

25th Annual NJDOT Research Showcase

Rapid Assessment of Infrastructure Using NDT Methods



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Introduction

- Per ASCE's 2021 Report Card for America's Infrastructure, our infrastructure scored a C-:
 - Roads: D Grade (Poor, at risk)
 - Bridges: C Grade (Mediocre, requires attention)
 - Public Transit: D- Grade
- This affects public safety and potential consequences of failure.
- Maintenance backlogs continue to be an issue.
- Asset management helps prioritize limited funding.
- Condition information/inventory of assets is highly needed.







Introduction



- Hammer sounding and chain dragging on bridge decks or
- Windshield inspections on roadway networks
- Traditional inspections have questionable accuracy and reliability, often yielding variable results.
- Require Maintenance & Protection of Traffic (e.g., lane closures, others). Inspectors at risk.



Non-destructive Testing (NDT) Methods

- A shift toward Non-destructive Testing (NDT) methods is preferred.
- NDT methods test the material in-situ.
- Safer: *Less inspectors on the ground*.
- Provide more in-depth condition assessment and performance monitoring while reducing dependency on the operators' judgment.
- Ground Truth data is always needed to compliment NDTs.









Non-destructive Testing (NDT) Methods

- Ground Penetrating Radar
- Laser Scanner Systems: LiDAR, 3D laser cameras
- Infrared Thermography
- Seismic/Ultrasonic
- Others: Profilers, Falling Weight Deflectometer, Skid Tester

Ground Penetrating Radar (GPR)

- Greater coverage area
- Limited to no traffic closures needed
- Can be combined with other technologies
- ASTM Standards: D4748, D6087, D6432



Air-Launched GPR



Ground-Coupled GPR



Multi-channel GPR



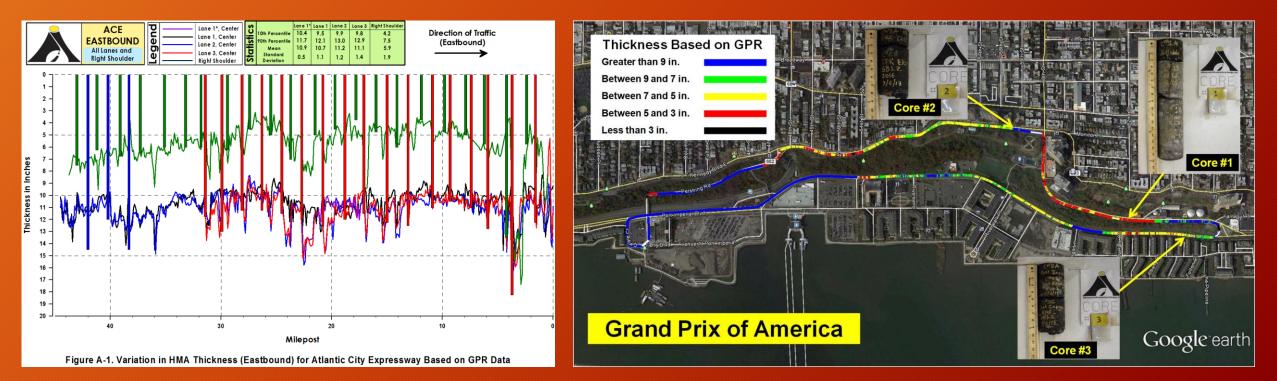
GPR: Applications

- Thickness Evaluation
- Subsurface/Utility Mapping
- Bridge Deck Evaluation
- Rebar Mapping
- Changes in Construction
- Air Voids Mapping (QC/QA of newly constructed roadways)



GPR: Thickness Evaluation

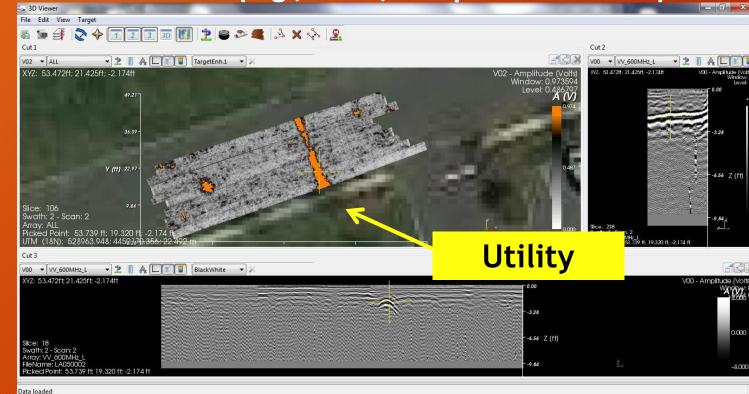
- Continuous Profile
- Layer Composition
- Limited Coring Needed for Verification







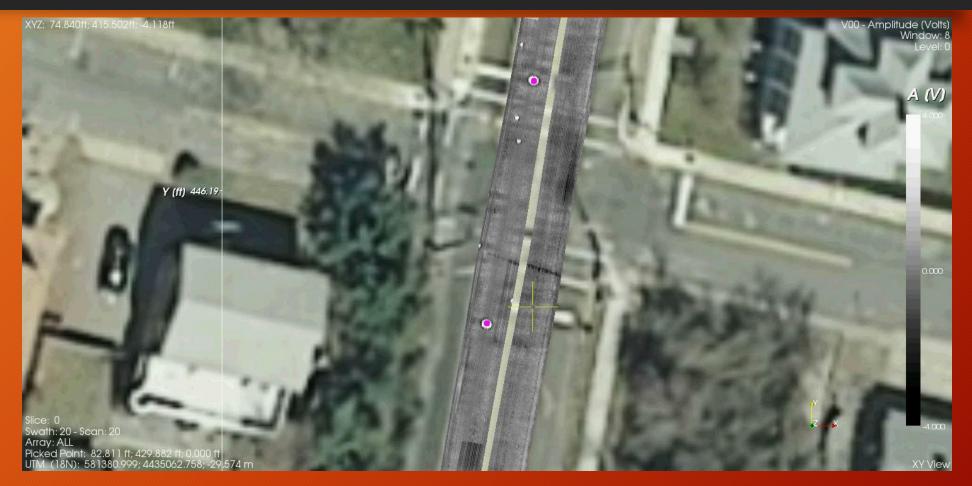
• Other Subsurface Anomalies (e.g., voids, compromised areas)



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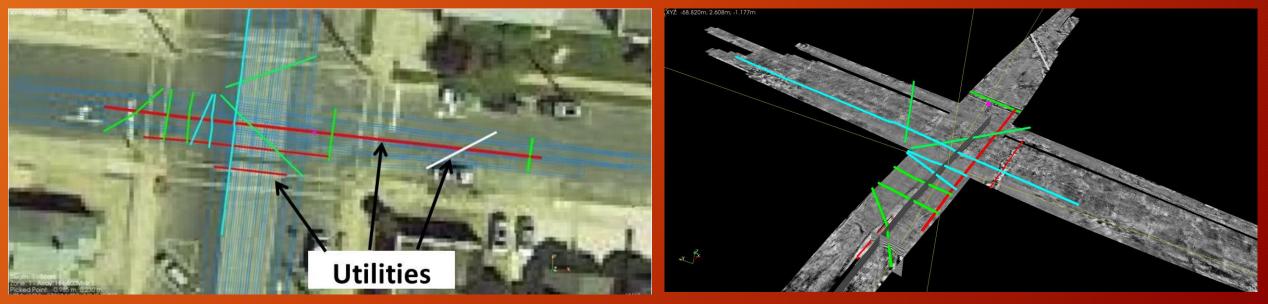
Easier Interpretation with Multichannel Systems





GPR Slices at Different Depths (Tomography)

- Subsurface Utilities
- Other Subsurface Anomalies (e.g., voids, compromised areas)



Utilities Displayed on Google Earth

Utilities Exported to AutoCad



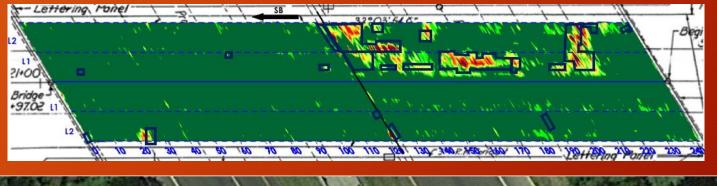


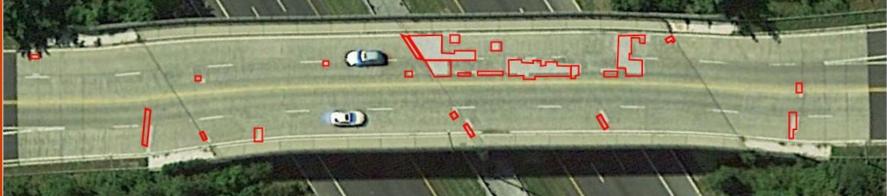


GPR: Bridge Deck Evaluation







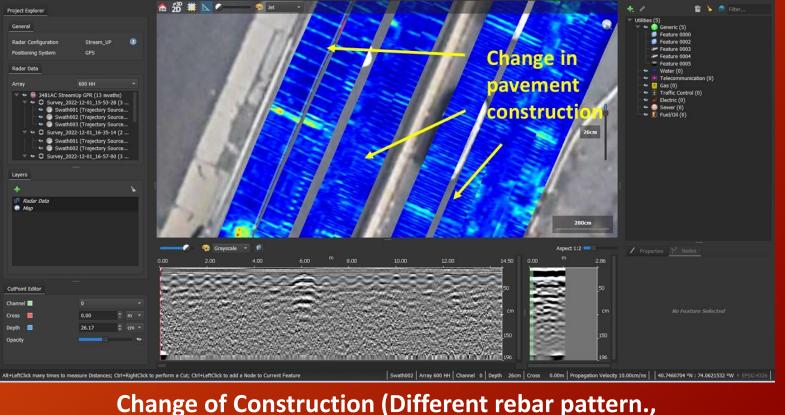


GPR: Rebar Mapping/Changes in Construction

Project Export Ed



Rebar Mapping to Complete As-builts



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Change of Construction (Different rebar pattern., flexible vs. rigid pavement areas)

GPR: Air Voids (New Pavements)

Turning Lane EB Lane 1 EB (Night 2) High density, Rt. 230 Eastbound (Night 2) NOT low air voids TESTED 3.8 3.6 0 min 10 3.4 ce from Edge (ft) 3.2 2.8 2.6 Low density, 2.4 high air voids 2.2 600 100 300 500 200 400 18.0% Distance from Start (ft) Rt. 230 Westbound 16.0% Lane 1 WB WB Lane-Shoulder 14.0% y = 1.4262e^{-0.81x} (Night 1) R² = 0.7562 Start: St. 620+78 Joint × 12.0% . ⊨ 10.0% 8.0%

> 6.0% ---4.0% ---2.00

> > **Dielectric Value**

Complete coverage of newly constructed asphalt pavements. Great correlation with cores

3D Laser Cameras (Roadway Inspection)

• 3D laser cameras are combined with other systems (e.g., video, GPS, GPR, profiler) for a comprehensive pavement assessment.

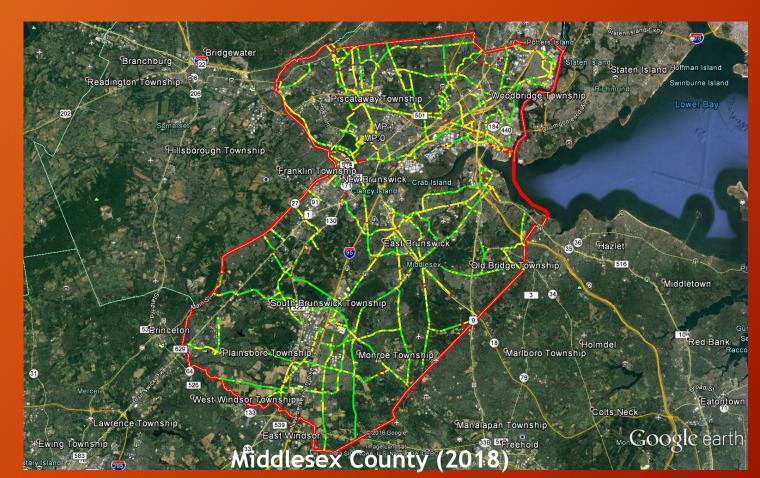






3D Laser Cameras (Roadway Inspection)

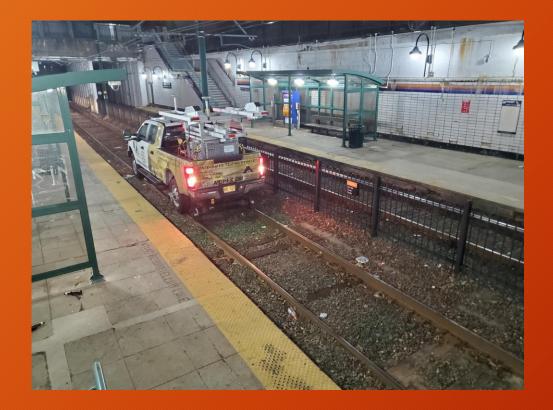
• Safe, efficient, and objective (i.e., defensible)

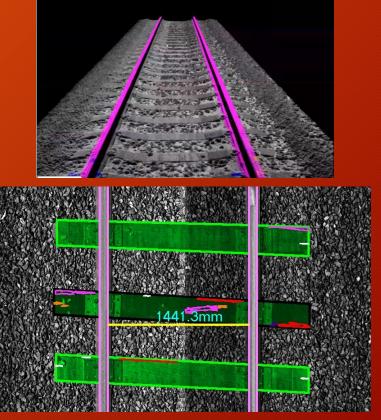




3D Laser Cameras (Rail Inspection)







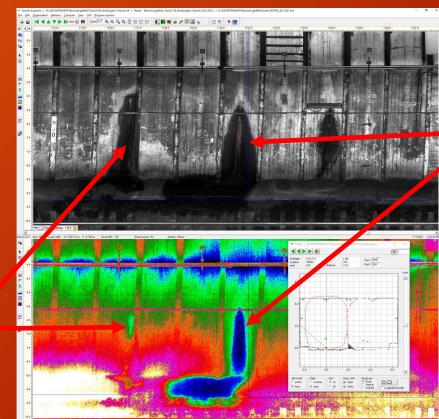
Rail and ties condition inspection is obtained



3D Laser Scanner (Tunnel Inspection)

- 3D laser system specifically designed for tunnels
- Integration of laser cameras and thermal cameras





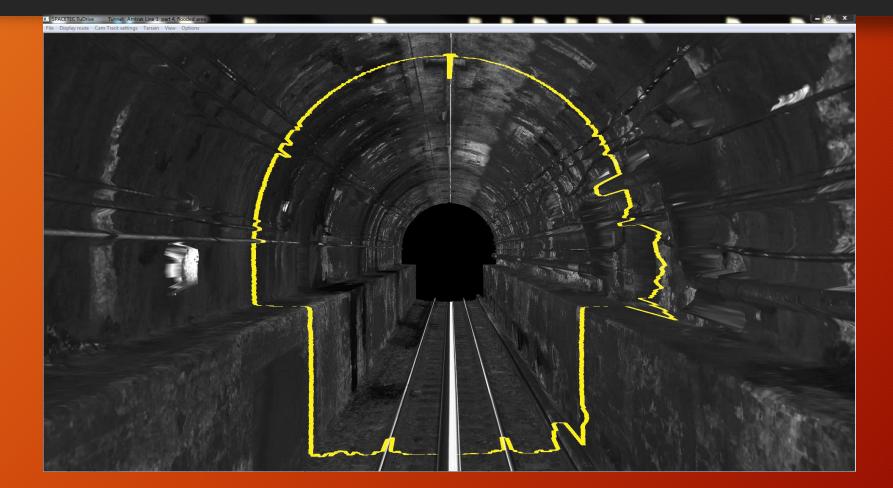
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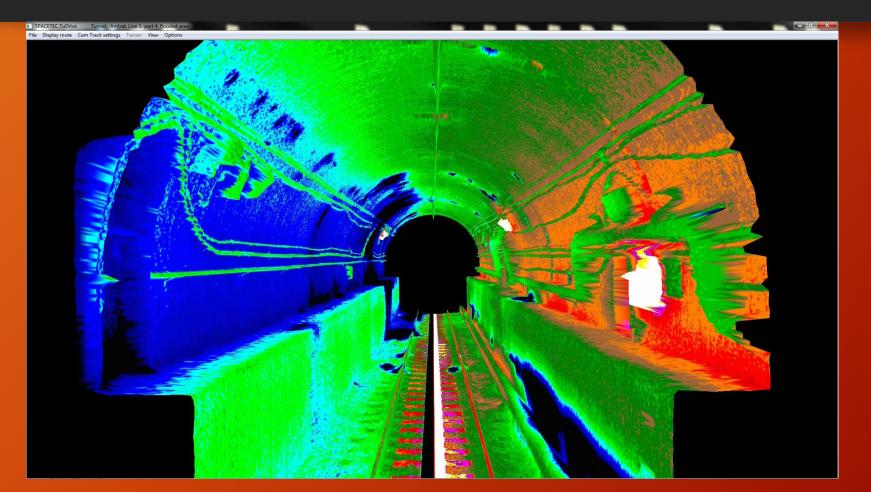
Active Water Leakage

3D Laser Scanner (Tunnel Inspection)





3D Laser Scanner (Tunnel Inspection)





3D Laser Scanner (Retaining Walls)



• Vertical walls can also be investigated with this type of scanner

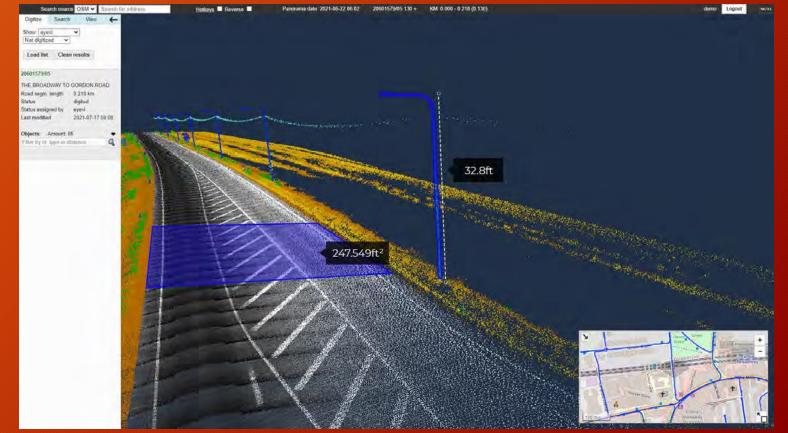


LIDAR



 LIDAR systems allow to create point cloud data and obtain measurements of assets of interest very accurately (e.g., traffic signs, pavement markings, bridge clearances, etc.).

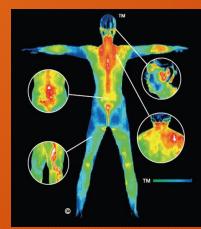




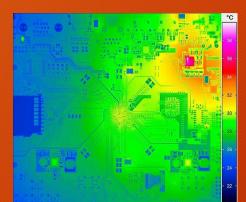
Infrared Thermography (IRT)

- The use of temperature data acquired from thermal imagery to study heat distribution in structures or regions.
- Subsurface Defect Assessment

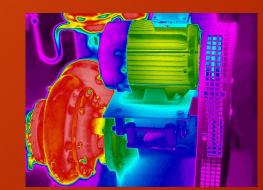
Medicine



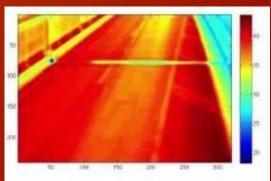
Electronics



Mechanical Engineering



Civil Engineering

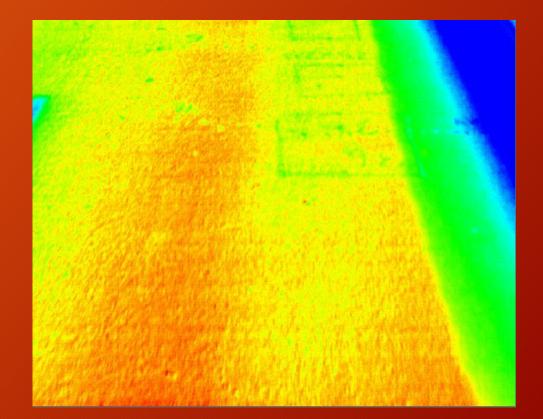




IRT: Roadway Assessment





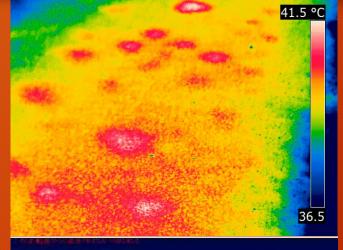


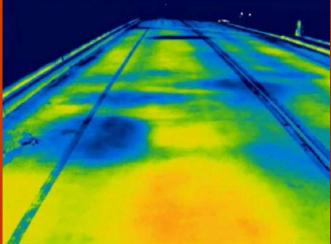


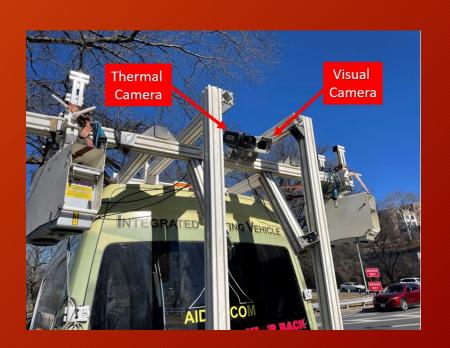
IRT: Bridge Assessment











Unmanned Aerial Vehicles (UAV)



- Able to record both thermal videos and pictures.
- Has active image stabilization.

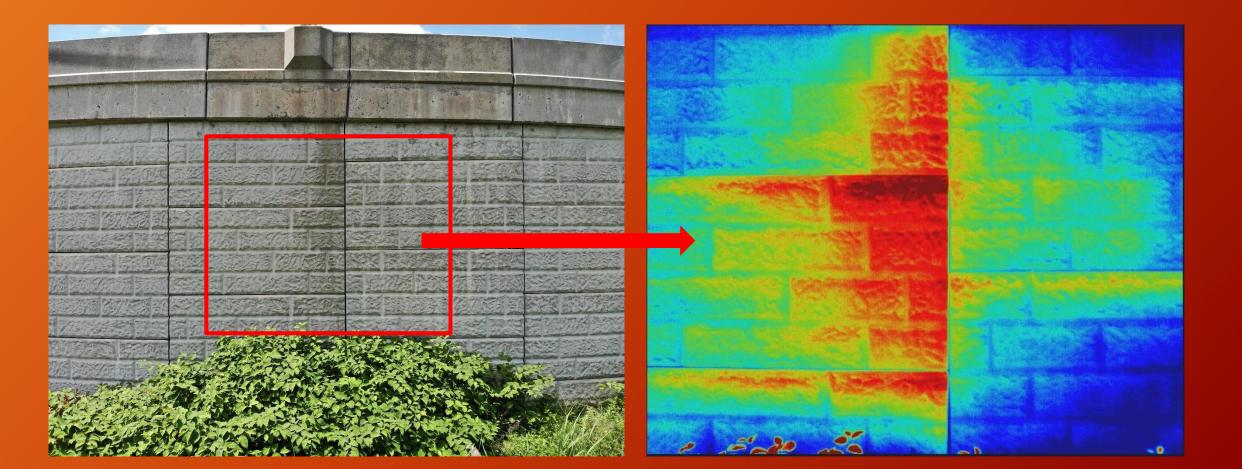






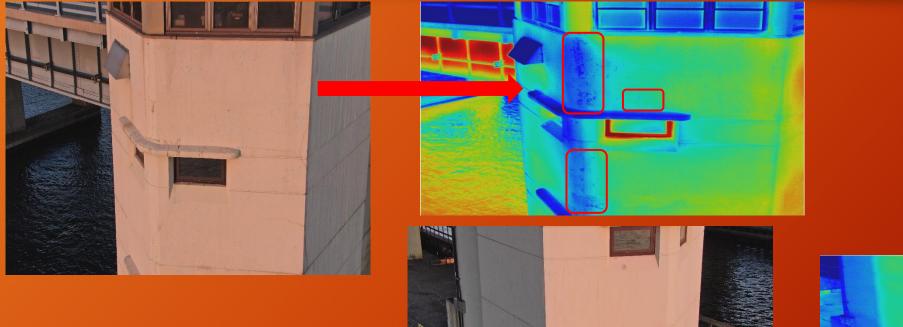
UAV. Retaining Wall Inspection





UAV. Building/Bridge Inspections







Other NDTs Used for Infrastructure



- Falling Weight Deflectometer (FWD): Structural Capacity, Joint Performance
- Skid Testing: Surface Friction







Skid Resistance Tester

Other NDTs Used for Infrastructure



Ultrasonic/Seismic: Concrete Integrity, void detection



Seismic (PSPA)



Ultrasonic Tomography

Summary



- NDT methods have a variety of applications to transportation infrastructure.
- Existing technologies are evolving and new ones are being developed.
- Many standards are available (e.g., ASTM, AASHTO).
- Safer in many cases as less people are needed on the ground.
- Important to recognize appropriate applications and limitations.
- A combination of NDTs typically enhances the infrastructure evaluation.
- Ground truth data is always needed to complement NDTs.
- Available manuals for best suited NDT methods from FHWA:
 - https://infotechnology.fhwa.dot.gov/

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