# Bridge Deck Condition Surveys using GPR

## Early GPR Developments at NHDOT

- NETC Study (1986 - 90) - MIT/UNH
- NHDOT SPR Study (1990-91) - Infrasense, Inc.
  - 44 Interstate Bridge Decks Surveyed
  - Horn (air-coupled) Antenna

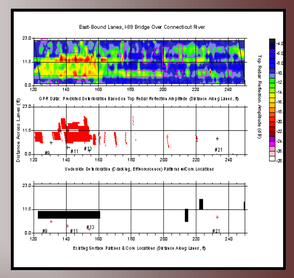
Very Effective at estimating "Percent Deteriorated Area" but not able to identify actual locations of deterioration


## 1998 Rehabilitation of I-89 Bridge/Connecticut River

- Geophysical Survey Systems, Inc. (GSSI) of Salem, NH
- Air and Ground-Coupled GPR Used to delineate expected repair areas. Underside inspection and chloride content tests used to confirm thresholds
- Compared to actual locations requiring repair as determined by sounding

RESULTS:

- This project demonstrated that repair decisions can be made effectively using high-resolution, GPR evaluations supported by limited destructive testing
- Study enables GSSI and NHDOT to refine predictions in the future
- GPR identified deteriorated areas, but did not differentiate between different deterioration mechanisms




## Later Developments

- Multi-antenna arrays allow for lanes to be surveyed in a single pass
- GPR compared favorably with corrosion potential data on 4 bridges in Thornton/Woodstock in 1999 without the need for any destructive testing
- GPR technology continues to improve

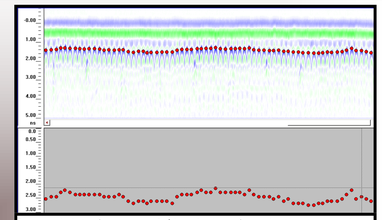

These are just some of the applications for GPR !

# GPR for Concrete Cover Determination

## NHDOT QC/QA SPECIFICATION FOR BRIDGE DECKS

- Applies to All New Bridge Decks
- Based on Random Sampling and Statistical Analysis
- Contractor's Payment Based on Measured Quality of Deck Concrete
  - Air Content, W/C Ratio, Permeability, Strength, and CONCRETE COVER

PROBLEM:
An accurate, repeatable method of measuring concrete cover was needed.



Processed data from a new bridge deck surface. In the top panel, red circles overlay the reinforcing steel reflection picks. The picks are located automatically by the system software through an algorithm that searches for the peak of each hyperbolic reflection in the data. In the bottom panel, horizontal position and depth to top of rebar are displayed with the results output to ASCII database.

## FHWA PRIORITY TECHNOLOGY PROGRAM - 1997

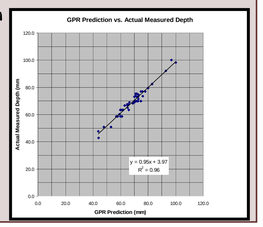
- Grant for NHDOT to purchase & evaluate GPR for this Application
- GSSI, Inc. supplied equipment and contributed development costs for software and hardware enhancements
- Second unit purchased with SPR funds at conclusion of study

## GOALS OF NHDOT STUDY:

- Measure the Correlation Between Radar Results and Actual Measured Depths
- Determine the Accuracy and Repeatability of the Radar Unit
- Compare Results to those of Existing Hand Held Units
- Build Confidence and Document Results

RESULTS:

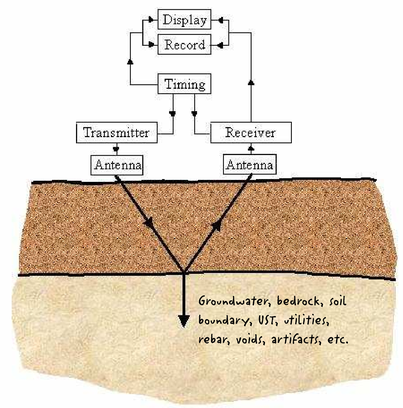
- Individual GPR predictions were accurate in all cases to within 5.1 mm of actual measured cover depths. With increased technician experience, the accuracy later in the study improved to within 3 mm
- GPR predictions correlated to the actual measured cover depths with a correlation coefficient of 0.98 and a standard error of estimate of 2.2 mm
- The Department's QC/QA specification was easily adapted to the use of GPR as a concrete cover measuring device. The Department has now fully implemented this technology




# GPR 101

BASIC RADAR CONCEPTS

- RAdio Detecting And Ranging
- Transmitting antenna radiates high frequency electromagnetic waves (pulses) into subsurface
- Some waves are reflected back — speed and amplitude of the reflection is related to the characteristics and boundaries of the subsurface materials
- Radar provides a "subsurface window" for a variety of geological, engineering, environmental and archaeological applications





ACKNOWLEDGMENTS:

BRIDGE DECK CONDITION SURVEYS

NHDOT: Mark Whittemore, Chris Waszczuk, Earl Kingsbury, Alan Rawson, Jeff Allbright, Glenn Roberts, Scott Leslie, Steve Brown, Joe Constant, Alan Perkins, Bill Real, Mike Juranty

Also: Francisco Romero (GSSI), Roger Roberts (GSSI), Ken Maser (Infrasense), Dave Hall (FHWA), Moores Marine Construction Corp.

CONCRETE COVER DETERMINATION

NHDOT: Jim Arrol, Glenn Roberts, Rick Lalumiere, Steve Brown, Alan Perkins,

Also: Roger Roberts (GSSI), Dave Hall (FHWA)

ENHANCING GEOTECHNICAL INFORMATION

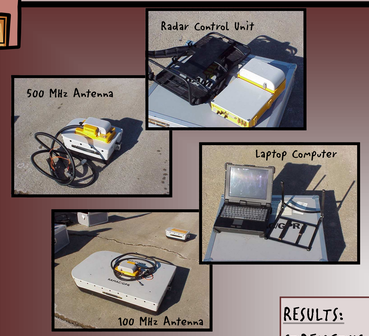
NHDOT: Marc Fish, Dick Lane, Doug Rogers, Scott Myers, John Soper, Ed Birckhead, Todd Belanger, Jimmy Pierce, Leon Fannion

Also: Mala Geoscience


# Ground-Penetrating Radar (GPR) Applications At NHDOT

New Hampshire DOT Department of Transportation RESEARCH

# Enhancing Geotechnical Information with GPR

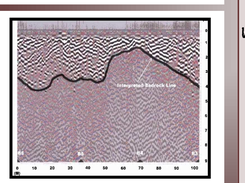



PROJECT SUMMARY:

Research was conducted in 2001-2002 to learn how well GPR could supplement or replace conventional test borings at different locations throughout New Hampshire. The objective of this study was to determine if GPR could:

- Distinguish between and accurately determine the depth to different soil layers
- Locate the surface of bedrock
- Find and measure the extent of bedrock fractures and subsurface voids
- Map river bottom profiles

GPR unit fully assembled & being towed over the ground surface



GPR profile between test borings

RESULTS:

STRENGTHS of GPR IDENTIFIED in this STUDY:

- One or two people can collect information in a minimal amount of time
- Equipment set-up is relatively simple and depending upon the existing ground surface, minimal preparation is needed
- Buried utilities do not need to be located because GPR is non-destructive
- The radar unit can be used at locations where a conventional drill rig could not or would have extreme difficulty accessing
- The subsurface information collected through GPR is continuous, so a complete profile can be obtained as compared to test borings where only point information is obtained.

WEAKNESSES of GPR IDENTIFIED in this STUDY:

- A path must be cleared to operate the radar unit in thickly wooded areas
- Highly conductive soil types will absorb the radar signal, leaving little reflected energy for the receiver to detect
- During winter operations, cold temperatures will reduce battery life and road salt will attenuate the radar signal
- It was uncommon to detect greater than two soil boundary layers because highly conductive or very thick soil layers are often located at or just below the ground surface
- Experience is required to recognize equipment limitations and effectively interpret/apply results