2018-33TS
Published January 2019

LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

Technical Liaison:
Guy Kohlnhofer, Dodge County
Guy.Kohlnhofer@co.dodge.mn.us

Project Coordinator:
Thomas Johnson-Kaiser, MnDOT
Thomas.Johnson-Kaiser@state.mn.us

Principal Investigator:
Charles Jahren, Iowa State University

TOTAL PROJECT COST:
$126,991

LRRB COST:
$76,992

A DCP tested the strength of the recycled pavement base.

DEPARTMENT OF TRANSPORTATION
RESEARCH SERVICES & LIBRARY

Stabilized Full-Depth Reclamation Increases Roadway Strength

Researchers found that stabilized full-depth reclamation has produced stronger roads for commercial loads in Minnesota, and the method shows promise for uses in rural agricultural areas. How much greater the strength gained with each stabilizing agent is better understood, though not conclusively.

What Was the Need?

With stabilized full-depth reclamation (SFDR), roadway builders pulverize and mix old (hot-mix or bituminous) pavement and on-site base aggregate with asphalt to create a new, thick layer of partially bound base over the remaining aggregate base of the former roadbed. The process eliminates the cost of hauling away old pavement and hauling in new, expensive aggregate, which is in limited supply.

Cracking and other damage in older pavements usually reflect through new asphalt and concrete overlays. SFDR roads, on the other hand, tend to avoid reflective cracking while meeting the increasing load demands of an aging roadway system in reduced funding environments.

To make a road stronger and more resistant to damage from heavy loads, most rehabilitation approaches require a thicker and wider roadway. SFDR may offer a way to build stronger roads without widening the road and without transporting old material from the road site and hauling new aggregate to the location.

In 2016, performance requirements of SFDR edged MnDOT and the Local Road Research Board (LRRB) closer to design standards for the technique by establishing testing, modeling and analytical methods for evaluating SFDR mixtures. Minnesota designers lack a method for giving SFDR designs structural design ratings to quantify how well the mixture will meet the needs of a new roadway. How much strength is gained by mixing in a stabilizer and laying the reclaimed road as a thick asphalt pavement base before adding the overlay remains unquantified.

What Was Our Goal?

Most replacement roadways need to be capable of bearing heavier commercial and agricultural loads than the original roads. Researchers sought to determine the structural value of SFDR in mixtures employing various stabilizing agents to help designers better accommodate rehabilitation and increased loading needs with SFDR.

What Did We Do?

Researchers visited 19 Minnesota road sites to look at 24 pavement sections and surveyed pavement conditions, cracking and potholing for each segment. The team conducted stability testing with a dynamic cone penetrometer (DCP) at each section and removed three pavement cores from each for laboratory testing.

SFDR pavement can be difficult to properly core, and most specimens failed before laboratory testing. Researchers conducted tests of dynamic modulus in a way that simulated high and low vehicle speeds in the lab on the surviving 14 samples. The tests simulated the movement of wheels over pavement surface and examined the resiliency of the pavements in springing back from these rolling loads.

Based on these results, researchers plotted the laboratory test results in mathematical curves. They then analyzed their findings while referencing flexible pavement design

continued

"We're really big on recycling, and we've been using SFDR and FDR for quite some time. We have increased confidence in SFDR. We just don't know how high that confidence should be."

—Guy Kohlnhofer,
County Engineer,
Dodge County

"We confirmed that what local engineers are doing has value, even if we weren't able to generate more optimistic numbers."

—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

A train of equipment runs on an SFDR site: a tanker of new asphaltic material connected to a reclaimer that pulverizes the old pavement and mixes in part of the road base and possibly stabilizing agents.

procedures using the concept of granular equivalents (GEs) that is familiar to many pavement designers in Minnesota. Finally, they estimated the structural difference between stabilized and unstabilized reclaimed materials and identified how the structural value varies with selected stabilization agents.

What Did We Learn?

Field surveys found roads performing well. Few of the pavement surfaces showed noticeable distress, and more recent surface coating treatments showed almost no distress over pavements in which distresses would quickly present themselves. DCP testing suggested that asphaltic stabilizers—asphalt, asphalt plus cement and modified asphalt—offered greater stiffness than fly ash and cement stabilization.

Lab testing suggested that while SFDR mixtures offer less stiffness compared to regular hot-mix asphalt (HMA) layers, their stiffness diminishes less in comparison to HMA for slow-moving heavy loads like seasonal agricultural equipment. SFDR is worthy of additional consideration as a base layer, in such loading environments.

The most critical goal for this study was to quantify the granular equivalency of SFDR mixtures with various additives to standard aggregate bases. Foamed asphalt and engineered emulsion proved the most structurally beneficial stabilizers; SFDR mixtures with these materials offered GE values of 1.46 to 1.55, confirming the general MnDOT approach that SFDR can be used for a GE of 1.5. If road builders pulverize 4 inches of asphalt roadway with 4 inches of base aggregate and add foamed asphalt or emulsion stabilizer, the 8-inch asphalt base offers the strength of a 12-inch aggregate base. A pavement of HMA or portland cement concrete can follow to create a roadway section with greater strength than a roadway section with the same thickness of nonstabilized base.

What's Next?

SFDR performs well in the field and shows particular promise for use on rural roadways subject to seasonal, heavy agricultural loads. Researchers confirmed current GE inputs for SFDR and documented the performance of specific stabilizer options employed in Minnesota. Continued monitoring of SFDR road performance and additional testing and analysis would add more detail to design procedures and provide designers with greater confidence.

This Technical Summary pertains to LRRB-produced Report 2018-33, "Field Investigation of Stabilized Full-Depth Reclamation (SFDR)," published November 2018. The full report can be accessed at mndot.gov/research/reports/2018/201833.pdf.