GREEN IS GOOD

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What’s this all about?
FHWA ETG on Sustainability

- Pavements
- Paving Materials
- Pavement Maintenance
- User Operations
What’s Behind It?

- How to Evaluate Environmental Effects of Pavement Systems

Life Cycle Analysis

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Life Cycle Cost Analysis
Life Cycle Cost Analysis

Life Cycle Assessment

Life Cycle Cost Analysis

an engineering economic analysis of alternative investment options.

Life Cycle Assessment

assess the environmental impacts from all stages of life from cradle to grave – to cradle again.
Life-Cycle Analysis

- Extraction
- Production
- Transport

- Traffic Delay
- On-site
- Equipment

- Rolling Resistance
- Carbonation
- Lighting
- Albedo
- Leachate

- Traffic Delay
- Extraction
- Production
- Transport

- Mtce
- Rehab
- End-of-

Boundaries

• Where to Set
• Grades
• Stopping
• Alternate Transportation
Life-Cycle Analysis

- Extraction
- Production
- Transport

Traffic Delay
- On-site Equipment

Rolling Resistance
- Carbonation
- Lighting
- Albedo
- Leachate

Traffic Delay
- Extraction
- Production Transport

Materials
- Construction

Use

Mtce
- Rehab

End-of-Life

Traffic Delay
- Salvage Transport...
pavement carbon footprint

Kg/t

- Feedstock
- Laydown
- Transport
- Manufacture
- Aggregate
- Binder

HMA  Warm Mix  PCC
    w/ RAP
pavement carbon footprint

Kg/t

- Feedstock
- Laydown
- Transport
- Manufacture
- Aggregate
- Binder

HMA
Warm Mix w/ RAP
PCC
pavement carbon footprint
pavement carbon footprint

Kg/t

HMA  Warm Mix w/ RAP  PCC

- Feedstock
- Laydown
- Transport
- Manufacture
- Aggregate
- Binder
pavement carbon footprint

Kg/t

HMA
Warm Mix w/ RAP
PCC

Feedstock
Laydown
Transport
Manufacture
Aggregate
Binder
Estimate of US Emissions for Hot-Mix Asphalt Production

- **U.S.A.**
  - In 2011, 380 million tons of asphalt mix

- **Typical Production Parameters**
  - No. 2 Oil, 4% Stockpile Moisture
  - 165°C Mix Temperature (110°C Stack)

- **Estimated Annual HMA Emissions ~**
  - 8,222,000 US tons CO$_2$e
Percentage of Total Asphalt Production in US
source: National Asphalt Pavement Association

- 2009: 4.7%
- 2010: 11.8%
- 2011: Increasing
As move continues to from Hot-Mix. Equivalent to removing 1.5 million cars off the road.

25% Savings

Total Predicted WMA Annual Emissions ~ 6,087,000 US tons CO₂e at 130°C
pavement carbon footprint

Initial Construction
Use phase carbon

$\text{CO}_2$ per lane mile, %

time
Vehicle fuel use

CO₂ per lane mile, %

0 10 50 100

Vehicle fuel use

time
4 Million Total Miles
600,000 Bridges

NHS 160,000 miles
• 4% of roads
• 40% VMT
• 75% Heavy Truck VMT
• 90% Tourist Traffic
MIRIAM Model Rolling Resistance
Example Concrete Section 30 year Period

Contribution of Macrotecture (MPD) and Ride (IRI)

- f(MPD)
- f(IRI, V)

\[ \text{RCC} = C_1 + C_2 \text{ MPD} + C_3 \text{ IRI} + C_4 \text{ IRI} \left( V - V_{ref} \right) \]
“Pavement roughness had a significant impact on fuel consumption of trucks applying loads to WesTrack pavement test sections. Under otherwise identical conditions, trucks used 4.5% less fuel on smooth (post rehabilitation) than on rough (pre rehabilitation) pavement.”

- NCHRP Report 455, p. 483
IRI versus Traffic/Time

- LTPP General Pavement Studies (GPS)
- NCHRP 20-50 (August 2001)
  - LTPP Data Analysis: Factors Affecting Pavement Smoothness, Perera, et.al.
**2009 NHS**

- 40% of All Traffic
- 75% of All Freight Traffic

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mileage of NHS</th>
<th>~Km Traveled</th>
<th>CO$_2$e(*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>8%</td>
<td>11%</td>
<td>8% additional</td>
</tr>
<tr>
<td>IRI &gt; 2.69 m/km</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>66%</td>
<td>69%</td>
<td>Net 0%</td>
</tr>
<tr>
<td>Good</td>
<td>26%</td>
<td>20%</td>
<td>3% savings</td>
</tr>
<tr>
<td>IRI ≤ 1.50 m/km</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Project Level (LCA)
LC Phases & System Boundaries...

1. Material Production
2. Construction, Maintenance, & Rehabilitation
3. Use...
4. End-of-Life...
Continuing to improve asphalt’s environmental sustainability

- RAP and In place recycling
- Shingles
- Porous
- Smooth
- Perpetual

Reduce / Reuse / Recycle
FHWA’s Sustainable Highways Self-Evaluation Tool
Sustainable Highways Tool

A web-based self-evaluation tool for measuring sustainability over the life cycle of a transportation project or program — from system and project planning through design, construction, and operations and maintenance
EPA’s Sustainability Definition

**Sustainability** means “meeting the needs of the present without compromising the ability of future generations to meet their own needs.”
Understanding Sustainability...
Goals

• Encourage sustainable highway practices
  - Internal improvement
  - External recognition

• Help agencies measure sustainability and quantify tradeoffs

• Provide a framework for communicating with stakeholders about sustainability

• Establish a method for evaluating sustainable highways
What the tool is NOT...

• The tool is not final. Ongoing work on a Beta-version
• The tool is not required. Use is purely voluntary.
What is a sustainable highway?

- Satisfies functional requirements
  - Fulfills transportation goals and needs (e.g. congestion reduction)
  - Addresses development and economic growth
- Reduces impacts
  - Environment
  - Consumption of resources
- Addresses environmental, economic, and social equity dimensions (triple bottom line)
- Addresses sustainability from planning through operations
The triple bottom line
What is included in the tool?

- Collection of **best practices**
- Repository of **real-world examples** where best practices have been applied
- **Self-evaluation tool** to measure sustainability
What are some of the tool’s characteristics?

- Web-based
- Criteria based on best practices (total of 68)
- Each criterion assigned a point value based on expected sustainability impact
- In coordination with ASCE effort
- Other sustainable highways tools used as references (GreenLITES, I-LAST, Greenroads)
Welcome!

FHWA Sustainable Highways Self-Evaluation Tool

The Sustainable Highways Self-Evaluation Tool identifies characteristics of sustainable highways and provides procedures and techniques to help agencies and organizations apply and integrate sustainability best practices into their highway development projects.
Which credits are pavement-related?

<table>
<thead>
<tr>
<th>Credit</th>
<th>Title</th>
<th>Requirements</th>
<th>Point Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-13</td>
<td>Noise Reduction Management Plan</td>
<td>Establish a Noise Reduction Management Plan (NRMP) for transportation systems.</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td><strong>System Planning and Processes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD-4</td>
<td>Lifecycle Assessment</td>
<td>Incorporate energy and emissions information into the decision-making process for pavement design rehabilitation alternatives.</td>
<td>2</td>
</tr>
<tr>
<td>PD-5</td>
<td>Lifecycle Cost Analysis</td>
<td>Determine the total lifecycle cost for pavements section alternatives to aid in project decision making.</td>
<td>2</td>
</tr>
<tr>
<td>PD-13</td>
<td>Recycled Materials</td>
<td>Reduce lifecycle impacts from extraction and production of virgin materials.</td>
<td>1-5</td>
</tr>
<tr>
<td>PD-21</td>
<td>Low-Emitting Materials</td>
<td>Reduce human exposure to hazardous airborne compounds from construction materials.</td>
<td>2-5</td>
</tr>
<tr>
<td>PD-24</td>
<td>Long-Life Pavement</td>
<td>Minimize life cycle costs by promoting design of long-lasting design pavement structures.</td>
<td>5</td>
</tr>
<tr>
<td>PD-25</td>
<td>Pavement and Structure Reuse</td>
<td>Reuse existing pavement and structural materials.</td>
<td>1-5</td>
</tr>
<tr>
<td>PD-27</td>
<td>Thermal Pavement</td>
<td>Use pavement thermal properties to enhance sustainability.</td>
<td>3</td>
</tr>
<tr>
<td>PD-28</td>
<td>Contractor Warranty</td>
<td>Incorporate contractor warranty and construction quality into the public low-bid process through the use of warranties.</td>
<td>3</td>
</tr>
<tr>
<td>PD-31</td>
<td>Equipment Emission Reduction</td>
<td>Reduce air emissions from nonroad construction equipment by encouraging early achievement of the EPA Tier 4 emission standard.</td>
<td>2</td>
</tr>
<tr>
<td>PD-35</td>
<td>Reduced Energy Materials</td>
<td>Reduce fossil fuels use at the hot mix asphalt or cement plant, decrease emissions at the plant, and decrease worker exposure to emissions during placement.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Transportation Systems, Management, Operations and Maintenance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OM-2</td>
<td>Pavement Management System</td>
<td>Make pavements last longer and perform better by preserving and maintaining them.</td>
<td>1-10</td>
</tr>
<tr>
<td>OM-4</td>
<td>Paved Surfaces Management System</td>
<td>Make paved surfaces last longer and perform better by performing routine maintenance and preservation activities on them.</td>
<td>1-10</td>
</tr>
</tbody>
</table>
Why are pavements emphasized?

“Highways and streets are the largest component of public transportation infrastructure spending. Pavement is by far the largest part of that spending, accounting for about 70 percent of state and local roadway expenditures.”

~ Bureau of Transportation Statistics

- Because pavements and their supporting structure make up a majority of roadway infrastructure cost and materials quantities, they should be given commensurate attention.
Thanks Questions