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Effects of Temperature and Erosion on Fatigue Life of Asphalt Concrete

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Abstract: In order to improve the fatigue performance of asphalt pavement in saline soil area, the SBS modified asphalt concrete freeze-thaw splitting fatigue test and water saturated salt solution, the influence of temperature and Chloride Erosion under the combined effect of asphalt concrete freeze-thaw fatigue life attenuation. The results show that the temperature and chloride erosion is effect of asphalt concrete freezing and thawing important factors of fatigue life. When the number of freeze-thaw cycles is the same, the asphalt concrete freeze-thaw fatigue life with freeze-thaw temperature decreased gradually decreased; when the freeze-thaw temperature is the same, the freeze-thaw fatigue life with freezing thawing times increased continuously decreased. Water was significantly lower than that of asphalt saturated salt solution in the freezing and thawing of concrete fatigue life, indicating chloride can accelerate the attenuation of asphalt concrete freeze-thaw fatigue life, freeze-thaw temperature is lower, the salt freezing damage more serious. Based on the number of tests According to regression analysis shows that asphalt concrete freeze thaw fatigue life and freeze-thaw cycle times with good correlation, and the exponential function relation between the two can be utilized to predict the asphalt concrete freeze thaw fatigue life.

Keywords: Splitting fatigue test; Asphalt concrete; Freezing and thawing fatigue life; Temperature; Chloride corrosion

1. Introduction

Northwest China has large area of saline land, saline soil of engineering structure has a serious harm. In particular, the asphalt pavement construction in these areas, due to the role of saline soil, the asphalt pavement premature to cracks and fatigue damage, seriously affecting the asphalt pavement quality and fatigue performance. The fatigue performance of asphalt pavement has been the focus of research in the field of road engineering. Zheng Jianlong studied by freeze decay temperature under the action of porous asphalt mixture ratio, compressive strength and water stability performance of thawing test; Wang Lixin through the freeze-thaw splitting fatigue test of 3 kinds of graded AC-25 type asphalt concrete, established the fatigue equation of water and anhydrous conditions; Tan Yiqiu et al according to injury the theory was established under freeze-thaw cycles damage general asphalt mixture suitable model, put forward the freeze-thaw damage prediction method of asphalt mixture life; bear sharp and were studied before and after freeze-thaw porosity of asphalt mixture and the splitting tensile strength, using GM (1, N) model. Prediction of the Zhang Siwei in 30 mm * 35 mm * 250 mm asphalt mixture beam specimens and the freeze-thaw cycle bending test, get the effect of asphalt mixture freeze thaw fatigue characteristics of the main factors As the number of freeze-thaw cycles and the asphalt aggregate ratio and gradation.

Ma Biao of immersion Marshall test and freeze-thaw splitting test and rutting test of asphalt mixture, analyzed the influence of type of asphalt, gradation type, nominal maximum size type on the Qinghai Tibet alpine region asphalt mixture water stability and high temperature performance; Zhou Jinzhi of AC-20C type asphalt concrete for 0 DEG bending test at different concentrations of chloride solution, the bending failure can critical value as low temperature performance evaluation of asphalt concrete index; Ma Qinyong research of AC-16 type asphalt concrete soaked in different concentrations of chloride in the splitting of variation of tensile strength, and freezing melting corrosion factor to evaluate the salt damage degree of.Kim using Schapery related principle and principle of continuous damage to establish viscoelastic continuum fatigue damage model Type, can only be used for uniaxial tensile test; Suo established three different types of asphalt concrete fatigue damage model and its failure criterion; Tayebali to study the fatigue failure of asphalt concrete and the factors affecting the material composition.

The above research are concentrated in freezing and thawing of single or chlorine salt erosion factors on the performance of asphalt mixture, and for temperature and chloride corrosion under the joint action of the asphalt mixture freeze-thaw research on fatigue characteristics are rarely reported. Therefore, on the basis of the existing research results, research temperature and Chloride Erosion interaction, freeze-thaw change rule of fatigue properties of asphalt concrete, improve saline land area of asphalt pavement fatigue. provide theoretical guidance for fatigue life.

2. Material Composition and Test Methods

2.1. Mix design

Asphalt concrete with SBS modified asphalt, measured technical indicators such as Table 1 shows. Aggregate using limestone aggregate, slag limestone powder, indicators are in line with requirements specification.

Table 1. SBS modified asphalt indicators

Asphalt type	Penetration	Ductility	Softening point
SBS modified asphalt	52	26	72

Asphalt concrete mix than on the essence of the design is determined the proportion of coarse aggregate, fine aggregate material, mineral powder and asphalt materials, meet the requirements of the performance of the asphalt pavement, and also meet the economic requirements. Mix design includes gradation design and optimum asphalt mineral admixture ratio determined the two part. According to the traffic characteristics and climatic conditions of the saline soil area, the final grading of asphalt concrete is AC-16 type, and the concrete gradation Table 2 composition of the optimum asphalt aggregate ratio by the Marshall test to determine the final 4.9%.

2.2. Production and maintenance of test pieces

According to the requirements of "highway engineering asphalt and asphalt mixture test procedures in the" using standard Marshall specimens and the specimen diameter 101.6 mm, 63.5 mm each side hit 50 times forming, under the condition of room temperature curing for 24 h removal. The test piece is divided into to two groups, a group of immersion in water, freeze-thaw splitting fatigue test, another group of immersion in chloride saturated solution of freeze-thaw splitting fatigue test.

Table 2 Aggregate gradation of AC-16

Sieve /mm										
19	16	13	9.5	4.7	2.3	1.1	0.6	0. 3	0.1	0.7
The quality percentage /%										
100	93	80	62	38	28	19	16	10.4	8.3	5.6

2.3. Test methods

The freezing thawing temperature is determined according to the meteorological data of winter days in East China and Northwest China. According to the data of the meteorological department for many years, the temperature range is between 15 and 5 in East China. Freezing and thawing time is the duration of the day and night.

the freeze-thaw cycle test design of freezing and thawing temperature of 20 DEG C, freezing and thawing cycle 2, 4, 6, 8 times. The specific test process is in a vacuum condition was maintained for 15 min, and restoration of the atmospheric pressure, the specimen in water or saturated chlorine salt solution to remove the test piece into a plastic bag, respectively, add 10 ml of water or saturated chlorine salt solution, tightly enclosed pocket, the specimen placed in constant temperature refrigerator 10 h, freezing temperatures were set to 5 ℃, - 10 ℃ and – 15℃ to remove the test immediately into the corresponding temperature of 15 degrees, 10 degrees and 5 constant temperature water tank, heat preservation 14 hours.

Fatigue test of asphalt concrete using standard Marshall specimens, splitting fatigue test and stress control mode is adopted, to try a complete rupture of the basis for judging. The half sine wave load, in order to accelerate the testing speed, between adjacent wave does not set time interval and the beginning of the experiment should be first pre load, so as to make the contact site.

3. Test Results and Discussion

In the same cycles of freeze-thaw action and asphalt concrete freeze thaw fatigue life were decreases with decrease of the temperature of freezing and thawing with, water in asphalt concrete freeze thaw fatigue life were higher than that under the same conditions in chloride salt solution of asphalt concrete freeze thaw fatigue life. Such as in 15 ~ 5 ℃, after eight times of freezing and thawing, water in asphalt concrete freeze thaw fatigue life is not freezing and thawing of 35. 8%, and saturated chlorine salt solution in asphalt concrete freeze-thaw fatigue life is only not during freezing and thawing of 25. 7%. Thus, the erosion of salt accelerated the asphalt concrete freeze thaw fatigue life of decay, indicating the presence of saline soil exacerbated the attenuation of the fatigue life of asphalt concrete; saline land area of asphalt pavement after water erosion, the fatigue life is lower. This phenomenon is mainly water intrusion into the asphalt and aggregate the interface, resulting in changes in surface tension, the pitch from the collection surface is gradually stripped, and saturated chlorine salt solution accelerated chloride salt solution to the asphalt membrane and material interface migration and permeation rate. Under the freeze-thaw and saline soil salinity in the erosion of the dual role, try a salt solution crystallization expansion. When the cooling speed faster, excess moisture in the pore of asphalt concrete will not be drained, freeze pressure increases. Temperature is low, and have to face the dangers of starvation and exposure time longer amount of ice, the more pressure of ice formation is also more and more high. And in the ice under the action of pressure, chlorine salt solution than water easier to migrate around the void, the salt frost damage increased. Therefore, freezing and thawing temperature is low, asphalt concrete freezing and thawing and fatigue life of the extent of the affected more, and low temperature duration longer, caused by salt frozen damaged more seriously.

Under the same temperature of freezing and thawing, both water and chloride saturated solution, the asphalt concrete freeze thaw fatigue life are with freeze-thaw cycles increases decreases., such as 15 to 5℃ water, after 2, 4, 6, 8 frozen. Financial recycling asphalt concrete freeze thaw fatigue life were 211, 182, 146, 132 times, and without freezing and thawing compared to decline were 42. 8%, 50%, 60%, 64. 2%. In the cycle of freezing and thawing, pore water freezes in the cold, produces volume expansion; when the temperature rises to above freezing, and melt volume decrease, this repeated cycle, resulting in asphalt concrete pores increases gradually, and then destroyed the skeleton structure of asphalt concrete, resulting in the asphalt concrete freezing and thawing reduced fatigue life.

4. Conclusions

Through to soak in the water and saturated or chlorine salt solution of asphalt concrete freeze-thaw splitting fatigue test, the in temperature and chloride erosion, asphalt concrete freezing and thawing the variation of fatigue life, get the conclusion mainly include:

Under the same freeze-thaw cycles, the fatigue life of asphalt concrete is decreased with the decrease of freezing thawing temperature. Salt solution infiltration and migration rate is larger than that of water, is saturated with chloride solution in asphalt concrete freeze-thaw fatigue life was significantly lower than that of the main cause of fatigue life in the water. The erosion of salt accelerated the asphalt concrete freezing and thawing the attenuation of the fatigue life, and the freezing and melting temperature is low, freezing pressure is bigger. The salt frost damaged more seriously.

Under the same freezing and thawing temperature, both the water and the saturated chloride solution, the fatigue life of asphalt concrete is decreased with the increase of the number of freeze-thaw cycles. There is a good correlation between the fatigue life of asphalt concrete and the number of freeze-thaw cycles, and it can be used to predict the fatigue life of asphalt concrete by the exponential function relationship between them.

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