

GUIDE FOR POWER LIFT® HELICAL SCREW PILES AND ANCHORS



Product Description

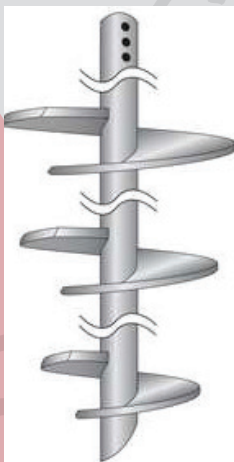


Power Lift® helical screw piles and anchors, also known as helical piles and anchors, are square bar or round tubular steel shafts to which helix plates are welded. The helix plates are simply round steel plates of various sizes that have been pressed into the form of a pitched screw thread. When the pile is rotated in the ground, the helix plates generate axial thrust, causing it to advance.

Power Lift® manufactures all sizes of pile shafts, from 1 ½" to 2 ¼" square bar and 2 ¾" O.D. to 12 ¾" O.D. round shafts. Our helical piles are custom designed to offer the capacity required in the most efficient and economical configuration. The shaft material consists of high strength carbon steel bar and tubing ranging from 55 KSI to 80 KSI minimum yields. The shafts are manufactured in various lengths, with

couplings on the ends to allow them to be connected together to penetrate deep into the ground as necessary to engage competent bearing stratum.

The helix plate are cut to exact shape using grade 50 steel plates, and pressed to the proper configuration with a die and hydraulic press. Each helix plate is a 360° spiral with 3" to 6" between the leading and trailing edges (referred to as the helix *pitch*). Special care is taken to ensure the helix spiral



has a uniform pitch angle to minimize disturbance of the soil during pile or anchor installation. These helix plates are generally ¾" to 1 ¼" thick, depending on the shaft diameter and loading conditions. When multiple helices are welded to the same shaft, smaller helices precede larger ones. The spacing distance between any two helices is a minimum of three times the diameter of the lower helix.





Helix plates are welded to the shaft by the gas metal-arc welding process using argon gas and a high amperage welder, which enables the penetration necessary for a strong weld attachment. In some cases engineered process welds are required. All welding is done in accordance with AWS D1.1/ D1.M1 structural welding code - steel. Special care is taken to insure that the vertical axis of all helices is in alignment on the shaft.

Shaft sections are connected together with thru-bolt connections (or full penetration welds) that resists (tension and compression) and lateral (shear and overturning) loads. These connections allow rapid make-up in the field and produce a rigid joint with better

flexural and torsional stiffness than other products, resulting in better buckling resistance under compressive loads.

Applications

Power Lift® helical screw piles and anchors are used to transfer loads from the surface to deeper, more suitable load-bearing strata. They may be used in tension for tower guys or tiebacks, in compression as for foundations, or in shear/overturning as for lighting pole or tower foundations. They may be installed vertically plumb, for supporting gravity loading, or at an inclination as anchors, or tiebacks, or as a pile group in a pile cap. They can be used to support or resist loads from 5 kips to 500 kips.

Power Lift® helical screw piles and anchors may be used in new construction where the costs or risks associated with conventional foundations dictate, or they can be utilized to stabilize or remediate existing structures whose foundations are in distress. In these applications, they are often used in conjunction with prefabricated steel brackets or pile heads that facilitate connection of the helical screw pile or anchor to the structure.

Advantages

Power Lift® helical screw piles or anchors can be installed in any weather. Their installation requires little or no



excavation, produces no measurable waste, utilizes no impact forces and produces no vibration, so their use minimizes the risk of damage to adjacent structures from soil movement. They are ready for use immediately after installation, requiring no cure time as with cast-in-place concrete foundation elements. Their installation produces no spoils to be disposed of or remediated, which is of particular importance for construction on contaminated sites. As well, the installation of our piles is fast. It is not uncommon to install as many as 40 piles per day.



Power Lift® helical screw piles or anchors are custom designed to solve the project's specific needs. We do not select products from catalogues or a chart. Our engineering team analyzes the load requirements, soil and site conditions to develop the most efficient and economical pile configuration for the job.

Installation

Power Lift® helical screw piles and anchors are installed by screwing them into the ground. As with wood screws, it is necessary to provide both torque (twisting effort) and crowd (axial thrust) to the top of the pile or anchor shaft. These forces must be maintained during the installation to ensure the pile or anchor does not either cease to rotate or cease to advance at the proper rate of about one pitch length per revolution.

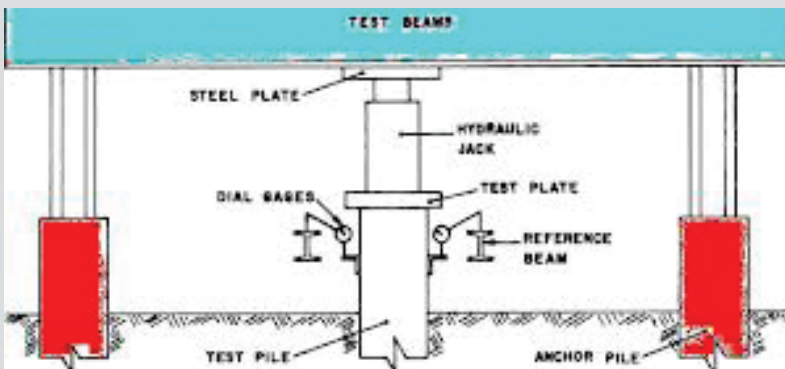
Installation can be done with either hand-held or machine-mounted equipment. As will be explained in the next section, the maximum load that an installed helical screw pile or anchor can support is directly related to the torsional resistance that is generated during installation. In many cases, as torsional resistance increases, crowd must likewise increase. Therefore, helical screw piles or anchors installed with hand-held equipment will necessarily be limited to supporting lighter loads because of the limited ability to provide torsional reaction and crowd force to accomplish



the installation. Although hand wrenches and electric motors can be used to supply the installation torque, the most commonly used equipment is a hydraulic motor in combination with a planetary gearbox to provide the low speed and high torque needed.

The torsional resistance generated during installation of helical screw piles or anchors is related to the strength of the soil encountered. Because pullout and plunging resistance of the installed piles or anchors are also related to soil strength, the installed piles or

anchor's pullout/plunging load capacity can be predicted by analysis of the torsional resistance encountered at the end of the installation operation. During installation, the torsional resistance encountered should be monitored and recorded at one-foot increments of pile or anchor embedment. This may be accomplished by the use of a mechanical torque indicator installed in the powertrain, or by correlation with the drop in voltage across an electric motor or drop of hydraulic pressure across a hydraulic motor used to drive the pile or anchor. The latter is also called differential pressure, and is not to be confused with the motor input or system pressure. Differential pressure can be calculated by subtracting the outlet pressure at the motor outlet port from the inlet pressure at the motor inlet port, or it can be measured directly by various differential pressure gages or transducers. Theoretically, inlet pressure at the drive head is only equal to differential pressure across the drive head when the outlet pressure is zero, i.e., when there is no flow through the drive head. This corresponds to a locked rotor condition, for which the output torque/pressure relation is not the same as when the motor is running. However, the error in using inlet pressure instead of differential pressure becomes minimal at very low motor speeds. The differential pressure-torsional resistance ratios are different for each make and model of helical driver. To obtain torque values via differential pressure, one must use the correct conversion. Manufacturers of hydraulic motor/planetary gear drivers can furnish graphs or tables for this purpose.



Torsional resistance during installation is usually measured by an electronic strain-gage torque sensor placed in line with the torque applied to the pile or anchor, or by correlation with the drop in voltage across an electric motor or the drop in pressure across a hydraulic motor used to drive the pile or anchor.

Predicting Performance

The failure mode of a helical screw pile or anchor depends on its relative depth d/B , where d is the depth of the upper helical plate and B its least lateral dimension. Assuming the pile does not fail structurally, if d/B exceeds a critical value of about 4 the mode of failure is “deep, local shear” like that of a deep footing or point-bearing pile (Sowers and Sowers, 1970). For tension loading, if d/B is less than about 4 the failure mode is one of complete rupture and eruption of a truncated, inverted conical mass of the soil above the anchor. In stress-controlled situations, the failure of such a pile or anchor is characterized by sudden, large-scale deflection and precipitous drop in load resistance. This type of failure is comparable to brittle fracture of other structural elements. Power Lift recommends its helical screw anchors used in tension be installed to minimum helix embedment of five diameters in clay and seven diameters in sand to preclude this failure mode. Piles used in compression should be installed to minimum helix embedment of five helix diameters to ensure

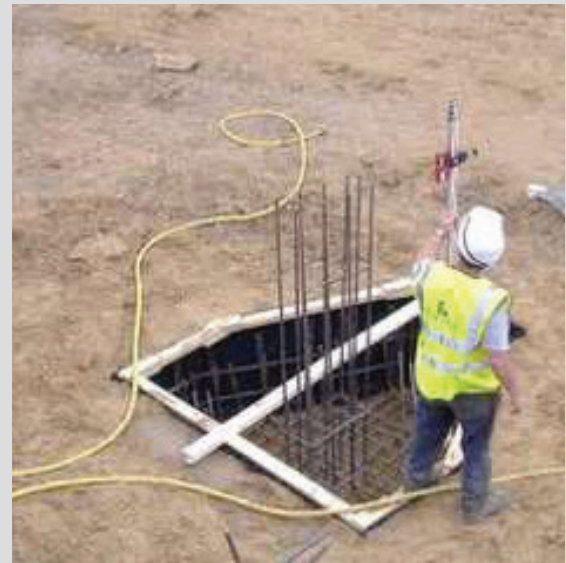


deep local shear failure of the soil. These requirements ensure that, like ductile structural elements, **Power Lift**® helical screw piles and anchors will continue to resist significant load even at large deflections. For near-horizontal anchors such as tiebacks or struts, the vertical depth of the helices can become an independent factor governing shallow/deep pile

or anchor behavior. Power Lift recommends a minimum helix vertical depth of 4 feet be maintained to help ensure deep pile or anchor behavior.

There are three generally accepted methods for predicting the ultimate pullout or plunging resistance of helical screw piles and anchors in deep, local shear. The first two commonly used methods for predicting pile or anchor performance utilize soil mechanics and the strength properties of the soil in which the screw pile or anchor is embedded. Thus, they are generally used to select the proper pile or anchor configuration for a particular job. They produce identical results for single-helix piles or anchors. The third method utilizes an empirical correlation between the pile or anchor's ultimate resistance and the torsional resistance encountered during its installation. This method is particularly useful for quality control during construction, but can require installation of trial pile or anchors at the construction site to be useful in configuration selection. Hoyt and Clemence (1989) found the torque correlation method to be the most reliable of the three methods of predicting pile or anchor capacity.

All three methods predict ultimate resistance defined as the load at which the load vs. deflection curve first exhibits zero slope. Note that the deflection necessary to reach this load may be as much as 30% of the diameter of the largest helix. All three methods also assume that the pile or anchor does not overhaul, i.e., it does not rotate under the influence of the axial load acting on the inclined plane of the helix(es).



Cylindrical Shear Method

The cylindrical shear method for calculating ultimate resistance of a multiple helix tension anchor assumes that when the soil fails, the helix plates and the soil between them are mobilized as one mass, while a bearing failure occurs above the top helix (see Figure I-1). The total resistance comprises the bearing resistance of the soil acting against the top helix plate plus the cylindrical shear resistance of the soil between the plates plus the soil friction/ adhesion resistance along the shaft above the top helix (Mitsch and Clemence, 1985; Mooney, Adamczak and Clemence, 1985). This

method is commonly extended to compression applications by assuming bearing failure below the bottom helix, rather than above the top helix, with no change to the other components of total resistance.

Pullout Resistance Q_t is expressed as:

$$Q_t = A_{cs}S_u + A_t (cN_c + \sigma'_v N_q) + \pi D_s L_s Q_s \quad (1)$$

Plunging Resistance Q_c is expressed as:

$$Q_c + A_{cs}S_u + A_b (cN_c + \sigma'_v N_q) + \pi D_s L_s Q_s \quad (2)$$

- Where A_b \equiv Area of bottom helix
 A_{cs} \equiv Surface area of the shear cylinder between top and bottom Helix plates ($= \pi D_a L_h$)
 A_t \equiv Area of top helix
 D_a \equiv Average diameter of cylindrical shear surface
 $= (D_b + D_t)/2$
 D_b \equiv Diameter of bottom helix
 D_s \equiv Outside diameter of shaft
 c \equiv Soil cohesion
 L_h \equiv Distance between helices
 L_s \equiv Length of shaft above helices that is contact with soil
 N_c \equiv Bearing capacity factor for cohesion
 N_q \equiv Bearing capacity factor for overburden
 Q_c \equiv Ultimate plunging resistance
 Q_s \equiv Ultimate shaft resistance
 Q_t \equiv Ultimate pullout resistance
 S_u \equiv Undrained soil shear strength
 σ' \equiv Effective vertical stress

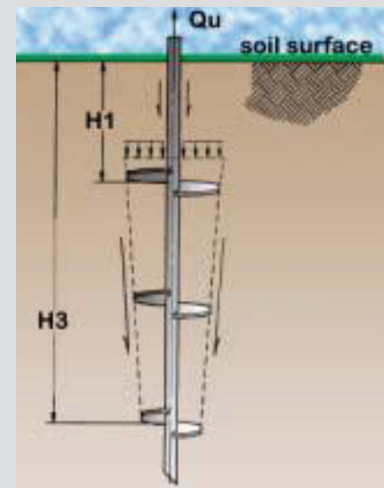


Figure I-1. Cylindrical Shear Failure Mode (Hoyt and Clemence, 1989)

The value Q_s must be appropriate for soil that has been disturbed by the passage of helices. In the case of tension anchors, the same applies to the values of N_c and N_q . For compression applications, the bottom helix bears on undisturbed soil. However, it is common (and conservative) to use the same bearing capacity factors for both tension and compression application. Numerical values may be found in Mooney, Adamczak and Clemence (1985) and in Mitsch and Clemence (1985).

It is common to completely ignore the shaft friction/adhesion component with pile or anchors having solid shafts, because such shafts typically have small surface areas per foot of length and external couplings. These shafts thoroughly remold the soil which ends up in contact with the shaft. Hollow shafts, including those manufactured by Power Lift, often have more significant surface areas per foot of length and couplings whose diameters are slightly larger than the shaft itself. Shaft friction/adhesion resistance may be a more significant portion of the total resistance for these shafts than for solid shafts, depending on the shaft's diameter, length and soil profile.



Individual Bearing Method

The *individual bearing* method for calculating ultimate resistance assumes a bearing failure of the soil supporting each helix (Hoyt and Clemence, 1989). The total resistance for the helix pile or anchor is the sum of the bearing resistances of the individual helix plates, plus the resistance due to soil friction/adhesion on the portion of the shaft above the top helix plate (see Figure I-2). The shaft friction/adhesion resistance may or may not be significant part of the total, as explained in relation to the cylindrical shear method, above.



The individual helix plates, plus the resistance due to soil friction/adhesion on the portion of the shaft above the top helix plate (see Figure I-2). The shaft friction/adhesion resistance may or may not be significant part of the total, as explained in relation to the cylindrical shear method, above.

Plunging and Pullout Resistance Q_c and Q_t are expressed as:

$$Q_c = Q_t = \Sigma[A_h (cN_c + \sigma'_v N_q)] + \pi D_s L_s Q_s$$

Where $A_h \equiv$ Area of individual helix plate (ℓ^2)

$D_s \equiv$ Outside diameter of shaft (ℓ)

$c \equiv$ Soil cohesion (f/ℓ^2)

$L_s \equiv$ Length of shaft above helices that is in contact with soil

$N_c \equiv$ Bearing capacity factor for cohesion (dimensionless)

$N_q \equiv$ Bearing capacity factor for overburden (dimensionless)

$Q_c \equiv$ Ultimate plunging resistance (f)

$Q_s \equiv$ Ultimate shaft resistance (f)

$Q_t \equiv$ Ultimate pullout resistance (f)

$Q_u \equiv$ Ultimate bearing resistance (f)

$\sigma'_v \equiv$ Effective vertical stress (sigma) (f/ℓ^2)

$\Sigma \equiv$ Summation operator

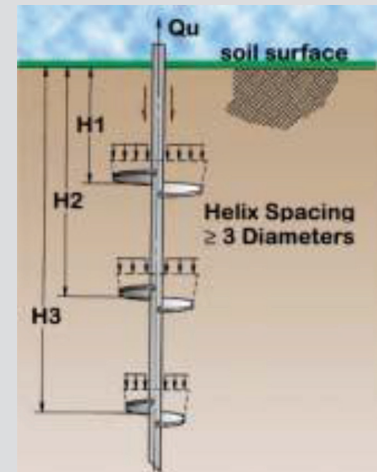


Figure I-2. Individual Bearing Failure Mode (Hoyt and Clemence, 1989)

Again, the shaft and bearing resistances must be calculated based on disturbed soil properties and it is common to use the same bearing capacity factors for both tension and compression applications. For deep piles or anchors, Power Lift recommends an N_c value of 9. Recommended values for N_q are given in Figure I-3.

Angle of Internal Friction, ϕ (deg)	N_q
0	1.0
5	1.6
10	2.5
15	3.9
20	6.4
25	11
30	18
35	33
40	64
45	130
50	320

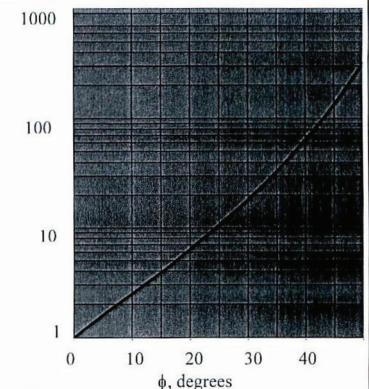


Figure I – 3, Bearing capacity factor N_q vs. soil angle of internal friction

The cylindrical shear method predicts a helical pile or anchor's capacity will increase

linearly with inter-helix spacing L_h . This is counterintuitive for very large spacings. However, the individual bearing method would predict an unchanging helix bearing resistance as the spacing is varied, which is counterintuitive for very small spacings. These relations are shown from a twin-helix pile or anchor in Figure I-4. Neither method makes sense for all values of helix spacing. Fortunately, the *upper bound* principles enable the development of the unified approach to resistance calculation that does work for all spacings.



The *upper bound* principle states that the load corresponding to any kinematically permissible failure mode is an upper bound to the true ultimate failure load. A kinematically permissible failure mode is one for which the material deformations do not violate any geometric (deflection or slope) constraints. So any failure mode one can imagine that does not violate geometric constraints such as boundary support conditions or material continuity is permissible failure mode, and the load that would have to be applied to create that failure mode is an upper bound to (i.e., is greater than or equal to) the actual failure load. The least *upper bound* principle states that of all the



kinematically permissible failure modes, the one having the least corresponding load is the true failure mode and its corresponding load is the true ultimate failure load. That is, one cannot apply a higher load than the lowest one that will produce a kinematically permissible failure mode.

Both the cylindrical shear and the individual bearing failure modes are kinematically permissible at all magnitudes of helix spacing. From Figure I-4 it is clear that the cylindrical shear mode has a lower corresponding load than the individual bearing mode for closely spaced helices. On the other hand, the individual bearing mode has the lower corresponding load for helix spacing greater than some spacings. Assuming

there are no other kinematically permissible failure modes (such as overhauling) to be considered, the least upper bound principle leads to the following conclusions:

1. The cylindrical shear mode controls for helix spacings less than s . Therefore, the cylindrical shear method is the preferred method for computing resistance for these helix spacings.
2. The individual bearing mode controls for helix spacings greater than s . Therefore, the individual bearing method is the preferred method for computing resistance for these helix spacings.
3. The cylindrical shear and individual bearing methods will yield similar results for helix spacings close to s .

So what is the correct value of s ? It has been shown that the stress field produced by a bearing plate at the surface of an elastic half-space decreases in intensity with distance from the plate. At a perpendicular distance of three times the diameter of the plate, the stress is reduced to a minor level in comparison with the stress at the plate's bearing surface. On this basis, manufacturers started spacing helices three times their diameters apart some thirty

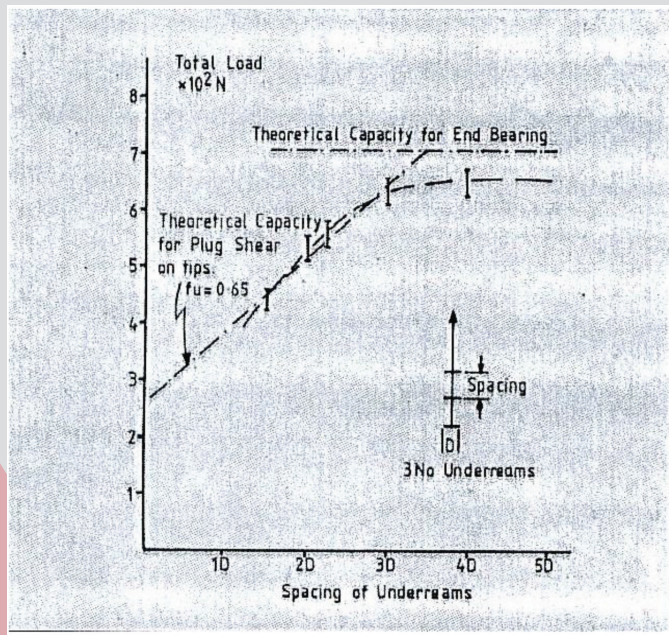


Figure I – 5. Anchor load capacity vs. underream spacing for 3 underreamed anchors in clay (after Bassett, 1977 as shown in Hanna, 1982)

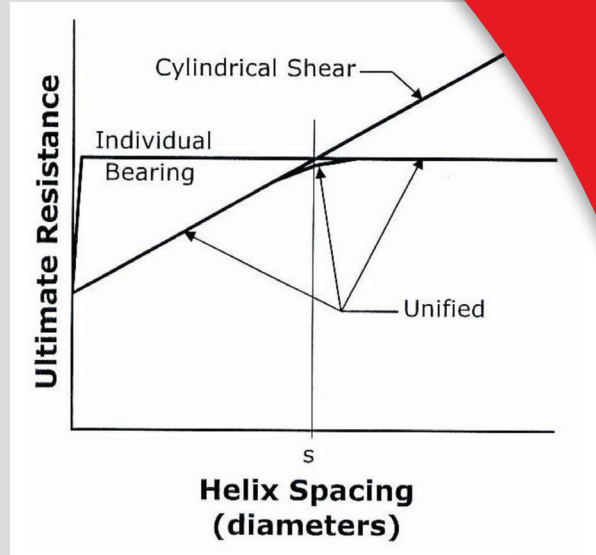


Figure I – 4. Ultimate resistance of twin helical screw anchor vs. helix spacing

years ago, reasoning that helices spaced that far apart would operate independently. Extensive laboratory testing by Bassett (1977) showed such a relation regarding multi-belled grout anchors, as shown in Figure I- 5. As previously stated, it has been shown that for bearing plates embedded inside an elastic half-space, the stress field is even smaller than for a plate at the surface, so three-diameter spacing is considered conservative.

Given that **Power Lift**® helical screw piles and anchors are manufactured with three-diameter helix spacing, one can use either the cylindrical shear method or the individual bearing method to predict their ultimate resistances. However, the computations for the individual bearing method are significantly simpler than those for the cylindrical shear method, thus the individual bearing method is the preferred method for

predicting ultimate pullout or plunging resistance of **Power Lift**® helical screw piles and anchors based on soil strength properties. In calculating the ultimate resistance of each helix, the strength properties of the soil within three diameters above or below the helix should be used for anchors loaded in tension or piles loaded in compression, respectively.

Various investigators have studied the effect of pile and anchor inclination on ultimate resistance. Though most of these studies have related to plates installed as shallow anchors, a few have looked at deep helical screw piles and anchors (Ghaly and Clemence, 1998; Adams and Radhakrishna, 1977; Trofimenkov and Mariupolskii, 1965). The angle of inclination has been found to have no appreciable effect on the ultimate resistance of deep helical screw piles and anchors. However, the three-diameter rule for selecting soil properties to be used in predicting resistance, given in the preceding paragraph, should be applied along the axis of inclined piles and anchors, not vertically.

Previous testing shows, the stress created by each helix reduces to an insignificant level within a lateral distance of 3/4 to 1 helix diameter. Power Lift recommends helical screw piles and anchors be spaced laterally at least three times the diameter of their largest helix to preclude capacity reduction due to group action stress overlap. This requirement applies only at the final depth where the helices are located. Where structural considerations require piles or anchors to be closely spaced at the foundation or superstructure connection level, they may be inclined apart (battered) slightly to give the necessary lateral spacing at helix depth. For typical pile or anchor embedment depths, this may be done without significant effect on the net resistance of the pile or anchor group.



Calculations

Examples

Example I-1: A 10" – 12" double helix pile or anchor with tip embedment of 12' in 12 blow clay. Calculate the ultimate compression capacity.

$$A_h(10") = 0.55 \text{ ft}^2$$

$$A_h(12") = 0.79 \text{ ft}^2$$

$$c = qu/2 = N/8 = 1.500 \text{ ksf (p. A-13)}$$

$$N_c = 9$$

$$N_q = 1$$

Then: $Q_c = Q_t = (0.55 + 0.79) (1.5 \times 9)$

$$Q_c = Q_t = 18.09 \text{ kips} = 18,090 \text{ lbs}$$

Example I-2: A 10" – 12" double helix pile with tip embedment of 12' in 12 blow sand. The water table is and will remain below 12'. Calculate the ultimate compression capacity.

$$A_h(10") = 0.55 \text{ ft}^2$$

$$A_h(12") = 0.79 \text{ ft}^2$$

$$H(10") = 12 \text{ ft}$$

$$H(12") = 9.5 \text{ ft}$$

$$Y_m = 110 \text{ pcf (Table A-2)}$$

$$\phi = 31 \text{ degrees (Table A-2)}$$

$$c = 0$$

$$N_q = 21 \text{ (Figure I-3)}$$

Then: $\sigma'_v(10") = 12 \times 110 = 1320 \text{ psf}$

$$\sigma'_v(12") = 9.5 \times 110 = 1045 \text{ psf}$$

$$Q_c = Q_t = 0.55(1320 \times 21) + 0.79(1045 \times 21)$$

$$Q_c = Q_t = 15,250 + 17,340 \approx 32,500 \text{ lbs}$$

Alternatively, the helix depths may be averaged giving:

$$\sigma'_v(\text{avg}) = 10.75 \times 110 = 1183 \text{ psf}$$

$$Q_c = Q_t = (0.55 + 0.79) \times 1183 \times 21$$

$$Q_c = Q_t = 1.34 \times 24843 \approx 33,500 \text{ lbs}$$

The change in this case is about 3%; it would decrease with increased embedment dept.

Example I-3: A 10" – 12" double helix anchor with tip embedment of 12' in 12 blow sand. The highest anticipated water table is a depth of 10'. Calculate the ultimate tension capacity.

$$A_h(10") = 0.55 \text{ ft}^2$$

$$A_h(12") = 0.79 \text{ ft}^2$$

$$H(10") = 12 \text{ ft}$$

$$H(12") = 9.5 \text{ ft}$$

$$Y_m = 110 \text{ pcf (Table A-2)}$$

$$Y_{\text{sub}} = 60 \text{ pcf (Table A-2)}$$

$$\phi = 31 \text{ degrees (Table A-2)}$$

$$c = 0$$

$$N_q = 21 \text{ (Table I-3)}$$



Then: $\sigma'_v(10'') = 10 \times 110 + (12-10) \times (60) = 1220 \text{ psf}$
 $\sigma'_v(12'') = 9.5 \times 110 = 1045 \text{ psf}$
 $Q_c = Q_t = 0.55(1220 \times 21) + 0.79(1045 \times 21)$
 $Q_c = Q_t = 14,090 + 17,340 \approx 31,500 \text{ lbs}$

Example I-4: A 10" single helix anchor inclined 45 degrees with tip embedment of 14' in 20 blow sand. The water table will remain below a depth of 15'. Calculate the ultimate tension capacity.

$A_h(10'') = 0.55 \text{ ft}^2$
 $H(10'') = 14\text{Sin}(45) = 9.90 \text{ ft}$
 $Y_m = 120 \text{ pcf (Table A-2)}$
 $\phi = 33 \text{ degrees (Table A-2)}$
 $c = 0$
 $N_q = 27 \text{ (Table I-3)}$
 Then: $\sigma'_v(10'') = 9.90 \times 120 = 1188 \text{ psf}$
 $Q_t = 0.55(1188 \times 27)$
 $Q_t = 17,500 \text{ lbs}$



Torque Correlation Method

Hoyt and Clemence (1989) found that the most reliable method for determining ultimate pullout resistance of helical screw anchors is to use an empirically derived relationship with the torsional resistance generated during anchor installation. This relationship was noted by the A. B. Chance Company during full-scale field loading tests conducted chiefly during the late 1950s and 1960s. The relationship has since been confirmed for ultimate plunging resistance as well.



In the torque correlation method, one multiplies the *effective* torsional resistance encountered during installation of the helical screw anchor by an empirical factor K_t to determine the ultimate pullout or plunging resistance of the anchor.

Plunging and Pullout Resistance Q_c and Q_t are expressed as:

$$Q_c = Q_t - K_t T_e$$

Where K_t = Empirical capacity/torque constant

T_e = Effective torsional resistance

One can hardly expect that the ultimate resistance of an anchor installed to a tip embedment of 30 feet, for instance, could be reliably predicted using the torsional resistance encountered at, say, 5 feet depth. The term *effective torsional resistance* simply means torsional resistance that can be used effectively to predict ultimate pullout or plunging resistance. For pullout resistance, effective torsional resistance is the average resistance encountered as the largest helix moves from a position three times its own

diameter ahead of its final position to its final position. For plunging resistance, effective torsional resistance is simply the torsional resistance encountered averaged over the final three feet of installation. In soils with cobbles, debris or other obstructions, torsional spikes will be generated when helices encounter the obstructions. One must be sure to use the “background” torque (marked in black in Figure I-6) in calculating effective torque in these cases, not the torsional spikes.

The empirical factor varies with anchor shaft size and soil characteristics. In the absence of site pile/anchor specific torque-resistance data, Power Lift recommends the following empirical factors as defaults:

Pile or Anchor Shaft Size	Empirical Factor K_t
1-1/2"	10
1-3/4"	10
2"	10
2-1/4"	10
2-3/8"	10
2-7/8"	9
3-1/2"	8
4-1/2"	7
5"	7*
7"	6*
9-5/8"	5*
12-3/4"	4*

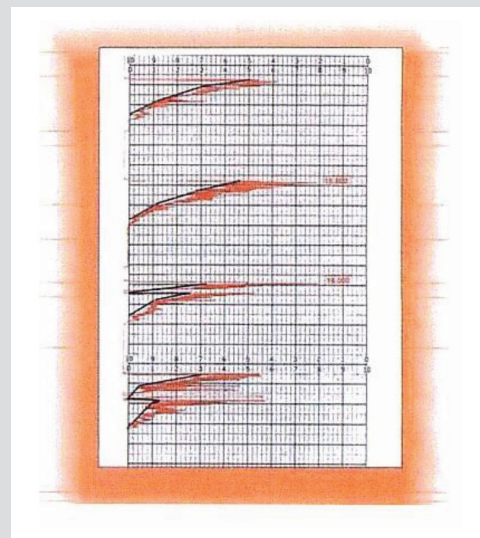


Figure I – 6. Torsional resistance vs. time for helical anchor installations in fractured limestone (after Chance, 1996)

*These values should be confirmed by on-site load test per ASTM standards.

These default values of K_t may need to be modified to fit individual site conditions. Some observations that may help zero in on the appropriate factor for a particular job:

- The helices themselves develop pullout/plunging resistance at a ratio of 8 to 25 lb per ft-lb of torsional resistance. Lower values are associated with more active clays (montmorillonite, illite), silts, rounded sands and silty sands; higher values are associated with less active clays (kaolinite), clean, angular sands and gravels. The recommended default value is 10.
- Adhesion and /or friction on the anchor shaft adds to both torsional and pullout/plunging resistance. This can be safely ignored for square shafts or round shafts less than 2-1/2" in diameter. For larger round shafts, the addition to pullout/plunging resistance is direct, while the addition to torsional resistance is

proportional to the radius of the shaft. Any length of shaft having a radius greater than 0.1 ft. (diameter greater than 2.4") will generate pullout/plunging resistance at less than the 10 to 1 default ratio given above for the helices, thus degrading the overall K_t . The larger the shaft, the more likely it is to generate appreciable resistance in relation to the helices, and the lower the pullout/plunging resistance to torsional resistance ratio for the shaft (and thus for the overall pile or anchor) will be. The appropriate modification, if any, will depend on the soil strength profile and the pile/anchor's helix configuration, shaft length and shaft diameter. Skin resistance on **Power Lift**® helical piles or anchors is somewhat less than on competitive products because of our coal tar epoxy corrosion protection coating.

Examples

Example I-5: A 10" – 10" – 12" multi-helix pile or anchor having a 2-3/8" shaft, installed with Power Lift® 6K hydraulic drive unit. No site-specific soil data is available. The installation torque readings for the last eight feet of embedment, measured with an electronic strain-gage type torque sensor are:

17'	1800 ft-lb
18'	1900 ft-lb
19'	1900 ft-lb
20'	2000 ft-lb
21'	2000 ft-lb
22'	2100 ft-lb
23'	2500 ft-lb
24'	2500 ft-lb

Calculate the ultimate tension and compression capacities.

$$K_t(2-3/8") = 10 \text{ (pg 13)}$$

$$T_e(\text{tens}) = (1900 + 1900 + 2000) / 3 = 1933 \text{ (pg 12)}$$

$$T_e(\text{comp}) = (2100 + 2500 + 2500) / 3 = 2367 \text{ (pg 12)}$$

Then: $Q_t = K_t T_e = 10 \times 1933 \approx 19,330 \text{ lbs}$

$$Q_c = K_t T_e = 10 \times 2367 \approx 23,670 \text{ lbs}$$



Example I-6: A 12" – 14" double helix pile having a 2-7/8" shaft, installed with a Power Lift® 12K hydraulic drive unit. No site-specific soil data is available. The installation torque readings for the last three feet of embedment, measured with an electronic strain-gage type torque sensor are:

32'	6400 ft-lb
33'	6300 ft-lb
34'	6550 ft-lb
35'	6800 ft-lb

Calculate the ultimate compression capacity.

$$K_t(2-7/8") = 9 \text{ (pg 13)}$$

$$T_e(\text{comp}) = (6300 + 6550 + 6800) 13 = 6550 \text{ (pg 12)}$$

$$\text{Then: } Q_c = K_t T_e = 9 \times 6550 \approx 58,950 \text{ lbs}$$

Example I-7: An 10" – 12" double helix pile having a 3 ½" shaft installed with Power Lift V30K hydraulic drive unit. The pile is required to support an ultimate load of 78,000 lbs. To what final torque should the pile be installed, to obtain a 78,000 lb. ultimate strength?

$$K_t(3 \frac{1}{2} ") = 8 \text{ (pg 13)}$$

$$\text{Then: Torque } T_e = Q_c 78,000 / K_t 8 \approx 9750 \text{ ft-lb averaged over last 3' of installation.}$$

Application Considerations

The maximum ultimate pullout/plunging resistance that can be attained by a helical screw pile or anchor is obviously dependent on the helix sizes and the soil strength. It is not so obviously dependent on the torsional strength of the shaft because of the way the pile or anchor must be installed. Dimensions, material properties and rated torsional strengths of **Power Lift**® helical pile and screw anchor shafts are given in Appendix C. The maximum allowable load for any installed helical screw pile or anchor may be limited by the mechanical strength of the shaft, or bending resistance of the helix. Maximum rated loads for **Power Lift**® helical screw pile and anchor shafts are also given in Appendix C.

When unstable situations such as expansive clay, collapsible soils or fluctuation of the water table are encountered, the anchor must be installed below the level of instability. This enables the helices to provide stable support through changing weather cycles. Furthermore, one cannot effectively use torsional resistance measured during installation in one season to predict the ultimate resistance a pile or anchor will exhibit in another season if the pile/anchor





is terminated in the seasonally affected zone.

Although helical screw piles and anchors are designed to generate load resistance through interaction with soil, they can be installed to bear on rock when the principal loading is compression. In these cases, the helices primarily provide a means for installation and tension resistance. Depending on the rock quality, compression loads may be resisted almost completely through end bearing of the shaft. It may be advantageous in these situations to modify the shaft lead point. Please contact **Power Lift**® for a recommendation for use in these materials.

