Marshall Performance Analysis Of Eggshells And Cement As Filler In Asphalt Concrete Mixtures (AC - WC)

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Abstract - *Roads are transportation infrastructure whose needs in Indonesia continue to increase, along with the increasing number of vehicles. Road construction is a construction that receives traffic loads, therefore it is expected that a road pavement layer must have a strong pavement construction and be able to receive loads from traffic users. AC-WC (Black-top Concrete - Wearing Course) asphalt layer is a road pavement construction consisting of asphalt composition, coarse aggregate, fine aggregate and filler. Fillers in asphalt mixtures function to increase the binding power of AC-WC asphalt, so as to improve mixture stability and fillers can fill the voids between aggregate particles, filler commonly used is stone ash. This research will be conducted with the addition of broiler eggshell filler and porland cement in the Asphalt Concrete wearing Course (AC-WC) mixture. The research was conducted with an experimental method conducted in the Civil Engineering laboratory of Abdurrab University. The specification used in this study is Public Road Revision 2 Year 2018, The optimum asphalt content (KAO) used was 6.5%. Based on the results of the study, the largest marshall stability and melting value is found in the 100% cement filler variation, which is 1772.7 Kg and the value of flow value (melting) 3.77 mm while the largest marshall quotient (MQ) value is found in the 25% eggshell filler variation, 75% cement, which is 529.2 Kg/mm.*

Keywords : filler, eggshells, cement, asphalt (AC-WC)

I.   PRELIMINARY

Along with the times, the need for transportation is something that is very vital for humans, where transportation is needed as a means of moving from one place to another, therefore road infrastructure is needed. In road work, the main thing to do is to choose the type of pavement, while road pavement is divided into three, including flexible pavement, composite pavement, and rigid pavement[1], [2], [3], [4], [5], [6].

In flexible pavement there are several types of surface layers, one of which is asphalt concrete. Where the asphalt concrete layer is divided into several layers including the bottom foundation layer, top, AC-BC (Asphalt Concrete Binder Course), and AC-WC (Asphalt Concrete Wearing Course). Asphalt concrete is a mixture of fine and coarse aggregates, fillers, and asphalt liquid. The filler is a non-plastic mineral material, free from lumps, dry, and if tested by wet screening must contain material that can pass on a No.200 sieve and has the function of filling the voids between the aggregate grains. So far, stone ash is the most commonly used material as a filler, while cement and several other materials have been used as alternatives[7], [8], [9], [10], [11].

As in previous studies, replacement or addition of fillers using some duck eggshell waste has been carried out, in this study an experiment will be carried out, namely the addition of slaughtered chicken eggshell filler and porland cement to the Asphalt Concrete wearing Course (AC-WC) mixture[12], [13], [14], [15], [16], [17], [18], [19], [20].

II.   RELATED RESEARCH

Yonas and Rikzan, 2021 researched the Analysis of the Effect of the Use of Egg Shells of Laying Race Ducks as Filler in Asphalt Concrete Mixtures. This study uses the Marshall method by reviewing the effect of laying-race duck egg shells on the value of stability, flow, VFA (Voids Filled Asphalt), VIM (Voids In Mix), and VMA (Void Mineral Aggregate). From the results of stability testing, it was found that the use of duck eggshell filler was greater than the use of cement filler. For flow testing, the value of all percentages is within the specification of at least 3mm. For the Marshall Quontient stability value, it is found that the more the addition of laying-race duck eggshells to the filler, the higher the MQ value. The VIM value obtained exceeds the minimum VIM value of 2.5%. As for the VMA value obtained, it is directly proportional where the more the percentage of laying-race duck eggshells eats the voids in the asphalt mixture the greater. For the VFA value, it shows that between the asphalt content of the mixture and the % of voids filled with asphalt, the mixture is included in the standard specifications for AC-WC concrete asphalt mixtures where the VFA value is at least 65%.[1]

Gunawanta Sembiring, 2022 examined the effect of the addition of a mixture of clam shell ash, eggshell ash, and morning husk ash as filler in asphalt concrete binder course (AC-BC) mixtures. This research combines the three wastes whose contents complement each other with a composition of 50% clam shell ash, 25% eggshell ash, and 25% rice husk ash as an additional stone ash filler in the AC-BC mixture with the provisions of the 2018 Bina Marga specification. The percentages taken from this research include 100:0, 75:25, 60:40 and 50:50 (the ratio between stone ash and the three additives) with 5.5% asphalt content. With a stability value of 1117.17 kg, flow (3.63 mm), marshall quotient (307.36 Kg/mm), VFA (74.94%), VMA (16.50%), and VIM (4.14%). The low void density (VIM) value indicates the density level of an AC-BC mixture while the higher stability value indicates the strength level of the AC-BC mixture towards the ability to accept loads.[41]-[42]

Doni rinaldi basri, et al, 2022 examined the utilization of wood powder ash and Portland cement as filler in asphalt congcrete- wearing course mixtures. Waste from wood processing is found in Pekanbaru city, so it needs to be utilized. The research utilizes sawdust waste and Portland cement as alternative materials to replace fillers in the manufacture of Asphalt Concrete-Wearing Course (AC-WC) mixtures.[21], [22], [23], [24], [25], [26], [27] The purpose of the study was to determine the characteristics of marshall testing on AC-WC layers using a combination of sawdust ash filler and Portland cement. The method used was laboratory experiments with a rare initial search for KAO (Optimum Asphalt Content) values with filler materials using stone ash, followed by replacing the filler with a combination of sawdust ash and Portland cement. The variations of the mixture of Portland cement and sawdust ash are 0%-0%, 15%-85%, 25%-75%, 30%-70%, 40%-60%, 50%-50%, and 100%-0%.[28], [29], [30], [31] The specification used in this research is the Universal Bina Marga Specification 2018 Revision 2. KOA was found to be 5.5%. Then marshall testing of each variation was carried out to obtain the stability value and density value of the mixture. The results of the marshall testing of the best filler variation in this research were in the variation of 60% sawdust ash and 40% Portland cement. It is shown that the source of the stability value in this composition gets a very large stability value of 1,278.64 kg, an MQ value of 491.78 kg/mm and a melting value of 2.60 mm so it is concluded that the best AC-WC quality in this research is in the filler variation of 40% Portland cement and 60% sawdust ash. Related research describes research reviews that have been carried out previously by other researchers that are relevant to the research being conducted. This section also includes differences in research conducted previously by previous research and research conducted by the author so that the differences in research conducted can be identified. [32], [33], [34]

III. RESEARCH METHODS

The research was conducted with an experimental method conducted in the Civil Engineering laboratory of Abdurrab University. The specification used in this study is Public Road Revision II Year 2018. Test specimens to find Optimum Asphalt Content as many as 12 pieces, the test objects for testing as many as 15 test objects, While the method used for mixture testing is the marshall method, where from the marshall test the results are obtained in the form of marshall components, namely stability, flow, Void in Mixture (VIM), Void Mineral Aggregate (VMA), Void Filled Asphalt (VFA) and then the Marshall Quotient can be calculated[35], [36], [37], [38].

IV. RESULTS AND DISCUSSION

A. Marshall Test Results for Optimum Asphalt Content

Testing with Marshall tools aims to obtain performance data on asphalt mixtures and is guided by the 2018 Revised Bina Marga General Specifications. II. Asphalt performance data includes Stability, VMA, VIM, VFA, MQ and Yield. At this stage of testing, usually carried out at several variations of asphalt content to obtain optimum asphalt performance, Marshall testing for optimum asphalt content is carried out at 4 variations of asphalt content, i.e. 5.5%, 5.0%, 6.0%, and 6.5%. Marshall test results are shown in table 1.

Table 1. Calculation Results Average value of VMA, VIM, VFA, Stability and Flow

Asphalt Content (%)	VMA (%)	VIM (%)	VFA (%)	Stability (Kg)	Flow (%)	MQ (Kg/mm)
	Min.15	3-5	Min.65	Min.800	2-4	Min.250
5,0	12,08	2,64	78,14	1031,6	3,75	275,1
5,5	13,27	2,78	79,07	1099,4	3,58	306,82
6,0	14,45	2,93	79,73	1530,5	3,67	418,21
6,5	15,71	3,2	79,64	1317,4	3,47	380,02

The asphalt content of 5% VIM and VMA values do not enter the criteria and the asphalt content of 5.5% and 6% VMA values do not enter the criteria of asphalt content and the asphalt content of 6.5% meets all these criteria and is determined for the optimum asphalt content used at 6.5% asphalt content.

B. Marshall Testing Results of Test Objects Each Variation of Eggshell Filler and Cement.

After obtaining the optimum asphalt content value, test specimens were made with various fillers. Based on the results of marshall testing of each filler variation, the data obtained is in accordance with table 2.

Table 2. Marshall Test Results with Eggshell Filler and Cement

Eggshell	Cement	STABILITY	VMA	FLOW	VFA	MQ	VIM
		Kg	%	mm	%	Kg/mm	%
100%	0%	1603,1	15,84	3,4	78,95	484,5	3,33
75%	25%	1525,7	15,89	3,1	78,63	492,1	3,4
50%	50%	1574,1	16,08	3,47	77,55	454,1	3,61
25%	75%	1675,8	16,19	3,17	76,88	529,2	3,74
0%	100%	1772,7	16,25	3,77	76,58	470,6	3,8

Based on table 2 above, it is obtained that the highest stability and flow values in the 0% eggshell - 100% cement filler combination with values of 1772, kg and 3.77 mm, the highest Marshall Quintent value in the 25% eggshell - 75% cement filler combination of 529.2 kg/mm, the highest VMA and VIM values in the 0% eggshell - 100% cement filler combination of 16.25% and 3.8%, and the highest VFA value in the 100% eggshell - 100% cement filler combination of 78.95%. - 0% cement by 78.95%.

So the results show that the filler variation of 100% eggshell, 100% cement, 75% eggshell and 25% cement, 50% eggshell and 50% cement, 25% eggshell and 75% cement, is a filler variation for mixing and compaction has met all the General Specifications of Bina Marga 2018 Revision II.[4]

V.   CONCLUSION

Based on the results and discussion, the following conclusions can be drawn based on the results of the aggregate properties testing that has been carried out, it meets the General Specifications of Bina Marga 2018 Revision II.

Of all the Marshall parameter values that meet the requirements for the Optimum Asphalt Content (KAO) value is 6.5%, namely the Stability value of 1317.4 Kg, Flow value of 3.47 mm, Marshall Quintent value of 380.02 Kg/mm, VMA value of 15.71%, VFA value of 79.64%, and VIM value of 3.32%.

In this study, the variation of eggshell and cement filler combinations with the highest stability and flow values in the 0% eggshell - 100% cement filler combination with values of 1772, kg and 3.77 mm, the highest Marshall Quintent value in the 25% eggshell - 75% cement filler combination of 529.2 kg/mm, the highest VMA and VIM values in the 0% eggshell - 100% cement filler combination of 16.25% and 3.8%, and the highest VFA value in the 100% eggshell - 100% cement filler combination of 78.95%. - 0% cement by 78.95%.

THANK-YOU NOTE

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