Research Update

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Kansas Asphalt Paving Conference
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Today’s Topics

- Regional research
  - North Central Superpave Center (NCSC)

- National level research
  - RAP ETG
  - FHWA Turner-Fairbank
  - ARC

- Brief Overviews
NCSC Research Focus Areas

- Recycling
  - High RAP Mixes
- Surface Characteristics
  - Use of Local Materials and RAP
  - Quiet Pavements
- Pavement Performance
  - Porous Friction Course Performance
  - Low Void Mixes
National Interest in RAP

- Strong incentives to increase RAP use
  - Material and energy costs
    - Binder costs rose over 300% in 2007 & 2008
  - Material supply issues
  - Environmental concerns
- Growing demand
  - RAP in more mixes (i.e. surfaces)
  - Higher RAP quantities
- Major research efforts nationwide
HMA Recycling ETG

- FHWA initiated in May 2007
- Managed by NCAT
- Purpose – Coordinate, develop national guidance and recommendations on RAP use
- Demo projects, document performance, share info, best practices, research
- Meeting 12/16-17 in Seattle
Removing/Lowering Barriers

- Nationwide specs vary widely
- Several states allow up to 50% RAP
- Some still do not allow RAP
  - Goal – all states allow RAP; encourage use of 25-30%
- Potential for WMA plus RAP
RAP mixes can perform as well as or better than virgin mixes.

RAP ETG wants to show states how to use 25% RAP and more.
## NCSC Study on RAP Plant Mixes

<table>
<thead>
<tr>
<th>Binder Grade</th>
<th>0%</th>
<th>15%</th>
<th>25%</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 58-28</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>PG 64-22</td>
<td>X</td>
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</tbody>
</table>
2006 Results

- One plant and one set of materials studied.
- The RAP mixes were not as stiff as expected.
  - High, intermediate and low temperatures
- The binder did not stiffen linearly with increasing RAP content.
- In this case, dropping the virgin grade to PG58-28 for 25% RAP was not necessary.
2007 Experiment

- Four more contractors (IN and MI)
  - Dynamic Modulus $|E^*|$
    - High and intermediate modulus, blending
  - Indirect Tension
    - Low temperature stiffness, strength and cracking
  - Binder extraction/recovery and PG grade
    - Blending analysis
- Fatigue Testing – at FHWA TFHRC
One Example

Log $|E'|$, MPa versus Log Reduced Frequency, Hz

PG64-22 versus PG58-28

MixC (25% RAP)
MixE (25% RAP)
MixD (40% RAP)
MixF (40% RAP)
Low Temperature Behavior

Stiffness, GPa

Pvmt. Cracking Temperature, C

Mixes

EB-A  EB-B  EB-C  EB-D  EB-E  EB-F

Stiffness
Temperature
Low Temperature Behavior

**Graph Description:**
- **Y-axis:** Strength, kPa
- **X-axis:** Mixes
- **Legend:**
  - Green line: Strength
  - Yellow line: Temperature

**Graph Details:**
- The graph shows the temperature cracking resistance and strength for PB-A to PB-F mixes.
- Strength and temperature values are plotted against each mix.
- The temperature cracking temperature is shown on the right Y-axis.
- The strength values are shown on the left Y-axis.
For these materials

- Grade change at 15% not necessary
- Low, intermediate and high temperature properties acceptable to 25%
- Pretty good blending of RAP and virgin binders to 25% RAP
Current Status

- Draft report on Phase 2 done by end of year
- Specification change underway in Indiana
- States should evaluate their own materials
RAP in Surface Courses

- Evaluate effect of poor quality RAP on friction
- Lab study of crummy RAP blended with steel slag, ACBF slag, crushed gravel
- Field evaluation of RAP surfaces on low volume roads
- Data analysis underway; report by Spring
Other NCSC Recycling Efforts

- Assistance with CIR mix design
- Field evaluation of RAP mix performance
- Evaluation of RAP plus shingles (pending funding)
- High RAP content study with NCAT, UNH
Surface Characteristics
Surface Characteristics/Performance

- RAP in Surface Courses
- Friction – NMAS, aggregate type, gradation
- Use of Local Aggregates in Surfaces
- Friction in Pavement Management System
- Thermoplastic Pavement Marking Material
- Evaluation of new aggregate sources
Porous Asphalt Surfaces

- New Generation Open Graded Friction Courses
- Porous European Mix
- Porous Friction Course

- For noise control and safety
  - Reduced splash and spray
  - High friction (macrotexture)
Pavement Porosity
Long Term Field Evaluation

- I74 Eastbound East of Indianapolis
- Constructed August 2003

Comparison of SMA, PFC and HMA
- Texture
- Friction
- Noise
- Performance
The Materials

- 9.5mm mixtures, Steel Slag and PG76-22
- PFC designed at 18-22% air voids
  - Old OGFC designed at 12-15% voids
  - Polymer modified binder and fiber
Design Gradations

Cumulative % Passing vs. Sieve for PFC, SMA, and HMA materials. Control points are indicated on the graph.
SMA vs. PFC
Conventional HMA
After One Year

- PFC significantly quieter than SMA or HMA – CPX and sideline
- In car noise significantly lower on PFC
- PFC -- higher macrotexture than SMA and much higher than HMA
- Friction higher for PFC and SMA than HMA
- PFC significantly reduced splash and spray
Questions remained -- how long will these effects persist?

- Does the PFC clog and lose effectiveness?
- High permeability is supposed to help prevent that, but ....
- Will traffic wear off film and increase IFI on PFC and SMA?
- Will PFC lose macrotexture and friction?
Changes in Noise vs. Traffic

![Graph showing changes in noise levels vs. traffic. The graph includes data points for different dates and vehicle types, such as PFC, SMA, and DGA at various speeds. The x-axis represents the number of axle passes (10^6), and the y-axis represents SPL in dB(A). The graph highlights the noise levels for different months, including 6/2005, 7/2005, 4/2007, 10/2006, 7/2007, 5/2007, 10/2007, and 8/2008. Different symbols and colors are used to distinguish between the vehicle types and dates.]
Heavy Vehicle Noise
Changes in Texture

![Graph showing changes in MPD over time for PFC, SMA, and DGA with specific dates marked for each material. The graph includes a scale for MPD (mm) on the y-axis and the number of axle passes (10^6) on the x-axis.](image-url)
Changes in Friction (F60)
After Five Years

- Texture decreased slightly after two years then stabilized
- Noise increased slightly, now steady
- PFC significantly quieter
- PFC and SMA friction the same
- PFC reduced splash and spray
- PFCs can hold up in Midwestern applications (when used properly)
- Did require somewhat more salt
Other Studies

- Quiet Pavements
  - European style surfaces in American terms
  - Extensive lab study

- Low Void Mixes
  - How low is too low?
  - NCAT Track performance, Accelerated Pavement Testing and lab testing
FHWA Research

- Polyphosphoric Acid Modification
- Improved Asphalt Binders
- Locking Point
- Fatigue – Endurance Limit
- RAP Binder Co-Mingling
- Virtual Mix Design
- Forensic Evaluations
Asphalt Research Consortium

- Western Research Institute, Advanced Asphalt, UW Madison, UNR, Texas A&M, FHWA
- Moisture Damage
- Fatigue
- RAP
- Engineered Materials
Asphalt Research

- Lots of exciting work on all levels
- Major advancements on the way
- Aimed at better performance, better environmental stewardship and more economical construction
Plug

North Central Asphalt User Producer Group
HMA Technical Conference
Overland Park, Kansas
February 3-4, 2009

*Stretching Pavement Dollars* - *Sustainability – Constructability*
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