Perpetual Pavements

North Dakota Asphalt Conference
Bismarck, ND
April 6, 2010
Perpetual Pavement

- Not a new concept
  - Full-Depth
  - Deep Strength
  - Mill & Fill

MS-1
Perpetual Pavement Principles

- Max Tensile Strain
- Pavement Foundation
- Flexible Fatigue Resistant Material (3 - 4”)
- Zone Of High Compression
- High Modulus Rut Resistant Material (Varies As Needed)
- 1.5 - 3” SMA, OGFC or Superpave

We’re driven: www.asphaltinstitute.org
Fatigue and Rutting

Repeated Bending Leads to Fatigue Cracking

Repeated Deformation Leads to Rutting

HMA

Base

Subgrade
Thinner pavements – High Strain

» Minimize Tensile Strain with Pavement Thickness

» Thin Asphalt Pavement = Higher Strain

» Higher Strain = Shorter Fatigue Life
Thicker pavements – Low Strain

» Minimize Tensile Strain with Pavement Thickness
  » Thicker Asphalt Pavement = **Lower Strain**
  » Strain Below Fatigue Limit = **Indefinite Life**
Mechanistic Performance Criteria

Under ESAL

Limit Bending to < 65με (Monismith, Von Quintus, Nunn, Thompson)

Thick HMA (> 8”)

Base (as required)

Limit Vertical Compression to < 200με (Monismith, Nunn)

Subgrade
It starts with the Base

- Bottom-up Design and Construction
- Foundation
  - Stable Paving Platform
  - Minimize Seasonal Variability and Volume Change in Service
- Fatigue Resistant Lower Asphalt Layer
- Rut Resistant Upper Asphalt Layers
Fatigue Resistant Asphalt Base

» High Effective Asphalt Content Mixes = **Greater Strain Capability**

» Modified Binders = **Greater Strain Capability**
Keep Deformation in Surface
Rut Resistant Upper Layers

- **Aggregate Interlock**
  - Crushed Particles
  - Stone-on-Stone Contact

- **Binder**
  - High Temperature PG
  - Polymers
  - Fibers

- **Air Voids**
  - Avg. 4% to 6% In-Place

- **Surface**
  - Renewable
  - Tailored for Specific Use
Rut Resistant Upper Layers

- Rutting Occurs in Upper Asphalt Layers

- Full-Scale Tracks
  - Mn/ROAD
  - WesTrack
  - NCAT

- Accelerated Pavement Testing
  - CalAPT
  - FHWA
Impact of Temperature Gradient on Asphalt Grade.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>High Perf. PG Binder</th>
<th>SMA, OGFC or SP 1.5 - 3”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement Foundation</td>
<td>Use proper PG Binder as dictated by climate and depth.</td>
<td>Rut Resistant Material (Varies)</td>
</tr>
<tr>
<td></td>
<td>Fatigue Resistant Material 3” to 4”</td>
<td></td>
</tr>
</tbody>
</table>
Low Temperature Cracking

- Historical Performance
- Maintenance
- Maintain Mix Volumetrics
- Use proper Binder Grade
New Jersey Turnpike

• First Perpetual Award Winner
• Built in 1950
• Has never been reconstructed
• 175,000 ADT
• 40% Trucks
LOCATION
I-695, NBL,
Baltimore Beltway

COMPLETION DATE
1993

19 mm GG
AC-20 w/ fibers

TRAFFIC
AADT - 175,000
Trucks - 19%

PERFORMANCE DATA - 1999

<table>
<thead>
<tr>
<th>DENSITY, %MAX</th>
<th>PG BINDER GRADE</th>
<th>PAVEMENT DEFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheelpath</td>
<td>99.0</td>
<td>70-22</td>
</tr>
<tr>
<td>Centerline</td>
<td>98.4</td>
<td></td>
</tr>
<tr>
<td>98.0</td>
<td>96.0</td>
<td></td>
</tr>
<tr>
<td>97.5</td>
<td>95.5</td>
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</table>

ARAN average, 0.12”
ARAN change, 0.04” (4 yr.)
Measurement, 1/8”
Perpetual Pavements in China

- Unregulated Loads
- 150,000-250,000# + Loads
- Will not purchase US or European Trailers
  - Build their own to accommodate loads
  - Use our wheel/axle configuration
- Perpetual Pavement Design by John D 'Angelo’s Team
- ~15 inches
Where can it be used?

- Perpetual Pavements are not just for highway projects
- Many municipal pavements can also be designed as Perpetual Pavements
- Increasing the thickness of the hot mix layers by 25 to 35 percent will likely result in a perpetual pavement
- There are tools to allow municipalities to look at Perpetual Pavement options
- **PerRoad v3.3** and **PerRoadXPress v1.0** are both available free of Charge
PerRoad 3.3

- Sponsored by APA
- Developed at Auburn University / NCAT
- M-E Perpetual Pavement Design and Analysis Tool
Hot Off the Presses!

http://www.asphaltroads.org/documents/Perpetual_Pavement_Synthesis.pdf
TRL Report 250
Nunn, Brown, Weston & Nicholls
Design of Long-Life Flexible Pavements for Heavy Traffic
http:\\www.trl.co.uk
Perpetual Pavement Award Winners

Figure 8. Distribution of Perpetual Pavement Awards

Source: Perpetual Asphalt Pavements – A Synthesis
Award Criteria

• Pavement must be a minimum of 35 years old.
• Pavement must have hot-mix or warm-mix asphalt binder and surface layers.
• No rehabilitation or series of rehabilitations over the preceding 35 years that has increased the total pavement thickness by more than 4 inches.
Award Criteria

• Resurfacing intervals of no less than 13 years on the average.
• Minimum project length is two miles for all roadway types.
• In the case of “stage construction,” the 35-plus year time frame against which the award criterion is evaluated begins when all stage construction is completed.
Tacked layers are very important
Washington State - Top-Down in Asphalt Pavements > 150 mm
Longitudinal crack in M1 TRL
Perpetual Pavement

» Structure Lasts 50+ years.
  » 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.AsphaltAlliance.com
LCCA - Zero Salvage Value?

This was worth Zero 35 years ago, What will it be worth in 2050?

THANK YOU!!