The Utilization Of Rejected Asphalt As A Substitute In Asphalt Concrete - Wearing Course Mixtures

Ika Sulianti, Anna Elvaria, Ibrahim,
Sekar Bening Larasati, Azzahra Nurfadilah

Civil Engineering Department, State Polytechnic Of Sriwijaya, Palembang, Indonesia
anna.elvaria@polsri.ac.id

Abstract. Due to the increased demand for various essentials of human life, natural resources for road pavement are becoming more and more scarce, necessitating the use of alternative materials. In this study, a rejected asphalt mixture serves as the foundation for an asphalt mixture to which emulsified asphalt and natural aggregates are added. A rejected asphalt mixture is an asphalt mixture that is not used in a pavement because the temperature at the time of sanding is lower or does not meet the required specifications. Through extraction testing, the asphalt content and gradation must be verified in order to identify the sort of combination that makes up the rejected asphalt mixture. An optimal asphalt content of 6.55% is used in this research with variations in asphalt percentage of 5%, 6%, and 7%. The comparison of Rejected Asphalt (RA) as a substitution with New Material (NM) used in asphalt concrete mixture layer asphalt concrete - wearing course is 0% RA : 100% NM, 25% RA : 75% NM, 50% RA : 50% NM, 75% RA : 25% NM, dan 100% RA : 0% NM. The results of the test analysis indicate that the most optimal comparison is 100% RA : 0% NM, with value of stability 1489.143 kg, flow 3.883 mm, VIM 4.738%, VFA 70.604%, VMA 16.097%, and MQ 383.470 kg/mm.

Keywords: Road Pavement, Reject Asphalt, Extraction

1 Introduction

1.1 The Background

The most popular type of pavement in Indonesia is called flexible pavement because of its flexibility, which allows vehicles to cross the road more comfortably. Flexible pavement is made up of a mixture of paved material on top and grained material underneath. The asphalt concrete – wearing course pavement layer is a pavement layer that is directly related to vehicles tires, is a waterproof layer, weather resistant, and has the required firmness with a minimum thickness of 4 cm [4]. Because the texture of the ac-wc layer is the smoothest when compared to other forms of laston, it is used as a surface layer in pavement [5]. Continuously graded laston mixes have fewer voids in the aggregate structure compared to discontinuously graded mixes. This makes ac-wc mixes more sensitive to variations in mix proportions.

Alternative materials are required for pavement since naturally occurring materials are not readily renewable. Recycling asphalt that has been rejected is one option. An

N. L. Husni et al. (eds.), *Proceedings of the 8th FIRST 2024 International Conference on Global Innovations (FIRST-ESCSI 2024)*, Advances in Engineering Research 261,
https://doi.org/10.2991/978-94-6463-678-9_8

asphalt mixture that is not used or layered over a pavement is known as recycled asphalt mixture.

1.2 Goal of The Research

The goal of this research is to figure out how the value of marshall characteristics is affected when reject asphalt is used in place of asphalt concrete mixtures in asphalt concrete – wearing course (ac-wc) layer.

2 Review Of Literature

2.1 Road Pavement

Road pavement is several layers of compacted material on top of the subgrade with the intention that traffic can run smoothly without being obstructed, functioning so that the subgrade is more resistant to traffic loads and weather, so that maintenance efforts can maintain the surface to remain in a good condition for travel [3].

2.2 Hotmix Asphalt Concrete

Hotmix asphalt concrete is one type of flexible pavement construction layer. This type of pavement is an even mixture of aggregate and asphalt as a binder at a specific temperature [6].

2.3 Reject Asphalt

Reject asphalt is asphalt that is not suitable for use or disposal in certain situations. This may be due to the temperature at the time of mixing being too high or not meeting the required specifications [2]. To understand the properties of asphalt reject mixtures, it is necessary to grade the asphalt using an extraction test. The type of mix to be graded should match the test results with a minimum grade of 80%, or with a modified minimum grade of 80% according to the characteristics of the asphalt mixture concerned.

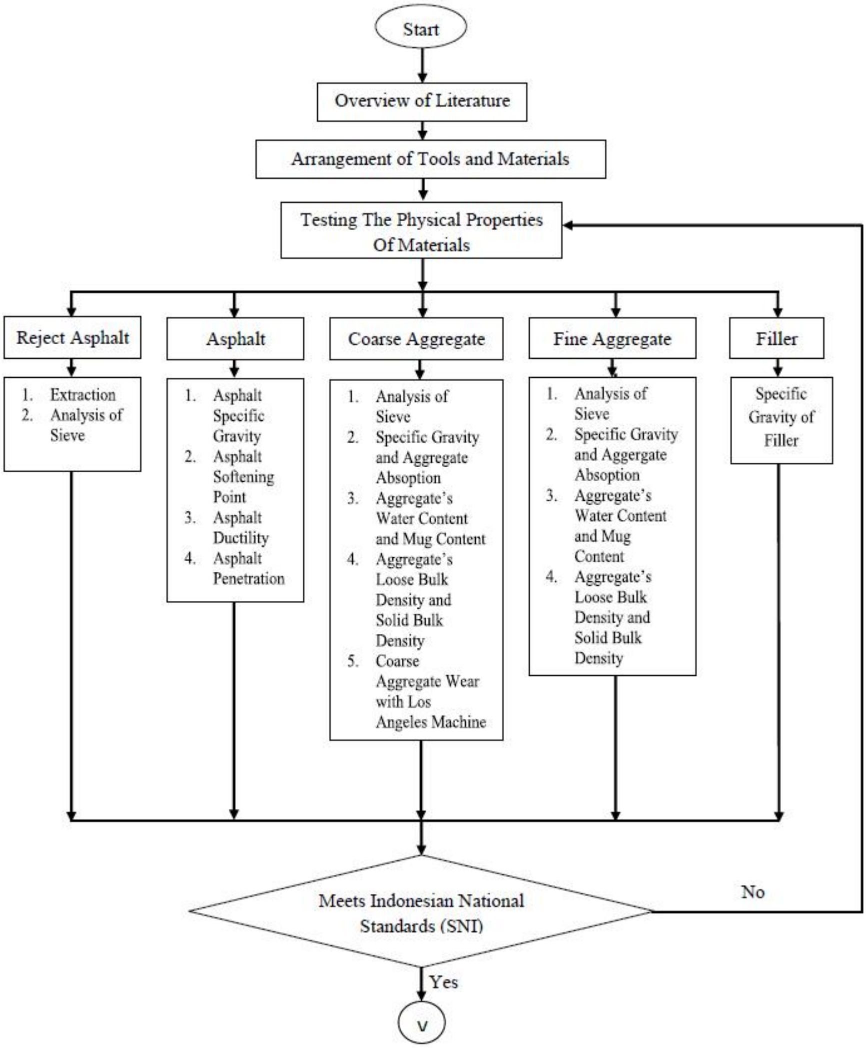
2.4 Extraction

One method that has been developed to test the asphalt content in the mixture is to use the extraction method according to the AASTHO testing procedure (T-164-80). Extraction is the separation of a mixture of two or more materials by adding a solvent that can dissolve one of the the materials in the mixture [1].

3 Research Methods

This research was carried out at the State Polytechnic of Sriwijaya's Material Testing Laboratory of the Civil Engineering Department, The South Sumatra National Road Implementation Center (BBPJN) Laboratory, and The Asphalt Mixing Plant

Laboratory of PT Hakaaston Indralaya – Prabumulih Production Unit. The standard for this testing refers to The General Specifications of Bina Marga 2018 Revision 2. The materials used in the current research include stone dust, reject asphalt from PT Hakaaston, fine aggregates from Tanjung Raja, solid asphalt's penetration grade of 60/70, coarse aggregates sized 1/2 and 1/1, and portland cement filler. Figure 1 below shows the research method diagram.



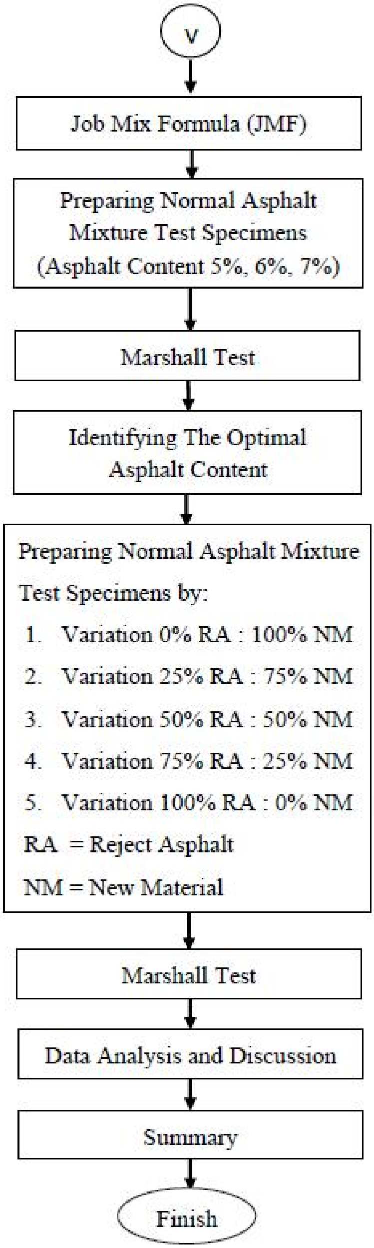


Fig. 1. Research Method Diagram

4 Testing and Discussion Results

4.1 Results of Reject Asphalt Testing

The reject asphalt used in this research is sourced from PT Hakaaston. The result of the reject asphalt testing shown in Table 1 below.

Table 1. Results of The Sieve Analysis from The Extraction Testing

Sieve	Retained Weight	Cumulative Percentage (%)	
(Inci)	(Gram)	Retained	Passed
3/4"	0	0	100
1/2"	27	4.8	95.2
3/8"	57	10.1	89.9
No. 4	178	31.6	68.4
No.8	310	55.1	44.9
No. 16	429	76.2	23.8
No. 30	481	85.6	14.4
No. 50	511	90.9	9.1
No. 100	526	93.6	6.4
No. 200	538	95.7	4.3

4.2 Results of Testing Physical Properties of Aggregates

The coarse aggregates used in this research are sourced from PT Hakaaston, and fine aggregates come from Tanjung Raja. The recapitulation of the physical property test for the coarse aggregates, specifically 1/2 and 1/1 sizes, is presented in Table 2, and the fine aggregates in the forms of sand is shown in Table 3.

Table 2. Results of Recapitulation of Testing Physical Properties of Coarse Aggregates

Type of Testing	Coarse Aggregate Results		Unit
	1/2	1/1	
Sieve Analysis	8.09	5.92	-
Bulk Specific Gravity	2.48	2.41	-
SSD Specific Gravity	2.51	2.45	-
Apparent Specific Gravity	2.56	2.50	-
Effective Specific Gravity	2.52	2.46	-
Absorption	1.28	1.45	%
Water Content	0.72	0.41	%

Mud Content	0.28	0.83	%
Loose Bulk Density	1.53	1.42	gr/cm^3
Solid Bulk Density	1.57	1.62	gr/cm^3
Test specimen passing 1,7 mm sieve (*Impact Value*)	13.63	%	

Table 3. Results of Recapitulation of Testing Physical Properties of Fine Aggregates

Type of Testing	Fine Aggregate Results		Unit
	Stone Dust	Sand	
Sieve Analysis	3.97	3.30	-
Bulk Specific Gravity	2.48	2.63	-
SSD Specific Gravity	2.51	2.64	-
Apparent Specific Gravity	2.56	2.66	-
Effective Specific Gravity	2.52	2.65	-
Absorption	1.26	0.50	%
Water Content	-	3,66	%
Mud Content	-	0.40	%
Loose Bulk Density	-	1.30	gr/cm^3
Solid Bulk Density	-	1.39	gr/cm^3

4.3 Results of Filler Testing

This research uses portland cement filler. The recapitulation of filler testing results is provided in Table 4.

Table 4. Result of Recapitulation of Filler Testing

Type of Testing	Result	Unit
Portland Cement Specific Gravity	3.019	gr/cm^3

4.4 Results of Asphalt Testing

Solid asphalt with a penetration grade of 60/70 is used in this research. The physical property test results for the asphalt are summarized in Table 5.

Table 5. Results of Recapitulation of Testing physical Properties of Asphalt

Type of Testing	Results	Unit
Asphalt Specific Gravity	1.04	-

Asphalt Softening Point	49.60	°C
Asphalt Penetration	62.0	mm
Asphalt Ductility	144.25	cm

4.5 Results of The Marshall Tests

Results of The Marshall Testing To Determine The Optimum Asphalt Content. The mixture design results for specimen preparation are based on the aggregate mix design obtained through testing with asphalt content variations of 5%, 6%, and 7% showed in Table 6.

Table 6. Recapitulation of Marshall Test To Determine The Optimum Asphalt Content

Mixture Characteristic	Unit	Asphalt Content (%)			Spec.
		5	6	7	
Stability	kg	931.30	1074.60	974.50	Min. 800
Flow	mm	3.00	3.60	3.30	2 - 4
VIM	%	5.00	4.20	3.50	3 - 5
VFA	%	63.80	72.20	78.60	Min. 65
VMA	%	13.90	14.96	16.10	Min. 14
Marshall Quotient	kg/mm	307.50	302.99	294.10	-

Table 6 presented asphalt content's variation that meet The General Specification of Bina marga 2018 Revision 2 are asphalt content variations from 5%, 6% and 7%, and from the analysis data indicated the optimum asphalt content for this research was 6.55%.

Results of The Marshall Testing With Reject Asphalt As A Substitution In Asphalt Mixtures. Table 7 presents marshall test results for reject asphalt used as a substitute in asphalt mixture with a 6.55% asphalt content.

Table 7. Recapitulation of Marshall Test Results with Reject Asphalt as a Substitution in Asphalt Mixtures

Proportion of Reject Asphalt (RA) and New Material (NM)	Mixture Characteristics					
	Stability	Flow	VIM	VFA	VMA	MQ
0% RA : 100% NM	1132.23	3.45	3.58	76.24	15.08	328.50
25% RA : 75% NM	1163.27	3.48	3.63	76.00	15.12	334.32
50% RA : 50% NM	1251.51	3.52	3.89	74.73	15.35	355.84
75% RA : 25% NM	1365.32	3.62	4.32	72.63	15.73	377.05

100% RA : 0% NM	1489.14	3.88	4.74	70.60	16.10	383.47

Stability analysis. The findings of the stability analysis are shown in Figure 3. The research's stability results are shown in Figure 3, where the stability value increases from the variation of 0% RA: 100% NM to the variation of 100% RA: 0% NM. 100% RA:0% NM is the composition that offers the best ideal stability value. A minimum stability value of 1000 must be met by modified asphalt in accordance with the General Specification of Bina Marga Revision 2. The extended lifespan of high stability asphalt mixtures on the road is due to their increased resistance to potholes, cracking, and rutting. All variations satisfy the necessary stability criteria, according to the analysis that was done..

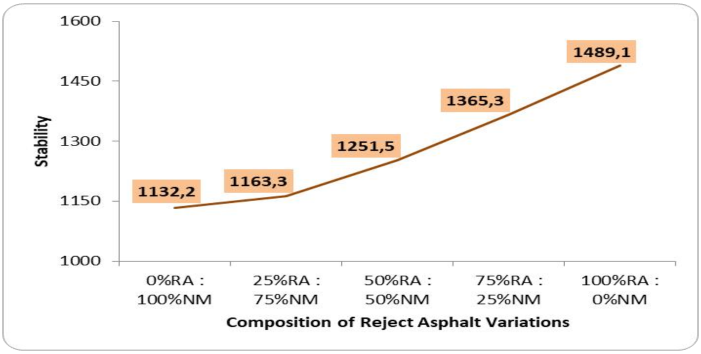


Fig.2. Graph of The Analysis Results of The Marshall Test on Modified Asphalt Regarding The Stability Value

Flow analysis. The flow analysis results are shown in Figure 4, where the variation value increases from 0% RA: 100% NM to 100% RA: 0% NM. According to The General Specification of Bina Marga 2018 Revision 2, the flow value for modified asphalt must be at least 2 and no more than 4. As the flow value rises, so does the likelihood of asphalt concrete bleeding. Bleeding may cause the road to become slippery, endangering the safety of drivers. All variations satisfy the necessary flow standard, according to the analysis that was done.

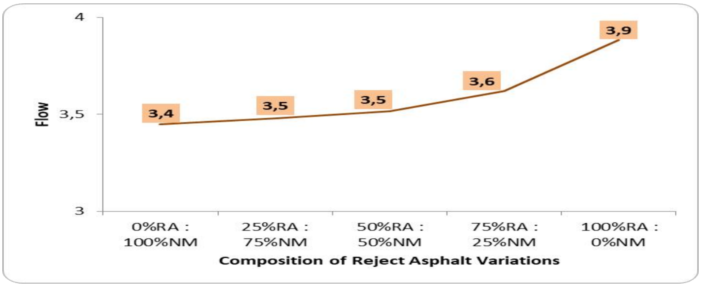


Fig.3. Graph of The Analysis Results of The Marshall Test on Modified Asphalt Regarding The Flow Value

Analysis of VIM. The results of the VIM analysis are shown in Figure 5, where the variation of 0% RA : 100% NM to the variation of 100% RA : 0% NM is represented by the VIM value that keeps on rising. The VIM value for modified asphalt has to meet a minimum requirement of 3, and a maximum of 5, in accordance with The General Specification of Bina Marga 2018 Revision 2. The water tightness decreaces with increasing VIM value, creating greater air gaps that make it easier for water to penetrate into the asphalt mixture. Based on the analysis conducted, all variations meet the required VIM standard.

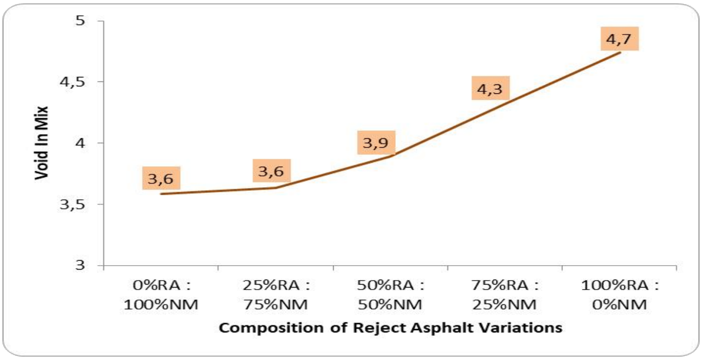


Fig.4. Graph of The Analysis Results of The Marshall Test on Modified Asphalt Regarding The VIM Value

Analysis of VFA. The result of the VFA analysis are shown in Figure 6, where the VFA value continues to decrease from the variation of 0% RA : 100% NM to the variation of 100% RA : 0% NM. The VFA value for modified asphalt has to meet a minimum requirement of 65, in accordance with the General Specification of Bina Marga 2018 Revision 2. A higher volume of air voids in the asphalt mixture is indicated by a low VFA value. These voids can become filled with water, which lead to stripping, the separation of asphalt from aggregates, and a reduction in the mixture's strength. Based on the analysis conducted, all variations meet the required VFA standard.

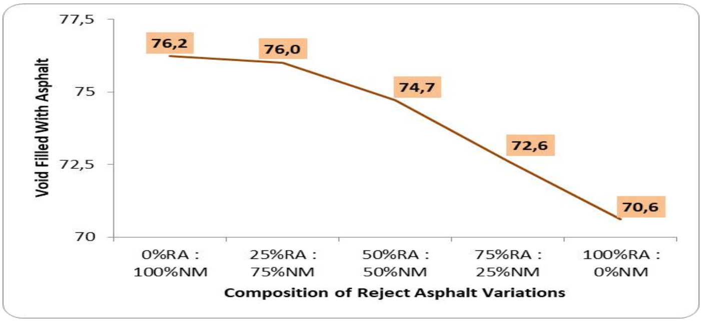


Fig.5. Graph of The Analysis Results of The Marshall Test on Modified Asphalt Regarding The VFA Value

Analysis of VMA. The results of the VMA analysis are shown in Figure 7, where the variation of 0% RA : 100% NM to the variation of 100% RA : 0% NM is represented by the VMA value, which continues rising. The VMA value for modified asphalt has to meet a minimum requirement of 15, in accordance with The General Specification of Bina Marga 2018 Revision 2. As the VMA value increases, it indicates a greater volume of voids between aggregates filled with asphalt. This could decrease the possibility of stripping, or the separation of asphalt from aggregates, and reduce the degree of moisture in the mixture, which will increase the pavement's lifetime. Based on the analysis conducted, all variations meet the required VMA standard.

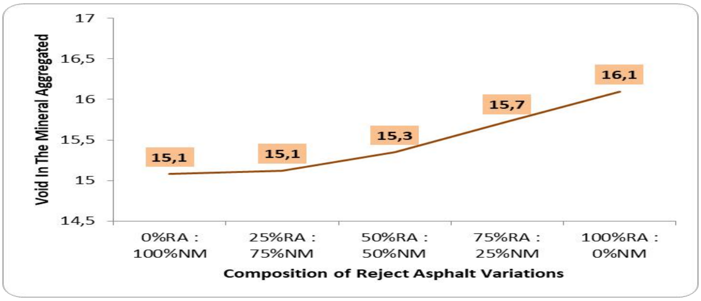


Fig.6. Graph of The Analysis Results of The Marshall Test on Modified Asphalt Regarding The VMA Value

Analysis of Marshall Quotient. The results of the MQ analysis are shown in Figure 8, where the value of the Marshall Quotient keeps rising from the variation of 0% RA : 100% NM to the variation of 100% RA : 0% NM. A higher Marshall Quotient value indicates that the asphalt mixture's stiffness (stability) and flexibility (flow) are better distributed. In addition, asphalt mixtures with a high Marshall Quotient are less likely to deform in hot weather and to crack when loaded with large loads. The best optimal Marshall Quotient value is found at the variation of 100% RA : 0% NM.

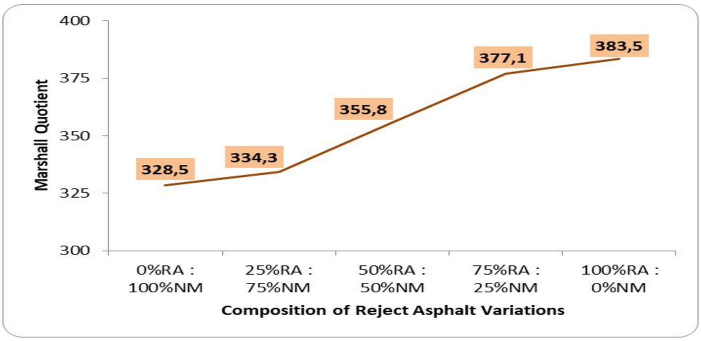


Fig.7. Graph of The Analysis Results of The Marshall Test on Modified Asphalt Regarding The Marshall Quotient Value

4.6 Discussion

Based on the marshal test analysis results, it can be concluded that all marshall characteristic values for the variations of 0% RA : 100% NM, 25% RA : 75% NM, 50% RA : 50% NM, 75% RA : 25% NM, dan 100% RA : 0% NM meet The General Specification of Bina Marga 2018 Revision 2. The comparison that exhibits the most optimum values is the ratio of 100% RA : 0% NM, with values of stability 1489.143 kg, flow 3.883 mm, VIM 4.738%, VFA 70.604%, VMA 16.097%, and marshall quotient (MQ) 383.470 kg/mm.

5 Summary

Based on discussion and analysis of the data from the testing in the research on the utilization of rejected asphalt as a substitute in asphalt concrete– wearing course (ac-wc) mixtures regarding marshall characteristic values, the researcher draws the following conclusions :

1. According to the results of the marshall test conducted with asphalt content variations of 5%, 6%, and 7%, the Optimum Asphalt Content (KAO) has been identified as 6.55%.
2. The Marshall test results utilizing rejected asphalt substitute show that the General Specification is met by the values for stability, flow, VIM, VFA, VMA, and MQ. 2018 Bina Marga Revision 2. The asphalt concrete wearing course (AC-WC) mixture can be modified by substituting the rejected asphalt from this study.
3. The best values that meet all the requirements of the General Specification of Bina Marga 2018 Revision 2 are found in the mixture with a ratio of 100% RA: 0% NM, with values of stability 1489.143 kg, flow 3.883 mm, VIM 4.738%, VFA 70.604%, VMA 16.097%, and MQ 383.470 kg/mm. This conclusion is based on the analysis of the Marshall test results using rejected asphalt as a substitute in the asphalt mixture.

References

1. Dwipayana, I.K., Comparison of Asphalt Content From Extraction Results in AC-BC Asphalt Mixture (Case Study: Simpang Semarapura – Watu Klotok). Hindu University of Indonesia (2018).
2. Gunawan, I.W., Thanaya, N.A., & Purbanto, I.G.R., Analysis of Hot Asphalt Mixture Characteristic Using Reject Asphalt Mixture. Scientific Jounal of Civil Engineering, Vol. 19, No.1 (2015).
3. Junianto, A., Ramadhan, R.M., Utari, J.P., & et al. Study of Rigid Pavement Structure Repair Using Pressure Grouting Method With Polyurethane and Epoxy (Case Study: Patriot – Perintis Kemerdekaan in Pekalongan City). Wahana Civil Enginering, State Polytechnic of Semarang (2019).

4. Martha, S.R. & Azzahra, R. : The Effect of Low Density Polyethylene (LDPE) Plastic Waste Addition as Substitution of Asphalt Mixture in AC-WC Pavement on Marshall Charateristic Value. State Polytechnic of Sriwijaya, Palembang (2021).
5. Mashuri, M. and Rahman, R.: The Effect of Asphalt Aging on The Charateristic of Asphalt Concrete Mixture in AC-WC Wearing Layer. Reconstruction of Tadulako, Civil Engineering Journal on Research and Development, pp. 47-56 (2020).
6. Sukirman, Silvia.: Hot Mix Asphalt Concrete. National Institute of Technology, Bandung (2016).