Study on the Mechanism and Technical Index of Rubber Powder /SBS Double Composite Modified Asphalt

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Abstract: The composite modified technology will waste rubber and SBS modified, the analysis of the composite modified asphalt under different rubber powder content and storage time of viscosity, penetration, softening point and changes in the extension and the performance were compared. The results showed that 20% crumb rubber content and composite modified asphalt has the best network structure, the performance best; crumb rubber and SBS composite modified asphalt mixture performance and SBS modified asphalt mixture performance difference and could meet the standard required value.

1 INTRODUCTION

The use of scrap rubber powder to modify the matrix asphalt can improve the viscosity of asphalt, improve the low temperature performance of asphalt, improve anti-aging, anti-fatigue performance, and ride comfort, safety, reduce the noise of driving, and is conducive to the recycling of used products [1-5]. At the same time, modified asphalts such as SBS and SBR have also improved the road performance of asphalt and asphalt mixtures, and the technology is mature. However, based on the complex traffic load and environmental conditions as well as the expensive material costs, the promotion and application of polymer modified asphalt is severely limited. With the development of rubber powder production technology, China's normal-temperature crude rubber powder and fine rubber powder have been industrialized and put into production, and their prices are far lower than SBS, PE, SBR and other modifiers, which has a good cost advantage [6-10] .

Based on this, the composite modified technology of waste rubber and SBS was modified by the author, using the composite modified technology of waste rubber and SBS was modified, and the analysis of the composite modified asphalt viscosity in different rubber powder content and storage time under the penetration, softening point and ductility changes, the road performance verification, to not only reduce the engineering cost of the modified asphalt, and improves the performance of the road.

2 RAW MATERIAL DETECTION AND PREPARATION METHOD

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2.1 Raw Materials

Using 30 mesh rubber powder and SK90# matrix asphalt, the amount of rubber powder was 20%, and the amount of SBS modifier was 1.5%, and waste rubber powder/SBS double composite modified asphalt samples were prepared. The technical performance index of the matrix asphalt meets the "Technical Specifications for Highway Asphalt Pavement Construction" JTG_F40-2004, and the performance indicators are shown in Table 1, 30 mesh with rubber powder gradation is shown in Table 2.

Table 1 Technical performance index of matrix asphalt.

Test project	Matrix asphalt	
	Test result	Specification
Penetration index PI	-1.29	-1.5-+1.0
25°CPenetration /0.1mm	89.5	80-100
10°CDuctility /cm	＞100	≥20
Softening Point /（°C）	48.5	≥45

Table 2 30 mesh rubber powder gradation.

Sieve size /mm	0.60	0.45	0.30	0.20	0.15
Accumulative mass on sieves /g	4.84	40.07	75.08	86.44	93.24
Percentage passing /%	95.15	59.93	24.92	13.56	6.76

2.2 Preparation Method of Waste Rubber Powder and SBS Composite Modified Asphalt

The method for preparing the waste rubber powder and the SBS composite modified asphalt is as follows: the modified asphalt is prepared by a FLUKO AF25 high-speed shear dispersing emulsifier, the stirring temperature is 150° C., the stirring time is 30 min, the shearing temperature is 180° C., the shearing time is 45 min, and the rotating speed. 7000r/min, oven placed 15h, oven temperature 140 °C.

2.3 Performance Analysis of Composite Modified Asphalt

SBS adopts 1.5% content to study the change of performance index of composite modified asphalt under different amount of rubber powder (18%, 20%, 22%) and different heat storage time (1, 2, 3, 4, 5, 6, 7, 8h).

2.3.1 Viscosity

The change curve of viscosity with storage time is shown in Figure 1.

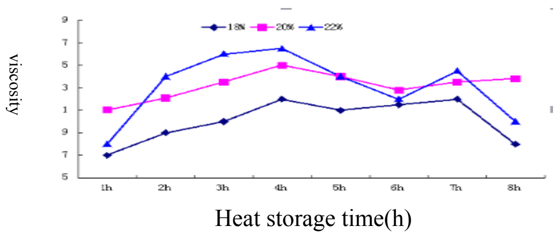

Figure 1 The change curve of viscosity with storage time.

The Brucella viscosity of composite modified bitumen increased with the increase of growth time, and showed a trend of increase from 1 to 4h. The variation was regular, and the dispersion between 6 and 8h was larger.

The reasons for the increase of viscosity of compound modified asphalt include: first, the swelling reaction of rubber powder in asphalt and then the volume increase, so that the interaction between rubber particles is strengthened. Secondly, the falling rubber powder is dissolved in asphalt, resulting in the increase of viscosity.

When the rubber powder content is 18%, the swelling reaction of a single rubber powder is relatively large, the rubber powder and the asphalt are homogeneously mixed, but the overall reaction swell is limited, and the interaction between the rubber particles is relatively weak, the adhesive powder has a tendency of free distribution in the matrix bitumen, so the viscosity of the modified asphalt is small.

When the amount of rubber powder increases, the rubber powder swells continuously in the matrix asphalt, and the effect of the unit volume of rubber powder particles in the matrix asphalt is continuously strengthened, and the network structure in the modified asphalt is more stable, so the viscosity increases; In addition, the swelling of the rubber powder increases the absorption of light components will increase, the asphalt becomes hard, the viscosity of the composite modified asphalt increases. When the content of rubber powder is 20%, the viscosity value of the composite modified asphalt is relatively large, but when the content of the rubber powder increases to 22%, the dispersion of the viscosity test results becomes large.

2.3.2 Penetration

The variation of penetration with storage time is shown in Figure 2:

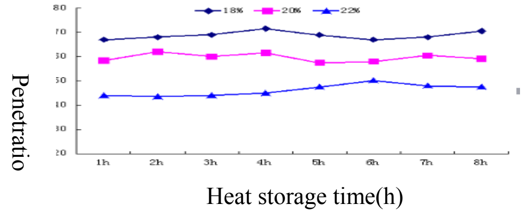

Figure 2 The change curve of the penetration with the storage time.

As can be seen from Figure 2, with the increase of the amount of rubber powder, the penetration rate of modified asphalt shows a decreasing trend. When the amount of rubber powder is 18%, the swelling rate of the rubber powder is relatively fast and the degree of swelling is relatively large, but the network structure is not formed, so the penetration is large. With the increase of the amount of rubber powder, the number of particles in the asphalt increased, and the rubber powder gradually changed from the original favorable dispersion state to two phase continuous system, and the asphalt became hard, resulting in the decrease of penetration.

When the dosage of the rubber powder increased from 20% to 22%, the penetration of the composite modified asphalt continued to decrease, but the amplitude was not significant. The main reason is that when the amount of rubber powder increases to a certain value, the network structure of the two kinds of bitumen has been formed, so the effect of excess rubber powder on penetration is no longer obvious.

2.3.3 Softening Point

The variation of softening point with storage time is shown in Figure 3:

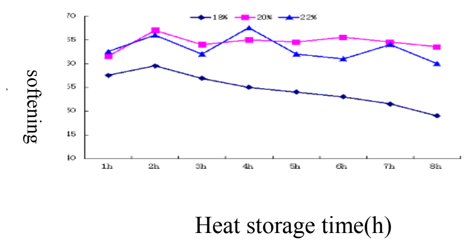

Figure 3 The change curve of the softening point with the storage time.

As can be seen from Figure 3, the softening point of the composite modified asphalt increases with the increase of the amount of rubber powder. When the composite modified asphalt is just prepared, the softening point first increases and then decreases with the increase of the amount of the rubber powder under the condition of ensuring a certain processing temperature. In addition, the time required to reach the peak value of the softening point of the composite modified asphalt with different rubber powder content is different, and the softening point increases with the increase of the amount of rubber powder.

The main reason for the above phenomena is that when the rubber powder content increases from 18% to 20%, the rubber powder in matrix asphalt changes from free state to two phase continuous state, and the bonding effect between gel particles is obviously enhanced, and the skeleton structure is developed and the softening point increases. However, the addition of rubber powder continued to increase from 20% to 22%, and colloidal particles reached saturation state in asphalt, and its connection function would weaken. Moreover, the bonding effect between rubber particles was weakened due to the serious agglomeration of rubber powder, so the softening point of composite modified asphalt decreased. In the process of thermal storage, the peak softening point of composite modified asphalt increases with the increase of the amount of rubber powder. The main reason is that the network structure of the composite modified asphalt is more perfect as the reaction continues, and the filling effect of the rubber powder will be better. Therefore, the softening point increases.

In summary, when the amount of 20% rubber powder is added, the composite modified asphalt has good high temperature performance and relatively stable properties.

2.3.4 Ductility

The variation of ductility with storage time is shown in Figure 4:

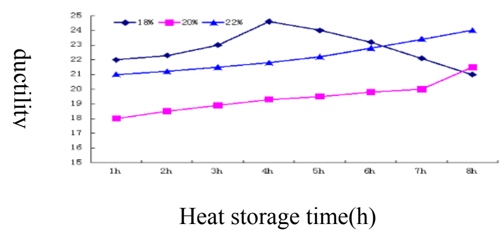

Figure 4 The change curve of the ductility with the storage time.

As can be seen from Figure 4, with the increase of the amount of rubber powder, the dispersion of the ductility is larger. With the storage process carried out at a certain temperature, the addition of rubber powder increased from 18% to 22%, and the ductility of composite modified asphalt increased with time. When the dosage of rubber powder was 20%, the ductility increased first and then increased with time.

The variation of bitumen ductility is not obvious when the dosage of rubber powder is 18% to 20%. The main reason is that rubber particles still play a major role in swelling when the amount of rubber powder is 20%, and the cracking and desulfurization of rubber powder reduce the number of molecular chain segments in asphalt, so the change in ductility is not significant. When the rubber powder content increases from 20% to 22%, the concentration of rubber particles in the asphalt increases, so that the stress dissipation point increases and the asphalt ductility increases.

In the heat storage process, when the content of the rubber powder is 18%, the dispersity in the asphalt is large, and the interaction between the colloidal particles is weak. In the long-term heat storage process, the deculturation and cracking of the colloidal powder is the main factor, and the ductility of modified asphalt increases with time. When the content of rubber powder increased to 20%, the concentration of rubber powder in asphalt increased, and the rubber powder was swelling and the asphalt became hard. After 4h, the desulfurization and cracking reaction of rubber powder was significant, and the ductility of composite modified asphalt increased first and then increased with time. When the rubber powder content further increased to 22%, the rubber powder and the asphalt reached a saturated state, and the swelling of the rubber powder was reduced. The ductility of the composite modified asphalt was mainly affected by the cracking and desulfurization of the rubber powder, and therefore, it was gradually increased with time.

3 STUDY ON ROAD PERFORMANCE OF COMPOSITE MODIFIED ASPHALT

Using the median gradation range specified by the SMA-13 specification, the road performance of rubber powder and SBS composite modified asphalt was verified at the optimum ratio of oil and stone. The test results are shown in Table 3:

Table 3 Performance test results of waste rubber powder and SBS composite modified asphalt mixture .

Test items		Best asphalt-aggregate ratio /%	Dynamic stability of rutting /(Times /mm)	Residual stability of Marshall /%	Strength ratio of freeze-thaw splitting /%	failure strain με
Index requirement value		——	≥3000	≥85	≥80	≥2500
Type of asphalt binder	Composite modified asphalt	6.2	7880	96.4	93.3	3850
	Rubber asphalt	6.3	6820	88.65	81.80	3260
	SBS modified asphalt	6.0	8200	98.1	94.2	3940

Table 3 shows that: SBS modified asphalt mixture has the best comprehensive performance, followed by composite modified asphalt mixture, the worst performance is rubber asphalt mixture, and the powder and SBS composite modified asphalt mixture and SBS modified asphalt mixture performance difference, and both meet the index requirements in the "Technical Specifications for Highway Asphalt Pavement Construction" JTG_F40-2004.

4 CONCLUSIONS

(1)The Brookfield viscosity of the composite modified asphalt increases with the development time, and it basically increases between 1 and 4 h. The change is more regular, and the dispersion between 6 and 8 h is larger. When the amount of 20% rubber powder is added, the viscosity value of the asphalt is large. When the amount of rubber powder was increased to 22%, the viscosity test results were not stable.

(2)With the increase of the amount of rubber powder, the penetration degree of composite modified asphalt gradually decreases, the dispersion of ductility is large, and the addition of rubber powder can not improve the low-temperature properties of composite modified asphalt. The softening point index of the composite modified asphalt increases with the increase of the amount of rubber powder, and the maximum of the softening point increases with the increase of the amount of rubber powder.

（3）When the amount of rubber powder is 20%, there is the best network structure of composite modified asphalt, and the rubber powder can play the best filling effect in asphalt. The performance of composite modified asphalt is the best, and the amount of rubber powder is the best amount at this time.

（4）The performance of rubber powder and SBS composite modified asphalt mixture has little difference with that of SBS modified asphalt mixture, which all meet the requirements of the standard.

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