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THE SUPPORTWORKS NEWSLETTER FOR DESIGN PROFESSIONALS

Shoring with Helical Soil Nail Walls

Soil nails are commonly installed in conjunction with shotcrete wall systems for temporary or permanent construction. They form a grid of individual reinforcing members installed within a soil mass to create an internally stable gravity wall/retaining system. Helical soil nails are a relatively new alternative to grouted soil nailing and differ from grouted tendons in how they develop resistance. Helical soil nails develop strength by the bearing capacity of soil against the individual helix plates while grouted tendons rely on the bond strength at the grout/soil interface. They also provide many advantages over grouted soil nail walls:

- No spoils are generated during the installation; therefore, no cleanup is required and contaminated soil sites do not require characterization and disposal of spoils.
- Faster construction and all-weather installation is possible since there is no grout curing requirement.
- Verification or proof testing can be performed immediately after installation.
- Capacity can be verified during installation by monitoring torque.
- Installation may be performed in areas of limited or tight access.
- Helical soil nails are installed with smaller equipment with lower mobilization costs.

One common application of helical soil nails is for the construction of building additions that require excavation below an existing foundation to construct a lower level or basement. Retrofit helical piles or push piers are first used to underpin the existing foundation. The top-down construction of the soil nail wall then provides shoring for the excavation. Design of the retrofit piers must include a buckling analysis for any temporary condition where there is a loss of side support during excavation and until the soil nail wall is constructed. The piers must also be terminated deep enough below the final excavation depth to provide fixity of the pile tip.

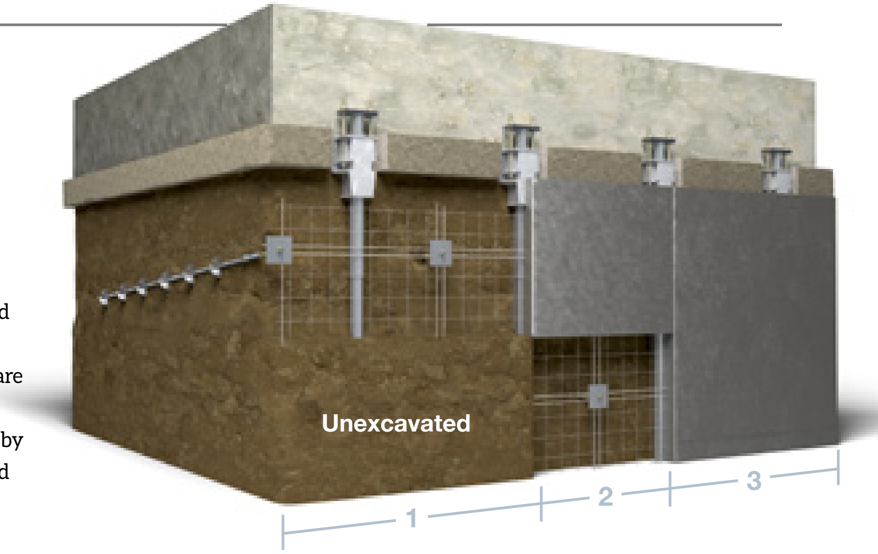


Figure 1: Typical helical soil nail Wall and underpinning system. Following pier installation: (1) initial cut, install soil nails and place reinforcing; (2) shotcrete over first cut, make second excavation, install soil nails and reinforcing; (3) shotcrete over second cut

Soil nail wall construction follows installation of the retrofit piers. A vertical excavation is made adjacent to the piers to a depth of three to five feet depending upon soil type and strength. The first row of helical soil nails is installed to a predetermined length and termination torque. A threaded rod adapter is connected to each soil nail, allowing a threaded rod to be terminated within the wall envelope with a bearing plate, beveled washer and nut. Wall reinforcement generally consists of welded wire fabric and rebar walers at the nail heads. Shotcrete is applied to the face of the excavation to cover the nail heads and reinforcing, and then allowed to cure before the next excavation is made. The process is repeated until the design depth is achieved. Figure 1 illustrates the typical phased construction process for an underpinning and soil nail wall system. Some projects may also incorporate helical tiebacks to provide lateral support to the structure or the retrofit piers.

For more information on the design and construction of helical soil nail walls, see the 2017 Supportworks Technical Manual.

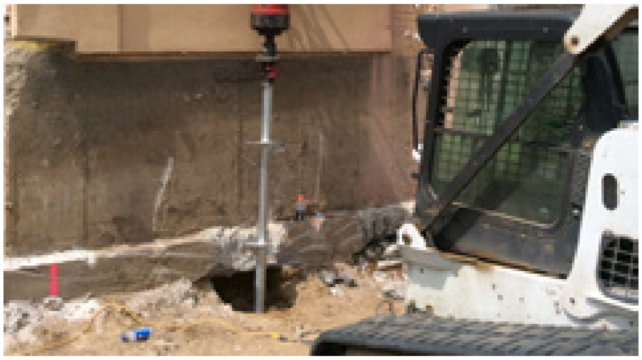
DONALD A. DEARDORFF, P.E., SENIOR APPLICATION ENGINEER

Project: Cass Lake Clinic Expansion
Location: Cass Lake, MN
Pile Installer: Innovative Foundation Supportworks®

Challenge: The Cass Lake Clinic expansion consisted of an approximate 25,400 square foot addition to the existing hospital/clinic building. The project required demolition of an eastern portion of the existing building and construction of the addition adjacent to a combination of existing interior and exterior wall lines. After demolition activities, a 156-foot long wall section required underpinning to facilitate excavation below the existing footings for construction of the basement level of the addition. Portions of the existing footings required new construction piles embedded into concrete grade beams and dowelled into the existing footings to support new column loading from the addition. An earth retention system was also required along the entire underpinned wall with retained soil heights varying from about 5.7 to 6.5 feet. The retrofit and new construction piles would resist service loads of 25 and 40 kips, respectively. The geotechnical investigation included four borings advanced to a depth of 20.5 feet and one boring advanced to a depth of 41 feet. The borings indicated a general soil profile consisting of about six to 11 feet of very loose to loose sand fill, medium dense sand to a depth of about 25 feet, dense sand to a depth of about 35 feet, and medium dense sand to the termination of the deepest boring at 41 feet. Groundwater was observed at a depth of 34 feet.

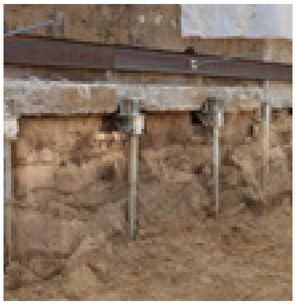
Solution: Helical piles were utilized to both underpin the existing footings and provide deep foundation support for the new columns. The 28 retrofit piles consisted of the HP288 (2.875-inch OD by 0.276-inch wall) round shaft with an 8"-10"-12" helix plate configuration. The HP288 helical pile capacity was verified with a field compression load test which showed less than 0.16 inch of net pile head movement at the 25 kip service load. The results of the load testing easily met the failure criteria established for the project which allowed no more than 0.5 inch of net pile head movement at the service load. The eight new construction helical piles consisted of the HP350 (3.50-inch OD by 0.340-inch wall) round shaft with a 10"-12"-14" helix plate configuration. The HP288 and HP350 helical piles were installed to lengths ranging from 14 to 21 feet and to torque-correlated ultimate capacities of at least two times the required service loading (FOS ≥ 2). The 28 retrofit helical piles (HP288) and eight new construction helical piles (HP350) were installed over a period of three days. Following installation of the vertical piles, helical tiebacks were installed for lateral wall support and helical soil nail/shotcrete walls were constructed for earth retention below the underpinned wall sections. The installation of 12 HA150 (1.5-inch solid square bar) helical tiebacks and 70 HS150 helical soil nails, and construction of the shotcrete earth retention system, were completed in four days.

Compression load test on HP288 helical pile



Installation of HP288 helical pile

Concrete coring for helical tieback locations above new construction and retrofit helical piles



Helical piles and tiebacks after excavation

Completed shotcrete wall section

Upcoming Webinar Opportunities

- **An Introduction to Helical Foundation Systems**

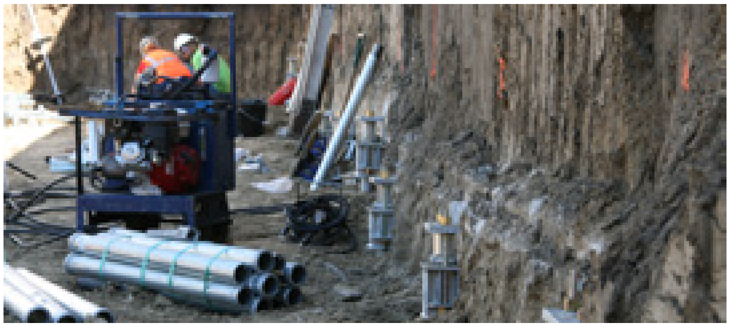
  1st Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)

- **An Introduction to Polyurethane Foam Injection**

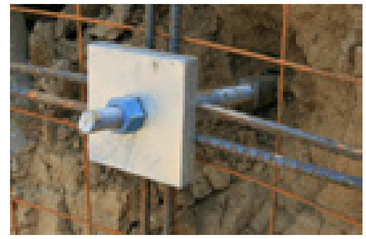
  2nd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)

- **An Introduction to Hydraulically Driven Push Pier Systems**

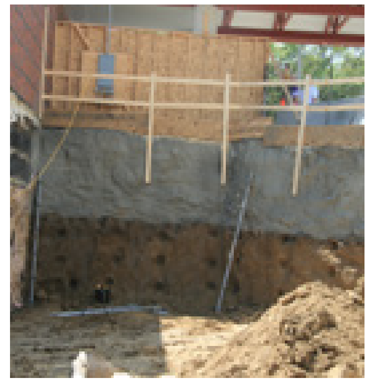
  3rd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)



Installed push piers with side-load foundation brackets



Helical soil nail head detail



Driving Model 288 push pier

Partially completed soil nail wall

Two-tiered soil nail wall under construction

Project: Memorial Hospital Addition
Location: Seward, NE
Pier Installer: Thrasher, Inc.

Challenge: An addition with a basement level was planned for the hospital. The existing exterior foundation walls adjacent to the addition would be underpinned to prevent settlement and the excavations made for the proposed basement would be shored to prevent sloughing of soil from beneath the existing structure. A drilled shaft retaining wall with intermittent helical tiebacks was originally planned; however, due to limited access and a quick turnaround needed to maintain the construction schedule, other retention systems were considered. A geotechnical investigation conducted in the area of the proposed addition identified a soil profile predominately consisting of stiff to very stiff lean clay to a maximum explored depth of 30 feet.

Solution: The underpinning design included twenty-seven (27) Model 288 (2.875-inch O.D. by 0.165-inch wall) hydraulically-driven push piers. The piers were spaced from approximately six to eight feet and advanced to depths ranging from 46 to 72 feet to achieve ultimate pier capacities at least 50 percent higher than the specified design working loads of 20 to 30 kips (FOS ≥ 1.5). Nine (9) helical tiebacks were installed along one section of excavation to laterally support the existing foundation. The helical tiebacks consisted of Model 287 (2.875-inch O.D. by 0.203-inch wall) hollow round shaft with a 10"-12"-14" triple-helix lead section. The helical tiebacks were installed to lengths of at least 12 feet and to achieve torque-correlated ultimate capacities of at least twice the design working tension loads of five to 7.5 kips (FOS ≥ 2.0). The helical tiebacks were components of lateral restraint systems and were attached to corresponding push pier brackets.

One hundred eighty-one (181) Model 150 (1.5-inch round corner square bar) soil nails were installed to retain soil during the basement level construction. The soil nails included six-inch helix plates spaced evenly along the lead section and extensions. The soil nail walls ranged in height from six to 10.5 feet with the soil nails arranged in grid patterns consisting of two to three rows. Vertical spacing ranged from three to 3.5 feet and horizontal spacing ranged from four to six feet. The soil nails were installed at a ten-degree downward angle to approximate lengths from seven to ten feet to achieve torque-correlated ultimate capacities of at least twice the design working load of 9.25 kips (FOS ≥ 2.0). Approximately 1,700 square feet of soil nail walls were sprayed with shotcrete. The shotcrete was reinforced with welded wire mesh and vertical and horizontal rebar walers at the nail heads.

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  Thrasher, Inc.

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