JOINT TRANSPORTATION RESEARCH PROGRAM

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Enhanced Treatment Selection for Reflective Joint Cracking in Composite Pavements

Introduction

Composite pavements are currently the most prevalent type of pavement on the highway system administered by the Indiana Department of Transportation (INDOT), mainly due to the fact that about 60% of all rehabilitated pavement projects are composite pavements.

The correct type of treatment for reflective cracking in composite pavements is commonly determined by a visual inspection of the crack on asphalt overlay, although it should be selected based on the condition of the concrete underneath because it is difficult to determine the condition of the concrete joints or cracks by only examining the surface distresses of the asphalt overlay. Due to this uncertainty, many good concrete pavements have been unnecessarily replaced as field engineers decided on full-depth patching, and this had been leading INDOT's dissipation of costs, materials, and manpower.

This research, therefore, was necessary to enhance identification of the condition of the underlying concrete joints by looking at the surface distresses of the asphalt pavements and to develop a decision-making process to enhance treatment selection for joint cracking in composite pavements. The main objectives of this research are to fulfill these research needs and to develop a guideline that can assist INDOT with evaluating reflective cracks and disseminating the findings of this research to its districts.

There are three different types of concrete pavements that commonly construct composite pavements: (1) jointed reinforced concrete pavement (JRCP), (2) jointed plain concrete pavement (JPCP), and (3) continuously reinforced concrete pavement (CRCP). The project scope included only the JPCP type, and the JRCP type was supplemented in May 2014.

The Purdue research team, with the help of the INDOT Study Advisory Committee (SAC), began Phase II of the study in January of 2013. Phase II mainly consists of collecting and analyzing sample data of reflective cracks from northern and southern Indiana and developing a decision-making tool to meet the research objectives. There are four steps in data collection process: (1) visual inspection of asphalt overlay, (2) Falling Weight Deflectometer (FWD) tests on reflective cracks, (3) coring tests on each cracks, and (4) visual inspection of exposed concrete. Therefore, the team should be able to check the condition of corresponded concrete cracks as well as asphalt cracks to complete sample data collection.

This research provides a field pocket book and a computer application to help field engineers organize their data collection procedures and increase their access to the sample data in the database. These project deliverables are expected to provide better visualization tools to compare cracks needing treatment to existing sample data.

Findings

Based on the analyzed results from the four-step data collection processes, this report documents the results of Phase II, which includes a summary of the study's major findings from the literature review, data collection and analysis, and the decision-making guidelines.

Visual inspections of reflective cracks on the pavement surface and the exposed concrete pavement are the first and the last steps of the data collection procedure. Based on the 2010 PCR Data Collection Manual, the visual inspection of reflective cracks was classified into three levels of severity (low, moderate, and high) and extent (few, several, and many).

- Based on the data collected from I-69 in Fort Wayne, a trend was revealed that the severity level of an asphalt crack was closely correlated to the severity level of the exposed concrete crack underneath the asphalt layer. Correlations between asphalt and concrete crack severity levels were as follows: 85% of high-severity asphalt cracks were located over high-severity concrete cracks; 60% of moderate-severity asphalt cracks were located over moderate concrete cracks; and 75% of low-severity asphalt cracks were located over low-severity concrete cracks.
- In terms of the distribution of joint cracks and mid-panel cracks at the I-69 site, 33 cracks were at the joint and the remaining 27 were at the mid-panel, and 55% of the cracks were located over joints whereas 45% of the cracks were located over mid-panel distresses in the concrete pavement. All the low-severity cracks were located over joints. Moreover, 65% of the moderate-severity cracks and 70% of the high-severity cracks were located over mid-panel distresses in the concrete pavement.
- FWD testing was conducted over the reflective cracks, and seven variables from the FWD results, along with the visual inspection results of the reflective cracks in the asphalt overlay, were statistically analyzed. As a result, this study found that the visual inspection of the asphalt was strongly correlated to the visual inspection of the concrete, as R^2 was equal to 0.6923. The FWD tests were conducted twice, at the middle and wheel paths. The seven variables indicated that the cracks were more severe at the wheel path than at the middle path.
- This study found that core testing when it is performed in the proper location can be a very useful step in assessing the condition of cracks in the exposed concrete without completely milling the surface asphalt overlay.
- The decision-making tool determines four different treatment suggestions based on four criteria: (1) severity level of the asphalt and concrete cracks from the visual inspection, (2) deflection 1 (D1) value, (3) load transfer efficiency (LTE) value, and (4) resilient modulus (Mr) value from the FWD testing. These criteria were particularly selected to develop the decision-making tool not only because they confirm a statistical correlation between the asphalt crack severity and the concrete crack severity but also because these values were recommended by INDOT engineers.
- This research found that if field engineers make decisions by only considering visual inspection of asphalt overlay, they have a 73.33% chance (with assumption 1) and a 63.33% chance (with assumption 2) to make a correct decision based on the collected sample data. However, these chances would increase to 79.83% (with assumption 1) and 73.28% (with assumption 2) if field engineers use the proposed decision-making tool to make their decisions. (ASSUMPTION 1: low- and moderate-severity concrete cracks need partial-depth patching, and high-severity concrete cracks need full-depth patching. ASSUMPTION 2: same crack treatments for low-severity concrete cracks need partial-depth patching, and moderate- and high-severity concrete cracks need full-depth patching.)
- This study found that based on the visual inspection of the exposed concrete, full-depth patching was not always needed for every high-severity concrete crack. Treatment methods for different levels of concrete crack severity should be defined in further research projects

Implementation

Although this study attempted to consider various factors and criteria for the decision-making tool, standardized results could not be provided in this report as it is realistically difficult to infer the condition of the concrete joints and cracks underneath an asphalt layer with 100% accuracy. Furthermore, only selected variables were used in this study to analyze the correlations between the severity levels of asphalt cracks and concrete cracks. For more accurate analysis, more variables need to be considered.

Furthermore, the decision-making tool proposed by this study employs the sample data that is already stored in the database to suggest crack treatments. Therefore, to obtain more reliable results with this tool, adding to the number of sample data is critical. This study therefore suggests conducting additional field evaluations (four steps) to add more sample data to the database to enhance the decision-making tool's suggestions.

This study also provides a database, a computer application, and a pocket book for INDOT field engineers. The database and the computer application will be helpful when organizing the collected data and will increase field engineers' access to the sample data, improving the analysis process by providing better visualization tools. Employing the pocket book will be useful when field engineers are making preliminary decisions on reflective crack treatments.

This study can be utilized to quickly estimate the condition of the concrete joint underneath the asphalt layer with a defined selection of factors and criteria required. Although the decision-making tool's usability is practical, its reliability remains uncertain. Therefore, the results and suggestions made by this study should mainly be implemented as an academic consultation and preliminary implementation, rather than as a definitive decision. If the crack treatments suggested by the decision-making tool in this study were to be used as final decision, it is recommended to have additional information, such as pavement history and maintenance records, before implementing the suggested treatment decision.

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