Session 3: Concrete Pavement Evaluation
Learning Outcomes

1. Describe the need for a thorough pavement evaluation
2. Name the common pavement evaluation components
3. Describe what information is obtained from each pavement evaluation component
Introduction

• For an existing pavement, the overall goal is to provide a cost-effective solution that:
  – Addresses pavement deficiencies
  – Satisfies constraints
• Detailed pavement evaluation required to achieve this goal
Purposes of a Pavement Evaluation

- Provides qualitative information to:
  - Determine causes of deterioration
  - Determine if pavement is not a candidate for preventive maintenance
  - Develop appropriate alternatives

- Provides quantitative information for:
  - Quantity estimates
  - Assessment of deterioration rates
  - Performing life-cycle cost analyses
Data Required for Pavement Evaluation

- Pavement and shoulder condition
- Pavement design
- Materials and soil properties
- Traffic volumes and loadings
- Climatic conditions
- Drainage conditions
- Geometric factors
- Safety aspects
- Other factors
Project Evaluation Approach

1. Historical data collection/records review
2. Initial site visit and assessment
3. Field testing activities
4. Laboratory materials characterization
5. Data analysis
6. Final field evaluation report
Key Pavement Evaluation Components

- Pavement Distress and Drainage Surveys
- Deflection Testing
- Roughness and Surface Friction Testing
- Field Sampling and Testing

Which activity is most useful in identifying candidate preservation projects?
Pavement Distress and Drainage Surveys
### Purposes of Distress Survey

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

- Fundamental performance indicator
- Characterized by:
  - Type
    - What?
  - Severity
    - How Bad?
  - Extent
    - How Much?
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>
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<tr>
<td>100</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>85</td>
<td>Preventive Maintenance</td>
</tr>
<tr>
<td>70</td>
<td>GOOD</td>
</tr>
<tr>
<td>55</td>
<td>Minor to Major Rehabilitation</td>
</tr>
<tr>
<td>40</td>
<td>FAIR</td>
</tr>
<tr>
<td>25</td>
<td>Reconstruction</td>
</tr>
<tr>
<td>10</td>
<td>POOR</td>
</tr>
<tr>
<td>0</td>
<td>FAILED</td>
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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

Table 3.3 on p. 3.10
Class Exercise

Distress Identification
Transverse Cracking
Pumping
Joint Faulting
Corner Break
Joint Spalling
Spalling Due to Joint Lockup
Joint Seal Damage
Transverse Cracking (Consecutive Slabs)
Blowup
Map Cracking
Alkali-Silica Reactivity
Longitudinal Cracking
Map (Plastic Shrinkage) Cracking
D-Cracking
Scaling
Patch Deterioration
Punchout (CRCP)
Manual Distress Surveys

• For project-level evaluation, manual procedures often preferred
  – Gather records and information
  – Windshield survey
  – Distress survey
    • Distress mapping
    • Measurements
    • Photos
Example Distress Form

Blank

Filled Out

Fig 3.1 on p. 3.12
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
Topography and Condition of Ditch
Condition of Outlets
Evaluation of Distress and Drainage Survey Results

- **Distress Evaluation**
  - Summarize key distress data
  - Prepare strip charts over project
  - Evaluate historical trends

- **Drainage Evaluation**
  - Overall pavement drainability
  - Condition of ditches and outlets
  - Evaluation of drainage times (DRIP program)
Closure—Distress and Drainage Surveys

- Provides fundamental information on pavement performance
- General indicator of pavement deficiencies and needs
- Drives the need for additional field testing
Deflection Testing
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
Falling Weight Deflectometer

Fig. 3.4 on p. 3.17
Backcalculation of Material Properties

- Equations used to analyze deflection basins
- Provides estimates of PCC and subgrade layer strengths
  - PCC elastic modulus
  - Modulus of subgrade reaction (k-value)
- Backcalculated values used in design
Deflection Load Transfer

0% Load Transfer

Wheel Load → Direction of Traffic

Approach Slab

Leave Slab

100% Load Transfer

Wheel Load → Direction of Traffic

Approach Slab

Leave Slab

LT = Loaded

Unloaded

Fig. 3.11 on p. 3.24
Void Detection with FWD

- Maximum deflection (typ. 20 to 35 mils)
- Load sweep and deflection plotting

Fig. 3.12 on p. 3.24
Closure—Deflection Testing

- Not needed on all pavement preservation projects
- Provides information on load transfer capabilities, voids, and structural capacity
- Can have significant testing and analysis costs
Roughness and Surface Friction Testing
Why Assess Pavement Roughness and Friction?

- Roughness affects “functional” performance
- Roughness leads to increases in:
  - Vehicle operating costs
  - User delays
  - Crashes
- Friction loss leads to increases in wet weather crashes
Pavement Serviceability

- Subjective measure of user’s perception of pavement rideability
- Measurement scale
  - 0.0 (very poor) to 5.0 (very good)
  - Working range: 1.5 to 4.5
- Basis for AASHTO design
- Correlations with other roughness indexes
Inertial Road Profiling Systems Equipment (IRPS)

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

- IRI current roughness measurement standard
- Serviceability (PSR) used in AASHTO
- General correlations:

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<tr>
<th>Ride Quality</th>
<th>IRI</th>
<th>PSR</th>
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<tbody>
<tr>
<td>Good</td>
<td>&lt;95</td>
<td>≥3.5</td>
</tr>
<tr>
<td>Acceptable</td>
<td>≤170</td>
<td>≥2.5</td>
</tr>
<tr>
<td>Not Acceptable</td>
<td>&gt;170</td>
<td>&lt;2.5</td>
</tr>
</tbody>
</table>

Table 3.4 on p. 3.28
Why Assess Pavement Friction?

• Assess overall adequacy of pavement friction as it contributes to safety (especially wet-weather crashes)
• Identify localized areas with poor friction
  – Curves
  – Intersections
  – Ramps
Definition of Surface Friction

- Force developed at pavement-tire interface that resists sliding
- Influenced by:
  - Surface texture
  - Microtexture
  - Macrotexture
  - Surface drainage (cross-slope)

![Diagram showing surface texture examples A to D with corresponding scale of texture: Macro (Large) and Micro (Fine).]

Fig. 3.13 on p. 3.26
How Do You Assess Surface Friction?

- Historical method—Measure friction directly (“skid number”)
- Must also consider surface texture
  - Microtexture
    - Roughness of individual aggregate
  - Macrotexture
    - General coarseness of surface
    - Formed water channels (grooving)
    - Large impact on surface friction
Friction Measuring Devices
Locked-Wheel Trailer

Does NOT measure texture!
Surface Texture Measuring Devices

- Volumetric ("Sand Patch") method
- Outflow meter
- Circular track meter (CTMeter)
- High-speed laser-based devices
Closure—Roughness and Surface Friction

- Provides indicator of “functional” performance
  - Rideability
  - Safety
- Possible need for testing indicated by user complaints and wet-weather crashes
Field Sampling and Testing
Purposes of Field Sampling and Testing

• Characterize material properties
  – In absence of deflection data
  – To complement deflection data
• Diagnose causes (mechanisms) of distress
• Identify existing material properties
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
Closure—Field Sampling and Testing

- Detailed field sampling and testing not needed on every project
- Information obtained from distress surveys will help identify needs
- Agencies should be selective in identifying testing needs, as many tests are specialized and costly
Review: Learning Outcomes

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