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ANALYSIS OF LASTON AC-WC MIXED WITH RECLAIMED ASPHALT PAVEMENT (RAP) AND ADDING STYROFOAM BASED ON MARSHALL PARAMETERS

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A RTICLE INFO A BSTRACT

One option that has the potential to be applied to road roughness is the reuse of Reclaimed Asphalt Pavement (RAP) material. RAP material can be reused by adding new asphalt and aggregate in accordance with the composition of the mixture so that it is expected to obtain the quality as planned. One of the efforts made to improve the quality of the RAP asphalt mixture is to use modified asphalt with additional material in the form of styrofoam. The use of styrofoam in asphalt is expected to improve the technical properties of a mixture. This research was conducted with variations in asphalt content of 5%, 5.5%, 6%, 6.5%, and 7%. bitumen content obtained from extraction is 6.28%, and the use of RAP is 30%. Next, make specimens for the standard marshall test at variations in Styrofoam levels of 0%, 6.5%, 6.75% and 7% on each KAA and the KAO value is 6.75% of the weight of the test object. The results of the Marshall test showed the optimum stability value for adding that the effective percentage of Styrofoam was found in a mixture of 7% Styrofoam, which was 4181 kg with an increase of 4,700 from a mixture of laston without Styrofoam addition. The flow value is 2.76 mm, while the Marshall Quotient (MQ) value has increased compared to without the use of Styrofoam with a value of 1.513. From the results of mixed analysis using RAP with the addition of optimum Styrofoam, it can improve the performance of the laston AC-WC mixture

KEYWORDS Asphalt Pen. 60/70, AC-WC, Styrofoam, RAP, Marshall

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INTRODUCTION

Civil buildings that use asphalt as the main material are roads. The role of roads is very important in everyday life, namely connecting one place to another , increasing travel time and facilitating traffic flow. Pavement that uses asphalt as the main component is flexible pavement (Sulianti, Ibrahim, Subrianto, Monita, & Medici, 2019) (Listiani, Sembiring, & Rahman, 2015)(Motlagh, Kiasat, Mirzaei, & Birgani, 2012).

Flexible pavement is a type of pavement other than rigid and composite pavements. Flexible pavement consists of several layers of subgrade, subbase layer, top foundation layer and surface layer (Adly, 2016). The surface layer is a mixture of asphalt, coarse aggregate and fine aggregate, in the process of mixing and compacting it is carried out at a predetermined hot temperature with a ratio of asphalt, fine aggregate, and coarse aggregate that has been determined through mix design planning (Nono, n.d.). One of the efforts to improve the performance of the surface layer flexible pavement is to add additional materials to the pavement mixture (Abinaya, Clement, & Shanmugam, 2016).

For periodic road maintenance, in the implementation process using a Cold Milling Machine (CMM) by dredging/peeling uneven roads is a way of handling road damage, but the results of stripping the asphalt surface layer, namely Reclaimed Asphalt Pavement (RAP) are not used properly (Al-Haydari & Masued, 2017). The advantages that can be obtained from the application of this recycling technology are material savings, maintaining road elevation, not adding dead loads to the road (Arianto, Saleh, & Anggraini, 2019).

In some countries, styrofoam has been applied as an additive to asphalt mixtures. For example in Baghdad, Iraq, styrofoam has been used in several roads and can reduce cracking and rutting, reduce aging, increase skid resistance.

Bitumen is an adhesive material (viscous cementitious material), black or dark in color, in solid or semi-solid form, which can be obtained in nature or as a result of production. Bitumen can be asphalt, tar, or pitch (Arianto et al., 2019). Asphalt can be obtained in nature or residue from petroleum refining, tar is the result of condensate in the destructive distillation of coal, petroleum, wood, or other organic materials, while pitch is obtained as residue from fractional distillation of tar (Noris & Mahardi, 2017) (Officials, 1993). Tar and pitch are not obtained in nature, but are chemical products. Of the three types of bitumen mentioned above, only asphalt is commonly used as a pavement-forming material, so bitumen is often referred to as asphalt (Baker, Abendeh, Abu-Salem, & Khedaywi, 2016) (PERDANA, Kurnia, & Pataras, 2022).

AC-WC Wearing Course or wear layer is a layer above the foundation. AC-WC functions as a surface layer that is resistant to weather, shear forces and wheel pressure and provides a waterproof layer that can protect the layer underneath from water seepage (Falderika, 2021).

RAP is a pavement material containing asphalt and aggregate that has been dismantled and is no longer used (Institue, 1997). To save materials and

energy, recycling is an attractive option to rehabilitate pavements (Arianto et al., 2019).

Aggregate is a mixture of gravel, crushed stone and other materials derived from natural minerals or rocks (Putrowijoyo, 2006). In the road pavement structure, the aggregate component is the main component with a percentage value of 90-95% based on weight percentage, or 75-85% aggregate based on volume percentage (Falderika, 2021)(Putrowijoyo, 2006) .

Styrofoam or its general name thermoplastic is a type of plastic commonly used for food and beverage packaging. Styrofoam is divided into 2 parts, namely foamed Styrofoam (FS), and Expanded Styrofoam (EPS), or also known as Styrofoam foam, which is colloquially known as Styrofoam. Styrofoam or also known as expanded polystyrene is produced from styrene (C6H5CH9CH2), which has a phenyl group (six carbon rings) arranged irregularly along the carbon line of the molecule (Noris & Mahardi, 2017).

RESEARCH METHOD

The method used in this research is the experimental method. The research was conducted in a laboratory laboratory, with the research material in the form of RAP (Reclaimed Asphalt Pavement) with the addition of Styrofoam as much as 0%, 6.5%, 6.75% and 7% of the asphalt weight. The test results based on Marshall characteristics obtained results in the form of stability values, flow, voids in the mixture (VIM), voids filled with asphalt (VFA), voids in aggregate (VMA) and then the Marshall Quotient can be calculated. All stages can be seen in the chart below (Farhan, 2019) (Rao, Parameshwaran, & Ram, 2018).

The research planning stage so that research runs smoothly, can be carried out properly, it is necessary to have a well-planned implementation stage.

- Stage of preparation of tools and materials.
- Material Inspection Phase (Asphalt, Styrofoam, RAP and other Aggregates).
- Mix Planning Phase (Styrofoam).
- Marshall Testing Phase to determine the optimum asphalt content (KAO).
- Stage of Making Test Objects on KAO for Analysis of the Effect of Styrofoam mixture on Marshall Properties.
- Testing Phase of Test Objects on KAO for Analysis of the Effect of Styrofoam mixture on Marshall Properties.
- Conclusion

RESULTS AND DISCUSSION

The data obtained from the research and testing of the test object A that has been carried out in the laboratory and = data = is processed to determine the value of Marshall properties.

A. Material Test

The results of the aggregate test are in accordance with the predetermined __-test method and use the required specifications.

Table 1 Aggregate Test Results

No	Test Type	Coarse Aggregate	Fine aggregate
1	West Type Bulk	2.3	2.53
2	SSD Density	2.52	2.82

3	Apparent Density	2.95	3.58
4	Effective Specific Gravity	2.62	
5	Flatness No.1/2	3.365810452	
6	Flatness No.3/8	14,67889908	
7	Oval No 1/2	12.70949721	
8	No. 3/8	29886364	
9	Abrasion	99.9%	
10	Sand Equivalent		77.58%

Here are the results of the Maspal test in the laboratory

No	Sample	Sample Weight After Extraction	Asphalt Level
1	West Sample Extraction 1	690	1.42%
2	West Sample Extraction 2	670	4.28%
3	West Sample Extraction 3	656	6.28%

B. Determination of Optimum Asphalt Content (KAO)

From the Marshall test that has been carried out, it is obtained = result = - Optimum Asphalt Content (KAO) of 6.75 % and 12 test objects are made again.

Table 5 Determination of Optimum Asphalt Content

Specification		50%	55%	60%	65%	70%
Stability	Min 800					
Flow(mm)	2-4					
MQ (Kg/mm)	250					
VIM (%)	3-5					
VMA (%)	Min 14					
VFA (%)	Min 65					

C. Analysis of the Effect of Adding Styrofoam to KAO on Marshall . Parameters

The following are tables and graphs that state the relationship of Marshall parameters with asphalt content and plastic content.

1. The Relationship of Adding Styrofoam to KAO to VIM

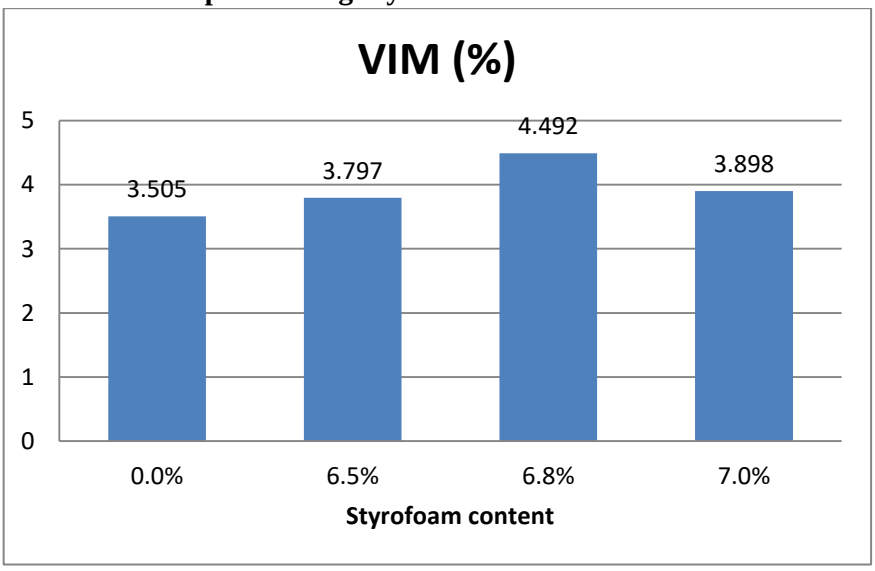

Figure 2 The relationship between the addition of Styrofoam on KAO to VIM

The VIM (Void In Mix) value in the asphalt mixture without styrofoam meets the specifications, as well as the asphalt mixture with the addition of styrofoam . The highest value of the cavity in the mixture was found at 6.75 % styrofoam with a VIM value of 4.492.

2. The Relationship of Adding PP Plastic to KAO to VMA

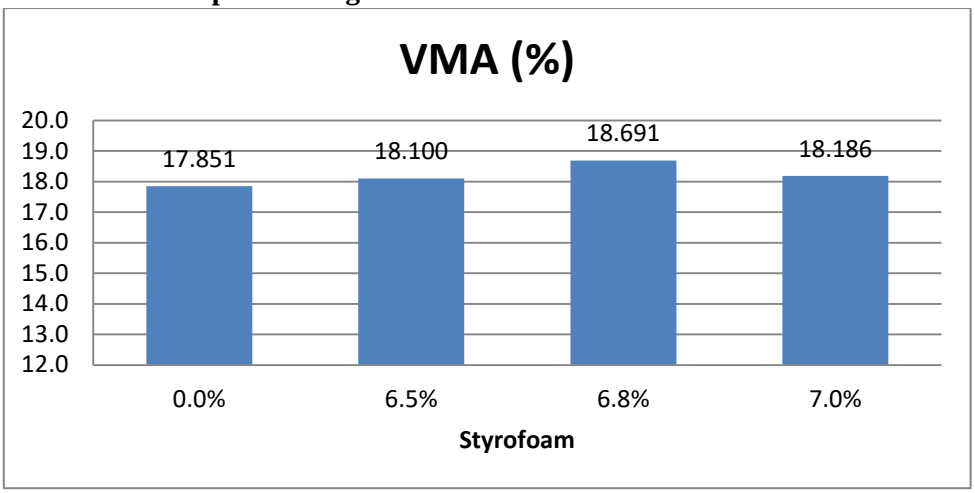

Figure 3. The relationship between the addition of Styrofoam in KAO to VMA

The VMA (Void Mineral Aggregate) value of the asphalt mixture without Styrofoam and with the addition of Styrofoam, all meet the specifications of Bina Marga, which is a minimum of 14mm. Graded aggregates provide small voids between aggregate grains. This is because the Styrofoam layer has covered and partially closed the cavity between the grains. Directly proportional to the value of VIM, for the highest value there is a styrofoam content of 6.75% with a value of 18.691 .

3. Relationship of Addition of Styrofoam to KAO to VFA

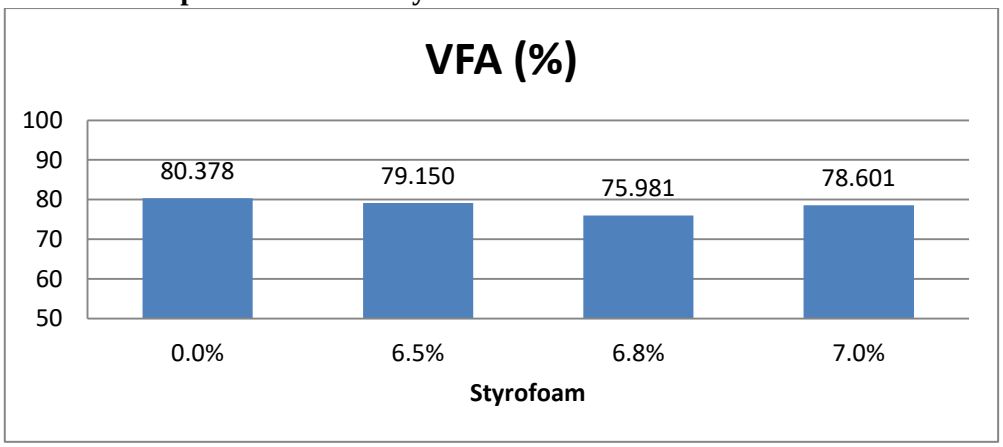

Figure 4 Relationship of Addition of Styrofame to KAO to VFA

The value of VFA (Void Filled Asphalt) of asphalt mixture without Styrofoam and mixture with Styrofoam addition fully meets the specifications, at 0% Styrofoam content 80.378 and at 6.75% Styrofoam 75.981. The higher the VFA value, the higher the cavity in the mixture filled with asphalt, so that the asphalt mixture is impermeable to water and air.

4. The Relationship of Adding Styrofame to KAO to Flow

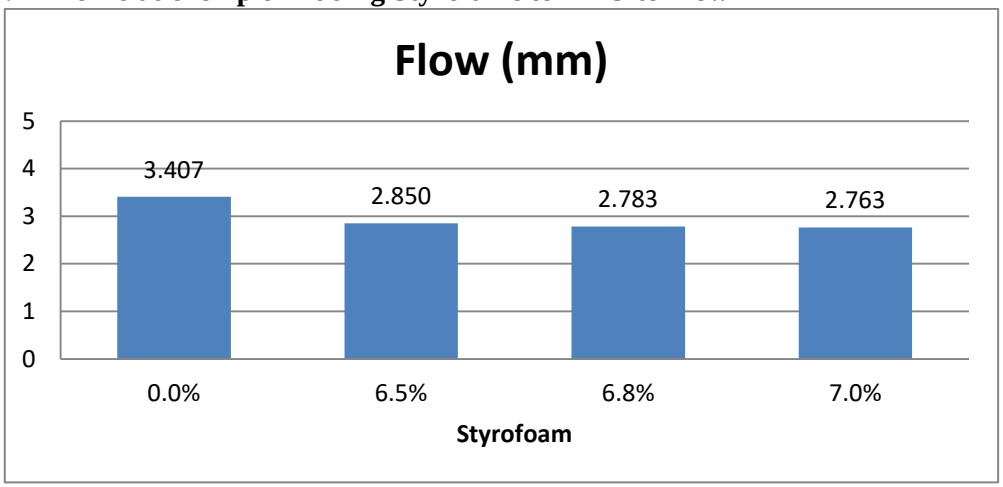

Figure 5 Relationship of Addition of Styrofoam to KAO to Flow

The flow value of the asphalt mixture without and with the addition of Styrofoam mixture , all meet the specifications. The higher the addition of the Styrofoam mixture, the lower the flow value obtained. In addition to the data obtained a decrease in the value of flow in the use of a mixture of styrofoam .

5. Relationship of Addition of Styrofoam to KAO to Stability

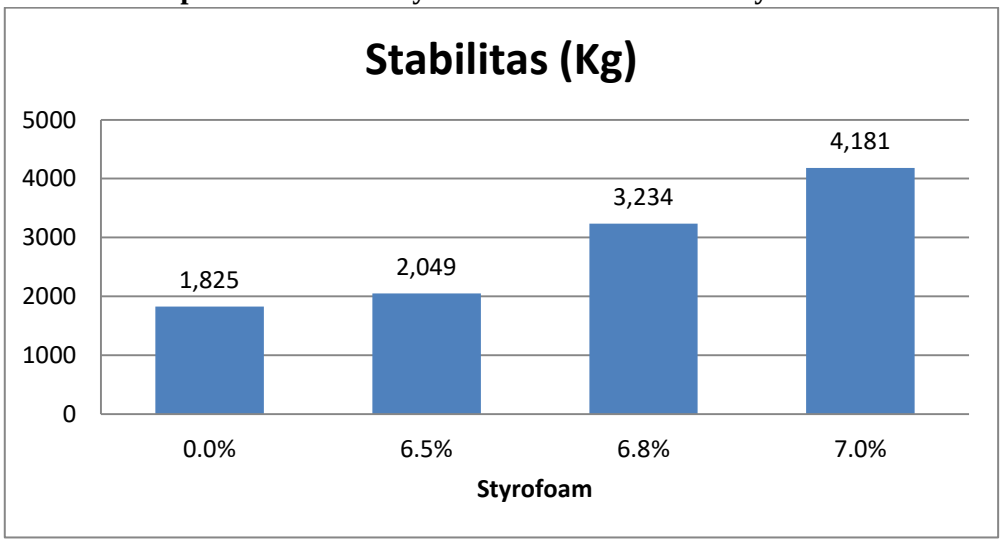

Figure 6 Relationship of Addition of Styrofoam to KAO to Stability

Stability values in asphalt mixtures without and by using the addition of Styrofoam content all meet the specifications. The addition of Styrofoam to the asphalt mixture causes an increase in the stability value, meaning an increase in the bonding power between asphalt and aggregate. In the graph beside, we can see that the more use of Styrofoam , the higher the stability value obtained.

6. The Relationship of Addition of Styrofoam to KAO to Marshall Quotient

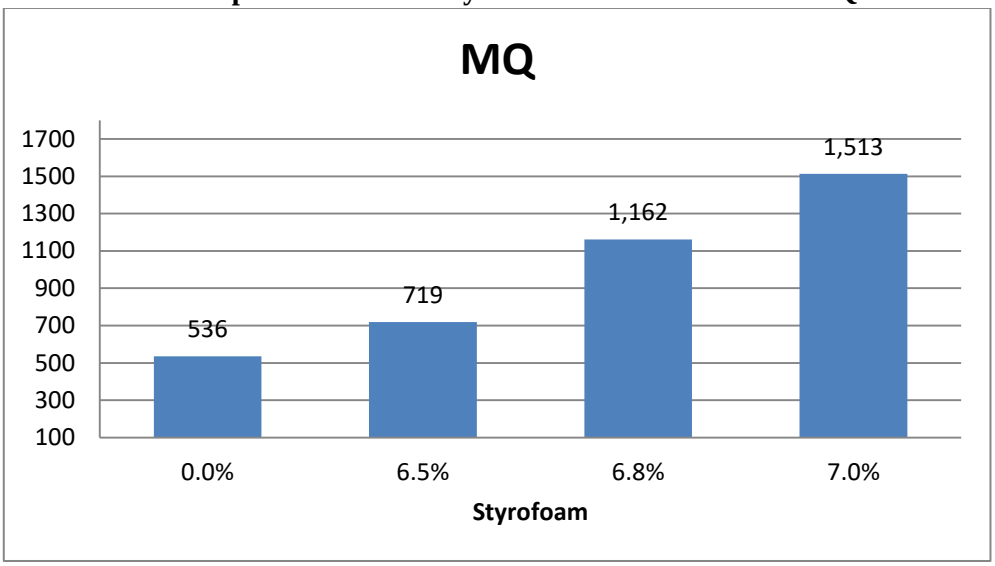

Figure 7 The relationship between the addition of Styrofoam in KAO to the Marshall Quotient

The MQ value of the asphalt mixture without or with the addition of Styrofoam all met the specifications. The increasing value of MQ indicates the asphalt mixture has a high stability value. The high value of MQ indicates the value of the mixture will be more rigid.

CONCLUSION

The asphalt used meets the requirements of all types of material inspection. The asphalt used is asphalt with a penetration of 60/70 with KAA values used are 5%, 5.5%, 6%, 6.5% and 7%. For the level of determination of KAO itself, the value is 6.75 % of the weight of the test object. And this study uses RAP So the final conclusions of this study are: The influence of the RAP material used in the Laston AC-WC mixture for the values of Stability, Flow, VMA, VIM, VFA and also MQ is partly still above the Bina Marga standard at 6.5% and 7% asphalt content and gets an KAO value of 6 ,75%. The use of Styrofoam also has an effect on the mixture, as seen from the graph which shows that the more the percentage of Styrofoam is used , the greater the stability value and vice versa for the flow value to decrease. The effective percentage of Styrofoam found in the mixture of Laston AC-WC and RAP is at 7% and 7% Styrofoam content with asphalt content of 6.5% and 7%, because the value of Stability Value is higher, the value of Flow, VMA, VIM, VFA and also MQ is still within the standards of Bina Marga (2018).

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