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Review of Recycled Asphalt Utilization (Rap) for Road Pavement Recycling

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Abstract- Technological developments and advances in road construction are increasing with the creation of technologies in faster and more efficient road construction. One of the asphalt recycling technologies is the use of Reclaimed Asphalt Pavement (RAP) which is hot hot mixed material from the excavation of cold milling mixed with certain additive materials to improve the quality of asphalt for longer life of asphalt because it is considered faster and to reduce continued damage within a short time after repair. This recycled asphalt mixture research aims to know the value of AIV and APV values of each mixing variation. The percentage of RAP used is 23%, 27%, and 31%. Based on the result of research, it is found that RAP aggregate still fulfill the required physical characteristic ie AIV value equal to 6,6% and APV value equal to 20,4% and minimum type minimum weight 2,5, so tends to be more stable at same condition indicated by the stability value is large and the flow is not too low for the AC-BC mixture, but the gradation of RAP aggregate is not suitable for AC-WC mixed specifications so it needs gradation improvement.

Keywords: *Reclaimed Asphalt Pavement (RAP), AIV value, APV value, aggregate gradation*

1. Preface

The highway as one of the most important transportation infrastructure in advancing the welfare of the people, the highway is often damaged and requires the repair and construction of new road facilities. It is therefore necessary to carry out periodic maintenance with overlay (Lubis, 2008). One of the highway construction technologies currently and often encountered is the process of making or repairing asphalt roads using a mixture of certain additive materials to improve the quality of asphalt for longer asphalt life, as it is considered to be faster and to reduce further damage in short time after repair.

The flexible pavement consists of a lower layer of foundation, an upper base layer, and a surface layer. The surface layer is asphalt mixture with coarse aggregate and fine aggregate (Department of Public Works, 2007), where the unification process is carried out at certain hot temperatures with asphalt, coarse, and fine aggregate ratios determined through mix design. The strength and durability of the pavement itself is largely determined by the carrying capacity of the soil and the type of asphalt used, and the aggregates as the main ingredient in the manufacture of flexible pavement (Rahman, 2010).

The purposes of this study are:

a. Evaluate and analyze the use of RAP material for reuse into paved road layers.
b. Know the percentage of RAP material that can be added in asphalt mixture.
c. Determine mixed asphalt content with additional RAP material.

d. Knowing the percentage of new aggregates to be added in the asphalt mixture with the addition of RAP material.
e. Know the characteristics of asphalt mixture of RAP material addition.

How to Mix:

Based on the way RAP material mixing is divided into 2, namely:

a. Recycling cold mix (cold recycling) eg CTRB (Cement Treated Recycling Base), CTRSB (Cement Treated Recycling Sub Base), mixed with emulsion asphalt binder, mixture with liquid asphalt binder, Foam Bitumen.
b. Recycle hot mixtures, for example: recycled AMP-heated scratching material back in the field (in plant) or in the place of mixing (in place).

According to (Rahman, et al, 2011) examined the fatigue performance of the asphalt concrete mixture using a recycled material and styrene-butadiene-styrene polymer. The test results show that asphalt RAP has lower penetration value and higher viscosity value. Fatigue testing indicates that an increased proportion of RAP will increase tiredness of the mixture. According to (Mochtar, et al, 2012) investigated the optimization of the use of cold milling material for the base course layer mixture by cement treated recycled base method. The extracted RAP material gradation indicates a discrepancy to the desired specification (Bina Marga V), the incompatibility of this gradation can be corrected by aggregate blending again. The asphalt quality contained in RAP still meets the requirements of penetration asphalt 60/70.

(Kasan, 2009) examines recycled concrete mixtures by adding a reinforcing material. From the result of extraction test of old asphalt mixture material, it was found that the asphalt content in the mixture was 4.6%, so the variation of the asphalt content was 5.6%; 6.1%; 6.6% with a variation of the ingredients 0%; 5%; 10%; 15% and 20%. The results showed that more of the reinforcing material in recycled asphalt concrete mixture resulted in decreasing mixed density value and mixed stability. The maximum content of the ingredients that still meet the specification of marshall stability value of 35.29% and which meets the remaining stability specification of 46.18%.

(Suroyo, 2004) examined the effect of recycling of asphalt material on asphalt concrete properties. The results showed that the mixture using aggregate of old batches was better than the value of Job Mix AC and can be re-used. As for (Susilowati et al, 2000) examined the utilization of Residual Oil Residue (ROB) as a concrete asphalt material for recycling pavement. The results showed that the optimum asphalt content of 9.634% and asphalt concrete mixture qualified Bina Marga 1987 and could be used for medium class traffic.

This study aims to introduce one method of road pavement repair using recycled pavement to obtain the physical and mechanical properties of hot asphalt concrete mixture as a result of recycling of old pavement and to determine the optimum bitumen content of hot recycled asphalt concrete mixture from the old pavement.

2. Research Methods

Scope of Research

This research includes preparation and testing of raw materials. Preliminary study of extraction polished, aggregate analyzed and weight testing of old pavement type. Making hot asphalt concrete mixture with Variation of bitumen content 5.0; 5.5; 6.0; 6.5; and 7.0%; and 0.25; 0.5; 0, 75; and 1.0% against asphalt bundles. After that performed stability and melting test.

Tabel 1. Persyaratan fondasi agregat

Sifat	Klas	Klas B
Abrasi agregat kasar (AASHTO T96-74)	0 – 40 %	0 – 40 %
Indeks Plastisitas (AASHTO T90 – 70)	0 – 6	4 – 10
Batas Cair (AASHTO T 98 – 68)	0 – 25	0 - 35
Hasil kali Indeks Plastisitas dengan persentase lolos saringan 75 micron	25 maks.	---
Bagian yang lunak (AASHTO T 112 – 78)	0 – 5 %	0 – 5 %
CBR (AASHTO T 193)	90 min.	60 min.

Sumber Bina Marga, 2010

Research variable

The independent variables in this research are variation of bitumen bitumen content 5.0; 5.5; 6.0; 6.5; and 7.0%; and 0.25; 0.5; 0, 75; and 1.0% to asphalt concrete blocks. While the dependent variable (research parameter) consisted of stability and melting included density, cavity prosen in aggregate, cavity prosen in mixture, proportion of cavity filled with asphalt, melting point, stability and Marshall Quotient. The materials used in this research are chunks or asphalt pavement waste.

Tabel 2. Persyaratan gradasi bahan lapis fondasi agregat

Ukuran Ayakan (mm)	Persen Berat Lolos	
	Klas A	Klas B
50,0	100	100
37,5	100	88 - 95
25,0	79 – 85	70 - 85
9,50	44 – 58	30 - 65
4,75	29 – 44	25 - 55
2,00	17 – 30	15 – 40
0,425	7 – 17	8 – 20
0,075	2 – 8	2 – 8

3. Results and Discussion

The results of the AC-WC Laston recycling extraction test show that the asphalt aggregate is still included in the aggregate gradation and can still be used for surface coating (Laston AC-WC) and the percentage of asphalt to the mixture is 5.84%. The results of the asphalt content of the plan (Pb) based on mixed formula design calculation is 5.83%. The value of Pb is less than RAP extraction results so that as a reference used the extraction results of 5.84%.

In the study did not add aggregate but only added asphalt with four variations upwards, that is 5,84; 6.09; 6.34; 6.59 and 6.84% because it is not possible to use variations of asphalt content downward. It also makes standard asphalt mixtures as comparators with variations in asphalt level 5.0; 5.5; 6.0; 6.5 and 7.0%.

Tabel 3. Hasil pengujian material RAP

Spesifikasi bahan fondasi jalan		Hasil	
Jenis pengujian		Klas A	Klas B
Abrasi agregat, %	59,60	40 maks.	40 maks.
Kadar aspal, %	4,55	-	-
Kepadatan maksimum, gr/cm^3	2,25	-	-
Kadar air optimum, %	5,00	-	-
California Bearing Ratio (CBR), %	26,80	90 min.	60 min.

Sumber : Bina Marga, 2010

Tabel 4. Distribusi butiran material RAP

Ukuran butiran (mm)	Persen lolos	Spesifikasi bahan pondasi jalan	
		Klas A	Klas B
50,0	100	100	100
37,5	100	100	88 – 95
25,0	94	79 - 85	70 – 85
9,50	82,6	44 – 58	30 – 65
4,75	58,5	29 – 44	25 – 55
2,00	31.5	17 – 30	15 – 40
0,425	10,1	7– 17	8 – 20
0,075	1,9	2 – 8	2 - 8

Density Analysis

As the asphalt level increases in the mixture, the density value tends to increase. This is because if the mixture is compacted the asphalt will fill the cavity between the particles that are formed. More cavities create higher density to the optimum limit, which then decreases as the free asphalt level diminishes as it overwrites aggregate granules.

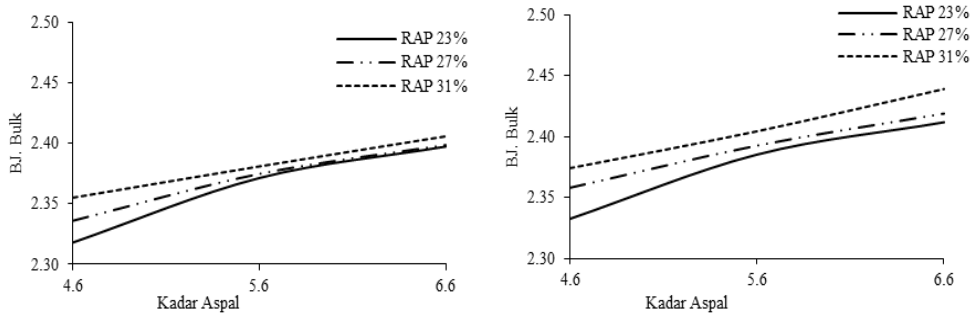

Figure 1. Graph of Relationship Between Asphalt Levels with BJ Bulk for Bleeding Damage
Figure 2. Graph of Relation Between Asphalt Levels with BJ Bulk for Cracking Damage

Analysis of Airspace Aggregate (VMA)

As the asphalt level increases in the mixture, the VMA value is lower, because the amount of asphalt entering the cavity is not enough space to fill the cavity.

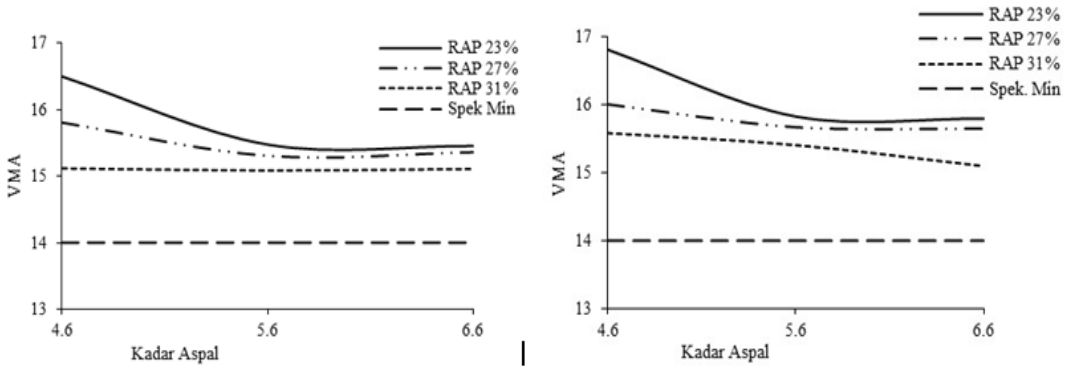

Figure 3. Graph of Relation Between Asphalt Levels with VMA for Bleeding Damage
Figure 4. Graph of Relation Between Asphalt Levels with VMA for Cracking Damage

Analysis of Air Cavity Filled Asphalt (VFA)

The VFA value will decrease as the asphalt level increases. This is because more and more asphalt can fill the cavities in the mixture, in addition to the increased VFA value indicates that the asphalt aggregates are more and more.

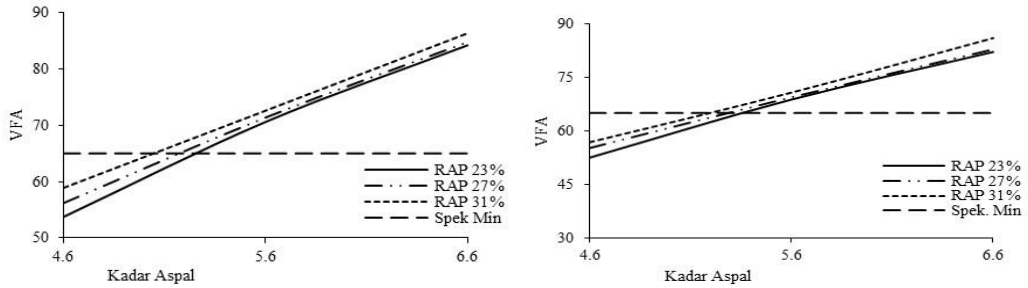

Figure 5. Graph of Relation Between Asphalt Levels with VFA for Bleeding Damage
Figure 6. Graph of Relation Between Asphalt Levels with VFA for Cracking Damage

Analysis of Air Cavities inside the Mix (VIM)

As the amount of asphalt increases in the mixture, the VIM value is lower which means the cavity is in the mixture slightly, so that there is not enough space, the asphalt may be ascending to the surface. The amount of asphalt that can fill the cavity between the grains is greater, so the cavity volume in the mixture decreases the asphalt concrete more durable.

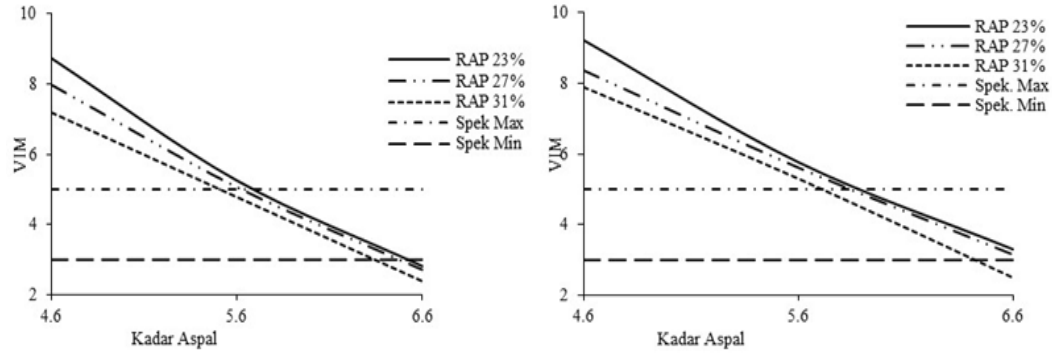

Figure 7. Graph of Relation Between Asphalt Levels with VIM for Bleeding Damage
Figure 8. Graph of Relation Between Asphalt Levels with VIM for Cracking Damage

Stability Analysis

The asphalt stability value will increase as the asphalt level in the mixture rises to a certain percentage then decreases again. This happens because the asphalt film that envelopes the aggregate is getting thicker.

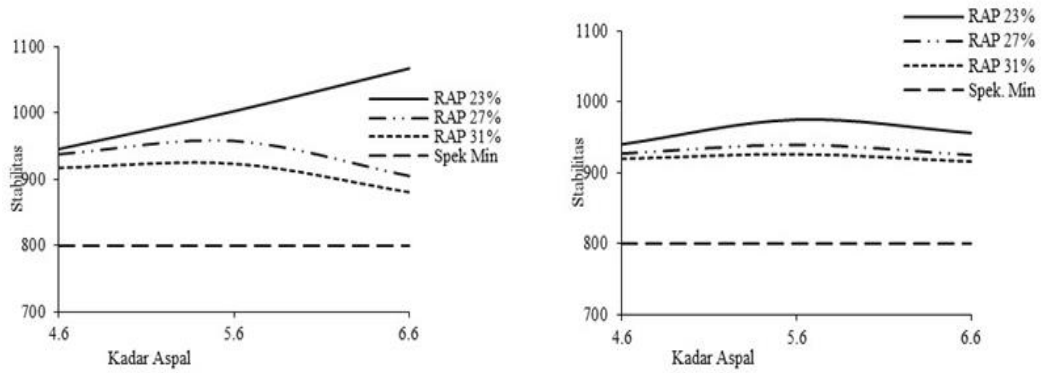

Figure 9. Graph of Relationship Between Asphalt Levels with Stability for Bleeding Damage
Figure 10. Graph of Relation Between Asphalt Levels and Stability for Cracking Damage

Melting Analysis (Flow)

As the asphalt level increases in the mixture, the melt tends to increase, since the asphalt mixture will be plastic so that it is easily deformed (plastic deformation) if exposed to heavy load or due to heavy and heavy traffic load.

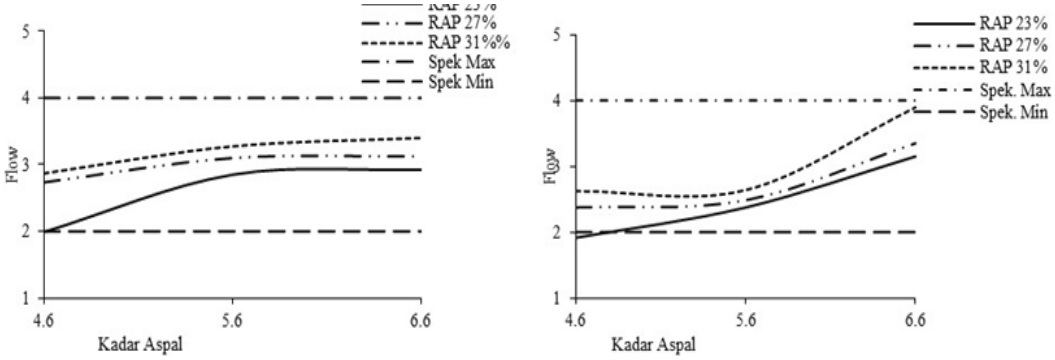

Figure 11. Graph of Relation Between Asphalt Levels with Flow for Bleeding Damage
Figure 12. Graph of Relationship Between Asphalt Levels with Flow for Cracking Damage

Marshall Quotient Analysis (MQ)

As the asphalt level increases in the mixture, the Marshall Quotient value tends to decrease, so the mixture becomes more flexible, tends to be plastic and flexible, so it is easy to change shape when receiving high traffic load.

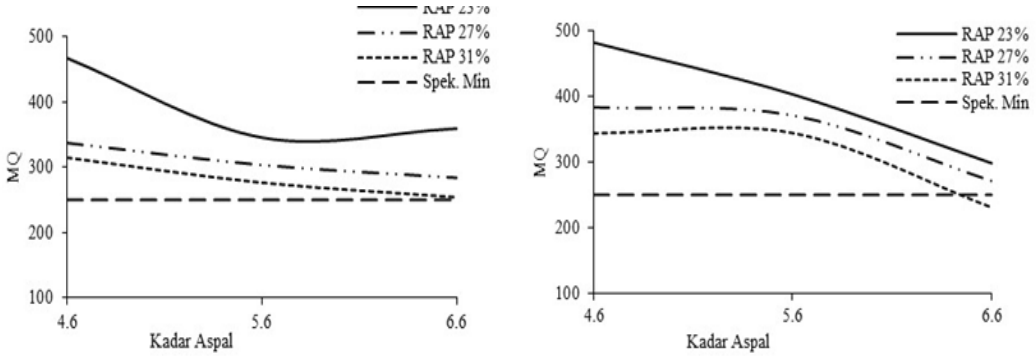

Figure 13. Graph of Relation Between Asphalt Levels with MQ for Bleeding Damage
Figure 14. Graph of Relation Between Asphalt Levels with MQ for Cracking Damage

Thickness Analysis of Asphalt (Asphalt Film)

Asphalt thickness decreases as the percentage of RAP type of bleeding increases, it is because the more fine material in the mixture the greater the absorption of the asphalt so that the asphalt covering the aggregate is not perfect, but the thickness of the asphalt cover will increase as the asphalt level increases on the mixture with RAP type bleeding material (Figure 18). Asphalt thickness increases when the percentage of RAP type of cracking and asphalt content in the mixture increases. This is because the larger the bitumen content the thicker the resulting blanket the greater.

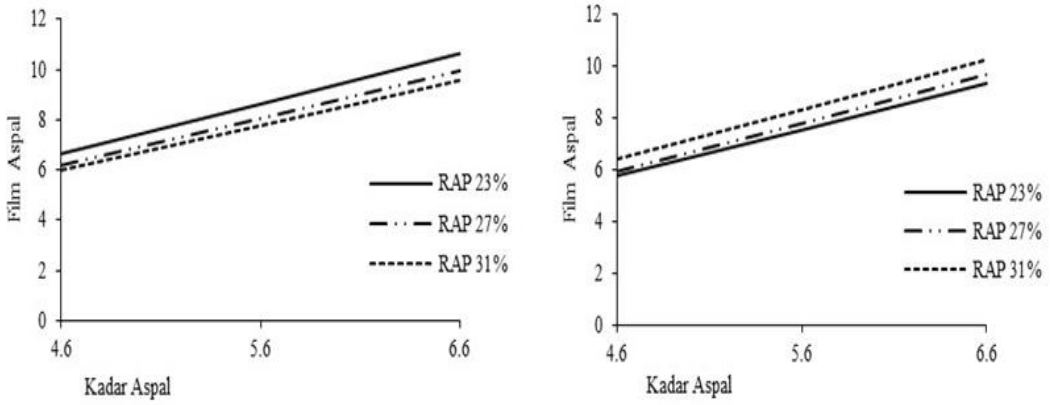

Figure 17. Graph of Asphalt Base Relation with Asphalt Levels for Bleeding Damage
Figure 18. Relation Chart of Asphalt Blast with Asphalt Levels for Cracking Damage

4. Conclusion

The results show that:

Asphalt recycling is one of the alternative ways to maintain and rehabilitate pavement layers with the advantage of saving materials, energy and maintaining environmental quality by reducing waste disposal asphalt. the physical and mechanical properties of the asphalt mixture for the old pavement mixture, the aggregate gradation still meets the Bina Marga 2010 specification for the Laston AC-WC, so no new aggregate is required. The asphalt content of extraction yield of 5.84%, showing the mixture of many cavities, too rigid so it is not durable, it needs to be added new asphalt to

be attached perfectly with old asphalt, while the physical and mechanical properties of recycled pavement or RAP and standard mixture, with Asphalt Level Optimum obtained value density, VMA, VFA, VIM, Stability Analysis, Melt Analysis and Marshall Quotient meet the specification of Bina Marga 2010 for surface layer or Laston AC-WC. Mixture is more flexible, tends to be plastic and flexible so it is easy to change shape when receiving high traffic load, and mixture will be more durable.

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