Assessing the durability of North Buton Asphalt seal with Polymer Modified and Rejuvenation in warm mixture design

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Abstract. Utilization of Buton Asphalt has been expanded with various optimizations through modification of the base material so that it can be used either as an additive in granular form or as modified asphalt. While in North Buton using Asphalt Buton that uses a special material specification Buton Asphalt cold mixture of Butur Seal, a thin layer of Buton Asphalt B 50/30 above the base course or existing asphalt pavement layer, which has been prepared in accordance with the General Specifications. Technically utilization of Butur Seal is still very sensitive to human resource capacity in understanding the physical condition of Asbuton, and severely affects construction to failure. Buton asphalt cold mix in the field also showed some kind of damage caused by difficulties or not fitting fluxing materials used. Making the challenge to do research on the characteristic properties of Asphalt Buton (Butur Seal) B50 / 30 with modifications, to get Asbuton that has higher durability in use in the field. Quality performance of the Asbuton cold mixtures is observed through a series of tests in the laboratory. This test includes testing the stability and the compressive test. Tests conducted in the laboratory are expected to be directly applicable as it is done in the field. This research aimed to investigate the characteristics of Butur Seal in warm mixture that can be used in the construction and maintenance of roads in North Burton and to investigate the characteristics of Butur Seal with the addition of elastomeric polymers and rejuvenation materials in warm mixing temperature of 30, 40, 60 and 80° C.

1. Introduction
Efforts to save the use of petroleum asphalt, began to develop research on road material, especially research for optimum use of local materials including Buton asphalt. In North Buton using Asphalt Buton that uses special material specification "Butur Seal". The definition of butur seal is asbuton B 50/30 spread on the base course or old existing asphalt pavement.

Technically utilization of Buton Asphalt (Butur Seal) is still very sensitive to human resource capacity in understanding the physical condition of Asbuton, and severely affects construction failure. Buton asphalt cold mix (Butur Seal) in the field also showed some kind of damage caused by hard or not fitting fluxing materials used. Making the challenge to do research on the characteristic properties of Asphalt Buton (Butur Seal) B50 / 30 with modifications, to get Asbuton that has higher durability in use in the field. Quality
performance Asbuton mixture (Butur Seal) can be known through observation and a series of tests in the laboratory. This test includes testing of Marshall. Tests conducted in the laboratory are expected to be directly applicable as it is applied in the field.

Asphalt demand in Indonesia continues to increase, but these needs are not met due to the limited capacity of producing asphalt. In addition to materials of petroleum-based asphalt, there is a genuine asphalt or natural bitumen, as can be mined on Buton Island, Indonesia. Type natural asphalt derived from Buton Island is divided into two kinds, namely the hard asphalt was found in the area Kabungka and soft asphalt that can be mined in the area Lawele. Natural asphalt comes from the island of Buton has bitumen content varies from 10% to 40%, with an average of about 21.8%. Total natural bitumen deposits are estimated at 350 million tons [1].

Asbuton stands for "Asphalt Buton" or "Rock Asphalt Buton". Asbuton as natural asphalt deposit is located in Buton Island Southeast Sulawesi Province. Asbuton first discovered by a Dutchman named Hetzel in 1920. Subsequently, in 1936 Hetzel has been able to map the deposit of Asbuton on Buton Island [2]. Asbuton, or natural asphalt from Buton Island with the highest in the world when compared with other natural bitumen deposits, is one of Indonesia's natural wealthiest potential as material substitution, especially on the asphalt pavement asphalt mixture [3].

2. Experimental

2.1. Butur Seal (North Buton Seal)

Utilization of Buton Asphalt has been expanded with various optimizations through modification of the base material so that it can be used either as an additive in granular form or as modified bitumen [2]. Asphalt Buton technical nature based on the location of the mine is presented in Table 1. These have Buton Asphalt bitumen content variation between (20-30)% by weight, with values varying penetration. Asphalt is derived from the Lawele mine has a value of penetration is much higher than the asphalt coming from the mine site Kabungka.

| Properties                        | Unit          | Kabungka Quarry | Lawele Quarry |
|-----------------------------------|---------------|-----------------|---------------|
| Asphalt content                   | % weight      | 20              | 30.8          |
| Penetration (25°C, 100g, 5 second)| 0.1mm         | 4               | 36            |
| Softening point                   | °C            | 101             | 59            |
| Flash point                       | °C            | -               | 198           |
| Ductility (25°C, 5 cm/min)        | cm            | <140            | >140          |
| Specific Gravity                  |               | 1.046           | 1.037         |
| Penetration (LOH) (25°C, 100g, 5 second) | % weight | 94              |               |
| Softening point (LOH)             | °C            | 62              |               |
| Loss of weight (163°C, 5 hour)    | % weight      |                 | 0.31          |
| Solubility in trichloroethylene   | % weight      |                 | 99.6          |

Sources: Road and Bridge Research & Development [4]

The Asphalt Buton from the mine site of Lawele or known Asbuton B 50/30 is selected for this research. In the area of North Buton, Buton B 50/30, better known by the name of North Buton Seal (Butur Seal). The property requirement for a North Buton seal are presented in Table 2.

2.2. Research Method

This research was conducted at the Highway Laboratory, Civil Engineering Department, Engineering Faculty, University of Sebelas Maret. The investigation utilizes the Marshall method. The materials used in this study are Asphalt Buton (Butur Seal) B50/30 and Polymer Elastomer (Latex).
The research process begins by carrying out the job mix design of Asbuton Butur Seal in warm mixing temperature at 30, 40, 60 and 80°C, then producing the Marshal sample with a mixture of Nort Buton seal. In addition the polymer latex was added to vary between 1% to 4%.

### Table 2. The property requirements for North Buton Seal 50/30

| No | The properties | Method | Requirements |
|----|----------------|--------|--------------|
| A  | Original shape | SNI 1969 | 9.5 mm |
| 1. | Granular size, mm | SNI 2490 | Max. 2 |
| B  | Asbuton Granular shape B 50/30 | SNI 03 3640 | 25 – 40 |
| 2. | Bitumen content, % | SNI 06 2456 | 40 - 60 |
| 3. | Softening point, °C | SNI 06 2434 | Min. 55 |
| 4. | Ductility, 25°C, Cm | SNI 06 2432 | ≥100 |
| 5. | Specific Gravity | SNI 06 2441 | Min. 10 |
| 6. | Flash point, °C | SNI 06 2433 | Min. 232 |
| C  | Residual after TFOT | SNI 06 2441 | ≤ 3 |
| 1. | Loss of Specific Gravity (LoH),% | SNI 06 2441 | ≥ 54 |
| 2. | Penetration | SNI 06 2458 | 25°C, 100g, 5 second, 0.1 mm |

Sources: Centre for Road and Bridge, DPU, 2012 [5]

### 3. Results and Discussion

The Test results on Asbuton Butur Seal in warm mixing with a temperature range of 30, 40, 60 and 80°C coupled with latex content at varying between 1 to 4%, the best results were obtained at temperature of 80°C with high levels of latex content. Table 3 to Table 6 show the Marshall and volumetric properties at the temperature of 30°C, 40°C, 60°C and 80°C, respectively.

### Table 3. The Marshall and volumetric properties at 30°C

| Latex Content (%) | Stability (Kg) | Flow (mm) | MQ (kg/mm) | Porosity (%) | Density (gr/cc) |
|-------------------|----------------|-----------|------------|--------------|-----------------|
| 1                 | 63.649         | 12.50     | 5.114      | 53.913       | 1.2             |
| 2                 | 104.516        | 9.67      | 10.818     | 53.014       | 1.3             |
| 3                 | 107.782        | 9.28      | 11.622     | 51.383       | 1.3             |
| 4                 | 87.973         | 6.80      | 12.928     | 48.511       | 1.2             |

### Table 4. The Marshall and volumetric properties at 40°C

| Latex Content (%) | Stability (Kg) | Flow (mm) | MQ (kg/mm) | Porosity (%) | Density (gr/cc) |
|-------------------|----------------|-----------|------------|--------------|-----------------|
| 1                 | 112.686        | 9.00      | 19.113     | 48.249       | 1.38            |
| 2                 | 134.367        | 0.00      | 19.372     | 45.932       | 1.37            |
| 3                 | 233.785        | 0.35      | 19.487     | 45.599       | 1.52            |
| 4                 | 158.620        | 5.75      | 37.878     | 44.169       | 1.40            |
The better workability of the North Buton mixture is expected by increasing the mixing and compaction temperature and the addition of polymer latex. Porosity and density values could be used as indicators of workability. The correlations between density and latex content at various temperature are presented in Figure 1. It could be seen that increasing temperature resulted in higher density value. The data of porosity in Figure 2 gives similar trend of better porosity at a higher temperature of compaction. The higher the temperature the more workability of the mixture [6], so that the better compaction could be achieved. The variation of latex contents shows that the optimum percentage of latex depend on the compaction temperature, the higher the temperature the higher the latex content required for better compaction efficiency.

![Figure 1](image-url)
Figure 2. The correlation between porosity and latex content at various temperatures

The Marshall properties as the indicators of the strength of the materials could be seen from the Marshall stability values. As presented in Figure 3, the higher the stability value could be achieved at higher compaction temperatures. The better workability has an influence on the strength of the compacted materials. The addition of polymer as rejuvenation also achieves the optimum at 3% of latex content. It could be concluded that the problem of the North Buton seal application is at the compaction temperature and the need of rejuvenation to improve the workability. Further research is required to investigate the optimum compaction temperature and the optimum rejuvenation content to achieve ideal construction of North Buton seal [7].

Figure 3. The correlation between latex content and Marshall Stability
4. Conclusion
Increasing the compaction temperature resulted in higher density and consequently lower porosity of the mixture, indicating that better workability has been achieved at higher combustion temperatures. Incorporating rejuvenation such as latex could improve the workability but the latex content need to be considered as the specific compaction temperature.

The Marshall stability values as indicator of the material's strength could achieve higher value at the better workability of the mixture during the compaction. Further research is required to investigate the optimum temperature compaction and rejuvenation content for better properties of the North Baton seal application.

References
[1] Hadiwardoyo, S. P., Sinaga, E. S., & Fikri, H. (2013). Construction and Building Materials, 42, 5-10.
[2] Hermadi, M. and Sjahdanulirwan, M., 2008. Jurnal terpublikasi. Bandung: Puslitbang Jalan dan Jembatan.
[3] Davidson, J. W., 1991., The geology and prospectivity of Buton island, SE Sulawesi, Indonesia. 209-233.
[4] Departemen Pekerjaan Umum, 2010, Pemerintah Tingkatkan penggunaan AsButon untuk Penanganan Jalan, Jakarta
[5] Dirjen Bina Marga, 2012; Dokumen Spesifikasi Khusus Lapis Pondasi Batu kapur (Butur Seal Asbutonseks 6.6 kh, Jakarta
[6] Chowdhury, A., & Button, J. W. , 2008. A review of warm mix asphalt (No. SWUTC/08/473700-00080-1). Texas Transportation Institute, the Texas A & M University System.
[7] Guo-yuan, H. W. T. X., 2012. Journal of South China University of Technology (Natural Science Edition), 2, 018.