

ARTICLE

RESEARCH ON THE APPLICATION OF SAND MIST SEAL TECHNOLOGY IN THE PREVENTIVE MAINTENANCE OF ASPHALT PAVEMENT IN AUTOMOBILE TEST FIELD

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ARTICLE DETAILS

ABSTRACT

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Based on the road age of the high-speed ring road test road in the automobile proving ground, this paper actively introduces the technology of sand mist sealing layer to carry out early preventive maintenance intervention on the high-speed ring road test road. In this paper, the construction technology, quality control and later effect tracking and comparison of sand mist sealing technology are described in detail. It was found that the sand mist seal material not only does not affect the use function of the road surface, but also has the effect of waterproof and anti-icing. It reflects the economical, effective, simple and easy application value of road surface protection of sand mist seal technology in the maintenance of high-speed ring roads in the test site. It has an instructive and practical positive effect on the management and implementation of the preventive maintenance of the test road of the future automobile test field.

KEYWORDS

Automobile proving ground, sand mist seal, preventive maintenance.

1. INTRODUCTION

Automobile products gradually entered the field of personal consumption from the field of means of production. According to the survey and research, the elasticity coefficient of automobile growth rate will continue to increase in the next 10 years or so. It is entirely possible for car sales to maintain a growth rate of around 10% [1]. However, the rapid development of automobiles is certainly inseparable from the automobile proving ground. Now all parts of the country are building car testing grounds one after another. According to statistics, there are about 30 car testing grounds in the country. With the passage of time when the vehicle proving ground is put into use, the road begins to age and various indicators decline. In the past, the treatment method of pavement mainly adopted the passive maintenance method of first damage and then repair. That is, when the performance of the road surface does not meet the requirements of the specification, the road surface is repaired and maintained. This maintenance method is not only expensive, but also has a long construction period, and the effect is not good. The safe and efficient operation management and maintenance management of the automobile proving ground has become the focus of the automobile proving ground industry.

Sand mist seal technology is a mature early preventive maintenance technology for asphalt pavement. Its thickness is thin (about 1 mm). While protecting the asphalt pavement, it almost does not cause damage to the texture structure of the original asphalt pavement. Due to the special test design of the asphalt pavement in the high-speed loop test of the automobile proving ground, the requirements for maintaining

the technical indicators of the asphalt pavement are more stringent. This is to ensure that the sand mist seal technology can maintain the technical parameters of the original test pavement to the maximum extent, maintain the high road performance of the pavement, delay the occurrence of diseases of the asphalt pavement, and prolong the service life of the test road.

2. PROJECT OVERVIEW

Vehicle testing at the Proving Grounds is busy. The test lane of the test field directly bears many driving factors such as driving load, vehicle speed, load type, and direction of action, which are different from conventional roads. The road surface design of the high-speed ring road runway needs to meet the technical requirements of the safety, comfort and experimentation of the vehicle at high speed. Table 1 and Table 2 respectively show the asphalt structure and anti-skid requirements of the high-speed ring road test road.

The high-speed loop test road has been in use since 2015. In 2020, the survey and statistics of the asphalt pavement conditions of the high-speed ring road will be carried out. A number of tiny cracks and the aging and peeling of the asphalt membrane were found (Figure 1). No major network cracks, cracks, ruts and other diseases were found. In order to prevent the development of early disease from affecting the overall structure of the pavement, small cracks in the pavement are closed. In order to maintain the driving safety of the test vehicle, it is necessary to maintain the anti-skid performance of the original road surface. A new type of resin-based sand-containing mist seal material provided

Table 1: Asphalt pavement structure of high-speed ring road of CARI auto test site

Build time	High-speed ring road pavement structure layer
2013	4 cm AC-13 (SBS) + 6 cm AC-20C (SBS) + 8 cm AC-25C + 1 cm lower sealing layer of modified emulsified asphalt + 18 cm cement stabilized gravel (4.0 MPa) + 18 cm cement stabilized gravel (3.0 MPa) + 20 cm comprehensive stabilized soil (total thickness: 75 cm)

Table 2: Anti-skid technical indicators

Anti-skid technical indicators	Lateral force coefficient	Continuous across the board	≥ 54	T0965	Straight and curved low-speed lanes
	Tectonic depth	10 points per 1 km	≥ 0.55	T0961-t0963	Straight and curved low-speed lanes
	Dynamic coefficient of friction	10 points per 1 km	≥ 0.59	T0964-t0968	Straight and curved low-speed lanes

by Thelma Company was adopted as the preventive maintenance construction of the high-speed ring road and the road of the test field.

In addition, Yancheng is located in the transition zone from north subtropical climate to warm temperate climate. Has transitional features. And it is greatly influenced by the ocean, and the monsoon climate is more obvious. The wind is more northerly in winter and southerly in summer [4]. It is easy to entrain sea salt in the wind and rain, causing salt corrosion to the road surface for a long time. The temperature in winter is mostly between -5 and 5°C. The high-speed loop test belt is prone to icing on the shady side in winter. It poses a serious safety hazard to the test drive. After preventive maintenance, the road surface indicators meet the needs of vehicle testing (as shown in Figure 2).

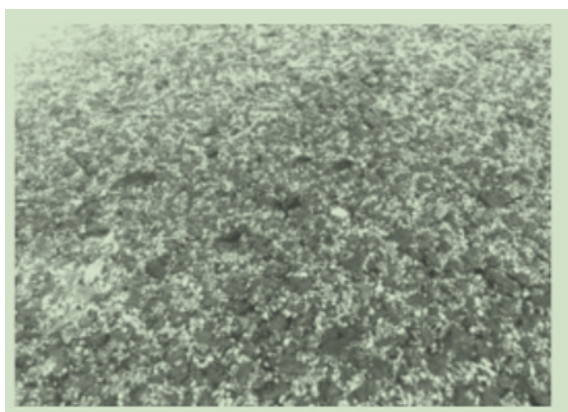


Figure 1: Photo of the original road



Figure 2: Photo after preventive maintenance

3. MATERIAL SELECTION

3.1 Resin type sand mist seal material

The indicators of the sand mist seal layer should meet the requirements of the sand mist seal layer material in the “Technical Specification for Highway Asphalt Pavement Maintenance” (JTG 5142-2019). In order

to ensure the durability of the sealing layer containing sand mist, the reasonable solid content range of the original solution is 54%-64% through the orthogonal test. This project adopts the resin-based sand mist seal material produced by Thelma Company. Its technical indicators are shown in Table 3.

Table 3: Technical requirements for raw materials of resin type sand mist seal

Project	Skills requirement	Experiment method
Evaporation residue content /%	54-64	
Heat resistance	No bumps and dents	Astm d2939
Adhesion and water resistance	Impermeable, no loss of bond	
Density (25°C)/(g/ml)	≥ 1.18	
Adhesion to aggregates, wrapping area	≥ 2/3	Jtg e20 t0654
Heat resistance, 120°C	No flow, no bubbles	Gb/t 16777
Alkali corrosion resistant	After soaking in 5% naoh solution for 168 hours, there is no abnormal phenomenon such as falling off, bulging, cracking, etc.	Gb/t 27806
Salt corrosion resistant	Soaked in 3% nacl solution for 168 hours, no abnormal phenomena such as falling off, bulging, cracking, etc.	Gb/t 27806
Volatile organic compounds (voc), g/l	Not greater than 120	
Sum of benzene, toluene, xylene and ethylbenzene content, mg/kg	Not more than 300	Gb 18582

3.2 Fine-grained sand

In order to improve the anti-skid performance of the pavement and ensure the friction coefficient of the original pavement, a certain proportion of fine-grained sand should be added to the fog seal layer. This project selects the basalt sand that has been screened by machinery. Its performance indicators are tested, and the test results are shown in Table 4.

4. CONSTRUCTION QUALITY CONTROL

4.1 Construction preparation

Before construction, the original road surface is required to be cleaned. The road surface is clean, free of debris, dust, and water. Oil stains on the original road surface need to be treated with Thelma Oil Stain Cleaner.

Table 4: Technical indicators of basalt sand

Project	Skills requirement				Experiment Method	
Nominal particle size /mm	0.85	0.60	0.30	0.15	0.075	sieve
Sieve quality pass rate /%	100	90-100	20-60	0-15	0-2	T0333
Mud content (content < 0.075 mm)/%	≤ 2				T0334	
Sand equivalent /%	≥ 70					
Apparent density	≥ 2.5				T0328	

Table 5: Pavement performance testing

Test items	Pre-construction	After construction
	2020.10	2021.5
Construction depth/mm	0.75	0.72
Water permeability coefficient / (ml/min)	33	0
Pendulum friction coefficient /bpn	57	63

Table 6: Peak braking force coefficient test

Serial number	Test speed/ (km/h)	Dry condition before construction	Dry condition after construction	Wetland conditions before construction	Wetland condition after construction
1	63-67	0.905	0.861	0.806	0.69
2	63-67	0.874	0.889	0.818	0.72
3	63-67	0.885	0.918	0.786	0.72
4	63-67	0.878	0.914	0.815	0.712
5	63-67	0.873	0.907	0.811	0.712
6	63-67	0.883	0.908	0.796	0.711
7	63-67	0.877	0.903	0.795	0.690
8	63-67	0.869	0.896	0.811	0.694
average value		0.881	0.9	0.805	0.739
standard deviation		0.011	0.018	0.011	0.017
Coefficient of variation		0.013	0.020	0.014	0.024

Remove dirt and oil spots from the original road. The original pavement potholes should be repaired in advance with a suitable hot or cold asphalt mixture. Cracks should be repaired with crack fillers.

In order to achieve the best effect, the material ratio should be mixed according to the following proportions. Resin type sand mist seal material: 100 kg; basalt sand: 45 kg; water: 5-10 kg.

4.2 Construction stage

The mixture containing the sand mist seal layer is sprayed with a high-pressure atomizing sprayer. The temperature should be higher than 10°C when spraying. And can not be constructed in rainy days. The spraying amount of the sand mist seal layer is controlled at 1.0 kg/m². Check the sprinkler head in advance to prevent clogging and uneven distribution. Adjust the nozzle angle and spreading width. unsprinkled

Manual brushing is carried out on the parts that arrive. To ensure the overall appearance, the spraying vehicle should keep driving at a constant speed.

4.3 Maintenance and recovery test drive

After the construction is completed, carry out curing. In principle, the curing time should not be less than 4 hours. After the emulsified asphalt is completely demulsified and solidified, the test run will be resumed according to the temperature.

5. CONSTRUCTION QUALITY EVALUATION

5.1 Comparison of before and after detection

Before and after construction, the pavement structure depth, water seepage coefficient, and anti-skid pendulum value shall be tested and compared, as shown in Table 5.

It can be seen from Table 5 that after the pavement with sand mist sealing layer is used for maintenance, the mean value of the water seepage coefficient of the pavement before and after the sealing layer decreases from 33 mL/s to 0 mL/s. It shows that the road surface after curing with sand mist seal layer is basically impermeable and has good waterproof performance. After the pavement is maintained with the sand-containing mist seal layer, the pavement structure depth decreases slightly, but the impact is small. The coefficient of friction increases slightly after the sand mist seal is applied. It shows that the pavement treated with sand mist sealing layer maintains the anti-skid performance of the original pavement, thus ensuring the driving safety.

5.2 Peak braking force coefficient test

In order to further demonstrate the driving safety of the sand-mist seal material, referring to GB/T 269867-2011 Road Vehicle Pavement Friction Characteristics Determination of Constant Speed and Transient Braking Force Method, the peak braking force coefficient of the original pavement and the sand-mist seal pavement was measured. (Table 6 below)

The direct factor of the car's forward motion is related to the friction of the ground. When the friction is too low and the driving force is high, the car will skid. The adhesion coefficient of the road is related to the wheel structure, material, road surface shape and material. The adhesion

coefficient of roads with different properties varies greatly. Generally, the longitudinal peak braking force coefficient of dry and clean asphalt pavement is as high as 0.8-0.9 [9].

It can be seen from Table 6 that when the road surface is dry, the friction coefficient of the road surface in the test section after the construction of the sand mist seal layer is 0.9. It is slightly larger than the original road surface of the high-speed ring road by 0.881. The test vehicle is safe to drive. When the road surface is wet, the friction coefficient of the road surface in the test section after the construction of the sand mist seal layer is 0.71. It is 0.805 lower than the original road surface of the high-speed ring road. Due to the small difference, the test vehicle is relatively safe to drive.

5.3 Anti-icing observation

This time, on the shady side of the high-speed ring road, which is prone to freezing in winter and low temperature weather, a section of sand-containing fog sealing material was implemented. The anti-icing effect was observed in the winter of 2020 at -6°C. The observed results are shown in Figure 3 below.

It can be seen from Figure 3 that there is no icing phenomenon in the road section where the sand mist seal layer is implemented. However, there is still ice on the road that has not been implemented. It can be proved that the resin-based sand mist sealing material of Thelma has a certain anti-icing effect. To a certain extent, the safety hazards of winter test driving can be eliminated.



Figure 3: Anti-icing effect

6. CONCLUSIONS

After the proving ground is completed and put into use, how to manage the operation and maintenance of the proving ground in a safe, efficient and scientific way has become a new topic of the automobile proving ground.

This project is the first application of the sand mist seal technology for

preventive maintenance in the high-speed loop of the China Automobile Test Site. From the results of safety, anti-seepage, anti-icing, etc., it has a good pre-curing effect. The occurrence and development of early diseases of asphalt pavement are closely related to water damage and freeze-thaw damage. The effectiveness of the sand mist seal technology delays the occurrence and development of the disease. It can avoid premature damage of asphalt pavement, prolong the service life of the pavement, and delay the time of major and medium repairs. This fills the technical gap in the early preventive maintenance of asphalt pavements in automotive proving grounds. It has a great promotion effect on the application of sand mist seal technology in the asphalt pavement of the automobile test field.

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