LONG-TERM ASSESSMENT OF ASPHALT TRACKBED
COMPONENT MATERIALS’ PROPERTIES AND
PERFORMANCE

by

Dr. Jerry G. Rose, PE
Professor of Civil Engineering

and

Henry M. Lees, Jr. PE
Sr. Engineer – Track & Structures

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2006 AAR STATISTICS

1.77 trillion ton-miles

141,000 miles of track

130 tons average freight car

143 tons (286,000 lbs) most new car gross weights
Premium Track Structure and Components

- Maintain Adequate Track Geometry
- Minimize Maintenance Costs
- Minimize Track Outages
- Minimize Slow Orders
- Maximize Operating Efficiency
Minimize Adverse Effects of Subgrade Failures

- Reduce Pressures on the Subgrade
- Improve Drainage
- Thicker Structural Components
- Premium Structural Components
TRACKBEDS

BALLASTED TRACKBED

ASPHALT TRACKBED
2006 AREMA Conference Paper

“Long-Term Performance of Asphalt Trackbeds at Special Trackworks”

• Tunnel Floors & Approaches

• Bridge Approaches

• Crossing Diamonds, Crossovers and Turnouts

• Rail/Highway At-Grade Crossings
Findings

• Improve Load Distribution to Subgrade
• Reduce Subgrade Pressures
• Reduce Excessive Track Deflections
• Waterproof Subgrade
• Confine Subgrade
• Confine Ballast

Performance Measures – Compare Before/After
2002 AREMA Conference Paper

“Tests and Evaluations of In-Service Asphalt Trackbeds”

2004 AREMA Conference Paper

“Pressure Measurements in Railroad Trackbeds”

- Pressure – various locations
- Track Deflections
- Track Modulus
- Temperature
Findings

- Typical Pressure on HMA ~ 20psi (140kPa)
- Typical Pressure on Subgrade ~ 10psi (70kPa)
- Typical Pressure on Rail/Plate ~ 600psi (4150kPa)
- Typical Wood Track Deflection ~ 0.25in (6mm)
- Typical Concrete Track Deflection ~ 0.05in (1.3mm)
- Typical Wood Track Modulus ~ 2900lb/in/in (20MPa)
- Typical Concrete Track Modulus ~ 7200lb/in/in (50MPa)
- Temperature Range ~ 75°F - 36°F (24°C – 2°C)
Tests and Evaluations

Trackbed Materials

• Ballast

• Subgrade
  - Moisture Content
  - Proctor Moisture-Density Classification
  - CBR

• Asphalt
  - Core Tests
  - Recovered Binder Tests

1998 - 2007
Core Drilling
Core Drilling
Core Drilling
Soil Tests
Moisture Content Test
Change in In-Situ Moisture Content between 1998 and 2007

<table>
<thead>
<tr>
<th>Location</th>
<th>Change, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Subgrade Guthrie, OK</td>
<td>-1.4</td>
</tr>
<tr>
<td>Clay Subgrade OK City, OK</td>
<td>-0.5</td>
</tr>
<tr>
<td>Clay Subgrade Quinlan, OK</td>
<td>-0.2</td>
</tr>
<tr>
<td>Silt Subgrade Quinlan, OK</td>
<td>0.3</td>
</tr>
<tr>
<td>Subballast Hoover, TX</td>
<td>0.7</td>
</tr>
<tr>
<td>Subgrade Hoover, TX</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Subgrade/Roadbed In-Situ Moisture Tests After Coring

**OK City Yard, New Subgrade**

- Year 1992: 17.4%
- Year 1993: 17.7%
- Year 1994: 16.7%
- Year 1995: 15.0%
- Year 1996: Avg. = 17.0%
- Year 1997: 18.1%
- Year 1998: 18.1%
- Year 1999: 17.6%

**Conway, KY Old Roadbed**

- Year 1983: 20%
- Year 1984: 18.4%
- Year 1985: 18.8%
- Year 1986: Avg. = 18.4%
- Year 1987: 17.5%
- Year 1988: 17.2%
Proctor Test
Changes in Optimum Subgrade Moisture Contents Between 1998 and 2007

![Chart showing changes in optimum moisture contents between 1998 and 2007 for different subgrade materials. The chart includes data for Select Subgrade Guthrie, OK, Clay Subgrade OK City, OK, Clay Subgrade Quinlan, OK, Silt Subgrade Quinlan, OK, Subballast Hoover, TX, and Subgrade Hoover, TX. The changes are represented in percentage terms, with values ranging from 1.0% to -1.4%.]
Relationships for Roadbed/Subgrade In-Situ and Optimum Moisture Contents
Classification Tests
## Unified Soil Classification

<table>
<thead>
<tr>
<th>Project</th>
<th>Date</th>
<th>Unified</th>
<th>OMC</th>
<th>CBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guthrie</td>
<td>1989</td>
<td>Silty sand</td>
<td>12%</td>
<td>14/5</td>
</tr>
<tr>
<td>OK City</td>
<td>1992</td>
<td>Lean clay</td>
<td>18%</td>
<td>8/3</td>
</tr>
<tr>
<td>Quinlan</td>
<td>1995</td>
<td>Lean clay</td>
<td>17%</td>
<td>9/4</td>
</tr>
<tr>
<td>Quinlan</td>
<td>1995</td>
<td>Sandy silt</td>
<td>13%</td>
<td>3 3/26</td>
</tr>
<tr>
<td>Hoover</td>
<td>1994</td>
<td>Subballast</td>
<td>9%</td>
<td>56/46</td>
</tr>
<tr>
<td>Hoover</td>
<td>1994</td>
<td>Clayey sand</td>
<td>11%</td>
<td>7/4</td>
</tr>
</tbody>
</table>
CBR Test
Comparison of 1998 and 2007 unsoaked and soaked CBR test values for the roadbed /subgrade samples

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>1998</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Subgrade, Guthrie, OK</td>
<td>16.0</td>
<td>12.1</td>
</tr>
<tr>
<td>Clay Subgrade, OK City, OK</td>
<td>8.5</td>
<td>8.2</td>
</tr>
<tr>
<td>Clay Subgrade, Quinlan, OK</td>
<td>10.0</td>
<td>8.8</td>
</tr>
<tr>
<td>Silt Subgrade, Quinlan, OK</td>
<td>23.1</td>
<td>22.7</td>
</tr>
<tr>
<td>Subballast, Hoover, TX</td>
<td>54.1</td>
<td>51.7</td>
</tr>
<tr>
<td>Subgrade, Hoover, TX</td>
<td>4.8</td>
<td>4.2</td>
</tr>
</tbody>
</table>

The chart shows the comparison of CBR test values for different samples in 1998 and 2007.
Subgrade Findings/Discussions

- In-situ Moisture Contents
  - Remain Consistent Over Time
  - Compare Favorably With Optimum
- Assume Unsoaked, Optimum Condition
- Bearing Capacity Remains At or Near Optimum
- Wide Range of Subgrades Evaluated
- Minimum Loading Induced Stress on Subgrade
Resilient Modulus
25°C (77°F)
1Hz
Resilient Modulus versus Age of Asphalt

[Graph showing the relationship between Resilient Modulus and Age of Asphalt Underlayment in Years, with data points and lines for different locations such as Cynthiana, Conway, Hoover, Guthrie, Quinlan, and Oklahoma City.]
Penetration  Absolute Viscosity
Penetration and Absolute Viscosity Versus Age of Asphalt
Penetration and Absolute Viscosity Values for Railroad and Lab Cured Asphalt Cores (2007 Data)
Dynamic Shear Rheometer
25³C (77³F)
Dynamic Shear Rheometer Values
Asphalt Findings/Discussions

• Resilient Modulus Values are Intermediate in Magnitude – Typical of Unweathered Asphalt Mixes
• Asphalt Binders do not Exhibit Excessive Hardening (brittleness), Weathering, Deterioration or Cracking
• Asphalt is Insulated from Environmental Extremes
• Asphalt Experiences Minimal Loading Induced Stress
• Conditions Influencing Typical Failure Modes Experienced by Asphalt Highway Pavements don’t Exist in Asphalt Railroad Trackbeds ??
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