civil Engineering, Christian Indonesia Paulus University. Coarse and fine aggregates to be used are aggregates originating from the Jeneberang River, Bili-bili District, Gowa Regency, South Sulawesi Province, Indonesia, while the asphalt used is asphalt used is penetration of 60/70.

B. Experimental Program

Testing of aggregate characteristics is carried out on the los angeles abrassion test, specific gravity and absorption of coarse and fine aggregate water, aggregate filter analysis, testing the amount of material in the aggregate (coarse and fine) that passes the filter number 200 / 0.075 mm, sand equivalent test, examination of flakiness and slope index,

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aggregate viscosity testing on asphalt, filler specific gravity testing. Asphalt characteristic testing is carried out on penetration, softening point with ring and ball, cleveland open cup, weight loss due to heating, ductility, asphalt density. Analysis of Marshall's characteristics is the value of stability, Flow, Voids Filled with Bitumen (VFB), Void In The Compacted Mixture (VIM), Void in the Mineral Aggregate (VMA), Optimum Asphalt Levels and Index Retained Strength (IRS).

C. Test Object Design

The design of the number of test specimens as in table 1 was made for testing asphalt content of 5%, 5.5%. 6%, 6.5% and 7% with variations in the total number of collisions of 25, 50 and 75. The total number of samples was 45.

TABLE 1. Test Object Design.

Asphalt Levels (%)	Total Test Objects		
	25 Collision	50 Collision	75 Collision
5 %	3	3	3
5.5 %	3	3	3
6 %	3	3	3
6.5 %	3	3	3
7 %	3	3	3
Total	45		

III. RESULT AND DISCUSSION

A. Analysis of Aggregate Characteristics

- The aggregate wear test results obtained the value of coarse aggregate resistance to wear from Fraction A is 10.6%, Fraction B is 20.4%, Fraction C is 21.56% and Fraction D is 25.52%. Specifications that is with a maximum value of 40%.
- The results of testing the specific gravity and absorption of coarse aggregate using two samples obtained the value for Bulk Specific Gravity is 2.62, SSD specific gravity is 2.66, apparent density is 2.73 and Water Absorption is 1.61%. All test results meet the 2018 General Specifications, namely for Bulk Specific Gravity, SSD Specific Gravity and Pseudo Specific Gravity is a minimum of 2.5 and a maximum Water Absorption of 3% or it can be said that aggregate absorption is small. This shows that the material meets the requirements.
- Based on the results of specific gravity and fine aggregate absorption, the value for Bulk Specific Gravity is 2.58, SSD Specific Gravity is 2.62, Pseudo Specific Gravity is 2.69 and Water Absorption is 1.63%. All test results meet the specifications namely Bulk Specific Gravity, Specific Gravity, Pseudo Specific Gravity is a minimum of 2.5 and a maximum Water Absorption is 3%. The results of this test meet the requirements.
- Filter Analysis Test Results show the results of filter analysis in which the aggregate combination of mixed designs is at the upper and lower limits of the specifications.
- Material test results passed filter No. 200 results obtained 0.6% where this value meets the maximum specification of 1%.
- Material test results passed filter No. 200 obtained a value of 0.6%, this value meets the requirements and can be said to be clean from clay and silt
- Testing the level of sludge shows the value of the results of testing sludge levels using 2 (two) samples obtained the average results for the Sand Equivalent (SE) value is 96.34% and sludge content of 3.66%. This meets the specifications of at least 50% for Equivalent Sand and a maximum of 5% for sludge content.
- Test Results of Flat Aggregate Flat Particles and Coarse Oblong obtained flat particle values of 9.62%, 8.95%, 7.56%, and 0.00%. While oval particles are 9.64%, 9.59%, 4.10% and 0.00%. Both of these values meet the requirements of a maximum of 10%.
- The filler specific gravity test results show an average value of 3.05. The Bina Marga specification does not include a limit value for filler specific gravity.

B. Analysis of Asphalt Characteristics

Testing the characteristics of asphalt used in the mixture shows the value that meets the standard specifications. The test results can be seen in table 2.

TABLE 2. Asphalt Characteristics Test Results.

Type of Testing	Results	Standard Spesification	
		Min	Maks
Penetrasi on 25°C (0,1 mm)	67.1	60	70
Daktalitas on 25°C (cm)	119.67	100	-
Softening Point (°C)	50,5	48	58
Flash point (°C)	300	200	-
Specific gravity (gr/cc)	1.044	1.0	-
Lost weight (%)	0.14	-	0.8
Penetrasi on TFOT (%at first)	98.5	54	-

C. Analysis Marshal Konventional

- *Stability*

From figure 1 for the 25 collisions test results at 5% asphalt content, the stability value is 1.052.60 kg, asphalt content is 5.5%, stability value is 1,266.48 kg, 6% stability value is 1,397.70 kg, 6.5% is 1,446.28 kg, 7% is 1,412.20kg.

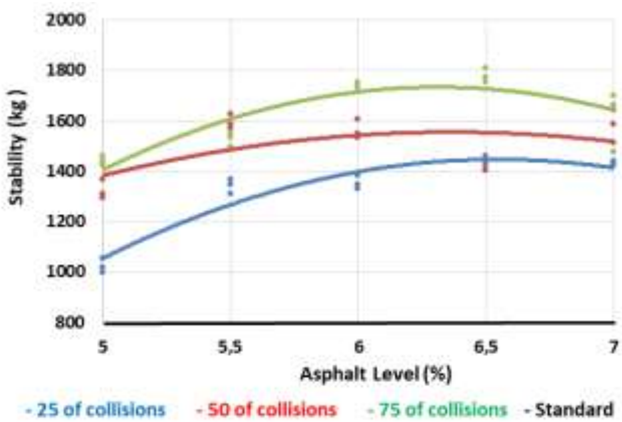

Fig. 1. Graph of the relationship of stability with the level of asphalt.

In the collision variation of 50 collisions with asphalt content of 5%, the stability value of 1.381.13 kg, 5.5% asphalt content

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is 1,484.86, 6% asphalt content is 1.541.99 kg, asphalt content 6.5% 1.552.52 kg, and asphalt content 7% is 1.516.45 kg. While the variation of 75 collisions with 5% asphalt content stability value is 1,403.60 kg, 5.5% asphalt content is 1,607.08, 6% asphalt content is 1,714.72 kg, 6.5% asphalt content is 1,726.52 and 7% asphalt content is 1,642.48 kg. All the results of the analysis of stability meet the specifications.

- *Flow*

Collision variations with asphalt levels as shown in Figure 2, obtained Flow values for 25 collisions between 4.20 to 3.94, for 50 collisions between 3.58 to 3.52 while in 75 collisions between 3.41 to 2.64.

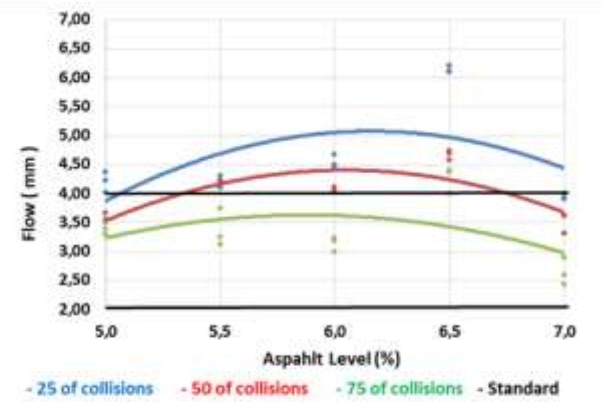

Fig. 2. Relationship between Flow and Asphalt Levels.

From Figure 2, it is known that the smaller the number of collisions and asphalt levels used, the greater the value of flexibility, but if the more the number of collisions and asphalt content, the cavity is smaller so that the flexibility value decreases, this is due to the greater number of collisions then the mixture will be more dense and will reduce the cavity between the aggregates which causes the value of flexibility decreases. Continuous loading will cause changes in the plastic form of the pavement and will reach the limit of collapse and breaking up

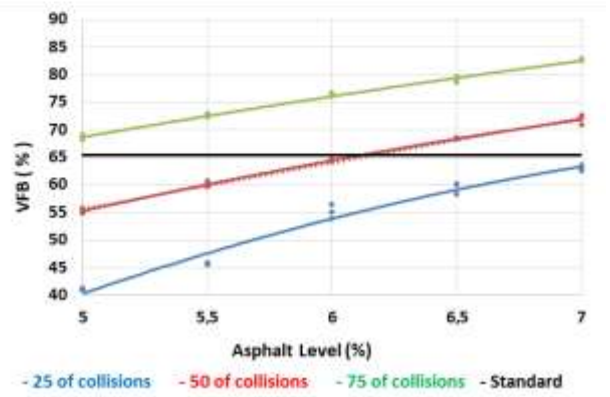

Fig. 3. Relationship between VFB and asphalt levels.

- *Voids Filled with Bitumen (VFB)*

Figure 3 shows the relationship between the values of the VFB analysis results with asphalt levels with the collision variation of 25 collisions, 50 collisions and 75 collisions obtained VFB values at 25 collisions between 41.11 to 62.98, at 50 collisions between 55.26 to 71.84, and at 75 collisions between 68.60 to 82.65. Based on the figure, it can be seen that the more the number of collisions and asphalt levels, the VFB value increases, and vice versa if the fewer the number of collisions the smaller the VFB value, this is due to the large number of collisions, it can increase the VFB value because of the cavities in the mixture with more asphalt.

- *Void In The Compacted Mixture (VIM)*

Figure 4 shows the relationship between the VIM values from the analysis with the percentage of asphalt levels can be known in the variation of 25 collisions the VIM value is between 13.62 to 8.54. at 50 collisions the VIM value is between 8.18 to 5.86, and 75 collisions is the VIM value between 4.80 to 3.23.

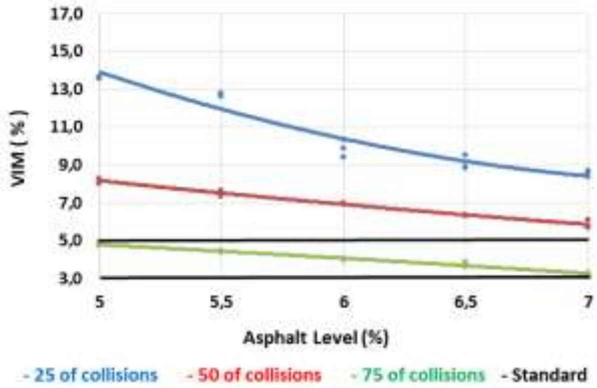

Fig. 4. Relationship of VIM with Asphalt Levels.

From this figure, it can be seen that the more the number of collisions and asphalt levels used, the smaller the VIM value and vice versa, if the fewer the number of collisions and asphalt levels used the smaller the VIM value will be greater, this is due to the greater number collision then the mixture will be more dense and will reduce the cavity between the aggregates. If the cavity in the mixture shrinks, the mixture will be denser so that the impermeability to water and air will be high. However, cavities that are too small can cause deformation.

- *Void in the Mineral Aggregat (VMA)*

The relationship between VMA and variation of asphalt levels on several collisions in Figure 5, shows at 25 collisions between 23.12 to 23.07, for 50 collisions 18.28 to 20.82 and for 75 collisions 15.27 to 18.60. From Figure 5 it can be seen that the more the number of collisions and asphalt levels used, the cavities in the aggregate get smaller so the VMA value will decrease. Likewise on the contrary the less the number of collisions and the bitumen content the less the cavities in the aggregate will be greater so that the VMA value is also getting bigger. This is influenced by the large number of collisions during mixing and compaction, the mixture will be denser, and the cavities between the aggregates will be smaller.

D. Optimum Asphalt Levels

From the marshall characteristic relationship as in Figure 1 to Figure 5 the value that meets the standard specifications is in the punch 75 as shown in Figure 6. From the picture can be determined the best asphalt content in the asphalt concrete

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mixture that is asphalt content that meets all the criteria is 7% asphalt content.

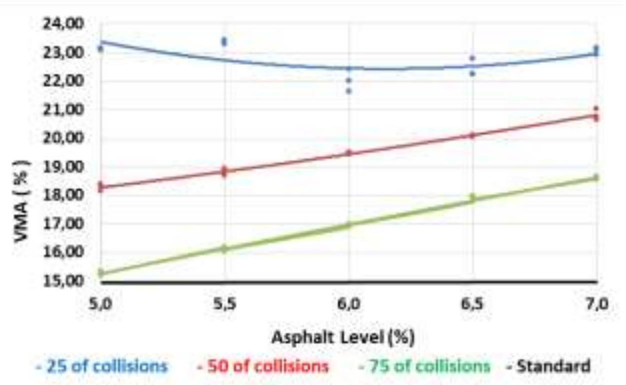

Fig. 5. Relationship between VMA and Asphalt Levels.

75 of collisions

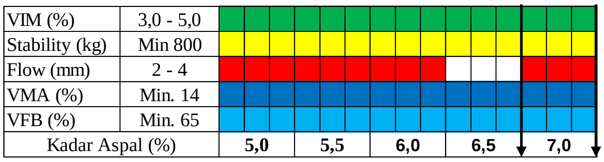

Fig. 6. Optimum Asphalt Levels.

E. Index Retained Strength (IRS).

The manufacture of test specimens in IRS testing uses 7% bitumen content. The specimens consisted of 9 samples, 3 samples for 25 collisions, 3 samples for 50 collisions and 3 samples for 75 collisions and then soaking for ± 24, hour at ± 60 °C.

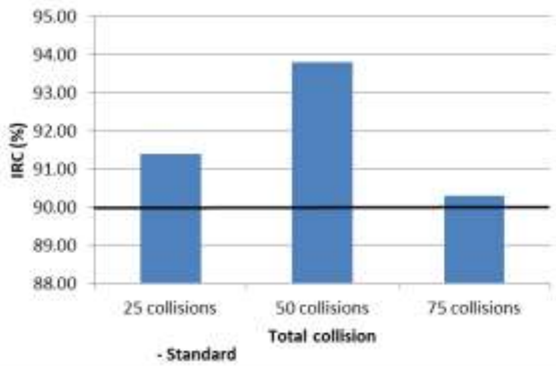

Fig. 7. IRC Testing Results.

The test results showed that there was an increase in the resistance of the AC-WC mixture to the effect of the number of collisions. This is because the more the number of collisions, the cavity in the mixture will be smaller and will help the water-tightness of the mixture (VIM value decreases). Besides that the VMA value gets smaller as the number of collisions increases. Likewise, the VFB value increases if the number of collisions increases. So the more amount of collision in AC-WC mixture with asphalt content of 7% will help the asphalt in filling cavities in the mixture and aggregate so that the mixture will be more waterproof.

IV. CONCLUSION

- Testing on 25 collisions with asphalt variations for the use of asphalt content of 5%, 5.5%, 6%, 6.5% and 7% stability values meet the specifications. The flow value that meets the requirements is 5% asphalt content. No VFB value meets the requirements, neither VIM value meets the requirements while all VMA values meet the requirements.
- Testing on 50 collisions with variations in asphalt content of 5%, 5.5%, 6%, 6.5% and 7%. Stability values for all uses of asphalt content meet the standard specifications. Flow values that meet the requirements are 5% bitumen content and 7% bitumen content. VFB values that meet the specification standards are asphalt content of 5.5%, 6%, 6.5% and 7%. No VIM value meets the requirements while all VMA values meet the requirements.
- Testing on 75 collisions with variations in asphalt content of 5%, 5.5%, 6%, 6.5% and 7%. Stability values for all uses of asphalt content meet the standard specifications. Flow values that meet the requirements are asphalt content of 5%, 5.5%, 6% and asphalt content of 7%. VFB values that meet the specification standards are asphalt content of 5.5%, 6%, 6.5% and 7%. VIM value and value of all variations of asphalt content meet the requirements
- Testing for 75 collisions of optimum asphalt content that can be used is 5%, 5.5%, 6% and 7%, while asphalt content of 6.5% there are variables that do not meet the standard specifications.
- By using a mixture composition of 39.9% coarse aggregate, 46.8% fine aggregate, 6.30% filler and 7% asphalt and collision 25 collisions, 50 collisions, 75 collisions, the AC-WC mixture is resistant to the effects of impact and immersion. Water where the VFB value increases and the VMA value decreases.

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