VDOT Reclamation Research

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FDR Symposium
October 24, 2016
Overview

• Agency methods to begin using FDR
  – Specifications
  – Guidelines

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

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

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

- **Partners**
  - University of MD
  - VDOT
  - Colas Solutions
  - Wirtgen
Dynamic Modulus (stiffness)

- Higher temperature:
  - CCPR
  - CIR
  - FDR

- Lower temperature:
  - CCPR
  - CIR
  - FDR
Repeated Load-Permanent Deformation

10 psi confining stress
70 psi deviatoric stress

Cumulative Microstrain vs Number of Cycles
What We Learned From 9-51

• Similar lab stiffness properties across recycling types
• Confinement very important for rutting testing
• Similar rutting testing results for recycled materials and AC base materials
I-81

- 23,000 AADT
- 28% trucks
- 7.2 lane miles
- Constructed 2011
<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-inch New AC</td>
<td></td>
</tr>
<tr>
<td>6-inch New AC</td>
<td></td>
</tr>
<tr>
<td>8-inch CCPR</td>
<td></td>
</tr>
<tr>
<td>6-inch CCPR</td>
<td></td>
</tr>
<tr>
<td>12-inch FDR</td>
<td></td>
</tr>
<tr>
<td>Subgrade</td>
<td></td>
</tr>
</tbody>
</table>

I-81

Right Lane
3% LKD + cement Mixed to 12 inches
What We Learned From I-81

• Recycling performs well on a high volume road

• Service is excellent after 5+ years
  – More than 10 million ESALs (right lane)
  – 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

• 15 million ESALs
• 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
Strain vs. Date

N4, 4 inch AC+CCPR

N3, 6 inch AC+CCPR

S12, 4 inch AC+CCPR+FDR

Tensile Microstrain

Average of Date

Average of Value
Strain vs. Date at 68°F

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

• Recycling performs well on a high volume road
• No cracking at nearly 15 million ESALs
• Ride quality steady
• Rutting not significant (< 0.25 inch)

• Is Section S12 (FDR) perpetual?
  – Presence of stabilized base reduced strain by 80% for same overlay thickness
  – Does a recycled layer have the same fatigue behavior as an AC layer?
NCAT Recycled Content

<table>
<thead>
<tr>
<th>Layer</th>
<th>Recycled Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.5% recycled</td>
</tr>
<tr>
<td>2</td>
<td>30% recycled</td>
</tr>
<tr>
<td>3</td>
<td>100% recycled</td>
</tr>
<tr>
<td>4</td>
<td>100% recycled</td>
</tr>
<tr>
<td>Entire cross section</td>
<td>80% 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
Implementing Research

• Confidence gained from lab and field testing
  – Searching for locations to implement results

• Design-Build project, I-64 near Williamsburg
  – Construct new lanes and reconstruct existing lanes
  – 71,000 vehicles per day (8.6% trucks)
Implementing Research

- **I-64 Lane Widening Project**
  - Awarded 2016
  - 7.08 miles (~60 lane miles)

- **Add travel lane and 12ft shoulder to the inside**
  - CCPR base, asphalt surface layers

- **Reconstruct existing lanes**
  - Remove existing concrete
  - FDR foundation
  - CCPR base, asphalt surface layers
I-64, Alternative Sections

$71 / SY

2-in SM + 2-in IM
4-in BM
8-in Cement Treated Aggregate
Subgrade

Same structural value
36% lower cost

$45 / SY

2-in IM + 2-in IM
6-in CCPR
12-in FDR
$6-$8/SY
Subgrade
Potential Cost Savings

• Segment II
  – 7.08 miles x 3 lanes x 2 shoulders
  – 168,000 tons of CCPR
  – 345,000 SY of FDR
  – Cost savings using recycling > $10 million
    • as awarded

• Segment III?
  – 7.6 miles x 3 lanes x 2 shoulders
  – Cost savings could exceed $12-14 million
What We Have Learned

• Recycled materials have good performance properties in the lab

• Recycling performs well on high volume roads

• FDR is providing a significant stiffening effect at the NCAT track
  – Difference in long-term performance?

“You can observe a lot just by watching”

Yogi Berra
Thank you!

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