NCAT Pavement Test Track

Implementation of Track Findings
Implementation Content

- Materials
- Mixes
- Structures
- Construction
- Preservation
Materials

- Expanded use of local/underutilized stockpiles
- Use of (fractionated) RAP & processed PC-RAS
- “Healthy” binder content for mix durability (BMD)
- Economical use of polymer modified binders
- GTR for sustainable binder modification
- Aramid fibers to improve mix durability (PFC)
- Highly polymer modified asphalt (HiMA).
Targeted Use of High Polymer Mixes
Local Aggregates
Mixes

• Transition to Superpave/gyratory mix designs
• Reduction in design laboratory compaction
• Choosing between SMA and DGA mix options
• Aged binder ratio (ABR) mix design philosophy
• “Healthier” binder content in balanced mix design
• Cracking test needed for design approval & QC (!)
• Benefits of smaller NMAS and/or finer mixes.
Reflective Cracking

**RAP BR = 29%**

**Aged BR = 41%**

**RAP BR = 20%**

**RAS BR = 21%**
Fine versus Coarse Gradations
Smaller NMAS "Thinlay" Mix

NCAT West Curve Cam 1970-01-06 23:43:51
Smaller NMAS “Thinlay” Mix

Before rolling

4.6 mm in APA

After rolling
Need for a Production Cracking Test!
Structures

- “M-E” versus “E” pavement buildup design
- Need for local calibration & strain thresholds
- Consideration for alternative materials/layers
- Layer coefficient increase from 0.44 to 0.54
- Reduces to 0.15 for OGFSC/PFC surfaces, but...
- Fog sealing prolongs OGFC/PFC surface life
- $0.36 \leq 100\% \text{ RAP CCPR base mix} \leq 0.39$. 
RAP$_{11}$+RAS$_3$ Thinlays$_{20}$ on Cold Recycle

No Rutting
No Cracking

CCPR

Foam
Emulsion

CIR

National Center for Asphalt Technology
Construction

• WMA and higher aged binder ratio (ABR) mixes
• Less distinction between HMA and WMA
• Smaller NMAS and/or finer aggregate blends
• Longitudinal joint quality/performance
• Prevention of premature/reflective distresses
• Tack coat is critical to pavement performance (!).
### Strategic Use of RAP, RAS, GTR, & WMA

<table>
<thead>
<tr>
<th>Purpose of Each Layer</th>
<th>N5 Control</th>
<th>S5 Higher RAP</th>
<th>S6 RAP+RAS</th>
<th>S13 Recyc Tires</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durable, Rut Resistant Surface</td>
<td>20% RAP\textsubscript{20} 67-22/82-16 DG</td>
<td>25% RAP\textsubscript{11} 67-22/76-22 SMA</td>
<td>5% RAS\textsubscript{21} 67-22/88-16 SMA</td>
<td>VIRGIN 82-22\textsubscript{12} SMA</td>
</tr>
<tr>
<td>Stiff, Strain Reducing Middle</td>
<td>35% RAP\textsubscript{39} 67-22/88-10 DG</td>
<td>50% RAP\textsubscript{41} 67-22/82-16 DG</td>
<td>50% AGED\textsubscript{26-24} 67-22/94-10 DG</td>
<td>35% RAP\textsubscript{37} 82-22\textsubscript{12} DG</td>
</tr>
<tr>
<td>Fatigue Resistant Base Layer</td>
<td>35% RAP\textsubscript{39} 67-22/88-10 DG</td>
<td>35% RAP\textsubscript{34} 94-28/94-10 DG</td>
<td>25% RAP\textsubscript{24} +76-22/88-16 DG</td>
<td>VIRGIN 88-22\textsubscript{20} AZ</td>
</tr>
</tbody>
</table>

Green = Evotherm Q1 Additive, Blue = Astec Green Foamer
Effect of Increased Tack Rate

- RAPDebonded
- Control
- GTR
- RAP+RAS
- RAPRebuilt

Equivalent Single Axle Loadings (ESALs) vs. Percent of Total Lane Area Cracked.

Graph shows the effect of different tack rates on the percentage of total lane area cracked at various equivalent single axle loadings (ESALs). The lines represent different conditions and treatments, with distinct markers and colors for easy identification.
Preservation

- Crack sealing improves cracking performance
- Scrub seals exhibit both crack & chip seal benefit
- Treatments reduce subgrade moisture, but...
- Robust treatments provide more life extension
- Objective selection of preservation alternatives.
Preservation Selection Process

Oversimplified “Decision Tree”

- Preservation
  - Select for Lowest Life Cycle Cost
    - Crack/fog seal
    - Chip/slurry/micro
- Rehabilitation
  - Thin overlay
  - Thick overlay
    - Shallow mill/inlay or hot recycle + overlay
- Reconstruction
  - Deep mill/inlay or cold recycle + overlay(s)
  - Reclamation + overlay(s)

Time / Traffic
<table>
<thead>
<tr>
<th>Treatment</th>
<th>PCI</th>
<th>Cracking (L=Low, M=Medium, H=High)</th>
<th>Deformation (L=Low, M=Medium, H=High)</th>
<th>Raveling/Weather</th>
<th>Ride</th>
<th>Friction</th>
<th>Noise</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Fatigue(^b) / Long WP(^c) / Slippage</td>
<td>Block / Transverse Thermal(^e) / Joint Reflection / Long / Edge(^d)</td>
<td>Wear / Stable(^a) Rutting / Corrug / Shove / Bumps / Sags / Patches</td>
<td></td>
<td></td>
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<tr>
<td>Crack Filling</td>
<td>75-90</td>
<td>L M H</td>
<td>L M H</td>
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<tr>
<td>Crack Sealing</td>
<td>80-95</td>
<td>L M H</td>
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<td>L M H</td>
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<tr>
<td>Single Chip Seal</td>
<td>70-85</td>
<td>L M H</td>
<td>L M H</td>
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<tr>
<td>Double Chip Seal</td>
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<tr>
<td>Slurry Sealing</td>
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<tr>
<td>Single Micro Surface</td>
<td>70-85</td>
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<tr>
<td>Ultra-Thin Bonded HMA Overlay</td>
<td>65-85</td>
<td>L M H</td>
<td>L M H</td>
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<td>L M H</td>
<td>L M H</td>
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<tr>
<td>¾” to ¾” HMA Overlay</td>
<td>65-85</td>
<td>L M H</td>
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<tr>
<td>⅜” to 1½” HMA Overlay</td>
<td>60-80</td>
<td>L M H</td>
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<tr>
<td>Mill &amp; HMA Overlay</td>
<td>60-75</td>
<td>L M H</td>
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<tr>
<td>Hot In-Place &amp; HMA Overlay(^a)</td>
<td>70-85</td>
<td>L M H</td>
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<tr>
<td>Cold In-Place &amp; HMA Overlay(^a)</td>
<td>60-75</td>
<td>L M H</td>
<td>L M H</td>
<td>L M H</td>
<td>L M H</td>
<td>L M H</td>
<td>L M H</td>
</tr>
</tbody>
</table>

\(^a\) Surface recycle with a thin HMA overlay
\(^b\) Fatigue (alligator) cracking: L=<1/4” width or <10% area; M=1/4 to 1/2” or 10-20% area; H=1/2” or 20-30% area
\(^c\) Longitudinal wheelpath and transverse cracking: L=<1/4” width; M=1/4 to 1/2”; H=1/2” width
\(^d\) Edge cracking: L=no material loss; M=0-10% material loss; H=>10% material loss
\(^e\) Stable rutting is related to densification, not plastic deformation
\(^f\) Green=highly or generally recommended in SHRP 2 Report S2-R26-RR-2; Red=not recommended by the preservation industry due to > 1/4” width of unsealed cracks
<table>
<thead>
<tr>
<th>Surface Treatment</th>
<th>Good Condition (PCI=80)</th>
<th>Fair Condition (PCI=60)</th>
<th>Poor Condition (PCI=40)</th>
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</thead>
<tbody>
<tr>
<td>Fog Seal</td>
<td>3 - 5</td>
<td>1 - 3</td>
<td>1 - 2</td>
</tr>
<tr>
<td>Chip Seal</td>
<td>7 - 10</td>
<td>3 - 5</td>
<td>1 - 3</td>
</tr>
<tr>
<td>Slurry Seal</td>
<td>7 - 10</td>
<td>3 - 5</td>
<td>1 - 3</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>8 - 12</td>
<td>5 - 7</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Ultrathin Bonded Wearing Course</td>
<td>10+</td>
<td>5 - 10+</td>
<td>2 - 10</td>
</tr>
<tr>
<td>Thin HMA</td>
<td>10 - 12</td>
<td>5 - 7</td>
<td>2 - 4</td>
</tr>
</tbody>
</table>
Benefits = \( f(\text{Pretreatment Condition}) \)
Benefits = $f$(Pretreatment Condition)
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Lee Road 159 Low Traffic Preservation

950k ESALs

80k ESALs

Funding Provided by:
Alabama, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, and FP2 via Auburn University and the Lee County Commission.
US-280 High Traffic Preservation

6½M Vehicles, 2M ESALs
Perpetual Pavement Top-Down Cracking

Crack Map (Recent Cracks in Solid Red, Potential Reflective Cracks in Blue, Patches Outlined in Green, and Trucking Percent Complete via Height of Gray Map Date Box)

Approx. Cracked Areas:  
- Lane: 21%  
- LWP: 16%  
- RWP: 22%

MnROAD  
Silica Solutions for Sustainable Roadways Through Innovative Research

NCAT  
at Auburn University
Perpetual Pavement Top-Down Cracking

↑ Blow and band

← Route and fill

← Untreated control

ASTM D 6690
Crack Sealing in Thinner Pavements

SINGLE MICRO SURFACE

SINGLE MICRO SURFACE + CRACK SEALING
Current Track Research Focus

- Balanced mix design (design and construction)
- Design w/ lime modification, cement stabilization
- Effect of high-to-low density on performance
- Interlayers to reduce reflective cracking
- Single pass full depth rapid reconstruction
- Soybean-based biopolymer asphalt modification
- Thinlays and ultra thinlays for preservation
- Validation of laboratory cracking tests (aging).
Reflective Crack Prevention
Full Depth Rapid Rebuild
Central Plant Cold Recycling
In-Place Cold Recycling
Cold Climate Sections
MnROAD Cold Recycling/FDR
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