Tech Brief

Demonstration of Ground Penetrating Radar (GPR) (NJDOT Statewide GPR Pilot Project)

GPR RU4474 March 2004

HERE'S THE PROBLEM

A Ground Penetrating Radar (GPR) antenna transmits high-frequency EM (Electro-Magnetic) waves into the ground. A portion of the energy is reflected back to the surface from the interface of two adjacent (usually layered) materials with different electrical properties and it is received at the antenna. GPR surveys are needed for network-level and pavement design-level project management purposes for the New Jersey Department of Transportation to determine pavement structure statistics.

AND, HERE IS THE SOLUTION…

To conduct a project using GPR to produce information regarding pavement structure and layer thickness on various pavement types and pavement ramp samples.

BUT, HOW CAN IT BE DONE?

By conducting ground penetrating radar field surveys, data analysis, and reporting on approximately 600 lane miles (test miles) of pavements designated as network level investigations, as well as 25 to 50 lane miles of project (design) level pavement.

THESE ARE OBJECTIVES OF THE STUDY…

- To evaluate the pavement structure and layer thickness at the management level for decision making.
- To develop useful information for NJDOT for improvement of FWD backcalculation and characterization of pavement thickness variability over potential project sections.

AND, HERE'S WHAT WE DID…

The GPR vehicle was equipped with a 1 GHz air-coupled (horn) antenna and a 1.5 GHz ground-coupled antenna, and two distance-measuring instruments (DMI),
each of a precision higher than 1 ft per mile (0.0189% of measured distance) at

an operating speed of 65 mph. During all surveys, there was a digital camera recording of the pavement with live audio feed from operator marking special pavement features and indicating milepost. A separate laptop computer controlled the camera and images were streamed to the computer simultaneously during surveys.

Data from the antenna was collected while surveying at posted speeds averaging between 50 and 60 mph on highways and expressways, and 30-50 mph on local roads on the network level. On the project level, data were collected at speeds less than 15 mph. Due to low speeds; mobile traffic control was required during project level surveys. However, the network level surveys were performed without any traffic control.

Each GPR scan produces information about the layer interfaces. These scans, interpreted for layer properties such as thickness or layer dielectric constant, provide a “depth sample”. A “depth sample” simply refers to the fact that the GPR signal, at every scan location, provides information about all the pavement layers in a vertical sequence. When evaluating pavement variation along its length, including layer structure variation and thickness of the various pavement components, GPR’s high spatial scan density can be thought of as being equivalent to a like number of core samples.

GPR Data Collection was collected with carefully designed and consistent procedures to ensure the quality of the data. Data were processed using GSSI’s **RADAN**® (**RA**dar **D**ata **AN**alyzer) software with Road Structure Assessment (RSA) Module.

Interpretation of the data resulted in identification of several pavement layers and pavement types (rigid, flexible and composite) along surveyed roadways. GPR profiles also capture several local features of roadways such as utility cuts, pavement repairs, bridges, and culverts… The final results of the work are provided in terms of ASCII and Excel files, summarizing GPR survey results in specified formats and intervals.

CONCLUSION…

Ground Penetrating Radar’s continuous profiling capability, and ability to estimate pavement layer thickness and type without the use of cores, is a valuable precursor to groundtruth, Falling Weight Deflectometer, and other evaluations. This capability is clearly demonstrated through out this work, which included network level survey of 600 lane-miles of interstate, 27 U.S., and local highways and project level survey of 25 lane-mile of designated routes.

WHAT IS THE NEXT STEP?

The following recommendations address some of the issues, which will significantly improve the usefulness of GPR data, and its efficient use as a part of a comprehensive pavement management system.

It is recommended that these issues be considered for implementation in future GPR surveys:

• The error in distance measurement is the most dominant cause of discrepancies in GPR measurements. To improve the distance measurements, it is suggested that future GPR surveys be conducted with GPS (global positioning system) to minimize the errors form inaccurate measurement of distance.

• The captured video images of pavement during testing, if properly linked with other data, are very valuable both in GPR interpretation and pavement management applications.

• The ability to link, view, analyze, and report GPR, video, map, and several other pavement related data together, as demonstrated e.g. with RoadDoctor™ software, is extremely valuable.

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