


SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

SHRP2 Advancement in Nondestructive Testing for Concrete Bridge Decks

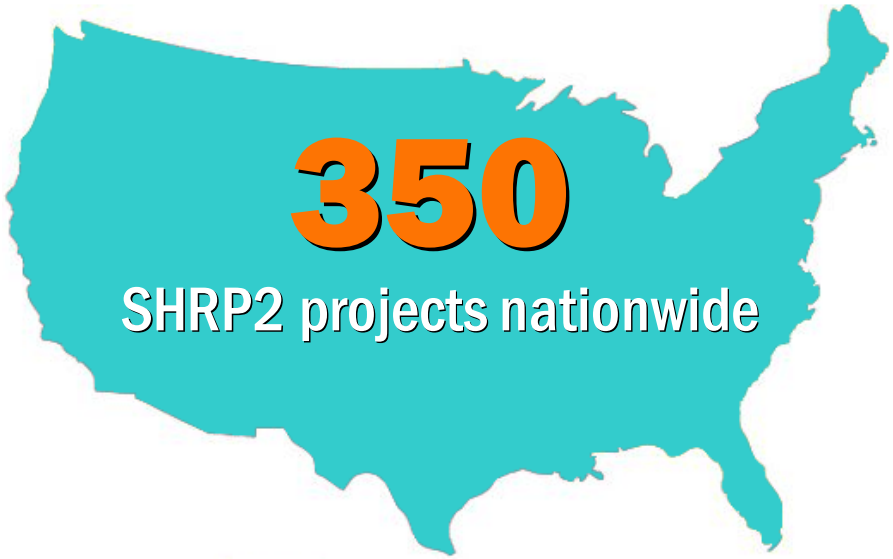
Yajai Tinkey, PhD, P.E., Olson Engineering, Wheat Ridge, Colorado
Matthew DeMarco, FHWA Resource Center, Lakewood, Colorado
Larry D. Olson, Olson Engineering, Rockville, Maryland
Patricia Bush, AASHTO, Washington, D,C,

U.S. Department of Transportation
Federal Highway Administration

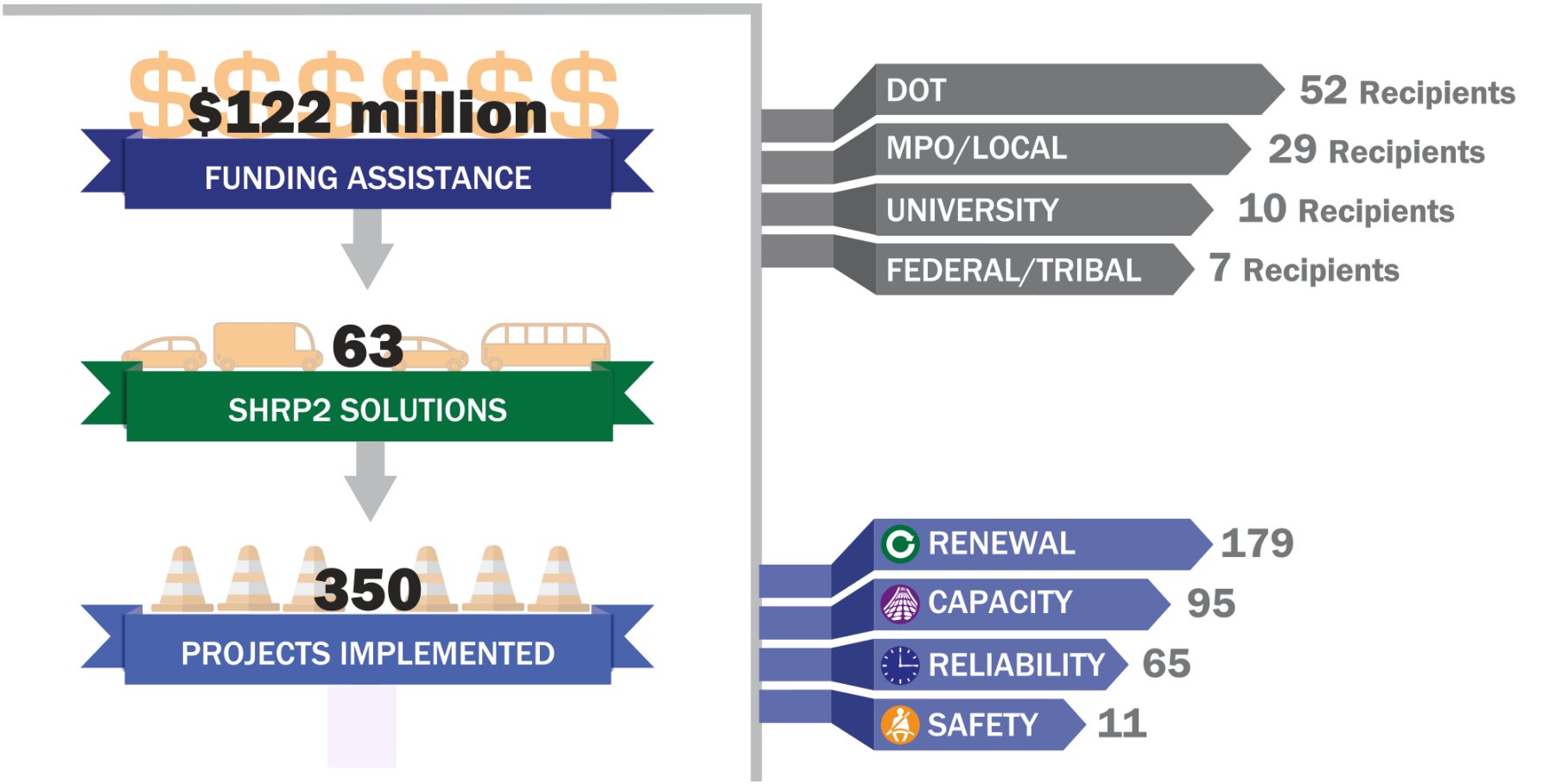
American Association of State Highway and Transportation Officials
AASHTO

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



SHRP2 Implementation: Moving Us Forward



Round 4 – 8 IAP State DOTs

★ **NDT for Bridge Decks**

NDT Techniques studied in SHRP2 R06A Research Rutgers University

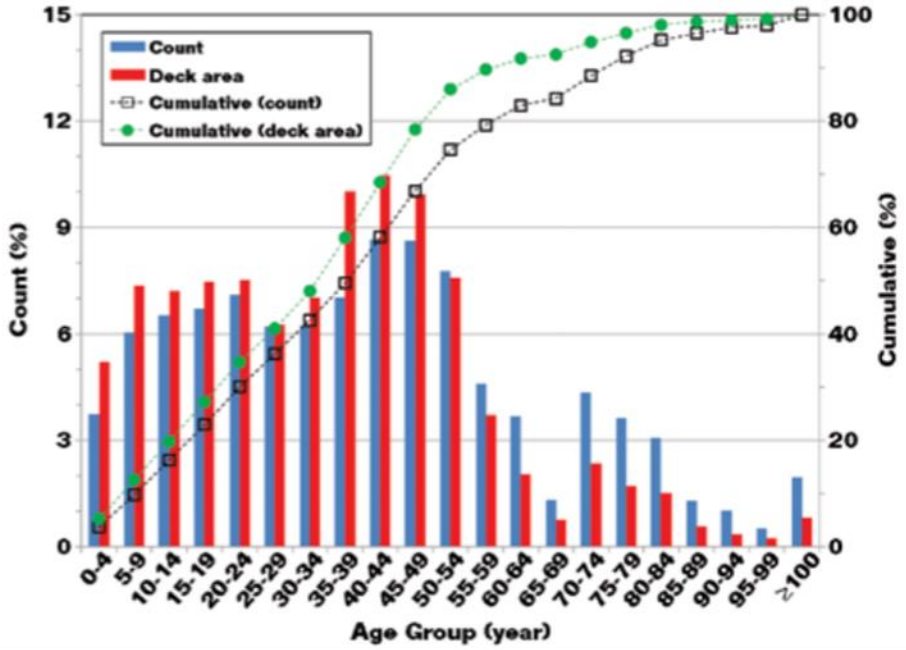
- Impact Echo Ultrasonic Surface Waves (IE)
- Impulse Response (IR)
- Ground-Penetrating Radar (GPR)
- Infrared Thermography (IR)
- Electrical Resistivity (ER)
- Galvanostatic Pulse (GP)
- Half Cell Potential (HP)
- Hammer Sounding/Chain Drag

Participants in the SHRP2 R06A Validation Testing

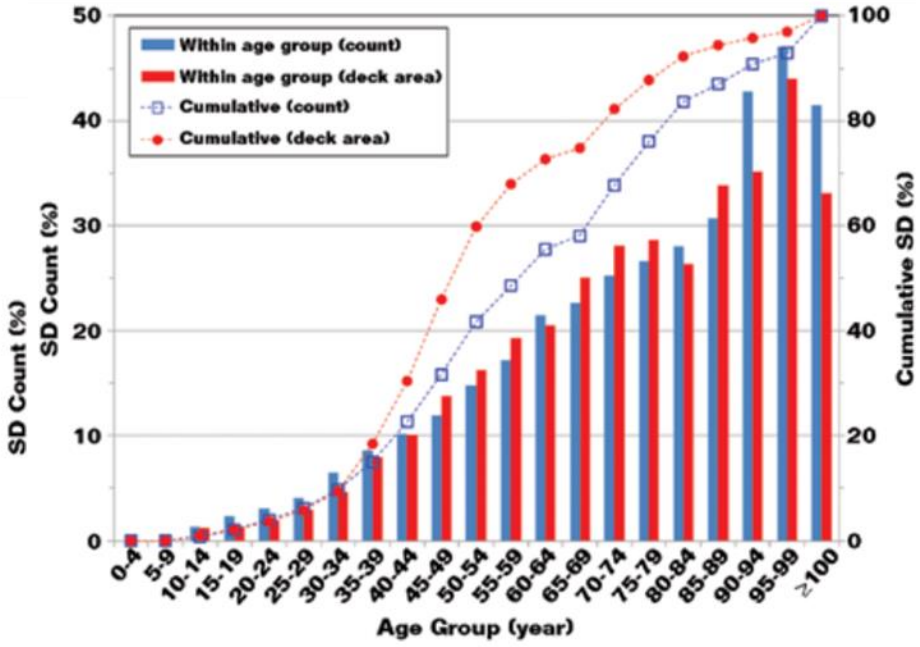
- Dr. Ralf Arndt, National Research Council Associate FHWA -Turner Fairbank Highway Research Center
- Germann Instruments
- Ingegneria Dei Sistemi S.p.A. (IDS)
- NDT Corporation
- Olson Engineering
- 3D Radar, Norway
- Dr. John Popovics, University of Illinois at Urbana-Champaign
- Rutgers University - Center for Advanced Infrastructure and Transportation
- Dr. Jinying Zhu, The University of Texas at Austin
- The University of Texas at El Paso - Center for Transportation Infrastructure Systems

Nondestructive Testing - Concrete Bridge Deck US Hwy 15 over I-66 in Haymarket, Virginia

Problems

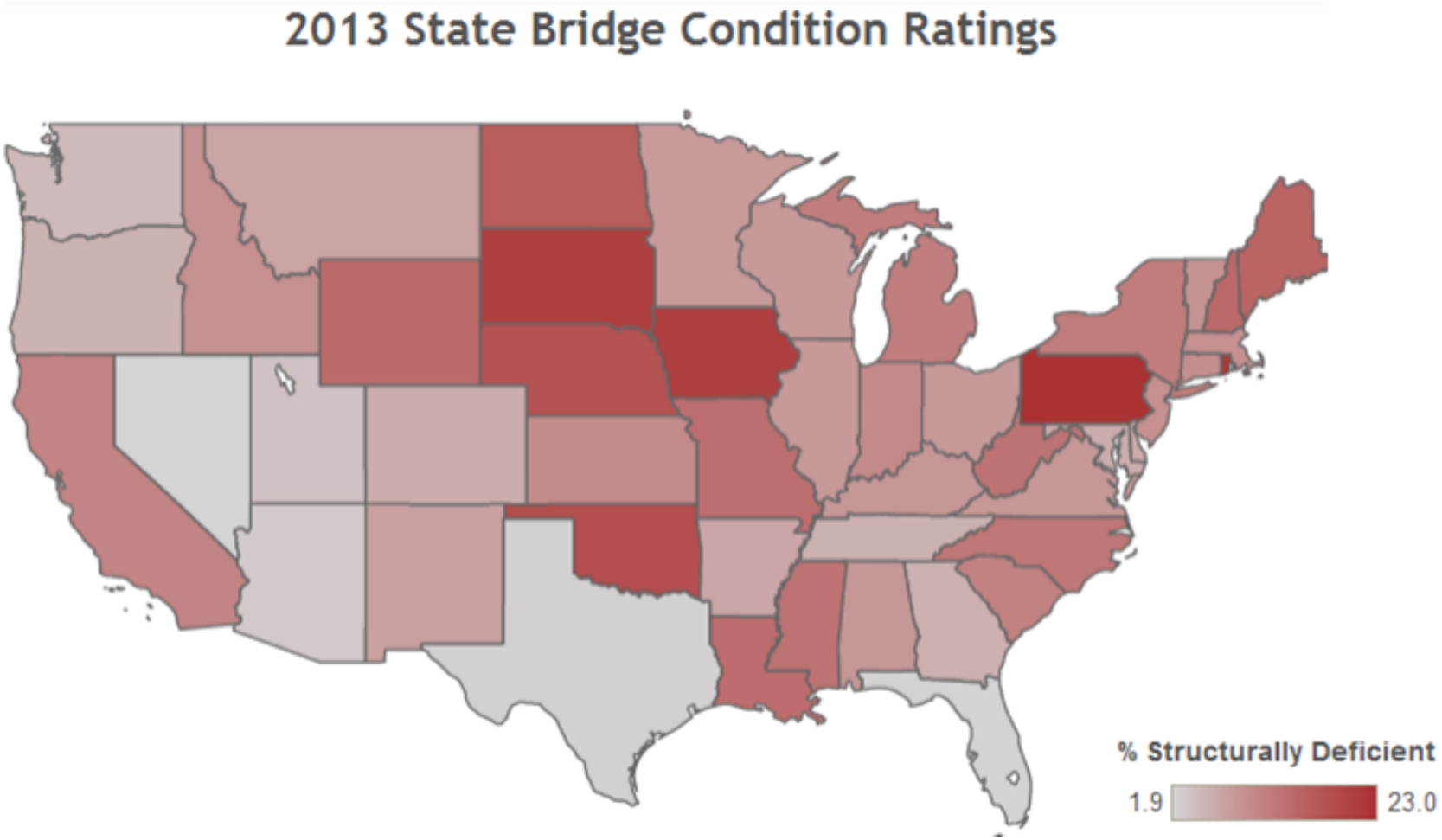


Distribution of the total bridges by age (2010 NBI data)

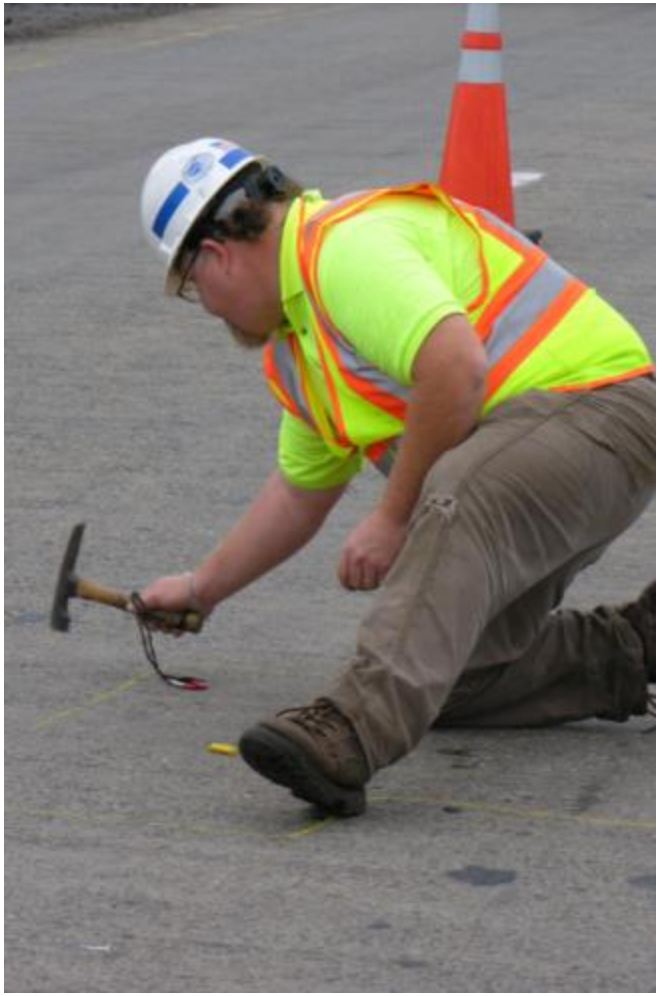


Structural deficient bridges by age (2010 NBI data)

Bridge Deterioration



R06A Challenge: State of Practice – Acoustic Sounding and Half-Cell Potential



Challenge: Evaluating the Full Range of Deterioration Types

Deterioration of Interest

- Delamination
- Corrosion
- Vertical cracking
- Degradation

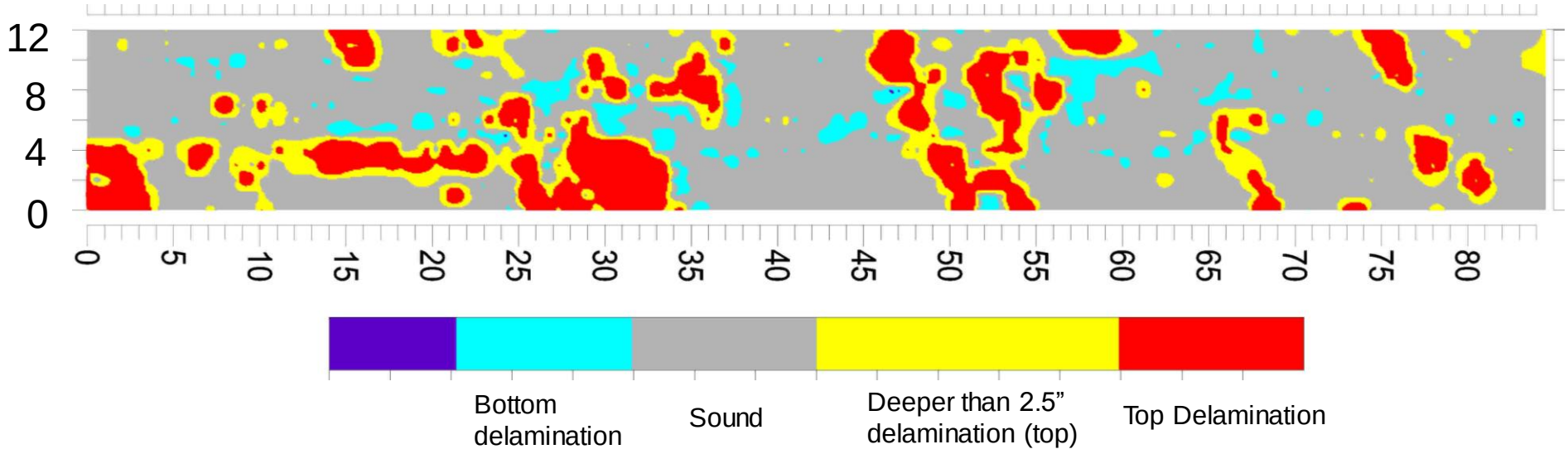
NDT Technologies

NDT Technique	Mode of Deterioration Detected	System	Resolution	Lane Closure
IE	1) Deeper cracks - top and bottom rebar mat 2) Shallow delaminination 3) Concrete degradation - ASR/DEF - Freeze thaw	1) Scanning 2) Point by Point	High Grid size	Yes Yes
GPR	1) Corrosion 2) Cracks (if filled with deicing salt) 3) Concrete degradation	1) Air coupled 2) Ground coupled	Lower High	No Yes
IR	Shallow delamination - Top and bottom	1) Truck mounted 2) Handheld	High High	No Yes
Resistivity	Corrosion	Point by Point	Grid size	Yes
Half Cell/GP	Corrosion	Point by Point	Grid size	Yes
Slab IR	Cracks	Point by Point	Grid size	Yes
SASW	1) Vertical cracks 2) Concrete degradation	1) Scanning 2) Point by point	High Grid size	Yes Yes

Vs.

Sounding	Only shallow delamination	Manual		Yes

Example Deliverable from NDT – Bridge Deck Scanner Impact Echo Results from SHRP2 R06A Research



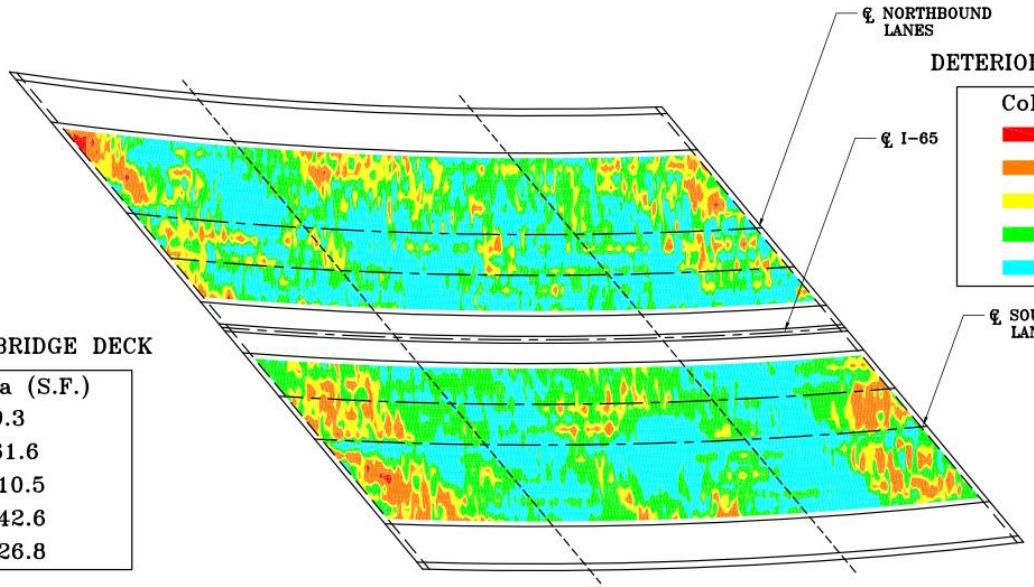
Areas with Probable Top Delaminations = 14%
Areas with Probable Incipient (Deeper)Top Delaminations = 13%
Areas with Probable Bottom Delaminations (or Thin Section) = 5.7%

Classroom Training and Field Demo of Airborne GPR and Bridge Deck Scanner Impact Echo

Indiana DOT

- Interested in evaluating the higher-volume urban Indianapolis area using high-speed GPR and IR
- Hired 2 consultants (Resource International and AECOM) to evaluate 48 bridge decks.
- Resource International recently completed the GPR testing on 48 bridge decks with a budget of $52,000

Indiana DOT - GPR Results



DETERIORATION – NORTHBOUND BRIDGE DECK

Color	Percent	Area (S.F.)
	0.3	24.9
	5.5	450.8
	15.6	1290.0
	36.8	3041.6
	41.8	3446.7

DETERIORATION – SOUTHBOUND BRIDGE DECK

Color	Percent	Area (S.F.)
	0.1	9.3
	9.6	761.6
	12.7	1010.5
	40.8	3242.6
	36.8	2926.8

Example Damage Map Provided by the GPR Technique

Florida DOT

- Interested in the IR, GPR and IE technologies
- Purchased 3 handheld IR cameras and recently have 10 staff trained for Level I – IR Inspection
- Field tested IR cameras on inspected bridges with mixed results. IR imaging appeared to be better when scanning bottom of decks.
- Hire a consultant to evaluate bridge decks exhibiting cracking and rebar corrosion efflorescence using GPR and IE
- Currently assembling a standardized format for field reports to be attached to NBI inspection reports.

Oregon DOT

- Interested in high-speed GPR, IR and IE
- Currently in the procurement process for NDT services to be let in June, with notice-to-proceed expected in July
- Identified 200+ bridges across three geographic regions as candidates for the field evaluation

Virginia DOT

- VDOT intends to progress through a series of pilot contracts to procure NDT services for rapid deck screening using GPR, IR and IE.
- The ultimate goal is to develop statewide task order contracts for NDT services that can be used by each district bridge office to evaluate bridges, with a focus on condition screening (more often using mobile scanning technologies).
- Currently in the procurement process, with current plans to issue notice-to-proceed in July/August timeframe. Field work will commence immediately thereafter to pilot the mobile GPR/IR methods and bridge-specific IE method, completing initial evaluations by the end of October.

Iowa DOT

- Interested in Impact Echo Scanning
- Iowa DOT will purchase a Bridge Deck Scanner ($75K + $10K in training) using 2 transducer wheels to evaluate bridge decks on a detailed project level.
- Currently estimated repair quantities are up to 100% underestimated. NDT will be used to both better estimate quantities for contracting and to provide contractor control during repair.

Missouri DOT

- Interested in Resistivity Technique
- Began lab testing end of 2015, including some initial trials of Wenner Probe resistivity measurements on concrete slabs at the lab coated with various dilutions of silane sealer.
- Currently making additional concrete panels in the lab for additional probes testing with sealants. Work is moving slowly due to severe resource shortages across MODOT.

Louisiana DOT

- Interested in high-speed GPR.
- Recently deployed GPR/IR NDT on the LA 1 Port Allen Canal Bridge (two bridges over the intercoastal waterway – non-SHRP2 related project), and will soon deploy GPR/IR on the I-20 Mississippi River Bridge near Vicksburg.
- Planning to hire a consultant to evaluate the I-10 Atchafalaya Basin Bridge (two bridges, each 16 miles long), near Baton Rouge.

Pennsylvania DOT

- Interested in GPR/IR technology
- Will purchased a ground contact GPR system that can be attached to a vehicle (speed up to 15 mph)

Summary

- Two-year project is progressing well by all 8 IAP states.
- State directions are different depending on their internal resources and type of bridge deck they own.
- Results from the NDT provide a quantitative areas of delaminated decks and will assist with the future planning of asset management for the highway department.
- SHRP2 recently offered the last round (Round 7) for this project and 14 states applied for the user incentive funds. Depending on how many awards are given to the states, almost half of the states in the US will have used NDT on their concrete bridge decks by 2017.

Resources

- FHWA: Matt DeMarco, matthew.demarco@dot.gov
- AASHTO: Patricia Bush, pbush@aashto.org
- SHRP2 Subject Matter Experts:
  - Larry Olson, Olson Engineering, larry.olson@olsonengineering.com
  - Yajai Tinkey, Olson Engineering, yajai.tinkey@olsonengineering.com

- www.fhwa.dot.gov/goshrp2
- http://shrp2.transportation.org/Pages/R06_NondestructiveTesting.aspx