### Automated Pavement Rating – National Practice

2018 NWPMA Fall Conference October 24, 2018

## Organization

- Condition surveys
   Data collection
- Automated surveys
- Highway agency trends with automated data collection
- Data quality



## **Condition Surveys**

- Assess existing condition
- Predict future condition
- Estimate budget needs
- Evaluate budget impacts
- Support asset management
- Project selection
- Treatment selection





### **Data Collection**





### What Do We Collect



#### **Data Collection**

AASHTO / ASTM Standards



Rutting



Faulting



Roughness

- Cross slope
- Radius of curvature
- Grade



### What Do We Collect (continued)

#### LTPP



#### **ASTM**

Designation: D 6433 - 07

#### Standard Practice for **Roads and Parking Lots Pavement Condition Index** Surveys<sup>1</sup>

This standard is isoted under the first designation B fdFD, the reacher interactionly following the designation indicates the year of original adoption or, in the case of reaction, the year of her revision. A number is parameterse indicates the year of her supproved, A supervised perjudy (c) reducts as an obtained design struct the last revision or suppress).

#### 1. Scope

 This practice covers the determination of roads and parking lots pavement condition through visual surveys using the Pavement Condition Index (PCI) method of quantifying pavement condition.

Exercise Contained. 1.2. The PCI for reads and parking lots was developed by the U.S. Army Corps of Engineers (1, 2).<sup>2</sup> It is further verified and adopted by DOD and APWA. 1.3. The values stated in inch-nound units are to be recarded.

1.5 The values stated in incre-point a unit are to ne regardise as the standard. The S1 units given in parentheses are for information only. 1.4 This standard deer no purport to address all of the spfery concerner, if any, associated with its use. It is the exposisibility of the user of this standard to resublicht appro-priate suffyr and health practices and descender the applica-tion of the standard statement of the standard statements. bility of regulatory limitations prior to use. Specific precautionary statements are given in Section 6.

#### 2. Terminology

2.1 Definitions of Terms Specific to This Standard: 2.1.1 additional sample—a sample unit inspected in addition to the random sample units to include nonrepresentative sample units in the determination of the pavement condition. This includes very poor or excellent samples that are not typical of the section and sample units, which contain an unusual distress such as a utility cut. If a sample unit containing an unusual distress is chosen at random it should be counted as an additional sample unit and another random control as an automatic sample unit and automet random sample unit should be chosen. If every sample unit is surveyed, then there are no additional sample units. 2.1.2 *angulat concrets (AC) sarface*—aggregate mixture with an asphalt concret funder. This serve also refers to surfaces.

constructed of coal tars and natural tars for purposes of this practice.

<sup>1</sup> This practice is order the justifiction of ACTM Controllog 117 or Vehicle Provident Systems and is the circum emperativity of Holorensizes 117.4 or Control of the System Vehicle Control Control (1994) and Systems and Systems Operation (1995), Las provident dis a generative for 2002 and 20032-00. The Io/Line accutor is paradiment of the fast of reflexases and excited of The Io/Line accutor is paradiment of the fast of reflexases and excited of The Io/Line accutor is paradiment of the fast of reflexases and excited of The Io/Line accutor is paradiment of the fast of reflexases and excited of The Io/Line accutor is paradiment of the fast of reflexases and excited of The Io/Line accutor is paradiment of the fast of reflexases and excited of The Io/Line accutor is paradiment of the fast of reflexases and excited of The Io/Line accutor is paradiment of the fast of reflexases and excited of The Io/Line accutor is fast of the Io/Line Io/

Constituti & ASTM International, 100 Day Histor Drive, PO Day C200, Wast Constructional M, 10405-2009, United States

#### 2.1.3 provement branch-a branch is an identifiable part of the pavement network that is a single entity and has a distinct function. For example, each roadway or parking area is a separate branch. 2.1.4 powenest condition index (PCI)—a numerical rating of the pavement condition that ranges from 0 to 100 with 0

being the worst possible condition and 100 being the best possible condition 2.1.5 pavement condition rating—a vertal description of pavement condition as a function of the PCI value that varies

from "failed" to "excellent" as shown in Fig. 1 2.1.6 provement distance—external indicators of provement distribution caused by leading, environmental factors, con-struction deficiencies, or a combination thereof. Typical distreases are cracks, ruting, and weathering of the pavement surface. Distress types and severity levels detailed in Appendix XI for AC, and Appendix X2 for PCC pavements must be used

to obtain an accurate PCI value. 2.1.7 provement server a subdivision of a pavement section that has a standard size range: 20 contiguous slabs ( $\pm$ 3 slabs if the total number of slabs in the section is not evenly divided by 20 or to accommodate specific field condition) for PCC pavement, and 2500 contiguous square feet,  $\pm$  1000 ff<sup>2</sup> (225  $\pm$  90 m<sup>2</sup>), if the pavement is not evenly divided by 2500 or to accommodate specific field condition, for AC pavement. 2.1.8 pavement section - a contiguous pavement area having uniform construction, maintenance, usage history, and condition. A section should have the same traffic volume and load intensity.

2.1.9 portland cement concrete (PCC) movement 2.1.9 jornama content concerte (PCC) parameter - agregate muture with portical content bundler including nonreinforced and reinforced jointed provement.
2.1.10 random sample—a sample unit of the pavement section selected for inspection by random sampling techniques, such as a random number table or systematic random precedure.

3.1 The rayament is divided into branches that are divided into sections. Each section is divided into sample units. The type and severity of pavement distress is assessed by visual

#### NWPMA/WSDOT

#### **Pavement Surface Condition** RATING



Sponsored by: Northwest Technology Transfer Center Local Programs Division Washington State Department of Transportation



### **Automated Data Collection**



## 2D Systems

- Area or line-scan camera
  - Captures laser beam reflection
  - Software generates surface image
- Surface distress determined by:
  - Human rater
     viewing
     images or
  - Analysis
     software

**IE** 





## 3D Systems

- High resolution 2D and 3D continuous profile
- Software & algorithms to detect:
  - Cracking (>1mm)
  - Raveling
  - Potholes





### **3D** Systems (continued)





Source: Pavemetrics Systems, Inc.

### 3D Systems (continued)

#### 2D Intensity Data (reflected light)



#### 3D Range Data (height)





Source: F. Li (Georgia Tech)

### **3D** Systems (continued)

#### **3D Laser Image**



#### Automated Crack Detection





Source: Dynatest, Inc.

## How good is 3D?

- Need precise and clear distress definitions
- Algorithm accuracy is critical
- Compare to manual surveys
  - Laurent et al. (2014) evaluated 6,200
     mi, 96% good agreement in crack type, multiple runs very repeatable
  - TxDOT (2014) evaluated 20 different sections, similar distress values



### Example of Results



Source: Minnesota DOT

# Advantages/Disadvantages

### Advantages

- Safety
- Accuracy for certain distresses
- Faster data collection and processing
- Track distress over time
- Asset data collection

### Disadvantages

- Link to historical manual distress data
- Changing technology
- Higher cost
- Potential vendor variability
- May required modification to distress manual, decision trees, models, etc.



### Trends in Automated Data Collection (2018 survey)



### Collection/Analysis Methods





### Who does what?





### What's collected?

#### Asphalt Pavements



No. of Agencies

### What's collected (continued)?

Jointed Plain Concrete Pavements

CE



No. of Agencies

## Data Quality

- DOTs required to have data quality management plan (FAST Act)
  - Equipment calibration & certification
  - Certification process for manual data collection
  - Quality control
  - Sample, review & check processes
  - Error resolution procedures
  - Data acceptance criteria



### **Process Overview**

Standards		Control Site		Production		Data Processin	g
<ul><li>Equipment</li><li>Rater</li></ul>		<ul> <li>Ground truth</li> <li>Automated</li> <li>Compare for accuracy &amp; repeatability</li> </ul>		<ul> <li>Verification sites</li> <li>Quality control (collection team)</li> </ul>		Acceptance (collection team)	
	Indepen Verificat	ident tion	Agency Accepta	ance	PMS		
	<ul> <li>Samplin</li> <li>Data ch</li> <li>Image</li> </ul>	ng necks quality	<ul> <li>Data ch</li> <li>Image</li> <li>Compa</li> <li>previou</li> </ul>	necks quality ire to is results	<ul> <li>Data los</li> <li>Addition</li> <li>function</li> <li>checks</li> </ul>	ad nal nal	

-

### Standards



# Monitoring Sites

- Control
  - Conducted by agency
  - Establish ground truth
  - Certify, calibrate, verify equipment
  - Rater training and certification
  - Located proximity to central office

- Verification
  - Conducted by agency
  - Spread across network
  - Location known by collection team
  - Can be traversed multiple times during collection
- Blind
  - Same as verification
  - Location unknown to collection team



## **Rater Certification**

- Agency-specific distress definitions
- Training
  - Conducted by agency or vendor
  - Identify and recognize agency distress
- Certification
  - Must be done by agency



# Quality Control (examples)

- Equipment calibration & certification
  - Profiler
  - Distance measuring instrument
  - Linear referencing system
- Location
  - Match agency

- Data completeness
  - Length
  - Number of sections
  - Blank or null values
- Distress/condition
  - Expected range
  - Pavement type
- Images
  - Quality
  - Confirm distress



# **QC Detail Examples**

- Profiler
  - Repeatability ± 5% (three runs)
  - Accuracy ± 10% of agency value
  - Bound test ≤8in/mi
  - Block check  $\pm 0.1$ in
- Imagery focus, color, luminance quality

- Location  $\leq$  30 ft
- IRI (3 runs):
  - Std  $\leq$  0.06 in/mi and
  - $\pm 0.06$  in. agency
- Rut (3 runs):
  - <sup>-</sup> Std  $\leq$  0.06 in. and
  - $\pm 0.06$  in agency
- Fault (multiple runs and historical avg):

- Std  $\leq 15\%$ 



### *Example of Control, Verification, and Blind Site Requirements*

Condition	Criteria	(3 runs)
-----------	----------	----------

- IRI Std ± 5% Class 1 profiler
- Rutting Std ± 0.06 in Class 1 profiler
- Faulting Std ± 0.06 in manual survey
- Distress ± 10% manual survey



- ≤ 10 images/mi or ≤ 2 consecutive images/mi with poor quality
- 1/8 in. wide cracks are visible







### Example of Acceptance Requirements

- 100% data & image completeness
- Conduct field verification (5-10% sample)
  - Verify images & results
  - IRI: >95%  $\pm$  10% agency value
  - Rut: >95%  $\pm$  0.06 in. agency value
  - Fault: >95%  $\pm$  0.06 in. agency value
  - Cracking >85% ± 10% agency value



# Example of Acceptance Requirements (continued)

- Location: >95% ± 30 ft
- Downward and ROW images > 95% meet criteria
- Confirm 100% data upload to PMS
- Major rehabilitation segment > 85% of segments ± 10% area agency value
- Year-to-year consistency checks



### Example of Corrective Action

Deliverable	Acceptance	Testing	Action
Data	> 98%	Total network miles	Re-collect
completeness	100%	Delivered data accurately populated	Correct
	> 98%	Accurately populated with required data elements	Correct
	> 98%	Delivered data < 10 consecutive fixed missing segments	Correct
IRI, rut depth, & faulting	> 95%	Compliant with the verification testing requirements	Re-collect
Distress ratings	> 95%	Compliant with the verification testing requirements	Re-collect
Location Information	100%	Database check of accuracy and completeness	Correct
Photolog & pavement images	100%	20% random sample compliant with verification requirements	Re-collect

## National Research

- NCHRP Synthesis (Spring 2019)
- NCHRP 1-57A (July 2019)
  - Standard definitions for automated cracking data
- NCHRP 1-60 (December 2021)
  - Calibration, certification, and verification of imaging systems



## National Research (continued)

- FHWA Pooled Fund
  - Improving quality of distress and profile data collection and analysis
    - Standard data format
    - Transverse profile verif/valid/calib protocols
    - Cracking assessment protocols
    - Faulting collection and analysis standards
    - Quality management guide

https://www.pooledfund.org/Details/Study/543



### Summary

### Data Collection

### Data Quality

### Pavement Management















Linda Pierce <u>lpierce@ncenet.com</u> (505) 603-7993

