Roadway Profile Testing in North Carolina

PAST PERFORMANCE AND LESSONS LEARNED
PRESENTED BY CHRISTOPHER BACCHI, TRIMAT MATERIALS TESTING, INC
AND NILESH SURTI, NCDOT
Why is Pavement Smoothness Important?

- Pavement Smoothness is important to the User (taxpayer, driver, etc.) – Research has shown that smoothness is the primary variable used by the public to judge the quality of roadways
- **Smother roads last longer** – NCHRP, FHWA and NAPA research on newly constructed pavements
- **Smother roads are safer** – increased roughness results in higher friction loss
- **Smother roads save money** – lower fuel consumption and less maintenance costs for users
Definitions

- **Inertial Profiler** – Device that utilizes an accelerometer to measure accelerations, a laser transducer to measure distance (or height), and DMI (or GPS) to measure longitudinal distance.

- **International Roughness Index (IRI)** – A mathematical transformation of a true road profile presented in units of slope (in/mi). (80’s, NCHRP, World Bank)

- **Mean Roughness Index (MRI)** – Average of two wheelpath IRI measurement

- **Localized Roughness (LR)** - Isolated areas of roughness, which by themselves can cause a significant increase in the overall reported smoothness index.

  - *LR is a constant moving average of the IRI and indicates what the overall section IRI will be*
Some Projects In NC
Project and Mix Types Where IRI has been Performed

- All surface mix type, S9.5B, 9.5C, etc
- Open Graded Friction Courses (avg. < 45 in/mi)
- Concrete – diamond ground and plain
- Binder mixes (when final lift is placed in one lift)
- SR Routes where 2 lifts of asphalt are placed
- Interstates
- NC Routes
- US Routes
- Airports (PI)
- Federal Roadways
- Bridges (<100 in/mi)
NCDOT Specification Review

Where is Final Surface Testing (FST) required?

Required on **Asphalt Pavement** when:
- 2 or more lifts of asphalt
- Speed limit is > 45 mph
- Map length is > 1 mile
- Contractor still has the option to do HEARNE Straightedge!
- Intent is on **Mainline Pavement including AUX and CD travel lanes** only!

**NOT REQUIRED:**
- SR routes
- Where it is **NOT PRACTICAL! – Examples:** Pre-existing subgrade conditions like soft soils or alligator cracking, multiple driveways, Y-lines, crossovers, number of utilities.
NCDOT Specification Review

- Where is Final Surface Testing (FST) required?
  - Required on **Concrete Pavement** when:
    - New concrete pavement
    - **Mainline + Auxiliary + Collector/Distributor travel lanes**
    - Diamond ground concrete pavement - SP shows that IRI testing needs to be done
NCDOT Specification Review (cont.)

- Same spec for concrete and asphalt with the exception of Hearne
- ProVAL is the free program used to analyze the data
- Smoothness numbers for every 528-ft (0.10 mile) in Table 610-7
- MRI is average of IRI numbers in both wheelpaths

<table>
<thead>
<tr>
<th>MRI after Completion (Inches Per Mile)</th>
<th>Price Adjustment Per Lane (0.10-Mile Section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>45.0 and Under</td>
<td>$200.00</td>
</tr>
<tr>
<td>45.1-55.0</td>
<td>PA = 600 – (10 * MRI)</td>
</tr>
<tr>
<td>55.1-70.0</td>
<td>Acceptable (No Pay Adjustment)</td>
</tr>
<tr>
<td>70.1-90.0</td>
<td>PA = 650 – (10 * MRI)</td>
</tr>
<tr>
<td>Over 90.1</td>
<td>Corrective Action Required</td>
</tr>
</tbody>
</table>
NCDOT Specification Review (cont.)

- Same spec for concrete and asphalt with the exception of Hearne
- Localized roughness
  - Checking for “bumps in 25-ft sections”
  - Program checks along the entire roadway in 25-ft continuous sections
  - Identifies all bumps where smoothness number is **165 in/mile or greater**
  - This is a separate report in ProVAL called the “SAM” report
  - Consultant will submit these results in their FINAL REPORT
  - Contractor MUST discuss corrective action with RE
  - RE will approve locations that need corrective action
  - RE will apply Pay Adjustment on non-corrective action locations as necessary using the formula \( LR = (165 - LR) \times 5 \) provided in the Asphalt Superpave Special Provision
Process for IRI Testing - Contractor

- Confirms testing is required (spec. review)
- Reviews feasibility on all project roadways
  - Y-line – case by case basis
  - Ramps, Loops, transitions – not to be tested!
- Discusses any concerns with NCDOT – Important
- Submit Plans and or KML files to profiler
- May perform internal QC on ride quality on initial lifts (binder or surface)
  - Use Hearne
  - “Seat of Pants”
- Schedule preliminary IRI testing for informational purposes
- Repair areas with high Localized Roughness – Corrective Action (discuss later)
- Run Final Surface test
Some Considerations.....

18 Driveways/entrances and 2 signalized intersections in about ½ mile!! (and c&g)

Probably not a good candidate for rideability...
Some Considerations.....

4 Intersections, 3 Bridges, numerous lane drops and adds, and a 180 degree turn in less than 1 mile

Probably not a good candidate for rideability...
Process for IRI Testing – NCDOT

- Confirm with Contractor that testing is required (spec. review)
- Reviews feasibility on all project roadways
  - Y-lines, Ramps, Loops, CD lanes, transitions, curb and gutter, short sections
- Ride the Roadway and use “seat of pants” judgment as a start and note concerns
- Ensure NCDOT is aware of date of testing and onsite during testing
- Receive raw test results when testing is complete (thumb drive)
- RE receives final report from Contractor
Process for IRI Testing – NCDOT (cont)

- Submit report and raw data to Pavement Management
- NCDOT Resident and Pavement Management (PMU) review report
- PMU will run ProVal on raw data and compare results to Contractor submitted final report
- Resident will verify incentive/disincentives
- Resident will verify “corrective action” locations
- Meeting with Contractor to discuss corrective action locations
- Contractor will propose corrective action measures

**Resident must approve all locations that need corrective action and corrective action repair methods!**
Process for IRI Testing – NCDOT and Contractor

- Contractor performs corrective action (grinding, mill and fill, etc.)
- IRI is re-run on corrected sections
- If action is unsuccessful, Resident will decide on pay adjustment or require additional corrective action to be taken
  - Formula: $PA = (165-LR) \times 5$
  - Resident determines final pay adjustment
### Process for IRI Testing – NCDOT (cont)

- Sample report, MRI tables:

<table>
<thead>
<tr>
<th>Reference Station</th>
<th>Start Sta. (ft)</th>
<th>Stop Sta. (ft)</th>
<th>Length (ft)</th>
<th>LWP IRI</th>
<th>RWP IRI</th>
<th>Avg or MRI</th>
<th>Incentive/Disincentive</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>528</td>
<td>528</td>
<td>131.67</td>
<td>116.88</td>
<td>124.28</td>
<td>Corr Action Req</td>
<td>Single Lift</td>
</tr>
<tr>
<td>528</td>
<td>1056</td>
<td>528</td>
<td>528</td>
<td>93.55</td>
<td>78.60</td>
<td>86.08</td>
<td>$ (210.76)</td>
<td>Water Valve</td>
</tr>
<tr>
<td>1056</td>
<td>1584</td>
<td>528</td>
<td>528</td>
<td>104.49</td>
<td>112.56</td>
<td>108.52</td>
<td>Corr Action Req</td>
<td>Corr Action Req</td>
</tr>
<tr>
<td>1584</td>
<td>2112</td>
<td>528</td>
<td>528</td>
<td>109.63</td>
<td>91.80</td>
<td>100.72</td>
<td>Old Intersection</td>
<td>Corr Action Req</td>
</tr>
<tr>
<td>2112</td>
<td>2640</td>
<td>528</td>
<td>528</td>
<td>66.35</td>
<td>54.12</td>
<td>60.24</td>
<td>No Pay Adj</td>
<td>No Pay Adj</td>
</tr>
<tr>
<td>2640</td>
<td>3168</td>
<td>528</td>
<td>528</td>
<td>64.65</td>
<td>51.03</td>
<td>57.84</td>
<td>No Pay Adj</td>
<td>No Pay Adj</td>
</tr>
<tr>
<td>3168</td>
<td>368</td>
<td>528</td>
<td>528</td>
<td>61.00</td>
<td>49.70</td>
<td>55.35</td>
<td>No Pay Adj</td>
<td>No Pay Adj</td>
</tr>
<tr>
<td>368</td>
<td>412</td>
<td>528</td>
<td>528</td>
<td>61.47</td>
<td>63.72</td>
<td>62.60</td>
<td>No Pay Adj</td>
<td>No Pay Adj</td>
</tr>
<tr>
<td>412</td>
<td>464</td>
<td>528</td>
<td>528</td>
<td>51.30</td>
<td>70.04</td>
<td>60.67</td>
<td>No Pay Adj</td>
<td>No Pay Adj</td>
</tr>
<tr>
<td>464</td>
<td>528</td>
<td>528</td>
<td>528</td>
<td>66.84</td>
<td>49.55</td>
<td>58.20</td>
<td>Culvert</td>
<td>No Pay Adj</td>
</tr>
<tr>
<td>528</td>
<td>580</td>
<td>528</td>
<td>528</td>
<td>58.72</td>
<td>57.95</td>
<td>58.34</td>
<td>No Pay Adj</td>
<td>No Pay Adj</td>
</tr>
<tr>
<td>580</td>
<td>636</td>
<td>528</td>
<td>528</td>
<td>67.76</td>
<td>67.66</td>
<td>67.71</td>
<td>Intersection</td>
<td>No Pay Adj</td>
</tr>
<tr>
<td>636</td>
<td>672</td>
<td>528</td>
<td>528</td>
<td>70.23</td>
<td>74.72</td>
<td>72.48</td>
<td>Intersection</td>
<td>Intersection</td>
</tr>
<tr>
<td><strong>AVG</strong></td>
<td></td>
<td></td>
<td></td>
<td>74.85</td>
<td></td>
<td>$ (285.52)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Project Stations – if plans and KML files are provided!
- Start and Stop stations – Not Project Stations!
Process for IRI Testing – NCDOT (cont)

- Sample report, LR tables:

<table>
<thead>
<tr>
<th>Wheelpath Description</th>
<th>IRI values for LR section</th>
<th>Length of localized roughness</th>
<th>Project Stations and/or anomalies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start and Stop stations – Not Project Stations!</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WB Lane 1 LWP</th>
<th>Start Distance (ft)</th>
<th>Stop Distance (ft)</th>
<th>Distance (ft)</th>
<th>IRI (in/mi)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Distance (ft)</td>
<td>Stop Distance (ft)</td>
<td>Distance (ft)</td>
<td>IRI (in/mi)</td>
<td>Comments</td>
<td></td>
</tr>
<tr>
<td>Start Distance (ft)</td>
<td>Stop Distance (ft)</td>
<td>Distance (ft)</td>
<td>IRI (in/mi)</td>
<td>Comments</td>
<td></td>
</tr>
<tr>
<td>Start Distance (ft)</td>
<td>Stop Distance (ft)</td>
<td>Distance (ft)</td>
<td>IRI (in/mi)</td>
<td>Comments</td>
<td></td>
</tr>
</tbody>
</table>

Sample report, LR tables:

<table>
<thead>
<tr>
<th>Start Distance (ft)</th>
<th>Stop Distance (ft)</th>
<th>Distance (ft)</th>
<th>IRI (in/mi)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2082</td>
<td>2116</td>
<td>34</td>
<td>238.51</td>
<td>Sta 92+50 LLT</td>
</tr>
<tr>
<td>3727</td>
<td>3754</td>
<td>26</td>
<td>210.47</td>
<td>Sta 69+00 LMED</td>
</tr>
<tr>
<td>4278</td>
<td>4300</td>
<td>22</td>
<td>177.34</td>
<td>Sta 65+50 LMED</td>
</tr>
<tr>
<td>516</td>
<td>546</td>
<td>31</td>
<td>190.06</td>
<td>Sta 50+00 LMED</td>
</tr>
<tr>
<td>none</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>none</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>none</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>none</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Google Earth file - KML
Current Issues Going Forward

- Current NCDOT certification and calibration (?)
- Elimination of curb and gutter sections
- Percent improvement spec for re-surfacing
Lessons Learned

◦ Not a lot experience with IRI across the state
◦ Understanding of raw data limitations
◦ Corrective action is difficult when LR is below 200 in/mi
◦ Some projects apply IRI specification blindly