Asphalt Pavement Sustainability

Kent Hansen, PE
Director of Engineering
National Asphalt Pavement Association
Sustainability - Definition

• Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

• Doing what is right
Why is asphalt sustainable

• 100% Recyclable
• Can use other recycled materials
• Low carbon footprint pavement
• Long life & Fast resurfacing
• Warm-Mix Asphalt
• Porous pavement for stormwater
Recycleability

- Asphalt is the No. 1 reused material
- 1995 FHWA Report to congress
  - 90 Million tons reclaimed
  - 80% recycled
- 2006 Contractor Survey
  - ~69% reused in HMA
  - ~27% other recycling
  - ~3% discarded
Why Recycle RAP into HMA

- Best and Highest use
- Reduces demand for new materials
- Reduces carbon footprint
- Contains valuable materials
  - Aggregate ~95% > $10/ton
  - Asphalt ~5% > $600/ton
  - Value > $39.50/ton (minus processing)
RAP from Multiple Sources
Shingles

- Materials already used in HMA
  - >20% asphalt binder
  - Fibers
  - Sand

- Usually 5% of mix
  - Saves 1% binder > $6.00 ton

- Primarily from Mfg. Waste

- Tear-offs
  - Concern about asbestos
  - Not used since early 80’s
  - 27,000 samples ~1% detected
Over the past two years, MoDOT has allowed contractors to put used shingles that have been removed from rooftops into their asphalt mix. The result is a very durable, more-rut resistant asphalt at a much lower price.

The use of recycled shingles saves $3 to $5 per ton of asphalt. That may not sound like much at first, but consider this: a typical resurfacing project would use about 30,000 tons of asphalt, for a savings of $90,000 to $150,000.
Other Recycled Materials

- Crumb rubber (from tires)
- Steel slag
- Glass
Energy Consumption per Tonne

Ref: Analysis of energy consumption and greenhouse gas emissions, Pierre T. Dorchies, M.Sc., P.Eng, Michel Chappat, Julian Bilal
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The BEES (Building for Environmental and Economic Sustainability) software brings to your fingertips a powerful technique for selecting cost-effective, environmentally-preferable building products. Developed by the NIST (National Institute of Standards and Technology) Building and Fire Research Laboratory the tool is based on consensus standards and designed to be practical, flexible, and transparent. Version 4.0 of the Windows-based decision support software, aimed at designers, builders, and product manufacturers, includes actual environmental and economic performance data for 230 building products.
Global Warming by Life-Cycle Stage

Note: Lower values are better

BEES
Urban Heat Islands
Pavement Temperatures vs. Albedos

myth or reality?
Location: University Dr., Tempe, AZ
Time: 2:30pm, May 15, 2007

Albedo = .192
Surf. Temp = 131, 131.5, 130 (°F)
Age = >5 years
Traffic = light foot, cart and bicycle traffic

Albedo = .090
Surf. Temp = 129.9, 130.2, 128.4 (°F)
Age = >5 years
Traffic = constant traffic

Albedo = .036
Surf. Temp = 146.8, 143.3, 147.4 (°F)
Age = 3 days
Traffic = no traffic

reflectivity & temperatures
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reflectivity & temperatures
cooler pavements
cooler pavements
cooler pavements
It's NOT a black and white issue

- pavement thickness
- material capacities
- surface vs. air temperature
- pavement air voids (OGFC) cooler
- UHI does NOT cause Global Warming
Leadership in Energy and Environmental Design

What is LEED®?

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings’ performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

LEED provides a roadmap for measuring and documenting success for every building type and phase of a building lifecycle. Specific LEED programs include:

- New Commercial Construction and Major Renovation projects
- Existing Building Operations and Maintenance
- Commercial Interiors projects
- Core and Shell Development projects
- Homes
- Neighborhood Development
- Guidelines for Multiple Buildings and On-Campus Building Projects
- LEED for Schools
- LEED for Retail
LEED: Leadership in Energy and Environmental Design

- Developed by USGBC
- National benchmark for design, construction, and operation of “green” buildings
- 5 key areas:
  - Sustainable site development
  - Water savings
  - Energy efficiency
  - Materials selection
  - Indoor environmental quality
- Earning LEED certification
  - Must meet certain criteria → credits / certification process
  - Levels based on total credits
- How asphalt pavements contribute to LEED credits

Retail Certification Levels
Certified: 26-32 points
Silver: 33-38 points
Gold: 39-51 points
Platinum: 52-70 points
LEED for new construction buildings  
as of 07/06

Distribution by geography

- 200+
- 100-199
- 50-99
- 20-49
- 1-19

Map showing the distribution of LEED certified buildings by state, with numbers indicating the count of buildings in each category.
<table>
<thead>
<tr>
<th>Rating Category</th>
<th>Credit Description</th>
<th>Pavement Type</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS Credit 6.1</td>
<td>SW Design: Quantity Control</td>
<td>Porous Asphalt</td>
<td>1</td>
</tr>
<tr>
<td>SS Credit 6.2</td>
<td>SW Design: Quality Control</td>
<td>Porous Asphalt</td>
<td>1</td>
</tr>
<tr>
<td>SS Credit 7.X</td>
<td>Heat Island Effect: Non-Roof</td>
<td>Reflective Surf. OG Asphalt Porous Asphalt</td>
<td>1 – 3</td>
</tr>
<tr>
<td>MR Credit 2.X</td>
<td>Const. Waste Mgt. Divert from disposal</td>
<td>RAP</td>
<td>1 – 2</td>
</tr>
<tr>
<td>ID Credit 1.X</td>
<td>Exceptional Performance or areas not addressed</td>
<td>WMA High RAP</td>
<td>1 – 4</td>
</tr>
</tbody>
</table>
Long Life

• **Lower Life Cycle Cost**
  – Better Use of Resources
  – Low Incremental Costs for Surface Renewal

• **Lower User Delay Cost**
  – Shorter Work Zone Periods
  – Off-Peak Period Construction
Perpetual Pavement

Max Tensile Strain

40-75 mm SMA, OGFC or Superpave

100 mm to 150 mm Zone Of High Compression

High Modulus Rut Resistant Material (Varies As Needed)

Flexible Fatigue Resistant Material 75 - 100 mm

Pavement Foundation
Rehabilitation

Possible Distresses
- Top-Down Fatigue
- Thermal Cracking
- Raveling

Solutions
- Mill & Fill
- Thin Overlay

Structure Remains Intact
50 - 100 mm

High Quality SMA, OGFC or Superpave

20+ Years Later
Warm Mix

• Will dominate the market in < 5 years
• Reduced energy consumption
• Reduced emissions
  ◆ No hazardous fumes/worker exposure
• Plants compatible in congested areas
• No odors
Porous Asphalt Pavements w/ Stone Recharge Beds
What are Porous Pavements?

Open-Graded HMA ~ 2 ½”

½” Agg. (#57) ~ 1 – 2” Thick

Clean Uniformly Graded 2”-3” Crushed Agg. (#2) – 40% Voids

Non-Woven Geotextile

Uncompacted Subgrade
Port of Portland
## Water Quality

<table>
<thead>
<tr>
<th>Total Suspended Solids (% Removal)</th>
<th>Total Phosphorus (% Removal)</th>
<th>Total Zinc (% Removal)</th>
<th>Total Petroleum Hydrocarbons in the Diesel Range (% Removal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>99</td>
<td>38</td>
<td>96</td>
<td>99</td>
</tr>
</tbody>
</table>

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### Table: Water Quality Data

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Parameter</th>
<th>Unit</th>
<th>Average Value</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site A, 2007</td>
<td>Temperature</td>
<td>°C</td>
<td>22.5</td>
<td>0.3</td>
<td>22.1</td>
<td>22.9</td>
</tr>
<tr>
<td>Site B, 2008</td>
<td>pH</td>
<td>pH</td>
<td>7.4</td>
<td>0.1</td>
<td>7.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Site C, 2009</td>
<td>Dissolved Oxygen</td>
<td>mg/L</td>
<td>7.8</td>
<td>0.2</td>
<td>7.4</td>
<td>8.2</td>
</tr>
</tbody>
</table>

*Note: More detailed data and analysis available in the full report.*
Detention vs. Infiltration

- Post-Dev. Inflow
- Infiltration Bed Discharge
- Pre-Development Runoff
- Detention Basin Discharge

Flow (cfs)

Time
1997 Report: “Twenty years later, a long time for one paving job on that busy parking lot, it still looks good and works well.”
Roads

Arizona

Porous

Dense Graded

Portland, OR

Salem, OR

Chicago, IL
What else are we or could we be doing

• Reducing energy consumption
  – Covering stockpiles
    • 1% moisture = 10+% production
  – Insulating tanks & lines
  – More efficient burners/heat transfer
  – VFD
RAP + Porous + Warm Mix

= Sustainability
Innovation
HMA Energy & Recycling Symposium

December 3 & 4, 2008
Atlantic City, NJ