SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

Pavement Solutions (R21, R06B, R06D, R06A, R06G)

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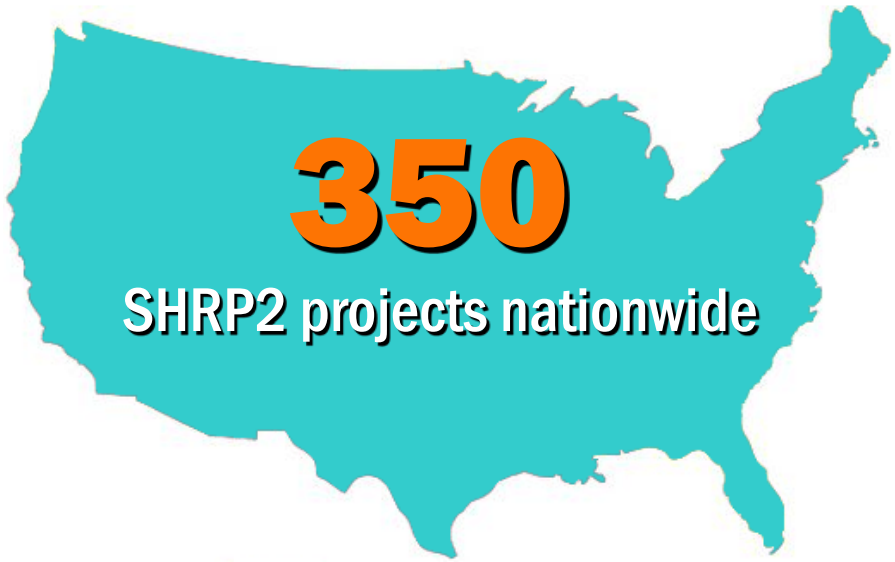
U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO
The Voice of Transportation

SHRP2 at a Glance

- **SHRP2 Solutions** – 63 products
- **Solution Development** – processes, software, testing procedures, and specifications
- **Field Testing** – refined in the field
- **Implementation** – 350 transportation projects; adopt as standard practice
- **SHRP2 Education Connection** – connecting next-generation professionals with next-generation innovations



Focus Areas

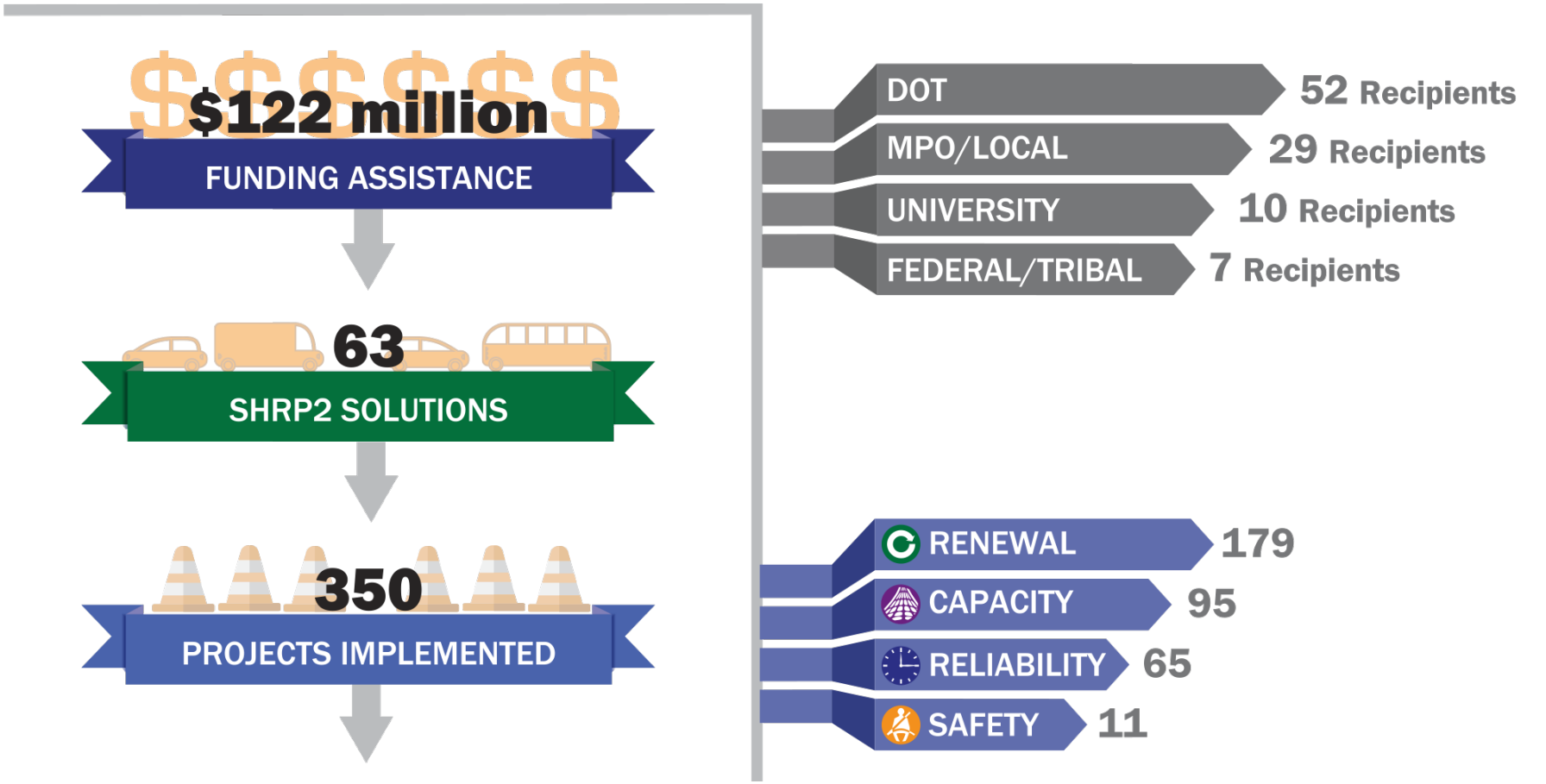
Safety: fostering safer driving through analysis of driver, roadway, and vehicle factors in crashes, near crashes, and ordinary driving

Reliability: reducing congestion and creating more predictable travel times through better operations

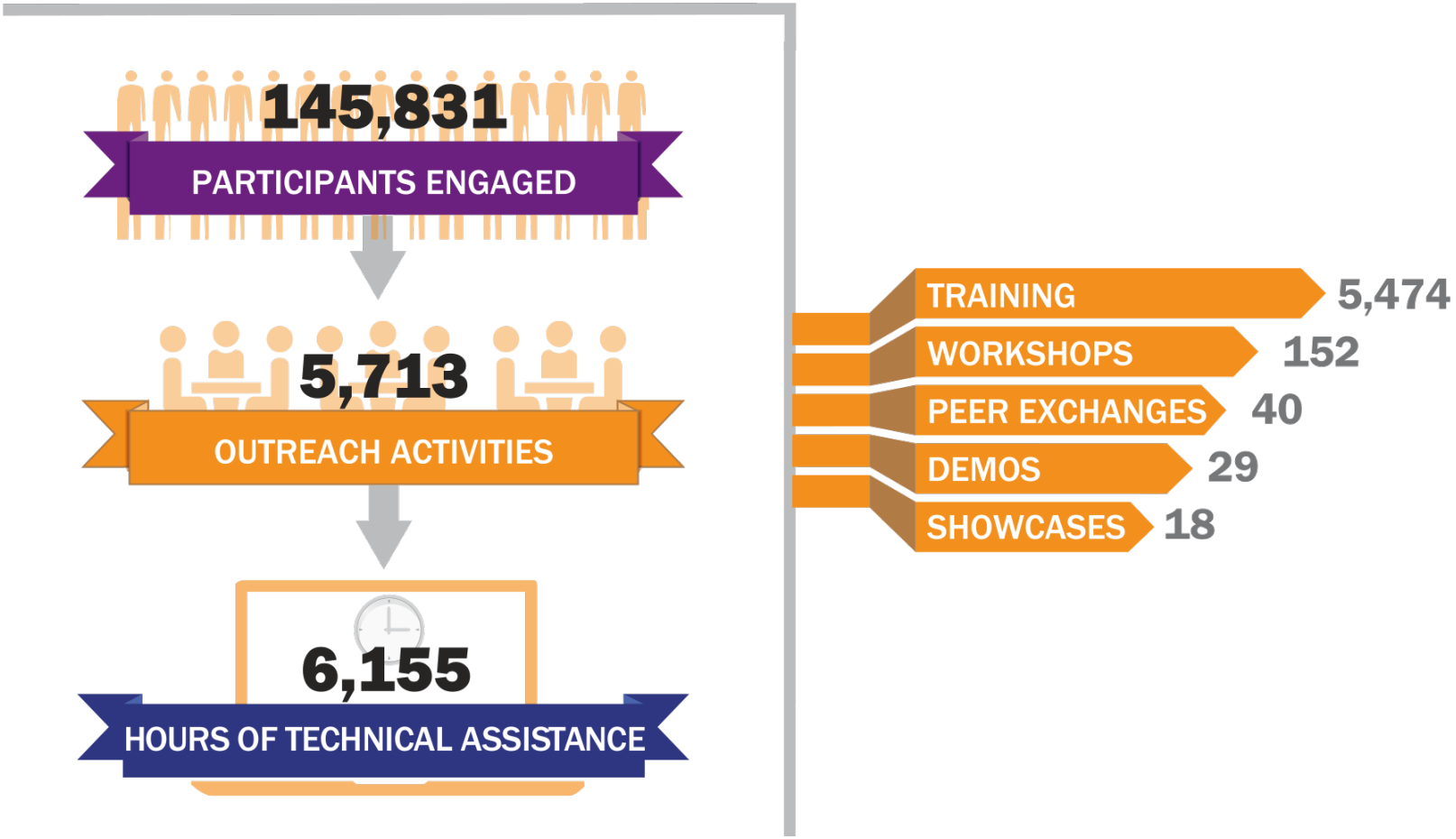
Capacity: planning and designing a highway system that offers minimum disruption and meets the environmental and economic needs of the community

Renewal: rapid maintenance and repair of the deteriorating infrastructure using already-available resources, innovations, and technologies

SHRP2 Implementation: Moving Us Forward



SHRP2 Implementation: Moving Us Forward



SHRP2 Implementation Assistance Program

- Designed to help State DOTs, MPOs, local agencies, and other interested organizations deploy SHRP2 Solutions.

Proof of Concept Pilot	Lead Adopter Incentive	User Incentive
To evaluate product readiness.	To help offset costs associated with product implementation and risk mitigation.	To support implementation activities, such as conducting internal assessments, changing processes, and organizing peer exchanges.

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Composite Pavement System Construction (R21)

Composite Paving System Construction

Composite Paving System Construction

Composite Paving System Construction

- Excellent Surface Characteristics:
  - Low noise
  - Smooth ride
  - Quality pavement
  - High durability

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Techniques to Fingerprint Construction Materials (R06B)

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CHALLENGE:

To accurately verify that construction materials meet project and contract specifications

RESEARCH GOAL:

To evaluate portable spectroscopy technologies to use in the field to verify commonly used construction materials

Techniques to Fingerprint Construction Materials (R06B)

Benefits

- Promising field technologies for analyzing quality assurance of some materials
- Rapid testing on site
- Minimizes noncompliance risk
- Only available method for Reclaimed Asphalt Pavement (RAP) testing

Techniques to Fingerprint Construction Materials (R06B)

SOLUTION:

- XRF:
  - Suited for identifying the metal content of any material
  - Specific application developed in R06B - testing traffic paints using their Ti content as QA/QC criterion.

X-Ray Florescence (XRF)

- FTIR:
  - Suited for fingerprinting pure chemical compounds; additives or contaminants in complex mixtures; and quantifying polymer additives.
  - Generic Guidance - For evaluating oxidation degree in RAP and admixtures in fresh Portland Cement Concrete (PCC) (accelerators, retarders, curing compounds)

Attenuated Total Reflectance Fourier Transform Infrared (ATR FTIR) Spectroscopy

XRF Applications for Construction Materials

- Detection of Pb and As in glass beads (NJ developed draft AASHTO standard)
- Detection of Pb and other contaminants in bridge paints, soils, aggregates or any other materials
- Detection of lime in asphalt
- Steel grade QA/QC
- QC for epoxies and traffic paints (draft AASHTO developed by R06B, ASTM standard recently published D5381-93(2014))

XRF Advantages and Limitations

Advantages

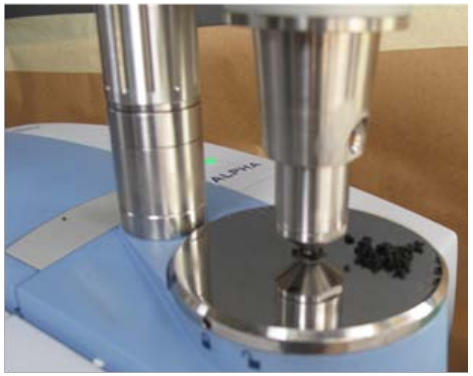
- Pre-calibrated for a wide range of elements
- Automatic reading – no analysis experience required
- 1-3 min testing time
- Little or no sample preparation required
- No maintenance required – costs only associated with equipment acquisition ($35K-40K)
- Several applications possible in addition to the paint testing -> more bang for your money

Limitations

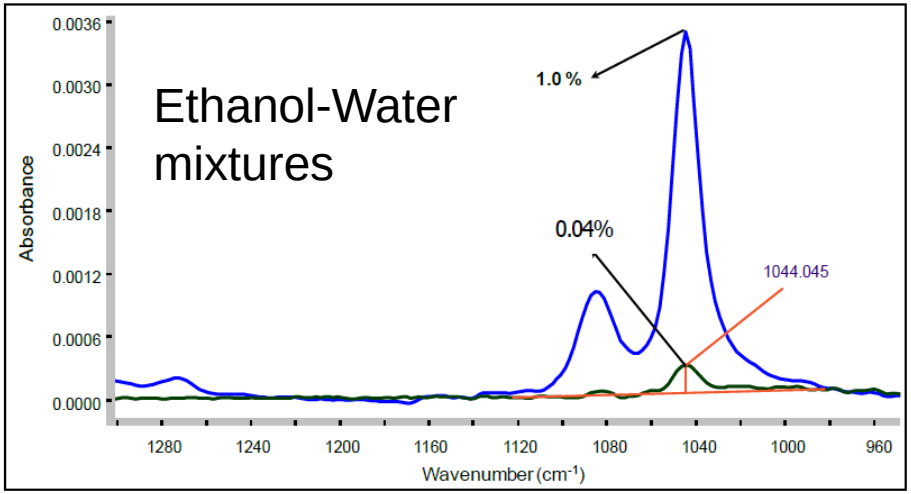
- Can only be used by certified personnel
- Upper and lower limits -> different calibrations needed for trace metals vs. ores (only a cost consideration)

How FTIR Works

ATR spectrometer
$25K-35K



1. Obtain a reference spectrum of a pure compound (identify characteristic peaks)
2. Compare material mixture with reference and determine whether the characteristic peaks of the compound show up (DETECTION)
3. Use height of observed peaks to infer concentration (QUANTIFICATION)



FTIR Advantages and Limitations

Advantages

- Only available method for the particular applications proposed
- Little to no sample preparation
- Actual testing time is 3-5 min
- No maintenance costs
- Widely applicable for a wide range of organic materials (e.g. solvents)

Limitations

- Detection limits fairly high for admixtures
- Training and experience required to interpret spectra, especially for the RAP application
- Wide variability in RAP composition and behavior renders standard development time-consuming and labor-intensive

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Advanced Methods to Identify Asphalt Pavement Delamination (R06D)

Advanced Methods to Identifying Pavement Delamination (R06D)

CHALLENGE:

- Several pavement distresses can be attributed to delamination.
- Primarily caused by de-bonding & stripping.
- Identifying the extent and severity of delamination is difficult.
- Coring is a destructive method providing limited value as part of a pavement evaluation.
- Non-destructive testing (NDT) methods are needed for comprehensive, rapid evaluation and detection.

RESEARCH GOAL:

Identify and develop NDT technology that can:

- Detect & quantify delamination in Hot Mix Asphalt (HMA)
- Operate at reasonable traveling speed
- Cover full-lane width

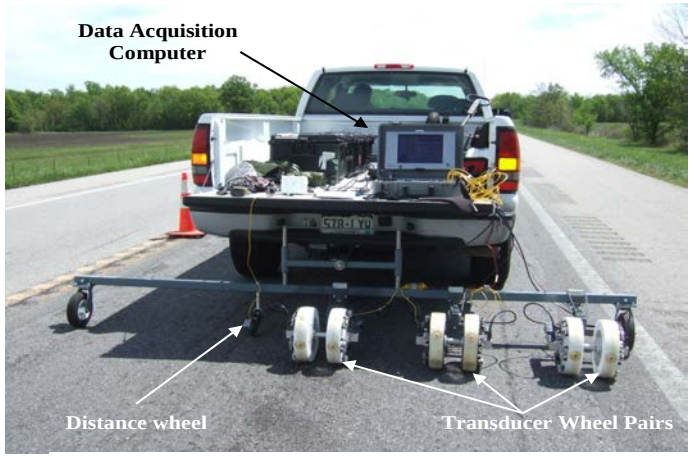
Advanced Methods to Identify Pavement Delamination (R06D)

Solutions

- Ground-penetrating radar (GPR) antenna array with frequency sweep
  - Manufactured by 3D-Radar

GPR Antenna Array

- Impact echo (IE) and Seismic Analysis of Surface Waves (SASW) rolling wheel scanning system
  - Built by Olson Engineering



IE/SASW Scanning System

GPR - Ground Penetrating Radar

IE/SASW – Mechanical Surface Waves

Advanced Methods to Identify Pavement Delamination (R06D)

Benefits

- GPR with frequency sweep antenna array
  - Can identify variations in the pavement, isolate the depth of discontinuity, and provide a relative degree of severity.
  - Operates at reasonable speed and full-lane width in a single pass.
  - Multi-functional NDT (pavement, bridge decks, embankment, etc.)
- IE/SASW scanner
  - Can identify variations in the pavement; width depends on system configuration and the depth of discontinuity.
  - Multi-functional NDT tool (pavement and bridge deck delamination)
  - Excellent forensic tool for project level analysis

Advanced Methods to Identify Pavement Delamination (R06D)

The Future

Product demand will drive software development to make data analysis more efficient and effective.

- Real-time display detail
- Automated signal identification in distressed areas

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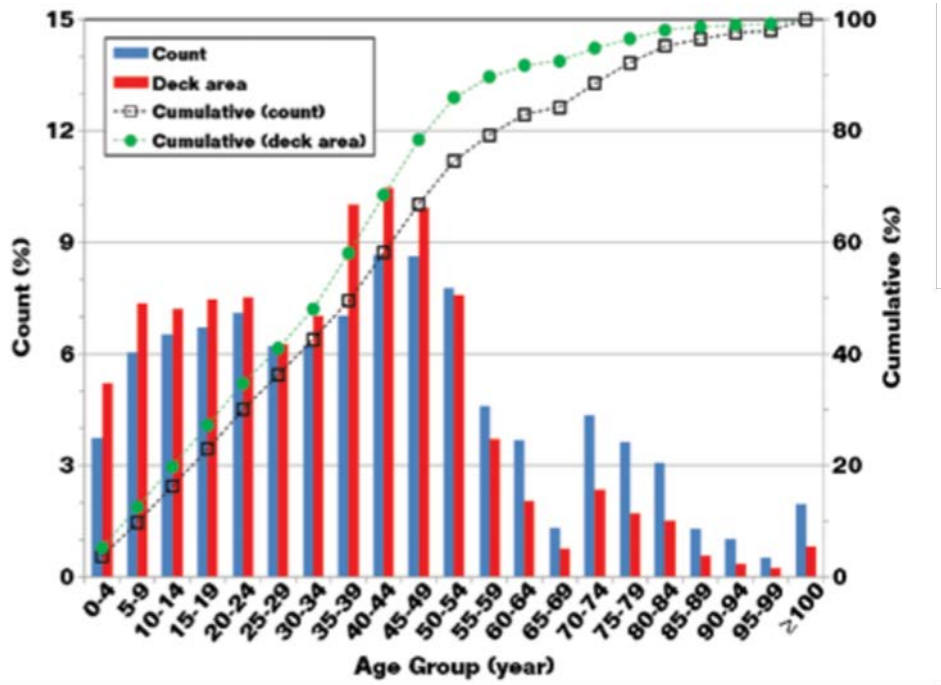
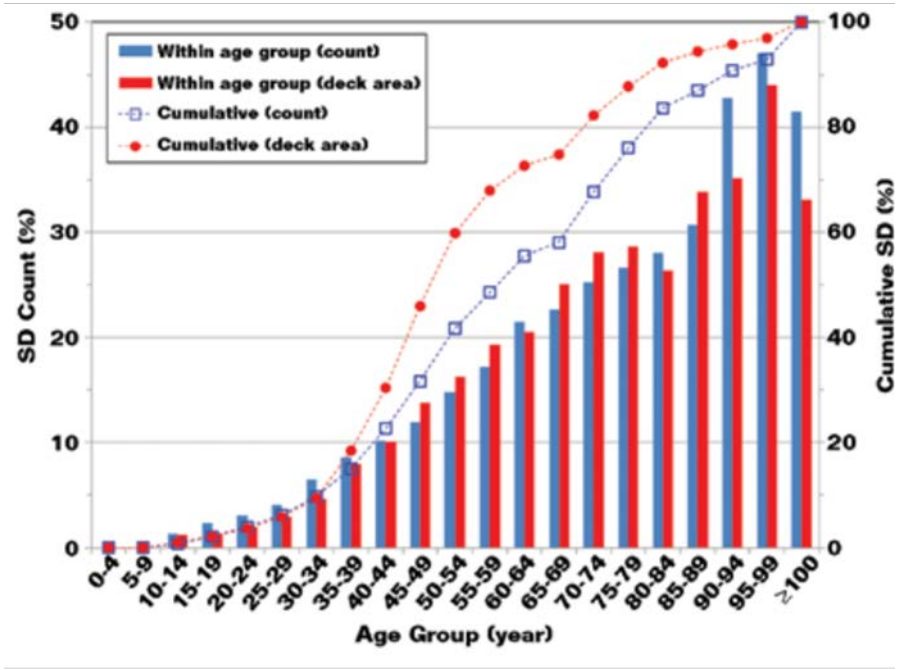
Nondestructive Testing for Concrete Bridge Decks (R06A) and Tunnel Linings (R06G)

SHRP2 Structures Products

Problems



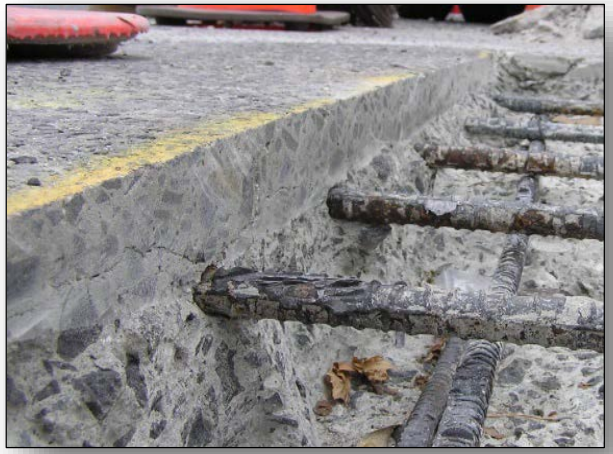
Distribution of the total bridges by age (2010 NBI data)



Structural deficient bridges by age (2010 NBI data)

Nondestructive Testing for Concrete Bridge Decks (R06A)

Challenge: Evaluating the Full Range of Deterioration Types



Deterioration of Interest

- Delamination
- Corrosion
- Vertical cracking
- Degradation

R06A NDT Technology Performance Solution

Performance Evaluation

- Accuracy
- Repeatability
- Speed
- Ease of use
- Cost

Deterioration of Interest

- Delamination
- Corrosion
- Vertical cracking
- Concrete degradation

Benefits

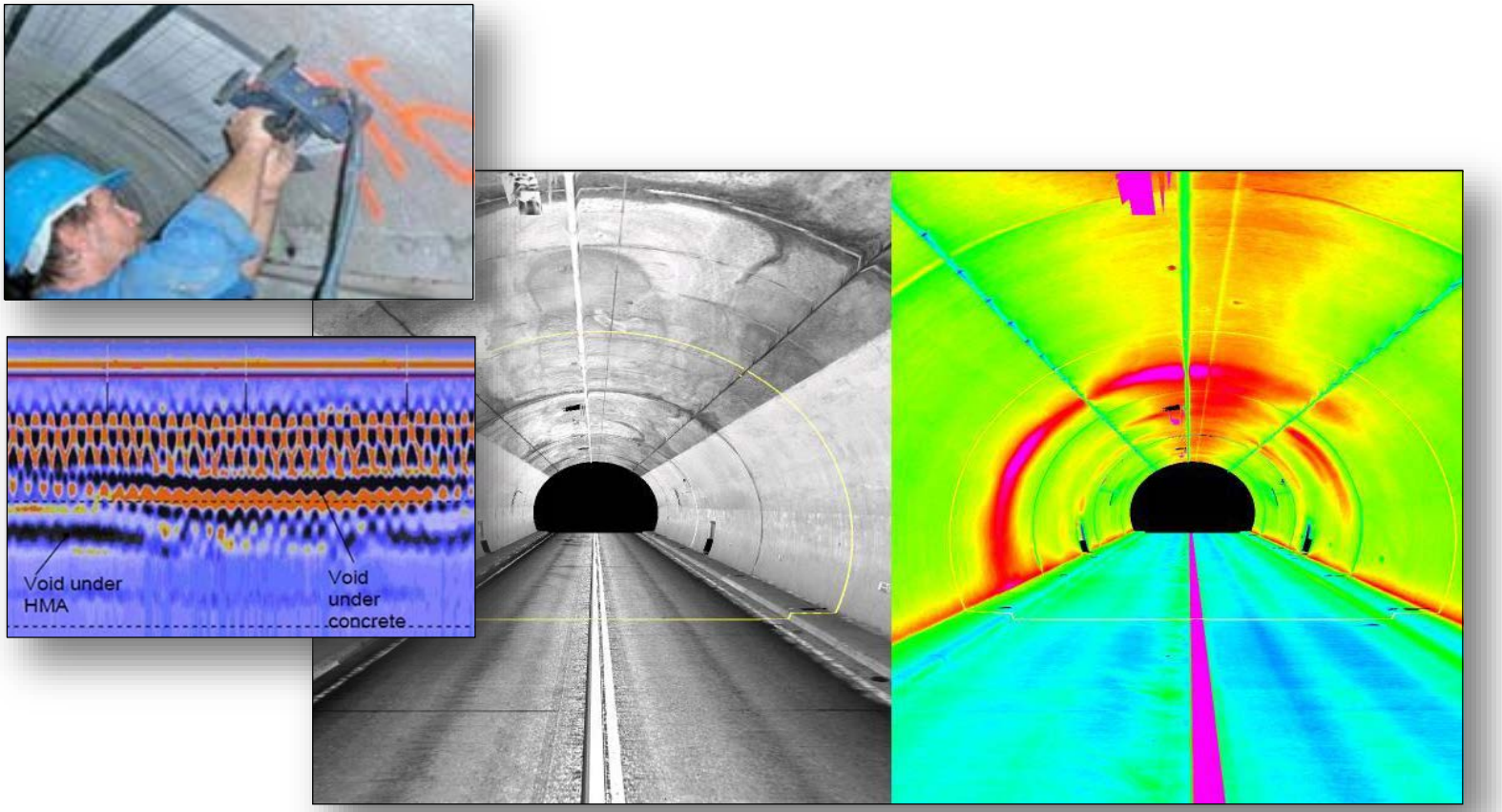
1. Provide more detailed and accurate information about internal deterioration or defects.
2. Enable more objective condition assessments on both project and network levels.
3. Can reduce the frequency of inspections, thus reducing traffic interruptions.
4. Can collect data at rates similar to or faster than traditional methods (chain-dragging and hammer sounding).
5. Provide similar cost between NDT technologies and traditional testing methods.
6. Provide a better bridge management program.

Tunnel Deterioration Overview

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

Nondestructive Testing for Tunnel Linings (R06G)



Lining assessment with mobile/hand-held technologies

Mapping Defects In or Behind Tunnel Linings

Use proven high-speed and detailed NDT methods to evaluate tunnel condition as part of an integrated Asset Management program.

High-Speed Mapping of Defects In or Behind Tunnel Linings

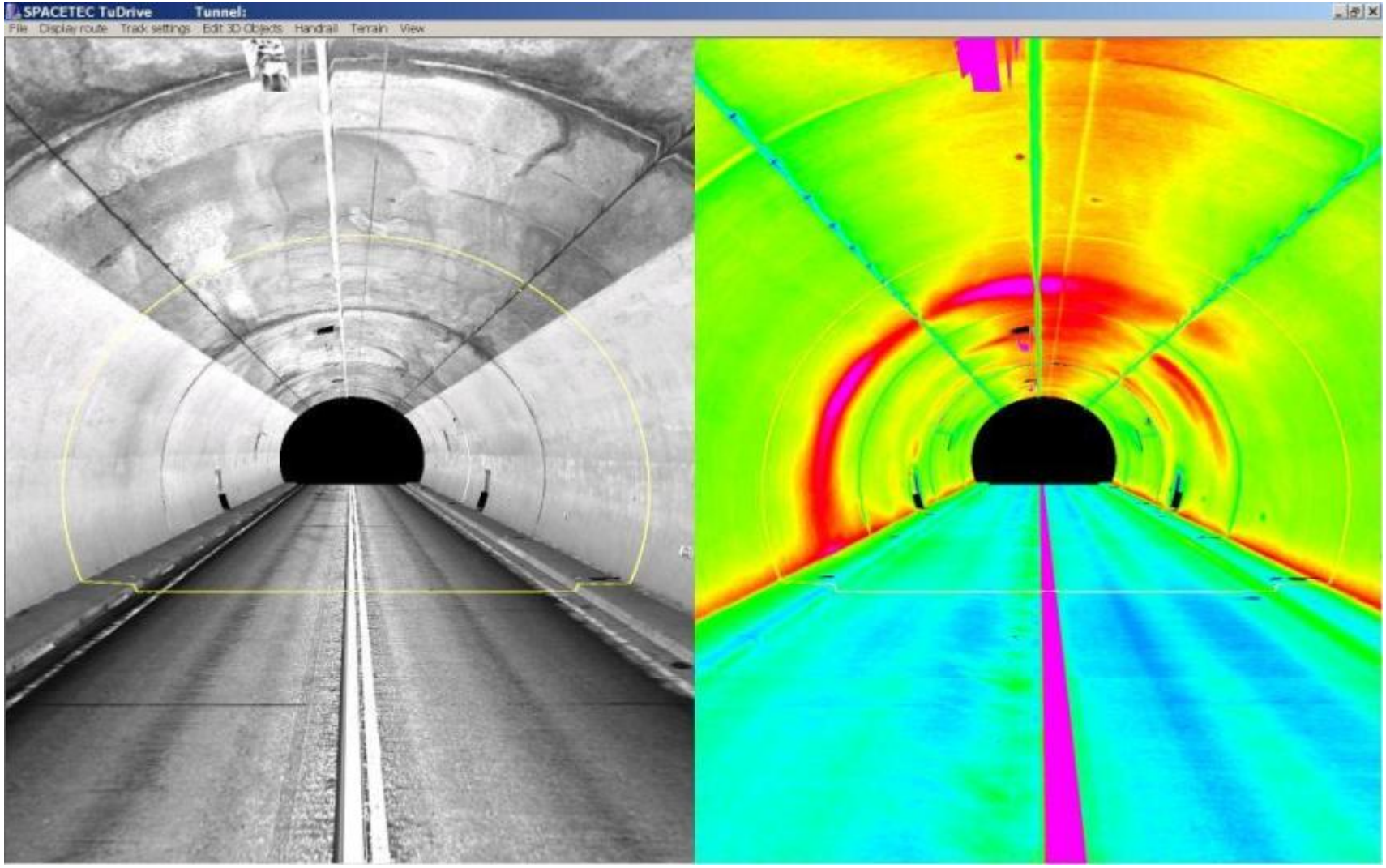
Challenge

- 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.

LiDAR and Infrared Scanning Examples



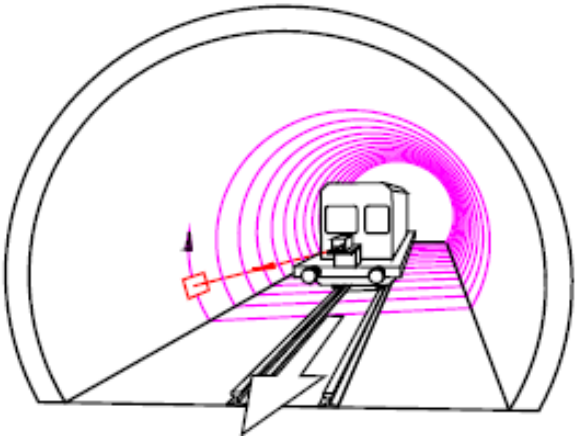
Previously Evaluated and Proven NDT Technologies

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.



For More Information

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Additional Resources:

GoSHRP2 Website:	fhwa.dot.gov/GoSHRP2
AASHTO SHRP2 Website:	http://shrp2.transportation.org
GoSHRP2 Alert Sign Up:	fhwa.dot.gov/goshrp2/contact
Email:	GoSHRP2@dot.gov