Highly Modified Asphalt (HiMA) Overlays for Urban Areas

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  - Frank Fee
Urban Pavements

- Northeast urban pavements generally contain heavy, slow moving traffic
  - Biggest cost during rehabilitation are utilities and user delays
- Years of multiple overlays, combined with utility work, result in faulted pavement surfaces requiring variability thickness to maintain cross slope and smoothness
Thin lift asphalt overlays provides a means to preserve the pavement while improving the structural and functional properties of the pavement surface

- Higher AC% for fatigue
- Finer aggregate and lower in-place air voids for impermeability
- Faster construction and more flexibility with respect to handwork and leveling
Project Location: 1st Avenue in NYC

- 1st Avenue in Manhattan is 30 year old 18” thick PCC pavement
- Cost of total replacement far beyond NYC DOT budget for a number of reasons....
1st Avenue in NYC – Underground Utilities

- Utilities beneath the pavement
  - Gas lines
  - Water lines
  - Sewer lines
  - Steam line
- Removing the PCC would most likely damage the utilities
  - NYC DOT tries not to use compaction with vibration when paving streets
  - After paving projects are completed NYC DOT tests utilities for leaks
- Funding not available to replace PCC pavement and the utilities
NYC is planning to improve bus service with an new bus lane on 1st Avenue and also add a bike lane.

Question – How to rehabilitate 1st Avenue?
Rehabilitation Plan

- Rehabilitation Design
  - Micro-mill existing PCC pavement
  - Patch areas as required
  - Crack seal as required
  - Place PG 76-22 tack coat and Mirafi PGMG4 fabric
  - Overlay with 1 ½” HPTO mix with HiMA asphalt binder
    - Added Evotherm warm mix additive to lower mix temperatures and improve workability
    - Produced mix at 300°F
- Project completed Sept 2013
1st Avenue Micro-Milling
1st Avenue Crack Sealing and Patching
1st Avenue Tack Coat and Fabric
- Mixture designed after NJDOT’s High Performance Thin Overlay (HPTO)
  - $N_{des} = 50$ gyrations
  - VMA > 18%
  - APA rutting < 4.0 mm
  - Overlay Fatigue > 700 cycles
  - Added for this project to ensure fatigue cracking resistance
HiMA vs Typical NYC HMA

- HiMA sampled during production and compared to NYC Surface Course mixture
  - NYC mix sampled from same asphalt plant prior to 1\textsuperscript{st} Avenue project

<table>
<thead>
<tr>
<th>NYC Surface Course Mixture vs HiMA</th>
<th>Sieve Number</th>
<th>Opening Size (mm)</th>
<th>NYC Surface Mix</th>
<th>Highly Modified Asphalt (HiMA)</th>
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</thead>
<tbody>
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<td>2.0&quot;</td>
<td>50.00</td>
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<td>1.5&quot;</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PG Grade Information (After Extraction and Rotavap Recovery)</th>
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<tbody>
<tr>
<td>Continuous PG Grade</td>
</tr>
<tr>
<td>Asphalt Content (%)</td>
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</tbody>
</table>
Asphalt Pavement Analyzer

- AASHTO T340
- 100 lb. wheel load; 100 psi hose pressure
- Tested at 64°C (148°F) for 8,000 cycles
- Samples at specified air voids
- APA Rutting < 4.0 mm to pass
APA Rutting Results

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

APA Rutting @ 8,000 Cycles

HiMA (9/20/13) = 1.92 mm (Std Dev. = 0.38 mm)

APA Criteria ≤ 4 mm Rutting

Number of Loading Cycles
AMPT Flow Number @ 54°C

![Bar chart showing AMPT flow number comparison between NuStar HiMA (Unaged) and Current NYC Mix (Unaged). The chart indicates that NuStar HiMA (Unaged) has a significantly higher AMPT flow number (982 cycles) compared to Current NYC Mix (Unaged) (405 cycles).]
- Sample size: 6” long by 3” wide by 1.5” high
- Loading: Continuously triangular displacement 5 sec loading and 5 sec unloading
- Definition of failure
  - Discontinuity in Load vs Displacement curve
Overlay Tester Results

<table>
<thead>
<tr>
<th>Binder and Aging Condition</th>
<th>STOA HiMA</th>
<th>LTOA</th>
<th>STOA Current NYC Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatigue Life (cycles)</td>
<td>&gt; 5,000</td>
<td>4,750</td>
<td>39</td>
</tr>
</tbody>
</table>
Flexural Beam Fatigue

- Flexural Beam Device, AASHTO T321
- Test mixes ability to withstand repeated bending
- Run at strain controlled mode to simulate bending/deformation in the field
Flexural Beam Fatigue Results

\[
N_{f,50\%} = k_1 \left( \frac{1}{\varepsilon_t} \right)^{k_2} \left( \frac{1}{E_0} \right)^{k_3}
\]

- **HiMA - LTOA**
- **Current NYC Mix - STOA**

- **Current NYC Mix - Only Short Term Aged**
1st Avenue Finished HiMA Pavement – September 2013
Conclusions

- Urban pavement systems provide a significant challenge to rehabilitate due to the multiple construction constraints
- Thin lift asphalt mixtures provide a structural and functional asphalt overlay system to help preserve the underlying pavement structure
- For NYC 1st Avenue, a highly modified asphalt (HiMA) was utilized to minimize rutting and fatigue cracking potential
  - WMA additive was used to help achieve low air voids without using vibratory mode on compactor
- 2 years after construction, pavement looks in great conditions – with no utility cuts yet!!!
Thank you for your time!
Questions?

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