RESEARCH
PROJECT CAPSULE [16-6GT]
April 2016
TECHNOLOGY TRANSFER PROGRAM

Incorporating the Site Variability and Laboratory/ In-situ Testing Variability of Soil Properties in Geotechnical Engineering Design

JUST THE FACTS:

Start Date:
July 1, 2016

Duration:
30 months

End Date:
December 31, 2018

Funding:
SPR: TT-Fed/TT-Reg

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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

PROBLEM

While structural engineering deals with mostly homogeneous manmade materials (e.g., concrete and steel), geotechnical engineering typically involves highly varied natural materials (e.g., soil and rock). As a result, high variance of the resistance of geotechnical structures is expected due to the horizontal and vertical spatial variation of soil properties at the site. Compounding the variability problem is the fact that the accuracy and reliability of design data is sometimes unknown or not controlled. If the uncertainties are not properly considered, under-design may result in failure of geotechnical structures or over-design may result in extra costs.

Geotechnical variability is a complex attribute that results from many disparate sources of uncertainty such as spatial variability due to natural geologic deposits, equipment and operator measurement variations, statistical errors due to limited information, and model bias. To account for uncertainty, the Louisiana Department of Transportation and Development (DOTD) changed from Allowable Stress Design (ASD) to Load and Resistance Factor Design (LRFD) for deep foundations and other geotechnical engineering work. Since LRFD treats both the loads and the resistances of geotechnical structures as random variables, the resistance factor (ϕ) is assessed based on a reliability analysis.

Current LRFD guidelines specify constant resistance factors for a project, regardless of the fact that soil properties vary across a project site or along its depth. Research is needed to evaluate site variability, measurement errors, and model transformation bias. While site variability is inherent and cannot be reduced, measurement uncertainty can be reduced by increasing the number of measurements or improving the method of measurement (standard operating procedures).

OBJECTIVE

The main objective of this research is to evaluate and quantify the different sources of variability for consideration when designing or analyzing geotechnical engineering systems. In general, this includes evaluating spatial variation of design soil properties, evaluating both operator- and equipment-induced variations during measurement of design soil properties, developing QC/QA guidelines for test data, and incorporating site variability and measurement error into geotechnical LRFD.

METHODOLOGY

This project will be divided into two phases. Phase I will focus on evaluating site variability and measurement error of design soil properties and on developing QC/QA guidelines for test data. Based on the outcome of Phase I, the research team will explore the possibility of incorporating its results into geotechnical LRFD (Phase II).

IMPLEMENTATION POTENTIAL

Ultimately, LRFD resistance factors will be modified to account for site variability and soil test measurement errors. QC/QA guidelines for DOTD soil test laboratories will be developed to increase accuracy and precision of test data. Supplemental guidance on how to incorporate variability into geotechnical LRFD will be provided.

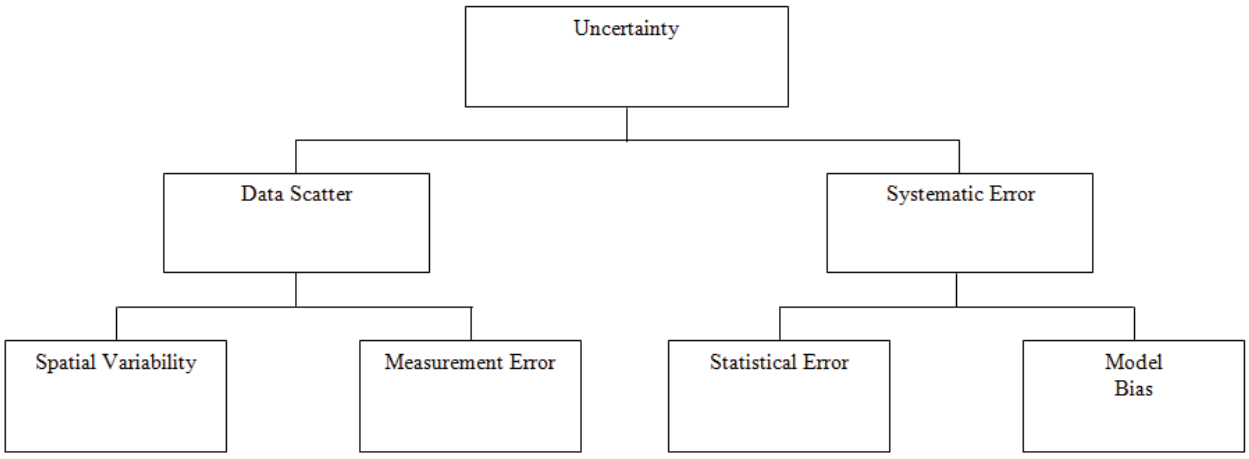

Figure 1
Source of uncertainty in geotechnical reliability analysis

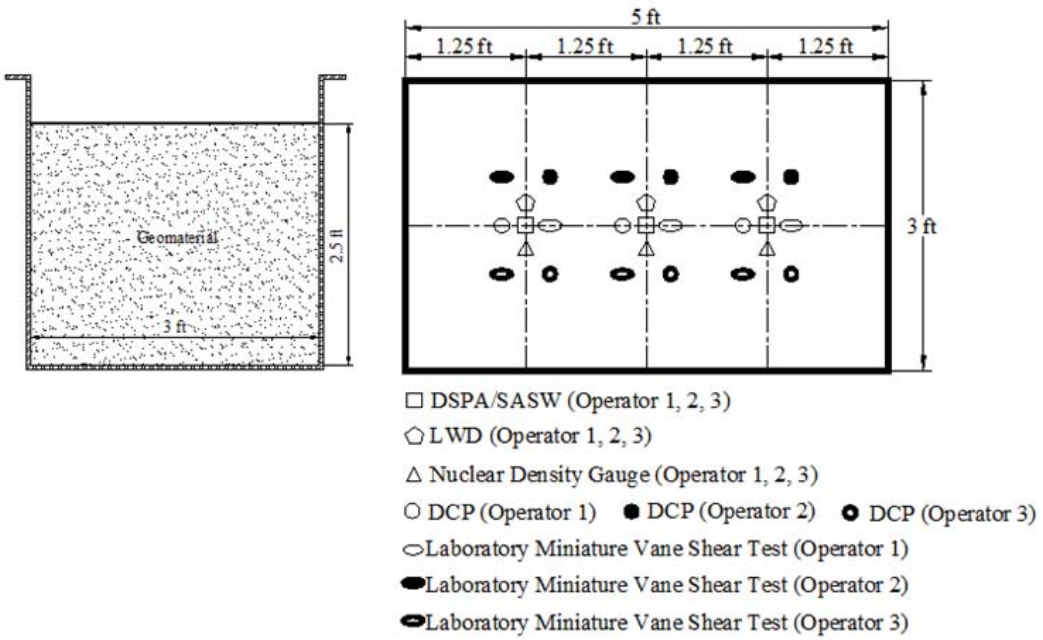

Figure 2
Schematic layout of laboratory test sections