Sustainable Civil Infrastructures

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Moisture Damage Resistance of Zycotherm-Modified Glasphalt: An Image Processing and Machine Learning Approach

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Abstract. Bituminous pavements are susceptible to moisture damage, leading to stripping. Glasphalt, a sustainable pavement material incorporating recycled glass as an aggregate, offers environmental benefits but remains vulnerable to moisture-induced damage. This study uses traditional tests and an innovative machine learning approach for image analysis to evaluate the moisture damage resistance of Zycotherm-modified glasphalt mixtures (containing 15% glass cullet). Glasphalt mixtures with varying Zycotherm content (0%, 0.2%, and 0.4%) were evaluated using the Modified Lottman test and boiling water tests. A digital image analysis approach employing machine learning was developed to transform visual stripping evaluations from boiling water tests. High-resolution images of the specimens were processed using MATLAB to quantify aggregate-binder interaction based on coating area, achieving a correlation coefficient of 0.9 with traditional assessments. Results showed that the mixture with 0.2% Zycotherm exhibited the highest moisture resistance, with TSR values improving from 83.2% in the control mix to 94.5% and a 59.95% reduction in white pixels, indicating significantly reduced stripping. This strong correlation between machine learning predictions and conventional tests demonstrates the potential of image analysis and machine learning to enhance moisture damage assessment in glasphalt pavements. This study shows that Zycotherm improves glasphalt mixture moisture resistance, enabling pavement construction to be more durable and sustainable.

Keywords: moisture damage · zycotherm · glasphalt · image processing · machine learning

1 Introduction

Bituminous pavements are fundamental to modern transportation infrastructure, providing durable and cost-effective surfaces for roads worldwide. However, these pavements are highly susceptible to moisture damage, which can severely compromise their structural integrity and longevity. Moisture damage, often manifested as stripping, occurs when water infiltrates the pavement layers. This problem is exacerbated in regions with

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