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ДОСЛІДЖЕННЯ МЕХАНІЧНИХ ВЛАСТИВОСТЕЙ АСФАЛЬТОБЕТОНУ ПРИ НИЗЬКИХ ТЕМПЕРАТУРАХ

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RESEARCH OF MECHANICAL PROPERTIES OF BITUMINOUS CONCRETE AT LOW-TEMPERATURE

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Introduction. The occurrence of cracks will have a great impact on driving safety and road life. Low temperature bending test is currently the most commonly used test method to evaluate the low temperature anti-cracking performance of asphalt mixtures. This paper introduces preparation of test beam, instrument, experimental procedure and data processing of low temperature bending test, and briefly evaluate the advantages and disadvantages of the test method.

Presentation of the material. Asphalt pavement, as a continuous flat road without joints, has been widely used in the world due to its many advantages, such as stable driving, comfort, small vibration, no dust, low noise, easy maintenance and repair, recyclable and suitable for staged construction[1]. However, in severe cold areas, cracks may occur due to thermal expansion and contraction of the pavement. This harsh weather condition puts forward high requirements on the pavement performance, and also brings the adaptability of the pavement structure in the area. At the same time, the analysis of relevant literature shows that the main form of pavement damage in high and cold areas is low temperature cracking caused by low temperature and large temperature difference [2]. This early disease of the pavement structure greatly reduces the service life of the pavement, reduces the service level of the road rapidly, which affects the driving quality and leads to a large amount of money wasted in the continuous maintenance process [3]. Therefore, reasonable evaluation of the low temperature anti-cracking performance of asphalt mixture is of great significance for improving the road performance of asphalt mixture and prolonging the service life of the pavement. Low-temperature bending test is a commonly used evaluation method at present. The flexural tensile strength, the maximum flexure tensile strain at the bottom of the beam, and the bending stiffness modulus are the most commonly used evaluation indicators [4].

Preparation of beam. The prepared material is made into a standard plate-like test piece with a size of 300mm×300mm×50mm by the wheel-grind method, and being demolded for at least 12 hours. After demoulding, the test piece is cut into a prism beam with a length of 250mm±2.0mm, a width of 20mm±2.0mm, and a height of 35mm±2.0mm, the span is 200mm±0.5mm.

Instrument. 1.Universal testing machine or press: The load is measured by the sensor, the maximum load should meet the requirements of not exceeding 80% of its range and not less than 20% of its range. 1kN or 5kN should be used with an accuracy of 0.01kN. With beam support, the center distance of the lower support is 200mm, the position of the upper indenter is centered, and the upper indenter and the support are arc-shaped fixed steel bars with a radius of 10mm, the upper indenter can move in close contact with the test piece. The temperature of the environmental insulation box should be accurate to ±0.5°C, and the loading rate can be selected. The testing machine should have a servo system, and the rate is basically unchanged during loading. 2. Mid-span displacement measuring device: LVDT displacement sensor. 3.Data acquisition system or X-Y recorder: Automatically collect electrical signals from sensors and displacement meters, store in the data acquisition system or draw load and mid-span deflection curves on the X-Y recorder. 4.Constant temperature water basin: The temperature range should meet the test requirements, and the temperature control should be accurate to ±0.5°C. When the test temperature is lower than 0°C, the constant temperature water basin can use a 1:1 methanol aqueous solution or an antifreeze as a cold medium. The liquid in the thermostatic water basin should be able to circulate back.

Methodology. 1.Place the test beams in a constant temperature water basin at a specified temperature for not less than 45 minutes until the internal temperature of the test beams reaches the test temperature ±0.5°C. The test beams shall be placed on the supported flat glass during heat preservation, and the distance between the test beams shall not be less than 10mm. 2.Set the environmental insulation box of the testing machine to the required test temperature ±0.5°C. 3.Take the test beams out of the constant temperature water basin, and immediately place it symmetrically on the support. 4.A displacement measuring device is placed in the center of the lower edge of the beam span, and the support is fixed on the testing machine. Select a suitable range, and the effective range should be greater than 1.2 times the expected maximum deflection. 5.Connect the load sensor and displacement meter to the data acquisition system or X-Y recorder. Use the x-axis as the displacement and the Y-axis as the load, select an appropriate range and adjust it to zero. The mid-span deflection can be measured with an LVDT displacement sensor. When the displacement of the indenter of the high-precision electrohydraulic servo tester is used as the deflection of the beam, the deflection can be obtained from the loading rate and the time recorded by the X-T recorder. In order to correctly record the mid-span deflection curve, the X-T recorder's x-axis paper speed (or scanning speed) is determined according to the test temperature when the loading rate is 50mm/min. 6.Start the press to apply a concentrated load in the center of the span at the specified rate until the test beam fails. At the same time, the load - span deflection curve was recorded by the recorder.

Data processing. Calculate the flexural tensile strength R_B of the beam, the maximum flexure tensile strain ε_B at the bottom of the beam, and the bending stiffness modulus s_B at failure according to the following formulas.

$$R_B = \frac{3 \times L \times P_B}{2 \times b \times h^2} \tag{1}$$

$$\varepsilon_B = \frac{6 \times h \times d}{L^2} \tag{2}$$

$$s_B = \frac{R_B}{\varepsilon_B} \tag{3}$$

Where:

R_B-The flexural tensile strength of specimen at failure (MPa);

ε_B-The maximum flexure tensile strain of beam at failure (μ_ε);

s_B- The bending stiffness modulus of beam at failure (MPa);

b- The mid-span width of the beam (mm);

h-The mid-span height of the beam (mm);

L-The span of the beam (mm);

P_B-Maximum load of the beam at failure (N);

d-Mid-span deflection of beam at failure (mm).

Conclusion. The low-temperature bending test has simple calculation of flexural tensile strength and flexure tensile strain, clear physical meaning, which is convenient for communication and learning. However, the low-temperature bending test has a high requirement on the uniformity of test beams, so it is necessary for the beams to ensure a small error in the cutting process.

In the actual test, it is found that the variation rule of flexural tensile strength often conflicts with flexure tensile strain. Therefore, it is suggested to adopt bending strain energy as the evaluation index, which takes into account both flexural tensile strength and flexure tensile strain, while flexure tensile strain can better represent the performance at low temperature than flexural tensile strength.

Reference.

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