SUSTAINABILITY: TOWARD “GREEN” ROADS

2014 International & Western States In-Place Recycling Conference, Denver, CO

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Director of Research & Development, MWV Asphalt Innovations
TOPICS OF TODAY’S PRESENTATION

- Sustainability definition
- What it means to be “sustainable” road
- Drivers of sustainable roads initiatives
- Sustainable pavement programs worldwide
  - DuboCalc from Holland
- Focus on green recycling technologies
  - Recycling HIR, CIR, FDR
- Long-term pavement performance studies
- Comparative LCA studies
- Conclusions
"development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (1)

SUSTAINABLE DEVELOPMENT

Use of land (natural resources) & labor (manufacturing) to meet current demand levels for goods & services

Neutral or positive Environmental Impact

While conserving, reusing, & renewing to prevent irreparable resource depletion/damage & / or waste accumulation
SUSTAINABLE ROADS: 2009

Roads that are “effectively & efficiently planned, designed, built, operated, upgraded, & preserved by means of integrated policies respecting the environment & providing the expected socio-economic services with optimal mobility & safety” (2) ensure sustainable economic growth.

(2) ERF & IRF BPC: “Sustainable Roads and Optimal Mobility,” October 2009.
It is well-established that per-capita GDP growth is directly proportional to the length of the highway network.
SUSTAINABLE ROADS: TODAY

“ASPHALT PAVEMENT DURABILITY” = SUSTAINABILITY AND ENVIRONMENTAL LIFE CYCLE

(2) ERF & IRF BPC: “Sustainable Roads and Optimal Mobility,” October 2009.
“ASPHALT PAVEMENT DURABILITY” = SUSTAINABILITY AND ENVIRONMENTAL LIFE CYCLE

Pavement service life and maintenance treatments are influenced by durability
SUSTAINABLE ROADS: 2014 IN THE EU

“...in a post fossil-fuel world...”

“...multiple recycling while maintaining long-term eco-stability...”

“...mitigating climate change...”
INCENTIVIZING GREEN ROADS

- DuboCalc
- JouleSAVE
- ROAD-RES
- PaLATE
- LCI Model
- GHG Calculator for Infrastructure
- AllBack2Pave
- 100% Recycling
- Green Dot
- AMW
- WLCO2T
- CO2 Performance Ladder
- Green Roads
- Green Dot
- Ecologiciel
- Highways Agency Carbon Calculator Tool
- WRAP
INCENTIVIZING GREEN ROADS: DuboCalc

Ministry of Transportation Netherlands

1. The DuboCalc software
2. The Library: a reference database with basic information
3. The project document (or project data)

Instructions for use of DuboCalc can be found at https://www.youtube.com/watch?v=LJY9QzxlW2w
INCENTIVIZING GREEN ROADS: DuboCalc

- Calculate the environmental impact of material and energy use
- Judge the sustainability of a design relatively quickly and easily
- Achieve significant environmental results
- Based on the methodology of the Life-cycle Analysis (LCA)
- Takes into account all the relevant environmental effects during the entire course of a project
- Expresses the effects of the project on the environment
- Environmental effect categories
- These effects are then translated into shadow prices
- This result is expressed as the value in Euros of the ECI

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INCENTIVIZING: CO₂ Performance Ladder

Vendors qualify for five levels of demonstrable CO₂ management capabilities. With each level the owner (began with the rail agency in Holland) can offer discounts off the tender bid.

<table>
<thead>
<tr>
<th>Level</th>
<th>Discount (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 5</td>
<td>10%</td>
</tr>
<tr>
<td>Level 4</td>
<td>7%</td>
</tr>
<tr>
<td>Level 3</td>
<td>4%</td>
</tr>
<tr>
<td>Level 2</td>
<td>2%</td>
</tr>
<tr>
<td>Level 1</td>
<td>1%</td>
</tr>
</tbody>
</table>
INCENTIVIZING: CO$_2$ Emissions Calculators

Carbon footprint asphalt:

60 g CO$_2$ equiv/kg

Excerpted from J. van de Zwan, “How to Diminish Carbon Footprint of Roads,” E&E 2012, Istanbul, Turkey
INCENTIVIZING: CO₂ Emissions Calculators

Carbon footprint asphalt:
   60 g CO₂ equiv/kg

Carbon footprint orange juice:
   1600 g CO₂ equiv/kg

Carbon footprint cheese burger:
   6000 g CO₂ equiv/kg

Excerpted from J. van de Zwan, “How to Diminish Carbon Footprint of Roads,” E&E 2012, Istanbul, Turkey
Carbon footprint milk:

2500 g CO$_2$ equiv/kg (17.6 lb CO$_2$ equiv/gallon)
INCENTIVIZING: asPECT in the UK

4 components of asPECT

- Protocol – a defined set of “rules” for footprinting asphalt products and applications
- Guidance – explains the decision making process behind the Protocol and provides worked examples
- Software – facilitates the calculation for those that choose to use it (calculations can alternatively be embedded into other company systems)
- Software User Guide

www.sustainabiltyofhighways.gov.uk
INCENTIVIZING GREEN: AllBack2Pave

Sponsor: Conference of EU Directors of Roads (CEDR)
Funding: $620,000
Goals: evaluate feasibility of moving to 100% recycled roads

Currently relying on WMA technologies
INCENTIVIZING GREEN: CoRePaSol

Advanced Cold Recycled Bitumen Stabilized Pavement Solutions

Sponsor: Conferrence of EU Directors of Roads (CEDR)
Funding: $480,000
Goals: evaluate feasibility of moving to 100% recycled base and binder layers

Tasks: - establish new mix evaluation procedures and pavement design protocol
- establish long-term ecostability
INCENTIVIZING GREEN ROADS: USA

Project Requirements
- PR-1 Environmental Review Process
- PR-2 Lifecycle Cost Analysis
- PR-3 Lifecycle Inventory
- PR-4 Quality Control Plan
- PR-5 Noise Mitigation Plan
- PR-6 Waste Management Plan
- PR-7 Pollution Prevention Plan
- PR-8 Low Impact Development
- PR-9 Pavement Management System
- PR-10 Site Maintenance Plan
- PR-11 Educational Outreach

2015 Pavement Test Track Conference

March 3-5, 2015
The Hotel at Auburn University and Dixon Conference Center
Auburn, Alabama

- WMA & High RAP/RAS/GTR Mixes
- Optimized Structural Design
- Pavement Preservation
- Implementation

Official registration information will soon be available at www.ncat.us
INCENTIVIZING GREEN ROADS

SUSTAINABLE HIGHWAYS INITIATIVE

The Sustainable Highways Initiative supports programs and activities conducted across the Federal Highway Administration to facilitate balanced decisionmaking among environmental, economic, and social values — the triple bottom line of sustainability.

INVEST 1.0 supports roadway sustainability

ACCESS THE TOOL >
INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by FHWA as a practical, web-based, collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures and practices) and projects.
## INCENTIVIZING GREEN ROADS: INVEST

### Project Development by Criteria Scorecard

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Paving</th>
<th>Urban Basic</th>
<th>Urban Extended</th>
<th>Rural Basic</th>
<th>Rural Extended</th>
<th>Custom Core Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD-17 Energy Efficiency</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PD-18 Site Vegetation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>PD-19 Reduce and Reuse Materials</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>PD-20 Recycle Materials</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PD-21 Earthwork Balance</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>PD-22 Long Life Pavement Design</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PD-23 Reduced Energy and Emissions in Pavement Materials</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>PD-24 Contractor Warranty</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>PD-25 Construction Environmental Training</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PD-26 Construction Equipment Emission Reduction</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PD-27 Construction Noise Mitigation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PD-28 Construction Quality Control Plan</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PD-29 Construction Waste Management</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Total Number of Criteria in Scorecard:** 12, 24, 29, 21, 25, 19

1 - Indicates the core criteria that must be included in the custom scorecard. The user may choose as many additional criteria as desired.
INCENTIVIZING GREEN ROADS: INVEST

INVEST Implementation Sites

By the Numbers
- 55 INVEST Implementation projects
- In 25 states and DC
- By 29 agencies, including:
  - 10 state DOTs
  - 13 MPOs
  - Federal Lands Highway Divisions (all 3 divisions)
  - 4 other transportation agencies

State DOT
MPO
Federal Lands Highway
Other
**TABLE 1: POINTS FOR AVERAGE RECYCLED CONTENT (PERCENT BY WEIGHT OR VOLUME OF MATERIALS)**

<table>
<thead>
<tr>
<th>Recycling Method Used</th>
<th>Points Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent average recycled material (ARC) required for recycling in pavements</td>
<td>10% 20% 30% 40% 50% or more</td>
</tr>
<tr>
<td>Percent average recycled material (ARC) required for granular base course or embankments</td>
<td>20% 30% 40% 50% 60% or more</td>
</tr>
</tbody>
</table>

2-6 points. In-Place Pavement Recycling

**TABLE 2: POINTS AWARDED FOR IN PLACE RECYCLING**

<table>
<thead>
<tr>
<th>Percentage Pavement Area Recycled</th>
<th>Points Awarded by Method of Recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HIR</td>
</tr>
<tr>
<td>50–74%</td>
<td>2</td>
</tr>
<tr>
<td>75–99%</td>
<td>3</td>
</tr>
<tr>
<td>100%</td>
<td>4</td>
</tr>
</tbody>
</table>
Over 130 CIPR projects studied.

Service lives exceeded the 10-year design life.

Compared to mill and overlay, the CIPR projects saved

$12,109 / lane-mile
COLD IN-PLACE RECYCLING (CIR) TECHNIQUE IN NEVADA: FIELD PERFORMANCE EVALUATION FOR A DECADE OF IN-SERVICE PERIOD

By

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Service life extensions projected to 20 years before rehab required.
COLD RECYCLING ECO-STABILITY

Two Life Cycle Assessment studies (5a & 5b) have been published recently, showing the relative environmental impact (fuel consumption most notably) of different asphalt application (paving) technologies.

<table>
<thead>
<tr>
<th>Product</th>
<th>Binders</th>
<th>Aggregates</th>
<th>Manufacture</th>
<th>Transport</th>
<th>Laying</th>
<th>Total (MJ/t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bituminous concrete</td>
<td>279</td>
<td>38</td>
<td>275</td>
<td>79</td>
<td>9</td>
<td>680</td>
</tr>
<tr>
<td>Road base asphalt concrete</td>
<td>196</td>
<td>36</td>
<td>275</td>
<td>75</td>
<td>9</td>
<td>591</td>
</tr>
<tr>
<td>High modulus asphalt concrete</td>
<td>284</td>
<td>38</td>
<td>289</td>
<td>79</td>
<td>9</td>
<td>699</td>
</tr>
<tr>
<td>Warm mix asphalt concrete</td>
<td>294</td>
<td>38</td>
<td>234</td>
<td>80</td>
<td>9</td>
<td>654</td>
</tr>
<tr>
<td>Emulsion bound aggregate</td>
<td>227</td>
<td>37</td>
<td>14</td>
<td>81</td>
<td>6</td>
<td>365</td>
</tr>
<tr>
<td>Cold mix asphalt</td>
<td>314</td>
<td>36</td>
<td>14</td>
<td>86</td>
<td>6</td>
<td>457</td>
</tr>
<tr>
<td>Road base asphalt concrete with 20% RAP</td>
<td>157</td>
<td>33</td>
<td>275</td>
<td>64</td>
<td>9</td>
<td>538</td>
</tr>
<tr>
<td>Road base asphalt concrete with 30% RAP</td>
<td>137</td>
<td>30</td>
<td>275</td>
<td>58</td>
<td>9</td>
<td>510</td>
</tr>
<tr>
<td>Road base asphalt concrete with 50% RAP</td>
<td>98</td>
<td>25</td>
<td>275</td>
<td>47</td>
<td>9</td>
<td>454</td>
</tr>
<tr>
<td>Emulsion in-situ recycling</td>
<td>105</td>
<td>4</td>
<td>-</td>
<td>15</td>
<td>15</td>
<td>139</td>
</tr>
</tbody>
</table>

COLD RECYCLING ECO-STABILITY

Two Life Cycle Assessment studies have been published recently, showing the relative environmental impact (energy consumption, most notably) of different asphalt application (paving) technologies.

CONCLUSIONS

Sustainable recycling technologies are proven across the globe to extend pavement service life in an economical and eco-stable manner.

- Long-term pavement studies bear this out.
- Eco-analysis and LCA prove the eco-stability of recycling.
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In Europe, owners are providing monetary incentives to achieve sustainability goals of durability and eco-stability.

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- CO₂ Performance Ladder are seminal developments.
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In Europe, owners are providing monetary incentives to achieve sustainability goals of durability and eco-stability.

- DuboCalc and
- CO₂ Performance Ladder are seminal developments.

Trends toward greater implementation of sustainability programs are clear. Given demonstrable pavement durability & long-term performance data, we must ask ourselves what does our industry need to do to expand sustainable pavement construction technologies like recycling?
GREEN RECYCLING TECHNOLOGIES ARE MARKET-READY.

THANK YOU.