Effect of Latex Dry Rubber Content (DRC) 30 on Marshall Parameters of Asphalt Concrete

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Abstract. Indonesia is one of the world's largest latex producers. Latex can be used as an asphalt modifier on road pavements. The level of road damage in Indonesia is high. The purpose of this research was to describe the effect of using DRC-30 latex on Asphalt Concrete in terms of Marshall parameters. The test specimens are made using two kinds of asphalt concrete (AC) gradations, namely the Asphalt Concrete Wearing Course (ACWC) gradation, and the AC-Base gradation. Test data were analyzed using Marshall parameters, namely stability, flow, void in mix (VIM), and void filled with asphalt (VFA). The test results showed that latex increased the stability value in all types of gradations. Latex increased the value of Flow AC-Base, but decreased the value of flow at ACWC. The addition of latex to AC decreased the VIM value of AC-Base and ACWC. Meanwhile, the addition of latex to AC-Base and ACWC increased the value of VFA, the highest increase was for AC-Base. Based on Marshall parameters, the best performance of AC due to the addition of latex is in the AC-Base gradation.

1 Introduction

Flexible pavement is most widely used because of the advantages that it has compared to the others. It has smooth and seamless surface, and requires shorter construction [1]. However, the issue that needs to be overcome is road damage occurring on flexible pavement. In Indonesia, the highest road damage occurs on regency roads. According to Public Work [2], 46% of regency roads are in a damaged condition, followed by provincial roads and national roads, respectively 32% and 7.19% are in a damaged condition. Road damage is caused by accumulated traffic loads, overloads, axle loads, and high temperatures [3,4]. There needs to be an asphalt mixture that has the properties of being resistant to high temperatures and has high stability so that it can withstand loads better and have a longer service life. In recent years, many researchers have focused on efforts to increase the service life and durability of pavement [5]. The approach that is often taken is by making asphalt modifications. Asphalt modification has been proven to improve the desired properties (e.g. durability, resistance of

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oxidation, term sensitivity, friction properties, and aging resistance). Several asphalt modifiers have been used, including resins, polymers, fibers, sulfur, and rubbers [6].

Natural rubbers in the form of latex are known to be widely used to improve the performance of asphalt mixtures and many scholars are in unison regarding this. Siswanto [7] mentions that latex DRC 60 increases resistance to deformation. Latex can reduce the use of asphalt [8][9]. Kamal et al. [10] found in their research that the presence of natural rubber modified asphalt in the asphalt mixture increase viscosity, stiffness, temperature sensitivity, and rutting resistance. Wen et al. [11] also added that natural rubber is considered a sustainable and renewable modifier.

2 Method

This research material consists of coarse aggregate, fine aggregate, filler, asphalt, and latex. The coarse aggregate and fine aggregate used are sourced from Pasuruan Regency, while the filler used is Portland Cement. The latex used comes from Bogor Regency. The type of latex used is 30% dry rubber content (DRC) latex. The test was carried out at the Civil Engineering and Planning Laboratory of Universitas Negeri Malang.

The analysis uses Marshall analysis parameters which include stability, flow, void in mix (VIM), void in mineral aggregate (VMA), void filled asphalt (VFA), and Marshall Question (MQ). The specifications used in this research are the Indonesian Specifications [12], and are shown in Table 1.

Table 1. Specification of Asphalt Concrete Modification

No.	Marshall Parameter	Unit	Specification
1	Number of blow per face	blow	75
2	VMA	%	≥ 14
3	VFA	%	≥ 65
4	VIM	%	3.0 – 5.0
5	Marshall Stability ACWC and ACBC	Kg	≥ 1,000
6	Marshall Stability AC-Base	Kg	≥ 1,800
7	Marshall flow ACWC and ACBC	Mm	2.0 – 4.0
8	Marshall flow AC-Base	Mm	3.0 – 6.0

3 Results and Discussion

The results of the stability test on the specimen are shown in Figure 1. It illustrates that stability generally increased with the addition of latex. The highest stability occurred in the AC-Base asphalt mixture, followed by ACWC. Based on Indonesian specifications, the minimum stability value is 1,000 kg, therefore, all stability test results for ACWC mix and AC-Base have met the specifications. The greatest increase in stability occurred in AC-Base mix followed by ACWC, respectively 29.31% and 19.93%. Stability can increase due to increased adhesion between the aggregate and the asphalt [13]. Latex has the potential to increase aggregate adhesion with asphalt in asphalt concrete. The presence of latex in asphalt increases viscocity, stiffness and resistance to rutting [10].

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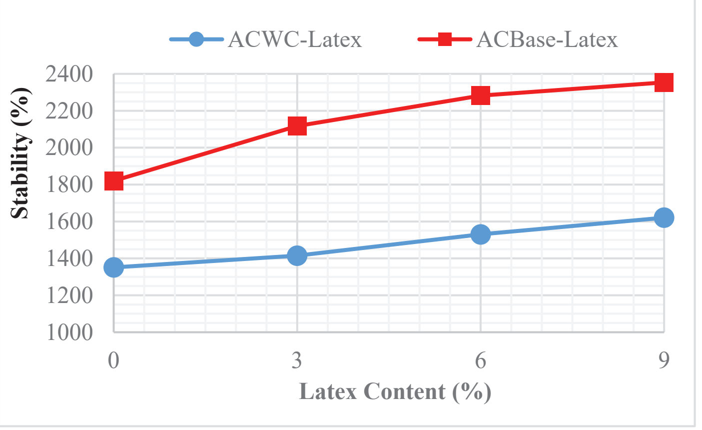

Fig. 1. Latex Content and Stability of Asphalt Concrete

The flow test results are shown in Figure 2. It is visible that the highest flow value was obtained from the AC-Base mixture, followed by ACWC. Based on the Indonesian Specifications, all flow values have met the specifications. AC-Base flows are all in the range of 3%–6%, while ACWC flows are in the specification range of 2%–4%. Flow AC-Base increased with increasing latex content in the mixture, on the contrary, ACWC flow decreased with increasing latex content. In this research, the optimum content value for ACWC mix and AC-Base was found to be the same, namely 5.9% of the mixture weight. ACWC has a smaller aggregate size than AC-Base, so the surface area of the ACWC aggregate will be larger. With the asphalt content of both mixtures being the same, it means that the asphalt will cover the AC-Base aggregate thicker than ACWC, therefore, AC-Base mix flow value is greater than the ACWC flow.

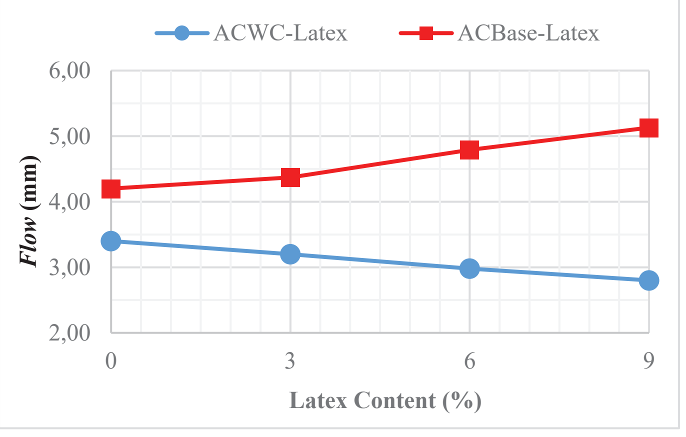

Fig. 2. Latex Content and Flow of Asphalt Concrete

Marshall Quetient calculation is shown in Figure 3. The MQ of ACWC asphalt mixture with the addition of latex increased along with the addition of latex. Meanwhile, the AC-Base, MQ asphalt mixture reached a certain latex content, then decreased. MQ in ACWC increased with increasing latex content because the flow value as a dividing factor decreases with increasing latex content. On the contrary, it happened in the AC-Base mix. The AC-Base flow value decreased as the latex content increased.

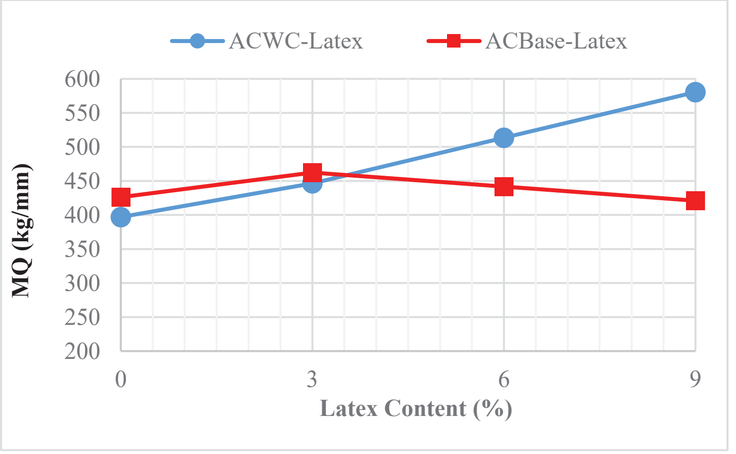

Fig. 3. Latex Content and MQ of Asphalt Concrete

The VIM data in this research is illustrated in Figure 4. Increasing the latex content in AC-Base and ACWC reduced the VIM value. With a VIM specification of 3%–5%, all test results met the specification requirements. A decrease in the VIM value indicates that the relationship between aggregates in the asphalt mixture is getting tighter, the density of the asphalt mixture is high, and the stability increases. The correlation between the stability test results and the VIM analysis results becomes synchronous. VIM is the most important parameter in asphalt mixtures, because it has an influence on the performance of the asphalt mixture [14–16].

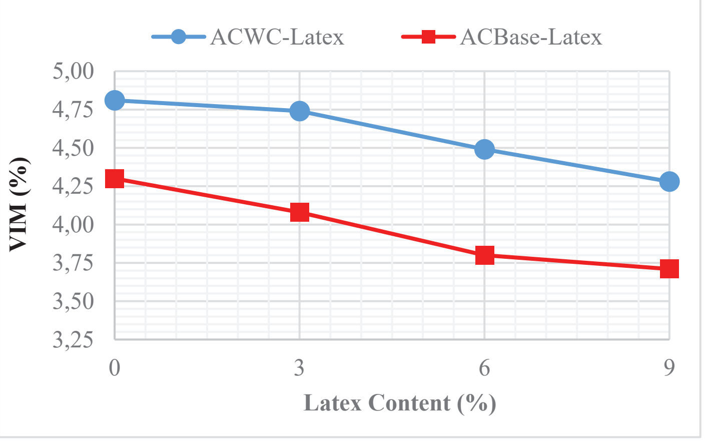

Fig. 4. Latex Content and VIM of Asphalt Concrete

Figure 5 displays the relationship between latex content and VFA. Increasing latex content in the ACWC and AC-Base mixture increases the VFA value. Based on the Indonesian Specifications, the VFA value must be equal to or greater than 65%, therefore, all ACWC mix and AC-Base mix test results have met the specification requirements.

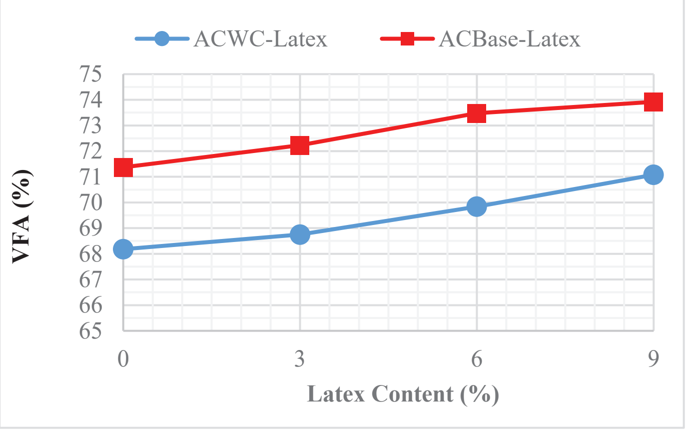

Fig. 5. Latex Content and VFA of Asphalt Concrete

Based on Marshall parameters, latex affects the asphalt mixture in all parameters. The greatest effect on stability occurred in the AC-Base mix, which increased by 29.31% at a latex content of 9%. The addition of latex to AC-Base increased the flow value, whereas the addition of latex decreased the ACWC flow value. The use of latex in asphalt mixtures will play a role in increasing the use of sustainable materials and play a role in the efficient use of asphalt in asphalt mix [8,9,11].

4 Conclusion

Latex increases the stability of asphalt mix. The highest increase occurred in the AC-Base mixture, followed by ACWC. The flow value of AC-Base increased with the addition of latex, whereas ACWC actually decreased. The addition of latex to AC-Base did not affect the MQ value, but the addition of latex to ACWC increased the MQ value. The VIM values of AC-Base and ACWC decreased with increasing latex content in the mixture. The greater the latex content in asphalt concrete, the greater the VFA value is.

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