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Study on Properties of SBS/ Basalt Fiber Composite Modified High Viscosity Asphalt

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Abstract: Based on the climatic conditions of the seasonal freezing area, the study of basalt fi ber and high viscosity modifier on the performance of the drainage asphalt was conducted to i mprove the disease of the drainage asphalt pavement. On the basis of SBS asphalt, 16 groups of composite modified asphalt blending schemes were designed for two modified materials, and multi-index tests were carried out under different blending ratios, and 16 groups of composite modified asphalt were tested with three indexes and Brinell viscosity. It is concluded that the performance of composite modified asphalt is the best when the yield of basalt fiber is 1% a nd the high viscosity modifier is 4%.

Keyword: Seasonal freezing area, basalt fiber, composite modified asphalt, high viscosity m odifier, asphalt properties

1. Introduction

In recent years, with the deepening of urbanization, the urban ground hardening rate has been increasing, resulting in problems such as urban heat island and urban waterlogging. In t he "Guiding Opinions of The General Office of the State Council on Promoting the construction of Sponge Cities" issued by the State Office, it is clearly required that by 2030, the construction of "sponge cities [1]" should reach more than 80% of the urban built-up area, and the road area accounts for about 1/3 of the urban area, and its sponge transformation and construction technology [2] has received wide attention. In order to reduce the impact of hardened ground on the urban environment, permeable pavement technology comes into being. It increases the infiltration of surface water into the soil, which can not only effectively alleviate urban waterlogging and replenish groundwater, but also significantly reduce the urban heat island effect. The application and promotion of permeable pavement [3] technology is mainly based on the application of permeable asphalt asphalt mixture [4], that is, open graded asphalt mixture (OGFC). As a permeable pavement material, permeable asphalt mixture has high porosity, anti-slip, noise r eduction and excellent drainage function [5,6].

As a permeable pavement material, OGFC asphalt mixture has large porosity and excellent drainage function. However, the shortcomings of permeable asphalt pavement are low strength, poor crack resistance and poor durability. In order to effectively improve the performance of pervious asphalt pavement, it is necessary to start from the viscosity, low temperature performance and high temperature performance, and the asphalt used for pervious pavement should have strong bonding force and durability. The seasonal freezing area has high temperature in summer and cold in winter, short spring and autumn time, and the lowest temperature in winter ca n reach -32℃ and the pavement is vulnerable to the impact of temperature changes, resulting in cracking, loose and other diseases. At present, industrial solid waste and fiber materials are used to modify asphalt and asphalt mixture to improve viscosity, which has become the most common and effective method. As the typical representatives of the above two types of materials, modifier and basalt fiber have gradually become a research hotspot in the field of asphalt and asphalt mixture modification due to their excellent performance. However, most of the current studies are single-doped SBS modifiers or basalt fibers, which can not cooperate with the advantages of industrial modifiers and fiber materials. There are few researches on composite modified asphalt mixture in China. The technical performance of asphalt mixture can be improved by adding basalt fiber or modifier only. The composite modification of basalt fiber, modifier and asphalt mixture can make up for each other's shortcomings. Greatly improve the performance and quality of asphalt pavement, and then reduce the pavement disease, extend the service life of asphalt pavement and achieve economic, environmental protection, energy saving and e mission reduction.

In this paper, basalt fiber and OLB-1 high viscosity modifier material were used to prepare composite modified asphalt based on SBS modified asphalt. The blending scheme of 16 groups of composite modified asphalt was designed by orthogonal experiment. Basalt fiber is a new type of green and environmentally friendly high-performance fiber material, and basalt fiber has good physical and chemical compatibility when it is combined with various materials (such as metals, resins, etc.) [7], and has stronger bonding strength than glass fiber, carbon fiber, etc. The composite modified high-viscosity asphalt obtained by composite modification of SBS modified asphalt, basalt fiber and OLB-1 high-viscosity modifier has the advantages of convenient preparation, excellent road performance and green environmental protection [8,9].

2. Experimental Design and Index Analysis

2.1 Test Raw Materials

In this paper, basalt fiber, OLB-1 high viscosity modifier and SBS modified asphalt were used to carry out compound modified asphalt test

Test item	Detection Result	Detection Requirement	Detection Method
Penetration 25℃ (0.1mm)	55	≥40	T0604

2.2 SBS Modified Asphalt

SBS modified asphalt is now commonly used as a road material. Table 1 shows the basic indexes of SBS modified asphalt.

Table 1 Technical parameters of SBS asphalt Basalt fibers

Penetration index PI	0.1	≥0	
Ductility 5℃(cm)	30	≥8	T0605
Softening point (℃)	81.1	≥80	T0606
Flash point (℃)	>300	>230	T0601
Kinematic viscosity 135℃ (Pa·s)	1.6	≦3	T0625

2.3 Basalt Fiber Parameters

The 6mm basalt fiber used in this paper is produced by Changsha Lime Xiang Building Materials Co., LTD. Basalt fibers are Continuous fiber made of natural basalt after melting at about 1500℃, the color is generally brown, mainly composed of silica, alumina, calcium oxide, magnesium oxide and other oxides, and has high temperature resistance, corrosion resistance, electrical insulation and other excellent properties. As shown in the chart.

Table 2 Basalt Fiber Parameters

Index	Index Detection Result	Detection Requirement	Detection Method
Relative density /(g•cm-3)	2.65	-	-
Diameter /µm	17	13-20	-
Length /mm	6	-	-
Tensile strength /MPa	1256	≧1200	GB/T7690.3
Ultimate elongation /%	3.01	≦3.01	GB/T7690.3

2.4 High Viscosity Modifier

The high viscosity modifier is the domestic OLB-1. The modifier is made of a combination of multiple polymers.

Table 3Main indexes of high viscosity modifiers

Index item	**Parameter Value**
Appearance	Yellow Particle
Particle (mm)	4
Density (g/cm3)	0.9
Softening point (℃)	88
Water absorption (%)	0.3
Viscosivity (N·m)	32.5
Film heating rate (%)	0.28

In this paper, high viscosity modifier content and basalt fiber content are selected as two influencing factors, referring to the two samples in permeable asphalt pavement engineering: high viscosity modifier content of 4% and basalt fiber content of 3% (mass percentage of asphalt mortar). Taking 4 levels of each factor, the orthogonal test method was used to design the composite modified asphalt. The content of basalt fiber in matrix asphalt is 0%, 1%, 3% and 5%. The content of high viscosity modifier was 0%, 4%, 6% and 8%, and there were 16 groups of test samples. The softening point, ductility, penetration degree, 135℃ viscosity and trabecular bending creep index of composite modified asphalt with different blending ratio of two modified materials were tested.

Needle Penetration

The penetration index is the most important index for evaluating the basic performance of asphalt as stipulated in China's code, and the grade of asphalt material is measured by its penetration value at 25℃ [10]. The size of the needle penetration index is a direct reflection of the consistency of asphalt. The greater the consistency, the smaller the needle penetration, and the greater the consistency, the greater the hardness of asphalt material [11]. In this paper, according to the test steps specified in the code, the needle penetration degree of the prepared basalt fiber /SBS composite modified high-viscosity asphalt with different content was measured, and the test results were shown in Figure 1.

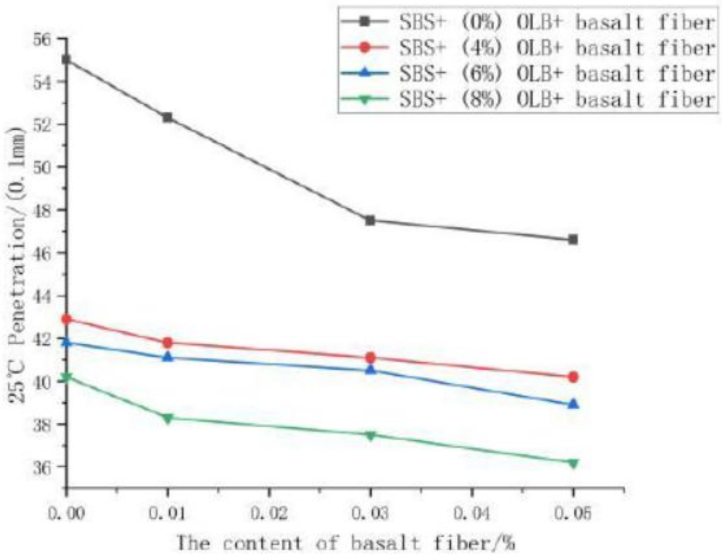

Figure 1 SBS/ basalt fiber composite modified high viscosity asphalt penetration

It can be seen from Figure 1 that when only high viscosity modifier is added, the penetration decreases with the increase of the content of high viscosity modifier. With the addition of basalt fiber, the penetration degree of the modified bitumen decreases with the increase of basalt fiber content.

Softening Point

Asphalt softening point is the temperature when the asphalt reaches the viscosity of the specified conditions, so the softening point is not only an important indicator of the temperature sensitivity of asphalt, but also a measure of the viscosity of asphalt. The index can reflect t he high temperature performance of asphalt [12]. In this paper, the softening points of several modified bitumen prepared were measured according to standard test procedures. The test results are shown in Figure 2.

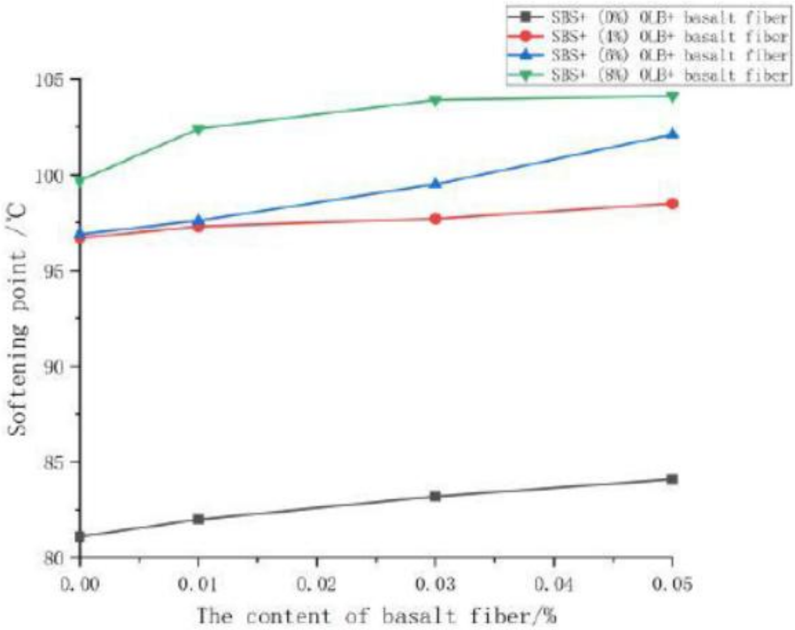

Figure 2 SBS/ basalt fiber composite modified high viscosity asphalt softening point

It can be seen in Figure 2 that when only high viscosity modifier is added, the softening point increases with the increase of high viscosity modifier content. With the addition of bas alt fiber, the softening point of composite modified high viscosity asphalt also increases with t he increase of basalt fiber content. It shows that basalt fiber and high viscosity modifier can b e well fused with the intervention of stabilizer.

Ductility

The ductility index can indirectly evaluate the low temperature performance of asphalt. The larger the ductility, the better the ductility. The higher the degree of deformation, the better the resistance to cracking. In this paper, 16 groups of modified bitumen were tested at low temperature under 5℃ environment. Figure 3 shows the ductility test results of composite modified asphalt.

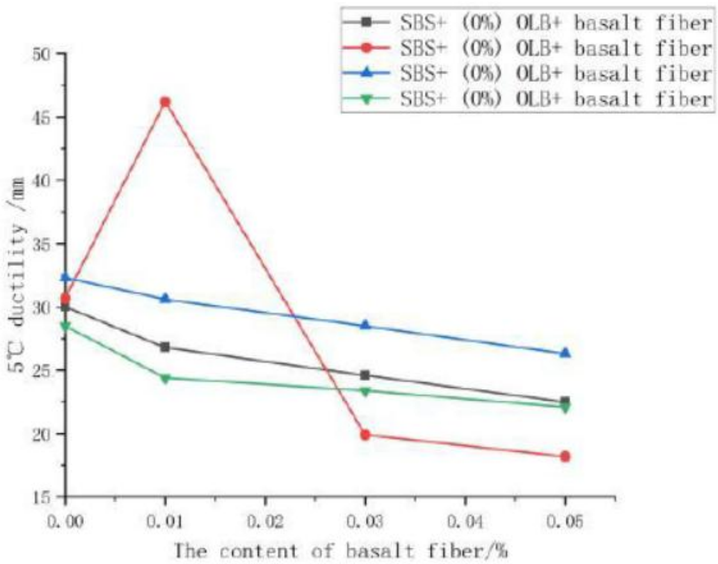

Figure 3 SBS/ basalt fiber composite modified high viscosity asphalt penetration

It can be seen from Figure 3 that when only high viscosity modifier is added, the ductility first increases and then decreases with the increase of the content of high viscosity modifier. With the addition of basalt fiber, the softening point of composite modified high viscosity asphalt first increases and then decreases with the increase of basalt fiber content. When 1% basalt fiber, 4% high viscosity modifier, the ductility effect is the best.

3. Viscosity test

3.1 60℃ dynamic viscosity test

The dynamic viscosity at 60℃ is the basic performance index of high viscosity asphalt products. In this paper, two kinds of high viscosity asphalt materials and their contrast samples were measured by vacuum vacuum vacuum capillary method according to our standard test method.

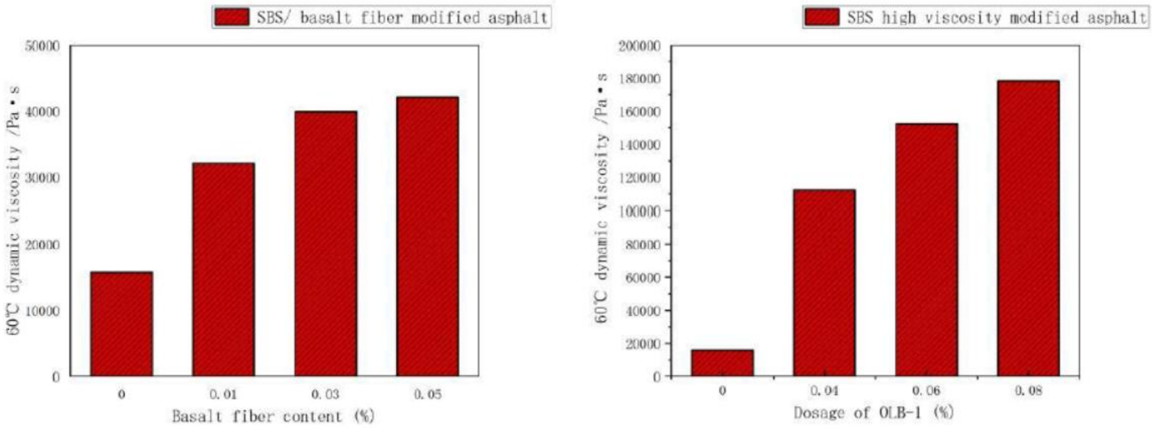

Figure 4and 5 Dynamic viscosity test at 60℃

The results of the 60 ° C power viscosity test of several modified asphalt can be seen that the viscosity of each modified asphalt has increased with the increase of different modifiers. #) Power viscosity is about 42000Pa.S, 8%mixed SBS high -viscosity asphalt modified asphalt (olb3 #) power viscosity is 17800 PA.S, Xuanwan fiber doping is 1%and high -viscosity modifier is 4, 6, 8%#SBS/Xuanwan fiber compound modification high -viscosity asphalt (A1#, B1#, C1#) 180000 PA 00 00 S, 160000Pa 00 S and 210000Pa 00 s, if the dynamic viscosity results of 60 ° C, the prepared modified asphalt OLB3 # BF3 # A1 # B1 # C1 # These five modified asphalt can meet the high viscosity values of my country's normative requirements.

3.2 Brinell viscosity of asphalt

The Brinell rotary viscosity index is mainly used to measure the rotary viscosity of asphalt materials at higher temperatures, and its measured value represents the apparent viscosity of asphalt materials. The test principle of the Brinell viscosity tester is to measure the real-time ratio of the two bitumen under a certain frequency and a certain amount of rotary shear stress, which is the same as the dynamic viscosity at 60℃. The Brinell viscosity index can also characterize the resistance of asphalt to flow shear deformation at higher temperatures. Generally, t he greater the Brinell viscosity value of asphalt material, the higher the rutting resistance of the asphalt material at this temperature. According to the relevant regulations of our country, the Brinell rotary viscosity can be used as a reference to determine the mixing temperature value of asphalt mixture. In this paper, according to the requirements of the corresponding regulations, suitable rotors were selected to test the Brinell rotary viscosity of several modified asphalt and highly viscous asphalt binder prepared at 135℃. The test results of modified asphalt are shown in FIG. 3.11. The viscosity of 1# SBS/ basalt fiber modified asphalt is shown in Figure 3.12, the viscosity of 2# SBS high viscosity asphalt is shown in Figure 3.12, the viscosity of 3# composite high viscosity asphalt is shown in Figure 3.13, and the comparison results of Brinell viscosity of several modified asphalt are shown in Figure 3.14.

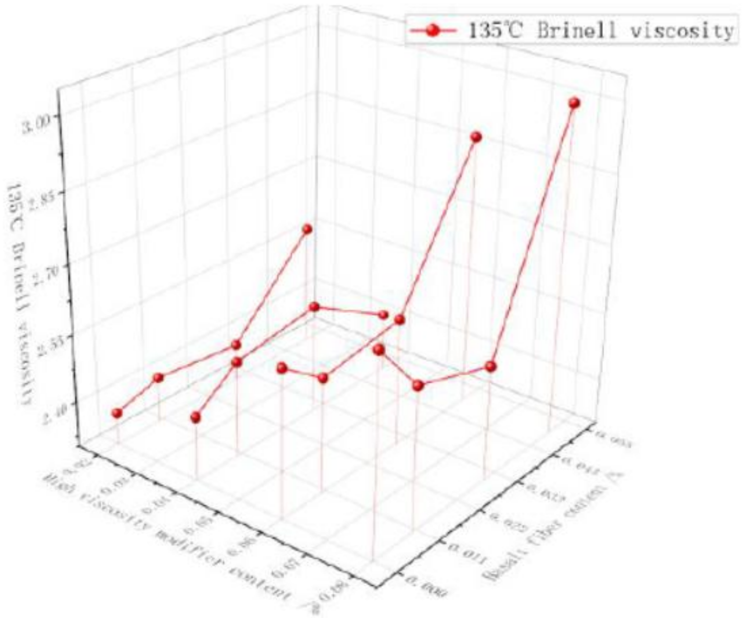

Figure 6 SBS/ basalt fiber composite modified high viscosity asphalt

It can be seen from the figure that under the same test temperature conditions, the pavilion of the high viscosity asphalt increases with the increase in the amount of high viscosity age nt. The Book of viscosity asphalt first increases to the maximum value and gradually decreases. It can be seen that when the basalt is 1%and the high -viscosity agent is 4%, the composite high viscosity asphalt increases The largest range, which is more obvious at a lower temperature. From Figure 4and Figure 5, the growth law of the same test temperature, the proportion of modifiers and the proportion of modifiers and the viscosity of Bu's, is the difference in the increase in the viscosity of the 1#SBS high -viscosity asphalt. Increase and increase. 2#SBS/Xuanwan fiber modification asphalt, with a certain amount of SBS doping, as the pavilion of the basalt fiber doped high -modified asphalt, the pavilion increased to the maximum value and gradually decreased. The growth rate is large, and as the amount of doping continues to increase, the increase of the viscosity of Bobe is relatively stable.

4. Conclusion

The conclusion of this paper is drawn through analysis and research

1) When only high viscosity modifier is added, the penetration and soft point decrease with the increase of high viscosity modifier. With the addition of basalt fiber, the penetration degree of the modified bitumen decreases with the increase of basalt fiber content.
2) When only high viscosity modifier is added, the ductility increases first and then decreases with the increase of the amount of high viscosity modifier. With the addition of basalt fiber, the softening point of composite modified high viscosity asphalt first increases and then decreases with the increase of basalt fiber content. When 1% basalt fiber, 4% high viscosity modifier, the ductility effect is the best.
3) Through the income of high-viscosity modifiers, the modified asphalt has a better meting high viscosity viscosity value for the requirements of my country's norms. Among them, t he 1#high -viscosity asphalt (OLB3#) of the British viscosity reached the highest after the doping of high viscosity agents reached 8%. The pavilion of Xuanwu Fiber's high -modular asphalt increased to the maximum value and gradually decreased. The growth rate is large, and as th e amount of doping continues to increase, the increase of the viscosity of Bobe is relatively stable.

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