National Concrete Pavement Technology Center

Thin Unbonded Overlay Performance on Composite Pavement

tech transfer summary

Analyzing design variables of thin unbonded overlays can help engineers design concrete pavement revitalization projects with optimum cost-effectiveness.

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RESEARCH PROJECT TITLE
Evaluation of Composite Pavement Unbonded Overlays: Phase III

SPONSORS
Iowa Highway Research Board (TR-478)
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The mission of the National Concrete Pavement Technology Center is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, tech transfer, and technology implementation.

ctre Center for Transportation Research and Education

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Objectives

The goal of this research project was to investigate the stability and durability of thin unbonded portland cement concrete (PCC) overlays over time. This project evaluates many independent design variables to gain information regarding the most cost-effective thin overlay designs for composite pavement.

Problem Statement

Previous asphalt concrete cement (ACC) resurfacing efforts have extended the design lives of many aging PCC pavements in Iowa and other states. Rather than continuing to revitalize these pavements with ACC overlays, however, engineers need concrete alternatives that provide longer life at a lower life-cycle cost. Recent studies on thin unbonded concrete overlays have substantiated them as a cost-effective option for the paving industry. Although the primary factors affecting thin whitetopping performance have been identified by previous research, questions still existed as to the optimum design incorporating these variables.

Project Description

The project consists of concrete widening and resurfacing along a 9.6-mile stretch of Iowa Highway 13 from Manchester, Iowa, north to Iowa Highway 3. Prior to new construction for this project, the two-lane driving surface was a 24-foot-wide ACC surface. Two ACC overlays covered the original PCC pavement surface. See Figure 1.

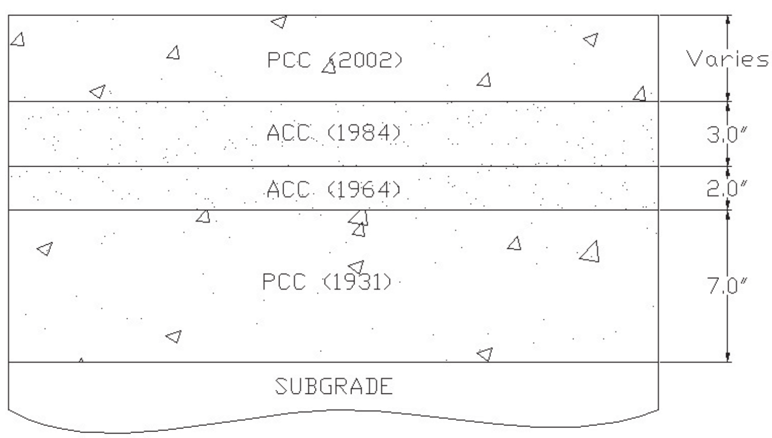

Figure 1. Pavement layers and dates of construction

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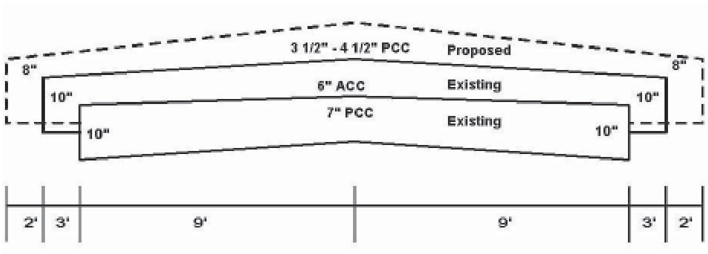

Figure 2. Cross section of the Iowa Highway 13 thin overlay project

With the new addition of a thin unbonded PCC overlay, the roadway surface is currently 28 feet wide with an 8-inch thickened edge on the outer 5 feet of each side. A thin concrete surface spans the middle 18 feet. See Figure 2.

Researchers designed 91 test sections within the project, each representing a stretch of roadway where variables, such as surface preparation and joint spacing, remained constant. Design variables considered in this project are displayed in Table 1.

For each test section, the following characteristics have been evaluated at varying intervals in the four years since completion of the new overlay: direct shear, load transfer, joint openings and faulting, visual distress, pavement profile, and weight of vehicles using this stretch of roadway.

Table 1. Design variables evaluated for the Iowa Highway 13 project

Design Category	Variables Tested
ACC surface preparation	Milled surface 1-inch-thick hot mix asphalt stress relief layer Broomed-only surface
Use of concrete fibers	Polypropylene fibrillated fibers Polypropylene monofilament fibers Proprietary structural fibers Without fibers
Pavement thickness	3.5 inches 4.5 inches
Joint spacing	Sections measuring 4.5 x 4.5 feet Sections measuring 6 x 6 feet Sections measuring 9 x 9 feet
Joint/crack preparation	Bridged with concrete Bridged with a #4 rebar stapled to the pavement surface

Key Findings

- Overlay depths of 3.5 inches or greater can be built without the use of fiber inclusion.
- Adding fibers to overlay depths of 4 inches or less will provide insurance against loss of materials in the event of an individual slab loss-of-support or multiple cracking.
- In overlays of 4.5 inches or less, structural fibers can provide an opportunity for larger slab sizes without subsequent loss of load transfer or increased cracking rates.
- Minimal scarification of the base asphaltic concrete surface is shown to be the most efficient way to control overlay quantities, assure proper cross slope, and minimize overlay thickness design while placing additional concrete in the rutted areas of existing surface.
- Maintenance personnel with normal materials and equipment can maintain the concrete surface when isolated panels fail under this design system.

Implementation Benefits

The results of this project and two others in Iowa indicate that a design process now exists to provide engineers with a cost-effective thin PCC overlay response to pavement rehabilitation needs.

Implementation Readiness

Since the design process for successful thin overlay projects has been developed, all that remains for this process is implementation and use. To improve our comprehension of thin overlay performance over time, the following actions should be taken:

- Shear Testing. Develop a protocol for testing the environment and handling materials to reduce variation in the results.
- Faulting. Review the relationships between faulting, panel size, and overlay depth for this type of overlay.
- Joint Openings. Future work should employ a more precise method of measuring joint openings, allowing for positive set of the caliper points and resisting salt action on the surface. This type of analysis should measure consecutive joints (3 or more) over the course of 72 hours or more to adequately represent the relationship between panel size and joint movements.