



TECHNICAL SUMMARY

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PROJECT COST:
\$275,000



FRAP mixtures were produced using conveyor belts to combine coarse and fine fractions in the right proportions and then send them to a mixing drum.



RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

Evaluating the Performance of Fractionated and Nonfractionated Recycled Asphalt Pavement

What Was the Need?

To help save costs and reduce the impact of road construction on the environment, MnDOT uses recycled materials when possible. These materials include asphalt removed from existing roadways during repair or reconstruction. Reclaimed asphalt pavement has been widely used in the United States since the 1970s.

MnDOT and other transportation agencies limit the percentage of RAP that can be used in asphalt mixtures because RAP contains fine particles and aged asphalt binder that can adversely affect the performance of the new pavement. To improve its quality, RAP can be fractionated (separated into piles of different particle sizes using sieves) and then added to new mixtures in the proportions desired by engineers. The use of fractionated RAP allows engineers to more precisely control particle size in mixtures. Since smaller particle sizes have a greater surface area that require more asphalt binder to coat, controlling particle size also controls asphalt content. Using fractionation could allow the use of asphalt mixtures with a higher percentage of RAP while maintaining the same quality.

Using RAP is common as are laboratory evaluations of mixtures using RAP. However, there was little data about the field performance of pavements with RAP and little laboratory or field data on FRAP.

What Was Our Goal?

The objective of this project was to evaluate and compare the laboratory and field performance of RAP and FRAP by monitoring test cells at the MnROAD facility between 2008 and 2012.

What Did We Do?

Researchers studied two FRAP and nine RAP test cells constructed at MnROAD in 2008. RAP pavement cells varied in:

- Binder performance grade (64-34, 58-34 or 58-28), an indication of the temperature range in which the petroleum product that binds aggregate particles together is expected to perform well.
- The use of hot-mix asphalt or warm-mix asphalt; pavement thickness (3 or 5 inches); and percentage of RAP (0, 20 or 30 percent).

FRAP cells were 5 inches thick, consisted of 30 percent FRAP from two piles created using a ¼-inch sieve, and used either PG 58-28 or PG 58-34 binders.

Researchers conducted laboratory tests on the mixtures used in the construction of these cells to evaluate stiffness and resistance to cracking. They also evaluated the stiffness of binder extracted from mixtures and the amount of blending occurring between RAP and virgin binders—a factor that may affect performance.

The use of fractionated recycled asphalt pavement allows engineers to better control the quality of materials used in asphalt mixes, possibly leading to longer lasting pavements and allowing the use of greater percentages of RAP.

“Using higher percentages of RAP in asphalt mixtures will require a tighter control of material quality. Fractionation allows us to do that.”

—**Greg Johnson**,
Assistant Bituminous
Engineer, MnDOT Office
of Materials and Road
Research

“Continued monitoring of the MnROAD cells constructed for this study will tell us whether fractionation produces better long-term results for asphalt pavements.”

—**Eddie Johnson**,
Research Project
Engineer, MnDOT Office
of Materials and Road
Research



FRAP involves separation based on particle sizes. In this project, RAP was divided into two piles of finer (left) and coarser (right) particles.

After construction, researchers periodically evaluated MnROAD test cells over four years for visual distress, mapping the location and severity of cracking. They also evaluated ride performance, rutting, noise and friction, and structural performance, using a falling weight deflectometer to measure pavement deflections.

What Did We Learn?

Laboratory testing showed that extracted binders met or exceeded their expected performance. Mixtures with more RAP were more prone to fracture at higher temperatures, a finding partially validated by field performance results.

Field results showed that RAP, FRAP and other mixtures performed very well after four years of service, exhibiting few signs of distress. However, several cells exhibited transverse cracking despite an unusually mild winter, and one cell suffered from rutting.

The performance of RAP, FRAP and other test cells did not differ significantly when it came to distress, ride quality, structural characteristics, or noise and friction. RAP percentage and fractionation did not greatly influence low temperature cracking and did not influence ride performance more than seasonal variations and base material type. Structural performance changed little over four years and did not vary greatly between test cells. Researchers expect to observe greater differences as monitoring continues.

Fractionating RAP resulted in less blending than typical processes, with mixtures using PG 58-28 binders exhibiting better blending than those with PG 58-34 binders. It is possible that the mixtures using polymer-modified PG 58-34 binders were not sufficiently heated at the mixing plant to activate the binder in the RAP to blend with the virgin binder. For this reason, the warm-mix asphalt mixture showed the least amount of RAP and virgin binder blending of any of the mixtures at MnROAD.

What's Next?

Researchers will continue to monitor MnROAD test cells for field performance, and notable results will be reported on the [RAP task report Web page](#). Additional cracking is anticipated as the pavements are continually exposed to low temperature conditions. Researchers also recommend investigating other Minnesota mixtures to determine if the lack of blending between virgin and RAP binder in this study was an isolated incident.

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