Pavement Recycling

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Overview

1. Pavement recycling techniques
2. Major projects and design lessons learned
   a) I-81
   b) NCAT
3. Application of design lessons learned
   a) I-64
4. Summary
Pavement Recycling Processes

• Full-depth reclamation
  – Pavement foundation
  – Mixed in the road

• Cold in-place recycling
  – Upper portions of the asphalt layers
  – Mixed in the road

• Cold central plant recycling
  – Similar to CIR but at a mobile plant
  – Can be placed in multiple layers
Why Agencies Should Recycle Pavements

• Costs
  – 30-50% reduction

• Greenhouse gases
  – Up to 50% reduction

• Address causes rather than symptoms

• Accumulating RAP
More than 10 million tons of RAP stockpiled in Virginia
Could pave a 12-foot wide lane, 12 inches deep for more than 2,300 miles
So what hurdles remain?

- Limited experience
- Failure mechanisms are not well understood
- Limited number of recycling contractors
- Limited number of projects
- It’s something different
I-81 (2011)

- 2011
- 3.7 miles
- AADT = 24,000
- 29% trucks
- About 14 million ESALs (right lane)
<table>
<thead>
<tr>
<th>Left Lane</th>
<th>Right Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-in Asphalt</td>
<td>4 &amp; 6-in Asphalt</td>
</tr>
<tr>
<td>5-in CIR</td>
<td>6 &amp; 8-in CCPR</td>
</tr>
<tr>
<td>~4-in Exist. Asphalt</td>
<td>12-in FDR</td>
</tr>
<tr>
<td>8-in Agg Base</td>
<td></td>
</tr>
<tr>
<td>Subgrade</td>
<td>Subgrade</td>
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I-81 Design Lessons

• Lab testing on cored materials
  – Showed CCPR and CIR were statistically the same in terms of stiffness

• FWD testing
  – Showed FDR layer coefficient could be nearly as high as CIR/CCPR
NCAT

- 2012
- 3 test sections
  - CCPR over agg base
  - CCPR over FDR
- 20 million ESALs
- Instrumented pavement sections
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
Tensile Microstrain Normalized to 68°F

- N3-6” AC
  - Linear: $y = 5.1641x + 242.61$
  - $R^2 = 0.2687$

- N4-4” AC
  - Linear: $y = 7.0714x + 382.13$
  - $R^2 = 0.095$

- S12-4” AC SB
  - Linear: $y = 0.2851x + 134.79$
  - $R^2 = 0.0029$

Million ESALs
NCAT Design Lessons

- **FWD testing**
  - Similar to I-81, showed FDR layer coefficient could be higher than what is often used

- **Strain measurements**
  - Low strain levels when FDR is included

- **4 inches of asphalt is sufficient cover over CCPR**
  - To 20 million ESALs, but likely longer
Section S12

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

- Entire cross section
  - 80% recycled
I-64 Lane Widening Recycle Designs

• New lanes
  – Import crushed concrete or RAP, stabilize in FDR process
  – OGDL, CCPR, 4 inches asphalt surface

• Existing lanes
  – FDR existing base materials
  – OGDL, CCPR, 4 inches asphalt surface
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
Design Lessons Used on I-64

- Excellent performance from recycled system is possible even on a high volume pavement section
- Use of FDR
  - Improved performance for overlying CCPR
- Designed using AASHTO ‘93 process
  - 0.35 for CCPR, 0.25 for FDR
- Potential for significant cost savings
Considering Segments 2 and 3

- Using CCPR and FDR
  - More than a million tons of material will be recycled
  - Compared to a non-recycling design, cost savings will exceed $15 million

- Future work
  - Instrumentation
  - Calculations to quantify greenhouse gas reductions
Thank you!

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