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Effect of Glass Powder and Husk Ash Filler on Pavement with Marshall Test Using Warm mix system on AC-WC

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Abstract: **Glass waste and rice husks often become garbage and have the potential to damage the environment because the glass is difficult to decompose and rice husks are abundant and has not been utilized properly. Whereas both materials can be utilized as a substitute for Portland Cement filler on road pavement especially AC-WC mixture. The purpose of this research is to know the Optimum Asphalt Content (OAC) and how big is the effect of the addition of glass powder and husk ash to Marshall result. Test specimens made from rice husks being burned and grabbed ashes and glass bottles of Marjan (clear glass) are smoothed to pass filter 200. The specimens of this research were variation of 5.5%, 6%, and 6.5% asphalt content and used four filler variations: portland cement, glass powder, husk ash, and 50% filler of glass powder and 50% filler of husk ash. The method used in this research is Marshall Test that is stability, flow, and density and pore analysis of the solid mixture formed. From the results of the research conducted on the mixture of AC-WC with the addition of variation of asphalt content and filler variation done at Pavement Cementing Planning Laboratory of Civil Engineering University of Mercu Buana obtained the optimum asphalt content of Portland Cement with 6%, the optimum asphalt content of 6% glass powder and the content asphalt optimum ash husk 5.9% and optimum asphalt content 50% filler of glass powder and 50% filler of husk ash which is 5.95%. However, the greatest stability value is in the husk ash filler, so the husk ash filler is stronger to withstand the traffic load with the optimum asphalt content of 5.9%.**

Keywords: **AC-WC, Warm Mix, Marshall Test, Powder Glass, Husk Ash.**

I. INTRODUCTION

Asphalt concrete as material for road construction has long been known and widely used in road construction. Its use also in Indonesia from year to year increase. Laston (Asphalt Concrete, AC) made as a hot mix is one type of pavement construction of flexible pavement and the most commonly used pavement construction. This pavement type is a uniform mixture between aggregate and asphalt as a binder at a certain temperature. The use of AC-WC is the surface layer (topmost) in the pavement and has the most delicate texture compared to other types of Laston. And is a pavement layer that is directly related to vehicle tires, is a waterproof layer, and resistant to weather. Looking at the various problems, the researcher tries to test the effect of filler on asphalt concrete-wearing concrete by using glass powder and husk ash. Glass is a hard and brittle substance, and in the glass there is silica as the main component material. It is known that silica is a binding material or has a high adhesion number. Based on research conducted at Columbia University and a survey in New York City as well as existing sources, finely milled glass can fill the cavities to the maximum and increase the durability of the asphalt layer. Similarly, the presence of rice husks are abundant in Indonesia is still not utilized properly. Several recent studies in the field of road construction show that rice husks are useful as a mixture in soil stabilization, particularly clay soil. The husk, which in its other form is ash husk, can fill the abandoned cavities among the aggregate granules that fill the mixture of a road structure. In addition to the ability to infiltrate, ash husk also has a cementation properties that serves to increase the rift between the particle grains. The cementation and gradation properties of the granules conform to the required specifications in one of the ingredients of the asphalt mixture, as a filler.

II. PAVEMENTS MATERIAL

A. Characteristics Aggregate:

Aggregates are generally distinguished by size. There is at least a type of aggregate size (Atkins, H. N., PE, 1997):

1. Rough aggregates Rough aggregates are aggregates retained from size 4 (4.75 mm) and should be clean, durable and free of clay or other unwanted materials and meet the requirements.
2. Fine aggregate Aggregate fine aggregate measuring between 2.36 mm (pass sieve No.8) and (retained filter No.200).
3. Aggregate is very smooth Very fine aggregate is the material that passes the filter No.200 (0.075 mm). Very fine aggregates usually serve as fillers.

B. Cement:

Portland cement is a type of material that has adhesive and cohesive properties that allow attachment of mineral fragments into a solid mass. Portland cement or so-called cement is a hydraulic binder in the form of fine powder produced by smoothing clinker (this material consists of hydraulic calcium silica), with a cast stone as an additive.

C. Husk Ash:

Ash of rice husk burning, which is essentially just a waste, turned out to be a fairly high source of silica / carbon. Further pyrolysis of rice husk combustion results indicate that SiO2 content reaches 80 - 90%. One of the most attempted attempts to utilize rice husk ash is to react with NaOH solution to produce broad industrial use of sodium silicate, such as a filler in soap and detergent, adhesive, and silica gel (Kirk and Orthmer, 1969 in Wanadri, A., 1999).

D. Glass:

Glass is one of the chemical industry products most familiar to our daily lives. In terms of physics glass is a very cold liquid substance. So called because the structure of its constituent particles are far apart as in the liquid, but the glass itself is solid. This occurs as a result of a very rapid cooling process, so that the silica particles do not "have time" to arrange themselves regularly. Chemically, glass is a composite of various non-volatile inorganic oxides, resulting from the decomposition and fusion of alkaline and alkaline earth compounds, sand and other constituents (Dian, 2011). Glass has distinctive properties compared with other ceramic groups. The specificity of these glass properties is mainly influenced by the uniqueness of silica (SiO2) and the process of its formation.

E. Asphalt:

Material is black or dark brown. At room temperature is solid to slightly dense, if heated to temperature it can be soft / liquid so that it can wrap the aggregate particles at the time of making the concrete asphalt mixture or to enter into the pores present in spraying on macadam pavement or resurfacing. If the temperature begins to fall, the asphalt will harden and bind the aggregate into place (thermoplastic properties).

III. RESEARCH METHODS

All the testing procedures carried out in this study based on applicable standards namely the Indonesian National Standard (SNI) Department of Public Works Directorate General of Highways.

SNI 03-1968-1990 : Testing Methods about Aggregate Sieve Analysis Smooth and Coarse

SNI 03-1969-1990 : Method of Testing Type Weight and Water Absorption Aggregate Coarse

SNI 03-1970-1990 : Method of Testing Type Weight and Water Absorption Fine Aggregate

SNI 03-2417-1991 : Test Method of Aggregate Wear with Machine Los Angeles Abrasion

SNI 06-2432-1991 : Ductility Testing Method of Asphalt Materials

SNI 06-2433-1991 : Flashing and Firming Point Testing Methods with Cleveland Open Cup Tool

SNI 06-2434-1991 : Asphalt and Asphalt Point Examination Method

SNI 03-1737-1991 : Procedures for the Implementation of Concrete Asphalt for Highway

SNI 06-2441-1991 : Heavy Asphalt Tester Weighing Method

SNI 06-2456-1991 : Testing Method of Penetrating Bitumenal Materials

SNI 03-6723-2002 : Specification of Filling Material for Powder Mixed

SNI 03-6819-2002 : Fine Aggregate Specification for Powdered Mixture

SNI 15-2351-1991 : Specific Gravity of Portland cement

AASHTO T-245-74 : Pill Test Method Mixed With Tool Marshall

IV. RESULT AND ANALYSIS

A. Characteristics of Aggregate Course:

The following are the results of the tests:

a. Rough Aggregate Type Weight Testing

The greater the bulk density value on the coarse aggregate, the value of the SSD and more pseudo-weight types. This is because of the incoming water into the aggregate pores. While the absorption on crude aggregate is only 0.002% and meet the standards, means a little aggregate water absorption.

b. Wear (Los Angeles)

To determine the rough aggregate wear seen from the aggregate resistance to the Los Angeles engine with a water absorption standard of a crude aggregate on a maximum AC-WC mixture type of 40%. We can see that the wear rate on crude aggregate is 15.1% then it meets the standard, which means that the aggregate used has good ability to withstand wear and impact in holding the traffic load.

B. Specific Weight Aggregate Type:

Laboratory results show the values of specific gravity, SSD, and pseudo-fine aggregate specific gravity meet the standards. The greater the bulk density value on the fine aggregate, the SSD value and the pseudos weigh the greater. This is due to the water entering into the aggregate pores. While the absorption on fine aggregate is only 0.05% and meets the standard, it means the fine aggregate of the water absorption is small.

C. Specific Gravity Filler (Cement, Powdered Glass and Husk Ash):

Filler used there are 3 that is cement, glass powder, and husk ash. From the laboratory results obtained the weight value of cement type 2.90 gr / cc, glass powder type 2.07 gr / cc and 2.67 gr / cc husk ash density. Then the value of filler weight on cement, glass powder and husk ash meets the standard, with weight value of cement type bigger than glass powder and husk ash.

D. Asphalt Characteristics:

The following are the results of the test:

a. Penetration Test In this study using penetration asphalt 60/70. With the condition of the penetration of 60-79 mm. From the laboratory results obtained penetration results 69.8 mm. Then the penetration value meets the standards.

b. Specific Weight Asphalt From the laboratory results obtained by weight value of asphalt type 1.29 gr / cm3. Then the value of the bit type of asphalt meets the standard. Because it exceeds the minimum value of 1 gr / cm3.

c. The soft spot From the laboratory results testing softening point meets the standards. With 48.5 ° C temperature the left bitumen fell. While the right asphalt fell at a temperature of 50℃.

d. Ductility From the laboratory results obtained the final result of 101 cm and on the value of the asphalt tested has not broken. Then the value of ductility meets the standards and is a good asphalt. Because the asphalt is <100 cm cut off is a less good asphalt. While the good asphalt is broken asphalt> 100 cm.

e. Flash Point and Burn Point From laboratory result of final test result that is at 201 ℃ bitumen not yet on. Then the asphalt will ignite at a Temperature of more than 200 ℃. And the result of testing point of flame and burn point meet the standard.

E. Marshall Testing Process:

Marshall test is done after the test object has been done soaking process. Then prepare the Marshall Test, insert the specimen into the test tool clip tool and adjust the scale that the needle points to zero. The Marshall Test is ready to go. Press the up button, note the melting scale, if the scale slows down and stops spinning, press the stop button to stop and read the scale on the stability pointer. Record the scale indicated by the test apparatus, and note the stability and the melted point. This test was conducted under AASHTO T-245-74. This test is intended to determine the resistance (stability) to the plastic melt (flow) from the asphalt mixture.

F. Marshall Test Results:

In this study used asphalt level of 5.5%, 6%, and 6.5%. From Marshall test obtained values of VMA, VIM, VFB, Stability, Melted, Stiffness, and the Optimum Aspalt Content. By using filler variations of Portland Cement filler, powder filler and husk ash filler to determine the effect on an asphalt mixture.

G. Optimum Asphalt Level On AC-WC Mixture with Portland Cement Filler, Glass Powder and Husk Ash:

After obtaining asphalt grade values that meet the standards at VMA, VIM, VFB, Stability, Melted, and Stiffness values for each sample for the Portland Cement filler, glass powder and husk ash, to determine the following Optimum Aspalt Content is the average yield table can be at 5,5%, 6%, and 6,5%.

TABLE I: RESULTS AND CONDITIONS OF NATURE PROPERTIES OF AC-WC MIXED WITH FILLER PORTLAND CEMENT

Portland Cement Filler						
No	**Information**	**Requirement**		**Asphalt Content (%)**		
		Min	**Max**	**5.5**	**6**	**6.5**
1	VMA (%)	13	-	24.13	25.03	21.94
2	VIM (%)	2	6	11.67	11.47	6.52
3	VFB (%)	60	-	35.55	37.14	48.10
4	Stability (Kg)	700	-	1605.39	1872.28	1209.09
5	Melted (mm)	2	-	3.24	4.23	3.46
6	Stiffness (Kg/mm)	200	-	496.33	446.59	351.94

TABLE II: RESULTS AND REQUIREMENTS OF NATURE PROPERTIES OF AC-WC MIXED WITH FILLER POWDER GLASS

Glass Powder Filler						
No	**Information**	**Requirement**		**Asphalt Content (%)**		
		Min	**Max**	**5.5**	**6**	**6.5**
1	VMA (%)	13	-	21.59	23.12	27.55
2	VIM (%)	2	6	6.71	7.26	11.38
3	VFB (%)	60	-	41.24	41.36	35.51
4	Stability (Kg)	700	-	1819.71	2005.72	1694.35
5	Melted (mm)	2	-	4.14	5.15	3.89
6	Stiffness (Kg/mm)	200	-	438.96	390.16	441.31

TABLE III: RESULTS AND CONDITIONS OF AC-WC MIXED PROPERTIES WITH FILLER HUSK ASH

Husk Ash Filler						
No	**Information**	**Requirement**		**Asphalt Content (%)**		
		Min	**Max**	**5.5**	**6**	**6.5**
1	VMA (%)	13	-	20.60	18.68	26.68
2	VIM (%)	2	6	7.12	3.52	11.79
3	VFB (%)	60	-	44.29	54.58	37.14
4	Stability (Kg)	700	-	1690.31	2672.95	2066.38
5	Melted (mm)	2	-	3.88	7.76	4.21
6	Stiffness (Kg/mm)	200	-	457.06	346.40	488.79

TABLE IV: RESULTS AND CONDITIONS OF AC-WC MIXED PROPERTIES WITH 50% FILLER POWDER GLASS AND 50% FILLER HUSK ASH

50% Filler of Glass Powder and 50% Filler of Husk Ash						
No	**Information**	**Requirement**		**Asphalt Content (%)**		
		Min	**Max**	**5.5**	**6**	**6.5**
1	VMA (%)	13	-	22.69	21.22	26.57
2	VIM (%)	2	6	8.89	5.85	11.01
3	VFB (%)	60	-	38.90	46.15	37.32
4	Stability (Kg)	700	-	1560.90	2135.12	1641.78
5	Melted (mm)	2	-	2.85	5.38	4.05
6	Stiffness (Kg/mm)	200	-	550.45	411.52	422.17

After obtaining the value of Optimum Asphalt Content that meets the standard on VMA, VIM, VFB, Stability, Melt, and Stiffness values, each OAC on Portland Cement filler, glass powder, husk ash, and 50% filler of glass powder and 50% filler of husk ash can be determined.

TABLE V: COMPARISON OF VALUE RESULTSS ASPHALT OPTIMUM AT ALL FILLER VARIATIONS

Information	**Filler**			
	Portland Cement	**Glass Powder**	**Husk Ash**	**50% Glass Powder and 50% Husk Ash**
	OAC 6%	**OAC 6%**	**OAC 5.9%**	**OAC 5.95%**
VMA (%)	25.03	23.12	18.5	21
VIM (%)	11.47	7.26	3.5	5.7
VFB (%)	37.14	41.36	54	46
Stability (Kg)	1872.28	2005.72	2590	2101
Melted (mm)	4.23	5.15	7.4	5.3
Stiffness (Kg/mm)	446.59	390.16	350	420

The highest value of Optimum Asphalt Content is on Portland Cement filler and glass powder with its value of 6%. While the lowest value is on the ash husk filler. However, if viewed from the highest stability value is on the ash husk filler. Thus, the use of ash husk at optimum asphalt level of 5.9% stronger to withstand the traffic load.

V. CONCLUSION

From the results of research conducted on the mixture of AC-WC with the addition of variations of bitumen content and filler variations conducted in the Laboratory of Pavement Planning of Civil Engineering Street of Mercu Buana University can be summarized as follows:

1. The highest value of Optimum Asphalt Content is on Portland Cement filler and glass powder with 6% value. While the lowest its value is on the ash husk filler with value of 5.9%. And value on 50% of glass powder filler and 50% filler of husk ash has value lower than filler value of portland cement and glass powder, but higher than filler ash husk value with OAC value 5.95%.

2. The greatest stability value is in the husk ash filler. And the second largest stability value that is on 50% filler glass powder and 50% filler ash husk. Thus, the use of glass powder and husk ash as an alternative filler on road pavement especially in AC-WC mixture can increase the stability value. So it is able to restrain a greater load.

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