

Effect of Blending Parameters on Physical Properties of Styrene-Butadiene Rubber Coagulum Modified Asphalt Binder

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Abstract: Polymer modified asphalt binder have gained high interest in recent years due to its promising performance. However, the uses of natural polymer such as natural latex is susceptible to contamination and require certain treatment to reduce the water content. This issue can cause the low homogeneity with asphalt binder. Therefore, this study explored another type of synthetic polymer, Styrene-Butadiene Rubber (SBR) coagulum. The base binder of penetration grade 60/70 was blended with 5% of SBR coagulum to determine the suitable blending temperature and blending time. Then this modified binder was further testing for physical properties penetration and ductility test. The results showed the penetration value decreased with increasing blending temperature and time. The suitable blending temperature and time were found as 190°C and 120 minutes. For conclusion, the application of using SBR coagulum as modifier has a good potential as asphalt binder modifier.

Keywords: Modified Asphalt, SBR Coagulum, Blending Parameters

1. Introduction

All country in the world experienced the rapid rate of developing in all aspect and especially in construction development [1]. The quality of road can determine the level of development in that country. The quality and sustainability of the road is vital to ensure the efficiency of transportation system. In a road construction, asphalt binder is a vital material [2]. Standard bitumen needs to be strengthened in terms of performance-related properties to reduce pavement surface damage such as resistance to permanent deformation and fatigue cracking [3]. Thus, it is necessary to understand the fundamental behavior and properties of roads before starting to develop advanced construction processes [4].

The use of polymers increased in recent years. Among polymeric materials, rubbers are known for their easy processing and high flexibility. Asphalt binder is a viscoelastic material with suitable physical properties for traditional paving and roofing applications because of their good adhesion properties to aggregates [5]. Binder modification with polymer is a common means of providing resistance to

pavement deformation [6]. There are various of polymer have been used in pavement modification such plastic and rubber such as natural rubber, styrene butadine styrene (SBS) and styrene-butadine -rubber (SBR). The fatigue resistance and low temperature properties of SBR are usually lower than natural rubber (NR), thus it's heat and abrasion resistance properties are better [7]. The performance and quality of pavement can be determined by the properties of the bitumen.

Styrene-butadiene-rubber (SBR) is a synthetic rubber from chemical formulation of styrene and butadine. It also an alternative replacement for natural rubber commonly in automotive industry, tire, and glove manufacturing [8]. From the SBR production plant, coagulum was produced in a large quantity. Therefore, the aim of this study is to investigate the effect of blending parameters such blending time and temperature on physical properties of modified polymer.

2. Materials and Methods

2.1 Materials

A penetration grade of PEN 60/70 was used as a base binder. 5 % of SBR coagulum was chosen according to Yaacob et. al [9]. The modified asphalt binder was tested for penetration and ductility test. Table 1 shows the standard method for conducting the physical testing for asphalt binder. Figure 1 shows the SBR coagulum used in this study. The specific gravity of SBR coagulum is 1.032.

Table 1: Properties of asphalt binder PEN 60/70

Properties	Results	Test standard	Requirement (JKR/SPJ/2008)
Penetration at 25°C (dmm)	66.86	ASTM D5	60-70
Softening point (°C)	53.25	ASTM D36	49-52°C
Viscosity at 135°C (Pa.s)	0.87	ASTM D4402	3.0



Figure 1: The SBR coagulum

2.2 Methods

Blending process of SBR coagulum modified binder was conducted at different blending temperature and time. Due to time constraint, the blending speed was choosing at 2000 rpm. About 500gm content of asphalt binder was heated in the oven at temperature 110°C until it melts. The SBR

was then added gradually to the heated asphalt binder. Two blending temperature were used, 170°C and 190°C. Then, the modified asphalt binder was mixed for 60 min and 120 minutes by using high shear mixer with proposed value of blending speed which is 2000 rpm. Figure 2 shows the blending process of base binder, PEN 60/70 and SBR coagulum modified binder.



Figure 2: Blending process of asphalt PEN60/70 and SBR coagulum modified binder

3. Results and Discussion

3.1 Effect of Blending Speed

Initially, the blending trial of SBR coagulum modified asphalt binder was blended at blending temperature of 170°C at 1500 rpm for 60 minutes. However, based on visual observation, some of the SBR coagulum did not completely dissolved in the asphalt binder. Next, the trial blending was conducted at 2000 rpm. Based on visual observation, the SBR coagulum is completely dissolved in the asphalt binder. Figure 3 shows the homogenous blend of SBR modified binder at 2000 rpm. Therefore, for the next blending work, 2000 rpm was further used for blending and produce the SBR coagulum modified binder.



Figure 3: The homogenous blend of SBR modified binder at 2000 rpm

3.2 Effect of Blending Temperature

Based on the result in Figure 4, it was observed that blending temperature of 170°C and 190°C with 2000 rpm of asphalt binder can have good a resistance to temperature susceptibility. Generally, the penetration value was found decreased with the increasing of blending temperature. According to Mashaan et al. [10], the penetration values is lower at different mix conditions of rubberized asphalt binder, it is indicating that the binder becomes stiff and more viscous.

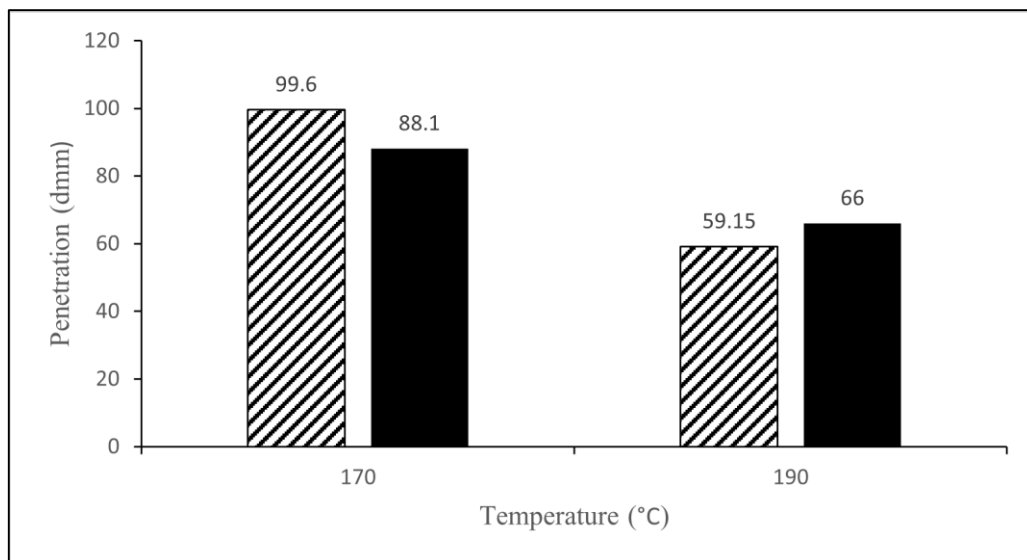


Figure 4: The penetration value of SBR coagulum at different blending temperature

3.3 Effect of Blending Time

Penetration test of SBR coagulum modified asphalt binder were shown in Figure 5 and 6. In Figure 5, the SBR coagulum modified asphalt binder was blended at temperature 170°C with different blending time (60 and 120 minutes). While, Figure 6 presents the penetration value of SBR coagulum modified binder at blending temperature of 190°C with different blending time (60 and 120 minutes). As can be seen, the penetration value decreased with increasing blending time. The results indicate that the blending time shows a significant effect in penetration value. The SBR coagulum content has a strong effect on reducing the penetration value by increasing the stiffness of the binder. Thus, it would make the asphalt binder less temperature susceptible and less to high resistance to permanent deformation like rutting [11].

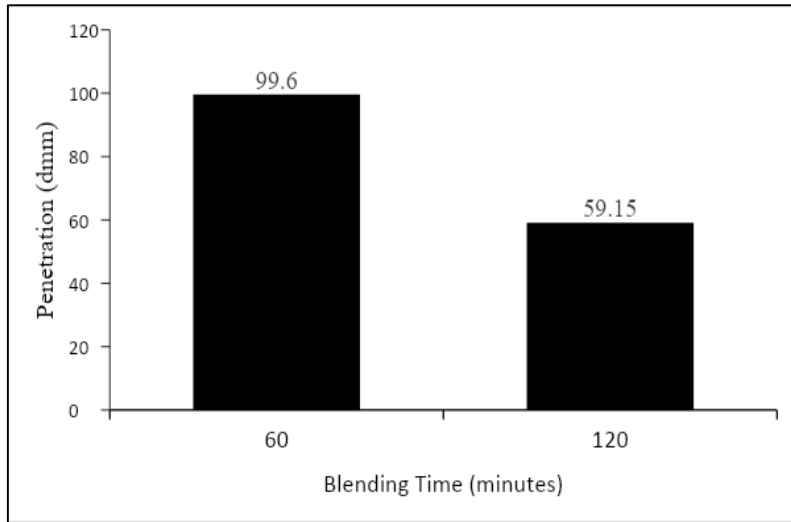


Figure 5: The penetration value for different blending time at blending temperature of 170°C

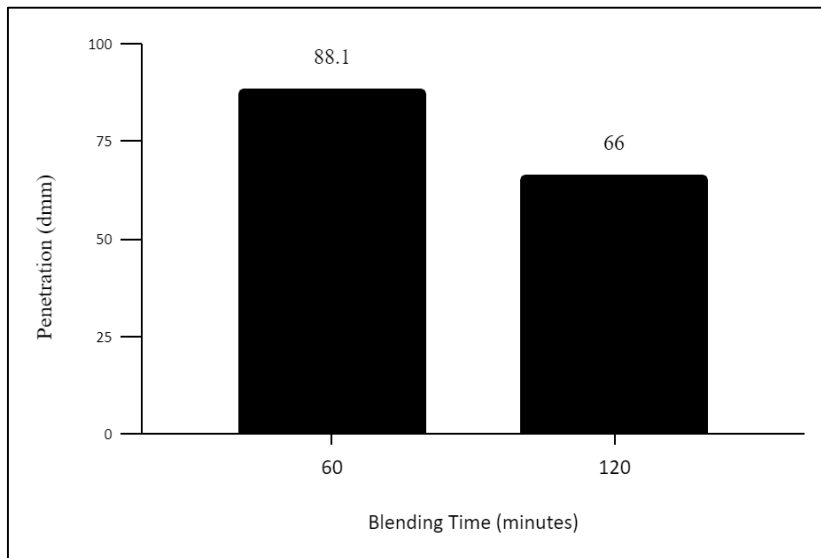


Figure 6: The penetration value for different blending time at blending temperature of 190°C

Ductility test provides a measure of tensile properties of bituminous materials. The ductility is a strength of bitumen that allowing modified asphalt to undergo deformation or elongation. The ductility result was conducted at 25°C. Table 2 presents the result of ductility for modified binder. In this study, the ductility for SBR coagulum modified binder was obtained as 35.8 cm which is lesser than the minimum value of 100 cm (specification of JKR/SPJ/2008) [12].

Table 2: Ductility result of polymer modified asphalt binder

Source	Polymer %	Blending parameter	Ductility value (mm)	Modifier
This study	5	190°C, 60 minutes, 2000 rpm	35.8	Styrene-Butadiene rubber coagulum (SBR)

Peng (2016) [13]	3	180°C, 60 minutes, 100 rpm	30.5	Styrene- Butadiene styrene (SBS)
Mashaan et. al (2011) [14]	4	180°C, 60 minutes, 200 rpm	70	Crumb rubber

4. Conclusion

The suitable blending temperature of 5% of SBR coagulum is 190°C and blending time 120 minutes for penetration test because provides a maximum degree of blending. This value can be used and acceptable since it decreases the penetration value which would enhance the binder stiffness, consistency, and resistance to flow. Polymer modification proves to be an effective way to improves the asphalt binder properties. Using SBR coagulum will give impacts on cost and environment where can save more cost and to conserve natural resources for future generation. However, from the result of the analysis, it can be concluded that the blending method has a significant influence on the degree of blending a SBR coagulum.

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