Research Project: *SHA/UM/3-11*
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RESEARCH SUMMARY

EFFECTIVE IMPLEMENTATION OF GROUND PENETRATING RADAR (GPR) FOR CONDITION ASSESSMENT & MONITORING OF CRITICAL INFRASTRUCTURE COMPONENTS OF BRIDGES AND HIGHWAYS

Problem

Recently Maryland State Highway Administration (SHA) started to explore use of Ground Penetrating Radar (GPR) technology to provide quantitative information for improved decision making and reduced operating costs. To take full advantage of the GPR capabilities, improved analysis techniques need to be developed and implemented.

Objective

The objective of this study was to assist SHA engineers, technicians, and decision makers in their current effort to explore the use of GPR in assessing the condition of critical infrastructure components and to identify potential improvements in GPR data analysis. The research team closely interacted with representatives from selected divisions of the Office of Materials Technology (OMT) to identify potential GPR applications using existing equipment accessible to SHA, targeting critical high priority areas for analysis and improvement.

Description

To address the needs of SHA the project team (i) identified applications for the GPR equipment currently accessible to SHA, (ii) identified a broader set of GPR applications for monitoring the spatial and functional conditions of infrastructure components, and provided recommendations of alternative equipment, when needed, (iii) developed improved analysis methods for GPR data collected for bridge decks, pavements and precast concrete elements, (iv) developed testing protocols, to be incorporated into the Maryland Standard Method of Test (MSMT) Manual, and (v) training modules.

Results

In regards to pavement structures, a new methodology was suggested to improve the accuracy of GPR data analysis. The initial analysis and results indicated that Multi-scale Pavement GPR data Analysis (MPGA) has significant potential to add value and accuracy to pavement thickness data used in pavement management and rehabilitation analysis. The MPGA results indicate that pavement thickness data trends can be identified based on either automated or semi-automated procedures based on target variability levels of thickness uniformity, and thus can be used to efficiently evaluate pavement material layers.

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Similarly, for bridge deck analysis, techniques such as migration imaging (for concrete cover depth measurement applications among others) and Fourier analysis of GPR waveforms (for qualitative bridge deck moisture analysis) were used in addition to emerging techniques such as Short Time Fourier Transform analysis (for anticipated quantitative moisture analysis) for improving GPR data interpretation. Migration and Fourier techniques were illustrated corresponding to GPR data collected using a GPR array on selected bridge decks in the Salisbury, MD area. When applied appropriately, such techniques can provide more reliable analysis of bridge deck inspection than conventional means.

In terms of precast concrete, this study has shown how GPR can be used to address several of the inspections needed in precast concrete production, including an evaluation of concrete cover depth, reinforcement location, and section thicknesses. The testing and demonstration showed significant potential for quality control using GPR.

The expected benefits of the GPR based condition assessment techniques include: i) higher precision and accuracy of the condition assessment of key infrastructure components and materials; ii) higher speed of condition assessment and reduced monitoring time and cost; iii) increased accuracy in locating material failures; iv) improving overall condition assessment methods and more accurate performance and life cycle predictions; v) facilitating a method of non-destructive testing for Quality Assurance testing and forensic investigations.

Report Information

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Link to Final Report:
http://www.roads.maryland.gov/OPR_Research/MD-15-SHA-UM-3-11_GPR-Phase1_Report.pdf