PublicPolicy Center

Tech Brief

Examination of Curing Criteria for Cold In-place Recycling

(Phase 2: Measuring Temperature, Moisture, Deflection and Distress from CIR Test Section)

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RESEARCH PROJECT TITLE:

Examination of Curing Criteria for Cold In-place Recycling (Phase 2: Measuring Temperature, Moisture, Deflection and Distress from CIR Test Section)

SPONSOR:

Iowa Highway Research Board (TR-590)

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Objectives

The main objectives of the research are to: (1) measure the moisture levels throughout a CIR layer and (2) develop a moisture loss index to determine the optimum curing time of CIR layer before HMA overlay.

Problem Statement

The previous research performed laboratory experiments to measure the impacts of the curing on the indirect tensile strength of both CIR-foam and CIR-emulsion mixtures. However, a fundamental question was raised during the previous research regarding a relationship between field moisture content measured using a nuclear gauge and the laboratory moisture content in gyratory compacted specimens. Therefore, it is critical to measure moisture and temperature at different depths of the CIR layer in the field, which can be related to the laboratory test results.

Research

To develop a set of moisture loss indices, the moisture contents and temperatures of CIR-foam and CIR-emulsion layers were monitored for five months. The moisture content was measured by embedding capacitance moisture sensors at a midpoint and a bottom of the CIR layer and compared against the moisture content measured by a nuclear gauge. The modulus and stiffness were measured using a falling weight deflectometer (FWD) and a geo-gauge during the curing time. A set of moisture loss indices was developed based on the initial moisture content and temperature of CIR-foam and CIR-emulsion layers.

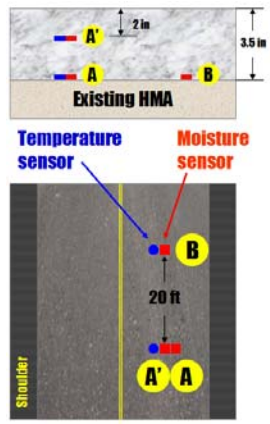
Benefits

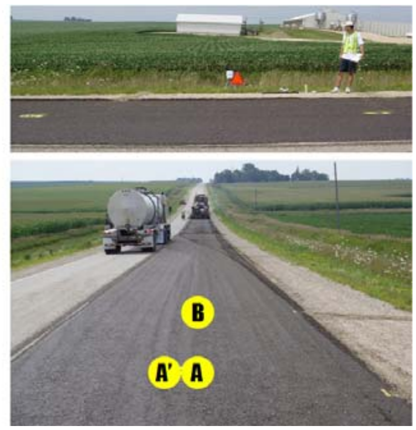
A set of moisture loss indices based on the moisture content and temperature in the field will help pavement engineers determine an optimum timing of an HMA overlay without continually measuring moisture conditions in the field using a nuclear gauge. This will increase the life of CIR pavements.

Key Findings

Based on the limited field experiment, the following conclusions are derived:

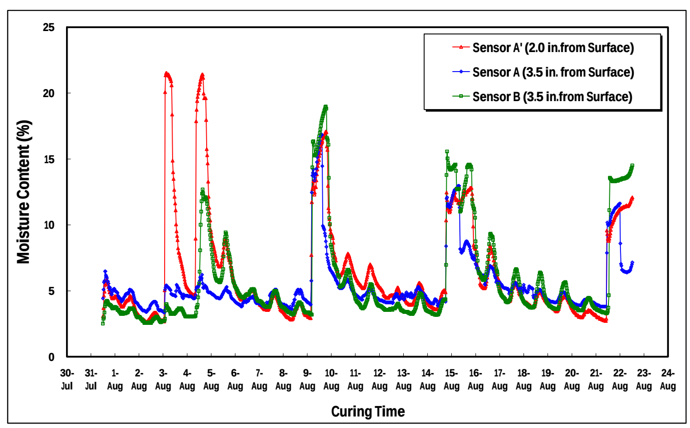
1. The moisture condition of a CIR layer can be monitored accurately using a capacitance moisture sensor.
2. The moisture loss index for a CIR layer is a viable tool in determining the optimum timing for an overlay without measuring the moisture content using a nuclear gauge.
3. The modulus of a CIR layer back-calculated from deflection measured by FWD seemed to be in a good agreement with the stiffness measured by geo-gauge.
4. The stiffness of a CIR layer increased as curing time increased. The layer stiffness seemed to be affected by the pavement temperature more than the moisture content.
5. The geo-gauge should be considered for measuring the stiffness of a CIR layer that can be used to determine the optimum timing of an overlay.

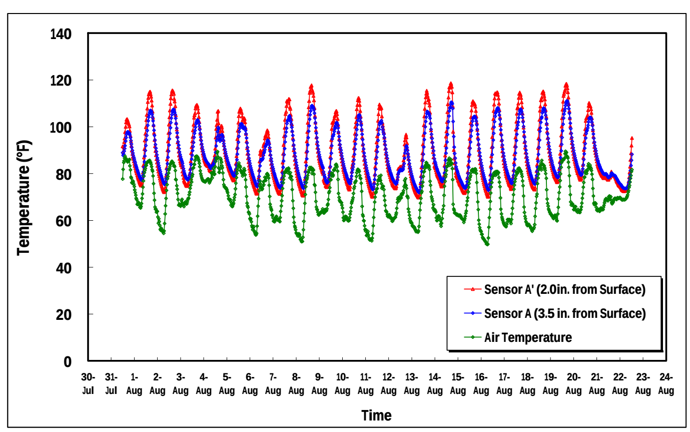




Recommended Refinements through Additional Research

To validate the moisture loss indices, six CIR construction sites that include two CIR-foam project sites, two CIR-emulsion (CSS-1) project sites and two CIR-emulsion (HFMS-2P) project sites, should be monitored using embedded moisture and temperature sensors. To further explore the concept of using CIR stiffness as a curing tool for determining an optimum timing for an overlay, the geo-gauge will be used to measure the stiffness of the above six CIR projects. The main goal of additional research is not only validate the moisture loss index but also find a correlation between stiffness and moisture content. It is very critical for the next phase to evaluate the potential of using the stiffness to supplement (or possibly replace) the moisture measurement by a nuclear gauge.





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