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Research Article

Comparative Study on Test Performance of Two Kinds of High Modulus Asphalt Concrete for the Steel Bridge Deck

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Abstract: Along with the popularization and application of the steel bridge in China, due to the high modulus of asphalt concrete with good waterproof, anti-fatigue, anti-aging and good performance, asphalt concrete with high modulus was widely used in steel bridge deck pavement, the test and comparative study of high modulus asphalt concrete were carried out based on two types of common high modulus asphalt concrete which include the casting type asphalt concrete and epoxy resin modified asphalt concrete, aims to further explore the performance features of the steel bridge deck with high modulus asphalt concrete, and provide help on the application of this asphalt concrete on the steel bridge deck.

Key words: Steel bridge deck; High modulus; Asphalt concrete; Test performance

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1 Introduction

In recent years, with the strong support for the construction of steel structure bridge in China, steel structure girder bridge has been rapidly promoted in highway construction with its excellent comprehensive performance, which has effectively promoted the transformation, upgrading, quality and efficiency improvement of China's highway construction. In order to deal with the problems of easy rust, fast thermal conduction and high elastic modulus of steel bridge deck, the transition layer between steel bridge deck and ordinary asphalt concrete pavement should not only have good performance of waterproof, rutting, shearing and sliding resistance, but also have high elastic modulus. In this paper, two kinds of high modulus asphalt concrete commonly used for steel bridge decks, pouring asphalt concrete and epoxy resin modified asphalt concrete, are tested and compared. Through in-depth research and analysis, the purpose of this paper is to further reveal their performance characteristics and explore the pavement technology of high modulus asphalt for steel bridge decks.

2 Preparation of raw materials

2.1 Aggregation

The coarse and fine aggregates used in the comparative test of the casting asphalt concrete and the epoxy resin modified asphalt concrete are the same, which are igneous rocks, in which diabase content is 84.6%. Mineral powder with high quality limestone mineral powder, plastic index is less than 1.7, the pass rate of 0.075 mm sieve is 99.9%.

2.2 Modified asphalt

The casting asphalt concrete adopts TAL+SBS high-strength bisexual modified asphalt, the TAL: SBS ratio is 60:40. The modified asphalt has good high temperature stability and low temperature crack resistance, and has good follow-through with steel bridge deck. The technical indexes are shown in Table 1. Epoxy resin modified asphalt concrete adopts two component modified asphalt, component A (epoxy resin) and BV (asphalt and curing agent mixture), the two-component mixing ratio of A: BV=12:88.

Table 1. Technical indexes of TAL+SBS high-strength bisexual modified asphalt

Indexes	Design requirements	Real testing	Experimental methods
Penetration (25℃)	30~50	33	T0604-2000
Softening point (ring and ball method) ℃	≥80	98.2	T0606-2000
Rebound rate (25℃) %	≥90	95.4	T0662-2000

3 Comparison of laboratory tests between the casting asphalt concrete and the epoxy resin modified asphalt concrete

3.1 Comparison of gradation design of asphalt concrete mixture

The casting asphalt concrete and the epoxy resin modified asphalt concrete are different in the gradation design of their mixtures due to their different paving and strength formation modes. In order to obtain higher fluidity and workability of the casting asphalt concrete, the asphalt content and low particle size aggregate content are higher in the design of mixture grading. The strength formation of epoxy resin modified asphalt concrete needs a certain health preservation, so more attention is paid to the skeleton function of gradation. Pairing ratios of the two levels are shown in Table 2.

Table 2. Comparison of pairing ratio

Asphalt concrete	Weighting percentage of passinf through sieves below (regular sieve, mm)(%)									Dosage of asphalt (%)
	19	13.2	9.5	4.75	2.36	0.6	0.3	0.15	0.075	
Casting	100	92.0	--	73.4	54.5	44.4	36.7	30.1	23.8	8.5
Epoxy	--	100	97.4	74.5	61.4	35.7	--	--	10.8	6.4

3.2 Performance control of castable asphalt concrete

The casting asphalt concrete has high fluidity. Before preparation, the temperature of modified asphalt should be controlled at 220 ℃ for mixing with preheated aggregates and mineral powder, and the final temperature of mixed material should be controlled within 240 ℃ . Because characteristics of the casting asphalt concrete are different from that of the common asphalt concrete, and the traditional Marshall stability test cannot be adopted to achieve the quality control, the construction workability was tested through the fluidity of the asphalt mixing material, the performance at low temperature and paring reasonability were tested through the buckling strain results at low temperature. In this test, the period of asphalt mixture flow is controlled in 15 ~ 20S, asphalt penetration is controlled in 2 mm ± 0.5 mm, (penetration increment is controlled in 0.4 mm) and the rationality of the mixture is finally tested with low temperature bending strain index. The test results are shown in Table 3.

Table 3. Performance indexes of the casting asphalt concrete

Indexes	Controlled requirements	Experimental data	Experimental methods
Fluidity of asphalt mixing materials (s)	<30	18	ZTVasphalt STB94
Penetration at 60℃ (mm)	1~4	2.3	ZTVasphalt STB94
Penetration increments at 60℃ (mm)	<0.4	0.33	ZTVasphalt STB94
Buckling strain at low temperature -10℃	>6×10-3	12×10-2	ZTVasphalt STB94

3.3 Performance control of epoxy resin modified asphalt concrete

The formation mode of strength of the epoxy resin modified asphalt concrete is different from that of the casting type asphalt concrete, there was an inert period in the early stage of the combination of the epoxy resin and curing agent in the modified asphalt, the reaction became more significant with the increasing temperature after the inertia period, it was shown that a large number of 2D lock structure were formed in the combination material under the micro electron micrograph, characterized by the mixture specimen Marshall stability increased as the growth of the curing time. Therefore, the performance control of the epoxy resin modified asphalt concrete is determined by "regimen - strength relationship experiments" and "construction time experiments".

1) Regimen - strength relationship test

14 Marshall specimens were made according to the optimum asphalt content in the experiment, put them

into 20℃ temperature 30℃ constant temperature box with the group of seven to healthy preservation, the strength experiment of one Marshall specimen was carried out every 24 h, and the Marshall strength and curing time diagram (Figure 1) were draw out, it be concluded that the strength of the epoxy resin modified asphalt concrete and the curing temperature and time is proportional to the relationship from figure 1.

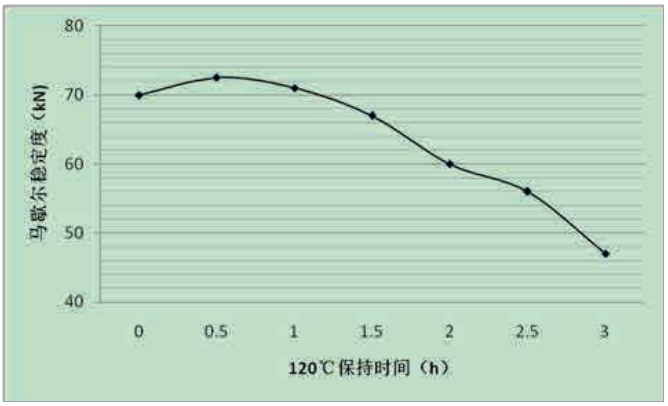

Figure 1. Health preservation-strength relationship experiments

2) Construction time experiments

In this experiment, the prepared epoxy resin modified asphalt concrete was stored in a thermostat at 120℃ , and a group of Marshall specimens were made by sampling every 0.5h. The specimens were placed in a thermostat at 30 ℃ for health preservation after cooling. After 7 days, the Marshall strength of each group was tested and the relationship curve was drawn (Figure 2). It can be concluded from Figure 2 that the Marshall stability of all samples within 2h is above 60kN, therefore, the construction time of the epoxy resin modified asphalt concrete should be controlled within 2h.

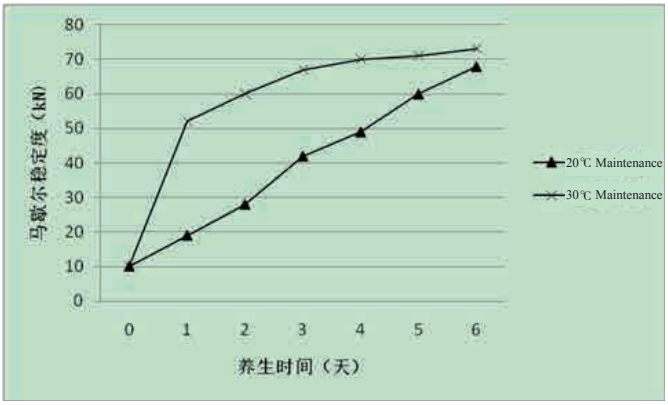

Figure 2. Construction time experiments

4 Analysis of paving the casting asphalt concrete and the epoxy resin modified asphalt concrete

4.1 The casting asphalt concrete

The casting asphalt concrete has good fluidity and workability, so the temperature of the mixture during construction should be maintained between 230℃ and 240℃, and the high temperature spreading should be carried out to ensure the quality of the paving. Through many on-site placement tests, it concluded that the aggregate were added into the mixing axe when it was preheated to 300 ℃, the cold mineral powder were added into the mixing axe, dry mixing them for 10 s and 220℃ of modified asphalt was added and mixed for 90 s, temperature of the discharge was controlled at around 240 ℃, the discharge load was set into the transmission device which has the thermal insulation characteristic, the site construction temperature was kept at 230℃ ~ 240℃ to ensure the quality of pavement.

4.2 The epoxy resin modified asphalt concrete

The construction of the epoxy resin modified asphalt concrete is similar to that of ordinary hot mixed asphalt concrete. After the material is discharged, it is transported by conventional transport vehicles. Because its "construction time" is generally less than 2 h, the construction needs to be completed within 2 h, which makes the construction organization difficult. The pavement strength needs to be formed after 7 days of drying and health preservation, so the requirements for the site after health preservation conditions are higher.

5 Conclusion

The casting asphalt concrete needs to be constructed at high temperature, and the strength will be formed immediately after the pavement temperature is lowered, without the need for health preservation. Because the site construction temperature is high, a high temperature early warning system must be established during the construction, the contraction of the expansion joint should be uninterrupted observed, in order to control the construction speed, to prevent accidents caused by thermal expansion. At the same time, due to the high temperature water gasification expansion coefficient is very high, the construction

should keep the site environment without water.

The paving process of the epoxy resin modified asphalt concrete is similar to that of the conventional asphalt concrete. Due to the limitation of construction time, health preservation temperature, humidity and other conditions, the inert period of the mixing materials should be determined before construction, the construction should be processed in the warmer season, and the construction should be completed within the inert period, after construction, the waterproof bonding material should be sprayed immediately to achieve water resistance, the upper layer should be paved as soon as possible.

Both types of high modulus asphalt concrete for steel bridge deck have advantages and disadvantages, the application environment and applicable conditions should be fully considered in the design and construction to choose a reasonable paving scheme. In the case of difficult site health preservation conditions and long transportation distance, the casting asphalt concrete should be choose; The epoxy resin modified asphalt concrete should be selected when it is difficult to meet the high temperature mixing requirement, and conditions of the close transport distance, high temperature and moisture-proof.

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