



Pre-Conference Workshop: Changing Methods in Pavement Data Collection



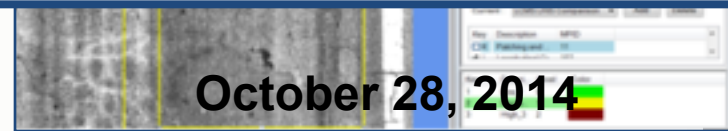
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KKeifer@dynatest.com



2014 NWPMA Conference – Seattle, WA

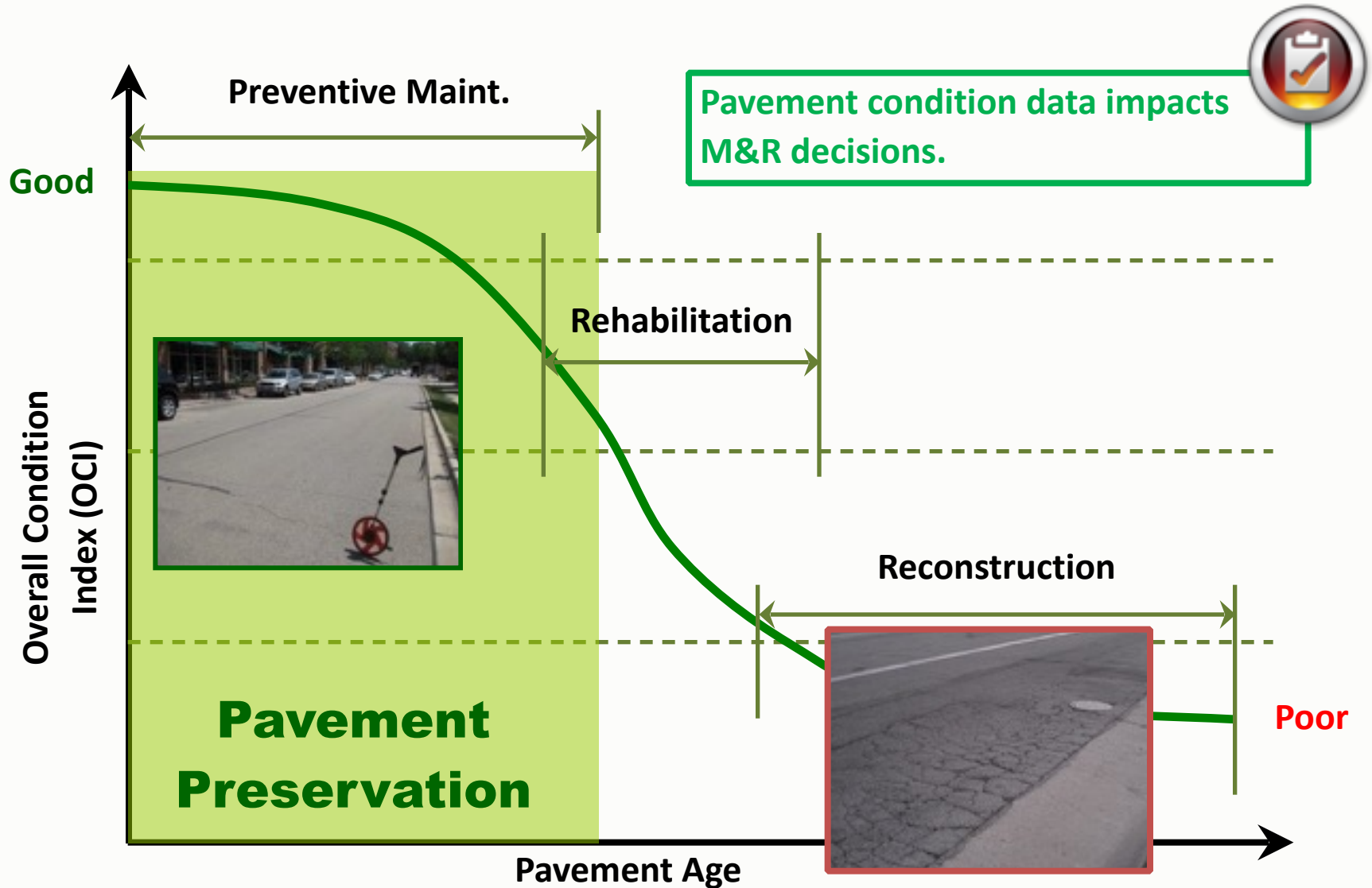


October 28, 2014

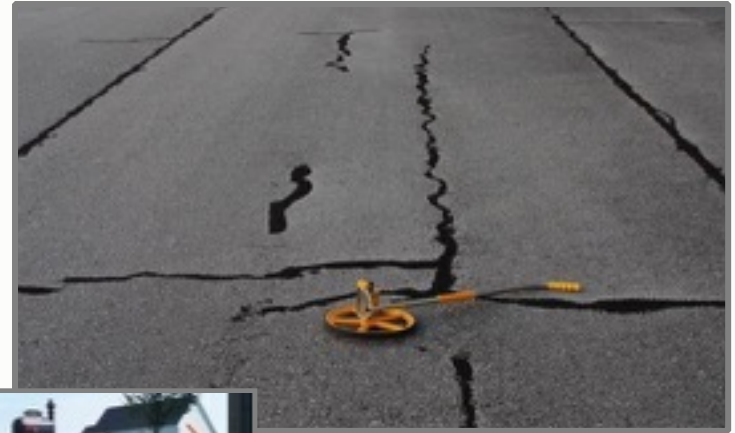
Presentation Outline

- ✓ **Background**
- ✓ **Pavement Condition Index (PCI) Inspections**
- ✓ **Evolution of Pavement Imaging**
- ✓ **2D vs 3D Laser Imaging**
- ✓ **Distress Detection vs Classification**
- ✓ **Automated vs. Manual PCI Inspections**
- ✓ **Benefits and Limitations of Automated PCI Inspections**
- ✓ **Case Study: Cook County**
- ✓ **Questions and Answers**

Proactive Pavement Preservation



Traditional Pavement Inspections



ASTM Pavement Condition Index (PCI)

ASTM D5340-12: Standard Test Method for Airport Pavement Condition Index Surveys

ASTM D6433-11: Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys

Manual surveys only!

 Designation: D5340 - 12

Standard Test Method for Airport Pavement Condition Index Surveys¹

This standard is issued under the fixed designation D5340; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of airport pavement condition through visual surveys of asphalt-surfaced pavements, including porous friction courses, and plain or reinforced jointed portland cement concrete pavements, using the Pavement Condition Index (PCI) method of quantifying pavement condition.

1.2 The PCI for airport pavements was developed by the U.S. Army Corps of Engineers through the funding provided by the U.S. Air Force (1, 2, 3)² It is further verified and adopted by FAA (4), and the U.S. Naval Facilities Engineering Command (5).

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Specific precautionary statements are given in Section 8.

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 any pothole 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 treated as an additional sample unit and another random sample unit should be chosen. If every sample unit is surveyed, then there are no additional sample units.

2.1.2 **asphalt concrete (AC) surface-aggregate mixture with an asphalt cement binder.** This term also refers to surfaces constructed of coal tar and natural tar for purposes of this test method.

2.1.3 **pavement branch**—a branch is an identifiable part of the pavement network that is a single entity and has a distinct function. For example, each runway, taxiway, and apron area are separate branches.

2.1.4 **pavement 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 verbal description of pavement condition as a function of the PCI value. Fig. 1 shows two examples of PCI rating scales.

2.1.6 **pavement distress**—external indicators of pavement deterioration caused by loading, environmental factors, or construction deficiencies, or a combination thereof. Typical distresses are cracks, ruts, raveling, and weathering of the pavement surface. Distress types and severity levels denoted as Appendix X1 for AC and Appendix X2 for FCC pavements must be used to obtain an accurate PCI value.

2.1.7 **pavement sample unit**—a subdivision of a pavement section that has a standard size range: 26 contiguous slabs (± 8 slabs if the total number of slabs in the section is not evenly divided by 26, or to accommodate specific field conditions) for FCC airfield pavement and 5000 contiguous square feet (± 2000 ft² [± 180 m²] if the pavement is not evenly divided by 5000, or to accommodate specific field conditions) for AC airfield pavement and porous friction surfaces.

2.1.8 **pavement section**—a contiguous pavement area having uniform construction, maintenance, usage history, and condition. A section should also have the same traffic volume and load intensity.

2.1.9 **porous friction surface**—open-graded select aggregate mixture with an asphalt cement binder. This is a subset of asphalt concrete pavement.

2.1.10 **portland cement concrete (FCC) pavement**—aggregate mixture with portland cement binder including nonreinforced and reinforced jointed pavement.

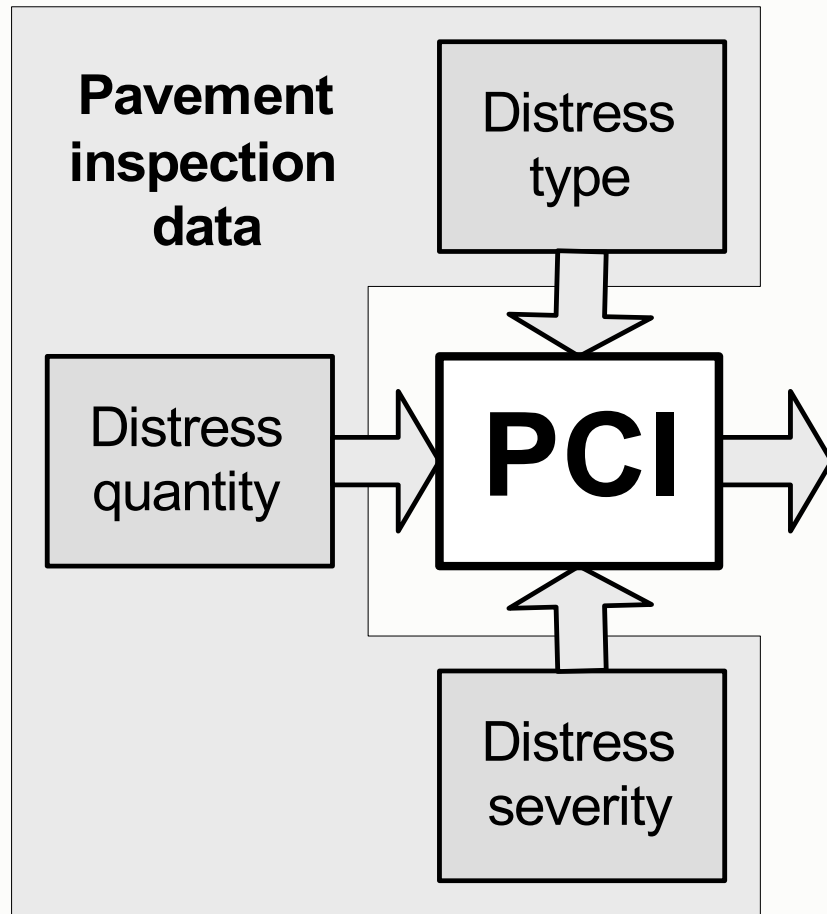
¹ This test method is under the jurisdiction of ASTM Committee E11 on Building Construction Standards and is the direct responsibility of Subcommittee E11.07 on Pavement Management and Data Needs. Current edition approved June 1, 2012. Published May 2012. Originally approved in 1988. Last previous edition approved in 2011 as D5340 - 11. DOI: 10.1520/D5340-12.

² The footnote numbers in parentheses refer to a list of references at the end of the text.

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Pavement Condition Index (PCI)



Pavement Condition Index Rating scale



Evolution of Pavement Imaging



2D Laser Imaging



3D Laser Imaging



Leader in vision systems for the automated inspection of transportation infrastructures.

Pavemetrics technology enables the automatic detection and evaluation of road features to optimize the use of road maintenance funds and to improve safety through better road surface maintenance. Our automated inspection technology is designed for both day and night time operation. It produces high resolution 2D images and 3D profiles of both asphalt and concrete road surfaces at speeds up to 100 km/h.

Contact Us



Laser Crack Measurement System (LCMS)

- Automatic crack detection
- Detection of ravelling
- 4000 point rutting (rut depth, rut width)
- Macro-texture (MPD, digital sand patch) in all 5 AASHTO bands (wheel paths, center lane and lane edges)
- Day and night operation, immunity to shadows
- Low power consumption
- Data compression algorithms to minimize storage



Laser Road Imaging System (LRIS)

- The most important feature of the system is that this optical configuration increases even the smallest crack incident illumination and to cause the cracks to shadows.



Laser Rut Measurement System (LRMS)

- 1 280 point 3D transverse profiles

Current Developers

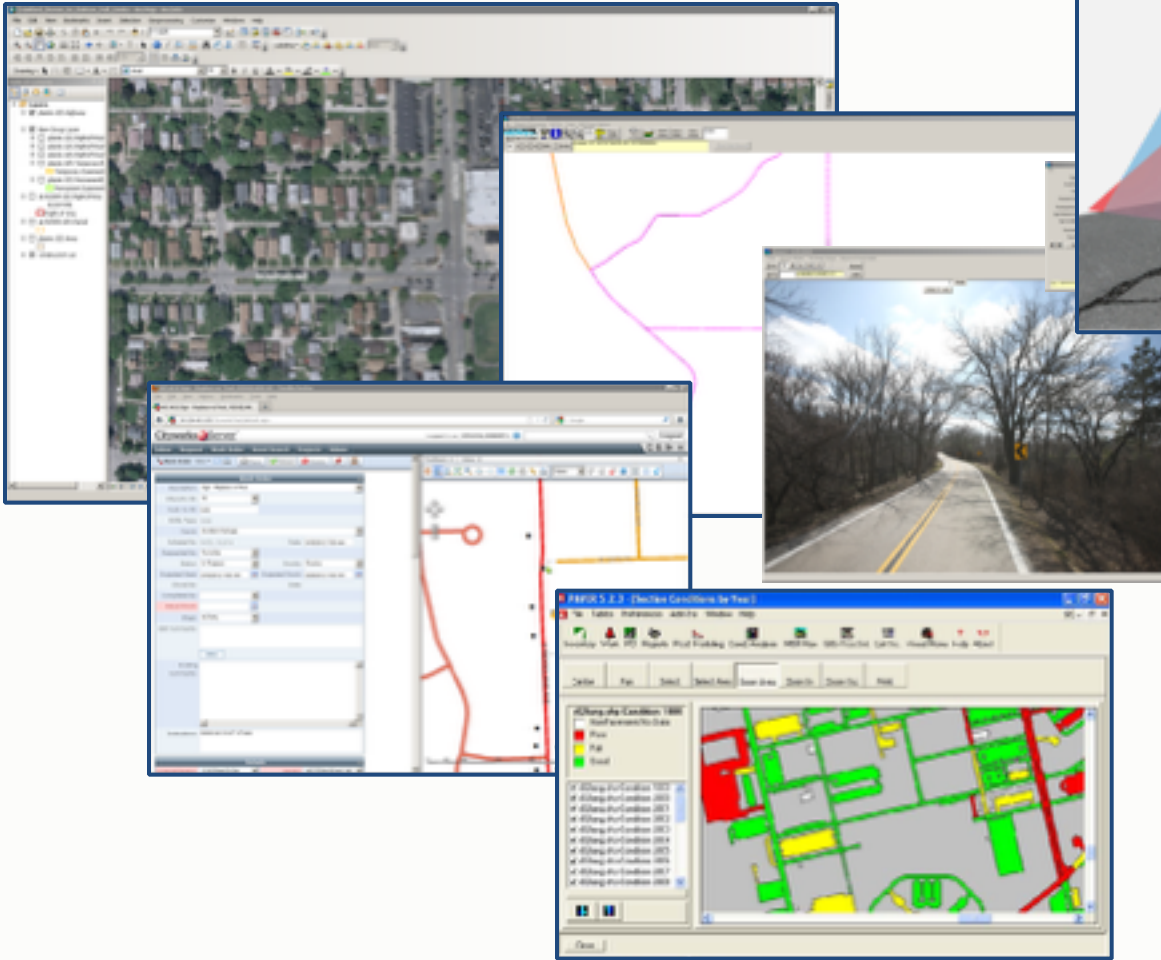
Pavemetrics
Pathway Systems
Waylink Systems
...and others?

- Low power consumption



Technology Infusion

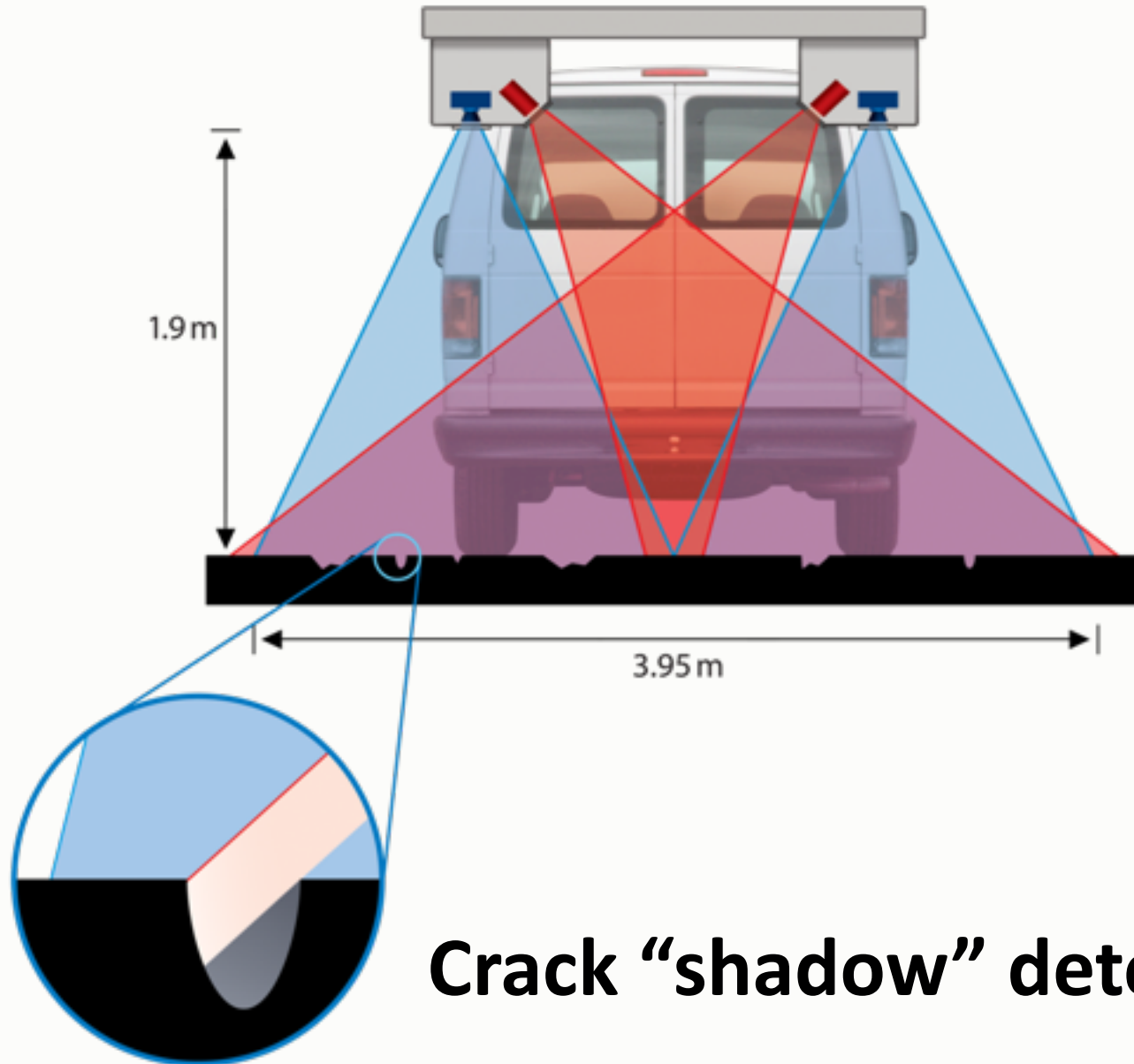
Technology Infusion



2D Laser Imaging System (LRIS)



2D Laser Imaging System (LRIS)

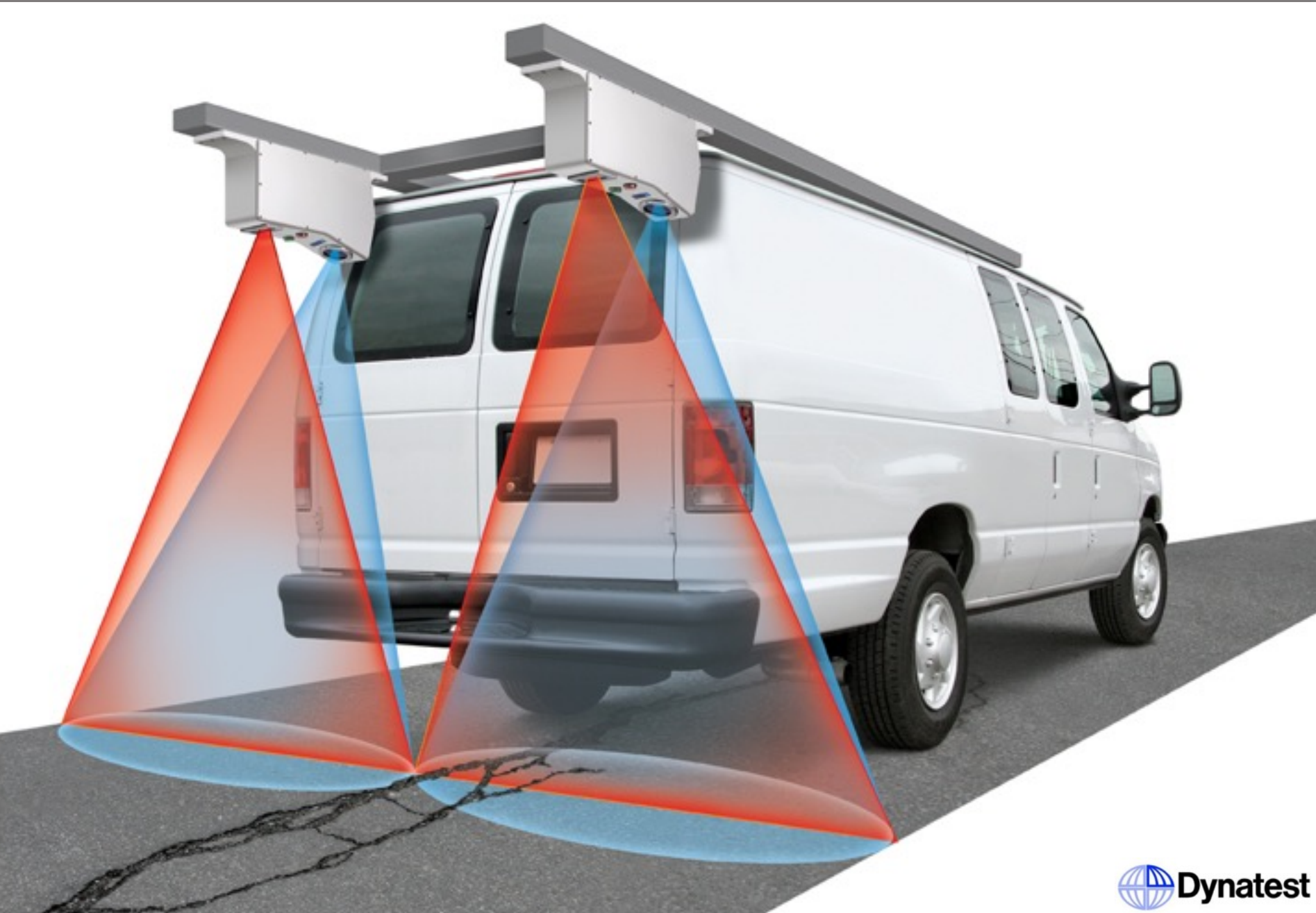


Crack “shadow” detection

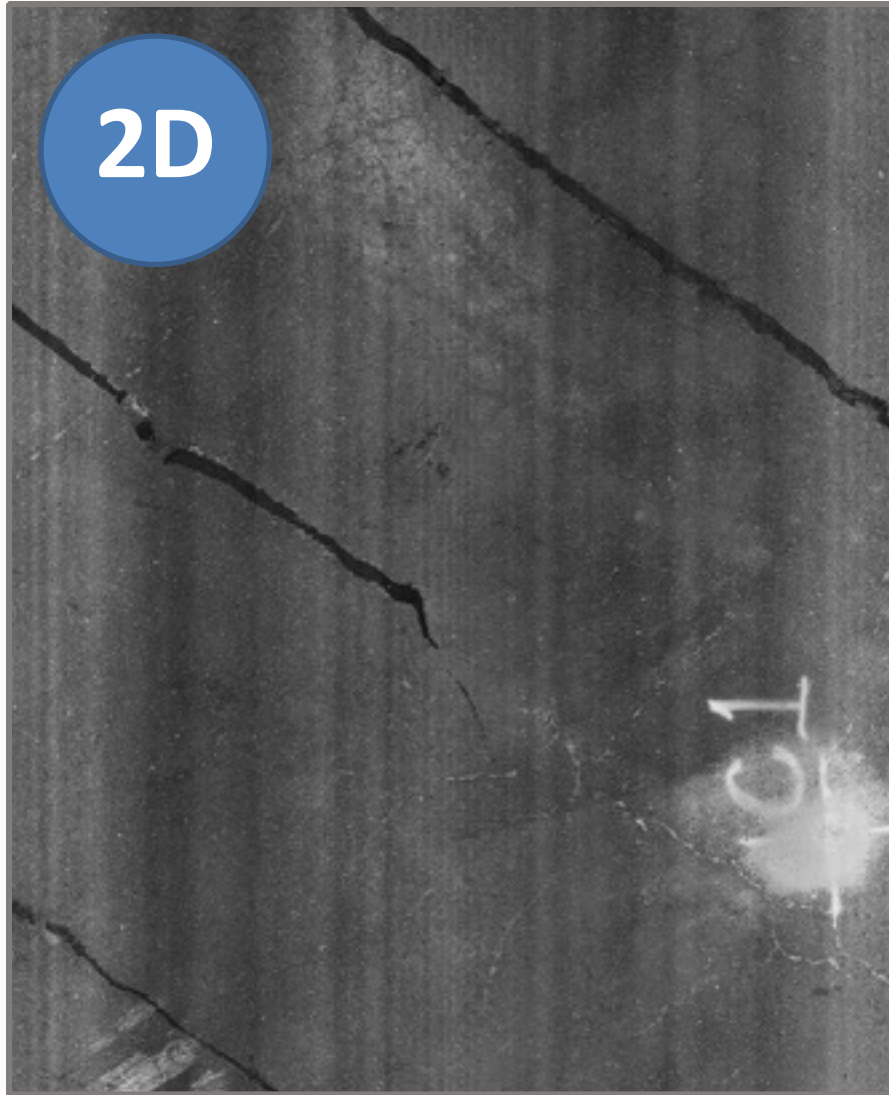
3D Laser Crack Measurement System (LCMS)



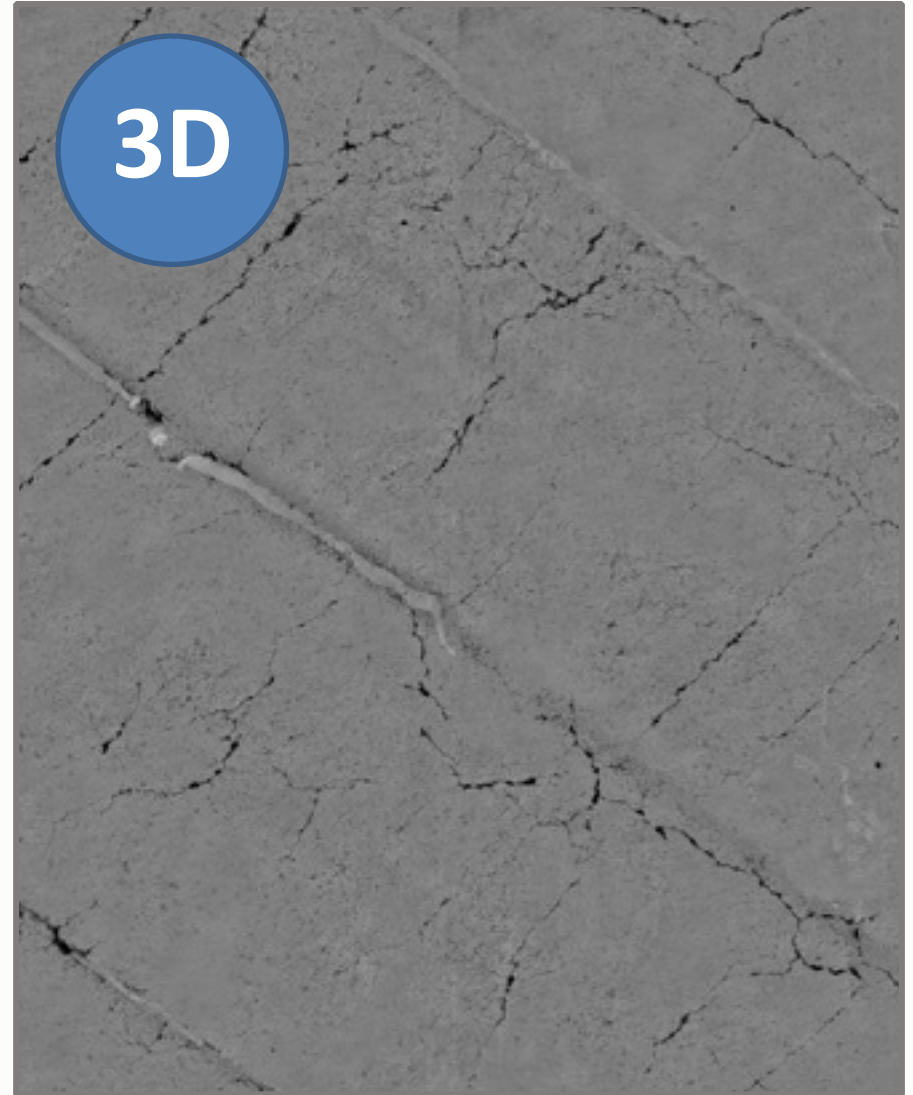
3D Laser Crack Measurement System (LCMS)



Asphalt Pavement



2D Laser "Intensity" Image

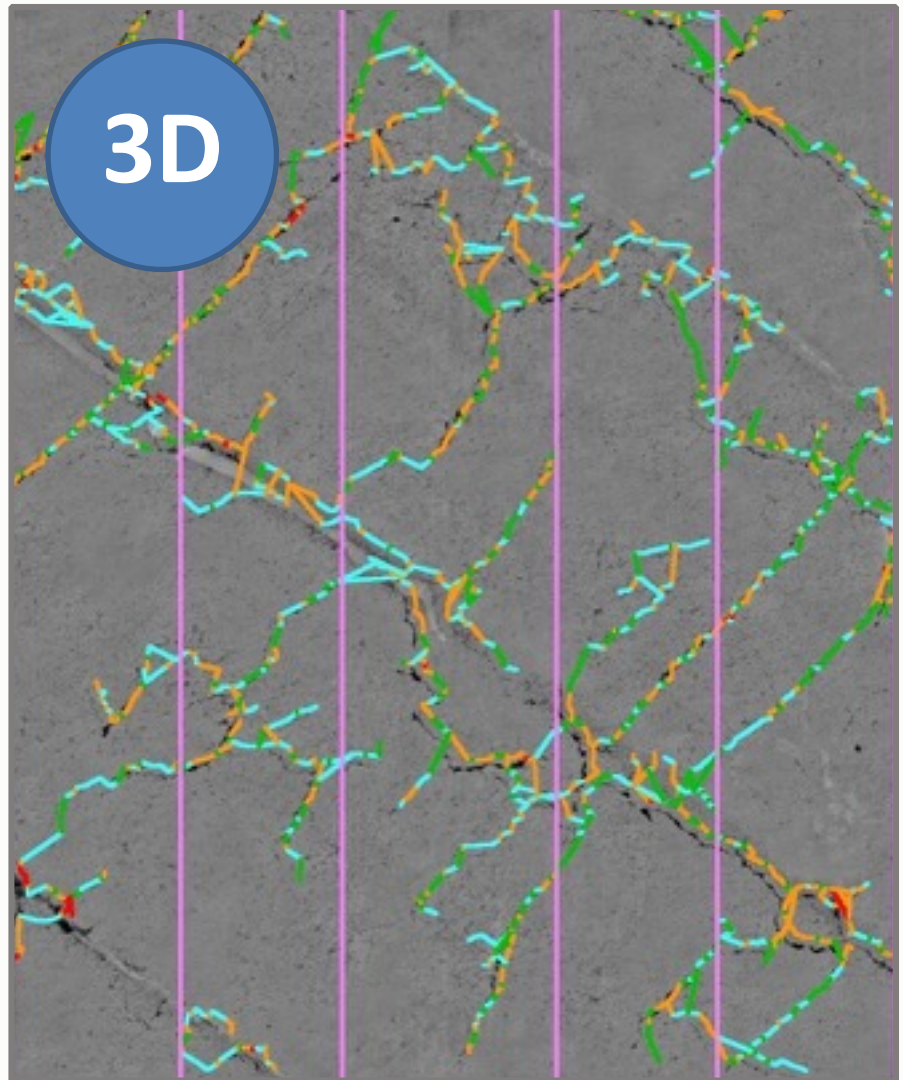


3D Laser "Range" Image

Asphalt Pavement



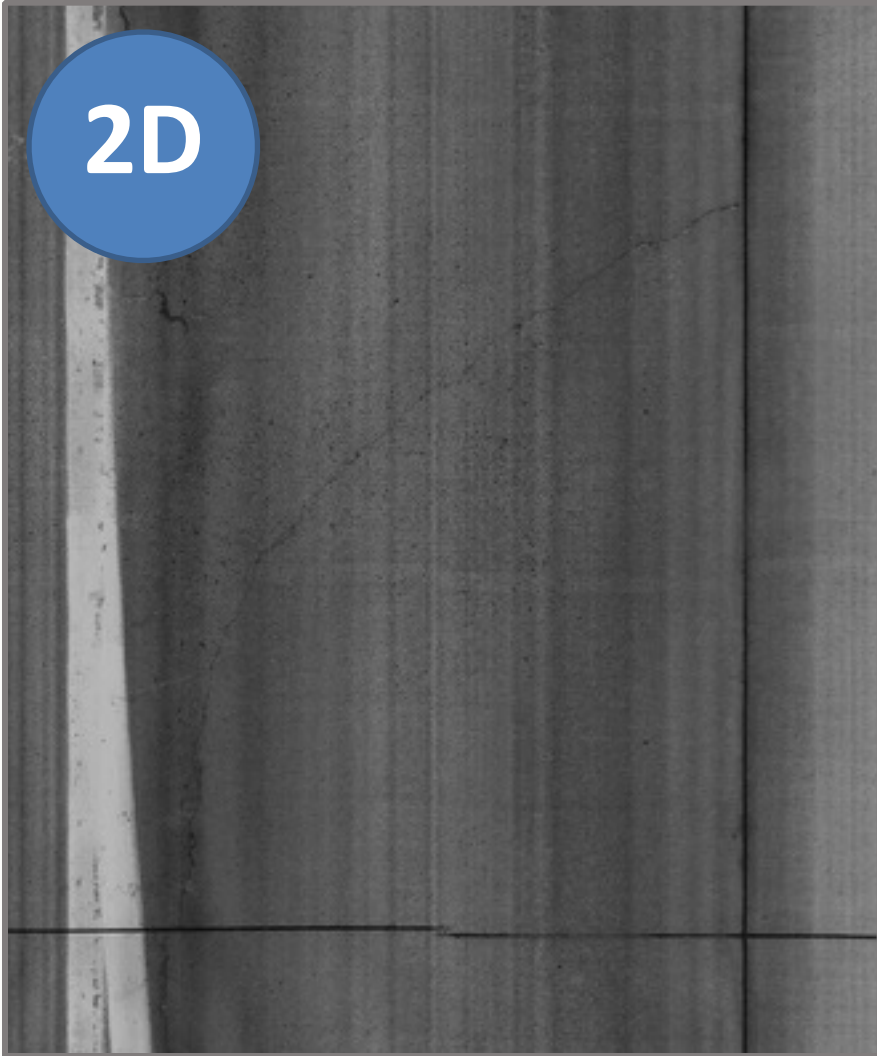
3D Laser "Range" Image



Automated Crack "Detection"

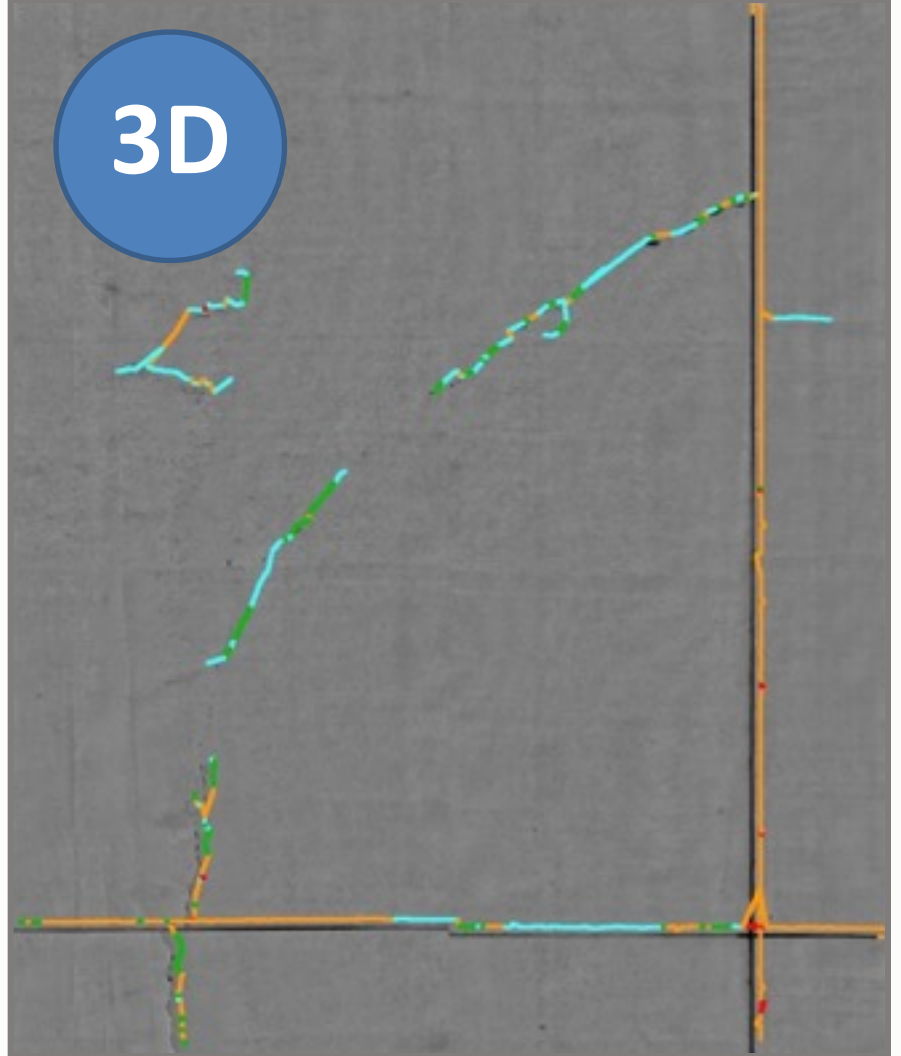
Concrete Pavement

2D



2D Laser "Intensity" Image

3D



3D Laser "Range" Image

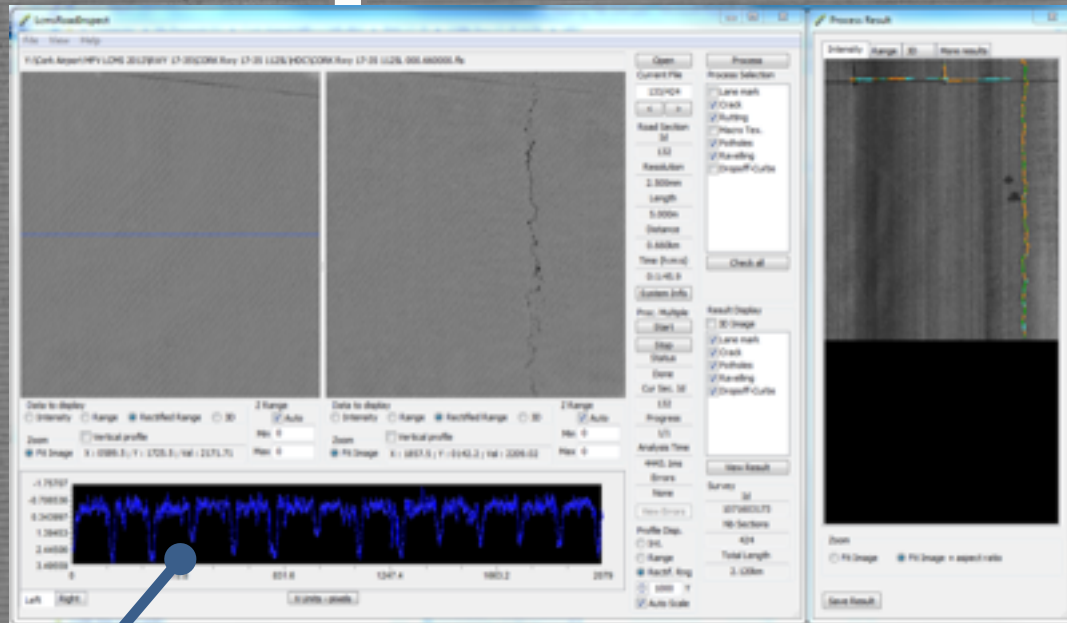
Concrete Pavement– Grooving

3D

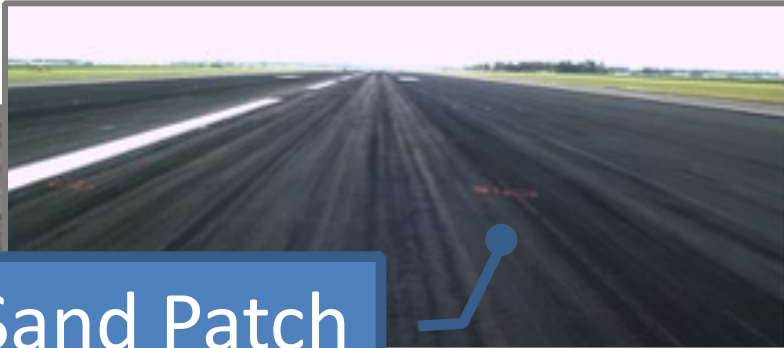
Grooves

3D Laser “Range” Image

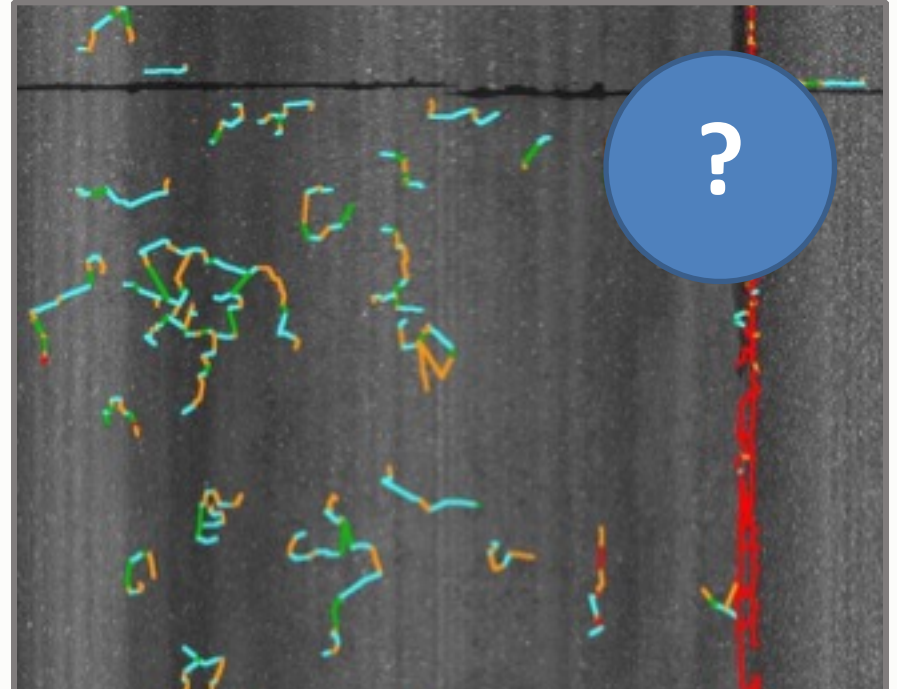
3D Laser “Range” Image



Asphalt Pavement – Raveling



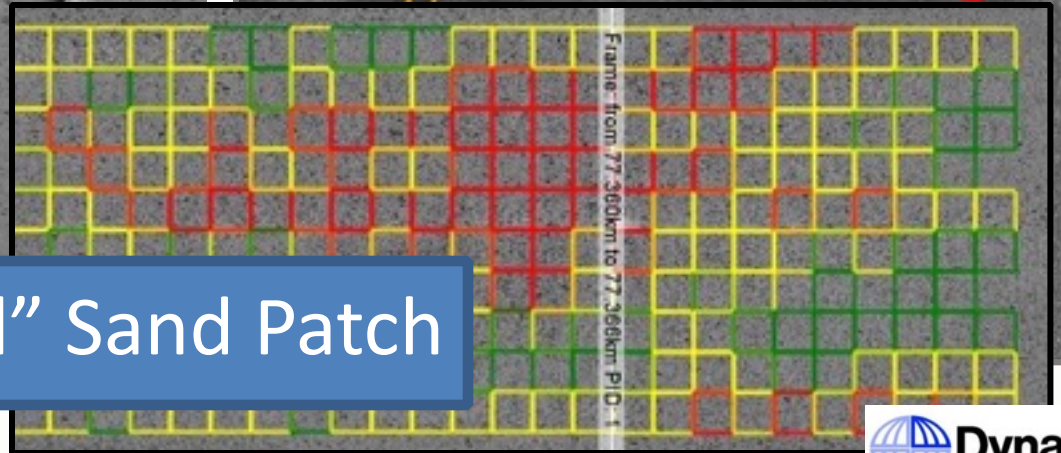
Sand Patch



?

3D

“Digital” Sand Patch



Distress Detection vs. Classification

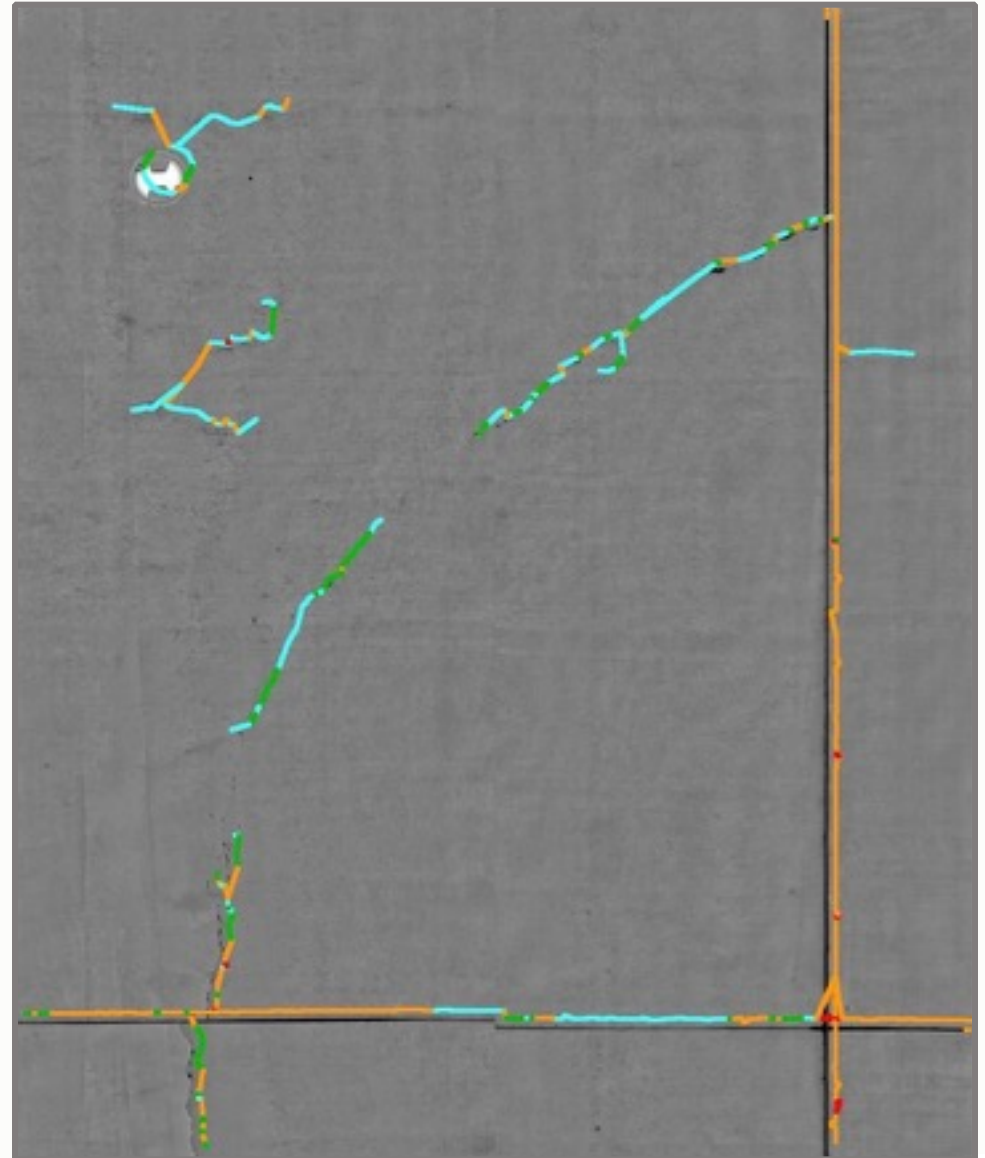
Step 1 Distress Detection

We have detected something!

Step 2 Distress Classification

Now what have we detected?

- Corner Break
- Cracks (Longitudinal, Transverse, and Diagonal)
- Durability (“D”) Cracking
- Joint Seal Damage
- Patching, Small
- Patching, Large and Utility Cuts
- Scaling, Map Cracking, Crazeing
- Shattered Slab/Intersecting Cracks
- Shrinkage Cracks
- Alkali-Silica Reaction (ASR)

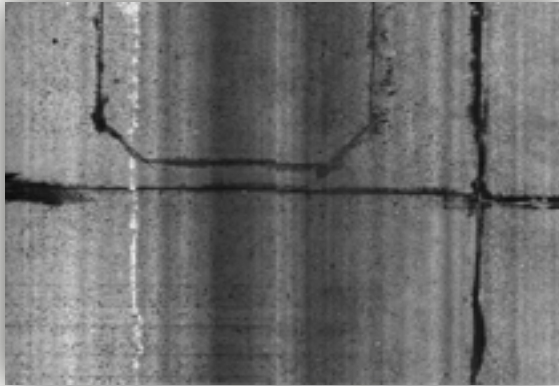


ASTM D6433 Pavement Distresses

 Automated

 Manual + Automated

 Manual



ASPHALT PAVEMENT

Alligator Cracking

Bleeding

Block Cracking

Corrugation

Depression

Edge Cracking

Joint Reflection Cracking

Longitudinal and
Transverse Cracking

Patching and Utility Cut Patching

Potholes

Lane-to-Shoulder Dropoff

Pumping

Polished Aggregate

Raveling

Rutting

Shoving

Slippage cracking

Swell

Weathering

CONCRETE PAVEMENT

Alkali Silica Reaction (ASR)

Blowup/Buckling

Corner Break

Cracks (Longitudinal,
Transverse, and Diagonal)

Durability ("D") Cracking

Joint Seal Damage

Patching, Small

Patching, Large and Utility Cuts

Popouts

Lane-to-Shoulder Dropoff

Polished Aggregate

Pumping

Scaling

Settlement or Faulting

Shattered Slab/Intersecting Cracks

Shrinkage Cracking

Spalling, Longitudinal and Transverse Joint

Spalling, Corner

Dynatest Pavement Condition Survey System (PCSS)

High resolution downward images

High resolution right-of-way (ROW) images

Rutting in both wheelpaths

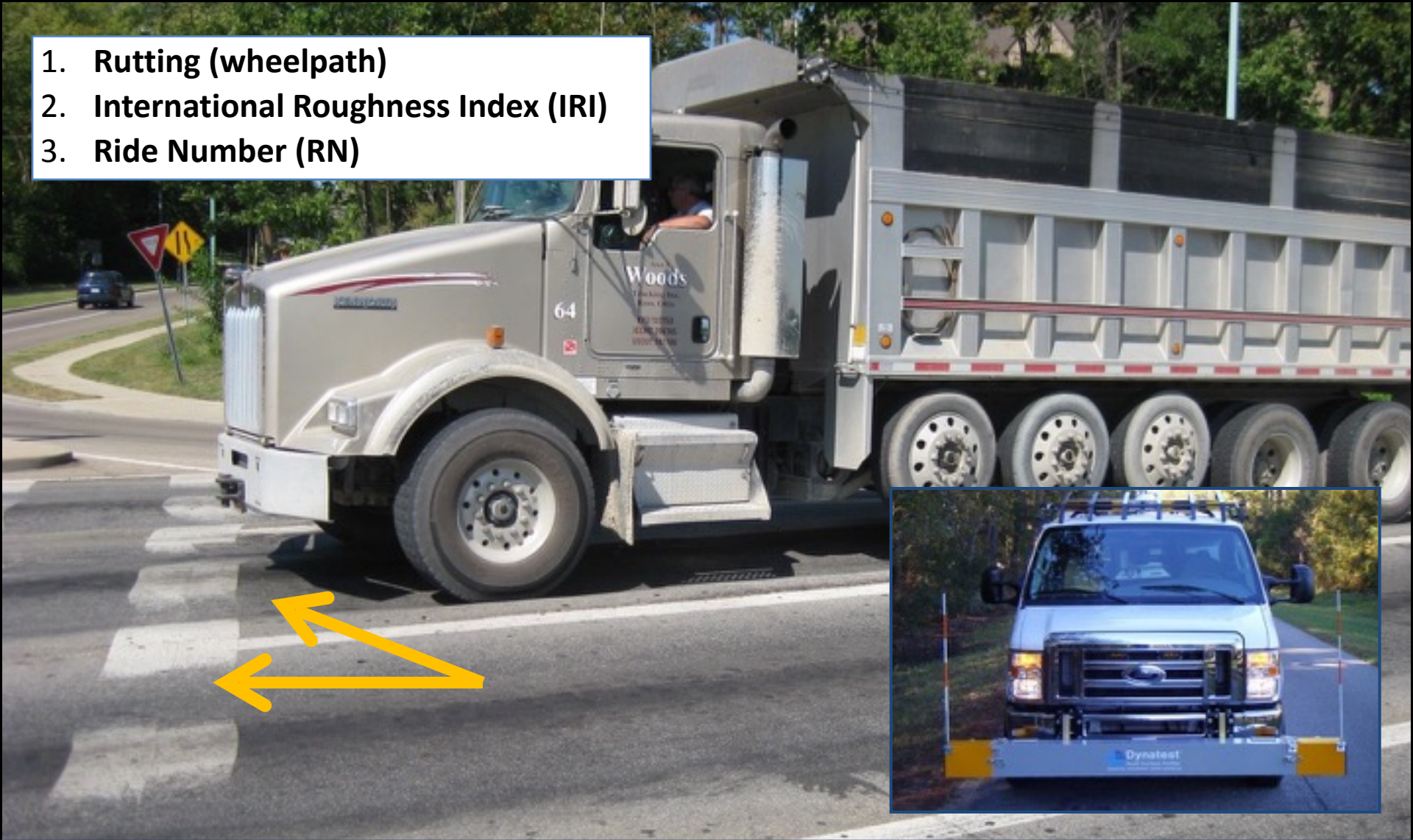
Longitudinal profile in both wheelpaths

International Roughness Index (IRI)

Applanix DGPS receiver and DMI



1. Rutting (wheelpath)
2. International Roughness Index (IRI)
3. Ride Number (RN)



**A PCI survey is not just crack counting.
Inertial profiling is needed as well.**

Benefits

Advantages

1. **Fast** – *minimize impact to operations, collect several lane miles of pavement data in a day*
2. **Comprehensive** – *capture the entire pavement surface and profile!*
3. **Safer** – *fewer bodies on the road, and pavement inspectors not exposed to traffic hazards.*
4. **Day or night survey**
5. **Automated distress detection may aid manual interpretation**
6. **Easier to QC/QA**



7. **Permanent record of pavement condition** – *witness 3D time-series pavement deterioration!*
8. **Geo-referenced Data** – *High accuracy GPS coordinates provide an exact location for each data unit captured*
9. **Quality of Data** – *ROW pictures (daytime)*
10. **Pavement Characteristics** – *Pavement ride quality (IRI) and continuous rutting measurements (Vehicle based system)*
11. **Pavement Geometry** – *Cross slope, radius of curvature and grade.*

Limitations

Limitations

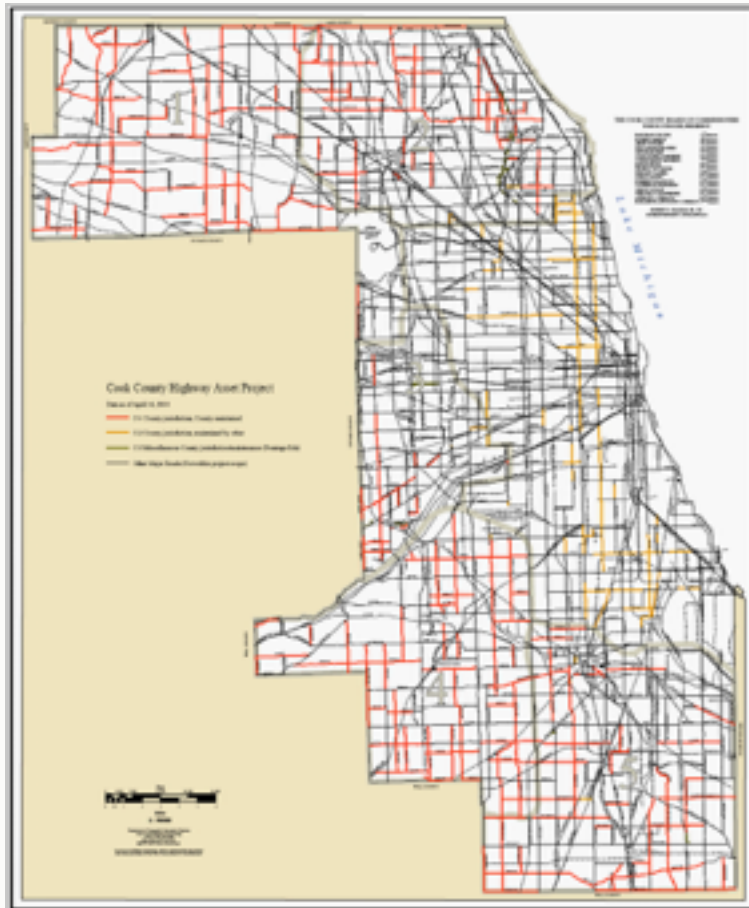
1. **Require manual interpretation of imagery**
2. **Sensitive to weather conditions (rain)**
3. **No forward facing images during night surveys – *only downward!***
4. **Difficult in narrow lanes**
5. **May require nominal investment in server space to warehouse imagery**
6. **May require redefinition of inspection protocol**



Case Study: Cook County

- Pavement Network Definition and Sectioning via GIS
- Pavement Work History Development
- *PAVER Training – Level 1*
- PAVER Database Creation, Customization and GIS linkage
- Automated Pavement Condition Index (PCI) Survey
- Falling Weight Deflectometer (FWD) Testing
- Collaborative QC/QA Program
- *PAVER Training – Level 2*
- *ELMOD Training*
- PAVER Analysis and Reporting
- *PAVER Training – Refresher*

1. Pavement Network Definition



PAVER Hierarchy

- **Network**
- **Branch**
 - Roadway
 - Parking lot
 - Alley
- **Section**
 - “Uniform” lengths/areas of a branch

2. Pavement Work History Development

Maintenance and Rehabilitation Records

- **Major Rehabilitation and Reconstruction (MR&R)**
- **Global Maintenance**
- **Localized Maintenance**

A somewhat painful but ultimately beneficial process!



Training

Level 1 – Pavement management with PAVER

PAVER capabilities

PAVER customization

Pavement Condition Index (PCI)

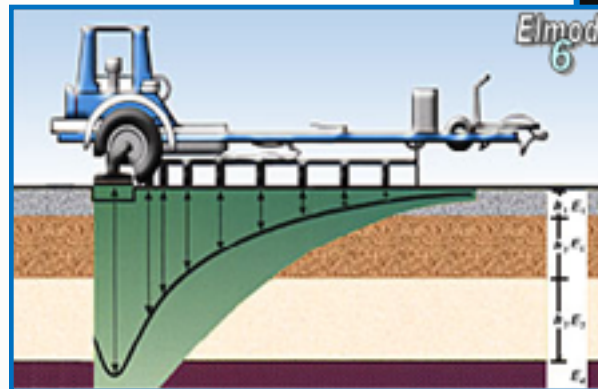
Level 2 – Real-world PAVER

County's database

Analysis and reporting

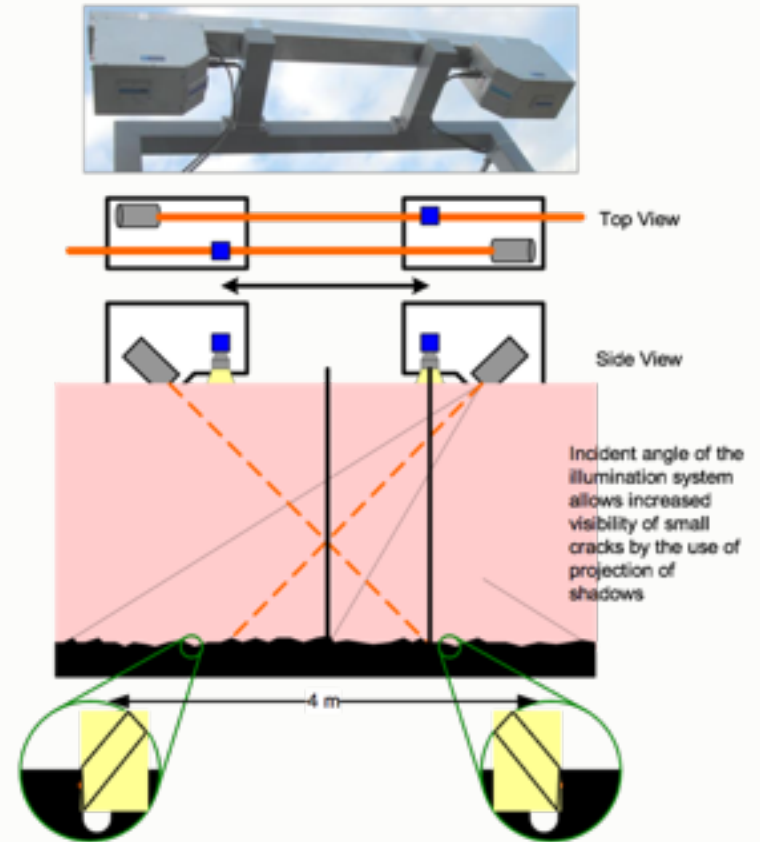
PAVER refresher training

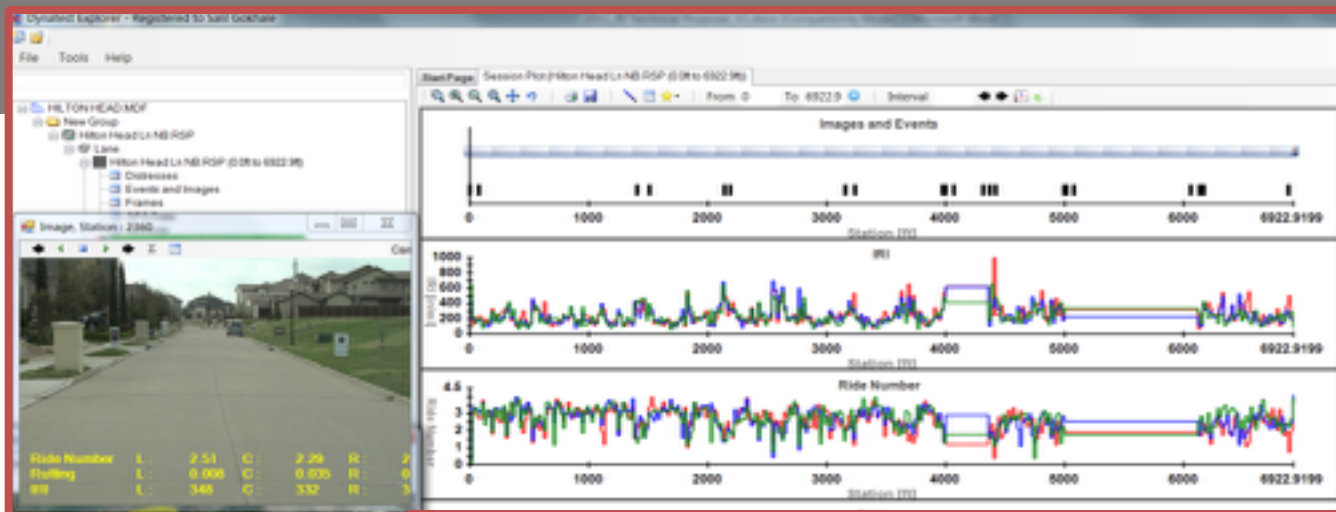
ELMOD Training



Automated PCI Survey

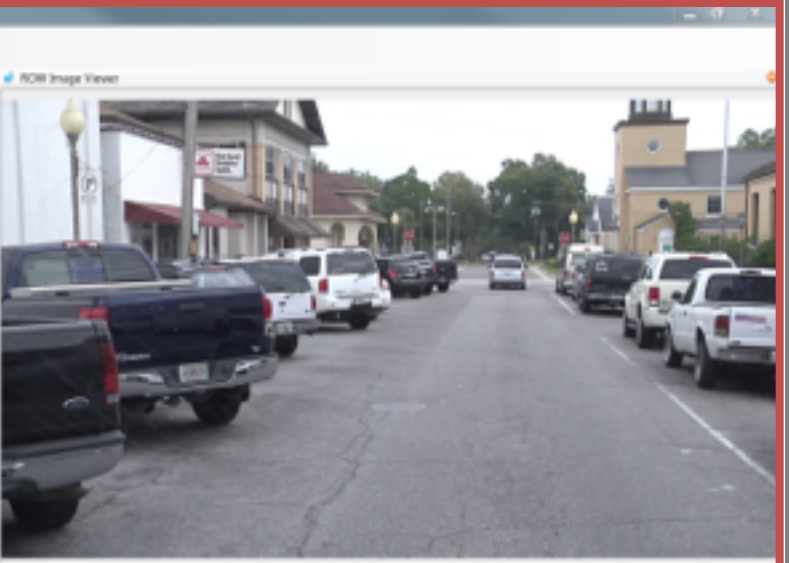
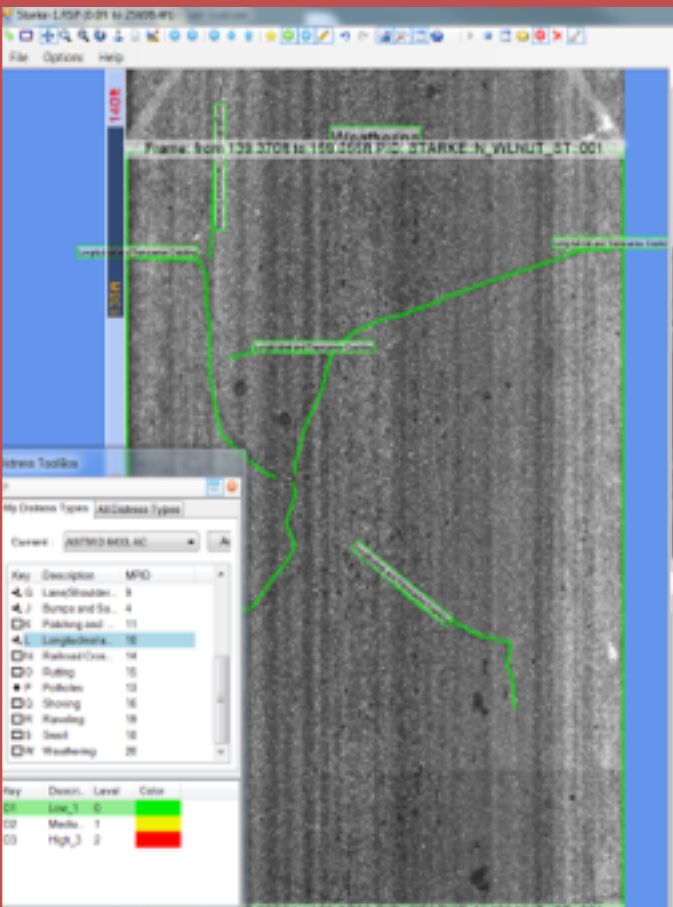
Dynatest Pavement Condition Survey System (PCSS)





Dynatest Explorer (DE)

Distress Rating Module (DRM)



Distress Toolbars

My Distress Types (All Distress Types)

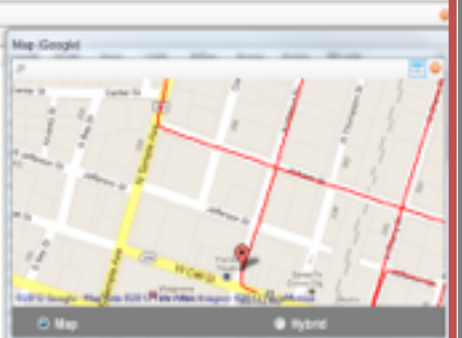
Current: ASTM D 653, AC

Key	Description	MPO
4.0	Lane/Shoulder	9
4.1	Bumps and Seals	4
4.2	Parking and	11
4.3	Longitudinal	16
4.4	Shoulder	14
4.5	Subgrade	15
4.6	Problems	13
4.7	Shoving	16
4.8	Raveling	18
4.9	Seal	18
4.10	Weathering	20

Key	Descn	Level	Color
0F	Like_1	0	Green
0P	Medic	1	Yellow
0S	High_2	2	Red

Summary Tables

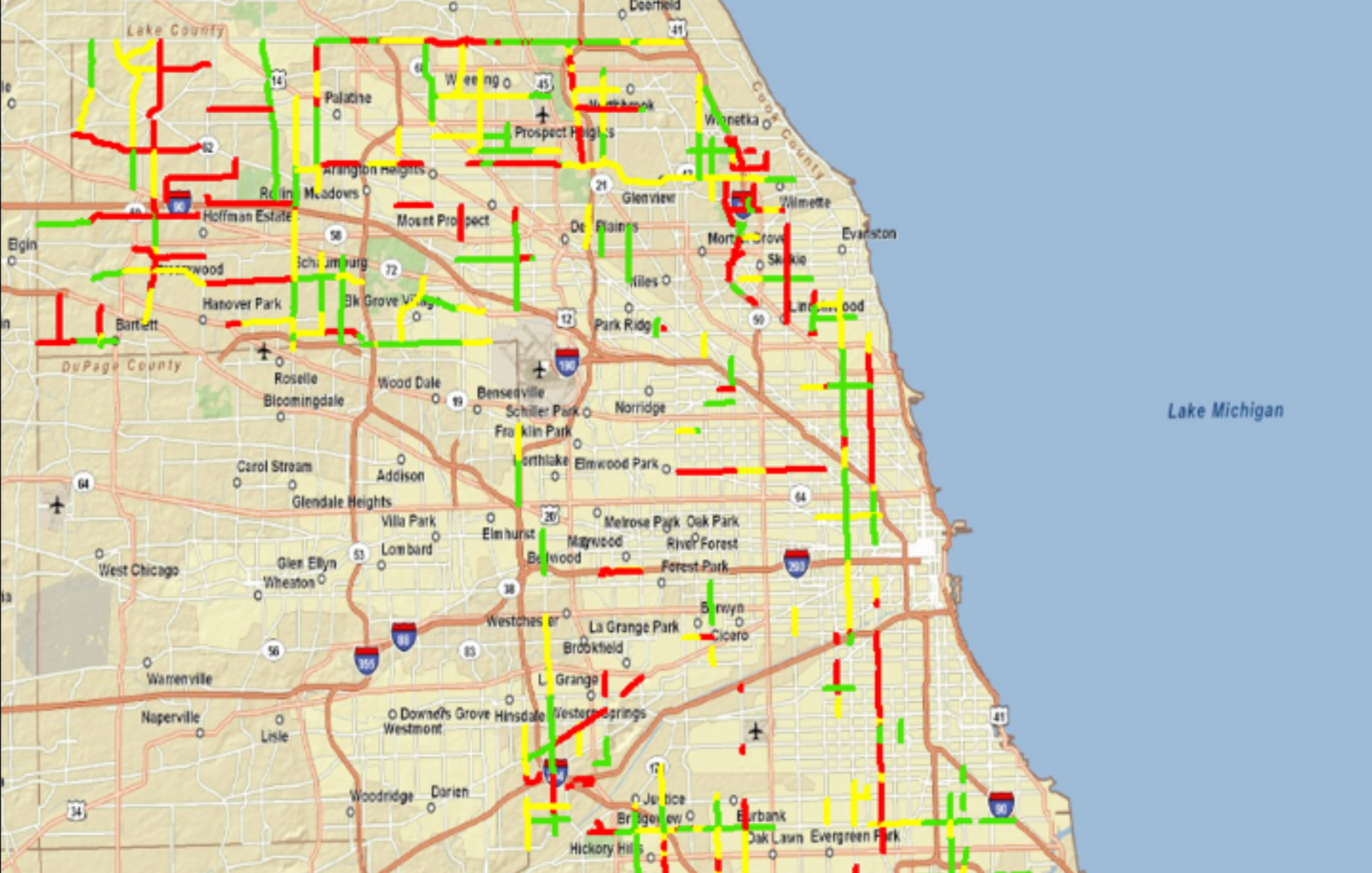
General	Distress	Frame	Section	
Section ID	From	To St.	From	PD
STANCO_N_WLNUT_ST_001	133.3708	260.000	29.944	STAN
STANCO_N_WLNUT_ST_002	260.000	420.000	29.945	STAN
STANCO_N_WLNUT_ST_003	420.000	439.999	17.918	STAN
STANCO_N_WLNUT_ST_004	1779.0	3310.0	29.945	STAD
STANCO_N_WLNUT_ST_005	3310.0	3600.0	29.945	STAN
CONTRACTE	2000.0	2140.0	29.950	CONIT
STANCO_N_CHRYV_ST_006	3148.0	3620.0	29.949	STAN
STANCO_N_CHRYV_ST_007	3620.0	3840.0	29.945	STAN
STANCO_N_CHRYV_ST_008	3840.0	4110.0	29.946	STAN
STANCO_N_CHRYV_ST_009	4110.0	4380.0	29.944	STAD
STANCO_N_CHRYV_ST_010	4380.0	4650.0	29.943	CONIT
STANCO_N_CHRYV_ST_011	4650.0	4920.0	29.943	STAN
STANCO_N_CHRYV_ST_012	4920.0	5190.0	29.944	STAN
STANCO_N_CHRYV_ST_013	5190.0	5460.0	29.945	STAD
STANCO_N_CHRYV_ST_014	5460.0	5730.0	29.946	STAN
STANCO_N_CHRYV_ST_015	5730.0	6000.0	29.946	STAD
STANCO_N_CHRYV_ST_016	6000.0	6270.0	29.945	STAN



Trained, Experienced PCI Inspectors

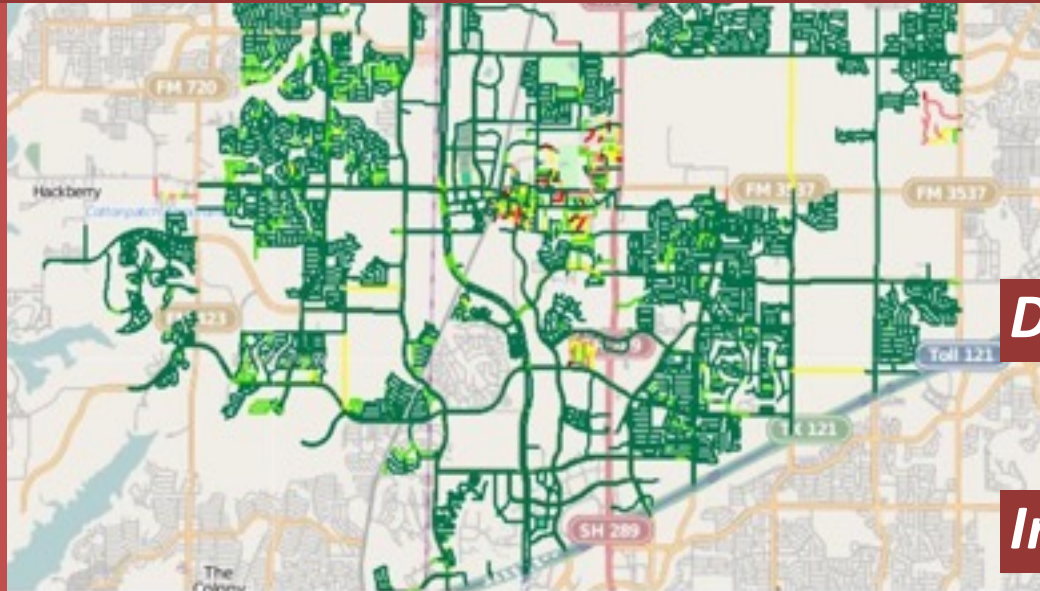
Excellent "In the Field" or "In the Office"



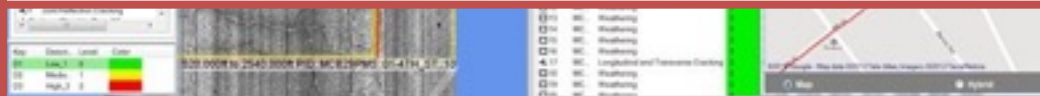


PAVER in GIS

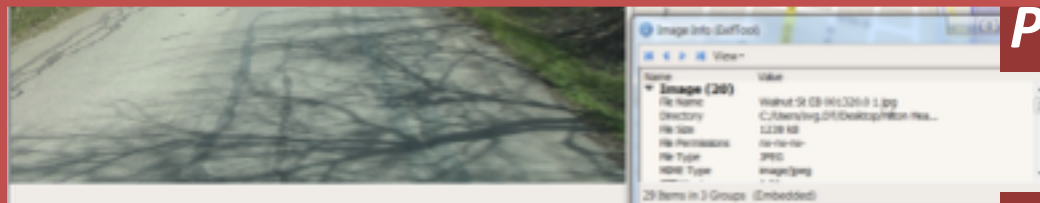
Pavement Condition



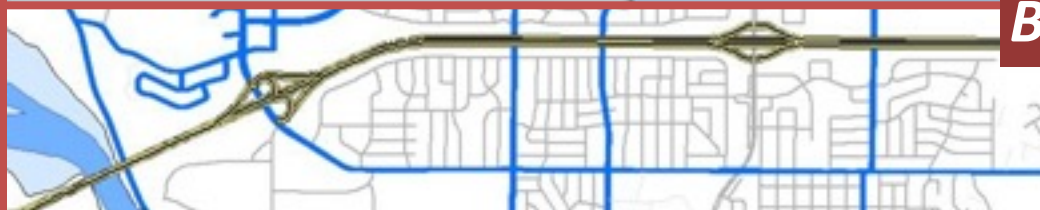
Distresses



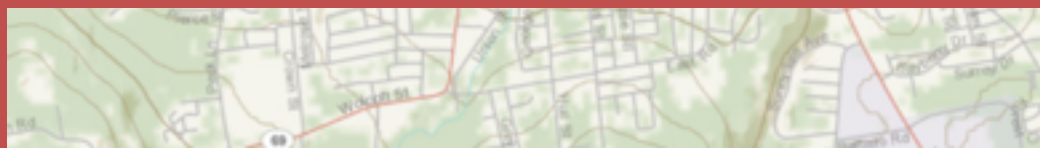
Images

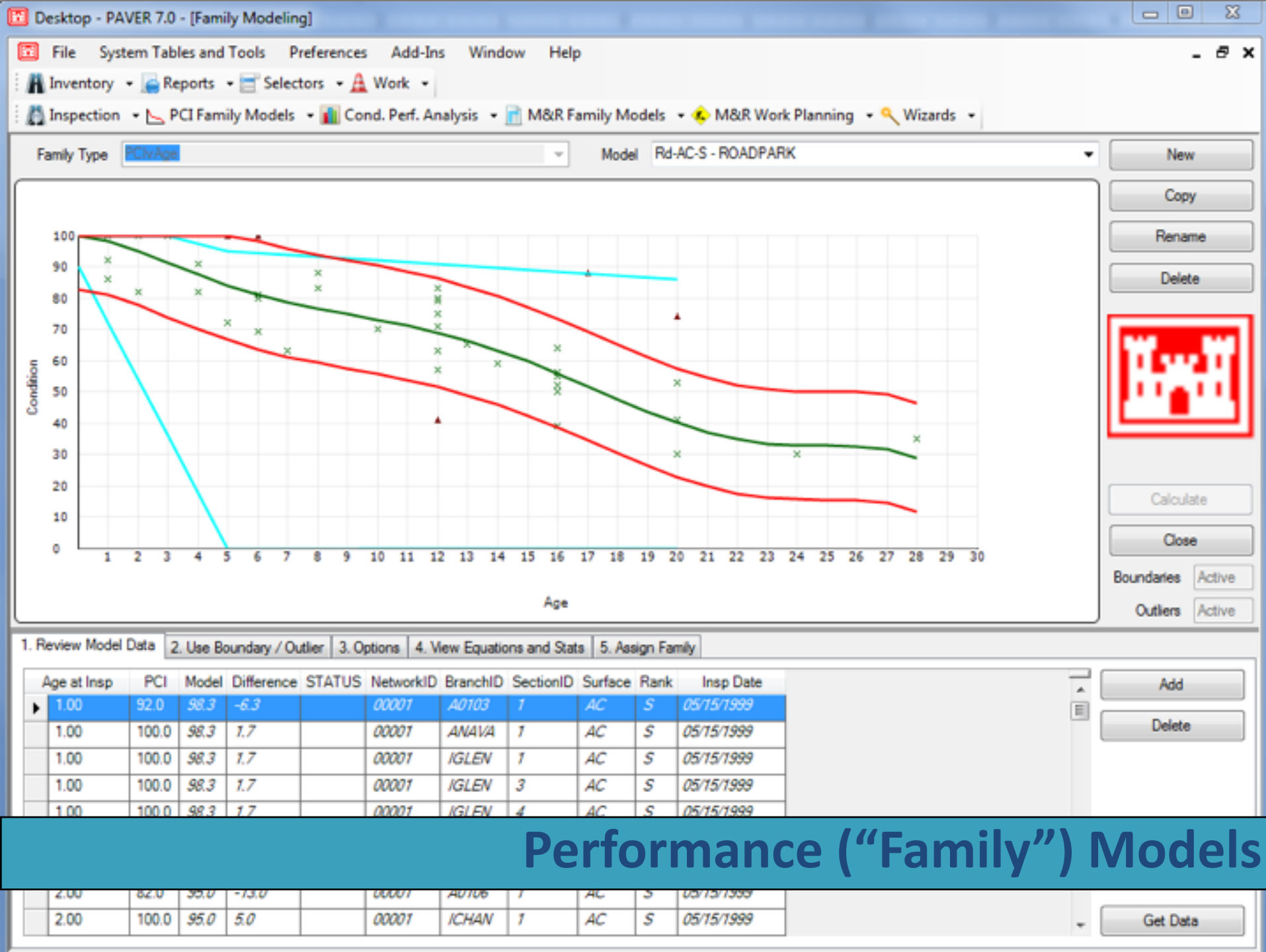


Profile Data



Base GIS





Condition Reporting

Performance Models

PAVER is a tool that must be maintained

Work history

Performance models – *Improve with multiple PCI inspections, but must be updated...*

Current condition reports – *Require updated PCI data...*

Price data and funding sources

Must be identified and included in analyses...

Predicting Repairs and Allocating Funding Sources

Construction and maintenance History

7. Project QC/QA Tasks

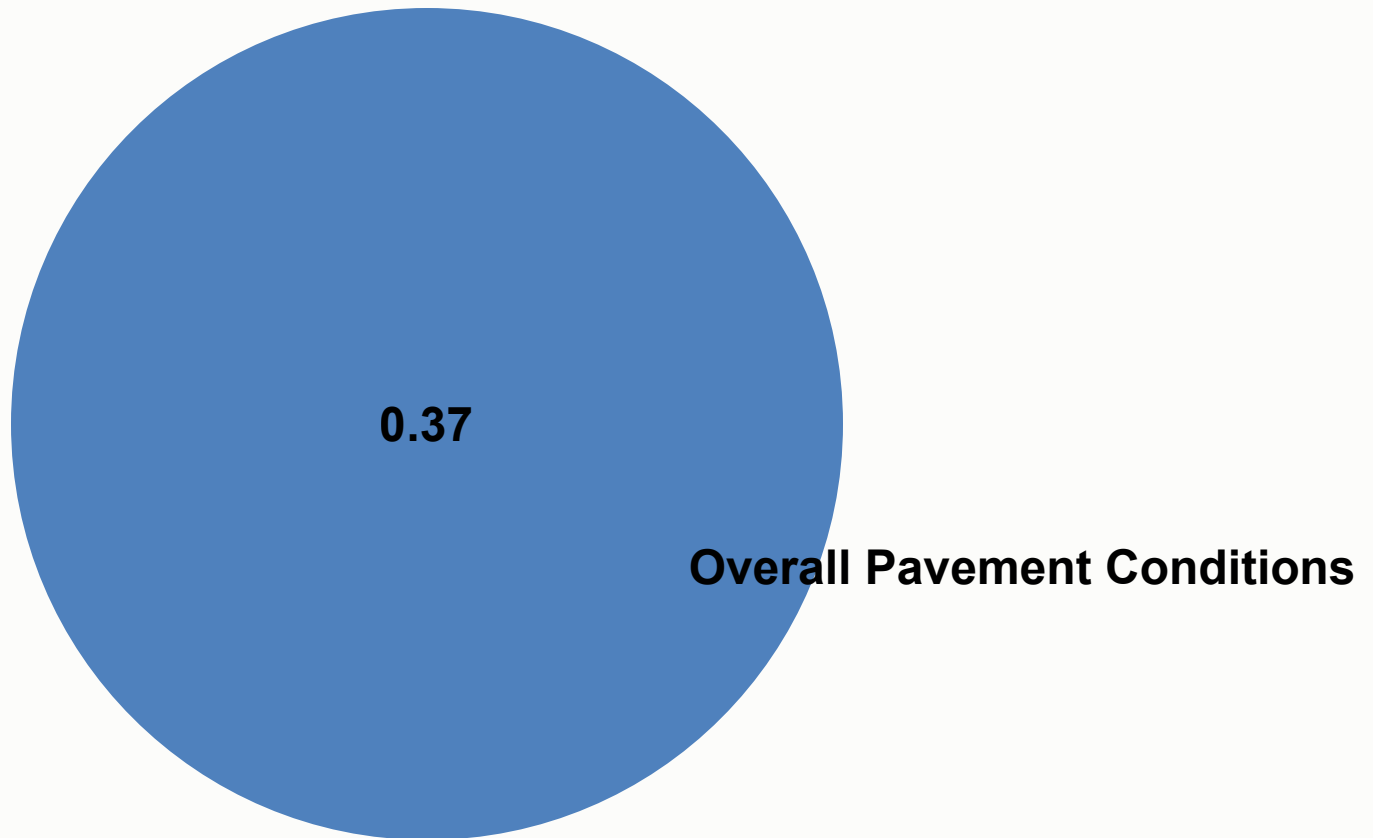


	Responsible Parties		
<i>Data Element(s)</i>	<i>Quality Control</i>	<i>Quality Assurance</i>	<i>Description of Check (Standard Practice)</i>
<i>Pavement Inventory Definition and Database Integrity</i>	<i>Dynatest Team Project Engineers</i>	<i>Dynatest Project Manager and County Staff – Before and after the automated PCI survey</i>	<i>Verify pavement section attribute data were collected and entered into PAVER prior to and after survey.</i>
<i>GIS Sectioning</i>	<i>Dynatest Team Project Engineers</i>	<i>Dynatest Project Manager and County Staff – Before and after the automated PCI survey</i>	<i>Verify pavement sections were correctly defined in GIS and properly linked to the pavement management database.</i>
<i>Automated PCI Inspection Data Collection</i>	<i>Dynatest Project Engineers and Technicians</i>	<i>Dynatest Project Manager (in the field)</i>	<i>Daily checks and calibration of vehicle instrumentation – GPS, DMI, RSP, and image collection hardware and software.</i>
<i>Automated PCI Inspection Data Interpretation</i>	<i>Dynatest Project Engineers and Technicians</i>	<i>Dynatest Project Manager and County Staff (in the field/office)</i>	<i>Verify accuracy of processed data during and following data interpretation.</i>
<i>Analysis and Reporting</i>	<i>Dynatest Project Engineers</i>	<i>Dynatest Project Manager and County Staff</i>	<i>Verify accuracy of analyses.</i>

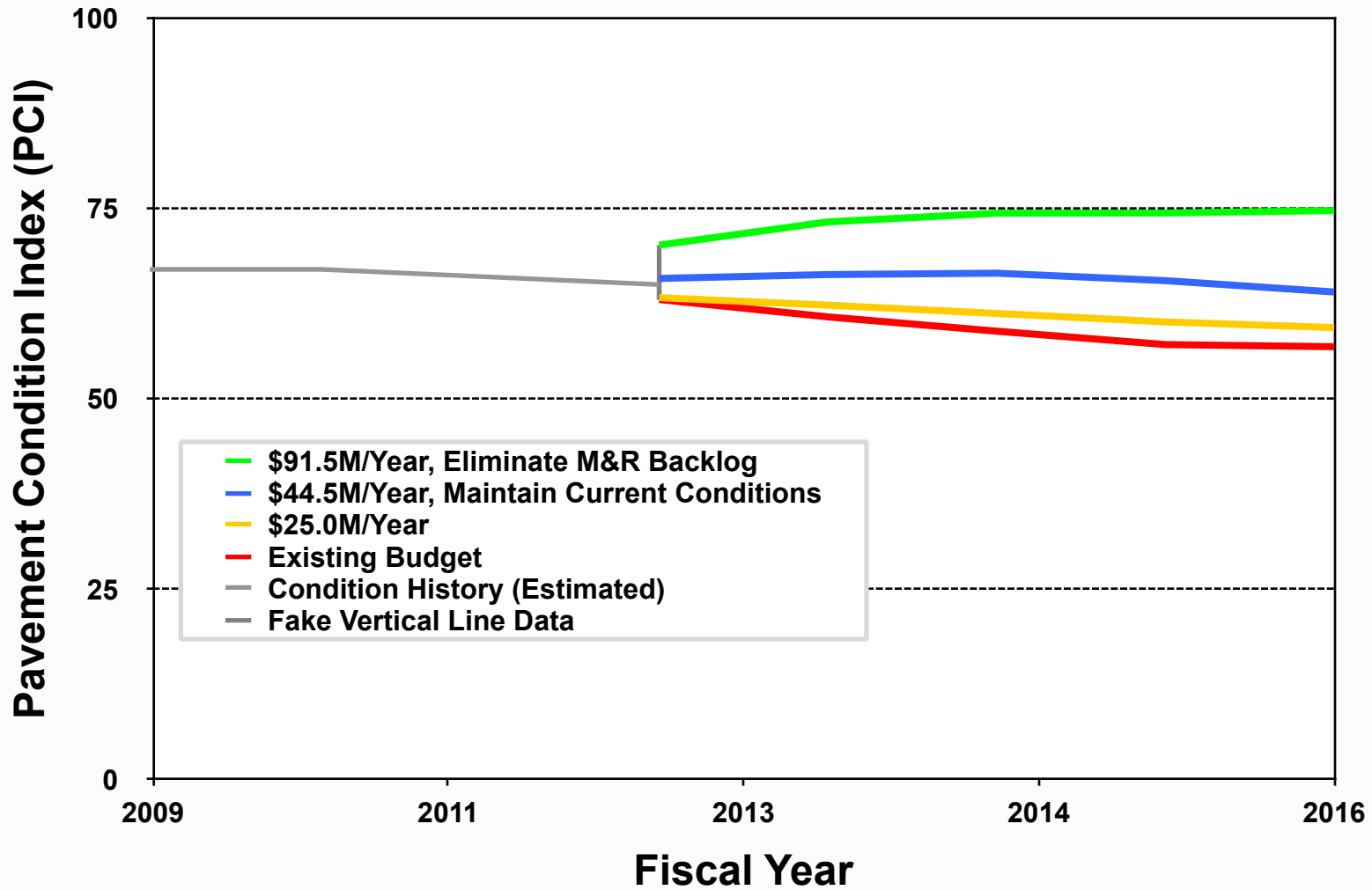


PAVER Analysis and Reporting Cook County Conditions and M&R Budget Scenarios

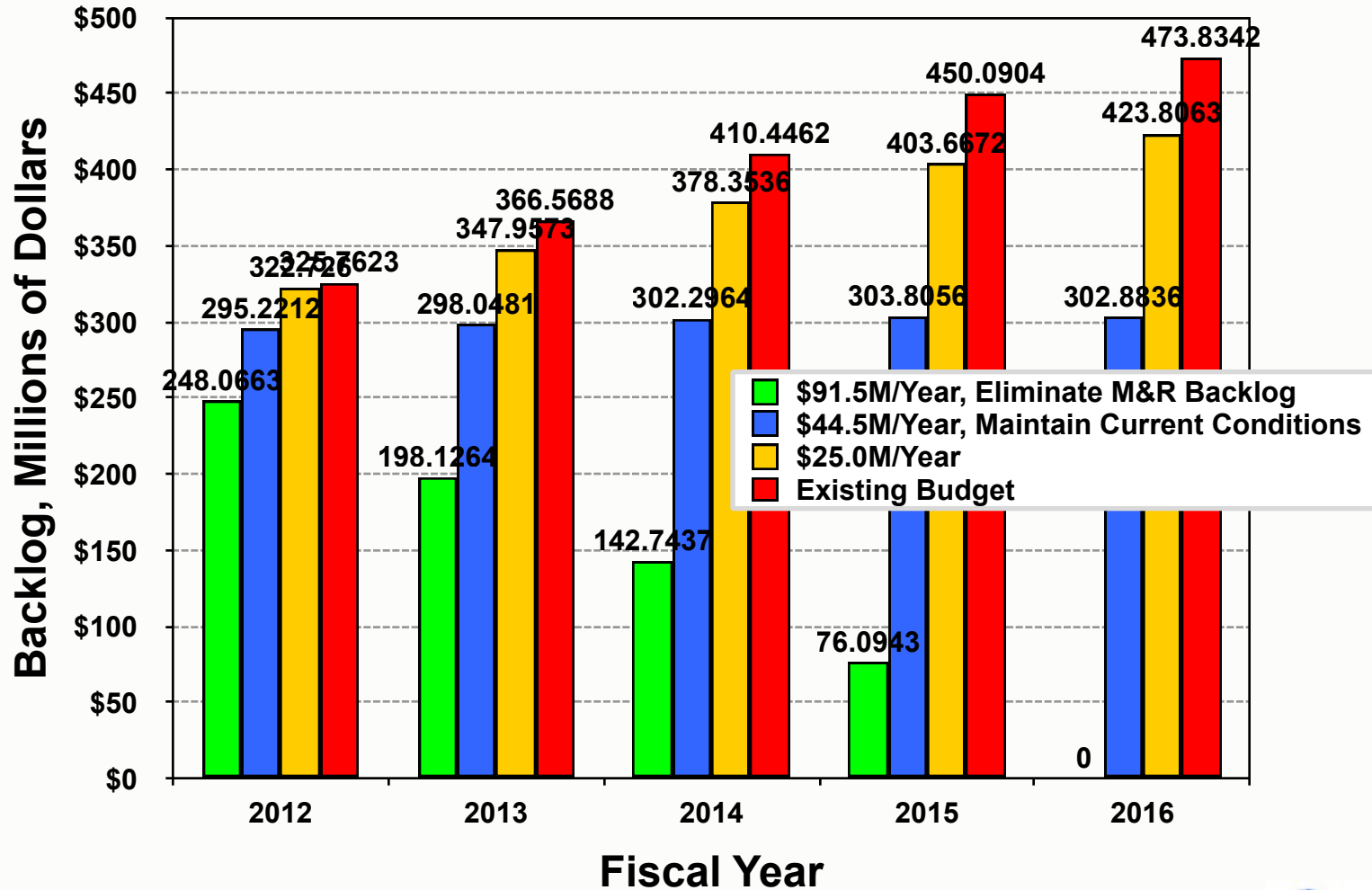
Overall Pavement Conditions



Impact of Funding on Pavement Condition



Impact of Funding on Pavement M&R Backlog



Summary

Pavement Imaging Technologies

- ✓ Faster Data Collection
- ✓ Comprehensive (Surface distresses + Profile + Rutting + Pavement Geometry)
- ✓ Safer
- ✓ Day and Night (Airports)
- ✓ Permanent Record (QC/QA)
- ✓ Geo-referenced Data
- ✓ Automatic Export to PMS Software (PAVER)



A Successful Application of Pavement Imaging Technologies for PMS implementation requires:

- ✓ Excellent trained and experienced PCI inspectors
- ✓ Excellent project management and communication
- ✓ In-house pavement management “champions” – along with GIS and IT resources
- ✓ Trained and experienced project staff with subject matter expertise
- ✓ Active QC/QA program

Thank You!



Northwest Pavement Management Association Conference – 2014

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Dynatest Consulting, Inc.