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IMPACT OF DEICING SALTS ON THE DYNAMIC STABILITY OF ASPHALT MIXTURES DURING DRY-WET CYCLE EXPOSURE

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Анотація

У холодному кліматі дороги часто потребують спеціальної обробки протиожеледними сумішами, щоб зменшити ризики, пов'язані з утворенням паморозі та накопиченням снігу. Тим не менш, використання цих сумішей може мати негативні наслідки для асфальтобетонних композитів. Це дослідження спрямоване на з'ясування впливу протиожеледних речовин на стійкість асфальтобетонних покриттів до підвищених температур в умовах циклічного впливу вологий-сухий шляхом проведення високотемпературних випробувань на утворення колії. Емпіричні дані свідчать про те, що асфальтобетон АС-13 демонструє вищу стійкість до руйнування, спричиненого протиожеледними сумішами, порівняно з АС-16. Руйнування, спричинене протиожеледними сумішами в асфальтобетонних сумішах АС-13, у порядку зменшення інтенсивності, відбувається у такій послідовності: етанол, сечовина, технічна сіль. І відповідно, для асфальтобетонних композитів АС-16 руйнування, спричинене протиожеледними сумішами, у порядку зменшення інтенсивності, відбувається за такою послідовністю: етанол, технічна сіль, сечовина.

Ключові слова: асфальтобетон, динамічна стабільність, протиожеледна речовина, поперемінний насичення циклу.

Abstract

In frigid environments, thoroughfares frequently necessitate treatment with anti-icing compounds to mitigate the risks associated with frost formation and snow accumulation. Nonetheless, the employment of these compounds may yield detrimental consequences for asphalt composites. The present investigation endeavors to elucidate the influence of anti-icing compounds on the elevated temperature stability of asphalt composites under wet-dry cyclical circumstances via the execution of high-temperature rutting assessments. Empirical findings denote that the AC-13 composite exhibits superior resilience to anti-icing compound-induced degradation compared to AC-16. The degradation induced by anti-icing compounds in AC-13 asphalt composites, in a decreasing magnitude of severity, is as follows: ethanol > urea > industrial salt. Conversely, for AC-16 asphalt composites, the degradation engendered by anti-icing compounds, in a decreasing order of severity, is: ethanol > industrial salt > urea.

Keywords: asphalt concrete, dynamic stability, deicing salt, dry-wet cycle.

Introduction

As anthropogenic climate change intensifies globally, the field of road engineering confronts mounting obstacles. In colder regions, the presence of ice and snow on road surfaces, in conjunction with wet-dry cycles, exerts substantial influence on the high-temperature stability of asphalt pavements, giving rise to surface fissures, rut formation, and additional manifestations of deterioration[1][2]. High-temperature stability constitutes a crucial performance metric for asphalt composites, encompassing elevated temperature rutting resistance and deformation resistance. Under wet-dry cyclical circumstances, anti-icing compounds may impinge upon the high-temperature stability of asphalt composites, consequently inducing surface degradation and curtailed service life. As such, the present investigation endeavors to examine the ramifications of anti-icing compounds on the elevated temperature stability of asphalt composites under wet-dry cyclical conditions, with the intention of furnishing valuable insights for the design and execution of road engineering projects[3][4].

Experimental method

Building upon prior investigations executed by the research team concerning the freezing point analysis of anti-icing compounds, the current study selected sodium chloride, urea, and ethanol as three deicing agents[5][6]. Considering the deicing efficacy and cost-efficiency of these agents, solutions comprising 20% sodium chloride

(NaCl), 15% urea (CH_4N_2O), and 20% anhydrous ethanol (CH_2CH_3OH) were prepared for the dry-wet cycles. Rutting plate specimens with AC-13 and AC-16 gradations were fabricated and subjected to 0, 5, 10, 15, 20, 25, and 30 dry-wet cycles. Each cycle entailed immersing the specimens in the three solutions for 24 hours, followed by air-drying for an additional 24 hours. Upon completion of the dry-wet cycles, the dynamic stability test was administered on the rutting plates in accordance with the " Standard Test Methods for Bitumen and Bituminous Mixtures for Highway Engineering" (JTG E20-2011).

Results analysis and discussion

Upon employing an AC-13 gradation for the asphalt composite, alterations in its dynamic stability subsequent to the dry-wet cycle evaluations are depicted in Figure 1.

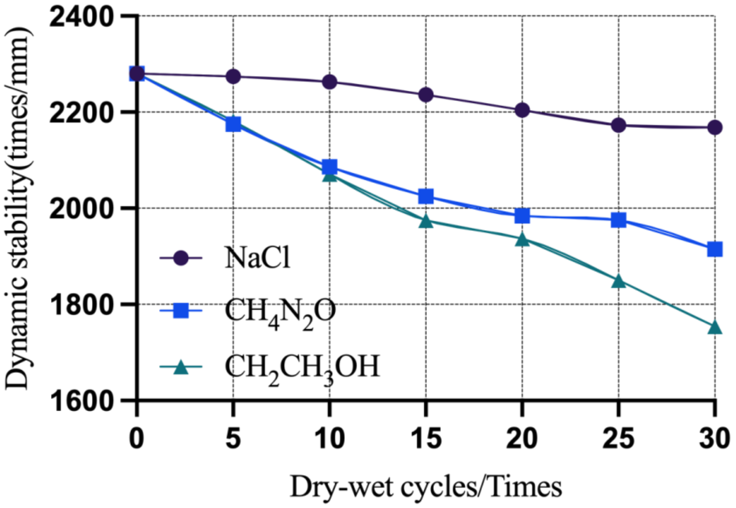

Fig. 1 Variations in dynamic stability for AC-13 gradation

Figure 1 illustrates that, for specimens with an AC-13 gradation, the dynamic stability (DS) demonstrates a declining pattern as the number of dry-wet cycles increases. The repercussions of the NaCl solution on DS are relatively minimal, succeeded by the influence of the CH_4N_2O solution, whereas the impact of the CH_2CH_3OH solution on DS is the most pronounced. The disparity between the effects of the CH_2CH_3OH solution and CH_4N_2O solution on DS is not considerable; however, the impact of the NaCl on DS is markedly less than that of the CH_2CH_3OH solution and CH_4N_2O solution.

For asphalt composites featuring an AC-16 gradation, alterations in dynamic stability subsequent to the dry-wet cycle evaluations are depicted in Figure 2.

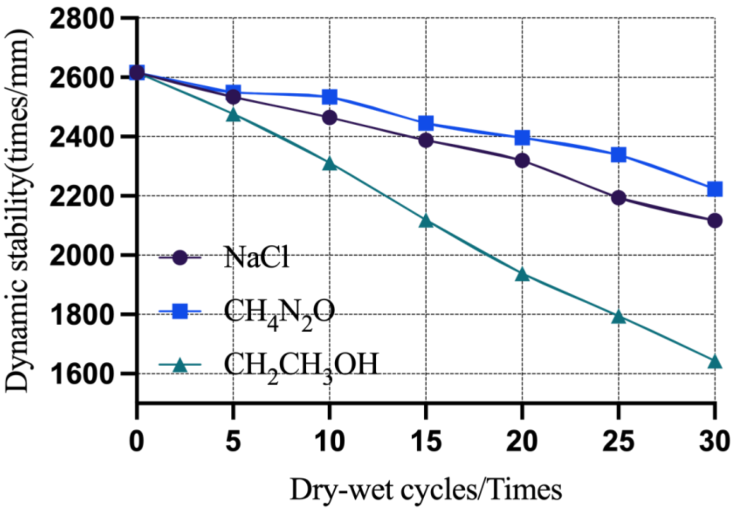

Fig. 2 Variations in dynamic stability for AC-16 gradation

Figure 2 demonstrates that, for specimens with an AC-16 gradation, the DS similarly exhibits a declining pattern as the number of dry-wet cycles increases. The repercussions of the CH_4N_2O solution on DS are the least pronounced, succeeded by the influence of the NaCl solution, while the impact of the CH_2CH_3OH solution on DS is the most substantial. The disparity between the effects of the NaCl solution and CH_4N_2O solution on DS is not considerable; however, the impact of the CH_2CH_3OH solution on DS is notably greater than that of the NaCl solution and CH_4N_2O solution.

Upon juxtaposing Figure 1 and Figure 2, a more pronounced decrease in DS is discernible for the AC-16 gradation compared to the AC-13 gradation. This observation suggests that, with respect to dynamic stability, the influence of the three salt solutions on AC-16 exceeds that on AC-13.

Conclusion

AC-13 and AC-16 asphalt composites underwent wet-dry cycles employing three distinct deicing salt solutions, with their alterations in high-temperature stability examined through high-temperature rutting assessments. The findings reveal that AC-13 demonstrates superior resilience to deicing salt-induced degradation compared to AC-16. In terms of the damage inflicted on AC-13 asphalt composites by deicing salts, the order of severity, in descending fashion, is: $CH_2CH_3OH > CH_4N_2O >$ NaCl. Conversely, for AC-16 asphalt composites, the order of damage severity caused by deicing salts is: $CH_2CH_3OH >$ NaCl $> CH_4N_2O$.

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