Use of NDT to Identify Delamination Between Asphalt Layers R06(D)

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Olson Engineering
3d-Radar
Presentation Overview

• Research Background
• SASW and IE
• GPR
• Summary and the Future
Bond Between Asphalt Layers

Built in several lifts to achieve compaction requirements

Tack coat is applied between lifts to improve bond

Bond between lifts is important

- Surface course
- Binder course
- Base course
Asphalt Delamination
SHRP2 R06(D) Project Goal

Identify and develop NDT technology that can:

- Detect delamination in HMA
- Operate at reasonable traveling speed
- Cover full lane width
1. Identify candidate NDT technologies
2. Evaluate potential to meet goal
3. Select NDT technologies with high potential to achieve goal
4. Promote development of hardware and software
5. Validate equipment improvements
6. Examine performance in the field
7. Demonstrate NDT to interested agencies
8. Prepared user guidelines
NCAT Pavement Test Track
## NCAT Test Sections

<table>
<thead>
<tr>
<th>Top 2-inch lift</th>
<th>Full bond</th>
<th>Full bond</th>
<th>Full bond</th>
<th>Partial bond</th>
<th>No bond</th>
<th>partial stripping</th>
<th>Full bond</th>
<th>Full bond</th>
<th>Full bond</th>
<th>Full bond</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom 3-inch lift</td>
<td>no bond</td>
<td>Full bond</td>
<td>Full bond</td>
<td>Full bond</td>
<td>Full bond</td>
<td>Full bond</td>
<td>Full bond</td>
<td>partial stripping</td>
<td>partial</td>
<td>No bond</td>
</tr>
<tr>
<td>Existing surface</td>
<td>PCC</td>
<td>PCC</td>
<td>HMA</td>
<td>HMA</td>
<td>HMA</td>
<td>HMA</td>
<td>HMA</td>
<td>HMA</td>
<td>HMA</td>
<td>HMA</td>
</tr>
</tbody>
</table>

- **Section 1** – no bond between 5-in. HMA overlay and PCC pavement
- **Section 2** – full bond between 5-in. HMA overlay and PCC pavement (control section)
- **Section 3** – full bond between 5-in. HMA overlay and HMA pavement (control section 1 of 2)
- **Section 4** – partial bond between 2-in. HMA overlay surface lift and 3-in. HMA overlay leveling lift
- **Section 5** – no bond between 2-in. HMA overlay surface lift and 3-in. HMA overlay leveling lift
- **Section 6** – simulated stripping in the wheel path between 2-in. HMA surface lift and 3-in. HMA leveling lift
- **Section 7** – full bond between 5-in. HMA overlay and HMA pavement (control section 2 of 2)
- **Section 8** – simulated stripping in the wheel path between 3-in. HMA overlay leveling lift and HMA pavement
- **Section 9** – partial bond between 3-in. HMA overlay leveling lift and HMA pavement
- **Section 10** – no bond between 3-in. HMA overlay leveling lift and HMA pavement
SASW / IE Equipment

- Impactor
- Receiver sensors
- Sensor spacing
- Measurement frequency (spacing)
- Data logger
- DMI
- Field display
Mounted Equipment

Data Acquisition
Computer

Distance wheel

Transducer Wheel Pairs
SASW Reporting

Depth = 0.1 – 0.2 ft

Depth = 0.2 – 0.3 ft

Depth = 0.3 – 0.4 ft

Depth = 0.4 – 0.5 ft

Depth = 0.5 – 0.6 ft

Depth = 0.6 – 0.7 ft

Surface Wave Velocity (ft/sec)
IE Reporting

<table>
<thead>
<tr>
<th>Section 1</th>
<th>Section 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No bond</td>
<td>Full bond</td>
</tr>
<tr>
<td>5-inch depth</td>
<td>control</td>
</tr>
</tbody>
</table>

Thickness Color Scale (in)
What is GPR?

Ground Penetrating Radar
GPR and Asphalt Delamination

- Upper AC Layer
- Lower AC Layer
- Moisture damage ("stripping")
- Moisture infiltration
- Delamination
Multi-antenna GPR Systems

Dual antenna (AHTD)

4 Antennas (FDOT)

31 antennas (3d Radar)
GPR Data Display (NCAT test track section)

"stripping"

ringing
GPR Depth “Slice” showing “stripping” and water infiltration.

Water infiltration

Water infiltration

Stripped areas
GPR Reporting

Activity Index
Likelihood of damage

+= core location
Summary

- SASW / IE and GPR can identify delamination in asphalt
- NDT technology continues to improve
- Recognize limitations for asphalt pavement use
- Sensors and antennas are established hardware
- GPR analysis software continues to improve
- Data collection is manageable (computer speed and storage)
- Data analysis evolving with end-user needs
GPR Equipment Spec

- Transverse array of multiple antenna elements
- GPR frequency: impulse >2.0 GHz, sweep up to 3.0 GHz
- Antenna spacing: maximum 1.5 feet
- Coverage per pass: full lane width
- Data collection: minimum 2 scans per foot-element (project) using DMI trigger, data volume dictates network collection
- Data collection speed: minimum 20 mph
- Real-time display of selected antenna in survey vehicle
- Detection depth for delamination: 2 to 12 inches
- Output amplitude as function of x-long, y-trans, z-time(depth)
The Future

• The future - product demand will drive software development
• GPR can be a network level evaluation tool
• GPR and SASW/IE can be used together to do project level evaluation

• GPR has multiple uses (pavement, base, drainage)
• SASW/IE has multiple uses (pavement, bridge decks)

• SHRP2 SOLUTIONS Implementation Program
• http://www.fhwa.dot.gov/goshrp2/ImplementationAssistance #round6
• June 2015
Questions ?

Thank You

S2-R06D-RR-1  Summary
S2-R06D-RW-2  Theoretical Models
S2-R06D-RW-3  Controlled Evaluations
S2-R06D-RW-4  Uncontrolled Evaluations
S2-R06D-RW-5  Field Core Verification
Draft        User Guidelines