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Influence of Thermal Variations on Fatigue Cracking of Asphalt Pavements

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Introdução

Climate change has led to significant alterations in thermal regimes, with potential impacts on the performance and durability of transportation infrastructure. However, these effects are still insufficiently addressed in Brazilian pavement design methods. The Brazilian National Pavement Design Method (MeDiNa), for instance, assumes a constant pavement temperature of 25 °C throughout the entire service life and does not explicitly incorporate thermal variability associated with real climatic conditions. Within this context, this study aims to evaluate the influence of temperature variations on fatigue cracking in asphalt pavements, considering different asphalt mixture types commonly used on Brazilian highways.

Objetivos

This study evaluates the influence of temperature variations on fatigue cracking in asphalt pavements, specifically focusing on different asphalt mixture types commonly used across Brazilian highways.

Metodologia

The research was conducted through computational simulations combined with statistical analyses, using four asphalt mixtures that were employed in the calibration sections of MeDiNa. The selection of these mixtures ensured consistency with the national pavement design framework and representativeness of typical Brazilian materials. The analyses were performed using the CAP3D-D software, which allows air temperature to be considered as an input variable in structural pavement evaluation. To isolate the thermal effect, a standard pavement structure was adopted, while traffic parameters, layer thicknesses, and granular material properties were kept constant, with temperature being the only variable.

Resultados e Discussão

The simulations encompassed multiple thermal scenarios, including both positive and negative deviations from the reference temperature, in order to represent distinct climatic conditions. Based on the simulation outputs, a database was developed containing the predicted percentage of fatigue-cracked area at the end of the pavement service life, enabling the application of statistical methods to assess the relationship between temperature and structural performance.

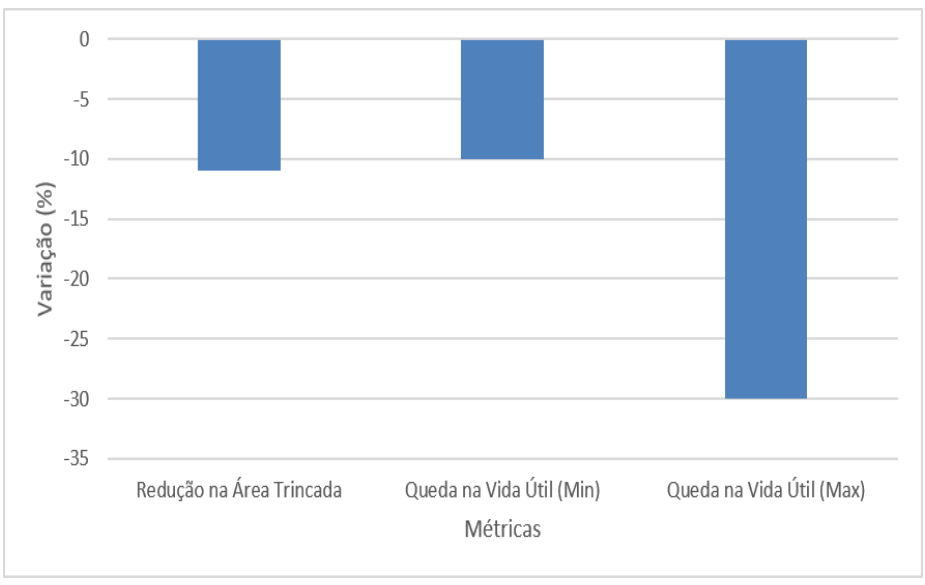


Figura 1. Impacto da Temperatura.

Conclusões

The results revealed a strong inverse correlation between temperature and fatigue cracking for all analyzed mixtures. An increase in temperature was associated with a reduction in the predicted cracked area, with an average decrease of approximately 11% for each 1 °C increase. Conversely, lower temperatures intensified structural degradation, leading to reductions in pavement service life ranging from 10% to 30%, depending on the asphalt mixture. These findings indicate that different materials exhibit varying levels of thermal sensitivity, reinforcing the need for mixture-specific analyses in pavement design.

Referências e Agradecimentos

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