RESEARCH
PROJECT CAPSULE [24-2GT]
January 2024
TECHNOLOGY TRANSFER PROGRAM

Web-based Tool to Advance Geotechnical Data Interchange and Reliability-based Site Characterization

JUST THE FACTS:

Start Date:
December 1, 2023

Duration:
24 months

End Date:
November 30, 2025

Funding:
TT-Fed/TT-Reg-5

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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

As advanced data-rich techniques and methodologies are developed for geotechnical site characterization, including those recommended by the Advanced Geotechnical Methods in Exploration (A-GaME) program from FHWA, there are opportunities for geo-professionals to advance their geotechnical data and project delivery.

This research will focus on innovative practices to improve geotechnical data management, highlighting the development and implementation of a web-based platform to efficiently visualize and interpret geotechnical data, and to eventually facilitate project delivery. A web-based platform can incorporate multiple types of geotechnical and geo-environmental data for data visualization and interpretation. "Dense" geotechnical datasets that can be captured and utilized on the platform include lab testing data from soil borings, cone penetration testing (CPT) data, LiDAR data, geophysical testing data, instrumentation data, and deep foundation field load testing data.

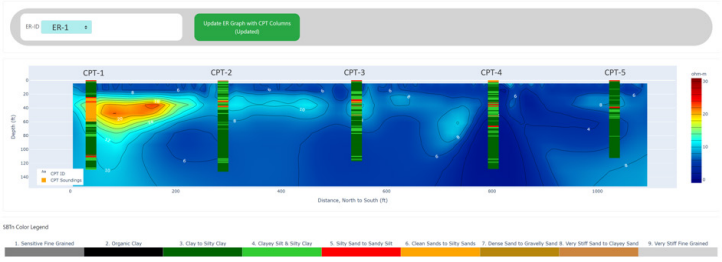

Figure 1. Interactive electrical resistivity survey profile with CPT soundings to evaluate spatial variability of a project design site (Source: Peng and Rauser 2021)

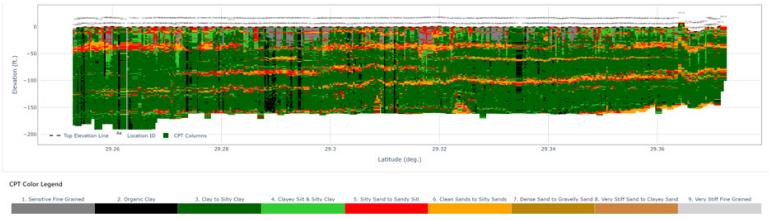

Figure 2. Soil stratigraphy profile with more than 300 CPT soundings to evaluate spatial variability of the design site

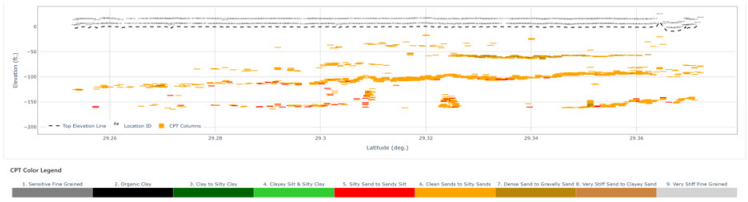

Figure 3. CPT stratigraphy profile with user-defined rules to identify and visualize critical soil design layers

OBJECTIVE

Web-Based Visualization

A web-based platform has been implemented by DOTD for several large highway and bridge design and construction projects. These larger projects focused on the ability to interactively visualize and interpret data from soil borings, CPTs, geophysical data, and conventional field survey data. This project will standardize this visualization process for all projects.

GEC-5
This project will also demonstrate how geotechnical engineers and consultants can efficiently quantify the uncertainty of site conditions and develop soil design models based on statistical analysis of soil boring data. The uncertainty model can be interactively evaluated based on the methods presented in FHWA's Geotechnical Engineering Circular (GEC) No. 5 – Geotechnical Site Characterization.

DIGGS
Additionally, the project will demonstrate how Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS) can be implemented into the web-based platform for standardized geotechnical data exchange. The implementation of DIGGS to efficiently increase the quality of geotechnical data deliverables as a digital asset. Other benefits of implementing DIGGS in geotechnical data management, visualization, and geotechnical design process will also be researched.

METHODOLOGY

Task 1 – Literature Review
The team will conduct a comprehensive literature review on relevant published works internally and externally.

Task 2 – Develop Test, Optimize, and Finalize Prototype Platform
- Finalize prototype web-based platform capable of consuming DIGGSml files to perform the following: interactively select soil borings, create a composite soil stratigraphy, plot soil properties and derived parameters vs. elevation, and develop design profiles.
- Implement security features to allow other stakeholders (consultants, LTRC, etc.) to access the tool in order to provide a centralized, repeatable, and standardized method to develop the statistical parameters needed for future load resistance factored design (LRFD) revisions.
- Find a long-term hosting solution for the web-based tool. LTRC hosts other research developed tools and software. There will be a developmental site, then long-term hosting via LTRC.

Task 3 – DIGGS Implementation
- Develop a standardized DIGGS dictionary based on the current gINT format for DOTD projects.
- Develop a conversion tool for DOTD geotechnical data (gINT files) to benefit DOTD and its retainer-contract consultants to ensure data is transferred appropriately into DOTD's current standard Open Ground Cloud.
- Test the module internally (LTRC and DOTD) and through conversions with consultants. The file conversions will work for various geotechnical software, as gINT is sun-setting, assuming appropriate data dictionaries are established and implemented with each software.

Task 4 – LRFD Module
In the web-based platform, automate the process of the statistical analyses that will be implemented in the next version of LRFD design specifications. This specification is being drafted and is expected to utilize concepts detailed in FHWA GEC No. 5. The intent of this module will be to standardize the selection of resistance factors and the evaluation of data variability.

Task 5 – Recommend and Implement Strategies
Recommend steps to continue the efforts developed in the research to realize efficiencies (time, data, productivity, etc.) within the department. Implementation strategies will be developed with the Project Review Committee (PRC) and guided by the researchers and stakeholders to the end users. Recommendations of best practices and those fitting Section 67 needs will be at the forefront.

Task 6 – Document the Research Effort
Prepare the final report to document the entire research effort. The final report will include data, discussion of results, and recommendations for future efforts and ideas generated by the study for implementation.

Task 7 – Process through Editing
The report will be processed through LTRC editing to refine the content, grammar, and format according to LTRC guidelines and Section 508 accessibility requirements. Revisions will be made with the help of the authors, and the report will be resubmitted for publishing.

IMPLEMENTATION POTENTIAL

- A standardized digital data transfer solution, allowing interoperability of geotechnical data between DOTD and its contractors and consultants. This solution is an implementation of DIGGS, a robust and extensible data transfer interchange supported by FHWA, multiple DOTs, United States Army Corps of Engineers (USACE), and others in the geotechnical community.
- A method to generate design profiles and develop statistical parameters that are expected to become the basis of future LRFD design code. These statistical parameters are tedious to generate without computer programming knowledge and thus may pose some difficulty to DOTD Staff and its consultant contractors when the LRFD code is updated. It is in the Department's best interests to help smooth the transition to any updated version of LRFD, which is the design standard to which we expect our consultants to adhere.