2016-14TS
Published May 2016

LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

Technical Liaison:
Tim Stahl, Jackson County
Tim.Stahl@co.jackson.mn.us

Project Coordinator:
Dan Warzala, MnDOT
Dan.Warzala@state.mn.us

Principal Investigator:
Charles Jahren, Iowa State University

LRRB PROJECT COST:
$64,130

The decision tree for selecting cost-effective pavement rehabilitation choices includes input from rut depth measuring devices.

MINNESOTA DEPARTMENT OF TRANSPORTATION

RESEARCH SERVICES & LIBRARY
OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

In-Place Recycling and Reclamations Offer Cost-Effective, Durable Solutions to Rural Road Rebuilds

What Was the Need?

Rural roads face less traffic, but not necessarily lighter loads. One county engineer explained that farmers driving their own equipment account for one-quarter of the semitruck traffic in southern Minnesota. Heavy equipment damages roadways. Counties face this the way state agencies face it: They seek cost-effective ways to coax more life from existing roadways.

For rural asphalt roads, strategies for lengthening roadway life range from grinding structures up into a kind of gravel road to fully rebuilding by grinding the pavement, hauling it to a plant, remixing it into new asphalt and hauling it back to be laid as new pavement. More commonly, crews mill off 1 or 2 inches of asphalt and lay a 3- to 5-inch layer of asphalt over the rough surface. Over time, cracks from below reflect through to the surface, and each new mill-and-fill layer raises the road and makes it narrower. Cost-effective, long-term solutions remain elusive.

Rural roadways get less traffic, but it often consists of heavy loads. Fully reconstructing damaged roads is expensive, but mill-and-fill also presents problems. Cold in-place recycling and full-depth reclamation with chip seals are cheaper than reconstruction and offer lower lifetime costs.

Reclaiming pavements appears less costly. Full-depth reclamation, in which the entire pavement is removed, ground and mixed on-site with asphaltic material to be laid down again as a stabilized base material, can save $70,000 per mile over full removal and rebuild. Cold in-place recycling, another option, works well on less-damaged roads; CIR takes off the top 2 to 4 inches of pavement, mixes that with asphaltic material and lays it back down as a new asphalt layer. Both CIR and FDR save money in terms of time, hauling expense and use of asphaltic materials, and in varying degrees destroy existing pavement distress patterns that might otherwise reflect through the structure into the new pavement.

These approaches require new surface layers. A thin layer of asphalt produces a good driving experience, but is expensive; chip sealing (covering with a fine layer of asphaltic material followed by a fine aggregate cover) is safe and less expensive than an asphalt layer, but can create a noisier, rougher driving experience.

What Was Our Goal?

Investigators sought to determine how well FDR and CIR perform with different surface layers, and how much they cost in terms of durability and performance. Research centered on pavement sites in Minnesota and neighboring states, evaluating CIR and FDR with chip seals in some cases and with asphalt surfaces in others. Performance was correlated with maintenance and installation costs for life-cycle cost analysis.

What Did We Do?

The investigation began with a literature search of practices, mix designs and performance studies of FDR, CIR and various surface treatments. The research team surveyed all 87 Minnesota counties, reviewed responses and followed up with select respondents in phone interviews. Investigators then selected 15 sites at five locations in Minnesota, Iowa and North Dakota for field evaluation. These sites employed CIR and FDR, some

continued

"With 85 different county engineers, people get to their decisions about road repair in different ways. This report was very helpful. It speeds up the search and the decision-making process about in-place recycling options."

—Tim Stahl,
Jackson County Engineer

"Using CIR or FDR with a chip seal puts another tool in the toolbox. When people are looking at what they can do with a rural road, they don't look at enough alternatives. This offers one more option; it's not a Cadillac treatment, but a Chevy treatment that might work quite a bit of the time."

—Charles Jahren,
Professor, Iowa State University Department of Civil, Construction and Environmental Engineering

Produced by CTC & Associates for:
Minnesota Department
of Transportation
Research Services & Library
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research

CIR trains like this one allow crews to grind up the top few inches of a pavement, mix the material with new bituminous material, and lay the new mix down in one pass to provide a long-lasting, new asphalt structure.

of each with thin asphalt surface courses and some with chip seal surfaces. Researchers followed performance evaluation with 30- and 50-year life-cycle cost analysis of CIR and FDR with each surface treatment compared to a conventional mill-and-fill approach.

What Did We Learn?

Fifteen of the 16 counties that responded to the survey have used FDR for pavement rehabilitation, and four have used CIR. The most common approach in Minnesota to surfacing FDR and CIR pavements is to use an asphalt overlay; however, chip seals are occasionally used.

Field sites featured pavements reclaimed from 1998 to 2014. Asphalt overlays varied from 1.5 inches to 4 inches. Site investigations showed that:

- Reclamation strategies worked, extending pavement life with at least satisfactory performance.
- All sections showed good roughness and no noticeable rutting.
- Asphalt overlays showed lower roughness than chip seals.
- All sites had good ride quality, with mostly good Pavement Quality Index ratings.
- The most common distress found at all sites was transverse cracking.
- The long-term performance of on-site recycling with asphalt overlays compared well with newly constructed asphalt, which expects 25- to 30-year life spans.
- Estimated life spans for treatments were 19 years for CIR with chip seals and 17 years for FDR with chip seals.

CIR and FDR offer lower equivalent annual costs than mill-and-fill with 4-inch overlays, showing 12 to 35 percent savings for 30 years and 14 to 42 percent for 50 years. FDR and CIR with chip seals offered lower EQAC and higher benefit-to-cost ratios than with asphalt overlays, but asphalt offers quieter and more visually appealing surfaces for most road users, which may impact perception of roadway performance.

What's Next?

Researchers delivered a decision tree for engineers to refer to when considering asphalt rehabilitation alternatives. The tool considers existing pavement distress types, construction and maintenance costs, constructability, treatment life expectancy and user demands. The decision tree is available to county engineers, and no further research appears necessary.

This Technical Summary pertains to the LRRB-produced Report 2016-14, "Alternative Design Methods to Renew Lightly Traveled Paved Roads," published March 2016. The full report can be accessed at mndot.gov/research/TS/2016/201614.pdf.