NJDOT HMA/Pavement Research Program

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Presentation Overview

- Reflective Cracking
- Implementation of MEPDG
- FHWA Quiet Pavement Pilot Program
- Winter Maintenance of Friction Course Mixes
- Pavement Preservation Program
Flexible Overlays for Rigid Pavements

- 2 year study to evaluate use of HMA overlays on rigid/composite pavements to minimize reflective cracking
  - Extensive material testing and FEM modeling
    - Performance-based HMA design
      (Balancing rutting and fatigue performance)
    - Optimizing forensic evaluation of PCC/composite pavements
    - Development of “Decision Tree” to select appropriate rehabilitation strategy
Tentative Performance-Based HMA Design

Similar to one proposed at TTI

- Determine optimum AC% (OAC) by Superpave Volumetrics
- Construct samples at -0.3% OAC, OAC, and +0.3% OAC
- Perform:
  - APA, Flexural Fatigue, and TTI Overlay
  - Select final AC% by overall performance
    - HMA placed on PCC (emphasize fatigue performance)
    - HMA placed on surface (emphasize rutting performance)
Tentative Decision Tree Input Parameters

- Used in conjunction with HMA performance design and traffic

FWD Testing and Coring Program

- $\delta_{\text{max}}$ at Joint/Crack
- LTE at Joint/Crack
- Modulus of Subgrade/Support

Core of PCC (CTE and Visual)

GPR Testing to Determine Thickness and Void Detection

Evaluate Results and Compare to Criteria

Selection of HMA Overlay Method and/or Rigid Pavement Rehabilitation

Construction and Monitoring for Future Revisions/Calibration of Decision Tree
NJDOT Interlayer Mix Specification

- NJDOT thought Route 10 job was successful
  - Had problem with proprietary nature of this application (back in 1997)

- NJDOT Reflective Crack Relief Interlayer (RCRI) Specification
  - Collaboration between Rutgers, SemMaterials and CITGO Asphalt
  - Utilizes performance-based specifications as pass/failure criteria during design and construction
  - Volumetric properties specified to aid in minimizing potential construction/compaction problems and maximize performance
NJDOT RCRI Specifications

- **Binder**
  - > 7% AC
  - High Temp ≥ PG70 (no low temp required)
  - RTFO Elastic Recovery > 75% @ 25ºC
  - Separation Test < 6ºC after 4 hrs

- **Aggregate blend (NO RAP ALLOWED)**

<table>
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<tr>
<th>Sieve</th>
<th>% Passing</th>
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<tbody>
<tr>
<td>9.5mm</td>
<td>100</td>
</tr>
<tr>
<td>4.75mm</td>
<td>75 – 100</td>
</tr>
<tr>
<td>2.36mm</td>
<td>30 – 85</td>
</tr>
<tr>
<td>0.075mm</td>
<td>6 - 14</td>
</tr>
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</table>
RCI Mix Design Criteria

- $N_{\text{design}} = 50$ gyrations
- Air voids: 1 to 3%
- VMA $\geq 16$

Performance Criteria

- Fatigue (AASHTO T321) $> 100,000$ cycles (ave.)
  - $\varepsilon_t = 2,000$ $\mu$-strain, $15^\circ C$, 10 Hz, AV $= 3 \pm 1.0$

- Rutting (AASHTO TP63) $< 10$ mm Rutting
  - $60^\circ C$, AV $= 3 \pm 0.5\%$, 100 psi hose, 100 lb load
Construction

■ Gradation Control
  ◆ 2.36mm (+/- 4.0% tolerance)
  ◆ 0.075mm (+/- 1.4% tolerance)

■ Volumetrics
  ◆ Mat compacted between 2 to 4% air voids
    – Minimize compaction issues while maximizing performance
    – Air Voids (+/- 0.8% tolerance)
  ◆ VMA (-1.0% tolerance)

■ Performance (min. once per project within 1st 2,000 mix tons, every 600 tons thereafter)
  ◆ Flexural Beam Fatigue (AASHTO T321) – same criteria as before
Implementation of MEPDG

- Developing HMA database of dynamic modulus and IDT/Creep Compliance
  - Utilizing plant produced samples (aging, RAP)
  - Comparing performance using repeated load, SST, Repeated Shear and Flexural Beam Fatigue testing

- Completed database for unbound materials
  - Resilient modulus, permeability, CBR

- TRAINING!
  - “Hands on” using software in computer lab
  - Materials and Traffic Inputs
Quiet Pavement Pilot Program (QPPP)

- **Main Goal:** To allow the use of pavement surface to eliminate or reduce the height of noise walls for highway noise mitigation
- **FHWA established program**
  - Initiated by Arizona DOT
- **Must have noise measurements for minimum of 5 years**
  - Must also include texture data, ride quality, skid resistance
  - NJDOT work will also evaluate winter maintenance issues (not included in Arizona and California work)
Relationship Between Noise and Wet Skid Resistance

![Graph showing the relationship between noise and wet skid resistance. The graph includes various materials such as OGFC, Micro-surface - Type 3, Novachip, 12.5 mm Superpave, 9.5 mm SMA, 12.5 mm SMA, PCC (No Finish), PCC (Transverse Tined), PCC (Diamond Grinding). The x-axis represents the Wet Skid Number (SN40), and the y-axis represents the Tire/Pavement Generated Noise (dB(A)). The graph indicates a poor and optimal relationship between noise and wet skid resistance.]
Tire/Pavement Noise vs RQI

With Outlier
\[ dB(A) = -17.59 \ln(RQI) + 122.95 \]
\[ R^2 = 0.81 \]

Without Outlier
\[ dB(A) = -18.05 \ln(RQI) + 123.77 \]
\[ R^2 = 0.89 \]
Measurement of Traffic Noise in QPPP

- **Wayside measurements**
  - Measure the effects of low-noise pavements on communities
  - Vary distance and height from pavement
  - Used in areas of “immediate need”

- **Source measurement**
  - Measures the effect of low-noise pavements on the tire/pavement interaction at the source
  - Testing on experimental sites and wayside sites
  - Recent NJDOT/Rutgers research used Close Proximity – moving to Sound Intensity for QPPP
Sound-Intensity
10 Quietest Pavement Surfaces Tested

Vehicle Speed = 60 mph

Sound Pressure (dB(A))

Crumb Rubber
HMA

96.2 96.8 97.0 97.1 97.1 97.9 98.1 98.1 98.2 98.3 98.3
NJ’s Winter Maintenance Issues

■ NJDOT
  ◆ Rock salt is predominant method
  ◆ Found OGFC significantly more difficult to maintain ice-free
    - More frequent applications and still tends to be icier
  ◆ 2005 began the use of brine solution

■ NJ Garden State Parkway (NJGSP)
  ◆ 100 of 1,200 lane miles OGFC
  ◆ Uses liquid magnesium-chloride for de-icing
  ◆ Combines surface temperature measurements and weather forecasts to know when to treat
    - Pre-treats OGFC surfaces (If too late, magnesium-chloride washes off)
    - OGFC requires twice the total application as other DGA
Winter Maintenance of Friction Course Surfaces

- Meeting in November to discuss research/testing plan
- If OGFC to be selected as “Quiet Pavement”, must improve winter maintenance
- Purpose is to optimize de-icing methods for friction course mixes
- Focusing on:
  - De-icing materials
  - Application rates
  - Measuring friction during storm event
    - Deceleration device (Coralba $C_\mu$-meter)
    - NJDOT Skid Trailer
Skid Friction – Deceleration Method

- OGFC Novachip®
- Inside Lane
- Outside Lane

Friction Number

<table>
<thead>
<tr>
<th>Time</th>
<th>OGFC</th>
<th>Novachip®</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:30 PM</td>
<td>71</td>
<td>38</td>
</tr>
<tr>
<td>7:45 PM</td>
<td>67</td>
<td>23</td>
</tr>
<tr>
<td>12:45 AM</td>
<td>63</td>
<td>37</td>
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Comparison of friction numbers between OGFC and Novachip® for inside and outside lanes at different times of the day.
Skid Friction – Skid Trailer

![Skid Friction Graph]

- Skid Rig Friction Number (SN40)
- 1:30 PM
- 8:15 PM

<table>
<thead>
<tr>
<th></th>
<th>OGFC Inside Lane</th>
<th>Novachip® Inside Lane</th>
<th>OGFC Outside Lane</th>
<th>Novachip® Outside Lane</th>
<th>Southbound</th>
<th>Northbound</th>
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<td>32</td>
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<tr>
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<td>32</td>
<td>31</td>
<td>40</td>
<td>25</td>
<td>17</td>
<td>21</td>
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OGFC vs Novachip®

**OGFC**

\[ SN = -21.924 \ln(RSA) + 72.689 \]

\[ R^2 = 0.7685 \]

**Novachip**

\[ SN = -22.084 \ln(RSA) + 67.443 \]

\[ R^2 = 0.7386 \]

% of Initial C-Skid Number, SN vs Roadside Snow Accumulation, RSA (inches)
Data developed during QPPP will also be used to optimize NJDOT's Pavement Preservation Plan

- NJDOT initiating “new” Pavement Preservation Plan for 2006
- Utilizing “thin-lift” mixes (< 1.0 inches)
  - Fine-graded OGFC, 9.5mm SMA, micro-surfacing, Novachip®
- Looking to place 1,000 lane miles per year of “thin-lift” HMA for Pavement Preservation
  - Currently only doing 500 lane miles
Other HMA-Related Research

- Influence of RAP % on HMA performance
  - PG64-22 and PG76-22 (0, 15, and 30% RAP) – Plant Produced
  - $E^*$, Flexural Fatigue, Low Temp, Rutting

- Fatigue Properties of PPA Modified HMA
  - Compare SBS, SBS+PPA, and PPA modified

- Optimizing RCI Mixture and Design
  - Vary gradations, aggregate sources, volumetrics to optimize fatigue, permeability, permanent deformation
Thank You for Your Attention!

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