Feature

In Pursuit of Accuracy

By Peggy Hagerty Duffy, P.E., D.GE, ADSC Technical Advisor

Designing Blind

Geotechnical engineering is unique in the area of design. Few other disciplines are based upon the evaluation of materials and conditions that are different on each site and are sometimes difficult to quantify. Structural engineers can design a steel beam in Hong Kong or in East Lansing and be confident in their assumptions of material properties. Similarly, mechanical engineers typically don't question whether the unit weight of water has changed when they are designing pipe systems. However, soil conditions can change over short distances, and rock strength characteristics often are functions of localized discontinuities.

To complicate this situation, geotechnical evaluations have been undervalued historically. Soil and rock mechanics have been understood only in recent times relative to the age of most design and construction methods. Many structural engineers, contractors, and owners have viewed geotechnical engineering as "voodoo science." This belief is based on the disclaimers about the limitations of subsurface explorations included in geotechnical reports. The doubters consider these disclaimers evidence that geotechnical evaluations are useless and misleading. While large federal infrastructure projects may include hundreds of borings with dozens of laboratory tests and full-scale load tests during construction, these projects constitute the minority of work done in the foundation industry. Obtaining accurate strength data for subsurface materials is routinely given the lowest priority (and budget dollars) of any part of the design process. In fact, owners on small to medium-sized construction projects often agree to only pay for a "bare bones" subsurface exploration, assuming the geotechnical engineer will rely on published soil and rock information or personal experience.

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Many geotechnical engineers are caught in this budgetary bind and compensate by recommending highly conservative values for soil and rock strength to be used during design. Conservatism can reach extreme levels in dealing with hard rock. Random reductions in strength and/or stiffness are assigned to rock in order to compensate for discontinuities in a rock mass. These reductions typically reflect no real relationship to documented rock mass behavior, but instead represent unsupported conservatism. Extreme conservatism often leads to significant cost implications in the foundation system and can affect foundation selection.

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Most owners do not see sufficient long-term value in increasing the collective knowledge of accurate strength information to fund such investigations. It is unlikely that a sufficient body of data will ever be amassed through the good intentions of private owners investing their own money to advance the accuracy of modern geotechnical design.

The Drilled Shaft Committee of the ADSC has assumed the responsibility of pursuing accurate soil and rock strength data to permit more appropriate and informed foundation design. The association recognizes that the pace of construction technology development has outstripped the collection of design data to an extreme degree. A large disparity exists between the understanding of how foundation systems behave and how specific soil and rock types behave in response to foundation loads.

A number of programs are in development to address this need. One such initiative was born of an impromptu committee discussion in Dallas in October of 2014.

Small-Scale Load Test Program

Full-scale load testing is expensive. Osterberg load cells provide invaluable data, but they are not at a price point that will allow routine use. Most load tests take place on large projects involving drilled shafts with relatively large diameters.

Al Rasband, ADSC President and Vice President of ADSC Contractor Member Malcolm Drilling, Kent, Washington, asked the question, "Why can't we come up with something that can be done more cheaply, and on every job. The data could be circulated and design values could move into more accurate ranges." The discussion that ensued produced an idea: Could a small-scale load test be developed so that strength data could be extrapolated to larger diameter shafts?

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Terry Holman, of ADSC Technical Affiliate Geosyntec, Chicago, Illinois, and Ray Fassett, ADSC Contractor Member Condon-Johnson Associates, Inc., Oakland, California, cautioned that extrapolation of rock strength behavior is dif-

ficult because rock mass behavior is dependent upon placement and orientation of discontinuities, as well as a variety of other factors. However, they both indicated that a test method could be studied to produce generalized data. These data, even if approximate, likely would be more accurate than the very general and overly conservative strength values used by many engineers. In addition, rock data could be produced in geographic areas where very little exploration and testing have been performed to date.

Dr. Anna Sellountou, ADSC Associate Member Pile Dynamics, Cleveland, Ohio, was present for the meeting and enthusiastically jumped into the technical discussion. Sellountou has extensive experience with field testing of pile capacity, and she echoed Holman's and Fassett's technical comments. She did indicate, however, that the idea had sufficient merit to warrant formation of an exploratory committee.

After several months of discussion, a preliminary exploration plan has been devised. Two technical committees will consider the implications of small-scale testing to supplement existing static and dynamic test methods. A steering committee will determine an organizational structure for encouraging participation and documenting test data. This committee will also be responsible for turning the test results into information that can be disseminated to design professionals to enhance the accuracy of their strength assumptions.

It is the intent of the ADSC to develop a test program that will be economically feasible for contractor members to regularly conduct on projects where load tests are not otherwise specified. The technical committees will provide guidance so that the test procedure provides data that can be translated reliably into strength data for other projects. Limitations and potential ranges for extrapolated values will be stated clearly so each engineer can assign a risk value with which he/she is comfortable.

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Adoption of a test method and implementation of the program should be in effect by late summer 2015. Comments about or technical input into the development of the program are welcome. Dr. Jesús E. Gómez, P.E., D.GE, ADSC Technical Affiliate GEI Consultants, Philadelphia, Pennsylvania, Dr. Antonio Marinucci, P.E., D.GE, ADSC Associate Member American Equipment Corporation, East Providence, Rhode Island, and Mohamad Hussein, P.E., D.GE, ADSC Associate Member Pile Dynamics, Inc., Cleveland, Ohio, are also contributing to the committee discussions.

The Next Chapter

The small-scale load test program is just the first step in the ADSC's mission to update current knowledge about soil and rock strength behavior, particularly rock strength. If more complete data are available to engineers during the design process, specifically engineers dealing with small projects with little to no significant site-specific information, it is possible that those engineers will take a closer look at their routine design assumptions. Perhaps engineers who use rule-of-thumb strength values simply because they don't have more accurate information will re-evaluate their procedures and make a conscious effort to produce designs that make sense.

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New and exciting initiatives will be introduced by the ADSC in coming months to support the ongoing pursuit of accurate and efficient design of drilled shaft foundations. These initiatives are intended to bring the general engineering community's understanding of shaft-subsurface interaction into the twenty-first century.

It should be noted that many projects are executed each year with in-depth subsurface exploration programs and comprehensive batteries of laboratory tests. These projects are performed by informed engineers who are knowledgeable about geotechnical design considerations for drilled shafts. But a larger group of geotechnical engineers design on a daily basis in a highly conservative manner due to the lack of sufficient pertinent data. This program is expected to reduce conservative guesswork and provide engineers on small projects resources to design as though they are working with much larger exploration budgets.

Anyone interested in contributing to the technical committees should contact the ADSC via email correspondence to Peggy Hagerty Duffy, (phagerty@adsc-iafd.com).

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