INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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Initial Study for Cost-Effectiveness of Joint/Crack Sealing

Introduction

The sealing and resealing of joints and cracks in concrete (PCC), asphalt (HMA) and composite pavements is assumed to be an important component of pavement maintenance and restoration and is one of the more commonly performed pavement maintenance activities. If performed effectively and in a timely manner, it is accepted that joint and crack sealing will help to reduce pavement deterioration and thereby prolong pavement life. One objective of the sealing is to reduce the amount of moisture that can infiltrate a pavement structure, thereby reducing moisture-related distresses. The second objective is to prevent the intrusion of incompressible materials into joints and cracks. It is believed that this will eliminate clogging thereby reducing harmful contraction and expansion pressure which may lead to further deterioration of joints and cracks. Therefore, pressure-related distresses, such as pumping and loss of support in PCC pavements and stripping in HMA pavements, are prevented.

In the past several years, the cost-effectiveness of crack and joint sealing has been questioned, at least in some applications. Additionally, studies that support a clear, quantitative defense that the practice is cost-effective appear to be few in number and limited in scope. Research conducted by the Wisconsin Department of Transportation (WDOT) on jointed concrete pavements over an extended period of time led that agency to discontinue joint sealing of PCC pavements. The agency claims to have saved 6 million dollars annually with no loss in pavement performance and with increased customer safety and convenience.

INDOT currently spends approximately 4 million dollars annually to accomplish crack and joint sealing. About one-half of this amount is allocated for sealing old pavements that are selected through a subjective process. There is no quantitative evidence to justify this expenditure. The sealing operations are conducted because industries assumed that the benefits of sealing weigh out the costs.

The primary objective of this research was to investigate the cost-effectiveness of joint/crack sealing in relation to pavement performance. This study focused on two specific questions:

1. Does joint/crack sealing improve the service life or serviceability performance of pavements (performance); and
2. If sealing does improve performance, is it cost-effective and in what situations?

These questions can only be effectively addressed through a rigorous review of the literature, a survey of practice, and finally the design and analysis of a field experiment. The potential outcomes will have immediate application to INDOT operations. It is hypothesized that the cost effectiveness of sealing is conditional and the final results of this study will identify those applications for which it is cost-effective. The results will then be formulated into a set of guidelines for implementation by maintenance and design personnel. The potential savings associated with this research could very well amount to a significant portion of the 4 million dollars now spent annually on joint and crack sealing by INDOT.

The study was divided into two phases. The first phase was a literature review and a synthesis of the current practice, intended to form a basis for determining whether or not further research was needed to determine the cost effectiveness of crack/joint sealing in Indiana. Based on the results of Phase I, Phase II involved an elaborate design of experiment, implementation of the design at in-service pavements, and monitoring the experimental sections.

Findings

The literature review considered over one hundred potential references and revealed that only eighteen specifically discussed cost-effectiveness of joint/crack sealing. Of these only four provided useful quantitative information related to the cost-effectiveness of joint/crack sealing. The statistical analysis of the practice survey results also showed that most of states, including Indiana, do not have quantitative justification for sealing policies nor do they know the cost-effectiveness of these operations. The literature review, as well as the survey of practice clearly indicated the need to develop and conduct a field study to answer the question of whether joint/crack sealing is cost effective in Indiana.

An experimental design for a field study was developed through a series of meetings with pavement technologists and a statistician. Nineteen test sites were selected under the principle that the chosen test sites must conform as closely as possible to the proposed experimental design. Both sealed and unsealed sections in each test site were rigorously maintained throughout the duration of the approximately two-year performance monitoring period. Pavement performance was monitored periodically during the field study. Performance response variables include International Roughness Index (IRI), Falling Weight Deflectometer (FWD), load transfer, individual pavement stress (condition survey), and physical and mechanical properties of pavement cores. A statistical model was developed to compare the pavement performance between sealed and unsealed sections for three pavement types, concrete, asphalt and composite. The results from two years of FWD measurements indicates that there appears to be no significant difference between the performance of sealed and unsealed sections, regardless of pavement type, drainage condition and road classification.

A three dimension finite element pavement model is developed to evaluate the effect that FWD test location has on load transfer measurements. This model consists of four dowel jointed concrete slabs supported by base and subgrade. Dowel bars are simulated using 3D mesh with one fixed end one lubricated end. To simply the simulation, it is assumed that all materials used in the model are elastic, and the FWD load is static. FWD tests are simulated at different locations to evaluate the effect test location has on the load transfer measurement. Based on both simulation and field measurements, it was concluded that FWD test location has no significant effect on FWD deflection.

Since pavement temperature may significantly affect the FWD deflection for both PCC and asphalt pavement, the effect of temperature is evaluated by statistical analyses based on a sample of FWD deflections collected at different temperatures at five research test sites. It is concluded that no temperature correction is recommended for FWD deflections and load transfer measurements for PCC pavement. A correction factor can be used to properly correct the FWD deflection within a certain temperature range for asphalt pavements. No correction is considered for load transfer across an asphalt crack.

Implementation

It is highly recommended that this research be extended for a ten years long period of time. Currently available researches indicate that there is no significant difference between the performance of sealed and unsealed sections, regardless of pavement type, drainage condition and road classification. However, it should be noted that only two years of data has been collected. No cost-effectiveness analysis for joint/crack sealing can be conducted with these limited pavement performance data and statistical analysis. The monitoring of the pavement test sites needs to be continued so that the long-term performance can be measured and additional conclusions can be drawn regarding the cost-effectiveness of joint/crack sealing.

It is also recommended that a more comprehensive study for temperature effect on FWD deflection be conducted. The temperature correction factor for FWD deflection on asphalt pavement is provided in this research. However, no pavement temperature gradient research is available in Indiana, and the statistical analyses of temperature correction factors are based on limited data collected from five test sites. Further research will be able to develop prediction models for pavement temperature in Indiana, and provide more reliable temperature correction factors for FWD measurements.

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