Purpose of a Pavement Evaluation

- Provides qualitative information to:
  - Determine causes of deterioration
  - Determine if pavement is not a candidate for preservation
  - Develop appropriate alternatives
- Provides quantitative information for:
  - Quantity estimates
  - Assessment of deterioration rates
  - Performing life-cycle cost analyses

Project Evaluation Approach

- Historical data collection/records review
- Initial site visit and assessment
- Field testing activities
- Laboratory materials characterization
- Data analysis
- Final field evaluation report
Key Pavement Evaluation Components

- Pavement Distress & Drainage Surveys
- Nondestructive Testing
- Surface Characteristics Testing
- Field Sampling and Testing

Purpose of Distress Survey

- Document pavement condition
- Identify types of distress characterized by severity and extent
- Group areas of similar performance
- Gain insight into causes of deterioration
- Identify additional testing needs
- Identify possible treatment alternatives
- Identify repair areas and quantities

Distress Identification Manual

- Standardized distress definitions
- Benefits
  - More consistent calls
  - Better communication within and between highway agencies
  - Improvements in any agency activity using pavement performance information

Example Distress Manuals
Output of Distress Surveys

- Distress types and quantities
- Overall indicator of condition (PAVER, PASER, State DOT procedures)

<table>
<thead>
<tr>
<th>PCI</th>
<th>Repair Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Preventive Maintenance</td>
</tr>
<tr>
<td>85</td>
<td>Minor to Major Rehabilitation</td>
</tr>
<tr>
<td>70</td>
<td>Minor to Major Rehabilitation</td>
</tr>
<tr>
<td>55</td>
<td>Minor to Major Rehabilitation</td>
</tr>
<tr>
<td>40</td>
<td>Minor to Major Rehabilitation</td>
</tr>
<tr>
<td>25</td>
<td>Minor to Major Rehabilitation</td>
</tr>
<tr>
<td>0</td>
<td>Reconstruction</td>
</tr>
</tbody>
</table>

Example Index

- PCI 100: Preventive Maintenance
- PCI 85: Minor to Major Rehabilitation
- PCI 70: Minor to Major Rehabilitation
- PCI 55: Minor to Major Rehabilitation
- PCI 40: Minor to Major Rehabilitation
- PCI 25: Minor to Major Rehabilitation
- PCI 10: Reconstruction
- PCI 0: Reconstruction

Common Concrete Pavement Distresses

- Corner Breaks
- D-Cracking or ASR
- Transverse Cracking
- Spalling
- Patch/Patch Deter.
- Joint Faulting
- Pumping
- Joint Seal Damage
- Blowup
- Map Cracking
- Punchout
- Scaling
- Longitudinal Cracking

Common Concrete Pavement Distresses

- Corner crack
- D-cracking
- Transverse crack
- Joint spalling
- Patch deterioration
- Joint faulting
- Pumping
- Map cracking
- Punchout
- Scaling
- Longitudinal cracking

Longitudinal Cracking
Chapter 6. Longitudinal Cracking

2. Severity

Table 6.1  Severity levels of longitudinal cracking

<table>
<thead>
<tr>
<th>LCC</th>
<th>Description and Severity Levels</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
<td>Cracks that are predominantly parallel to the pavement centerline</td>
<td>Record the length of longitudinal cracking at each severity level. Also record the length of longitudinal cracking with sealant in good condition at each severity level. Sealant is not considered to be in good condition unless at least 3 ft (1 m) of continuous sealant in good condition is present. In cases where a crack is less than 3 ft (1 m) long, the sealant must be present and in good condition over the entire length of the crack.</td>
</tr>
<tr>
<td>J3</td>
<td>Crack widths greater than 0.125 in. (3 mm) but less than 0.30 in. (7.5 mm) or with spalling less than 3 in. (75 mm) or fouling up to 0.50 in. (13 mm)</td>
<td></td>
</tr>
<tr>
<td>JH</td>
<td>High: Crack widths greater than 0.50 in. (13 mm) or with spalling greater than 3 in. (75 mm) or fouling greater than 0.50 in. (13 mm)</td>
<td></td>
</tr>
</tbody>
</table>

Example Distress Form

Drainage Survey

- Purposes:
  - Identify moisture-related distress
  - Document drainage conditions
  - Assess overall pavement drainability

- Things to look for:
  - Topography and cut/fill
  - Pavement/shoulder slopes
  - Condition and geometrics of ditches
  - Condition of drainage outlets or inlets

Nondestructive Testing

- Not needed on all pavement preservation projects
- Information can be confirmed such as thicknesses, pavement properties, load transfer capabilities, voids, and embedded steel alignment
- Can have significant testing and analysis costs
Deflection Testing

- For pavement preservation work, valuable tool for assessing:
  - Joint load transfer
  - Presence of voids
  - Structural adequacy
  - Fast and produces repeatable results
  - Commonly used in project-level analysis

Use and Interpretation of Deflection Data

- Deflection uniformity along project
- Backcalculation of pavement properties
- Evaluation of joint/crack load transfer
- Void detection

Ground Penetrating Radar (GPR)

- Determine layer thickness
- Embedded steel location
- Presence of underlying voids

<table>
<thead>
<tr>
<th>Layer Type</th>
<th>Accuracy (vs. Cores)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Asphalt</td>
<td>3 – 5%</td>
</tr>
<tr>
<td>Existing Asphalt</td>
<td>5 – 10%</td>
</tr>
<tr>
<td>Concrete</td>
<td>5 – 10%</td>
</tr>
<tr>
<td>Granular Base</td>
<td>8 – 15%</td>
</tr>
</tbody>
</table>

Magnetic Imaging Tomography (MIT)

- MIT Scan-2
  - Evaluate dowel bar location and orientation
- MIT Scan T2
  - Determine concrete slab thickness
Ultrasonic Tomography (MIRA)

- Layer thickness
- Relative concrete strength
- Cracking in the concrete layer
- Debonding between concrete layers
- Location of embedded steel
- Areas of joint deterioration and poor consolidation

Roughness Surveys

- Measures actual pavement profile
- Widespread use in network-level pavement management
- Relatively accurate and repeatable measurements

Testing Equipment

- Non-Contact Lightweight
- Portable Laser
- High-Speed Profiler

Roughness Indicators

- International Roughness Index (IRI), current measurement standard
- Pavement Serviceability Rating (PSR)
- General correlations:

<table>
<thead>
<tr>
<th>Ride Quality</th>
<th>IRI (in/mi)</th>
<th>PSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>&lt; 95</td>
<td>&gt; 3.5</td>
</tr>
<tr>
<td>Acceptable</td>
<td>&lt; 170</td>
<td>&gt; 2.5</td>
</tr>
<tr>
<td>Not Acceptable</td>
<td>&gt; 170</td>
<td>&lt; 2.5</td>
</tr>
</tbody>
</table>
Friction Surveys

- Assess overall adequacy of pavement friction as it contributes to safety
- Identify localized areas with poor friction
  - Curves
  - Intersections
  - Ramps

Assessing Surface Friction

- Measure surface friction directly with various devices (e.g., skid trailer)
- Must also consider surface texture
  - Microtexture
  - Macrotexture

Measuring Surface Texture

- Volumetric (“Sand Patch”) method
- Outflow Meter
- Circular track meter (CTMeter)
- High-speed laser-based devices

Tire/Pavement Noise Survey

- Emerging as a critical issue, especially in high-volume urban areas
- Problematic to adjacent property and business owners and the traveling public
- On-Board Sound Intensity (OBSI) method
### Purpose of Field Sampling and Testing

- **Purposes:**
  - Determine layer thicknesses
  - Characterize material properties
  - Diagnose causes (mechanisms) of distress
- **Can consist of:**
  - Field sampling
  - Field testing
  - Laboratory testing

### Common Field Sampling and Testing Methods

- **Coring**
- **Material sampling**
- **Dynamic cone penetrometer (DCP)**
- **Standard penetration testing (SPT)**

### Common Laboratory Tests

- **Subgrade and granular base/subbase**
  - Characterization (soil classification, moisture content)
  - California Bearing Ratio (CBR)
  - Resilient Modulus (Mr)
- **Stabilized layers and PCC slab**
  - Indirect Tension
  - Unconfined Compression
  - Special Materials Evaluation Tests

### Then and Now Distress Identification

<table>
<thead>
<tr>
<th>Then</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discrete Test Locations (Sampling)</td>
<td>100% Roadway Coverage</td>
</tr>
<tr>
<td>Manual Data Collection &amp; Analysis</td>
<td>Automated Data Collection &amp; Analysis</td>
</tr>
<tr>
<td>Limited Computing Capacity</td>
<td>Almost Unlimited Computing Capacity</td>
</tr>
<tr>
<td>Field Reviews Only</td>
<td>In-Office Visual Review of Roadways</td>
</tr>
<tr>
<td>Guestimates of Climate Data</td>
<td>Accurate Environmental Data</td>
</tr>
<tr>
<td>Little to No Ability to Evaluate Products or Test Sections</td>
<td>Ability for PMS to Test Sections and Products</td>
</tr>
<tr>
<td>Linear MP Location Data</td>
<td>GPS Coordinates</td>
</tr>
<tr>
<td>2D Profile Measurements</td>
<td>3D Profile Measurements</td>
</tr>
<tr>
<td>Limited to No Maintenance Data</td>
<td>Exact Maintenance Locations and Costs</td>
</tr>
<tr>
<td>Questionable Traffic Data</td>
<td>Better Traffic Data?</td>
</tr>
</tbody>
</table>
Additional Information

- Introduction
- Preventive Maintenance and Pavement Preservation Concepts
- Concrete Pavement Evaluation p. 17-57
- Slab Stabilization and Slab Jacking
- Partial-Depth Repairs
- Full-Depth Repairs
- Retrofitted Edgedrains
- Dowel Bar Retrofit, Cross Stitching, and Slot Stitching
- Diamond Grinding and Grooving
- Joint Resealing and Crack Sealing
- Concrete Overlays
- Strategy Selection

Will be updated 4th quarter 2020

Thanks for your time
Concrete Pavement Evaluation for Restoration

CP Tech Center Preservation Webinar
June 9, 2020

John Donahue, P.E.
Construction and Materials Liaison Engineer

PCC Restoration History in Missouri

• Missouri had traditionally addressed pavement distresses in new and existing PCC pavements with full depth repairs or asphalt overlays.
• Often, the magnitude of the solutions were disproportionate to the severity of the distresses.
• A move to employ alternate, less intrusive preservation, repair, and rehabilitation treatments began in the early 2000's.
• PCC restoration techniques have yielded short-to-long term performance benefits.

I-35 JRCP in Clinton County with Asphalt Overlay Milled

Only do what’s necessary!
PCC Pavement Evaluation Considerations

- Distress severity
- Location of distresses
- Age of PCC pavement
- Depth of reinforcement
- Load transfer
- Aesthetics
- Estimating quantities

Full depth repairs should be a last resort!

Primarily for –
- Shattered slabs
- Severe spalling
- Internal degradation (D-cracking, ASR, etc.)

Distress Severity

I-35 Shattered Slab
I-64 Joint Spalling

D-Cracking

Low Air Content

Short-Term Solution
US 412 in Dunklin County

Do nothing?

PDR Candidate

PDRs on US 63 in Randolph County
Location of Distresses

US 36 in Macon County

Panel 215
Panel 216
Panel 217

#10
#9
#8
#7

Median Side
Age of PCC Pavement

Rte 105 in Charleston at 47 Years

65-Year Old Pavement!!

45-Year Old JRCP

No Mid-Panel Cracks
7-Year Old Unbonded JPCP Overlay

Interior Punch-out

No Interlayer !!

Epoxy Repairs on US 36
Depth of Reinforcement

JRCP Wire Mesh Placement

‘Manual’ Depth Adjustments

Checking Depth of Steel Reinforcement
Not a grinding candidate!

Ignore?

Load Transfer

FWD Load Transfer Testing
**US 71 NB at Bridge A-2022 in Jasper Co.**

3rd Approach Slab

![Graph showing Ave. Load (lb) vs Ave. Deflection (mils)]

- **US 67 in Butler County**
- **I-35 JPCP Faulting**
- **Inadequate Dowel Bar Embedment**

Before Undersealing

After Undersealing
Longitudinal cracking and faulting

Rte 94 in St. Charles County

Faulting

AC Millings

Old Fill

New Fill

March 2009

Heavy Duty Cross-Stitching

February 2013

Aesthetics
I-55 Exit Ramp in Scott County

Cross-sectional View

End View

US 63 Mudballs
Estimating Quantities

Scoping Repair Quantities

• Generally, repair quantities can be expected to increase ~ 10% from the time of project scoping to the award of contract, so roadway designers should set up plan quantities accordingly.

• Logmile or GPS coordinates for repairs should be included.

• May (or not) add other preservation treatments as contingency.

Field Inspector Reviews

• After a project is let, plan quantities for repair work will probably require modifications based on real time conditions.

• Construction inspectors will increasingly find themselves making repair decisions on the fly and therefore should have a general understanding of concrete restoration treatments and triggers.

• Project construction engineers must make decisions to stay within the contract budget.
Thank you!

Questions?

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(573) 526-4334