



TECHSUMMARY October 2022

State Project No. DOTLT1000285 | LTRC Project No. 20-4GT

Feasibility Study on Geophysical Methods to Estimate Geotechnical Properties in Louisiana

INTRODUCTION

Subsurface investigations currently rely on conventional soil borings with the aid of cone penetrometer test (CPT) soundings. However, these geotechnical explorations can be expensive and information is not provided between boreholes. Geophysical methods can aid in providing some information between the boreholes at a lower cost for the Louisiana Department of Transportation and Development (DOTD). These cost-effective geophysical surveys include other advantages, such as site accessibility, portability, operator safety, shorter project delivery times, and reduced construction delays.

OBJECTIVE

This synthesis investigated geophysical tools and test methods based on available research and advancements from other state DOTs, FHWA, and NCHRP. The objective of this study was to synthesize available geophysical methods and provide DOTD headquarters (HQ) geotechnical designers with a short list of appropriate technologies that can offer the department cost-effective alternatives. This included a detailed description of each method's applicability to geotechnical engineering, pros and cons, cost of each method, and required equipment. The research also developed recommendations and provided an action plan for DOTD to consider using geophysical methods in various geotechnical applications in Louisiana.

SCOPE

The LTRC Geotechnical group evaluated the effectiveness of available geophysical methods and provided detailed descriptions of each method. A series of surveys and meetings with DOTD HQ led to a finalized, simplified list of geophysical tools to utilize for Louisiana applications. Device utilizations, cost-benefit scenarios, and training requirements (i.e., pros and cons) were also evaluated.

METHODOLOGY

The Louisiana Transportation Research Center (LTRC) geotechnical research investigated previous and ongoing work and advancements consisting of geophysical methods and tools nationally. A survey was conducted with the DOTD Geotechnical group to develop a list of methods based on potential geotechnical applications for Louisiana.

RESULTS

The DOTD Geotechnical group's survey selected the following geophysical methods offering benefit and insight to compare on a closer level: seismic refraction, seismic reflection, cross-hole seismic tomography, ground penetrating radar (GPR), electrical resistivity, multichannel seismic waves, and refraction microtremor. LTRC evaluated how each of these methods would be utilized (i.e., site specific, number of personnel, limitations). Researchers also included cost-comparison data and information on other state DOTs that currently utilize these geophysical methods in-house. Case studies are included in the report to further validate which geophysical methods may be most suitable for Louisiana and would be beneficial for DOTD.

CONCLUSIONS

Survey results showed that the following geotechnical applications are of interest to DOTD:

- Mapping lithology (< 30-ft. depth)
- Mapping lithology (> 30-ft. depth)
- Foundation integrity studies
- Landslide site evaluation
- Detection of voids beneath pavement

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LTRC searched for economical benefits of geophysical methods; however, cost evaluation for geophysical methods tends to be hard to quantify. Many factors include cost of certain contractors or geophysical experts, the size of the geophysical crew required to conduct survey, and the size (area/depth) of the test area. A typical 120-ft. boring could cost DOTD around \$15,000 each. Whereas, one insight provided by the Interstate Technology & Regulatory Council (ITRC) states that their most common geophysical methods (seismic refraction, GPR, and electrical resistivity) cost a daily contract rate of about \$2,000–\$4,000.

Researchers found the most common geophysical methods utilized in-house across the nation's DOTs are seismic refraction, GPR, and the electrical resistivity methods. In addition, case studies from Minnesota, Ohio, and California have proven resistivity, seismic, and tomography geophysical methods to be successful. In these findings, the project review committee and researchers ultimately refined the geophysical method list to include the following that would be the most beneficial to the department with relative ease of implementation: electrical resistivity, seismic refraction, and cross-hole tomography.

RECOMMENDATIONS

Based on the research work and conclusions, the following items are recommended for implementation.

- Researchers recommend a more detailed research study directed toward implementing the selected geophysical methods.
- The recommended follow-up study should include field and laboratory work to validate the benefits and provide the department efficient and economical implementation strategies.
- Device-specific training is recommended for any implemented devices.