Helical Anchor Design

Our Engineering Department is standing by to help from conception to completion for civil and structural engineers as well as project management personnel. A complete description of helical ground anchors is available in our Design and Technical Service Manual or Call today to speak with our trained staff.

Helical Ground Anchors are designed and sized to match load requirements, soil conditions and available site access. Multiple sizes and capacities allow precise designs for the utility industry. Helical ground anchors can be used to resist mast and tower loads which consist of lateral and compressive loads focused at the base of the structure. Whether a self supporting tower, a guyed tower or pipeline helical ground anchors provide a cost effective solution. No matter the application ECP Helical Anchors are the Designed and Engineered to Perform product of choice for the utility industry.

Table 2.	**Capacities of Helical Torque Anchors™**				
Shaft Size	Installation Torque Factor (k)	Axial Compression Load Limit	Ultimate-Limit Tension Strength	Useable Torsional Strength	Practical Load Limit Based Torsional Strength
1-1/2” Square Bar	9 - 11	70,000 lb.	70,000 lb.	7,500 ft-lb	Load limited to the rated capacity of the attachments and the lateral soil strength against the shaft
1-3/4” Square Bar	9 - 11	100,000 lb.	100,000 lb.	10,000 ft-lb	
2-1/4” Square Bar	10 - 12	200,000 lb.	200,000 lb.	23,000 ft-lb	
2-7/8” Tubular – 0.262” Wall	8 - 9	100,000 lb.	100,000 lb.	9,500 ft-lb	80,000 lb
3-1/2” Tubular – 0.300” Wall	7 - 8	115,000 lb.	120,000 lb.	13,000 ft-lb	97,000 lb
4-1/2” Tubular – 0.337” Wall	6 - 7	160,000 lb.	160,000 lb.	22,000 ft-lb	143,000 lb

Multiple sizes and capacities allow precise design and load match for all applications. The table above displays a complete selection of Helical Anchors available for the utility industry. Helical ground anchor leads are available in lengths from 3’ (1M) to 10’ (3M). Helix flight diameters range for 6” (150mm) to 14” (355mm) in both 3/8” and ½” thickness.

Multiple helix combinations, situated on the same shaft, allows designer to target ideal load bearing soils and formations. Helical ground anchor extensions are also available in 3’ (1M) to 10’ (3M) lengths with a forged coupling for quick precise connection. Various termination connectors are available to secure the guywire to the ground anchor from threaded thimble eyes to clevis applications.

Corrosion protection is provided in the form of hot dipped galvanization (per ASTM A123). Hot dipped galvanization is a great choice for protection from the elements giving design professionals the assurance of long term performance. This added protection allows for installation in aggressive soils and wet areas alike; see our Design and Technical Service Manual for full corrosion information.

Helical Torque Anchor Design Considerations

Projected Areas of Helical Plates: When determining the capacity of a screw pile in a given soil, knowledge of the projected total area of the helical plates is required. This projected area is the summation of the areas of the helical plates in contact with the soil less the cross sectional area of the shaft. Table 8 provides projected areas in square feet of bearing for various plate diameters on different shaft configurations.

Important: When a 900 spiral cut leading edge is specified, the projected areas listed above will be reduced by approximately 20%.

Table 8.	Projected Areas* of Helical Torque Anchor Plates					
Helical Plate	**6" Dia.**	**8" Dia.**	**10" Dia.**	**12" Dia.**	**14" Dia.**	**16" Dia.**
Shaft	**Projected Area – ft2**					
1-1/2" Sq.	0.181	0.333	0.530	0.770	1.053	1.381
1-3/4" Sq.	0.175	0.328	0.524	0.764	1.048	1.375
2-1/4" Sq.	0.161	0.314	0.510	0.750	1.034	1.361
2-7/8" Dia	0.151	0.304	0.500	0.740	1.024	1.351
3-1/2" Dia	0.130	0.282	0.478	0.719	1.002	1.329
4-1/2" Dia	0.086	0.239	0.435	0.675	0.959	1.286

* Projected area is the face area of the helical plate less the cross sectional area of the shaft.

Allowable Helical Plate Capacity: When conducting a preliminary design, one must also be aware of the mechanical capacity of a helical plate and the shaft weld strength. Average capacities of plates are given in Table 9. Actual capacities are generally higher than shown for smaller diameter helical plates. Capacities are also slightly higher when the helices are mounted to larger diameter tubular shafts.

Table 9.	Allowable Mechanical Helical Plate Capacities	
6" through 14" Diameter Plates		
Helical Plate Thickness	Average Ultimate Load	Average Working Load
3/8"	40,000 lb	20,000 lb
1/2"	50,000 lb	25,000 lb
16" Diameter Plate		
1/2"	40,000 lb	20,000 lb

When designing with 12" to 14" diameter plates on square bar shafts, the ultimate mechanical capacities are slightly lower than shown. This variance is usually not a concern except when a small shaft is highly loaded with only a single or double helix.

Relationships between Installation Torque and Torque Anchor™ Capacity: Estimating the capacity of a given screw pile based upon the installation torque has been used for many years.

Unless a load test is performed to provide a site specific value of "k", a conservative value should be selected when designing. While values for "k" have been reported from 2 to 20, most projects will produce a value of "k" in the 6 to 14 range. Earth Contact Products suggests using the values for "k" as shown in Table 10 when estimating Torque Anchor™ ultimate capacities.

It is important to understand that the value of "k" is a measure of friction during installation. This friction has a direct relationship to the soil properties and anchor design. For example, "k" for clay soil would usually be greater than for dry sand. The "k" for a square bar is generally higher than for a tubular pile. Keep in mind that the suggested values in Table 10 are only guidelines.

Table 10. Installation Torque Factor "k"	
Torque Anchor™ Type	**Estimated Empirical Torque Factor Range – "k"**
1-1/2" Solid Square Bar	9 - 11
1-3/4" Solid Square Bar	9 - 11
2-1/4" Solid Square Bar	10 - 12
2-7/8" Diameter Tubular	8 - 9
3-1/2" Diameter Tubular	7 - 8
4-1/2" Diameter Tubular	6 - 7

It is also important to refer to Table 2 for the maximum practical shaft torsional values to avoid shaft fractures during installation.

Equation 3: Helical Installation Torque
T = (Pu or Tu) / k or **(Pu or Tu) = k x T**

Where,
T = Final Installation Torque - (ft-lb)
(Averaged Over the Final 3 to 5 Feet)
Pu or Tu = Ult. Capacity of Torque Anchor™ - (lb)
k = Empirical Torque Factor - (ft-1)

An appropriate factor of safety of 2.0, minimum, must always be applied when using design or working loads with Equation 3.

To determine "k" from field load testing, Equation 3 can be rewritten as:

Equation 3a: Empirical Torque Factor
k = (Pu or Tu) / T

Where,
k = Empirical Torque Factor - (ft-1)
Pu or Tu = Ult. Capacity of Torque Anchor™ - (lb)
T = Final Installation Torque - (ft-lb)
Always verify capacity by performing a field load test on any critical project.

Torque Anchor™ Spacing – "X":
Equation 4 is used to determine the center-to-center spacing of Torque Anchors.

Equation 4: Torque Anchor™ Spacing
"X" = Pu / (w) x (FS) or **Pu = ("X") x (w) x (FS)**

Where,
"X" = Product Spacing - (ft)
Pu = Ultimate Capacity - (lb)
w = Distributed Load on Foundation or Wall (lb/ft)
FS = Factor of Safety (Typically 2.0 – Foundations or Permanent Walls and 1.5 for Temporary Walls)

Plate Embedment in Tension Applications: When a pile must resist uplift or tension loads, the pile must be adequately embedded into the bearing stratum to offer resistance to pull out.
The pile must first qualify as a deep foundation, defined as being installed to a depth from the surface of no less than six times the diameter of the largest and shallowest helical plate (**6 x dLargest)**. In addition, to insure that the pile is fully embedded, the required terminal torsion applied to the shaft must be an average of the torsion developed over a distance of no less than three times the diameter of the uppermost (largest) plate (**3 x dLargest)** on the pile or anchor.

Preventing "Punch Through": On occasion a soil boring will show competent soil overlaying a weak and softer stratum of soil. When designing the Torque Anchor™ to achieve axial compressive bearing in the competent soil situated above a weaker soil, one must consider the possibility that the Torque Anchor™ could "punch through" to the weaker soil when fully loaded.

When designing a pile in such situations, it is recommended that a distance greater than five times the diameter of the lowest (smallest) helical plate (**5 x dLowest**) exist below the Torque Anchor™ to prevent "punching through" to the stratum of weaker soil and possibly failing.