RESEARCH
PROJECT CAPSULE
December 2020
[20-4GT]
TECHNOLOGY TRANSFER PROGRAM

Feasibility Study on Geophysical Methods to Estimate Geotechnical Properties in Louisiana

JUST THE FACTS:

Start Date:
December 1, 2020

Duration:
15 months

End Date:
February 28, 2022

Funding:
80/20 SPR

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Sponsored jointly by the Louisiana Department of Transportation and Development and Louisiana State University

POINTS OF INTEREST:

Problem Addressed / Objective of Research / Methodology Used / Implementation Potential

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PROBLEM

Current geotechnical exploration practices in Louisiana rely on conventional soil borings with the aid of cone penetrometer test (CPT) soundings. The characteristics of these technologies are site specific by providing discrete profile information, missing any information between soil borings, CPT, or any other discrete tests. Interpretations of conditions between borehole/cone locations are sometimes made by connecting similar soil layers with fence diagrams, but this is an inexact science and an estimate. Spatial variation exists and has been studied in relation to the proximity of adjacent boreholes. Subsurface investigations can be expensive, especially when samples are collected for laboratory testing. Increasing the number of subsurface boreholes improves and verifies the subsurface conditions, but doing so increases costs. Utilizing soil borings and CPTs does not provide information between each of the holes tested. However, geophysical methods can aid in characterizing this missing information at a lower cost.

In contrast, geotechnical geophysical surveys are the most co-effective and rapid means of obtaining subsurface information, and they can be used to select and reduce the amount of borehole locations (Academic, 2005). Geophysical methods can provide cross-section information between typical bore/CPT holes and provide a broader area of information with continuous interdimensional information of an entire soil layer. Other advantages of geophysical technology include site accessibility, portability, noninvasiveness, operator safety, and others. This can allow geophysical surveys to be performed at locations, such as heavily urban areas, under bridges, extreme slopes, and marshy terrain (FHWA, 2019).

The following is an example of how the Louisiana Department of Transportation and Development (DOTD) could save both time and construction costs by utilizing geophysical methods. One such case is the I-10 twin span project. The soil stratigraphy varied within the same pile group during construction, which caused significant cut-offs on many piles. This also added necessary, additional borings, which significantly increased the total cost of the project and increased construction times. These cost and time delays could have been avoided by utilizing geophysical testing during preliminary geotechnical explorations. This I-10 project led to the initiation of this research project to help DOTD increase knowledge and understanding of advanced geophysical methods and learn more about geophysical testing that is applicable to Louisiana soils and conditions. Research was needed regarding the applicability of geophysical methods in Louisiana soils, costs of the equipment, and requirements regarding specialized knowledge to interpret the data.

OBJECTIVE

The main objective of this study is to synthesize available geophysical methods and provide headquarters (HQ) geotechnical designers and the Project Review Committee with a short-list of appropriate technologies that can offer the department cost-effective alternatives. The research will also develop recommendations and provide an action plan for DOTD to consider using geophysical methods in various geotechnical applications in Louisiana.

METHODOLOGY

To achieve the objective of this research, the following tasks will be completed. First, a thorough literature review will be conducted to investigate other previous and ongoing research regarding advancements in geophysical testing practices. Next, a list of geophysical methods will be compiled and their applications will be described. The research team will then focus on identifying the best geophysical methods for the different applications identified.

For example, Figure 1 shows an example from Minnesota DOT (MnDOT) indicating the electrical resistivity profile of a construction site (Anderson, 2008) The Electrical Resistivity Profile method involves the measurement of electrical resistivity of soils as it passes between two surface points. Results are plotted as a function of elevation (depth) and horizontal position (FHWA, 2019). The different colors indicate the Electrical Resistivity profile as a relative heat map with red as the highest value and blue as the lowest value. Like a contour map, colors help differentiate between cohesive and granular soils based on their resistivities. Figure 1 shows how this particular geophysical technology can aid designers by providing information between the borings, reducing the unknowns and potential construction costs.

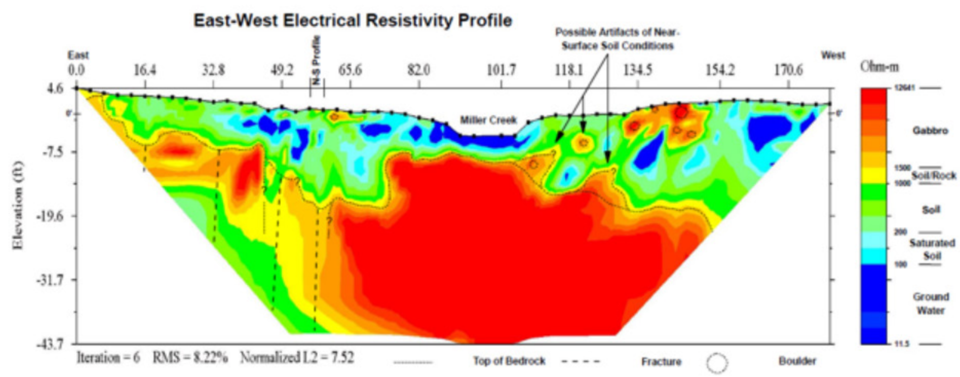

Figure 1

Minnesota DOT geotechnical site characterization example (Anderson, 2008)

Following this task, the team will discuss with DOTD headquarters to determine a potential list of geophysical methods for Louisiana. Based on this discussion, the research team will recommend specific geophysical methods per application for further consideration in Louisiana. A follow-up study with field and laboratory work will likely follow this research, validate benefits, and provide the department with efficient and economical implementation strategies. Lastly, a final report summarizing all findings will be prepared.

IMPLEMENTATION POTENTIAL

This research will benefit the department in several ways. For example, by utilizing geophysical tools in addition to standard geotechnical exploration practices, the department can provide a more detailed pre-construction characterization of the geotechnical conditions at sites, improve current QA/QC methods, and potentially incorporate a new TR method to describe how to conduct recommended geophysical methods for Louisiana. Other potential benefits include shorter project delivery times, reducing possible setbacks, improved QA/QC, and reducing risks within the areas between investigated subsurface site conditions. This information will improve the design aspect, ideally produce more efficient and cost effective designs, provide confidence through other test methods, and hopefully reduced overall construction costs.

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