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ANALYSIS OF MARSHALL CHARACTERISTICS WITH FLY ASH MATERIAL ON STONE DUST SUBSTITUTION AS FILLER IN HRS-WC MIXTURE

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ABSTRACT

Lataston asphalt mix is a thin layer of asphalt concrete that is often used on light-traffic roads because it produces roads with good flexibility and durability. An economical way of doing this is to vary the asphalt mix, especially by modifying fillers, to improve the quality of the road pavement and asphalt mix. So an alternative was found, namely the use of fly ash residue from the Asam-Asam PLTU. The filler material for fly ash which will be varied with the filler for stone dust plays a role in filling the voids between aggregate grains in the Hot Rolled Sheet-Wearing Course (HRS-WC) mixture with each predetermined composition. This study aims to determine the characteristics of the HRS-WC asphalt mixture with the utilization rate of rock dust and fly ash fillers. To find out the characteristics of an HRS-WC mixture with mixed variations of the two fillers, the method that will be used is the Marshall Test by analyzing each characteristic of the parameters to be obtained by 2018 Revised Highways Specifications II the Year 2018 to make the mixture hot asphalt. The bitumen content used in this study was 4,5%, 5,0%, 5,5%, 6,0%, and 6,5%, with varying levels of fly ash and rock dust filler, namely 100%: 0%, 80%: 20%, 50%: 50%, 20%: 80%, and 0%: 100%. The results of the Marshall characteristic calculation analysis show that the asphalt mixture with lataston is very influential in the substitution of rock ash as a fly ash filler. Lataston asphalt mixture tends to be stiff and easily cracked because it has a high stability value of 1,615.38 kg and the lowest flow value of 4,10% in the 100% fly ash filler variation. At optimal asphalt content, the HRS-WC asphalt mixture for each variation in the range of fly ash and rock dust produces a decreased asphalt content because the water absorption capacity of rock dust is less than that of fly ash filler, so less asphalt is needed. In addition, the HRS-WC asphalt mixture also shows increasing durability, along with the replacement of rock dust filler with fly ash filler, which can be seen from the increased stability values, MQ values, and VFB values.

Keywords: HRS-WC Micture, Fly Ash Filler, Marshall Characteristics

1. INTRODUCTION

Lataston is a road that is quite flexible and durable in light traffic. To improve the quality of the asphalt mixture, the road surface can be prepared with a variety of asphalt mixtures, especially replacing fillers with other materials. To produce an economical mixture, it is necessary to change the materials used as fillers in hot asphalt mixtures. Therefore, the waste material must be recycled so that it can be used as an alternative filler for the asphalt mixture. The alternative used in this study is to vary the filler content of fly ash in the Asam-Asam PLTU with rock dust as a filler that fills the voids between the aggregate grains.

The purpose of filler is to increase the density of the asphalt, increase the viscosity of the asphalt, reduce the permeability of the asphalt mixture and reduce its heat resistance. Therefore it is necessary to vary fillers to see the effect of increasing and decreasing filler levels in the HRS-WC lataston mixture (Hamzah, Rizky & Kaseke, Oscar, 2016).

2. THEORETICAL STUDY

Pavement is a mixture of aggregates and binders used to support traffic loads. Road surfaces are classified into flexible pavements, rigid pavements, and composite pavements according to the binder used to form the surface layer. (Hadihardjaja, 1997).

The HRS-WC (Hot Rolled Sheet) mixture is a surface pavement layer with a porous layer. The main characteristics of this mixture are durability and flexibility, but this layer must also have sufficient stability to support the direct traffic load (Purnomo, 2019).

Fly ash is known in England as a flammable ash powder. Fly ash itself cannot bind like cement. However, due to its small particle size, the silicic acid contained in fly ash reacts chemically with the calcium hydroxide produced in the cement hydration process in the presence of water and forms a substance with binding properties. The fly ash is 84% of the total coal ash. The scale and fineness of fly ash can meet the dimensions of the mineral filler AASTHO M17 (Aminullah, 2022).

3. METHOD

This research begins with a literature search through the literature, then continues with research that will be conducted at the Transportation and Highway Laboratory of the Civil Engineering Study Program, Faculty of Engineering, Lambung Mangkurat University, Banjarbaru City, South Kalimantan Province. The steps in this research are as follows:

1) Material Preparation

The following are the materials used in this study:

a. Coarse aggregate from split stone of Mount Martadah

b. Fine aggregate of Awang Bangkal sand
c. Asam-Asam fly ash (FA)
d. Stone dust from the results of Ex. Stone Crusher (DB)

2) Material Testing

The material testing carried out in this study was as follows:

a. Coarse aggregate testing

Testing Coarse aggregate testing only performs tests that include:

i. Sieving analysis testing (SNI ASTM C136:2012)
ii. Specific gravity and water absorption test (SNI 1969:2016)
iii. Aggregate abrasion (SNI 2417:2008)

b. Fine aggregate testing

Testing Fine aggregate testing only performs tests that include:

i. Sieving analysis testing (SNI ASTM C136:2012)
ii. Specific gravity and water absorption test (SNI 1969:2016)

c. Asphalt testing

Testing In asphalt testing, tests are only carried out including:

i. Asphalt-specific gravity testing (SNI 2441:2011)
ii. Penetration testing (SNI 2456:2011)
iii. Softening point test (SNI 2434:2011)
iv. Test flash point and fire point (SNI 2433:2011)
v. Ductility test (SNI 2432:2011)

d. Filler testing

Testing In asphalt testing, tests are only carried out including:

i. Sieving analysis testing (SNI ASTM C136:2012)
ii. Specific gravity and water absorption test (SNI 1970:2016)

3) HRS-WC Asphalt Mix Planning

After testing is complete and all materials meet the requirements of Highways 2018 Revision II. Followed by the calculation of the KAO plan with equation 1.

$$Pb = 0{,}035(\%CA) + 0{,}045(\%FA) + 0{,}18(\%filler) + K \quad (1)$$

Description :

Pb = Estimated bitumen content.

CA = % of aggregate that has been retained on sieve No. 8

FA = Aggregate passing sieve No. 8 and retained on sieve No. 200 as a %

Filler = % of aggregate which it passing sieve No. 200

k = Constant (0,5 – 1,0 for Laston and Lataston)

Pb = 0,035(43,22 %) + 0,045(48,78 %) + 0,18(8%) + 0,5

Pb = 5,65 %

The calculation results show that the asphalt content used is 4,5 %, 5,0%, 5,5%, 6,0%, and 6,5% with variations in *filler* to be used between 100%: 0%, 80%: 20%, 50%: 50%, 20%:80%, and 0%:100%. The planning design for each composition is shown in Table 1.

Table 1 Proportion of HRS-WC Design

Filler Proportions			Composition		Asphalt Content				
FA	:	DB			4,50%	5%	5,50%	6%	6,50%
100%	:	0%	Asphalt (gr)		54	60	66	72	78
			Aggregate Percent		95,50%	95,00%	94,50%	94,00%	93,50%
			Coarse aggregate (gr)		495,30	492,71	490,11	487,52	484,93
			Coarse aggregate (gr)		559,02	556,09	553,17	550,24	547,31
			Filler(gr)	FA	91,68	91,20	90,72	90,24	89,76
				DB	0	0	0	0	0
TOTAL					1200	1200	1200	1200	1200
80%	:	20%	Asphalt (gr)		54	60	66	72	78
			Aggregate Percent		95,50%	95,00%	94,50%	94,00%	93,50%
			Coarse aggregate (gr)		495,30	492,71	490,11	487,52	484,93
			Coarse aggregate (gr)		559,02	556,09	553,17	550,24	547,31
			Filler(gr)	FA	73,34	72,96	72,58	72,19	71,81
				DB	18,34	18,24	18,14	18,05	17,95
TOTAL					1200	1200	1200	1200	1200
50%	:	50%	Asphalt (gr)		54	60	66	72	78
			Aggregate Percent		95,50%	95,00%	94,50%	94,00%	93,50%
			Coarse aggregate (gr)		495,30	492,71	490,11	487,52	484,93
			Coarse aggregate (gr)		559,02	556,09	553,17	550,24	547,31
			Filler(gr)	FA	45,84	45,6	45,36	45,12	44,88
				DB	45,84	45,6	45,36	45,12	44,88
TOTAL					1200	1200	1200	1200	1200
20%	:	80%	Asphalt (gr)		54	60	66	72	78
			Aggregate Percent		95,50%	95,00%	94,50%	94,00%	93,50%
			Coarse aggregate (gr)		495,30	492,71	490,11	487,52	484,93
			Coarse aggregate (gr)		559,02	556,09	553,17	550,24	547,31
			Filler(gr)	FA	18,34	18,24	18,14	18,05	17,95
				DB	73,34	72,96	72,58	72,19	71,81
TOTAL					1200	1200	1200	1200	1200
0%	:	100%	Asphalt (gr)		54	60	66	72	78
			Aggregate Percent		95,50%	95,00%	94,50%	94,00%	93,50%
			Coarse aggregate (gr)		495,30	492,71	490,11	487,52	484,93
			Coarse aggregate (gr)		559,02	556,09	553,17	550,24	547,31
			Filler(gr)	FA	0	0	0	0	0
				DB	91,68	91,2	90,72	90,24	89,76
TOTAL					1200	1200	1200	1200	1200

In this study, 75 samples were required as test objects. After the score KAO was obtained, the score marshall could be seen on every ratio variation content *filler* works effective mixture HRS-WC. Figure 1 below is a flow chart of the research.

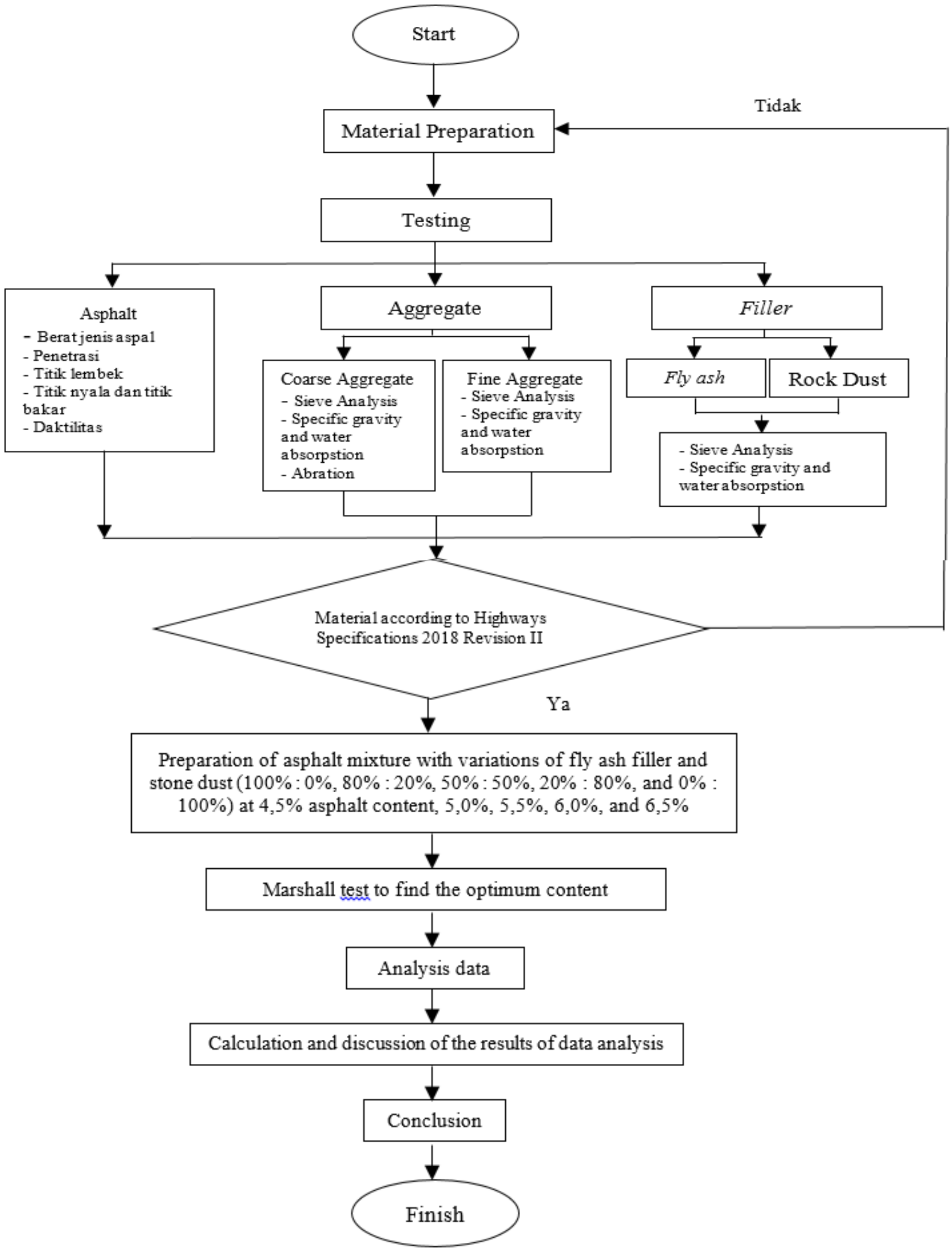


Figure 1 Research Methodology

4. RESULT AND DISCUSSION

The result of material testing aims to determine the physical properties and properties of the material used. The following results of material testing are shown in Table 2.

Table 2 Material Inspection Results

No.	Test Type	Test Method	Standard	Results	Information
Coarse Aggregate Inspection Results					
1	Water Absorption	SNI 1969:2016	< 3 %	1,88	Fulfil
2	Aggregate Specific Gravity	SNI 1969:2016	> 2,1	2,68	Fulfil
3	Abration	SNI 2417:2008	< 40 %	21,78	Fulfil
Fine Aggregate Inspection Results					
1	Water Absorption	SNI 1970:2016	< 3 %	2,55	Fulfil
2	Aggregate Specific Gravity	SNI 1970:2016	> 2,1	2,25	Fulfil
Asphalt Inspection Results					
1	Specific Gravity	SNI 2441:2011	≥ 1,0	1,02	Fulfil
2	Penetration	SNI 2456:2011	60 - 70	62,80	Fulfil
3	Soft Point	SNI 2434:2011	≥ 48	71,00	Fulfil
4	Flash Point and Burn Point	SNI 2433:2011	≥ 232	328	Fulfil
5	Ductility	SNI 2432:2011	≥ 100	100,00	Fulfil
Filler Examination Results					
1	Water Absorption	SNI 1970:2016	-	10,57	-
2	Specific Gravity	SNI 1970:2016	-	2,06	-

The results of various tests on the properties of aggregate, asphalt, and filler indicate that the materials used in the research meet the requirements. Table 3 shows the summary results of the optimum asphalt content for each mix change made.

Table 3 Optimum Asphalt Content Recapitulation Results in

Mixed Proportions (%)	KAO (%)
100 % FA : 0 % DB	6,40
80 % FA : 20 % DB	6,30
50 % FA : 50 % DB	6,25
20 % FA : 80 % DB	6,20
0 % FA : 100 % DB	6,15

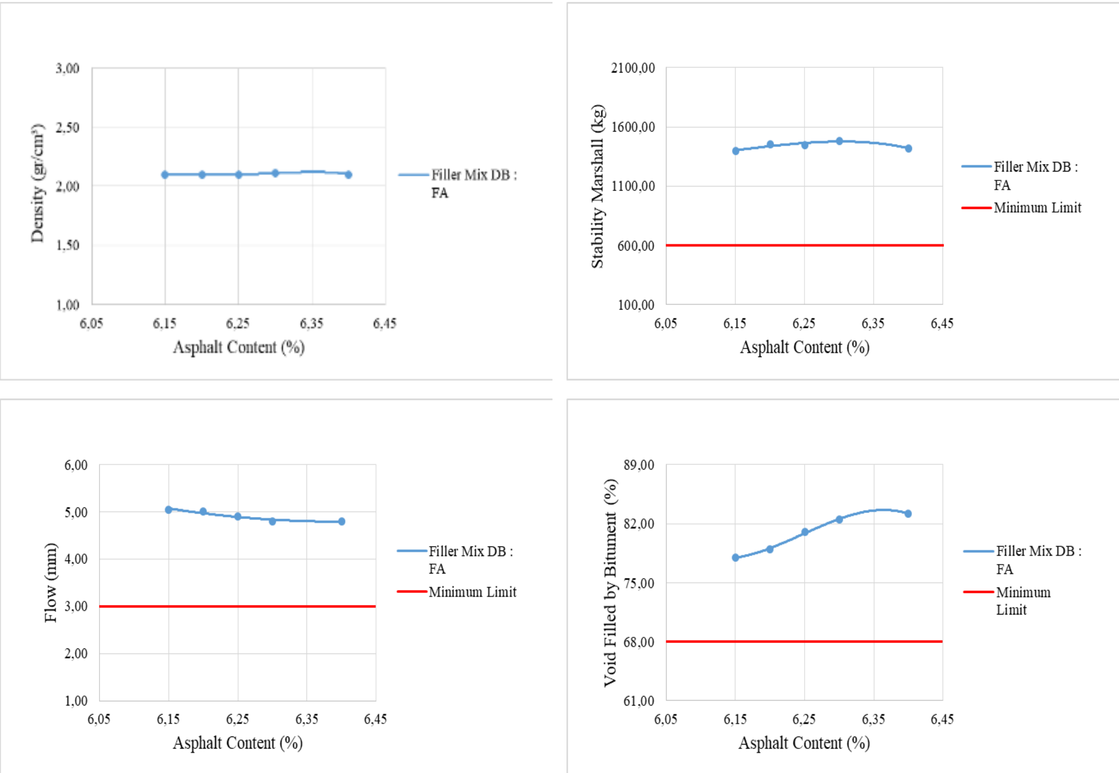
The amount of water absorbed by the aggregate will affect the asphalt content required. The higher the value of water absorption, the greater the need for asphalt in the asphalt mixture. In the mixed variation, the content of 100% FA : 0% DB has a high asphalt content of 6,40% compared to 0% FA: 100% DB which has a low asphalt content of 6,15%. This is because the absorption capacity of filler is lower than filler FA, so the need for asphalt in this variation is reduced. HRS-WC lataston mixture with 100% filler FA has a lower volume so more asphalt is needed to cover the aggregate than a mixture with filler with less stone dust. The amount of water absorbed by the aggregate will affect the asphalt content required in the asphalt mixture. The higher the value of water absorption, the greater the need for asphalt in the asphalt mixture. The variation in the content of 100% FA: 0% DB has a high proportion of asphalt, 6,40%, compared to 0% FA: 100% DB has a low asphalt content of 6,15%. This is because the absorption capacity of DB filler is lower than that of FA filler, so the need for asphalt in this variation is reduced. HRS-WC lataston mixture with 100% FA filler has a lower volume, so more asphalt is needed to cover the aggregates than combinations with less rock dust filler.

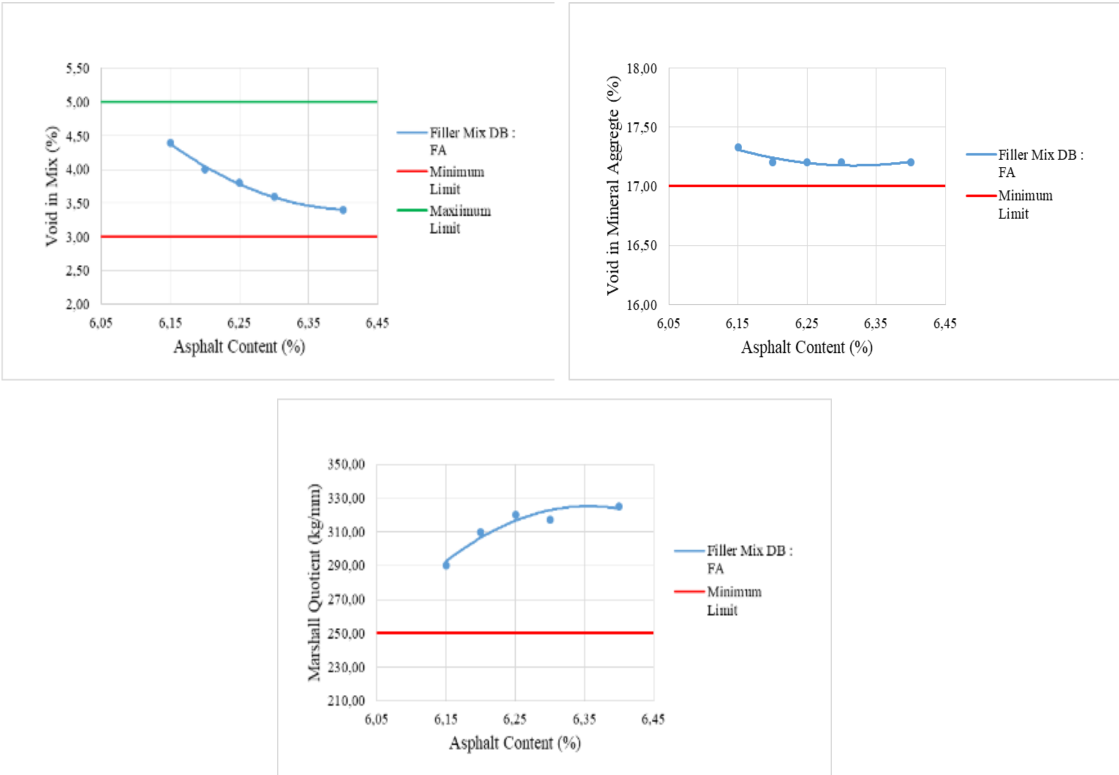
The following is a recapitulation of Marshall characteristics in KAO shown in Table 4.

Table 4 Marshall Characteristics Recapitulation Results in KAO

Mixed Variety (%)		KAO	Stability	*Flow*	VIM	VMA	VFB	MQ	*Density*
FA	DB	%	kg	mm	%	%	%	kg/mm	
100	0	6,40	1420,00	4,80	3,40	17,20	83,20	325,00	2,10
80	20	6,30	1485,00	4,80	3,60	17,20	82,50	317,00	2,11
50	50	6,25	1447,00	4,90	3,80	17,20	81,00	320,00	2,10
20	80	6,20	1450,00	5,00	4,00	17,20	79,00	310,00	2,10
0	100	6,15	1400,00	5,05	4,40	17,33	78,00	290,00	2,10
Condition			> 600	> 3	3-5	> 17	> 68	> 250	-

Based on the test results, it can be stated that the results of the KAO obtained in the lataston mixture for marshall characteristics have met the required specifications. Asphalt mixture using filler FA filler will be very influential. This is because the specific gravity of filler is lower than that of filler DBThe water absorption filler is higher than that of filler DB for more details, it can be seen in the KAO for FA DB filler with filler shown in Figure 2.





Gambar 2 Graph of Marshall Test Results with KAO

Marshall test shows that for a certain asphalt content, the asphalt mixture increases to the maximum point for the stability value obtained with variations content filler FA and DB. Then, the stability value decreased because the bitumen content which was originally a binder turned into a lubricant. The more bitumen added, the better the flexibility of the mixture. Value flow with a mixture of lataston using 100% and 80% filler FA flow. This is because FA has a smooth surface, which is characterized by high crystallinity and water absorption. The MQ value increased due to variations in the mixture of 100% filler which has a high stability value and flow. The VIM and VMA values decreased with increasing bitumen content because the volume weight of filler was higher than filler, so it has a smaller volume and smaller air gap. The VFB value increases with each replacement of the proportion of FA DB filler to filler in the lataston mixture, which can reduce the air gap formed in the lataston mixture. The density in the lataston mixture produces a stable value. This is due to the specific gravity of the filler being almost the same as the specific gravity of the filler DB.

5. CONCLUSION

Based on the results of research on the properties of the HRS-WC lataston mixture, it can be concluded as follows:

1. Inspection of materials for physical and mechanical properties in the HRS-WC asphalt mixture has met the requirements of the 2018 Highways Revision II.
2. The greater the replacement of filler FA filler, the lower the KAO. In lataston mixture with filler, 100% FA resulted in an OAC value of 6,40%, while the 100% DB lataston filler produced a KAO of 6,15%.
3. The results of the marshall characteristic test can be concluded that the greater the substitution of FA DB filler for filler in the HRS-WC asphalt mixture, the stability, VFB, and MQ values increase, so that if filler it will last longer and be able to carry higher traffic loads than filler DB. While the values of flow, VIM, and VMA decreased because the volume weight of the filler was greater than the volume weight of the filler DBHowever, the density has good density, this is because the proportion of the mixture between the two fillers has almost the same specific gravity.

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