Study of Low Temperature Performance of Different Asphalt Types in Qinghai-Tibet Region

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Abstract: The climate conditions in Tibet are special, and the performance requirement of asphalt pavement is different from that of general area. The study of asphalt pavement in this area is aimed at the secondary roads. There is no experience for high grade asphalt pavement design .Based on the study of asphalt binder and mixing materials in high altitude area, used low-temperature bend test, analysis the influence of asphalt type on the low temperature performance of asphalt mixture. The results show that low temperature anti-cracking performance of SBS/SBR composite modified asphalt mixture is optimal. It is suggested to choose composite modified asphalt with high grade.

1 INTRODUCTION

The low temperature cracking of asphalt pavement is a worldwide problem that has long been concerned at home and abroad (Ma, 2011). Previous research has shown that there are many factors influencing low temperature cracking of asphalt pavement. It mainly includes the properties of asphalt and asphalt mixture, the properties of basic materials, climatic conditions, traffic loads, design factors and construction factors (Underwood, 2013).According to the mechanism or main inducement of pavement cracking, the crack in asphalt pavement is generally divided into load crack and non-load crack. For semi-rigid base asphalt pavement cracking and low temperature cracking of asphalt pavement, non-load crack is the main form (Sha, 2012).Non-load is commonly transverse cracks, mainly is the low temperature, cooling and temperature cycle repeatedly on the asphalt pavement temperature shrinkage crack and shrinkage cracking semi-rigid base and the reflective crack (Li, 2008).

The Tibetan has high altitude, low annual average temperature, big temperature difference, frequent freeze-thaw cycle, strong solar radiation and a variety of adverse conditions, which affects the mechanical properties and durability of the asphalt mixture significantly (Ma, 2015). Low temperature crack seriously affects the service life of road. However, in the Qinghai-Tibet plateau, the low temperature crack has a more significant impact on road life and pavement performance. The low temperature performance evaluation index of asphalt mixture is studied systematically by domestic and foreign researchers. The American highway strategic research program (SHRP) has proposed a temperature stress test and J - integral test as the main method to evaluate the low temperature cracking of asphalt pavement (Iliuta, 2004).China "five-year" project with 0 °C bending creep test of asphalt mixture creep rate as the evaluation index of asphalt mixture low temperature crack resistance (Zhao, 2011). In the past, many researchers have used low temperature bending strength or low temperature bending strain as the evaluation index in the study of low temperature crack resistance of asphalt mixture (Wang, 2016).For the evaluation method proposed by China "five-year" project, because its experimental temperature is far from the actual temperature in the Qinghai-Tibet plateau, it should not be used to evaluate the low temperature performance of asphalt mixture in this area. However, the low temperature bending strength or low temperature bending strain used by most researchers can only reflect the characteristics of asphalt mixture at low temperature, and cannot comprehensively reflect its low temperature performance (Chazono, 1989; Ho, 2002).Therefore, there are many evaluation indexes for the low temperature crack resistance of asphalt mixture, and there is no uniform standard at home and abroad.

In this paper, according to the low temperature bending test results of asphalt mixture in Qinghai-Tibet alpine region, the effect of asphalt variety on the crack resistance of asphalt materials was analysed.

2 TEST MATERIALS

2.1 Materials

The asphalt used in this study was SBS90#modified asphalt, SBS/SBR90#co-modified asphalt,SBR90# modified asphalt, SBS110# modified asphalt, SBS/SBR110# co-modified asphalt and SBR110# modified asphalt, the corresponding serial number is 1#~6#. The specific technical indicators and test results are shown in Table1.

Table1: Technical indicators of modified asphalt

Technical index		Experimental value					
		1#	2#	3#	4#	5#	6#
Penetration (0.1mm)		96	96	93	107	102	109
Ductility (cm)		56	84	148	62	120	150
Softening point (℃)		61.5	62.3	60.2	59.7	59.5	57.9
Kinematic viscosity (135℃)		1.49	2.73	2.94	1.23	2.53	2.87
Penetration index		3.04	4.29	3.46	2.25	3.33	2.77
Flash point (℃)		247	231	243	243	234	246
Solubility (%)		99.7	99.6	99.6	99.5	99.6	99. 6
RTFOT	Quality change (%)	0.34	0.34	0.27	0.5	0.45	0.48
	Residual penetration (%)	74.9	74.9	71.6	74.6	87.8	77.6
	Residual ductility (cm)	65	65	98	48	88	113

The coarse aggregate was granite, fine aggregate was artifical sand, mineral powder was limestone mineral powder.

2.2 Test Methods

The bending test (T 0715-2011) of 《Standard Test Methods of Bitumen and Bituminous Mixtures for Highway Engineering》(JTG E20-2011) was used to test the low-temperature performance of asphalt mixture.

3 RESULTS AND DISCUSSIONS

3.1 Analysis of the Low Temperature Bending Strength

The low temperature bending strengths of different asphalt are shown in Figure 1.

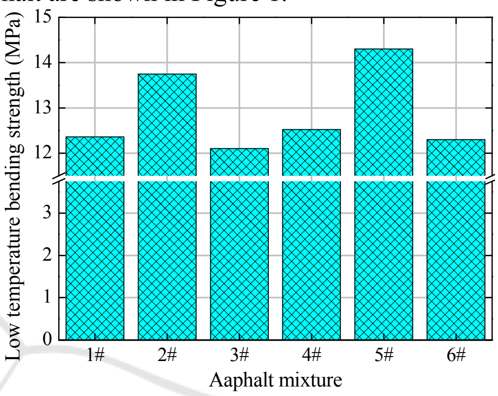

Figure 1Low temperature bending strength of asphalt mixture .

As can be seen in Figure 1, all kinds of asphalt mixture low temperature bending strength are high, and the low temperature bending strength of different asphalt types differs slightly. More specifically, the low temperature bending strength of SBS/SBR110# co-modified asphalt mixture is the maximum, the corresponding value is 14.3 MPa, and that of SBR90# modified asphalt mixture is the minimum, the corresponding value is 12.1 MPa.

As for the asphalt mixture with the same aggregate gradation and penetration grade, the low temperature bending strength of composite modified asphalt mixture is higher than that of the two other asphaltmixtures, the low temperature bending strength of SBS modified asphalt mixture and SBR modified asphalt mixture are almost the same, and the low temperature bending strength of SBR modified asphalt mixture is a little bigger thanthat of SBS modified asphalt mixture.

As for the same modified asphalt, with the increasing of the penetration degree, the low temperature bending strength of asphalt mixture decreased.

From the low temperature bending strength index of asphalt mixture, the composite modified asphalt has the advantages of SBS modified asphalt and SBR modified asphalt, and the low temperature resistance of composite modified asphalt mixture is the best.

3.2 Analysis of the Low Temperature Bending Strain

The low temperature bending strains of different asphalt are shown in Figure 2.

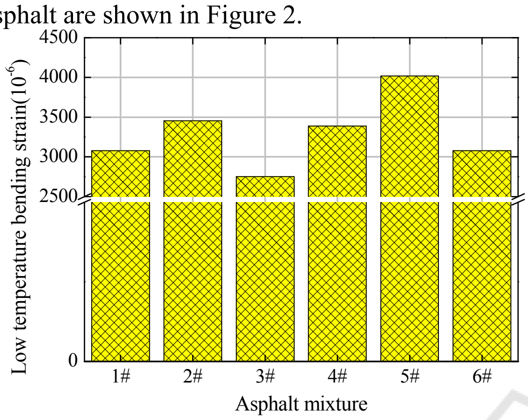

Figure 2Low temperature bending strain of asphalt mixture

In Figure 2, the low temperature bending strain of all asphalt mixtures is greater than 3000, which meet the specifications. It is different from low temperature bending strength, there is a significant difference between different asphalt mixture the low temperature bending strain. Specifically speaking, the low temperature bending strain of SBS/SBR110# co-modified asphalt mixture is the maximum, the corresponding value is 4017, and that of SBR90# modified asphalt mixture is the minimum, the corresponding value is 2751.

As for the asphalt mixture with the same aggregate gradation and penetration grade, the low temperature bending strain of SBR modified asphalt mixture is the minimum, the low temperature bending strain of SBS/SBR co-composited modified asphalt mixture is the maximum, and the low temperature bending strain of SBS modified asphalt mixture is middle. The difference between low temperature bending strain of SBS/SBR co-composited modified asphalt mixture and SBR modified asphalt mixture is significant, while the difference between SBS/SBR co-composited modified asphalt mixture and SBS modified asphalt mixture is small.

As for the same modified asphalt, with the increasing of the penetration degree, the low temperature bending strength of asphalt mixture increased, and the influence of penetration degree on the low temperature bending strain of asphalt mixture is significant.

From the low temperature bending strain index of asphalt mixture, the low temperature resistance to deformation of SBS/SBR co-composited modified asphalt mixture is the best, the SBS modified asphalt mixture is the second, and the SBR modified asphalt mixture is the worst. Combined low temperature bending tensile strength and bending strain of asphalt mixture, the low temperature performance of SBS/SBR co-composited modified asphalt mixture is the optimum.

3.3 Analysis of the Low Temperature Stiffness Modulus

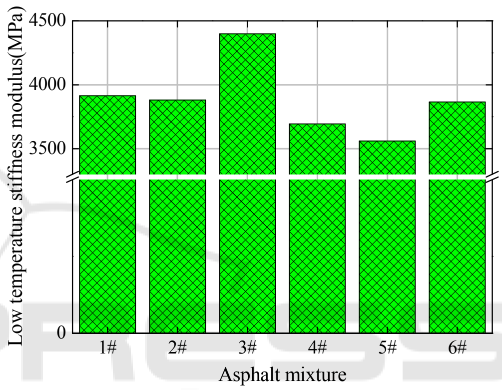

Figure 3Low temperature stiffness modulus of asphalt mixture

As can be seen from Figure 3, the low temperature bending stiffness modulus of different asphalt mixture is small. The low temperature bending stiffness modulus of SBR90# is the maximum, the corresponding value is 4398MPa, and that of the SBS/SBR110# is the minimum, the corresponding value is 3560MPa.

As for the asphalt mixture with the same aggregate gradation and penetration grade, the low temperature bending stiffness modulus of SBR modified asphalt mixture is the maximum; the low temperature bending stiffness modulus of SBS/SBR co-composited modified asphalt mixture is the minimum, and the low temperature bending stiffness modulus of SBS modified asphalt mixture is middle.

As for the same modified asphalt, with the increasing of the penetration degree, the low temperature bending stiffness modulus of asphalt mixture decreased.

The low temperature bending stiffness modulus is a comprehensive performance of low temperature strength and deformation resistance of asphalt mixture, which reflect the flexibility of asphalt mixture to some extent. Generally speaking, the smaller the bending stiffness, flexible of asphalt mixture under cold condition, the better.

In conclusion, the low temperature bending strength and bending strain of SBS/SBR co-composited modified asphalt mixture are both larger, the low temperature stiffness modulus of SBS/SBR co-composited modified asphalt mixture is smaller.

4 CONCLUSIONS

As for the low temperature bending strength of asphalt mixture, the composite modified asphalt has the advantages of SBS modified asphalt and SBR modified asphalt, and the low temperature resistance of composite modified asphalt mixture is the best;As for the low temperature bending strain index of asphalt mixture, the low temperature resistance to deformation of SBS/SBR co-composited modified asphalt mixture is the best, the SBS modified asphalt mixture is the second, and the SBR modified asphalt mixture is the worst; As for the low temperature bending stiffness modulus of asphalt mixture, SBR modified asphalt mixture is the worst; the low temperature bending stiffness modulus of SBS/SBR co-composited modified asphalt mixture is the best.In a word, the low temperature performance of SBS/SBR co-composited modified asphalt mixture is optimum. In addition, high grade asphalt is selected to improve the low temperature performance of asphalt mixture.

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