2015 WINTER CONFERENCE

PAVEMENT MANAGEMENT PRACTICES

Todd Anderson, P.E.
ROAD DATA SERVICES ENGINEER
DATA COLLECTION

43,180 Collection Miles

- 1,700 mile Interstate System (Directional mileage)
- 10,480 mile Primary System (Directional mileage)
  - 4,230 miles of US routes
  - 6,250 miles of SC routes
  - 3,760 miles designated National Highway System
- 31,000 mile Secondary System (Centerline mileage)

Miscellaneous Collection
- Oversize/Overweight evaluation
- Post weather event evaluation
INTERSTATE SYSTEM COLLECTION

- Vendor Collected
- Collection Cycle
  - Entire system collected annually
- Data Collected
  - Roughness data
  - Rutting data
  - Distress data
  - Forward images
PRIMARY SYSTEM COLLECTION

Includes all US and SC Routes
Vendor Collected
Collection Cycle

National Highway System Routes
- Annually (FHWA requirement)
  - Rutting data
  - Roughness data
  - Forward imaging
- Every 3 years (collecting 1/3 of the system annually)
  - Distress data

Remaining Primary System Routes
- Every 3 years (collecting 1/3 of the system annually)
  - Rutting data
  - Roughness data
  - Distress data
  - Forward imaging
SECONDARY SYSTEM COLLECTION

- Collected by SCDOT

Collection Cycle
- Routes with AADT exceeding 400 collected every 3 years
- Routes with AADT less than 400 collected every 6 years unless requested sooner by RME

Data Collected
- Roughness data
- Rutting data
- Distress data
- Forward imaging
STANTEC Corporation

Collection Equipment

- High-Speed Inertial Profiler
- Semi-Automated Collection
  - Automated Collection
    - Roughness data
    - Rutting data
    - Forward imaging
    - GPS
- Manual Collection
  - Distress data
    - Downward imaging
    - Rated in office with help of software

Outfitted by:
International Cybernetics Corporation, Largo, Florida
SCDOT INFORMATION

Collection Equipment
- High-Speed Inertial Profiler
- Semi-Automated Collection
  - Automated Collection
    - Roughness data
    - Rutting data
    - Forward imaging
    - GPS
- Manual Collection
  - Distress data
    - Windshield Survey using distress keyboard

Outfitted by:
International Cybernetics Corporation, Largo, Florida
DISTRESS DATA

- Bituminous & Composite Pavements (Bituminous/Concrete)
  - Fatigue Cracking
  - Transverse Cracking
  - Longitudinal Cracking
  - Raveling
  - Rutting
  - Patch Deterioration

- Concrete Pavements (Continuous and Jointed)
  - Transverse Cracking
  - Longitudinal Cracking
  - Spalling
  - Faulting
  - Patching
  - Punchouts
DISTRESSES
SCDOT COLLECTION

Fatigue Cracking

Transverse Cracking

Longitudinal Cracking

Severity and extent of distress are recorded with the Distress Board
DISTRESSES
SCDOT COLLECTION

Raveling

Patch Deterioration

Rutting (Collected Automatically)

Severity and extent of distress are recorded with the Distress Board
DISTRESS
STANTEC COLLECTION

32.52 ft 37 ft 42 ft
1.39 ft 1.89 ft 1.75 ft 2.01 ft 1.98 ft
92.91 sq ft
104.67 sq ft 2.1 sq ft
1.13 ft 1.96 ft 1.33 ft
0.96 ft
### RUTTING

#### Measurement (Inches) | Rutting (Inches)
--- | ---
L1 | L2 | L3 | RT | LT | AVG

#### Diagram

![Diagram of measurement points and vehicle](image-url)
## RUTTING

<table>
<thead>
<tr>
<th>MEASUREMENT (Inches)</th>
<th>RUTTING (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>L1</td>
</tr>
<tr>
<td>L2</td>
<td>L2</td>
</tr>
<tr>
<td>L3</td>
<td>L3</td>
</tr>
<tr>
<td>RT</td>
<td>RT</td>
</tr>
<tr>
<td>LT</td>
<td>LT</td>
</tr>
<tr>
<td>AVG</td>
<td>AVG</td>
</tr>
</tbody>
</table>

| CAL     | 12 | 12 | 12 | 0 | 0 | 0 |

### Calibration

- L-1
- A-1
- L-2
- A-2
- L-3

### Diagram

- CALIBRATION

![Diagram of vehicle with measurement points](image-url)
# Rutting

<table>
<thead>
<tr>
<th>Measurement (Inches)</th>
<th>Rutting (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>12</td>
</tr>
<tr>
<td>L2</td>
<td>12</td>
</tr>
<tr>
<td>L3</td>
<td>12</td>
</tr>
<tr>
<td>RT</td>
<td>0</td>
</tr>
<tr>
<td>LT</td>
<td>0</td>
</tr>
<tr>
<td>AVG</td>
<td>0</td>
</tr>
</tbody>
</table>

| 0+00 | 12 | 11 | 12 | 1 | 1 | 1 |

## Diagram

- **L-1**
- **A-1**
- **L-2**
- **A-2**
- **L-3**

*0+00*
<table>
<thead>
<tr>
<th>Measurement</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>RT</th>
<th>LT</th>
<th>AVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAL</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0+00</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1+00</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**RUTTING**

L1 - L3: Measurements in inches.
RT, LT, AVG: Calculated values for rutting.

1+00: Measurement point on the pavement.
## RUTTING

<table>
<thead>
<tr>
<th>MEASUREMENT (Inches)</th>
<th>RUTTING (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>L2</td>
</tr>
<tr>
<td>CAL</td>
<td>12</td>
</tr>
<tr>
<td>0+00</td>
<td>12</td>
</tr>
<tr>
<td>1+00</td>
<td>12</td>
</tr>
<tr>
<td>2+00</td>
<td>11</td>
</tr>
</tbody>
</table>

### Diagram

- **L-1**
- **A-1**
- **L-2**
- **A-2**
- **L-3**

At 2+00:

- Level:
  - **L-1**: 12 inches
  - **L-2**: 11 inches
  - **L-3**: 12 inches
  - Average: 11 inches

- Rut:
  - **L-1**: 0 inches
  - **L-2**: 1 inch
  - **L-3**: 0 inches
  - Average: 0.67 inches
## RUTTING

### Measurement Table

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>CAL</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>RT</th>
<th>LT</th>
<th>AVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0+00</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1+00</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2+00</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>3+00</td>
<td>11</td>
<td>10</td>
<td>12</td>
<td>1</td>
<td>2</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

### Diagram

The diagram illustrates the measurement points at 0+00, 1+00, 2+00, and 3+00. The rutting values are shown at each point.
## RUTTING

<table>
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<th>L1</th>
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<th>L3</th>
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<tr>
<td>CAL</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0+00</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1+00</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>0.5</td>
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<tr>
<td>2+00</td>
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<td>11</td>
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<td>0</td>
<td>1</td>
<td>0.5</td>
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<tr>
<td>3+00</td>
<td>11</td>
<td>10</td>
<td>12</td>
<td>1</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>4+00</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Diagram:**
- L-1, L-2, L-3, A-1, A-2
- 4+00
## RUTTING

### MEASUREMENT (Inches) | RUTTING (Inches)
---|---
| L1 | L2 | L3 | RT | LT | AVG |
| CAL | 12 | 12 | 12 | 0  | 0   | 0   |
| 0+00 | 12 | 11 | 12 | 1  | 1   | 1   |
| 1+00 | 12 | 11 | 11 | 1  | 0   | 0.5 |
| 2+00 | 11 | 11 | 12 | 0  | 1   | 0.5 |
| 3+00 | 11 | 10 | 12 | 1  | 2   | 1.5 |
| 4+00 | 11 | 11 | 11 | 0  | 0   | 0   |

- n

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PAVEMENT MANAGEMENT
# RUTTING

## Table

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<tr>
<td></td>
<td>L1</td>
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</tr>
<tr>
<td>2+00</td>
<td>11</td>
</tr>
<tr>
<td>3+00</td>
<td>11</td>
</tr>
<tr>
<td>4+00</td>
<td>11</td>
</tr>
<tr>
<td>n</td>
<td></td>
</tr>
</tbody>
</table>

Average Rutting for 0.10 mile segment: 0.7
ROUGHNESS
International Roughness Index - IRI

IRI – Quarter Car Model

IRI

Measured Profile

Body Mass
Susp Spring and Damper
Axle Mass
Tire Spring

Computer Algorithm

IRI

150 inches/mile
Grading for pavement condition is called the Pavement Quality Index – PQI

PQI is made up of 2 components:
- Distress component on a 5 point scale – PDI
- Roughness component on a 5 point scale - PSI
GRADING PAVEMENT CONDITIONS

Pavement Distress Index – PDI

- Deduct value for each distress – DV
  \[ DV = 10^{(a+b \times \log_{10}(PDA))} \]
  
  \( PDA = \text{Percent Distressed Area} \)
  \( a = \text{model coefficient} \)
  \( b = \text{model coefficient} \)

- Total Deduct Values – TDV
  \[ TDV = \sum_{i} DV_i \]

- Number of Equivalent Distresses - NED
  \[ NED = \sum_{i} \frac{DV_i}{DV_{\text{max}}} = \frac{TDV}{DV_{\text{max}}} \]

- Adjusted Deduct Value – ADV
  \[ ADV = 10^{(0.0014 - 0.3958 \times \log_{10}(NED) + 0.9565 \times \log_{10}(TDV))} \]

  \[ PDI = 5 - ADV \ (5 = \text{Index Scale}) \]
GRADING PAVEMENT CONDITIONS

Pavement Serviceability Index – PSI

PSI values calculated by HPMA

\[ PSI = 5 \times e^{-0.0040 \times IRI} \]

5 = Index Scale
0.0040 = Local Calibration Factor
IRI = International Roughness Index (in/mi)

Pavement Quality Index - PQI

\[ PQI = PDI^{0.76} \times PSI^{0.20} \]

<table>
<thead>
<tr>
<th>Pavement Condition</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>PQI Range</td>
<td>0.0 – 2.64</td>
<td>2.65 – 3.34</td>
<td>3.35 – 5.0</td>
</tr>
</tbody>
</table>

Reconstruction range 0.0 - 2.4
Rehabilitation range >2.4 - 3.2
Preservation range >3.2 - 5.0
DATA APPLICATIONS

Federal Requirements
- Highway Performance Monitoring System (HPMS)
  - National Highway System
  - HPMS sample sites

SCDOT Applications
- Annual Condition Reports
- Resurfacing Candidate List
- Budget Forecasting
- Asset Forecasting
- Legal Support
- Research (Research and Material Lab, Universities, etc...)
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Primary System
- 46% Poor
- 38% Fair
- 16% Good
QUESTIONS ?