Sustainable Pavement Management practices

Pavement Management Challenges
- Historic - manage the system to optimize serviceability with the available resources
- Today - manage the system to optimize serviceability with the available resources in an environmentally sustainable and responsible manner

ASPHALT: The environmentally sustainable pavement
- Perpetual Pavements
- Stormwater management / porous pavement
- Recycled materials / RAP
- Warm Mix Asphalt
- Rehab strategies to reduce material usage
- Env. Impacts and Carbon Footprints

Question #1
- How long can an asphalt pavement last?

Perpetual Pavement
- Structure Lasts “forever”
  - Bottom-Up Design and Construction
  - Indefinite Fatigue Life
- Renewable Pavement Surface
  - High Rutting Resistance
  - Tailored for Specific Application
  - Consistent, Smooth and Safe Driving Surface
  - Environmentally Friendly
  - Avoids Costly Reconstruction

www.pavegreen.com
Rehabilitation

Possible Distresses
- Top-Down Fatigue
- Block Cracking
- Raveling
- Thin Overlay

Solutions
- Mill & Fill
- Thin Overlay

High Quality SMA, OGFC or Superpave

20+ Years Later

Perpetual Pavements

Performance Goals - Avoid These

- Repeated Bending
  - Leads to Fatigue Cracking
  - Leads to Rutting

Subgrade
- Repeated Deformation

Perpetual Pavements

Washington State - Top-Down in Asphalt Pavements > 150 mm

50 mm

150 mm

Perpetual Pavements

New Jersey I-287 Surface Cracking

Perpetual Pavements

NON-STRUCTURAL RUTTING

Question # 2

What distress type results from the dreaded bottom up fatigue crack?
Perpetual Pavements

- Rut Resistant Upper Layers
- Rutting Occurs in Upper Asphalt Layers
- Full-Scale Tracks
  - Mn/ROAD
  - WesTrack
  - NCA
- Accelerated Pavement Testing
  - CalAPT
  - FHWA

**Fatigue Cracking**

- **Wheel Load**
  - Crack (bottom of asphalt)
  - Tensile Strain

**Professor Monismith**
University of California, Berkeley
1972 AAPT Proceedings

“Moreover, based on recent studies, it was assumed that strains less than 70 x 10^-6 would cause no fatigue damage.”

**Question # 3**

Why didn’t Professor Monismith perform a fatigue test at 70 micro strain?

**Traditional Fatigue Plot**

- Load Cycles to 50% Stiffness (Failure)
**Perpetual Pavements**

**100 Micro Strain Test**

![Graph showing 100 Micro Strain Test](image)

**Perpetual Pavements**

**Fatigue Theory for Thick Pavements**

- **High Strain = Short Life**
- **Low Strain = Unlimited Life**

![Graph showing Fatigue Life](image)

**Question # 4**

Can a local road or city street be designed to be Perpetual or is this just for highways?

**Perpetual Pavements**

**Example**

<table>
<thead>
<tr>
<th>Section</th>
<th>AASHTO Structural Number</th>
<th>AASHTO ESAU's</th>
<th>Mechanistic Fatigue Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; Asphalt</td>
<td>~2.5</td>
<td>100,000 ±</td>
<td>100,000</td>
</tr>
<tr>
<td>12&quot; AB</td>
<td>~2.5</td>
<td>100,000 ±</td>
<td>245,000</td>
</tr>
<tr>
<td>4&quot; Asphalt</td>
<td>~2.5</td>
<td>100,000 ±</td>
<td>540,000</td>
</tr>
<tr>
<td>9&quot; AB</td>
<td>~2.5</td>
<td>100,000 ±</td>
<td>540,000</td>
</tr>
</tbody>
</table>

Material Cost for each ~ 2.0 – 2.15 ft²

**Guide Concepts for Local Agencies**

- Asphalt Pavements with thickness > 5-6" on sound bases will develop distress Top Down
- To enhance fatigue response use higher binder content in bottom lifts
- To improve density/compaction construct thick base lifts (3" minimum)
Common Recycled Materials in Asphalt Pavements
- Shingles
- Crumb / Tire Rubber
- Glass
- Slag
- Foundry sand
- All are in different stages of utilization / evaluation

Question # 5
What is the nation's #1 recycle material?

Reclaimed Asphalt Pavement “RAP”
- Removed and/or reprocessed pavement materials containing asphalt and aggregates
- Over 80 percent of the asphalt pavement, removed each year for widening and resurfacing, is re-used
- Represents close to 100 million tons / year
- RAP is the Nation’s No. 1 recycled material in both total amount and percentage recycled

Benefits of using “RAP”
- Sustainable-reduces demand for new materials
- Saves energy
- Reduces carbon output
- Improves performance
- Saves money

FHWA / USEPA Report to Congress, EPW/EROS 04/05

30,000 Tons of RAP
70 - 6,000 Gallon Transport Trailers and 28,200 Tons of Clean Aggregate

RAP: sustainable & carbon neutral
The entire annual CO2 / greenhouse gas emissions / carbon footprint from a typical hot-mix plant (~ 2,500 tons) are totally offset by the use of 20 - 25% RAP in pavement mix designs – accomplished by minimizing acquisition of energy intensive (natural) raw materials such as aggregate and petroleum asphalt.

30,000 tons of RAP contains 1,800 tons of asphalt worth $800,000 and aggregate worth over $300,000. If a contractor gives a 50% “credit” in their bid the owner/agency will save $6-7 per ton of mix over the price of 100% virgin mix.

Many studies show RAP mixes improve Rut resistance
Some studies show slight increase in cracking
When softer binder used crack resistance is found to be equal to or better than new mix
RAP mixes generally improve resistance to moisture damage

ODOT allows 30% in all Level 2 and 3 mixes
Local agencies should not establish more restrictive RAP practice
ODOT working on specs to allow higher RAP content
May require softer binder grade, separated sizes

Roofing shingles comprised of:
- Polymer modified asphalt
- Fiberglass or felt fibers
- Grit – angular fine aggregates
- Mineral filler

Raise the Roof with Shingles

RAP: sustainable & carbon neutral

RAP is Worth the Virgin Material It Replaces

RAP: Save money
Example
- Roofing shingles contain ~ 20% asphalt
- Use 5% shingles in HMA, reduce 1% asphalt
- Reduce 0.1 ton AC/ton HMA
- Reduce cost by $4.50/ton HMA

RAS performance
- Asphalt with RAS will improve high temperature performance (rutting)
- Some evidence of improved crack resistance owing to the presence of the fibers
- Oregon DOT plans to construct test sections this year

Not What We’re Looking For!

Rehab Strategies
- The most cost effective sustainable approach involves mill and fill for pavement rehab
- Removes surface distress
- Prepares surface for overlay
- Maintains grade
- Generates RAP for future use
Economics of Mill and Fill
- 2 inch mill and fill – 30% RAP $7.95/SY
- 1” level, 2” overlay – 30% RAP $10.85/SY
Mill and fill is cheaper, better and more sustainable (net gain in RAP for future use)
For road with gravel shoulders savings is greater
If you add value of extra RAP generated savings is greater.

Porous Pavements
Why Porous Pavements?
- Reduce impervious surface
- Recharge ground water
- Improve water quality
- Eliminate need for detention basins
- Provide useful purpose in addition to storm water management (parking lot, trail, street)

EPA Small MS4 Stormwater Program Overview
Applicable controls could include preventative actions such as protecting sensitive areas (e.g., wetlands) or the use of structural BMPs such as grassed swales or porous pavement.

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>

Question # 6
What pavement type has the longest successful history of use in porous applications?

http://www.epa.gov/npdes/pubs/fact2-0.pdf
Overview & History

Pringle Creek Community – Porous Asphalt Streets

The completed project came out very nice, owner is extremely happy.

Warm Mix Asphalt

- Technologies that allow production and placement of asphalt at reduced temperatures

Purpose

- Present the state of the pavement for roads
- Overview of technologies
- Benefits
- Test projects for production and evaluation
- Future trends
Advantages of Lower Temperatures
- Lower fumes and emissions
- Lower energy consumption
- Improved working conditions
- Reduced aging of binder
- Improved compaction
- Extended haul and paving season

What are “Foamed” or “Foam” WMA Systems?
- Water injection into asphalt cement as a way of producing WMA mixes
- No chemicals used
- Standard water used as additive
- No additional cost per ton from additives beyond one-time capital cost of equipment
Foaming Process

- Hot liquid is sprayed and intermixed with a very fine mist of atomized water (2% by wt. of AC)
- Temporarily lowers viscosity of binder to allow better coating of aggregates
- Mix temperatures are typically 35°F – 50°F cooler than conventional mixes
- Improves workability and compaction

Viscosity / Temperature (Approx.)

Warm Mix in Oregon

- More than 10 plants in Oregon modified to produce warm mix
- Uses foaming technology
- All 3 plants in Eugene have converted
- ODOT did 4 test sections in 2009
- Many other agencies did test projects and have developed permissive specifications

ASPHALT: the environmentally sustainable pavement

- Porous pavements manage stormwater
- Build all new pavements to manage at the surface (Perpetual)
- Asphalt pvmnts accept recycled goods / are recycled (RAP)
- HMA pavements are environmentally preferred
- Less energy to construct, low carbon footprint, speed of construction, very low emissions
- Warm Mix lowers energy consumption & emissions
- Mill and fill with high RAP content is most sustainable approach to providing high quality pavement
- RAP can offset the entire annual HMA GHG emissions

Question # 7

- Can an Asphalt Pavement ever really be Green?