Performance of Wearing Surface with Addition of Wetbond-SP

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Abstract. Having a pavement that lasts until its designed life is a goal for road engineers. Moisture-induced pavement distresses in flexible pavement are often found during initial stage of pavement lifetime. Previous study has shown that, based on laboratory test, using an anti-stripping agent named Wetbond-SP at dosage of 0.5% of binder weight can improve the moisture susceptibility and increase the stability of the asphaltic mixture. This research project aims to evaluate the performance of asphaltic mixture with 0.5% Wetbond-SP when subjected to actual traffic and climate condition. It was found that the laboratory test result showed an unsatisfactory result for the asphaltic mixture, but when the mixture was applied as patching infield, it can be seen that the patching performs reasonably well with only minor ravelling occurred 27 days after the patching works were completed, despite the fact there were few heavy rainfalls occurred. The research results also indicated that the usage of marginal aggregates is possible and needed to be explored further.

Keywords: Wetbond-SP, Aggregate, Wearing Surface, Patching, Flexible Pavement

1. Introduction

Having a long-lasting pavement is a goal for every pavement engineers. One of the causes in having pavement distresses is moisture, where the aggregates were being stripped off from the asphalt [1]. There are a number of additives or anti-stripping agents that are added to the asphaltic mixture to make flexible pavement lasts longer, such as asWetfix-BE[2], Wetbond-SP [3], Elvaloy®[4], and hydrated lime[5], [6]. This research project is a continuation of previous research study that has shown that Wetbond-SP at dosage of 0.5% was an additive that can be effective in improving the stability and the moisture susceptibility of the prepared asphaltic mixture samples [7]. In this study, 0.5% Wetbond-SP was trialled to be mixed with asphaltic mixture and was applied as patching for potholes. The objectives of this research study are to evaluate the in-situ performance of the wearing surface that has been mixed with 0.5% Wetbond-SP when subjected to actual traffic and climate conditions, to compare the laboratory and infield performance of asphaltic mixture, and to assess the performance of the marginal aggregates.
2. Experimental design

2.1. Materials

Natural aggregate sourced from a quarry was used for the patching. Preliminary tests according to *Standar Nasional Indonesia* (SNI) were conducted to assess the suitability of the aggregates to be used in the asphalt mixture, as listed in Table 1.

It was found that some of the parameters, such as bulk specific gravity and absorption level, did not satisfy the standard requirements. This could be caused by the fact that, by visual observation, there were some limestones mixed in the aggregates. These aggregates can be categorized as marginal aggregates. However, the aggregates were still used as this research would like to assess the effect of using additive on marginal aggregates.

| Tests                              | Results | Requirements |
|------------------------------------|---------|--------------|
| Coarse                | Fine             |
| Bulk Specific Gravity            | 2.308  | 2.338        |
| SSD Specific Gravity             | 2.411  | 2.700        |
| Apparent Specific Gravity        | 2.573  | 2.592        |
| Absorption (%)                  | 4.456  | 4.030        |
| Los Angeles Abrasion (%)         | 29.18% | ≤ 40         |

Moreover, the binder used was sourced from Shellasphalt binder with 60/70 penetration was used. The binder was also undergone preliminary tests according to SNI and the results are listed in Table 2. It can be seen that the binder met all the requirements stated by SNI.

| Tests                               | Results | Requirements |
|-------------------------------------|---------|--------------|
| Penetration Test at 25°C (0.1 mm)   | 61      | 60-70        |
| Specific Gravity (gr/cc)            | 1.03    | ≥ 1.0        |
| Ductility at 25°C (cm)              | 152     | ≥ 100        |
| Softening Point Test (°C)           | 49      | ≥ 48         |
| Flash Point Test (°C)               | 305     | ≥ 232        |
| Fire Point Test (°C)                | 328     | ≥ 288        |

The additive added in this project was Wetbond-SP, which was added at the dosage of 0.5% of the binder weight. This dosage was chosen based on the previous research project[7]. Wetbond-SP is one of the anti-stripping agent that can be added to improve the bond between the binder and the aggregates, so that the asphaltic mixture could be more resistant to water intrusion or moisture [8].

2.2. Laboratory Test

The Marshall test was conducted for both control samples and samples with Wetbond-SP added according to SNI 06-2489-1991[9]. The test was done three times for each sample variation to obtain a statistically significant result. Some parameters that can be obtained from this test are stability, flow, Void in Mix (VIM), Void in Mineral Aggregate (VMA), Void Filled with Asphalt (VFA), and density.
2.3. Infield Application

The designed asphaltic mixture was applied as patching at three locations, which are located at Jakarta-Merak Toll Road KM 39+800. One patching site (denoted as C1) was a control location where the asphaltic mixture without Wetbond-SP applied and the other two patching sites (denoted as W1 and W2) were the locations were patched with asphaltic mixture mixed with 0.5% Wetbond-SP. Each patch was made to be 50 cm by 50 cm and with 5 cm width. The patching locations were at one same lane, which can be illustrated in Figure 1.

2.3.1. Mixing Method

The aggregates, binder, and Wetbond-SP were mixed on site by using a mixer. This was done to ensure that the Wetbond-SP was able to be thoroughly mixed with the asphalt and covered the aggregates. Wetbond-SP is available in liquid state, and therefore, if the additive was mixed with asphaltic mixture brought from asphalt mixing plant, there was a concern that the Wetbond-SP would only cover the binder part or the surface part, but would not combine well with the asphaltic mixture. After all the materials were mixed well, the asphaltic mixture was poured to the prepared holes and then compacted.

2.3.2. Data collection

The quality of the patching was monitored regularly by using the Pavement Condition Index (PCI) method, as stated in [10], by three surveyors. The data was collected weekly up to 41 days after the patching was constructed. The climate condition was also collected to analyse the infield performance of the asphaltic mixture and was retrieved from the website of Meteorological, Climatological, Geophysical Agency.

3. Results and Discussion

3.1. Marshall Test Results

Table 3 shows the Marshall test results for the prepared samples. It can be seen that the stability values for both sample variations were lower than the requirements, but the stability value of the sample mixed with Wetbond-SP was higher than the control sample. Other parameters, except the VMA, also
did not satisfy the requirements and this could be caused by the job mix for asphaltic mixture was dominated by coarse aggregates, which resulted in high void in mixture, and hence made it difficult to reach the desirable density and affected the stability of the prepared samples. It was also observed that the aggregates contain some limestones, which could cause the absorption level to be rather high.

Moreover, it can be observed from the data that the samples mixed with Wetbond-SP had higher stability values, which suggested the ability of the additive to improve the stability of the sample. However, the samples mixed with Wetbond-SP seemed to have a higher flow value, lower VIM, and higher VFA. These findings are most likely related to the job mix and aggregate grading as the amount of Wetbond-SP added was small compared to the whole mixture.

Table 3. Marshall test results for sample variations

| Parameters | Unit | Control | 0.5% Wetbond-SP | Requirements |
|------------|------|---------|-----------------|--------------|
| Stability  | kg   | 151.02  | 183.513         | > 800 kg     |
| Flow       | mm   | 4.85    | 6.97            | 2-4 mm       |
| VIM        | %    | 8.04    | 7.77            | 3-5 %        |
| VFA        | %    | 59.5    | 60.59           | > 65%        |
| VMA        | %    | 19.86   | 19.71           | > 15%        |
| Density    | gr/cm³ | 1.96    | 1.96            | ≥ 2.2        |

3.2. PCI results

Table 4 shows the conditions of all patching from the first day until about 41 days after the patching works were completed. It can be seen that some minor damage, which is low severity of ravelling, can be observed 27 days after the patching was placed. Minor ravelling was found on patching C1 was the size of 4 cm by 1 cm. On patching W1, the low severity ravelling was the size of 4 cm by 6 cm. After 41 days, patching W2 was still in good condition and no damage was observed.

From the monitoring result, it can be seen that, at early stage, the patching that uses asphaltic mixture mixed with Wetbond-SP perform equally good compared to the control patching. However, after almost a month, the control patch C1 started to show minor distress although C1 was located in the middle of the lane, and hence, was not exposed to wheel load as much as the others.

Comparing the infield and laboratory test results, it can be understood that the laboratory test results conducted in this study did not give a good indication of what the infield performance would be. The laboratory test results indicated that the asphaltic mixture used had inadequate strength to withhold the traffic loadings, but by looking at the monitoring results, it can be seen that the asphaltic mixture performed reasonably well.
| Date          | Patching age (day) | C1 (Control) | W1 (Wetbond 0.5%) | W2 (Wetbond 0.5%) |
|--------------|---------------------|--------------|-------------------|-------------------|
| 18 July 2020 | 0                   | PCI = 100    | PCI = 100         | PCI = 100         |
| 22 July 2020 | 4                   | PCI = 100    | PCI = 100         | PCI = 100         |
| 29 July 2020 | 11                  | PCI = 100    | PCI = 100         | PCI = 100         |
| 14 August 2020 | 27               | PCI = 99     | PCI = 98          | PCI = 100         |
| 28 August 2020 | 41               | PCI = 99     | PCI = 98          | PCI = 100         |

3.3. Rainfall Data
Based on Indonesian Meteorological, Climatological, and Geophysical Body (BMKG) website, there were three rainfall occurrences recorded, as listed in Table 5. The patching application and the monitoring period was done during dry season, and hence, there was not much rain occurred. However, based on the data collected, it can be seen that there were a number of occurrences of light rain and heavy rain, which occurred three days and 27 days after the patching was completed.
It can be seen from the monitoring results (Table 4) that the all patching sites were only slightly affected by rain or exposure to moisture, and thus, the performance of asphaltic mixture with Wetbond-SP cannot be evaluated as yet.

| Date             | Patching age (day) | Rainfall Precipitation (mm) |
|------------------|--------------------|-----------------------------|
| 21 July 2020     | 3                  | 47.3                        |
| 6 August 2020    | 19                 | Not Available               |
| 8 August 2020    | 21                 | Not Available               |
| 10 August 2020   | 23                 | 6.4                         |
| 12 August 2020   | 25                 | 0.4                         |
| 14 August 2020   | 27                 | 44                          |
| 17 August 2020   | 30                 | 2                           |
| 18 August 2020   | 31                 | 2.6                         |

3.4. Traffic data
The traffic data obtained from the toll road management shows that a total number of 31119 vehicles passing the road each day, which varied from cars to five-axled trucks. The traffic volume was converted to equivalent single axle load (ESAL), which resulted in 109028.54 ESAL. This is equal to an equivalent of 889672.89 tonnes of load each day. With the data obtained, the road is considered to be busy and has enough load to test the flexible pavement quality.

4. Conclusions
Having a long-lasting pavement is always desirable by road engineers. This project is a continuation of previous research study, which has shown the effectiveness of adding 0.5% Wetbond-SP onto the asphaltic mixture. This study aims to evaluate the infield performance of asphaltic mixture when subjected to actual traffic and climate conditions, to compare the laboratory and infield performance of the mixture, and to assess the performance of the marginal aggregates.

From the research results, it can be seen that the aggregates used were marginal aggregates that did not satisfy the requirements stated by SNI. However, when the asphaltic mixture was applied as patching at three locations, it can be seen that the asphaltic mixture performed reasonably well with only minor ravelling found 27 days after the works were completed at patching C1 and patching W1, while there were no distresses found at patching W2, even after a number of rainfall occurrences. This shows that the marginal aggregate was able to withstand the actual traffic and the climate conditions. Additionally, this also raises the question on the ability of the laboratory test to predict the infield performance.

Comparing the performance of the asphaltic mixture mixed with and without Wetbond-SP, it can be seen from the Marshall test results that the asphaltic mixture mixed with Wetbond-SP had a higher stability value than the control sample. However, when both variations were applied as patching infield, there was no significant difference in the performance of both mixtures.

For further research, it is important to ensure that the three patching sites are monitored regularly, especially during monsoon season, where there will be more frequent and heavier rainfall.

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