ORIGINAL ARTICLE

Key Points of Construction Quality Control of SMA Asphalt Pavement

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Abstract: Compared with ordinary pavement, SMA pavement structure not only has a good high temperature resistance to rutting and low temperature crack resistance, but also has excellent performance, such as seepage resistance, anti-skid, fatigue and durability, so it is widely used for SMA asphalt pavement and the supervision of the work also gradually standardized. In this paper, through the example of SMA asphalt pavement construction quality supervision of Sui-Yue-Zhong Expressway, the main points of SMA asphalt pavement construction quality control are introduced.

Key words: SMA, quality control, supervision

Introduction

SMA is the asphalt mastic gravel mixture, abbreviation of Stone Mastic Asphalt. It is the asphalt binder and a small amount of fiber stabilizer, fine aggregate and more filler (slag) composed of asphalt mastic fill in the intermittent graded coarse aggregate gap, which composed of asphalt mixture. Compared with ordinary road, SMA pavement structure not only has a good high temperature anti-rutting, low temperature crack resistance and anti-seepage, anti-skid, fatigue and other superior performance, which will be more and more widely used. The SMA pavement cost is relatively high, the process is relatively complex, and the construction supervision requirements are correspondingly higher. With the construction of the SMA-13 pavement with the thickness of 4cm on the SuiYueZhong Expressway, the supervision of K0 + 000 ~ K33 + 700 SMA pavement (hereinafter referred to as this project) undertook by Yunnan Highway Engineering Supervision and Consultancy Compan. has achieved complete success. The effective implementation of SMA road construction supervision accumulated experience. The author summarizes the construction supervision of the SMA pavement and puts forward the following several quality control points.

1. Raw material control

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1.1 Asphalt

1.1.1 Selection of asphalt and technical indicators

Asphalt for SMA should have good adhesion and temperature stability, generally used modified asphalt, such as SBS, SBR, EVA and so on. With the SuiYueZhong Expressway Headquarters through the public tender, select the Hubei Guochuang Hi-tech Material Co.,Ltd to provide the PG level (PG76-22) SBS modified asphalt. According to the climatic and traffic conditions of the project location, the owners will improve the softening point index and elastic recovery index requirement of SBS modified asphalt in order to ensure the quality of the project. The supervisory laboratory conducts independent sampling and testing of SBS modified asphalt and its technical indicators are compared with the specifications and project requirements.

Table 1 Sui Yue Zhong-highway SBS modified asphalt technical indicators

Technical Specifications		Specification Value	Itemized Value	Detection Value
Penetration（25℃,100g,5s） (0.1mm)		30-60	40-60	56.0
Ductility (5cm/min,5℃) Minimum (cm)		20	20	27.4
Softening point (Global Law) Minimum (° C)		60	75	78.9
Flash point (COC) Minimum (° C)		230	230	301
Kinematic viscosity 135 ° C Maximum (Pa.s)		3	3	2.256
Elastic recovery (25 ℃, 10cm) Minimum (%)		75	80	92.0
Storage stability segregation, 48h softening point Maximum (℃)		2.5	2.5	1.5
Rotary film oven test 163 85min	Mass loss Max.（%）	±1.0	±1.0	-0.20
	Penetration ratio (25 ℃) Min. (%)	65	65	72.3
	Ductility（5℃） Min.（cm）	15	15	19.4

Note: The value of the itemized value of the highway technical standards used value, the detection value of the actual test laboratory test value, the same as the below.

1.1.2 Asphalt factory supervision

To supervise the production and testing of the asphalt factory in the asphalt plant and to supervise the asphalt plant supervision process of the factory supervision and supervise the supply of the asphalt tank storage of the project and sign for the modified asphalt.

1.1.3 Transport and storage of asphalt

Modified asphalt transportation, transport temperature of not less than 150 ℃ to the site of the modified asphalt to be tested by the three indicators before passing into the asphalt storage tank. Asphalt storage tank to have enough volume to insulation storage and heating, and to ensure that the modified asphalt is agitated when necessary. During the use of asphalt, the asphalt stored in the tank temperature of not less than 140 ℃ and not higher than 170 ℃. Modified asphalt storage time should not be too long, as per according to the construction progress report, one week ahead of the schedule to be prepared 1 to 2 days before the scene.

1.2 Coarse aggregate

1.2.1 Coarse aggregate technical indicators

For the SMA coarse aggregate should be high strength, rough surface, and clean, square shape, less needle-like particles, no soil or impurities and to meet the technical requirements of the mixture. Coarse aggregate technical indicators in Table 2, the project to improve the crushing value, wear value and other key indicators.

Table 2 Sui Yue Zhong-highway on the top layer of coarse aggregate technical indicators

Indicator		Unit	Specification Value	Itemized Value	Detection Value
Crushing value		%	≤26	≤20	13.0
Los Angeles Abrasion Value		%	≤26	≤22	9.8
Polishing value		BPN	≥42	≥42	48.6
Apparent density		t/m3	≥2.60	≥2.60	2.993
Water absorption		%	≤2.0	≤2.0	0.56
Adhesion to Asphalt			Grade 5	Grade 5	Grade 5
Robustness		%	≤12	≤12	2.2
Soft rock content		%	≤3	≤3	1.2
< 0.075mm content (Washing method)		%	≤1	≤1	0.6
Needle sheet content	＞9.5mm	%	≤12	≤12	11.5
	＜9.5mm	%	≤18	≤18	14.0

1.2.2 Quality control of coarse aggregate

Reported by the headquarters of the approved, the project aggregated Sanyang basalt plant used in the production of basalt. Coarse aggregate using 1 # material (9.5 ~ 16mm), 2 # material (4.75 ~ 9.5mm), the aggregate used grade 2 crushing, the second level using counter-break form processing. Construction units and supervision units sent to supervise the production, strictly control the material source, mud content, dust, complex rock content, regularly check the screen and rammer and the file storage separately stored, which is strictly prohibited to be mixed. Timely sampling test. The test results of the coarse aggregate technical indicators are shown in Table 2.

1.3 Fine aggregate

1.3.1 Technical specifications for fine aggregate

The proportion of fine aggregate in SMA is small, but its quality has great influence on the high temperature stability of the mixture. Fine aggregate should have a certain angular, clean, dry, no weathering exposure, no impurities, and no soil, to have good adhesion with asphalt and meet the requirements of the ruggedness. The technical indicators in Table 3.

Table 3 Sui Yue Zhong-highway on the top layer of fine aggregate technical indicators

Indicator	Unit	Specification Value	Itemized Value	Detection Value
Apparent density	t/m3	≥2.50	≥2.50	2.965
Ruggedness（＞0.3mm part）	%	≤12	≤12	3.2
Sand equivalent	%	≥60	≥75	89
Mud content < 0.075mm content	%	≤3	≤3	1.2
Methylene blue value	g/kg	≤25	≤25	20
Angularity (flow time)	s	≥30	≥30	36

1.3.2 Quality control of fine aggregate

The fine material of this project is 0 ~ 2.36mm grade 4 # material, with the same coarse aggregate from Sanyang basalt plant, with the same aggregate rock, while production, quality control measures with coarse aggregate. In fact, technical indicators to meet the specifications and project requirements, see Table 3.

1.4 Mineral powder

1.4.1 Technical indicators of mineral powder

The amount of mineral powder in SMA is much higher than ordinary asphalt concrete around 8 to 10%. The quality of the mineral powder is critical. Mineral powder should be used limestone or hydrophobic rock grinding, requires good adhesion with the asphalt, and fineness should meet the requirements. The quality standard of the slag is shown in Table 4.

Table 4 Sui Yue Zhong-highway on the top layer of mineral powder technical indicators

Indicator		Unit	Specification Value	Itemized Value	Detection Value
Apparent density		t/m3	≥2.50	≥2.50	2.698
Water content		%	≤1	≤1	1
Particle size range	＜0.6mm	%	100	100	100
	＜0.15mm	%	90~100	90~100	94.3
	＜0.075mm	%	75~100	75~100	89.0
Hydrophilic coefficient			＜1	＜1	0.8
Plasticity index			＜4	＜4	3.0

1.4.2 Quality control of slag

In order to ensure the quality of mineral powder, the project used in the middle layer of the use of 1 # 2 # aggregate grinding alone, stone is a 5 grade adhesion of limestone, each class to do a grain fineness.

Mine powder in the mixing plant supervision visual inspection can be pumped into the powder warehouse, observation and inspection of three indicators: First, the color should be gray, yellow mud content is higher, black mud content is higher than coal gangue; Secondly, ore powder mixed into the water for stirring, if on the surface there is floating material which indicate of containing impurities; thirdly is hand twist fineness, fineness and cement quite the same, which is slightly thicker than the cement with no obvious grainy.

Ore powder storage which required to keep the warehouse dry to prevent the impact of moisture production.

1.5 Fiber stabilizer

1.5.1 Selection of fiber stabilizers

SMA has a good road performance due to three more (on aggregate, asphalt and mine powder) one little (on fine material) factors, the more important is to join the fiber stabilizer. Fiber stabilizer has one of the indispensable components of SMA with reinforcement, dispersion, adsorption, stabilizing and thickening.

Fiber stabilizers are included ligno-cellulose fiber, mineral fiber, polymer fiber and glass fiber and other types. Among them, wood fibers are organic fibers obtained by chemical treatment of natural wood and have good comprehensive performance and thus are the most widely used.

This project uses German Xcel ligno-cellulose fiber as a stabilizer. Cellulose fiber has both granular and flocculent, and it is found that the dispersion of granular cellulose fiber is difficult, not only the mixing time is increased, but the mixture is not easy to mix well. The final determination of flocculent ligno-cellulose fiber.

1.5.2 Technical indicators of ligno-cellulose

The technical specifications of ligno-cellulose should meet the requirements of Table 5.

Table 5 Technical specifications for ligno-cellulose

Test item	Unit	Specification value
Fiber length, not more than	mm	6
Ash content	%	18±5
PH value		7.5±1
Oil absorption rate, not less than		5 times the fiber quality
Moisture content (by mass) not more than	%	5

1.5.3 Quality control of ligno-cellulose

Ligno-cellulose selection required to report the approval of the headquarters, each batch of fiber to be sent to send the authority to detect the authority before use.

2. Match design control

After the material is selected, the key work is to match the design, mix design must choose a reasonable level and the amount of asphalt in order to obtain road performance superior asphalt mixture. The Marshall method is divided into three stages: the design of the target mix design, the production mix design and the production ratio verification and the rotary compaction verification.

2.1 Target mix design

Matching design must be representative of the sampling, the target mix than the design phase sampling can not be sampled in the material edge, but should be in the top of the pile at different parts of the plan after about 10cm after sampling.

The target mix ratio design step is to determine the composition ratio of each mineral material→forming Marshall specimen→determine the maximum theoretical density→calculate the calculation of the volume index and the Marshall index→determine the best amount of asphalt → road performance test.

It should be noted that, although there are some controversies about whether or not some indicators are suitable for the design of SMA as a basis for the Marshall molding method, which is based on the fine graded asphalt mix, it is necessary to obtain a good mix of road performance, indicators of cognition are consistent. In the aspect of optimizing the gradation, the content of aggregates between 2.36 and 4.75mm has a significant effect on the volume index of SMA and it should pay attention to the passage rate and avoid on the restricted area. The molding temperature has a great influence on the density, VCAmix and VV are the goals that the designer should focus on first, the skeleton should be filled as much as possible (VCAmix is less than and close to VCADRC), VV chooses a lower value to achieve durability and ease of construction; Indicators as a basis for testing and control mix design.

2.2 Production mix design

(1) Determination of the amount of cold material: The cold material of the belt measuring device in advance calibration, according to the size of each stall to determine the size of the door to open at different speeds weighing the material quality, drawing speed - quality curve, and finally according to the target match ratio to determine the belt feeding speed.

(2) Determination of the ratio of hot material production ratio: According to the target mix ratio of the supply of cold material, through drying and secondary screening, respectively, from the hot silos were sieved to determine the material of the hot material ratio, so that the aggregate grade is close to the target mix design for the mixing machine control room to use.

(3) Production mix ratio for determination of the best amount of asphalt: Take the target mix ratio of the best amount of asphalt, the best amount of asphalt 0.3% of the amount of three asphalt test Marshall test, through the indoor test and mixing sampling test to determine the most comprehensive good asphalt dosage.

2.3 Production Proportion Verification and Rotation Compaction Verification

2.3.1 Production Proportion Verification

Mixing machine with the production ratio of mixing and paving test sections with the mixture of asphalt mixture and drilling on the core of the Marshall test to determine the standard production mix.

2.3.2 Rotation compaction verification and test section verification

By the unified organization of the headquarters, through comparative verification, in order to optimize the mix design. Gradation Verification: The selected gradation passes through the control point and avoids the restricted area. Mixing Material Verification: The rotary concrete compaction specimen is used to verify the performance of the mixture according to the maximum traffic control. Through the test section test to adjust the ratio.

Through the repeated adjustment of the above steps, the standard mix ratio of asphalt mixture production is 1 #: 2 #: 4 #: mineral powder = 45: 34: 11: 10, the optimum bitumen is 6.0%, lignocellulose additional amount was 0.3%.

Mix the relevant test data in Table 6, Table 7.

Match design to achieve the desired purpose.

Table 6 SMA-13 synthesis gradation

Sieve size mm	16	13.2	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075
Required grading %	100	90-100	50-75	20-34	15-26	14-24	12-20	10-16	9-15	8-12

Synthetic grading %	100	94.7	63.4	26.8	18.7	17.2	13.3	12.5	11.7	10.2

Table 7 SMA-13 standard mix ratio technical indicators

Technical indicators	Whetstone ratio (%)	Stability (KN)	Flow value (0.1mm)	VV (%)
Specification value		≥6	20--50	3--4.5
Standard mix ratio	6.0	9.44	37.8	4.0
Technical Specifications	Asphalt Saturation (%)	Mineral Gap (%)	Coarse Aggregate Skeleton Gap rate VCAmix (%)	Dynamic stability (Times / mm)
Specification value	75--85	≥17	≤VCADRC	≥5000
Standard mix ratio	77.2	17.6	35.2＜42.2	7083
Technical Specifications	Freezing and thawing Residual strength ratio (%)	Immersion Marshall Residual stability (%)	Sherenberg Asphalt Leakage test on binder loss (%)	Kentucky Scattering test on mixture loss (%)
Specification value	≥80	≥85	≤0.1	≤15
Founding value	89.3	91.8	0.1	6.4

3. Construction preparation control

3.1 Equipment inspection

Asphalt pavement construction equipment model and quantity should meet the tender requirements, a variety of mechanical facilities complete to ensure the continuity of road construction. After inspection, the construction machinery and equipment complete, in good condition, to meet the tender documents, construction schedule and duration requirements.

3.2 Site laboratory establishment

Construction units and supervision units have established a site laboratory to obtain temporary qualifications.

3.3 Preparation of raw materials inspection

The construction of a variety of raw materials required for inspection, storage quantity is reasonable to meet the continuous construction and quality control requirements.

3.4 Technical preparation

Under the layer (the middle layer) for acceptance, elevation to meet the design requirements. Construction organization plan and mix design has been approved, technical completion has been completed.

In the top layer before paving, cleaning under the layer, spreading PCR modified emulsified asphalt adhesive oil, spread the amount of 0.3 ~ 0.5kg / m2. Qualified by the supervision and acceptance before laying the top layer.

3.5 Construction of test sections

The test section of the project selected in the K8 +595 ~ K9 + 033, a total of 436 meters. Through the construction of the test section, the following objectives have been achieved: to verify the target mix ratio, to determine the standard construction mix ratio; to master the use of materials, technical performance data, the materials used are in line with project requirements; determine the pine crack coefficient of 1.2; Reasonable number of machinery, model and combination; to determine the construction process; the establishment of drilling and nuclear density meter to determine the degree of compaction curve.

4. Construction process control

4.1 Mix the mixture

The project uses Nissan NBD320 automatic control of intermittent asphalt concrete mixing equipment, mixing machine by calibration measurement, temperature control system error within the allowable range. Equipped with automatic printing equipment to print the amount of material and temperature data. The use of secondary dust, prohibit the use of recycled powder, dust equipment shall not be connected with the mixing tank, the recovery of dust through the pipeline to the tanker transport. Mixer stable production of 260T / h.

Feeding order: Aggregate → cellulose → mineral powder → asphalt.

Cellulose using mechanical feeding, real-time monitoring to prevent blocking. After the fiber was added, the dry mixing time was 10s longer than that of the ordinary asphalt concrete and the total mixing time increased by 15s. SBS modified asphalt with heat conduction oil heating, heating temperature of 160 ~ 170 ℃, mineral heating temperature of 190 ~ 200 ℃ to ensure that the asphalt mixture factory temperature of 175 ~ 185 ℃.

In the mixing plant supervision is responsible for checking the mixture mix, the mixture should be consistent in color, no white, no clumps and no serious segregation. When found that the temperature of the mixture below 165 ℃ or higher than 195 ℃, white, serious segregation and other phenomena, which are not allowed to appear, the mixture to be abandoned.

4.2 Mixture transportation

The project transport vehicles are all 20T dump truck, the number of 20 vehicles. Car body floor wall coated with soapy water to prevent bonding, the car with a tarpaulin, used to heat and prevent pollution.

When loading the truck back and forth in the order of moving back and forth loading, each car is not less than 5 heap to avoid gradation isolation.

When transport truck reach the construction site, the frontcourt supervision inspection asphalt mixture temperature must not less than 165 ℃, the appearance to be qualified before use.

This project uses LHZ25C asphalt transfer vehicle in the truck and paver indirect asphalt mixture, effectively solve the temperature segregation and aggregate segregation phenomenon.

4.3 Mixing paving

The project uses ABG423 paver 1 full-width paving, bilateral balance beam automatically leveling. Paver in place, install and debug a good reference beam, preheat screed to 100 ℃ or more, according to the road thickness and loose pile coefficient to adjust the screed height, adjust the screed angle.

Asphalt transfer vehicle LHZ25C in front of the paver, check the heating, mixing, transmission system is normal. Adjust the height of the feed port, position, align the paver center.

Began to pave the way, the front waiting for unloading the transport vehicles should not less than 5, the normal paving to maintain 3 to 5, to ensure continuous paving. Paving temperature of not less than 165 ℃, according to the mixer production to adjust the paving machine paving speed of 3m / min, to maintain uniform speed forward, asphalt conveyer and paver traveling speed consistent. When the feed is tight, it can be gradually slowed down to 2m / min, but should not be frequent changes in speed. When the material intermittently for a long time should stop paving, according to the seam processing.

Paving process, the paver hammer frequency set at 4.5 grade, so that the initial compaction of more than 85%, and according to the nuclear density meter to measure the initial compaction degree, timely adjustment.

Paver spiral feeder should be stable, in uniform rotation and paving material should be greater than 2/3 screw position to avoid the occurrence of aggregate separation.

4.4 Mixing process

SMA road rolling should follow the "high frequency low amplitude, high temperature followed by slow pressure" principle, the use of rigid roller rolling, generally do not use rubber roller. Rolling start, the brake is slow, which is strictly prohibited from rolling on the road to turn, U-turn or parking. Rolling pressure, pressure, final pressure (including molding) three stages, according to the way to determine the way to test.

The initial pressure: This project uses 13t DD130 double drum roller 1 static pressure for 1 times, immediately after the mixture paving, the initial pressure start temperature of not less than 145 ℃, the higher the better. Rolling speed of 2 ~ 3km / h, roller uniform speed of travel, shall not produce the transition, cracks. Should be measured from the outside to the center rolling, overlapping 1/3 ~ 1/2 wheel width.

Re-pressure: re-pressure followed by the initial pressure after the use of 13TDD130 double drum roller 2 sets of vibration 2 times, 18tCC722 double drum roller 1 static pressure for 1 times. Vibration frequency 50HZ, amplitude 0.5mm, adjacent roller with overlapping width of 20cm, rolling speed of 3 ~ 5km/h. Vibration roller to change the direction of travel before the first stop vibration to be the other direction after the start of vibration, so as not to form a drum package.

Final pressure: DD130 double drum roller static pressure 2 to 3 times the face to eliminate the track, improve the flatness. Rolling speed at 3 ~ 6km/h. Final pressure of the end of the temperature of not less than 100 ℃.

Conclusion

(1) Material control is the primary link of SMA road quality control. The pre-control effect on the quality of aggregates and asphalt is obvious.

(2) According to the road performance for the test and control the basis of design basis, the use of rotary compaction (GTM) method to verify the Marshall method with the ratio, which is conducive to improving the road performance of the mixture;

(3) The use of asphalt transfer vehicles to reduce the temperature and aggregate segregation effect is obvious;

(4) Pay attention to the initial degree of compaction, which can improve the flatness;

(5) For good performance, supporting a reasonable machinery, SMA is an important guarantee for the quality of the road, which is an important part of the supervision engineer monitoring.

References

1. Shen Jin An, Modified Asphalt and SMA Pavement [M], Beijing, People's Communications Press, 1997
2. Qian Hua, Lignocellulose in the Performance Evaluation of SMA, J, Hebei Transportation Technology, 2006, (2)
3. Wu Ding Lue, Modified Asphalt and SMA Road Construction Quality Control Measures, J, Shanxi Architecture, 2008 (02)
4. Highway Asphalt Pavement Construction Technical Specifications [S], People's Communications Press, 2004,11
5. Hubei Sui Yue middle-highway construction headquarters, Asphalt Surface Construction Rules, 2006,12