PUTTING RESEARCH TO WORK **BRIEF**

Correlating Soil Test Results to Reduce Design Costs

Highways and overpass structures require solid, stable foundations. The soil tests conducted to assess the strength, stability and other structural properties of underlying soils can be quite costly if designers employ sophisticated laboratory and in situ field testing.

What's the Problem?

The soil testing that will be required for WisDOT's planned improvement of the freeway system in southeastern Wisconsin provides the opportunity to curtail costs if more routine, less expensive soil testing methods can be used while still ensuring reliable results.

Researchers posited that the large amount of data resulting from subsurface investigations for the recently completed Marquette Interchange reconstruction project could be used to develop correlations between results from sophisticated tests and those from simpler and more routine tests. Using data from previously characterized soils may allow WisDOT's future design work in southeastern Wisconsin to be based on more routine tests, reducing design costs.

Research Objectives

The objectives of this research included:

- Investigating the soils data generated by the Marquette Interchange reconstruction project to correlate routine laboratory tests with more sophisticated laboratory or in situ field tests used to determine geotechnical design parameters.
- Exploring the range of values, variations, trends and correlations in terms of different soil types and/or geological origin and comparing them to published correlations, when possible.
- Establishing recommendations for when it may be appropriate to use routine laboratory or field tests in place of more sophisticated tests for particular soils.

Methodology

Researchers reviewed 3,763 boring log samples—each boring log included 54 types of data—and laboratory test results from the data generated by the Marquette Interchange reconstruction project's extensive subsurface investigation. Information about geological origin and soil characteristics was gathered from other compilations of data. Data relating to structural properties of the soil—such as strength, compressibility, swelling potential and permeability—were reviewed with respect to geological origin from a review of boring logs, index properties (the type and conditions of the soil) and soil descriptions. The structural properties were then correlated with geological unit designations.

Researchers identified variables with statistically significant correlations that could be used to develop reliable, easy-to-use correlation equations for geotechnical data. They identified existing empirical equations through a literature review and evaluated them to assess their suitability for Wisconsin soils, comparing existing correlation equations with the correlations identified in this study.

Results

The investigation established a solid basis for estimating effective strength and compression parameters from simple index properties and geological origins. Researchers identified a series of correlation equations that can be applied to arrive at geotechnical design parameters using lower-cost field and laboratory tests. Recommended correlations include:

- Wet unit weights for inorganic and organic soils
- Undrained shear strength as a function of soil type and geological origin

Investigator

"The relationships identified in this study estimate soil structural properties based on geological origin and simpler index tests. Structural test results can now be verified using historical data."

–Tuncer Edil
University of Wisconsin–Madison
edil@engr.wisc.edu

Investigator

Craig Benson
University of Wisconsin–Madison
benson@engr.wisc.edu

Project Manager

"The correlation equations developed in this study can be used to more effectively evaluate alternatives in early design phases."

–Bob Arndorfer
WisDOT Bureau of Technical Services
robert.arndorfer@dot.wi.gov

Co-investigators:
Lin Li, David Mickelson, Felipe Camargo, University of Wisconsin–Madison

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Soil boring data were used to identify correlation equations that can be used to estimate effective strength and compression parameters using simple index properties and geological origin.

- Drained strength parameters as a function of soil type and geological origin
- Compression parameters

Implementation and Benefits

Study results can be applied at different stages of construction:

Preliminary design. While there are no test values to consider during a project's early planning stages, the correlations resulting from this study give designers a more accurate basis for presumptive test values in preliminary design. Use of the correlations can result in a more accurate selection of design alternatives before moving into the final design phase.

Subsurface investigation. Test results generated during subsurface investigation can be verified against the correlations, which provide a range of variation for certain soil properties and likely values within that range. The accuracy of test results can be verified using a relatively small number of samples.

Most of the correlations resulting from this study rely on a soil's index properties and geological origin. This means that application of study results are largely limited to areas where geological units are similar to those encountered in southeastern Wisconsin, where the test samples on which the correlations were based were obtained. The correlation equations may also be used in areas of Wisconsin that do not exhibit the same geological origins as southeastern Wisconsin if a correlation equation relies solely on a soil's index properties.

Even with these limitations, the volume of planned transportation projects in the densely populated southeastern region of Wisconsin offers WisDOT an opportunity to save on design costs by using the correlations to reduce the amount of more expensive field and laboratory procedures needed.

This brief summarizes Project 0092-06-05, "Comparison of Basic Laboratory Test Results with More Sophisticated Laboratory and In-Situ Test Methods on Soils in Southeastern Wisconsin," produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research Program, 4802 Sheboygan Ave., Madison, WI 53707.

Daniel Yeh, WisDOT Research and Communication Services