THE SUPPORTWORKS NEWSLETTER FOR DESIGN PROFESSIONALS

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Supportworks

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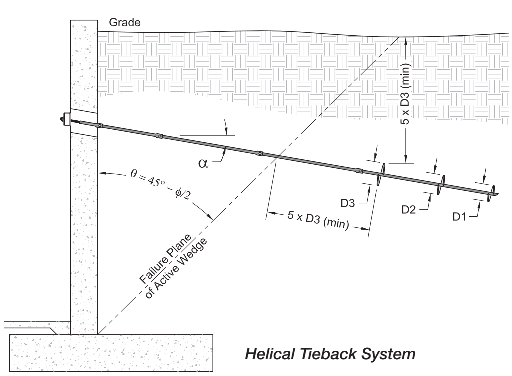
Understanding the Differences between Helical Tiebacks and Helical Soil Nails

Helical tiebacks are commonly used to provide additional lateral support for poured concrete retaining walls, sheet pile walls, soldier pile and lagging walls or other earth retention systems. Helical soil nails are also used on earth retention projects, but there are fundamental differences in the design and performance of a soil nail compared to a tieback. Unfortunately, the two systems are occasionally confused and incorrectly specified, which can lead to design changes, schedule delays and change orders.

Helical Tieback Systems

A helical tieback is an end-bearing element that includes one or more helix plates welded to the lead section or the lead and first extension sections. Multi-helix tiebacks generally consist of increasing plate sizes from the tip. Tiebacks are advanced to a specified torque-correlated capacity, but also to a length to extend the helix plates beyond the active soil zone. The active zone is defined by an assumed linear failure plane with an angle of inclination dependent upon the retained soil type and strength. The soil within the active zone puts lateral load on the wall. For helical tiebacks used in conjunction with a retaining wall system, Supportworks recommends that the helix plates be advanced a minimum distance of five times the diameter of the trailing helix plate beyond the failure plane. This is to prevent an influence of soil stress from the helix plates overlapping into the active zone. We further recommend that the helix plates be at least five diameters below the surface to prevent a shallow anchor condition and allow use of the deep foundation bearing capacity equations. The figure to the right illustrates a typical helical tieback retaining wall with an assumed failure plane and the embedment and depth criteria.



Helical Tieback System

After a helical tieback is installed, it is pretensioned to remove any slack from the system and to mobilize the soil strength at the helix plates. It is then locked off at a specified load which is usually around the service load of the tieback. Subsequently, the wall no longer has to deflect before the tiebacks are put into service, thereby limiting future wall movement.

Pretensioning a Helical Tieback

The tension capacity of a helical tieback is generated through end bearing of the helix plates embedded in the soil. This tension force is then transferred through the shaft to the wall connection. This tieback tension force must be considered in the strength evaluation of existing walls, or in developing details for new construction. Typically, a more substantial wall detail is required for use with tiebacks.

There are fundamental differences in the design and performance of a soil nail compared to a tieback.

Helical Soil Nail Systems

A helical soil nail typically consists of a solid square shaft with helix plates spaced evenly along the entire shaft length. This helix spacing is one of the primary differences between a helical soil nail and a helical tieback and, as a result, the two systems behave differently upon loading. The helix plates are either 6 or 8 inches in diameter with the same diameter helix plate used along the entire soil nail shaft. An 8-inch helix may be preferable when wall loads are high or soils are weak, and the 6-inch helix may be preferred for more lightly-loaded applications or within higher strength soils. The soil nails are typically installed at a downward batter angle of 10 degrees from horizontal or less. The soil nails are installed in a grid pattern with typical vertical spacings of about 3 to 5 feet and horizontal spacings of about 4 to 7 feet. The grid of soil nails essentially creates an internally-stabilized soil mass that acts similar to a gravity retaining wall system.

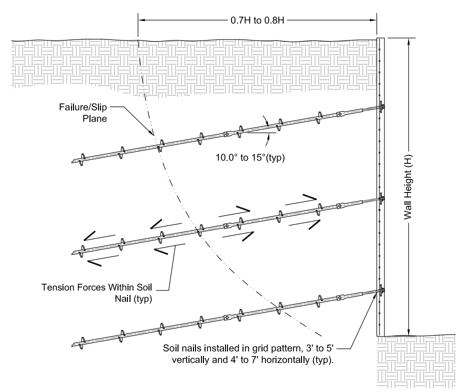
Installation of helical soil nails

Helical soils nails are considered passive elements because they rely on soil and wall movement to mobilize the nail strength. They are designed to have helix plates on both sides of the failure plane and, therefore, generate the maximum tensile force along the length of the nail rather than at the wall facing. As you can see in the figure to the right, the tension forces act in different directions along the nail depending upon which side of the failure plane the helix plates are located. You may also notice that the failure plane geometry is curvilinear rather than the linear failure plane of a tieback.

Since the maximum tensile force in the helical soil nail is along the nail length rather than at the wall facing, a rigid wall facing is typically not required and a shotcrete wall with minimal reinforcement can be considered. It is important to understand that for similar wall heights

Application of shotcrete facing

and retained soil properties, the same shotcrete wall facing used for a soil nail system cannot be used in a helical tieback system. Pretensioning a soil nail to design loads following installation would likely cause localized wall deflection and cracking. A soil nail wall system relies on wall movement to mobilize the nail strength, so there is more lateral movement at the wall face for a soil nail wall than a tieback wall of similar height and retained soil properties. The majority of the movement occurs at the top of the wall, where you can expect about ⅛ to ¼ inch of lateral wall movement for every 5 feet of soil nail wall height. So for a 20-foot high wall you might expect about ½ to 1 inch of lateral movement at the top of the wall. This may also result in soil movement near the failure plane which can impact nearby structures unless they are underpinned prior to construction of the soil nail wall. Helical soil nail walls are often selected when equipment access is limited, when top down construction is preferred and/or when driving soldier piles or sheet piles would result in excessive vibration and possible damage to nearby structures.



Helical Soil Nail System

For more information about helical tieback or helical soil nail systems, see the Supportworks Technical Design Manual at ***OnStableGround.com*** *or reach out to the Supportworks engineering staff.*

DON DEARDORFF, P.E.

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)

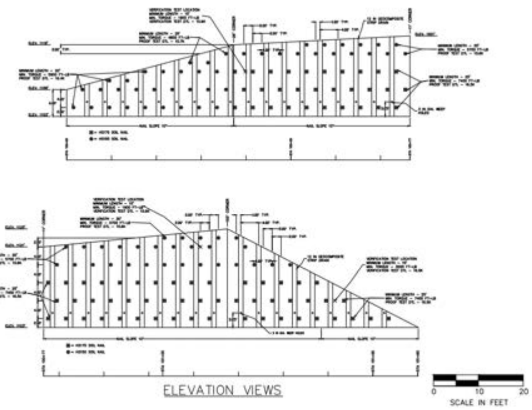
- An Introduction to Hydraulically Driven Push Pier Systems

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

Project: **Farm Credit Services of America**
Location: **Omaha, NE**
Pier Installer: **Thrasher Commercial Group**

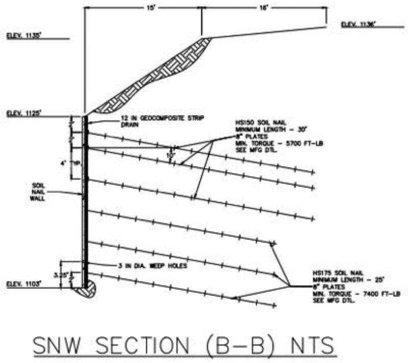
Challenge: A four-story office building was planned directly west of and across the road from the existing Farm Credit Services of America (FCSA) building in Omaha, NE. The new building would be linked to the existing FCSA building via a new skywalk constructed across South 118th Street. The west building would have two lower floors for a parking garage with two floors of office space above. Significant earthwork operations were required to construct the parking garage at the south and southwest areas of the site with maximum vertical excavations of about 25 feet anticipated. The excavations would require a temporary shoring system that would not encroach on the P Street right of way at the southwest corner of the site. Low density cellular concrete was then planned as backfill between the temporary shoring wall face and the parking garage, effectively taking the shoring wall out of service and limiting the earth pressure on the new foundation walls. A geotechnical investigation near the area of proposed shoring showed a soil profile consisting of about 4 to 12 feet of stiff to very stiff lean clay fill underlain by stiff to very stiff residual lean clay.

Solution: Helical soil nails and a shotcrete wall were selected for the earth retention system at the south and southwest areas of the site based on their cost effectiveness and ability to stay away from the P Street right of way. Olsson Associates designed a 160-foot long helical soil nail wall with six rows of nails at its tallest point, approximately 22-feet high. At this height, the six rows consisted of three upper rows of Model 150 (1.5-inch square shaft) and three lower rows of Model 175 (1.75-inch square shaft) helical soil nails with 8-inch helix plates spaced evenly along the nail length for both shaft sizes. The wall required a total of 71 Model 150 nails and 81 Model 175 nails. The Model 150 helical soil nails were installed to lengths ranging from 30 to 35 feet and termination torque values ranging from 4,780 to 6,470 ft-lb. The Model 175 helical soil nails were installed to lengths from 25 to 35 feet and torque from 5,750 to 7,790 ft-lb. Verification testing was performed on three sacrificial soil nails to verify the equivalent design bond pressure and eight proof tests were performed on production nails to verify capacity and creep criteria. Reinforcement and drainage medium were installed prior to shotcreting. The wall reinforcement consisted of continuous 6x6-W1.4xW1.4 welded wire mesh and two horizontal and vertical waler bars of #4 steel rebar. The drainage medium was installed vertically along the soil face of the excavation with connections to weep holes located at the bottom of the wall. The shotcrete was placed with a minimum 4-inch thickness and a required minimum concrete compressive strength of 4,000 psi. The soil nail wall was constructed over a period of 12 days. After construction of the building foundations, 3,060 cubic yards of low density (30 pcf) permeable cellular concrete were placed in 4-foot lifts around the perimeter of the building.



Elevation plan drawing of the helical soil nail locations

Helical soil nail wall in service prior to building construction



Cross-section view of tallest portion of the helical soil nail wall

Cellular concrete placed between office building and soil nail wall

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please visit supportworks.com or call 800.281.8545.

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What's Inside

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WINTER 2020

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FEATURED CASE STUDY:

Farm Credit Services of America – Omaha, NE
Thrasher Commercial Group

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