A Case Study in Establishing Quality Assurance Limits for Automated Pavement Distress Data in North Carolina

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Presentation Outline

• Background
• Data Collection
• Analysis
• Benefits
BACKGROUND
Background

• Began automated data collection in 2012
  ▪ Transition from manual to automated rating
  ▪ Maintained two distress guides

• 19,000 miles of interstate & primary

• Develop quality limits for control of the distress data
Important that control sites represent a range of representative conditions

- Variety of distress types
- Variety of extents
- Variety of severity levels

NCDOT was provided with an initial matrix

- Review historical data to fill the cells
- Sites within a day’s drive of Raleigh
## Control Site Selection

<table>
<thead>
<tr>
<th>OID</th>
<th>SURFACE TYPE</th>
<th>COUNTY NAME</th>
<th>COUNTY NUMBER</th>
<th>DIVISION</th>
<th>ROUTE</th>
<th>BEG_MP</th>
<th>END_MP</th>
<th>LENGTH (miles)</th>
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<tbody>
<tr>
<td>1</td>
<td>AC</td>
<td>Davidson</td>
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<td>Edgecombe</td>
<td>33</td>
<td>4</td>
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</table>
### Control Site Selection

- **Windshield definitions**

<table>
<thead>
<tr>
<th>DISTRESS TYPE</th>
<th>LIGHT</th>
<th>MODERATE</th>
<th>SEVERE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alligator (Small Quantity)</td>
<td>4, 7, 10</td>
<td>2, 3</td>
<td>2, 11</td>
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<tr>
<td>Alligator (Large Quantity)</td>
<td>1, 5, 9, 12, 14</td>
<td>5, 11, 13, 14</td>
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<tr>
<td>Transverse Cracking</td>
<td>4, 5, 6, 9, 10, 11, 12, 14</td>
<td>4, 5, 14</td>
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</tr>
<tr>
<td>Rutting</td>
<td>6, 13</td>
<td></td>
<td></td>
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<tr>
<td>Raveling</td>
<td>6, 8, 13</td>
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<td></td>
</tr>
<tr>
<td>Bleeding</td>
<td>8</td>
<td></td>
<td>6, 7</td>
</tr>
<tr>
<td>Patching</td>
<td>5, 9</td>
<td></td>
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<tr>
<td>Oxidation</td>
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</table>
### Control Site Selection

#### High speed definitions

<table>
<thead>
<tr>
<th>DISTRESS TYPE</th>
<th>LIGHT</th>
<th>MODERATE</th>
<th>SEVERE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse</td>
<td>4,5,6, 13,14</td>
<td>4,5,7, 11,12,14</td>
<td>9,10,11</td>
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<tr>
<td>Longitudinal (Outside of WP)</td>
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<tr>
<td>Longitudinal Lane Joint</td>
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<tr>
<td>Alligator</td>
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<td>2,3,4,5,9,11,12,13,14</td>
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<td>Patching (WP)</td>
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<td>Patching (NWP)</td>
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<tr>
<td>Delamination</td>
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<tr>
<td>Bleeding</td>
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<td>6,7</td>
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<tr>
<td>Rutting</td>
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<td>Raveling</td>
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<tr>
<td>Transverse Reflective</td>
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<tr>
<td>Longitudinal Reflective</td>
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</tr>
</tbody>
</table>
Field Reviews

• Data collection team of NCDOT and contractor experienced distress raters

• Historical windshield review
  - Drive at low rate of speed
  - Document ride quality (low, moderate, high)
  - Identify distress in bins (combined severity, estimate quantity)
  - Stop and reviewed ratings, but did not change windshield rating
Field Reviews

• Vendor collected high speed data
  ▪ Data collected over 2 month period
• Data includes:
  ▪ Roadway geometrics
  ▪ Ride quality (IRI)
  ▪ Rutting
  ▪ 3-D pavement images
  ▪ Semi-automated distress ratings
Rater Pool

- Rater pool was used to independently evaluate each control site from images
  - 4 raters from the QA contractor
  - 3 raters from NCDOT
  - 1 vendor rating
ANALYSIS
Comparison to Field Ratings

- Vendor reported more distress for 9 out of 14 control sites based on PCR
Comparison to Field Ratings

• General differences
  ▪ Vendor identified larger % of alligator cracking at higher severities
  ▪ Vendor reported more moderate ride quality, compared to low from windshield
  ▪ Vendor had severe patching on site 13 compared to no patching from field team
  ▪ Field raters generally reported the transverse cracking in a lower bin
Comparison to Field Ratings

• The distress identified by the vendor was generally more complete than the windshield surveys

• This comparison did identify some deficiencies in the automated rating process
  ▪ Identification of bleeding
  ▪ Transverse crack algorithm
Comparison to Image Ratings

- Vendor reported more distress for 8 out of 14 control sites based on PCR
Comparison to Image Ratings

• Based upon VDOT Non-Load Related Distress Index (NDR)
Comparison to Image Ratings

• Based upon VDOT Load Related Distress Index (LDR)
Comparison to Image Ratings

• General differences
  ▪ Rater pool generally identified higher quantities of low severity alligator cracking but lower quantities of longitudinal cracking
  ▪ Rater pool identified more transverse cracking on most sites
  ▪ Vendor generally rated higher quantities of bleeding
Recommendations from Comparisons

- Redefine transverse cracking
- Review ride quality rating limits
- Review the rating/reporting of patching
- Differences in distress identification and classification existed (low alligator cracking, longitudinal cracking, patching and bleeding)
- Detailed distress rater training was recommended
What to Control & How

• Review the current NCDOT PMS decision trees for treatment to identify significant distress

**PATCHING TREE - INTERSTATE**

- **Interstate**
  - **Patching Index < 25**
    - Interstate - Mill 2.5" & Replace / 1.5" Overlay (D Level)
  - **25 <= Patching Index < 60**
    - Interstate - 1.5" Overlay (D Level)
  - **60 <= Patching Index < 85**
    - Do Nothing
  - **Patching Index >= 85**
    - Do Nothing
What to Control & How

• Considered options
  ▪ Individual distress
  ▪ Index values (PCR, LDR, NDR)

• Statistical analysis based on ASTM d2s methodology (represents reproducibility of the process)
Determination of QA Limits

- Applied d2s to the 14 control sites (rater pool)
- The difference in PCR values between the vendors reported data and QA determined data should not exceed the absolute value of 15
- The difference in the total quantity of alligator cracking data reported (based upon the windshield reporting and summary method) should not exceed a value of 2.0
Application of QA Limits

- When outside of the limits – investigate

Error Type?
- Random
- Systematic
BENEFITS
Benefits of Control Sites

- Early identification of misinterpretation of distress definitions
- Confirmation of computer algorithms
- Acceptance of summarization and reporting methods
- Minimal time & effort compared to inaccurate data reporting
Recommendations

• Select control sections with a wide range of distresses (type, severity, extent)
• The larger the rater pool the better
• Vendor must report data as for production ratings
• Vendor should repeat control site efforts annually
THANK YOU