Issues for Mixtures with High RAP or RAS Content

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  – Independence Construction Materials
  – Reliable Contracting Company, Inc.
Why Do Agencies Limit RAP/RAS Content?

• Binder Grade Changes
  – Stiff Aged Binders
  – Roofing Binders
• Mixture Homogenity
• Variability of RAP Stockpiles
• Excessive Fines
• Aggregate Friction Properties
• Others?
Binder Grades

• RAP
  – < 15 % RAP, no grade change
  – 15-25 % RAP, one grade softer
  – > 25 % RAP, use blending chart

• RAS
  – No national guidance
PG Blending Chart (AASHTO M323)

- Provides a Good Estimate for Maryland RAP
  - RAP PG 82-16 to PG 94-16
  - Virgin binder properties are critical
  - Can often use 25% or more RAP without changing the binder grade

- Can Not Be Applied to RAS
  - Roofing asphalt is very different from paving asphalt
Blending Chart PG 94-16 in PG 64-22

HIGH TEMPERATURE GRADE

PG 70 Min Limit

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Blending Chart PG 94-16 in PG 64-22

LOW TEMPERATURE GRADE

% RAP

M320 Max Limit

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Blending Chart PG 94-16 in PG 64-22

INTERMEDIATE TEMPERATURE

% RAP vs. Tc (Intermediate) chart showing the PG 64-22 Limit.

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Mixture Homogenity

• How Well Does the RAP/RAS Binder Mix with the New Binder?
  – Black Rock
  – Complete Mixing

• Process Specific
  – Plant Type
  – Plant Operations
  – RAP/RAS Processing
One Tool

• Dynamic Modulus Data Can Be Used to Evaluate RAP and RAS Mixtures
  – Test Is Highly Sensitive to Binder Stiffness
    • Assess Degree of Mixing of New and Recycled Binders
  – Interpreted to Estimate the Effective Grade of the Combined Binder
  – Relatively Easy to Perform with the Simple Performance Test System
Simple Performance Test System

• Rugged
  – 4 Years in FHWA Mobile Asphalt Lab

• Technician Friendly
  – Automated Testing Cell
  – Easy to Install Instrumentation
  – Standard Software
    • Testing and Analysis
    • Data Quality

• Reasonable Cost
  – $55,000
How?

• Perform Dynamic Modulus Master Curve Testing on Plant Produced Mixture
  – Standard Test in Simple Performance Test System

• Use Mixture Modulus Data to Estimate Effective Binder Modulus
  – Hirsch Model
    • Mixture Modulus = f(Binder modulus, VMA, and VFA)

• Compare Estimated Binder Modulus to PG Requirements
Examples

- Compare Estimated Binder Modulus With Recovered Binder Modulus
  - Example 1. 9.5 mm Mixture With PG 64-22 Produced in a Batch Plant
  - Example 2. 9.5 mm Mixture with PG 64-22 & 5% RAS Produced in a Batch Plant
  - Example 3. 19.0 mm Mixture with PG 64-22 & 45 % Fractionated RAP Produced in a Double Barrel
9.5 mm With PG 64-22, Batch Plant

Binder G* (kPa) vs. Reduced Frequency (rad/sec) for binder from mix and recovered binder.
9.5 mm With PG 64-22 + 5% RAS, Batch Plant

Binder G*, kPa

Reduced Frequency, rad/sec

From Mix

Recovered Binder
19.0 mm With PG 64-22 + 45 %
Fractionated RAP, Double Barrel

Reduced Frequency, rad/sec

Binder G*, kPa

PG 64-22 With 45 % RAP
From Mix Modulus

PG 64-22 With 45% RAP
From Recovered Binder
Mix Design / Evaluation

• Perform Dynamic Modulus Tests on Plant Produced Mixture
• Estimate Effective Combined Binder Modulus
• Compare to Allowable Binder Modulus
  – Lower Limits to Guard Against Poor Mixing
  – Upper Limits to Guard Against Excessive Stiffening
Graphically

Reduced Frequency at 20°C, rad/sec

Binder G*, kPa

Low Temperature
Intermediate Temperature
High Temperature

PG 64-22
PG 70-22

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RAP Stockpile Variability

- Maryland Captive Stockpiles
- Same Plant – 1997 - 2004
RAP Stockpile Variability

2003

2002

2001

2000

1999

1998

1997

Percent Passing

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RAP Stockpile Variability

- 2003
  - Binder Content
  - Passing 0.075 mm

- 2002
  - Binder Content
  - Passing 0.075 mm

- 2001
  - Binder Content
  - Passing 0.075 mm

- 2000
  - Binder Content
  - Passing 0.075 mm

- 1999
  - Binder Content
  - Passing 0.075 mm

- 1998
  - Binder Content
  - Passing 0.075 mm

- 1997
  - Binder Content
  - Passing 0.075 mm

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RAP Stockpile Variability

- AC: 0.31
- 0.075 mm: 1.31
- 2.36 mm: 5.17
- 9.5 mm: 4.90

Standard Deviation
Further Processing

- Reduce Gradation Changes
- More Fines?
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• Others?
Questions?