TEST MEASUREMENTS AND PERFORMANCE EVALUATIONS ON IN-SERVICE RAILWAY ASPHALT TRACKBEDS

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UK
1.7 trillion ton-miles

141,000 miles

129 ton average

143 tons or 286,000 lbs.
Premium Track Structure and Components
Track Geometry
Maintenance Costs
Track Outages
Trackbed Failure Modes:

Subgrade Failure

Too Weak

Well-Compacted

- Confined

- Reasonably Dry
Trackbed Failure Modes:

Trackbed Structural Components Failure
-Clogged/Fouled

• Ballast Degradation
• Subgrade Infiltration
• Droppings from Cars
• Wind-blown Fines
Periodic Replacement of Track Components
Frequent Surfacing of Track
Solutions – Minimizing Subgrade Failures

- Reducing pressure on subgrade
- Improve/maintain good drainage
- Use thicker structural components
- Use higher quality components
Solutions – Minimizing Trackbed Structural Component Failures

• Achieve optimum track stiffness
• Maintain track geometric features
Typical All-Granular Ballast Trackbed

Typical Hot Mixed Asphalt (Underlayment) Trackbed
Geokan Model 3500 Earth Pressure Cell
Linear Variable Displacement Transducer

[Diagram of a Linear Variable Displacement Transducer with labels for Zero Deflection Reference Rod and LVDT Pin]
Cell Placement on Asphalt
Cell Location at Richmond
Loaded Coal Train at Richmond

P-Cell 819 Beneath Rail in Crib

P-Cell 820 Beneath Rail and Tie

P-Cell 821 C/L Track in Crib

P-Cell 822 C/L Track and Tie
Loaded Auto Train at Richmond

P-Cell 819 Beneath Rail in Crib

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

Pressure vs. Time (psi)

Time (s)

P-Cell 820 Beneath Rail and Tie

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

Pressure vs. Time (psi)

Time (s)

P-Cell 821 C/L Track in Crib

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

Pressure vs. Time (psi)

Time (s)

P-Cell 822 C/L Track and Tie

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

Pressure vs. Time (psi)

Time (s)
5-in. (125 mm) HMA Layer on Wood Tie Track

2 6-Axle Locos

Initial 6 Cars

1 in. = 25mm

Deflection (in.)

Time (s)

8-in. (200 mm) HMA Layer on Wood Tie Track

2 6-Axle Locos

Initial 6 Cars

1 in. = 25mm

Deflection (in.)

Time (s)
6-in. (150 mm) HMA Layer on Concrete Tie Track

2 6-Axle Locos
Initial 6 Cars

1 in. = 25mm
Reduction of Dynamic Stresses

- **Stress (psi)**
  - 0 to 30

- **Time (s)**
  - 2 to 10

- **8 in. HMA surface**
- **Subgrade surface**
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

1 in = 25 mm
1000 lb/in/in = 6.89 MPa

1 in = 25 mm
10 psi = 69 kPa
## Comparison of the KENTRACK Predictive Values (KPV) versus In-Track Data (ITD) for the CSXT mainline at Conway, Kentucky

<table>
<thead>
<tr>
<th>Thickness Ballast/HMA in.</th>
<th>Vertical Compressive Stress on Ballast KPV/ITD, psi</th>
<th>Vertical Compressive Stress on HMA KPV/ITD, psi</th>
<th>Vertical Compressive Stress on Subgrade KPV/ITD, psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0 / 5.0</td>
<td>47.9 / –</td>
<td>21.0 / 16.0</td>
<td>13.6 / –</td>
</tr>
<tr>
<td>10.0 / 8.0</td>
<td>48.7 / –</td>
<td>22.0 / 15.0</td>
<td>11.7 / –</td>
</tr>
</tbody>
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## Comparison of the KENTRACK Predictive Values (KPV) versus In-Track Data (ITD) at TTCI in Pueblo, Colorado

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</tr>
</thead>
<tbody>
<tr>
<td>12.0 / 4.0</td>
<td>43.5 / –</td>
<td>11.7 / 14.9</td>
<td>8.3 / 8.0</td>
</tr>
<tr>
<td>8.0 / 8.0</td>
<td>47.0 / –</td>
<td>21.9 / 14.9</td>
<td>8.2 / 7.7</td>
</tr>
</tbody>
</table>
Findings

• Peak Dynamic Pressures (286,000 lb cars)
  ≈ 20 psi max on top of HMA mat
  ≈ 10 psi max under HMA mat

• Dynamic Track Deflections (286,000 lb cars)
  ≈ 0.25 inch wood tie track
  ≈ 0.05 inch concrete tie track
Findings

• Dynamic Track Modulus (286,000 lb cars)
  ≈ 2,900 lb/in/in wood tie track
  ≈ 7,200 lb/in/in concrete tie track

• In-Track Pressure Measurements Consistent

• CSX Heavy Haul / TTCI High Tonnage Loop
Previous Studies

• Moisture Contents of Subgrade / Subballast
  - Consistent with time
  - Remain near optimum

• Waterproofing and Confinement

• HMA Mat – minimum variation in temperatures

• Modulus – remains near uniform

• Fatigue Life - ?
Conclusions

• Direct Pressure Measurements in Track Structure Compare Favorably with Predicted Pressures from KENTRACK
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