



PUTTING RESEARCH TO WORK

# BRIEF

## Effects of Recycled Shingles and Increased RAP Percentages

As asphalt binder becomes more expensive, the use of recycled asphalt materials becomes more attractive. Recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS) offer a partial substitute for virgin aggregate and binder in asphalt pavement mixtures. Their use reduces the demand on natural resources, energy and landfill space as well as the cost of asphalt mixtures. The Federal Highway Administration increasingly encourages use of this green highway technology.

### What's the Problem?

Aged binders found in RAP and RAS do not perform the same as virgin binders. Their use can lead to stiffer pavements that can become brittle in the cold, causing an increased sensitivity to thermal cracking. WisDOT's 2010 specifications allow RAS as a binder replacement at 15 percent of the liquid in surface courses and 20 percent in lower courses. RAP can be used as a binder replacement at up to 25 percent in surface courses and 35 percent in lower courses.

To use RAP and RAS, mix designers rely on AASHTO Superpave specifications, which, among other things, evaluate the performance grade of the extracted recycled material. The practice works fairly well with RAP; however, it is less suited for RAS, which contains additional materials to extract and liquid that is much harder than traditional paving grade asphalt binder.

Trends suggest the demand for recycled materials in asphalt pavement will grow. Increased use of RAP and RAS according to current AASHTO methods, including the AASHTO mixture blending chart, concerns WisDOT because of the potential problems in effectively analyzing material according to AASHTO standards while trying to maintain performance standards.

### Research Objectives

The primary objective of the research was to evaluate the effect of recycled binders on the performance grade binder in mixtures containing RAP and RAS and to evaluate WisDOT's criteria for binder replacement. To effectively perform this evaluation, the research included the extension of current RAP blending chart analyses to RAS and to blends of RAP and RAS, and the characterization of RAP and RAS sources from Wisconsin.

### Methodology

Research entailed three study phases:

- Review WisDOT 2010 binder replacement criteria and research the AASHTO blending chart procedure to develop an experimental plan.
- Extend blending chart analysis to RAS and other binders, including combinations of RAS and RAP.
- Apply blending chart analysis to 18 recycled materials used in Wisconsin. These include 12 RAP sources and six RAS sources. The analysis included use of data from 170 weather stations throughout Wisconsin to assess the impact of increased use of RAP/RAS on the reliability of the low temperature performance grade of the asphalt binder.

### Results

Researchers developed a blending chart that works effectively with both RAP and RAS.

Wisconsin RAP from multiple sources and regions has similar performance grading properties, demonstrating little sensitivity to type of RAP binder or geographic origin. Geographic variation was more noticeable in recycled shingles with softer RAS found in sources from southern Wisconsin. Due to their higher stiffness RAS binders change properties of asphalt more rapidly than do RAP binders.

#### Investigator



*"The findings of this study show that WisDOT is currently allowing too much recycled binder in surface courses, but the agency can increase the percentage of recycled binder in the lower courses."*

—Ramon Bonaquist  
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Ground up asphalt shingles can be used as a partial replacement for expensive asphalt binders in pavement mixtures.



When used in the right proportions, crushed asphalt pavement and sorted asphalt shingles like these from residential roofs and sidings can be effective in asphalt pavement mixtures.

Project Manager



*“The biggest cost element of HMA is the asphalt binder. The more we defray the cost of virgin asphalt, the better and this study points us towards an improved effective balance”*

–Judie Ryan  
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Adding any recycled binders reduces the reliability of low-temperature performance grades; this impact is greater at locations already struggling with reliability of virgin binder. If exceptional quality virgin binders are used in these blends, reliability improves.

WisDOT 2011 allowable binder replacement for RAS and RAP indicated reduced low temperature grade reliability. At current maximum allowable replacement levels for surface courses, mixtures with RAS binders are expected to have significantly poorer performance in low temperature cracking than RAP mixtures, and RAP mixtures are expected to have poorer low temperature performance than virgin mixtures.

Based on these results, researchers recommend several practices for WisDOT, including:

- For surface courses, WisDOT percent binder replacement levels of RAS should be limited to 5 percent or less, and to 20 percent or less for RAP. For combinations of RAS and RAP, the RAP level should be reduced by 4 percent for every 1 percent of RAS used.
- For lower layers, RAS should be limited to 20 percent binder replacement or less, and RAP to 45 percent or less. For combinations of RAS and RAP, RAP should be reduced by 2.25 percent for every 1 percent of RAS used.
- Exceeding recommended recycled binder replacement levels can be permitted as long as methods from this study are applied to samples to demonstrate reliability at sites where they will be used.
- This study’s procedures should be applied to a random sampling of recycled binder sources in Wisconsin to keep abreast of variations in the performance of RAP and RAS binders. Through analysis of both recycled and virgin binders, this study’s reliability analysis can be updated for use in evaluating future mixes.

## Next Steps

The WHP Flexible Pavements Committee will communicate the results of this project to Bureau of Technical Services management. The committee will call for further evaluation and potential adoption to WisDOT’s Standard Specifications for three study results: (1) the adjusted mixing chart; (2) procedures to analyze alternative levels; and (3) recommended general replacement levels of RAS and RAP.

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*This brief summarizes Project 0092-10-06, “Effect of Recovered Binders from Recycled Shingles and Increased RAP Percentages on Resultant Binder PG,” produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research Program, P.O. Box 7915, Madison, WI 53707.*

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