Tests and Evaluations of In-Service Asphalt Trackbeds

By:

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Strengthens Trackbed Support

Waterproofs Underlying Roadbed

Confines Ballast and Track
Dense-Graded Highway Base Mix
1 – 1 ½ in. Maximum Size Aggregate
Asphalt Binder +0.5% above Optimum
Low to Medium Modulus Mix, 1 - 3% Air Voids
Trackbed Materials Classifications
• Roadbed/Subgrade Moisture Contents
  – At or Near Optimum
  – Thus, HMA Mat not Trapping Moisture
  – For Design - Use Unsoaked Condition

• HMA Cores
  – No Significant Weathering or Deterioration
  – No Loss of Fatigue Life
Geokon Hydraulic Earth Pressure Cells

9 in. Diameter
Empty Coal Train at Conway

P-Cell 209 on 5 in. HMA Layer

Pressure (psi) vs. Time (s)

4 6-Axle Locos
Initial 5 Cars
Empty Coal Train at Conway

P-Cell 206 on 8 in. HMA Layer

4 6-Axle Locos

Initial 5 Cars
Flat Wheel on a Loaded Auto Train at Conway

P-Cell 206 on 8 in. HMA Layer

Time (s)
Pressure (psi)

0 20 40 60 80 100 120

67 Cars

2 6-Axle Locos

Conway
286,000 lb
13 - 17 psi

62,000 lb
2 - 4 psi

180 lb
6 psi

100 - 200+ psi
Loaded Coal Train at Conway

5 in. HMA Layer on Wood Tie Track

Deflection (in.)

Time (s)

2 6-Axle Locos
Initial 7 Cars
Loaded Coal Train at Conway

8 in. HMA Layer on Wood Tie Track

Deflection (in.)

Time (s)

Loaded Coal Train at Conway

8 in. HMA Layer on Wood Tie Track

Deflection (in.)

Time (s)
Loaded Coal Train at Brush Creek
Conway Top of HMA Temperature vs. Time
### Composition of Dense-Graded HMA Mix

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>Amount finer, mass %</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recommended</td>
<td>Actual</td>
</tr>
<tr>
<td>1.5 inch</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>¾ inch</td>
<td>70 - 98</td>
<td>76</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>44 - 76</td>
<td>52</td>
</tr>
<tr>
<td>No. 4</td>
<td>30 - 58</td>
<td>41</td>
</tr>
<tr>
<td>No. 8</td>
<td>21 - 45</td>
<td>30</td>
</tr>
<tr>
<td>No. 16</td>
<td>14 - 35</td>
<td>23</td>
</tr>
<tr>
<td>No. 30</td>
<td>8 - 25</td>
<td>17</td>
</tr>
<tr>
<td>No. 50</td>
<td>5 - 20</td>
<td>11</td>
</tr>
<tr>
<td>No. 200</td>
<td>2 - 6</td>
<td>4.5</td>
</tr>
<tr>
<td>Asphalt</td>
<td>3.5 - 6.5</td>
<td>6.4</td>
</tr>
</tbody>
</table>

### Marshall Mix Design Criteria for HMA Underlayment

<table>
<thead>
<tr>
<th>Property</th>
<th>Required Range</th>
<th>Actual Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaction</td>
<td>50 blows</td>
<td>50 blows</td>
</tr>
<tr>
<td>Stability (lbs)</td>
<td>750 minimum</td>
<td>1730</td>
</tr>
<tr>
<td>Flow (inch)</td>
<td>0.15 – 0.25</td>
<td>0.24</td>
</tr>
<tr>
<td>Percent air voids</td>
<td>1 - 3%</td>
<td>2%</td>
</tr>
<tr>
<td>Voids filled w/ asphalt</td>
<td>80 - 90%</td>
<td>86%</td>
</tr>
<tr>
<td>In-place density*</td>
<td>92 - 98%</td>
<td>94%**</td>
</tr>
</tbody>
</table>

*Maximum density = 151 ptc

** Average nuclear density test results
Longitudinal Cross Section of HMA Test Track

12 in. ballast
4 in. HMA (16 ft. wide)
4 in. subballast

8 in. ballast
8 in. HMA (16 ft. wide)
4 in. subballast

350 ft.  350 ft.  10 ft.
Test Results in Track Modulus and Subgrade Stress

- **Track Modulus (lb/in./in.):**
  - 18 in. granular tracks
  - 4 in. HMA
  - 8 in. HMA

- **Subgrade Stress (psi):**
  - 18 in. granular tracks
  - 4 in. HMA
  - 8 in. HMA
Reduction of Dynamic Stresses

![Graph showing stress over time for 8 in. HMA surface and Subgrade surface.](image)
Track Settlement as a Function of Traffic

![Graph showing track settlement as a function of traffic for 4 in. HMA and 8 in. HMA.](image-url)
HMA Temperature vs. Air Temperature
Findings and Conclusions

• HMA Underlayment Steadily Growing
• Long-Term Performance - Outstanding
• Test Measurements - CSXT Revenue & TTCI Test
• Peak Dynamic Pressures in Trackbed

\[
\begin{array}{ccc}
286,000 \text{ lb locomotive} & 62,000 \text{ lb car} & 180 \text{ lb person} \\
13 - 17 \text{ psi (HMA)} & 2 - 4 \text{ psi (HMA)} & 6 \text{ psi} \\
5 - 7 \text{ psi (subgrade)} &
\end{array}
\]
Findings and Conclusions (cont.)

• Dynamic Track Deflections – 286,000 lb Loco
  – 0.25 in. Wood Ties; 0.05 in. Concrete Ties

• Dynamic Track Modulus (Stiffness)
  – 2500 lb/in/in Wood Ties; 7500 lb/in/in Concrete Ties

• Roadbed/Subgrade Moisture Contents
  – Remain at or Near Optimum

• HMA
  – Minimal Weathering and Oxidation
  – Minimal Temperature Variations
  – Stiffness (Modulus) Uniform
  – Low Induced Stress Levels
  – Long Fatigue Life
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