Driving Indiana’s Economic Growth

Pavement Evaluation Resources Supporting PMS Program

Samy Noureldin, INDOT R & D
Joyce Stone, INDOT Planning
William Flora, INDOT Planning

INDOT System Information

<table>
<thead>
<tr>
<th>Route System</th>
<th>Lane Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Routes</td>
<td>27,217</td>
</tr>
<tr>
<td>Interstates</td>
<td>4,261</td>
</tr>
<tr>
<td>Non – Interstates – NHS</td>
<td>5,154</td>
</tr>
<tr>
<td>Non – NHS</td>
<td>17,802</td>
</tr>
</tbody>
</table>
Contracted Resources

Video Inspection Vehicle

Estimated Cost = $100/Lane Mile

Distress Data Collection

Cameras used to record pavement distress for PCR Computations
Lasers used to measure roughness, rutting and/or faulting

5 Lasers Measure the Distance to Pavement (Accelerometers in each Wheelpath)

In-House Resources – INDOT R&D

Pavement Skid Resistance/ Friction
Pavement Surface Skid Resistance

- 40 mph, Smooth Tire, Wet Pavement Surface

<table>
<thead>
<tr>
<th>Condition</th>
<th>Friction Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>&gt;40</td>
</tr>
<tr>
<td>Very Good</td>
<td>35 – 40</td>
</tr>
<tr>
<td>Good</td>
<td>25 – 35</td>
</tr>
<tr>
<td>Fair</td>
<td>20 – 25</td>
</tr>
<tr>
<td>Poor</td>
<td>&lt; 20</td>
</tr>
</tbody>
</table>

Friction Performance

Friction Number = Original Number - 1.72 Years

Friction Number vs Years Graph
Friction Performance

Years

Skid Numbers

0 10 20 30 40 50 60


Average Skid Resistance (Friction number)
40 mph, Smooth Tire & Wet pavement

Friction Number

Years

Warranty

Intestate

Network
Decisions Driven by Friction Data

- Initially was used just to report the pavement surface condition
- Preservation at Locations of Low Friction Values – Saved Lives and Properties
- Planning for preservation needs
- Warranty Contract Compliance
- Special Tests (What Materials best suited to provide acceptable values)

Ground Penetrating Radar- GPR

- Air Coupled Antenna
  - Highway Speed
- Ground Coupled Antenna
  - Traffic Control
Ground Penetrating Radar, GPR

- Antenna
- Surface Layer
- Support Layer
- Subgrade

$\Delta t_1 = \text{travel time in asphalt}$
$\Delta t_2 = \text{travel time in base layer}$
<table>
<thead>
<tr>
<th>Material</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement Concrete</td>
<td>9</td>
<td>6 – 12</td>
</tr>
<tr>
<td>Asphalt Concrete and Dry Sand</td>
<td>5</td>
<td>3 – 7</td>
</tr>
<tr>
<td>Rock</td>
<td>9</td>
<td>6 – 12</td>
</tr>
<tr>
<td>Dry Aggregate Base/Subbase</td>
<td>7</td>
<td>5 – 9</td>
</tr>
<tr>
<td>Wet Aggregate Base/Subbase</td>
<td>15</td>
<td>10 – 20*</td>
</tr>
<tr>
<td>Subgrade</td>
<td>15</td>
<td>5 – 25*</td>
</tr>
<tr>
<td>Air</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

**Ground Penetrating Radar- GPR**

- Thickness Evaluation
- Moisture Entrapment Causing Stripping or Disintegration
- Water Infiltrations at Joints and cracks and Subsurface Drainage effectiveness
- Utility Location
- Bridge Deck Evaluation
Ride Quality, IRI, and Texture Depth Measurements

- IRI: Warranty Contracts - Now
- IRI: Smoothness Award - Now
- IRI: Network Data Quality Cross Check and Calibration - Planned
- IRI: Construction specifications Planned – Research
- Texture Depth: Preservation Needs Planned – Research
- Texture Depth: Evaluation of Materials used in preservation – Planned – Research
Falling Weight Deflectometer

Project Level Pavement Deflection

FWD

Network Level?
**Project Level Pavement Deflection**

FWD Standard Tests
AASHTO T – 256
ASTM D 4694

9000 Pounds 68 F

Bound Layers
Support Layer
Subgrade

Deflection Basin is Dependent Upon Thickness & Material Properties

---

**Pavement Deflection**

**Falling Weight Deflectometer, FWD**

- Pavement and/or Shoulder Structural Evaluation
- Remaining Life Calculations
- Overlay Design
- Joints and Cracks Evaluation
- Pavement Layers Moduli Backcalculation
- Undersealing Requirements
- Subgrade Evaluation
**Project Level Pavement Deflection**

**Pavement Deflection**

Center Deflection in mils, 9000 Pounds (40 KN), 68 F (20 C)

<table>
<thead>
<tr>
<th>Interstates</th>
<th>Heavy Traffic</th>
<th>Medium Traffic</th>
<th>Light Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>&lt; 4</td>
<td>&lt; 5</td>
<td>&lt; 6</td>
</tr>
<tr>
<td>Very Good</td>
<td>4 – 6</td>
<td>5 – 7</td>
<td>6 – 8</td>
</tr>
<tr>
<td>Good</td>
<td>6 – 8</td>
<td>7 – 9</td>
<td>8 – 10</td>
</tr>
<tr>
<td>Fair</td>
<td>8 – 10</td>
<td>9 – 11</td>
<td>10 – 12</td>
</tr>
<tr>
<td>Poor</td>
<td>&gt;10</td>
<td>&gt;11</td>
<td>&gt;12</td>
</tr>
</tbody>
</table>

ESALs, Millions > 30 | 10 – 30 | 3 – 10 | < 3

---

**Undersealing**

**Concrete and Composite Pavements**

<table>
<thead>
<tr>
<th>Center Deflection</th>
<th>Outer Deflection</th>
<th>Extent</th>
<th>Underseal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Low</td>
<td>The Majority of the Pavement Segment</td>
<td>No</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Localized</td>
<td>Yes</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Localized</td>
<td>Yes</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>The Majority of the Pavement Segment</td>
<td>No</td>
</tr>
</tbody>
</table>