FWD/HWD Void Detection
Beneath Concrete Pavements or Overlaid Concrete Pavements

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Presentation Outline

• Voids – what’s the big deal?

• What causes them?

• How can we detect them?
Oops...
Development of Voids

- Pumping action of concrete pavement
- Subbase disintegration
- Lack of doweled pavement
- Poor subbase and/or subgrade compaction
- Poor construction
Development of Voids

- Excess subgrade and subbase (unbound materials) moisture
- High water table
- Aggregate segregation during construction
- Combination of one or more of the above
Pumping & loss of fines
Faulting (Pumping Mechanism)

EXPULSION OF WATER AND FINES

DIRECTION OF TRAFFIC

PCC SLAB

SUBBASE

SUBGRADE

ACCUMULATION OF ERODED BASE MATERIAL

INADEQUATE LOAD TRANSFER CAUSING DIFFERENTIAL DEFLECTIONS
Void Detection/Underseal

- Underseal Analysis
  - Conduct FWD/HWD test at multiple load levels
  - At a minimum, test leave and approach PCC slabs within 60-100 cm (2-3 ft) of slab edge
  - Recommend randomly testing PCC slab centre
  - Test at the direction of traffic movement
  - Avoid testing at extreme temperature
Slab Curling – Temperature Difference

DAYTIME CURLING

NIGHTTIME CURLING
Slab Curling

- At high surface temp = edge contact
- At low surface temp = centre contact
- Avoid corner tests if slab does NOT have edge contact
- Recommend FWD/HWD testing when curling/warping does not exist – usually when temperature differential is minimum between top and bottom of the slab
FWD/HWD Void detection is performed at corner of the Slab.

Test near corner of the slab (within 60-100 cm or 2-3 ft) from edge of the slab where corner cracking is most likely to occur.

This is load transfer testing – not void detection.
Testing Sensitivity

- FWD/HWD is very sensitive to the presence of voids beneath the corner of PCC or overlaid PCC slabs
- FWD/HWD sensitivity is reduced where dowels are used for load transfer across PCC slabs
- FWD/HWD testing must be conducted at multiple load levels to detect the voids beneath PCC or overlaid PCC Slabs
Deflection Basin Parameters

Weak Pavement/
High deflection
(Void-like
conditions)

Strong Pavement/
Low deflection
(No void-like
conditions)

- Deflection magnitude
- Slope
- Deflection difference
- Radius
- Area
- Deflection ratio
Void Detection Method 1: Multiple Load Testing

- Theoretically at zero load, there is no deflection.
- Regression line of D0 passing through or near the origin indicates no voids.
- Regression line of D0 passing above zero deflection/zero load intersection indicates presence of voids.

75 microns (3 mils)
### Void Detection Method 2: Centre Slab Load Test Comparison

<table>
<thead>
<tr>
<th>Load Transfer</th>
<th>D0 (at center of the slab)</th>
<th>D0 (at slab corner)</th>
<th>D0 function of thickness &amp; load</th>
<th>D0 Normalized to 40 kN (9,000 lbf) (for overlaid PCC must normalize to 20°C or 70°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doweled</td>
<td>Example: 75 microns (3 mils)</td>
<td>2.5 – 3 times measured centre deflection (D0)</td>
<td>40 kN (9,000lbf)</td>
<td>≥ 187 - 225 microns (7.5 -9.0 mils)</td>
</tr>
<tr>
<td>Non-Doweled</td>
<td>Example: 75 microns (3 mils)</td>
<td>3.5 – 4 times measured centre deflection (D0)</td>
<td>40 kN (9,000lbf)</td>
<td>≥ 262 - 300 microns (10.5 – 12.0 mils)</td>
</tr>
</tbody>
</table>
Void Detection Method 3: Maximum Deflection Criteria

- Under Load
- Last Sensor
- Surface Criteria
- SubGrade Criteria

Deflection (mils)

Station
After Underseal

Void Detection Method 3: Maximum Deflection Criteria

- Under Load
- Last Sensor
- Surface Criteria
- SubGrade Criteria

Deflection (mils)

Station
Keep in mind...

• It is possible that one methodology may indicate the presence of voids, while another method may indicate no voids
  – Relatively small void (for now)
  – Presence of other distresses

• All three methodologies are used in conjunction with each other
Questions

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