MIT Scan-T2
A Device for Concrete Pavement Thickness Measurement

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**Background**

- Concrete thickness is critical to pavement performance.
- Thickness reduction by 1 inch can result in 50% reduction in service-life.
- Large reduction in lot payment can result when measured thickness is less than specified.
- Accurate measurement of concrete pavement thickness is an important activity.
Coring

Most highway agencies use drilled core method to determine pavement thickness

Coring provides accurate thickness; it is also destructive, expensive, labor intensive, and time-consuming

Limited core samples may not establish a statistically robust representation of pavement thickness

Core length can be affected by base type, particularly open-graded permeable base, where concrete can penetrate into the base
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Coring
Non-Destructive Test (NDT) Techniques
NDT Techniques

- Ultrasonic Tomography (UT)
- Multiple Impact Surface Waves (MISW)
- Impact Echo (IE)
- Ground Penetrating Radar (GPR)
- Magnetic Imaging Tomography (MIT)
NDT Techniques

- Impact Echo *(ASTM C1383)*
  - Piezoelectric transducers with impactor
  - Accurate when used properly
  - Used mainly for detecting voids in concrete
**NDT Techniques**

- **Impact Echo Limitations**
  - Limited for pavement thickness of 3 inches or less
  - Significantly affected by material properties
  - Limited accuracy when testing fresh concrete
  - Dependent on user’s experience/expertise
NDT Techniques

- **Ground Penetrating Radar (GPR)**
  - GPR systems detect layers with difference in dielectric constants

Air-Coupled Systems - high frequency (≥1GHz), highway speed, yield better vertical resolution, but low penetration depth

Ground-Coupled Systems - Low frequency (< 1GHz), penetrate deeper, but lower vertical resolution
Figure 11. Typical GPR data from SR 228 showing dowel bars and interface fluctuation
NDT Techniques

- **Ground Penetrating Radar (GPR)**
  - GPR systems detect layers with difference in dielectric constants
  - Air-Coupled Systems - high frequency ($\geq 1\text{GHz}$), highway speed, yield better vertical resolution, but low penetration depth
  - Ground-Coupled Systems - Low frequency ($< 1\text{GHz}$), penetrate deeper, but lower vertical resolution
Air-Coupled System
NDT Techniques

- Ground Penetrating Radar (GPR)

  - GPR systems detect layers with difference in dielectric constants

  - Air-Coupled Systems - high frequency (≥1GHz), highway speed, yield better vertical resolution, but low penetration depth

  - Ground-Coupled Systems - Low frequency (< 1GHz), penetrate deeper, but lower vertical resolution
Ground-Coupled System


**NDT Techniques**

- **GPR Systems Limitations**
  - Newly placed concrete attenuates signal and reduces penetration depth
  - Accuracy is affected by signal frequency, material properties (ex; water content), and electromagnetism
  - Automated data processing and analysis software has not advanced enough
  - Requires special expertise
Magnetic Imaging Tomography (MIT)

- MIT SCAN-T2 (T2)
◆ **Operating Principal**

- A coil mounted in the device generates a pulse of magnetic field

  The magnetic pulse induces an Eddy current in a pre-placed metal reflector on the surface of the base

  Electromagnetic sensors in the device measure the intensity of the magnetic field caused by the Eddy current in the reflector
Operating Principal

- A coil mounted in the device generates a pulse of magnetic field.
- The magnetic pulse induces an Eddy current in a pre-placed metal reflector on the base surface.

Electromagnetic sensors in the device measure the intensity of the magnetic field caused by the Eddy current in the reflector.
induced current
MIT

Operating Principal

- A coil mounted in the device generates a pulse of magnetic field
- The magnetic pulse induces an Eddy current in a pre-placed metal reflector on the surface of the base
- Electromagnetic sensors in the device measure the intensity of the magnetic field caused by the Eddy current in the reflector
Operational Procedures

Phase 1 - Prior to concrete placement

- Reflector plates are placed at desired locations on the surface of the base
- Reflector plates are fastened to the base using dowel basket nails or asphaltic tack coat
- Reflector plates placed at least 3 ft away from dowel bars and tie bars
Operational Procedures

Phase 2 - Following *concrete placement*

- Assemble the device
  - Locate the reflector plate
  - Scan over the reflector
*T2*

**Operational Procedures**

Phase 2 - Following *concrete placement*

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Scan over the reflector
T2

- Operational Procedures

Phase 2 - Following *concrete placement*

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**T2**

- **Advantages**
  - Most concrete materials have no effect on magnetic fields
  - Eddy current approach eliminates biases caused by variations in the concrete material properties
  - MIT technique is medium-independent
  - T2 can measure thicknesses of up to 20 inches
T2 Test Trials
T2 Test Trials

Concrete Removal

Concrete Placement

8 in new concrete
12 ft
Bridge Deck

28 ft × 20 ft

17 in total new concrete

8 in new concrete
9 in existing concrete
9 in concrete
T2 Test Trials

5.5 feet

5.5 feet
T2 Test Trials

3 feet
T2 Test Trials

MIT-SCAN-T2 Measured Thickness (inch)

Test Location

Operator 1
Operator 2
Operator 3
## T2 Test Trials

<table>
<thead>
<tr>
<th>Test Location</th>
<th>Average Thickness (in)</th>
<th>Difference (in/mm)</th>
<th>St.Dev (in/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T2</td>
<td>Core</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>8.20</td>
<td>8.25</td>
<td>0.05 / 1.27</td>
</tr>
<tr>
<td>B</td>
<td>17.20</td>
<td>16.95*</td>
<td>0.25 / 6.35</td>
</tr>
<tr>
<td>C</td>
<td>8.02</td>
<td>8.04</td>
<td>0.02 / 0.51</td>
</tr>
</tbody>
</table>

* Tape measured
**T2 Test Trials**

- **APT**
  - Average error 0.10 in (2.7 mm)
  - Repeatability 0.03 in (0.8 mm)
  - Reproducibility 0.05 in (1.3 mm)

- **OTHER**
  - US field trials consistently produced error less than 0.1 inch (3mm)
  - Specified accuracy - 0.5% of actual depth + 1mm (translates to 0.1 in (3 mm) for 13 inch pavement)
T2 Test Trials

Ref: J.Grove et al. NDT Thickness Measurements for Concrete Pavements – It Really Works !, TRB 2012
T2 Test Trials (Duval Co.)

- **SR 9A/9B**
  - 11.5 inch pavement
  - Archer Western Contractors
  - England, Thims & Miller Inc. (Robert Hansgen, P.E.)

- **SR 115 (MLK Parkway) / 21st St.**
  - 12.5 inch pavement
  - Archer Western Contractors
  - HNTB Corp (Thomas Woods, P.E.)
Conclusion

- Simple, easy, fast to operate
- Provides accurate, repeatable, reproducible results
- Does not require special expertise or training
Concrete Pavement Technology Program (CPTP)

Provides information on CPTP product availability, field trials, and implementation experiences

http://www.fhwa.dot.gov/pavement
QUESTIONS ?