



TECHNICAL SUMMARY

Technical Liaisons:

John Brunkhorst, McLeod County
john.brunkhorst@co.mcleod.mn.us

David Linell, Mn/DOT
david.linell@state.mn.us

Administrative Liaison:

Dan Warzala, Mn/DOT
dan.warzala@state.mn.us

Principal Investigators:

Eddie Johnson, Mn/DOT
Jim McGraw, Mn/DOT
Roger Olson, Mn/DOT

PROJECT COST:

\$30,789



Counties provided 6-inch-diameter wear and nonwear course core samples for the evaluation of dynamic modulus and other properties.



RESEARCH
SERVICES SECTION

Best Practices for RAP Use Based on Field Performance

What Was the Need?

Recycled asphalt pavement has been recovered from existing roads, crushed and filtered, and can be mixed with asphalt binders as part of a fresh hot-mix asphalt mixture. RAP is frequently used in many states—including Minnesota—in the base layer of asphalt pavements as a cost-effective and environmentally friendly way of building roads.

However, engineers have been wary of using RAP in the wear course, or top layer, of a pavement. Because the pavements from which RAP is reclaimed have already been subjected to harsh environmental conditions, including high temperatures and freeze-thaw, the behavior of asphalt pavements containing RAP is not as predictable as those without, and the pavements may be more prone to cracking and rutting. Because of these concerns, some Minnesota agencies using RAP exclude it from the wear course mixture.

What Was Our Goal?

The goal of this study was to determine whether asphalt pavements containing RAP in the wear course are prone to early failures.

What Did We Do?

Researchers first conducted a literature review and surveyed practicing local engineers from 52 Minnesota agencies to document the state's use of RAP in asphalt pavements. Survey questions focused on whether agencies used RAP in pavement design specifications, typical applications for which it was used and the effect of RAP on wear course performance. Researchers also asked about the percentages of RAP used for various applications, the most common performance grades of the asphalt binders with which it was mixed, and RAP recycling methods and stockpile management.

These survey results were used to select several construction projects for early performance monitoring. Selected projects included two bituminous overlay projects and four new pavement constructions reflecting current Minnesota practices and a range of field performance characteristics. After a period of service, researchers obtained wear course and nonwear course core samples from these sites and tested them for aggregate gradation, asphalt content and binder grade, specific gravity and dynamic modulus.

What Did We Learn?

Survey results showed that because of concerns about cracking, rutting and construction problems, roughly one-third of Minnesota agencies exclude RAP from wear course mixtures. Another survey result was that in Minnesota the most commonly used asphalt binders—in mixtures both with and without RAP—were performance grades PG 58-28 and PG 58-34. These typically included RAP at levels of 20 percent to 30 percent.

Field performance monitoring showed that PG 58-34 performed better than PG 58-28 during the early period of service of the selected construction projects. In one project, the use of 30 percent RAP with PG 58-28 binder led to extensive transverse cracking during the first winter of service, while in another the use of 20 percent RAP from the same source with PG 58-34 binder did not lead to early transverse cracks. While these pavements displayed popouts and spalling, another pair of projects using PG 58-34 binder with RAP from a contractor stockpile showed good performance during the first year, and only a few cracks in the RAP section during the second winter of service, suggesting that stockpile practices can affect performance.

“Lab results showed that we can be less conservative about our use of RAP in the wear course, and that binder grade is more predictive of performance than the percentage of RAP.”

–Eddie Johnson,
Research Project
Engineer, Mn/DOT
Materials and Road
Research

“This study should ease any concerns counties may have had concerning the use of RAP in pavement wear courses.”

–John Brunkhorst,
County Engineer,
McLeod County

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Minnesota Department
of Transportation
Research Services Section
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
(651) 366-3780

www.research.dot.state.mn.us



Dynamic modulus tests were used to evaluate various RAP mixtures over a range of temperatures.

Lab test results showed that with the exception of one project, the asphalt binders met high- and low-temperature performance grade design standards. In general, wear and nonwear course mixtures performed essentially the same, and field performance depended more on the dynamic modulus of underlying layers, which significantly affected the performance of the wear course. Field performance also depended more on the low-temperature performance grade of new asphalt binder in the mixture than on its percentage of RAP.

What's Next?

While survey results confirmed that many local engineers have concerns about using RAP in pavement wear courses, experimental results suggest that Minnesota agencies should consider revising their policies to allow RAP for this application. All RAP mixtures performed acceptably for rutting resistance, and results showed only a moderate relationship between the percentage of RAP in mixtures and the onset of early thermal cracking. Further, concerns about the low-temperature performance of pavements can be addressed during the mixture design phase by using low-temperature binders, whether or not the mixtures include RAP.

Researchers recommend using low-temperature performance grade -34 binders. They also recommend material control, including progressive RAP stockpile management techniques to increase recycling, attain high-quality designs and achieve optimum field performance. Stockpile management techniques include specifying the origin of source material, screening, and separating by particle size or asphalt content.

Further research is beginning using similar methods to analyze mixtures with higher RAP content and to determine best practices in the use of recycled shingles in hot-mix asphalt.

This Technical Summary pertains to the LRRB-produced Report 2009-15, “Best Practices for RAP Use Based on Field Performance,” published April 2009. The full report can be accessed at <http://www.lrrb.org/PDF/200915.pdf>.