Kansas Department of Transportation

TECHNICAL SUMMARY

Tolerable Strains for Hot Mix Asphalt Overlays over Concrete Pavements

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Introduction

Application of EBL Tack Coat before Placing an HMA Overlay

Due to change of temperature and/or moisture, freezing-thaw cycles, loss of subgrade support by erosion, and traffic loading, concrete pavements can develop different types of distresses during service life. Hot mix asphalt (HMA) overlays are commonly used to improve the serviceability of damaged concrete pavements. The most challenging issue for HMA overlays over concrete pavements is the development of reflection cracks through the overlays at the locations of joints and existing cracks on concrete pavements. Even though different techniques have been used to overcome this issue, they often do not yield satisfactory results and performance. Cracking of HMA overlays results from intolerable tensile strain and/or shear movement developed in the overlays due to the movement of concrete pavements.

Project Description

HMA materials from two Kansas Department of Transportation (KDOT) projects were used in the laboratory study. All testing was conducted at room temperature. Considering typical HMA overlay thicknesses used in Kansas, the selected thicknesses of the HMA overlays were 1.5 and 2.0 inches. Direct shear tests and semi-circular bend tests were conducted on these chosen HMA mixtures to characterize their shear and tensile properties respectively. Overlay loading tests were conducted on HMA overlays adhered to gapped concrete blocks to evaluate the interaction between the HMA overlays and the concrete blocks with a gap subjected to static or cyclic loading. Steel bars having a diameter of 0.25, 0.375, or 0.5 inches were used as spacers to create a gap in a direct shear test in the lab. These gaps simulate joints in concrete pavements. Measured relative shear displacements of these HMA specimens at failure varied from 6.0 % to 9.0 % of the specimen thickness depending upon the simulated gap width. Tolerable tensile strains of Mix 1 specimens under fatigue loading in the semi-circular bend tests were from 1.2% to 4% while those of Mix 2 specimens were from 0.6% to 1.4%.

Project Objective

Limited studies have been conducted so far to determine the tolerable tensile strain and shear deformation of HMA overlays on concrete pavements. If the strain and shear deformation the HMA can endure are known, the methods that will limit or prevent that strain and deformation can be sought. This research experimentally determined the tolerable tensile strain and the relative shear movement of the HMA overlays. Direct shear tests and semi-circular bend tests of HMA specimens and HMA overlay loading tests under static and cyclic loading on gapped concrete blocks were conducted in this research.

Project Results

Test results show that the compressive load capacity of a specimen under the semi-circular bend test was linearly correlated to the shear load capacity of the specimen at the same mix and thickness under the direct shear test. Specimens at the onset of cracking in the overlay loading tests had the permanent vertical displacements with similar magnitudes as the shear displacements corresponding to the shear load capacities in the direct shear tests. The tolerable tensile strains of HMA specimens in the overlay tests were smaller than those in the semi-circular bend tests; however, an increase of the applied load or gap width minimized their differences. The overlay loading tests showed that the cracking could be avoided if the tensile strains in the HMA overlays were less than 0.5%.

Based on the HMA mixes, the specimen thicknesses, the gaps between the concrete blocks, the load levels, and the test temperatures used in this research, it can be concluded that:

1. The shear failure could be avoided if the shear deformation of the HMA overlay was less than 6% of the overlay thickness.

2. The cracking could be avoided if the tensile strain in the HMA overlay was less than 0.6%. The methods that will limit or prevent reflection cracks due to shear deformation and tensile strain should be sought in a future study.

Report Information

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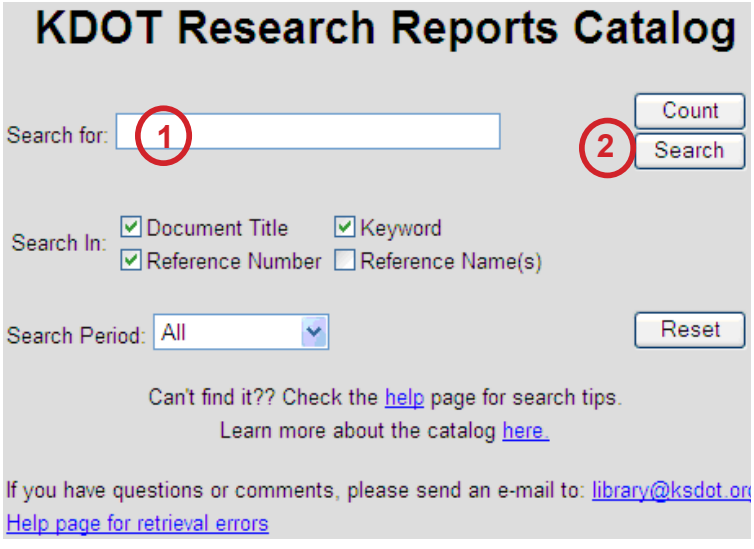

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