Nondestructive Testing for Tunnel Linings (R06G)

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Mapping Defects In or Behind Tunnel Linings

Use proven high-speed and detailed NDT methods to evaluate tunnel conditions as part of an integrated Asset Management program.
According to the Federal Highway Administration:

- **473+** highway tunnels in the national inventory (state and federal, including Puerto Rico) spread out across the nation.

- **37 States** have at least 1 tunnel on a highway:
  - California – 64
  - NPS – 64
  - Colorado – 38

Photos courtesy Wikipedia
Tunnel Evaluation

• New Tunnel Inspection Requirements are now in place for all DOT tunnels across the country with the National Tunnel Inspection Standard (NTIS).

• Clear inspection and reporting requirements, with new needs for high-speed inspection.
High-Speed Mapping of Defects In or Behind Tunnel Linings

Challenge
• Safely performing tunnel inspections in a high-traffic and confined work space.

Solution
• Use proven NDT scanning technologies to evaluate tunnel linings more quickly and comprehensively.
• Results then directly coupled with an integrated Asset Management program.
Tunnel deterioration is a major maintenance problem for highway departments.

**Issues for Tunnel Liners:**
- Corrosion of Reinforcing Steel
- Moisture Intrusion
- Debonding/Delamination of Shotcrete and Tile
- Drainage System Failure
- Cracking of Concrete
- Deformations and Bulges
Initial training on NDT methods completed.

Field testing of two PennDOT tunnels completed using various scanning methods.

Testing reports due shortly for review.

Tunnel-specific asset management programs created – and available for sharing with other states.

Distribution of Cracks Greater Than 1/8”, Armstrong Tunnel
R06G Product Approach

• Participate in educational programs on the use of high-speed NDT methods for evaluation of tunnels.

• Learn about and apply effective Asset Management programs that use NDT data and other sources as inputs.

• Use these NDT technologies to conduct high-speed evaluations of tunnels.

• Use the NDT results and other data to populate and use an effective tunnel Asset Management program.
Previously Evaluated and Proven NDT Technologies

Techniques Used:

- Air-coupled ground-penetrating radar (GPR)
- Thermography (handheld or vehicle mounted thermal camera)
- LiDAR scanning
- Photogrammetry
- Ground-coupled GPR
- Ultrasonic echo
- Ultrasonic surface waves and impact echo
Benefits of NDT Technologies

- Shorter and possibly fewer tunnel shutdowns during inspections, resulting in fewer detours.
- Safer for inspectors.
- Scanning tests provide 100% coverage.
  - LiDAR and Photogrammetry
  - Air Coupled GPR
  - Scanning Infrared
- Handheld devices to test areas in depth.
LiDAR and Infrared Scanning
Examples
Air Coupled GPR Example

- Tunnel Lining Surface Reflection
- Surface Dielectric
- Possible Low Density Interface
- Possible Lining Interface
- Depth Scale, in.
- Distance Scale, ft.

- ~14” Concrete
- ~1” Drainage Layer
- ~14” Shotcrete
Hand-Held IR Example

IR Image of Debonded Shotcrete (debonds in red)

Shotcrete Lined Tunnel

FLIR 1 IR Camera
For More Information

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**Additional Resources:**

**SHRP2 Websites:**

fhwa.dot.gov/GoSHRP2  
http://shrp2.transportation.org

**GoSHRP2 Alert Sign Up:**

fhwa.dot.gov/goshrp2/contact

**Email:**

GoSHRP2@dot.gov