Comprehensive LCC of a Pavement Recycling Project in Virginia

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Outline

• Review of the Project
  ▪ Methods Used
  ▪ Results of Comprehensive LCA

• LCC and LCCA

• Analysis of the Project

• Conclusions
I-81 Project

Virginia Department of Transportation (VDOT) used novel recycling methods to reconstruct a project on I-81:

- Apparent structural problems
- Prior to reconstruction, pavement required maintenance every 4-6 years
- AADT = 23,000 (28 percent trucks)
- 7.2 lane miles

**Table:**

<table>
<thead>
<tr>
<th>Left Lane</th>
<th>Right Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-inch New AC</td>
<td>4-inch New AC</td>
</tr>
<tr>
<td>5-inch CIR</td>
<td>8-inch CCPR</td>
</tr>
<tr>
<td>Existing AC</td>
<td>6-inch New AC</td>
</tr>
<tr>
<td>Existing Aggregate</td>
<td>6-inch CCPR</td>
</tr>
<tr>
<td>Existing Aggregate</td>
<td>12-inch FDR</td>
</tr>
<tr>
<td>Subgrade</td>
<td>Subgrade</td>
</tr>
</tbody>
</table>
Cold Central-Plant Recycling
Full-Depth Reclamation
Performance of Project

I-81 In-Place Pavement Recycling Project


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Comprehensive LCA

- 50 year time horizon
- Included all phases minus EOL
  - Use phase evaluated using Chatti and Zaabar’s NCHRP models and MOVES
  - Traffic congestion effects considered using MOVES
  - Impact Assessment using TRACI
- Each Alt had different rehab schedules
Description of Alternatives

• Corrective Maintenance
  ▪ 2 inch mill and OL on a 4 to 6 year basis
  ▪ Limited patching based on VDOT schedule

• Recycling
  ▪ What was implemented
  ▪ Maintenance Schedule based on VDOT guide

• Reconstruction
  ▪ All virgin materials and traditional practices
  ▪ Same maintenance as recycling
## Comprehensive LCA

<table>
<thead>
<tr>
<th></th>
<th>CC</th>
<th>AC</th>
<th>EU</th>
<th>HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycling-based</td>
<td>(-22%)</td>
<td>(-19%)</td>
<td>(-28%)</td>
<td>(-29%)</td>
</tr>
<tr>
<td></td>
<td>121,398</td>
<td>20,305</td>
<td>20,867</td>
<td>47,618</td>
</tr>
<tr>
<td>Reconstruct</td>
<td>(-21%)</td>
<td>(-19%)</td>
<td>(-28%)</td>
<td>(-28%)</td>
</tr>
<tr>
<td></td>
<td>123,727</td>
<td>20,471</td>
<td>20,813</td>
<td>48,213</td>
</tr>
<tr>
<td>Corrective Maintenance</td>
<td>173,898</td>
<td>29,176,659</td>
<td>28,245</td>
<td>67,368</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>PS</th>
<th>ARD MR</th>
<th>ARD FF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycling-based</td>
<td>(-29%)</td>
<td>(-40%)</td>
<td>(-31%)</td>
</tr>
<tr>
<td></td>
<td>284,244</td>
<td>0.0022727</td>
<td>2,466,662,453</td>
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<tr>
<td>Reconstruct</td>
<td>(-28%)</td>
<td>(8%)</td>
<td>(-30%)</td>
</tr>
<tr>
<td></td>
<td>288,991</td>
<td>0.0041290</td>
<td>2,498,445,378</td>
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<tr>
<td>Corrective Maintenance</td>
<td>400,392</td>
<td>0.0038097</td>
<td>3,564,507,198</td>
</tr>
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</table>
Comprehensive LCC

• LCC links processes with cash flows
  ▪ More detailed than LCCA
  ▪ Splits variable and fixed costs
  ▪ Designed to be used with LCA results

• LCCA can be ‘black box’
  ▪ LCC can be more transparent
Cost Data

- Costs were disaggregated as much as possible
  - VDOT data was requested
  - Literature data used where more local data not available
  - Equipment relative value was accounted for

- NPV was calculated
  - 2.3% discount rate per OMB (2013)
User Costs

• **Work Zone**
  - Costs due to time lost in queueing
  - Values from USDOT OST (2003), adjusted accordingly
  - VOC were also accounted for

• **Use Phase**
  - VOC models: HDM calibrated models by Chatti and Zaabar
End of Life

- Residual value based on terminal IRI
  - 200 inches/mile as terminal
  - Very poor on VDOT Dashboard
Results

<table>
<thead>
<tr>
<th>Recycling-based</th>
<th>Traditional Reconstruction</th>
<th>Corrective Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV (M$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>$2.4386</td>
<td>$4.5387</td>
</tr>
<tr>
<td>Construction</td>
<td>$0.3582</td>
<td>$0.7261</td>
</tr>
<tr>
<td>Transportation</td>
<td>$0.2332</td>
<td>$0.6856</td>
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<tr>
<td>WZ Traffic</td>
<td>$9.1215</td>
<td>$10.1087</td>
</tr>
<tr>
<td>Usage</td>
<td>$2.4651</td>
<td>$2.4651</td>
</tr>
<tr>
<td>Total</td>
<td>$14.4648</td>
<td>$18.3723</td>
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</tbody>
</table>

Pavement life cycle phase

6/4/2015
Conclusions

• Recycling based strategy better in LCA and LCC terms

• For each alternative
  ▪ Materials phase and WZ traffic management most expensive

• Linking LCC and LCA guides to better understanding of sustainable management
Acknowledgments

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Thank You

Sustainable Transport...