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RESEARCH PROJECT TITLE

Reflective Crack Mitigation Guide for Flexible Pavements

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Reflective Crack Mitigation Guide for Flexible Pavements

tech transfer summary

Using Iowa's Pavement Management Information System (PMIS) and site investigations, a variety of crack mitigation strategies were analyzed to assess their intended design life.

Background

Reflective cracking of asphalt mixtures is a common distress that results in a loss of pavement ride quality and service life. Several strategies exist to mitigate reflective cracking depending on the pavement structure, including the use of crack relief layers in the form of membranes and specialty asphalt mixtures (e.g., Strata), crack and seat, rubblization, cold in-place recycling (CIR) of existing asphalt overlays, and full-depth reclamation (FDR). Depending on the pavement structure, pavement condition, and traffic level, varying strategies exist that improve the performance of the pavement economically.

Problem Statement

The Iowa Department of Transportation (DOT) currently does not have a guideline or specification for reflective cracking control and mitigation in conventional composite pavement. A standard technical guide is needed for Iowa to provide detailed guidance on choosing the optimal reflective cracking mitigation strategy for a project.

Objectives

- Use Iowa's Pavement Management Information System (PMIS) to select reflective cracking mitigation strategies at the network level
- Perform project-level pavement site investigations to evaluate existing treated composite pavements



Rubblization using a multiple-head breaker

Research Description

A survival analysis was conducted to identify the most appropriate pavement rehabilitation methods for composite pavements and to evaluate the influence of different factors on reflective crack development. Four composite pavement rehabilitation methods, including mill and fill, overlay, heater scarification (SCR), and rubblization, were analyzed using three pavement performance indicators: reflective cracking, international roughness index (IRI), and pavement condition index (PCI). Data on pavement structure, traffic, and field performance were collected.

In addition, the modulus and performance of four reflective cracking treatments were evaluated at 16 pavement sites in Iowa using pavement condition surveys, pavement structural moduli testing by falling weight deflectometer (FWD), and surface wave method (SWM) testing. Treatments included full rubblization, modified rubblization, crack and seat, and rock interlayer.

Because of a steady increase of CIR for pavement rehabilitations, an analysis of CIR data for 100 CIR projects was also completed.

Key Findings

The results of the survival analysis, which involved the development of a treatment selection guideline, showed the following:

- A Kaplan-Meier estimator clearly illustrated that pavement rubblization can significantly retard reflective cracking development in composite pavements, more than the other three methods. The mill and fill treatment also exhibited better performance than hot-mix asphalt overlay in terms of reflective cracking mitigation.
- The general trend of a hazard/failure function for reflective cracking followed a lognormal distribution, with an early-time increase followed by a constant or decreasing probability of failure. The corresponding survival function showed a sharp initial drop with a long tail in later service life.
- No significant differences in PCI were seen in the survival analysis among the four rehabilitation methods. The hazard function for the PCI, however, is best described by a Weibull distribution, which has an accelerated failure time pattern.
- The SCR method showed the lowest survival probability in terms of reflective cracking and IRI. Higher initial IRI values were found for the SCR and mill and fill treatments in the database. This finally led to lower IRI survival probabilities for the two treatments.
- According to a multivariate analysis, traffic level was not a significant factor for reflective cracking. Higher trafficked roads even demonstrated a lower probability of reflective cracking failure.

The results of the project-level analysis, which focused on the structural condition of existing reflective cracking treatments, showed the following:

- SWM was a viable method for in situ material characterization of pavement systems. Portland cement concrete (PCC) modulus values from the SWM compared well with the FWD results on traditional composite pavement.
- The effect of SWM low-strain amplitude was evident in the measurement of the modified rubblization layer. The SWM moduli were typically two to three times higher than the values predicted by the FWD.
- SWM was used effectively to determine the moduli of thin rock interlayers, while the FWD method had difficulty in measuring and back-calculating the thin layer moduli.
- Among the four treatment methods, the crack and seat treatment had the highest moduli, followed by the modified rubblization layer. The full rubblization layer and the rock interlayer give similar, but lower, moduli.
- Field performance data showed that the traditional composite pavement site had the highest amount of reflective cracking. A moderate amount of reflective cracking was observed for the full rubblization projects. Poor subgrade soil properties could be the reason to use rubblization.
- CIR clearly exhibited an overall performance improvement for the first 12 to 14 years post-rehabilitation. Data are currently insufficient because the PMIS does not contain projects greater than 14 years old.

Implementation Readiness and Benefits

This project demonstrated that increasing the new pavement thickness was effective in retarding reflective cracking propagation for all four treatments. The removed pavement thickness did not significantly affect the survival probability.

Although the literature showed that subgrade soil properties can influence the use of rubblization in the field, this project did not observe these properties because modifying the rubblization pattern to compensate for weaker subgrades is already commonly performed by practitioners.

After assessing both the modulus and pavement performance of the existing reflective cracking mitigation treatments, this project recommends that the rock interlayer and modified rubblization methods be used in the field.

A steady increase in the use of CIR for pavement rehabilitation has highlighted the need for a performance review of the CIR pavements on the Iowa network. CIR performance data show an overall improvement in pavement performance post-rehabilitation. This information can be used to aid future decision making for pavement rehabilitation at the network level.