Concrete Smoothness Update

2019 Construction Conference
State Materials Office
Charles Holzschuher, P.E.
January 17, 2019
Concrete Smoothness Initiatives

➢ Goals:
  ❑ Transition from Profilograph to High Speed Laser Sensors for Profilers
  ❑ Support IRI Smoothness Specifications for Rigid Pavements
    ✓ IRI conversion to Ride Rating completed for annual PCS survey
  ❑ Select Optimum Laser Sensor for both Rigid and Flexible Pavements
High Speed Laser Profiler

- Class 1 Profiler, ASTM E-950
- 3 – Bumper Mounted Lasers
  - High Speed – 60 mph
  - Point Laser/Line Laser
- IRI, RN, Rut
  - Network
  - Acceptance
High Speed Laser Profiler (Continued)

- Laser measures the pavement profile (elevation changes with distance)
- Smoothness algorithms process into RN or IRI
- Laser in each wheel path
- Historically used Point Laser, recently added Line Laser
Smoothness Challenges for Concrete

- All new concrete pavements are longitudinally ground
- Artificial texture has challenges for lasers with a small footprint
- Texture is anisotropic
Concrete Smoothness Experiment

- 14 Rigid locations
  - Varying Pavement Age
  - Sensor Type
  - Repeatability
  - % IRI Difference
Developed Multi-Laser Profiler

- 3-Sensor Type
  - Point
  - Wide Spot
  - Line
- Wheel Path
- High Speed
Laser Footprint for Pavement Smoothness

Point Laser

Wide Spot 1.9 mm

Roline 100 mm
Rigid Pavement Summary

IRI Using Line Laser (in/mile) vs. IRI Using Point Laser (in/mile)

- LDG all points
- LDG within 1 year

Florida Department of Transportation
### All Lasers Repeatable

- Large Difference with Point Laser, new pavements
- Texture Wear Noted

#### Surface Type

<table>
<thead>
<tr>
<th>Pooled Standard Deviation of Three Repeat Runs (in/mile)</th>
<th>Point</th>
<th>Wide Spot</th>
<th>Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDG &gt; 1 year</td>
<td>2.73</td>
<td>2.68</td>
<td>2.51</td>
</tr>
<tr>
<td>LDG &lt; 1 Year</td>
<td>3.51</td>
<td>1.76</td>
<td>1.17</td>
</tr>
<tr>
<td>All Projects</td>
<td>2.71</td>
<td>2.21</td>
<td>1.89</td>
</tr>
</tbody>
</table>

#### Section

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Avg. IRI Difference (in/mile)</th>
<th>95% Confidence Interval or IRI Differences (in/mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Limit</td>
<td>Upper Limit</td>
</tr>
<tr>
<td>LDG &gt; 1 year</td>
<td>Point vs. Wide Spot 2.34</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>Point vs. Line 2.90</td>
<td>2.44</td>
</tr>
<tr>
<td></td>
<td>Wide Spot vs. Line 0.56</td>
<td>0.28</td>
</tr>
<tr>
<td>LDG &lt; 1 year</td>
<td>Point vs. Wide Spot 18.08</td>
<td>14.69</td>
</tr>
<tr>
<td></td>
<td>Point vs. Line 20.17</td>
<td>17.01</td>
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<tr>
<td></td>
<td>Wide Spot vs. Line 2.09</td>
<td>1.36</td>
</tr>
<tr>
<td>All Projects</td>
<td>Point vs. Wide Spot 5.51</td>
<td>4.22</td>
</tr>
<tr>
<td></td>
<td>Point vs. Line 6.38</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td>Wide Spot vs. Line 0.87</td>
<td>0.59</td>
</tr>
</tbody>
</table>
IRI-Based Acceptance Specification

- Recently implemented IRI-based incentive specification for limited access flexible pavements
  - Incentive: IRI < 43 in/mile
  - Full Pay: 43 in/mile ≤ IRI < 55 in/mile
  - Disincentive: 55 in/mile ≤ IRI < 95 in/mile
  - Remove & Replace: IRI > 95 in/mile

- Will this work for rigid pavements?
Recently Tested New Construction Rigid Pavements

Incentive ($/Mile) for Recent Projects using New Asphalt IRI-Based Incentive Specification

<table>
<thead>
<tr>
<th>Laser Type</th>
<th>I-295</th>
<th>SR 9B</th>
<th>I-4</th>
<th>SR 710</th>
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</thead>
<tbody>
<tr>
<td>Single Spot</td>
<td>($847)</td>
<td>($891)</td>
<td>$583</td>
<td>NA</td>
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<tr>
<td>Wide Spot</td>
<td>$131</td>
<td>$830</td>
<td>$2,191</td>
<td>NA</td>
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<tr>
<td>Line</td>
<td>$557</td>
<td>$1,031</td>
<td>$2,283</td>
<td>$4,573</td>
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</tbody>
</table>

Implementation of Line Laser would result in incentive on all projects tested to date.
Future Efforts

➢ To meet rigid smoothness needs:
  ▶ Implementation of the Line Laser is the future
➢ Finalize work towards building a single ride specification for both rigid and flexible pavements
FDOT Concrete Test Road Project

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Topics

➢ Background
➢ Design
➢ Measuring Performance
➢ Ongoing Challenges
Background
State Highway System (FDOT Maintained)
- 12,116 centerline miles
- 43,593 lane miles
- 54% of all traffic
Why Do We Need a Test Road?

- Build a rigid pavement data inventory under Florida conditions
- No rigid pavement test facility open to real world traffic in the southeastern US
- Provide data for local ME calibration
- Testing ground for new & innovative construction, rehabilitation, & maintenance materials/techniques
Test Track - Clay County, US 301
Florida’s Concrete Test Road

- Route serves as a significant truck connection between NE & SW Florida
- Existing 4-lane rural arterial with a 40 ft. median, 31% trucks, design speed of 70 mph
- 2.5 miles of two-lane roadway adjacent to existing northbound lanes
Test Track Configuration

- NB traffic will be diverted to parallel concrete test road
- Existing NB asphalt road will provide alternate traffic lanes during evaluation periods
- WIM installation at south end of test sections
- Data building at south end of test road
Design
Test Road Committee

➢ FDOT & Industry

➢ Objective to determine research needs
  - Local ME calibration
    ✓ Cracking model coefficients
    ✓ Appropriate thickness
  - Edge drain effectiveness
  - Other needs:
    ✓ Alternative surface textures
    ✓ New base option
    ✓ Recycled materials: RAP as concrete aggregate
# Pavement Geometry

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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Passing lane</strong></td>
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<tr>
<td>12 ft. x 15 ft. slabs</td>
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<tr>
<td><strong>Travel lane</strong></td>
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<tr>
<td>13 ft. x 15 ft. slabs</td>
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<tr>
<td><strong>Widened edge</strong></td>
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<td></td>
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<tr>
<td><strong>10 ft. shoulder</strong></td>
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<td>(1 ft. widened edge + 9 ft. asphalt)</td>
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</tbody>
</table>
20 test sections (includes replicates)
- Four thicknesses (6, 7, 8 & 10 inches)
- Multiple base types (Type B/SP, LR, A-3)
- RAP & fiber mix designs

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Joint Spacing(ft)</th>
<th>Edge Drain</th>
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<tbody>
<tr>
<td>225</td>
<td>15</td>
<td>Y</td>
</tr>
<tr>
<td>225</td>
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<tr>
<td>225</td>
<td>13</td>
<td>Y</td>
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</tbody>
</table>
Drainage Test Sections

- Two thicknesses (7 & 10 inches)
- Three base types
- With & w/o edge drains
- With & w/o joint sealant

|   | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Length(ft) | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 | 225 |
| Edge Drain | Y   | N   | N   | Y   | N   | N   | Y   | Y   | Y   | N   | N   | Y   | Y   | Y   | N   |
| Joint Sealant | Y   | N   | N   | Y   | N   | N   | Y   | N   | Y   | N   | N   | Y   | Y   | Y   | N   |
| Joint Spacing(ft) | 15 | 15 | 15 | 15 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 15 | 15 | 15 | 15 |
Calibration Test Sections

- Two thicknesses (7 & 10 inches)
- Two joint spacings (13 & 17 ft)
- Control set conditions thru placement time &/or curing methods

<table>
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<tr>
<th>Length(ft)</th>
<th>Joint Spacing (ft)</th>
<th>Set Gradient</th>
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<tr>
<td>4&quot; Type B</td>
<td>4&quot; Type B</td>
<td>4&quot; Type B</td>
<td>4&quot; Type B</td>
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<td>4&quot; Type B</td>
</tr>
</tbody>
</table>
Surface Textures

- Longitudinal diamond grinding (LDG) in travel lane for the entire project
  - Standard FDOT rigid pavement texture (Section 352)
- Experimental pavement textures in passing lane
  - LDG only (control/standard texture)
  - LDG + transverse grooving (FDOT bridge deck)
  - Next generation concrete surface (NGCS)
    - ✓ LDG + longitudinal grooving
- Texture performance parameters:
  - Noise (OBSI, wayside)
  - Texture (MTD, MPD)
  - Friction (FN)
  - Drainage/hydroplaning potential?
Measuring Performance
How Will We Measure Performance?

- Comprehensive material characterization
- Routine pavement performance monitoring
  - Distress development, smoothness/faulting, NDT, etc.
- Embedded instrumentation to measure critical pavement responses
  - Dynamic and static data collection
Cores will be taken from either end
Transitions to occur
Instrumentation will be limited to north end
Ten interior slabs will be monitored for performance (assuming 15’ jt spacing)
Performance surveys will be conducted at least twice a year
- Seasonal extremes
- Unique events
Performance Measurements

Smoothness / Faulting

Distress Survey

Pavement Support (FWD)

Friction/Texture

Layer Thickness/Moisture (GPR)

Pavement Images
Instrumentation

➢ Primary instrumentation
  ❑ Concrete strain
  ❑ Concrete temperature

➢ Drainage sections
  ❑ Moisture of granular support layer
  ❑ Edge drain outflow

➢ Monitoring wells
Instrumentation Data Collection

- **Environmental loads (primary)**
  - Every 15 minutes

- **Dynamic loads**
  - FDOT vehicle of known axle loads & speed while traffic is diverted
  - Limited periods of live traffic
Test Road Timeline

- Jan 2010 – Test road feasibility study
- Oct 2011 – Test road committee formed
- Jan 2013 – Primary experiments finalized
- August 2015 – Phase III plans
- June 2016 – Contract A
  - Earthwork
- December 2018 – Contract B Advertised
  - Paving
- Summer 2021 – Open to traffic