

# The Usage of Fly Ash for Reclaimed Asphalt Pavement (RAP), Asphalt Concrete Binder Course (AC-BC) Filler

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**Abstract**– Material Reclaimed Asphalt Pavement (RAP) and fly ash as waste that whose is abundant. So interesting to be researched. The research will be started by analyze of RAP, be obtained characteristics of aggregates and asphalt, then analyzed on an aggregate gradation; if aggregate gradation does not on gradation envelope will be required the addition of new aggregate. If asphalt does not match the requirements then also be required the addition of new asphalt. The next will be made the composition of mix-design for Asphalt Concrete - Binder Course (AC-BC) with variations addition of fly ash volume as filler. The aim of research to get variations addition of fly ash volume (4%, 5% and 6%)

**Keywords** – Asphalt Concrete - Binder Course (ACBC), Reclaimed Asphalt Pavement (RAP), fly ash.

## I. INTRODUCTION

The material potential from Cold Milling Machine known as Reclaimed Asphalt Pavement (RAP) as the material of the National Road Maintenance in East Java has enough large, ± 50.000 m<sup>3</sup> every year RAP contained asphalt and aggregate. Its can be reused as substitution of new asphalt and aggregate in road pavement. The material recycling of RAP can save natural resources (aggregate, sand and asphalt) and reduce the rate environmental damage caused by mining (Hassan, 2009)

Fly ash is coal waste that whose is abundant, the number of fly ash was be estimated as 13 million ton in 2015.

The aim this research is optimized the usage of fly ash for Reclaimed Asphalt Pavement (RAP), Asphalt Concrete - Binder Course (ACBC) filler.

## II. METHOD

The steps of this researches are:

1. Analysis RAP to get characteristics of aggregates and asphalt, then analyzed on an aggregate gradation, if aggregate gradation does not on gradation envelope will be required the addition of new material (aggregate and asphalt).
2. If asphalt does not match the requirements then also be required the addition of new asphalt.
3. Make the composition of mix- design for Asphalt Concrete - Binder Course (AC-BC) with variations addition of fly ash volume as filler.

## III. RESULTS AND DISCUSSION

The result of the research are :

- A. Characteristics of RAP (aggregate and asphalt) and Characteristics of new material (agregat dan aspal).

TABLE 1.  
RESULT THAT ACCORDING TO REQUIREMENT

Characteristic of rap (agregat) No	Type of test	Requirement	Result
1	Soudness (%)	Max 12	3,15
2	Abrasi (%)	Max.40	20,19
3	Stickness agregat to aspal	Min 95	> 95
4	Specific gravity gr/cm <sup>3</sup>	-	2,6
5	Water absorption (%)	-	1,42

Table 1 shows that all of result that according to requirement at Spesifikasi Binamarga 2010 Revisi 3 Figure 1 shows that sieve size 1/2 and sieve size 3/8 out layer from gradation envelope so it does not meet the requirements spesifikasi Binamarga 2010 Revisi 3. In order to meet requirements its, it is necessary to add new material.

Table 2 shows that all of result that according to requirement at Spesifikasi Binamarga 2010 Revisi 3, except in test of penetrasi with result is 49 mm, while required that (60 – 70) mm. Which on requirement (60-70) mm. Table 3 shows that all of result that according to requirement at Spesifikasi Binamarga 2010 Revisi 3.

Figure 2 shows gradation for Coarse aggregate (CA), Medium aggregate (MA) and Fine aggregate (FA) that will be used as additional material at RAP (aggregate) so the combined aggregate gradation can be included in “the envelope gradations” that according Spesifikasi Binamarga 2010 revisi 3.

By comparing the physical properties of the new material on the specifications, so it can be concluded that characteristic of aggregates from Asphalt Mixing Plant (AMP) PT surya Marga Utama (SMU) in Pasuruan and Asphalt Pen 60/70 meets the required specifications so it can be used as mixture of Asphalt Concrete Binder Course (AC-BC).

The composition of mix- design for Asphalt Concrete - Binder Course (AC-BC) with variations addition of fly ash volume as filler.

In order to require envelope gradation according to specifications, so new aggregate is added consisting of:

- a. Coarse agregat (10-20)
- b. Medium agregat (5-10)
- c. Fine agregat (0-5)

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d. Fly ash as filler

**B. The first of Combined gradation**

Based on gradation of RAP aggregate and new aggregate gradation (CA, MA, FA ) and fly ash so be

done the composition of mix design. The details of its are presented in table 5 and figure 3.

TABLE 2.  
 CHARACTERISTIC OF RAP (ASPHALT)

No	Type of test	Requirement	Result
1	Asphalt content in the mix	-	4%
2	Penetrasi pada 25°C (mm)	60-70	49
3	Viskositas 135°C (cSt)	> 300	2.3
4	Titik lembek (°C)	> 48	55
5	Daktilitas pada 25°C, (cm)	>100	> 120
6	Specific gravity (gr/cm <sup>3</sup> )	> 1,0	1,067

TABLE 3.  
 CHARACTERISTIC OF NEW AGREGAT

No	Type of test	Requirement	Result
1	Soudness (%)	Mak 12	8,04
2	Abrasi (%)	Mak.40	15,91
3	Stickness agregat to aspal	Min 95	> 95
4	Specific gravity gr/cm <sup>3</sup>	-	2,84
5	Water absorption (%)	-	1,26

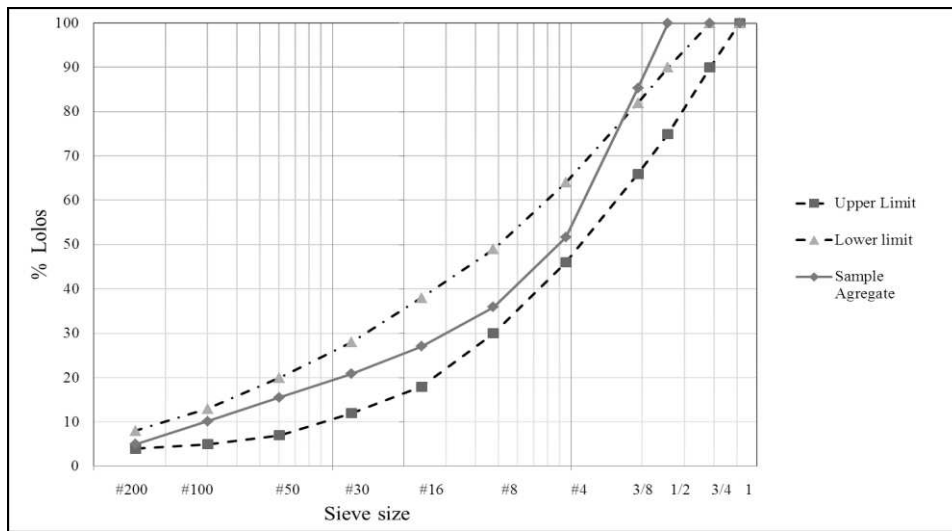


Figure 1. Gradation of RAP Agregat

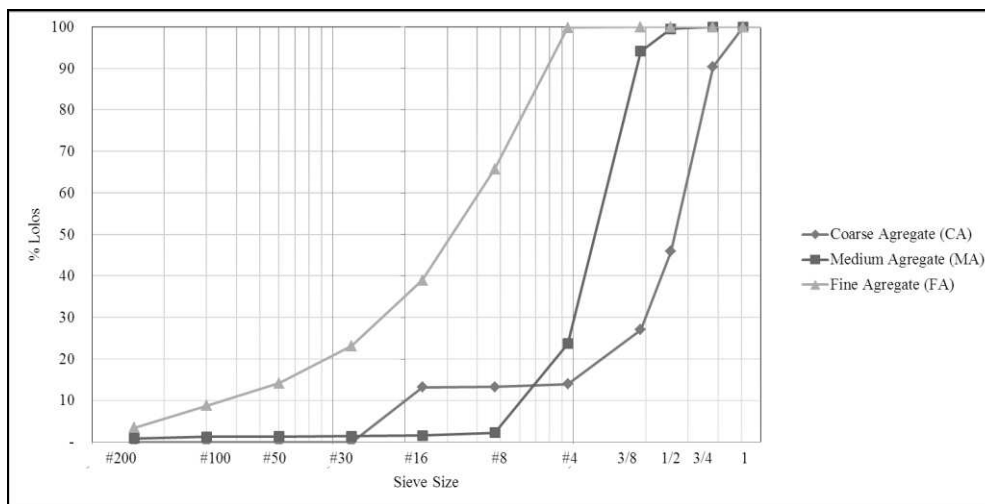


Figure 2. Gradation of New Agregat

TABLE 4.  
 CHARACTERISTIC OF NEW ASPHALT

No	Type of test	Requirement	Result
1	Penetrasi at 25°C (mm)	60-70	62
2	Viskositas 135°C(cSt)	≥300	393
3	Titik Lembek(°C)	≥48	49,1
4	Daktilitas pada 25°C (cm)	≥100	> 140
5	Titik Nyala (°C)	≥232	240
6	Solubility Trichloroethylene	≥99(%)	99,82
7	Specific gravity (gr/cm <sup>3</sup> )	≥1,0	1,03
Residu Test of TFOT Result			
8	Weight Loss (%)	≤0.8	0,21 %
9	Penetrasi at 25°C (mm)	≥54	58 %
10	Daktilitas pada 25°C (cm)	≥ 100	100

TABLE 5.  
 COMBINED AGGREGATE GRADATION WITH FLY ASH OF 4 %

Explanation	Proporsition (%)	Sieve Size									
		(% Lolos)									
Inch		3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Mm		19.0	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
<b>Data of Aggregate Grading</b>											
- RAP		100	100	85,34	51,64	35,91	27,08	20,88	15,56	10,18	5,00
- CA		90,43	45,89	27,02	13,98	13,27	13,18	0	0	0	0
- MA		100	99,55	94,12	23,70	2,26	1,56	1,41	1,33	1,26	0,85
- FA		100	100	100	99,88	65,80	38,99	23,19	14,19	8,78	3,49
- Fly Ash		100	100	100	100	100	100	100	100	100	100
<b>Agregat Combinated</b>											
- RAP	20	20	20	17,07	10,33	7,18	5,42	4,18	3,11	2,04	1,00
- CA	20	18,09	9,18	5,40	2,80	2,65	2,64	-	-	-	-
- MA	31	31,00	30,86	29,18	7,35	0,70	0,48	0,44	0,41	0,39	0,26
- FA	25	25,00	25,00	25,00	24,97	16,45	9,75	5,80	3,55	2,20	0,87
- Fly Ash	4	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00
<b>Total of mix</b>	<b>100</b>	<b>98,09</b>	<b>89,04</b>	<b>80,65</b>	<b>49,44</b>	<b>30,99</b>	<b>22,28</b>	<b>14,41</b>	<b>11,07</b>	<b>8,62</b>	<b>6,14</b>
<b>Gradation Envelope Spek.</b>											
Maks.		100	90	82	64	49	38	28	20	13	8
Min		90	75	66	46	30	18	12	7	5	4
<b>Ideal Gradation</b>		<b>95,0</b>	<b>82,5</b>	<b>74,0</b>	<b>55,0</b>	<b>39,5</b>	<b>28,0</b>	<b>20,0</b>	<b>13,5</b>	<b>9,0</b>	<b>6,0</b>

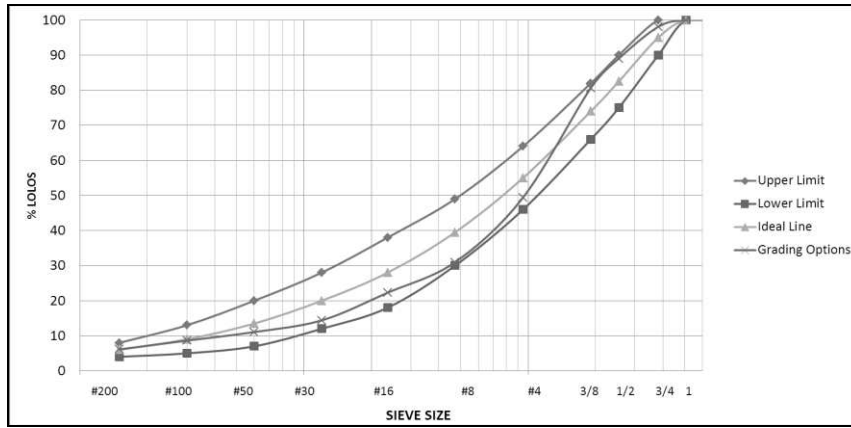


Figure 3. combined aggregate gradation with fly ash of 4 %

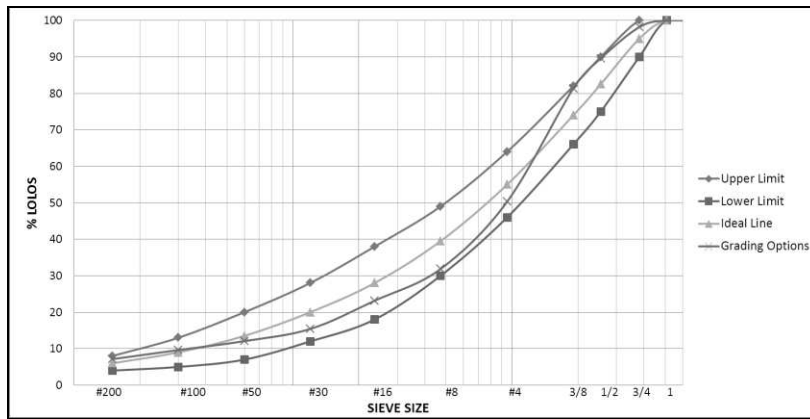


Figure 4. Combined Aggregate Gradation with Fly Ash of 5 %

TABLE 6.  
 COMBINED AGGREGATE GRADATION WITH FLY ASH OF 5 %

Explanation	Proposition (%)	Sieve Size									
		(% Lolos)									
Inch		3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Mm		19.0	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
<b>Data of Aggregate Grading</b>											
- RAP		100	100	85,34	51,64	35,91	27,08	20,88	15,56	10,18	5,00
- CA		90,43	45,89	27,02	13,98	13,27	13,18	0	0	0	0
- MA		100	99,55	94,12	23,70	2,26	1,56	1,41	1,33	1,26	0,85
- FA		100	100	100	99,88	65,80	38,99	23,19	14,19	8,78	3,49
- Fly Ash		100	100	100	100	100	100	100	100	100	100
<b>Agregat Combinated</b>											
- RAP	20	20	20	17,07	10,33	7,18	5,42	4,18	3,11	2,04	1,00
- CA	19	17,18	8,72	5,13	2,66	2,52	2,50	-	-	-	-
- MA	31	31,00	30,86	29,18	7,35	0,70	0,48	0,44	0,41	0,39	0,26
- FA	25	25,00	25,00	25,00	24,97	16,45	9,75	5,80	3,55	2,20	0,87
- Fly Ash	5	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
<b>Total of mix</b>	<b>100</b>	<b>98,18</b>	<b>89,58</b>	<b>81,38</b>	<b>50,30</b>	<b>31,85</b>	<b>23,15</b>	<b>15,41</b>	<b>12,07</b>	<b>9,62</b>	<b>7,14</b>
<b>Gradation Envelope Spek.</b>											
Maks.		100	90	82	64	49	38	28	20	13	8
Min		90	75	66	46	30	18	12	7	5	4
<b>Ideal Gradation</b>		<b>95,0</b>	<b>82,5</b>	<b>74,0</b>	<b>55,0</b>	<b>39,5</b>	<b>28,0</b>	<b>20,0</b>	<b>13,5</b>	<b>9,0</b>	<b>6,0</b>

Figure 3 shows that the addition of the aggregate with the composition according to table 5 can result the combined aggregate gradation that according to specifications. Based on table 5, the composition of the

combined aggregate to require envelope gradation is RAP (Reclaimed Asphalt Pavement) 20%, CA (Coarse Aggregate) 20%, MA (Medium Aggregate) 31%, FA (Fine Aggregate) 25% and fly ash 4%.

C. The second of combined gradation.

Based on gradation of RAP aggregate and gradation of new aggregate (CA, MA, FA ) and fly ashso be done the composition of mix design. The details of its are presented in table 6 and figure 4. Figure 4 shows that the addition of the aggregate with the composition according to table 6 can result the combined aggregate

gradation that according to specifications. Based on table 6, the composition of the combined aggregate to require envelope gradation is RAP Reclaimed Asphalt Pavement)20%, CA ( Coarse Aggregate) 19%, MA (Medium Aggregate) 31%, FA (Fine Aggregate)25% and fly ash 5%.

TABLE 7.  
 COMBINED AGGREGATE GRADATION WITH FLY ASH OF 6 %

Explanation	Proporsition (%)	Sieve Size									
		(% Lolos)									
Inch		3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Mm		19.0	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
<b>Data of Aggregate Grading</b>											
- RAP		100	100	85,34	51,64	35,91	27,08	20,88	15,56	10,18	5,00
- CA		90,43	45,89	27,02	13,98	13,27	13,18	0	0	0	0
- MA		100	99,55	94,12	23,70	2,26	1,56	1,41	1,33	1,26	0,85
- FA		100	100	100	99,88	65,80	38,99	23,19	14,19	8,78	3,49
- Fly Ash		100	100	100	100	100	100	100	100	100	100
<b>Agregat Combinated</b>											
- RAP	20	20	20	17,07	10,33	7,18	5,42	4,18	3,11	2,04	1,00
- CA	28	25,32	12,85	7,57	3,91	3,72	3,69	-	-	-	-
- MA	26	26,00	25,88	24,47	6,16	0,59	0,41	0,37	0,35	0,33	0,22
- FA	20	20,00	20,00	20,00	19,98	13,16	7,80	4,64	2,84	1,76	0,70
- Fly Ash	6	6,00	6,00	6,00	6,00	6,00	6,00	6,00	6,00	6,00	6,00
<b>Total of mix</b>	<b>100</b>	<b>97,32</b>	<b>84,73</b>	<b>75,10</b>	<b>46,38</b>	<b>30,65</b>	<b>23,31</b>	<b>15,18</b>	<b>12,29</b>	<b>10,12</b>	<b>7,92</b>
<b>Gradation Envelope Spek.</b>											
Maks.		100	90	82	64	49	38	28	20	13	8
Min		90	75	66	46	30	18	12	7	5	4
<b>Ideal Gradation</b>		<b>95,0</b>	<b>82,5</b>	<b>74,0</b>	<b>55,0</b>	<b>39,5</b>	<b>28,0</b>	<b>20,0</b>	<b>13,5</b>	<b>9,0</b>	<b>6,0</b>

D. The third of combined gradation

Based on gradation of RAP aggregate and gradation of new aggregate (CA, MA, FA ) and fly ashso be done

the composition of mix design. The details of its are presented in table 7 and figure 5.

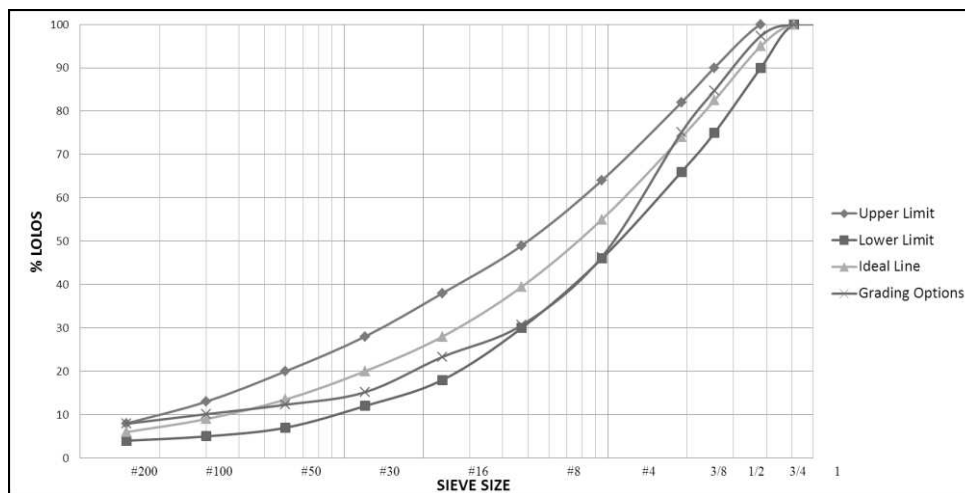


Figure 5. Combined Aggregate Gradation with Fly Ash of 6 %

Figure 5 shows that the addition of the aggregate with the composition according to table 7 can result the combined aggregate gradation that according to specifications. Based on table 7, the composition of the

combined aggregate to require envelope gradation is RAP (Reclaimed Asphalt Pavement)20%, CA (Coarse Aggregate) 28%, MA (Medium Aggregate) 26%, FA (Fine Aggregate) 20% and fly ash 6%.

#### IV. CONCLUSION

Result from the usage of fly ash for RAP, AC-BC filler that according to Bina Marga Specification at 2010 Revisi 3 are :

1. The composition of the combined aggregate is RAP (Reclaimed Asphalt Pavement) 20%, CA (Coarse Aggregate) 20%, MA (Medium Aggregate) 31%, FA (Fine Aggregate) 25% and fly ash 4%.
2. The composition of the combined aggregate is RAP (Reclaimed Asphalt Pavement)20%, CA ( Coarse

Aggregate) 19%, MA (Medium Aggregate) 31%, FA (Fine Aggregate)25% and fly ash 5%.

3. The composition of the combined aggregate is RAP (Reclaimed Asphalt Pavement)20%, CA (Coarse Aggregate) 28%, MA (Medium Aggregate) 26%, FA (Fine Aggregate) 20% and fly ash 6%.

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