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Characteristics of Yalimo Papua Kinang Jingkion powder as filler in HRS-WC mixture

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ABSTRACT

Kinang Jingkion is the name of an area in Yalimo Regency, Papua, that has unique material deposits with specifications that make it suitable for use as aggregate in pavements, including as filler in powder form. The high cost of construction in the Yalimo region and generally in the Papua Mountains is due to logistics, where materials such as cement and asphalt are mobilized by airplane. With the alternative use of local filler material, it will eliminate the long and expensive mobilization. This study aims to analyze the characteristics of Yalimo Papua kinang jingkion powder and determine whether it can be used as a filler material in HRS-WC mixtures. The method was carried out by Marshall testing to obtain stability and adhesion values. The test method was carried out in accordance with General Specifications Revision 2 of 2018, the Directorate General of Highways, and Indonesian National Standards (SNI) for each test, including asphalt, coarse and fine aggregates, and Kinang Jingkion material. The optimal asphalt content (OAC) obtained from Kinang Jingkion filler is 6.85%. Based on the results of the research and discussion that have been described, it is concluded that the results of the Marshall characteristics test for Kinang Jingkion Filler at 6.85% asphalt content show a stability value of 1194.40 Kg, MQ 460.2 Kg/mm, VIM 2.68%, and VFB 80.16.

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Introduction

Hot Rolled Sheet (HRS) is a surface layer without structural properties that contains particles with alternating gradations. Asphalt is a kind of combination that is applied as a coating material over the pavement surface of a highway. Asphalt is designed to withstand and transfer traffic loads to the layers below. In addition, asphalt also serves as an impermeable layer, which protects the construction underneath (Ampung, 2013; Marianto & Kamba, 2020). The use of HRS is suitable for implementation in Indonesia due to its great flexibility (Adhitya, Pataras, Kadarsa, & Nurainiyah, 2020; Putri, Purnawan, Adji, & Herman, 2021). In addition, HRS also has resistance to liquefaction, which is particularly advantageous given the tropical environment in Indonesia (Kusuma & Rachman, 2018). The HRS-WC combination, which is a non-structural layer with a higher amount of fine aggregate and asphalt, is prone to plastic deformation.

This deformation can lead to the formation of grooves on the asphalt surface, thus spoiling its appearance (Alpius, 2018). Therefore, it is very important to improve its quality. The selected material should have good physical and mechanical characteristics. Filler in HRS-WC mixtures plays an important role alongside aggregate and asphalt. Filler serves to fill the gaps in the asphalt mixture, resulting in increased resistance to friction and

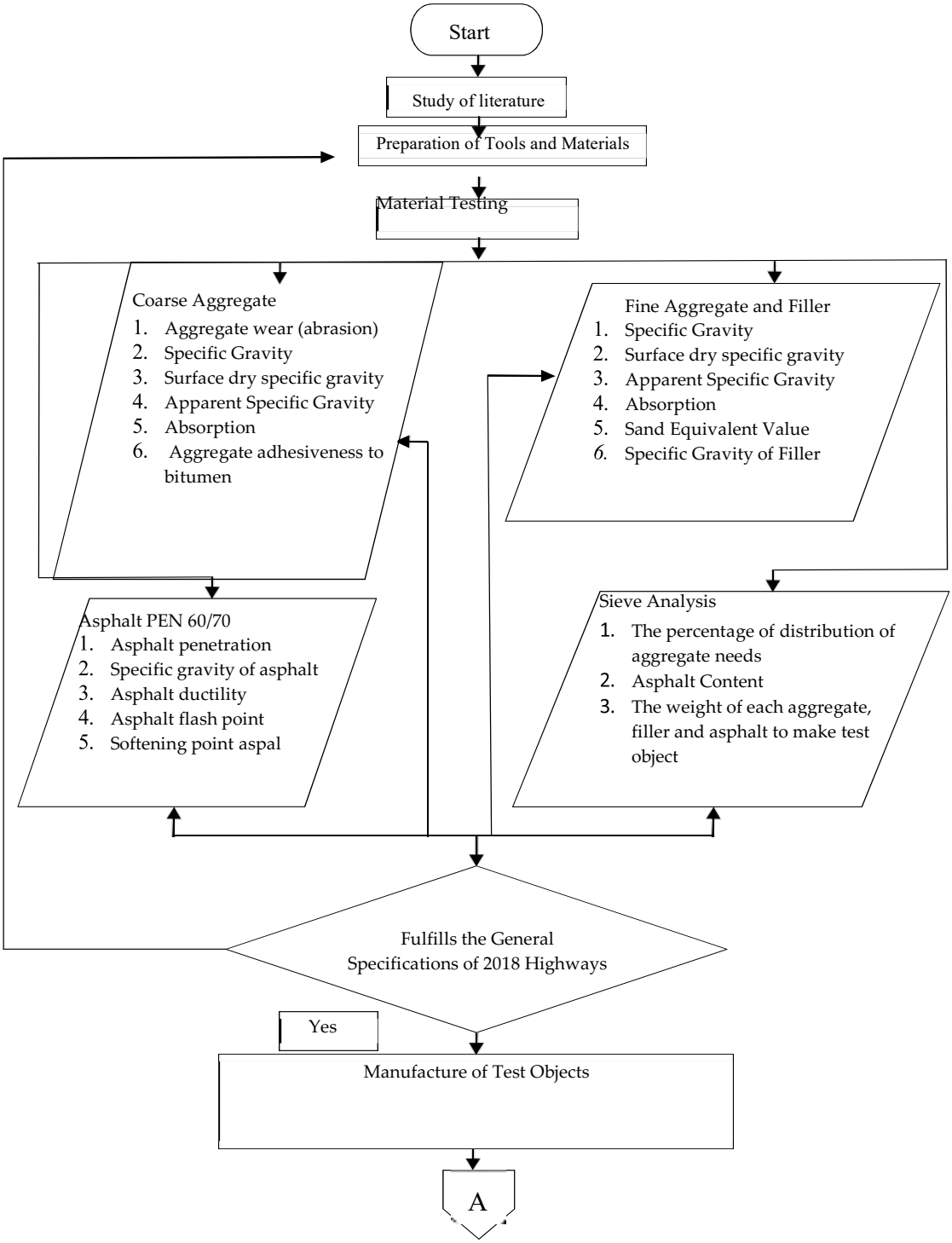
improved aggregate interlocking. The stability of the combination will be affected by the quality of the filler, as the filler will contribute to the reduction of voids.

The current government recommends using materials that exist around the road construction site, in order to make the most of the natural potential of the area. Kinang Jingkion is the name of an area in Yalimo Regency, Papua, which has unique material deposits with specifications that make it suitable for use as aggregate in pavements, including as filler in powder form (Ahmad et al., 2021). Jan Ukago, one of the first researchers on this aggregate, named the material after the region or location, so the material from the Kinang Jingkion region is now called Kinang Jingkion material. It is estimated that the Kinang Jingkion material deposit is up to 45 billion cubic meters, making it highly potential for road material. Currently, the local technical agency has already used Kinang Jingkion material as a local material for road body formation and foundation or base. Due to its good quality, the Kinang Jingkion base layer is already excellent to use and forms a smooth surface layer. Because of its characteristics that can form a smooth and cohesive surface layer, it no longer requires conventional cover layers with cement or asphalt binding materials. This material has been used in several rural roads in Yalimo Regency. One type of local material is black sandy gravel soil that can be used as a filler in hot asphalt mixtures (Ukago, 2022)

The characteristics of Kinang Jingkion aggregate that can form pavement layers without any binder materials, such as asphalt or cement, will provide a solution to road construction in mountainous areas, especially in Yalimo, where the cost per kilometer is very expensive. The cost of building one kilometer of road with asphalt binder in mountainous areas ranges from 9 to 10 billion rupiahs per kilometer. This high cost is due to the need to transport materials from outside the area using aircraft. Therefore, the discovery of Kinang Jingkion aggregate has reduced the cost of road construction, especially for low and medium traffic roads without any binder materials, to open up isolated areas (Handayani, Setiaji, & Wardani, 2015). For medium to high traffic, a proper composition is needed by using asphalt binder as both coarse and fine aggregates as well as fillers. The use of Kinang Jingkion material is not only as a foundation layer, but its characteristics also make it possible to be used as a filler in HRS-WC mixtures (Nento, Djau, Bumulo, & Dayanti, 2022).

There is currently limited research on Kinang Jingkion material. One of the first researchers to study this material was Yan Ukago in 2022. Another study conducted by Sihaloho, Bahtiar, & Rante (2022) investigated the impact of using zeolite powder and Kinang Jingkion powder as fillers in HRS-WC hot asphalt mixtures. Additionally, Idie conducted research in 2023 on the thickness of the Pavement Layer using Kinang Jingkion material. In contrast to previous research, this study will analyze the characteristics of kinang jingkion powder Yalimo Papua and find out whether it can be used as a filler in the HRS-WC mixture.

Method


Start
Study of literature
Preparation of Tools and Materials
Material Testing
Coarse Aggregate
1. Aggregate wear (abrasion)
2. Specific Gravity
3. Surface dry specific gravity
4. Apparent Specific Gravity
5. Absorption
6. Aggregate adhesiveness to bitumen
Fine Aggregate and Filler
1. Specific Gravity
2. Surface dry specific gravity
3. Apparent Specific Gravity
4. Absorption
5. Sand Equivalent Value
6. Specific Gravity of Filler
Asphalt PEN 60/70
1. Asphalt penetration
2. Specific gravity of asphalt
3. Asphalt ductility
4. Asphalt flash point
5. Softening point aspal
Sieve Analysis
1. The percentage of distribution of aggregate needs
2. Asphalt Content
3. The weight of each aggregate, filler and asphalt to make test object
Fulfills the General Specifications of 2018 Highways
Yes
Manufacture of Test Objects
A

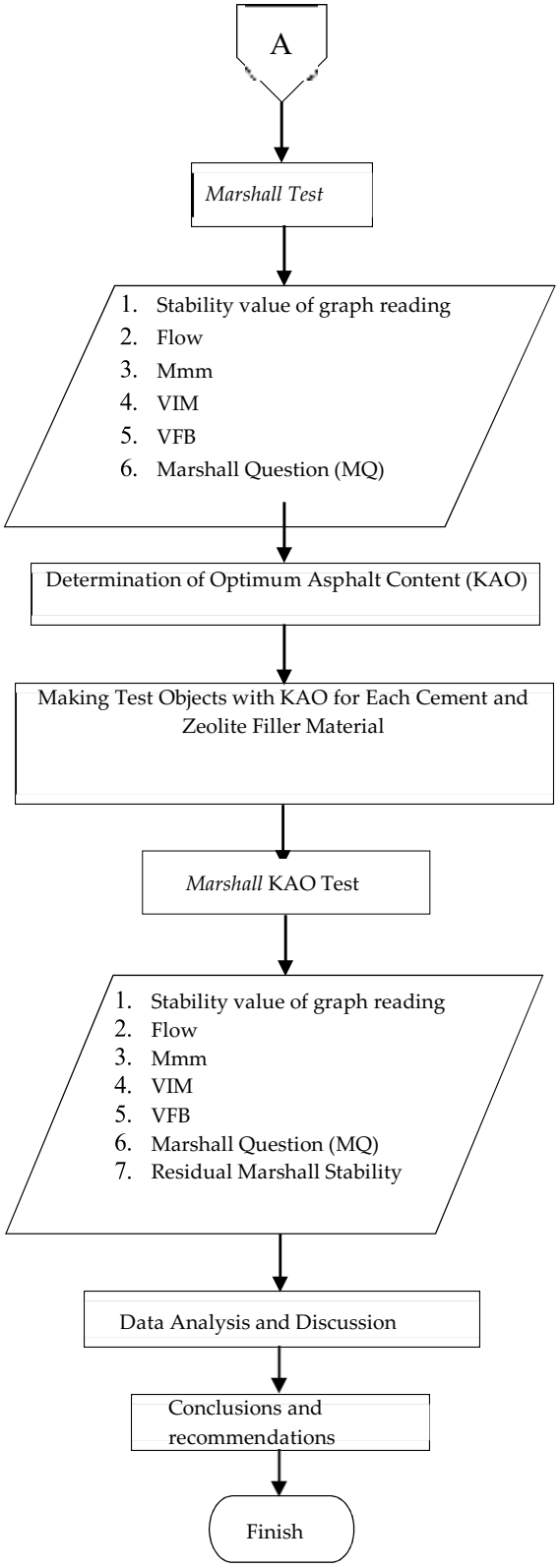


Figure 1. Research Flow Chart

Results and Discussions

Los Angeles Machine Aggregate Wear (Abrasion) Testing

This testing refers to SNI 2417:2008 with the aim of determining the wear rate expressed as the ratio between the weight of worn material to the original weight in percent (Kusumaningtyas, 2003). The results of this testing can be seen in Table 1.

Table 1. Aggregate Wear Test (Abrasion) With Los Angeles Machines

Filter		Weight and Gradation of Test Objects (grams)	
Get away	Restrained	Test Object 1	Test Object 2
3 / 4 "	1 / 2 "	2500	2500
1 / 2 "	3 / 8 "	2500	2500
Total weight (A)		5000	5000
Retained weight of filter no. 12 (B)		4738,00	3941,70
Number of Balls		11	11
Number of Collisions		100	500
Terms (Maximum)		8%	40%
Aus weight (C = A – B)		262,00	1058,30

Source: Data Analytics, 2023

Wear Rate for 100 Cycles = 5,24%
Wear Rate for 500 Cycles = 21,17%

Based on the test results obtained, the value of coarse aggregate abrasion is 21.17%, which meets the requirements and can be used to make test specimens (Suparma, Andrian, Purnomo, & Saleh, 2014)

The Test of Specific Gravity And Absorption of Coarse Aggregate

This testing refers to SNI 1969:2016 with the aim of determining the increase in weight of an aggregate due to water that penetrates into its pores but not including water retained on the surface of the particles, expressed as a percentage of its dry weight. The results of this test can be seen in Table 4.2 and Table 4.3. Based on the results of the specific gravity and absorption test of the coarse aggregate (size 1-2 cm), the specific gravity value of the aggregate is 2.653%. This meets the standard set in SNI 1969:2016 which is a minimum of 2.50%. Therefore, the aggregate can be used to make HRS-WC hot mix asphalt (Dur, 2017).

Table 2. Specific Gravity Test and Coarse Aggregate Absorption (Uk. 0.5-1)

Description		Testing		
		I	II	Average
Oven dry test object weight	BK	727.0	776.5	751.75
Saturated surface test object weight	BJ	734.7	784.6	759.65
The weight of the test object in water	BA	458.8	489.6	474.2

Filler Material Testing

The specific gravity test for the Filler material was conducted on Thursday, January 12th, 2023, and was only performed on the Kinang Jingkion Filler material, while the Fillers made of Cement and Zeolite used secondary data. The Kinang Jingkion used in this test was obtained from the Kali Habie Quarry in Yahukimo Regency (Tambunan & Pitriani, 2019). The results of the specific gravity test for the Kinang Jingkion Filler material can be seen in table 3.

Table 3. Specific Gravity Test for Kinang Jingkion Filler Materials

No. Pycnometer		I	II
Pycnometer weight + *Filler* = (W1)	gr	65,23	66,99
Pycnometer weight = (W2)	gr	44,90	47,20
Filler weight = (WT = W1-W2)	gr	20,33	19,79
Temperature	gr	28	28
Pycnometer + Water + *Filler* = (W3)	gr	157,42	162,05
Pycnometer + On Water ^{o}C = (w4)	gr	144,44	149,5
(W1 – W2) + W4 = W5	gr	164,77	169,29
Fillers = (W5 –W3)	gr	7,35	7,24
Specific gravity = WT/ (W5 –W3)	gr/cm^3	2,766	2,733
Specific gravity Average	gr/cm^3	2,75	

Source: Data Analysis, 2023

From the test results for the Kinang Jingkion material, a specific gravity of 2.75 g/cm3 was obtained. Based on the test results, it can be said that Kinang Jingkion can be used as a substitute for Filler in hot mix asphalt because the required specific gravity for the minimum Filler specific gravity is 1.00%. Considering that the Kinang Jingkion deposit in Yalimo Regency is estimated to be 45 billion cubic meters, it is highly recommended to use Kinang Jingkion as a substitute for Filler in HRS-WC hot mix asphalt (Saleh & Suparma, 2016).

Gradasi Agregat Campuran HRS – WC

After conducting sieve analysis for each aggregate to be used in making test specimens, the aggregate gradation calculation for the HRS-WC mixture was carried out to determine the percentage of each aggregate to be used (Wu, Wen, Chaney, Littleton, & Muench, 2017). From the aggregate gradation calculation results, it can be seen that all fractions of the aggregate meet the requirements set in the 2018 General Specification for Highway Construction (Spesifikasi Umum Bina Marga Tahun 2018 Revisi 2). It can be concluded that the aggregates can be used to make test specimens of HRS-WC asphalt mix according to the percentage calculation for each aggregate. The results of the aggregate gradation calculation for the mixture can be seen in the following report (Atkins, 1997 in Gonçalves & Margarido, 2015)

Figure 2. Combined Gradation Graph

Asphalt Content Calculation

Calculation of Asphalt Content (Pb) is done after knowing all the combined aggregate percentages using the following formula:

$$Pb = 0{,}035(\%CA) + 0{,}045\ x\ (\%FA) + 0{,}18x(\%FF) + K$$

With:
Pb = Estimated bitumen content of the mixture, percentage by weight of the mixture,
CA = Aggregate retained on sieve number 8,
FA = Aggregate passes sieve number 8 and is retained in sieve No.200, FF = Filler material passes sieve number 200, and
K = Constant 2.0 to 3.0 for lataston.
From the mixed gradation results in Table 4.21, the following values are obtained CA = 34, 33%; FA = 26,46%; FF = 7,87% and for the value of K is taken = 2,5 So:
Pb = 0,035(34,37) + 0,045 x (26,94) = 0,18x(7,44) + 2,5Pb = 1,203 + 1,212 + 1,339 + 2,5
Pb = 6,254 ~ 6,5

From the results of the Asphalt (Pb) Value Calculation obtained at 6.5%, test objects will be made with asphalt content ranges of 5.5%, 6.0%, 6.5%, 7.0% and 7.5% respectively - as many as 3 test objects for each Cement Filler, Zeolite and Kinang Jingkion material. So that the total test objects for each Filler material are 15 pieces each. The weight of each aggregate based on asphalt content can be seen in the tables below (Gustam, 2009).

HRS-WC Marshall Test Results With Kinang Jingkion Filler

The HRS-WC Marshall Test with Kinang Jingkion Filler was carried out on Tuesday, January 24 2023 at the BPJN Wamena Laboratory. The purpose of this Marshall test is to determine the value of stability and flow. The results of the Marshall test and data analysis can be seen in Table 4.31. The results of the Marshall test with

Kinang Jingkion Filler showed that at 7% asphalt content, the HRS-WC hot asphalt mixture met the Marshall parameter specifications, while at 5.5%, 6.0%, 6.5 and 7.5% asphalt content several parameters Marshall on the HRS-WC hot asphalt mixture did not meet the specifications (Krebs & Walker, 1971 in Mashaan, Ali, Karim, & Abdelaziz, 2014)

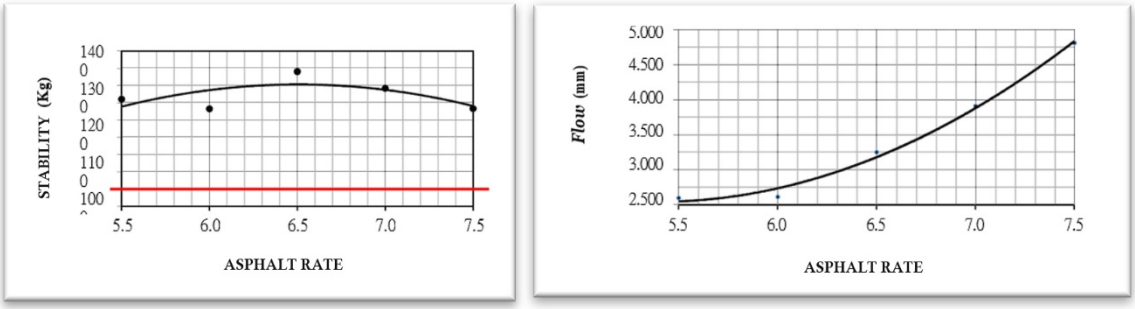


Figure 4. Graph of the Relationship between Asphalt Content and Stability and Flow

From the graph of the relationship between asphalt content using Kinang Jingkion Filler and stability, it shows that the value of stability increases in the asphalt content range of 5%-6.5% and after that shows a decrease until it reaches a minimum point in the asphalt content range of 6.5%-7.5% . From the graph of the relationship between asphalt content using Kinang Jingkion Filler with Flow, it shows that the Flow value is increasing in the asphalt content range .of 5.5% - 7.5% until it reaches the maximum point. It shows higher (Saputra, 2006).

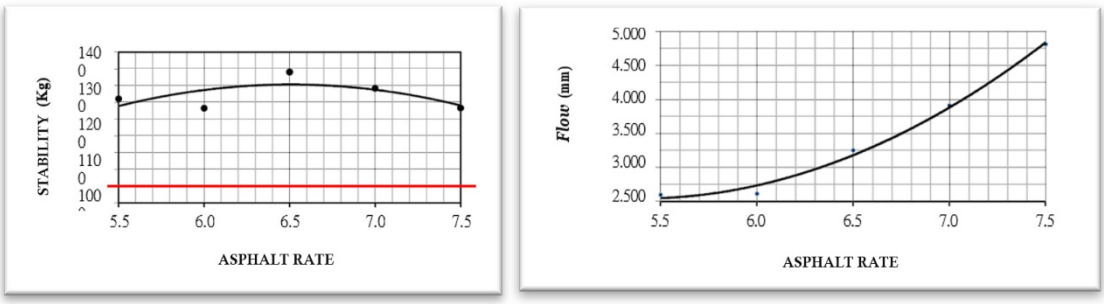


Figure 5. Relationship between Kinang Jingkion Filler Asphalt Content and Marshall Quetient and Air Cavities
Source: Data Analysis Results, 2023

From the graph of the relationship between asphalt content using Kinang Jingkion Filler and Marshall Quetient, it shows that the Marshall Quetient value decreases in the range of asphalt content 5.5% - 7.5% until it reaches the minimum point. From the graph of asphalt content relationship using Kinang Jingkion Filler and Air Cavity (VIM)) shows the value of Air Cavity (VIM) decreases in the asphalt content range of 5.5% -7.5% until it reaches the drinking point.

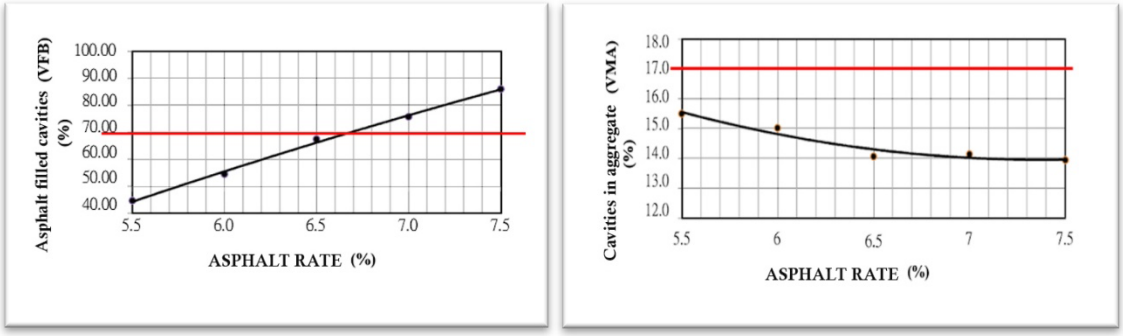


Figure 6. Relationship between VTB and VFB asphalt content
Source: Data Analysis Results, 2023

From the graph of the relationship between asphalt content using Kinang Jingkion Filler and Cavity Filled with Asphalt (VFB) it shows that the Cavity Filled with Asphalt (VFB) value increases in the asphalt content range of 5.5% -7.5% until it reaches the maximum point.

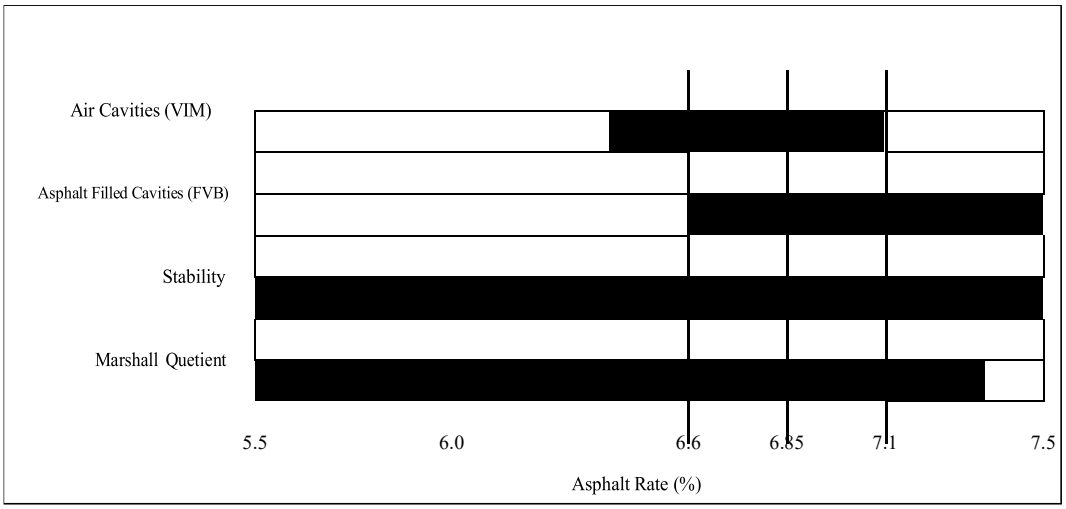


Figure 7. Graph of Relationship between Marshall Filler Kinang Jingkion Test Values
Source: Data Analysis Results, 2023

From the graph of the relationship between marshall parameter values and asphalt content, the Kinang Jingkion Filler shows that the range of asphalt content from 6.60% to 7.1% HRS-WC hot asphalt mixture meets all the specified requirements (Susilowati, Wiyono, & Pratikto, 2021). Based on this range, the middle value of the range is 6.85% as the value of Optimum Asphalt Content (KAO). The results of the Marshall parameter value test with KAO of 6.85% can be seen in Table 3.

Table 3. Marshall Test Results with Kinang Jingkion Filler at Optimum Asphalt Content (KAO)

			Marshall Characteristic Parameters			
Asphalt Content (%)	**Stability(Kg)**	**Flow (mm)**	**MQ (Kg/mm)**	**VIM (%)**	**VFB (%)**	***Marshall Remainder* (Kg)**
7.04	1194.4	2.60	460.2	2.68	80.16	1064.2
Specification	Min. 600	-	Min. 250	3-5	Min. 68	Min. 90% x 600

Source: Data Analysis, 2023

From Table 11, it shows that the Marshall Characteristic parameter values with Kinang Jingkion Filler meet the specifications in terms of stability values and are suitable for use for HRS-WC hot asphalt mixtures (Sihaloho et al., 2022).

Conclusions

Based on the results of the research and discussion that has been described, the following conclusions are drawn: First, Optimum Asphalt Content (KAO) obtained from Kinang Jingkion Filler is 6.85%. second, Marshall characteristic test results for Kinang Jingkion filler at KAO of 6.85% obtained a stability value of 1194.40 Kg, MQ of 460.2 Kg/mm, VIM of 2.68% and VFB of 80.16%.

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