VDOT Recycling Research and Imported FDR

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Overview

• Specifications
• Lab testing
  – NCHRP Projects
• Field performance
  – I-81 to I-64
  – Imported FDR concept
Pavement Recycling

• A set of cost-effective and environmentally sensitive techniques for pavement rehab
  – CIR, CCPR, FDR

• Benefits
  – Reduced emissions
  – Lower costs
  – Reduced virgin materials use
  – Utilize stockpiled materials (e.g., RAP)
VDOT Spec Highlights

• Quality control plan
  – Identify responsible parties for all phases of work
  – Develop contingency plans
    • Weather changes, deficient density, equipment breakdown, etc.

• Mix design

• Acceptance
  – Density (direct transmission), depth, gradation, dosage rate

• Payment
  – By the SY, typical for us is $7-8/SY
### Mix Design Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>FDR</th>
<th>CIR</th>
<th>CCPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL, PL, PI, Soil Classification</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target Gradation</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Target Moisture and Density</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Compressive Strength (cement only)*</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marshall Stability (emulsion only)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Indirect Tensile Strength (foam only)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Emulsion/foam properties</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Target Stabilizing/Recycling Agent Content</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

* Min 250, Max 450 psi
VDOT Recycling Research (Lab)

• NCHRP 9-51 (completed 2016)
  – Develop Pavement_ME design inputs
  – See NCHRP Report 863

• NCHRP 9-62 (ongoing)
  – Field quality tests to identify time to opening / surfacing
  – Focusing on stiffness, shear, and raveling tests
Repeated Load (rutting)

10 psi confining stress
70 psi deviatoric stress
VDOT Recycling Research (Field)

- I-81, 2011
- NCAT, 2012
- I-64, 2016-present
I-81 (2011)

- South of Staunton, VA
- SB direction
- 3.7 miles
- FDR + CCPR right lane
- 29,000 AADT
- 29% trucks
I-81 Performance – Right Lane

- July 2018 (7 years)
  - 0.1 inches rutting
  - 44 inches per mile

- Current traffic (April 2019)
  - 15.9 million ESALs
I-81 Performance Example
NCAT Test Track 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
- 6-inch Agg Base
- 8-inch FDR
- Subgrade
NCAT Test Track Current Conditions

• No observable surface distresses for any of the sections after 21.7 million ESALs

• Perpetual type performance from Section S12
Section S12

- Recycled content
  - Layer 1 = 12.5%
  - Layer 2 = 30%
  - Layer 3 = 100%
  - Layer 4 = 100%

- Entire cross section
  - 80% recycled
I-64 Widening / Reconstruction Project

• In 2015, VDOT awarded a contract to reconstruct and widen a portion of I-64 near Williamsburg
  – Segment II, 7.1 miles in each direction

• Final design includes CCPR over FDR (similar to I-81 and NCAT)
  – But how do you FDR material that doesn’t exist yet?
I-64 Widening / Reconstruction Project

- **New lanes (inside)**
  - Imported foundation material were stabilized using an FDR process
  - RAP or crushed concrete were allowable

- **Existing lanes (outside)**
  - Remove existing concrete, reclaim underlying material using FDR
  - Produced a stabilized foundation
SN = 7.08, $83/SY

12-in AC
2-in OGDL
8-in Cement Treated Agg
Subgrade

SN = 7.06, $40-61*/SY

4-in AC
6-in CCPR
2-in OGDL
12-in FDR/RC*
Subgrade
I-64 Imported FDR Concept

- A consistent platform for upper pavement layers
- Incorporate recycled materials
- Good performance from other sections using FDR below other recycled layers
I-64 Imported FDR

- VDOT specified minimum pavement sections
- Both asphalt- and concrete-based designs included 12 inches of FDR
  - Once CCPR was discussed, became preferred option due to cost
- Bidders were instructed to assume 6 percent cement for estimating
I-64 Imported FDR

- Crushed concrete or reclaimed asphalt pavement (RAP) were allowable
  - Mostly crushed concrete
- Cement contents ranged from 4 to 6 percent, 4% was typical
  - Over 200 mix designs
I-64 Imported FDR

• Density
  – Minimum 97 percent of modified proctor from mix design
  – Density based on Lots. Lots based on 5,000 linear feet of paving, with five sublots
  – Two density measurements taken per subplot

• Thickness
  – Two thickness measurements per lot
Differences Between Imported and Traditional FDR
Future Applications

• Process is well suited to lane additions or new alignments
• Could also be used to blend with existing materials for a “semi-imported” FDR

• I-64, Segment III
  – 8.3 miles, 2018-2021
## I-64 Quantity of Recycled Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Segment II</th>
<th>Segment III</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDR existing lanes</td>
<td>345,000 SY</td>
<td>229,000 SY</td>
</tr>
<tr>
<td>Cement treated concrete/ RAP new lanes</td>
<td>146,000 tons</td>
<td>201,000 tons</td>
</tr>
<tr>
<td>CCPR</td>
<td>168,000 tons</td>
<td>196,000 tons</td>
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</tbody>
</table>

About a million tons
I-64 Widening / Reconstruction Projects

• Segment II
  – Original design = $83/SY
  – Recycled design = $40-61/SY

• Segment III
  – Original design = $95/SY
  – Recycled design = $57-79/SY

• Total cost savings, $15+ million
Thank you!

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