Joint Transportation Research Program

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Synthesis: Accelerating Implementation of Research Findings to Reduce Potential Concrete Pavement Joint Deterioration

Introduction

Over the last several years, the Indiana Department of Transportation (INDOT) initiated multiple research projects focused on identifying the origins and failure mechanisms responsible for premature joint deterioration in concrete pavements, as well as on the development of potential guidelines for eliminating or slowing down this distress. Similar studies have been performed by other states or groups of states through the pooled fund study mechanism.

A number of potential causes and mechanisms responsible for the observed distress have been proposed, and a few methods have been suggested to detect, repair, or potentially mitigate this distress. Unfortunately, to date no unified, comprehensive approach has been developed to document the steps and design changes needed to implement revisions for the construction or maintenance of these joints.

The objective of this study was to develop a synthesis document that compiles and analyzes recorded laboratory and field experiences related to concrete pavement joint deterioration. The findings serve as a basis to develop recommendations for potential joint damage detection, repair, mitigation, and preventive techniques that can be used to eliminate—or at least substantially reduce—the occurrence of joint deterioration in the future.

The intent of this synthesis is to advance the knowledge and understanding of the variables involved in joint deterioration and suggest best practices that can lead to its reduction or mitigation.

Findings

The following primary issues emerged from analysis of the joint deterioration studies presented in this synthesis: the importance of the timing of joint sawing, the width of the joint opening, the degree of concrete or joint sealing, drainage and the degree of saturation of the concrete at the joint, the quality of the air void system, the role of deicing chemicals, the quality of curing, and the degree of restraint at the joint. Although this broad collection of issues implies that we still lack full understanding of all causes of joint deterioration, it also makes clear that the observed damage results from a combination of several factors that can be generally classified into two broad categories:

1. classic freeze-thaw damage due to increased levels of saturation for pavement joints with no or low salt concentrations, and
2. chemical reactions between chloride bearing salts (especially $CaCl_2$ and $MgCl_2$) and the cementitious matrix (specifically calcium hydroxide, $Ca(OH)_2$) for high salt concentrations.

The following list provides a short summary of the main findings from the previous projects. The numbers in parentheses at the end of the individual list entries identify sections of the synthesis document (this report) that provide the specifics of these findings.

1. Increase the Specified Volume of Air Entrainment and Reduce the Variation in Air Content (3.1)
2. Reduce the Volume of Cementitious Paste in Concrete Pavements (3.2)
3. Reduce the Values of Water-to-Cementitious Materials Ratio Used in Concrete Pavements (3.3)
4. Use a Formation Factor to Specify the Transport Properties of Concrete (3.4)
5. Use Supplementary Cementitious Materials (SCM) to Reduce Susceptibility to Salt Damage (3.5)
6. Use a Topical Treatment for Concrete That Repels Water or Seals the Concrete (3.6)

7. Reduce the Tie Bar Size and Spacing to the Necessary Level (3.7)
8. Remove the Backer Rod or a Cavity in the Design of Pavement Joints (3.8)
9. Consider the Use of Unsealed Joints (3.9)
10. Use a Capillarity Break Below the Pavement (3.10)
11. Reduce the Strength Required to Open a Pavement to Traffic (3.11)
12. Increase the Use of Maturity to Accept Concrete Pavement at Early Ages While Long-Term Strength Is Used in Design (3.12)
13. Improve the Use of Methods to Detect Water Ponding in Concrete Pavements (3.13)
14. Examine the Proportion of Salts in Blended Systems (3.14)

Implementation

This project was intended to be a state-of-the-art synthesis on concrete pavement joint deterioration. The findings presented in this report will allow INDOT to benefit from a systematic review of numerous study results and will prevent duplication of efforts, resulting in potential cost savings.

The preliminary results from this study were presented to INDOT personnel in the form of technical recommendations at the Joint Deterioration Workshop held on April 27, 2015 (see Appendix to report). Following the workshop, some of the suggested recommendations were implemented (e.g., a change in the types of deicing salts used). Implementation of other findings will require joint efforts between INDOT and contractors, resulting in specification changes. Premature joint deterioration significantly impacts a wide range of issues, from the selection of the type of pavement material, to the cost of pavement repair and maintenance, to the cost to the user. To avoid costly mistakes, this problem must be addressed through the systematic process of making fact-based decisions regarding all aspects of pavement construction and maintenance. The numbered list provided in the Findings section above serves as a starting point for implementation activities. The options listed there can be used either independently or in combination to address specific technical issues.

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