Variation of Soaking Time on Asphalt Concrete Properties using Anti Stripping Materials

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Abstract: The purposes of this study were to obtain Marshall property values and determine the optimum submersion time in AC-WC asphalt concrete mixture using anti-stripping added ingredients. Marshall specimens were made with an optimum asphalt content of 6%, wetfixbe content of 0.3% to asphalt and each was made with a variation of submersion time 3, 6, 9, 12, 15, 18, 21, 24, 36 and 48 hours. The method of implementation is by mixing the wetfixBe first with asphalt, then aggregate according to the proportion of the ideal gradation of the mixture. Marshall testing method based on SNI 06-2489-1991. The results of the study found that the addition of submersion time can increase the percent value of Void Filled with Bitumen (VFB) and *flow* and reduce the percent of Void in Mix (VIM), percent of Void in the Mineral Aggregate (VMA), Stability, and Marshall Quotient. The submersion period that still meets Marshall property is at the soaking time of 3 to 45 hours. The Optimum Soaking Time for asphalt concrete mix is 24 hours, with VMA value 17,80%, VFB 74,04%, VIM 4,63%, Stability 1071.76 kg, flow 3.25 mm and MQ 360 kg / mm, asphalt concrete mixture meets Bina Marga 2018 specifications.

1 INTRODUCTION

Water is one of the factors causing road damage, both from rainwater and water from the road drainage system. Submerging asphalt concrete mix can cause the release of aggregate granules from asphalt and peeling off asphalt from road pavement, according to (Djalante, 2011) that one of the most important aspects in highway planning is the effort to protect roads from water. According to (Nurhuduyah, 2009) that the effects of continuous immersion damage are faster than ordinary immersion. Soak the asphalt mixture *Hot Rolled Sheet-Wearing Course* (HRS-WC) either continuously or periodically in high tide has a greater effect than the use of laboratory water. To increase the bond between the aggregate and asphalt by adding anti-peeling additives or more commonly known as the anti-*stripping agent.*

Moisture susceptibility is the tendency towards the peeling of asphalt mixtures. Exfoliation usually starts at the bottom of the asphalt mixture layer and usually moves upward. That situation is a gradual loss of power over the years, which causes many to arise on the surface such as grooves, folds, waves, *raveling, cracking*, etc. (Krebs and Walker,1971). In specification (Bina Marga, 2018), stickiness and anti-*stripping agent* must be added in liquid form to the mixture.

Werfix BE is an anti-chemical *stripping* that useful for improving bonding and stabilizing the mixture between aggregate and asphalt, especially in the rainy season as a result of research (Susilowati and Wiyono, 2015).

The quality of asphalt concrete mixes in the field is influenced by the process of making mixtures in the laboratory or Asphalt *Mixing Plant* (AMP), laying and compaction in the field. To get the characteristics of asphalt concrete mixture and its effect on water immersion, testing is done using a device *Marshall,* by settling the specimen first before removing it from the mold and then settling it for approximately 24 hours at room temperature.

Then measure thickness, weight, and immerse the test specimen in the water at room temperature for 24 hours. According to (Amal, 2009) that immersion variation of 2 to 72 hours is very influential on the nature of the mixture *Marshall* and the plastic melt value, it is necessary to add materials that can be used as an asphalt concrete mixture, so that the asphalt concrete mixture is resistant or waterproof.

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Some previous studies that support this research include research by (Nurhuduyah, 2009) This is indicated by the durability value of the asphalt mixture in the immersion with low tide compared to the asphalt mixture immersed in laboratory standard water. According to (Arifin et all, 2008), Decreased mixed performance due to the influence of rainwater content on the characteristics of the *Marshall* Laston mixture. From the results of these experimental studies, it has been concluded that in general the characteristics of *the Marshall* Laston mix have decreased with increasing rainwater content. This research (Sanusi, 2012) used an experimental method on a mixture of laston with optimum asphalt content of 6% of the total weight of the aggregate levels *filler* Replacement used vary from 4%, 5%, 6%, 7%, 7.91% to the total weight of aggregates with immersion for durability testing: 30 minutes (0 days), 1 day, 7 days and 14 days. The results showed the greatest stability was a mixture with a *filler* cement then carbide waste with an immersion of 14 days. According to (Kosim, 2013), The results of all the LASTON mixtures obtained showed that the use of the addition of a proportion *additive filler* cement of 4% to the concrete asphalt mixture would increase the stability of the mixture, with long immersion in water for 3 days. By using the proportion of adding an *additive filler* cement of 4% to the asphalt concrete mixture, a pavement material will be obtained which can withstand heavy traffic loads, during the service life of the road. (Fauziah and Handaka, 2017), that the effect of rainwater on characteristics *Marshall* and the durability of the mixture *Split Mastic Asphalt*, using two types of asphalt as binding material, namely Starbit E-55 asphalt, and AC 60/70 asphalt is that the longer the rainwater immersion time the mixed stability value, Marshall Quotient and the value of the *index of retained strength* decreases and the value of melt increases. SMA mixes that use Starbit E-55 asphalt bonding materials can maintain performance *Marshall* and durability due to better rainwater compared to SMA mixes with AC 60/70 asphalt binding materials. The stability of fly ash and stone dust tends to decrease after 72 hours of soaking, with an even more drastic decrease in fly ash. Whereas Portland Cement shows the inverse. Portland cement as aggregate filler showed improvement along with the increase in immersion time (Latifah, et all, 2012). According to (Pratama and Fauziah, 2017) The Longer immersion in Aspalht Porous Based Buton Granular Asphalt (BGA) can increase the value of VIM, VFB, Flow and reduce VMA, stability and Marshall Quetient. The longer time immersion of seawater can decrease the durability index values of asphalt concrete with and without substitution EVA waste (Rahmi, et all, 2017). According to (Angga, 2016), That the retained strength as well as tensile strength of mixtures with Retona were obtained better in each duration of seawater immersion than those with asphalt pen 60/70. According to (Rizal, et all, 2017), the influence of the LTOA process on the porous asphalt with BGA and without BGA showed that the performance of porous asphalt with 2.5% BGA super passed the mixture without BGA.

This study aims to obtain the property values *Marshall* of AC-WC asphalt concrete mixtures in the variation of immersion time and determine the optimum immersion time by using anti-added ingredients *stripping* that meet the specifications (Bina Marga, 2018).

2 RESEARCH METHOD

The research method is an experimental method by making hot mix asphalt concrete specimens, with 0.6% asphalt content, Wetfixbe content 0.3% of the weight of asphalt.

This research was conducted at the Civil Engineering Test Material Laboratory, State Polytechnic of Jakarta.

The materials used in this study are Esso asphalt, the coarse aggregate of crushed stone, stone ash and *filler of* portland cement and *anti-Stripping Wetfix Be.* Hot asphalt concrete mixed specimens with immersion time variation of 3, 6, 9, 12, 15, 18, 21, 24, 36 and 48 hours. Each variation was tested 3 (three) times. Then the test is performed *Marshall* to get the VMA, VFB, VIM, Stability, Meltability, and Marshall Quotient (MQ) values. The stages in this study can be illustrated with the flow chart as follows

3 RESULT AND DISCUSSION

The Results of Aggregate and Asphalt Tests of physical aggregate, both for fine aggregates and coarse aggregates all meet the Specifications [4].

Test results with a density greater than 2.5 indicate that aggregates can be used for roads with high traffic volume. The results of the physical properties of aggregate are presented in Table 1.

Table 1. Fine and Coarse Aggregate Test Result

Tests	Results of Testing		Requirement Bina Marga 2018	
	Fine Aggr	Coarse Aggr	Min	Max
-Bulk Specific Gravity	2.57	2.56	2.5	-
-SSD Specific Gravity	2.61	2.61	2.5	-
-Apparent Specific Gravity	2.68	2.70	2.5	
-Water Absorption(%)	1.59	2.15	-	3

As for the Physical Examination Results, of Asphalt with WetfixBe all of them meet Specifications [4]. According to the test results, that asphalt is included in the group with Penetration of 60/70 and a minimum of 48^0 C softening points; suitable for roads with high traffic volume. The results of physical asphalt examinations in Table 2.

Table 2. Hard Asphalt Test Results

Testing	Results of Testing	Requirement Bina Marga 2018	
		Min	Max
Penetration(mm)	65	60	70
Specific Gravity	1.02	0.92	1.06
Softening Point ^{0}C	48.5	45	-
Ductility(mm)	101	100	-

3.1 Planning Mixed Marshall Test Object

Calculation of proportion of mixture using rough aggregate passes 19 mm size filter and retained on the 4.75 mm filter and used as fine aggregate is stone ash which passes the 4.75 mm filter size and retained on the 0.075 mm filter size. The *filler* used by cement passes 0.075 mm sieve more than 75%.

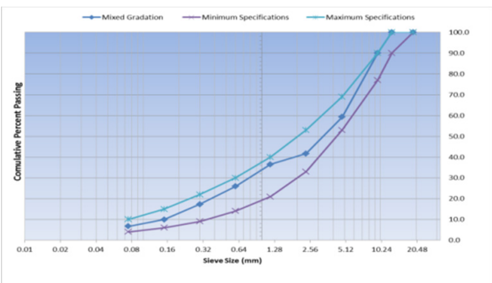

Figure 1. Combined Aggregate Gradation Graph

Determination of Asphalt Level Variation is done by calculating the initial estimate of the asphalt level of the plan (Pb). Estimated asphalt content is obtained from the following result.

Pb=[0.035 (% CA) + 0.045 (% FA) + 0.18 (% F)] +k
= [0.035 (40.7%) + 0.045 (52.6%) + 0.18 (6.7%)] x 0.75 = 5.99% ≈ 6%

Estimated ideal asphalt levels obtained from calculation 5, 99%, used for making test specimens with added *wetfixbe* 0.3%.

3.2 Marshall Test Results

Marshall test results for the variation of immersion time at KAO 6.0%, and *Wetfix Be* 0.3%, recapitulation is presented in Figure 3a to 3f.

a. Percentage of Voids in Mineral Aggregate (VMA)

Based on the results of statistical tests it was found that the immersion time had less effect on VMA. This is indicated by the F value and the significant value> 0.05 and the R-square value of 0.164, which means that the variation of immersion time has an effect of 16.4% on VMA. The result of the test also shows that VMA value tends to decrease with increasing immersion time, although the decrease is small. The average VMA values obtained from the test results are: 17.99%, 18.02%, 18.23%, 17.58%, 18.12%, 18.12%, 18.08%, 18.03%, 17.80%, 17.77% and 17.90%. The specification of the VMA value required by Bina Marga 2018 is at least 15% so that the results of the overall VMA value test meet the required specifications. (As in Figure 2a)

b. Percentage of Voids Filled with Bitumen (VFB)

Based on the results of statistical tests it was found that the immersion time did not affect VFB. This can be seen from the R square value of 0.409 which means that the variation of immersion time has an effect of 40.9% on VFB. The test results also showed that the VFB value increased according to the addition of variations in the immersion time. all results obtained from testing meet the 2018 Bina Marga specifications of at least 65%. (As in Figure 2b).

c. Percentage of Voids in Mix (VIM)

Based on the results of statistical tests it was found that immersion time affects VIM. This can be seen from the R square value of 0.422 which means that the variation of immersion time has an effect of 42.2% on VIM. The smaller the pore is left the more water-resistant and the less air in the asphalt concrete which results in a stronger asphalt film oxidizes with air and becomes brittle. VIM value still meets the requirements according to 2018 Bina

Marga specifications, namely 3.0 - 5.0% (As in Figure 2c).

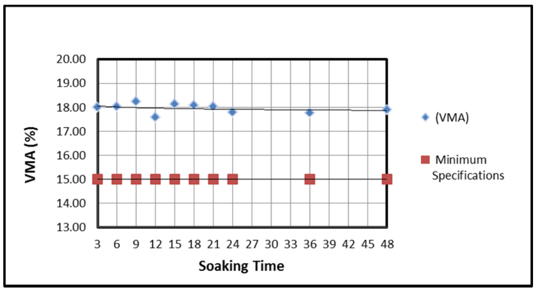

Figure 2a. VMA Graph

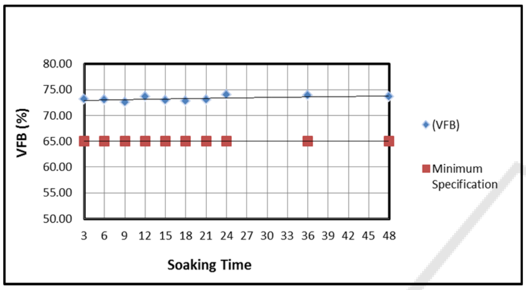

Figure 2b. VFB Graph

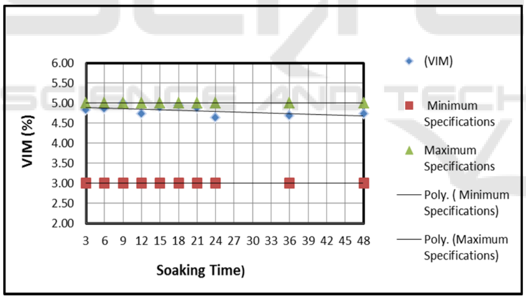

Figure 2c. VIM Graph

d. Stability

Based on the results of statistical tests indicate that immersion time has a significant effect on stability. This can be seen from the R-square value of 0.606 which means that the variation of immersion time has an effect of 60.6% on stability. The test results show that the value of stability obtained tends to decrease. The average stability values obtained from the test results on the variation of each immersion time are: 1170.77; 975.23; 1245.03; 1254.93; 1158.39; 998.74; 1017,31; 1071.76; 884.88; 800.73 kg. The test results on the variation of immersion time of 3 hours to 45 hours still meet specifications (Bina Marga, 2018). The decrease in the value of stability indicates a decrease in the ability of the pavement layer (AC-WC) in receiving traffic loads. The longer the layer of pavement (AC-WC) is submerged in water, the less durable it is. (As in Figure 2d)

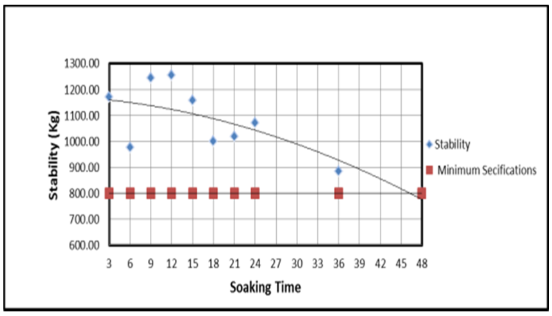

Figure 2d. Stability Graph

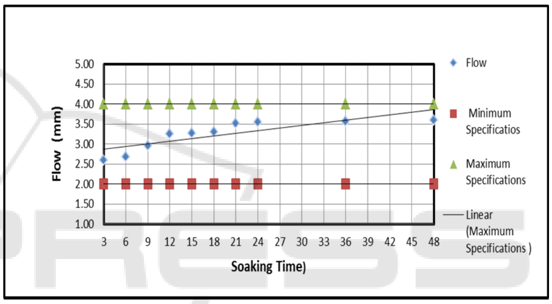

Figure 2e. Flow Graph

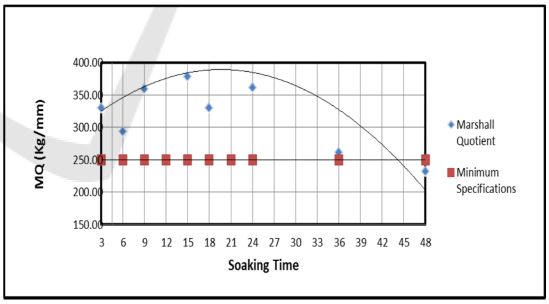

Figure 2f. MQ Graph

e. Flow

Based on the results of statistical tests indicate that the immersion time affects the melt. This can be seen from the R square value of 0.523 which means that the variation of the immersion time of 3 to 48 hours has an effect of 52.3% on the melt. the test results show that the value *flows* with the addition of soaking time up and down. The value *flow* still meets the requirements according to the 2018 Bina Marga specifications, namely 2-4 mm is at the time of immersion of 3 hours to 48 hours. (As in Figure 2e).

f. Marshall Quotient

Based on the results of statistical analysis showed that the soaking time affects the *Marshall* Quotient. This can be seen from the R square value of 0.586, which means that the variation of immersion time has an effect of 58.6% on Marshall Quotient. The *Marshall Quotient* (MQ) value rises to a certain extent then decreases with increasing immersion time starting from 3 Hours to 48 Hours. The MQ value that meets the requirements according to the 2018 Bina Marga specifications, namely a minimum of 250 kg / mm, is at the time of immersion of 3 to 45 hours. (As in Figure 2f).

Determination of the Optimum Immersion Time, after all Asphalt concrete properties have been known, then the Optimum Immersion Time can be determined from this Marshall test. To obtain the Optimum Immersion Time a marshall chart is made in Figure 3.

Mixed characteristic values generated in the test *Marshall* in Figure 4. All parameters *Marshall* that meet the requirements are in the Immersion Time range 3 to 45 hours. From these results, it can be concluded that:

Optimum Soaking Time = {(3 + 45}: 2 = 24;

Then Optimum Soaking Time is 24 Hours.
Table 3. Results of Mechanical Properties by Using Optimum Soaking Time

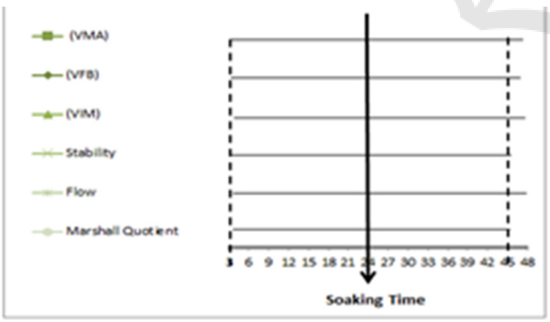

Figure 3. Determining the Optimum Soaking From the results of the Time Chart

4 CONCLUSION

Statistical test results show that:
Based on the research by making hot mix asphaltic concrete specimens, with 0.6% asphalt content, Wetfixbe content 0.3% of the weight of asphalt, with the various of immersion time, it can be concluded.

Variation of immersion time from 3 hours to 48 hours affects significant to VFB, VIM, Stability, Flow, and Marshall Quotient values but has less effect on the VMA value because of the significant value >0.05.

The addition of immersion time can increase the % of Voids Filled with Bitumen (VFB) and Flow and reduce the % of Voids in Mix (VIM), Voids in Mineral Aggregate (VMA), Stability, and Marshall Quotient.

The immersion time that still meets Marshall property is the time of soaking 3 to 45 hours. The Optimum Soaking Time for asphalt concrete mix is 24 hours, with VMA value 18.06%, VFB 72.29%, VIM 5.03%, Stability 1071.76 kg, flow 3.25 mm and MQ 360 kg / mm.

The variation of soaking time on Asphalt concrete with 24 hours meets the specifications of Bina Marga 2018.

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