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Ultra-Thin PCC Overlays

tech transfer summary

RESEARCH PROJECT TITLE
Ultra-Thin Portland Cement Concrete Overlay Extended Evaluation (TR-432)

FINAL REPORT DATE
January 2005

SPONSOR
Iowa Highway Research Board
Iowa Department of Transportation

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KEY WORDS
interface bonding
portland cement concrete overlay
ultra-thin overlay
whitetopping

This research and the full report were contracted through Iowa State University's Department of Civil, Construction and Environmental Engineering. This technology transfer summary was prepared by the PCC Center at Iowa State University.

Objectives

- Evaluate conventional methods of slab removal and asphalt surface preparation for subsequent overlays of portland cement concrete (PCC) in the "remove and replace" areas.
- Evaluate existing asphaltic concrete surface under the "remove and patch" areas of rehabilitation areas and evaluate joint formation in the areas of patching.
- Evaluate polypropylene fiber enhanced concrete at the three-inch depth to determine the cost/benefit of its inclusion.
- Evaluate the performance of the rehabilitated ultra-thin whitetopping sections and the extended performance of the existing ultra-thin sections with and without patching.
- Validate existing ultra-thin whitetopping design procedures of the Portland Cement Association (PCA) and American Concrete Pavement Association (ACPA) for application in Iowa.

Problem Statement

The existing transportation infrastructure has aged to or past the design life of the original pavement design. In many cases, increased commercial traffic is creating the need for additional load carrying capacity, causing state highway engineers to consider new alternatives for rehabilitation of existing surfaces. Alternative surface materials, thicknesses, and methods of installation must be identified to meet the needs of individual pavements and budgets. With overlays being one of the most frequently used rehabilitation alternatives, it is important to learn more about the limitations and potential performance of thin bonded portland cement overlays and subsequent rehabilitation.

Research Description

This project extended over the five-year period. The first year involved the identification and rehabilitation of select areas of deteriorated whitetopping. The second through fifth years provided an evaluation period through which the performance of the pavement could be monitored. The section of Iowa Highway 21 chosen for research is a 24-foot-wide two-lane roadway, with 9-foot-wide granular shoulders and open ditch drainage. Test sections were tested annually with all tests being conducted during similar times of the day to ensure comparable results.

The testing consisted of performing falling weight deflectometer (FWD) tests, conducting visual distress surveys in accordance with the Strategic Highway Research Program (SHRP), and obtaining core samples for a shear analysis of interface bonding.

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Research Description continued

Research staff from Iowa State University and the Iowa Department of Transportation (Iowa DOT) provided the support necessary for the testing program. ERES Consultants of Champaign, Illinois, performed FWD testing. The Iowa DOT Office of Materials Special Investigations Unit obtained the coring samples and conducted the shear tests.

Key Findings

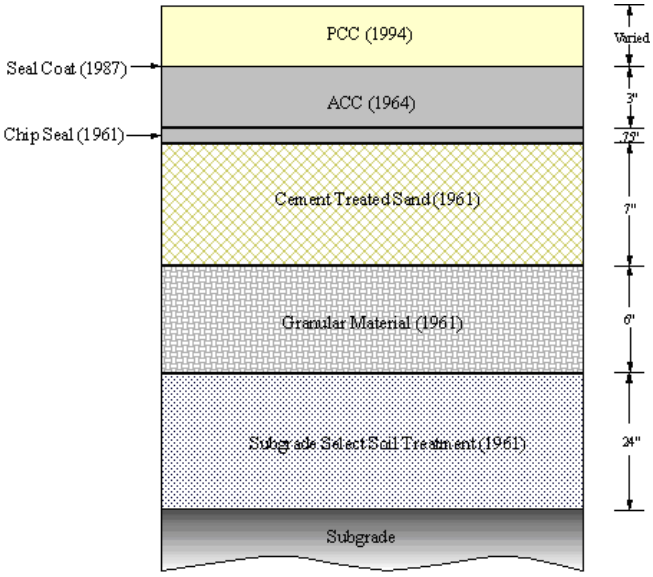
- Ultra-thin whitetopping exhibited exceptional performance (10+ years) and is an effective approach to pavement rehabilitation.
- Pavement deflections were significantly reduced with the addition of the ultra-thin overlays. Pavement deflections can be used to estimate the life of the overlay.
- Removal of all loose asphalt cement concrete (ACC) material in the partial depth patch areas is essential to patch performance and to bonding at the interface between the PCC and ACC layers.
- Milling the base asphalt provides the highest bond from construction through the present day.
- Conventional partial depth patch techniques proved effective in rehabilitation of distressed ultra-thin slabs.
- Patching and cold in-place recycle (CIPR) base preparation provide bond at construction and show improved bond over time.
- The two-inch overlay depth performs adequately under a stable base and provides good overlay depth control and good pavement drainage. The two-inch overlay depth is limited in slab size to 4′x4′ for good performance, which is enhanced through the addition of fibers for durability.
- The four-inch overlay depth performed well over slab sizes from 2′x2′ to 6′x6′. Fiber addition exhibited no improvement in performance.
- The research has verified that slab size for ultra-thin overlays is limited to a length/width in feet equal to two times the overlay depth in inches.
- Adequate pavement drainage is an important factor in ensuring dependable pavement performance under varying environmental conditions.
- Data from this study validate the PCA/ACPA and Colorado DOT/ERES design procedures.

Implementation Benefits

Successful implementation of ultra-thin portland cement concrete overlays as an alternative pavement rehabilitation technique will help meet the needs of individual pavements and budgets.

Implementation Readiness

- Alternative depths and slab sizes should be considered in various arrangements to best determine the most effective configuration.
- Installation of various fiber types under further variable configurations would be useful in determining when fiber reinforcement is most effective.
- The impact of various depths of stress reliever layers on the performance of overlays should be assessed.
- The correlation of climate changes and traffic loadings to shear strength development over time should be examined.
- The impact of increased traffic volumes and truck loading on existing designs should be investigated.



Pavement cross section

Measuring deflections with FWD and Road Rater