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FSI NEWSLETTER FOR DESIGN PROFESSIONALS

Load Testing Helical Piles – A High Value Proposition

The eighth issue of this newsletter (Summer 2011) included a discussion of the three most common methods used to predict helical pile capacity. Two of those methods, individual bearing and cylindrical shear, are theoretical approaches which rely heavily on the accuracy and reliability of the provided soil information. The torque-correlation method, on the other hand, is based on ample empirical data and is typically more reliable in predicting helical pile capacity at a given site since it is contingent on the torsional resistance (soil strength) measured during pile installation. However, the default torque-correlation factors published by the ICC Evaluation Service in the "Acceptance Criteria for Helical Pile Systems and Devices" (AC358) are generally considered conservative for most soil conditions and can underestimate pile capacity. **The only way to truly verify site-specific helical pile performance is by conducting a full-scale load test.**

Load tests verify ultimate pile capacity by measuring the relationship between applied loading and pile head movement over a specified period of time. AC358 defines ultimate helical pile capacity as the maximum load achieved when either plunging of the pile occurs or when the net deflection exceeds ten percent of the average helix plate diameter, whichever occurs first. Net deflection is defined as the total pile head deflection minus the elastic shortening or lengthening of the shaft.

Tension load test

AC358 specifies that full-scale load tests on helical piles be conducted in general accordance with the Quick Test Method of either ASTM D1143 for compression applications or ASTM D3689 for tension applications. These standards are not specific to helical piles, but are almost universally accepted for the evaluation of all axially-loaded deep foundations.

Helical pile load tests are often specified for commercial projects, and even for some residential projects, for various reasons. Load tests may be considered:

- to confirm compliance with allowable deflection criteria
- to verify a current helical pile detail
- to determine site-specific torque-correlation factors
- to avoid overly-conservative safety factors specified in local building codes
- to determine the most cost-effective helical pile design
- if soil conditions are variable or not well defined
- when the project engineer is less familiar with helical piles than other deep foundation options

Load tests for helical piles are no more involved than load tests for other deep foundations, and in most cases, cost less and have less of an impact on the construction schedule. When load tests allow us to develop more efficient designs, significant cost savings can be realized for a project. Even without a potential overall cost savings, load tests provide design professionals and clients with an increased understanding of helical pile performance and the confidence that they will perform as anticipated; added "value" that should not be overlooked when deciding whether or not to run load tests.

JAKE BLESSEN, E.I.T., APPLICATION ENGINEER

Compression load test

Advancing HP450 helical pile

Advancing HP288 helical pile

Pile installation complete

Project: Cottage Foundations
Location: Georgina, Ontario
Pile Installer: Foundation Supportworks of Ontario

Challenge: A 4,000 square-foot family cottage was planned for a lakefront property. A geotechnical investigation identified a general soil profile consisting of approximately 45 feet of marginal silts and sands over 10 feet of competent glacial till. Occasional gravel, cobbles, and boulders were observed throughout the soil profile. Groundwater was measured approximately five feet below preconstruction grade. Deep foundations were required to support the structure and minimize the risk of settlement. The owner and the design team preferred a foundation option that would limit construction traffic and disturbance to the site and surrounding properties.

Solution: Helical piles were considered to be the most viable deep foundation solution to bear the new structure within the competent soils discovered below the weaker silts and sands. Helical piles can be installed quickly, with little noise, and with relatively small equipment. The orginal foundation design included 144 helical pile locations with service loads ranging from 5.6 to 95.6 kips. Additional piles were proposed where service loads exceeded 65 kips.

Two full-scale, compression load tests were performed on sacrificial piles consisting of 2.875-inch OD and 3.50-inch OD shaft sizes to verify capacities and the deflection-to-load response.

One hundred twelve (112) Model 288 (2.875-inch OD by 0.276-inch wall), forty-six (46) Model 350 (3.50-inch OD by 0.313-inch wall), and three (3) Model 450 (4.50-inch OD by 0.337-inch wall) round shaft helical piles were installed to support service loads up to 32.2, 55.9, and 61.9 kips, respectively. The first helix plate on all lead sections was 0.5-inch thick with a "V-Style" cut to help advance the piles past the gravel, cobbles, and boulders observed during the geotechnical investigation. Standard extensions advanced the piles to depths ranging from 48 to 52 feet. The helical piles were installed to torque-correlated ultimate capacities of at least twice the design working loads (FOS ≥ 2.0). Pile installation was completed within the allotted 21-day working schedule.

Upcoming Webinar Opportunities

- **An Introduction to Helical Foundation Systems**
  1st Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)
- **An Introduction to Polyurethane Foam Injection**
  2nd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)
- **An Introduction to Hydraulically Driven Push Pier Systems**
  3rd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)

Project: Environmental Treatment Plant
Location: West Elizabeth, PA
Pile Installer: Baker's Waterproofing & Foundation Repair

Challenge: A proposed environmental treatment plant would include two main structures with building footprints of 1,980 and 3,200 square feet. The buildings would be located downslope from an abandoned coal mine where site preparation would involve cutting into the slope of the steep hillside. The slab-on-grade structures were originally designed with shallow foundations; however, a geotechnical investigation identified varying depths of coal waste fill in the upper soil profile, prompting the need for deep foundations.

Solution: Helical piles were chosen as the ideal deep foundation solution given the identified soil profile and the relatively light foundation loads. Helical piles can also be installed quickly without generating spoils. The helical pile configuration consisted of Model 287 (2.875-inch OD by 0.203-inch wall) round shaft with an 8"-10"-12" triple-helix plate lead section. The piles were advanced to depths up to 23 feet below finish floor elevation to bear below the coal waste fill and to achieve torque-correlated ultimate capacities of at least twice the specified design working compression load of 20 kips (FOS ≥ 2.0). The piles were fitted with standard new construction brackets to be cast into structural slabs as well as grade beams and pile caps to support the building foundations. The helical pile components were hot-dip galvanized for corrosion protection.

Prior to installing the production piles, a full-scale load test was performed on a sacrificial pile to verify helical pile capacity and the deflection-to-load response, per the project specifications. The measured total deflection at design working load was 0.207 inch, resulting in a calculated net deflection of only 0.086 inch.

Heavy rains during construction created difficult working conditions and caused the site to be closed several times due to cut-slope failures. A total of 235 helical piles were installed to support the treatment plant structures.

Compression load test

Installing helical pile

Site overview

Installed piles

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- Name of the firm
- Location of firm
- Approximate number of engineers/architects/GCs that will be in attendance

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