Pavement Evaluation

Workshop on Design and Rehabilitation of Local Roadways in Ohio’s Counties. Newark, Ohio April 28, 2015

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Pavement Performance Factors
Pavement Performance Factors

Performance

Structure/Materials
Pavement Performance Factors

Thickness vs. Loadings

- Red squares: Concrete - optimal MC
- Black squares: Flexible - optimal MC

ESAL (million) vs. Thickness (inch)
Perpetual Design Criteria

Surface: High Performance
Base: Economical & Durable
Fatigue Resistant Layer

Maximum Tensile Strain for Fatigue Control
Fatigue Behavior (S-N Diagram)

Log Number of Load Cycle

Strain

Thin

Thick and Flexible
Pavement Performance Factors

Performance

Structure/Materials

Traffic
Axle Configuration Parameters

- Wheel Base
- Axle Spacing
- Dual Tire Spacing
- Axle Width
- Tire Pressure
Pavement Performance Factors

• Load: Pavement damage follows approximately a 4th-power rule.
  – If the load is doubled the damage is increased by a factor of $2^4 = 16$
  – If the load is increased by 20%, the damage is doubled
Lateral Distribution

Figure 3.3.8. Fatigue analysis wander approach.
Pavement Performance Factor: Speed
WAY 30 July 2006
(Temp ≥90° F (32.2° C)): ODOT 20.4 kip (90.5 kN) Single Axle
Pavement Performance Factors

- Performance
- Structure/Materials
- Traffic
- Climate
Subgrade Volumetric Moisture Content Variation
Section 876 (AC1 – 390181)
10 TDR Sensors
Strain vs. Surface Temperature: US30
FRL Longitudinal Strain

December (temp 30° F (-1.1° C)) vs. July (temp 90° F)

30 mph Test: ODOT 28 Kip Single Axle Truck Run 1
7/17-19/06

25 mph Test: ODOT 20.4 Kip Single Axle Truck Run
1 12/6/05
Pavement Evaluation
Distress Identification Guide

from the Long-Term Pavement Performance Program

Long Term Pavement Performance (LTPP) Distress Identification Guide

ODOT Pavement Condition Rating (PCR) System

Ohio Research Institute for Transportation and the Environment
RUSS COLLEGE OF ENGINEERING AND TECHNOLOGY
ODOT PCR form for flexible pavement

Section: ________________________  Date: ________________________
Log mile: ______ to ________  Rated by: ________________________
Sta: ________ to __________  # of Utility Cuts ______________

### FLEXIBLE

#### PAVEMENT CONDITION RATING FORM

<table>
<thead>
<tr>
<th>DISTRESS</th>
<th>DISTRESS WEIGHT</th>
<th>SEVERITY WT.*</th>
<th>EXTENT WT.**</th>
<th>DEDUCT POINTS***</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAVELING</td>
<td>10</td>
<td>0.3 L 0.6 M 1 H</td>
<td>0.5 O 0.8 F 1 E</td>
<td></td>
</tr>
<tr>
<td>BLEEDING</td>
<td>5</td>
<td>0.8 L 0.8 M 1 H</td>
<td>0.6 O 0.9 F 1 E</td>
<td></td>
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<tr>
<td>PATCHING</td>
<td>5</td>
<td>0.3 L 0.6 M 1 H</td>
<td>0.6 O 0.8 F 1 E</td>
<td></td>
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<tr>
<td>DEBONDING</td>
<td>5</td>
<td>0.4 L 0.7 M 1 H</td>
<td>0.5 O 0.8 F 1 E</td>
<td></td>
</tr>
<tr>
<td>CRACK SEALING DEFICIENCY</td>
<td>5</td>
<td>1 L 1 M 1 H</td>
<td>0.5 O 0.8 F 1 E</td>
<td></td>
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<tr>
<td>RUTTING</td>
<td>10</td>
<td>0.3 L 0.7 M 1 H</td>
<td>0.6 O 0.8 F 1 E</td>
<td>1 • •</td>
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<tr>
<td>SETTLEMENT</td>
<td>0</td>
<td>0.0 L 0.0 M 0.0 H</td>
<td>0.0 O 0.0 F 0.0 E</td>
<td></td>
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<tr>
<td>POHOLES</td>
<td>10</td>
<td>0.4 L 0.8 M 1 H</td>
<td>0.5 O 0.8 F 1 E</td>
<td>1 • •</td>
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<tr>
<td>WHEEL TRACK CRACKING</td>
<td>15</td>
<td>0.4 L 0.7 M 1 H</td>
<td>0.5 O 0.7 F 1 E</td>
<td>1 • •</td>
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<tr>
<td>BLOCK AND TRANSVERSE CRACKING</td>
<td>10</td>
<td>0.4 L 0.7 M 1 H</td>
<td>0.5 O 0.7 F 1 E</td>
<td></td>
</tr>
<tr>
<td>LONGITUDINAL CRACKING</td>
<td>5</td>
<td>0.4 L 0.7 M 1 H</td>
<td>0.5 O 0.7 F 1 E</td>
<td></td>
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<tr>
<td>EDGE CRACKING</td>
<td>10</td>
<td>0.4 L 0.7 M 1 H</td>
<td>0.5 O 0.7 F 1 E</td>
<td>1 • •</td>
</tr>
<tr>
<td>THERMAL CRACKING</td>
<td>10</td>
<td>0.4 L 0.7 M 1 H</td>
<td>0.5 O 0.7 F 1 E</td>
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</tbody>
</table>

*L = LOW  **O = OCCASIONAL  TOTAL DEDUCT =
M = MEDIUM  F = FREQUENT  SUM OF STRUCTURAL DEDUCT (•) =
H = HIGH  E = EXTENSIVE  100 - TOTAL DEDUCT = PCR =
Rutting

Dipstick

LRMS

Profilometer
Section 390103-2 Transverse Profile

- Dipstick Profile
- 3/16 in/ft Design Slope
- Profilometer Profile

Linear foot along transverse axis

Verticle displacement (inches)
Coring

- Layer Thickness
- Sample for lab testing
- Access for DCP testing
Pavement Evaluation: Ground Penetrating Radar (GPR)
Ride Quality

High Speed and Lightweight Inertial Profiliners
Measures of Ride Quality

IRI – International Roughness Index

– Represents accumulated vertical distance between the axle and body of a vehicle
– Units – vertical inches of roughness per longitudinal mile
Skid Resistance

Skid number: \( SN = 100(f) \)

where: \[ F = \text{frictional resistance to motion in plane of interface} \]
\[ L = \text{load perpendicular to interface} \]

<table>
<thead>
<tr>
<th>Check</th>
<th>Variable</th>
<th>Congested Freeway</th>
<th>Signalized Intersection</th>
<th>Unsignalized Intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 a.</td>
<td>If wet/total crash rate, and</td>
<td></td>
<td>( \geq 25 ) percent</td>
<td></td>
</tr>
<tr>
<td>1 b.</td>
<td>Annual average number of wet pavement crashes (2 or 3 year average), then</td>
<td>( &gt; 2 ) for rural settings</td>
<td>( &gt; 4 )</td>
<td>( &gt; 2 )</td>
</tr>
<tr>
<td>1 c.</td>
<td>Check minimum friction number</td>
<td>( FN40R_{min} &lt; 38 ) or ( FN40S_{min} &lt; 28 )</td>
<td>( FN40R_{min} &lt; 40 ) or ( FN40S_{min} &lt; 28 )</td>
<td>( FN40R_{min} &lt; 40 ) or ( FN40S_{min} &lt; 30 )</td>
</tr>
<tr>
<td>2</td>
<td>Minimum MTD</td>
<td></td>
<td>( &lt; 0.04 ) in (1.0 mm) sand patch test</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Roughness spikes based on 20-ft (6.1-m) sliding base length</td>
<td></td>
<td>( &gt; 300 ) in/mile (4.7 m/km)</td>
<td></td>
</tr>
</tbody>
</table>
Deflection/Stiffness
Falling Weight Deflectometer (FWD)
FWD Analysis using Modulus 6.0 Software
Deflection/Stiffness
Light Weight Deflectometer (LWD)
FWD Strain Response in APLF
Longitudinal strain in FRL

FWD Testing, DYN 03 Response
82 MPa (12 kips), South Sasobit

Micro Strain

Time (Sec)
US30 FWD Measurements (Cont’)

AC – Maximum Deflections along Centerline

WAY 30 FWD Profiles
Maximum Midslab Deflection
C/L - 5/14/08

(1 mil/kip = 5.71 mm/MN)
(100 feet = 30.5 m)
Pavement Evaluation:
Portable Seismic Properties Analyzer (PSPA)
Field Testing

• Seismic Analysis
  – Determination of layer modulus by use of Portable Seismic Pavement Analyzer Software (PSPA)

Pavement Evaluation:
Dynamic Cone Penetrometer (DCP)
DCP plot: Penetration Index vs. depth
DCP plot: Resilient Modulus vs. depth

- X-axis: Resilient Modulus, Mr (Ksi)
- Y-axis: Depth (in)

The graph shows a fluctuating line, indicating changes in resilient modulus with depth.

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ORITE Mobile Civil Infrastructure Laboratory
ORITE Mobile Civil Infrastructure Laboratory

• The Ohio University Civil Infrastructure Laboratory (OUCIL) is a mobile facility housed in a semi truck.

• The OUCIL equipped with state of the art equipment that allows researchers to conduct in-depth on-site investigations of the “state of good repair” of pavements, bridges, structures, etc.

• The laboratory is equipped for:
  – Non-destructive testing
  – Materials properties for asphalt and concrete pavements
Questions?
Create for Good.