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Research Article

Rheological Characteristics of Tire Rubber-Modified Asphalt following Thermal Variation

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In recent years, due to the development of the automobile industry, there are more and more waste car tires, and the reuse of waste tires has become an urgent problem to be solved. In this study, the crushed rubber of waste automobile tires is used to modify asphalt to prepare rubber-modified asphalt, which can not only solve the problem of using waste tires but also effectively improve the performance of asphalt pavement. This study defines four modified asphalts with different rubber powder content, which are defined as 1#, 2#, 3#, and 4#, respectively. The performance difference between the four modified asphalts and the base asphalt was compared through experiments to illustrate the advantages of rubber-modified asphalt. The four selected rubber asphalts and base asphalt are subjected to the viscous toughness test, apparent viscosity test, DSR test, and BBR test to determine the high- and low-temperature characteristics of rubber asphalt. The analysis of experimental data shows that rubber-modified asphalt can effectively improve the low-temperature performance of the asphalt, make the asphalt have better toughness, and also improve the high-temperature shear resistance of the asphalt. Finally, it is determined that adding 10% rubber powder to the base asphalt has the best effect.

1. Introduction

Long-term stacking of a large number of waste tires will occupy land resources, destroy vegetation [1, 2], and may cause fires. The decomposition of these used tires will cause a lot of environmental problems. If there is no site treatment, landfill is required, and it will cause pollutant soil infiltration problems. According to incomplete statistics and forecasts, by 2030, the global annual output of used tires will reach 1.2 billion [3]. In the United States, 290 million waste tires were generated in 2017 [4]. The destinations of these tires are as follows: the market consumes 8%, tire-derived fuel consumes 43%, artificial landscape consumes 25%, civil engineering market consumes 8%, and 16% is treated as useless waste in landfills [5]. As one of the most successful materials for asphalt modification, rubber has obvious advantages. It has better rutting resistance, thermal crack resistance, slip resistance, and fatigue properties [6–8]. Moreover, rubber-modified asphalt has better economic and environmental benefits [9, 10].

In order to reuse waste tires, we will maximize the role of waste tire rubber. First, the waste tires are processed into rubber powder. Rubber powder as a modifier has a beneficial effect on the rheological properties of rubber asphalt. Its components can improve the high-temperature performance and antiaging performance of asphalt and enhance the bonding effect of asphalt and mineral materials [11]. Domestic scholars have conducted in-depth research on the application of rubber and styrene-butadiene-styrene composite-modified asphalt in permeable pavement. The research results show that modified asphalt can be applied to permeable asphalt pavement [12–16]. Yu et al. conducted a comprehensive study on the performance of rubber-modified warm-mix asphalt mixtures, and the results showed that rubber can improve the crack resistance of warm-mix asphalt mixtures and can make the warm-mix asphalt mixtures have a longer life [14–16]. Glover et al. studied the dissolution and antivulcanization of rubber in asphalt and found that 90% of the rubber was dissolved in asphalt under high-speed shear for 40 minutes and treated at 260°C for 6.5 h [17]. Wang used sodium hypochlorite, activator, gasoline, and diesel to pretreat rubber, which can greatly improve the compatibility between rubber and asphalt. However, modified asphalt still has higher viscosity and poor storage stability at high temperatures [18]. Takallou et al. through the extraction experiment of rubber asphalt proved that there are chemical reactions in rubber asphalt, but most of them are mainly physical reactions [19]. Rubber plays a strong bonding role in rubber asphalt. Rubber powder-modified asphalt can increase Newtonian shear flow by 20% [20] when the specimen is removed from the stress. As the content of rubber powder increases, the deformation of the specimen decreases. Yildirim shows the characteristics of elastic materials [21]. From 2005 to 2007, Bradley J. Putman and Serji N. Amirkhanian of Clemson University, USA, conducted a study. In-depth research on the mechanism of rubber asphalt has been carried out, and the interactive reaction and the filling effect of rubber powder in the rubber asphalt have been confirmed [22].

At present, there are few research studies on the temperature sensitivity of rubber-modified asphalt, and the data and results are relatively scarce. In this paper, we prepared waste tire rubber powder-modified asphalt by ourselves. It is used to improve the overall performance of asphalt pavement according to the determined mixing time, mixing temperature, shear speed, and rubber powder mesh number of modified asphalt. The sieved rubber powder is added to the asphalt according to the predetermined content to prepare modified asphalt. And we conduct a bending rheological stiffness test, rheological property test, and viscous toughness test. Through the above tests, two waste tire rubber powder-modified asphalts with the best comprehensive performance were finally screened out to lay a good foundation for the subsequent mixture test. At the same time, it provides a theoretical basis for the superiority of rubber asphalt.

2. Materials and Methodology

2.1. Experimental Materials

2.1.1. Asphalt. According to the latest "Asphalt rubber for highway engineering (JTT798-2011)", the base asphalt for the production of tire rubber powder-modified asphalt can be selected as the A grade 50#, 70#, 90#, and 110# road petroleum asphalt that meets the JTG F40 regulations. In this test, the heavy traffic 90# matrix asphalt produced in Panjin, Liaoning, was selected. Its various indicators are shown in Table 1.

2.1.2. Tire Rubber Powder. Due to the addition of various modifiers to the tire rubber, the tire has good strength and elasticity and can withstand the test of high temperature in summer and low temperature in winter, rain, and snow. At the same time, it has long-term durability to ensure its quality. Therefore, most of the preparation of rubber asphalt uses tire rubber powder as the source of rubber powder. The rubber asphalt prepared in this way has high performance and good quality. The production method of rubber powder used in this article is normal temperature pulverization. This method of using mechanical external force to crush rubber at room temperature makes the rubber surface uneven and full of fracture marks caused by mechanical crushing. It is precisely because of the existence of this fracture mark. The rubber powder can more fully absorb the light components in the base asphalt during the reaction with the asphalt, and the swelling reaction occurs to improve the connection performance of rubber powder and asphalt and the overall performance of rubber asphalt itself. The waste tire rubber powder used in this article is 40 mesh and 60 mesh waste tire tread rubber powder produced by Jiaozuo Hongrui Rubber Co., Ltd. The production of rubber powder is produced in accordance with the "Asphalt rubber for highway engineering (JTT798-2011)" standard.

2.1.3. Preparation Process of Tire Rubber Powder-Modified Asphalt. This article uses a specially customized high-speed shearing emulsifier as the mixing equipment. At the same time, this article uses a specially customized high-precision oil bath temperature control pot as the temperature control equipment. These two pieces of equipment are used for the preparation of tire rubber powder-modified asphalt. In the process of preparing waste tire rubber powder-modified asphalt, several control parameters were changed, and different types of waste tire rubber powder-modified asphalt were prepared. The main parameters are as follows: the fineness of waste tire rubber powder (20 mesh, 30 mesh, 40 mesh, 50 mesh, 60 mesh, 70 mesh, and 80 mesh rubber powder can be obtained by further screening); the amount of tire rubber powder added in the base asphalt (5%, 10%, 15%, 20%, 25%, and 30%); test stirring speed (1000 r/min, 4000 r/min, 7000 r/min, 10000 r/min, and 13000 r/min); mixing temperature (155°C, 160°C, 165°C, 170°C, 175°C, and 180°C); mixing time (15 min, 30 min, 45 min, 60 min, and 75 min); and the latest *Application Handbook of Standard Test Methods of Bitumen and Bituminous Mixtures for Highway Engineering (JTG E20-2011)* implemented by the Ministry of Transport of the People's Republic of China in 2011. The three basic indexes of asphalt are tested for base asphalt and modified asphalt. Through the performance evaluation of the three major indicators, several types of waste tire rubber powder-modified asphalt with superior comprehensive performance were selected for preparation. Initially, we chose rubber powder with a fineness of 60 mesh. After high-speed shear, we found that it does not couple well with asphalt. Finally, we have determined to add 50 mesh rubber powder to 90# matrix asphalt through many experiments. The stirring temperature is 165°, the shear speed is 7000 r/min, and the stirring time is 45 min. The parameters of rubber powder are 5%, 10%, 15%, and 20%, respectively. They are defined as 1#, 2#, 3#, and 4#. The three major indicators of the four rubber-modified asphalts are shown in Table 2.

2.2. Experimental Method

2.2.1. Viscosity Performance Test of Tire Rubber Powder-Modified Asphalt. During the test, a constant temperature

Table 1: 90# matrix asphalt properties and technical requirements.

Pilot projects	Unit	Skill requirement	Measured value	Experiment method	Remarks
Penetration 25°C	0.1 mm	80~100	81	T0604	Qualified
Softening point	°C	≥45	46	T0606	Qualified
Ductility 15°C	cm	≥140	160	T0605	Qualified
Ductility 5°C	cm	≥30	100	T0605	Qualified
Flash point (ductility °C)	°C	≥245	288	T0611	Qualified
Relative density 15°C	g/cm^3	Measured	1.000	T0603	Qualified
Wax content	%	≤2.0	1.78	T0615	Qualified
PI (penetration index)	—	-1.5~+1.0	0.52	T0604	Qualified

Table 2: Three indexes of 4 kinds of rubber-modified asphalt.

Pilot projects	Rubber powder content			
	1# (5%)	2# (10%)	3# (15%)	4# (20%)
Penetration 25°C (0.1 mm)	7.90	6.73	5.17	4.93
Softening point (°C)	47.40	51.10	57.40	63.90
Ductility 25°C (mm)	36.43	33.16	30.36	26.99

Table 3: Toughness test results of tire rubber powder-modified asphalt.

Serial number	Viscosity (N·m)	Toughness (N·m)	Toughness/ viscosity (%)	Maximum load (N)
1#	4.9	1.2	24.5	235.1
2#	6.8	3.7	54.4	187.4
3#	4.3	0.6	14.0	245.9
4#	1.8	0.4	22.2	170.5
90#	3.4	0.8	23.5	183.2

water bath is used to control the temperature, and the test temperature is 25°C ± 0.1°C. The test instrument used in this test is "SYD-0624 Asphalt Viscosity Tester" produced by Shanghai Changji Instrument Co., Ltd. The maximum loading capacity of the instrument is 1 kN, and the tensile loading rate is 500 mm/min. The test process is as follows:

(1) Before the test, control the constant temperature water bath at the test temperature of 25°C ± 0.1°C

(2) 90# matrix asphalt and 1#, 2#, 3#, and 4# (5 kinds of asphalt samples) are put into the viscous tester in turn, and the test instrument is turned on

(3) The asphalt in the viscous tester is stretched at 500 mm/min until the test piece is broken or the deformation reaches 300 mm, and the test ends

2.2.2. Apparent Viscosity Performance Test of Tire Rubber Powder-Modified Asphalt. In this study, the apparent viscosity of asphalt at 135°C and 175°C was used to draw the viscosity-temperature curve, and the temperature when the viscosity was 0.17 Pa · s ± 0.02 Pa · s was used as the mixing temperature range. The temperature at 0.28 Pa · s ± 0.03 Pa · s is taken as the compaction molding temperature range. The test steps are as follows:

(1) The temperature of the oven is controlled at 150°C ± 0.1°C before the start of this test

(2) The prepared 90# matrix asphalt and 1#, 2#, 3#, and 4# (5 kinds of asphalt samples) are placed in the apparent viscosity test container in turn, and the test is started when the temperature stabilizes to 135°C and 175°C of the instrument, and record the data

(3) The apparent viscosity of various asphalts at 110°C, 120°C, 135°C, 150°C, 160°C, 175°C, and 190°C is recorded

2.2.3. Flexural Creep Performance Test of Tire Rubber Powder-Modified Asphalt. The bending beam rheometer method is abbreviated as the BBR method, which is mainly based on the relevant standards and test methods formulated by the American Society for Testing and Materials (ASTM) and the American National Highway and Transportation Association (AASHTO). The BBR method can be used to measure the flexural stiffness modulus and *m* value of the original asphalt rotating film oven aging and pressure aging and evaluate the flexural creep characteristics of asphalt under low-temperature conditions. The test steps are as follows:

(1) Anhydrous ethanol is used as the medium of the constant temperature bath, and the test temperature range is 0°C~-36°C, accurate to ±0.1°C

(2) The size of the asphalt specimen is length 127 mm ∗ width 12.7 mm ∗ thickness 6.35 mm

(3) Turn on the BBR test instrument, the test load is 980 mN ± 50 mN, the initial contact load is 35 mN ± 10 mN, and the test time is 240 s

(4) The test temperature starts from -12°C and decreases by 6°C each time until the bending stiffness modulus

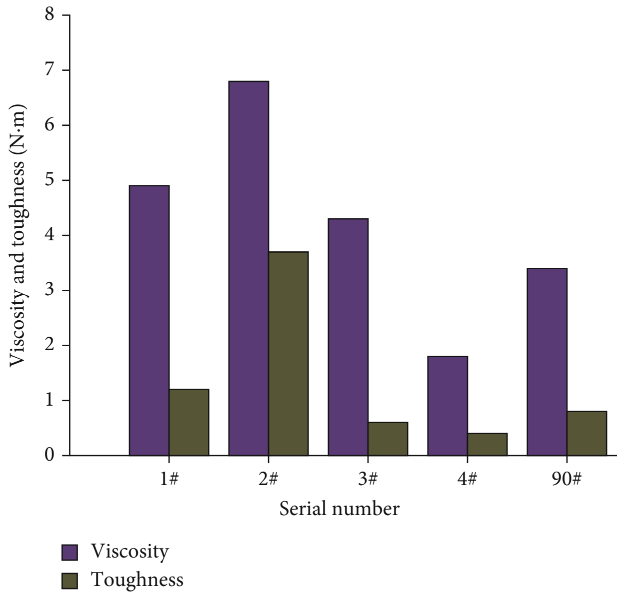

Figure 1: Column chart of the viscous toughness test of tire rubber powder-modified asphalt. The performance of 2# modified asphalt is significantly higher than that of other asphalt samples.

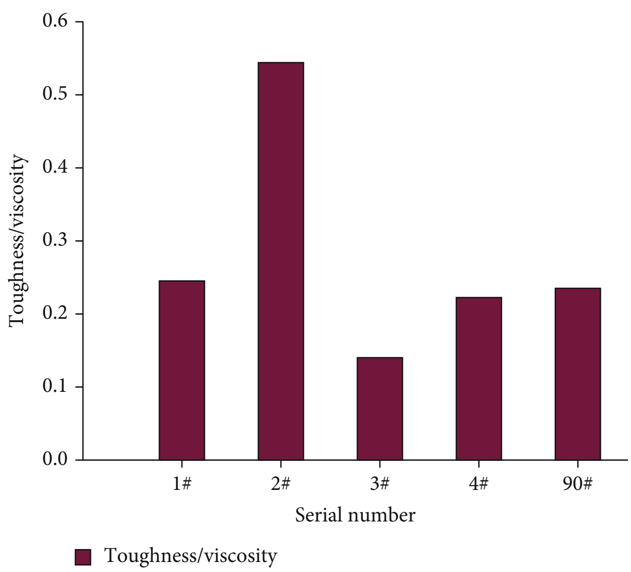

Figure 2: Toughness/viscosity histogram of tire rubber powder-modified asphalt.

is greater than 300 MPa or the m value is less than 0.3, and stop the test

2.2.4. Shear Rheological Properties of Tire Rubber Powder-Modified Asphalt. The dynamic shear rheometer method is abbreviated as the DSR method, which is compiled with reference to the relevant standards and test methods formulated by the American National Highway and Transportation Association (AASHTO). The DSR method can measure the dynamic shear modulus and phase angle of

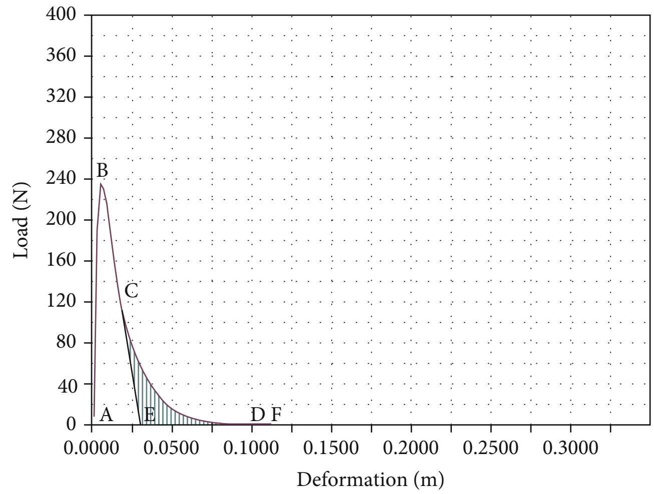

Figure 3: 1# tire rubber powder-modified asphalt viscosity test load-deformation diagram.

the original asphalt rotary film oven aging and pressure aging so as to evaluate the high-temperature performance and medium and low-temperature fatigue performance of the asphalt binder. The experimental steps are as follows:

(1) The mixed liquid of ethylene glycol and water is used as the medium of the constant temperature bath, and the test temperature range is 5°C~85°C, accurate to ±0.1°C

(2) The diameter of the test piece plate is 25 mm ± 0.05 mm

(3) Both the base asphalt and the modified asphalt are subjected to two parallel tests, and the average value is used as the test result

(4) For the original asphalt, the test temperature starts at 76°C and increases or decreases by 6°C each time until the $G*/\sin$ (Delta) value is greater than or equal to 1.0 kPa, and stop the test

3. Results and Discussion

3.1. Analysis of Test Results of Asphalt Viscosity. In this paper, standard viscous tests were carried out on the four selected tire rubber powder-modified asphalts (1#, 2#, 3#, and 4#) and 90# matrix asphalt. Through the test, the viscosity and toughness of base asphalt or modified asphalt can be obtained.

The tire rubber powder-modified asphalt viscosity test results can be seen in Table 3 and Figures 1 and 2. Except for 4# modified asphalt, the viscosity index of 1#, 2#, and 3# modified asphalt is greater than that of 90# matrix asphalt. Among them, 2# modified asphalt has the highest viscosity and toughness, followed by 1#, 3#, and 90#, and 4# has the lowest viscosity. It shows that in the 1#, 2#, and 3# modified asphalt, the reaction effect of tire rubber powder

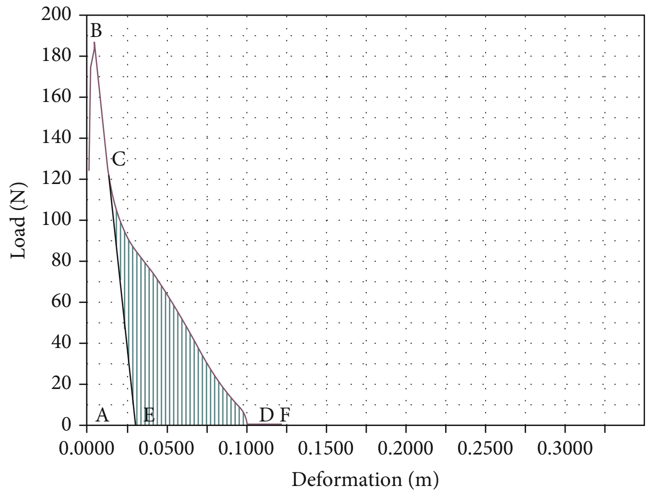

Figure 4: 2# tire rubber powder-modified asphalt viscosity test load-deformation diagram.

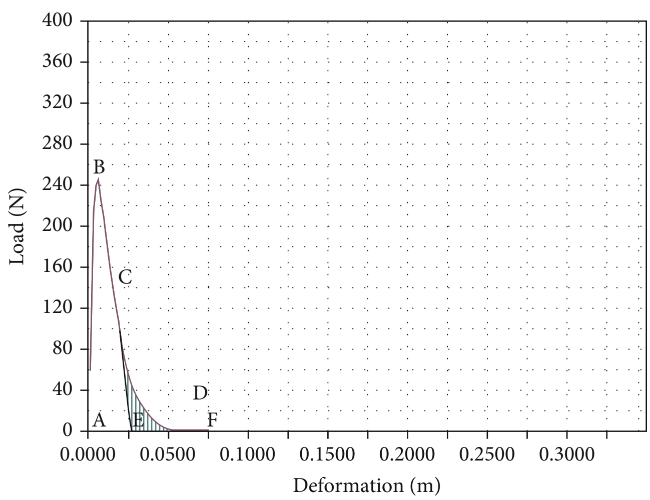

Figure 5: 3# tire rubber powder-modified asphalt viscosity test load-deformation diagram.

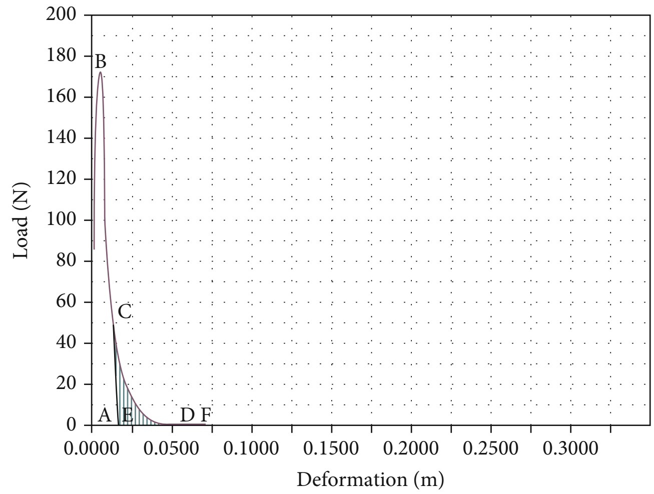

Figure 6: 4# tire rubber powder-modified asphalt viscosity test load-deformation diagram.

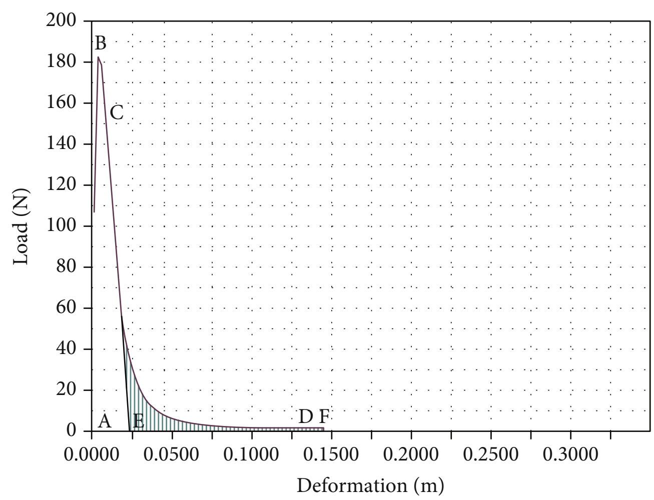

Figure 7: 90# matrix asphalt viscosity test load-deformation diagram.

and base asphalt is better. Tire rubber powder effectively improves the viscosity and toughness of the base asphalt. From the relative index of toughness and viscosity of 2#, the ratio of toughness to viscosity of tire rubber powder-modified asphalt is the largest and exceeds 50%. The ratio of toughness to viscosity of 1# and 4# tire rubber powder-modified asphalt is close to that of 90# matrix asphalt. The ratio of toughness to viscosity of 1# is slightly larger than that of 90# matrix asphalt. The ratio of toughness to viscosity of 4# is slightly smaller than that of 90# matrix asphalt. The ratio of toughness to viscosity of 3# tire rubber powder-modified asphalt is the smallest.

The viscous test load-deformation diagrams can be found in Figures 3–7. The front part of the curve is the area of the linear elastic region, and the back part of the curve is the area of the nonlinear elastic region. The total area is the viscosity of asphalt. The area of the rear nonlinear elastic region is toughness, and its unit is N·m. From the perspective of the maximum load, the maximum load of the 1# and 3# curves is relatively large, about 240 N. The maximum load of 2# and 90# matrix asphalt is around 180 N. 4# has the smallest load, about 170 N. From the perspective of deformation degree, 90# matrix asphalt has the largest deformation, exceeding 10 cm, followed by 2# that is about 10 cm. 1# is about 7 cm, and 3# and 4# have the smallest deformation, about 5 cm. The addition of tire rubber powder effectively improves the viscosity of the base asphalt, and the incorporation of rubber powder can effectively reduce the low-temperature cracking probability of the asphalt mixture.

3.2. Analysis of Asphalt Rotational Viscosity Test Results. In this paper, 90# matrix asphalt and 1#, 2#, 3#, and 4# tire rubber powder-modified asphalt were tested at 110°C, 120°C, 135°C, 150°C, 160°C, 175°C, and 190°C apparent viscosity.

Table 4: Test results of the apparent viscosity of tire rubber powder-modified asphalt.

Asphalt	Apparent viscosity (mPa·s)						
	110°C	120°C	135°C	150°C	160°C	175°C	190°C
1#	8950.3	5781.3	2448.3	1366.3	841.9	539.7	384.9
2#	18606.7	10556.7	5663.3	2729.7	1775.7	994.4	654.7
3#	11323.3	5143.3	2056.3	1209.7	756.3	491.4	247.6
4#	29800.0	14510.0	7899.7	4887.7	2530.3	1427.0	834.4
90#	1734.7	1007.6	485.4	240.5	147.3	97.6	—

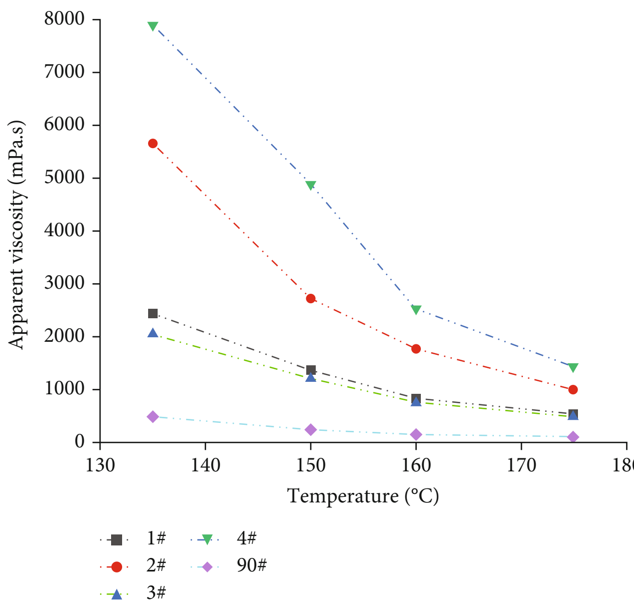

Figure 8: 135°C/175°C viscosity-temperature curve of tire rubber powder-modified asphalt.

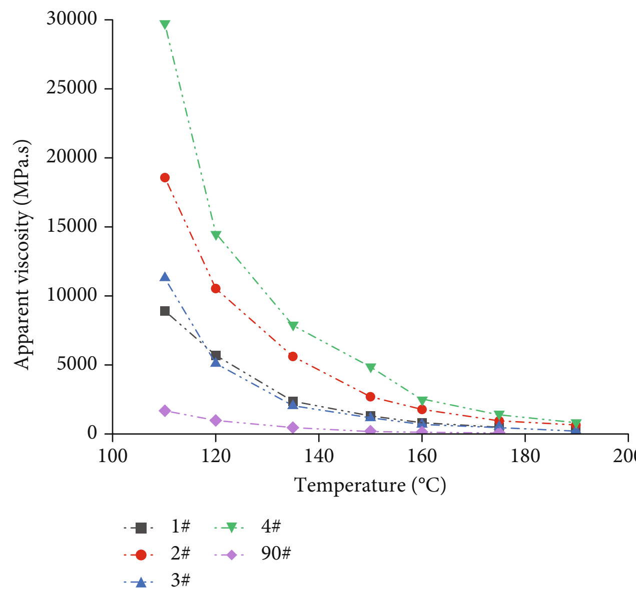

Figure 9: Viscosity-temperature curve of tire rubber powder-modified asphalt at full temperature.

As can be seen in Table 4 and Figures 8 and 9, whether it is base asphalt or tire rubber powder-modified asphalt, its apparent viscosity decreases with the increase of test temperature. The viscosity-temperature curve of 4# modified asphalt has the largest value. The second is 2# modified asphalt, the viscosity-temperature curve of 1# and 3# modified asphalt is in the middle, and the viscosity-temperature curve of 90# matrix asphalt is the smallest. This is due to the good high-temperature stability of tire rubber powder. After reacting with the base asphalt, the overall high-temperature resistance of the modified asphalt is improved. Asphalt modified by rubber powder has improved temperature sensitivity and improved flow resistance. The viscosity coefficient of rubber powder-modified asphalt is higher than that of base asphalt, indicating that the modified asphalt has higher resistance to flow deformation.

3.3. Flexural Creep Test Results of Tire Rubber Powder-Modified Asphalt. This test uses the current domestic advanced TE-BBR-F bending beam rheometer. The 90# matrix asphalt and 1#, 2#, 3#, and 4# tire rubber powder-modified asphalt were subjected to low-temperature flexural creep tests. Due to the different nature of the asphalt, the base asphalt is tested at -12°C, while the tire rubber powder-modified asphalt is tested at -18°C. The test results take the bending creep stiffness and m value corresponding to 60 s.

As can be found from the experimental data in Table 5 and Figures 10 and 11, whether it is tire rubber powder-modified asphalt or 90# matrix asphalt, the flexural creep performance changes with temperature are consistent. As the test temperature decreases, the bending creep stiffness of asphalt gradually increases, while the m value gradually decreases. As far as the low-temperature performance of asphalt is concerned, under the same test temperature, the smaller the bending creep stiffness, the larger the value of m. This shows that the better the low-temperature deformation ability of asphalt is, the better it can resist low-temperature shrinkage deformation damage. Conversely, if the bending creep stiffness is greater, the value of m is smaller. It shows that the worse the low-temperature deformation ability of asphalt is, the temperature shrinkage deformation failure will occur at a lower temperature. The low-

Table 5: Flexural creep test results of tire rubber powder-modified asphalt.

Asphalt	-12°C Bending creep stiffness (MPa) (60 s)	-12°C m value	-18°C Bending creep stiffness (MPa) (60 s)	-18°C m value	-24°C Bending creep stiffness (MPa) (60 s)	-24°C m value	-30°C Bending creep stiffness (MPa) (60 s)	-30°C m value
1#	—	—	89.1	0.442	258.5	0.315	544.0	0.232
2#	—	—	56.1	0.397	168.0	0.311	416.5	0.245
3#	—	—	76.3	0.406	252.0	0.330	615.5	0.214
4#	—	—	58.3	0.435	191.5	0.334	479.5	0.246
90#	43.6	0.536	166.0	0.393	455.0	0.279	—	—

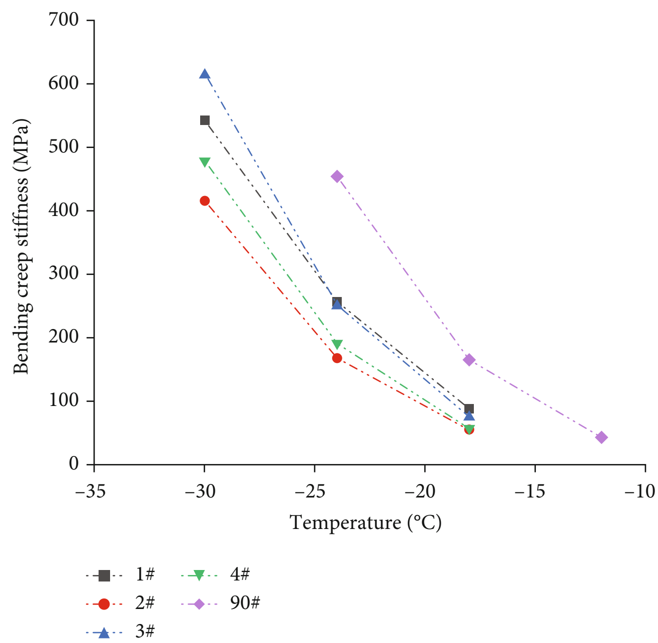

Figure 10: Flexural creep stiffness curve of tire rubber powder-modified asphalt.

temperature flexural creep properties of 1#, 2#, 3#, and 4# modified asphalt are better than that of 90# matrix asphalt. Among them, 2# tire rubber powder-modified asphalt has the best low-temperature performance. Rubber powder-modified asphalt can improve the low-temperature performance of asphalt mixture and reduce the temperature sensitivity of asphalt.

3.4. Analysis of Shear Rheological Test Results of Tire Rubber Powder-Modified Asphalt. This test uses the most advanced GEM-200-903 dynamic shear rheometer in China. Using the dynamic shear rheological test of 90# matrix asphalt and 1#, 2#, 3#, and 4# tire rubber powder-modified asphalt, the PG classification test results of 4 kinds of tire rubber powder-modified asphalt are obtained. According to the different properties of asphalt, the test starts at 76°C. And adjust the test temperature according to the $G*/\sin$ (Delta) value obtained from the test. Each time it raises or lowers by 6°C and until $G*/\sin$ (Delta) value ≥ 1.0 kPa, the corresponding temperature is the result of the PG classification test of the asphalt.

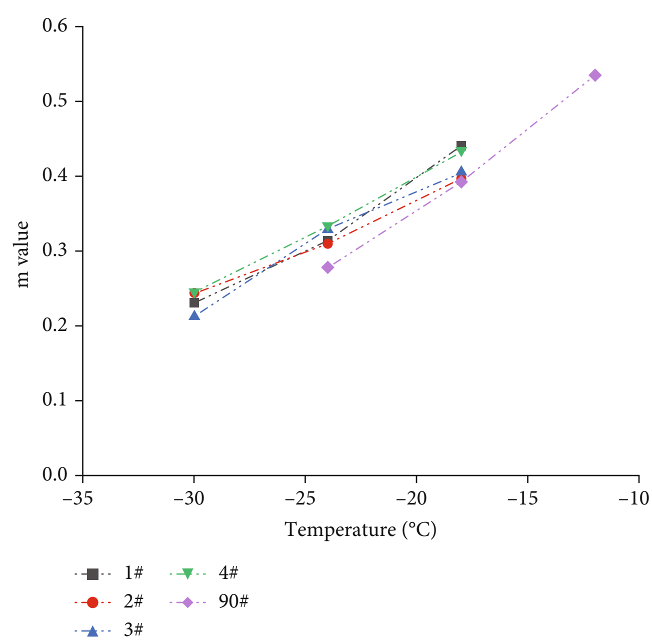

Figure 11: *m* value curve of tire rubber powder-modified asphalt.

Table 6: Dynamic shear rheological test results of tire rubber powder-modified asphalt.

Asphalt	$G*/\sin$ (Delta) (kPa) 64°C	70°C	76°C	82°C	TruGrade temperature (°C)
1#			1.060	0.628	76.68
2#			1.500	0.902	80.80
3#			1.260	0.733	78.56
4#			1.340	0.797	79.37
90#	1.100	0.549	0.297		64.86

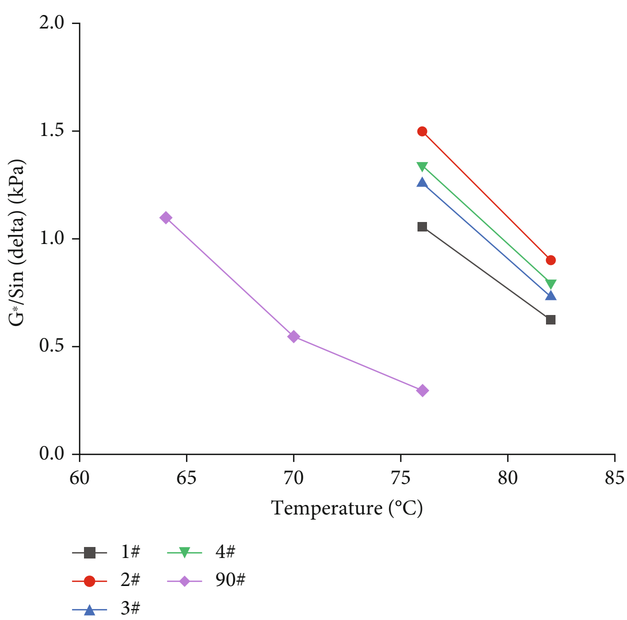

Figure 12: Dynamic shear rheological test results of tire rubber powder-modified asphalt.

As can be clearly found in Table 6 and Figure 12, when $G*/\sin$ (Delta) ≥ 1.0 kPa is used as the critical value required for asphalt PG classification, the PG classification temperature of 1#, 2#, 3#, and 4# tire rubber powder-modified asphalt is significantly higher than that of 90# base asphalt by more than 10°C. Among them, 2# tire rubber powder-modified asphalt has the highest PG classification temperature, reaching 80.80°C, followed by 4#, 3#, and 1#. The PG classification temperature of 90# base asphalt is the lowest, only 64.86. Judging from the degree of increase in PG classification temperature, 2# tire rubber powder-modified asphalt increased the most, which was 24.6%. The 4#, 3#, and 1# tire rubber powder-modified asphalt ranges were 22.4%, 21.1%, and 18.2%, respectively. Tire rubber powder-modified asphalt produces this result. The reason is still due to the addition of tire rubber powder. The tire rubber powder effectively improves the high-temperature shear rheological properties of the base asphalt. The incorporation of rubber powder effectively improves the shear resistance of asphalt so that the asphalt mixture has better shear resistance and can effectively extend the life of the asphalt pavement.

4. Conclusion

In this paper, 90# matrix asphalt and 1#, 2#, 3#, and 4# tire rubber powder-modified asphalt have been tested for viscosity and apparent viscosity, as well as a comparative test of flexural creep properties and dynamic shear rheological properties. Through the research results, the following conclusions can be drawn:

(1) In this study, through the viscosity test, creep test, etc., the optimal content of rubber powder-modified asphalt was finally determined to be 10%

(2) The rubber powder-modified asphalt effectively improves the low-temperature flexural creep performance of the base asphalt so that the modified asphalt has a relatively excellent low-temperature deformation ability. For the long-term winter low-temperature environment in the northeast seasonally frozen area, this kind of large deformation under low-temperature conditions without destroying the performance is particularly important. Rubber powder-modified asphalt can effectively reduce the shrinkage damage of asphalt pavement caused by low temperature and reduce the length, width, and length of cracks caused by temperature shrinkage damage. It can effectively improve the overall performance and long-term service life of asphalt pavements in Northeast China

(3) The rubber powder-modified asphalt effectively improves the high-temperature shear rheological properties of the base asphalt so that the modified asphalt has a relatively excellent resistance to high-temperature shear deformation. For the summer high-temperature environment in the northeast seasonal freezing area, rubber powder-modified asphalt can effectively reduce the rutting deformation and damage of the asphalt pavement due to high temperature and vehicles and can effectively improve the overall performance and long-term service life of the asphalt pavement in Northeast China

This article analyzes the performance of rubber powder-modified asphalt. At present, the method used is still limited to the macrotest method. Further research will start from the microlevel. Mainly analyze the chemical composition and microstructure of asphalt. In addition, the rubber powder used in this article is purchased by the manufacturer. The types and properties of rubber powder are quite different. Further study the self-preparation of tire rubber powder. Analyze the influence of rubber powder made from different types of tires on the properties of asphalt.

Data Availability

The experimental data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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