How to Optimize Your Project With In-Place Recycling?

Western States

Regional In-Place Recycling Conference
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Parsons Transportation Group
Why In-Place recycling? Meets the 3E Challenge

Environmental

Economics

Engineering
Timing of Rehabilitation Techniques
(The Right Project, at The Right Time, and The Right Strategy)

- HIR
- CIR
- FDR/Reconstruct

Pavement Preservation Techniques

Pavement Condition
- Very Good
- Good
- Fair
- Poor
- Very Poor

Time / Traffic Loading
Pavement Preservation & Rehabilitation Tool Box

- Pavement Preservation Strategies
  - Fog and rejuvenating
  - RAP, REAS slurries
  - Microsurfacing
  - Chip seals and cape seals
  - Cold In-Place Recycling (CIR)

- Rehabilitation Strategies
  - Mill & Fill
  - Full Depth Reclamation
What is a good strategy for surface raveling?

HIR
What is a good strategy for medium and wide transverse and block cracking?
What is a good strategy for alligator cracking?

FDR
Project Selection Criteria

1. Existing pavement condition and design
   - Distress type, level, and extent
   - Traffic Loading
2. Environmental condition
3. Roadway geometry
4. Project site consideration
5. Initial funding constraint
6. Life-cycle cost based on long-term performance
7. Traffic Control
1. Existing Pavement Evaluation

- Condition Survey
- Core or Depth Check
- FWD on Project with Questionable Structural Section
- Determine Cause of Pavement Distress
- Functional Distress
  - Surface Distress
    - HIR
  - Cracking >2"
    - CIR and Wearing Surface
- Structural Distress
  - FDR and Overlay
Engineering Requirements

- **Subsurface Investigation:**
  - Coring to determine pavement thickness

  Coring Plan
  - Look for lift locations
  - Digout thickness
  - Deep lifts of asphalt concrete
  - Fabric

Joe Peterson, Caltrans, 2008 In-Place Recycling Presentation
Pavement Thickness Design

- Use either MEPDG or 1993-AASHTO Design Guide
- Use structural number 0.28-0.35 for CIR
- MR for CIR varies from low 200’s to 1 M
- Do not make the recycled material too stiff
- Calculate projected traffic loading for the design life
## Structural Layer Coefficient

<table>
<thead>
<tr>
<th>FDR Method</th>
<th>Minimum Thickness of Riding Surface</th>
<th>Typical Structural Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical</td>
<td>2” HMA</td>
<td>0.10 – 0.12</td>
</tr>
<tr>
<td>Bituminous</td>
<td>Surface Treatment or Structural HMA</td>
<td>0.20 – 0.28</td>
</tr>
<tr>
<td>Cement</td>
<td>Surface Treatment or Structural HMA</td>
<td>0.15 – 0.20</td>
</tr>
</tbody>
</table>

Mike Voth, FHWA, 2008 In-Place Recycling Presentation
# Mix Design Process

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) RAP: Core or Grindings from Project</td>
<td>Cores or Milling are crushed to passing 1”</td>
</tr>
<tr>
<td>2) Mixing</td>
<td>3 emulsion contents and H2O content are made</td>
</tr>
<tr>
<td>3) Compaction</td>
<td>Use Gyratory Compactor</td>
</tr>
<tr>
<td>4) Curing of Specimens</td>
<td>48 hours</td>
</tr>
<tr>
<td>5) Cured Specimens Measurements</td>
<td>2 sets: dry and soaked</td>
</tr>
<tr>
<td>6) Mix Design Selection</td>
<td>Determine optimum emulsion content</td>
</tr>
</tbody>
</table>
Mix Design Process

Gyratory Compactor

Marshall Stability

Raveling Test

RAP Preparation
1. Existing pavement condition and design
   - Distress type, level, and extent
   - Traffic Loading
2. Environmental condition
3. Roadway geometry
4. Project site consideration
2. Environmental Condition
(Climatic conditions must be considered when selecting in-place recycling)

Factors to consider

- Good drainage is a MUST
- Type and thickness of the wearing surface (slurry seal, double chip seal, hot mix overlay, and friction course)
- PG grade binder
Ranking of climates that can influence the choice of in-place recycling processes

<table>
<thead>
<tr>
<th>Climate</th>
<th>HIR</th>
<th>CIR</th>
<th>FDR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold/Wet</td>
<td>Fair</td>
<td>Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>Hot/Wet</td>
<td>Good</td>
<td>Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>Cold/Dry</td>
<td>Good</td>
<td>Very Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>Hot/Dry</td>
<td>Very Good</td>
<td>Very Good</td>
<td>Very Good</td>
</tr>
</tbody>
</table>
Project Selection Criteria

1. Existing pavement condition and design
   - Distress type, level, and extent
   - Traffic Loading
2. Environmental condition
3. Roadway geometry
4. Project site consideration
3. Roadway Geometry

- Profile grade
- Drainage ditches
- Guard rail
- Overhead
- Cross slope

Kingsbury Grade, Nevada
10% grade
1. **Existing pavement condition and design**
   - Distress type, level, and extent
   - Traffic Loading
2. **Environmental condition**
3. **Roadway geometry**
4. **Project site consideration**
4. Project Site Consideration

- Contractors availability
  - Contact ARRA - [www.arra.org](http://www.arra.org)

- Project length
  - At least 4 miles for HIR and CIR

- Construction season
5. Initial funding constraint
6. Life-cycle cost based on long-term performance
7. Traffic Control
Mill & Overlay vs. CIR & Overlay

93-AASHTO Design

3” Mill & 3” HMA

- Existing HMA (SN-0.2/inch)
- New HMA (SN-0.42/inch)

- Total SN-
  \[(3”\times0.42)-3\times0.2=0.66\]

3” CIR & 1.5” HMA

- 0.3-CIR (SN-0.3/inch)
- 0.42 New ACP (SN-0.42/inch)

- Total SN-
  \[(3\times(0.3-0.2)+0.42\times1.5=0.93\]

40% Increase in SN value
3” MILL & 3” OVERLAY
- 3” Milling-$1.5/ Sq. Yd.
- 3” HMA- $18/ Sq.Yd.
- Total cost for one mile (32’ wide)= $370 K

3” CIR & 1.5” OVERLAY
- 3” CIR-$4.5
- 1.5” HMA- $9/ Sq.Yd.
- Total cost for one mile (32’ wide)= $253K

30% Cost decrease
## 5. Initial Funding Constraint
(Nebraska DOT Cost Comparison)

<table>
<thead>
<tr>
<th>Category</th>
<th>ESALs</th>
<th>Strategy</th>
<th>Total structural number</th>
<th>Strategy Cost</th>
<th>Reduced Cost/ Mile</th>
<th>Change in SN</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>&lt; 1 Million</td>
<td>2” Mill &amp;fill</td>
<td>2”(0.35-0.18)= 0.34</td>
<td>625K</td>
<td>63%</td>
<td>(12%)</td>
</tr>
<tr>
<td></td>
<td>3” CIR Double Chip Seal</td>
<td>3(0.28-0.18) =0.30</td>
<td>230K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEDIUM</td>
<td>&gt; 1 Million &lt; 3 Million</td>
<td>3” Mill 3” HMA</td>
<td>3”( 0.35-0.18)=0.51</td>
<td>910K</td>
<td>37%</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>3” CIR 1.5” HMA</td>
<td>3” (0.28-0.18) +1.5” *0.35=0.82</td>
<td>570K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIGH</td>
<td>&gt; 3 Million</td>
<td>3” Mill 6” HMA</td>
<td>(6”)(0.35)-(3”) (0.18)=1.56</td>
<td>1.82 M</td>
<td>28%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>3” CIR 4” HMA</td>
<td>3(0.28-0.18) +4(0.35)=1.70</td>
<td>1.3 M</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. Initial funding constraint
6. Life-cycle cost based on long-term performance
7. Traffic Control
State-of-the-Practice on CIR and FDR Projects
NDOT, Nov. 21, 2005

Price in Thousands

- 3" CIR and 1.5" Overlay
- FDR and 4" Overlay 3" Mill and 3" Overlay
- 2" Overlay
- Reconstruction (Remove Existing & Replace w/ 12" Base, 5" PBS)

PW Cost
Initial Cost
Long-Term Performance

9-year Performance

CIR and 2” Overlay Section, Reno, Nevada
Long-Term Performance
20-year Performance
US-95 NV

PBS
1999 CIR
1987 CIR
5. Initial funding constraint
6. Life-cycle cost based on long-term performance
7. Traffic Control
Factors to consider:
- Day time vs. night time construction
- ADT and type of traffic (cars vs. trucks)
- Opening to traffic
- Intersections and other stop and go
- Access to local business
CIR on I-80 in Nevada

Agency: NDOT District 3
Contractor: Road & Highway Builders
Subcontractor: Valentine Surfacing
2007-2008
Lake Almanor, Caltrans Project-2011
Agencies should consider adding HIR, CIR, and FDR rehabilitation strategies to their tool box
Start slowly and get contractors involved early
Continue improving the process
Conclusions
HIR, CIR and FDR Meet the 3E Challenge

Sustainability

Energy Use Per Tonne Of Material Laid Down

- Laydown
- Transport
- Manufacture
- Aggregate
- Binder

Source: The Environmental Road of the Future, Life Cycle Analysis by Chappat, M. and Julian Bilal. Colas Group, 2003, p.34

Ontario

Ministry of Transportation
Ministère des Transports

$600M Cost-Saving with CIR and FDR

20-Yr CIR Performance

- PBS
- 1999 CIR
- 1987 CIR

- 1 2 3 4
Let’s Create a Sustainable Future!

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