Characteristics of marshall additional hot rolled sheet base rattan fiber

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Abstract. All Lataston or HRS structure consists of a mixture of coarse aggregate, fine aggregate, filler and binding material in the form of hot asphalt mixture. The relatively high asphalt content of the mixture aims to increase flexibility, durability and resistance to melt and not easily cracked. The mechanical properties of rattan are related to the ability to withstand external forces, including: compressive strength, fracture, stiffness, tenacity, tensile strength, shear, splitting and durability. This study aims to examine the characteristics of Marshall with the addition of rattan fiber as a mixture of gap graded Hot Rolled Sheet Base. Tests carried out on the characteristics of Marshall. The test results show the addition of rattan fiber with levels of 0%, 2%, 4%, 6%, 8% and 10% and asphalt content of 6.35% obtained VIM values with an increase of an average of 0.08%, Stability increases rattan fiber and will decrease if more rattan fiber is used, Flow will decrease along with the addition of rattan fiber and increase the value of flexibility if more rattan fiber is used, VMA increases with increasing rattan fiber used 0.07%, so that each additional rattan fiber will increasing VMA, VFB decreases with increasing rattan fiber used, durability testing results indicate the addition of rattan fiber will increase resistance to the load.

1. Introduction

Lataston or HRS structure consists of a mixture of coarse aggregate, fine aggregate, filler and binding material in the form of hot asphalt mixture. The relatively high asphalt content in the mixture aims to increase flexibility, durability, and resistance to melting and not easily cracked. or 80 mixed in a hot state with a thick thickness between 2.5 - 3 cm. HRS consists of two types, namely HRS type A (Wearing Course) and HRS type B (Base course) [1]. Lataston consists of two kinds of mixtures namely foundation layer lataston (HRS-Base) and surface lataston (HRS-WC) with the maximum aggregate size of each mixture is 19 mm. HRS-Base has a proportion of coarse aggregate fraction greater than HRS-WC. A filler is a group of aggregate minerals which generally pass the No. filter 200 [2]. This filler will fill the cavity between coarse aggregate particles in order to reduce the size of the cavity, increasing the density and stability of the mass [3]. The fillers can use limestone dust, Portland cement, fly ash, cement kiln ash or other non-plastic material, as long as the passage passes through filter No. 200 equal or more than 75% by weight.

The use of rattan fiber for the construction of the main road mixed with Hot Rolled Sheet is not yet popular in Indonesia, but this material is mostly produced from rattan industry waste in Indonesia [4]. The physical properties of rattan are the properties that can be observed in plain sights such as color, gloss, odor, taste, weight, hardness/elasticity, wide diameter and others. The structural properties of rattan are not yet known because there is no specific research on the properties of these structures that
can be used as indicative indications are pores. The mechanical properties of rattan are related to the ability to withstand external forces, including: compressive strength, fracture, stiffness, tenacity, tensile strength, shear, splitting and durability. The researched on the Effect of Rattan Fiber Addition on the Stability of Hot Rolled Sheet-WC Mixture results obtained by Marshall Immersion obtained an average value for the immersion index that is 94.77% [5]. Based on this value the road pavement that uses Rattan Fiber as added material for Lataston HRS-WC is resistant to temperature and water immersion [6].

2. Methodology

2.1. Location

The material in this study consisted of aggregates, asphalt, and mixed additives of laaston (rattan fiber). Coarse and fine aggregates are taken from the Jeneberang River, Bili-bili District, Gowa Regency, South Sulawesi Province. Rattan fiber is taken from the forest in Messawa Sub district, Messawa Sub district, Mamasa Regency, West Sulawesi Province. Rattan is taken directly from its roots and has an old age so it has a strong endurance. The procedure for taking rattan in the forest is then cut into pieces with a maximum size of 2 cm, then dried after that and then crushed and turned into rattan fiber. Makassar. The asphalt that will be used is asphalt with 60/70 penetration.

![Location of sampling](image1)

**Figure1.** Location of sampling.

2.2. Experimental program

The composition of the mixture is based on the aggregate gradation of the mixture chosen. The composition of the mixture is divided into three fractions, namely: coarse aggregate fraction, fine aggregate fraction, and filler fraction. Where the size of the fraction is based on the 2010 Revised 3 Bina Marga specifications.
The type of mixture used for the manufacture of test specimens is the Lataston mixture.

Table 1. The number of specimens.

| Bitumen Content (%) | Gradation of HRS-BASE | Rattan Fiber (%) | Specimens Marshall Test (gram) | conventional | Immersion |
|---------------------|------------------------|------------------|------------------|--------------|-----------|
| 6.35                | Gap graded             |                  |                  |              |           |
| 0                   | 0                      | 3                |                  |              |           |
| 2                   | 1.52                   | 3                |                  |              |           |
| 4                   | 3.04                   | 3                |                  |              |           |
| 6                   | 4.57                   | 3                |                  |              |           |
| 8                   | 6.09                   | 3                |                  |              |           |
| 10                  | 7.62                   | 3                |                  |              |           |
| Specimens           | 18                     | 3                |                  |              |           |

3. Result and discussion

3.1. Aggregate characteristics

Based on the results of the Jeneberang river stone aggregate characteristics, Bili-bili District, Gowa Regency, South Sulawesi Province and the characteristics of the cement filler, the aggregate wear test results obtained the gross aggregate value of the wear from Faction A was 28.22%, Faction B was 24.64%, Faction C was 18.28% and Faction D is 19.20% of all test results, each faction conforms to a maximum standard of 40%. The density and absorption of coarse aggregate consisting of two samples obtained the value of Bulk Specific Gravity is 2.675%, SSD specific gravity is 2.700%, apparent density is 2.742% and water absorption is 0.903%. The density and absorption of fine aggregate using two samples obtained the average value for Bulk Specific Gravity was 2.601%, SSD Specific Gravity was 2.660%, Pseudo Specific Gravity was 2.764% and Water Absorption was 2.251%. The results of the filter analysis test are as shown in Figure 2. Testing the density of 100% Cement filler can be seen that the value of the density of the filler obtained is 3.02 gr/cm³. Thus the filler meets the established standards and can be used in asphalt mixtures. Testing material passed to filter 200, obtained a value of 4.28% while the general standard specification of 8%. The test for sludge content obtained by Sand Equivalent results was 96.25% and sludge content 3.02%. Both meet a minimum standard of 50% for Equivalent Sand and a maximum of 5% for sludge content. From the testing of the fluctuation index and the slope it can be seen that the coarse aggregate obtained by the flaked index is 9.20%, 8.68%, 7.59% and the slope index is 7.34%, 6.19%, 5.85%. The value of the fluctuation and gaps index meets the Bina Marga Standard, which is a maximum of 10%. The asphalt viscosity testing is only a visualization that does not go through the calculation process. The viscosity value is determined from.
the surface area of the sample covered with asphalt (less than 95% or more than 95%). From this observation it can be seen that asphalt can adhere well to the aggregate with a viscosity value > 95%.

3.2. Asphalt characteristics
Asphalt characteristic data is secondary data obtained from previous tests. The test results for 60/70 penetration asphalt characteristics in table 2.

3.3. Total Mixed Composition
The total composition of the mixture for the lastaston HRS Base, after determining the aggregate composition in the mixture and the asphalt content, we can find out the total composition of the mixture to be used as shown in table 3.

| Table 2. Recapitulation of Asphalt Penetration Characteristics Test Results 60/70. |
|----------------------------------|-----------------|----------------|-----------------|-----------------|
| Test                            | Method               | Result | Bina Marga Specification | Unit     |
| Penetration Before Losing Weight | SNI 06-2456-1991    | 65.7   | 60                           | 79        | (0.1) mm       |
| Ductility                       | SNI 2432-2011       | 121    | 100                          | -         | cm             |
| Asphalt Softening Point         | SNI 2434-2011       | 50     | 48                           | 58        | °C             |
| Burning and Flame               | SNI 2433-2011       | 300    | 200                          | -         | °C             |
| Asphalt Specific Gravity        | SNI 2441-2011       | 1.047  | 1.0                          | -         | gr/cc          |
| Losing weight                   | SNI 06-2440-1991    | 0.020  | -                            | 0.8       | %              |
| Penetration After Losing Weight | SNI 06-2456-1991    | 98.02  | 54                           | -         | % first        |

| Table 3. Total mixed composition. |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Additional                        | 0% Rattan Fiber | 2% Rattan Fiber | 4% Rattan Fiber | 6% Rattan Fiber | 8% Rattan Fiber | 10% Rattan Fiber |
| Coarse Aggregate Width (gr)       | 244.60          | 244.60          | 244.60          | 244.60          | 244.60          | 244.60          |
| Fine Aggregate Width (gr)         | 825.9           | 825.9           | 825.9           | 825.9           | 825.9           | 825.9           |
| Weight of filler (semen) (gr)     | 53.3            | 53.3            | 53.3            | 53.3            | 53.3            | 53.3            |
| Asphalt Weight (gr)               | 76.2            | 76.2            | 76.2            | 76.2            | 76.2            | 76.2            |
| Mixed Weight (gr)                 | 1200            | 1200            | 1200            | 1200            | 1200            | 1200            |
| Material Rattan Fiber Additive (gr)| 0               | 1.62            | 3.24            | 4.86            | 6.48            | 8.1             |
| Total                            | 1200            | 1201.62         | 1203.24         | 1204.86         | 1206.48         | 1208.1          |
3.3.1. Bulk Testing Results for Lataston HRS Base

Manufacture of test specimens using 60/70 asphalt penetration for HRS. Data processing and marshall test results for HRS Base can be in table 4 below:

Table 4. Aggregate composition test results.

| Gradation of Aggregate | Specifit Gravity | Aggregate Composition (%) |
|------------------------|------------------|--------------------------|
|                        | Bulk A | Semu b | Effective (a+b)/2 | D |
| Coarse Aggregate       | 2.68   | 2.84   | 2.76             | 20.38 |
| Fine Aggregate         | 2.70   | 2.89   | 2.79             | 68.83 |
| Filler (Tonasa Cement) | 3.02   |        |                  | 4.44  |
| Asphalt                |        |        |                  | 6.35  |
|                        |        |        |                  | 100.00|

3.3.2. Marshall Characteristics

In compaction the Marshall standard in this study only uses 2x75 collisions (heavy traffic) in accordance with the standards used by Bina Marga namely SNI specifications 03-1737-1989.

3.3.3. Void in Mix (VIM).

The use of Rattan Fiber 0% - 10% for Lataston HRS Base obtained a VIM value between 5.34% - 5.75%. VIM value with rattan fiber 0% - 10% meets the requirements that have been set, namely Min 3 - 6. From Figure 3 it is known that the VIM value has increased, the greater the use of Rattan Fiber, the greater the VIM value. This is caused by the many uses of rattan fiber so that the asphalt will cover the surface of the rattan fiber and a few that fill cavities in the mixture.

\[ y = -1.7019x^2 + 4.1222x + 5.3455 \]
\[ R^2 = 0.9177 \]

Figure 3. VIM Relationships and Rattan Fiber.

3.3.4. Analysis of Stability

By using rattan fiber 0% - 10% for Lataston HRS Base, the Stability value between 1514.11 - 1391.01 Kg meets the specifications of Figure 4 can be seen that the use of rattan fiber will help increase the strength/stability of the lastaston mixture at 6% rattan fiber. While in the mixture of 8% -10% rattan fiber the strength/stability will be reduced because asphalt will overlay the rattan fiber, resulting in reduced bonding between aggregates thereby reducing the strength/stability of the mixture.
3.3.5. **Analysis of Flow**
The use of rattan fiber 0% - 10% for Lataston HRS Base obtained a Flow value between 3.22 - 4.52 mm. where the specifications are min 3 mm. From figure 5 the relationship between Flow and rattan fiber can be seen, the bending of the rattan fiber can increase the flow and flexibility in the mixture so that the mixture becomes more flexible.

3.3.6. **Analysis of Void in Mineral Aggregate (VMA)**
By using Rattan Fiber 0% - 10% for Lataston HRS-BASE, the value of VMA is between 18.09 - 18.45%. From figure 6 it is known that the VMA value has increased, the greater the use of rattan fiber, the greater the VMA value. This is due to a large amount of asphalt covering the aggregate, filler and rattan fiber so that the cavities in the aggregate that are not filled with asphalt are increasing.

3.3.7. **Analysis of Void Filled Bitumen (VFB)**
0% - 10% Fiber Addition obtained VFB values ranging from 70.49 - 68.83%. Using Fiber Fiber meets the predefined VFB. From Fig. 7 it can be concluded that with each addition of rattan fiber the more air voids are filled and the mixing efficiency of the water and air decreases. Too low a VFB value will
cause the mixing to decrease in water due to asphalt-filled cavities. With many empty cavities, water and air can easily penetrate the hard layer so that the hardness of the hard layer is reduced.

![Figure 7](image-url) Graph of relationship between vfb and rattan fiber.

3.3.8. Determination of Optimum Rattan Fiber

From the table and graph the determination of the proportion of rattan fibers can be determined rattan fibers in a mixture of Lataston HRS Base that is rattan fiber that meets all the criteria or characteristics of marshall mix starting from the proportion of rattan fiber 0% - 10% for HRS-BASE lataston. To determine the optimum value for Marshall immersion, the rattan fiber used is 10%. Because it uses the most rattan fiber, also with the least stability so that if the mixture is still resistant to immersion, let alone other blends with great stability.

![Figure 8](image-url) Optimal fiber determination graph.

Table 5. Residual strength index.

| Rattan Fiber (%) | Stability (Kg) | Residual strength index or Immersion index (%) |
|------------------|----------------|---------------------------------------------|
|                  | Conventional Marshall | Immersion Marshall |                             |
| 10               | 1384.85          | 1292.53                          | 93.33                       |
| Average          | 1391.01          | 1286.37                          | 92.48                       |

3.3.9. Durability

\[
IP = \frac{\text{Stabilitas Marshall Immersion}}{\text{Stabilitas Marshall Konvensional}} \times 100\% = \frac{1286.37}{1391.01} \times 100\% = 92.48\%
\]

Marshall Immersion is one of the tests to see durability (resistance to load and the influence of temperature on a mixture submerged in water) or the durability of a mixture, the result of this test is the stability ratio. The ratio compares the stability of Marshall specimens after being immersed in water at 60 °C in a waterbath for 24 hours against the stability of marshall specimens with 60 °C immersion for 30 minutes, commonly called an immersion index (IP) or residual strength index (IKS).
From the Marshall Immersion test results obtained an average value for the immersion index is 92.48%. This immersion index value has met the standard that is $\geq 90\%$. Based on these values it can be concluded that road pavement that uses Rattan Fiber as an added material for HRS Base is resistant to temperature and water immersion.

4. Conclusions
From Based on the analysis conducted on the characteristics of the HRS Base lataston mixture that uses rattan fiber as added material obtained:

- Increasing the value of VIM along with the increase in rattan fiber used as added material. This can be seen in Figure 3, in the line equation $y = -1.7019x^2 + 4.1222x + 5.3455$, an increase in VIM is obtained by an average of 0.08%, with this, each addition of rattan fiber as an additive in lataston will increase VIM. Based on the correlation value $R^2 = 0.9177$, there is a large influence of the addition of rattan fiber to the stability of the mixture.

- Stability increases with the addition of rattan fiber and will decrease if more and more rattan fiber is used. shown by the line equation in figure 4, $y = -159643x^2 + 14821x + 1489.7$, an increase in stability increases by an average of 129.25 kg to 4% rattan fiber and stability will decrease by an average of 237.99 kg if more and more rattan fiber is added. Based on the correlation value $R^2 = 0.8247$, there is a large influence of the addition of rattan fiber to the stability of the mixture.

- The flow will decrease along with the addition of rattan fiber and increase the value of flexibility if more and more rattan fiber is used. This can be seen in Figure 5. The equation of the line $y = -72,867x^2 + 20,417x + 3,2223$, a flexibility of 0.11 is obtained. Based on the correlation value $R^2 = 0.9649$, there is a large influence of the addition of rattan fiber to the mixed flow.

- VMA increases with the increase in rattan fiber used as an added material as shown in figure 6. With the equation $y = -1.4726x^2 + 3.5668x + 18.099$, an increase in VMA is obtained by an average of 0.07%, so that each addition of rattan fiber as the added ingredient in lataston will increase VMA. Based on the correlation value $R^2 = 0.9177$, there is a large influence of the addition of rattan fiber to the mixed VMA.

- VFB decreases with increasing rattan fiber used. This can be seen in Figure 7, shown by the equation $y = 0.539x^2 - 16.999x + 70.466$, a decrease in VFB is obtained by an average of 0.33%, so that the use of the addition of rattan fiber as an additive to lataston can reduce VFB. Based on the correlation value $R^2 = 0.9177$, there is a large influence of the addition of rattan fiber to the mixed VFB.

- Durability of resistance to load and the influence of temperature on water-immersed mixtures or the durability of mixtures where rattan fibers are used 10% It can be seen in Table 5 shown by the increase in the value of the durability by an average of 0.72% with this, the addition of rattan fiber will increase resistance to the load.

Reference
[1] Footnotes Sukirman and Silvia 2003 Hot Mixed Asphalt Concrete Jakarta Granit
[2] Kusuma A and Rachman R 2018 Study Characteristics of Nickel Slag For Gradient Gap on Mixtured Hot Rolled Sheet Base International Journal of Innovative Science Engineering & Technology 3 8-13
[3] Directorate General of Highways of the Ministry of Public Works of the Republic of Indonesia General Specification 2010
[4] Mulyatno I P and Sarjito Jokosisworo S 2018 Technical Analysis of the Use of Rattan Skin Fiber as a Reinforcement in Polymer Composites with Yukalac 157 Polyester Matrix in terms of Tensile Strength and Bend Strength., Jurnal KAPAL 3
[5] Alpius 2018 Effects of Additional Rattan Fiber on Hot Rolled Sheet Wearing Course (HRS-WC) Stability International Journal of Innovative Research in Science Engineering and Technology 3
[6] Azizah N and Rahardjo B 2017 Mixed Performance of Hot Rolled Sheet-Wearing Course (HRS-WC) with Sugarcane Ash Filler Jurnal Bangunan 2 Geospatial Information Authority of Japan 2017 Basic Plan for the Advancement of Utilizing Geospatial Information 4