In-Place Pavement Recycling

Southeast Pavement Preservation Partnership
Louisville, Kentucky
May 29, 2014

Brian Diefenderfer, PhD, PE
Overview

- Why we should recycle
- In-place pavement recycling processes
- Ongoing research in Virginia
- Next steps
Why We Should Recycle our Pavements

• Economic
  – Nevada DOT saved $600 million over 20 years
  – Other studies show 30-50 percent cost savings

• Environment
  – MTO (Ontario) estimated 50 percent less greenhouse gases emitted

• Construction
  – Fixes deterioration causes rather than symptoms

• FHWA recycled materials policy
  www.fhwa.dot.gov/legsregs/directives/policy/recmatpolicy.htm
In-Place Recycling Processes

• Hot in-place recycling (HIR)

• Cold recycling
  – Cold in-place recycling (CIR)
  – Cold central-plant recycling (CCPR)

• Full-depth reclamation (FDR)

Increasing depth and level of deterioration
Hot In-Place Recycling

• All process
  – Scarify, rejuvenate, spread / pave, and compact

• Surface recycling
  – Top 1-2 inches prior to surfacing

• Surface remixing
  – Top 1-2 inches while adding additional materials prior to surfacing or as the wearing course

• Surface repaving
  – Top 1-2 inches along with an overlay to create a single thermally-bonded layer
Cold In-Place Recycling

- **CIR process**
  - Pulverized in-place
  - Recycling agent is added
  - Layer is compacted
    - 2 to 5 inches
    - Within the bound layers (a.k.a. partial depth)
  - Without addition of heat
  - Single-unit vs. multi-unit trains

- **Recycling agents & additives**
  - Foamed asphalt, emulsified asphalt
  - Cement, lime
Cold Central-Plant Recycling

- Similar to CIR but the recycling agent is added at a mobile plant

- Uses
  - Alternative to CIR
  - When access to deeper layers is needed
    - Mill, FDR, CCPR
    - Mill, CIR, CCPR
  - When stockpiles of existing RAP are available
    - Lane addition, shoulder widening
Cold Central-Plant Recycling

Similar to CIR but the materials recycling agents are added at a mobile plant

Uses
- When stockpiles of existing RAP are available
- Lane addition, shoulder widening
- When access to deeper layers is needed
- Mill, FDR, CCPR
- Mill, CIR, CCPR
CCPR with Existing RAP

- Virginia has about 4.5 million tons of RAP
CCPR with Existing RAP

• Could pave a 12-foot lane at 6 inches for about 2,000 miles
Full-Depth Reclamation

• FDR process
  – Pulverized in-place
  – Recycling agent is added
  – Layer is compacted
  – Creates a stabilized base course
    • 4 to 12 inches
    • Includes unbound layers
  – Without addition of heat
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
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

Full-Depth Reclamation
Full-Depth Reclamation
Pavement Recycling & Preservation

• Pavement Recycling
  – Can include treatments ranging from minor rehabilitation to full reconstruction

• Preservation
  – Cost-effective treatments to extend the service life of a pavement
    • Not reconstruction
  – HIR & CIR
    • FDR & CCPR
Training Options

• **NCPP**
  – Checklists
  – Regional workshops

• **NHI**
  – **131050 & 131050A**
    • Asphalt Pavement In-Place Recycling Techniques
    • Instructor-led (fee) web-based (free)
  – **134114**
    • Inspector Training for CIR
    • Web-based (free)
    • HIR and FDR available soon(ish)
Virginia In-Place Pavement Recycling Research

- I-81
- NCAT test track
- NCHRP 9-51
I-81 Pavement Recycling, 2011

- AADT = 23,000 (28 percent trucks)
- 7.2 lane miles

- Left Lane:
  - 4-inch New AC
  - 5-inch CIR
  - Existing AC
  - Existing Aggregate
  - Subgrade

- Right Lane:
  - 4-inch New AC
  - 8-inch CCPR
  - 6-inch New AC
  - 6-inch CCPR
  - 12-inch FDR
  - 12-inch FDR
  - Subgrade
Ride Quality

Months after construction:

<table>
<thead>
<tr>
<th>Months after construction</th>
<th>Left lane</th>
<th>Right lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>52</td>
<td>42</td>
</tr>
<tr>
<td>9</td>
<td>56</td>
<td>46</td>
</tr>
<tr>
<td>12</td>
<td>54</td>
<td>45</td>
</tr>
<tr>
<td>16</td>
<td>55</td>
<td>46</td>
</tr>
<tr>
<td>23</td>
<td>55</td>
<td>46</td>
</tr>
<tr>
<td>28</td>
<td>54</td>
<td>44</td>
</tr>
<tr>
<td>34</td>
<td>56</td>
<td>45</td>
</tr>
</tbody>
</table>
Average Effective Structural Number

Months After Construction

<table>
<thead>
<tr>
<th>Months After Construction</th>
<th>Right lane</th>
<th>Left lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>9.0</td>
<td>5.5</td>
</tr>
<tr>
<td>15</td>
<td>9.9</td>
<td>5.8</td>
</tr>
<tr>
<td>28</td>
<td>9.9</td>
<td>5.7</td>
</tr>
</tbody>
</table>
NCAT Recycled Sections
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

N3, 6 inch AC
N4, 4 inch AC
S12, 4 inch AC+FDR

Rut depth, inches

17%
41%
51%
75%
NCHRP 9-51

- Material Properties of CIR and FDR Asphalt Concrete for Pavement Design
  - Developing design inputs for Pavement-ME

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

- Looking for projects in Southeast US
  - Constructed in 2012 or 2013
  - Asphalt emulsion or foamed asphalt
Next Steps

1. Think recycling
2. Number of projects
3. Design inputs for pavement designers
4. Document long-term performance
Brian Diefenderfer, PhD, PE
brian.diefenderfer@vdot.virginia.gov