Use of New High Performance Thin Overlays (HPTO)

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NJ’s Thin-Lift Materials

New Jersey requirements

- Thin-lift ≤ 25mm thick (Ideally)
  - Minimal change to existing infrastructure (bridge clearances, drainage, etc.)
- Minimal Impact to Users (Coverage vs Unit Time)
- Re-new and upgrade road surface
  - Ride Quality (Smoothness)
- No “Cure-time” dependent materials (i.e. – cold applications)
  - Typical high ESAL’s limit use
High Performance Thin-Overlay

Focused Applications

- Preventative Maintenance – NJDOT
  - Placed after signs of surface distress
  - Also potential use of “Shim” course on PCC prior to Wearing Course

- Pavement Overlay – Locals/Municipalities
  - Place immediately on surface of pavements showing signs of surface distress without milling
    - No alligator cracking
    - Surface cracking with minimal rutting
High Performance Thin-Overlay

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>100</td>
</tr>
<tr>
<td>#4</td>
<td>65 - 85</td>
</tr>
<tr>
<td>#8</td>
<td>33 - 55</td>
</tr>
<tr>
<td>#16</td>
<td>20 - 35</td>
</tr>
<tr>
<td>#30</td>
<td>15 - 30</td>
</tr>
<tr>
<td>#50</td>
<td>10 - 20</td>
</tr>
<tr>
<td>#100</td>
<td>5 - 15</td>
</tr>
<tr>
<td>#200</td>
<td>5 - 8</td>
</tr>
<tr>
<td>Min. % Binder</td>
<td>7.0</td>
</tr>
</tbody>
</table>

- FAA > 45% (AASHTO T304)
- Fine aggregate of stone sand (no natural sands)
- Sand Equivalency > 45% (AASHTO T176)

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<table>
<thead>
<tr>
<th>Requirements</th>
<th>Required Density (% of Max. Sp. Gr.)</th>
<th>Voids in Mineral Aggregate (VMA)</th>
<th>Dust to Binder Ratio</th>
<th>Draindown, AASHTO T305</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ndes (50 Gyrations)</td>
<td>Ndes (100 Gyrations)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>96.5</td>
<td>&lt; 99.0</td>
<td>&gt; 18.0%</td>
<td>0.6 - 1.2</td>
</tr>
<tr>
<td>Control</td>
<td>95.5 - 97.5</td>
<td>&lt; 99.0</td>
<td>&gt; 18.0%</td>
<td>0.6 - 1.2</td>
</tr>
</tbody>
</table>
High Performance Thin-Overlay

- **Binder**
  - PG76-22 (NJDOT Spec)
  - RTFO Elastic Recovery > 65% @ 25°C (AASHTO T301)
  - Separation Test < 4.5°C after 4 hrs (ASTM D5976)

- **Performance Specification**
  - Utilize the Asphalt Pavement Analyzer (AASHTO TP 63) for stability check
    - Must supply for mix design verification and control (1st Lot and every other Lot after)
Asphalt Pavement Analyzer

- AASHTO TP 63
- 100 lb wheel load; 100 psi hose pressure
- Tested at 64°C for 8,000 loading cycles
- Samples at 5 +/- 0.5% air voids
- APA Rutting < 4 mm to PASS
HPTO Performance Evaluation

- Mixture properties relative to field performance
  - Fatigue resistance
    - Flexural Beam Fatigue (AASHTO T321)
  - Permanent Deformation Stability
    - Asphalt Pavement Analyzer (AASHTO TP63)
  - Resistance to PCC Slab Horizontal Movement
    - Overlay Tester
  - Permeability
    - Flexible Wall Permeability (ASTM D5084)
Rutting Stability – APA

I4HD from AC Expressway

APA Criteria
Passing: 4 mm or Less at 8,000 Cycles (for AV = 5%)
Rutting Stability – APA

I5HD from Garden State Parkway

APA Criteria
Passing: 4 mm or Less at 8,000 Cycles (for 5% AV)

APA Rutting (mm)

Number of Loading Cycles

HPTO 5% AV = 3.33 mm
HPTO 7% AV = 4.31 mm
I5 HD 5% AV = 3.99 mm
I5 HD 7% AV = 6.38 mm
Fatigue Evaluation

- Flexural Beam Fatigue Device, AASHTO T-321
- Tests mix’s ability to withstand repeated bending which causes fatigue failure
- Data = number of loading cycles to failure (loss of stiffness)
- Run at high level of tensile strain (1000 μ-strain) to simulate excessive bending, similar to movements @ PCC joints
Fatigue Resistance

I4HD from AC Expressway

1,000 $\xi$-strain, 15°C

Fatigue Cycles to Failure

I4 HD - AC Expressway (Ave.) = 3,354
HPTO (Ave.) = 51,636
Fatigue Resistance

I5HD from Garden State Parkway

$1,000 \approx$-strain, $15^\circ$C

Fatigue Cycles to Failure

I5 HD - Garden St. Pkwy. (Ave.) = 1,390
HPTO (Ave.) = 51,636

Loading Cycles (n)

Flexural Stiffness (MPa)
Fatigue Resistance

NJDOT 12H76 from Rt 31 & I95

1,000 \( \gamma \)-strain, 15°C

Fatigue Cycles to Failure

12H76 (Ave.) = 2,732
HPTO (Ave.) = 51,636
Climatic Loading – Horizontal Movement

Hot Mix Asphalt Overlaid on PCC

Horizontal Tensile Stress due to Expansion/Contraction of PCC from Temperature

Horizontal Stress/Strain is modeled using Overlay Tester
Overlay Tester
Overlay Tester Results

I5HD from Garden State Parkway

TxDOT Requirement for Surface Mix on PCC Overlay @ 77F = 300 Cycles

Test Parameters
Joint Opening = 0.63mm (0.025 in.)
1 Cycle (Load/Unload) = 10 sec.

Number of Cycles to Failure

<table>
<thead>
<tr>
<th></th>
<th>59F</th>
<th>77F</th>
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<tbody>
<tr>
<td>I-5 HD</td>
<td>46</td>
<td>189</td>
</tr>
<tr>
<td>HPTO</td>
<td>144</td>
<td>541</td>
</tr>
</tbody>
</table>
Overlay Tester Results

NJDOT 12H76 from Rt 34N

TxDOT Requirement for Surface Mix on PCC Overlay @ 77F = 300 Cycles

Number of Cycles to Failure

Test Parameters
Joint Opening = 0.63mm (0.025 in.)
1 Cycle (Load/Unload) = 10 sec.

12H76 59F 144 HPTO 77F 11 12H76 541 HPTO
Flexible Wall Permeability Testing

- For Pavement Preservation, important to “seal” pavement to limit moisture
- Permeability on order of a silt/clay, required testing in “Flexible Wall” Permeability Set-up

Samples cored from 6-inch diameter gyratory sample
Typical Permeability Values

Typical Superpave Dense Graded Asphalt Mixes

- HPTO (3.9% AV)
- 12H76 (3.0% AV)
- 12H76 (5.0% AV)
- 12H76 (7.0% AV)

Permeability (cm/sec)
Comparative Costs

- Mill 2”/Pave 2” with 12H64 = $8.80/yd²
- Mill 1”/Pave 1” with HPTO = $6.35/yd²
- Pave HPTO on Existing = $4.35/yd²

* Based on local material cost estimates
### Surface (Skid) Friction, SN$_{40}$

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Skid Number</th>
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<tbody>
<tr>
<td>HPTO (New)</td>
<td>53</td>
</tr>
<tr>
<td>12.5mm SP (New)</td>
<td>51.6</td>
</tr>
<tr>
<td>12.5mm (4 Yrs)</td>
<td>54.3</td>
</tr>
<tr>
<td>19mm SP (4 Yrs)</td>
<td>55.7</td>
</tr>
<tr>
<td>19mm SP (5 Yrs)</td>
<td>47.7</td>
</tr>
</tbody>
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Conclusions

- NJDOT investing time and money into Pavement Preservation
  - Preserve infrastructure and improve ride quality
  - “Get in/Get out”

- NJ Municipalities looking for similar preservation/rehabilitation treatments

- Laboratory comparisons show HPTO
  - Rut resistant
  - Durable – flexural fatigue and overlay tester
  - Low permeability to seal existing cracks
Conclusions

- Thin lift provides cost effective alternative
- Initial skid resistance testing shows good resistance and comparable to NJ’s DGA surface mixes
Northeast Asphalt User/Producer Group
Wilmington/Christiana Delaware
October 11-12, 2006

Questions?