Recycled Asphalt Shingles in HMA:
Effect on Binder Properties & Assessing Blending

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Outline

- RAS Blending Chart Problem
- Practical Solution
- Effect of RAS on Blended Binder Properties
- Mixing Analysis of RAS/RAP Blends
Blending Chart


% RAP Binder

Low Temperature Continuous Grade, C


RAP Binder

Virgin Binder

0 10 20 30 40 50 60 70 80 90 100

% RAP Binder

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RAS Issue

• Can’t Grade Recovered RAS Binder
  - Critical High Temp
    • > DSR Limit
  - Critical Low Temp
    • $S < \text{BBR Min. Temp}$
    • $m > \text{BBR Max. Temp}$
AAT’s Solution (PDA)

- Percent RAS Binder, %
- Low Pavement Temp Continuous Grade, °C

Virgin Binder

50/50 RAS/Virgin
Low Temp Grade

Graph showing the relationship between Percent RAS Binder, % and Low Pvmnt Temp Continuous Grade, °C.
Intermediate Temp Grade

Percent RAS Binder, % vs. Intermediate Pavement Temperature Continuous Grade, °C

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RAS/ RAP Blend

![Graph showing the relationship between Percent RAP Binder and Low Pavement Temperature Continuous Grade. The graph illustrates a linear increase in temperature as the percent RAP binder increases. The Virgin/RAS Blend is shown at a lower temperature compared to the RAP Binder.]
Selecting Recycled Content

Mixture Binder Content, %

Maximum RAP Content, %

- RAP Only
- 2 % Landfill RAS
- 3 % Landfill RAS
- 4 % Landfill RAS
- 5 % Landfill RAS
- 6 % Landfill RAS
- 7 % Landfill RAS
Effect of RAS

• 25 % RAS Binder
  – Low Temperature
    • One Grade Level Poorer
  – Intermediate Temperature Grade
    • 3 °C Higher
  – High Temperature Grade
    • Improves 2 Grade Levels

• Proper Virgin Binder Selection Key to Obtaining Acceptable Blended Binder Properties
Assessing Blending

• How Well Does the RAP Binder Mix with the New Binder?
• Process Specific
  - Plant Type
  - Plant Operations
  - RAS Processing
One Tool

• **Dynamic Modulus**
  
  – Test is Highly Sensitive to Binder Stiffness
  
  • Assess Degree of Mixing of New and Recycled Binders
  
  – Relatively Easy to Perform with the Asphalt Mixture Performance Tester
How?

• Perform Dynamic Modulus Tests on Plant Produced Mixture
  – Plant Mixed Condition

• Recover Binder, Test and Estimate Dynamic Modulus Using Predictive Model
  – Fully Blended Condition

• Compare Measured and Estimated
5 % RAS + 20 % RAP

Testing Condition

Dynamic Modulus, ksi

Measured
Estimated for Complete Mixing

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8% RAS + 20% RAP

Dynamic Modulus, ksi

- Measured
- Estimated for Complete Mixing

Testing Condition

- 4C, 10 Hz
- 4C, 1 Hz
- 4C, 0.1 Hz
- 20C, 10 Hz
- 20C, 1 Hz
- 20C, 0.1 Hz
- 40C, 10 Hz
- 40C, 1 Hz
- 40C, 0.1 Hz

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10 % RAS + 20 % RAS

Dynamic Modulus, ksi

Testing Condition

4 C, 10 Hz  4 C, 1 Hz  4 C, 0.1 Hz  20 C, 10 Hz  20 C, 1 Hz  20 C, 0.1 Hz  40 C, 10 Hz  40 C, 1 Hz  40 C, 0.1 Hz

Measured  Estimated for Complete Mixing

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Assessing Blending

• Possible to Obtain High Degree of Mixing of New and RAS Binders
• Changes in Processing/Plant Operations Needed to Use High RAS Contents?
Conclusions

• RAS/RAP Blends Can Be Used Effectively in HMA
• Requires Engineering Analysis
  – Select Appropriate Virgin Binder Grades and RAS Percentages
  – Degree of Blending of Recycled and Virgin Binders
Questions/ Contact

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