National Concrete Pavement Technology Center

Effects of Early Entry Sawing on PCC Cracking

tech transfer summary

Early entry sawing can increase productivity and reduce costs for sawing operations, but the technique may delay joint cracking.

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RESEARCH PROJECT TITLE
Crack Development in Ternary Mix Concrete Utilizing Various Saw Depths

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Objectives

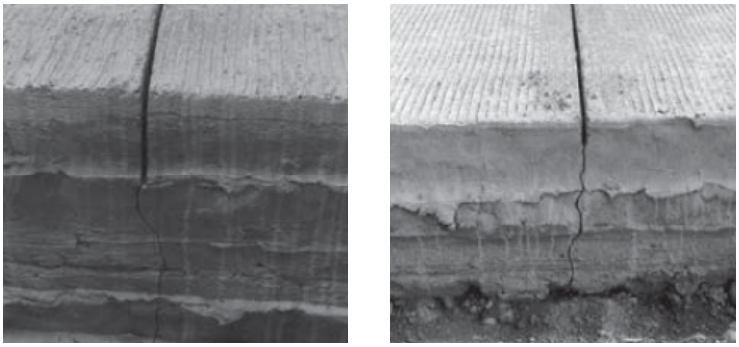
This study was designed to investigate whether delayed random cracking may occur in pavements constructed using early entry sawing. Because cracking is related to stress development in concrete, the specific objective was to examine the stress levels that develop at pavements' early entry sawing joints. The results of the study will help assess the risk of late-age random cracking in early entry sawed pavements.

Problem Statement

Saw cutting is designed to reduce random cracking in portland cement concrete (PCC) pavement by producing weak cross-sections and controlled cracks at desired (sawed) locations. These controlled cracks allow the concrete segments to deform or move freely, thereby reducing the stresses built up in the concrete and preventing late-age random cracking caused by shrinkage.

Early entry sawing, which uses a lightweight sawing machine to apply earlier and shallower cuts than conventional sawing, is believed to increase sawing productivity and reduce costs. Conventional sawing typically occurs 4 to 12 hours after paving and involves cuts about one-third or one-fourth of the pavement thickness. In contrast, early entry sawing usually takes place 1 to 4 hours after paving, and joints are cut to a depth of about one inch. Because the concrete is still relatively soft during early entry sawing, the manpower requirements and blade wear are also low.

For conventional sawing, joint cracking is generally observed within several days after sawing. However, some early entry sawing joints (transverse) in Iowa were found to experience delayed cracking, including delays of weeks or months after sawing. An urgent concern is whether early entry sawing could lead to late-age random cracking.



Cracked joints from different types of saw cuts: conventional sawing (left) and early entry sawing (right)

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Research Description

In this study, ten joints were made with the early entry sawing method to a depth of 1.5 in., and two strain gages were installed in each of the joints. Another ten joints were made with the conventional sawing method, five of which were sawed to a depth of one-third of the pavement thickness (3.3 in.), and the other five of which were sawed to a depth of one-quarter of the pavement thickness (2.5 in.). One strain gage was installed in each of the joints made with the conventional sawing method. In total, 30 strain gages were installed in 20 joints.

Geokon 4200 vibrating wire strain gage used in this study

Key Findings

- All 30 joints cracked within 25 days after paving. No random cracking was observed in the test section two months after construction.
- Most joints made using the early entry sawing method cracked later than the joints made with the conventional sawing method. The average joint cracking time for early entry sawing was 12.3 days. The average joint cracking time for the joints made with the conventional sawing method was 2.2 days for joints sawed to one-quarter of the pavement thickness and 0.6 days for joints sawed to one-third of the pavement thickness.
- The strain gages were capable of monitoring the deformations at the joints. The deformations were in the ranges of 0.0055–0.0622 in., 0.0012–0.0410 in. and 0.042–0.0458 in., respectively, for the sawings that were early entry, one-quarter pavement thickness, and one-third pavement thickness.
- The joint crack (or crack initiation) times measured by the strain gages were generally consistent with visual observations.
- After the joints cracked, the pavement expanded or shrank according to the daily ambient temperature. The average length change of a 20 ft long concrete slab was 0.025 in. due to the ambient temperature effect.

Test section joints showing different sawing depths: conventional sawing to one-third pavement thickness (left), conventional sawing to one-quarter pavement thickness (middle), early entry sawing (right)

Conventional sawing equipment

Early entry sawing equipment

Implementation Benefits

With the results of this study, the Iowa Department of Transportation (Iowa DOT) and the paving industry can identify potential late-age random cracking problems (if any) in pavements constructed with early entry sawing. The results may also help the Iowa DOT and paving contractors modify early entry sawing operations, for example, in terms of sawing depth and joint spacing for low-shrinkage concrete mix pavements.

Implementation Readiness

Only one concrete mix was studied in this project, and the shrinkage behavior of the concrete prior to cracking was not evaluated. These factors should be considered in future studies of pavement strain development and cracking potential.