

Effects of Additional Rattan Fiber on Hot Rolled Sheet Wearing Course (HRS-WC) Stability

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ABSTRACT: This study aims to determine the effect of adding rattan fiber to the stability of Hot Rolled Sheet Wearing Coarse (HRS-WC) mixture. Specifications that used established by the Directorate General of Highways Ministry of Public Works of the Republic of Indonesia, General Specifications 2010 Division 6 revisions 3.1. The rattan used is taken from the forest in Messawa Sub-district, Messawa Sub-district, Mamasa Regency, West Sulawesi Province, Indonesia. Rotan taken directly from the roots and has an old age that has a strong endurance. The procedure of taking rattan are taking rattan in the forest then cut into pieces with a maximum size of 2 cm, then dried after that crushed and become rattan fiber. The percentage of rattan fiber addition used is 0%, 2%, 4%, 6%, 8% and 10% by weight of mixture of HRS-WC.

The effect of using rattan fiber in the HRS-WC lataston mixture is increased stability, VIM, flows, VMA, but decreased VFB. The durability / strength index / Mixed immersion index still in the requirements / specifications of Highways Ministry temperature and duration submerged in water. From Marshall Immersion test results obtained the average value for the immersion index is 94.77%. The value of this immersion index has in the standards of DGH is : $\geq 90\%$. Based on these values, it can be concluded that road pavement using Rattan Fiber as an added material for Lataston HRS-WC is resistant to temperature and water immersion.

KEYWORDS: Rattan Fiber, Stability, HRS-WC, Marshal..

I. INTRODUCTION

The use of rattan fiber for the main road construction of Hot Rolled Sheet Wearing Course (HRS-WC) mix has not been used in Indonesia, but this material is widely produced from rattan industry waste in Indonesia. Rotan is one of Indonesia's biological source, which is quite large. As the largest rattan producing country, Indonesia has contributed 80% of the world's rattan needs. Of these 90% of rattan is produced from natural forest in Sumatra Island, Kalimantan Island, Sulawesi Island, and about 10% is produced from rattan cultivation [1]. Based on specification of Directorate General of Highways Ministry of Public Works Republic of Indonesia, General Specification 2010 Division 6 revision 3.1.[2]

Marshall Immersion is one of the tests to determine durability (resistance to load and temperature effect on a waterlogged mixture) or durability of a mixture, the result of this test is the stability ratio. The ratio compares the stability of Marshall test objects after soaking water at 60 ° C in waterbath for 24 hours to the stability of marshall test objects by immersion 60 ° C for 30 minutes so-called immersion index or residual strength index). Some researchers previously examined about Hot mix utamanyajenis HRS-WC seperti, Effects of mineral fillers on hot-mix asphalt laboratory-measured properties [3], Effects of Asphalt Mix Design Properties on Pavement Performance: A Mechanistic Approach[4], Aggregate Shape Properties and Their Influence on the Behavior of Hot-Mix Asphalt[5], Effect of Sugarcane Bagasse Ash as Filler in Hot Mix Asphalt[6], The Influence Of Fly Ash On The Engineering Properties Of Asphalt And Hot Mix Asphalt[7]. Experimental Study of Hrs-Wc Mixture With Asphalt Oil And Addition Of Latex Additives As A Binder[8], Combination Performance Hot Rolled Sheet-Wearing Course (Hrs-Wc) With Filler Abu Ampas Sugar Cane[9]. Design of Hrs-Wc Mixed Laboratory Using Buton Granular Asphalt (BGA)

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 7, Issue 3, March 2018

As Additive Material[10].The Effect of Coconut FiberFiber As Added Material With Bentonite Powder Filler In HRS-Base And HRS-WC[11]. This study aims to determine the effect of adding rattan fiber to the stability of Hot Rolled Sheet Wearing Coarse (HRS-WC) mixture.

II. LITERATUR REVIEW

Hot Rolled Sheet

The HRS-WC layer is a surface layer made of gap graded aggregate with the dominance of sand and hard asphalt mixed, spread and thickened in a hot state at a certain temperature. The important characteristics of this layer are durability and flexibility and sufficient stability in holding traffic loads which works on it. All graded granular mixtures will use a mixture of coarse and fine aggregates. Usually two sizes for coarse aggregates and also two sizes for fine aggregates where one of them is fine grained soil[12].The provisions of the gap graded limit of 2.36 mm sieve but retained by 0.600 mm sieve shall be observed, the mixture being made with a cavity in the mixture at a refusal density of 2%.The characteristics of Hot Rolled Sheet are waterproof, resistant to traffic wear, high resilience, capable of being used on roads with heavy traffic, sharp turns, road intersections, and areas where road surfaces can withstand heavy wheel loads .

Rattan Fiber

The anatomical structure of rattan rods associated with durability and strength include the size of the pore and the thickness of the fibrous cell wall. Fiber cells are the components that give strength to the rattan. The thick cell walls make the rattan stronger and heavier. In general, rattan chemical composition consists of holocellulose (71-76%), cellulose (39% -56%). Likin (18% -27%), silica (0.54% -8%) [13]. The physical properties of rattan are visually observable properties such as color, luster, odor, taste, weight, hardness / alastisity, wide diameter and others. The nature of the structure of rattan is not known because it has not been a special study of the properties of the structure that can be used as an indentification guide is pore. Rattan pore is very simple and differentiated in several parts, among others, the size of the shape and arrangement. The mechanical properties of rattan relate to the ability to withstand forces from the outside, among others: firmness, compression, fracture, stiffness, ductility, tension, shear, cleavage and durability.

Marshall Test

This examination is to detemine the resistance strength to the flow of asphalt mixture. Resistance and stability is the ability of asphalt mixture to obtain loads until flow occurs (kilogram/pounds). Flow is deformation of an asphalt mixture occurring as a result of a load until the time expressed in mm or 0.01”

III. METHODOLOGY

This research was conducted on Road Laboratory of Civil Engineering Program of Universitas Kristen Indonesia Paulus. The specification used determined by Directorate General of Highways Ministry of Public Works of Republic of Indonesia, General Specification 2010 Division 6 revision 3.1. The rattan fiber used is taken from the forest in Messawa Village, Messawa Sub-district, Mamasa Regency, West Sulawesi Province, Indonesia.Rotan taken directly from its roots and has an old age so that it has a strong endurance. The procedure of taking rattan in the forest then cut cut with a maximum size of 2 cm, dried then pounded into rattan fiber.The percentage of rattan fiber addition used was 0%, 2%, 4%, 6%, 8% and 10% by weight of HRS-WC mixture. The composition of the material used as shown in table 1.

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Table 1. Total Material Usage

Material	Additional Rattan Fiber Composition					
	0%	2%	4%	6%	8%	10%
Coarse Aggregate (gr)	213	213	213	213	213	213
Fine Aggregate (gr)	823.5	823.5	823.5	823.5	823.5	823.5
Filler (cement) (gr)	82.5	82.5	82.5	82.5	82.5	82.5
Asphalt (gr)	81	81	81	81	81	81
Mixture (gr)	1200	1200	1200	1200	1200	1200
Rattan Fiber (gr)	0	1.62	3.24	4.86	6.48	8.1
Total	1200	1201.62	1203.24	1204.86	1206.48	1208.1

IV. ANALYSIS AND DISCUSSION

From Marshal characteristic test obtained Void in Mix (VMA) value, Void in Mineral Aggregate (VMA), Flow, Stabilitasdan Void Filled Bitumen (VFB) as seen on table2.

Table 2. Marshal Characteristic Test

Fiber Rattan Additional	Marshal Characteristic				
	VIM	VMA	Flow	Stabilitas	VFB
0%	4,18	18,13	3,23	1477,18	76,95
	4,14	18,10	3,20	1458,71	77,11
	4,06	18,04	3,25	1495,64	77,47
2%	4,30	18,24	3,80	1661,82	76,40
	4,43	18,35	3,83	1569,50	75,86
	4,39	18,32	3,81	1606,43	76,02
4%	4,46	18,38	4,25	1846,47	75,71
	4,51	18,42	4,23	1864,93	75,52
	4,47	18,39	4,27	1920,33	75,67
6%	4,80	18,66	4,70	1717,22	74,29
	4,76	18,63	4,74	1698,75	74,47
	4,76	18,63	4,71	1754,15	74,47
8%	4,96	18,80	4,90	1723,37	73,63
	4,84	18,70	4,96	1661,82	74,14
	5,00	18,84	4,93	1643,36	73,45
10%	4,93	18,78	5,40	1587,96	73,74
	5,04	18,87	5,45	1631,05	73,30
	5,04	18,87	5,42	1551,03	73,30
Specification	4 - 6(%)	Min 18	Min 3	Min 800	Min 68
Minimal	4,06	18,04	3,20	1458,71	73,30
Maximal	5,04	18,87	5,45	1920,33	77,47

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Void in Mix (VIM)

VIM test obtained percentage range value from 4,06% until 5,04% as seen on table 2. The value fits the specification.

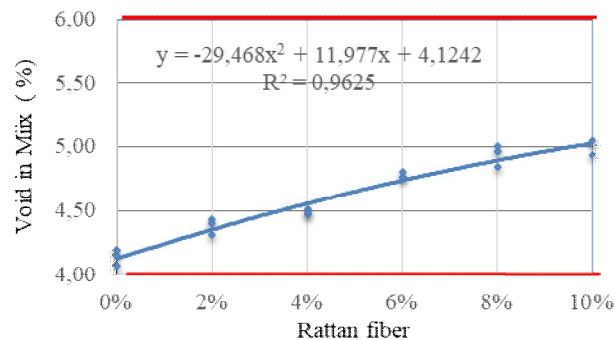


Fig1. Void in Mix With Rattan Fiber Additional

On Figure 1, it can be seen that the addition of rattan fiber will increase the VIM value. It is shown by the equation of line $y = -29,468x^2 + 11,977x + 4,1242$ then obtained increase of value at VIM equal to 0,17%, Based on correlation value $R^2 = 0,9625$ hence there is big influence of rattan fiber addition with mixed stability.

Void in Mineral Aggregate (VMA)

Tests performed on VMA were rated between 18.04% and 18.87%. As with the VIM, the cavity contained in the aggregate increases as the percentage of rattan fibers increases. This is still greater than the rated value.

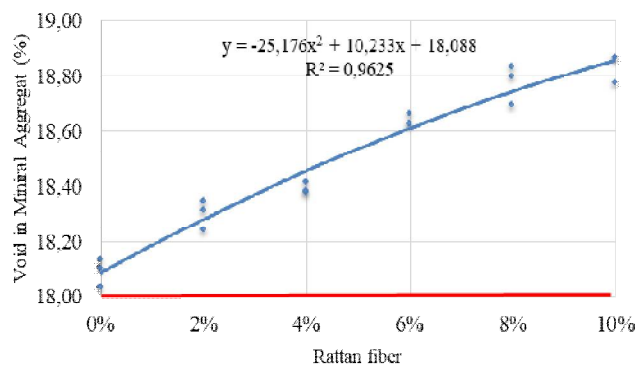


Fig. 2. VMA With Rattan Fiber Additional

The increase of cavity in aggregate is caused by the amount of asphalt which envelop aggregate, filler and rattan fiber so that cavity in aggregate unallocated with asphalt gets bigger. Correlation values equal to $R^2 = 0,9625$ then influence of rattan fiber addition to stability of mixture is substantial.

Flow

Rattan fiber additional from 0% until 10% as seen on Figure 3, obtained Flow value from 3,20 until 5,45 mm. The values is greater than rated value.

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Vol. 7, Issue 3, March 2018

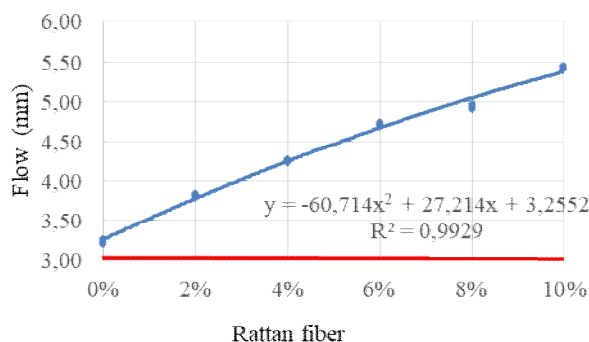


Fig. 3. Flow With Rattan Fiber Additional

The effect of rattan fiber addition, it can be seen that the rattan fiber is flexible and can increase the flow in the mixture so that the mixture becomes more flexible. From Figure 3, the correlation value $R^2 = 0.9929$ then there is a great influence of the addition of rattan fiber to the stability of the mixture. From the trendline $y = -60,714x^2 + 27,214x + 3,2552$ obtained by increasing of flexibility along with the increasing of rattan fiber addition of average 0,44.

Stability

On Table 2, it can be seen that rattan fiber additional will obtain stability value from 1458,71– 1920,33kg. The values is greater than rated value.

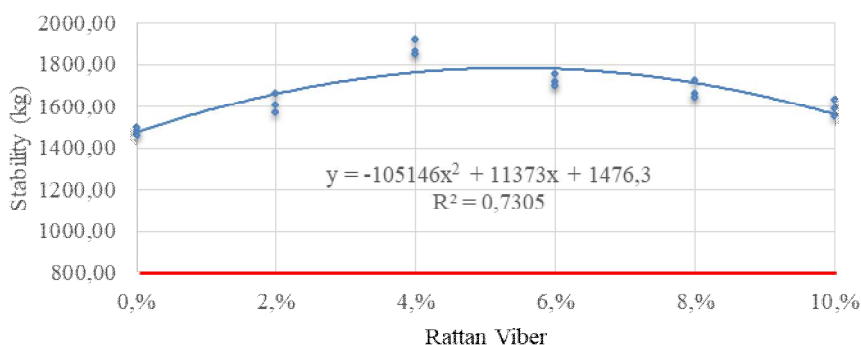


Fig. 4. Stability with Rattan Fiber Additional

From Figure 4 it can be seen that the use of rattan fiber will increase the strength or stability by adding 6% rattan fiber. While the addition of 8% to 10% of rattan fiber reduced stability is due to the asphalt will coat the rattan fiber resulting in reduced bonding between aggregates consequently decrease the strength / stability of the mix. Based on the correlation value $R^2 = 0.7305$ then there is a great influence of fiber addition rattan to the stability of the mixture

Void Filled Bitumen (VFB)

Rattan fiber additional from 0% until 10% as seen on table 2, obtained VFB value from 73,30– 77,47. This values are greater than rated values.

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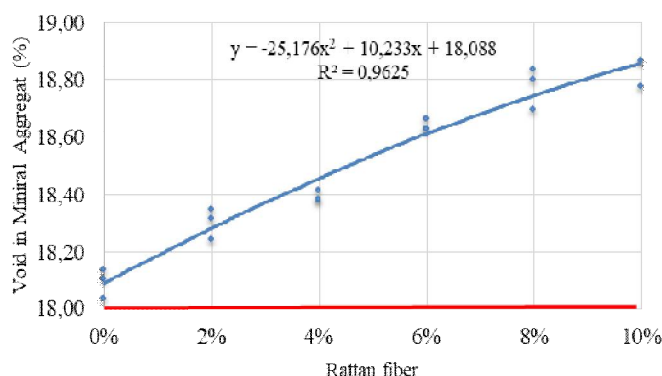


Fig. 5. VFB with Rattan Fiber Additional

From figure 5, it can be seen that each addition of rattan fiber then the more air cavity filled and mixed water and air resistance will be lower. VFB values that are too low will cause the water mixture to be reduced due to a little cavity filled with asphalt. With the number of empty void, water and air will easily enter into the hard layer so that the durability of the hard layer will be reduced. Based on the correlation value $R^2 = 0.9632$ then there is a great influence of the addition of rattan fiber with mixed stability.

Durability

From table and graph determination of Rattan fiber proportion can be determined optimum rattan fiber on lataston HRS-WC mixture that is complied with all characteristic of Marshall mixture ranging from 100% rattan fiber to HRS-WC lataston. Because using most rattan fibers, also with the smallest stability so that if the mixture is still resistant to immersion, let alone other mixtures of great stability.

Table 3. Determination of Time Strength Index / Durability

Rattan Fiber (%)	Stability (Kg)		Durabilitas (%)
	Marshall Konvensional	Marshall Immertion	
10%	1551.03	1477.18	95.24
10%	1514.11	1421.78	93.90
10%	1532.57	1458.71	95.18
Average	1532.57	1452.56	94.77

Durability / resistance to load and temperature influence on a water-immersed mixture or mixed durability wherein rattan fiber is used 10%. This can be seen in table 33 indicated by the increase in value at durability by an average of 0.03% with this then the addition of rattan fiber will increase the resistance to the load.

V. CONCLUSION

The effect of using rattan fiber in the HRS-WC lataston mixture is increased stability, increased VIM, increased flows, increased VMA, and decreased VFB. The durability / strength index / Mixed immersion index still meets the standards / specifications set in Highways Ministry temperature and duration submerged in water. From Marshall Immersion test results obtained the average value for the immersion index is 94.77%. The value of this immersion index has met the standards set by DGH as follows: $\geq 90\%$. Based on these values, it can be concluded that road pavement using Rattan Fiber as an added material for lataston HRS-WC is resistant to temperature and water immersion.

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