UDC 625.8

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THE INFLUENCE OF DEICING SALTS ON THE RESIDUAL STABILITY OF ASPHALT COMPOSITIONS UNDER WET-DRY CYCLING CONDITIONS

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Анотація

Протиожеледні солі, які широко застосовуються для танення льоду та снігу на дорогах, ефективно знижують точку замерзання таких поверхонь, тим самим зводячи до мінімуму збої в русі транспортних засобів. Незважаючи на це, ці солі різною мірою можуть чинити шкідливий вплив на дорожні матеріали. У цьому дослідженні оцінюється вплив протиожеледних солей на водостійкість асфальтових сумішей шляхом виконання випробувань Маршалла попеременне витримування у вологих і сухих умовах.

Ключові слова: асфальтобетонне покриття, водостійкість, протиожеледна сіль, механічні властивості, довговічність.

Abstract

Deicing salts, widely employed for mitigating ice and snow on roadways, effectively decrease the freezing point of such surfaces, thereby minimizing vehicular travel disruptions. Nonetheless, these salts can exert detrimental effects on underlying road materials to varying degrees. This investigation assesses the influence of deicing salts on the water stability of asphalt mixtures through the implementation of immersion Marshall tests under alternating wet-dry conditions.

Keywords: asphalt concrete pavement, water stability, deicing salt, mechanical properties, durability.

Introduction

As global climate change and urbanization accelerate, road infrastructure assumes a vital role in facilitating transportation and fostering economic growth. Nevertheless, the longevity of roads is influenced by diverse environmental factors, including temperature fluctuations, precipitation, and ice and snow accumulation. In colder regions, winter road icing considerably impacts traffic safety and routine travel[1]. To mitigate the repercussions of ice and snow on transportation, common deicing strategies, such as salt application, are employed. Although deicing salts serve as prevalent agents for ice and snow degradation, they may also impart specific effects on road materials. The infiltration of these salts can alter the moisture and salt content within asphalt mixtures, subsequently affecting their mechanical properties and durability [2-3].

Asphalt mixtures, as an indispensable component in road construction, bear substantial implications for the service life, safety, and durability of roadways. Under alternating wet-dry environmental conditions, these mixtures are exposed to the concomitant influences of moisture, chemical corrosion, and other factors, potentially resulting in marked alterations to their residual stability [4]. Consequently, examining the impact of deicing salts on the residual stability of asphalt mixtures under wet-dry cycling conditions holds substantial practical significance for directing the selection and design of road materials[5-6].

Experimental method

Building upon the research group's prior investigations on deicing salts' freezing point tests, this study employed three distinct deicing salts: sodium chloride, urea, and ethanol[7-9]. Considering the deicing efficacy and economic factors, 20% industrial salt (NaCl), 15% urea (CH_4N_2O), and 20% anhydrous ethanol (CH_2CH_3OH) solutions were formulated for the wet-dry cycling process. Marshall specimens with AC-13 and AC-16 gradations were fabricated and subjected to 0, 5, 10, 15, 20, 25, and 30 wet-dry cycles. Each cycle entailed a 24-hour

immersion in each of the three solutions, followed by a subsequent 24-hour air-drying period. Upon completion of the wet-dry cycling, residual stability tests were performed on the Marshall specimens 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 mixture, Figure 1 illustrates the alterations in residual stability subsequent to the wet-dry cycling tests.

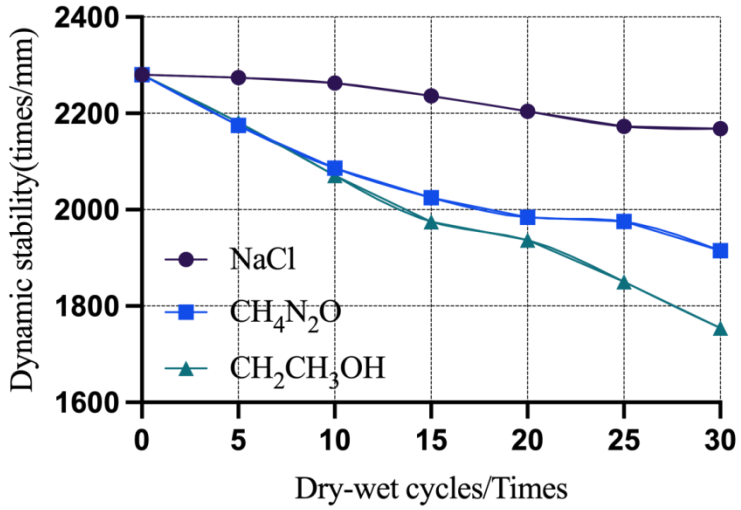

Fig. 1 Variations in residual stability for ac-13 gradation

Figure 1 demonstrates that for an asphalt mixture with an AC-13 gradation, residual stability diminishes with increasing wet-dry cycles. Among the 30 cycles, the influence of NaCl on residual stability is the least pronounced, followed by that of CH_2CH_3OH, while the impact of CH_4N_2O is the most substantial. By the 20th cycle, the residual stability values for CH_4N_2O and CH_2CH_3OH are 73.8% and 74.6%, respectively, falling short of the prevailing specification requirement of greater than 75%. In contrast, the residual stability corresponding to NaCl adheres to the current specification requirement of exceeding 75% throughout all 30 cycles.

Upon employing an AC-16 gradation for the asphalt mixture, Figure 2 illustrates the alterations in residual stability subsequent to the wet-dry cycling tests.

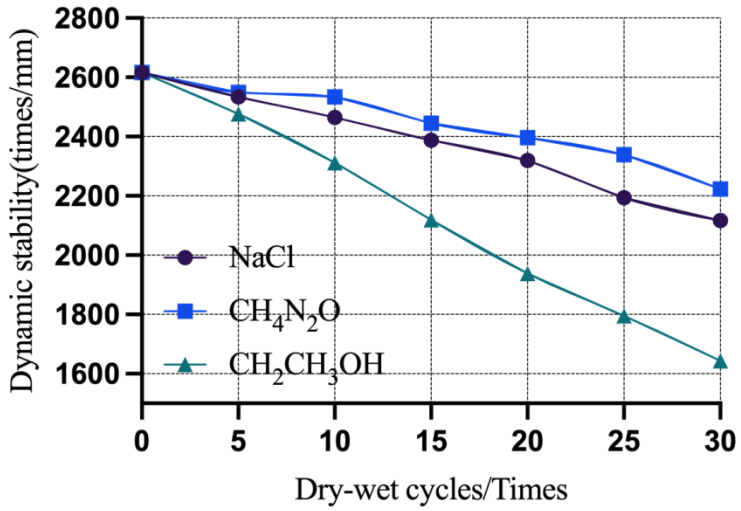

Fig. 2 Variations in residual stability for AC-16 gradation

As illustrated in Figure 2, when employing an AC-16 gradation for the asphalt mixture, the residual stability diminishes with an increase in the number of wet-dry cycles. Among the 30 wet-dry cycles, the influence of CH_2CH_3OH on residual stability is the least pronounced, followed by NaCl, while the impact of CH_4N_2O is the most substantial. At the 10th cycle, the residual stability value for CH_4N_2O is 72.0%; at the 15th cycle, the residual stability value for NaCl is 74.7%; and at the 20th cycle, the residual stability value for CH_2CH_3OH is 72.4%, all of which fall short of the prevailing specification requirement exceeding 75%.

Upon juxtaposing Figure 1 and Figure 2, it becomes evident that the rate of decline in residual stability for AC-16 gradation is marginally more pronounced than that for AC-13 gradation. This suggests that the influence of the three salt solutions on AC-16's residual stability surpasses their impact on AC-13's residual stability.

Conclusion

AC-13 and AC-16 asphalt mixtures underwent wet-dry cycling with three distinct deicing salt solutions. Alterations in water stability were investigated via immersion Marshall tests. The findings reveal that AC-13 exhibits superior resistance to deicing salt erosion compared to AC-16. The descending sequence of deicing salt-induced water stability degradation for AC-13 asphalt mixtures is as follows: $CH_4N_2O > CH_2CH_3OH > NaCl$. In the case of AC-16 asphalt mixtures, the damage hierarchy is: $CH_4N_2O > NaCl > CH_2CH_3OH$.

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