Influence of replacement Portland cement with white limestone powder from Madura as filler on hot asphalt mixture (hot mix) Asphalt Concrete Wearing Course (ACWC) on Marshall characteristic

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Abstract. Road pavement layers are essential road construction that supports traffic loads, and as infrastructure that connecting one place to another and used by society should have good quality pavement, excellent performance and comfort serviceability to human movement in transportation. As is known filler has term and condition specification in Bina Marga General Specification (Edited Version 3) (2010), the added filler requirements consist of limestone dust, Calcium Carbonate, CaCO\(_3\), or lime dust by AASHTO M303-89 (2006). While the lime powder that has used as filler is according to the test results from the chemical engineering laboratory, ITS Surabaya pure white limestone Madura is a waste of natural lime rock containing Calcium Carbonate (CaCO\(_3\)) as much as 58.46%. It will be seen from the value of stability and flow by using Marshall Test Performance by combines mixture of asphalt-aggregate with filler of white lime powder of Madura with difference of asphalt content 5.5%, 6% and 6.5% and variation of content filler 0%, 1%, 2% 3% and 4% on mixed Asphalt Concrete Wearing Course (ACWC). From the result of the testing and analysis of Marshall, the replacement Portland cement with white limestone powder on asphalt concrete wearing course layer are finding combine of asphalt content 5.5 %, 6.0% and 6.5% and higher levels of filler in asphalt mixture shows the higher value stability while the value of flow decrease with increasing value of filler content in the asphalt mixture. Based on the value of the variation filler that meets specifications Marshall 4% white limestone Madura and 6% asphalt content as the proportion that meets all of Marshall parameter value.

1. Introduction
Hot mix asphalt (HMA) mixture as a material for road construction has long been recognized and widely used in road construction such as asphalt pavement. Its use in Indonesia has increased from year to year. The current emerging issue on road construction in Indonesia is the lack of filler supply, stone dust and Portland cement commonly used as filler, however, due to limited supply HMA offers a simple, cost-effective way to maintain roads construction, its ability to support high vehicle loads and can be made from local materials that are available and have excellent weather resistance. Therefore, it is necessary to search for new alternatives as filler. The filler material in the concrete asphalt mixture is material that passes No.200 (0.075 mm) sieve. The types of filler that can be used are stone dust, lime, Portland cement (PC), and fly ash. The amount of filler in the concrete asphalt mixture is minimal. Most fillers,
the mixture will be very stiff and easy to crack beside requiring much asphalt to meet workability. On the contrary, the lack of filler ingredients mixes become very flexible and easily deformed by the wheels of the vehicle, resulting in a bumpy road. Filler characteristics in road pavement mixtures are cavity fillers, increase the binding capacity of concrete asphalt, improve the stability of the mixture, and minimize melting or settlement.

An alternative filler is to use white limestone from Lesong village Pamekasan city of Madura, this filler has selected because in the 2010 General Specifications of Bina Marga (revised 3) the requirements for added fillers consisted of limestone dust (limestone dust, Calcium Carbonate, CaCO3), or quenched limestone dust in accordance with AASHTO M303-89 (2006) and according to the results of testing from the chemical engineering laboratory of ITS Surabaya, Madura white limestone powder is a waste of natural limestone that is containing 58.46% calcium carbonate (CaCO3), however the nature of cementation in white limestone dust is considered assist able to binding aggregates. The selection of Madura white limestone powder as a filler in addition to the more economical price compared to cement filler is also the result of Madura nature, so if in this type of filler research is proven to improve Marshall characteristics in accordance with the specifications that have been determined, then automatically earn the Madura limestone miners can be increased if this filler can be mass produced. In this study, it is expected that the use of Madura white limestone powder as a filler on ACWC pavement can produce significant changes in the density, stability, and flow values.

The objective of this study is to evaluate the performance of Asphalt Concrete - Wearing Course (AC-WC) by using white limestone dust as a filler and asphalt pen 60/70 as bitumen. For such purposes, there are two kinds of things to be done:

- To evaluate the AC-WC mixture using white limestone dust as a filler with asphalt pen 60/70, can increase the density of Marshall test
- To evaluate the AC-WC mixture using limestone as a filler and asphalt pen 60/70, can increase the stability of Marshall test with white limestone filler variation at the percentage of 0%, 1%, 2%, 3% dan 4% of the total weight of the mixture.

2. Literature reviews
Asphalt Concrete (Hot mix) is a type of flexible pavement that consists of an aggregate mixture, with or without additional ingredients. Asphalt concrete with dense graded aggregate is commonly used for massive traffic load road [1] and forming materials are mixed in the mixing plant at a specific temperature, then transported to the location, spread and compacted. Mixing temperature is determined based on what type of asphalt will be used [1]. In mixing asphalt must be heated to obtain a high level of liquidity (viscosity) to get a good mix quality and ease of execution. The choice of the type of asphalt to be used is determined by climate, traffic density and the type of construction to be used. One type of asphalt concrete that is commonly used is Asphalt Concrete -Wearing Course (AC-WC) mixture. Concerning its function, asphalt concrete consists of three types: Asphalt Concrete-Wearing Course (AC-WC), Asphalt Concrete-Binder Course (AC-BC) and Asphalt Concrete-Base with the maximum size of aggregate were 19 mm, 25.4 mm, 37.5 mm, respectively. The three types of Asphalt Concrete are an asphalt mix specification concept that has been refined by Bina Marga together with the Road Research and Development Center. In planning the new specifications use an absolute density approach. The use of AC-WC is for the surface layer (top) in the pavement and has the subtlest texture compared to other types of Asphalt Concrete. According to Silvia Sukirman, (2003) asphalt concrete characteristics are stability, durability, flexibility or fatigue resistance, surface hardness or shear resistance, water resistance and workability.

2.1. The material of asphalt mixture
Asphalt concrete mixture is a combination of bitumen material with aggregate which is a pavement surface that is commonly used. Mixed characteristics are obtained through analysis of the results of the design and testing carried out during material mixing and compaction. Asphalt material is used for all types of highways and is one part of the first to lower grade asphalt road concrete layer. Bitumen material
is a hydrocarbon that can dissolve in carbon disulfate. This type of asphalt mixture is a mixture consisting of asphalt and dense graded aggregate, spread and compacted in a hot temperature. The material is usually in good condition at average temperatures and if the heat will soften or decrease in density. According to Rian Putrowijoyo when there is a mixture of aggregates and bitumen which is then cooled, the mixture will harden and will bind aggregate together and form a layer of the pavement surface [2].

Table 1. Properties asphalt concrete mixture.

| Properties          | WC  |     | Base       |
|---------------------|-----|-----|------------|
|                     | Coarse | Fine | Coarse | Fine | Coarse | Fine |
| Asphalt Content     | Min  | 5,1 | 4,3       | 4,3  | 4      | 3,5  |
| Asphalt Absorption  | Maks |    | 1,2       |      |        |      |
| VIM (%)             | Min  | 3   |           |      |        |      |
|                     | Maks |    | 5         |      |        |      |
| VMA (%)             | Min  | 15  | 14        | 13   |        |      |
| VFB (%)             | Min  | 65  | 63        | 60   |        |      |
| Stability (kg)      | Min  | 800 | 1800      |      |        |      |
| Flow (mm)           | Min  | 3   | 4,5       |      |        |      |
| MQ (kg/mm)          | Min  | 250 | 300       |      |        |      |

Bina Marga Kementrian Pekerjaan Umum, 2010.

2.1.1. Aggregate. Aggregates are becoming stone, gravel, sand or other minerals, both from the natural and artificial origin in the form of solid minerals in the form of large or small sizes or fragments. Aggregate is a major component of the road pavement structure, the amount of aggregate in a mixture is about 90-95% of the total weight of the mixture or 75-85% of the total volume of the mixture. The road pavement quality also determined by the nature of the aggregate and the results of the aggregate mixture with other materials [1].

Table 2. Specification of course aggregate for hot mix asphalt.

| Test                          | Standard          | Spec |
|-------------------------------|-------------------|------|
| Bulk Specific Gravity         | SNI 03-1969-1990  | Min 2,5 |
| Water Absorption              | SNI 03-1969-1990  | Min 3.0 % |
| Abrasion by Los Angeles Machine | SNI 03-2417-1991 | Max 40% |
| Asphalt viscosity             | SNI 03-2439-1991  | Min 95% |

Bina Marga Kementrian Pekerjaan Umum, 2010.

2.1.2. Filler. The filler which means general materials used are dust, limestone dust, Portland cement or minerals derived from asbuton whose source is approved by the work directors. If asphalt modified from the type of asbuton is used, the filler added must come from minerals obtained from the asbuton. The filler material must be free of lumps and according to SNI 03-4142-1996 Filler is a non-plastic material with a minimum of 75% of the weight passes through the sieve No. 200 (0.075 mm). The specification of filler can be seen in table 3.

Table 3. Specification of filler.

| Test                                      | Standard          | Spec     |
|-------------------------------------------|-------------------|----------|
| The weight passes through the sieve No. 200 (0.075 mm) | SNI 03-1968-1990  | Min 75%  |
| Specific gravity                          | SNI 03-2531-1991  | 3.0 -3.2 |

Bina Marga Kementrian Pekerjaan Umum, 2010.
2.1.3. **White Limestone Powder.** Madura white limestone powder is the remains of a limestone saw that is found in the Madura area, one of them in the village of Lesong, Batuarmar District, Pamekasan Regency - East Java, Limestone itself is a sedimentary rock which consists of calcium carbonate.

2.1.4. **Asphalt.** Asphalt is a thermoplastic material, solid or semi-solid cement material in its consistency where the main protruding is bitumen that occurs naturally or produced by petroleum refining. Asphalt is a complicated colloidal from hydrocarbon material made from Asphaltenes, resindan oil. Asphalt is usually derived from crude oil distillation, but asphalt is found as a natural material (e.g., asbuton), which is often also called mineral [2]. Natural asphalt is asphalt obtained in the earth and can be used with simple processing, such as asphalt of Buton Island (Asbuton) and Trinidad lake asphalt. Petroleum asphalt is asphalt of refining petroleum residue. A common type of petroleum asphalt in Indonesia is asphalt penetration 60/70 and asphalt penetration 80/100. The specification of asphalt pen 60/70 can be seen in Table 4.

| Test                                | Standard            | Spec  |
|-------------------------------------|---------------------|-------|
| Penetration 25 C, 100gr 5 seconds; 0.1 mill | SNI 06-2456-1991    | 60-79 |
| Softening point; C                  | SNI 06-2434-1991    | 48-58 |
| Ductility, 25 C; cm                 | SNI 06-2432-1991    | Min 100 |
| Specific gravity                    | SNI 03-2531-1991    | Min 1.0 |

Table 4. Specification of asphalt pen 60/70.

Bina Marga Kementrian Pekerjaan Umum, 2010.

2.2. **Aggregate gradation**

According to Silvia Sukirman aggregate is a gradation of aggregate grain arrangement of appropriate size [1]. Aggregate grain size can be obtained through the examination of an analytical sieve. This distribution is distinguished into well graded, continuous graded, and poorly graded. Well graded the aggregate which has the same or almost the same aggregate called a uniform. This aggregate has pores between grains that are quite large, so often called open-graded aggregates. Continuous gradation is a gradation with aggregates that all grain sizes exist and are well distributed. This aggregate is more often used in flexible pavement layers. To get a small pore and high ability, so that good interlocking occurs. Poorly graded aggregate is the composition of aggregate grain size does not fit evenly. Poorly graded aggregates known by several names of aggregate gradation, they are uniform, gap, and open graded aggregate. Gradation type used in this research for asphalt concrete (AC-WC) is well graded. Gradations used guided by the new specification of asphalt pavement in 2010 by Bina Marga Kementrian Pekerjaan Umum. Salim mentions in the AC-WC mixture, besides the limit of gradation control there are some requirements we should consider, they are the Fuller curve and restrict zone [3].

2.3. **Asphalt content**

The initial estimate of optimum asphalt content can be planned after the selection and merger of the three aggregate fractions. Anonymous indicates the formula to estimate the initial asphalt content, as follows

\[
Pb = 0.035 \times \text{(%CA)} + 0.045 \times \text{(%FA)} + 0.18 \times \text{(%Filler)} + \text{Constant} \tag{1}
\]

where:
- \(Pb\) = Estimation of asphalt content, the percentage of mix's weight;
- CA = Coarse aggregate, the percentage of aggregate retained sieve no. 8;
- FA = Fine aggregate, the percentage of aggregate passing sieve No. 8 and retained no. 200;
- Filler = Aggregate has minimum weight 75% passing sieve no. 200;
- Constant value = 0.5 – 1.0 for AC and HRS.
The calculation results of Pb are rounded to 0.5% up to the nearest. Parameters and formulas for analyzing hot asphalt mixtures are as follows:

2.4. Marshall test
According to Sukirman mix design method mostly used in Indonesia is based on empirical testing, using a Marshall test [1]. Marshall test is to determine the characteristics of the asphalt mixture. Characteristics of asphalt mixture are shown in Marshall parameters, i.e., stability, flow, density, Marshall quotient, voids in the mix (VIM), voids in mineral aggregate (VMA) and voids filled with asphalt (VFA). Marshall test is one method for asphalt concrete mix design.

2.5. Optimum asphalt content
Optimum asphalt content (OAC) is the bitumen content that can produce the best properties of a mix. OAC is obtained from the evaluation of Marshall parameters. Optimum means identical to the compromise that is not possible to determine the asphalt content that gives the best results for each requirement. For example, if the high flexibility desired, then high asphalt content would be the best. If high stiffness desired, then low asphalt content would be the best. Asphalt content is compromised taken from each of the corridors that meet every requirement value [4].

3. Methodology
The research methods, including the description of the material preparation and research procedure such as testing course aggregate, fine aggregate and asphalt bitumens, the research procedure, and the design used. Materials consist of petroleum asphalt pen 60/70 produced by PT. Pertamina. Aggregate used was produced from the Stone crusher plant in Pasuruan Regency, East Java. Stone dust used as a filler was also the product of stone crusher plant. White limestone used in this research also came from Lesong Subdistrict, Batumarmar District, Pamekasan Regency, Madura. The research was conducted at the Laboratory of Transportation, Department of Civil Engineering, Faculty of Engineering, Madura University and Laboratory of Asphalt Mixing Plant PT. Dua Putri Keudaton, Pademawu District, Pamekasan Regency, Madura. Before held mixing, so gradations mix to be used should be determined first. Filler used is lime with variation limestone 0%, 2 %, 3 %, and 4 % to the total aggregate. Estimates the asphalt in a mixture of the asphalt steady estimated by means of determined steady empirically with the equation (1). The rate of bitumen is obtained from one of these formulas are rounded to the nearest 0.5% figure is approaching. Example, If the calculation resulting from the levels of the asphalt was 6.3%, then the value of the levels of asphalt Middle = 6.5%. After the known value of the asphalt is ideal value then add up to 2 times with interval 0.5% and in subtract 2 times with interval 0.5%.

3.1. Job mix design
Preparation of specimens was generally grouped into three types of mixtures, the mixture of AC-WC using white limestone powder variation as a filler with asphalt pen 60/70 content 5% and the mixture of AC-WC using white limestone powder variation as a filler with asphalt pen 60/70 content 6%, and the mixture of AC-WC using white limestone powder variation as a filler with asphalt pen 60/70 content 6.5%. Each asphalt content was made by 12 specimens. Thus, in total there were 36 specimens for three variations of asphalt content. The types of a mixture that were generally based on different types of filler and asphalt used can be seen in Table 5.

| Type of Mixture | Asphalt Content | Filler Proportion |
|-----------------|-----------------|-------------------|
| ACWC 1          | 5%              | 0%, 2 %, 3 %, 4%  |
| ACWC 2          | 6%              | 0%, 2 %, 3 %, 4%  |
| ACWC 3          | 6.5%            | 0%, 2 %, 3 %, 4%  |

Table 5. Type of mixtures.
4. Result and discussion

4.1. Material testing
Material testing in this study consisted of testing coarse aggregates, fine aggregates, and fillers. This test includes specific gravity testing and aggregate absorption, sieving and abrasion testing.

4.1.1. Testing aggregate specific gravity and absorption. Tests were carried out on fine aggregates and coarse aggregates with sizes of 00-05 mm, 05-10 mm and 10-15 and also tested on filler specific gravity. Specific gravity test results and aggregate absorption can be seen in Table 6.

Table 6. Specific gravity dan absorption.

| Type of Test                                         | Aggregate Size | Specification |
|-----------------------------------------------------|----------------|---------------|
|                                                      | 10-15 mm       | 05-10 mm      | 00-05 mm      | Filler |
| Specific Gravity (saturated surface specific Gravity)| 2.770          | 2.764         | 2.688         | 2.63 |
| Berat jenis semu (Apparent Specific Gravity)        | 2.791          | 2.776         | 2.735         | - |
| Penyerapan (Absorption) %                            | 0.762          | 1.088         | 1.750         | - |

4.1.2. Sieve analysis test. After testing, each aggregate then performs a gradation (sieve analysis) to determine whether the combined aggregate gradation meets the requirements or does not meet the requirements. Tests are carried out on all types of aggregates used as in Table 7.

Table 7. Analysis of coarse aggregate filters (10-15 mm).

| No. | Aggregate                        | Sieve Size | Result | Specification |
|-----|----------------------------------|------------|--------|---------------|
| 1   | Coarse Aggregate (10-15 mm)     | #200       | 0%     | 2%            |
| 2   | Medium Aggregate (05-10 mm)     | #200       | 0%     | 2%            |
| 3   | Fine Aggregate (00-05 mm)       | #4         | 93.91% | 80%           |
| 4   | Filler                          | #200       | 94.95% | 75%           |

Based on the results of the sieve analysis in Table 7, it was concluded that the aggregate meets the requirements for use in the hot asphalt mixture referring to the Bina Marga 2010 Revision 3 specification which is a maximum of No. 200 is 2% for coarse aggregate and medium aggregate while in testing it is obtained at 0%. In fine aggregate testing, it was obtained 93.91% at No. 4 and specifications mentioned at least pass No. 4 by 80%. Likewise, with filler testing that meets the specifications, that is a minimum of passing No. 200 at least 75% while the test result is 94.95%.

4.2. Determine the composition of mixture and asphalt level plan

4.2.1. Mixed composition. The composition of the planned hot asphalt mixture, is obtained based on the results of the filter analysis found in Table 8.
Table 8. The composition of Hot Asphalt Mixtures (ACWC).

| No. | Type of Aggregate     | Composition (%) |
|-----|-----------------------|-----------------|
| 1   | Coarse (10-15mm)      | 18 18 18 18     |
| 2   | Medium (05-10mm)      | 35 35 35 35     |
| 3   | Fine (00-05mm)        | 47 46 45 44     |
| 4   | Filler                | 0 1 2 3 4       |

100 100 100 100 100

In table 8 there is a percentage of each aggregate for a combination of fillers 0%, 1%, 2%, 3% and 4% with a total weight of 1200 grams.

4.2.2. Asphalt level plan. Calculation of asphalt content plan using the results of the filter analysis tests that have been carried out on each aggregate and used the Equation (1) formula. From the calculation results obtained asphalt content in Table 9.

Table 9. Asphalt level plan.

| Filler (%) | Use of Asphalt (%) |
|------------|---------------------|
| 0          | 5,5                 |
| 1          | 35                  |
| 2          | 47                  |
| 3          | 0                   |
| 4          | 100                 |

4.2.3. Testing specific gravity and absorption of test objects. The test consists of testing specific gravity, apparent density, effective specific gravity, maximum mix density, asphalt absorption and density of specimens. The results of the calculation of density and absorption are found in Table 10.

Table 10. The results of the calculation of density and absorption.

| Filler | Asphalt | Specific Gravity of Total Agg. | Berat jenis Semu Dari Total Agg. | The effective specific gravity of Total Agg. | Maximum Mixed Specific Gravity | Density | Asphalt Absorption (% Weight of total mix) |
|--------|---------|--------------------------------|----------------------------------|---------------------------------------------|--------------------------------|--------|------------------------------------------|
| 2%     | 5,5%    | 2.723                          | 2.826                            | 2.774                                       | 2.538                          | 2.254  | 0.704                                    |
| 6%     | 2.723   | 2.826                           | 2.774                            | 2.518                                       | 2.269                          | 0.704  |                                          |
| 6,5%   | 2.723   | 2.826                           | 2.774                            | 2.499                                       | 2.284                          | 0.704  |                                          |
| 4%     | 5,5%    | 2.726                          | 2.828                            | 2.777                                       | 2.540                          | 2.278  | 0.694                                    |
| 6%     | 2.726   | 2.828                           | 2.777                            | 2.521                                       | 2.348                          | 0.694  |                                          |
| 6,5%   | 2.726   | 2.828                           | 2.777                            | 2.501                                       | 2.359                          | 0.694  |                                          |
| 6%     | 5,5%    | 2.730                          | 2.831                            | 2.780                                       | 2.543                          | 2.312  | 0.685                                    |
| 6%     | 2.730   | 2.831                           | 2.780                            | 2.523                                       | 2.324                          | 0.685  |                                          |
| 6,5%   | 2.730   | 2.831                           | 2.780                            | 2.504                                       | 2.355                          | 0.685  |                                          |
| 8%     | 5,5%    | 2.733                          | 2.833                            | 2.783                                       | 2.545                          | 2.350  | 0.676                                    |
| 6%     | 2.733   | 2.833                           | 2.783                            | 2.525                                       | 2.360                          | 0.676  |                                          |
| 6,5%   | 2.733   | 2.833                           | 2.783                            | 2.506                                       | 2.372                          | 0.676  |                                          |
| 10%    | 5,5%    | 2.737                          | 2.835                            | 2.786                                       | 2.547                          | 2.334  | 0.666                                    |
| 6%     | 2.737   | 2.835                           | 2.786                            | 2.528                                       | 2.353                          | 0.666  |                                          |
| 6,5%   | 2.737   | 2.835                           | 2.786                            | 2.508                                       | 2.398                          | 0.666  |                                          |
4.2.4. *Marshall test*. Marshall test was conducted to determine the value of Marshall characteristics, namely the value of stability, flow, VIM, VMA, VFB and Marshall quotient. The Marshall calculation is found in Table 11.

**Table 11. Marshall test results.**

| Asphalt (%) | Filler (F) | Stability (Kg) | Flow (mm) | MQ (Kg/mm) | VIM (%) | VMA (%) | VFB (%) |
|------------|------------|----------------|-----------|------------|---------|---------|---------|
| 0          | 1040       | 3.80           | 273.63    | 11.18      | 21.77   | 48.61   |
| 1          | 1031       | 3.80           | 271.34    | 10.33      | 21.05   | 50.90   |
| 2          | 1166       | 4.00           | 291.49    | 9.05       | 19.95   | 54.62   |
| 3          | 1344       | 3.20           | 420.11    | 7.64       | 18.74   | 59.21   |
| 4          | 1471       | 2.70           | 544.64    | 8.36       | 19.39   | 56.91   |
| 5.50%      | 0          | 1044           | 3.57      | 292.76     | 9.89    | 21.65   | 54.33   |
| 1          | 1227       | 3.40           | 360.85    | 6.85       | 19.04   | 64.03   |
| 2          | 1075       | 3.50           | 307.03    | 7.88       | 19.97   | 60.52   |
| 3          | 1384       | 3.37           | 410.94    | 6.53       | 18.83   | 65.29   |
| 4          | 1357       | 3.33           | 407.22    | 6.89       | 19.17   | 64.04   |
| 6.00%      | 0          | 1122           | 4.00      | 280.62     | 8.61    | 21.57   | 60.06   |
| 1          | 1162       | 3.63           | 319.71    | 5.71       | 19.1    | 70.13   |
| 2          | 1127       | 3.70           | 304.55    | 5.95       | 19.34   | 69.26   |
| 3          | 1331       | 3.03           | 438.89    | 5.34       | 18.85   | 71.70   |
| 4          | 1349       | 4.07           | 331.65    | 4.77       | 18.4    | 74.07   |
| 6.50%      | 0          | 1122           | 4.00      | 280.62     | 8.61    | 21.57   | 60.06   |
| 1          | 1162       | 3.63           | 319.71    | 5.71       | 19.1    | 70.13   |
| 2          | 1127       | 3.70           | 304.55    | 5.95       | 19.34   | 69.26   |
| 3          | 1331       | 3.03           | 438.89    | 5.34       | 18.85   | 71.70   |
| 4          | 1349       | 4.07           | 331.65    | 4.77       | 18.4    | 74.07   |
| Specification | >800   | >3             | >250    | 3.5      | >15    | >65    |

From the calculation results in Table 11, it can be concluded that the stability value of all test items meets the specifications of Bina Marga 2010 revision 3, which must be greater than 800 Kg. The relationship between stability and bitumen content can be seen in Figure 1.

![Figure 1. Relationship of stability value with asphalt level.](image)

Flow values in Table 11 of 5 types of filler can be seen that there is only one type of mixture that does not meet the specifications, namely the use of 5.5% asphalt with a filler of 4% with a flow value of 2.70 mm while the specification is > 3 mm as shown in Figure 2.
From the Marshall test results, it can be concluded that the Marshall Quotient value for the use of fillers 0%, 1%, 2%, 3% and 4% can meet the minimum requirements of the Marshall Quotient value of 250 kg/mm as shown in Figure 3.

From the test results contained in Table 11, it can be concluded that the value of VIM (Void in Mix) that meets the requirements is found in the use of filler 4% with the use of asphalt 6.5% with a VIM value of 4.77% as seen in Figure 4.

Based on Table 6, it can be concluded that the value of VMA (Aggregate Void Minerals) for the use of fillers 0%, 1%, 2%, 3% and 4% can meet the minimum requirements of 15% Void Mineral Aggregate (VMA) values as seen in Figure 5.
From the Marshall test results, it can be concluded that the VFB / Asphalt Filled Air Cavity values that meet the requirements are found in the use of fillers 3% and 4% with the use of 6.0% asphalt, filler use% 0%, 1%, 2%, 3% and 4% with asphalt 6.5% as shown in Figure 6.

**Figure 5.** Relationship of VMA value with asphalt level.

**Figure 6.** Relationship of VFB value with asphalt level.

5. Conclusion

Thus, it can be concluded that the use of Madura white limestone powder filler can affect the characteristic value of Marshall. From the table data above, it can be concluded that the use of Madura white limestone powder filler as much as 4% as a filler in the AC-WC mixture with 6.5% asphalt content, can increase the density value = 2,359 ton/m³ and also can meet the specifications required by Bina Marga in 2010. Thus, the proportion of asphalt mixture with aggregate is CA (10-15 mm) = 18%, MA (05-10 mm) = 35%, FA (00-05 mm) = 43%, filler = 4% and asphalt = 6, 5%.

6. Suggestions

From the results of the research that has been done, it is suggested: 1. Similar research can be done for comparison with other fillers. 2. Further research is needed with filler levels of 5% - 10% 3. Similar testing needs to be done with other asphalt penetration and different aggregate usage. 4. Further research is needed to assess the economic value and compare with other fillers.

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