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Study on Aging of SBS Modified Asphalt Based on Temperature Sensitivity

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Abstract: In order to explore the influence and variation law of SBS modified asphalt with different dosages on temperature stability under different aging times, a rotating thin film oven was used to simulate the aging process of asphalt. The softening point and ductility of SBS modified asphalt with different dosages were tested after aging for different durations. The softening point and ductility were used as indicators to evaluate the temperature stability of asphalt, and the variation law of softening point and ductility under different aging times was analyzed. The results indicate that with the increase of aging time, the overall ductility of SBS modified asphalt with different dosages shows a downward trend, and the softening point increases with the increase of aging time, and the change rates of the two indicators are completely opposite. Overall, the increase in aging time reduces the temperature stability of SBS modified asphalt.

1. Introduction

Due to the advantages of fast construction speed, easy maintenance, and safe driving, asphalt pavement is widely used in China's high-grade highways and municipal roads. However, the performance of asphalt mixture is affected by light and moisture during mixing, construction, and use, resulting in a decrease in the service life of the pavement.

SBS modified asphalt is widely used in asphalt mixtures due to its unique properties, which can effectively improve the rheological properties of asphalt [1-4]. Due to the combined effect of light and water oxygen, the asphalt oxidation and SBS copolymer degradation lead to the aging of SBS-modified asphalt mixtures, and the high and low-temperature performance is seriously affected [5-7]. Therefore, more and more scholars are interested in the aging of SBS-modified asphalt mixtures. Meng Xu et al [8] studied the performance of modified asphalt before and after aging with different SBS dosage, and tested the conventional performance and rheological properties before and after aging; Zhang [9] et al studied the aging characteristics of SBS modified asphalt by using three test methods, namely, rotating film oven aging, aging in pressure aging container and UV aging; Zeng et al [10] added SBS modified asphalt with POE for composite modification, found that the composite modified anti-aging performance is better than SBS modified asphalt, and has a unique high-temperature stability; Hao et al [11] scholars to improve the low-temperature cracking resistance of SBS modified asphalt through the WPU; LI et al [12]5 through the study of SBS modified asphalt microstructural and macroscopic properties, to explore the CeO_2 on SBS modified

asphalt anti-thermal oxidative aging performance of SBS-modified asphalt. However, most of the scholars' studies on the aging of SBS-modified asphalt mainly focus on the rheological properties and the performance comparison before and after aging. There is a lack of research that only focuses on the effect of SBS-modified asphalt aging on temperature sensitivity.

In this study, we will simulate the aging process of asphalt by using different dosages of SBS-modified asphalt in a rotating film oven, and test the two indexes of softening point and elongation after different aging times, so as to study the effect of SBS-modified asphalt aging on the high and low temperature performance.

2. Materials and Test Methods

2.1 Raw Material Performance

This experiment used 70 # matrix asphalt, according to "highway engineering asphalt and asphalt mixture test procedures" (JTG E20-2011) to detect the main technical indicators of asphalt, the test results are shown in Table 1.

Table 1: Technical indexes of asphalt

Test items	unit	test result	technical requirement
Needle penetration(25℃)	0.1mm	68.3	60-80
softening point	℃	47.5	≥46
Elongation(15℃)	cm	152	≥15
flash point	℃	316	≥260

2.2 Experimental Method

The matrix asphalt was modified with different dosage of SBS, the SBS dosage was 3.5%, 4.0%, 4.5% and 5.0%, and the aging was simulated by using the rotating film oven to test the elongation and softening point of SBS modified asphalt under different aging time to evaluate the changes in the high and low temperature performances of the SBS modified asphalt after aging.

3. Results and Discussion

3.1 Different Dosage of SBS Modified Asphalt Aging Performance Research

Different dosage of SBS modified asphalt aging test, testing the softening point and ductility under different aging time, the results are shown in Figure 1.

Doping 3.5% SBS modified asphalt in 2d to 8d aging time, the softening point rises sharply, from 79.6 ℃ to 93.4 ℃, the rate of change of 17.34%; in the aging of 8d-20d time, the dosage of SBS modified asphalt softening point of 93.4 ℃ to 94.2 ℃, the degree of increase is very small, less than 1%,; after that, with the aging time continues to increase, the softening point 94.2 ℃ to 96.4 ℃, also only 2.33%. Softening point of 94.2 ℃ rose to 96.4 ℃, the rate of change is only 2.33%. And the doping of the ductility value in the beginning of aging to 12d time, from 23.8cm to 12.3cm, the rate of change of 48.32%; and then the doping of the ductility of the change is small, in the aging time up to 20d, the ductility and a sharp decline from 11.9cm to 7.2cm, the rate of change of 39.50%. It can be seen from the analysis with the deepening of the degree of aging, the dosage of 3.5% SBS modified asphalt softening point rise and the degree of decline in the degree of delay are gradually reduced.

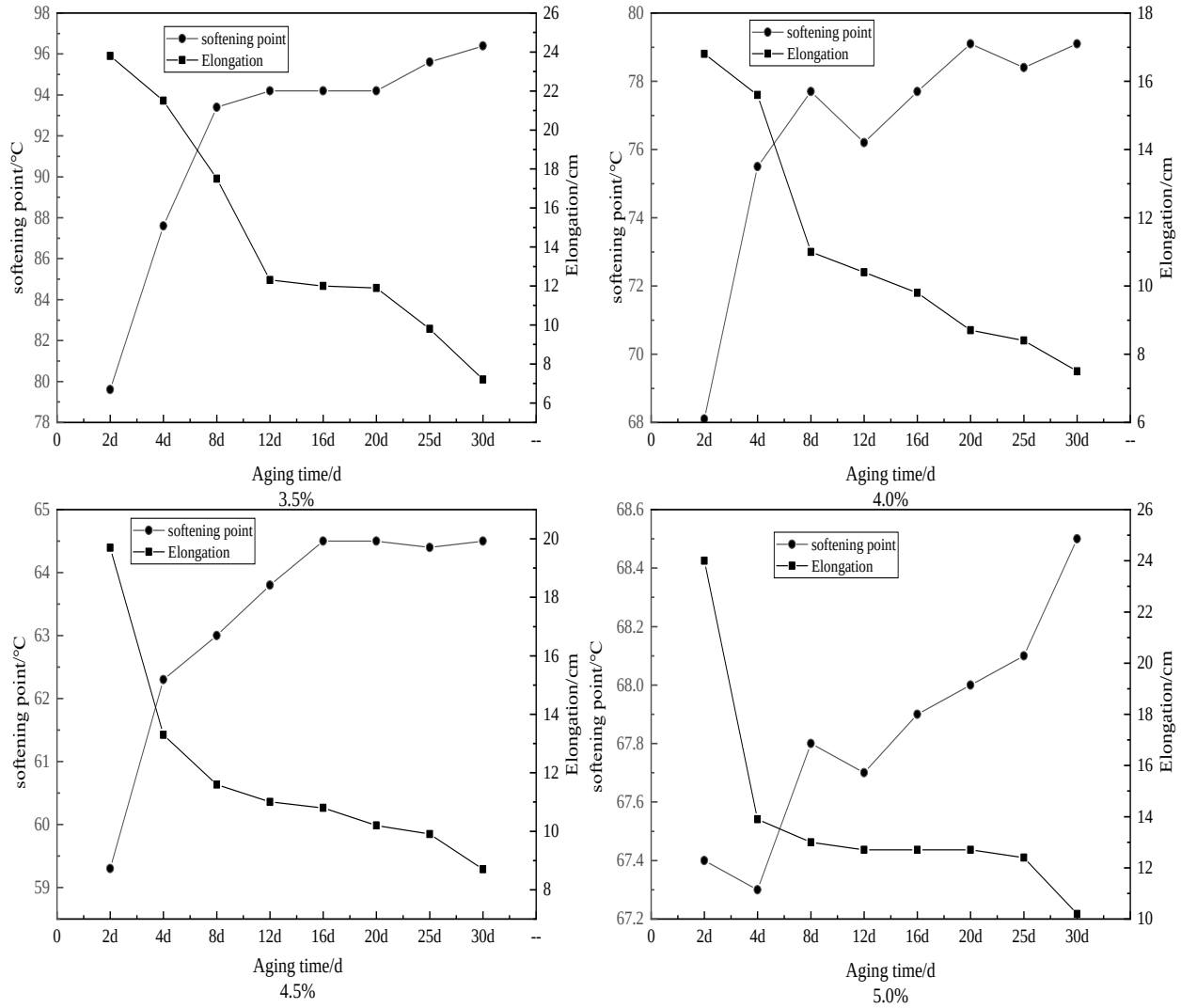

Figure 1: Softening point and elongation under different aging times

The softening point of 4.0% SBS-modified asphalt increased sharply from 68.1 ℃ to 77.7 ℃ with a change of 12.36% during the aging time from 2d to 8d; in the subsequent aging time, the softening point showed fluctuating changes of decreasing and increasing from 77.7 ℃ to 76.2 ℃ and then 77.7 ℃. The softening point of SBS-modified asphalt increased from 68.1 ℃ to 77.7 ℃ and then 77.7 ℃ again. And the ductility has been showing a decreasing trend under the one-month thermo-oxidative aging. In the aging time before 8d, the dosage of SBS modified asphalt ductility from 16.8cm to 11.0cm, the rate of change of 34.52%; in the 8d to the end of aging, the ductility from 11.0cm to 7.2cm, the rate of change of 34.55%, it can be seen that the degree of change of the modified asphalt ductility of the two periods of time is nearly equal.

Doping 4.5% SBS modified asphalt in the 2d to 16d aging time, the softening point from 79.6 ℃ to 94.2 ℃, the rate of change of 15.50%; after half a month of aging time, the softening point from 94.2 ℃ to 96.4 ℃ gradual increase; and the doping modified asphalt in the thermo-oxidative aging under the measured value of the elongation of the 19.7cm down to 13.3cm, 10.8cm and finally down to 8.7cm. cm and finally to 8.7 cm, with the change rates of 32.49%, 18.80% and 19.44%, respectively. The decrease in ductility decreases with increasing aging time.

Doping 5.0% SBS modified asphalt at the beginning of aging is a downward change, unlike

other dosage of modified asphalt softening point trend. In one month's thermo-oxidative aging time modified asphalt softening point value experienced two downward changes, the first is in the beginning of aging to aging to reach 4d, the softening point from 67.4 ℃ to 67.3 ℃; the second is in the 8d-12d aging time from 67.8 ℃ to 67.7 ℃, the degree of decline are small. In 4d-8d aging time softening point from 67.3 ℃ to 67.8 ℃; in the aging time up to 12d until the end of the softening point from 67.7 ℃ to 68.5 ℃; the amount of SBS modified asphalt, with the deepening of the aging degree, the softening point of the degree of increase is not obvious, but the overall trend is up. And the elongation has been a downward trend, from 24cm directly to 10.2cm, the rate of change is 57.50%.

As can be seen from Figure 1, different dosage of SBS modified asphalt in the thermo-oxidative aging measured under the softening point of the overall trend, but sometimes there will be rising, falling fluctuation changes, while the delay has been a downward trend. The main reason for the decline in ductility is the increase in asphaltene, gums, saturated points, aromatic components of the volatilization is reduced, resulting in changes in the asphalt components, aging of asphalt resulting in a decrease in the plasticity of the asphalt, ductility deterioration. The softening point fluctuation is due to the polymer composition of SBS modified asphalt at high temperatures and oxygen under the action of a certain reaction to enhance the hardness of asphalt, so that it rises; and with the test, the hardness is gradually destroyed, resulting in a decrease in softening point.

3.2 SBS Modified Asphalt Aging Performance Attenuation Study

Through the dosage of 3.5% and 4.5% of SBS modified asphalt softening point and ductility test results, in different aging time under the rate of change of the two indicators are shown in Figure 2.

As shown in Figure 2, the dosage of 3.5% of SBS modified asphalt, with the increase in aging time, the rate of change of ductility is relatively large, especially in the 4d-12d stage, the rate of change appeared to plummet, at this time, the ductility of the straight-line decline, and then relatively stable, in 30d and appeared to be a large change, mainly due to the asphalt aging caused by asphalt plasticity decline, ductility deterioration. The softening point of the rate of change is small, and in 4d after the rate of change is basically stable, 16d after almost no change. The dosage of 4.5% SBS modified asphalt, with the increase of aging time, the rate of change of ductility appeared to increase and then decreased, and then increased the phenomenon, in the 4-12d time, the rate of change of ductility increased steadily, and then a sudden change, there is a sudden drop in 25d and then began to increase significantly. The rate of change of softening point has a similar trend with SBS modified asphalt with a dosage of 3.5%, slowly decreasing in the process of 4-12d, and almost stabilizing after 12d, with no large-scale trend of change. Analysis that, with the increase in aging time, the softening point temperature relative increase, is due to the SBS modified asphalt in the polymer composition at high temperatures and oxygen under the action of a certain reaction to enhance the hardness of the asphalt, and the ductility of the asphalt components mainly aging aggravated by the asphalt components to change the asphalt after aging resulting in the decline in plasticity, ductility deterioration.

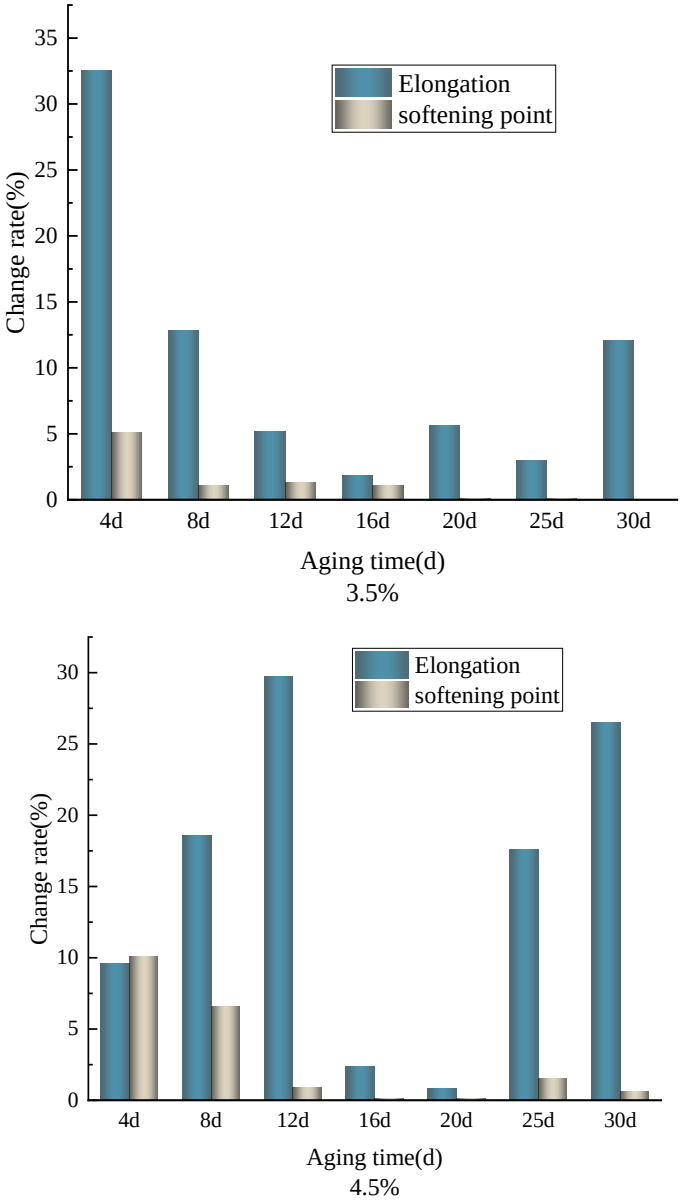

Figure 2: Change rate of two indicators under different aging times

4. Conclusion

As the aging time of SBS modified asphalt increases, its aging degree intensifies, polymers degrade, asphalt components change, gum, saturated and aromatic components decrease, resulting in poor ductility and decreased temperature stability of SBS modified asphalt.

The increase in aging time leads to a completely different trend in the change rate of ductility and softening point. The change trend of softening point is relatively unstable, while the change rate of ductility is relatively stable.

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