Ground Penetrating Radar
Pavement Density Validation

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NÉSMEA
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Presentation Overview

- Maine’s need for improved asphalt evaluation
- Testing of Ground Penetrating Radar technology
- Interim results
- Next steps
Maine’s Transportation Needs

- Concern about quality of asphalt pavement construction
- Between 4,000 – 12,000 tons of pavement replaced annually due to defects
- Substandard practices cannot always be identified with current random sampling
- Tool needed to improve consistency of laydown practices
Quality Characteristics

• Smoothness
  – Easily measured with current technologies

• In-place density
  – Density gauges or core samples
  – Random sampling; not complete evaluation

• Surface uniformity (seldom measured)
  – Difficult to measure with current methods
Rapid Technologies to Enhance Quality Control on Asphalt Pavements (R06C)

Two non-destructive techniques for evaluating asphalt pavements during construction
  – Infrared thermal scanning
  – Ground Penetrating Radar
• Measures uniformity and potential defect areas in asphalt pavements during construction.
• Offers real-time testing of potentially 100 percent of the pavement area.
Rapid Technologies to Enhance Quality Control on Asphalt Pavements (R06C)

- GPR technology provides density data over a greater area
- Can identify areas of low density quickly
- Potential to provide better information for QC and Acceptance
Early Efforts with GPR

NCHRP IDEA Project 61 – “Development of a Portable Pavement Thickness/Density Meter”

• Goal – portable GPR device to measure thickness & density in real time
• Help achieve more uniform pavement layers
• Tried several GPR configurations on various test sites – correlated to cores
  – Thickness showed strong correlation
  – Density correlation not as strong
Early Efforts with GPR
Early Efforts with GPR
SHRP2 R06C research - GPR

- Built upon past work – focused on density, not thickness
  - Texas Transportation Institute
  - Finland
- New device measures surface dielectric
- Software correlates dielectric value to air voids

SHRP2 Validation Project research team:
Lev Khazanovich and Ryan Conway

Department of Civil, Environmental, and Geo-Engineering
University of Minnesota

Technical assistance from GSSI
Prototype Rolling Density Meter

• Provides direct readout of density – no post-processing
• Lightweight, portable
• Can be used on thin layers
  – TxDOT ½” overlays
• Needs further validation
GSSI PaveScan RDM
Density Profiles

ADJACENT TO EDGE OF PAVEMENT
Calibration Procedure

- Scan a pavement section
- Device identifies high, low, median density locations
- Take static reading directly over each location
- Obtain cores for correlation
Calibration Procedure
First project

- 4 miles
- 1-1/4” Overlay
- 9.5mm HMA
## Correlation results

<table>
<thead>
<tr>
<th>GPR LOCATION</th>
<th>CORE RESULT (% Gmm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
<td>95.9</td>
</tr>
<tr>
<td>HIGH</td>
<td>96.0</td>
</tr>
<tr>
<td>LOW</td>
<td>91.5</td>
</tr>
<tr>
<td>LOW</td>
<td>90.4</td>
</tr>
<tr>
<td>MEDIAN</td>
<td>93.6</td>
</tr>
<tr>
<td><strong>Average Core Density</strong></td>
<td><strong>93.5%</strong></td>
</tr>
<tr>
<td><strong>Acceptance Cores</strong></td>
<td><strong>95.6, 91.7, 93.2</strong></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>93.5%</strong></td>
</tr>
</tbody>
</table>
Regression Analysis

The graph shows the relationship between Air Voids and Dielectric, where the equation of the curve is given by:

\[ y = 32.843e^{-1.237x} \]

with an \( R^2 \) value of 0.9322.
Density Profiles

ADJACENT TO CENTERLINE JOINT
Density Profiles

WHEEL PATH PROFILE
<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Max.</th>
<th>Std.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Edge</td>
<td>6.22</td>
<td>14.60</td>
<td>1.11</td>
</tr>
<tr>
<td>Joint</td>
<td>6.32</td>
<td>18.63</td>
<td>1.12</td>
</tr>
<tr>
<td>Wheel Path</td>
<td>5.03</td>
<td>5.92</td>
<td>0.14</td>
</tr>
</tbody>
</table>
Additional Projects

- Project 2
  - 16 miles, I – 95
  - 1-1/2” Mill & Fill
  - 12.5mm HMA

- Project 3
  - 4.5 miles
  - 3/4” Overlay
  - 9.5mm HMA

- Work still underway – Calibration correlation not available at this time
Desired Short-term Benefits

- More uniformly constructed hot- and warm-mix asphalt layers
- Better in-place field density
- Improved communication among paving crews, QC, and DOT personnel
- Improved ride
- Less reliance on visual inspection
- Reduced discrepancies between contractor and agency test data
Long-Term Goals

• Better inspection coverage to avoid noncompliance penalties.
• Smoother, longer-lasting pavements.
• Reduced need for corrective action due to low-density asphalt pavements.
• Reduced construction time; fewer incidents of replacing new pavement.
• Lessen exposure of workers and public to work zone hazards.
Next Steps

• Additional validation work in 2017
• Evaluate various applications:
  – Thin overlays
  – Different Mix types
• Portability of calibration
• Ruggedness testing
Next Steps

- Determine best use for device:
  - QC, Acceptance, both?
- Contractor education
- Demonstration projects
- Specification development
For more information on improving the quality of your asphalt pavements through SHRP2 products contact:

- Steve Cooper (FHWA) stephen.j.cooper@dot.gov
- Evan Rothblatt (AASHTO) erothblatt@aashto.org

For more information on Maine’s experience, contact:

- Rick Bradbury (Maine DOT) Richard.Bradbury@maine.gov

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