

GroundED

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55

Testing Helical Tiebacks for Earth Retention

A helical tieback system is a factory-manufactured steel foundation designed to resist axial tension loads. The helical tieback system consists of a central steel shaft, one or more helix-shaped bearing plates and a termination device, which is usually a threaded rod adapter and threaded rod. Helical tiebacks are commonly used for lateral support in earth retention systems with rigid wall facing, such as sheet pile walls, secant walls, soldier pile and lagging walls and concrete retaining walls. Helical tiebacks have many advantages over grouted tiebacks, including verification of capacity during installation based on the final installation torque and the opportunity for immediate testing after installation since there is no wait time for grout to cure.

When considering helical tiebacks, project specifications may include various types of testing to document tieback capacity and performance. The three general types of testing are pre-production testing, performance testing and proof testing. The level of testing can vary significantly from one project to another, depending upon the importance of the structure, the number of tiebacks and budgeting concerns.

Preproduction Testing

Preproduction testing is performed on a sacrificial tieback that is loaded to its ultimate capacity. A sacrificial tieback is a tieback with the same design and installation criteria as a production tieback but dedicated for the load test. The ultimate capacity of a tieback would be defined by the failure criteria applicable for the project. One common test method is detailed in the ASTM D3689 Quick Test Method, which gives specific requirements for the setup and loading sequence. However, there are other methods and procedures used in the industry beyond the ASTM standard.

Like the performance and proof testing, the load is applied using a calibrated, hollow-core hydraulic cylinder, pump and pressure gauge setup and movement is recorded with one or more calibrated dial gauges. Unlike performance and proof testing, the preproduction test setup cannot utilize the rigid retaining wall facing as a reaction during loading and requires the setup of an independent load frame. The preproduction test setup becomes further complicated if the tieback is tested at the batter angle specified for the project. Due to the costs and time associated

with preproduction testing, the tests are generally limited in number and usually only specified for very large projects with high-capacity tiebacks. A typical preproduction test setup for a battered tieback is shown in Figure 1.



Figure 1: Preproduction testing a battered tieback

Performance and Proof Testing

Performance tests are used to verify capacity and deflection on production tiebacks after installation but before they are put into service. The performance test setup utilizes the strength of the wall to provide the load reaction during testing. This is accomplished with a reaction assembly, commonly called a “chair”, that allows the hydraulic cylinder to be aligned with the tieback and provides access to the tieback/wall connection so that the tieback may be “locked off” at a specified load. Locking off the tieback at a specified load (typically at or near the service load) reduces wall movement once the tiebacks are put into service.

A typical performance test setup for a tieback is shown in Figure 2. In this image, the cylinder is reacting against a “chair” bearing on a steel waler connected to the wall. A typical proof test setup is shown in Figure 3.

Since the test tiebacks will be used as production tiebacks, the maximum load applied to the tieback is generally limited to about 1.2 to 1.3 times the design load to minimize soil disturbance at the helix plates and stresses



Figure 2: Performance test setup with "chair"

within the tieback. Most large projects require a certain percentage of production tiebacks to be performance tested. A typical amount of performance tests for a large project may be two percent or more of the total tiebacks or a minimum of two tiebacks.

The performance test includes cyclical loading to determine tieback movement under repeated loading and unloading conditions. Except for the maximum test load, the load is applied and held at each load increment only long enough to record the movement. A creep test is performed at the maximum test load, which involves holding the load constant and monitoring creep movement between log cycles of time (e.g., 1 and 10 minutes or 6 and 60 minutes). A common method is to hold the maximum load for 10 minutes and record movements at 1, 2, 3, 4, 5, 6 and 10 minutes. If the movement between the 1- and 10-minute period is greater than a specified amount (typically about 0.08 inches), then the load is maintained for another 50 minutes to determine the movement between the 6- and 60-minute log cycle of time. If the movement at the second log cycle of time is greater than a specified amount (typically about 0.10 inches), then the test may be extended again for a third log cycle of time. If the tieback cannot meet the failure criteria, the tieback could be advanced deeper to a higher termination torque and retested or have its capacity derated. A typical performance load test schedule is shown in Table 1.

Any production tieback that is not performance tested should be proof tested. Proof testing removes slack in the tieback created by the coupling detail. More importantly, we also want to fully mobilize the soil strength surrounding the helix plates so the retaining wall does not have to deflect before the tiebacks go into service. The proof test setup is the same as that of the performance test. The proof test does not include cyclical loading but has similar loading increments as the

Table 1: Helical Tieback Performance Test Schedule

Loading as a Factor of Design Load (DL)				
AL ¹	AL	AL	AL	AL
0.25DL	0.25DL	0.25DL	0.25DL	0.25DL
	0.50DL	0.50DL	0.50DL	0.50DL
		0.75DL	0.75DL	0.75DL
			1.00DL	1.00DL
				1.25DL ^{2,3}

¹Alignment load (AL) is 5 to 10% of the DL

²Hold the maximum load for creep testing per specifications

³Reduce to lock-off load after creep testing

last cycle of the performance test. A creep test at the maximum test load may also be performed during the proof test.

In Summary

There are three different types of testing applicable for helical tiebacks for earth retention: preproduction, performance and proof testing. Although the scope of testing will vary from project to project, Supportworks recommends that all helical tiebacks be proof tested to take the slack out of the system, seat the helical bearing plates and allow the tieback to be locked off at a specified load. The proof testing minimizes wall movement when the tiebacks are put into service. The scope of testing for a helical tieback project may not need to be as intensive as for a grouted tieback project, given the ability to estimate tieback capacity by monitoring torque during installation and the problems associated with grout placement and curing. For more complete information and model specifications for helical tiebacks, please visit the Supportworks commercial website at www.onstableground.com.



Figure 3: Proof testing helical tiebacks for a secant wall

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Helical Tiebacks for Roadway Widening

Project: Anahuac National Wildlife Refuge Tiebacks
Location: Anahuac, TX

Challenge: Located along the Gulf coast of Texas near Houston, the Anahuac National Wildlife Refuge encompasses 34,000 acres of protected coastal marsh and prairies. In 2008, Hurricane Ike damaged a significant portion of the existing unpaved roadways within the refuge, which were temporarily repaired. A 2.5 mile stretch of unpaved scenic roadway surrounding Shoveler Pond included six pullover viewing areas which required improvements for vehicle access. Erosion from tidal and storm activity would need to be mitigated along the roadway prior to any improvements. A comprehensive improvement plan was developed and approved by the U.S. Department of Transportation for this area of roadway, which included construction of a seawall along the pond side of the roadway along with raising the roadway elevation up to 2 feet prior to the placement of asphalt pavement. Soil borings were completed at each of the pullover locations and generally showed soft to stiff clay to a depth of about 10 feet underlain by stiff clay. Based on the soil conditions, tiebacks would be necessary for the lateral support of the seawall system. Access for tieback installation was complicated by the water directly adjacent to the pullover areas. The construction process was further complicated by requiring tieback installation prior to driving the vinyl sheet piling to accommodate smaller diameter holes through the sheet piling.

Solution: Helical tiebacks incorporated into a vinyl sheet pile wall were selected for the earth retention system because of the ability to install into the roadway with smaller equipment and the limited work areas. The shoring design consisted of vinyl sheet piling embedded 17 feet below existing grade with one row of tiebacks located 2 feet below the top of wall. The tiebacks would be battered 45 degrees into the roadway and connected to the vinyl sheet pile wall with a threaded rod and timber waler. The tieback design required 7-foot spacings with design working tension loads of 12.5 kips. A minimum factor of safety of 2.5 was specified for the tiebacks to meet strict proof test failure criteria, resulting in a required ultimate axial tension capacity of 32 kips. Based on the tieback loading, the HA150 solid square shaft with a 10"-12"-14" helix plate configuration was selected. Proof tests were performed at 14 locations prior to construction of the wall to verify tieback performance. The production tiebacks were installed to 40-foot lengths and minimum termination torques of 3,200 ft-lb to achieve torque correlated ultimate capacities of 32 kips. With the 7-foot spacings, 195 tieback locations were required at the six pullout areas. The testing and tieback installation was performed over a period of 20 days.



Roadway prior to construction with pond area to the left



Helical tieback installation



Proof testing helical tieback prior to sheet piling



Helical tiebacks installed prior to sheet piling



Roadway side of the seawall prior to backfill and pavement



Shoveler Pond side of the seawall with timber waler



Roadway side with backfill and pavement installed

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