Laboratory study: durability characteristics of Asphalt concrete binder course utilizing Bantak and Clereng as aggregate and Asbuton Lawele as fine aggregate (using Marshall Methods)

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Abstract. Construction of roads and will continue and growing, while on the other side of the raw material reserves for the road less. Given this, the researchers tried to use the mining waste material at the bottom of Sabo Dam from Merapi which is bantak to substituted coarse aggregate and asbuton is substituted fine aggregate to tackle the lack of asphalt and to utilise local’s natural resources. This research carried out by using a mixture of 40% Bantak and 60% Clereng and substitute fine aggregate (substitution) with asbuton Lawele type 20/25 with the same amount. The asbuton concentrate variation that used in the test are (100%:0), (75%:25%), (50%:50%), (25%:75%), (0%:100%). All the specimens tested and analysed using Marshall Method as Public Work Department specification (2007), determined the optimum asphalt value of each specimen. All specimens with optimum value will immersed in water during half hour, 24 hours and 48 hours before Marshall test. Result of the test is used to know the asbuton substitution variation effects based on stability value, and residual strength index. The result shows that optimum asphalt value of asbuton specimens with percentage asbuton 0%, 25%, 50%, 75% and 100% are 6.2%; 5.6%; 5.25%; 5.1% and 5%. On standardise immersion asbuton variation of 0%, 25%, 50%, 75% and 100% the mix stability value are of 1498 kg, 1629 kg, 1405 kg, 1264 kg and 1258 kg respectively. While on 48 hour immersion, the residual strength index are 97.97%, 88.86%; 71.06%; 64.41% and 57%. In the conclusion optimum utilisation asbuton is 25% with optimum asphalt value 56% because has high stability, but has low durability.

1. Introduction
Indonesia is a country with abundant natural resources. One of them is active Merapi volcano with lava eruption releases mining material, known as Bantak that porous material and has a low level of hardness. Research conducts a test between the aggregate mixture of Bantak (porous aggregate from Mountain Merapi) and aggregate from Clereng, resulting the proportion of mixture for the hardness layer are 40% Bantak and 60% clereng [1]. Asbuton Lawele is one type of asbuton that is relatively soft from Lawele. Totomiharjo [2] Asbuton is a type of natural asphalt, found in reef rocks, so that the asphalt is mixed with limestone (CaCO₃). The surface of the Bantak is porous, asphalt more absorbed in the mixture to fill the pore.
Asbuton containing minerals and asphalt is expected to be a pore filler on porous material and to increase strength and durability of the pavement. Pavement Durability is related to the effect of a mixture of water and temperature for a long time. The pavement mixture must be resistant to water due to evaporation and oxidation. Pavement Durability depends on the good mixture, the composition of the mixture in accordance with the requirements, strength according to planning, work implementation and good maintenance. Study state that 8% of granular asbuton growth Marshall Stability and Marshall Immersion and Optimum Asphalt Content values in Asphalt Concrete-Binder Course Mixture [3].

The purpose of this research is to create a mix design asbuton and porous aggregate. Thus obtained optimum level of Asbuton with the required strength. In addition, it also to find out the optimum level of durability from porous aggregate and asbuton mixture through immersion index (IP) for ½ hour, 24 hours and 48 hours at 60 °C. Study state no significant difference for all mixture when BGA replaced petroleum asphalt in ACBC pavement [4].

2. Method and materials
The methodology used in this research is the experimental method, its starts from material testing, design mix and performance testing with Marshall Test (1939).

2.1 Aggregate
In this research, using aggregate Clereng (60%), Bantak (40%), and fillers as can be seen in Table 1.

| Table 1. Physical properties of aggregate |
|------------------------------------------|
| Properties | Test Value | Indonesian Standard |
|-------------|------------|---------------------|
| Aggregate   |            |                     |
| 1. Abration (%) | 24.4       | 40                  |
| 2. Stickiness (%) | 98         |                     |
| 3. Absorption (%) | 1.79       | 3                   |
| 4. Specific gravity (gr/cm3) | 2.729 |                     |
| 5. Soundness test (%) | 1.57 | 7                   |
| Bantak      |            |                     |
| 1. Abration (%) | 60.21      | 30.55               |
| 2. Absorption (%) | 1.523     | 3                   |
| 3. Specific gravity (gr/cm3) | 2.645 |                     |
| 40% Bantak + 60% Aggregate |       |                     |
| Abration (%) | -          | 40                  |
| Fine Aggregate |            |                     |
| 1. Absorption (%) | -         | 3                   |
| 2. Specific gravity (gr/cm3) | 2.5 | 2.868               |
| Filler      |            |                     |
| Berat jenis (gr/cm3) | 2.722 | 2.5                 |

2.2 Asphalt
Physical properties of petroleum asphalt 60/70 can be seen in Table 2.

| Table 2. Physical properties of petroleum asphalt 60/70 |
|---------------------------------|
| Properties | Test Value | Indonesian Standard |
|------------|--------------|---------------------|
| Penetration 25 °C | 62.2 | 60-79 |
| Softening point | 48 | 60-79 |
| Flash point | 347 | 48-85 |
| Ductility 25 °C | >100 | >200 |
2.3 Asbuton
The Asbuton used is a varied 25%, 50%, 75%, and 100% (Table 3).

Table 3. Physical properties of Asbuton

| Properties        | Test Value | Indonesian Standard |
|-------------------|------------|---------------------|
| Bitumen Content   | 27.54      | 25-40               |
| Penetration 25°C   | 20.6       | 19-22               |
| Water content     | 0.83       | <2                  |

3. Result
More immersion time, value of Marshall Quotient was decrease because flow was increase and stability index was decrease. After added 25% of Asbuton, Marshall Quotient continues to decline. It is indicate for this condition stiffness on mix desain. This is due to the decreased of stability and the increasing flow value of the test objects. The result of the research on the image shows that the value of MQ in the mix with the degree of Asbuton 25% higher than 0% Asbuton. After adding 25% of the Asbuton MQ value continues to decline because it has reached the optimum value. This indicates in this condition the stiffness of the mixture decreases and is prone to plastic deformation.

The results showed that the strength index of asbuton variation of 50%, 75% and 100% at immersion 24 hours and 48 hours did not meet the specifications required by the Public Works Department which is 80% [5]. This suggests that the mixture has no good enough durability to withstand its stability due to the influence of the weather and the traffic load over the lifetime of the plan.

In the Table 4, it can be seen that the long immersion and added asbuton affects the rise of residual index and stability index values in all variations of Asbuton. That indicate the greater the occurrence of stability decreases which means the durability of the mixture is decreasing.

Table 4. Result of mix design

| Marshall Characteristic | Indonesian Standard | 0   | 25  | 50  | 75  | 100 |
|------------------------|---------------------|-----|-----|-----|-----|-----|
| Optimum Asphalt (%)    | 6.20                | 5.60| 5.25| 5.10| 5.00|
| Density (gr/cc)        | 2.33                | 2.28| 2.22| 2.13| 2.04|
| VMA (%)                | ≥ 14                | 16.29| 14.63| 13.13| 12.82| 12.60|
| VFWA (%)               | ≥ 63                | 73.38| 71.03| 71.83| 68.26| 66.16|
| VITM (%)               | 3.5-5.5             | 4.34| 4.26| 3.70| 4.08| 4.38|
| Stability (Kg)         | ≥ 800               | 1498.48| 1629.10| 1405.64| 1264.39| 1257.98|
| Flow (mm)              | ≥ 3                 | 3.67| 3.70| 3.83| 4.03| 4.27|
| Marshall Quotient (kg/mm) | ≥ 250             | 409.15| 440.28| 367.75| 312.95| 300.37|
| Residual index (Immersion 24 hours) | ≥ 80          | 99.71| 95.87| 78.04| 73.88| 58.29|
| Residual index (Immersion 48 hours) | 97.97          | 88.86| 71.06| 64.41| 57.00|
| Stability index (%)    | (Immersion 48 hours)| 0.26| 0.41| 1.54| 1.86| 2.68|
| Loss of strength (Kg)  | (Immersion 48 hours)| 5.82| 6.68| 21.70| 23.53| 33.72|
4. Conclusion
The mixture of 40% porous aggregate and 60% aggregate used the optimum Asbuton as a substitute for fine aggregate in the mixture is 25%. The value of decreased stability index (r) as well as the loss of strength/ value of decreased stability (R) of the mixture is increasing as the long of immersion and the variation of Asbuton. This shows that the greater the occurrence of stability decreases which means the durability of the mixture is decreasing.

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