



INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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Mid-Panel Cracking of Portland Cement Concrete Pavements in Indiana

Introduction

Portland cement concrete slabs are a common form of highway pavements in Indiana. As a result of their widespread use, the economic impact of their maintenance and life span is therefore tremendous. In Indiana, these types of pavements have been experiencing premature random transverse mid-panel cracking. This phenomenon has been observed under a variety of environmental and traffic conditions. Also, it has been found that the cracking occurs in conjunction with the opening of the lanes to traffic, within months of construction.

Although, theories abound as to the causes for the random mid-panel cracking problem, such as usage (driving/passing lane) and sub-grade conditions, no repeatable experimental or analytical evidence has

been developed to explain this phenomenon. In an attempt to rectify the problem, INDOT made adjustments in the geometry of the concrete slabs. However, it was found that this change did not affect mid-panel cracking.

In this project, a research synthesis was carried out to determine exactly what the current state of knowledge on random transverse mid-panel cracking of Portland cement concrete pavements. This was accomplished by means of a comprehensive literature review of published works and through a survey of other DOT's. In addition, preliminary analyses were carried out to help further understand and confirm the findings from the research synthesis.

Findings

The results from the literature review indicate there is no one clear factor that can be identified as the major cause of transverse cracking of jointed plain concrete pavement. According to most researchers, the combined mechanisms of curling of the concrete slab due to temperature gradients, and fatigue due to repeated traffic loads, lead to the occurrence of the transverse cracks. In addition, the improper control of the shrinkage of the concrete in the early

stages of construction is also cited as an important cause of cracking in JPCP.

All states that used JPCP were surveyed -- thirty-three states responded. In addition, case studies received from Florida, Georgia, Nebraska, New Mexico, North Carolina, Ohio, and Virginia. Florida, Illinois, Indiana, Michigan, North Carolina, and Wisconsin, in-house all of which sponsored research projects relating to cracking of

JPCP. The survey responses indicate there is no one clear factor that can be identified as the major cause of transverse cracking of jointed plain concrete pavement.

Three factors that may affect the mid-panel cracking of JPCP have been studied in detail using the finite element analysis method. The first is the effect of the assumption of a nonlinear versus a linear temperature distribution over the concrete slab depth. The second is the effect of the stiffness of the soil subgrade, and the third is the effect of slab thickness. It has been found that the temperature distribution assumption has a major impact on the stress distributions in

JPCP. The assumption of linear versus nonlinear temperature distribution throughout the PCC slab was studied. It was found that the linear assumption is inappropriate for PCC pavement analysis. The effect of the stiffness of the soil subgrade was studied. Four different load cases were studied using three different subgrade materials. It was found that the stiffness of the soil subgrade has a moderate effect on the stress distribution in the JPCP slab. Three slab thickness values (12", 14" and 15") under three loading conditions were investigated. It was found that the slab thickness has a moderate effect in the maximum normal bending stresses.

Implementation

Although the state-of-the-art in pavement research and practice cannot conclusively predict the lifespan of a particular pavement, INDOT must be able to provide estimates for design and rehabilitation schedules based on predicted cumulative damage analyses. Therefore, INDOT requires the ability to perform accurate finite element analysis of JPCP subjected to a wide variety of wheel loads,

subbase/subgrade conditions, environmental conditions, and dowel bar interactions. The cumulative damage caused by these various effects need to be blended into a tool that provides a quick and accurate estimate for pavement life expectancy. The available tools do not fulfill this requirement. Thus, it is recommended that such a tool be developed.

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