Reclamation Research at VDOT

Brian Diefenderfer, Ph.D., P.E.
Senior Research Scientist

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Overview

• Agency methods to begin using FDR
  – Specifications
  – Guidelines

• Research to extend use of FDR
  – Long-term performance monitoring
  – Instrumented pavements
  – Laboratory testing
Pavement Recycling

• A set of cost-effective and environmentally sensitive techniques for pavement rehab

• Benefits
  – 30 to 50 percent cost savings
  – 50 percent less greenhouse gases emitted
  – Fix deterioration causes rather than symptoms

• Used by VDOT
  – Full-depth reclamation, cold in-place recycling, cold central-plant recycling
Full-Depth Reclamation

• Mechanical stabilization
  – Additional aggregate or RAP

• Asphalt stabilization
  – Foamed asphalt
  – Emulsified asphalt

• Chemical stabilization
  – Cement
  – Lime
  – Fly ash (type C or F)
  – Cement / lime kiln dust
VDOT Pavement Recycling History

• Pre-2008
  – Regional focus, no monitoring

• 2008-2011
  – 8 projects, 2-year FDR study
  – I-81 project
  – NCAT test sections constructed

• 2012-today
  – Specs and usage guidelines
  – NCAT test sections continuation
Agency Methods to Begin Using FDR

- Specifications
- Guidelines
Specifications

• Experience requirement

• Quality control plan
  – Corrective action list

• Acceptance requirements
  – Field density
  – Stability / indirect tensile / compressive strength
  – Gradation
  – Depth
  – Stabilizing agent dosage

maximum?
Specifications

• Mix design
• Recycling equipment
  – Roller weights, etc.
• Test strip construction
• Weather limitations
Guidelines

• Length of project
• Distress rating
• Maintenance history
• Overlay thickness requirements
  – Generally meet SN calculations
  – 2-course overlay on interstate
  – May specify thickness for given traffic levels
• Directives / carrots
  – First consideration for greater than 4 inches?
  – Dedicated pot of funding
FDR Research

- I-81
- NCAT
- NCHRP 9-51
I-81

- 23,000 AADT
- 28% trucks
- 7.2 lane miles
- Constructed 2011
I-81

<table>
<thead>
<tr>
<th>4-inch New AC</th>
<th>6-inch New AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-inch CCPR</td>
<td>6-inch CCPR</td>
</tr>
<tr>
<td>12-inch FDR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subgrade</td>
</tr>
</tbody>
</table>

Right Lane
What We Learned From I-81

• Recycling performs well on a high volume road

• Service is excellent after 3+ years
  – Nearly 8 million ESALs
  – Rutting less than 0.1 inches
  – Ride quality range = 45-55 inches/mile

• Layer coefficients from this project (lab & field)
  – FDR + CCPR $\sim$ 0.37
  – CCPR range = 0.36 to 0.44
  – CIR range = 0.35 to 0.39
NCAT Recycled Sections

- 10 million ESALs applied in 2 years
- Constructed 2012
NCAT Recycled Sections

N3
- 6-inch AC
- 5-inch CCPR
- 6-inch Agg Base
- Subgrade

N4
- 4-inch AC
- 5-inch CCPR
- 6-inch Agg Base
- Subgrade

S12
- 4-inch AC
- 5-inch CCPR
- 8-inch FDR
- Subgrade
Rutting

% of 10 million ESALs

Rut depth, inches

N3, 6 inch AC
N4, 4 inch AC
S12, 4 inch AC+FDR
Tensile Strain Beneath CCPR Layer at 68F

- N3, 6 inch AC
- N4, 4 inch AC
- S12, 4 inch AC+FDR
What We Learned From NCAT

- Recycling performs well on a high volume road
- No cracking at 10 million ESALs
- Ride quality steady
- Rutting not significant (< 0.25 inch)

- Is FDR section perpetual?
  - Presence of stabilized base reduced strain by 80% for same overlay thickness
  - Does a recycled layer behave the same as an AC material in terms of fatigue?
**NCAT Recycled Content**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
<th>Recycled Content</th>
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<tbody>
<tr>
<td>4-inch AC</td>
<td>1</td>
<td>12.5% recycled</td>
</tr>
<tr>
<td>5-inch CCPR</td>
<td>2</td>
<td>30% recycled</td>
</tr>
<tr>
<td>8-inch FDR</td>
<td>3</td>
<td>100% recycled</td>
</tr>
<tr>
<td>Subgrade</td>
<td>4</td>
<td>100% recycled</td>
</tr>
</tbody>
</table>

- **17 inches manipulated**
  - Layer 1 = 12.5% recycled
  - Layer 2 = 30% recycled
  - Layer 3 = 100% recycled
  - Layer 4 = 100% recycled

- **Entire cross section**
  - 81% recycled
NCHRP 9-51

- *Material Properties of CIR and FDR for Pavement Design*

- Partners
  - University of MD, VDOT, Colas Solutions, Wirtgen

- Project locations (23)
  - California, Colorado, Delaware, Edmonton, Georgia, Illinois, Kansas, Maine, New York, Ontario, Utah, Washington, West Virginia
Example Results

Avg Dynamic Modulus at 21°C and 10Hz, psi

<table>
<thead>
<tr>
<th>Project Type</th>
<th>CCPR</th>
<th>CIR</th>
<th>FDR</th>
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</thead>
<tbody>
<tr>
<td>Avg Dynamic Modulus</td>
<td>500,000</td>
<td>500,000</td>
<td>400,000</td>
</tr>
</tbody>
</table>
Lessons Learned

• Recycling performs well on a high volume road

• FDR is providing a significant stiffening effect at the NCAT track
  – Difference in long-term performance?
    • If what we know about asphalt pavements is transferable, “yes”

• The more you know, the more you know you don’t know. You know?
Future Needs

• Design
  – Representative layer stiffness for AASHTO M-E design *(see 9-51 study)*
    • Additives, gradation, source materials, etc.

• Performance
  – Deterioration prediction models
  – Failure mechanisms
  – Performance with thinner overlays / surface treatments
Thank you!

brian.diefenderfer@vdot.virginia.gov
We bring innovation to transportation.
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