CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-7071: Evaluate Geophysical Methods to Detect Underground Voids

Texas Department of Transportation (TxDOT) Project 0-7071, entitled "Evaluate Geophysical Methods to Detect Underground Voids," is aimed at the comparative assessment of the effectiveness of four geophysical methods in detecting subsurface anomalies, with particular focus on underground voids.

Under the auspices of the project four geophysical methods are studied: a. Electrical Resistivity Tomography (ERT); b. Multi-Channel Analysis of Surface Waves (MASW); c. Full-Waveform Inversion (FWI); and d. Ground Penetrating Radar (GPR).

The primary objective of the project is to lend clarity on the applicability and limitations of each one of the four geophysical methods, while also arriving at recommendations for the most appropriate course of action when faced with site investigations aimed at detecting the presence of voids.

To comparatively assess the methods and to inform our recommendation: a. we conducted computational studies driven by synthetic data; b. we performed field experiments at two sites and used inverse modeling tools to image the subsurface; and c. we sought to verify the imaging resulting from the field experiments using the findings of invasive drilling at select locations at the field experiment sites.

We concluded that a: ERT is well-suited for detecting and localizing subsurface anomalies, but may not be able to accurately size or characterize the material composition of an anomaly/void; b. MASW is unsuitable under most realistic field conditions; c. FWI appears suitable based on computational simulations, and would likely meet the demands of field conditions, but this capability was not tested; and d. GPR's ability in anomaly detection is very limited due to depth constraints, it lacks consistency, and depends highly on operator experience; even when detection is successful, sizing and characterizing the anomaly using GPR is infeasible.

We believe that no single method operating on its own can consistently

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deliver a fine resolution subsurface image at a heterogeneous site that includes subsurface anomalies and surface topographic features. However, if one were to choose a single method out of the ones we experimented with in order to get an approximate picture of the subsurface that may reveal the presence of anomalies/voids, we recommend ERT, subject to the cautionary statements made herein and in the final project report.

We identified a number of areas where gaps exist and improvements need to be made if the near-surface soil deposits were to be reliably imaged for infrastructure projects. In particular, we urge attention to multi-physics-based imaging, where two (or more) geophysical methods are used synergistically to invert for the subsurface properties, which would facilitate anomaly/void detection. Additional gaps include the lack of well-tested, well-documented, reliable software suites dedicated to the 3D inversion based on ERT and FWI that also account for topographic effects.

For More Information

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