COMPOSITE PAVEMENT OVERLAY
PROJECT: US 130 MAIN STREET TO US ROUTE 1

2018 NJ Asphalt Paving Conference

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PAVEMENT DESIGN
Acknowledgement

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Outline

° Basic Information of Composite Pavement
° Challenges of Composite Pavement
° Composite Pavement Rehabilitation Strategies
° Case Study-Route 130
Basic Information of Composite Pavement
COMPOSITE PAVEMENT

HMA/ASPHALT

CONCRETE
Composite Pavement Rehabilitation Goals

Improve Pavement Condition
Improve Ride Quality
Improve Safety
Extend Life
Typically Functional Overlay – Minor Rehab
Sometimes A Structural Overlay – Major Rehab
Reduce Life Cycle Costs
Increase Customer Satisfaction
  ◦ Noise Reducing Surface(s)
Challenges of Composite Pavement
Risk of Removing HMA Overlay
Challenges of Removing HMA Overlay:

Pavement Recommendation:

Mill 3” and Pave with 3” SMA 12.5 MM Surface Course
Challenges of Removing HMA Overlay:

Core Information:

Lane 1 Core information was 5.25” to 7.75” HMA over PCC.

Lane 2 Core information was not available during design.

Lane 3 Core information was 3.5” to 19.5” HMA over PCC.
Challenges: Pavement ME Analysis for Composite Pavement
Challenges: Pavement ME Analysis for Composite Pavement

3” AC Over JPCP

8” AC Over JPCP
Challenges: Composite Pavement

- NJDOT’s concrete/composite pavement infrastructure continuing to age and deteriorate
- PCC reconstruction costly
- Rubblization is option, but require minimum of 6 inches Overlay
- PCC rehabilitation generally not successful
- Most simple rehabilitation technique – Hot Mix Asphalt (HMA) Overlay
  - Unfortunately, high deflections at PCC joints/cracks creates excessive straining in HMA overlay
  - Most cases, cracking initiated in HMA above crack/joint in PCC (called Reflective Cracking)
Challenges: Composite Pavement

- When reflective crack reaches pavement surface
  - Affects overall integrity of pavement
    - Smoothness – intermittent cracking also affects safety
    - Pathway for water intrusion
    - Area for immediate raveling
  - Little guidance on how to design HMA overlays for PCC pavements
    - HMA material/mixture selection
Modes of Reflective Cracking

- Mode 1 – Poor Load Transfer at joint/crack results in independent movement of PCC slabs
- Mode 2 – Excessive Vertical Bending at PCC joint/crack (Pure Tensile Straining)
- Mode 3 – Horizontal Deflections (PCC slab expansion and contraction) due to environmental cycling
Reflective Cracking: Mode 1

- Mode 1 – Poor Load Transfer at joint/crack results in independent movement of PCC slabs
“Poor load transfer...”

Mode 1: Vertical Shear Stress
“Poor load transfer...”

Mode 1: Vertical Shear Stress
“causes shear stresses in the overlay.”
“causes shear stresses in the overlay.”
“causes shear stresses in the overlay.”
“causes shear stresses in the overlay.”

Mode 1: Vertical Shear Stress
Mode 1: Vertical Shear Stress
Mode 1: Vertical Shear Stress
“Over many repeated loads...”

Mode 1: Vertical Shear Stress
“Over many repeated loads...”
“reflection cracks develop.”
“reflection cracks develop.”
“reflection cracks develop.”

Mode 1: Vertical Shear Stress
“reflection cracks develop.”
“reflection cracks develop.”
Reflective Cracking: Mode 2

- Mode 2 - Tensile stress at bottom of AC layer
  - Poor support
  - Weak base
  - Load Associated Problem (Traffic Loading)
“Traffic loads at the joint...”

Mode 2: Horizontal Tensile Stress due to load
“Traffic loads at the joint...”

Mode 2: Horizontal Tensile Stress due to load
“cause tensile stresses at the bottom of the overlay.”
“cause tensile stresses at the bottom of the overlay.”
“cause tensile stresses at the bottom of the overlay.”
“Over many repeated loads…”

Mode 2: Horizontal Tensile Stress due to load
“Over many repeated loads...”

Mode 2: Horizontal Tensile Stress due to load
“Over many repeated loads...”

Mode 2: Horizontal Tensile Stress due to load
“reflection cracks develop.”
“reflection cracks develop.”
"reflection cracks develop."
Reflective Cracking: Mode 3

- Mode 3 – Horizontal Tensile Stress
  - Thermally Induced stresses
  - Magnitude depends on Slab length (or Crack spacing), 24 hour temperature change, and coefficient of thermal expansion of PCC
“Slab shrinkage under cooling temperature...”

Mode 3: Horizontal Tensile Stress due to climate
“Slab shrinkage under cooling temperature...”
“Slab shrinkage under cooling temperature...”
“causes tensile stresses in the overlay.”
“causes tensile stresses in the overlay.”
Mode 3: Horizontal Tensile Stress due to climate
Mode 3: Horizontal Tensile Stress due to climate
Mode 3: Horizontal Tensile Stress due to climate
“Over many cycles...”

Mode 3: Horizontal Tensile Stress due to climate
“Over many cycles...”

Mode 3: Horizontal Tensile Stress due to climate
“reflection cracks develop.”

Mode 3: Horizontal Tensile Stress due to climate
“reflection cracks develop.”

Mode 3: Horizontal Tensile Stress due to climate
Composite Pavement Rehabilitation Strategies
Composite Pavement Rehabilitation Strategies

Full Depth Repairs before Milling
- Full Depth Concrete Pavement Repair, HMA (453006)
- Hot Mix Asphalt Pavement Repair (401021)

Mill and Overlay with Better Mixes
- AROGFC
- Polymer modified HMA
- HPTO
- SMA
- Reflective Crack Relief Interlayer (RCRI) or Strata
- Binder Rich Intermediate Course, 4.75 MM
Full Depth Repair with HMA (typically before milling)

Proposed HMA Surface Course

EXISTING HMA OVERLAY WHERE APPLICABLE

EXISTING JOINT TO BE REMOVED

TACK COAT

PROPOSED HMA SURFACE COURSE

NOTES:
REMOVAL OF THE JOINT SHALL BE AS DIRECTED.

EXISTING CONC. TO REMAIN

EXISTING DOWEL

SAWOUT

6' 0" MIN.

ROADWAY EXCAVATION AS DIRECTED

FULL DEPTH CONCRETE PAVEMENT REPAIR, HMA

EXISTING CONCRETE TO BE SAWCUT FULL DEPTH (BOTH SIDES)

SUBBASE, NON-STABILIZED OPEN-GRADED DRAINAGE LAYER OR DENSE GRADED AGGREGATE BASE COURSE IF AND WHERE DIRECTED
Mill & Overlay with HMA

Surface Milling
Why premium mixes?

Better fatigue life
Better durability
Increased skid/safety
Reduced noise
Increased customer satisfaction
Better reflective crack resistance
Asphalt Rubber Open Graded Friction Course
High Performance Thin Overlay
SMA 12.5mm Surface Course

Visual Survey of JRC Pavement

Rehab. Design of Asphalt Outside Shoulder
  ◦ Roadway Excavation
  ◦ Pave with 3” min. & var. HMA 25M64 Base Course
  ◦ Pave with 4” (2 lifts) of high quality HMA

Full Depth Concrete Repairs with Very Early Strength Concrete

Overlay Design with 4” (2 lifts) of high quality HMA

3 test sections and 1 control section

Proposed Pavement Design (8/07)
BEFORE REHAB

SDI = 2.07

Ride Quality
- MP 13.4-14.75, IRI=197.2
- MP 14.75-15.25, IRI=154.7
- MP 15.25-15.75, IRI=143.8
- MP 15.75-17.03, IRI=151.5
- Ride Quality for the project, IRI=168.6

AFTER REHAB

SDI = 5.0

Ride Quality
- MP 13.4-14.75, IRI=88.3
- MP 14.75-15.25, IRI=78.0
- MP 15.25-15.75, IRI=77.7
- MP 15.75-17.03, IRI=75.0

Ride Quality for the project, IRI=80.4
BEFORE REHAB


AFTER REHAB

IRI Versus Year

- 13.4 to 14.7
- 14.7 to 15.7
- 15.7 to 17

Rt.70 (MP8.61-12.06)- Maintenance Roadway Repair Contract No. 327 (2007)
Located high deflection joints (> 15 mils deflection) with FWD during construction

Failed joints were successfully (reduced deflection < 10 mils) grouted with HDP by Uretek

Full Depth Repairs with HMA were performed on high severity joints/areas
Rt. 70 (MP 8.61-12.06) - Maintenance Roadway Repair Contract No. 327 (2007)

<table>
<thead>
<tr>
<th>BEFORE REHAB</th>
<th>AFTER REHAB</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDI = 1.56</td>
<td>SDI = 4.9</td>
</tr>
<tr>
<td>Ride Quality IRI = 157</td>
<td>Ride Quality IRI = 94</td>
</tr>
</tbody>
</table>
Rt.70 (MP8.61-12.06) - Maintenance Roadway Repair
Contract No. 327 (2007)
Rt. 70 (MP 8.61-12.06) - Maintenance Roadway Repair
Contract No. 327 (2007)
Case Study-Route
130
Route 130 Main St to Rt 1 Resurfacing -2016

Limit of the project:
   MP 72.68 to MP 74.12
   MP 76.03 to MP 80.97
   MP 81.59 to MP 83.58

Total Lane Miles of the project: 33.56

Prime Contractor: Trap Rock Industries, LLC

Letting Date: June 23, 2015

Project Completed: June 17, 2016
Visual Survey of Composite Pavement

Cores performed to establish proper milling depth

Full Depth Repair areas identified by visual survey during final design

Calculated approximately 20 million ESAL’s

Overlay Design consisted of milling 3” depth and resurfacing with:

- 2” Stone Matrix Asphalt 12.5 MM Surface Course
- 1” Binder Rich Intermediate Course, 4.75 MM
# BRIC - SPECIFICATION

<table>
<thead>
<tr>
<th>Sieve Sizes</th>
<th>Percent Passing&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Production Control Tolerances&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>100</td>
<td>±0%</td>
</tr>
<tr>
<td>No. 4</td>
<td>90-100</td>
<td>±4%</td>
</tr>
<tr>
<td>No. 8</td>
<td>55-90</td>
<td>±4%</td>
</tr>
<tr>
<td>No. 30</td>
<td>20-55</td>
<td>±4%</td>
</tr>
<tr>
<td>No. 200</td>
<td>4-10</td>
<td>±2%</td>
</tr>
<tr>
<td>Asphalt Binder Content (Ignition Oven)</td>
<td>7.4 % minimum</td>
<td>±0.40%</td>
</tr>
<tr>
<td>Maximum Lift Thickness</td>
<td>1.5 inch</td>
<td></td>
</tr>
</tbody>
</table>

1. Aggregate percent passing to be determined based on dry aggregate weight.
2. Production tolerances are for the approved JMF and may fall outside of the wide band gradation limits.
Table 902.09.03-2  Volumetric Requirements for Design and Control of BRIC

<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 T 305</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Requirements</td>
<td>$@ N_{des}$ (50 gyrations)</td>
<td>$\leq 99.0$</td>
<td>$\geq 18.0%$</td>
<td>0.6 – 1.2</td>
</tr>
<tr>
<td>Control Requirements</td>
<td>$96.5 – 98.5$</td>
<td>$\leq 99.0$</td>
<td>$\geq 18.0%$</td>
<td>0.6 – 1.3</td>
</tr>
</tbody>
</table>
### Table 902.09.03-3  Mix Design Performance Testing Requirements for BRIC

<table>
<thead>
<tr>
<th>Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Pavement Analyzer (AASHTO T 340)</td>
<td>&lt; 6 mm@ 8,000 loading cycles</td>
</tr>
<tr>
<td>Overlay Tester (NJDOT B-10)</td>
<td>&gt;700 cycles</td>
</tr>
</tbody>
</table>

### Table 902.09.03-4  Production Performance Testing Requirements for BRIC

<table>
<thead>
<tr>
<th>Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Pavement Analyzer (AASHTO T 340)</td>
<td>&lt; 7 mm@ 8,000 loading cycles</td>
</tr>
<tr>
<td>Overlay Tester (NJDOT B-10)</td>
<td>&gt; 650 cycles</td>
</tr>
</tbody>
</table>
BRIC – Performance Analysis

- Evaluated changes in SDI to evaluate performance of BRIC on New Jersey pavement sections
- BRIC analysis difficult as always overlaid with a surface course
  - Analysis looked at performance with and without BRIC
  - Analysis looked at different surface courses
- Compared performance life for different scenarios
  - All data averaged for same “system” compared
- An SDI value of 2.4 is a trigger for rehabilitation
BRIC – Performance Analysis

![Graph showing SDI over time for different types of BRIC Composites](image-url)

- **9.5mm SMA with BRIC**
- **12.5mm SMA with BRIC**
- **9.5mm SMA with 12.5M64**
- **12.5mm SMA with 12.5M64**
- **12.5mm Surface with BRIC**
- **9.5 or 12.5 Surface - No BRIC**
BRIC – In-Service Life Evaluation

- Performance of BRIC material highly dependent on the surface course overlaying the BRIC
  - SMA overlays performed best
    - Still “flexible” enough to withstand residual vertical straining
  - Dense graded overlays performed the worst
    - Too “stiff” – can not withstand residual flexing
- SMA alone provides a good alternative
  - Not as good performance but could be beneficial for areas of “good” concrete conditions
Route 130 Main St to Rt 1
Resurfacing - 2016

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<tr>
<th>BEFORE REHAB</th>
<th>AFTER REHAB</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDI = 2.4</td>
<td>SDI = 5</td>
</tr>
<tr>
<td>Ride Quality IRI = 178</td>
<td>Ride Quality IRI = 65</td>
</tr>
</tbody>
</table>
Route 130 Main St to Rt 1
Resurfacing - 2016
Route 130 Main St to Rt 1 Resurfacing (MP72.68-83.58)-2016

Application of New Technique:
- Thermal Profile System (Item# 401019P)
- Intelligent Compaction (Item# 401023P)

Special Mix for Skid Resistance:
- High Friction Surface Treatment (Item# 423003M)
Thermal Profile System

Paver Mounted Thermal Profile (PMTP) Method:
A system that continually monitors the surface temperature readings of the mat immediately behind the paver screed during placement operations.
Intelligent Compaction

IC rollers are vibratory rollers equipped with instrumentation fed to a documentation and feedback control system that processes compaction data in real time for the roller operator.
Intelligent Compaction

Global Positioning System (GPS)

Onboard Report System

Continuous Measurement System

Courtesy of Bomag
High friction surface treatments (HFST) are pavement treatments that dramatically and immediately reduce crashes, injuries, and fatalities associated with friction demand issues, such as:

- A reduction in pavement friction during wet conditions, and/or
- A high friction demand due to vehicle speed and/or roadway geometrics.
HFST
QUESTIONS?

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Thanks