

Discussion on Test and Detection Technology of Highway Asphalt Pavement

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Abstract: The road traffic industry in China has been developing rapidly in recent years. Asphalt has become the main material in road construction because of its seamless connection and short construction period, and it has an important impact on the overall quality of highway construction. Therefore, it is necessary to conduct scientific and reasonable tests and detections for highway asphalt pavement. This paper presents a discussion on the test and detection technology of highway asphalt pavement for future reference.

Keywords: Highway; Asphalt pavement; Test and detection technology

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1. Introduction

Although choosing asphalt as the pavement material comes with many advantages, it is difficult to guarantee the quality of asphalt pavement due to factors like construction technology, construction management, post-maintenance, and other factors, which may affect the traffic and transportation in the future. In order to reduce risk events, prolong the service life of the pavement, and reduce maintenance costs in the future, it is necessary to conduct appropriate tests on asphalt pavements. It is necessary to focus on the items tested, including aggregate, proportion of materials in a mixture, road compaction, and other aspects^[1]. In order to improve the quality and safety of highway asphalt pavement, it is necessary to conduct an in-depth discussion on the test and detection technology of highway asphalt pavement.

2. Quality requirements for highway asphalt pavement

To improve the testing of highway asphalt pavement, the basic quality requirements of highway asphalt pavement should first be determined. According to the situation and needs of our country's road traffic, the current quality requirements of highway asphalt pavement mainly include the following aspects (**Table 1**).

Table 1. Quality requirements for highway asphalt pavement

Serial number	Requirement	Effect
1	Able to withhold high pressure	Prevent inelastic deformation structural damage
2	Good aging resistance	Delay pavement aging and prolong road service life
3	Stable	Resist deformation and lateral flow caused by passing vehicles
4	Strong temperature resistance	Prevent pavement cracking in low temperatures
5	Appropriate road surface roughness	Prevent skidding and improve driving safety

3. Highway asphalt pavement testing and detection technology

3.1. Quality inspection of the aggregate

Besides asphalt, one of the key raw materials used in road asphalt pavement construction is aggregate, which mainly plays a supporting role in the pavement structure. For the aggregate testing, the sample taken should be representative, and it should be uniform. The performance tests can then be carried out including the testing of needle-like particles, mechanical properties, and density. A gauge or a vernier caliper is used to measure the needle-like particles. A press is used to test the maximum bearing capacity of the aggregate, and the basket method is used to test its density. The dry weight, wet weight, and saturated weight of the aggregate is measured, and then the polished stone value is measured by a grinder [2].

3.2. Mixture quality inspection

3.2.1. High temperature anti-rutting performance testing technology

Ruts on the asphalt road cause traffic accidents easily. To prevent rutting, a high temperature anti-rutting performance test can be carried out. First, the temperature of the test environment should be set at 60°C and, with the wheel pressure at 0.7MPa. The sample is rolled over several times with a distance of 230 mm ± 10 mm, the reciprocating speed is 42 times/min ± 1 time /min, and the test is carried out continuously for 60 minutes, and the rutting depth of the specimen is observed. An asphalt pavement analyzer (APA) can also be used to set up different test environments, where the loading wheel is rolled on the test piece with a constant pressure, and the data generated during this process will be collected and analyzed by a computer.

3.2.2. Low-temperature crack resistance performance testing technology

The pavement can shrink when the temperature drops, which can cause low -temperature cracking. The low temperature crack resistance of asphalt pavement, the following methods can be measured using several methods. (i) Indirect tensile test: taking an asphalt mixture specimen with a specification of 101.6 mm × 63.5 mm as an example, the loading layer test is carried out, and the splitting strength, horizontal deformation, and vertical deformation is measured through a sensor. (ii) Direct tensile test: taking an asphalt mixture specimen with a specification of 101.6 mm × 63.5 mm as an example, the sample is first paste it on the drawing plate and stretched at a speed of $1.2 \times 10^{-3} - 2.5 \times 10^{-3}$ mm/min. The cracking temperature can be estimated according to the relationship curve between the strength and temperature [3].

3.2.3. Anti-slip detection technology

The skid resistance of asphalt pavement can have a major impact on the safety of road use. The surface structure depth, polishing resistance, particle shape, etc. of mineral aggregates can all have an impact on the skid resistance of asphalt pavement. The skid resistance can be measured using a few methods. (i) Pendulum method: firstly, the road section is sampled randomly, and the pendulum is placed on the road surface measurement point; then, the pendulum is allowed to swing in the driving direction, and the switch is turned on; the pendulum value shown when the pendulum passes is the skid resistance value of the road surface; this test should be performed a few times, and the average value will be taken as the final road surface skid resistance. (ii) Depth test: After selecting a measuring point, the road surface of that area is cleaned, some sand with uniform density is poured on it and spread into a perfect circle as much as possible; then, its diameter and length is measured in a vertical direction, and the average value is calculated. (iii) Sideway force coefficient test vehicle: test wheels are installed on a vehicle, and keep an angle of 20° between its angle and the driving direction of the vehicle; when the test starts, the water supply system will automatically sprinkle water, and the test wheel touch the ground; load is then applied on the vehicle, and the sensor the vertical and lateral force acting on test wheel will be detected by a sensor, the greater the sideway force coefficient, the stronger the anti-skid ability of the road surface.

3.3. Road compaction test

After the asphalt mixture is paved, it needs to be compacted. Compaction can have an important impact on the overall stability and smoothness of the road surface, so it is necessary to test the degree of compaction of the road surface. Core sampling method is usually applied in testing the degree of compaction. This test can only be performed after the paving and rolling of the asphalt mixture is completed. After the temperature of the pavement drops to room temperature, core sampling can be carried out, and the samples are brought back to the laboratory. The degree of compaction is determined based on the density of the mixture. The core sampling process is relatively complicated, and it might damage the pavement, especially if the sampling method is inappropriate or that the detection method is unscientific, which may affect the accuracy of the results, thus affecting the compaction correction process. The sand filling method is also a commonly used method for testing the compaction of asphalt pavement. The test is performed and after compaction, and the volume of sand consumed by the two sand fillings are compared. However, this method is inaccurate. Therefore, a new type of nuclear density meter is being used. The nuclear density meter can be used directly on the construction site to detect the compaction degree of asphalt mixture. The whole detection process is relatively simple, fast, efficient, and the results are accurate, so it has high application value ^[4].

3.4. Road surface roughness detection

The smoothness of the road surface is crucial in ensuring road safety. Several methods can be used to detect the smoothness of the asphalt pavement.

3.4.1. Road flatness meter

When using a road flatness meter, it is necessary to use a vehicle or manpower to pull the instrument on the road. The small measuring wheel on the instrument can move up and down with the unevenness of the road and move the displacement measuring rod in the instrument. As a result, the positive and negative poles and the magnitude of the external output potential of the sensor change continuously, and the smoothness of the road surface can be determined according to the potential difference. This method is only suitable for the detection of road surface roughness, it is not suitable for roads that are severely damaged or have a large number of potholes.

3.4.2. Laser level method

The instrument is composed of a laser sensor and a distance sensor. It detects the longitudinal section of the road surface. The height of the road surface is determined through the vehicle's wheel marks. Therefore, the longitudinal flatness of the road surface can be determined according to the change of the vehicle's wheel marks when the vehicle is running. As this method is highly accurate, it is suitable for application on roads with high requirements such as urban roads, expressways, and airport runways ^[5].

3.4.3. Vehicular bump-integrator method

The vehicular bump-integrator method is convenient, cheap, and fast. The instrument is mainly composed of a data processor, a sensor, and a micro-printer. The sensor is located on the floor of the detection vehicle. The smoothness of the road surface is then determined based on the driving speed and vibration ^[6].

3.5. Pavement strength test

The Beckman beam method is one of the most popular methods for strength test. In this method, the rebound deflection value of the pavement under the extremely slow loading state or the static loading state is determined, which can reflect the overall pavement strength, that is, the larger rebound deflection value,

the smaller the bearing capacity, and the smaller the strength of the pavement, and vice versa ^[7]. For this method, a Beckman beam deflection tester is required, which mainly includes three parts, namely the Beckman beam, the dial gauge, and the gauge frame. It is necessary to inspect the vehicle before carrying out the test to ensure that its brake system is working properly and the inflation pressure is sufficient. After loading the aggregate in the vehicle groove, the weight of the rear axle of the vehicle is determined to make sure that it complies with the relevant regulations. The weight of the vehicle should be constant when it is running, and several measuring points are set in the test road section. Then, the vehicle is driven when the whistle is blown ^[8]. During this process, the dial indicator pointer moves with the deformation of the road surface. At the same time, the forearm of the Beckman beam is connected to the ground, and the rear wall is connected to the dial indicator. The displacement is displayed according to the change of the pointer's position. Then, the deformation of the forearm endpoint is determined according to the principle of similar triangles, and the obtained value is the rebound deflection of the road surface, which will be the strength of the road surface ^[9].

3.6. Pavement thickness detection

To detect the thickness of asphalt pavement, ground penetrating radar can generally be used. Detection errors are prone to occur in traditional ground penetrating radar systems. Detection errors are mainly caused by changes in driving speed, so high-frequency electromagnetic waves are mainly used nowadays. Signals are transmitted to the asphalt pavement, and different media can reflect different corrugations.. At this time, radar detects the time difference between the corrugations, the node orientation is then displayed, and the burial depth of asphalt pavement can be calculated, which will be the thickness of the pavement. Because this method is highly efficient, there will be no damage or breakpoints, and hundreds of kilometers can be measured in a day. With this method, any cracks or voids can be detected easily ^[10].

3.7. Mixture ratio detection

Before the construction of the asphalt pavement, it is necessary to determine an appropriate ratio of materials in the asphalt mixture through the test data. This is because the mixture ratio has a significant impact on the quality of pavement construction. Generally, simulation tests can be done by selected organizations. During the test, the effects of different mixture ratios are verified. Therefore, the amount and proportion of different raw materials in the mixture can be optimized accordingly ^[11]. After the most suitable mix ratio is determined, the mix ratio should be used to make a mixture sample, and the sample should be tested on the construction site. The main parameters to be tested include low temperature crack resistance, thermal stability, water stability, and anti-crack performance. When testing low temperature crack resistance performance, low temperature bending creep test can be used, and a graph can be plotted to analyze the low temperature crack resistance performance. To test the thermal stability, the road surface temperature should be set at a temperature of 60°C, and then a test vehicle is used to carry out repeated rolling several times to confirm the dynamic stability of the road surface. To test the water stability, a freeze-thaw splitting test is first carried out to test the strength of the pavement, and the water stability of the pavement is evaluated based on it.

4. Conclusion

The test and inspection of highway asphalt pavement is not only important to ensure the quality of the road surface, but to ensure driving safety. Besides, it can have a certain impact on the service lives of the road surface and the vehicle. We should first clarify. The basic quality requirements of the pavement such as compression resistance and aging resistance should first be determined, and the appropriate time and technology to should be used to ensure the qualities of the aggregate, mixture, and the pavement's

compaction, smoothness, strength, thickness, and other aspects. In this way, the quality and construction effect of highway asphalt pavement can be controlled as much as possible, thus improving improve the use effect and driving safety of highway asphalt pavement.

Disclosure statement

The author declares no conflict of interest.

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