

## Use of High Percentages of RAP

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## Overview


- Where are we at in RAP Usage?
- What is the current practice?
- What is the future of RAP to allow greater percentages?

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## Where are we at in RAP usage?


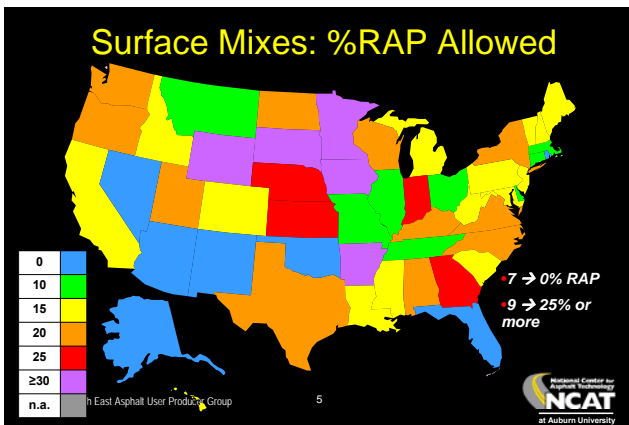
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## Survey of DOT's on RAP Usage

- Conducted by North Carolina DOT in 2007-2008
- How much RAP is allowed by specification for surface, intermediate, and base mixes?
- How much RAP are contractors actually using in the different mixes?
- What are the barriers to increasing RAP contents?


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## Current RAP Usage

- Typical RAP usage is between 10 – 15% in the surface.
  - How much do you use?
- Why is the typical use between 10-15%?
- Who is interested in going higher than 15%?

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## Superpave RAP Guidelines

- Tier 1: Up to 15% RAP
  - use specified grade
  - use  $G_{sb}$  of virgin material
- Tier 2: 15%-25% RAP
  - use one full grade lower, e.g., a PG 64-28 instead of a PG 70-22
  - estimate  $G_{sb}$  from  $G_{se}$
- Tier 3: Over 25% RAP
  - use blending charts to determine required grade
  - estimate  $G_{sb}$  from  $G_{se}$

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## Characterize RAP

- Need to know RAP properties
- Asphalt Content
- Stiffness of RAP Asphalt
- Aggregate Gradation
- $G_{sb}$

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## Asphalt Content

- Why is asphalt content of the RAP important?
  - RAP binder contribution
  - RAP binder reduces amount of virgin binder needed
  - Save money
- How is the asphalt content determined
  - Ignition oven
  - Solvent extraction

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## Asphalt Grade

- Why do you want to know the grade of the RAP asphalt?
  - Estimate blended binder properties
  - Evaluate stiffness
- How is the asphalt grade of the RAP determined?
  - Recovered binder is graded unaged
  - Many only grade when RAP exceeds 25%

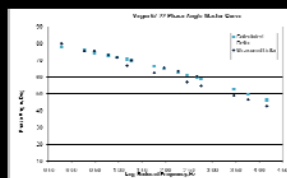
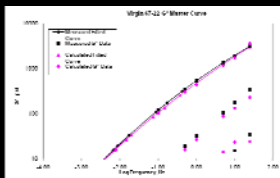
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## Future of Asphalt Grade

- Back calculate binder grade



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## Asphalt Grade, Cont.

- What do you do if the blended binder grade is too stiff?
  - Bump the virgin binder grade down
    - Example: PG 64-22 → PG 58-28

OR

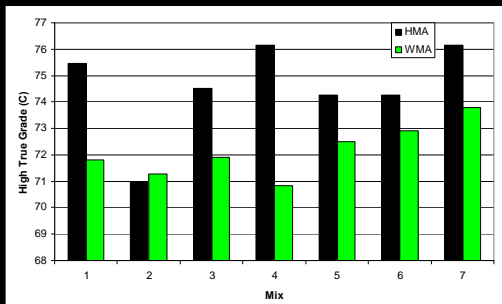
- Use a warm mix asphalt (WMA) technology
  - Reduced temperatures result in a less oxidized binder → a binder that is not as stiff after plant mixing

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### High True Grade

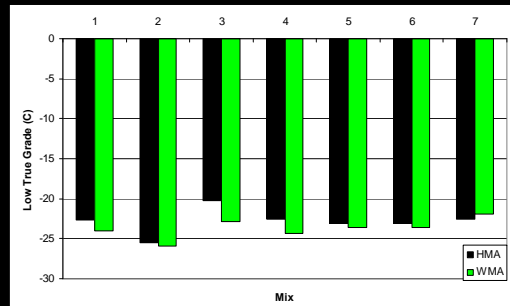


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### Low True Grade



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### Aggregate Properties

- Why do we need to know RAP aggregate properties?
  - Ensure that quality material is being added to the mix
  - RAP aggregate properties are as important as virgin aggregate properties
  - Combined properties of aggregates should meet consensus aggregate properties

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### Aggregate Properties, Cont.

- $G_{mm}$  Method
  - Recently extraction evaluation
  - Assume an absorption value for the area
  - Determine  $G_{mm}$  of RAP
  - Determine asphalt content from ignition oven
    - Only use ignition oven if aggregate not prone to significant aggregate degradation

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### Ability to Meet Volumetrics



- Treat RAP as mix component
- Challenges: VMA and dust/asphalt ratio
  - Good processing practices can be used to overcome this issue
    - Minimize generating dust in RAP stockpiles
    - Fractionate RAP for mix design flexibility and gradation control

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### Compacting Samples

- Preheat RAP
  - Activates the binder
- Prior to blending with other materials make sure chunks are broken down

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### Moisture Susceptibility

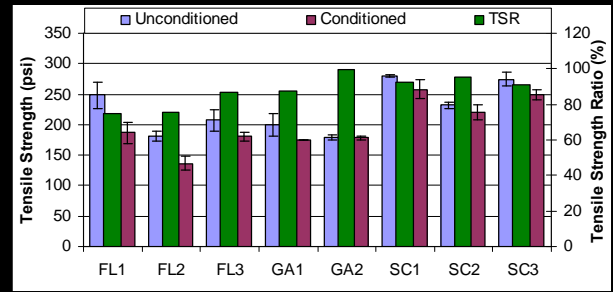
- Conduct moisture susceptibility testing in accordance with AASHTO T 283
- Typically, high indirect tensile strengths
- Not uncommon to see TSRs below 80% for high RAP
  - GA allows as low as 70 % if the ITS are greater than 100 psi

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### High RAP TSR



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### Do High RAP Content Mixes Perform Well?

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### Existing Pavement Sections

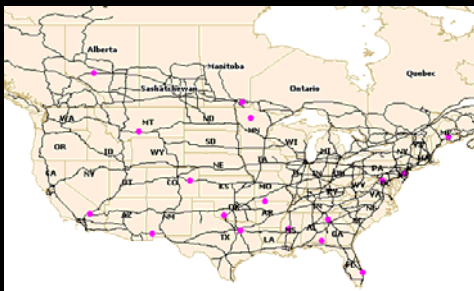
- LTPP SPS-5 sections
  - Virgin
  - 30% RAP
  - Milled and non-milled surface
  - 50 and 125 mm thick
  - Oldest is over 17 years

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### SPS-5 Project Locations



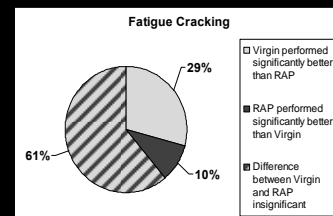
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### Fatigue Cracking, Cont.

71% RAP fatigue cracking was equivalent or less than virgin



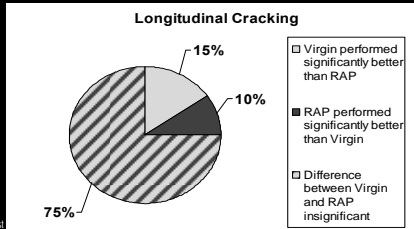
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### Longitudinal Cracking, Cont.

85% RAP longitudinal cracking equivalent to or less than virgin

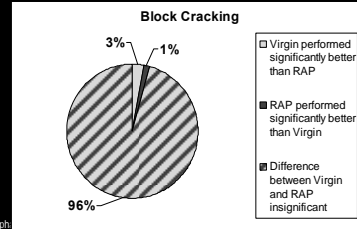


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### Block Cracking, Cont.

97% RAP equivalent to or less block cracking than virgin

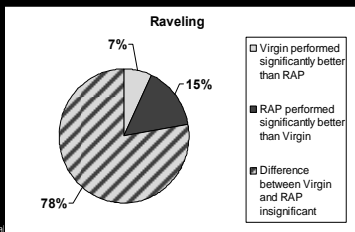


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### Raveling

93% RAP exhibited raveling equivalent to or less than virgin



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### Questions?

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