The Effect Of Natural Rubber (Latex) Addition On Hrs-Wc Asphalt Mixing With Fly Ash As Filler

Mohammad Erfan , Vega Aditama , Afriza Marianti S.

Abstract : Increasing traffic volume which is increasing rapidly can result in a level of damage such as deformation of the road surface layer caused by the influence of excessive traffic loads (overload), it is necessary to have a good quality pavement mixture with high durability or durability. Improve the quality of the asphalt mixture with the addition of natural rubber (latex) as an additive which is expected to improve the characteristics of the pavement. In addition to the addition of natural rubber, the use of rock ash filler is replaced with fly ash. This study used variations of asphalt content of 7%, 7.5%, 8%, with variations in the content of natural rubber in 7%, 8%, 9% of the total weight of asphalt and variations of fly ash filler 4%, 5%, 6% of the weight. specimen to find the optimum mixture. Based on the results of testing the characteristic value of Marshall with the addition of latex using fly ash filler in the HRS-WC mixture, it can be seen that the stability value has increased by 15.75% from before the addition of latex. The results of the correlation analysis are 0.99899, this indicates a strong relationship. Based on the results of hypothesis testing, it was found that the effect of variations in latex levels, variations in levels of fly ash, and variations in asphalt levels on the marshall parameter value.

Index Term: Asphalt, fly ash, latex

1. INTRODUCTION

Infrastructure development in Indonesia is increasing, one of which is the development of transportation facilities and infrastructure as an important role in various social and economic aspects. Roads are land transportation that is most often used to connect one place to another. Increasing traffic volume which is increasing rapidly can result in a level of damage such as deformation of the road surface layer caused by the influence of excessive traffic loads (overload), it is necessary to have a good quality pavement mixture with high durability. HRS / Lataston (Hot Rolled Sheet / Thin Layer Top Concrete) is a cover layer consisting of a mixture of unequally graded aggregate, filler and hard asphalt with a certain ratio [1] Latex is a type of natural rubber which has high resistance to crack and has high wear resistance. Improving the quality of the asphalt is to mix it with the addition of natural rubber (latex) as an additive which is expected to improve the characteristics of the pavement. Besides the addition of natural rubber, the use of filler gray stone is replaced with fly ash . Fly ash is a waste of fly ash from burning coal which is flowed from the combustion chamber through a boiler in the form of a burst of smoke. Fly ash from coal contains pazzolan elements which function is as cavity filling material. Based on the results of previous research, Anas Tahir (2009), Characteristics of Asphalt Concrete Mixture (AC-WC) Using Variations in Coal Fly Ash Filler Levels, the results showed that the higher the percentage of fly ash filler in the mixture, the lower the flow value, the stability value and optimum Marshall Quotient for fly ash filler additions ranged from 6% -7%. I Gusti Raka Puranto, et al (2016), Study of the Characteristics of Wear-Layer Concrete Asphalt Mixtures (AC-WC) Using 60/70 Penetration with the Addition of Latex, 6 variations of natural rubber (latex) were added, namely 0%, 2%, 4 %, 6%, 7% and 8%. The results showed that the higher the percentage of latex in the mixture, the higher the flow value, the stability value and the highest Marshall Quotient in the addition of 8%.[2] From the description above, the more natural rubber content increases, the higher the stability and marshall quotient, and the more use of fly ash filler results in lower flow values. Asphalt mixture with high flow values produces a plastic pavement layer so that the pavement will easily experience changes in wave-like shape, therefore this study will combine previous research using natural rubber and fly ash filler in the HRS-WC mixture with the title Effect of adding Natural Rubber (Latex) on HRS-WC Asphalt Mixture with Fly Ash as Filler. With the hope of producing a better HRS-WC pavement layer and extending the service life of the service plan.

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2. THEORETICAL REVIEW

HRS-WC (Hot Rolled Sheet-Wearing Course) Blend

According to Sukirman (2003), Lataston (Thin Layer Asphalt Concrete) is a gap-graded asphalt concrete. Latason is also often referred to as HRS (Hot Rolled Sheet). The most important characteristics of asphalt concrete in this mixture are durability and flexibility. In accordance with its function, lataston has 2 kinds of mixtures, namely lataston as a wear layer, known as HRS-WC (Hot Rolled Sheet-Wearing Course) with a minimum nominal thickness of 3 cm, lataston as a foundation layer, known as HRS-Base (Hot Rolled). Sheet-Base) with a minimum thickness of 3.5 cm.

Latex Characteristics

Latex is the sap released by the rubber pohen which is a colloid solution with rubber particles and not rubber suspended in a medium that contains a lot of various substances. Natural rubber is a hydrocarbon which is a macro molecule of polyisoprene (C_5H_8). The polyisoprene chain forms a "Cis" configuration with an orderly spatial arrangement, so that the chemical formula of 1.4 CIS polyisoprene has elastic properties. The elasticity is related to the viscosity or plasticity of the rubber. Latex is obtained from the sap of several types of rubber plants by injuring the bark of the tree so that the tree will respond which produces more latex. At normal temperatures, rubber is amorphous. At low temperatures the rubber will crystallize. As the temperature increases, the rubber will expand. A decrease in temperature will bring back this swelling state. This is the reason why rubber is elastic. Rubber consists of chemical compounds called hydrocarbons. Hydrocarbons from natural rubber are composed of long chains containing 1000-5000 isoprene units. The chain is a polyisoprene (C5H8) chain. The arrangement of such spaces makes rubber elastic. In each isoprene bond there is a methylene group double bond, this group is a reactive group that can cause oxidation rejection so that it can damage rubber (Hofman, 1989). According to Jaelani, akhmad (2017, p. 37) in his thesis "Research Study on the Utilization of Lapindo Mud as a Combination Filler of Rock Ash in Asphalt Concrete" the steps to determine the value of Marshall characteristic are formulated as follows:

a. Stability.
The stability value of the test object was obtained from the stability watch reading during the Marshall test. These results are matched with the proving ring calibration numbers in units of lbs or kilograms and still have to be corrected with the correction factor used by the thickness of the specimen.

b. Flow (fatigue)
Flow value requirements between 2-4 mm. Low flow values will cause the mixture to become stiff so that the pavement layer becomes prone to crack, while the mixture with high flow values will produce a plastic pavement layer so that the pavement will easily experience changes in wave-like shape.

c. Cavity between mineral aggregates (VMA)
The cavity between the mineral aggregates is the number of pores between the aggregate grains in the solid asphalt concrete, expressed as a percentage. The pores between the aggregates in solid asphalt filled with asphalt (VFA). This value shows the percentage of mixed cavity containing asphalt, the value will increase based on the increase in asphalt content to a certain extent, namely when the cavity is full.

d. Cavity in the mixture (VIM)
VIM is the percentage of cavities present in the total mixture. The VIM value in percent can be obtained by the following formula:

e. Marshall Quotient
The Marshall Quotient value is 200 kg / mm to 350 kg / mm. the characteristic value of Marshall is obtained by the following formula:

3. RESEARCH METHODOLOGY

This study uses the use of natural rubber (latex) and aggregate as an additive to the HRS-WC (Hot Rolled Sheet-Wearing Course) mixture, penetration of 60/70 asphalt and fly ash filler with testing guidelines referring to AASHTO (The American Association of State Highway standards and Transportation Officials), BS (British Standard), ASTM (American Society for Testing and Materials).
Study Phase
This research was conducted by identifying road pavement problems that often occur, one of which is the cracking of the pavement layer caused by traffic vehicle loads and due to weather factors. Therefore, it is necessary to conduct research to improve the quality of the asphalt mixture. At the literature study stage, references are obtained from research reports and previous research journals that have been conducted with related research topics.In a study, the sample population is very important for the level of accuracy in testing. For this research, the sample size is planned as follows:

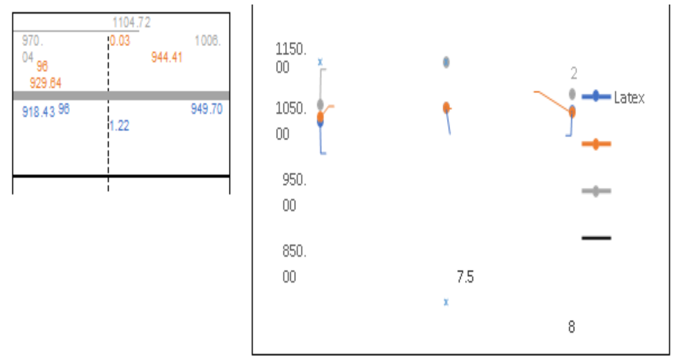


Figure 1 . *Relationship between Asphalt Levels and Stability Using Fly Ash*

Table 1.*Number of Samples at 7% Asphalt Levels*

Latex %	Fly ash filler %			Number of Samples
	4%	5%	6%	
7%	5 pieces	5 pieces	5 pieces	15 pieces
8%	5 pieces	5 pieces	5 pieces	15 pieces
9%	5 pieces	5 pieces	5 pieces	15 pieces
Total				45 pieces

Table 2.*Number of Samples at 7.5% Asphalt Content*

Latex %	Fly ash filler %			Number of Samples
	4%	5%	6%	
7%	5 pieces	5 pieces	5 pieces	15 pieces
8%	5 pieces	5 pieces	5 pieces	15 pieces
9%	5 pieces	5 pieces	5 pieces	15 pieces
Total				45 pieces

Table 3.Number of Samples at 8% Asphalt Levels

Latex %	Fly ash filler %			Number of Samples
	4%	5%	6%	
7%	5 pieces	5 pieces	5 pieces	15 pieces
8%	5 pieces	5 pieces	5 pieces	15 pieces
9%	5 pieces	5 pieces	5 pieces	15 pieces

Total	45 pieces

Data collection
Data were collected from the test results of asphalt, aggregate, a mixture of asphalt and aggregate for sealing the Hot Rolled Sheet - Wearing Course (HRS-WC). Based on the requirements and specifications that have been determined and tested the stability, flow, VIM, VMA, and Marshall Quotient values for all test objects using the Marshall tool. Retrieval of data on the Marshall tool is done by recording the magnitude of the force obtained by destroying the test object. From the Marshall test, the optimum mixture will be obtained.

Technique of Adding Natural Rubber to the Mixture
In this study, the authors used dry method (dry process), which is a method of mixing where the latex is added to the aggregate that has been mixed with asphalt at 1400C, compaction is carried out at 1210C.

Finding Planned Asphalt Content (Middle / Ideal)
The total asphalt content in the asphalt concrete mixture is the effective asphalt content which wraps or covers the aggregate grains, fills the pores between aggregates, plus the asphalt content which will be absorbed into the pores of the aggregate grains. Middle / ideal asphalt content is used for the mixed design in the laboratory. Middle asphalt content is the mean value of the range of asphalt content in the mixture specification. If the plan (middle / ideal) asphalt content is obtained is a%, then the test object is made for different asphalt content of 0.5% where 2 variations are less than the middle asphalt content value. For example, if the middle asphalt content is 7.5%, then a 7%, 7.5%, 8% mixture is made.

Research variable
Marshall test on the HRS-WC mixture using two variables, including the following:
1. The independent variable, namely by mixing natural rubber using fly ash filler in the HRS-WC mixture.
2. Dependent variables, namely the results of the Marshall test include:
    a. Stability Value
    b. Flow Value
    c. Cavity value in mix (VIM)
    d. Cavity value in aggregate (VMA)
    e. Marshall Quotient (MQ)

Stability Data Validation
Data validation is an activity carried out to test a test object whether the test object is correct or to collect data. For more details, validation is a testing activity. While validity is the result of testing the truth of a test object.

Data analysis
In this study, the data that have been obtained from the test results are then analyzed using the confidence interval method. In using this confidence interval method, there are usually two words, namely "true" and "false". In other words, it can be interpreted that the word "true" means that the data meets the requirements in the confidence interval method while the word "false" can be interpreted the other way around, that is, it has not met the requirements in the confidence interval method. In the confidence interval method, at least 4 samples of specimens made from each level must have 3 samples that meet the standard of the confidence interval method. In this study using a 95% confidence interval, with an error tolerance of around 5%.

ANALYSIS OF RESULTS AND DISCUSSION

The data on the HRS-WC mixture without latex and fly ash filler were taken from the optimum level data and for the addition of latex content and fly ash filler was used in the optimum mixture state. For comparison, see the table below:

Table 4.*Comparison between HRS-WC Mixture without Latex and Filler with HRS-WC Mixture Using Latex and Filler*

Mixed Characteristics	No latex and filler fly ash	With the optimum mixture of latex and fly ash filler	Influence	HRS-WC requirements	Information
Stability (kg)	954.38	1104.72	Increase (15.75 %)	Min. 450	Qualified
Flow (mm)	4.20	3.40	Decrease (19.05 %)	Min. 3	Qualified
VIM (%)	4.03	4.85	Increase (20.35 %)	4 - 6	Qualified
VMA (%)	19.08	19.77	Increase (3.62%)	Min. 18	Qualified
MQ (kg / mm)	229.20	317.67	Increase (38.6%)	Min. 250	Qualified
VFA (%)	79.90	75.24	Decrease (5.83)	Min. 68	Qualified

The Effect of Adding Latex to the HRS-WC Mixture (Hot Rolled Sheet - Wearing Course)
Graph of the relationship between levels of latex mixture using fly ash filler between the stability values of the HRS-WC mixture (Hot Rolled Sheet - Wearing Course)

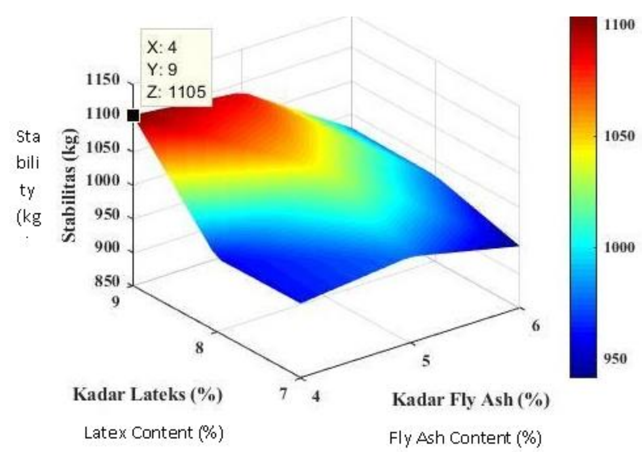


Figure 2 . *Relation of 7.5% Asphalt Levels with Stability (3D)*

Based on the research results from Figures 1 and 2, it can be seen that the addition of latex has increased to the optimum latex mixture content. The stability value increased until the optimum latex content was reached, namely 1104.72 kg. The results of hypothesis testing for stability obtained that Ho is rejected and Ha is accepted (Fcount = 6.913> Ftable = 3.01). This indicates that there is an effect of variation in latex mixture levels on the stability value. Based on the regression analysis for stability, the equation y = 1,0232 + 81,241x1 + (-41,919) x2 + 47,683 x3 is obtained with a correlation coefficient value of 0.99899. This indicates that there is a strong or close relationship because the correlation coefficient value approaches the number 1.

Flow (Melt)

The graph of the relationship between the levels of the latex mixture using fly ash filler between the flow values of the HRS-WC (Hot Rolled Sheet - Wearing Course) mixture can be seen in graphs below:

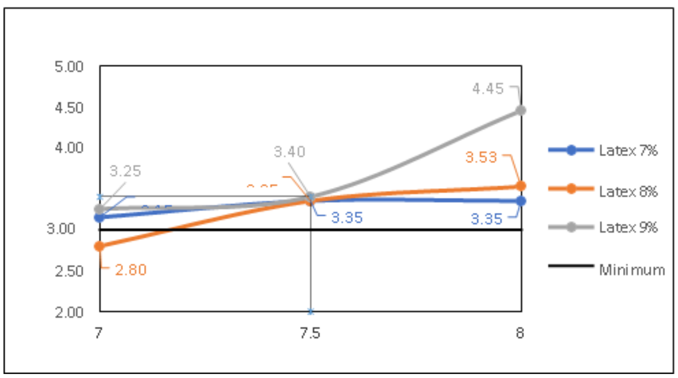
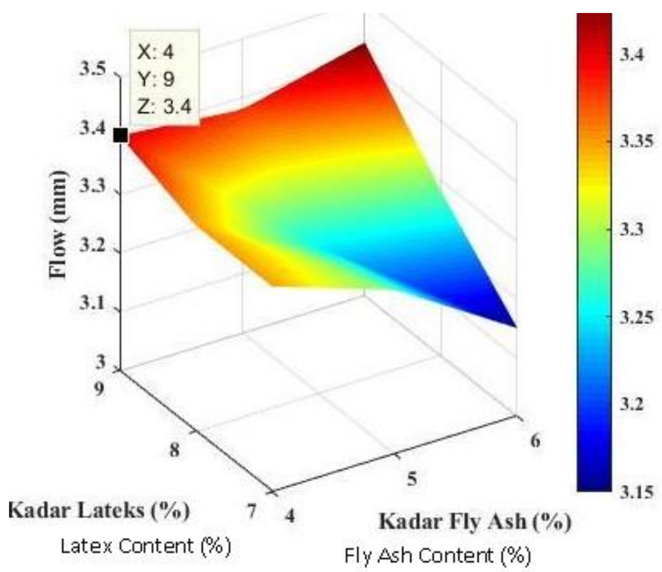


Figure 3 . *Relationship between Asphalt Levels and Flow Using Fly Ash .*

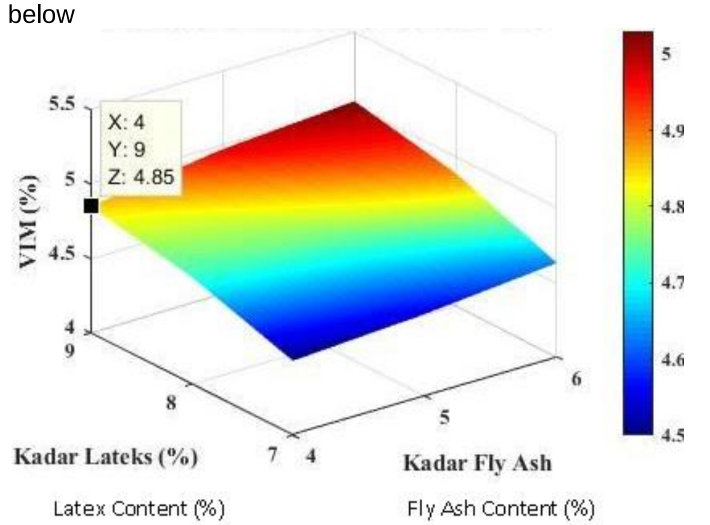


Graph 4 . Relation of *7.5% Asphalt Content with Flow (3D Matlab)*

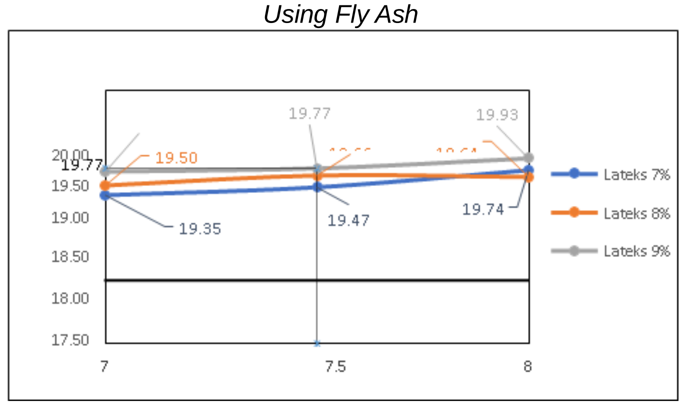
Based on the research results from graphs 3 and 4, it can be seen that each addition of latex content the higher the flow value obtained. The results of hypothesis testing for flow obtained that Ho was rejected and Ha was accepted (Fcount = 13.440> Ftable = 3.01). This indicates that there is an effect of variation in the latex mixture levels on the flow value. Based on the regression analysis for Flow, the equation obtained is y = -0.00252 + 0.322499 x1 + (-0.08421) x2 + 0.172481 x3 with a correlation coefficient value of 0.99831. This indicates that there is a strong or close relationship because the correlation coefficient value is close to 1.

Void In The Mix (VIM) / Cavity Air In The Mix

The graph of the relationship between the levels of the latex mixture using fly ash filler between the VIM values of the HRS-WC (Hot Rolled Sheet - Wearing Course) mixture can be seen in the graphs 4.23 and 4.24 below



Graph 5 . *Relationship between Asphalt Levels and VIM Using Fly Ash*



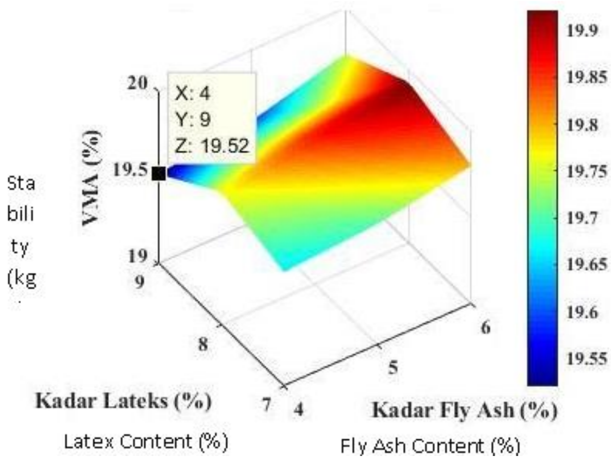
Graph 6 . *Relationship of 7.5% Asphalt Content with VIM (3D Matlab)*

Based on the research results from graphs 4.23 and 4.24, it can be seen that each addition of latex content the higher the VIM value obtained and each addition of asphalt content the VIM value decreases. The results of hypothesis testing for VIM show that Ho is rejected and Ha is accepted (Fcount =

10.655> Ftable = 3.01). This indicates that there is an effect of variations in the levels of latex mixture on the VIM value. Based on the regression analysis for VIM, the equation y = 0.0352 + (-0.21495) x1 + 0.2589 x2 + 0.627491 x3 is obtained with a correlation coefficient value of 0.986278. This indicates that there is a strong or close relationship because the correlation coefficient value is close to 1.

Void In Mineral Aggregate (VMA) / Cavity Between Aggregate Minerals

The graph of the relationship between the levels of the latex mixture using fly ash filler between the VMA values in the HRS-WC (Hot Rolled Sheet - Wearing Course) mixture can be seen in graphs 7 and 8 below:



Graph 7 . *Relationship between Asphalt Levels and VMA Using Fly Ash*

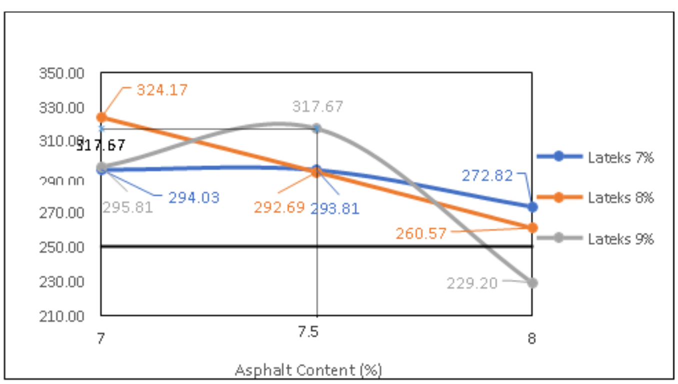


Figure 8 . *Relationship of 7.5% Asphalt Levels with VMA (3D Matlab)*

Based on the research results from graphs 4.25 and 4.26, it can be seen that each addition of latex content the higher the VMA value obtained and each addition of asphalt content, the VMA value is getting higher. The results of hypothesis testing for VMA show that Ho is rejected and Ha is accepted (Fcount = 9.055> Ftable = 3.01). This indicates that there is an effect of variations in latex mixture levels on the VMA value. Based on the regression analysis for VMA, the equation obtained is y = 0.03421 + 1.8293 x1 + 0.25145 x2 + 0.5832 x3 with a correlation coefficient value of 0.99925. This indicates that there is a strong or close relationship because the correlation coefficient value is close to 1.

Marshall Quotient (MQ)

The graph of the relationship between the levels of the latex mixture using fly ash filler between the MQ value of the HRS-WC (Hot Rolled Sheet - Wearing Course) mixture can be seen in charts 9 and 10 below:

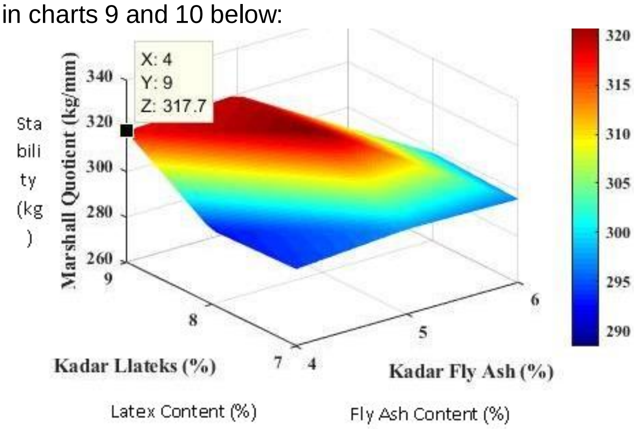
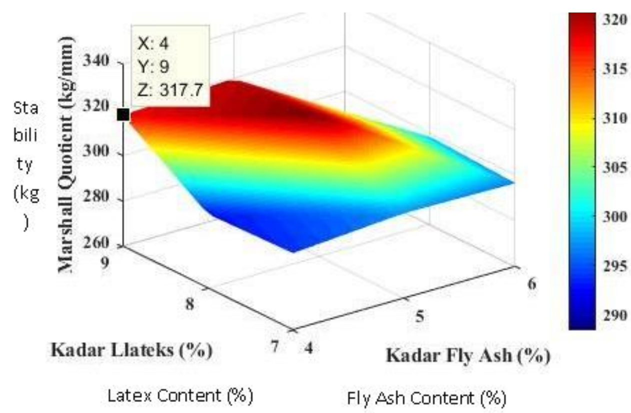


Figure 9 *. Relationship between Asphalt Levels and MQ Using Fly Ash*

(2D Excel)

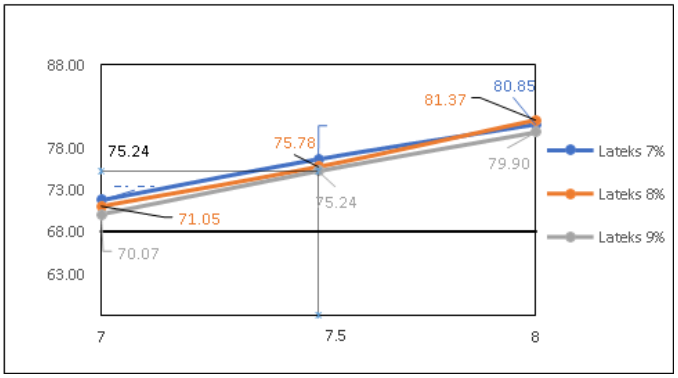


Gambar 10 . *Relationship of 7.5% Asphalt Levels with MQ (3D Matlab)*

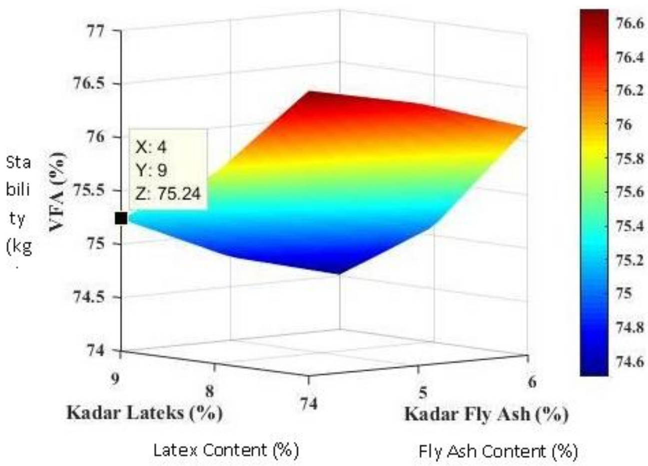
Based on the research results from graphs 4.27 and 4.28, it can be seen that the optimum marshall quotient content is at 7.5% asphalt, 8% rubber, and 4% fly ash with a value of 317.67. The results of hypothesis testing for MQ show that Ho is rejected and Ha is accepted (Fcount = 3.864> Ftable = 3.01). This indicates that there is an effect of variations in latex mixture levels on the VMA value. Based on regression analysis for VMA it is obtained that the equation y = 1.0564 + 23.8322 x1 + 9.8948 x2 + 7.2915 x3 with a correlation coefficient value of 0.99496. This indicates that there is a strong or close relationship because the correlation coefficient value is close to 1.

Void Filled With Asphalt (VFA) / Cavity Filled Asphalt

The graph of the relationship between the levels of the latex mixture using fly ash filler between the VFA values of the HRS-WC (Hot Rolled Sheet - Wearing Course) mixture can be seen in the graphs 4.29 and 4.30 below:



Graph 11. *Relationship between Asphalt Levels and VFA Using Fly Ash*



Graph 12. *Relation of 7.5% Asphalt Content with VFA (3D Matlab)*

Based on the results of the research from graphs 4.29 and 4.30, it can be seen that each addition of latex levels, the VFA value obtained decreases. The results of hypothesis testing for VFA show that Ho is rejected and Ha is accepted (Fcount = 19.716> Ftable = 3.01). This indicates that there is an effect of variations in latex mixture levels on the VMA value. Based on the regression analysis for VFA, the equation obtained is y = 0.022485 + 10.5313 x1 + 0.18805 x2 + (-0.53217) x3 with a correlation coefficient value of 0.999925. This indicates that there is a strong or close relationship because the correlation coefficient value is close to 1.

CONCLUSION

Based on the results of testing the characteristic value of Marshall with the addition of latex using fly ash filler in the HRS-WC mixture, it can be seen that the stability value has increased by 15.75% from before the addition of latex. The results of the correlation analysis are 0.99899, this indicates a strong relationship. Based on the results of hypothesis testing, it was found that there was an effect of variations in latex levels, variations in levels of fly ash, and variations in asphalt levels on the marshall parameter value. The value of the optimum mixture content is the asphalt content of 7.5%, 4% fly ash content, and 9% latex content of the total weight of the test object.

Based on the marshall parameter value above, it can be stated that the added latex material is appropriate to be mixed into the HRS-WC mixture, because it is still at the minimum and maximum requirements specified in the General Specifications of DPU Bina Marga 2018.

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