Cost Considerations of In-Place Recycling as a Pavement Rehabilitation Alternative

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Flexible Pavement Rehabilitation

• State DOT’s
  – Extend service-life of pavement structures
  – Stretch available funding

• How?
  – Optimize pavement rehabilitation treatments
    • Based on available funding, other decisions, etc.
  – Seek use of innovative techniques
Flexible Pavement Rehabilitation

• Traditional methods
  – Overlay
  – Partial- and full-depth mill & replacement

• Innovative techniques
  – In-place pavement recycling
    • hot in-place
    • cold in-place
    • full-depth reclamation
FDR and CIR

• Full-depth reclamation
  - Bound layers plus a predetermined portion of the unbound materials are mixed and treated to form a stabilized base course

• Cold in-place recycling
  - Existing pavement materials (bound layers) are mixed with additives and repaved in-place without the application of heat
Full-Depth Reclamation

• Recommended for pavements with structural deterioration
  – Deep rutting
  – Full-depth cracking
  – Having deep pavement and/or base issues

• Usually performed at a depth of 10-12 inches
Potential Benefits

• Nevada DOT emphasizes the use of FDR and CIR
  – $600 million saved over last 20 years
    • compared to traditional techniques
• MTO (Ontario) comparison to mill and overlay
  – Emits 50% less green-house gases
  – Consumes 62% less aggregates
  – Costs 40-50% less

Bemanian et al. (2006) TRR 1949
Kasmierowski (2008) presentation to AEMA-ARRA-ISSA Annual Meeting
FDR Usage

• VDOT’s use of FDR has been limited
  – 3 projects in 2008 (approx. 16 lane miles)
  – 2 projects in 2010

• By comparison
  – Nevada DOT has completed 900 centerline miles of FDR since 1985
    • average >40 lane miles per year

Bemanian et al. (2006) TRR 1949
Objective

- Explore the potential for cost savings if VDOT were to implement an FDR program on its flexible pavement network
  - Start with study on primary network and then extend to secondary network
  - Could realistic list of candidate sites be developed from typical condition-based criteria?
Methodology

• Life-cycle cost analysis
  – Present cost methodology
    • maintenance treatment assumptions
    • statewide average materials and labor cost data
  – Considered two rehabilitation approaches
    • partial- and full-depth mill and replacement
    • partial-depth mill and replacement + FDR

• Applied to pool of potential FDR sites
  – Selected based on PMS condition data
## Two Approaches

<table>
<thead>
<tr>
<th>Year</th>
<th>Partial- and full-depth mill and replacement</th>
<th>Partial-depth mill and replacement + FDR</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2 inches mill &amp; overlay</td>
<td>2 inches mill &amp; overlay</td>
</tr>
<tr>
<td>22</td>
<td>4 inches mill &amp; overlay</td>
<td>2 inches mill &amp; overlay</td>
</tr>
<tr>
<td>32</td>
<td>Reconstruct (9.5 inches HMA)</td>
<td>2 inches mill + 8 inches FDR + 4 inches overlay</td>
</tr>
<tr>
<td>42</td>
<td>2 inches mill &amp; overlay</td>
<td>--</td>
</tr>
<tr>
<td>44</td>
<td>--</td>
<td>2 inches mill &amp; overlay</td>
</tr>
<tr>
<td>50</td>
<td>Salvage</td>
<td>Salvage</td>
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</tbody>
</table>
## Cost Assumptions

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>Cost, $</th>
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</thead>
<tbody>
<tr>
<td>HMA milling</td>
<td>SY at 2-inch depth</td>
<td>1.50</td>
</tr>
<tr>
<td>HMA milling</td>
<td>SY at 4-inch depth</td>
<td>3.00</td>
</tr>
<tr>
<td>HMA</td>
<td>Ton (110 lb/SY/inch)</td>
<td>70.00</td>
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<tr>
<td>FDR</td>
<td>SY at 8-inch depth</td>
<td>6.00</td>
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</tbody>
</table>
LCCA Assumptions

- **Based on VDOT’s LCCA procedure**
  - Analysis period = 50 years
  - Discount rate = 4%
- **Existing pavement structure**
  - 8 inches of HMA over aggregate
- **Layer coefficients**
  - HMA = 0.44, FDR = 0.30
- **Salvage value**
  - Cost of previous treatment multiplied by proportion of life remaining
LCCA Results

• Partial- and full-depth mill and replacement
  – $27.30 / SY

• Partial-depth mill and replacement + FDR
  – $17.28 / SY

• Potential savings of 36%
  – Consistent with results found in literature
Upon Further Review…

- Preventive maintenance?
- LCCA calls for deep mill & replacement at 32 years
  - All surface/intermediate layers
    - Not complete reconstruction
- Equivalent structural sections
  - 9.5 inch HMA = 8 inch FDR + 4 inch HMA overlay
- When all actions (but year 32) are equal
  - FDR savings = 24%
Extension to VDOT Pavement Network (Primary Routes)

- **Determine initial list of FDR project sites**
  - 2009 automated distress survey

- **Criteria**
  1. LDR less than 50
  2. Length greater than 1 mile
  3. Existing patched area greater than 15%
     - assumes existing patching to be a temporary repair

- **Result**
  - 251 lane miles at 47 sites
  - Average project = 5.3 lane miles
Extension to VDOT Pavement Network (Primary Routes)

• 251 lane miles = 1.4 million SY

• Cost over a 50-year life cycle
  – Partial- and full-depth mill and replacement
    • 1.4 million SY * $27.30 / SY = $38.9 million
  – Partial-depth mill and replacement + FDR
    • 1.4 million SY * $17.28 / SY = $24.6 million

• Potential savings of $14 million
  – Primary network only
Extension to VDOT Pavement Network

• **Primary network**
  – Potential savings of $14 million

• **Same criteria applied to secondary network**
  – 230 lane miles at 114 sites
  – More difficult to apply same methodology
    • more variation in pavement structures
  – **Savings could be of similar or greater magnitude**
    • Condition survey covers only 20% of secondary network
Summary

• LCCA compared costs of pavement rehab program using traditional methods versus one that incorporated FDR
  – Present costs were 37% less

• Selection criteria applied to primary network
  – 47 potential sites, $14 million potential savings
  – Similar economic savings over 20% of secondary network
Opportunities

• **Address deep distresses**
  – Normally covered up with overlays

• **Ability to remove backlog of highly deteriorated pavement sections**
  – Achieve longer lasting solution than overlay or mill and overlay
Next Steps?

• Decision to include in-place pavement recycling as “standard” option

• Identify best candidate locations
  – Refinement of project selection criteria

• Further research
  – Consideration of environmental benefits?
  – Consideration of curing
    • design for initial or long-term conditions
Thank you!

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