FHWA-NDE CENTER

Methods Available for Testing & Evaluation of Structures

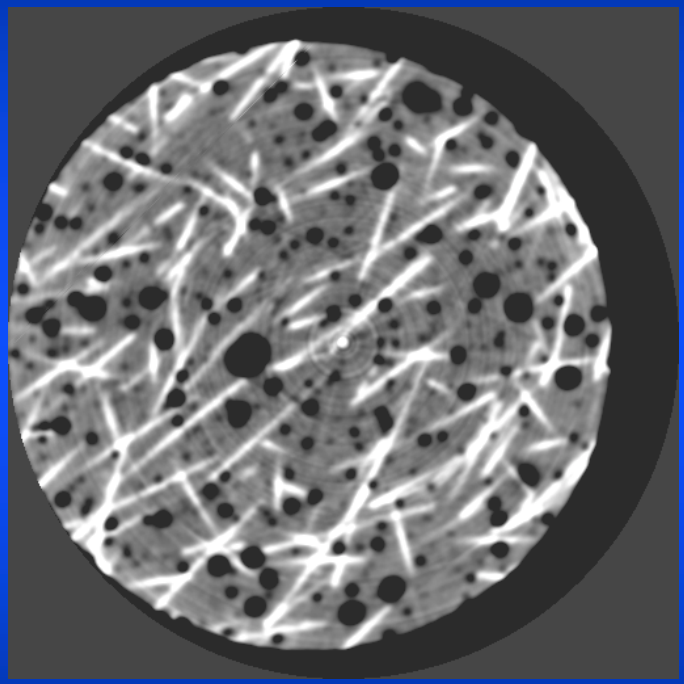
NDE Center
Federal Highway Administration

FHWA NDE Center Current Projects

- Ultrasonic NDE
- Ground Penetrating Radar, PERES II
- Thermal NDE
- Laser System Measurements
- Load Testing
- Bridge Data Acquisition Systems - LTBP

UHPC - Basic Material Properties

Material	Amount (kg/m^3)	Percent by Weight
Portland Cement	712	28.7
Fine Sand	1020	41.1
Silica Fume	231	9.3
Ground Quartz	211	8.5
Superplasticizer	13	0.5
Steel Fibers	160	6.4
Water	136	5.5



UHPC Comp. Strength ~ 200 MPa (29 ksi)

Normal Concrete = ~41 MPa (6 ksi)

Modulus of Elasticity ~ 52 GPa (7,600 ksi)

Normal Concrete ~ 30 GPa (4,400 ksi)

Steel fibers 2% by volume

Steel Fiber = 0.2 x 12 mm

Largest particle = 0.6 mm

UHPC Bridge Sections

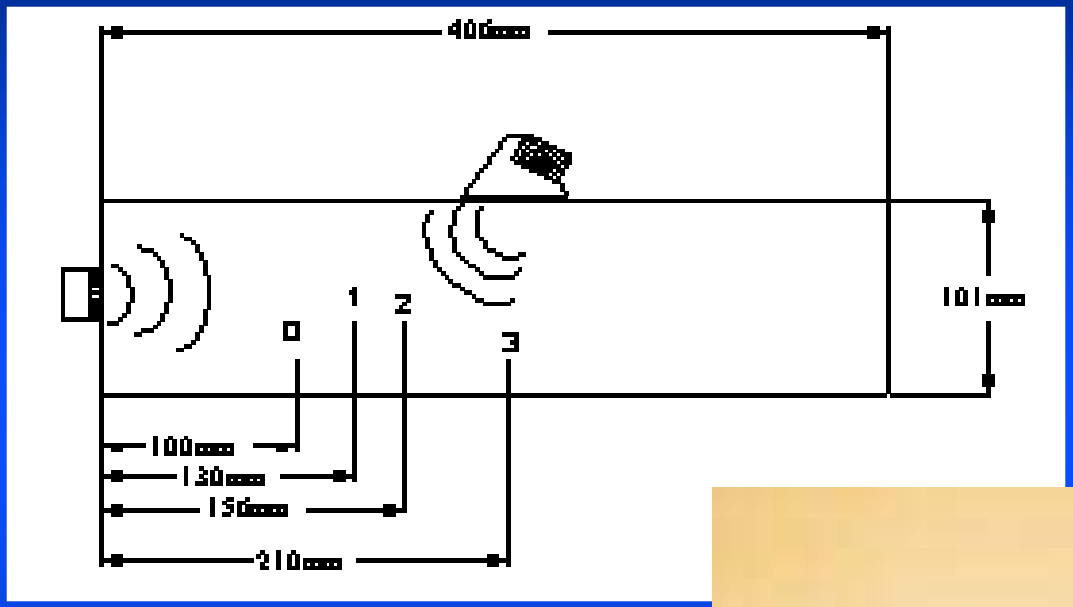
AASHTO TYPE II

Π - SHAPE

NDE Roles for UHPC

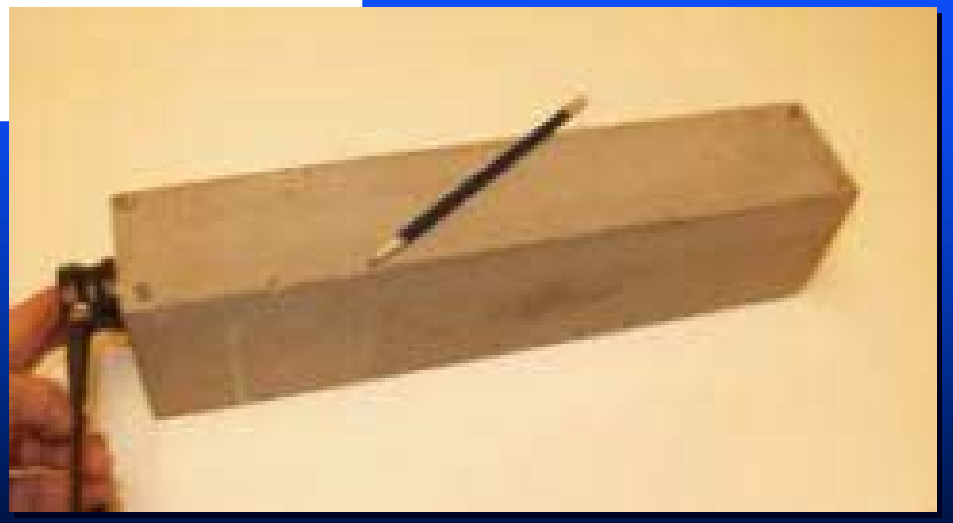
- Condition Assessment
  - Detection of voids
  - Crack detection
  - Microcracking / corrosion damage
- Physical Properties
  - Magnetic properties
  - Elastic properties
- Quality Control
  - Modulus of elasticity, compressive strength

Crack Detection

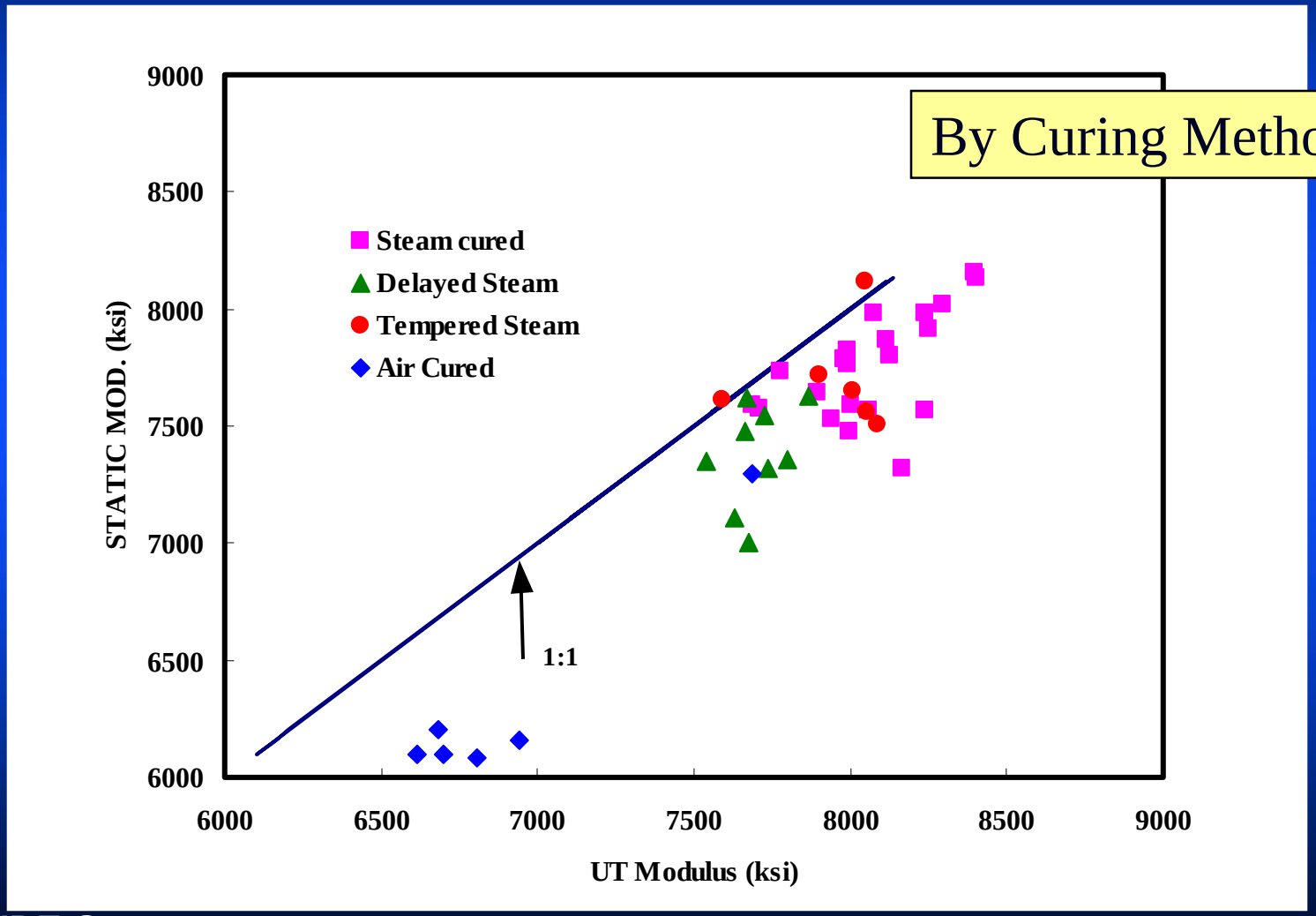


Shear wave &
Longitudinal wave

Pulse-echo mode

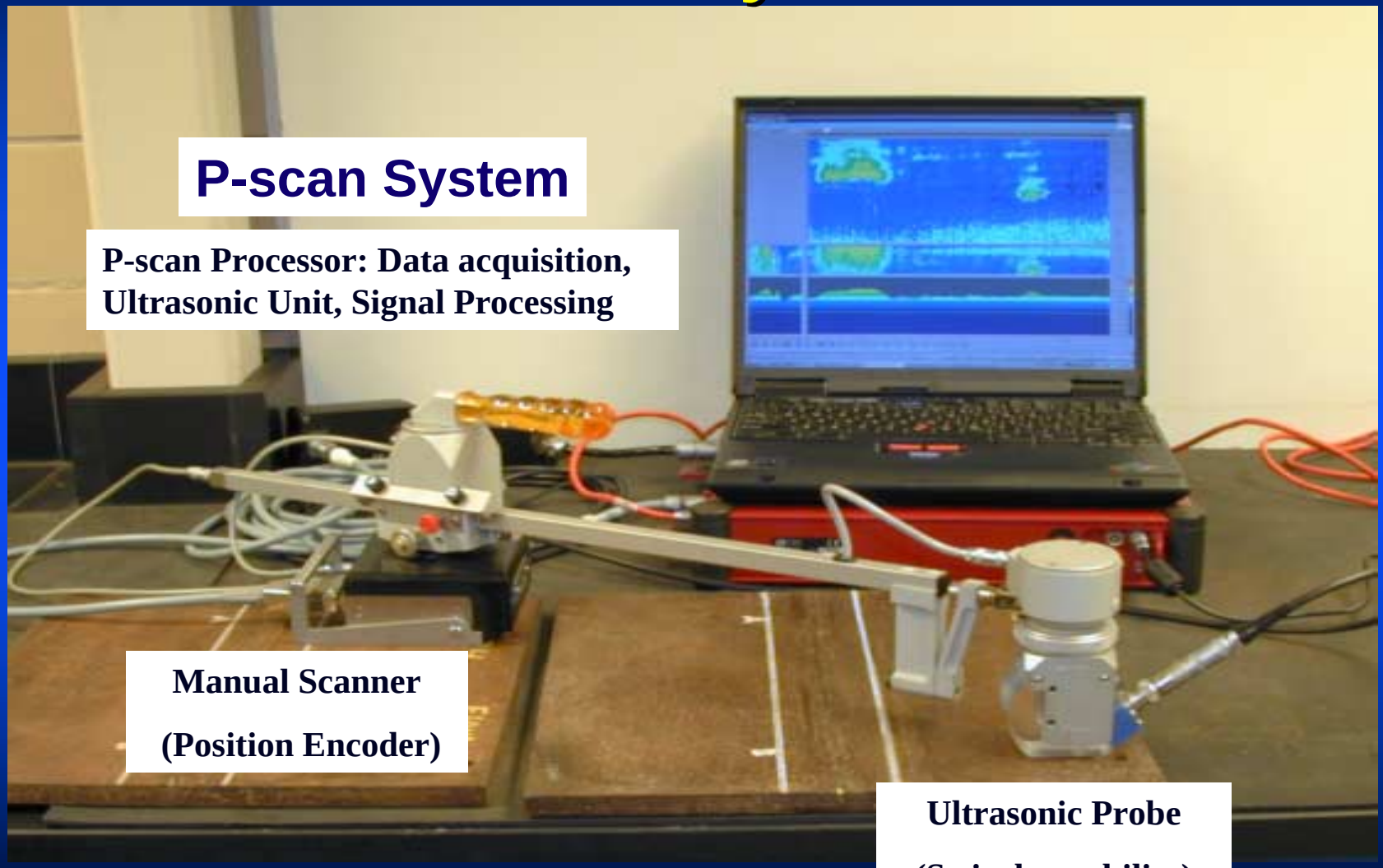


UT vs. Static Modulus



Correlation coefficient 0.94

AUT System


P-scan System
P-scan Processor: Data acquisition, Ultrasonic Unit, Signal Processing
Manual Scanner
(Position Encoder)
Ultrasonic Probe
(Swivel capability)

AUT Testing to Date

- Approx. 150 hours of field testing
- More than 30 plates have been tested
  - Thickness ranging from 1 - 3.15 in., widths from 10 to 34 in.
  - About 1/3 have had thickness transitions
- Few inconsistencies with RT of UT have been observed to date
  - Analysis of results may be required to identity these differences

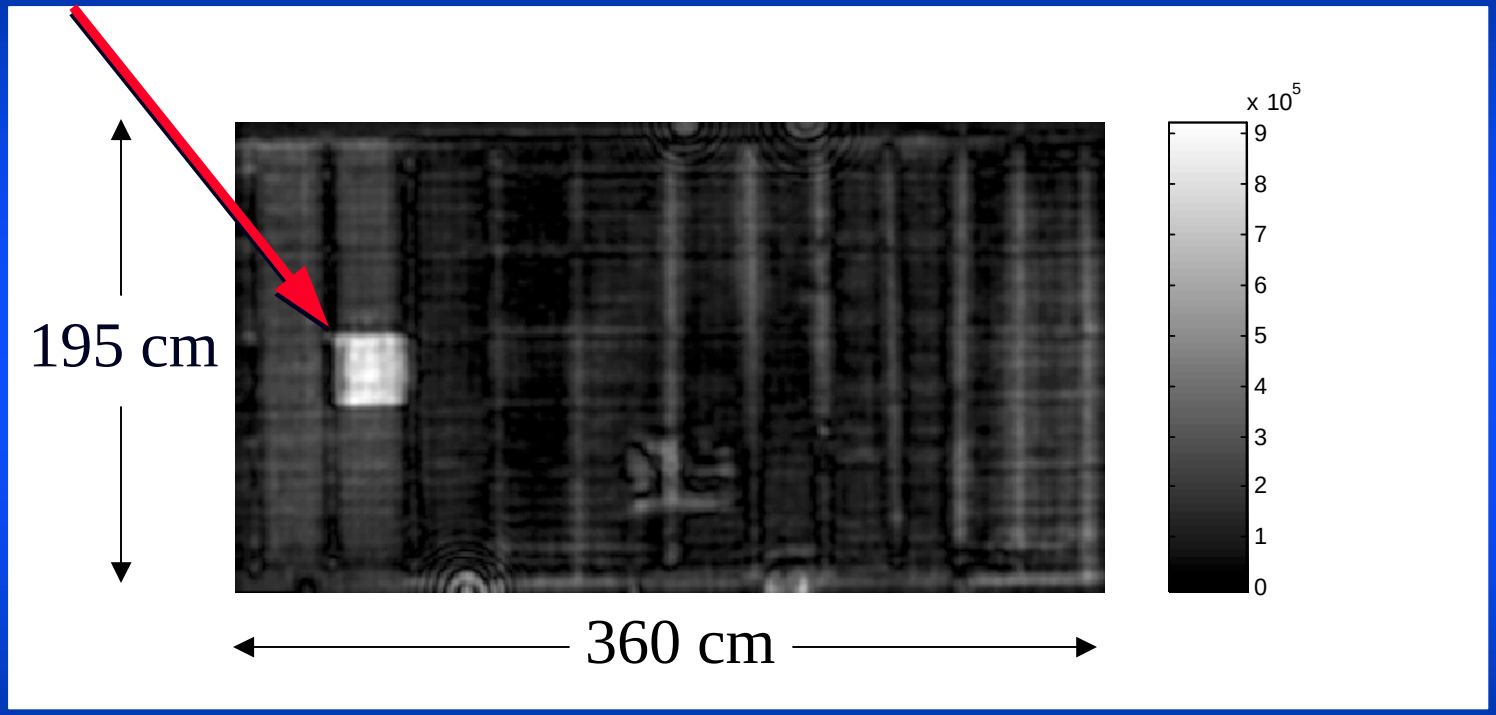
HERMES II Project

- A new PERES II cart system has been developed by LLNL and tested at the FHWA-NDE Center
- A contract for continued testing of the system has been awarded to the University of Vermont

PERES II System

Example PERES II Data

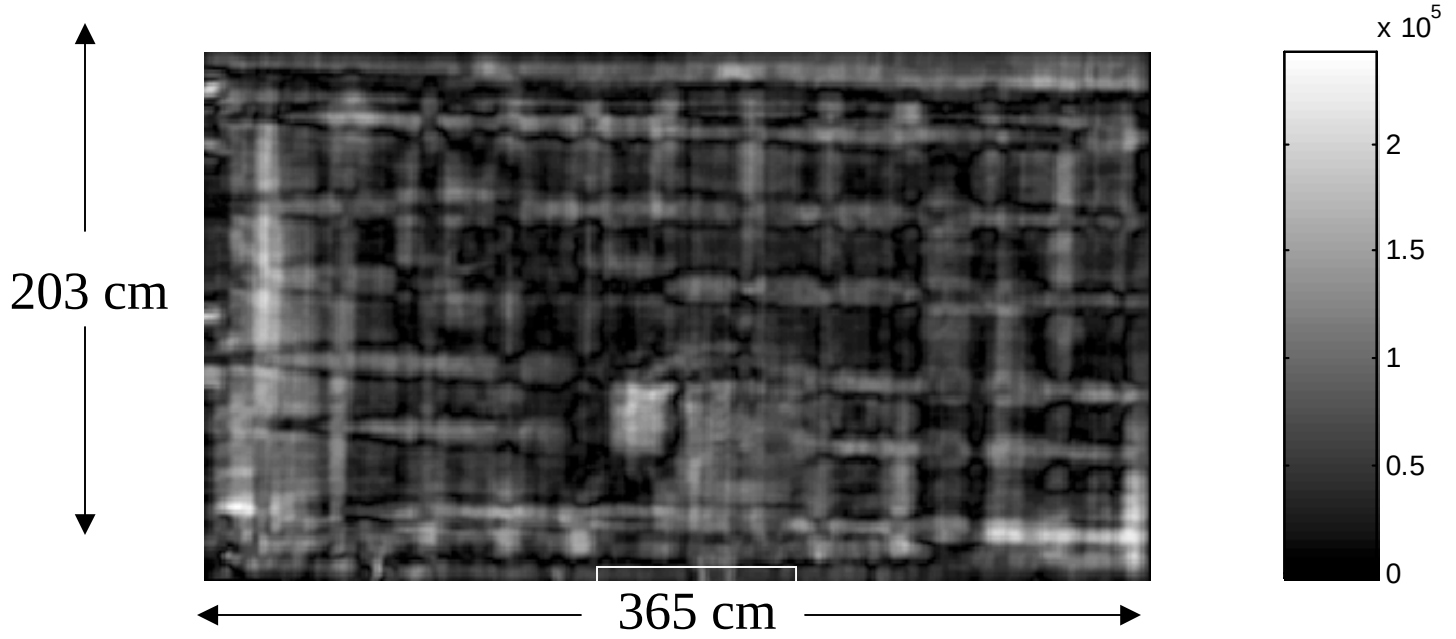
Deck Section with Simulated Defect: 1-inch Thick Styrofoam



Plan view at layer depth = 4 cm

Example PERES II Data

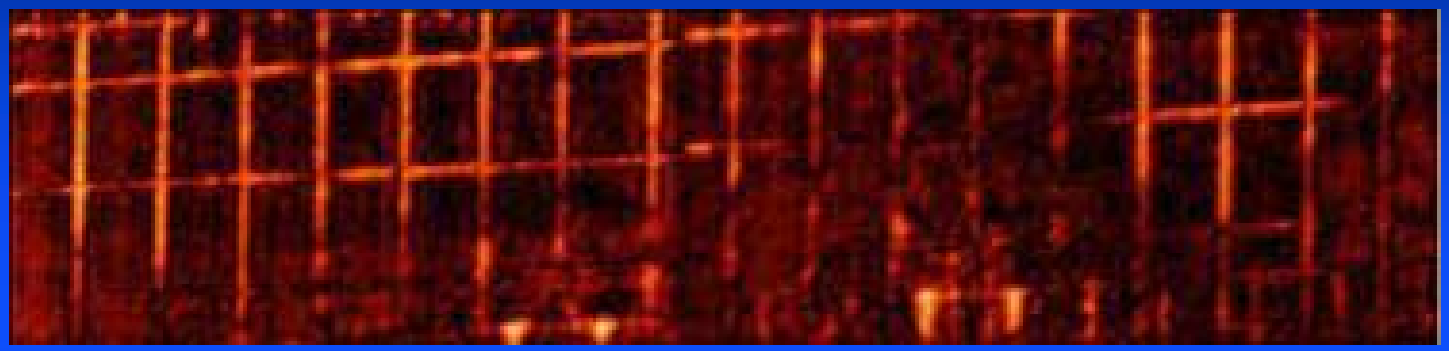
Deck Section with Actual Delamination



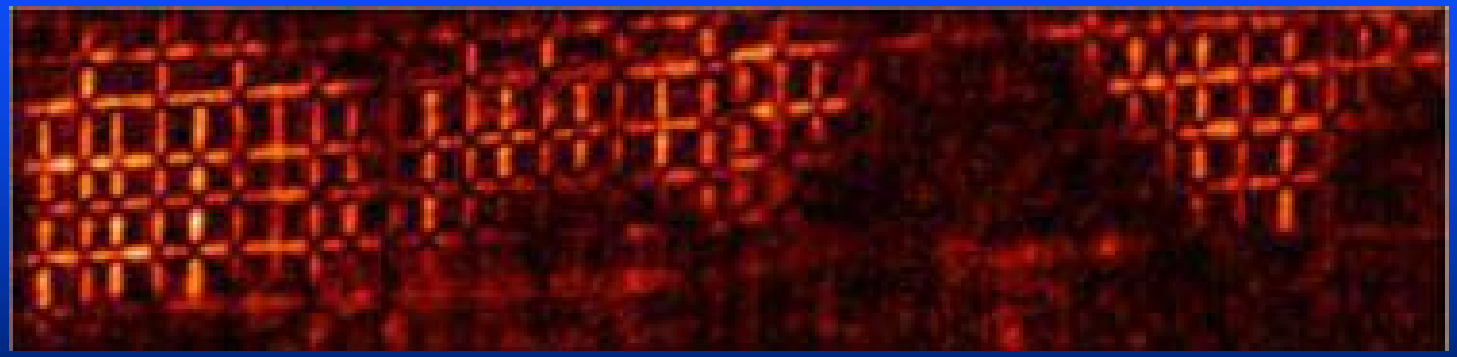
Plan view at layer depth = 8 cm

Example PERES II Data

Lake Anna Bridge Indicating Actual Delamination



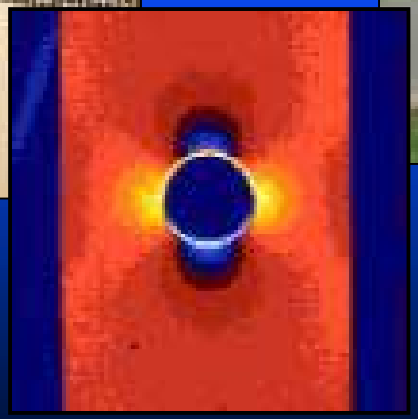
Top Rebar Mat

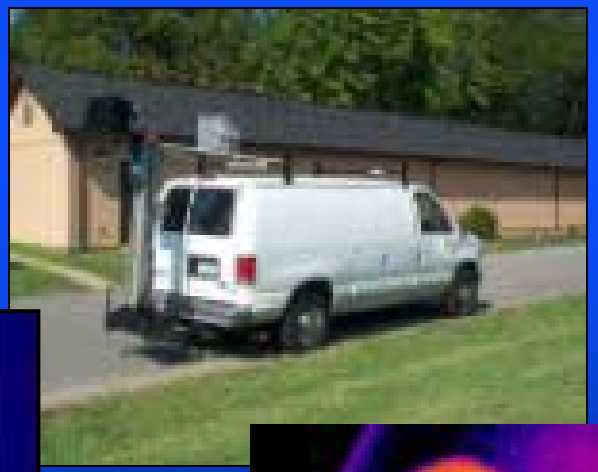


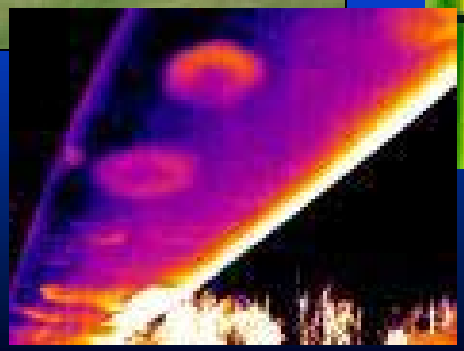
Bottom Rebar Mat

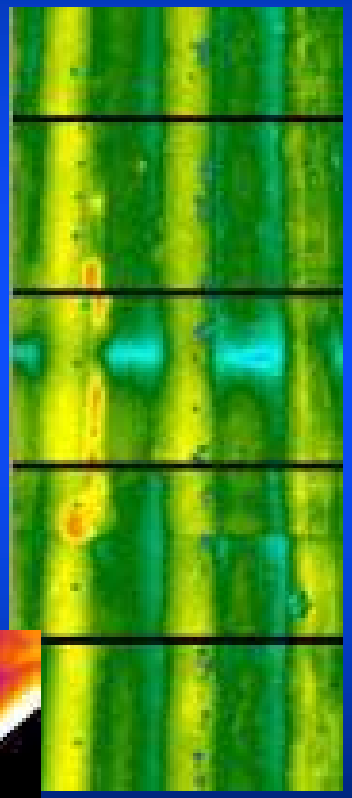
Thermal NDE

- Bridge Deck Inspection using Thermogrpahy
- Thermal Stress Measurement









NDE Center IR System

System Description

Camera Head
IR Camera, LW
IR Camera, SW
Deck Video Camera
Distance Sensor

Antenna
Wireless Video & Switches

Video Camera
Wireless, External View

Wireless Switch
Trigger Data Collection

Video Camera
Rear View

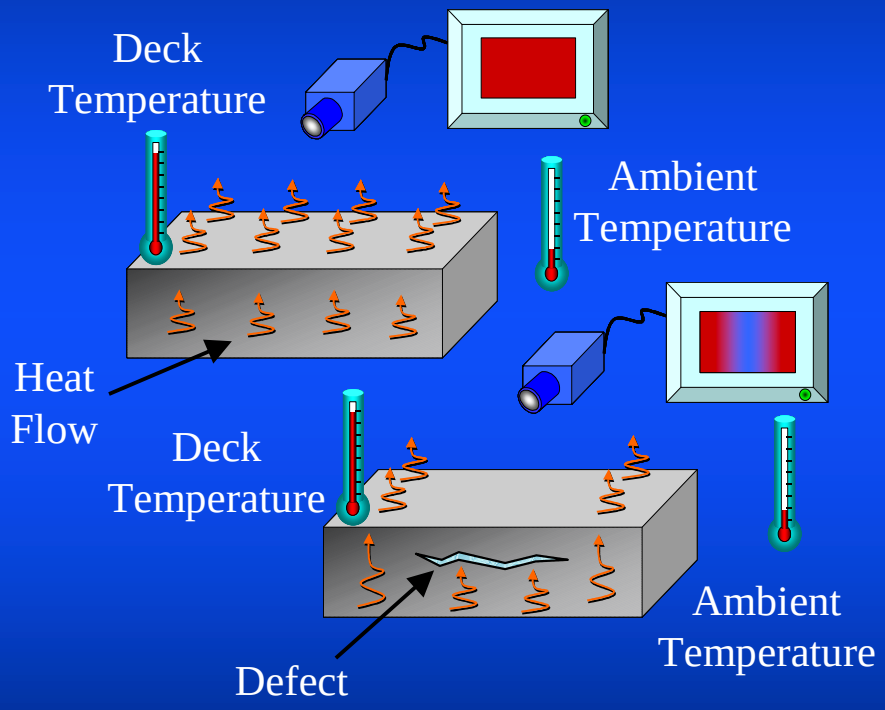
Video Camera
Front View

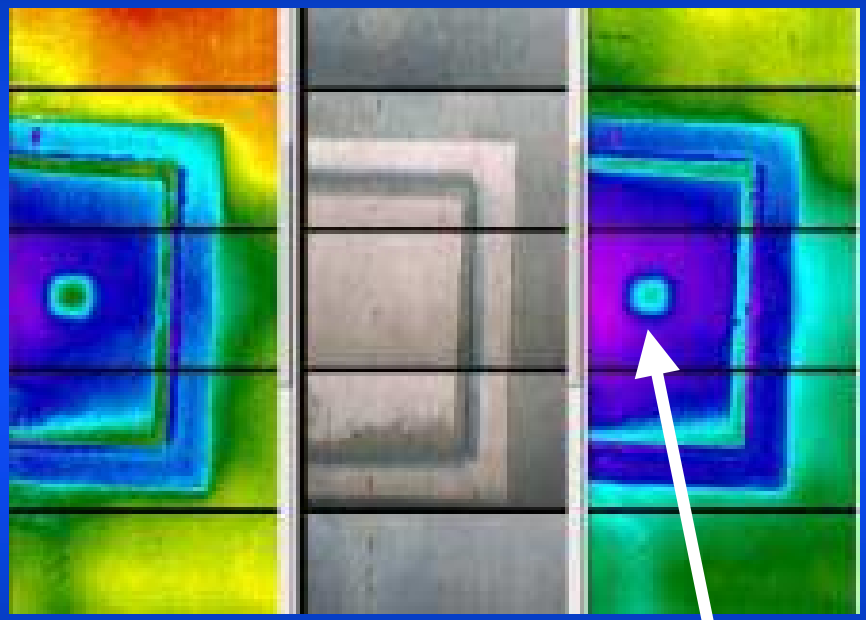
Electronic Enclosure
IR System Controller
Main Controller
Other Systems

Encoder
Vehicle Position

Operator Workstation
System Control
Data Collection
Data Analysis

Measurement Principle





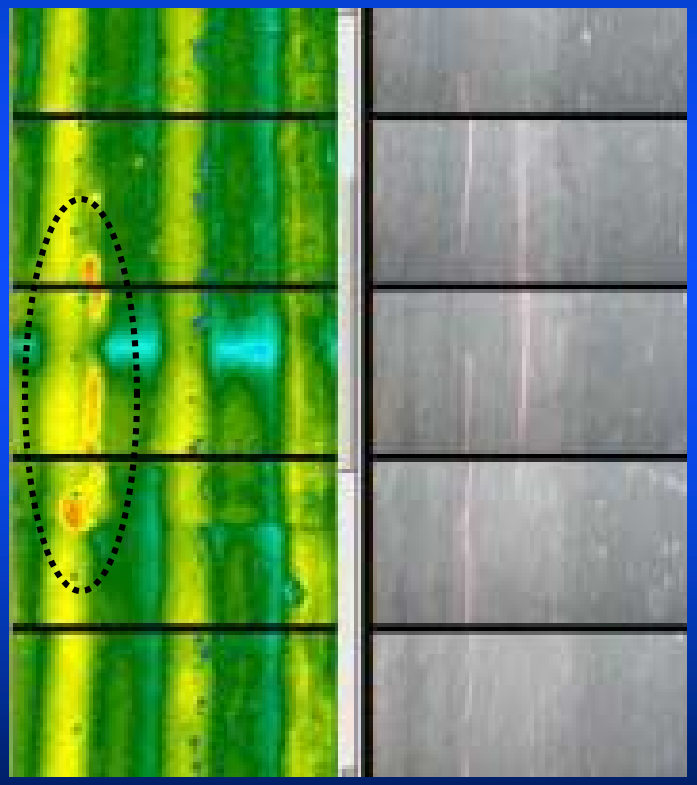
Poplar St. Bridge

St. Louis, MO

- 2200 ft span length
- 8 lanes of traffic
- 5/8” thick steel orthotropic deck
- ½” thick low modulus epoxy concrete overlay

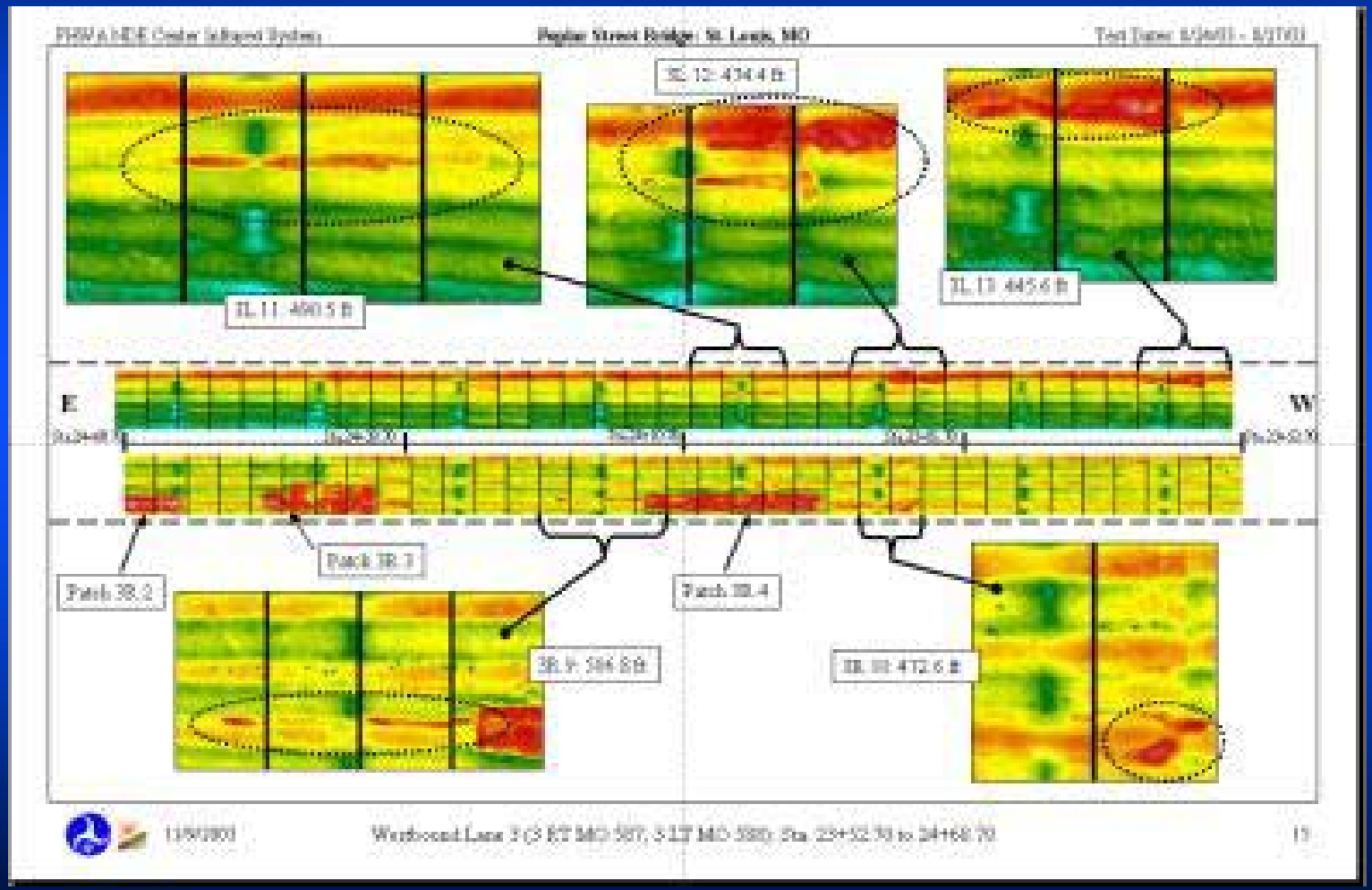
Typical Defects

Poplar St. Bridge, St. Louis, MO



IR Data Example

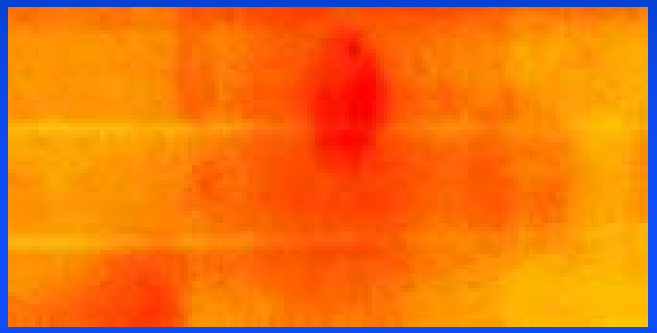
Poplar St. Bridge, St. Louis, MO



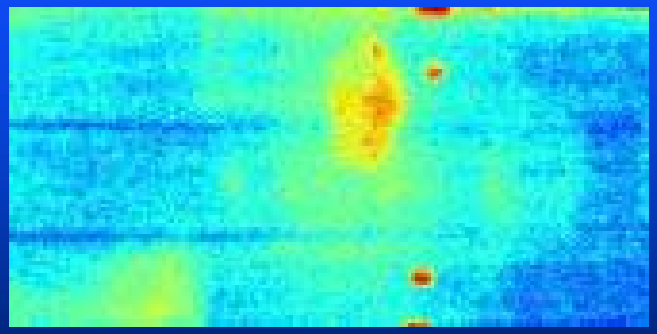
Concrete Box Girder with Composite Retrofit

Concrete Box Girder with Composite Retrofit

Infrared Images



Long Wave

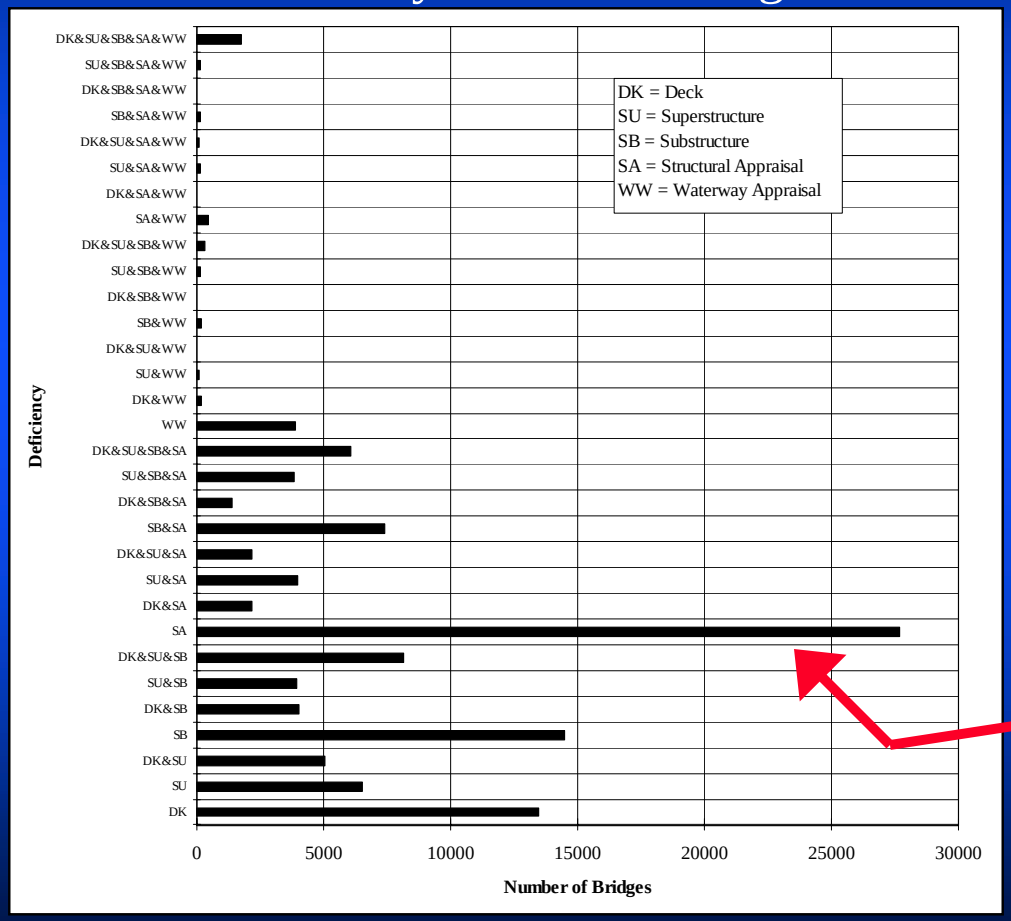


Short Wave

Areas marked found by tap test

Why Perform a Load Test

Structurally Deficient Bridges



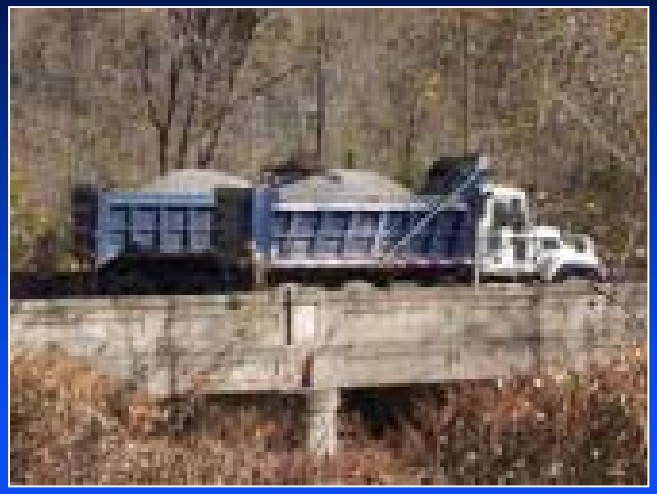
NBI Statistics

≈580,000 bridges

≈ 100,000 structurally deficient

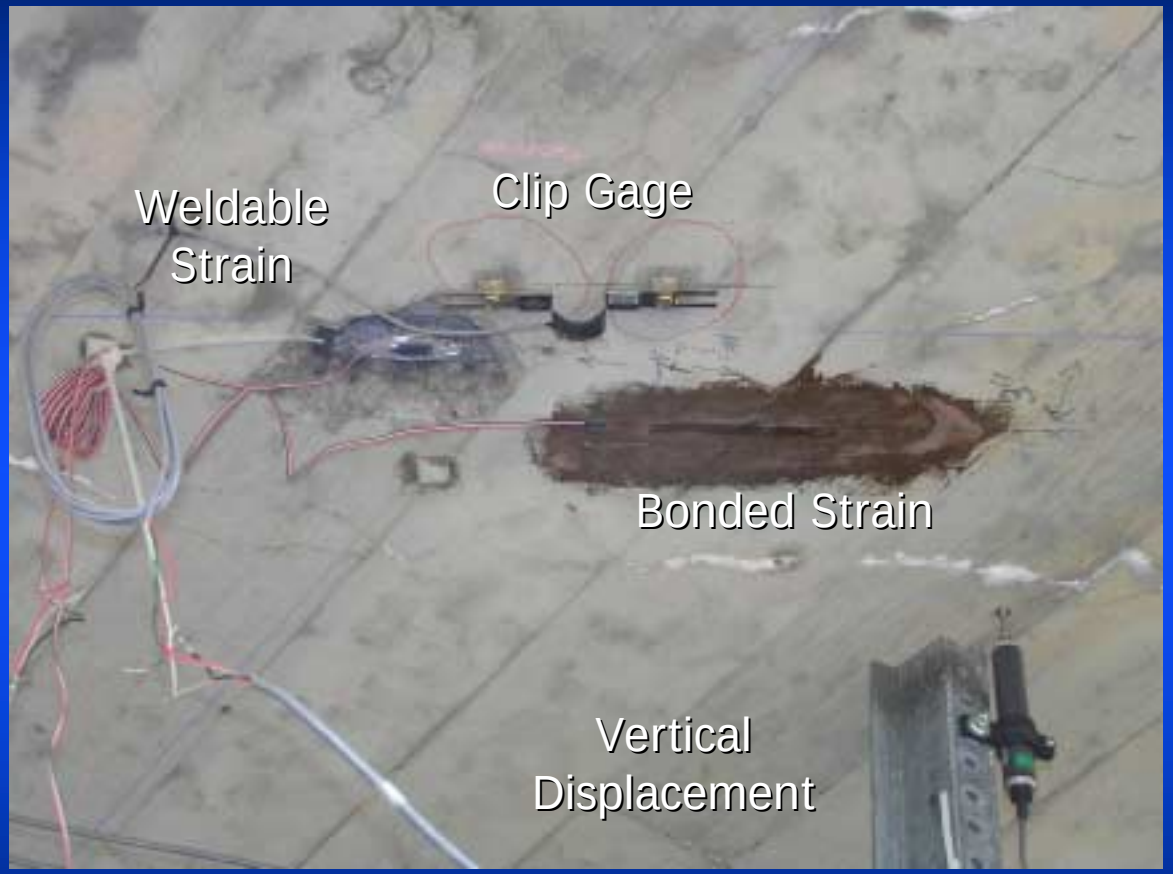
Structural Appraisal **27,707** bridges (Theoretical Load Rating)

Load Testing of Tams Slab Bridge (Tams, WV)



Side by Side Load Case

Back to Back Load Case



Typical Instrumentation

NDE Center
Federal Highway Administration

Comparison of Three Load Rating Methods (SU-45 Tridem Axle Truck)

	Tams Slab (Multi-Lane Loading)		Amigo Arch (Single Lane Loading)	
	Flexure	Shear	Flexure	Shear
Load Rating Method	**OPR**	**OPR**	**OPR**	**OPR**
AASHTO LRFR using minimum recommended properties	0.72	1.28	1.52	1.98
AASHTO LRFR using measured material properties	1.18	2.20	2.09	3.20
Finite Element Based Rating with measured material properties	2.36	1.42	2.5	3.06
NCHRP based load rating using diagnostic field test	3.69		2.74	

Load Testing Concrete Bridge

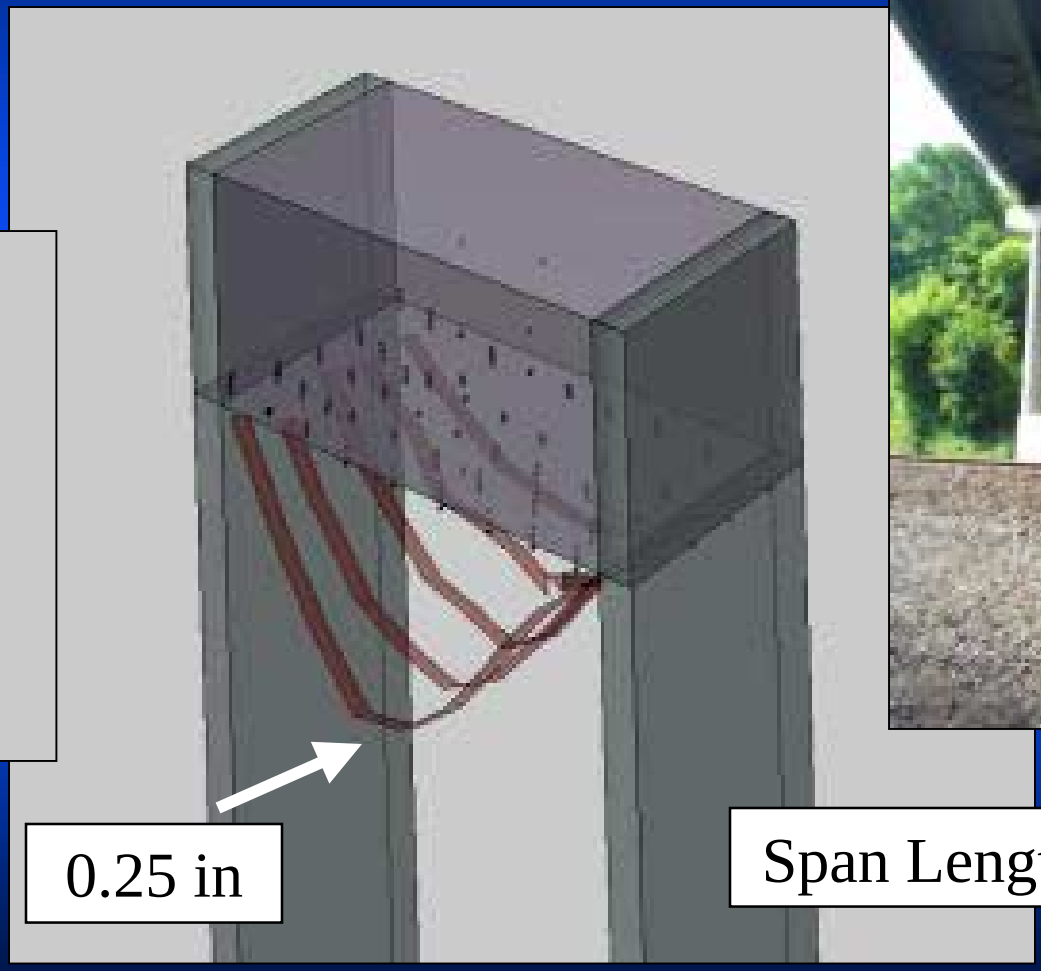
Carderock, Maryland

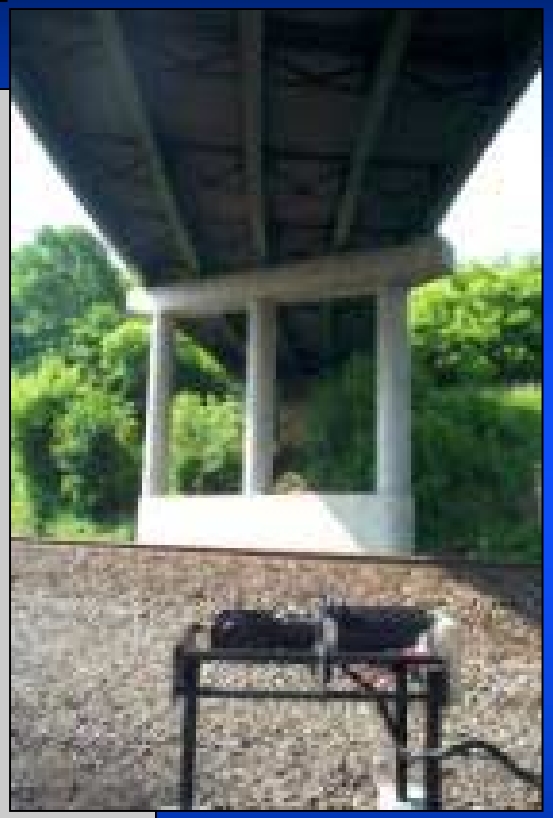
Laser scanner

Traffic under bridge not altered

Conventional deflection transducers

Load Test Data





Span Length: ≈95 ft

Bridge Data Acquisition System

Geosynthetic Reinforced Soil Bridge

Defiance, OH

84 Sensor Channels: *Strain, Soil Pressure, Displacement, Temperature*

NDE Center
Federal Highway Administration

Thank You!

Frank Jalinoos

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www.tfhrc.gov/hnr20/nde/home.htm