Sustainability In Asphalt Pavements

Mid-Year Asphalt Pavement Technical Seminar

July 12, 2012
Sustainability

“Meeting the needs of the present without compromising the ability of future generations to meet their own needs”
Sustainable Concepts

• Sustainable Technologies Should Be:
  – Economical
  – Resource-responsible
  – Long-life Solutions
  – Environmentally Sound
  – Increase Performance and Value

• 3R’s: Reduce, Recycle, Re-use
3R’s: Reduce

• Asphalt Pavements Reduce Demand on Virgin Raw Materials:
  – Reclaimed Asphalt Pavement (RAP)
  – Reclaimed Asphalt Shingles (RAS)
  – Ground Tire Rubber (GTR)
  – Perpetual Pavement Design for Long-life Performance.

• Reduce Energy Consumption with Warm Mix Asphalt
3R’s: Recycle

- **Asphalt Pavement**: Use of RAP Reuses & Rejuvenates Old Asphalt Pavement and Avoids Placing Hundreds of Thousands of Tons of Waste Material Annually in Landfills.

- **Shingles**: Tear-offs from Old Roofs or Manufacturer Waste Used as a Component of Asphalt Pavements.

- **Scrap Tires**: Formerly Destined for Landfills Incorporated into Asphalt Pavements Improving Binder Properties and Material Performance.
Recycling Rates by Category

- 64% Scrap Steel
- 60% Aluminum Cans
- 56% Newspapers
- 37% Plastic Soft Drink Bottles
- 31% Glass Beverage Containers
- 23% Magazines
- 90% Asphalt Pavements
3R’s: Reuse

• Asphalt Pavements are 100% Reusable & Do Not Require Removal & Disposal Costs.
• Can be Incorporated Entirely Into New Asphalt Pavements.
Sustainable Attributes of Asphalt Pavements

- Reclaimed Asphalt Pavement (RAP)
- Reclaimed Asphalt Shingles (RAS)
- Ground Tire Rubber
- Bio-Derived Binder Extenders
- Warm Mix Asphalt
- Porous Pavements
- Perpetual Pavement
- Smoothness
- Low Carbon Footprint
Reclaimed Asphalt Pavement (RAP)

• Asphalt is the Most Recycled Material in America Saving More Than $300 Million Annually.

• 73 Million Tons Reused Annually.
  – Nearly twice as much as paper, glass, aluminum & plastics combined.

• RAP in Landfills:
  – Less Than 10% nationally.
  – Less Than 1% in Ohio.
RAP Usage in Ohio

• Ohio one of Top 5 states for Reported Average RAP Usage.
• Ohio among 8 states to Use 30% RAP in base courses.
• Ohio among top 5 states to Use 30% RAP in Intermediate Courses.
• Ohio among large group of states allowing:
  – Up to 15% in Heavy Surface Courses.
  – Up to 25% in Light Traffic Surface Courses.
NCAT Reclaimed Asphalt Pavement Publication

• Developed by NCAT & FHWA Recycled Asphalt Pavement Expert Task Group
• Overview of the economic, performance and environmental benefits of RAP
• Available at: www.morerap.us
Reclaimed Asphalt Shingles

• Reclaimed Asphalt Shingles (RAS) is generally of two origins:
  – Manufacturing Waste
  – Roofing Tear-offs
RAS: Background

- 10 Million Tons of Asphalt Shingles Annually Enter Waste Stream
  - 1 Million Tons Manufacturer Waste
  - 9 Million Tons Tear-offs

- 3rd Largest Construction Material Waste
Why use Shingles?

• Economic Benefit
  – Considerable Cost Savings Per Ton of HMA

• Ease of Recycling
  – Shingles Composed of Materials Routinely Used in HMA

• Process Can be Engineered to Provide Asphalt Pavements with Equivalent or Superior Performance
Ground Tire Rubber (GTR)

• Two Main GTR Applications:
  – Dry Process: Aggregate Replacement
    • Granulated/Ground Rubber is Added with Aggregate During Mixture Process.
    • Substitute for 1%-3% of Aggregate.
  – Wet Process: Asphalt Rubber (AR)
    • Crumb Rubber is Added to Liquid Asphalt before Mixing at Asphalt Plant.
    • Asphalt Cement Modifier.
GTR Environmental Benefits

• Two-Inch thick overlay of AR Asphalt Pavement Will Utilize Approximately 2,000 Tires Per Lane Mile

• Approximately 10 Million Tires are Annually Recycled in Paving Applications
NCAT Test Track GTR Research

• MoDOT Sponsored NCAT Research Viability of GTR as Alternate Binder Modifier for Styrene-Butadiene-Styrene (SBS) in Interstate Surface Mixes.

• Constructed Two Test Sections and Monitored Results for Two Years (2009-2011).
Preliminary Research Conclusions

• No Significant Rutting or Cracking.
• GTR Demonstrated Equivalent or Better Performance Compared to SBS Modified Mixture.
• GTR Can be Used as a Polymer Substitute Without Sacrificing Asphalt Mix Performance.
Ohio Asphalt: Summer 2012

Flexible Pavements of Ohio Turns 50

Asphalt Pavement continues to be a leader in innovations that increase sustainability.

Asphalt pavement continues to be a leader in innovations that increase sustainability. Of recent note is the introduction of modified asphalt that incorporates reclaimed tire rubber. This form of asphalt has been shown to increase the longevity of asphalt pavements, and may help to reduce landfill costs for the disposal of tires. The use of recycled tire rubber is also being considered for its potential to increase the performance of asphalt pavements. The use of tire rubber in asphalt pavements is an example of sustainable practices that can help to reduce the environmental impact of pavement construction.
Bio-Derived Binder Extenders

• Vegetable Oil Formulations (Soybean, Corn, Sunflower & Canola) in Development as Possible Asphalt Binder Modifiers & Extenders.

• Nu-Vention Solutions, Inc.
  – Ohio Company
  – BR2: Swine Manure Based Bio-oil to Extend & Improve Asphalt Binder.
Warm Mix Asphalt (WMA)

• General Term for Technologies That Allow Reduced Asphalt Production & Placement Temperatures.
• Reductions of 50° to 100° Fahrenheit
Warm Mix Asphalt (WMA)
Reduced Mixing Temperatures (50º-100º F)

Temp = 320º F

Temp = 245º F
Advantages of WMA (Plant)

- Improves Air Quality Emissions
- Reduces Energy Consumption & Mix Production Cost
- Facilitates the use of RAP
- Reduced “Carbon Footprint”
Advantages of WMA (Placement)

• Improves Worker Environment
  – Reduced Exposure to Fumes/Smoke

• Cool Weather Paving
  – Extends the Paving Season

• Improved Workability
  – Compaction Aid for “Stiff” Mixes
WMA Technologies

- Additives:
  - Zeolite
  - Sasobit
- Modified Binder:
  - Evotherm
- Foaming
  - Simple and Effective
  - All Manufacturers
WMA in Ohio

• In 2006: ODOT Began Lab investigations & Field Trials to Demonstrated Effectiveness of WMA.

• In 2008: Use Permissive Under ODOT Specs.

• 2011: 78 out of 151 Asphalt Plants Possess the Capability to Produce WMA
## Warm Mix Asphalt in Ohio

### Ohio DOT WMA Usage

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Tons</th>
<th>WMA Tons</th>
<th>Percent WMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>4,173,618</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>4,677,966</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2008</td>
<td>5,130,600</td>
<td>10,430</td>
<td>.2%</td>
</tr>
<tr>
<td>2009</td>
<td>4,953,472</td>
<td>148,576</td>
<td>3%</td>
</tr>
<tr>
<td>2010</td>
<td>3,573,764</td>
<td>1,071,994</td>
<td>30%</td>
</tr>
<tr>
<td>2011</td>
<td>5,000,000</td>
<td>2,800,000</td>
<td>56%</td>
</tr>
</tbody>
</table>
Porous Asphalt

Pavement Structure with Permeable Surface that Permits Stormwater to Pass Through Surface for Infiltration and/or Storage in the underlying layer.
Why Porous Asphalt Pavements?

• Environmental Benefits:
  – Limits Quantity & Improves Quality of Stormwater
  – Recharges Groundwater
  – Reduces Amount of Impervious Surfaces

• Economic Benefits:
  – Reduces/Eliminates Conventional Stormwater Control Facilities & Maximizes Developable Space
  – Stormwater Regulations & Taxable Outflow
Pavement Longevity

• Walden Pond State Reservation, Concord, MA.
• Still in use Today.
Other Porous Asphalt Applications: Buckeye Varsity Field
The Ohio State University

- 500-seat Field Hockey Stadium
  - Opened 2010.
- Field Construction:
  - Porous Asphalt Base
  - 3/8” Closed-cell Foam Intermediate Layer
  - Astroturf Surface.
ODNR Rainwater & Land Development Manual

• Design, Construction & Maintenance Guidance for Permeable Paving Materials

• Available for Purchase from ODNR or On-line at: http://www.dnr.state.oh.us/tabid/9186/default.aspx
APA Cleaner Water with Asphalt Pavements

• Written as a single source, scientifically documented resource.

• Focuses on the benefits of asphalt pavements for improved water quality, stormwater management, and the reduction of roadside pollution.

• Available as a Free Download at: www.asphaltroads.org
Perpetual Pavements

(3) SMA, OGFC or SUPERPAVE
(2) High Modulus Rut Resistant Asphalt
(1) Flexible Fatigue Resistant Asphalt

Pavement Foundation
Perpetual Pavement Design

- Full-depth Asphalt Pavement Designed To Eliminate Structural Distresses:
  - Bottom Up Fatigue Cracking
  - Structural Rutting
- All Distresses Can be Quickly Remedied from Surface
- Result in a Structure with ‘Perpetual’ or ‘Long Life’ Performance
Advantages of Perpetual Pavements

- Efficient Design – No Overdesign
- Avoid Need for Reconstruction or Rehabilitation
- Reduce Life Cycle Cost
- Reduce Energy Consumption
- Reduce Use of Virgin Materials
- Ease of Maintenance
  - Maintenance Primarily Consists of Crack Filling & Minor Resurfacing
  - Night Construction
  - Maintenance of Traffic is Easier
Perpetual Pavements in Ohio

• No Deep-Strength Asphalt Pavement on Ohio’s Interstate System has ever Required Replacement or Major Rehabilitation.
  – Earliest Constructed in the Late 1950’s.

• FPO Study, “Economic Evaluation of Ohio's Flexible and Rigid Interstate Pavements.” Available at:
  
APA Perpetual Pavement Awards

• National Award for Asphalt Pavements:
  – At Least 35 Years Old.
  – No Structural Failures.
  – 13 Year Average Resurfacing Interval.

• 80 Pavements Have Received Perpetual Pavement Awards Since 2001.
  – 3 in Ohio.
Smoothness in Sustainable Pavement Construction

• Asphalt Pavements are Consistently Smoother Than Other Pavements.
  – Smoother When First Constructed.
  – Smoother Over Life of the Surface.
• Smoothness is Restored with Resurfacing.
• Studies show Smoothness Has Sizeable Impact on Vehicle Energy Use.
• Asphalt is the Smoothest Type of Pavement as Validated by Ohio Department of Transportation Measurements of Asphalt & Concrete Pavements.
APA Smoothness Matters

• Vehicle Fuel Efficiency Improves When Rolling Resistance is Reduced.
• Improving Smoothness is the Greatest Factor in Reducing Rolling Resistance.
• Available as a Free Download at: www.asphaltroads.org
Carbon Footprint

• What is Carbon Footprint?
  – Total amount of Greenhouse Gas Emissions Caused Directly & Indirectly by a . . . product [or material].” Usually expressed in Carbon Dioxide “equivalents” (CO2e).

• Carbon Footprint of Pavements Includes:
  – Raw Materials Extraction & Processing
  – Pavement Manufacturing
  – Pavement Transportation & Placement
  – Pavement Maintenance

• Sustainable Asphalt Technologies that Offset Greenhouse Gas Production:
  – RAP Reduces Acquisition of Virgin Raw Materials
  – WMA Reduces Energy Requirements & CO2
Carbon Footprint of Asphalt Pavements Are Less than 30% of Equivalent Portland Cement Concrete Pavements.
APA Carbon Footprint

• Examines Greenhouse Gas Production of Asphalt & Concrete Pavements.

• Analysis Demonstrates Asphalt has the Lowest Carbon Footprint for Roadway Construction.

• Available as a Free Download at: www.asphaltroads.org
Asphalt Pavements in Sustainable Rating Systems
Leadership in Energy in Environmental Design (LEED)

- Developed by the U.S. Green Building Council, LEED is the Nationally Accepted Benchmark for the Design, Construction & Operation of High Performance Green Buildings.
How Asphalt Earns LEED Credits

• Sustainable Sites
  – Porous Asphalt to Control Quantity & Improve Quality of Stormwater Runoff.
  – Open-graded Pavements or Reflective Surface to Mitigate Urban Heat Island

• Materials and Resources
  – RAP & RAS
  – Recycling Existing Pavements or Asphalt Shingles in Renovation Projects.

• Innovation & Design
  – Warm Mix Asphalt (Reduced Emissions & Fuel Savings)
  – High-RAP Pavements (20% or Higher)
NAPA Asphalt Pavements and the LEED Green Building System

• Outlines the various ways which asphalt pavements may be used to obtain or contribute to LEED credits.

• Includes a scorecard that can use as a guide to earning LEED credits for asphalt pavements.

• Available for purchase from the NAPA Bookstore at: www.hotmix.org
Greenroads

- Greenroads Quantify the Sustainable Attributes of a Roadway Project.

Planning → Design & Construction → Operation
Greenroads Requirements

• 11 Mandatory Requirements that all projects must meet.
• 118 types of Voluntary Credits with varying credit values covering 38 different types of sustainable design and construction approaches.
• A minimum of 32 Voluntary Credits are required.
## Mandatory Credit Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>PR-1</td>
<td>Environmental Review Process</td>
</tr>
<tr>
<td>PR-2</td>
<td>Life Cycle Cost Analysis (LCCA)</td>
</tr>
<tr>
<td>PR-3</td>
<td>Life Cycle Inventory (LCI)</td>
</tr>
<tr>
<td>PR-4</td>
<td>Quality Control Plan</td>
</tr>
<tr>
<td>PR-5</td>
<td>Noise Mitigation Plan</td>
</tr>
<tr>
<td>PR-6</td>
<td>Waste Management Plan</td>
</tr>
<tr>
<td>PR-7</td>
<td>Pollution Prevention Plan</td>
</tr>
<tr>
<td>PR-8</td>
<td>Low-Impact Development (LID)</td>
</tr>
<tr>
<td>PR-9</td>
<td>Pavement Mgmt. System</td>
</tr>
<tr>
<td>PR-10</td>
<td>Site Maintenance Plan</td>
</tr>
<tr>
<td>PR-11</td>
<td>Educational Outreach</td>
</tr>
</tbody>
</table>
## Voluntary Credit Requirements

<table>
<thead>
<tr>
<th>Voluntary Credits</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>EW Environment &amp; Water</td>
<td>Stormwater, habitat, vegetation</td>
<td>21</td>
</tr>
<tr>
<td>AE Access &amp; Equity</td>
<td>Modal access, culture, aesthetics, safety</td>
<td>30</td>
</tr>
<tr>
<td>CA Construction Activities</td>
<td>Construction equipment, processes, quality</td>
<td>14</td>
</tr>
<tr>
<td>MR Materials &amp; Resources</td>
<td>Material extraction, processing, transport</td>
<td>23</td>
</tr>
<tr>
<td>PT Pavement Technology</td>
<td>Pavement design, material use, function</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total Voluntary Credit Points</strong></td>
<td></td>
<td><strong>108</strong></td>
</tr>
<tr>
<td>CC Custom Credits</td>
<td>Write your own credit for approval</td>
<td>10</td>
</tr>
</tbody>
</table>

**Total Points** 118
- warm mix asphalt
- life cycle cost analysis
- env. mgmt. sys.
- long-lasting pavement
- scenic views
- local material
- natural cut slope
- recycled materials
- LID stormwater
- quality construction
2010 Street Reconstruction Program
City of Upper Arlington, OH

- Construction & Materials Points Obtained through Use of:
  - WMA
  - RAP
  - Full-depth Reclamation
- Greenroads Pilot Project
Cheney Stadium Project
City of Tacoma

• Points Obtained through Use of:
  – Porous Asphalt Roadway & Parking Lot
• Achieved Greenroads Silver Certification
Questions?