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The Effect of Immersion and Humidification toward Performance of Hot Rolled Asphalt Mixture

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Abstract

Some roads in Indonesia which are located in areas associated with high rainfall are often inundated with water and high temperature humidity. This can affect the performance of asphalt pavement, especially the problem of durability. This research will examine the performance of the Hot Rolled Asphalt mixture pavement by analyzing the durability of the results of the stability and flow test due to immersion and humidification. The duration of immersion and humidification for stability is 96 hours while for flow the duration of time used is 168 hours. The asphalt content used was 4.4% of the weight of the specimens with 60/70 penetration. The method used is an experimental method with the general specifications directorate general of highways reference standard. The results showed the durability of the mixture Hot Rolled Asphalt in this case the stability and flow decreases in line with the increasing duration of immersion and humidification. The process of decreasing stability and flow due to immersion takes place faster than humidification

Keywords: Immersion, Moisture, Stability, Flow, HRA

INTRODUCTION

The main strength of a Hot Rolled Asphalt (HRA) mixture comes from the stiffness of the sand/filler/bindermortar. A major factor in the performance of the mortaris the binder, normally 50 pen grade bitumen to BS 3690. Filler stiffens the bitumen which binds all theaggregates together. Some filler is contained in the fineand coarse aggregates in the mixture, but most is added.Whilst cement is a permitted filler, most if not all HRA is made with limestone dust, 75% of which currentlymust pass a 75 micron sieve [1]. Hot Rolled Asphalt (HRA) is a dense, gap graded bituminous mixture in which the mortar of fine aggregate, filler and high viscosity binder are major contributors to the performance of the laid material. Coated chippings (nominally single size aggregate particles with a high resistance to polishing, which are lightly coated with high viscosity binder) are rolled into the surface to improve skid resistance and drainage [1]. The main strength of a HRA mixture comes from the stiffness of the sand/filler/binder mortar. A major factor in the performance of the mortar is the binder, normally grade 40/60 bitumen or polymer modified binder with approval of the NRA. Filler stiffens the bitumen which binds all the aggregates together. Some filler is contained in the fine and coarse aggregates in the mixture, but most is added to the mix. The design process optimises the binder content for the chosen constituents used[1].

The performance of the road pavement structure, which is an unprotected structure, is strongly influenced by the climatic conditions of the location where the road was built. This climatic condition has a long-term effect not only on the performance of the road pavement structure but also on the response of the pavement structure to the load. Climatic conditions that greatly affect the performance of the pavement structure are humidity and temperature [2].

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In planning a pavement, it is demanded that a good and optimal road be produced. A good road is a road that is able to withstand or support destructive forces (the ability to damage) the traffic load that is expected to pass and is able to withstand the effects of weather durability and is expected to cost relatively cheap pavement and maintenance [3]. Permeability is the ability of the pavement surface to hold water seepage into the pavement, besides the pore volume in the mixture is one of the characteristics of hot asphal, which is very important in relation to the level of impermeability to water in the pavement layers. This means that the pavement layer must have a small permeability value. Durability is the ability of asphalt concrete to accept repetition of traffic loads, friction, and weather and climate wear and tear [3] [4].

Some roads in Indonesia which are located in areas associated with high rainfall are often inundated with water and high temperature humidity. This can affect the performance of asphalt pavement, especially the problem of durability. One of the performance parameters of asphalt concrete mixture is durability. To get good durability usually requires high levels of asphalt. Even though using high asphalt content, if the road is always submerged by water, then the road will quickly get damaged (brittle) before reaching the planned age [5].

LITERATURE REVIEW

Some researchers who examined the HRA mixture include Priambodo, researching about the influence of the iron sand usage as a fine aggregate at hot mixture of asphalt HRA to the characteristic of marshall and durability dengan hasil Asphalt mixture performance using Iron Sand as the fine aggregate, in fact has lower stability value mixture than those using river sand as fine aggregate. This is caused by the imbalance offine aggregate particle distribution at get away sieve test size 2,36 mm and hold by sieve test size 0,6 mm, so that the amount of asphalt needed to fill the cavity that happened become greater and can cause media striping. It can be seen from the need of asphalt optimum degree on the mixture of asphalt with river sand as a fine aggregate which was 5,786 %, while the need of the mixture of asphalt with Iron Sand as a fine aggregate was about 6,83 %. On the other hand, the flow value of asphalt mixture with iron sand as a fine aggregate was lower than those with river sand as a fine aggregate. That was caused by the asphalt absorption of iron sand as fine aggregate was higher than absorption the river sand value as fine aggregate. It showed by the value of iron sand absorption in the amount of 2,146 % and absorption the value of river sand was 1, 01 % [6]. Lalamentik, examines the use of asbuton micro as a filler for the durability of a hot rolled asphalt mixture. The results obtained by asbuton micro can be used as a filler in the HRA mixture because of the results of testing on the basic criteria of the mixture obtained results that meet the requirements, even the test results obtained are not too far when compared with the results achieved by the mixture with a cement filler. Mixtures with asbuton micro fillers have better durability potential compared to mixes with cement fillers. This is based on the results of Marshall standard immersion testing and Marshall modification immersion testing [7]. Marteano, researched the performance evaluation of hot rolled asphalt mixed with sawdust ash as a filler. Hasil penelitian menunjukkan The mixture using 100% sawdust filler is not recommended for heavy traffic, because it may be bleeding will be experienced, while the mixture using filler of 50% stone dust – 50% sawdust have to be further studied to find the best composition, since its structural values obtained nearly approaches the standard mixture (filler of 100% stone dust). Further test have to be concerned and especially its durability and permeability [8]. Putri, examined the effect of compaction temperature variations on the hot rolled asphalt workability index by using the Mount Sinabung volcanic ash filler. The test results showed that the value of the workability index (WI) in the HRA-HRS mixture using 6.1% asphalt at temperatures of 90 ° C, 100 ° c, and 120 ° c was 2.285; 2,421; 3,019. These results show the increase in WI value with each increase in compaction temperature. From the results of marshall testing on 6 specimens weighing 1185 gr, 1188 gr and 1188.2 gr, the resulting stability values increase according to the increase in compaction temperature of 90 °C, 100 ° C, and 120 ° c are 750, 804 and 1010, while the value of flow produced at temperatures of 90 °C, 100 ° c and 120 °C is 3.8; 3,6; and 3,5 [9].

In this research, the pavement performance of Hot Rolled Asphalt mixture will be analyzed by analyzing the durability of the results of the stability and flow test due to immersion and humidification. The duration of immersion and humidification time for stability is 96 hours while for flow the duration of time used is 168 hours. The asphalt content used was 4.4% of the weight of the specimens with 60/70 penetration. The method used is an experimental method with the general specifications directorate general of highways reference standard [10].

METHODOLOGY

This research is an experimental study. Outline of the research carried out includes the examination of material characteristics, the design of mixed compositions, the manufacture of test specimens, Immersion and Humidity, and the Marshall test. The series of tests was carried out at the Road and Asphalt Laboratories, Civil Engineering Departement, Faculty of Engineering, Christian Indonesia Paulus University. Aggregates used are aggregates originating from the Bili-bili river, Gowa Regency, South Sulawesi Province. The asphalt used is penetration 60/70.

Material Characteristics

In this stage, it will be divided into 2 stages, namely the examination of aggregate characteristics using rock and sand and the examination of asphalt characteristics using 60/70 penetration oil asphalt.

Sieve analysis testing, wear testing with Los Angeles abrasion, specific gravity and coarse absorption, specific gravity and fine aggregate testing, sludge content testing, aggregate viscosity testing for asphalt with SNI 03-2439-1991, fluctuation index and slope index testing.

Asphalt characteristics testing includes, penetration testing before and after weight loss, asphalt softening test, flash point and burn point testing, flash point and burn point testing, weight loss testing, asphalt ductality testing, asphalt density testing, viscosity testing asphalt.

Mixed Design

Determination of the composition of the aggregate mixture uses an aggregate mixture composition in accordance with the General Specifications Directorate General of Highways 2010 [10]. The results of the analysis are as in table 1, obtained from the results of sieve analysts on the division of aggregate classification where coarse aggregates are retained in filters 3/4 ", 5/8 ", 3/8 ", No.8 and for fine aggregates retained in filters No.30, No. 50, No.200 and filler material that passed the No. filter. 200

Table 1. Mixed composition

Mixed composition (%)	
Coarse Aggregate	40.00
Fine Aggregate	49.00
Filler	6.60

Test Object Design

After obtaining the percentage of each aggregate and asphalt fraction, the weight of the material is determined for the mixture design with the existing mold capacity. Then do the mixing and printing test specimens. The number of test specimens used in the Marshall test were 69 pieces as in table 2.

The mixture composition used is a gradation of the Hot Rolled Asphalt (HRA) type F. The formula for determining the asphalt content in the Hot Rolled Asphalt mixture is: [11].

$$P = 0.015(s) + 0.036(b) + 0.17(c) \tag{1}$$

Where:

P = percentage of asphalt in the mixture in weight ratio

s = Percentage of aggregate withheld 10 mm (filter 3/8)

b = Aggregate percentage passed 10 mm (sieve3 / 8) retained 0.075 mm (sieve 200)

c = percentage of aggregates that passed 0.075 mm (sieve 200)

Calculation of bitumen content of equation 1, is obtained as follows:

P = 0,015 (s) + 0,036 (b) + 0,17 (c)

P = 0,015(15) + 0,036(64) + 0,17(11)

P = 4,40%

Table 2. Total of test specimens

Duration (hour)	Test Marshall	
	Immertion	**Humudity**
0	3	3
0.5	3	3
12	3	3
24	3	3
36	3	3
48	3	3
60	3	3
72	3	3
84	3	3
96	3	3
120		3
144		3
168		3
Total	**30**	**39**

Immersion

The immersion method used in this research is by entering the Hot Rolled Asphalt (HRA) Mix test object into a place or container that has been filled with water. Where the test specimen is in a submerged / submerged condition. The process of immersion of the test specimen is carried out where the variation in the duration of time used is 0.5 hours, 12 hours, 24 hours, 36 hours, 48 hours, 60 hours, 72 hours, 84 hours, 96 hours.

Humidification

The humidification method used in this study is by inserting the soil, broken stone, and sand in a sequence into a container or place, where the height of the soil in the container is ± 15 cm, the height of broken stone in the container is ± 15 cm, the height of the sand in the container is ± 15 cm cm. After the container is filled with soil, broken stone and sand, then the container is filled with water with a water level in the container that is ± 37.5cm. After that, the Hot Rolled Asphalt (HRA) mixture is placed on the top of the sand. The humidification process of the specimens was carried out where the humidification time duration varied, namely 0.5 hours, 12 hours, 24 hours, 36 hours, 48 hours, 60 hours, 72 hours, 84 hours, 96 hours., 120 hours, 144 hours, 168 hours.

Marshall Test

Testing with Marshall tools is carried out to determine the characteristics of the mixture, determine the resistance or stability to the plastic discharge (flow) of the asphalt mixture. Stability is the ability of the pavement layer to accept the burden of traffic without experiencing permanent changes (permanent deformation) such as waves, grooves (rutting), or experiencing bleeding. The stability value is influenced by cohesion or asphalt penetration, asphalt content, internal friction, interlocking properties of aggregate particles, surface shape and texture, and aggregate gradation. Flow is a vertical deformation that occurs from the beginning of loading until the stability condition decreases, which shows the amount of deformation that occurs in the pavement layer due to withstand the load it receives. The amount of the flow value is expressed in mm or 0.01 ". Flow value is influenced by asphalt content, asphalt viscosity, aggregate gradation, compaction amount and temperature.

RESULTS AND DISCUSSIONS

Aggregate Characteristics

The testing of aggregate characteristics is carried out in the Road and Asphalt laboratory of the Civil Engineering Department, Christian Indonesia Paulus University. Aggregate testing standards use British Standard 594-1 [12] and Indonesian National Standard 03-3425-1994 [11]. The test results are as follows:

The results of the coarse and fine aggregate sieve analysis as shown in Figure 2 show that the job mix is between the upper and lower limits required. This shows that the aggregate used meets the required standard specifications.

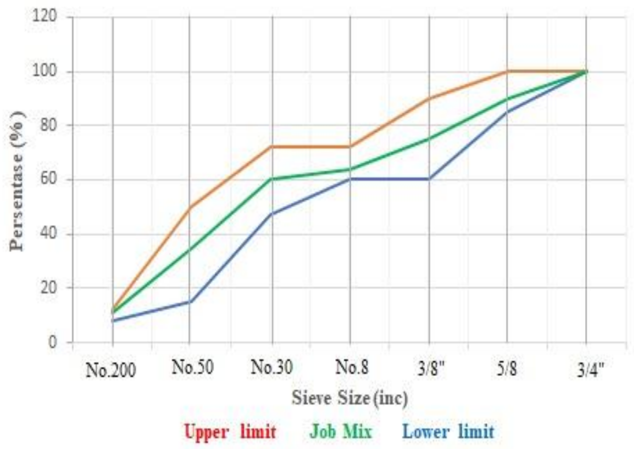

Figure 2. Job mix aggregate graph

Aggregate testing is carried out with four fractions. The results of wear testing with the Los Angeles Abrasion tool obtained the value of the rough aggregate resistance to wear from Faction A was 24.00%, Faction B was 19.58%, Faction C was 20.04% and Faction D was 20.30%. All of them meet the specifications of a maximum of 40%. From the results of aggregate wear testing, it can be seen that this aggregate can be used as road surface coating material because it is resistant to wear due to friction between aggregate and aggregate or aggregate with vehicle wheels.

Testing the density and absorption of coarse aggregate using two samples obtained results with an average value for the Bulk Specific Gravity is 2.68%, SSD specific gravity is 2.74%, apparent density is 2.84% and Water Absorption is 2 , 03%. All test results meet the specification standards for Bulk Specific Gravity is at least 2.5%, SSD Specific Gravity is at least 2.5%, Pseudo Specific Gravity is at least 2.5% and Maximum Water Absorption is 3%. The results of this test show that the material meets the requirements as road pavement material.

The results of specific gravity and fine aggregate absorption test using two samples obtained the average value for Bulk Specific Gravity is 2.70%, SSD Specific Gravity is 2.76%, Pseudo Specific Gravity is 2.89% and Water Absorption is 2.46 %. All test results meet the specification standards for Bulk Specific Gravity is at least 2.5%, SSD Specific Gravity is at least 2.5%, Pseudo Specific Gravity is at least 2.5% and Maximum Water Absorption is 3%. This shows that the material meets the requirements.

Testing the level of sludge using two samples. The test results obtained an average Sand Equivalent (SE) value of 96.00% and sludge content of 4.00%. Both of them meet the specification standard of at least 50% for Equivalent Sand and a maximum of 5% for sludge content.

Provisions Asphalt viscosity testing is only a visualization that does not go through a calculation process. The viscosity value is determined from the surface area of the sample covered with asphalt, from this observation it can be seen that asphalt can be attached to the aggregate surface is 96%. greater than the specified standard that is 90%.

The results of testing the flakiness index and gross aggregate gain obtained by the flaked index were 7.37%, 5.03% and 6.24%. And the slope index is 4.40%, 0.79% and 0.15%. Both of these indices are standard specifications, which are a maximum of 10%.

In this test using cement as a filler. The test results show this material meets the standard specifications for use as a filler in this mixture.

Asphalt Characteristics

Asphalt characteristics testing was carried out in the Road and Asphalt laboratory of the the Civil Engineering Department, Christian Indonesia Paulus University. The testing standard used is the General Specifications of Highways [10]. The test results are as follows:

Penetration testing before losing weight obtained average results for the value of penetration before losing weight is 65.7 dmm and for the value of penetration after losing weight is 64.4 dmm. The results of this test meet the standard specifications of at least 60 (0.1) mm - a maximum of 79 (0.1) mm.

Asphalt softening test results obtained an average result for the softening point value is 50 ° C, meets the specifications of the standard that is a minimum of 48 ° C and a maximum of 58 ° C.

The average value of the test point of the burn point and the flash point is obtained at 305˚C, the value has met the standard specifications of at least 200˚C.

Weight loss testing obtained an average result for the value of weight loss is 0.020%, has met the standard specifications of a maximum of 0.8%.

Tests obtained the average results for the value of ductality is 121 cm, has met the standard specifications of at least 100 cm.

Asphalt specific gravity test results obtained an average result for the asphalt specific gravity value is 1.047 gram / cc, meets the specifications of the minimum 1 gram / cc

Viscosity testing results obtained at a temperature reading of 100 ˚C time / SFS is 382.5 seconds, kinematic viscosity value is 833.85 Cst, temperature 120 ˚C time / SFS is 55.49 seconds kinematic viscosity value is 120.97 Cst and temperature 140 ˚C time / SFS is 41.78 seconds the value of kinematic viscosity is 91.08 Cst. To find out the value of compaction temperature and mixing temperature can be seen in Figure 3.

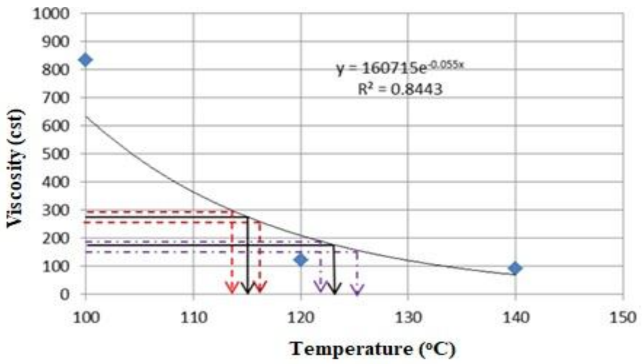

Figure 3. Relationship of Viscosity and Temperature

The Mixing Temperature is determined based on the Viscosity value of 170 ± 20 Cst while the Compaction temperature is set based on the Viscosity value of 280 ± 20 Cst. From Figure 3 for the Viscosity value of 170 ± 20 Cst the mixing temperature is obtained (122ºC - 125ºC) while for the Viscosity value of 280 ± 20 Cst the compaction temperature obtained (114ºC - 116ºC).

Marshall Testing

Asphalt characteristics testing was carried out in the Road and Asphalt laboratory of the the Civil Engineering Department, Christian Indonesia Paulus University. The testing standard used is the General Specifications of Highways [10]. The test results are as in table 3 and table 4.

Table 3. Immersion Testing Results

Duration (hour)	Temperature (ºC)		Weight of the sample (lb)		Weight of Water in sample (lbs)	Stability (lbFs)	Flow (mm)
	Water	Air	Before	Done			
0	-	-	2.60	2.60	0.00	364.67	2.85
0.5	30.5	27.5	2.61	2.61	0.00	364.85	2.47
12	29.4	27.2	2.61	2.62	0.01	365.23	2.26
24	29.8	27.4	2.61	2.63	0.02	361.09	1.92
36	28.4	26.5	2.61	2.64	0.03	352.76	1.83
48	28.3	26.9	2.62	2.67	0.05	346.18	1.72
60	28,5	26.6	2.62	2.67	0.05	335.22	1.68
72	28,7	26.8	2.63	2.68	0.05	322.94	1.62
84	28,6	26.7	2.63	2.68	0.05	320.21	1.57
96	28.7	27.2	2.63	2.68	0.05	310.36	1.55

Table 4. Humudity Test Results

Duration (hour)	Temperature (ºC)		Weight of the sample (lbs)		Weight of Water in sample (lbs)	Stability (lbFs)	Flow (mm)
	Water	Air	Before	Done			
0	-	-	2.60	2.60	0.00	364.67	2.85
0.5	31.2	27.8	2.60	2.60	0.00	361.54	2.81
12	31.4	27.9	2.60	2.61	0.01	350.64	2.43
24	31.5	27.9	2.61	2.62	0.01	348.37	2.12
36	31.1	27.8	2.60	2.62	0.02	346.18	1.92
48	29.1	27.7	2.61	2.63	0.02	340.27	1.85
60	29.8	27.7	2.61	2.64	0.03	338.72	1.81
72	29,1	27,5	2.60	2.63	0.03	336.92	1.74
84	29.9	27.7	2.61	2.63	0.02	334.69	1.70
96	29.8	27.9	2.61	2.63	0.02	332.13	1.68
120	29,9	28,2	2.60	2.63	0.03	330.90	1.66
144	30.3	28.4	2.61	2.63	0.02	329.22	1.62
168	30.1	28.1	2.60	2.64	0.04	325.43	1.60

The HRA mixture in the manufacture of test specimens uses 60/70 penetration asphalt with 4.40% asphalt content. Marshall testing is carried out on test specimens to obtain stability and flow values in the mixture of the test results with immersion treatment as in table 3.

In the stability test as in table 3, the stability value tends to rise to 12 hours immersion. The increased stability value tends to be caused by water entering the mixture cavity, where until the duration of 12 hours the cooling process of the mixture is still ongoing so that the incoming water helps the cooling process of the mixture, where the aggregate bond becomes stronger which is marked by an increase in the stability value of the mixture. At 48 hours immersion, the stability value decreases to 96 hours immersion.

The results of stability testing tend to increase up to 12 hours immersion with a stability value of 365.23 lbFs and then decrease to 96 hours immersion ie the stability value of 310.36 lbFs, this indicates that the immersion duration affects the magnitude of the stability value. But the duration above 12 hours the amount of water that enters the pavement becomes large so that stability decreases due to reduced intergregate bonding. Flow testing as shown in table 3 shows a decrease starting from the immersion duration of 0.5 hours to the time of soaking 96 hours. This flow value is influenced by the amount of water that enters the mixture more and causes asphalt to become more rigid / brittle so that its flexibility decreases.

Marshall tests were carried out on test specimens to obtain stability and flow values in this mixture. The results of testing with moisturizing treatment can be seen in table 4. From the results of laboratory testing the stability value tends to decrease at 24 hours humidification and then again at 48 hours humidification. In the next humidification Flow value has decreased, this indicates that the long humidification affects the value of the stability value. The tendency of the tendency to increase in the 48 hour duration of the humidification process is thought to result from water being in the cavity of the mixture, helping the cooling process of the mixture so that the aggregate bond by asphalt becomes stronger and the stability of the mixture increases. But the duration above 48 hours (2 days) the amount of water vapor entering the pavement becomes large so that the stability decreases due to reduced intergregate bonding. From the results of testing in the laboratory flow value has decreased from the initial duration of the initial humidification time to 24 hours to the end time duration of 168 hours. / brittle so that flexibility is reduced.

Durability of Mixed Stability

From table 3 and table 4, the stability value of the mixture due to immersion and moisture is graphed as shown in Figure 4. From the immersion graph, the initial stability value is 364.67 lbFs. The stability of the mixture over a 12 hour duration has increased the stability value by 0.15% from the initial value, while the next 12 hours ie for 24 hours immersion the stability value in the mixture has decreased by 1% from the initial value. Immersion of the mixture for 48 hours will cause a decrease in stability of the mixture by 5%, while immersion of the mixture for 96 hours or four days will decrease the value of the mixture's stability by 15% from the initial stability value. And so on the longer the water immersed the lower the stability value of the mixture which will cause damage to the asphalt pavement.

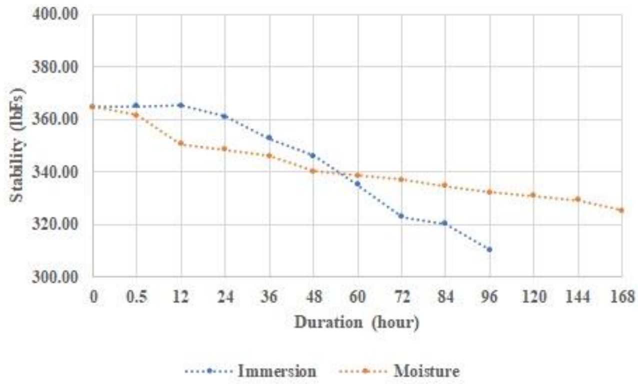

Figure 4. Effect of Immersion and Moisture on Stability

As with the effect of moisture, the value of the stability of the mixture is not too significant. In Figure 4 shows the moisture with a duration of 12 hours increased by 4% of the initial stability value, but the moisture with a duration of 24 hours or 1 day the stability value of the mixture decreased by 4%. Moisture with 96 hours humidification duration decreased the stability value of the mixture by 9% from the initial stability value of the mixture and when the moisture for 168 hours or 7 days the stability value decreased by 11% from the initial value. From the results of the comparative analysis of the stability between immersion and humidification with a duration of 48 hours in Figure 4, it is known that the stability value of the immersion is smaller than the stability of the humidification, due to the water entering the mixture cavity at the immersion is absorbed more quickly so that accelerating the cooling process of the mixture causes stability in the immersion is smaller than the value of stability in the humidification.

Durability of Mixed Flow

From table 3 and table 4, the mixture flow values due to immersion and moisture are graphed as shown in Figure 5. The initial flow values for this test for both immersion and moisture are 2.85 mm. Test immersion test with a duration of 12 hours obtained a decrease in the flow value of 20.70% from the previous value, while testing the moisture of the test object with the same time duration experienced a decrease in flow of 14.74% from the previous flow value. The immersion test for the duration of 24 hours obtained a decrease in flow value of 32.63% while the test specimen for moisture in the duration of the 24 hour immersion obtained a flow value of 25.61%. For immersion and moisture testing with a duration of 96 hours, a flow value of 45.61% and 41.05% also decreased. Test specimens for moisture were continued until moisture with a duration of 168 hours obtained a flow value of 43.86%. From the results of the comparative analysis of flow between immersion and humidification with a duration of 24 hours in Figure 5, it can be seen that the flow value in immersion is smaller than flow moisture, this phenomenon is caused by water entering the mixed cavity in immersion absorbing water faster and causing asphalt the mixture becomes brittle faster so that its flexibility is reduced compared to moisture.

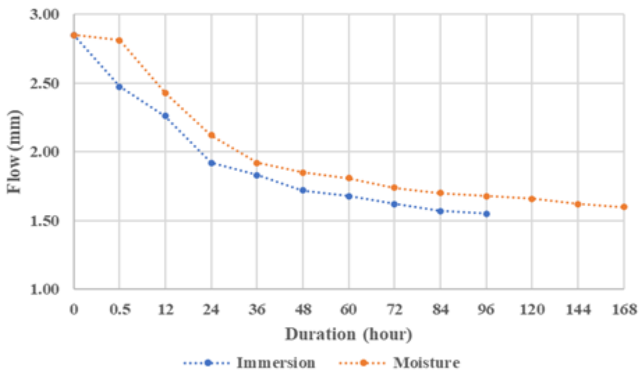

Figure 5. Effect of Immersion and Moisture on Flow

CONCLUSION

- Based on the results of the study the characteristics of the aggregate and asphalt Hot Rolled Asphalt (HRA) asphalt mixture which is influenced by immersion and moisturization are obtained:
- The stability value tends to rise until soaking 12 hours and then down. indicates that immersion duration affects the amount of stability value. stability which tends to decrease in the duration of the humidification period of 24 hours and then decreases to a duration of time of 168 hours. This indicates that the moisture duration affects the stability value. At 48 hours duration the stability value on the immersion is smaller than the stability of the humidification. caused by water entering the mixture cavity at the immersion more quickly absorbed into it so as to speed up the cooling process of the mixture causing the stability value at the immersion is smaller than the stability value at the humidification.
- The flow value has decreased in the immersion duration of 0.5 hours to the immersion time of 96 hours. This flow value is influenced by the amount of water that enters the mixture more and causes asphalt to become more rigid / brittle so that its flexibility decreases. The flow value has decreased from the initial duration of the initial moisture time to 24 hours to the end of the duration of 168 hours. This flow value is influenced by the amount of water vapor entering the mixture more and more in each duration of time and causes asphalt to become more rigid / brittle so that its flexibility decreases.
- At a time duration of 24 hours the flow value on the immersion is smaller than the flow humidification. caused by the water entering the mixture cavity in the immersion is more quickly absorbed by water and causes the asphalt mixture in the immersion to become stiff faster / brittle so that its flexibility is reduced compared with moisturizing.
- The duration of the Hot Rolled Asphalt mixture in this case the stability and flow decreases in line with the increasing duration of immersion and humidification. The process of decreasing stability and flow due to immersion takes place faster than humidification.

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