FOUNDATION NATION
FSI NEWSLETTER FOR DESIGN PROFESSIONALS

HELICAL PILE FOUNDATIONS

More the Preferred Option

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Helical piles can be installed in areas of **limited access** with **smaller equipment**, yet achieve relatively **high capacities**. In my opinion, much of the continued growth in the use of helical pile foundations can be attributed to those benefits, along with design professionals simply becoming more aware, informed and confident with using helical piles. For many design professionals, helical piles are moving from consideration as an alternative, to becoming their preferred deep foundation option.

This claim is supported by the increase in the number of large helical pile projects over the last several years. These projects are large in respect to the number of piles, with hundreds and sometimes thousands of piles installed on wide open project sites with unrestricted access. Other projects are large in regard to pile size. While 3.5-inch O.D. pile shafts and smaller are still the most commonly installed sizes, 6.625 to 8.625-inch O.D. pile shafts are getting specified more often. Higher design loads require larger piles and larger installation equipment, but large diameter helical piles then compete more directly with the more traditional deep foundation options such as drilled shafts, auger cast piles and driven piles. Helical piles are being pushed to new limits and this is largely driven by the specifiers who have enjoyed their benefits and would like to see them have more widespread use.

So what are some of the other benefits helical piles may offer to make them the preferred deep foundation for your next project?

- **Generally lower mobilization costs.** Installation equipment can range from hand held systems to large track excavators. Helical piles may then be a cost-effective solution, especially in limited pile quantities, even if more helical piles are required to support the design loads.
- **Predictable capacity when adequate test boring and soil strength information is available.** The Individual Bearing Method and Cylindrical Shear Method for determining helical pile capacity are rooted in traditional geotechnical methodology, slightly modified with empirical data. Refer to the FSI Technical Manual at *www.OnStableGround.com* for more information about these design methods.
- **Capacities of smaller diameter piles can be verified by torque correlation.** The ICC Evaluation Service (ICC-ES) Acceptance Criteria for Helical Pile Systems and Devices (AC358) provides default torque correlation factors for shaft sizes up to 3.5 inches. Helical pile manufacturers provide torque correlation factors for their larger shaft sizes based on historic results from full-scale load testing. For shaft sizes larger than about six inches, the capacity is generally determined by theoretical methods and then verified with full-scale load testing.
- **All-weather installation.** Helical piles can be installed in extreme adverse weather conditions without affecting pile integrity or capacity.
- **Installation does not require casing.** Helical piles are advanced through granular soils and below the water table without the need for casing. Casing drilled shaft excavations adds significant cost to a project.
- **Vibration-free installation.**
- **Installation does not generate spoils.** There are costs associated with disposing of drill spoils. If the soil profile is contaminated, the spoils would have to be treated or disposed of properly at designated sites or facilities.
- **No concrete curing period.** Helical piles are ideal for schedule sensitive projects. Load tests can be conducted and foundation concrete can be poured immediately following installation.
- **Clean installation.** Most helical pile installations do not require concrete or grout.

The four case studies presented within this newsletter are of projects where helical piles were used for school additions and renovation projects where there were limited access and tight working conditions. All of the projects were completed within strict construction schedules. It's easy to see how some of the above benefits made helical piles the ideal deep foundation solution.

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- **Helical Tiebacks**
- **Helical Soil Nails**
- **Hydraulically Driven "Push" Piers**
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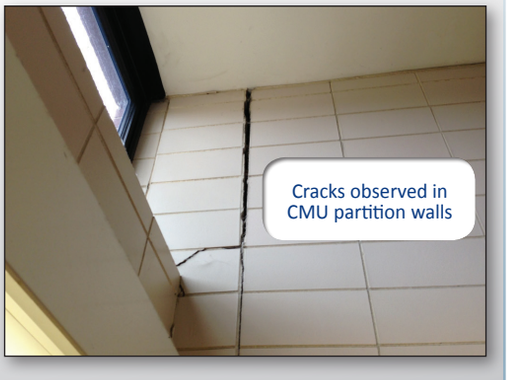
CASE STUDIES - HELICAL PILES/TIEBACKS

Project: Menard Hall Renovation ● **Location:** Springfield, IL
Pile Installer: Foundation Supportworks® by Woods

Challenge: Menard Hall on the Lincoln Land Community College campus is a two-story structure with offices, classrooms, and student dining. Renovations to the building included the repair of the first floor men's and women's restrooms. The restrooms are located within a slab-on-grade portion of the building. Cracks were observed in the CMU partition walls within the restrooms, indicating settlement of the shallow foundations. A soil boring completed outside the building identified 7.5 feet of clay fill over medium dense silt and stiff silty clay to a depth of 21 feet, underlain by very dense sand and hard clay till to the maximum explored depth of 25 feet. New partition walls were planned with deep foundation support to bear below the fill and within competent soils.

Solution: Helical piles were selected as the ideal deep foundation solution for this project given their ability to be installed within the confined space of the existing building using relatively small equipment. Model 287 (2.875-inch O.D. by 0.203-inch wall) hollow round shaft helical piles with an 8"-10" double-helix lead section were selected to support the design working load of 9 kips per pile. A 500 pound lateral design load at the pile heads was also specified. Finite element analysis software was used to evaluate the lateral capacity of the HP287 shaft. A compression load test was performed outside the building to verify pile capacity.

The interior walls within the restrooms were demolished and portions of the floor slabs broken out for pile installation. Twenty (20) helical piles were installed to be cast into structural grade beams. A hand held drive unit, powered by a remote hydraulic source, was used to install the production piles to an average depth of 23 feet below grade to achieve installation torques correlating to at least twice the design working load (FOS ≥ 2). A V-style cut on the leading edge of the 8-inch helix plate was used to help penetrate the very dense to hard bearing soils. The interior installation of all 20 production piles was completed in just four days.

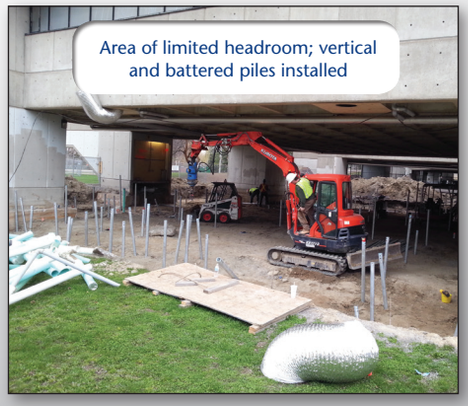

Cracks observed in CMU partition walls


Helical piles installed with hand held equipment

Project: John McCrae High School ● **Location:** Toronto, Ontario
Pile Installer: Foundation Supportworks® of Ontario

Challenge: An approximate 55,000 square foot building addition was proposed to create a ground floor for the southern two-thirds of the existing two-story elevated high school. The original building was constructed in 1968 and essentially consisted of three interconnected structures supported on shear walls and drilled shaft foundations. Portions of the school were known to have been built over or near an abandoned landfill. The discovery of gas and landfill material prompted consideration of a deep foundation alternative that would not create spoils and could be sealed off after installation to prevent the upward migration of subsurface gases. The overhead clearance in some areas of the project was limited to 3.1 meters (10 feet). The construction schedule required completion of the building addition footings and floor slab within a three week timeframe.

Solution: Helical piles were chosen as the ideal deep foundation solution for this project given the limited overhead clearance and the ability to install the piles quickly without generating spoils. Prior to the installation of production piles, two compression load tests were performed on sacrificial piles to determine the deflection to load response. Six hundred twenty-three (623) Model 287 (2.875-inch OD by 0.203-inch wall) round shaft helical piles with an 8"-10"-12" helix blade configuration were installed to depths ranging from 10 to 18 feet to support the proposed footings and floor slab for the addition. The helical piles were designed in accordance with the Ontario Building Code using Limit State Design (LSD) methodology. The helical pile factored compression loads were 70 kN (≈ 16 kips) and the required nominal resistance (ultimate pile capacity) was 175 kN (≈ 40 kips) using a resistance factor of 0.4. The helical piles were grout filled prior to field welding the new construction pile caps. A methane gas barrier system was installed above the subgrade and around each helical pile prior to pouring the concrete floor slab. The 623 helical piles were installed within the allotted three week schedule.

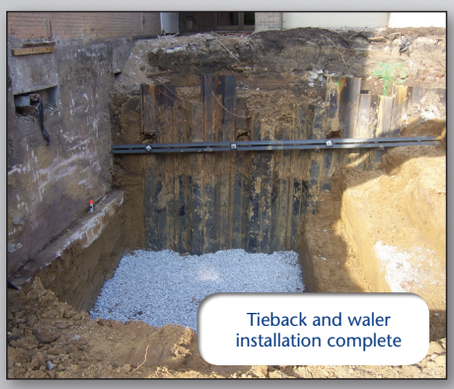

Area of limited headroom; vertical and battered piles installed


Methane gas barrier system being installed around helical piles

COMMERCIAL

Project: Palmer College Elevator Addition ● Location: Davenport, IA
Pile Installer: MidAmerica Basement Systems

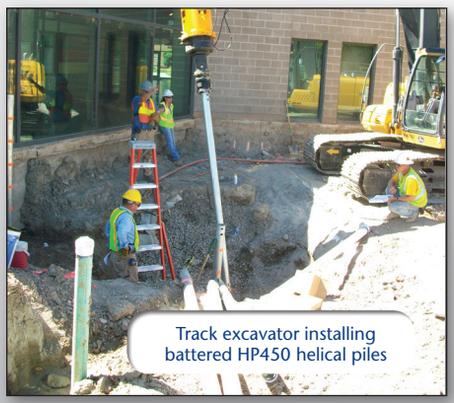
Tieback lead section advanced through sheet pile wall


Tieback and waler installation complete

Challenge: Palmer College of Chiropractic planned an elevator addition to the outside of an existing building near the location where two "wings" of the building meet. The 12-foot by 17-foot foundation for the proposed elevator would be 18 feet deep and approximately seven feet away from the adjacent building. A permanent steel sheet pile wall would be constructed between the existing building and the proposed elevator to allow for the excavation and prevent undermining of the existing foundations. Helical tiebacks were proposed to support the top of the sheet pile wall. New construction helical piles were proposed to support the mat foundation of the elevator and a grade beam for a structural slab at the elevator entrance.

Solution: The sheet pile wall design included three (3) helical tiebacks with a design working tension load of 9 kips each. Openings were torch-cut through the completed sheet pile wall at each tieback location. Model 150 (1.5-inch square bar) helical tiebacks with a 10"-12"-14"- 14"-14" helix plate configuration were advanced at a downward angle of 20 degrees from horizontal, to lengths of 30 to 35 feet, and to installation torques of at least 2,700 ft-lb, correlating to ultimate capacities of at least 27 kips (FOS ≥ 3). A waler system was installed and the tiebacks were pre-tensioned to the design working load. The foundation design included nine (9) helical piles to support the mat foundation and one (1) helical pile to support the grade beam for the structural slab. The helical pile configuration consisted of the Model 287 (2.875-inch OD by 0.203-inch wall) hollow round shaft with a 10"-12"-14" triple-helix lead section to support a design working compression load of 15 kips per pile. The piles were advanced to depths ranging from 14 to 21 feet below the excavation (32 to 39 feet below grade) and to ultimate torque-correlated soil capacities of at least twice the design working load (FOS ≥ 2). The tops of the piles were cut to the specified elevation and fitted with new construction brackets.

Project: Performing Arts Center Addition ● Location: Grand Junction, CO
Pile Installer: Foundation Repair of Western Colorado, LLC


Track excavator installing battered HP450 helical piles


Proposed addition under construction

Challenge: A slab-on-grade, steel-framed addition was proposed for the Moss Performing Arts Center at Colorado Mesa University. Previous subsurface explorations completed near the project site identified soft sandy clay soils extending approximately 50 feet below grade. A high water table was also anticipated. A deep foundation system including helical piles was therefore considered to penetrate the saturated, soft sandy clays for bearing within deep competent soils. Design working loads of 60 kips and 30 kips in compression and tension, respectively, were specified for each helical pile. The proposed addition was located between the existing Performing Arts Center and a busy roadway. With the limited working space, material had to be staged off site. Additional safety and traffic control measures were also required. The construction schedule allowed only seven days for mobilization and helical pile installation.

Solution: The deep foundation system included thirty-one (31) Model 450 (4.5-inch OD by 0.337-inch wall) round shaft helical piles with a 10"-12"-14" triple-helix lead section. All helix plates were ½-inch thick with a V-style leading edge to allow for better penetration into the deep bearing soils. Piles would be advanced to a specified embedment length and to torque correlated ultimate capacities of at least twice the design working loads (FOS ≥ 2). A 45,000 ft-lb hydraulic drive head and a John Deere 200D track excavator were used to provide sufficient torque and crowd during installation. Standard ten foot extensions were used to advance the piles to the necessary depths. The tops of the piles were fitted with custom brackets. Various combinations of battered and vertical piles were used at the pile cap locations. To maintain a continuous supply of material during installation, a two-man crew was assigned specifically to deliver product from the staging area to the project site. Installation of the helical piles, including two pre-production test piles to verify depth and torque, was completed in just four days.

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LOOK INSIDE!

Cover Article

Helical Pile Foundations: More the Preferred Option

"Helical piles can be installed in areas of limited access with smaller equipment, yet achieve relatively high capacities."

Featured Case Studies:

- Menard Hall Renovation - Springfield, IL
- John McCrae High School - Toronto, Ontario
- Palmer College Elevator Addition - Davenport, IA
- Performing Arts Center Addition - Grand Junction, CO

Upcoming Webinar Opportunities

An Introduction to Helical Foundation Systems
1st Wednesday of every month 11:30am(CST) and 1:30pm(CST)

An Introduction to Polyurethane Foam Injection
2nd Wednesday of every month 11:30am(CST) and 1:30pm(CST)

An Introduction to Hydraulically Driven Push Pier Systems
3rd Wednesday of every month 11:30am(CST) and 1:30pm(CST)

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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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