THE SUPPORTWORKS NEWSLETTER FOR DESIGN PROFESSIONALS

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SPRING 2019

38

Lateral Resistance of Helical Piles

Small diameter helical piles are a proven, economical foundation that can be installed with relatively small installation equipment, yet be advanced deep into the ground to achieve high capacities. However, that same shaft size, which provides so much economy and benefit during installation, brings with it some limitations when evaluating its ability to resist certain types of loads.

Helical piles offer a great deal of resistance in compression and tension, but the most common shaft sizes (4.50 inches and smaller) do not offer a great deal of side-to-side resistance. In other words, a helical pile will provide a strong reaction along its axis while its ability to provide a reaction across (transverse to) its axis is much more limited, and most often should be neglected. A designer should instead let a helical pile do what it's good at and depend on it only for its axial reaction. This is a limitation that can often be accommodated quite simply with a little bit of forethought.

For vertically installed helical piles with small magnitude lateral forces, this merely becomes an exercise in considering alternate load paths. A pile cap may be tied to adjacent grade beams, or to an interior slab, which could be considered as providing resistance to the applied lateral force. Also, a pile cap can sometimes consider the passive resistance of the soil that surrounds it to provide some lateral resistance. A project's soil report, however, may require that this passive resistance be neglected within a certain depth from the surface—often related to frost depth. When this is the case, it's usually more cost effective to specify the bottom of the pile cap to be placed below frost depth so some passive resistance is available to provide the required lateral reaction.

If a designer prefers to depend on the helical pile to provide a transverse reaction, then there are a few things that should be considered, including the initial soil disturbance that occurred during installation and the strength of the soils near the pile head, which is where these transverse forces will dissipate. It's important to note that the final installation torque is only providing feedback about the strength of the soil at the depth of bearing. The fact that helical piles are being considered often means that the soils near the pile head are quite weak. Even when the helical pile is determined to have the strength to resist the transverse forces being considered, the amount of transverse movement required to mobilize this reaction is usually much higher than the supported structure would be able to tolerate. Larger piles, or even grouted helical piles, could be considered, but again, soil strengths near the surface will typically still allow excessive movement. Pile costs for material and installation would also increase significantly.

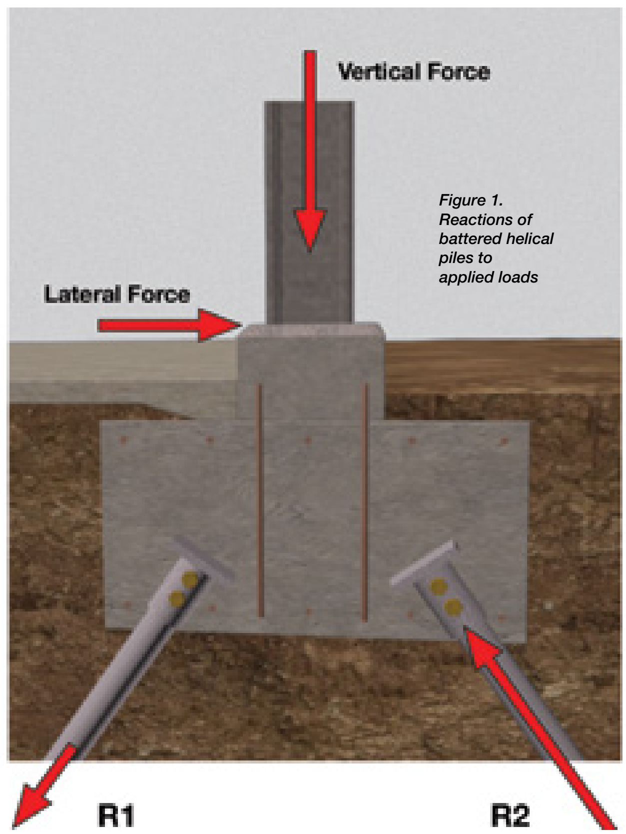
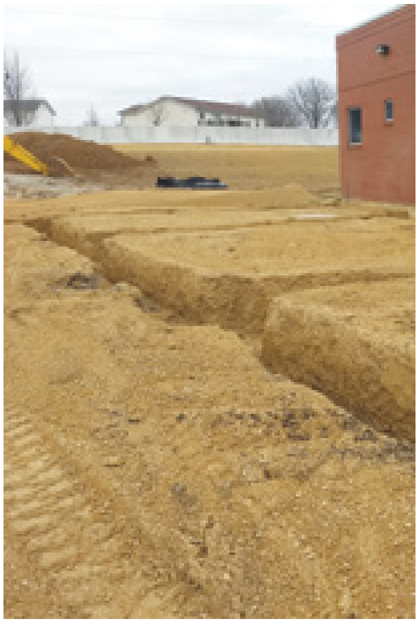


Figure 1. Reactions of battered helical piles to applied loads

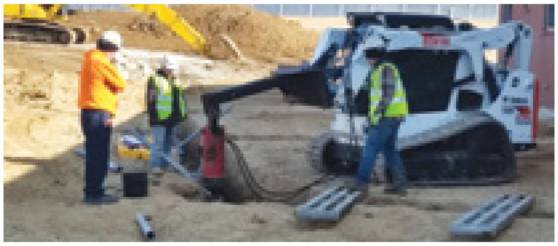
This brings us back to our recommendation that the helical piles should most often be depended upon for an axial reaction only.

Battered helical piles should be treated the same way. They can be arranged to resist lateral loads from the structure through axial reactions along the pile shaft (Figure 1). You can think of a battered helical pile as an inclined support, which should spark fond memories of some of the problems you had to solve back in your university statics class. Combining multiple piles at different angles can allow you to resist larger magnitude lateral forces, overturning forces or any number of other things. Be creative with your pile layout, but remember to let the helical piles do what they are good at.

KYLE OLSON, P.E.



Excavations for grade beams and pile caps



Installing helical piles with a skid steer

Vertical and battered helical piles within pile cap

Pile cap and grade beam reinforcement installed around helical piles

Project: **Scenic Regional Library Addition**
Location: **Warrenton, MO**
Pier Installer: **Foundation Supportworks® by Woods**

Challenge: A 3,000-square-foot building addition was planned for the main entrance of the Warrenton Scenic Regional Library. Four soil borings were advanced within the building addition footprint. The borings identified very soft to soft clay to depths of about 3 to 9 feet. Medium stiff to very stiff clay and medium dense sand layers were observed below the soft clay, extending to the termination depth of the borings at 20 feet. Groundwater depths were from 5 to 7 feet during the investigation. Based on the presence of the upper very soft to soft clay, the geotechnical recommendations included a shallow footing design with over-excavation and replacement with select fill to a depth of at least 3 feet below the bottom of the proposed footings. However, during the over-excavation activities, soil conditions were found to be worse than what was anticipated from the geotechnical investigation.

The poor soil conditions would require deeper over-excavation and additional shoring along with underpinning of the existing foundation. There were also problems performing the over-excavation and compaction due to high groundwater levels and cold weather conditions. The combination of these issues was going to significantly delay the project.

To minimize the project delay, the design team pursued options for a deep foundation system with pile caps and grade beams. The redesigned pile caps included column compression loads ranging from 15 to 65 kips and tension loads ranging from 15 to 25 kips. Some of the pile cap locations also included 15 kip lateral loads to be resisted by the piling system.

Solution: Helical piles were selected as the preferred deep foundation option given the site accessibility, low vibration installation, quick installation, and the ability to pour grade beams and pile caps immediately after pile installation. The design included multiple piles per pile cap with a combination of vertical and battered piles to support the compression, tension and lateral loading.

The helical pile design consisted of the Model 288 (2.875-inch OD by 0.276-inch wall) hollow round shaft with 8"-10" double-helix lead sections. The vertical piles required termination torques of either 6,000 or 7,900 ft-lb and the battered piles required termination torques of at least 6,000 ft-lb to provide a factor of safety of 2.0 for the various loading conditions. The piles were fitted with new construction brackets and cast into the concrete pile caps and grade beams. The pile leads, extensions and brackets were hot-dip galvanized for corrosion protection. Thirty-four (34) helical piles were installed in one day.

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

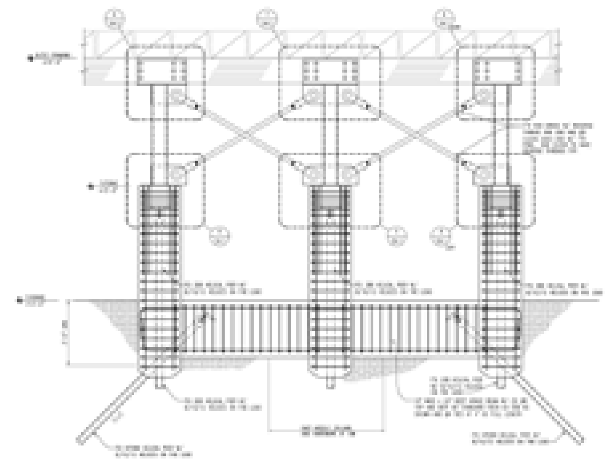
  3rd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)

Project: **Barale Ranch Lodge Stabilization**
Location: **Colusa County, CA**
Pier Installer: **Foundation Repair of California**

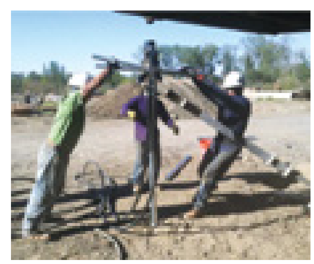
Challenge: The Barale Ranch duck hunting lodge experienced up to 9 inches of settlement over a period of several years. The elevated wood structure, with the main floor nearly two stories above grade, was built along the bank of a natural creek. At the time of building construction, a wooden retaining wall up to 5 feet tall was built to create a level building pad. The lodge was then constructed on wood columns and shallow concrete footings. The settlement created an obvious lean to the building with sloped floor conditions across the width of the footprint. A geotechnical investigation included two exploratory borings, one at each end of the building. Boring B-1 identified medium stiff to stiff silty clay fill to approximately 7 feet, stiff to hard clayey silt to 9 feet, and stiff silty clay to the bottom of the boring at 32.5 feet. Boring B-2 encountered stiff silty clay fill to 7 feet, medium stiff to stiff silty clay to 13.5 feet, stiff to very stiff silty clay to 17 feet, and medium dense to dense sand and gravel to the bottom of the boring at 31.5 feet. Deep foundations were required to support the building below the fill and weak native clay soils. The project required a five week foundation design/construction schedule to ensure that the lodge would be ready in time for the upcoming hunting season.

Solution: The lodge would be supported on a completely new foundation consisting of grade beams, concrete piers/columns and steel braced frames. Eighty-eight (88) Model 288 (2.875-inch OD by 0.276-inch wall) hollow round shaft helical piles with an 8”-10”-12” triple-helix lead section were installed vertically and cast into the concrete columns to support design compression loads up to 24.5 kips. Seventeen (17) Model 288 helical piles with a 10”-12”-14” triple-helix lead section were installed at a 45-degree batter and cast into the grade beams to resist design lateral loads up to 20 kips. Thirty-two (32) Model 237 (2.375-inch OD by 0.154-inch wall) hollow round shaft helical piles with an 8”-10” double-helix lead section were installed vertically and cast into concrete columns to support design compression loads up to 8.7 kips for the surrounding wood deck. The Model 288 piles were installed with a tracked skid steer while the Model 237 deck piles were installed with hand-held equipment. All piles were installed to torque-correlated ultimate capacities of at least two times the design loads (FOS ≥ 2.0). With the variable soil profile and the range in required pile capacities, vertical and battered pile lengths ranged from 18.5 to 50 feet. Installation of the 137 helical piles was completed within the allotted time frame to keep the project on schedule to reopen the lodge. With the new foundation system in place, the building was disconnected from the existing columns in sections, leveled and then resupported on the new foundation.


Elevated lodge


Foundation detail


Predrilling at column locations prior to helical pile installation


Installing HP237 piles for deck support


Helical piles installed within grade beams at column locations

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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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What's Inside

38

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FEATURED CASE STUDIES:

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Foundation Supportworks® by Woods

Barale Ranch Lodge Stabilization – Colusa County, CA
Foundation Repair of California

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