NJDOT High RAP Specification and Implementation – I-295

Northeast Asphalt User Producer Group (NEAUPG)
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Rutgers University
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• Dan Karcher – R.E. Pierson
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• Frank Fee and Karissa Mooney – NuStar Asphalt
Industry
(RE Pierson, NuStar Refining, Arawak Paving)

Academia
(Rutgers University)

Agency
(NJDOT)

Success
In 2008, NJDOT began evaluating higher RAP mixtures
  - Under the classification of “research pilot studies”
Some immediate issues were brought up
  - Proper AC determination of RAP
  - Ignition oven correction factors
  - Need of softer binder to maintain -22°C low temp?
    - Were blending charts right way? Extraction/recovery?
  - Mixture tests indicated higher RAP had fatigue issues – especially Overlay Tester (crack propagation)
Initiation vs Propagation – NJ SPS-5

- Section 506 - 2" Virgin HMA - Milled
- Section 509 - 2" 30% RAP - Milled
- Section 505 - 2" Virgin HMA - No Milling
- Section 502 - 2" 30% RAP - No Milling
Initiation vs Propagation – Overlay Tester for NJ SPS-5

Overlay Tester Fatigue Life (cycles)

<table>
<thead>
<tr>
<th></th>
<th>LTPP Virgin</th>
<th>LTPP 30% RAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose Mix</td>
<td>132</td>
<td>28</td>
</tr>
<tr>
<td>Field Cores</td>
<td>17</td>
<td>1</td>
</tr>
</tbody>
</table>
Average Results for Overlay Tester (2008 to 2009)

- 0% RAP = 138 cycles
- 15% RAP = 40 cycles
- 20% RAP = 38 cycles
- 25% RAP = 40 cycles
- 30% RAP = 24 cycles (only 1 mix – 19mm)
2010 NJDOT Higher RAP Projects (25% RAP Surface Course Mixes)

- Rt 206 – production and construction data met specifications
  - Holding water in 2011 – Maintenance 2012
- I-80 – issues with volumetrics throughout first half of project
- I-78 – compaction issues resulted in high in-place air voids and poor ride
- South Jersey Maintenance Roadway Repair Contract (#1)
  - Could not get mix verified through plant
- South Jersey Maintenance Roadway Repair Contract (#2)
  - Only project not to report issues
In 2011, NJDOT held NJ asphalt industry to current specifications
  - 15% RAP in surface; 25% RAP in intermediate/base

In winter 2012, Rutgers and NJDOT worked to develop a Performance-Based High RAP (HRAP) specification
  - Utilized database of performance testing results to establish performance requirements for both rutting (Asphalt Pavement Analyzer) and cracking (Overlay Tester)
The supplier is not held to PG grade, max. RAP content, aggregate angularity, etc.

- Have to meet basic Superpave requirements
- NJDOT increased VMA 1% over current specs
- Could use softer binder, rejuvenators, WMA

However, acceptance based on final mixture performance, based on database of typical “virgin” HMA
Minimum of 20% RAP in Surface Course
Minimum of 30% RAP in Intermediate/Base
Lab design and plant produced material must meet rutting (APA) and cracking (Overlay Tester) requirements

<table>
<thead>
<tr>
<th>Test</th>
<th>Surface Course</th>
<th>Intermediate Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>APA @ 8,000 loading cycles (AASHTO T 340)</td>
<td>PG 64-22 &lt; 7 mm</td>
<td>PG 76-22 &lt; 4 mm</td>
</tr>
<tr>
<td></td>
<td>PG 64-22 &lt; 7 mm</td>
<td>PG 76-22 &lt; 4 mm</td>
</tr>
<tr>
<td>Overlay Tester (NJDOT B-10)</td>
<td>&gt; 150 cycles</td>
<td>&gt; 175 cycles</td>
</tr>
<tr>
<td></td>
<td>&gt; 100 cycles</td>
<td>&gt; 125 cycles</td>
</tr>
</tbody>
</table>
NJDOT HRAP – I295

- I295 SB – Milepost 11.26 to 14.48
- Contractor
  - Arawak Paving
- Supplier
  - R.E. Pierson
- Asphalt liquid
  - NuStar Refining
## Fractionated RAP

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Fine RAP</th>
<th>Coarse RAP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Passing</td>
<td>% Passing</td>
</tr>
<tr>
<td>Sieve Size</td>
<td>inch/mm</td>
<td>#1 #2</td>
</tr>
<tr>
<td>50.0</td>
<td>2 inches</td>
<td>100 100</td>
</tr>
<tr>
<td>37.5</td>
<td>1 1/2 inch</td>
<td>100 100</td>
</tr>
<tr>
<td>25.0</td>
<td>1 inch</td>
<td>100 100</td>
</tr>
<tr>
<td>19.0</td>
<td>3/4 inch</td>
<td>100 100</td>
</tr>
<tr>
<td>12.5</td>
<td>1/2 inch</td>
<td>100 100</td>
</tr>
<tr>
<td>9.5</td>
<td>3/8 inch</td>
<td>100 100</td>
</tr>
<tr>
<td>4.75</td>
<td>No. 4</td>
<td>94.7 95.3</td>
</tr>
<tr>
<td>2.36</td>
<td>No. 8</td>
<td>72.7 74.7</td>
</tr>
<tr>
<td>1.18</td>
<td>No. 16</td>
<td>58.7 59.3</td>
</tr>
<tr>
<td>0.600</td>
<td>No. 30</td>
<td>44.6 45.9</td>
</tr>
<tr>
<td>0.300</td>
<td>No. 50</td>
<td>25.8 26.3</td>
</tr>
<tr>
<td>0.150</td>
<td>No. 100</td>
<td></td>
</tr>
<tr>
<td>0.075</td>
<td>No. 200</td>
<td>9.70 9.20</td>
</tr>
<tr>
<td>Asphalt</td>
<td>%</td>
<td>6.93 7.08</td>
</tr>
</tbody>
</table>

83.8-18.8 (29.1)  
PG82-18
R.E. Pierson contracted NuStar Refining for binder.

- Reminder – no PG grade specified
- NuStar required to formulate binder specifically to help meet performance requirements

R.E. Pierson designed and submitted over 5 different variations (each) of mixtures for the 9.5M76 and 12.5M64 HRAP mixtures required for the project.
Final HRAP Mix Designs

9.5M76 (SURFACE COURSE)
- 25% RAP
- 6.0% Total AC
  - 27.4% Binder Replacement
- PG70-22 (74.6-26.99)
- 25% Fine RAP Fraction Only

12.5M64 (INTERMED. COURSE)
- 35% RAP
- 5.8% Total AC
  - 29.7% Binder Replacement
- PG64-28 (64.8-28.29)
- 17.5% Fine RAP/ 17.5% Coarse RAP
APA Rutting Performance

APA Rutting @ 8,000 Cycles

RE Pierson 9.5mm PG76-22 25% RAP = 3.56 mm (Std Dev = 0.82 mm)
Plant Produced August, 2012

APA PG76-22 Surface Course Criteria ≤ 4 mm Rutting

APA Rutting @ 8,000 Cycles

RE Pierson 12.5mm PG64-22 35% RAP = 6.57 mm (Std Dev = 0.63 mm)
Plant Produced August, 2012

APA PG64-22 Surface Course Criteria ≤ 7 mm Rutting

64°C Test Temp.; 100psi Hose Pressure; 100 lb Load Load
Overlay Tester

Red line represents minimum for PG64-22 Intermediate Course (> 100 cycles)
Black line represents minimum for PG76-22 Surface Course (> 175 cycles)

Overlay Tester Fatigue Life (cycles)

12.5mm HRAP, 35% RAP

9.5mm HRAP, 25% RAP

Overlay Tester Fatigue Life (cycles)

409

1691
Final Product
Final Product
For plant production, NJDOT allowed lower air voids in gyratories than “normal” HMA
- 95% to 98.5% of Gmm

9.5M76 HRAP Cores
- Lot #1: Average = 7.4% air voids
- Lot #2: Average = 5.9% air voids

12.5M64 HRAP Cores
- Lot #1: Average = 4.6% air voids (Full bonus)
- Lot #2: Average = 5.7% air voids (Full bonus)
- Lot #3: Average = 6.5% air voids
9.5M76 WMA
- 11.54 – 11.26: Average = 57.8 ft/mile
- 13.93 – 11.54: Average = 37.7 ft/mile
- 14.39 – 13.93: Average = 76.9 ft/mile

9.5M76 HRAP
- 14.39 – 13.93: Average = 57.8 ft/mile
- 13.93 – 11.54: Average = 44.0 ft/mile
- 11.54 – 11.26: Average = 60.8 ft/mile

Ave = 57.5 ft/mile
Ave = 54.2 ft/mile
In Summary

- NJDOT took a different approach to higher RAP mixtures
  - Put ownership on contractor/supplier to use as much RAP as possible, but need to meet mixture performance
- Collaboration between Industry, Academia, and Agency resulted in a successful project
  - Field monitoring will continue to evaluate performance
Thank you for your time!

Questions?

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