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# Analysis of the properties of chemical content and the use of local material Kinang Jingkion as coarse aggregate against the characteristics of WC last (AC) mixture in Yalimo Regency

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Kinang Jingkion; Abrasion; Optimum Asphalt Grade (KAO).

**ABSTRACT**

This study aims to analyze the nature of chemical content, analyze abrasion value and optimum asphalt content using local Kinang Jingkion as road pavement material. In this study, XRF and XRD testing methods were used to determine the chemical content of Kinang Jingkion local material, then testing the characteristics of rough aggregate to determine the abrasion value, testing fine aggregate characteristics, and testing asphalt pen 60/70 and marshall test to determine the optimum asphalt content (KAO). The tests obtained the results of comparative data analysis between laboratory tests and literature standards that meet the eligibility requirements. The results showed that: First, the results of XRF and XRD analysis on Wilihingke samples, 0.15 mm granules, 2.36 mm granules, and Kinang Holuwon found that all chemical elements contained in the four samples were solid metal inorganic chemical elements. The results of this analysis prove that the four samples, which are fine aggregates and coarse aggregates, do not contain organic substances. Where the results of this analysis are by the requirements of aggregates which are one of the components in the concrete mixture, where the aggregates used must meet certain conditions, one of which must not contain excess organic matter because it can undergo decay by bacteria using dissolved oxygen; Second, from the test results obtained, the aggregate wear value (abrasion) was 32.69%; Third, based on the test results, the value of the Marshall parameter with Optimum Asphalt Content (KAO) obtained a value of 6.125%.

## Introduction

The area of Papua, which is the largest island in Indonesia, is 78,000 KM2, so to develop and drive national development, the land transportation sector plays a very important role in bringing a district closer to other districts in the context of realizing the archipelago insight, so as to direct the growth of trade and general development activities (Budiman, Saori, Anwar, Fitriani, & Pangestu, 2021).

The transportation system is an important element in the development of the Regency / City area, especially for Papua Province which has 29 districts / cities, where to connect between districts / cities, one of which is through land transportation, besides that the transportation system is also a support in the economic activities of a region (Prastika, Suhendra, & Dony, 2021). The construction, improvement, and maintenance of roads and bridges is one of the priority programs in almost all local and central governments (Fitri, Yusibani, & Yufita, 2016).

Yalimo Regency is one of the regencies located in the mountainous area (Lapago); Yalimo Regency was divided from Jayawijaya Regency, with the capital located in Elelim district. The transportation system of goods and services in Yalimo Regency still relies on the Wamena-Jayapura air and land transportation routes (Kumendong, Kaseke, & Diantje, 2015). Currently there is a Trans Papua Road that allows access from Yalimo Regency to Jayapura Regency, but at certain times it cannot be passed due to landslides or damage to the road body, so that some basic materials, fuel, and building materials are transported by airplane from Jayapura to Wamena, then sent to Yalimo Regency using trucks, this results in the price of goods in Yalimo Regency increasing high, because the cost of air transportation from Jayapura-Wamena is quite large (Business News.id, 2022).

In addition to high fuel and basic food prices due to logistics transportation costs, the cost of road pavement work in Yalimo Regency has also indirectly increased because road pavements generally use flexible pavement where asphalt is the main adhesive (Situmorang, Pratomo, & Herianto, 2016). Papua has abundant wealth and natural resources, especially Yalimo Regency, which has potential natural resources that can be used as alternatives or substitutes for asphalt, which can reduce the use of road infrastructure budgets so that the budget can be diverted to education, health, and other infrastructure development. This natural material to replace asphalt was discovered by Ir. Yan Ukago, M.T., Head of the PUPR Office of Yalimo Regency named Kinang Jingkion in his presentation said "Yalimo asphalt is a natural product not a residue of oil and gas processing and can be a local material for domestic infrastructure projects such as roads, bridges or others", this local material has been used on primary local class roads connecting Local Activity Centers (PKL) and Regional Activity Centers (PKW).

However, the local material of Kinang Jingkion cannot be known in detail in terms of material content as road pavement material, for that the author is interested in analyzing the chemical content of local material Kinang Jingkion as a layer of road pavement in Yalimo Regency (Fitri, Yusibani, & Yufita, 2017).

The purpose of the research is to analyze the nature of chemical content, abrasion value in use, and Optimum Asphalt Content (KAO) value in the use of Kinang Jingkion local material to be used as road pavement material (Hamzah & Learn, 2010). The benefits to be achieved are for the development of theories related to the nature of chemical content and the use of local material Kinan Jingkion as a crude agregrat to the characteristics of laston mixtures (Vitri & Herman, 2019).

Based on research by (Suaryana, Susanto, Ronny, & Sembayang, 2018) entitled Testing Local Materials as Road Pavement Materials on Remote and Outermost Islands, where it is explained that local materials that can be used for road construction in the Mentawai Islands are yellow sirtu and black sirtu respectively for the foundation layer with 6% cement stabilization; for the Aru Islands are coral for foundation layers and sea sand for paved mixtures and cement concrete mixtures; and, Morotai Island is Momojiu limestone for foundation layers, Rau limestone for paved mixtures, Bere-bere sea sand for paved mixtures and cement concrete mixtures, and Sabatai sea sand for paved mixtures and cement concrete mixtures. Another study was conducted by (Yoo et al., 2019) with the title Determination of the Quality of Local Aggregate Material as a Flexible Pavement Mixture in the Macadam Penetration Layer in the form of Gradation, Wear, Flatness Index and Blanketing and Peeling Test Results on Cisero aggregates better than Puncak Kalong and Pareang aggregates (Darlita, Joy, & Sudirja, 2017). The broken field in Pareang aggregate is better than Cisero aggregate and Puncak kalong aggregate because the material comes from rocks in the hills. In general, good aggregates used as lapen construction are Cisero and Puncak kalong. The aggregate from the Pareang quarry above can be used for pavement on environmental roads and footpaths.

## Research Methods

This study was taken from Eleim District, Yalimo Regency, Papua Province samples. The primary data directly taken is in the form of local material Kinang Jingkion, which is the result of gradation of coarse aggregate held in filter no.8. The skunder data used is in the form of literature by studying similar previous research, theories related to Laston AC-WC, methods, research procedures and data analysis techniques that support research on the use of Kinang Jingkion as a coarse aggregate (Sugiyono, 2017). After the data is collected, the next step is material preparation and data analysis techniques.

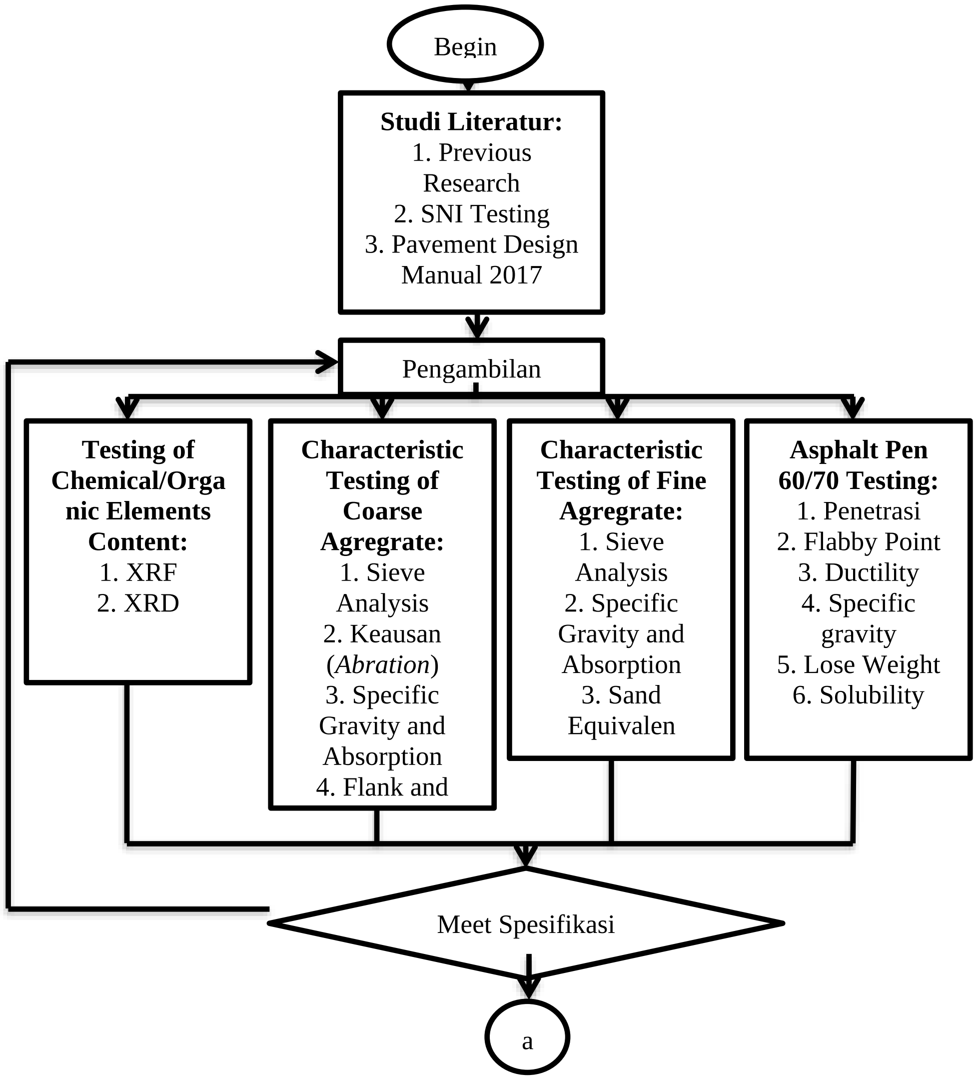



**Figure 1 Research Flow Chart**

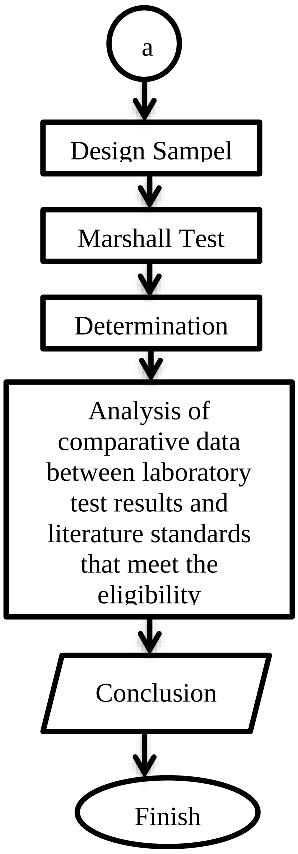



**Figure 2 Advanced Research Flow Chart**

## Results and Discussion

The results of XRF analysis on Wilihingke samples, 0.15 mm granules, Kinang Holuwon, and 2.36 mm granules found that all chemical elements contained in the four samples were solid metal inorganic chemical elements. The results of this analysis prove that the four samples which are fine aggregates and coarse aggregates do not contain organic substances where the results of this analysis are in accordance with the requirements of aggregates which are one of the components in the concrete mixture, where the aggregates used must meet certain conditions, one of which must not contain excess organic matter because it can undergo decay by bacteria using dissolved oxygen.

From each chemical element data contained is not much different and almost the same number of elements and percentages, and it was found that the elements that dominate the alloy of materials formed are Aluminum (Al), Silisium (Si), and Iron (Fe). This can make the four prancing samples classified as ferrous metals. Ferrous metal is an alloy metal with iron as the main constituent compared to other types of metals.

There are also metal characteristics, namely:

1. Its mechanical properties include strength, flexibility, hardness, fatigue resistance, and other properties.

2. Physical properties, such as heat conductivity, electricity, density, magnetic, and and optical conductivity.
3. Chemical properties include resistance to corrosion and other things related to chemically materials.
4. Technology includes the ability of metals to be further processed, such as shaped, welded, joined, machined, cast, and hardened.

Which corresponds to the science of metal metallurgy. The properties possessed by a metal will be related to one another. A component made of metal in its application is largely determined by the ability of the metal to be used. Where the metal is used and the material of the metal so that knowledge covers the various characteristics of the metal used. The macroscopic behavior of materials certainly plays an important role in explaining the properties of materials as hard, strong, brittle, forgible, magnetic, wear-resistant, and others that are relevant to the properties of asphalt.

Chemically pure iron (Ferro or Fe) is not suitable as a material because it is too soft. Technically treatable iron is always an alloy of iron (Fe) with charcoal (C) and other elements. The measure that determines hardness, strength and ductility is the amount of charcoal (carbon) contained in iron, where the characteristics of the jingkion kinang sample are in accordance with the characteristics of asphalt raw materials, the properties and raw materials that make up asphalt are having durability, cohesion and adhesion, sensitivity to temperature, asphalt hardness and asphalt viscoelasticity.

**Analysis of Element Content Using XRD**

To determine the accuracy of the material elements, researchers run or test each sample. The following are the results of chemical element testing using XRD.

1. XRD Aeris Suite Spectrometer Tool Specification vs. 1.4b (28)

Aeris is a Benchtop X-ray diffractometer and PANalytic device with the following configuration:

**Table 1**
**Spectrometer XRD Aeris Suite Configuration vs. 1.4b (28)**

| | |
|---|---|
| X-Ray Tube | Empyrean Cu/Co Tube |
| Detector | PIXcel1D Ultrafast Detector |
| Filter | Nor do they give faith |
| Spinner | Reflection Transmission Spinner |
| Arc Movement | DOPS Gonio Technology |

2. Test Results
a. Wilihingke

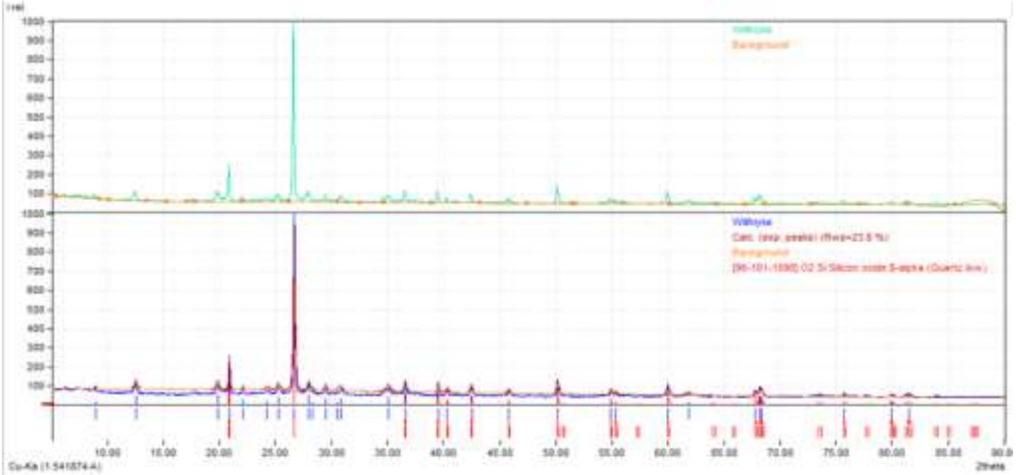


**Figure 3 Wilihingke XRD Test Results and Wilihingke Match Data**

The results of qualitative analysis with Search-Match [Hartono et al., 2009] show that the oxide element that makes up rocks predominantly is Quartz (SiO2). This can be seen in the XRD results that the quartz content (Quartz) appears at each crystal peak in the results of the 0.15 mm Granule sample match data; these results prove that the results of analysis using XRF containing Silica as much as 50.493% by the results of analysis using the search match application.

b. Details 0.15 mm

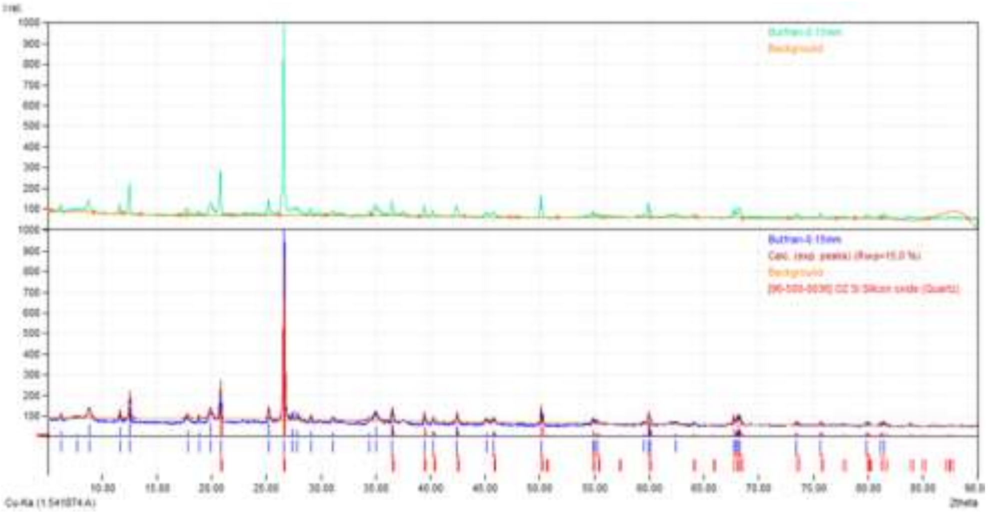
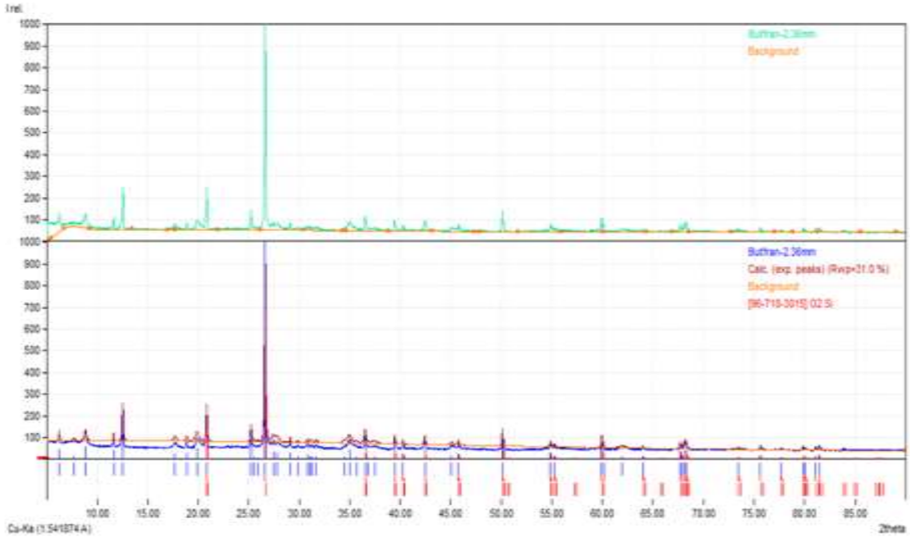


**Figure 4 XRD Test Results and Match Data Details 0.15 mm**

The results of qualitative analysis with Search-Match [Hartono et al., 2009] show that the oxide element that makes up rocks predominantly is Quartz (SiO2). This can be seen in the XRD results that the quartz content (Quartz) appears at each crystal peak in the results of the 0.15 mm sample match data; these results prove that the results of analysis using XRF containing Silica as much as 42.3063% by the results of analysis using the search match application.

c. Details 2,36 mm



**Gambar 5 Hasil Pengujian XRD dan Match Data Butiran 2,36 mm**

The results of qualitative analysis with Search-Match [Hartono et al., 2009] show that the oxide element that makes up rocks predominantly is Quartz (SiO2). This can be seen in the XRD results that the quartz content (Quartz) appears at each crystal peak in the results of the 2.36mm Granules sample match data; these results prove that the results of analysis using XRF containing Silica as much as 45.983% by the results of analysis using the search match application.

d. Kinang Holuwon

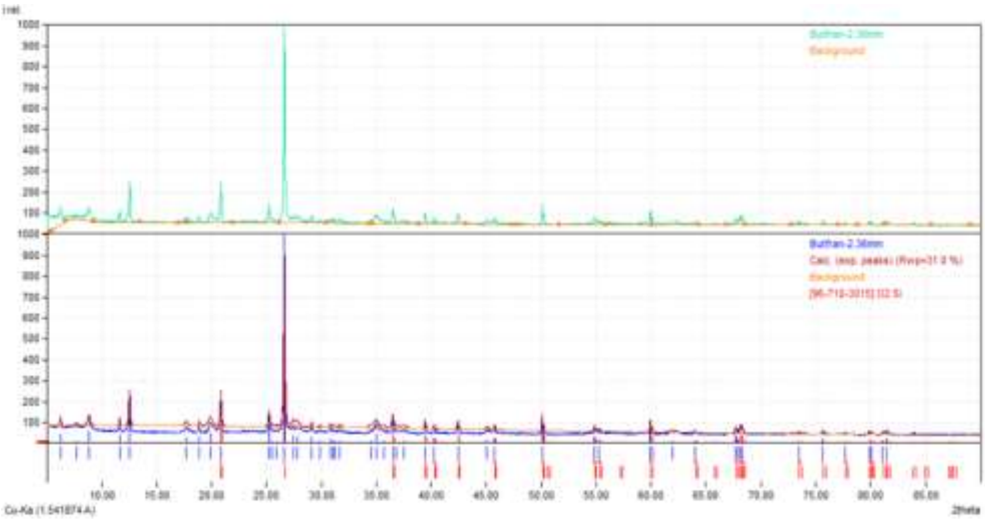


**Figure 6 XRD Test Results and Kinang Holuwon Match Data**

The results of qualitative analysis with Search-Match [Hartono et al., 2009] show that the oxide element that makes up rocks predominantly is Quartz (SiO2). This can be seen in the XRD results that the quartz content (Quartz) appears at each crystal peak in the results of the Kinang Holuwon sample match data; these results prove that the results of the analysis using XRF containing Silica as much as 41.0436% and containing Annite and Aluminum by the results of analysis using the search application match (in figure 7).

Annite falls into the category of "biotite" minerals usually used in the field because the group of black mica minerals (annite, siderophyllite, fluoro phlogopite, eastonite, and so on) generally cannot be distinguished without optical, chemical, or x-ray analysis. Biotite can form under metamorphic conditions when claystones are exposed to heat and pressure to form schists and gneiss. Although biotite is not very resistant to weathering and can turn into clay minerals, sometimes biotite can still be found in sedimentary and sandstone materials. Biotite minerals have commercial uses, such as being used as fillers and "extenders" in paints, as additives to drilling mud, as inert fillers and molding media, and as surface coatings in the asphalt industry. Biotite is also used in potassium-argon and argon methods in igneous rocks.

Aluminum metal is a metal that has light properties whose utilization is very wide. Besides being lightweight, it has other advantages, such as good heat introduction. This material is used in a wide field not only for household appliances but also for the material needs of aircraft, cars, ships, and construction. Aluminum has several physical character properties, including having a specific gravity of about 2.65-2.8 kg/dm3, having good electrical and thermal conductivity, resistance to corrosion in some materials, melting point of 6580°C.

The presence of the dominant content of annite and aluminum in the holuwon king sample can prove that the results of this analysis are suitable as raw materials for asphalt. The index of rocks, in addition to being determined by the proportion of weight of coarse and fine grain fractions, is also influenced by the amount of minerals that make up the mass. X-ray diffraction (XRD) is a very important method in mineral characterization. The stages of XRD work consists of four stages: production, diffraction, detection, and interpretation (Rahman, 2008).

XRD identification was analyzed to determine mineralogy characteristics, and the comparison of the results of XRF analysis on the four samples used in this study should be comparable. Mineral content testing aims to determine the type and percentage of mineral content contained in jinking king samples. XRD test output data, in the form of diffractogram graphs, are used to determine what phases (crystals) are included in the test specimen. Phase identification is done by finding the peak position and matching the phase in the database. This study used the help of the Match 2.0 program to match the spectrum of XRD test results with a reference database of previously known mineral spectra.

Based on the search-match results, XRF analysis can be identified in proportion to the mineral content of the four jingling bird samples and their percentage. The Wilihingke sample obtained has a dominant mineral content consisting of Quartz ($SiO_2$) 50.493%, Fe 17.467%, and Al 12.5643%, the 0.15 mm Granule sample obtained has a dominant mineral content consisting of Quartz ($SiO_2$) 42.3063%, Fe 22.4476% and Al 16.0036%, the 2.36 mm Granulated sample obtained has a dominant mineral content consisting of Quartz ($SiO_2$) 45.983%, Fe 20.293% and Al 16.486%, Kinang Holuwon samples obtained have a dominant mineral content consisting of Quarts (SiO2) 41.0436%, but in the Kinang Holuwon sample, Fe and Al content is greater than the other three samples, namely Fe 30.08% and Al 8.89%.

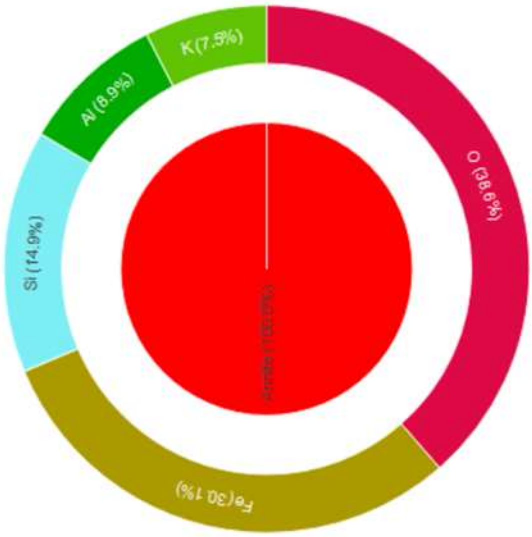



**Figure 7**
**Percentage of Mineral Content from XRD Analysis with Search Match**

Based on the results of XRD analysis, the four samples of Kinang Jingkion, namely Wilihingke, Granules 0.15 mm, Granules 2.36 mm, and Kinang Holuwon, the results of Quartz (SiO2) content were at each crystal peak of the four samples. Quartz (SiO2) content, which is very dominant in sample test results, must influence the quality of the four samples. Quartz minerals have a hardness scale of 7, so it can be concluded that the greater the level of mineral hardness in the sample, the greater the CBR value. From these advantages, quartz value (Quartz) has the potential to be used to improve asphalt performance.

**Crude Agregrat Testing**

The crude aggregate testing was conducted on Tuesday, January 10 to 11, 2023, at the National Road Implementation Center (BPJN) Laboratory in Jayapura. The aggregate used is the coarse aggregate produced by the crusher produced by PT. Topas.

**Aggregate Wear (Abrasion) Testing With Los Angeles Machines**

This test refers to SNI 2417: 2008 to determine the wear rate expressed by the ratio between the weight of the worn material to the original weight in percent. The results of this test can be seen in Table 2.

**Table 2**
**Agregrat (abrasion) wear testing with Los Angeles engines**

| **Sieve** | | **Weight and Gradation of Test Specimen (grams)** | |
|---|---|---|---|
| **Escape** | **Stuck** | **Test Specimen 1** | **Test Specimen 2** |
| 3 / 4 " | 1 / 2 " | 2500 | 2500 |
| 1 / 2 " | 3 / 8 " | 2500 | 2500 |
| Total weight (A) | | **5000** | **5000** |

| | | |
|---|---|---|
| Weight restrained filter no. 12 ( B ) | **4611,60** | **3365,70** |
| Number of Balls | 11 | 11 |
| Number of Collisions | 100 | 500 |
| Requirements (Maximum) | 8% | 40% |
| The weight of the Aus (C = A – B) | **388,40** | **1634,30** |

Rating fr 100Turs often $= \frac{\text{worn weight}}{\text{weight ofhe specimen}} \times 100\%$

$$= \frac{388{,}40}{5000} \times 100\% = 7{,}77\%$$

r400 Rouns $= \frac{\text{worn weight}}{\text{weight of the specimen}} \times 100\%$

$$= \frac{1634{,}30}{5000} \times 100\%$$

$$= 32{,}69\%$$

From the test results obtained, the gross aggregate wear value is 32.69%, meets the requirements, and can be used to make test specimens.

**Blanketing and peeling testing on aggregate-asphalt mixtures**

This test refers to SNI 2439: 2011 to determine the percentage of aggregate surface area covered with asphalt against the entire aggregate surface. The results of this test are seen visually, that the asphalt blanketing of aggregate is 100%. This means meeting the required specifications of at least 95%.

**Specific gravity and absorption testing of coarse aggregates**

This test refers to SNI 1969: 2016 to determine the weight gain of an aggregate due to water seeping into the pores, but excluding water retained on the outer surface of the particles, expressed as a percentage of their dry weight. The results of this test can be seen in Table 3 and Table 4.

**Table 3**
**Specific gravity and absorption testing of crude aggregates (Uk. 1-2)**

| No | Description | | | Testing I | Testing II | War - War |
|---|---|---|---|---|---|---|
| 1 | Oven dry specimen weight | | BK | 1196.0 | 1198.0 | 1197.0 |
| 2 | Weight of saturated surface specimen | | BJ | 1235.4 | 1238.5 | 1237.0 |
| 3 | The weight of the specimen in the water | | BA | 757.0 | 759.1 | 758.1 |
| | Specific Gravity | ( Bulk ) | $\frac{BK}{BJ-BA}$ | 2.50 | 2.50 | 2.50 |
| | The specific gravity of saturated surface dry | ( SSD ) | $\frac{BJ}{BJ-BA}$ | 2.58 | 2.58 | 2.58 |
| | Apparent specific gravity | (Apparent ) | $\frac{BK}{BK-BA}$ | 2.72 | 2.73 | 2.73 |
| | Absorption | | $\frac{BJ-BK}{BK} X\ 100\%$ | 3.29 | 3.38 | 3.34 |

Based on the test results of specific gravity and absorption of coarse aggregate (UK. 1-2 cm), the specific gravity value of aggregate is 2.50%. This meets the standards set in SNI 1969: 2016, which is at least 2.50%. Thus, aggregates can be used to make AC-WC hot asphalt mixtures.

**Table 4**
**Specific gravity and absorption testing of crude aggregates (UK. 1-2)**

| No | Description | | | Testing I | Testing II | War - War |
|---|---|---|---|---|---|---|
| 1 | Oven dry specimen weight | | BK | 1235.2 | 1237.3 | 1236.3 |
| 2 | Weight of saturated surface specimen | | BJ | 1277.8 | 1279.7 | 1278.8 |
| 3 | The weight of the specimen in the water | | BA | 768.7 | 770.1 | 769.4 |
| | Specific Gravity | ( Bulk ) | $\frac{BK}{BJ-BA}$ | 2.53 | 2.48 | 2.50 |
| | The specific gravity of saturated surface dry | ( SSD ) | $\frac{BJ}{BJ-BA}$ | 2.57 | 2.54 | 2.56 |
| | Apparent specific gravity | (Apparent) | $\frac{BK}{BK-BA}$ | 2.65 | 2.65 | 2.65 |
| | Absorption | | $\frac{BJ-BK}{BK} X\ 1$ | 1.83 | 2.62 | 2.22 |

Based on the test results of specific gravity and absorption of coarse aggregate (UK. 0.5-1 cm), the specific gravity value of aggregate is 2.50%. This meets the standards set in SNI 1969: 2016, which is at least 2.50%. Thus, aggregates can be used to make AC-WC hot asphalt mixtures.

From the test results for coarse aggregates measuring 1-2 cm and measuring 0.5-1 cm, it can be seen that the larger the aggregate size, the greater the aggregate specific gravity value. It can also be seen that the larger the aggregate size, the smaller the aggregate absorption. This is because a larger aggregate surface area results in smaller absorption.

**Fine Agregrat Testing**

Fine aggregate testing was carried out on Tuesday, January 10 to 12, 2023 at the National Road Implementation Center (BPJN) Laboratory in Jayapura. The aggregate used is a fine broken aggregate resulting from the crusher produced by PT. Topas and Sand of the Landik River.

**Specific gravity testing and fine agregrat absorption**

This study refers to SNI 2417: 2008 with the aim of determining the wear rate expressed by the ratio between the weight of worn material to the original weight in percent. The results of this test can be seen in Table 5 and Table 6.

**Table 5**
**Specific gravity and absorption testing of fine agregrat (fine rupture agregrate)**

| No | Description | | Testing I | Testing II | War - War |
|---|---|---|---|---|---|
| 1 | Weight of saturated surface specimen | ( SSD) | 500 | 500 | 500 |
| 2 | Oven dry specimen weight | (B ) | 489.1 | 488.2 | 488.65 |
| 3 | Picnometer weight + water (Calibration) | (B) | 658.0 | 659.1 | 658.55 |
| 4 | Picnometer weight + Water + Examples | ( Bt ) | 962.7 | 964.8 | 963.75 |
| Specific Gravity | (Bulk) | $\frac{BK}{BJ + 500 - Bt}$ | 2.504 | 2.513 | 2.508 |
| Specific gravity of saturated surface dry | (SSD) | $\frac{500}{B + 500 - Bt}$ | 2.560 | 2.573 | 2.567 |
| Apparent specific gravity | (Apparent) | $\frac{BK}{B + BK - Bt}$ | 2.652 | 2.675 | 2.664 |
| Absorption | | $\frac{500 - BK}{BK} X\ 100\%$ | 2.229 | 2.417 | 2.323 |

Based on the test results of specific gravity and absorption of fine aggregate (fine broken aggregate), the specific gravity value of aggregate is 2.508%. This meets the standards set in SNI 1969: 2016, which is at least 2.50%. Thus aggregates can be used to make AC-WC hot asphalt mixtures.

**Table 6**
**Specific gravity and absorption testing of fine agregrrates (sand)**

| No | Description | | | Testing I | Testing II | War - War |
|---|---|---|---|---|---|---|
| 1 | Weight of saturated surface specimen | | (SSD) | 500 | 500 | 500 |
| 2 | Oven dry specimen weight | | (BK) | 490.1 | 489.1 | 490.1 |
| 3 | Weight picnometer + water ( Calibration ) | | ( B ) | 660.6 | 667.2 | 660.6 |
| 4 | Picnometer weight + Water + Examples | | ( Bt ) | 964.0 | 972.9 | 964 |
| Specific Gravity | | (Bulk) | $\frac{BK}{BJ+500-Bt}$ | 2.493 | 2.522 | 2.508 |
| Specific gravity of saturated surface dry | | (SSD) | $\frac{500}{B+500-Bt}$ | 2.543 | 2.573 | 2.558 |
| Apparent specific gravity | | (Apparent) | $\frac{BK}{B+BK-Bt}$ | 2.625 | 2.685 | 2.655 |
| Absorption | | | $\frac{500-BK}{BK} X\ 100\%$ | 2.020 | 2.648 | 2.334 |

Based on the test results of specific gravity and absorption of fine aggregate (sand), the specific gravity value of aggregate is 2.508%. This meets the standards set in SNI 1969: 2016, which is at least 2.50%. Thus aggregates can be used to make AC-WC hot asphalt mixtures.

**Testing of fine agregrat or sand containing plastic material in a sand-equivalent manner**

This research refers to SNI 4428:1997 with the aim of determining the quality of sand or fine aggregate that passes filter number 4 (4.76 mm). The results of this test can be seen in Table 7 and Table 8.

**Table 7**
**Testing of fine agregrat or sand containing plastic material by means of sand equivalent (fine broken agregrat)**

| No | Description | Testing I | Testing II |
|---|---|---|---|
| 1 | Tera height stem pointing the load into the measuring cup (glass in dry condition) | 10 | 10 |

| | | | |
|---|---|---|---|
| 2 | Read the mud scale (mud surface scale reading look at the wall of the measuring cup) | 5.0 | 4.8 |
| 3 | Load input, read the load scale on the pointing stem | 12.6 | 12.5 |
| 4 | Read the sand scale (reading 3 - reading 1) | 2.6 | 2.5 |
| 5 | Sand Equivalent Value, sand scale (4/2 ) x 100% | 52.00 | 52.08 |
| 6 | War – War | 52.04 | |

Based on the test results of fine aggregate or sand containing plastic materials by means of sand equivalent (fine broken aggregate), the equivalent value of sand for aggregate is 52.04%. This meets the standards set in SNI 4428:1997, which is at least 50.00%. Thus aggregates can be used to make AC-WC hot asphalt mixture.

**Table 8**
**Testing of fine agregrat or sand containing plastic material in a sand-equivalent way (sand)**

| No | Description | Testing | |
|---|---|---|---|
| | | I | II |
| 1 | Tera height stem pointing the load into the measuring cup (glass in dry condition) | 10 | 10 |
| 2 | Read the mud scale (mud surface scale reading look at the wall of the measuring cup) | 4.5 | 4.5 |
| 3 | Load input, read the load scale on the pointing stem | 14.0 | 14.0 |
| 4 | Read the sand scale (reading 3 - reading 1) | 4.0 | 4.0 |
| 5 | Sand Equivalent Value, sand scale (4/2 )x 100% | 89.89 | 88.89 |
| 6 | War - war | 89.39 | |

Based on the test results of fine aggregate or sand containing plastic materials by means of sand equivalent (sand), the equivalent value of sand for aggregate is 89.39%. This meets the standards set in SNI 4428: 1997, which is at least 50.00%. Thus aggregates can be used to make AC-WC hot asphalt mixture.

**Asphalt Testing**

Asphalt testing will be carried out on Monday, January 16, 2023 at the National Road Implementation Center (BPJN) Laboratory in Jayapura.

**Asphalt Penetration Testing**

This test refers to SNI 2456: 2011 with the aim of measuring the consistency of asphalt. A high penetration value indicates a softer consistency of asphalt. The results of this test can be seen in Table 9.

**Table 9**
**Asphalt Penetration Testing**

| Penetration Check | **Test Specimen** | |
|---|---|---|
| at °C, 100gram, 5sec | **I** | **II** |
| Observation 1 | 66 | 66 |
| Observation 2 | 65 | 67 |
| Observation 3 | 64 | 68 |
| Observation 4 | 67 | 67 |
| Observation 5 | 63 | 67 |
| War – War | 65 | 67 |
| Rata – Rata | 66 | |
| Specifications | 60 -70 | |

From the results of asphalt terteration testing, 66 mm results were obtained. This means that PEN 60/70 asphalt can be used to make asphalt mixture test specimens as required by 60-70 mm.

**Asphalt Specific Gravity Testing**

This test refers to SNI 2441: 2011 with the aim of determining the ratio of the mass of a material with the mass of water at the same content and temperature. The results of this test can be seen in Table 10.

**Table 10**
**Asphalt Specific Gravity Testing**

| **Test Specimen** | **I** | | **II** | |
|---|---|---|---|---|
| Picnometer Weight + Asphalt | 48.373 | gram | 48.563 | gram |
| Empty Picnometer Weight | 32.163 | gram | 32.196 | gram |
| Asphalt Weight (a) | 16.21 | gram | 16.367 | gram |
| Picnometer Weight + water | 59.217 | gram | 59.308 | gram |
| Empty Picnometer Weight | 32.163 | gram | 32.196 | gram |
| Water weight (b) | 27.054 | gram | 27.112 | gram |
| Picnometer Weight + Water + Asphalt | 59.507 | gram | 59.718 | gram |
| Picnometer + Aspal | 48.373 | gram | 48.563 | gram |
| Water weight (c) | 11.134 | gram | 11.155 | gram |
| Asphalt Fill (b-c) | 15.92 | ml | 15.957 | ml |
| Specific Gravity I = Weight of asphalt/asphalt content | 1.018 | | | gram/ml |
| Specific Gravity II = Weight of asphalt / asphalt content | 1.026 | | | gram/ml |
| War – War | 1.022 | | | gram/ml |

| | |
|---|---|
| Specifications | ≥1.0 grams/ml |

From the results of testing the specific gravity of asphalt, the results were obtained 1.022 g / ml. This means that PEN 60/70 asphalt can be used to make asphalt mixture test specimens as required greater than or equal to 1 gr/ml.

**Asphalt ductility testing**

This test refers to SNI 2432: 2011 with the aim of determining the extundance properties of asphalt measured at the time of breaking. The results of this test can be seen in Table 11.

**Table 11**
**Asphalt ductility testing**

| Ductility Check<br>at 25°C.5 cm per minute | Test Specimen |
|---|---|
| Observation | 113.9 |
| Specifications | ≥ 100 cm |

From the results of asphalt ductility testing, 113.9 cm results were obtained. This means that PEN 60/70 asphalt can be used to make asphalt mixture test specimens as required greater than or equal to 100.00 cm.

**Asphalt Flash Point Testing**

This test refers to SNI 2433: 2011 with the aim of determining the lowest temperature at which the vapor of the test specimen can ignite (short blue flame) when passed by the tester's flame. The results of this test can be seen in Table 12.

**Table 12**
**Asphalt Flash Point Testing**

| Flash Point | Example (°C) |
|---|---|
| Observation 1 | 286 |
| Observation 2 | 292 |
| Specifications | ≥ 232 °C |

From the results of asphalt flash point testing, observations 1 and observation 2 were obtained respectively 286 oC and 292 oC. This means that PEN 60/70 asphalt can be used to make asphalt mixture test specimens as required greater than or equal to 232 oC.

**Asphalt Soft Point Testing**

This test refers to SNI 2434: 2011 with the aim of determining the temperature when a steel ball with a certain weight &; pressing down a layer of asphalt that is held in a certain sized ring &; so that the asphalt touches the base plate located in the wet ring at a distance of 25.4 mm and as a result of a certain heating speed. The results of this test can be seen in Table 13.

**Table 13**
**Asphalt Soft Point Testing**

| Soft point check<br>temperature rise of 5°C per minute | Left |
|---|---|
| Observation | 49 |
| Specifications | ≥ 48 $^{oC}$ |

From the test results of the asphalt soft point, observations of 49 oC were obtained. This means that PEN 60/70 asphalt can be used to make asphalt mixture test specimens as required greater than or equal to 48 oC.

**Filter Analysis**

The filter analysis test was carried out on Wednesday, January 11, 2023 at the National Road Implementation Center (BPJN) Laboratory in Jayapura. This study refers to SNI 1968: 1990 with the aim of obtaining the distribution of the magnitude or percentage of grains both fine aggregate and coarse aggregate. The obtained distribution can be indicated in a table or graph. Analysis is carried out on coarse and fine aggregates and filler materials. The results of this test can be seen in the tables below.

**Table 14**
**Crude Agregrat Sieve Analysis (Uk. 1-2 cm)**

| No. | Brt. Restrained | Cumulative | | Average | No. | Brt. Restrained | Cumulative | |
|---|---|---|---|---|---|---|---|---|
| Sieve | Cumulative | % Tthn. | % Passes | | Sieve | Cumulative | % Tthn. | % Passes |
| 1 1/2" | 0.0 | 0.00 | 100.00 | 100.00 | 1 1/2" | 0.0 | 0.00 | 100.00 |
| 1" | 0.0 | 0.00 | 100.00 | 100.00 | 1" | 0.0 | 0.00 | 100.00 |
| 3/4 " | 0.0 | 0.00 | 100.00 | 100.00 | 3/4 " | 0.0 | 0.00 | 100.00 |
| 1/2 " | 1662.4 | 78.45 | 21.55 | 20.45 | 1/2 " | 1624.9 | 80.65 | 19.35 |
| 3/8 " | 2091.5 | 98.70 | 1.30 | 1.66 | 3/8 " | 1974.0 | 97.97 | 2.03 |
| No. 4 | 2115.9 | 99.85 | 0.15 | 0.20 | No. 4 | 2009.5 | 99.74 | 0.26 |
| No. 8 | 2117.3 | 99.92 | 0.08 | 0.12 | No. 8 | 2011.4 | 99.83 | 0.17 |
| No. 16 | 2117.7 | 99.94 | 0.06 | 0.10 | No. 16 | 2012.1 | 99.87 | 0.13 |
| No. 30 | 2117.9 | 99.95 | 0.05 | 0.09 | No. 30 | 2012.4 | 99.88 | 0.12 |
| No. 50 | 2118.1 | 99.96 | 0.04 | 0.07 | No. 50 | 2012.7 | 99.90 | 0.10 |
| No. 100 | 2118.7 | 99.99 | 0.01 | 0.04 | No. 100 | 2013.6 | 99.94 | 0.06 |
| No. 200 | 2119.0 | 100 | 0.00 | 0.02 | No. 200 | 2014.0 | 99.96 | 0.04 |
| PAN | 2119 | | | | PAN | 2014.8 | | |

From the results of sieve analysis for coarse aggregate (Uk. 1-2 cm) obtained the percentage of aggregate passing filter No. 200 of 0.02%. This means that coarse aggregate (Uk. 1-2 cm) can be used on AC-WC hot asphalt mixture as required maximum pass 1.00%.

**Table 15**
**Crude Agregrat Sieve Analysis (Uk. 0.5-1 cm)**

| No. | Brt. Restrained | Cumulative | | Average | No. | Brt. Restrained | Cumulative | |
|---|---|---|---|---|---|---|---|---|
| Sieve | Cumulative | % Tthn. | % Passes | | Sieve | Cumulative | % Tthn. | % Passes |
| 1" | 0.0 | 0.00 | 100.00 | 100.00 | 1" | 0.0 | 0.00 | 100.00 |
| 3/4 " | 0.0 | 0.00 | 100.00 | 100.00 | 3/4 " | 0.0 | 0.00 | 100.00 |
| 1/2 " | 8.4 | 0.38 | 99.62 | 99.62 | 1/2 " | 8.5 | 0.38 | 99.62 |
| 3/8 " | 73.0 | 3.33 | 96.67 | 97.11 | 3/8 " | 54.8 | 2.45 | 97.55 |
| No .4 | 2115.2 | 96.53 | 3.47 | 3.46 | No. 4 | 2158.8 | 96.54 | 3.46 |
| No. 8 | 2188.3 | 99.86 | 0.14 | 0.15 | No. 8 | 2232.3 | 99.83 | 0.17 |
| No. 16 | 2189.1 | 99.90 | 0.10 | 0.12 | No. 16 | 2233.2 | 99.87 | 0.13 |
| No. 30 | 2189.4 | 99.91 | 0.09 | 0.10 | No. 30 | 2233.5 | 99.88 | 0.12 |
| No. 50 | 2189.6 | 99.92 | 0.08 | 0.09 | No. 50 | 2233.8 | 99.90 | 0.10 |
| No. 100 | 2190.2 | 99.95 | 0.05 | 0.06 | No. 100 | 2234.4 | 99.92 | 0.08 |
| No. 200 | 2190.6 | 99.97 | 0.03 | 0.05 | No. 200 | 2234.8 | 99.94 | 0.06 |
| PAN | 2190.8 | | | | PAN | 2235.2 | | |

From the results of sieve analysis for coarse aggregate (Uk. 0.5-1 cm) obtained the percentage of aggregate passing filter No. 200 of 0.05%. This means that coarse aggregate (Uk. 0.5-1 cm) can be used in AC-WC hot asphalt mixture as required maximum pass 1.00%.

**Table 16**
**Fine Agregrat Sieve Analysis (Fine Broken Agregrat)**

| No. | Brt. Restrained | Cumulative | | Average | No. | Brt. Restrained | Cumulative | |
|---|---|---|---|---|---|---|---|---|
| Sieve | Cumulative | % Tthn. | % Passes | | Sieve | Cumulative | % Tthn. | % Passes |
| No. 4 | 0.0 | 0.00 | 100.00 | 100.0 | No. 4 | 0.0 | 0.00 | 100.00 |
| No. 8 | 397.9 | 25.20 | 74.80 | 87.40 | No. 8 | 0.0 | 0.00 | 100.00 |
| No. 16 | 683.5 | 43.28 | 56.72 | 57.52 | No. 16 | 576.2 | 41.68 | 58.32 |
| No. 30 | 1031.7 | 65.33 | 34.67 | 35.19 | No. 30 | 888.7 | 64.29 | 35.71 |
| No. 50 | 1274.9 | 80.74 | 19.26 | 19.84 | No. 50 | 1100.0 | 79.58 | 20.42 |
| No. 100 | 1434.8 | 90.86 | 9.14 | 9.64 | No. 100 | 1242.1 | 89.86 | 10.14 |
| No. 200 | 1473.3 | 93.30 | 6.70 | 7.20 | No. 200 | 1275.9 | 92.30 | 7.70 |
| PAN | | | | | PAN | | | |

From the results of sieve analysis for fine aggregate (fine broken aggregate) obtained the percentage of aggregate passing filter No. 200 of 7.20%. This means that fine aggregate (fine broken aggregate) can be used on AC-WC hot asphalt mixture as required maximum pass 10.00%.

**Table 17**

**Fine Agregrat Sieve Analysis (Sand)**

| No. | Brt. Restrained | Cumulative | | Average | No. | Brt. Restrained | Cumulative | |
|---|---|---|---|---|---|---|---|---|
| Sieve | Cumulative | % Tthn. | % Passes | | Sieve | Cumulative | % Tthn. | % Passes |
| No. 4 | 0.0 | 0.00 | 100.00 | 100.00 | No. 4 | 0.0 | 0.00 | 100.00 |
| No. 8 | 138.4 | 15.71 | 84.29 | 85.64 | No. 8 | 100.6 | 13.01 | 86.99 |
| No. 16 | 413.3 | 46.90 | 53.10 | 55.09 | No. 16 | 331.7 | 42.91 | 57.09 |
| No. 30 | 712.2 | 80.82 | 19.18 | 21.13 | No. 30 | 594.6 | 76.92 | 23.08 |
| No. 50 | 839.4 | 95.26 | 4.74 | 5.74 | No. 50 | 721.0 | 93.27 | 6.73 |
| No. 100 | 865.5 | 98.22 | 1.78 | 2.17 | No. 100 | 753.3 | 97.45 | 2.55 |
| No. 200 | 871.6 | 98.91 | 1.09 | 1.27 | No. 200 | 761.8 | 98.55 | 1.45 |
| PAN | 881 | | | | PAN | | | |

From the results of the sieve analysis for fine aggregate (sand), the percentage of aggregate passing filter No. 200 was 1.27%. This means that fine aggregate (sand) can be used in the AC-WC hot asphalt mixture as required to pass a maximum of 10.00%.

**Table 18**
**Filler Filter Analysis (Cement)**

| No. | Brt. Tertahan | Komulatif | | Rata-Rata | No. | Brt. Tertahan | Komulatif | |
|---|---|---|---|---|---|---|---|---|
| Ayakan | Komulatif | % Tthn. | % Lolos | | Ayakan | Komulatif | % Tthn. | % Lolos |
| No. | 0.0 | 0.00 | 100.0 | 100.00 | No. 100 | 0.0 | 0.00 | 100.0 |
| No. | 0.0 | 0.00 | 100.0 | 100.00 | No. 200 | 0.0 | 0.00 | 100.0 |
| PAN | 506 | 100.0 | 0.00 | 0.00 | PAN | 503 | 100.0 | 0.00 |

From the results of the filter analysis for Cement filler materials, the percentage of aggregate passed filter No. 200 was 100.00%. This means that Cement filler material can be used in AC-WC hot asphalt mixture as required to pass at least 75.00%.

**Gradation of Agregrat Mixture AC – WC**

After sieve analysis is carried out for each aggregate to be used for the manufacture of test specimens, a gradation calculation of AC-WC mixture aggregates is carried out to determine the percentage of each aggregate to be used.

From the results of the calculation of the gradation of mixed aggregates, it can be seen that all fractions for aggregates fall within the requirements set out in the General Specification of Highways Year 2018 Revision 2. It can be concluded that aggregates can be used to make AC-WC asphalt mixture test specimens according to the calculation of the percentage of each aggregate.

**Asphalt Content Calculation**

The calculation of Asphalt Content (Pb) is carried out after all combined aggregate percentages are known with the following formula:

Pb=0,035 x (%CA) +0,045 x (%FA) + 0,18 x (%FF) + K with:

Pb = Estimated asphalt content to the mixture, percentage of weight to the mixture,

CA = Sieve held aggregate number 8,

FA = Aggregate passed filter number 8 and restrained filter No.200,

FF = Filling material passes filter number 200, and

K = Constants 2.0 to 3.0 for latastons.

From the results of mixed gradation in Table 4.26 obtained the following values

CA = 47,53%; FA = 32,80%; FF = 4,73% dan untuk Nilai K diambil = 2

Maka:

Pb=0,035 x (47,53) + 0,045 x (32,80) + 0,18 x (4,73) + 2

Pb=1,664 +1,476+0,851+2

Pb=5,991 ~ 6,0

From the results of the Calculation of Asphalt Content Value (Pb) obtained at 6.0%, test specimens will be made with a range of asphalt content of 5.0%, 5.5%, 6.0%, 6.5%, and 7.0% each as many as 3 test objects for each Cement and Kinang Jingkion filler material. So that the total test specimens for each filler material are 15 pieces. Marshall AC-WC Test Results With Cement Filler

Marshall AC-WC testing with Cement Filler was carried out on Friday, January 20, 2023 at the BPJN Wamena Laboratory with reference to SNI 2489:1991. The purpose of this marshall test is to determine the stability and flow values as for the results that can be that at 5.5% asphalt content, the AC-WC hot asphalt mixture meets the specifications against Marshall parameters, while at 5.0%, 6.0%, 6.5 and 7.0% asphalt levels some Marshall parameters in the AC-WC hot asphalt mixture do not meet the specifications.

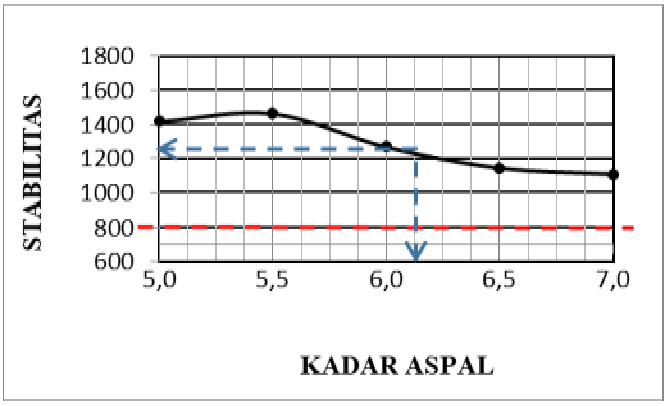



**Figure 8 Graph Up aspal**

From the graph above, the relationship between asphalt content using Cement Filler and stability, the black line shows that the stability value increases in the range of asphalt content 5.0% - 5.5% and after that shows a decrease until it reaches the minimum point in the range of asphalt content 6.0% - 7.0%, while the red line shows the minimum parameter of the relationship between asphalt content and stability, which is 800 kg.

## Conclusion

The results of XRF and XRD analysis on Wilihingke samples, 0.15 mm granules, 2.36 mm granules and Kinang Holuwon found that all chemical elements contained in the four samples were solid metal inorganic chemical elements. The results of this analysis prove that the four samples which are fine aggregate and coarse aggregate do not contain organic substances where the results of this analysis are in accordance with the requirements of aggregate which is one of the components in the concrete mixture, where the aggregate used must meet certain conditions, one of which must not contain excess organic matter because it can undergo decay by bacteria using dissolved oxygen. From the test results obtained, the aggregate wear value (abrasion) was 32.69%. Based on the test results, the value of the Marshall parameter with Optimum Asphalt Content (KAO) obtained a value of 6.125%.

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