Asphalt Underlayment Trackbeds for Special Trackwork Applications and Long-Term Performances

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Strengthens Trackbed Support

Waterprooofs 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

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)

67 Cars
2 6-Axle Locos

Flat Wheel on a Loaded Auto Train at Conway

P-Cell 206 on 8 in. HMA Layer

Time (s)
Pressure (psi)

67 Cars
2 6-Axle Locos
Cell Placement on Asphalt
Loaded Auto Train at Richmond

P-Cell 819 Beneath Rail in Crib

1 6-Axle Loco | 1 4-Axle Loco | Initial 2 Cars

Pressure (psi)

Time (s)

P-Cell 820 Beneath Rail and Tie

1 6-Axle Loco | 1 4-Axle Loco | Initial 2 Cars

Pressure (psi)

Time (s)

P-Cell 821 C/L Track in Crib

1 6-Axle Loco | 1 4-Axle Loco | Initial 2 Cars

Pressure (psi)

Time (s)

P-Cell 822 C/L Track and Tie

1 6-Axle Loco | 1 4-Axle Loco | Initial 2 Cars

Pressure (psi)

Time (s)
Loaded Concrete Truck at Richmond

P-Cell 820 Beneath Rail and Tie

![Image of concrete truck at Richmond]

Graph showing pressure (psi) over time (s) for P-Cell 820 Beneath Rail and Tie.
Loaded Coal Truck at Lackey

P-Cell 510 Beneath High Rail and Tie
Goals and Attributes
Rail/Highway Crossing Management

• Cost Effective Crossing
  – Safe
  – Smooth
  – Servicable
  – Long life

• Stable and Smooth
  – No costly disruption
  – Can be skipped over

• Accomplish
  – Minimum of time
  – 4-hour train curfew
  – 8 to 12-hour highway closure

• Utilize Cooperative Approach
  – Railroad company (contractor)
  – Local highway/governmental agency
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

2 6-Axle Locos
Initial 7 Cars

Time (s)
Deflection (in.)
Loaded Coal Train at Brush Creek

HMA Layer on Concrete Tie Track

Deflection (in)

Time (s)

2 6-Axle Locos

Initial 6 Cars

Loaded Coal Train at Brush Creek

Creek
Conway Top of HMA Temperature vs. Time

- 7-Day Average Ambient Temp
- Top of 5-inch HMA
- Top of 8-inch HMA
- 7-Day Max Air Temp
- 7-Day Min Air Temp

Temperature (F)

Date

05/03/00
06/03/00
07/01/00
08/08/00
09/13/00
10/11/00
11/11/00
12/12/00
01/12/01
02/12/01
03/15/01
04/15/01
05/16/01
06/18/01
07/17/01
08/17/01
Composition of Dense-Graded HMA Mix

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>Amount finer, mass %</th>
<th>Recommended</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 inch</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>¾ inch</td>
<td>70 - 98</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>3/8 inch</td>
<td>44 - 76</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>No. 4</td>
<td>30 - 58</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>No. 8</td>
<td>21 - 45</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>No. 16</td>
<td>14 - 35</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>No. 30</td>
<td>8 - 25</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>No. 50</td>
<td>5 - 20</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>No. 200</td>
<td>2 - 6</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Asphalt</td>
<td>3.5 - 6.5</td>
<td>6.4</td>
<td></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/ asphault</td>
<td>80 - 90%</td>
<td>86%</td>
</tr>
<tr>
<td>In-place density*</td>
<td>92 - 98%</td>
<td>94%**</td>
</tr>
<tr>
<td>*Maximum density = 151 ptc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>** Average nuclear density test results</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

The graph shows the comparison of dynamic stresses between an 8 in. HMA surface and a subgrade surface over a period of time. The y-axis represents stress (in psi) ranging from 0 to 30, while the x-axis represents time (in seconds) from 2 to 10.

The graph indicates that the subgrade surface experiences lower dynamic stresses compared to the 8 in. HMA surface, especially during the initial stages of the time period.
Locomotive

(P) 593 PSI

(A) 46.66 in²

(F) 27675 lb

Force vs. Frames

Force, Pounds

Frames

0 2000 4000 6000 8000

0 5000 10000 15000 20000 25000 30000
Empty Freight Car

(P) 268 PSI  (A) 45.45 in²  (F) 12168 lb

Force vs. Frames

Force, Pounds

Frames

0 500 1000 1500 2000

0 5000 10000 15000 20000 25000 30000
This is the front tire of a loaded coal truck with approximately 70 tons of coal plus the truck weight. The Pressure is about 115 for this tire and the load is approximately 7750 pounds.
CSXT Truck Tire
Dumping and spreading ballast

Spreading asphalt

Dumping asphalt 10:15

Compacting asphalt and dumping ballast

Dumping and spreading ballast
Spreading cribbing rock 11:30

Compacting ballast 11:20

Positioning new panel

Tamping ballast
3 weeks later

Compacting hand-spread approaches

Regulating ballast 12:40

Finished compacting asphalt approaches 16:50

3 weeks later
Hauling fouled ballast from tunnel
Loading steel ties and roadbed at north end
Excavating trackbed material
Unloading hot mix asphalt for transloading to hi-rail dump
Unloading hot mix asphalt at north end to be distributed by loader
Unloading hot mix asphalt inside tunnel
Spreading cold mix on floor
Wood panel on asphalt layer prior to adding ballast
Asphalt Stabilization of Railroad Track

**PROBLEM:** Water seepage into weak and/or swelling subgrade soils can result in costly maintenance of railroad track and operational problems for railroad traffic.

**TECHNOLOGY:** Construction of an asphalt underlayerment section over a compacted subgrade acts as a subballast layer under the conventional track structure.

**DEMO SITE:** Red River Army Depot, TX FY85

**BENEFITS:** At the demo site, track maintenance savings of approximately $7,000 per mile per year are anticipated.

Top: Bulldozers and other equipment cut the subgrade for aeration and work the soil to reduce the moisture content. 
Bottom: The completed asphalt underlayerment will greatly decrease maintenance requirements and costs while extending the track's life.

A conventional steel-wheeled vibratory roller compacts the asphalt to 90 - 92 percent of its maximum density.