Effect of Aggregate Physical Properties Observed Void in Minerals Aggregate (VMA) Value

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Abstract. The main component of the main mixture of hot asphalt is aggregate ie 90% - 95% of the total weight of the mixture. Aggregates on each quarry will result in different porosity values. Pekanbaru City still uses the aggregate of a local quarry that is aggregate of quarry Koto Kampar, Ujung Batu, and Sand Pengaraian, on the implementation of small-scale roadworks project. The aggregate physical properties will affect the results of Marshall testing in asphalt mixtures one of them is VMA (Void in Mineral Aggregate). The purpose of this study to determine the effect of aggregate physical properties on VMA values. The method used is laboratory testing, by testing the aggregate type and marshall testing. The results obtained by an aggregate bulk density of each quarry are Pasir Pangaraian 2.589, Ujung Batu 2.580, and Koto Kampar 2.578. The Marshall test for VMA is Pasir Pangaraian 15.04%, Ujung Batu 15.07%, and Koto Kampar 15.47%. The conclusion is that bulk aggregate bulk value values influence VMA value. The higher the aggregate bulk value then the VMA value will be small.

Keywords: Aggregate Bulk Type Weight, Marshall Test, VMA

1. Introduction

The aggregate physical properties affect the value of VMA (Void in Mineral Aggregate), since on the hot asphalt mixture the aggregate contribution is 90-95% to the weight of the mixture. For the design of hot asphalt mixture is generally carried out in the laboratory by conducting marshall testing. The aggregate use of roadworks in small-scale projects in Pekanbaru City still uses the aggregate of the local quarry of Pasir Pangaraian quarry, Ujung Batu, and Koto Kampar. The different quarry will result in different porosity values as well. The use of these three local quarries attracts the author's interest in researching the aggregate. How does the effect of aggregate physical properties on VMA value on each quarry?

The purpose of this study to determine the effect of aggregate physical properties on VMA values. Several existing studies,[1] performed pore level analyzes at several quarry sites. [2] examined the "Comparison of Pore Aggregate Mixed Concentrations of AC-WC Before and After Extraction. [3] examined the effect of "The Effect of Aggregate Physical Properties on Cavities In Hot Asphalt Mixes. [4] examines the "Comparison Pore Aggregate Levels After Extraction With Solvents
Pertamax Plus and Gasoline. [5] conducted an analysis of the Causes of Differences of the Maximum Heat Value of Heat Treatment Heat Pallets Based on Marshall Methods Wanted Directly Based on AASTHO T209. [6] examined the effect of Aggregate Porosity Against Cavities In Hot Asphalt Mixes.

2. Theory and Hypotheses (if required)

2.1 VMA (Void in Mineral Aggregate)

VMA or Void in Mineral Aggregate is the volume of mixed compressed air cavities, including the space filled by asphalt and expressed as the percent of total volume. The graded aggregate provides a small VMA price compared to the aggregate of graded gaps. The larger VMA in the aggregate causes greater space available for asphalt blankets. On the other hand, if the aggregate has a small VMA value, it may result in the aggregate bitumen being limited and resulting in a thin asphalt blanket [7].

To calculate the value of VMA can use the following formula [7]:

\[ VMA = 100 \left( \frac{G_{mb} - \frac{G_{mb} (1 - P_{bt})}{G_{sb}}} \right) \]

Where:
- \( G_{mb} \) = bulk density of solid mixture.
- \( G_{sb} \) = bulk density of aggregate
- \( P_{bt} \) = asphalt content, percent to total weight of the mixture

2.2 Aggregate Porosity

All aggregates are porous. The aggregate caliber determines the amount of liquid that can be absorbed by the aggregate. The aggregate ability to absorb water (asphalt) is an important information that must be known in the manufacture of asphalt mixtures. If the aggregate absorption is very high, this aggregate will continue to absorb the asphalt both during and after aggregate mixing. This will cause the bitumen on the aggregate surface that is used to bind the aggregate particles to less so that it will produce a thin asphalt film [1].

3. Research Methods

The study was conducted through laboratory testing. Refers to the tests of Specific Weight and Absorption of Rough Aggregate Water using SNI 03-1969-2008 and Tests of Smooth Aggregate Type and Water Absorption using SNI 03-1970-2008. Test marshal to get VMA value. The research was conducted by taking data directly in the field in the form of aggregate samples from quarry Pasir Pangaraian, Ujung Batu, and Koto Kampar. The material used is a mixture of AC-WC (Asphalt Concrete Wearing Course) with an optimum bitumen content of 5.80%.

4. Result and Discussion

The result of aggregate initial examination is aggregate wear (abrasion) test. The value of each aggregate wear (abrasion) is:
Table 1. Aggregate abrasion value

| Agregat Rough Quarry | Abrasi Value (Wear %) | Term of Spec. Max (%) |
|----------------------|-----------------------|-----------------------|
| Pasir Pangaraian     | 30,58                 | 40                    |
| Ujung Batu           | 34,58                 | 40                    |
| Koto Kampar          | 36,20                 | 40                    |

Source: Anggraini et al. (2018)

Large abrasion values indicate cavities in aggregates that are large enough so that absorption is also higher [8]. The results of laboratory testing of pore aggregate and fine aggregate content of each quarry hence obtained the value of specific gravity and its absorption are:

Table 2. Test results of quarry aggregate pores from Quarry Koto Kampar

| Testing          | Aggregate Coarse | Medium Aggregate | Stone Ash | Sand | Spec. |
|------------------|------------------|------------------|-----------|------|-------|
| BJ Bulk (Sd)     | 2,574            | 2,543            | 2,597     | 2,570|
| BJ SSD (Ss)      | 2,604            | 2,585            | 2,617     | 2,590|
| BJ Semu (Sa)     | 2,655            | 2,653            | 2,650     | 2,623|
| Water Absorption (Sw) | 1,186        | 1,629            | 0,756     | 0,796| Maks. 3% |

Source: [6]

Tests of these aggregate pores result in values that still meet the general specification is 3%.

Table 3. Test result of quarry aggregate pores from Quarry Ujung Batu

| Testing          | Aggregate Coarse | Medium Aggregate | Stone Ash | Sand | Spec. |
|------------------|------------------|------------------|-----------|------|-------|
| BJ Bulk (Sd)     | 2,576            | 2,540            | 2,575     | 2,570|
| BJ SSD (Ss)      | 2,597            | 2,579            | 2,604     | 2,590|
| BJ Semu (Sa)     | 2,630            | 2,642            | 2,651     | 2,623|
| Water Absorption (Sw) | 0,800        | 1,521            | 0,918     | 0,796| Maks. 3% |

Source: [6]
Tests of these aggregate pores result in values that still meet the general specification is 3%.

**Table 4.** Test result of quarry aggregate pores from Quarry Pasir Pangaraian

| Testing          | Aggregate Coarse | Medium Aggregate | Stone Ash | Sand | Spec. |
|------------------|------------------|------------------|-----------|------|-------|
| BJ Bulk (Sd)     | 2,606            | 2,614            | 2,600     | 2,575|       |
| BJ SSD (Ss)      | 2,627            | 2,629            | 2,617     | 2,590|       |
| BJ Semu (Sa)     | 2,661            | 2,655            | 2,645     | 2,615|       |
| Water Absorption (Sw) | 0.797    | 0.584            | 0.654     | 0.594| Maks. 3% |

Source: [6]

Tests of these aggregate pores result in values that still meet the general specification is 3%. Result VMA value from marshel testing on each aggregate are:

**Table 5.** The results of pore aggregate pore aggregate porosity test from Quarry Pasir Pangaraian

| Quarry          | Aspal Content (%) | BJ Bulk Agregat | BJ Bulk Mixed | VMA Value (%) |
|-----------------|-------------------|-----------------|---------------|---------------|
| Pasir Pangaraian | 5.80              | 2.589           | 2.334         | 15.04         |
| Ujung Batu      | 5.80              | 2.580           | 2.326         | 15.07         |
| Koto Kampar     | 5.80              | 2.578           | 2.305         | 15.47         |

Source: [6]

From the table can be seen the highest VMA value is on agar quarry Koto Kampar is 15.47% and the smallest on agar quarry Pasir Pangaraian namely 15.04%. VMA values are influenced by aggregate bulk density, where higher aggregate null aggregate values will result in lower VMA values.

**5. Conclusion**

The conclusion of this research is that the aggregate physical properties will affect the VMA value, whereas the higher the bulk aggregate bulk density value will result in lower VMA value.
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