Holding Strategies for Low-Volume State Routes – Phase II

tech transfer summary

The results of this research help agencies develop strategies for highly distressed low-volume roads with composite pavements by assessing a variety of treatments that can lengthen the service life of a roadway for less investment than the costs associated with a major rehabilitation.

November 2020

RESEARCH PROJECT TITLE
Holding Strategies for Low Volume State Routes – Phase II

SPONSORS
Iowa Highway Research Board
(IHRB Project TR-735)
Iowa Department of Transportation
(InTrans Project 17-634)

PRINCIPAL INVESTIGATOR
Chris Williams, Director
Asphalt Materials and Pavement Program
Iowa State University
rwilliam@iastate.edu / 515-294-4419
(orcid.org/0000-0002-8833-6232)

RESEARCH ASSISTANT
Paul Ledtje, Asphalt Materials Laboratory Coordinator, Iowa State University
(orcid.org/0000-0002-2770-6922)

MORE INFORMATION
intrans.iastate.edu

Asphalt Materials and Pavements Program,
Institute for Transportation
Iowa State University
2711 S. Loop Drive, Suite 4700
Ames, IA 50010-8664
515-294-8103
ampp.intrans.iastate.edu

The Asphalt Materials and Pavements Program (AMPP) at InTrans specializes in improving asphalt materials and pavements through research and technology transfer and in developing students' technical skills in asphalt.

IOWA STATE UNIVERSITY
Institute for Transportation

Problem Statement

Low-volume rural roads are generally low funding priorities compared to the roads that are part of the National Highway System (NHS). Therefore, low-volume rural roads tend to deteriorate to a point where traditional pavement preservation and maintenance techniques either no longer have the desired effect or sufficient funding is not available for complete rehabilitation.

Objective

The main objective of this study was to assist the Iowa Department of Transportation (DOT) and local agencies in developing holding strategies for maintaining low-volume roads that are near the end of their service life to a satisfactory level in order to delay the larger expense of rehabilitating or reconstructing them. This second phase focused on treatments for highly distressed composite pavements that have asphalt overlays on portland cement concrete (PCC) pavements.

Background

The Iowa DOT approach to road maintenance has been to invest its limited resources in preventive maintenance that has the potential to further extend the service life of pavements, which has resulted in an improvement in average pavement condition at the network level for less investment. However, this strategy has led to challenges for low-volume traffic routes, where conditions are more critical due to their lower funding priorities.

Holding strategies, which could address these challenges, include the application of more intensive treatments than preventive maintenance with the aim of delaying major reconstruction projects. These treatments typically have lower costs but shorter service lives when compared to major overhaul projects.

Roadway test section showing application of holding strategy treatment

Project Description

The project team conducted several investigations prior to testing holding strategies. The pre-construction efforts included documenting current conditions and distresses by conducting pavement condition surveys and assessing field cores.

Eight test sections were constructed on US 65 between Hubbard and Zearing in Iowa in 2018. The test sections each studied different treatments to assess the proposed holding strategies. The treatments included cold in-place recycling (CIR) with hot-mixed asphalt (HMA) resurfacing, double course microsurfacing, milling, and high-performance overlays. The table summarizes the details for each test section.

US 65 holding strategy treatment section lengths

Section number	Surface preparation	Surface treatment	Section length (miles)
7 North	None	Double course microsurfacing	2.14
1	4.0 in. CIR	2 in. HMA surface mix	0.7
2	4.0 in. CIR	1.5 in. HMA surface mix	0.7
3	4.0 in. CIR	1 in. high-performance thin lift overlay	0.7
4	1.0 in. milling	1 in. high-performance thin lift overlay	1.0
5	1.0 in. milling	1 in. high ultra-thin lift overlay	1.0
6	2.5 in. milling	1 in. interlayer + 1.5 in. HMA surface mix	0.7
7 South	Grinding	Double course microsurfacing	2.26

Key Findings

Phase II

- Microsurfacing had little effect on the transverse cracking mitigation while reducing some of the longitudinal cracks present. In a survey two years post-construction, these sections saw comparatively little reduction in cracking density for the investment. It is expected that these sections will return to their pre-construction cracking densities at two to three years post-construction.
- All sections except 7 North and 7 South, both of which used double course microsurfacing, showed major improvement in both longitudinal and transverse cracking. In addition, all treatments with the exception of the two microsurfacing treatments have an estimated holding life of 10 or more years.
- The total cracking seen in the non-microsurfacing sections after two years initially appears to be related to the thickness of the treatment. The recycling technologies were the most effective treatments to prevent reflective cracking. The thin interlayer with ultra-thin asphalt overlay technologies showed excellent performance with a small amount of bottom-up cracking occurring.
- Sections 3, 4, and 5 performed the best, likely due to the high elastic recovery in the surface treatments of thin lift to ultra-thin lift overlays.
- In a cost analysis, Section 5 showed the best cracking performance two years post-construction at an investment per mile over the holding period of $7,256.99. Section 4 was next in the economic ranking at $7,792.53. Section 3 was third in the economic ranking.

Phase I, Six Years Post-Construction Survey

- The CIR and full-depth reclamation (FDR) sections showed the lowest amount of transverse and longitudinal cracking after five years, with a reduction of more than 92% in transverse cracking and more than 97% in longitudinal cracking compared to the pre-construction survey.
- The CIR and FDR sections also had among the lowest equivalent annual costs.
- The six-year post-construction findings support the unpublished Phase I report's conclusion that the recycling technologies, including CIR and FDR, were the most effective treatments for mitigating reflective cracking.

Conclusions and Recommendations

Phase II Conclusions

- Treatment thickness was related to lower one-year transverse cracking regardless of treatment type.
- Double microsurfacing had no effect on transverse cracking.
- All surface treatments applied corrected the longitudinal cracking to a higher degree than the transverse cracking.
- The deterioration rate of each treatment is yet to be determined.

Phase II Recommendations for Future Research

- Additional pavement condition surveys over the life span of these treatments are necessary to evaluate the long-term performance of the individual treatments. The method proposed is a multi-year post-construction pavement survey evaluation that will track the combined cracking density and compare it to the initial investment by treatment.

Phase I Conclusions and Recommendations

- Reflective transverse cracking is the primary early-age distress type for the holding strategy treatments involved in this study.
- The effectiveness of the methods to prevent reflective cracking, from the most effective to the least effective, are as follows: CIR or FDR, high-quality asphalt material or thick asphalt lift thickness, an additional chip seal layer, and 1 in. milling.
- CIR or FDR with a thin asphalt overlay and CIR with a double chip seal provide a comparable service life to a new asphalt pavement, but with lower construction and life-cycle costs. These treatments can be used as a lower-cost alternative to traditional rehabilitation treatments.
- The functionality of the chip seal is comparable to that of the asphalt surface from a safety perspective. However, chip seals can lead to an increased noise level and tire wear. In addition, a chip seal applied on an FDR layer may require frequent maintenance activities and increased maintenance costs, and a chip seal applied on a milled pavement surface on an urban street can be vulnerable to damage from snow plowing.
- FDR with a double chip seal and an interlayer with an ultra-thin asphalt overlay are recommended to use as holding strategies to postpone major rehabilitation or reconstruction.
- An asphalt overlay of less than 2 in. without an aggressive base preparation treatment can result in considerably higher life-cycle costs than the traditional rehabilitation method. This method is not recommended as a holding strategy.

Implementation Readiness and Benefits

The research results will help local agencies and the Iowa DOT to develop strategies and find the appropriate treatments beyond preventive maintenance to lengthen the service life of low-volume roads without the investment needed for a complete rehabilitation.