THE SUPPORTWORKS NEWSLETTER FOR DESIGN PROFESSIONALS

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Proof Testing Helical Anchors

Helical anchors are tension-loaded steel elements used in a variety of applications, including tiebacks for earth retaining structures, guy-wire support for towers or other structures, and tie downs for wind/uplift loading, seismic restraint and buoyancy control. When considering helical anchors or alternative solutions, project specifications may include performance and/or proof testing to verify anchor capacity. Performance tests determine the ultimate anchor capacity by loading a sacrificial anchor to failure, or a practical limit above the design load, to verify an adequate factor of safety. Proof tests are performed on production anchors to verify anchor capacity up to and slightly above the service load. For some projects, it may not be practical to complete performance tests on sacrificial anchors, so proof testing may be the sole test method used to verify capacity. The proof test results, considered along with ultimate capacities correlated from installation torque (for helical anchors), would give the designer confidence in the product and installation.

Supportworks, Inc., recommends that proof testing of production helical anchors be considered on every project, with or without a performance test. Proof testing not only verifies capacity, but also removes slack due to coupling details and misalignment, while also mobilizing the soil strength surrounding the helical bearing plates.

Coupling rigidity comparison: round shaft versus square shaft

Helical anchors typically use solid square shaft products with forged, socket-like connections that allow transverse movement at the couplings (see figure left). This lack of coupling rigidity, as compared to the round shaft coupling, may create a variance from straightness between extension sections during installation. Furthermore, when helical anchors are installed, the use of crowd (downward force) to facilitate installation may result in compression of the coupling, which would allow movement of the coupling bolt(s) within the bolt holes when a tension load is applied. Proof testing effectively removes this slack and shaft misalignment.

Another benefit of proof testing is that helix plates are firmly seated into the bearing soil, thereby preloading the soil and reducing axial movement that would be experienced when service loads are applied. This may be particularly important for earth retention applications where minimal wall movement is desired.

Proof test on a tieback anchor

Proof testing is performed using a calibrated, hollow-core hydraulic ram, pump and pressure gauge setup and a reaction device that allows an applied load to be “locked off,” if desired. A dial gauge is recommended to monitor the movement during each load cycle. A typical proof test setup for a tieback anchor is shown above. The ram is reacting against a “chair” bearing directly on the wall.

It may not be feasible to lock off anchor loads for some projects where the anchor terminations are cast into new concrete without access for tensioning. In these cases, Supportworks still recommends proof testing with a reaction setup against the soil, even if the anchor is then fully unloaded. Most of the benefits of proof testing are still realized with this method.

Proof testing procedures generally restrict the maximum load to no more than 1.25 to 1.35 times the anchor service load. If a test load of more than 1.35 times the service load is specified, Supportworks recommends testing on sacrificial anchors versus production anchors.

In summary, proof testing is an important part of any helical anchor project and should be used to verify anchor capacity, remove slack due to coupling details and shaft misalignment, mobilize the soil strength at the helix plates, and minimize structural deflections upon loading.

DONALD A. DEARDORFF, P.E.

Project: **Commercial Property Retaining Wall**
Location: **Appleton, WI**
Pier Installer: **Foundation Supportworks of WI**

Challenge: A commercial property, located at the corner of Highway (Hwy) 41 and Hwy BB in Appleton, Wisconsin, was being sold. Title work showed that a portion of the property encroached on the Hwy 41 right-of-way. The current owner negotiated with the state to deed over a strip of land along Hwy BB in exchange for the portion being encroached. The state also required a new, 167-foot long retaining wall to be constructed for potential expansion of Hwy BB prior to the transfer of ownership. The retaining wall design consisted of a poured concrete stem wall with permanent facing formed to create a faux stone appearance. One row of nine helical tiebacks was included in the design of the wall for lateral stability. The tiebacks were specified to have a minimum embedment length of 20 feet and achieve a 15 kip allowable capacity. The tiebacks were also required to be pretensioned after final construction of the wall and facing.

Solution: Nine Model 150 (1.5-inch round corner square bar) helical tiebacks with 10”-12”-14” triple-helix lead sections were installed along the wall at an approximate 15-degree downward angle and to lengths greater than 20 feet. The tiebacks were terminated when the final installation torque was at least 3,000 ft-lb to provide a minimum factor of safety of two. The tiebacks would transition to threaded rods to pass through the formwork, steel bearing plates and the wall reinforcement. Since the tiebacks needed to be pretensioned after construction of the wall, the tieback bearing plates were located within the wall reinforcement with corrugated plastic tubes on each side extending to the front and back formwork. The tubes allowed insertion of the threaded rods through the steel plates after the forms were removed. The tiebacks were then pretensioned and the load locked off by tightening a nut against the bearing plate. Pretensioning of the tiebacks serves to reduce wall movement by mobilizing the soil strength at the helix plates and take out any slack that may be in the coupling connections. After the tiebacks were pretensioned, any threaded rod that was sticking out of the wall was torched off and the small access ports in the permanent facing were filled with matching concrete. The nine tiebacks were installed in two days.

Helical tiebacks installed with a skid steer

Top view of bearing plate inside the reinforcement

Transition from the anchor to threaded rod

Pretensioning the anchors after wall was poured

Torching off the excess thread bar on final wall face

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

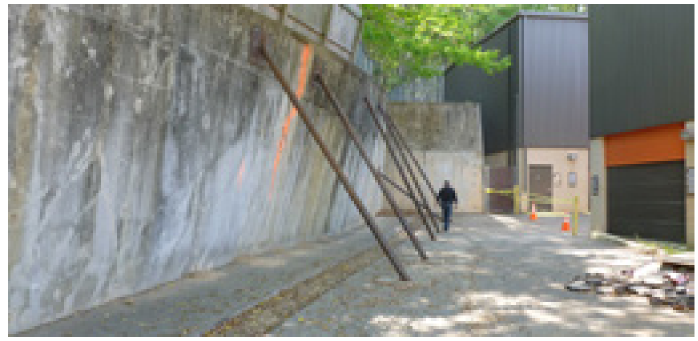
  3rd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)

Project: **Storage Facility Wall Stabilization**
Location: **Tallahassee, FL**
Pier Installer: **Alpha Foundations**

Challenge: A 12- to 17-foot tall poured concrete, cantilevered retaining wall provides grade separation near the property line of a storage facility. Over many years, the retaining wall continued to yield and rotate outward to more than 12 inches from vertical at the worst location. This movement caused numerous diagonal cracks to develop along the affected length, as well as one severe vertical crack near the point of maximum inward deflection. As a measure to prevent wall failure and subsequent damage to existing structures and adjacent properties, the wall was temporarily braced with diagonal steel tubes anchored to both the wall and the pavement below. A tieback system was then proposed to permanently stabilize the failing retaining wall.

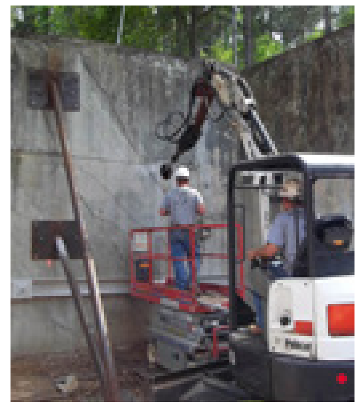
With the property line essentially along the top of the wall, a temporary easement had to be obtained from the adjacent property owner to complete a subsurface exploration through the retained soils. A permanent construction easement was then required to allow a tieback system to extend beyond the property line.

Solution: The wall stabilization detail included 17 Model 150 (1.5-inch round corner square bar) helical tiebacks. Helical tiebacks could be installed with a mini-excavator capable of maneuvering between the existing steel braces and within the limited space between the retaining wall and the existing buildings. An 8”-10”-10” triple-helix lead section was selected to pass through the maximum 10-inch diameter cores in the wall and support the design working tension load of 24 kips. Two rows of tiebacks, approximately three feet and 10 feet up from the base of the wall, were installed to stabilize 70 feet of the failing retaining wall. The tiebacks were spaced eight to 10 feet, center-to-center. The tiebacks were installed at a downward angle of 15 degrees from horizontal and to lengths of about 25 feet. Each tieback was installed to a torque of at least 5,500 ft-lb, correlating to ultimate capacities exceeding the design working load by a factor of safety greater than two (FOS > 2). The tiebacks terminated with thread rod adaptors and high strength thread rod to connect to 10-inch steel channel walers. The tiebacks were then pretensioned and the core holes were filled with concrete. The tieback installation and wall stabilization was completed in just four days. The steel tube bracing was later removed.



Retaining wall temporarily stabilized with steel tube bracing

Bottom row of helical tiebacks being installed around bracing



Top row of tiebacks; bottom waler attached

Top and bottom tieback and waler system in place

Completed tieback and waler system prior to removal of temporary bracing

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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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FEATURED CASE STUDIES:

Commercial Property Retaining Wall – Appleton, WI
Foundation Supportworks of WI

Storage Facility Wall Stabilization – Tallahassee, FL
Alpha Foundations

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