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RESISTANCE TO CRACKING OF ASPHALT CONCRETE SATURATED WITH ROAD SALT DURING FREEZING

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The article deals with issues of resistance to cracking at low temperature, low-temperature characteristics of asphalt concrete, tensile strength in bending, and the ratio of tensile strength to bending deformation, which reflects the flexibility of asphalt concrete.

When the temperature is relatively low, the asphalt concrete should have a certain deformation capacity, and the temperature shrinkage crack can be reduced under the low temperature condition. The ultimate flexure tensile strain at low temperature is closely related to the performance of asphalt. Increasing the viscosity of asphalt can improve the low-temperature crack resistance of pavement.

Key words: *crack resistance, asphalt concrete, deformation capacity, thermal shrinkage cracks.*

Introduction

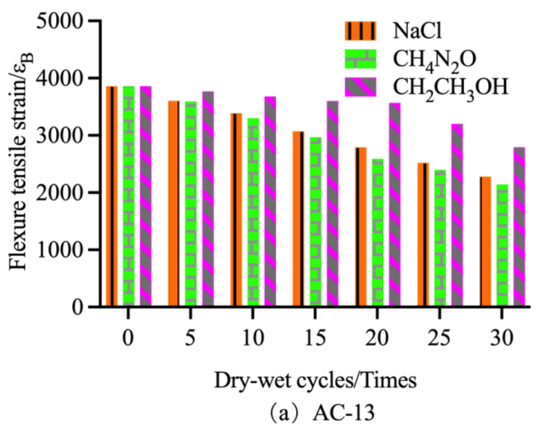
In recent decades, the world's transportation industry has developed vigorously, and a large number of asphalt pavement have been built [1-4]. However, the asphalt pavement in high latitude areas is covered with ice and snow for a period of time every winter, which will greatly reduce the traffic safety of the road and easily lead to traffic accidents[5-7].

The asphalt, gradation type and mixing uniformity of the asphalt mixture have important impacts on the low-temperature deformation capacity of the mixture[8-10]. Two types of dense asphalt concrete mixtures (AS-13 and AS-16) of different composition and bitumen content were produced for experimental research. Both series of samples meet the requirements and were used to conduct experimental studies of low-temperature parameters of the asphalt concrete mixture during dry-wet cycles.

Main part

When the temperature is relatively low, the asphalt concrete should have a certain deformation capacity, and the temperature shrinkage crack can be reduced under the low temperature condition. The ultimate flexure tensile strain at low temperature is closely related to the performance of asphalt. Increasing the viscosity of asphalt can improve the low-temperature crack resistance of pavement.

For AC-13 gradation, the flexure tensile strain and its loss rate under multiple dry-wet cycles are shown in Fig. 1.



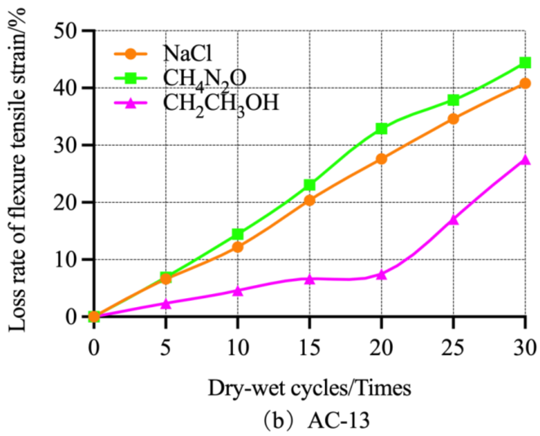


Fig. 1 – Flexure tensile strain of AC-13 under multiple dry-wet cycles

It can be seen from Fig. 1 (a) that when the gradation of asphalt mixture is AC-13, the flexure tensile strain corresponding to the three kinds of deicing salts decreases with the increase of dry-wet cycles, the CH_2CH_3OH has the smallest impact on the flexure tensile strain, the CH_4N_2O and NaCl have greater impacts on the flexure tensile strain, and the minimum value of the flexure tensile strain corresponding to the three kinds of deicing salts is higher than the minimum value of 2000με specified in the specification. It can be seen from Fig. 1 (b) that in the first 20 dry-wet cycles, the loss rate of the flexure tensile strain corresponding to CH_2CH_3OH

increases slowly, and the total loss rate is less than 10%, and it increases rapidly from 25th cycle and finally reaches 27.6% at the 30th cycle; The corresponding loss rates of NaCl and CH_4N_2O remains stable, reaching 40.8% and 44.4% respectively at the 30th cycle.

For AC-16 gradation, the flexure tensile strain and its loss rate under multiple dry-wet cycles are shown in Fig. 2.

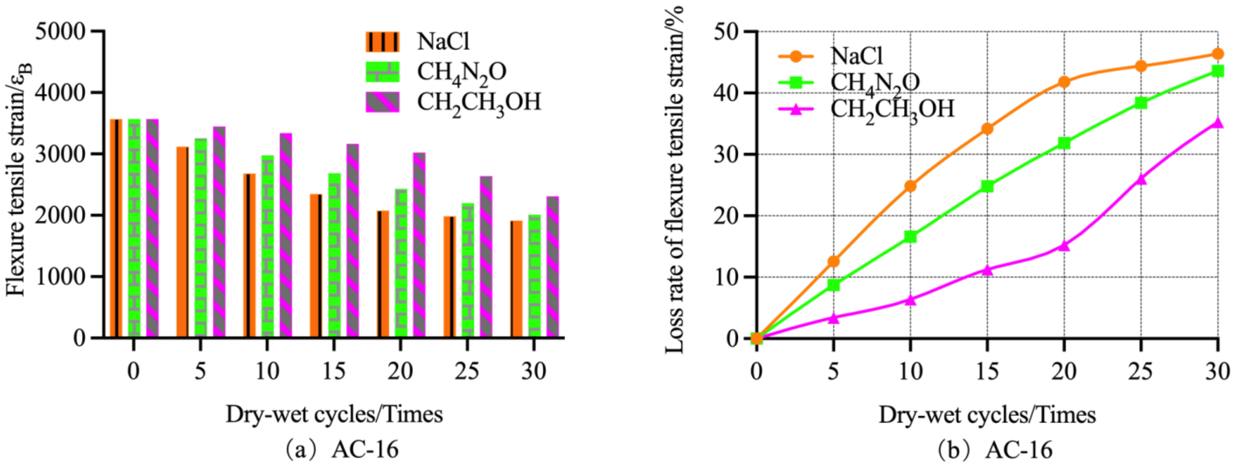


Fig. 2 – Flexure tensile strain of AC-16 under multiple dry-wet cycles

It can be seen from Fig. 2 (a) that when the gradation of asphalt mixture is AC-16, the flexure tensile strain corresponding to the three kinds of deicing salts decreases with the increase of dry-wet cycles, the CH_2CH_3OH has the smallest impact on the flexure tensile strain, the CH_4N_2O and NaCl have greater impacts on the flexure tensile strain, and the flexure tensile strain corresponding to NaCl is 1984.2με at the 25th cycle, which cannot meet the requirements of minimum value of 2000με specified in the specification. It can be seen from Fig. 2 (b) that during the process of 0 to 30 dry-wet cycles, the loss rate of the flexure tensile strain corresponding to CH_2CH_3OH shows a law of slow growth at the initial stage and rapid growth at the later stage, and finally reaches 35.3% at the 30th cycle; The loss rate of the flexure tensile strain corresponding to NaCl showes a law of rapid growth at the initial stage and slow growth at the later stage, and finally reaches 46.4% at the 30th cycle; The corresponding loss rate of CH_4N_2O remains stable and reaches 43.6% at the 30th cycle.

Low temperature performance of asphalt concrete has a great relationship with flexural tensile strength. The lower temperature in winter will produce temperature stress in the pavement, and if the flexural tensile strength of the pavement is insufficient, temperature shrinkage cracks will occur. Therefore, when the flexural tensile strength is large, it can play a favorable role in the crack resistance of asphalt pavement.

For AC-13 gradation, the flexural tensile strength and its loss rate under multiple dry-wet cycles are shown in Fig. 3.

It can be seen from Fig. 3 (a) that when the gradation of asphalt mixture is AC-13, the flexural tensile strength corresponding to the three kinds of deicing salts decreases with the increase of dry-wet cycles, the CH_2CH_3OH has the smallest impact on the flexural tensile strength, the CH_4N_2O and NaCl have greater impacts on the flexural tensile strength. It can be seen from Fig. 3 (b) that in the first 20 dry-wet cycles, the loss rate of the flexural tensile strength corresponding to CH_2CH_3OH increases slowly, increases rapidly from the 25th cycle, and finally reaches 34.2% at the 30th cycle; The corresponding loss rates of NaCl and CH_4N_2O remains stable, reaching 48.5% and 52.5% respectively at the 30th cycle.

For AC-16 gradation, the flexural tensile strength and its loss rate under multiple dry-wet cycles are shown in Fig. 4.

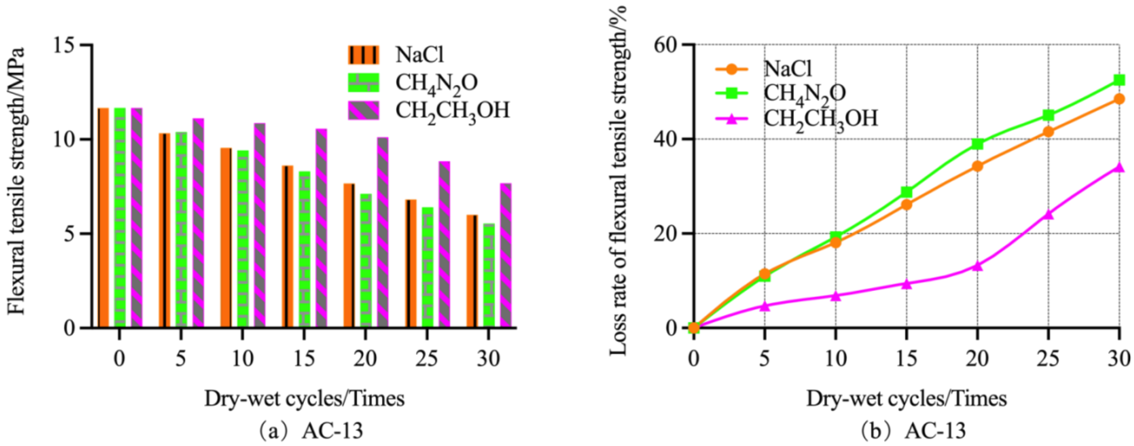


Fig. 3 – Flexural tensile strength of AC-13 under multiple dry-wet cycles

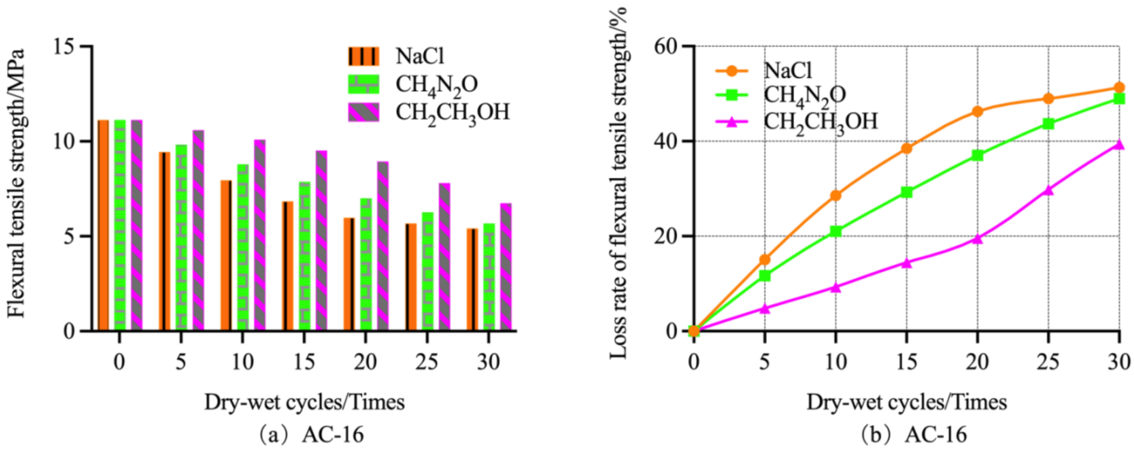


Fig. 4 – Flexural tensile strength of AC-16 under multiple dry-wet cycles

It can be seen from Fig. 4 (a) that when the gradation of asphalt mixture is AC-16, the flexural tensile strength corresponding to the three kinds of deicing salts decreases with the increase of dry-wet cycles, the CH_2CH_3OH has the smallest impact on the flexural tensile strength, the CH_4N_2O and NaCl have greater impacts on the flexural tensile strength. It can be seen from Fig. 4 (b) that during the whole dry-wet cycles, the loss rate of the flexural tensile strength corresponding to CH_2CH_3OH shows a law of slow growth at the initial stage and rapid growth at the later stage, and finally reaches 39.4% at the 30th cycle; The loss rate of flexural tensile strength corresponding to NaCl shows a law of rapid increase at the initial stage and slow increase at the later stage, and finally reaches 51.3% at the 30th cycle; The corresponding loss rate of CH_4N_2O remains stable and reaches 49.0% at the 30th cycle.

Stiffness modulus is the ratio of flexural tensile strength to flexure tensile strain, which reflects the flexibility of asphalt concrete. For AC-13 gradation, the stiffness modulus and its loss rate under multiple dry-wet cycles are shown in Fig. 5.

It can be seen from Fig. 5 (a) that when the gradation of asphalt mixture is AC-13, the stiffness modulus corresponding to the three kinds of deicing salts decreases with the increase of dry-wet cycles, the CH_2CH_3OH has the smallest impact on the stiffness modulus, the CH_4N_2O and NaCl have greater impacts on the stiffness modulus. It can be seen from Fig. 5 (b) that in the first 15 dry-wet cycles, the loss rate of the stiffness modulus corresponding to CH_2CH_3OH increases slowly, increases rapidly from 20th cycles, and finally reaches 9.1% at the 30th cycle; The corresponding loss rates of NaCl and CH_4N_2O remains stable, reaching 13.0% and 14.6% respectively at the 30th cycle. In general, the damages of stiffness modulus are not significant.

For AC-16 gradation, the stiffness modulus and its loss rate under multiple dry-wet cycles are shown in Fig. 6.

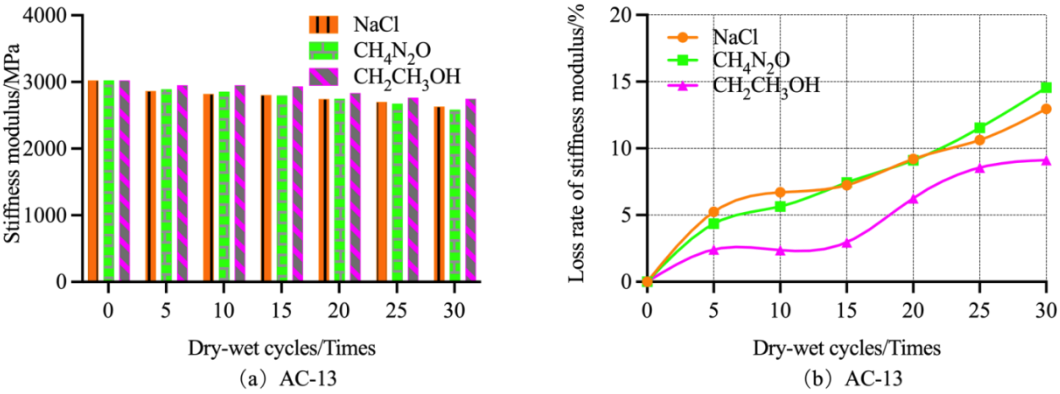


Fig. 5 – Stiffness modulus of AC-13 under multiple dry-wet cycles

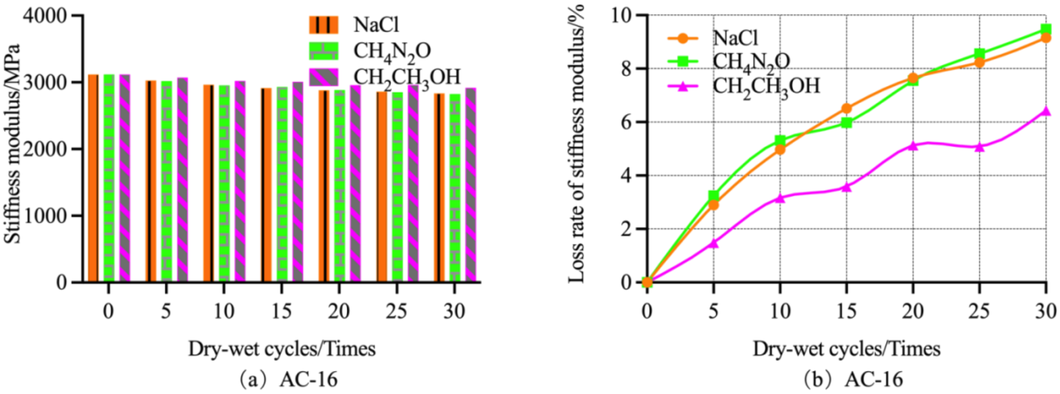


Fig. 6 – Stiffness modulus of AC-16 under multiple dry-wet cycles

It can be seen from Fig. 6 (a) that when the gradation of asphalt mixture is AC-16, the stiffness modulus corresponding to the three kinds of deicing salts decreases with the increase of dry-wet cycles, the CH_2CH_3OH has the smallest impact on the stiffness modulus, the CH_4N_2O and NaCl have greater impacts on the stiffness modulus. It can be seen from Fig. 6 (b) that the loss rate of stiffness modulus corresponding to CH_2CH_3OH is low during the process of whole dry-wet cycles, which reaching 6.4% at the 30th cycle; The loss rate of the stiffness modulus corresponding to NaCl and CH_4N_2O is similar, and finally reaches 9.2% and 9.5% respectively at the 30th cycle.

Conclusions

The dry-wet cycles of three deicing salt solutions are carried out for AC-13 and AC-16 asphalt mixtures, and the changes of their mechanical properties are studied.

According to the residual stability, the ability of AC-13 to resist the damage of deicing salt is slightly greater than that of AC-16, and the damage of deicing salt solution to AC-13 from large to small is: CH_4N_2O > CH_2CH_3OH >NaCl, and the damage of deicing salt solution to AC-16 from large to small: CH_4N_2O > NaCl > CH_2CH_3OH.

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СТІЙКІСТЬ ДО РОЗТРІСКУВАННЯ АСФАЛЬТОБЕТОНУ, НАСИЧЕНОГО ДОРОЖНЬОЮ СІЛЛЮ, ПРИ ЗАМОРОЖУВАНІ

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В статті розглянуті питання стійкості до розтріскування при низькій температурі, низькотемпературні характеристики асфальтобетону міцності на розтяг при згині та відношення межі міцності при розтягуванні до деформації при згині, що відображає гнучкість асфальтобетону.

При відносно низькій температурі асфальтобетон повинен мати певну деформаційну здатність, а температурна усадкова тріщина може бути зменшена в умовах низької температури. Гранична деформація розтягування при згині при низькій температурі тісно пов'язана з характеристиками асфальту. Збільшення в'язкості асфальту може покращити стійкість тротуару до розтріскування при низьких температурах.

Відповідно до залишкової стабільності, здатність АС-13 протистояти пошкодженню солі для запобігання ожиледиці трохи більша, ніж у АС-16, а пошкодження розчину солі для протиожеледності для АС-13 від великого до малого: CH_4N_2O > CH_2CH_3OH >NaCl, а шкода протиожеледного розчину солі для АС-16 від великого до малого: CH_4N_2O > NaCl > CH_2CH_3OH.

Після циклу заморожування-відтавання солі стійкість до розтріскування при низьких температурах модифікованого асфальту SBS поступово знижується зі зниженням температури.

Ключові слова*: тріщиностійкість,асфальтобетон, деформаційна здатність, температурні усадочні тріщини.*

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