0-7217: Synthesis: Commercial Air-Coupled Ground Penetrating Radar Systems to Be Used for Pavement Evaluations in Texas

Background

Ground Penetrating Radar (GPR) is a widely used non-destructive evaluation (NDE) technology for assessing pavement layer thickness, detecting subsurface anomalies, and supporting pavement design and maintenance decisions. GPR has served as a valuable NDE tool for TxDOT's pavement evaluations since the early 2000s. TxDOT currently employs an air-coupled GPR system integrated with the PaveCheck software for these evaluations.

However, the existing system faces increasing limitations due to aging hardware, outdated software, limited availability of replacement parts, federal restrictions on acquiring high-frequency antennas, data format compatibility issues, gaps in staff training, and rising maintenance costs.

To address these challenges, TxDOT initiated this project to identify and recommend a modern, vehicle-mounted air-coupled GPR system that better aligns with current and future pavement evaluation needs. The objective was to evaluate commercially available GPR systems in terms of technical performance, compatibility with existing workflows, long-term cost-effectiveness, and ease of use across TxDOT districts—while requiring minimal disruption to current operations and offering scalability for future advancements in data processing and analysis.

What the Researchers Did

The research team completed a series of coordinated technical tasks to evaluate and recommend a modern, air-coupled GPR system for TxDOT's pavement evaluation program. The key activities are summarized below:

• Conducted a comprehensive literature review of air-coupled GPR technologies and their applications across U.S. and international transportation agencies. The review highlighted best practices, limitations of existing systems, and emerging trends such as multi-channel configurations, UAV-mounted deployment, and AI-assisted layer.

• Gathered information from nine TxDOT districts through surveys to assess current GPR usage, operational barriers, data processing challenges, software limitations (especially related to PaveCheck), and staff training gaps.

• Evaluated four commercial GPR systems—GSSI RoadScan, IDS Hi-Pave, Kontur AIR Series, and ImpulseRadar Raptor-80—based on hardware specifications, antenna configurations, data resolution, scanning speed, ease of deployment, and vendor support.

• Analyzed data format compatibility with PaveCheck, focusing on each system's ability to

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convert proprietary radar file formats (e.g., .DZT, .rd3) into .DAT format required by PaveCheck.

• Provided final recommendations and implementation guidance based on the literature review, stakeholder feedback, system evaluations, and data format assessments conducted under Tasks 2 through 8 of TxDOT Project 0-7217.

What They Found

From the literature review, the research team found that GPR is widely used by transportation agencies for pavement layer thickness evaluation, subsurface anomaly detection, and network-level pavement condition assessment. Survey responses from nine TxDOT districts revealed that 78% of districts currently use air-coupled GPR, primarily for pavement design and rehabilitation. The current TxDOT GPR system presents increasing challenges due to outdated hardware, limited support, software compatibility issues, training gaps, equipment shortages, and difficulty using PaveCheck software and restrictions on acquiring high-frequency antennas.

Four commercially available air-coupled GPR systems—GSSI RoadScan, IDS GeoRadar Hi-Pave, Kontur AIR, and ImpulseRadar Raptor-80—were evaluated. All systems met core criteria, but GSSI RoadScan was identified as the most suitable option due to its due to its widespread adoption by DOTs for TxDOT current pavement evaluation needs. However, the other systems—Kontur AIR Sensors, IDS GeoRadar RIS Hi-Pave, and ImpulseRadar Raptor-80—offer advanced features. Kontur

AIR provides high-resolution 3D imaging for research and specialized investigations. IDS RIS Hi-Pave supports multi-lane, high-speed surveys with semi-automated layer interpretation. ImpulseRadar Raptor-80 offers deep subsurface diagnostics with advanced antenna design. While not immediate priorities for routine surveys, these systems hold potential for future research and targeted innovation projects.

What This Means

The evaluation results indicate that GSSI RoadScan is the most suitable option for TxDOT's immediate pavement evaluation needs. While GSSI RoadScan meets current needs, the other systems—Kontur AIR Sensors, IDS GeoRadar RIS Hi-Pave, and ImpulseRadar Raptor-80—offer advanced features that may be valuable for future research or specialized projects. Kontur AIR provides high-resolution 3D imaging, IDS Hi-Pave supports multi-lane high-speed surveys, and ImpulseRadar Raptor-80 offers deep subsurface diagnostics. While these advanced features may not be necessary for routine surveys, they hold significant potential for future research pilots and targeted innovation projects as TxDOT's needs evolve. These systems may also serve to expand TxDOT's technical capacity in advanced pavement evaluation techniques.