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COMMON EVALUATION METHODS FOR WATER STABILITY OF ASPHALT MIXTURE

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Анотація

З метою вирішення проблеми пошкодження асфальтобетонного покриття водою використовують основні методи випробування та оцінки водостійкості асфальтобетонної суміші, а також коротко розглянуто переваги та недоліки кожного випробування. Виходячи з існуючої ситуації, коли відносно досконалих індексів оцінки досі немає, для комплексної оцінки водостійкості асфальтової суміші можна використовувати різноманітні методи оцінки, а також слід активно вивчати та розвивати нові методи оцінки.

Ключові слова: асфальт, асфальтобетонна суміш, водостійкість, метод оцінки.

Abstract

Aiming at the problem of water damage of asphalt pavement, the main test and evaluation methods of water stability of asphalt mixture are introduced, and the advantages and disadvantages of each test are briefly reviewed. Based on the current situation that there is still no relatively perfect evaluation index, a variety of evaluation methods can be used to comprehensively evaluate the water stability of asphalt mixture, and new evaluation methods should be actively studied and developed.

Keywords: asphalt, asphalt mixture, water stability, evaluation method.

Introduce

Water damage of asphalt pavement is the phenomenon that water seeps into the interface or inside of asphalt and mineral aggregate under the action of external force, which reduces the adhesion between asphalt and mineral aggregate and gradually loses the bonding ability, so as to gradually peel the asphalt film from the surface of mineral aggregate, resulting in loose particles of asphalt mixture, and then cause the overall damage of asphalt pavement [1-3]. Relevant research shows that more than 70% of the early damage of asphalt pavement is related to water damage. Water damage has become one of the main reasons for the shortening of asphalt pavement life and the decline of service quality. Therefore, it is of great significance to evaluate and predict the water stability of asphalt mixture reasonably and effectively [4-6].

Results of the research

Common evaluation methods of asphalt and aggregate

Water-boiling method

Water-boiling method is mainly for the coarse aggregate with a particle size of 13.2 ~ 19mm. During the test, dry the clean aggregate first, soak the aggregate in bitumen at 130 ~ 150°C for 45s to ensure that the bitumen film is fully covered on the surface of the aggregate, then cool it to room temperature, hang it in slightly boiling water and soak for 3min. So far, after the test, take out the aggregate, visually inspect the coating of asphalt film, judge the peeling degree of asphalt film, and determine the adhesion grade between asphalt and aggregate [7]. The characteristics of simple and easy operation of water boiling method play a great role in the preliminary identification of the adhesion between asphalt and coarse aggregate, but the test conditions are difficult to master, the understanding of "slightly boiling" state varies from person to person, and there are large errors in the percentage of peeling by visual inspection. The drying aggregate used in the

test cannot reflect the actual situation of some aggregates in the construction process. In addition, The peeling of asphalt film from fine aggregate was ignored in the test process.

Water immersion method

The adhesion test of coarse aggregate with maximum particle size less than 13.2mm shall adopt water immersion method, which can be divided into static water immersion method and dynamic water immersion method according to the specified immersion temperature and time [8].

The standard test method in Japan is the static water immersion method, in which the coated aggregate is immersed in a constant temperature water tank at 80°C for 30 minutes, and then the peeling of the asphalt film is visually inspected. The water immersion method solves the uncertainty of the "slight boiling" state in the water boiling method by constant water temperature, but it lacks the ability to destroy the sample in the static water state, and the distinguishing ability needs to be considered.

Like water-boiling method, the evaluation of this method is too subjective, and the evaluation results have a large difference, so it is suitable for the preliminary judgment of the test method, cannot be used for the decisive test. Based on the static water immersion method, the dynamic water immersion method continuously shakes the test piece for 5 ~ 30min. After the test, clean water is used to wash off the peeled particles of the asphalt film. The mass loss is taken as the evaluation standard, and the one with mass loss less than 5% is preferred. The dynamic water immersion method creates a more demanding test environment on the basis of the static immersion method, and the degree of damage is increased. The evaluation index is quantitative and more objective than static water immersion method and water-boiling method. However, this method is rarely used at present.

Photoelectric colorimetry

Photoelectric colorimetry is to judge the adhesion between asphalt and aggregate by calculating the peeling rate of asphalt film. The test principle is based on the selective absorption of light wavelength by substances. When the spectrum passes through a solution, the light of some wavelengths will be absorbed, and the corresponding dark band will appear in the spectrum [9-11].

In the test, 4.5g asphalt and 200g clean aggregate with a diameter of 2.5 ~ 5mm are fully mixed until an asphalt film is formed on the aggregate surface. The mixture is evenly divided into two conical bottles and placed in 200ml of phenol saffron biological dye solution after standing for 24h, and the temperature is controlled at 60 C°. At the same time, a group of comparison solutions are prepared with clean aggregate. After three conical bottles are placed in 60 C° water bath for 2h, 5mL solutions are taken out respectively and put into the test tube for cooling, the absorbance is measured, and the residual concentration of dye, the adsorption capacity Q_1 of raw aggregate and the adsorption capacity Q_2 after peeling test are calculated. The peeling rate of asphalt film was obtained by $Q_0 = Q_1 / Q_2 \times 100\%$.

Tracer salt method

During the test, the tracer salt is coated on the aggregate surface and divided into two groups. One group is mixed with asphalt to form an asphalt film, which is soaked in distilled water for 16 ~ 18h. Finally, the tracer salt concentration of the two groups of specimens dispersed in the aqueous solution is measured, and the concentration ratio is taken as the evaluation index.

NAT test

NAT test is one of the results used to determine the adhesion between asphalt and aggregate in the U.S. highway strategic research program. The test mechanism is that the aggregate surface has adsorption effect on asphalt and water has displacement effect on asphalt film. During the test, the test aggregate shall be fully mixed in the mixed solution of asphalt and toluene. After it is stabilized, the solution absorbance and asphalt adsorption capacity shall be measured by photoelectric spectrophotometer; Then add a certain amount of water to the asphalt and toluene solution, replace the asphalt film with water, and measure the asphalt absorption again after circulating for a certain time to calculate the asphalt peeling rate of aggregate surface peeling.

Photoelectric colorimetry, tracer salt method and NAT test have quantitative indexes for the falling off of asphalt film. The test results are less affected by subjective factors. They are more scientific test methods, but they are rarely used in practice because of the difficulty of test operation and complex process.

Common evaluation methods of asphalt mixture

Abrasion resistance test

The test simulates the water damage of asphalt pavement under the combined action of water and traffic load, and takes the mass loss as the evaluation index. During the test, the test piece is soaked at room temperature for 20h, then soaked in 38 C° water for 5h, or soaked in 49 C° water for 6 days, and then the

underwater abrasion test is carried out at a certain temperature. Although the test technical requirements are not high, the test results have large dispersion, poor reproducibility and limited application range.

Immersion marshall test

Two groups of standard Marshall compacted specimens were used in the test. The first group was immersed in 60 C° water bath for 0.5h, and its Marshall stability S_1 was measured; The second group was immersed in 60 C° water bath for 48h, and the Marshall stability S_2 was measured. The evaluation index residual Marshall stability was $S_0 = S_2 / S_1 \times 100\%$.

A large number of test results show that this index can distinguish the performance of acid stone and nonacid stone, but it has large dispersion. Therefore, this test method is not enough to distinguish the water stability of different graded asphalt mixtures, and it still needs to be improved.

Vacuum water-saturated marshall test

The basic principle of the test is to infiltrate water into the specimen under the action of vacuum pressure, which is improved on the basis of water immersion Marshall test. Two groups of standard Marshall specimens were used in the test. The first group was immersed in 60 C° water bath for 0.5h, and the Marshall stability M_1 was measured; The second group was immersed in normal temperature water for 20min, then immersed in water and vacuumized for 15min, and the air pressure was 0.09mpa. Finally, after soaking in 60 C° water bath for 24h, the Marshall stability M_2 was measured, and the residual stability of the evaluation index was $M_0 = M_2 / M_1 \times 100\%$.

The practice shows that the level difference of vacuum saturated Marshall test is slightly larger than that of immersion Marshall test, but the two test results are basically the same. The effect of vacuum saturated water is not obvious, and the test still needs to be further improved.

Freeze-thaw splitting test

The freeze-thaw splitting test adopts Marshall specimens compacted 50 times in front and 50 times in back. The specimens are divided into two groups. The first group is the standard specimen, after soaking in 25 C° water bath for 2h, the splitting strength H_1 is measured; The second group is the conditional specimen, after the test piece is vacuum saturated with water, put it into the plastic bag, add 10ml of water, tighten the bag mouth, freeze it in the refrigerator at - 18 C° for 16h, then take it out, put it into the constant temperature water tank at 60 C° for 24h, and then immerse it in the constant temperature water tank at 25 C° for no less than 2h to measure its splitting strength H_2, The evaluation index freeze-thaw splitting strength ratio is $H_0 = H_2 / H_1 \times 100\%$.

According to the road condition investigation, the test results of this method have a good correlation with the actual situation of the pavement, but the three processes of vacuum water saturation, freeze-thaw and high-temperature water bath cannot well simulate the formation mechanism of on-site water damage. In addition, the conditions of freeze-thaw splitting test have insufficient damage to the splitting strength of asphalt mixture, and the test conditions need to be further improved. A large number of test results show that the test is beneficial to the asphalt mixture with high viscosity of asphalt mastic.

Immersion splitting test

There are differences in environmental requirements, condition control and operation standards, but the splitting strength ratio TSR before and after immersion is used as the evaluation standard. During the test, the specimens were divided into two groups. The first group was immersed in 25 C° water bath for 2h, and the splitting strength R_1 was measured; The second group was immersed in 60 C° water bath for 48h, and then placed in 25 C° water bath for 2h. The splitting strength R_2 was measured, and the splitting strength ratio $TSR = R_2 / R_1$. Generally, the asphalt mixture with $TSR > 0.75$ has good water damage resistance. The immersion splitting test equipment is popular, the test operation is moderate, and has been widely used.

In addition, there are many methods to evaluate the water stability of asphalt mixture, but they all have shortcomings. The methods used vary from country to country.

Conclusion

Although there are many test methods to evaluate the water stability of asphalt mixture, each has its advantages, disadvantages and applicable conditions, and the accuracy and effectiveness are also controversial. In particular, there is a great difference between the simulation of pavement environment and the consideration of long-term aging of pavement. Therefore, the evaluation methods and indicators of mixture water stability need to be further studied, and the correlation design between test and pavement should be strengthened. At the same time, when evaluating the water stability of asphalt mixture, a variety of test methods should be used as far as possible.

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