The Effect of Pulp Cane Ash Filler and Concrete Waste as Replacement of Coarse Aggregate to The Marshall Characteristic on Asphalt Concrete Mixtures

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Abstract. Asphalt quality improvement efforts start from the construction of buildings, infrastructure and roads continue to be developed. This development will increase the need for material used. This study aims to (1) determine the effect of bagasse ash filler with concrete waste as a coarse aggregate on Marshall characteristics on asphalt concrete mixture, in terms of density, VIM (void in the mix), VMA (voids in mineral aggregates), VFA (void filled with asphalt), stability, flow (melting), and MQ (Marshall quotient). (2) As well as knowing the suitability of the Marshall test results with the requirements of Bina Marga 2010. This study uses an experimental testing method implemented by making test specimens following existing standards and conditions, as well as the use of bagasse ash as filler material and concrete waste as a substitute for coarse aggregate in asphalt mixture, with a variation of the percentage using bagasse ash filler with 0%, 5%, 10%, and 15% content. For each treatment, three samples were made. The results of testing the concrete asphalt mixture are: (1) density 2.16 gr/cc, VIM 11.56%, VMA 17.39%, VFA 33.91%, stability 3263.92 kg, flow (melting) 2.03 mm, MQ 2353.70 kg / mm. (2) Test results for all specimens, with the addition of bagasse ash filler as asphalt mixture filler, have met the 2010 Bina Marga requirements, as a minimum requirement for the highway, with stability values of more than 800 kg and flow values between 2 mm to 4 mm.

1. Introduction
Currently, infrastructure development in Indonesia has undergone very rapid development. Start from the construction of buildings, infrastructure, and roads, and it continues to be developed. This development will increase the material requirements used. The large number of buildings that are not suitable for use or have entered the planned age will be destroyed and produce much concrete waste. Also, the widespread use of Ready-Mix concrete in building construction often exceeds the supply, and the rest is usually wasted on the ground. There is a pile of materials from the demolition of buildings due to damage caused by natural disasters or former building renovations. The waste from the building’s demolition requires a disposal site and costs to dispose of the waste. Concrete waste from construction remains a large proportion of the total construction material waste. Currently, concrete waste is only used for fill material, so it has not been utilized properly.

Disposal of this waste requires a fee and a place for disposal. Disposal of solid waste like this can reduce soil fertility. Therefore, to minimize environmental damage, it must reduce the use of new
aggregates by utilizing concrete waste as construction raw materials [6]. When examined, the physical properties of concrete are almost the same as the physical properties of rocks. From this equation, Demolition materials in the form of concrete have been tried as an alternative to coarse aggregate in making road pavements. However, concrete waste cannot be used just like that, and it is necessary to test the performance of the asphalt mixture using concrete waste as a substitute for coarse aggregate to obtain optimal results in its planning [6].

Rice husk ash and sand as a mixture of clay soil can increase soil bearing capacity, reduce the decreasing of soil layer and the potential of soil swell [5]. Road pavement construction planning is growing from time to time, and many have tried various alternatives to improve the quality of asphalt. Many innovative materials for road pavement have been developed, one of which is a combination of fine aggregate, coarse aggregate, and fillers. The fillers commonly used are cement, lime, and ash. The specimen with the cold joint connection in normal concrete has a decrease in quality (flexural and compressive), so does with the concrete with superplasticizer (high early compressive strength), whereas in concrete using fiber has increased in strength compared to normal concrete without cold joint connection [10].

The utilization of waste materials or industrial waste such as waste from burning coal (fly ash), bagasse, and wood industry waste in Indonesia is generally not optimally utilized. Therefore, the processing is carried out so that it can be used in more valuable materials. Use of bagasse and waste the rest of the wood industry can be used as a filler in the laston mixture.

In this study, the combination used as a filler is to use bagasse ash from the combustion of bagasse waste from the sugar factory of PT. Madukismo Yogyakarta. Bagasse is produced from squeezing or grinding sugarcane stalks five times during the production process at the factory. Sugarcane waste that piles up every day creates problems for the factory. Sugarcane bagasse ash waste has a fruitful nature, so it requires a larger storage area. Other than that, the less optimal utilization of bagasse waste makes bagasse ash just thrown away. To solve this problem, the authors are interested in researching bagasse ash as a filler in the asphalt mixture.

For other reasons in this study, bagasse ash was used as a filler, among others, because bagasse ash contains high enough silica, is a cavity filling material (voids), the filler is part of the aggregate, the filler will fill the voids between the aggregate grains. Besides, a filler can also increase the binding power (cohesion) of concrete asphalt, improve the mixture's stability, and reduce the reduction/plastic melt (flow). When mixed with asphalt filler, it will form a high consistency binder to bind the granules stronger than not using a filler. The filler application to the hard layer asphalt mixture will give a small pore content because the filler particles will fill the voids in the asphalt mixture. The filler grains and the asphalt form a gel to bind fine aggregates by changing their stability value [3]. The cohesion-adhesion will increase then decreasing in addition of plastics content. The highest adhesion occurs when the optimum plastics content is 1%-2% [2]. The most effective addition is at a level of 5% with a wire length of 3 cm, because at that time the Marshall stability value experienced a very high increase [4].

2. Research Method

2.1. Type of Research
The method used in this research is the experimental method, namely the method carried out by making the test object following the existing standards and conditions, as well as the use of bagasse ash as a filler and concrete waste as a substitute for coarse aggregate in the manufacture of asphalt mixtures with the percentage variation determined at the consideration of other research references.

2.2. Place of Research
This final project research was carried out at the Highway Laboratory, Department of Civil Engineering and Planning Education, Faculty of Engineering, Yogyakarta State University.

2.3. Research Subject/Object
The research subjects used were 12 samples with different sugarcane bagasse ash content.
2.4. Procedure
In this study, the testing was carried out in stages, consisting of testing the aggregate (coarse, fine, filler), asphalt, and testing the mixture (Marshall test). Testing of aggregates includes sieve analysis, an inspection of specific gravity, and water absorption. For bitumen testing and penetration testing, the flash point-burning point, softening point, and specific gravity. While the method used as a mixture tester is the Marshall method, the Marshall test results are obtained in the form of Marshall components, namely stability, flow, Void in the Mineral Aggregate (VMA), voids in the mixture Void In The Compacted Mixture. (VIM), air cavity filled with Voids Filled with Bitumen (VFB) asphalt, and the Marshall / Marshall Quotient (MQ). The ratio of the mixture of variations in the composition of the bagasse ash filler used was 0%, 5%, 10%, 15%.

The source used as a reference and data on the results of the tests that have been carried out used to plan the KAO (Optimum Asphalt Content) test for the manufacture of asphalt mixture test specimens. Determination of the optimum asphalt content to determine the amount of effective asphalt content in the mixture required to manufacture new specimens with the same aggregate composition but with predetermined optimum asphalt content.

2.5. Data Collection Technique
Each specimen will be given a separate name or code to facilitate identification and grouping with a different code notation arrangement for each test object.

2.6. Data Analysis Technique
The analysis was carried out by analyzing the characteristics of Marshall, namely: Density, VIM, VMA, VFA, Stability, Flow, and MQ.

3. Research Results and Discussion
The characteristic testing carried out in this study uses the SNI 06-2456-1991 reference [9], the softening point test with the SNI 06-2434-1991 reference [8], and the flash and burn point testing with the SNI 06-2433-1991 reference [7]. For asphalt testing: Specific gravity of asphalt 1.193 gr/cc, a penetration rate of 64.2 mm/gr/sec, softening point 53 °C, flash point 234 °C, burn point 320 C. For coarse aggregate testing: bulk density 2.25 gr / cc, SSD specific gravity 2.42 gr / cc, apparent density 2.70 gr / cc, absorption 7.29%. For fine aggregate: bulk density 2.59 gr / cc, SSD specific gravity 2.65 gr / cc, apparent density 2.75 gr / cc, 2.30% absorption. For fillers: bulk density 2.07 gr / cc, SSD specific gravity 2.25 gr / cc, apparent specific gravity 2.55 gr / cc. The test results of the asphalt-aggregate mixture on the marshall properties can be seen in Table 1.

| Filler levels | Filler levels | Filler levels | Filler levels |
|---------------|---------------|---------------|---------------|
| 0%            | 5%            | 10%           | 15%           |

| Sifat Marshall     | 2,18 | 2,11 | 2,22 | 2,12 |
|--------------------|------|------|------|------|
| Density (gr/cc)    | 11,98| 11,20| 11,31| 11,76|
| VIM (%)            | 17,78| 17,06| 17,16| 17,58|
| VMA (%)            | 33,65| 34,59| 34,23| 33,18|
| Stability (kg)     | 2205,23| 2438,70| 3876,93| 4534,76|
| Flow (mm)          | 3,36 | 1,33 | 2,14 | 1,28 |
| MQ (kg/mm)         | 671,76| 2898,77| 1895,04| 3949,22|

The following are the results of testing the test objects on the characteristics of Marshall:
From Figure 1, it is known that in the addition of 5% bagasse ash filler content, the density value decreased by 2.106 gr/cc, then the addition of 10% bagasse ash filler content increased by 2.225 gr/cc, but at the addition of the pulp ash sugarcane filler, 15% has decreased again by 2.120 gr/cc. It can be concluded that the amount of bagasse ash filler added affects the density value of the asphalt mixture, but it must use the appropriate filler content. It happens because the bagasse ash filler mixed into the asphalt will fill every air cavity in the asphalt mixture to become denser.

From Figure 2, it can be seen that the VIM value of the asphalt mixture using bagasse ash filler has decreased the VIM value at the 5% bagasse ash filler percentage by 11.204%, but then an increase in the 10% bagasse ash filler percentage is 11.309% and 15% of 11.760%, where the higher the percentage of bagasse ash filler, the higher the VIM value.

However, the test results indicate that the test object does not meet the requirements because the added test object with 0%, 5%, 10%, 15% exceeds the maximum limit required by Bina Marga 2010 [1]. The increase in VIM value can occur because the added bag of bagasse ash filler blocks the asphalt from filling the cavities in the mixture. The more filler content is used, the larger the cavity will be formed so that the mixture is porous.
From Figure 3, it can be seen that the VMA value of the asphalt mixture using bagasse ash filler has decreased the VMA value at the 5% bagasse ash filler percentage by 17.063%, but then an increase in the 10% bagasse ash filler percentage is 17.161% and 15% of 17.582%, where the higher the percentage of bagasse ash filler, the higher the VMA value. The trend that occurs in the VMA value is similar to or proportional to the VIM value, so it is concluded that the VMA value and characteristics are directly proportional to the VIM value. However, the test results show that the test object does not meet the requirements because the test object with 0%, 5%, 10%, 15% added exceeds the maximum limit required by Bina Marga 2010.

From Figure 4, it can be seen that the VFA value of the asphalt mixture using bagasse ash filler has increased the VFA value in the 5% bagasse ash filler percentage of 34.591%, but then decreased the 10% bagasse ash filler percentage of 34.234% and 15% of 33.178 %, where the higher the percentage of bagasse ash filler, the lower the VMA value. The trend in VFA values is inversely related to VIM and VMA values, where the higher the VIM and VMA values, the lower the mixed VFA value. However, the test results show that the asphalt mixture specimen does not meet the requirements because it does not meet the minimum limit required by Bina Marga 2010 [1].

From Figure 4. It shows that the lowest stability value is at 0% bagasse ash filler content, namely 2205.292 kg. The stability value of the mixture of asphalt using bagasse ash filler experienced an increase in the stability value of the 5% bagasse ash filler percentage of 2438.699 kg, the 10% bagasse ash filler percentage of 3876.931 kg, and 15% of 4534.759 kg, where the higher the percentage of bagasse ash filler, the higher the stability value of the asphalt mixture.
The higher the stability value, the more likely it is to accept traffic loads without changing shape. The stability value at the bagasse ash filler content fulfils the requirements because it meets the minimum limit set by Bina Marga 2010.

From Figure 5, it can be seen that there is a decrease in the value of flow along with the high content of the filler used in the asphalt mixture specimen. So it can be concluded that the percentage of addition of bagasse ash filler affects the flow value of the asphalt mixture. The higher the percentage of filler used, the lower the flow value of the asphalt mixture.
From Figure 6, it can be seen that the addition of 5% bagasse ash filler content has increased by 2898.767 kg / mm, then the addition of 10% bagasse ash filler content has decreased by 1895.041 kg / mm. 15% bagasse ash filler has increased again by 3949.225 kg/mm.

If the MQ value is too high, the mixture will be too stiff and crack easily. Conversely, if the MQ value is too low, the pavement will become too flexible and tends to be less stable. From the results of Marshall’s research, the MQ value that meets the requirements is the asphalt concrete mixture at all levels of bagasse ash filler. Factors that affect the MQ value such as the stability and melt value of the asphalt mixture.

4. Conclusions and Suggestions

4.1 Conclusions
Based on data analysis from the tests that have been carried out, it can be concluded that the addition of bagasse ash as a filler as much as 0%, 5%, 10%, 15% using concrete waste as a substitute for coarse aggregate in the mixture of asphalt concrete (Laston) layers can affect the characteristic value of Marshall. The effect is that the more the percentage (5%, 10%, 15%) of the addition of bagasse ash filler, the higher the VIM, VMA, stability, and MQ (marshall quotient) values that are formed. The value of density, VFA, and flow (melting) will decrease along with the increase in the percentage (5%, 10%, 15%) of the addition of bagasse ash filler used. In addition, Marshall stability for all specimens with the addition of bagasse ash filler as a filler for asphalt mixture has met the requirements of Bina Marga 2010, as a minimum requirement for highways, namely with a stability value of more than 800 kg and a flow value of 2 mm to 4 mm.

4.2 Suggestions
It is still necessary to do further research on "The Effect of Sugarcane Filler Ash with Concrete Waste as a Substitute for Coarse Aggregate on the Characteristics of Marshall in Concrete Asphalt Mixtures." by using different percentage variations of concrete waste. In addition, it is also necessary to determine the maximum value of each test, further testing should be carried out with a more varied percentage variation of the addition of bagasse ash filler so that the maximum value is known. In the manufacture of test objects, the number can be increased so that the results obtained are more accurate than before. In the manufacture of test objects, it is better to use aggregates with good gradations so that the test results of the test objects get a more maximum value.

5. Reference

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