Environmental Benefits of In-Place Pavement Recycling

VAA Environmental/Safety Workshop
December 1, 2011
Brian Diefenderfer, Ph.D., P.E.
Green House Gas Emissions

• Pew Center for Global Climate Change (2/11)
  – Saving Oil and Reducing Greenhouse Gas Emissions through US Federal Transportation Policy

• Policies should be developed to reduce petroleum usage and GHG emissions in construction
  – Pavement research mentioned as a means to accomplish this goal
5 Key Solutions

• Increase state agency leadership
• **Promote sustainability in infrastructure**
• Implement statewide infrastructure plans that coordinate with regional and national plans
• **Address life-cycle and ongoing maintenance costs**
• Increase and improve investment in infrastructure from public and private sources
In-Place Pavement Recycling

- Reuses existing materials
  - Incorporates a stabilizing additive
- Can address deep deterioration

- Hot in-place recycling (HIR)
- Cold in-place recycling (CIR)
  - Cold central (mobile) plant
- Full-depth reclamation (FDR)

increasing depth and level of deterioration
Cold In-Place Recycling

- Portion of the existing bound layers are pulverized, stabilized, and compacted
- Typically 3 to 6 inches

Image courtesy of Wirtgen
Full-Depth Reclamation

- Bound layers plus a portion of the unbound materials are pulverized, stabilized, and compacted.
- Typically up to 12 inches.
Potential Benefits of In-Place Pavement Recycling

• Economic
  – Nevada DOT saved $600 million over last 20 years
  – Reduced project backlog with level funding

• Environment (and economic)
  – MTO (Ontario) compared CIR to traditional methods and found that it emits 50% less green-house gases and costs 40-50% less

Bemanian et al. (2006) TRR 1949
Alkins, Lane, and Kazmierowski (2008) TRR 2084
VDOT In-Place Recycling Projects

FDR
- 2008: SR 6, 13, 40
- 2010: U.S. 60

FDR and CIR
- 2011: U.S. 60, SR 35, I-81
- 2012: U.S. 17
I-81 Project, Summer 2011

• Right lane
  – 10-inch mill
  – 12 inches FDR (lime-kiln dust + portland cement)
  – 6 inches CCPR (foamed asphalt)
  – 6-inch asphalt overlay
  – 4 lane closures, total of 17 days

• Left lane
  – 2-inch mill
  – 5 inches CIR (foamed asphalt)
  – 4-inch asphalt overlay
  – 1 lane closure, total of 3 days
FDR
Central (Mobile) Plant
Environmental Savings

• **Existing material recycled on-site**
  – Decreased fuel consumption/emissions from materials production and construction

• **Recycling at ambient temperatures**
  – Only asphalt binder is heated

• **Central-plant recycling should have application to existing RAP stockpiles**
Quantifying Environmental Savings

• Estimated material quantities
  – Traditional vs. recycling

• Estimated carbon dioxide equivalent
  – Production of raw materials, transportation, production of final materials, and placement

• Carbon dioxide equivalent (CO$_2$-eq)
  – Includes: carbon dioxide (CO$_2$), methane (CH$_4$), nitrous oxide (N$_2$O)
  – Does not include, CO, NO$_x$, sulfur dioxide, PM-10
## CO₂-eq
### Emissions by Material

<table>
<thead>
<tr>
<th>Operation</th>
<th>Representative CO₂-eq (lb/yd²-in)</th>
<th>CO₂-eq range (lb/yd²-in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement milling</td>
<td>1.730</td>
<td>0.080-3.500</td>
</tr>
<tr>
<td>Hot-mix asphalt</td>
<td>5.900</td>
<td>5.600-5.900</td>
</tr>
<tr>
<td>CIR (partial depth)</td>
<td>0.711</td>
<td></td>
</tr>
<tr>
<td>CIR (full depth)</td>
<td>1.354</td>
<td>0.900-4.100</td>
</tr>
<tr>
<td>Aggregate base</td>
<td>1.553</td>
<td>1.400-1.600</td>
</tr>
<tr>
<td>Treated subgrade</td>
<td>1.645</td>
<td>1.421-1.868</td>
</tr>
</tbody>
</table>

*Robinette and Epps (2010) TRR 2179*
Right Lane Processes

• **Traditional process**
  – Deep milling
  – Reconstruction with hot-mix asphalt

• **Recycling process**
  – Deep milling (same as above)
  – Subgrade stabilization (FDR)
  – Cold in-place recycling
    • no values for CCPR
  – Hot-mix asphalt overlay
Left Lane Processes

• **Traditional process**
  – Milling
  – Repaving with hot-mix asphalt

• **Recycling process**
  – Milling (same as above)
  – Cold in-place recycling
  – Hot-mix asphalt overlay
CO$_2$-eq By Process

47% reduction
Consistent with other published estimates
Summary

• In-place pavement recycling offers the potential for significant environmental savings

• Example from I-81 project
  – GHG emissions (CO$_2$-eq), 47% reduction

• Application to existing RAP stockpiles
Thank you!

brian.diefenderfer@vdot.virginia.gov