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

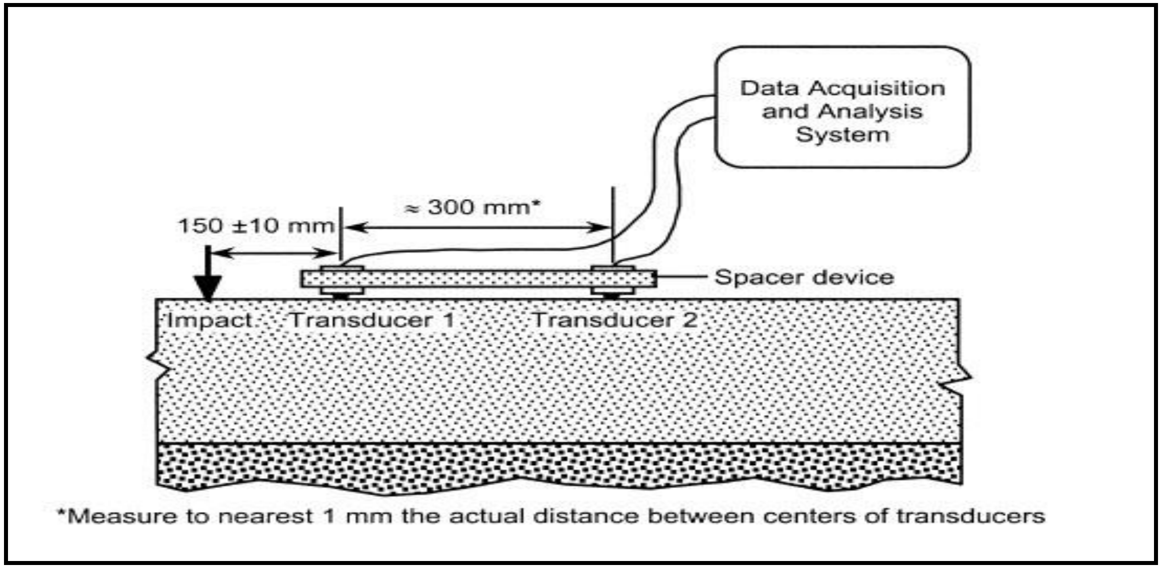
Non-Destructive Test (NDT) Techniques

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

GPR

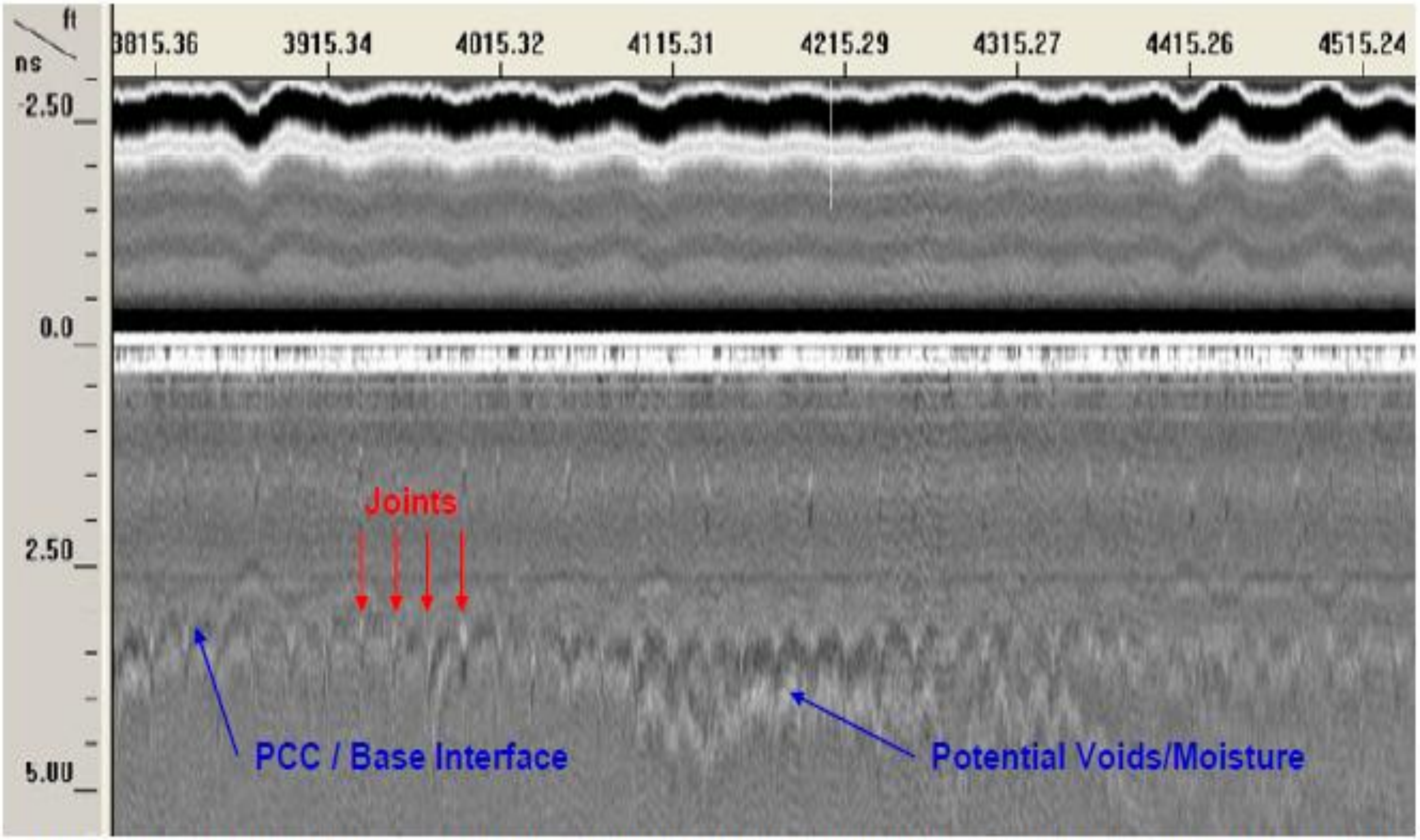


Figure 11. Typical GPR data from SR 228 showing dowel bars and interface fluctuation

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Air-Coupled System

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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)

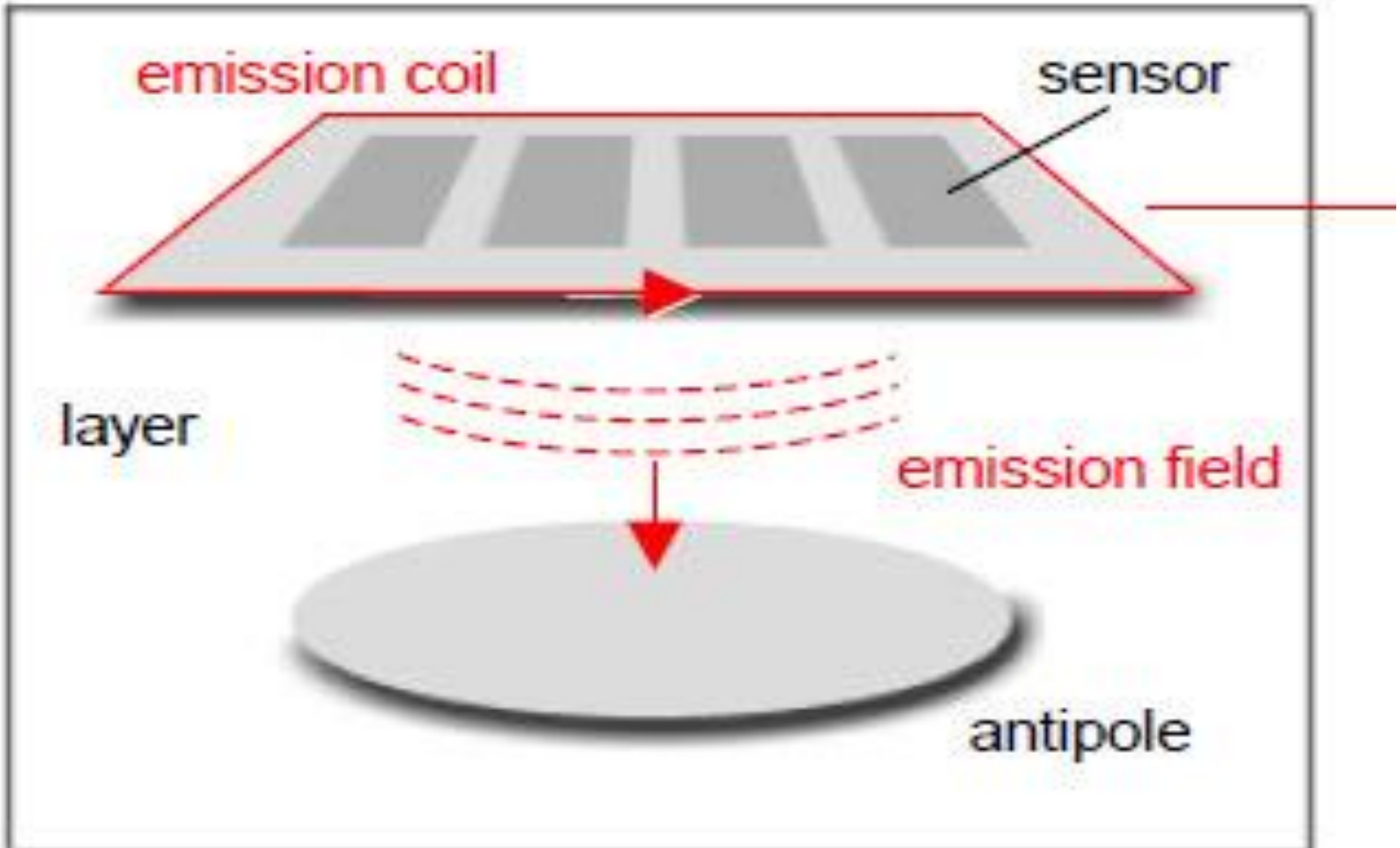
MIT

- ***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

MIT



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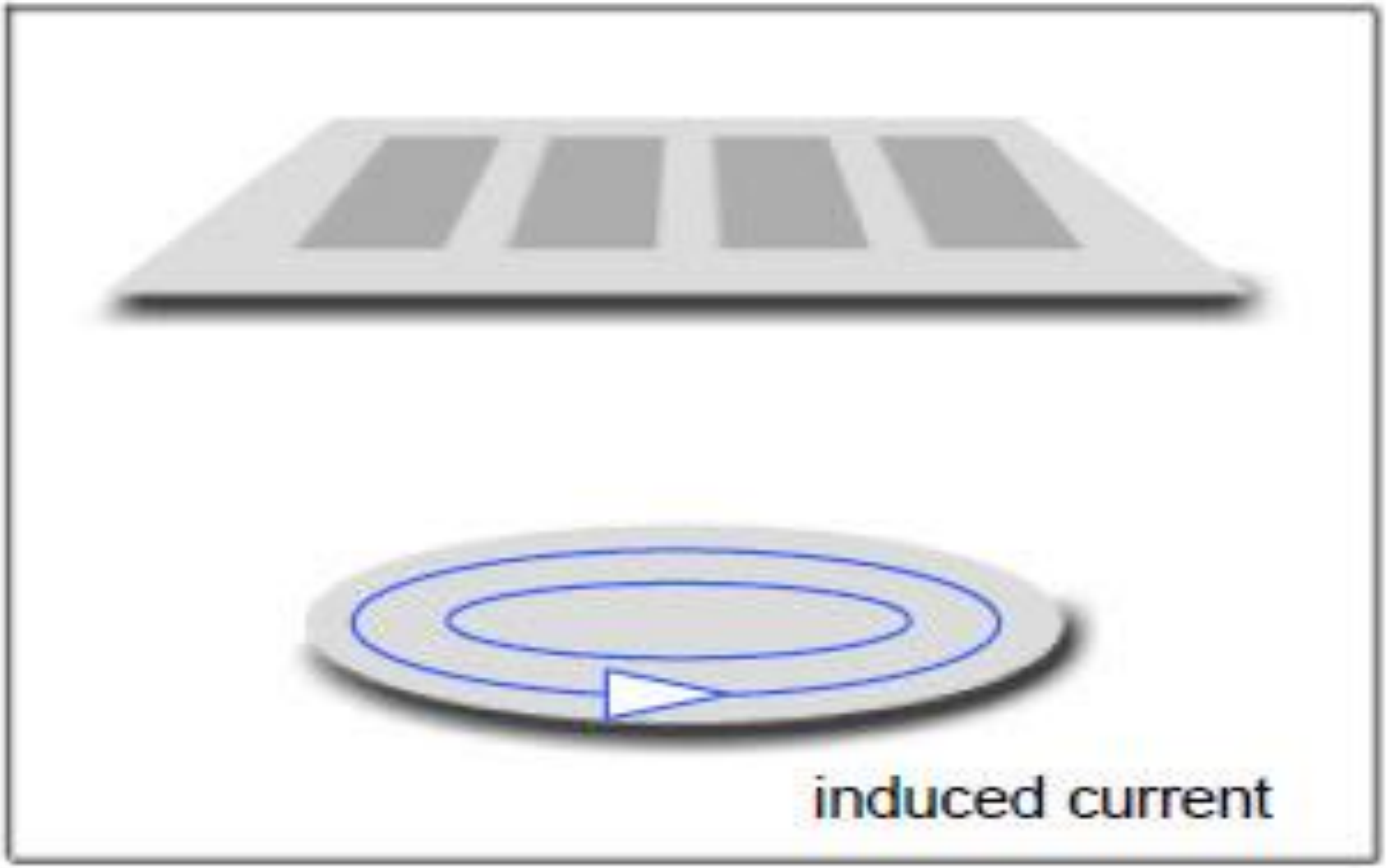

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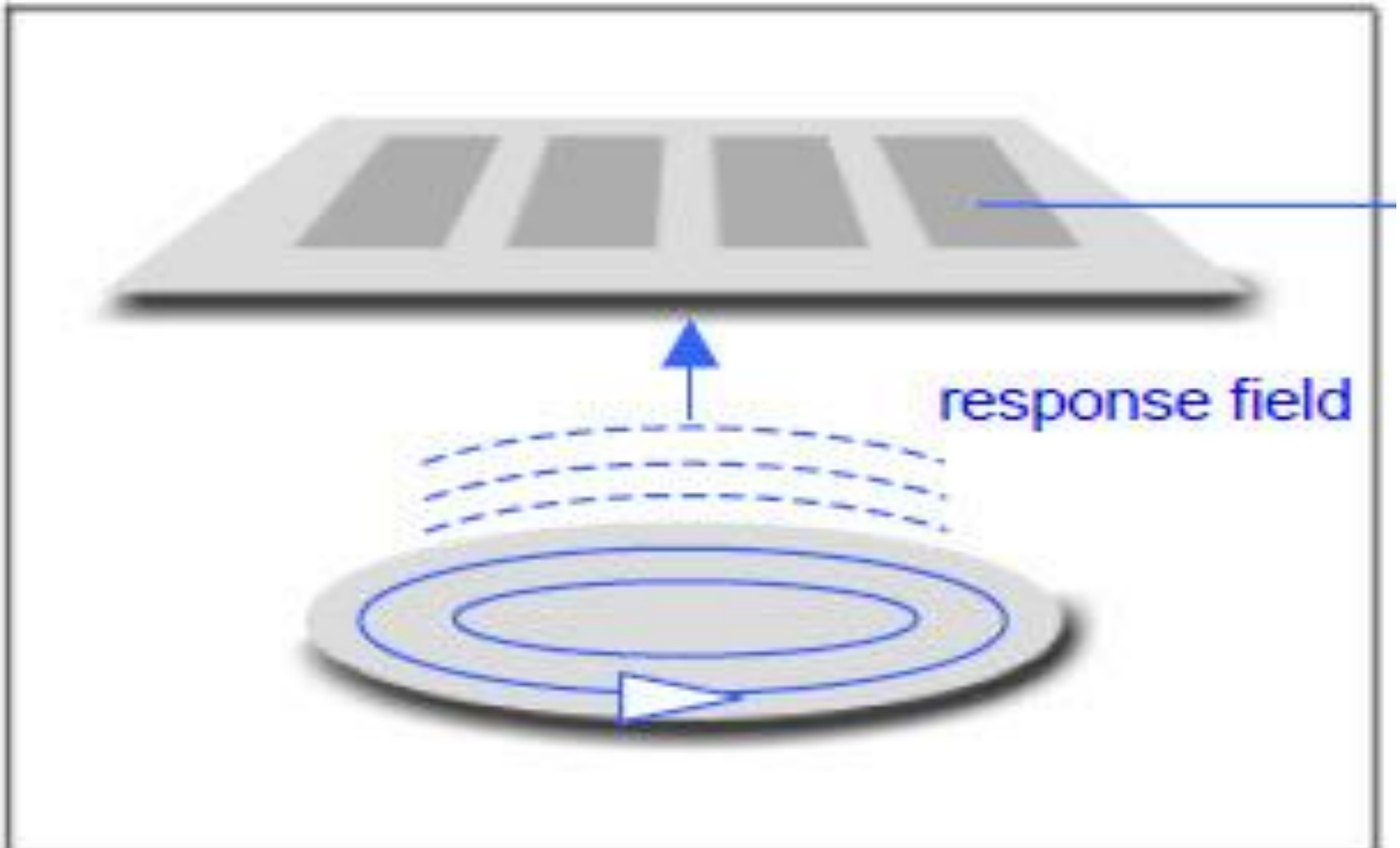

T2

- **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

T2

- **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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T2

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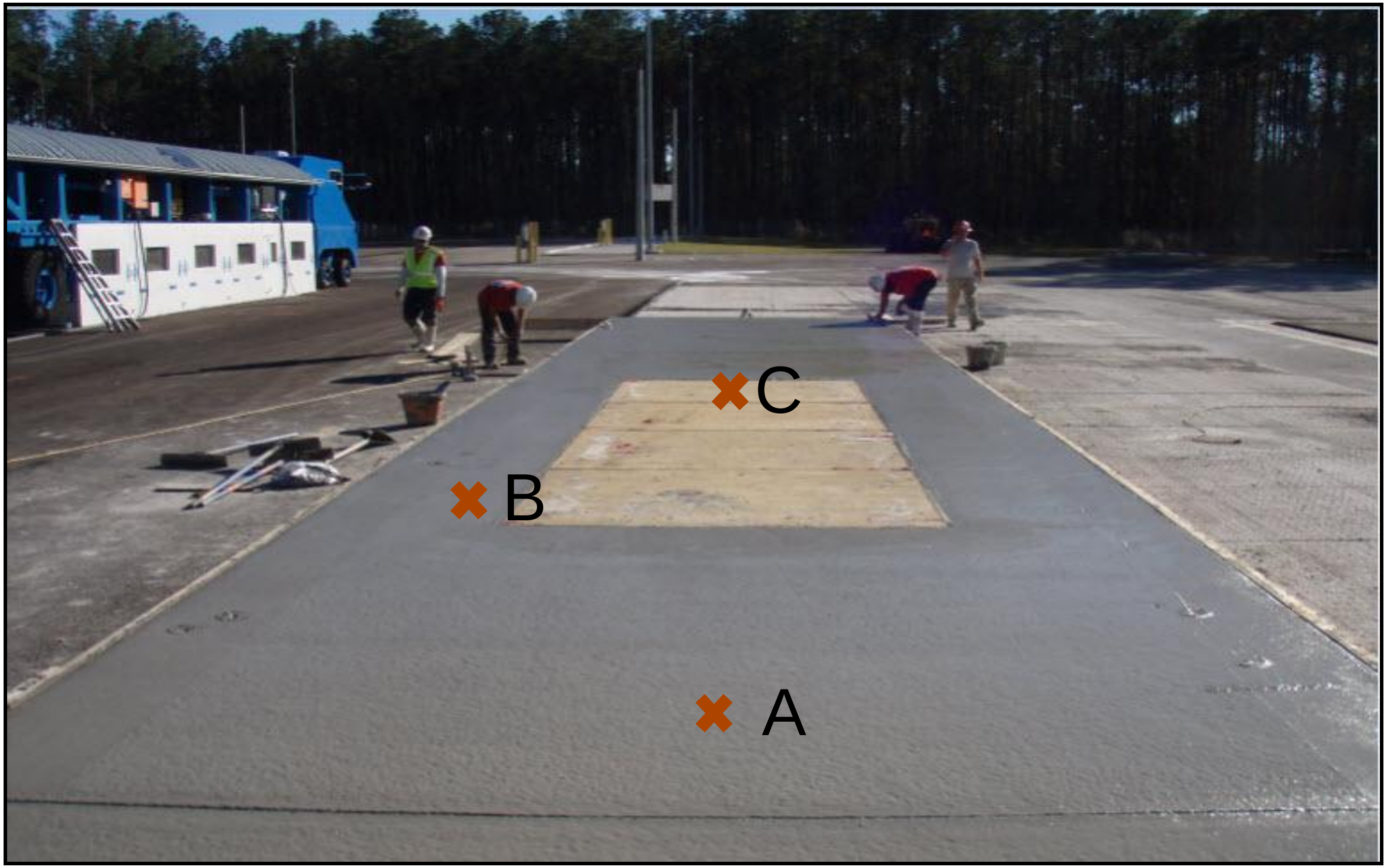
- Scan over the reflector


STORE RESULT
PRINT LAST RESULT
PRINT COMPLETE SERIES
333
3
C
6
D
E
F

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



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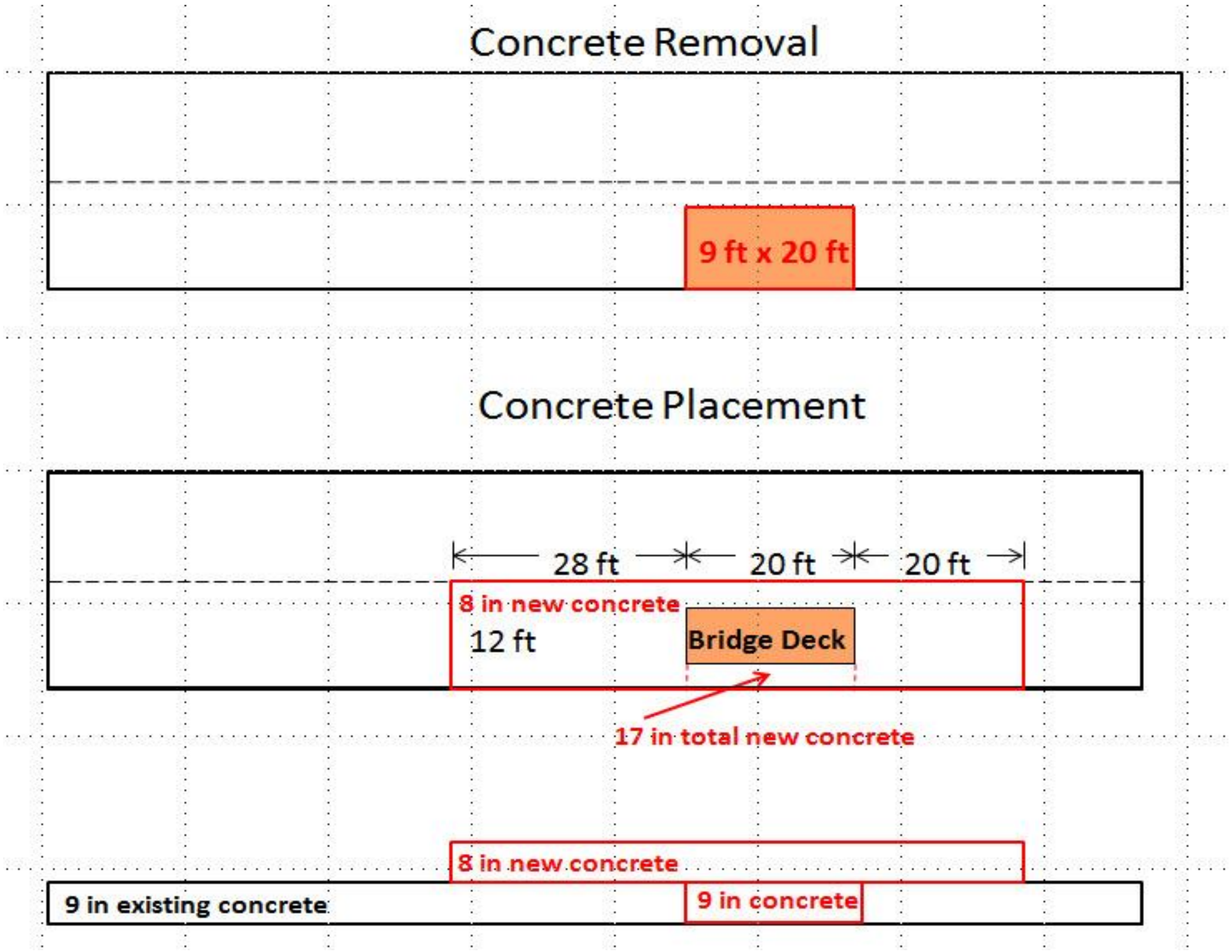

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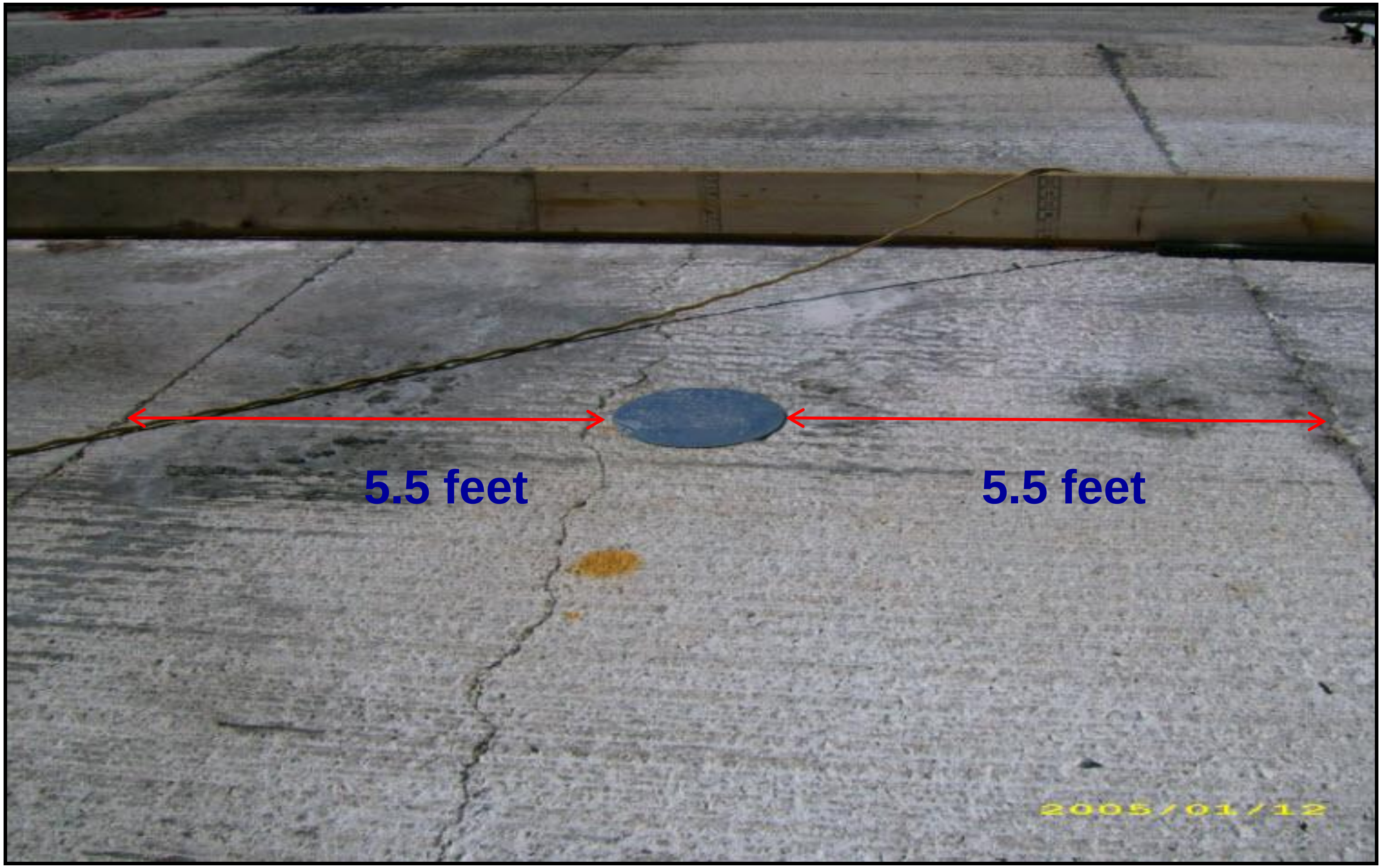

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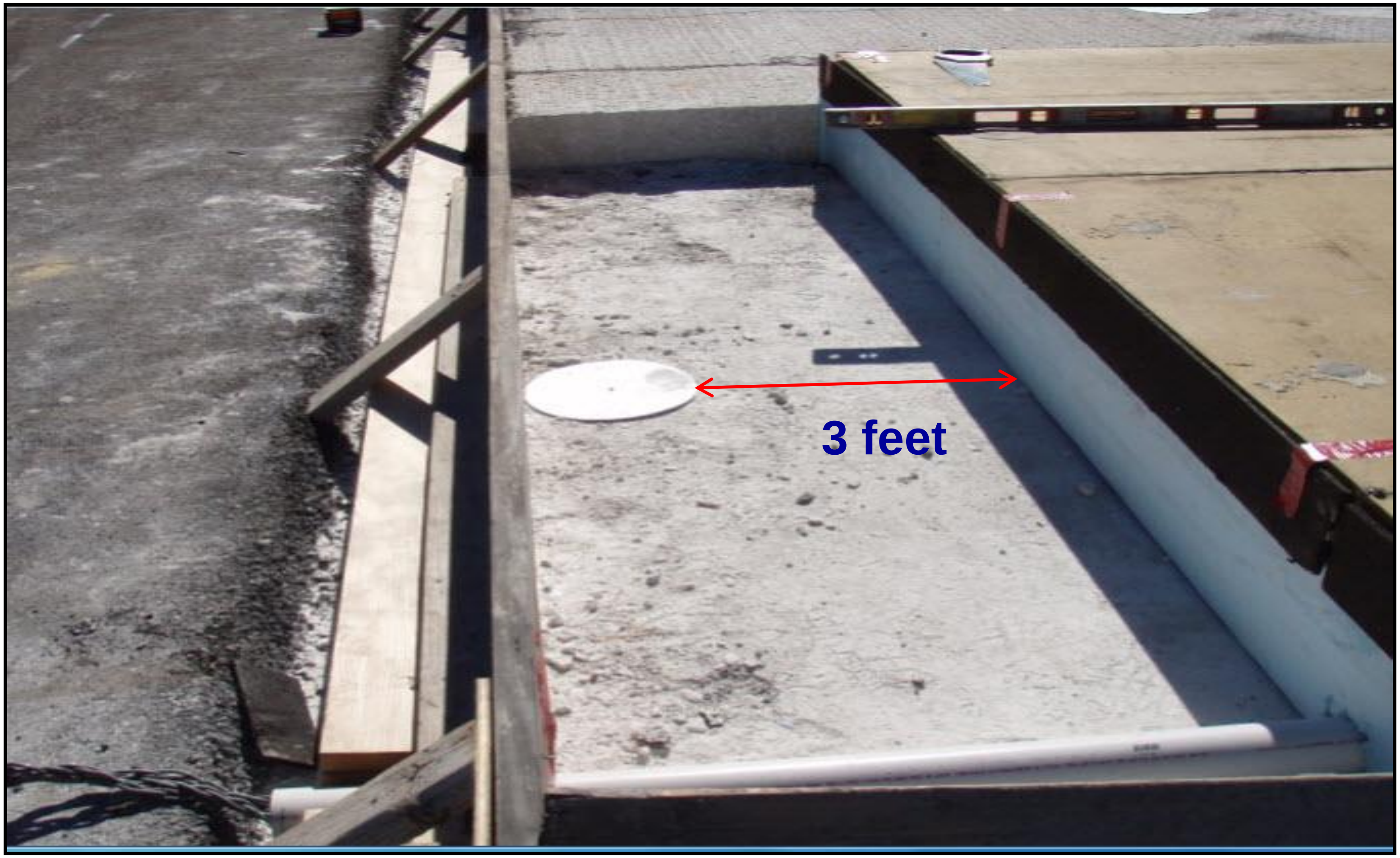

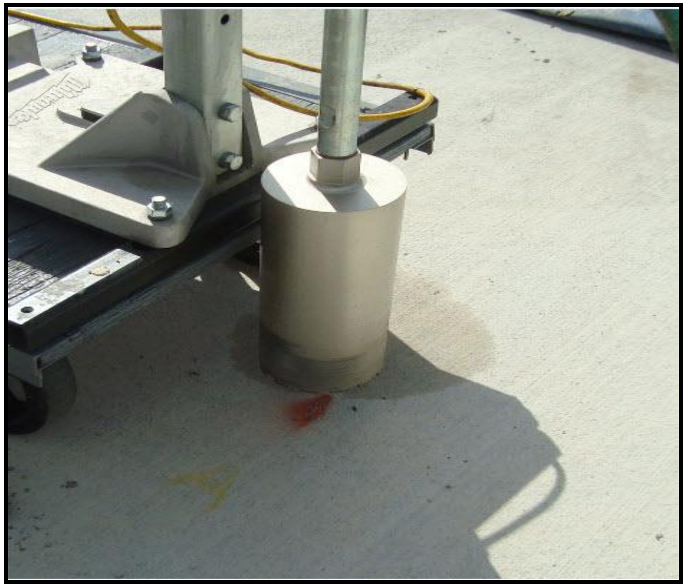

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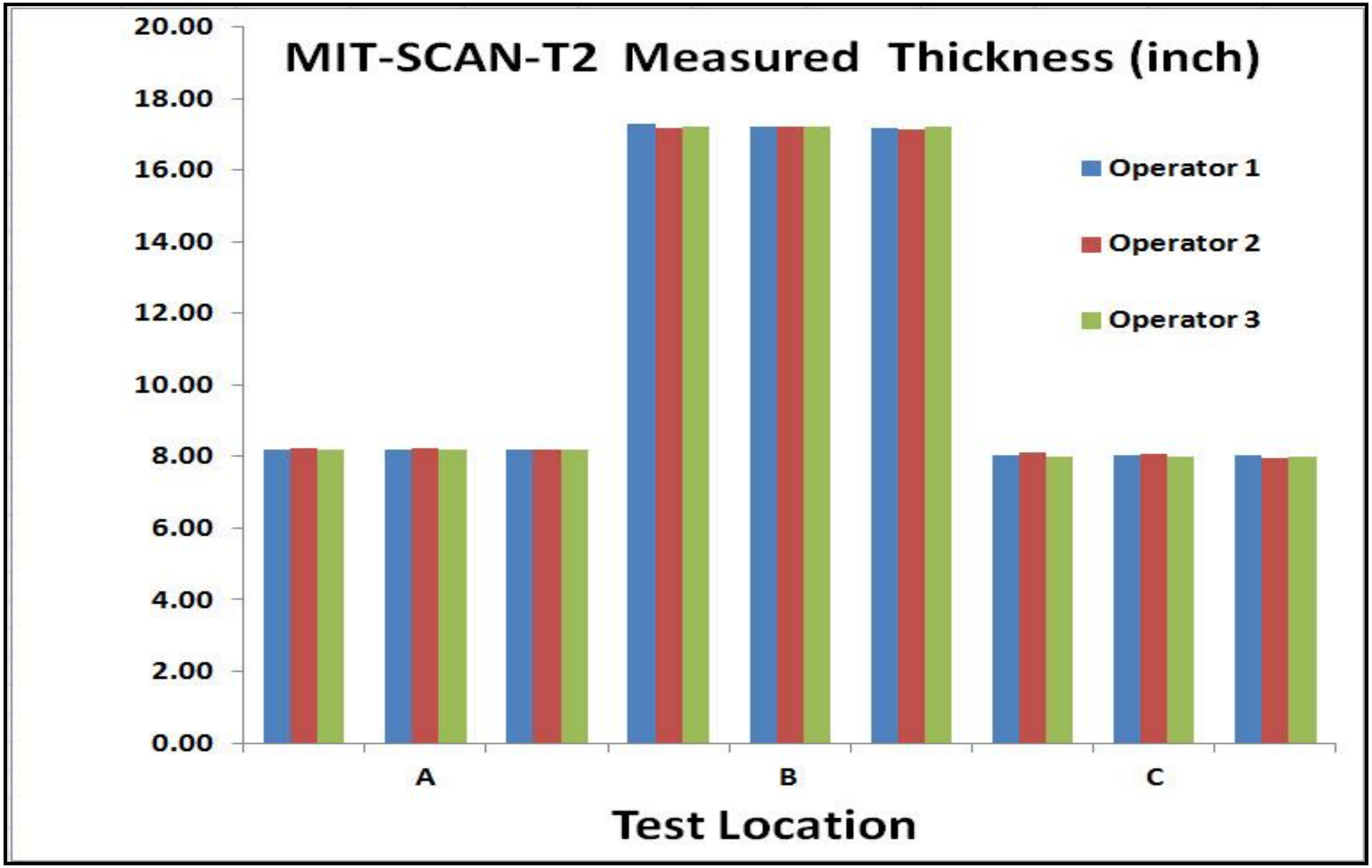


T2 Test Trials

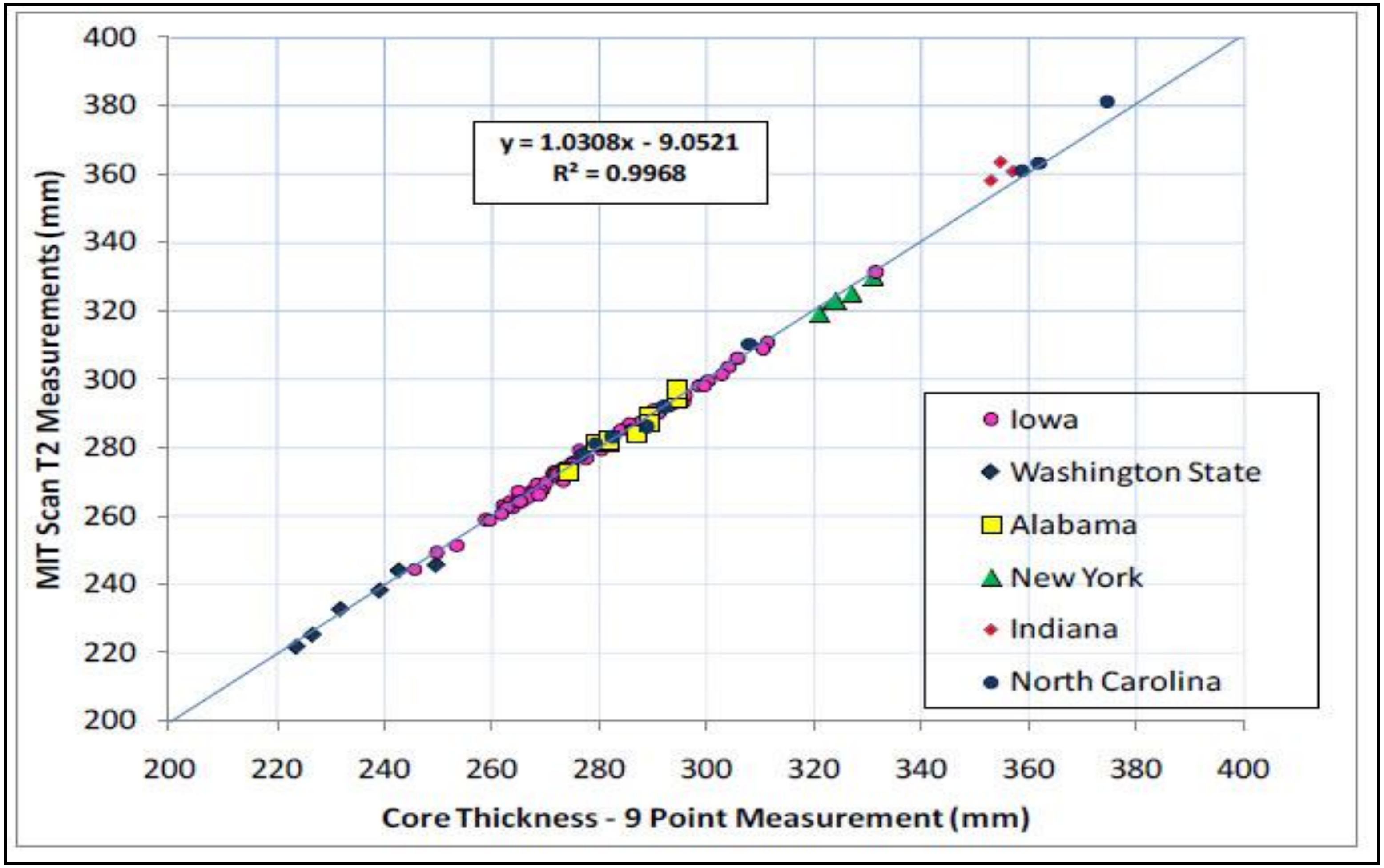
Test Location	Average Thickness (in)		Difference (in/mm)	St.Dev (in/mm)
	T2	Core		
A	8.20	8.25	0.05 / 1.27	0.01 / 0.3
B	17.20	16.95*	0.25 / 6.35	0.04 / 1.0
C	8.02	8.04	0.02 / 0.51	0.04 /1.0

* 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.)

T2

- **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

CONCRETE PAVEMENT CPTP TECHNOLOGY PROGRAM

TechBrief

The Concrete Pavement Technology Program (CPTP) is an integrated, national effort to improve the long-term performance and cost-effectiveness of concrete pavements. Managed by the Federal Highway Administration through partnerships with State highway agencies, industry, and academia, CPTP's primary goals are to reduce congestion, improve safety, lower costs, improve performance, and foster innovation. The program was designed to produce user-friendly software, procedures, methods, guidelines, and other tools for use in materials selection, mixture proportioning, and the design, construction, and rehabilitation of concrete pavements..

www.fhwa.dot.gov/pavement/concrete

U.S. Department of Transportation
Federal Highway Administration

Determination of Concrete Pavement Thickness Using the Magnetic Imaging Tomography Technique

This technical summary discusses the application of a recently introduced technique, based on magnetic imaging tomography, to determine the thickness of freshly placed concrete. This technique may be used for process testing and for acceptance testing during construction of new concrete pavements. The technique is applicable only to plain (nonreinforced) concrete pavements. The results of recent field trials using this technique are presented.

BACKGROUND

Concrete slab thickness plays a critical role in the performance of concrete pavements. A small deficit in slab thickness can significantly reduce the service life of a concrete pavement. Based on the structural design procedures for concrete pavements, a reduction in concrete slab thickness by an inch (2.54 cm) can result in as much as a 50 percent reduction in the service life of the pavement. Many highway agencies have tight specifications for concrete pavement thickness. Typically, a large reduction in lot payment may result if the concrete pavement thickness is 12.5 mm (0.5 in.) less than specified for as-designed pavement thicknesses in the range of 250 mm to 300 mm (9.8 in. to 11.8 in.). Such requirements make the measurement of concrete pavement thickness an important activity to determine the compliance of concrete pavement construction with the project construction specifications.

For most highway agencies, ASTM C 174 (ASTM 2006a), "Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores," is the standard method to determine the thickness of as-constructed concrete pavement. Although this method produces accurate thickness measurement, the testing procedure is destructive, time consuming, labor intensive, and costly. Normally only one core is drilled per sublot (typically every few hundred feet of pavement). With these few sampling points, it is hard to establish a statistically robust representation of the pavement thickness in a constructed lot. In addition, the measurement of the core length can also be affected by base type, particularly by open-graded permeable base where concrete can penetrate significantly into the base.

Some nondestructive tests are available for measuring concrete pavement thickness, such as the ASTM C 1383, "Standard Test Method for Measuring the P-Wave Speed and the Thickness of Concrete Plates Using the Impact-Echo Method" (ASTM 2006c), and ASTM D 4748, "Standard Test Method for Determining the Thickness of Bound Pavement Layers Using Short-Pulse

QUESTIONS ?