For granular soil (sand):

$$P_a = ½K_a\rho H^2$$ **Equation 5-51**

$$P_p = ½K_p\phi\rho H^2$$ **Equation 5-52**

For cohesive soil (clay):

$$P_a = ½K_a\rho H^2 - 2cH + 2c^2/\phi'\rho$$ **Equation 5-53**

$$Pp = ½K_p\rho H^2 + 2cH$$ **Equation 5-54**

where:
K_0 = Coefficient of earth pressure at rest
K_a = Coefficient of active earth pressure
K_p = Coefficient of passive earth pressure
H = Height of wall or resisting element
c = Cohesion
ϕ' = Effective stress friction angle of soil
P_a = Active earth pressure
ρ = Unit weight of soil

Equations 5-48 through 5-54 are from NAVFAC Design Manual DM7, Foundations and Earth Structures (see References at the end of this section).

Table 5-15 is a tabulation of the coefficient for at rest, active, and passive earth pressure for various soil types, relative densities and consistencies.

Table 5-15 Coefficients of Earth Pressure (Das, 1987)

Soil	K_0, Drained	K_0, Total	K_a, Total	K_p, Total
Clay, soft *	0.6	1	1	1
Clay, hard *	0.5	0.8	1	1
Sand, loose	0.6	0.53	0.2	3
Sand, dense	0.4	0.35	0.3	4.6
* Assume saturated clays				

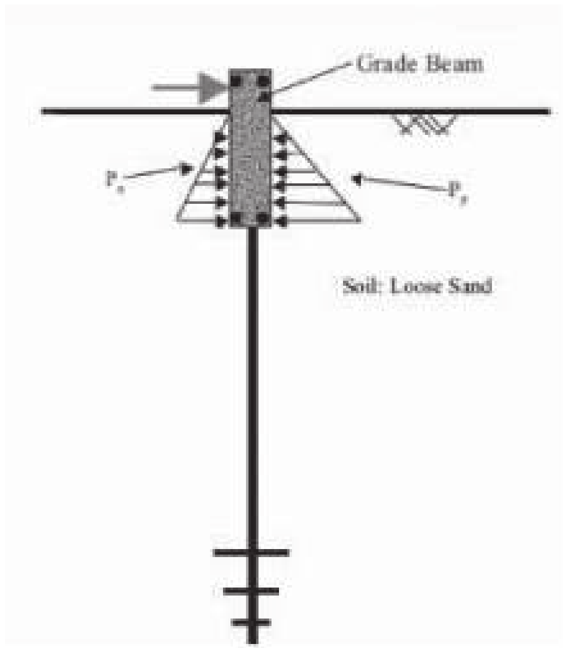

Figure 5-21. Earth Pressure on a Grade Beam

Using the Rankine solution may be an over-simplification of the problem but tends to be conservative since the height of the projected area of the footing or pile cap is not large and the cohesion term will generally be small. Design Example 8-15 in Section 8 illustrates the use of the Passive Resistance method to determine the lateral capacity of a foundation.

Battered CHANCE® Helical Piles/Anchors for Lateral Loading

Lateral loads are commonly resolved with battered helical piles and anchors. The method is to statically resolve the axial load capacity into its vertical and horizontal components. As stated earlier, it is best to use vertically installed helical piles and anchors to resist only vertical loads and battered helical piles and anchors to resist only lateral loads.

CHANCE® Helical Piles and Anchors and piles have been supplied to the seismic prone areas of the west coast of the United States and Canada for over 30 years for civil construction projects. In tension applications, they have been in service for over 50 years. They have been subjected to many earthquakes and aftershocks with good experience. Our helical pre-engineered products have been used far more extensively than any other manufacturer's helical product in these areas. To date, there have been no ill effects observed using battered helical piles and anchors in seismic areas. These foundations, both vertically installed and battered, have been subjected to several earthquakes of magnitude 7+ on the Richter scale with no adverse affects. Anecdotal evidence indicates the structures on helical piles experienced less earthquake-induced distress than their adjacent structures on other types of foundations. Their performances were documented anecdotally in technical literature, including the *Engineering News Record*.

Additional Comments

The lateral capacity of round shaft (Type RS) helical piles and anchors is greater than the square shaft (Type SS) helical anchors and piles because of the larger section size. Typical pipe diameters of 2-7/8" (73mm), 3-1/2" (89 mm) and 4-1/2" (114 mm) OD are used for CHANCE® Helical Piles. As shown in Design Example 8-13 in Section 8, enlarged shaft sections are used for certain applications. From a practical standpoint, the largest diameter helical pile available from Hubbell Power Systems, Inc. is 10-3/4" diameter, but larger shaft diameters are available on a project specific basis.

As previously noted, there are several other methods used to analyze the lateral capacity of the shaft of piles. Murthy (2003) also presented a direct method for evaluating the lateral behavior of battered (inclined) piles.

5.8 BUCKLING/BRACING/SLENDERNESS CONSIDERATIONS

Introduction

Buckling of slender foundation elements is a common concern among designers and structural engineers. The literature shows that several researchers have addressed buckling of piles and micropiles over the years (Bjerrum 1957, Davisson 1963, Mascardi 1970, and Gouvenot 1975). Their results generally support the conclusion that buckling is likely to occur only in soils with very poor strength properties such as peat, very loose sands, and soft clay.

However, it cannot be inferred that buckling of a helical pile will never occur. Buckling of helical piles in soil is a complex problem best analyzed using numerical methods on a computer. It involves parameters such as the shaft section and elastic properties, coupling strength and stiffness, soil strength and stiffness, and the eccentricity of the applied load. This section presents a description of the procedures available to evaluate buckling of helical piles, and recommendations that aid the systematic performance of buckling analysis. Buckling of helical piles under compression loads, especially square shaft helical piles, may be important in three situations:

1. When a pile is relatively long (>20 feet [6 m]) and is installed through very soft clay into a very hard underlying layer and is end-bearing.
2. When a pile is installed in loose, saturated clean sand that undergoes liquefaction during an earthquake event.
3. When a pile is subject to excessive eccentric load without adequate bracing.

Bracing

Bracing of pile foundation elements is a common concern among designers and structural engineers, especially for helical piles and resistance piers with slender shafts. Section 1810.2.2 of the 2009 & 2012 International Building Code requires deep foundations to be braced to provide lateral stability in all directions. Bracing can be provided many different ways – including pile groups of three or more, alternate lines of piles spaced apart, and using slabs, footings, grade beams and other foundation elements to provide lateral stability. When CHANCE® Helical Piles and ATLAS RESISTANCE® Piers are used for foundation repair, the piers must be braced as per situation 3 above. The following figures show two methods that are often used to ensure adequate bracing is used.

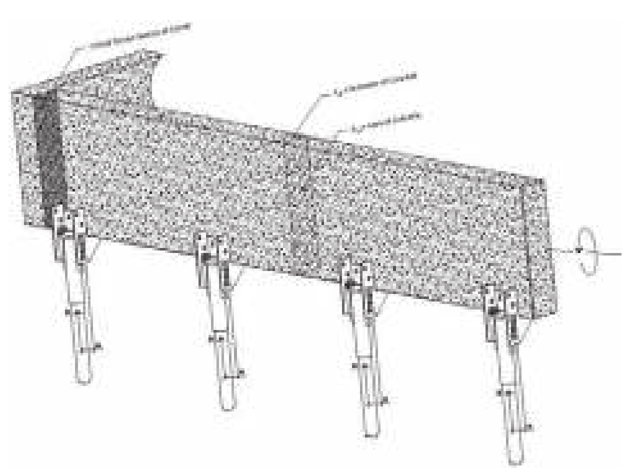

Figure 5-22

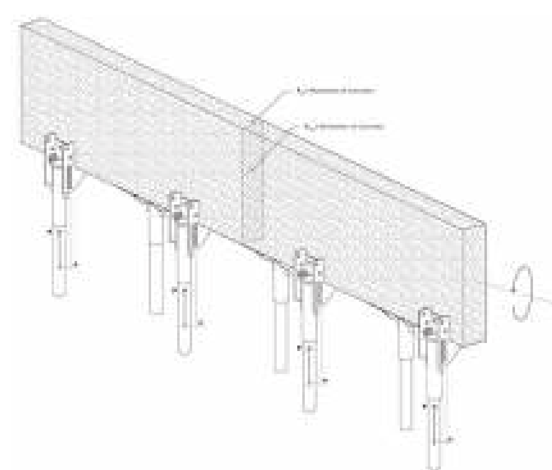

Figure 5-23

DESIGN METHODOLOGY

Figure 5-22 on the left is a portion of a grade beam foundation underpinned with ATLAS RESISTANCE® Piers. The grade beam provides torsional stiffness based on its section properties and steel reinforcement. The 90° foundation element on the left end also provides torsional and shear stiffness. Figure 5-23 on the right is a portion of a long continuous grade beam foundation underpinned with ATLAS RESISTANCE® Piers. The piers are staggered and alternated both on the inside and outside, which provides bracing.

Buckling Background

Buckling of columns most often refers to the allowable compression load for a given unsupported length. The mathematician Leonhard Euler solved the question of critical compression load in the 18th century with a basic equation included in most strength of materials textbooks.

$$P_{crit} \quad \pi^2 EI/(KL_u)^2 \qquad \textbf{Equation 5-55}$$

where

	E	=	Modulus of elasticity
where	I	=	Moment of inertia
	K	=	End condition parameter that depends on fixity
	L_u	=	Unsupported length

Most helical piles have slender shafts which can lead to very high slenderness ratios (Kl/r), depending on the length of the foundation shaft. This condition would be a concern if the helical piles were in air or water and subjected to a compressive load. For this case, the critical buckling load could be estimated using the well-known Euler equation above.

However, helical piles are not supported by air or water, but by soil. This is the reason helical piles can be loaded in compression well beyond the critical buckling loads predicted by Equation 5-55. As a practical guideline, soil with N_{60} SPT blow counts per ASTM D-1586 greater than 4 along the entire embedded length of the helical pile shaft has been found to provide adequate support to resist buckling - provided there are no horizontal (shear) loads or bending moments applied to the top of the foundation. Only the very weak soils are of practical concern. For soils with N_{60} values of 4 blows/ft or less, buckling calculations can be done by hand using the Davisson Method (1963) or by computer solution using the finite-difference technique as implemented in the LPILE^{PLUS} computer program (ENSOFT, Austin, TX). In addition, the engineers at Hubbell Power Systems, Inc. have developed a macro-based computer solution using the finite-element technique with the ANSYS® analysis software. If required, application engineers can provide project specific buckling calculations - given sufficient data relating to the applied loads and the soil profile. If you need engineering assistance, please contact your CHANCE® Distributor in your area. Contact information for CHANCE® Distributors can be found at www.abchance.com. These professionals will help you to collect the data required to perform a buckling analysis. The distributor will either send this data to Hubbell Power Systems, Inc. for a buckling analysis or provide this service themselves.

Buckling/Lateral Stability per International Building Code (IBC) Requirements

IBC 2009 Section 1810.2.1 - Lateral Support states that any soil other than fluid soil shall be deemed to afford sufficient lateral support to prevent buckling of deep foundation elements in accordance with accepted engineering practice and the applicable provisions of this code. Per IBC 2006 Section 1808.2.9.2 & IBC 2009 Section 1810.2.1, pier/piles driven into firm ground can be considered fixed and laterally supported at 5 feet below the ground surface and in soft material at 10 feet below the ground surface. The IBC does not specifically define fluid, soft, and firm soil. To remedy this, ICC-ES Acceptance Criteria AC358 defined these soil terms as follows:

Firm soils are defined as any soil with a Standard Penetration Test blow count of five or greater.

Soft soils are defined as any soil with a Standard Penetration Test blow count greater than zero and less than five.

Fluid soils are defined as any soil with a Standard Penetration Test blow count of zero [weight of hammer (WOH) or weight of rods (WOR).

Therefore, one method to check the effects of buckling and lateral stability of helical piles and resistance piers is to assume the depth to fixity is either 5 feet in firm soil, or 10 feet in soft soil. The corresponding axial compression capacity of the pile shaft is determined based on either 5 feet or 10 feet of unsupported length. This is the method used to determine the nominal, LRFD design, and ASD allowable compression strengths of the helical pile product families provided in Section 7 of this manual.

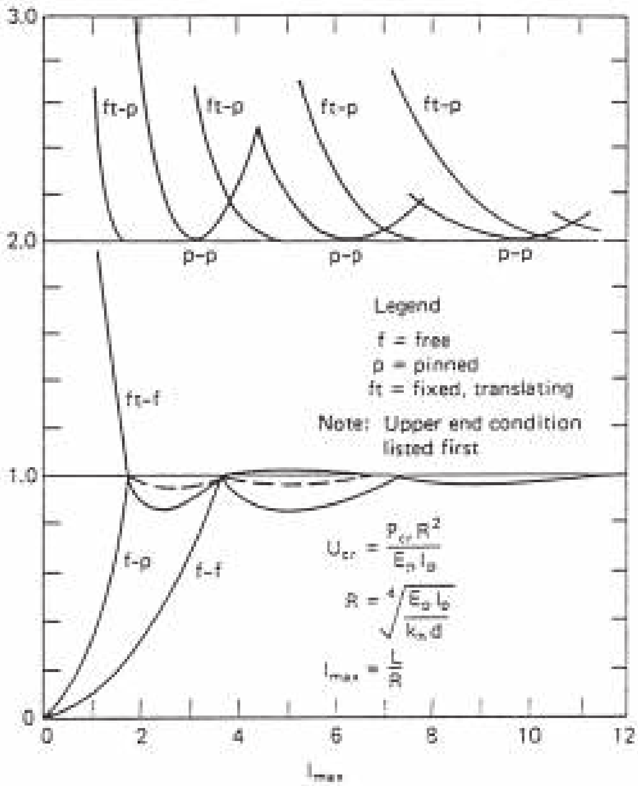

Figure 5-24 Poulos and Davis (1980)

Buckling Analysis by Davisson (1963) Method

A number of solutions have been developed for various combinations of pile head and tip boundary conditions and for the cases of constant modulus of sub grade reaction (kh) with depth. One of these solutions is the Davisson (1963) Method as described below. Solutions for various boundary conditions are presented by Davisson in Figure 5-24. The axial load is assumed to be constant in the pile – that is no load transfer due to skin friction occurs and the pile initially is perfectly straight. The solutions shown in Figure 5-24 are in dimensionless form, as a plot of U_{cr} versus I_{max}.

where $U_{cr} = P_{cr}R^2/E_pI_p$ or $P_{cr} = U_{cr}E_pI_p/R^2$ **Equation 5-56**

where $R = \sqrt[4]{E_pI_p/k_hd}$ **Equation 5-57**

where

I_{max} = L/R **Equation 5-58**

P_{cr} = Critical buckling load

E_p = Modulus of elasticity of foundation shaft

I_p	=	Moment of inertia of foundation shaft
K_h	=	Modulus of sub grade reaction
d	=	Foundation shaft diameter
L	=	Foundation shaft length over which k_h is taken as constant
U_{cr}	=	Dimensionless ratio

By assuming a constant modulus of sub grade reaction (kh) for a given soil profile to determine R, and using Figure 5-24 to determine U_{cr}, Equation 5-56 can be solved for the critical buckling load. Typical values for k_h are shown in Table 5-16.

Table 5-16. Modulus of Sub Grade Reaction - Typical Values

Soil Description	odulus of Subgrade Reaction (K_h) (pci)
Very soft clay	15 - 20
Soft clay	30 - 75
Loose sand	20

Figure 5-24 shows that the boundary conditions at the pile head and tip exert a controlling influence on U_{cr}, with the lowest buckling loads occurring for piles with free (unrestrained) ends. Design Example 8-16 in Section 8 illustrates the use of the Davisson (1968) method to determine the critical buckling load.

Another way to determine the buckling load of a helical pile in soil is to model it based on the classical Winkler (mathematician, circa 1867) concept of a beam-column on an elastic foundation. The finite difference technique can then be used to solve the governing differential equation for successively greater loads until, at or near the buckling load, failure to converge to a solution occurs. The derivation for the differential equation for the beam-column on an elastic foundation was given by Hetenyi (1946). The assumption is made that a shaft on an elastic foundation is subjected not only to lateral loading, but also to compressive force acting at the center of the gravity of the end cross-sections of the shaft, leading to the differential equation:

$$EI(d^4y/dx^4) + Q(d^2y/dx^2) + E_s y = 0$$

where

y	=	Lateral deflection of the shaft at a point x along the length of the shaft
x	=	Distance along the axis, i.e., along the shaft
E	=	Flexural rigidity of the foundation shaft
Q	=	Axial compressive load on the helical pile
$E_s y$	=	Soil reaction per unit length
E_s	=	Secant modulus of the soil response curve

The first term of the equation corresponds to the equation for beams subject to transverse loading. The second term represents the effect of the axial compressive load. The third term represents the effect of the reaction from the soil. For soil properties varying with depth, it is convenient to solve this equation using numerical procedures such as the finite element or finite difference methods. Reese, et al. (1997) outlines the process to solve Equation 5-59 using a finite difference approach. Several computer programs are commercially available that are applicable to piles subject to axial and lateral loads as well as bending moments. Such programs allow the introduction of soil and foundation shaft properties that vary with depth, and can be used advantageously for design of helical piles and micropiles subject to centered or eccentric loads.

To define the critical load for a particular structure using the finite difference technique, it is necessary to analyze the structure under successively increasing loads. This is necessary because the solution algorithm becomes unstable at loads above the critical. This instability may be seen as a convergence to a physically illogical configuration or failure to converge to any solution. Since physically illogical configurations are not always easily recognized, it is best to build up a context of correct solutions at low loads with which any new solution can be compared. Design

Example 8-17 in Section 8 illustrates the use of the Finite Difference method to determine the critical buckling load.

Buckling Analysis by Finite Elements

Hubbell Power Systems, Inc. has developed a design tool, integrated with ANSYS® finite element software, to determine the load response and buckling of helical piles. The method uses a limited non-linear model of the soil to simulate soil resistance response without increasing the solution time inherent in a full nonlinear model. The model is still more sophisticated than a simple elastic foundation model, and allows for different soil layers and types.

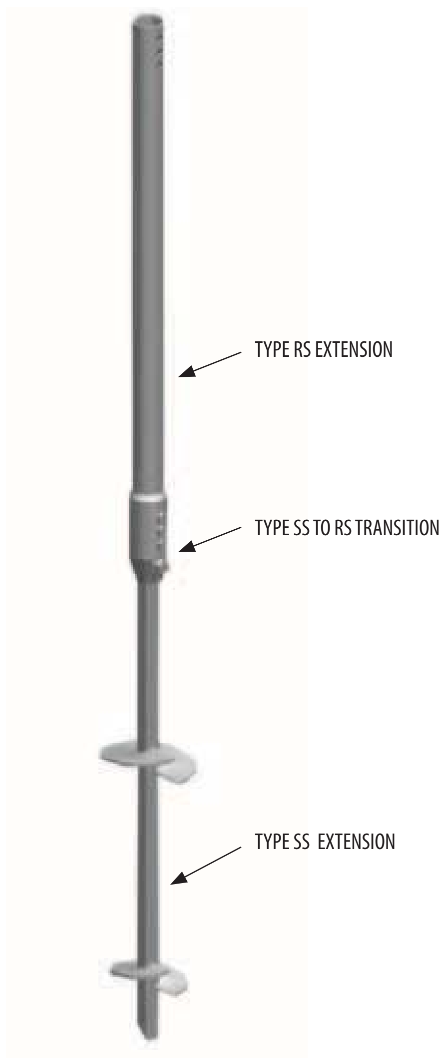

Figure 5-25 Type SS to RS Combination Pile

The helical pile components are modeled as 3D beam elements assumed to have elastic response. Couplings are modeled from actual test data, which includes an initial zero stiffness, elastic/rotation stiffness and a final failed condition – which includes some residual stiffness. Macros are used to create soil property data sets, helical pile component libraries, and load options with end conditions at the pile head.

After the helical pile has been configured and the soil and load conditions specified, the macros increment the load, solve for the current load and update the lateral resistance based on the lateral deflection. After each solution, the ANSYS® post-processor extracts the lateral deflection and recalculates the lateral stiffness of the soil for each element. The macro then restarts the analysis for the next load increment. This incremental process continues until buckling occurs. Various outputs such as deflection and bending moment plots can be generated from the results. Design Example 8-18 in Section 8 illustrates the use of the Finite Element method to determine the critical buckling load.

Practical Considerations – Buckling

As stated previously, where soft and/or loose soils (SPT N_{60} blow count ≤ 4) overlie the bearing stratum, the possibility of shaft buckling must be considered. Buckling also becomes a potential limiting factor where lateral loads (bending and shear) are present in combination with compressive loads. Factors that determine the buckling load include the helical pile shaft diameter, length, flexural stiffness and strength, the soil stiffness and strength, any lateral shear and/or moment applied at the pile head, and pile head fixity conditions (fixed, pinned, free, etc.). In addition, all extendable helical piles have couplings or joints used to connect succeeding sections together in order to install the helix plates into bearing soil. Bolted couplings or joints have a certain amount of rotational tolerance. This means the joint initially has no stiffness until it has rotated enough to act as a rigid element. This is analogous to saying the coupling or joint acts as a pin connection until it has rotated a specific amount, after which it acts as a rigid element with some flexural stiffness.

Concern about slender shafts and joint stiffness, along with the fact that helical piles are routinely installed in soils with poor strength; are some of the reasons why helical piles are often installed with grouted shafts (helical pulldown piles) and are available with larger diameter pipe shafts (Type RS). Pipe shaft helical piles have better buckling resistance than plain square shaft (Type SS) because they have greater section modulus (flexural resistance), plus they have larger lateral dimensions, which means they have greater resistance to lateral deflection in soil. See the specifications section of the helical pile product family pages in Section 7 for the section properties and dimensions of both Type SS and RS helical piles/anchors.

Type SS helical piles/anchors provide the most efficient capacity-to-torque relationship (see Section 6, Installation Methodology). Type RS helical piles/anchors provide lateral capacity and better buckling resistance. A good compromise to address buckling in soft/loose soils is to use helical combination piles, or “combo piles” for short. A combo pile consists of Type SS square shaft material for the lead section and Type RS pipe shaft material for the extension sections (see Figure 5-25). The combo pile provides the advantages of both Type SS and RS material, which enables the helical pile/anchor to penetrate dense/hard soils, while at the same time provide a larger shaft section in the soft/loose soils above the bearing strata. See Section 7 for more information on combo piles.

The HELICAL PULLDOWN® Micropile is a method for constructing a grout column around the shaft of either a Type SS (square shaft) or RS (round shaft) helical pile installed in soft/loose soil. The installation process displaces soil around the central steel shaft and replaces it with a gravity fed, neat cement grout mixture. Upon curing, the grout forms a column that increases the section modulus of the pile shaft to the point that buckling is not the limiting condition. In addition to buckling resistance, the grout column increases axial load capacity due to skin friction or adhesion along the shaft; plus the load/deflection response of the helical pile is stiffer. See Section 7 for more information on CHANCE HELICAL PULLDOWN® Micropiles.

CHANCE HELICAL PULLDOWN® Micropiles cannot be installed in every soil condition. To date, grouted shaft helical piles have been successfully installed in overburden soil with SPT blow counts greater than 10 blows/ft. In those cases, the grouted shaft is being used to develop greater load capacity and a stiffer response, not necessarily to prevent buckling. Contractors have successfully installed pulldown micropiles in glacial tills (SPT $N_{60} > 50$) using special soil displacement methods. Increasingly dense soil makes installation more difficult for the displacement element, which has to force soil laterally outward away from the central steel shaft.

5.9 HELICAL PILE DEFLECTION AT WORKING LOAD

Most of the discussion thus far has focused on evaluating the ultimate load capacity of helical piles/anchors in axial compression or tension. This is considered as the Load Limit State and gives the upper bound on the load capacity. The displacements of the pile/anchor at this load state will be very large (> 2 inches [51 mm]) and technically the pile/anchor cannot sustain additional load but the deflection just keeps increasing. However, it is also of great interest to most engineers to consider the behavior of a helical pile/anchor at a lower working load or Serviceability State which will be well below the Load Limit State.

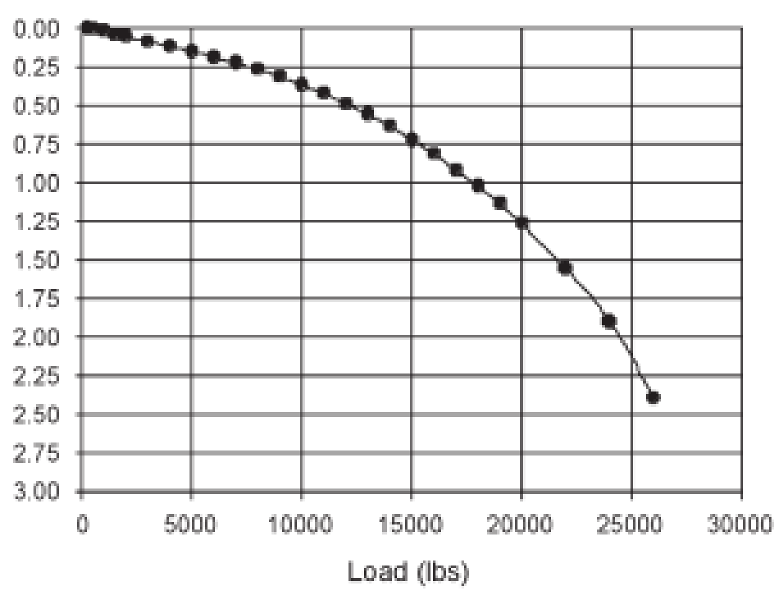

Figure 5-26

We can consider a typical Load-Displacement curve as shown above. This plot is the test results of a 1.5 in. x 1.5 in. square-shaft helical anchor with a single 12 in. helix installed to a depth of 10 ft. in a medium dense silty sand. The test was performed in tension. According to the IBC, the Ultimate Capacity may be taken as the load producing a net displacement of 10% of the helix diameter or in this case the load at 1.20 in. which is 19,500 lbs. It is obvious that in this

 |

case, as in most cases, the anchor can actually take more load, up to as much as 20% of the helix diameter.

Using a ASD Factor of Safety of 2.0, the working load for this anchors would be equal to 19,500 lbs/2.0 = 9,750 lbs. Because the load-displacement curve of most helical piles/anchors is generally nonlinear it would be expected that the displacement at the working load would be less than ½ of the displacement at 1.20 in. In this case, the displacement at the working load of 9,750 lbs is on the order of 0.36 in. Using a lower Factor of Safety gives a higher displacement. For example if a Factor of Safety of 1.5 is used, the working load becomes 19,500 lbs/1.5 = 13,000 lbs and the displacement corresponding to this load is on the order of 0.55 in.

Based on a review of a number of tests performed on single-helix pile/anchors in Colorado, Cherry and Perko (2012) recently suggested that for many anchors/piles, the displacement at the working loads (F.S. = 2) averaged about 0.25 in. Additional work is needed to determine how this may vary for multi-helix piles/anchors and if other soils show different behavior.

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INSTALLATION METHODOLOGY
SECTION 6

CONTENTS

SYMBOLS USED IN THIS SECTION

DISCLAIMER

The information in this manual is provided as a guide to assist you with your design and in writing your own specifications.

Installation conditions, including soil and structure conditions, vary widely from location to location and from point to point on a site.

Independent engineering analysis and consulting state and local building codes and authorities should be conducted prior to any installation to ascertain and verify compliance to relevant rules, regulations and requirements.

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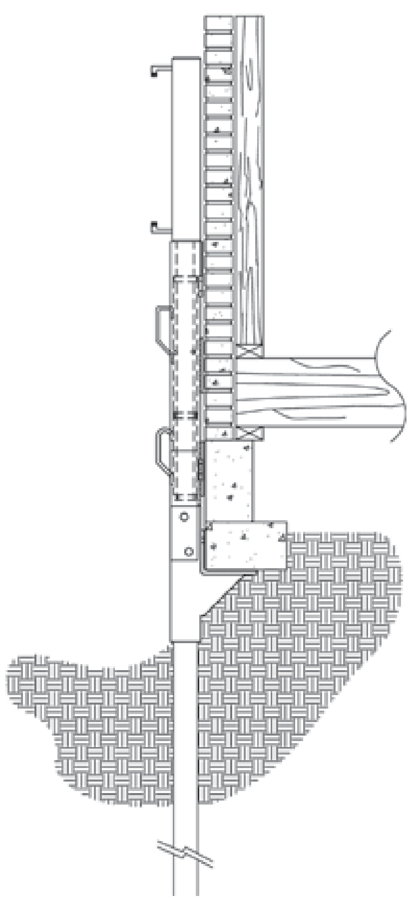
Hubbell Power Systems, Inc., does NOT warrant the work of its dealers/installing contractors in the installation of CHANCE® Civil Construction foundation support products.

ATLAS RESISTANCE® PIERS

ATLAS RESISTANCE® Piers develop their capacity as a result of a pile tip or end bearing reaction in soil or rock that is achieved by hydraulically driving hollow pier sections to suitable strata utilizing the reaction weight of an existing structure or any other mass or reaction assembly capable of resisting pushing loads in excess of design loads required. The friction reduction collar on the initial or starter section allows for an end bearing pile. Most ATLAS RESISTANCE® Piers are installed to a force equal to a minimum of 150% of the calculated total load at each pier placement. The total load condition is a sum of the structure Dead Loads (DL) and all known potential Live Loads (LL). In addition to the usual calculated loads, it is extremely important to include loads imposed from soil overburden over a projected area, primarily outside of the foundation wall footprint (toe or heel) of the footing. The area of the projection plus the height of soils above it produce a loading condition that is quite often in excess of the structure load itself. When lifting the structure is desired, an additional "soil wedge" area and/or volume should be considered relative to the soil type and its particular characteristics. To be conservative in design calculations it is prudent to consider the long term loading effect from soils outside of the vertical and horizontal plane of the soil overburden even when stabilization only is desired.

LOAD VERIFICATION

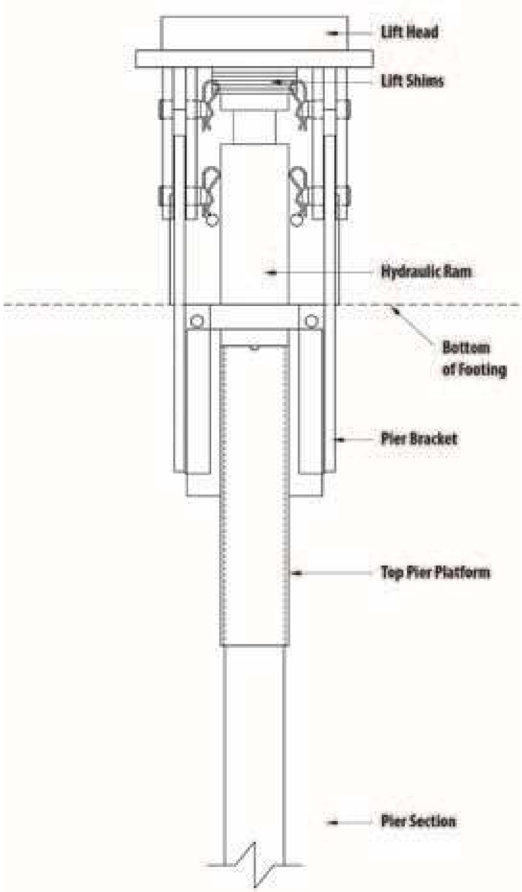
ATLAS RESISTANCE® Piers are installed using hydraulic cylinders with known effective areas. Although larger cylinders are available for extreme load conditions, the standard installation cylinders have an effective area of 8.29 in^2. The effective area of the cylinder is multiplied by the hydraulic pressure monitored by a gauge mounted between the hydraulic pump and the cylinder. The net result of this number is the actual force (in lbs) achieved as the pier sections are driven against the reaction weight of the structure until the required load is achieved or structure lift occurs. Additional pier sections are added as necessary until a competent bearing stratum is reached.
The force is logged at the end of each pier section driven on the field installation log.



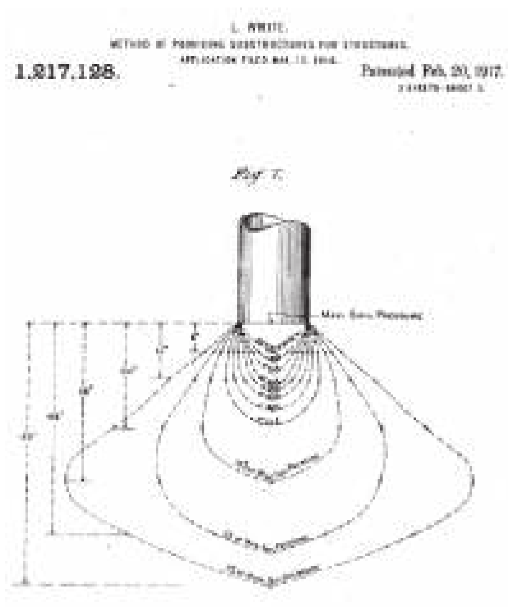
Installation Configuration
Figure 6-1

TWO STAGE SYSTEM METHODOLOGY

The installation of ATLAS RESISTANCE® Piers incorporates a two stage method that consists of driving each pier individually using the reaction from adjacent line loads. The integrity of the foundation determines the extent to which additional Factors of Safety (FS) can be achieved between the installation force and final lift loads. Figure 6-1 provides a schematic drawing that illustrates the installation of pier sections. The second stage occurs when all or the majority of the piers are loaded simultaneously using a manifold or series of manifolds and hydraulic rams placed at each pier. The manifolds and rams are connected to a pump or series of pumps depending on the number of piers being lifted. During the lifting stage the hydraulic pressure is monitored on each manifold system gauge. Typical 25 ton lifting rams have an effective area of 5.15 in2. The load at each pier is monitored at the final lock off and noted on the field installation logs. The actual lift or lock off load at each pier can then be compared to the installation loads at each pier to determine the actual Factor of Safety developed between installation loads and actual loads required to produce structural lift and support. Figure 6-2 provides a schematic drawing illustrating the lift stage.



Restoration Using Lift Head
and Hydraulic Ram
Figure 6-2



Assumed Stress Bulb Under Pile Tip
Figure 6-3

BEARING CAPACITY

The compressive bearing capacity of ATLAS RESISTANCE® Piers is developed predominantly by end-bearing due to the friction reduction collar at the lead end of the initial or starter section. Friction calculations do not normally enter into design steps unless required to comply with some older municipal codes. Increased tip areas (larger diameter pipe) will typically increase load resistance during installation of the pile. Standard pier section diameters are 2-7/8”, 3-1/2”, and 4-1/2”. The selection of pier size is determined through consideration of pile load requirement, column stability (buckling concerns) structure integrity and the ability to drive the pile past seasonal zones of influence relative to available reaction forces. Bracket assemblies are coupled with the appropriate pier section size to service both the geotechnical and structural requirements.

CLAY SOILS

In clay soil conditions defined as very stiff to hard, i.e., Standard Penetration Test (SPT) “N” values in excess of 35-40 blows/foot, it has been shown empirically that an ATLAS RESISTANCE® Pier can generate substantial end-bearing capacity, often in excess of 50,000-60,000 lbs of bearing resistance. While the high capacities defy absolute calculation for both very dense sand and hard clay, empirical data developed over the last several decades gives evidence to this phenomenon. Data developed by A.S. Vesic (1972) for the Transportation Research Board suggests that hard/dense soil develops very high capacities due to the formation of a larger pile bulb at the base of an end-bearing foundation. This phenomenon results in higher values for the bearing capacity factor (Nq), especially for driven piles. Figure 6-3 is an excerpt from Patent 1.217.128 issued to L. White. It is a graphical rendition of the assumed large stress bulb formed under a pile tip.

SAND SOILS

ATLAS RESISTANCE® Piers also develop substantial end-bearing capacities in granular soils, but the sand or gravel must typically exhibit a high relative density with “N” values in excess of 30-35 blows/ft. The same pile bulb described above for clay soils will form at the base of an ATLAS RESISTANCE® Pier in sand soils. In granular soils, the overburden pressure (effective vertical confining stress) has a large influence on bearing capacity, so the deeper the pier tip is embedded, the higher the bearing capacity will be for a given sand deposit of uniform density. A design condition consisting of a shallow ground water table (GWT) will require ATLAS RESISTANCE® Piers to be installed to a sufficient depth to counteract the reduction in confining stress caused by the buoyancy effect of the water.

BEDROCK BEARING SURFACE

The presence of an intact bedrock surface represents an ideal ground condition for a totally end-bearing load transfer for any type of foundation. In this case the ATLAS RESISTANCE® Pier is installed to the rigid bearing surface represented by the bedrock layer, with load confirmation being verified by monitoring of the hydraulic pressure and effective area of the installation cylinder. The design capacity in this case is directly related to the structural strength of the pier shaft and bracket assembly.

INSTALLATION OVERVIEW

When the loading, structural and geotechnical conditions have been determined, the proper pier brackets and pier sections can be selected. Following excavation for the installation, the footing (if present) is notched to a point flush with the wall to be underpinned. Should steel reinforcement be encountered, notify the Engineer of Record prior to cutting. This procedure is performed to minimize the eccentricity of the pier assembly. In situations where notching the footing is prohibited, consideration needs to be given to the published pier capacity ratings if the footing extension from the wall is excessive, possibly increasing the eccentric load on the pier assembly resulting in a lower capacity. The bottom of the footing should be prepped and/or a load bearing grout added between the pier bracket and footing to provide a uniform bearing connection. This is a critical point, especially in high load conditions. Failure to comply with this step could result in a point load on the bracket and cause an early bracket failure.

When the bracket and installation equipment are properly positioned and anchored to the foundation or wall, the starter section can be placed in a vertical and plumb position. Activate the hydraulic pump to advance and retract the installation cylinder as necessary to drive the pier sections (see photo at top right). The pressure is recorded at the end of each 42" pier section. Continue driving pier sections until reaching strata capable of resisting the estimated Proof Load (PL) or until structure lift occurs. When approaching the end of the drive, a good rule of thumb is to drive pipe until either the structure begins to lift and/or the pressure continues to build. If a small amount of movement has occurred but the pressure remains constant, an experienced installer will continue to drive pipe until either a more significant movement is noted or a consistent build in pressure occurs. Depending on the integrity of the foundation and the comfort level of the installer, this will often result in substantial Factors of Safety in excess of 1.5. When driving the pier pipe is completed, the installation equipment is removed, pier sections are cut off to an appropriate elevation relative to the bracket type and load transfer components are set in place.

When all piers have been installed, the manifolds and hydraulics are loaded uniformly as much as possible (see photo at bottom right). Upon transfer of load to the entire pier assembly, lift pressures are noted at each pier and recorded on the field log. The actual verified Factor of Safety between installation pre-load and final lock off can then be confirmed. Table 6-1 is an example of the driving (installation) and lift forces that could be involved in the installation of ATLAS RESISTANCE® Piers.

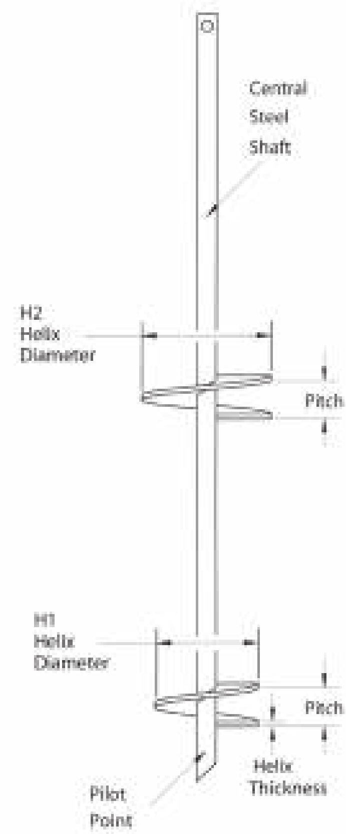
Installation Load vs Lift Load, Table 6-1

FIRST STAGE			DRIVE	LIFT	SECOND STAGE			
INSTALLATION LOAD SUMMARY	STD. DRIVE CYLINDER EFFECTIVE AREA (SQ. IN) 8.29		←	→	PIER LIFT/LOCK SUMMARY	STD LIFT RAM EFFECTIVE AREA (SQ. IN) 5.15		F/S DRIVE vs LIFT
PIER NUMBER	PSI	LOAD			PIER NUMBER	PSI	LOAD	
1	4,200	34,818			1	4,000	20,600	1.7
2	4,600	38,134			2	4,000	20,600	1.9
3	4,600	38,134			3	4,500	23,175	1.6
4	4,800	39,792	←	→	4	4,500	23,175	1.7
5	5,000	41,450			5	4,800	24.720	1.7

Refer to the *ATLAS RESISTANCE® Standard, Heavy Duty and Modified 2-Piece Pier Systems Model Specification* found under the Resources tab on www.abchance.com for detailed installation instructions.

CHANCE® HELICAL PILE/ANCHORS

By definition, a helical pile/anchor is a low soil displacement foundation element specifically designed to minimize disturbance during installation. In their simplest forms, helical pile/anchors consist of at least one helix plate and a central steel shaft (see Figure 6-4). The helix geometry is very important in that it provides the downward force or thrust that pulls a helical pile/anchor into the ground. The helix must be a true ramped spiral with a uniform pitch to maximize efficiency during installation. If the helix is not formed properly, it will disturb the soil more than if a true helix advances at a rate of one pitch per revolution. The central steel shaft transmits the rotational energy or torque from the machine to the helix plate(s). Most helical piles in North America use a low displacement (less than 4.5 inches (114 mm) diameter shaft in order to reduce friction and soil displacement during installation. A helical pile/anchor functions very similar to a wood screw except that it has a discontinuous thread-form and is made to a much larger scale.



Helical Pile/Anchor
Figure 6-4

INSTALLATION TORQUE/LOAD CAPACITY RELATIONSHIP

Before installation, a helical pile/anchor is simply a screw with a discontinuous thread and a uniform pitch. When installed into soil, a helical pile/anchors functions as an axially loaded end-bearing deep foundation. The helix plates serve a two-fold purpose. The first purpose is to provide the means to install the helical pile/anchor. The second purpose is to provide the bearing element means for load transfer to soil. As such, helical pile/anchor design is keyed to these two purposes, both of which can be used to predict the ultimate capacity.

 |

Section 5 detailed how helix plates act as bearing elements. The load capacity is determined by multiplying the unit bearing capacity of the soil at each helix location by the projected area of each helix. This capacity is generally defined as the ultimate theoretical load capacity because it is based on soil parameters either directly measured or empirically derived from soil exploration sounding data.

The purpose of this section is to provide a basic understanding of how installation torque (or installation energy) provides a simple, reliable means to predict the load capacity of a helical pile/anchor. More importantly, this prediction method is independent of the bearing capacity method detailed in Section 5, so it can be used as a "field production control" method to verify load capacity during installation.

The installation torque-to-load capacity relationship is an empirical method originally developed by the A. B. Chance Company in the late 1950's and early 1960's. Hubbell Power Systems, Inc. has long promoted the concept that the torsion energy required to install a helical anchor/pile can be related to the ultimate load capacity of a pile/anchor. Precise definition of the relationship for all possible variables remains to be achieved. However, simple empirical relationships, originally derived for tension loads but also valid for compression loads, have been used for a number of years. The principle is that as a helical anchor/pile is installed (screwed) into increasingly denser/harder soil, the resistance to installation (called installation energy or torque) will increase. Likewise, the higher the installation torque, the higher the axial capacity of the installed pile/anchor. Hoyt and Clemence (1989) presented a landmark paper on this topic at the 12th International Conference on Soil Mechanics and Foundation Engineering. They proposed the following formula that relates the ultimate capacity of a helical pile/anchor to its installation torque:

$$Q_{ult} = K_t \times T$$ **Equation 6-1**

where
- Q_{ult} = Ultimate uplift capacity [lb (kN)]
- K_t = Empirical torque factor [ft^{-1} (m^{-1})]
- T = Average installation torque [lb-ft (kN-m)]

Hoyt and Clemence recommended $K_t = 10$ ft^{-1} (33 m^{-1}) for square shaft (SS) and round shaft (RS) helical anchors less than 3.5" (89 mm) in diameter, 7 ft^{-1} (23 m^{-1}) for 3.5" diameter round shafts, and 3 ft^{-1} (9.8 m^{-1}) for 8-5/8" (219 mm) diameter round shafts. The value of K_t is not a constant - it may range from 3 to 20 ft^{-1} (10 to 66 m^{-1}), depending on soil conditions, shaft size and shape, helix thickness, and application (tension or compression). For CHANCE® Type SS Square Shaft Helical Piles/Anchors, K_t typically ranges from 10 to 13 ft^{-1} (33 to 43 m^{-1}), with 10 ft^{-1} (33 m^{-1}) being the recommended default value. For CHANCE® Type RS Pipe Shaft Helical Piles/Anchors, K_t typically ranges from 3 to 10 ft^{-1} (10 to 33 m^{-1}), with 9 ft^{-1} (30 m^{-1}) being the recommended default for Type RS2875; 7 ft^{-1} (23 m^{-1}) being the recommended default for Type RS3500.300; and 6 ft^{-1} (20 m^{-1}) being the recommended default for Type RS4500.337.

The Canadian Foundation Engineering Manual (2006) recommends values of $K_t = 7$ ft^{-1} for pipe shaft helical piles with 90 mm OD, and $K_t = 3$ ft^{-1} for pipe shaft helical piles approaching 200 mm OD.

The correlation between installation torque (T), and the ultimate load capacity (Q_{ult}) of a helical pile/anchor, is a simple concept but a complicated reality. This is partly because there are a large number of factors that can influence the determination of the empirical torque factor K_t. A number of these factors (not including soil), are summarized in Table 6.2.

It is important to understand that torque correlation is valid when the helical pile/anchor is advancing at a rate of penetration nearly equal to one helix pitch per revolution. Large displacement shafts [>8-5/8" (219mm)] are less likely to advance at this rate, which means torque correlation cannot be used as a means to determine capacity.

Factors Influencing K_t, Table 6-2

Factors Affecting Installation Torque (T)	Factors Affecting Ultimate Capacity (Q_{ult})
Method of Measuring Installation Torque (T)	Number and Size of Helix Plates
Installed Depth Used to Determine "Average" Torque	Direction of Loading (Tension or Compression)
Applied Down-Force or "Crowd"	Geometry of Couplings
Rate of Rotation	Spacing of Helix Plates
Alignment of Pile/Anchor	Shape and Size of Shaft
Rate of Advance	Time between Installation and Loading
Geometry of Couplings	
Shape and Size of Shaft	
Shape and Size of Shaft	
Number & Size of Helix Plates	
Pitch of Helix Plates	

The factors listed in Table 6-2 are some of the reasons why Hubbell Power Systems, Inc. has a dealer certification program. Contractors who install helical piles/anchors are trained in the proper methods and techniques before they are certified. In order for Equation 6-1 to be useful, installation torque must be measured. There are a variety of methods used to measure torque. Hubbell Power Systems, Inc. offers two in-line torque indicators; in-line indicators are the best method to determine torque for capacity prediction. Other useful methods to measure torque are presented later in this section. For torque correlation to be valid, the rate of penetration should be between 2.5" to 3" per revolution. The rotation speed should be consistent and in the range of 5 to 15 RPM. And, the minimum effective torsional resistance criterion (the average installation torque) should be taken over the last 3 feet of penetration; unless a single helix pile is used for compression load, where it is appropriate to use the final (last) installation torque.

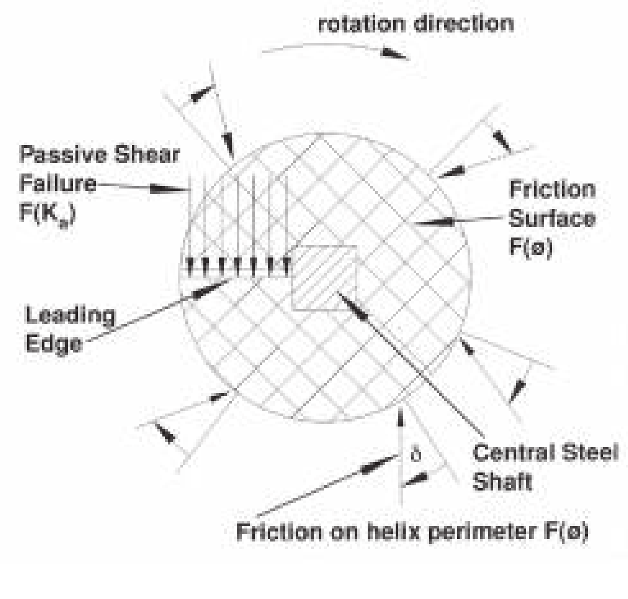
ICC-ES Acceptance Criteria AC358 for Helical Pile Systems and Devices Section 3.13.2 provides torque correlation (K_t) values for conforming helical pile systems based on shaft size and shape. They are the same as recommended by Hubbell Power Systems, Inc. and by Hoyt and Clemence. Hubbell Power Systems, Inc. helical piles are conforming per AC358. The AC358 K_t values are the same for both tension and compression axial loads.

The International Building Code (IBC) 2009 & 2012 Section 1810.3.3.1.9 states there are three ways to determine the load capacity of helical piles – including well documented correlations with installation torque.

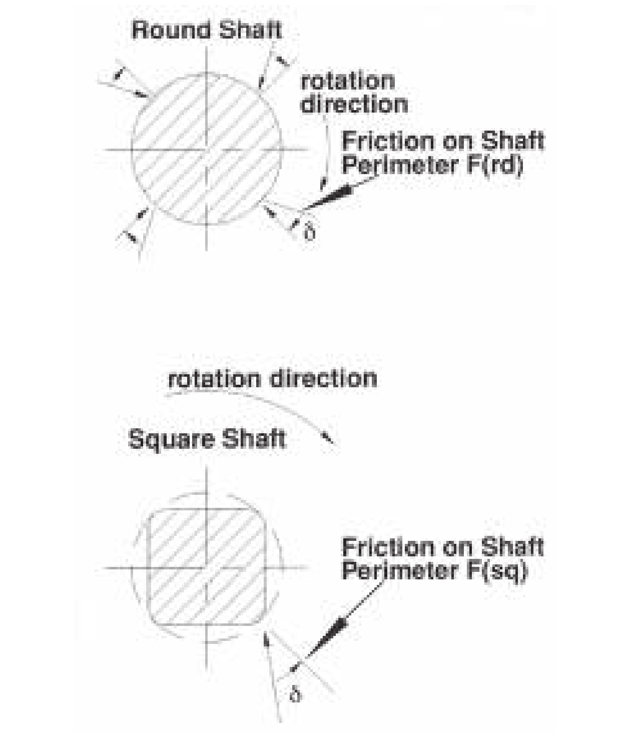
Soil Factors Influencing K_t

Locating helix bearing plates in very soft, loose, or sensitive soils will typically result in K_t values less than the recommended default. This is because some soils, such as salt leached marine clays and lacustrine clays, are very sensitive and lose considerable shear strength when disturbed. It is better to extend the helical pile/anchor beyond sensitive soils into competent bearing strata. If it's not practical to extend the helical pile/anchor beyond sensitive soils, testing is required to determine the appropriate K_t.

Full-scale load testing has shown that helical anchors/piles typically have at least the same capacity in compression as in tension. In practice, compression capacity is generally higher than tension capacity because the pile/anchor bears on soil below rather than above the helix plates, plus at least one helix plate is bearing on undisturbed soil. Soil above the bearing plates is disturbed by the slicing action of the helix, but not overly disturbed by being "augured" and removed. Typically, the same values of K_t are used for both tension and compression applications. This generally results in conservative results for compression applications. A poorly formed helix shape will disturb soil enough to adversely affect the torque-to-capacity relationship, i.e., K_t is reduced. To prevent this, Hubbell Power Systems, Inc. uses matching metal dies to form helix plates which are as near to a true helical shape as is practically possible. To understand all the factors that K_t is a function of, one must first understand how helical piles/anchors interact with the soil during installation.



Top View of Helix
Figure 6-5



Friction Forces Action on Central Shafts
Figure 6-6

Torque Resistance Factors

There are two main factors that contribute to the torque resistance generated during a pile/anchor installation, friction and penetration resistance. Of the two factors, friction is the larger component of torque resistance.

Friction Has Two Basic Parts:

(1) Friction on the helix plate and friction along the central steel shaft. Friction resistance increases with helix size because the surface area of the helix in contact with the soil increases with the square of the diameter (see Figure 6-5). Likewise, friction resistance increases with pitch size, i.e., the larger the pitch, the greater the resistance. This is analogous to the difference between a coarse thread and a fine thread bolt. Basic physics tells us that "work" is defined as force time's distance. A larger pitch causes the helix to travel a greater distance per revolution, thus more work is required.

(2) Friction along the central steel shaft is similar to friction on the helix plate. Friction resistance increases with shaft size because the surface area of the shaft in contact with the soil increases as the diameter increases. An important performance factor for helical pile/anchors is the helix to shaft diameter ratio (H_d/S_d). The higher the H_d/S_d ratio, the more efficient a given helical pile/anchor will be during installation. Friction resistance also varies with shaft shape (see Figure 6-6). A round shaft may be the most efficient section to transmit torque energy, but it has the disadvantage of full surface contact with the soil during installation. When the central steel shaft is large (> 3" [76 mm] in diameter) the shaft friction resistance contributes significantly to the total friction resistance. However, a square shaft (< 3" [76 mm] in diameter) has only the corners in full surface contact with the soil during installation, thus less shaft friction resistance. Friction energy (energy loss) required to install a helical pile/anchor is related to the helix and shaft size. The total energy loss due to friction is equal to the sum of the friction loss of all the individual helix plates plus the length of shaft subjected to friction via contact with the soil.

Penetration Resistance Has Two Basic Parts:

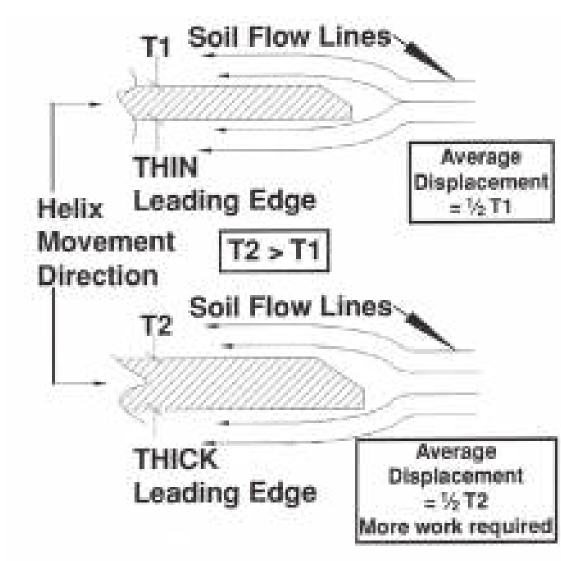
(1) Shearing resistance along the leading edge of the helix plate to allow passage of the helix plate and penetration resistance of the shaft/pilot point. Shearing resistance increases with helix size because leading edge length increases as the diameter increases. Shearing resistance also increases with helix thickness because more soil has to be displaced with a thick helix than with a thin helix (see Figure 6-7). The average distance the soil is displaced is equal to approximately 1/2 the helix thickness, so as the thickness increases the more work (i.e., energy) is required to pass the helix through the soil.

(2) Penetration resistance increases with shaft size because the projected area of the hub/pilot point increases with the square of the shaft radius (see Figure 6-8). The average distance the soil is displaced is approximately equal to the radius of the shaft, so as the shaft size increases, the more work (i.e., energy) is required to pass the hub/pilot point through the soil.

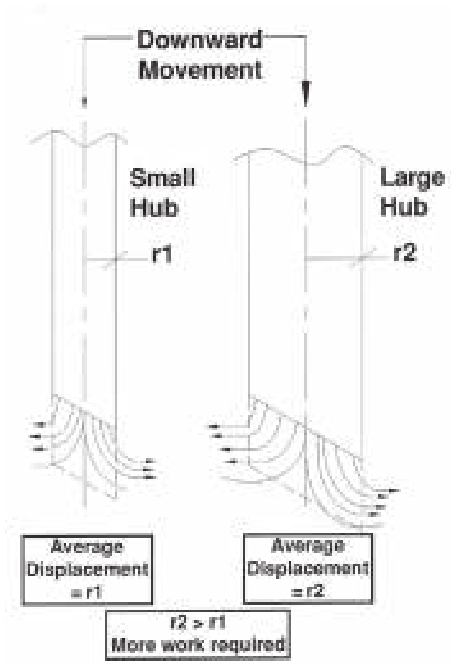
The penetration energy required to install a helical pile/anchor is proportional to the volume of soil displaced times the distance traveled. The volume of soil displaced by the anchor/pile is equal to the sum of the volumes of all the individual helix plates plus the volume of the soil displaced by the hub/pilot point in moving downward with every revolution.

Energy Relationships

Installation energy must equal the energy required to penetrate the soil (penetration resistance) plus the energy loss due to friction (friction resistance). The installation energy is provided by the machine and consists of two components, rotation energy supplied by the torque motor and downward force (or crowd) provided by the machine. The rotation energy provided by the motor along with the inclined plane of a true helical form generates the thrust necessary to overcome the penetration and friction resistance. The rotational energy is what is termed "installation torque." The downward force also overcomes penetration resistance, but its contribution is usually required only at the start of the installation, or when the lead helix is transitioning from a soft soil to a hard soil.



Section View of Leading Edge with Flow Lines
Figure 6-7



Shaft/Pilot Point with Flow Lines
Figure 6-8

INSTALLATION METHODOLOGY

From an installation energy standpoint, the perfect helical pile/anchor would consist of an infinitely thin helix plate attached to an infinitely strong, infinitely small diameter central steel shaft. This configuration would be energy efficient because penetration resistance and friction resistance is low. Installation torque to capacity relationships would be high. However, infinitely thin helix plates and infinitely small shafts are not realistically possible, so a balanced design of size, shape, and material is required to achieve consistent, reliable torque to capacity relationships.

As stated previously, the empirical relationship between installation torque and ultimate capacity is well known, but not precisely defined. As one method of explanation, a theoretical model based on energy exerted during installation has been proposed [Perko (2000)]. The energy model is based on equating the energy exerted during installation with the penetration and friction resistance. Perko showed how the capacity of an installed helical pile/anchor can be expressed in terms of installation torque, applied downward force, soil displacement, and the geometry of the pile/anchor. The model indicates that K_t is weakly dependent on crowd, final installation torque, number of helix plates, and helix pitch. The model also indicates that K_t is moderately affected by helix plate radius and strongly affected by shaft diameter and helix plate thickness.

The important issue is energy efficiency. Note that a large shaft helical anchor/pile takes more energy to install into the soil than a small shaft pile/anchor. Likewise, a large diameter, thick helix takes more energy to install into the soil than a smaller diameter, thinner helix. The importance of energy efficiency is realized when one considers that the additional energy required to install a large displacement helical pile/anchor contributes little to the load capacity of the pile/anchor. In others words, the return on the energy "investment" is not as good. This concept is what is meant when Hubbell Power Systems, Inc. engineers say large shaft diameter and/or large helix diameter (>16" diameter) pile/anchors are not efficient "torque-wise." This doesn't mean large diameter or large helix plate piles are not capable of producing high load capacity, it just means the installation energy, i.e. machine, must be larger in order to install the pile.

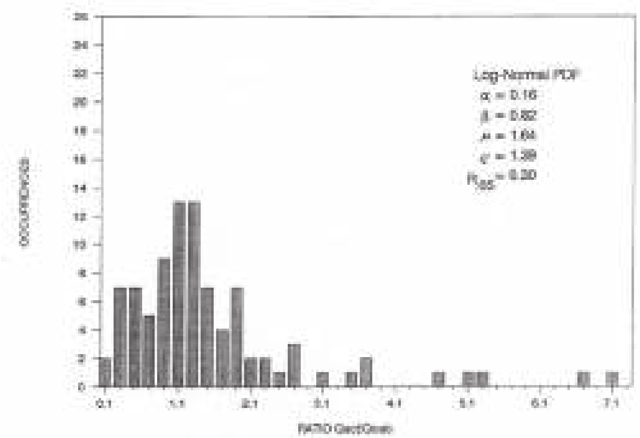
If one considers an energy balance between the energy exerted during loading and the appropriate penetration energy of each of the helix plates, then it can be realized that any installation energy not specifically related to helix penetration is wasted. This fact leads to several useful observations. For a given helix configuration and the same available installation energy (i.e., machine):

1. Small displacement shafts will disturb less soil than large displacement shafts.
2. Small displacement shafts result in less pore pressure buildup than large displacement shafts.
3. Small displacement shafts will penetrate farther into a given bearing strata than large displacement shafts.
4. Small displacement shafts will penetrate soils with higher SPT "N" values than large displacement shafts.
5. Small displacement shafts will generate more axial load capacity with less deflection than large displacement shafts.
6. K_t varies inversely with shaft diameter.

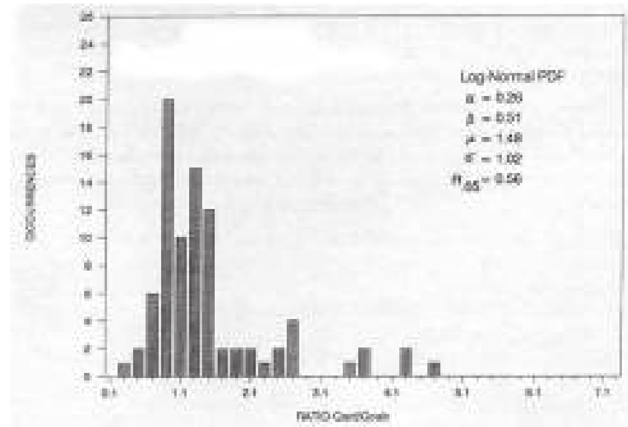
Reliability of Torque/Capacity Model

Hoyt and Clemence (1989) analyzed 91 tension load tests at 24 different sites with sand, silt and clay soils all represented. All of the tests used in the study were short term; most were strain controlled and included a final loading step of imposing continuous deflection at a rate of approximately 4 inches (102 mm) per minute. This final load was taken as the ultimate capacity. The capacity ratio Q_{act}/Q_{calc} was obtained for each test by dividing the actual capacity (Q_{act}) by the calculated capacity (Q_{calc}). Q_{calc} was calculated by using three different load capacity models: (1) Cylindrical shear, (2) Individual bearing, and (3) Torque correlation. These data were then compared and plotted on separate histograms (see Figures 6-9 and 6-10, cylindrical shear histogram not shown).

All three capacity models exhibited the capability of over-predicting pile/anchor capacity. This would suggest the use of appropriate Factors of Safety. However, the authors did not discriminate between "good" and "poor" bearing soils when analyzing the results. In other words, some of the test data analyzed were in areas where the helix plates were located in soils typically not suitable for end bearing, (i.e., sensitive) clays and loose sands.



Individual Bearing Method
Figure 6-9



Torque Correlation Model
Figure 6-10

All three capacity models' mean values were quite close, but the range and standard deviation were significantly lower for the torque correlation method than for the other two. This improved consistency is probably due to the removal of several random variables from the capacity model. Therefore, the installation torque correlation method yields more consistent results than either of the other two methods. The installation torque method does have one disadvantage, however, in that it cannot be used until after the helical pile/anchor has been installed. Therefore, it is better suited to on-site production control and termination criteria than design in the office.

Perko (2012) suggested that if both individual bearing capacity and torque correlation are used to determine the bearing capacity of a helical pile/anchor, the resulting capacity will be accurate to within 97.7% reliability.

Measuring Installation Torque

The torque correlation method requires the installation torque to be measured and recorded in the field. There are several methods that can be used to measure torque, and Hubbell Power Systems, Inc. has a complete line of torque indicators to choose from. Each one is described below along with its advantages and disadvantages:

• Shaft Twist

A.B. Chance Company stated in early editions of the Encyclopedia of Anchoring (1977) that for standard SS5 Anchors, "the most secure anchoring will result when the shaft has a 1 to 1-1/2 twist per 5-foot section." Shaft twist is not a true torque-indicating device. It has been used as an indication of "good bearing soil" since Type SS anchors were first introduced in the mid-1960's. Shaft twist should not be used exclusive of a true torque-indicating device. Some of the reasons for this are listed below.

Advantages:

- Simple, cheap, easy to use.
- Doesn't require any additional tooling.
- Visible indication of torque.


Shear Pin Torque Limiter
Figure 6-11

Disadvantages:

- Qualitative, not quantitative torque relationship.
- Not very accurate.
- Shaft twist can't be correlated to installation torque on a consistent basis.
- Type SS5, SS150, SS175, SS200, and SS225 shafts twist, or wrap-up, at different torque levels.
- Shaft twist for a round shaft is not obvious without other means of reference.

• Shear Pin Torque Limiter

A shear pin torque limiter is a mechanical device consisting of two shear halves mounted to a central pin such that the shear halves are free to rotate (see Figure 6-11). Shear pins inserted into perimeter holes prevent the shear halves from rotating and are rated to shear at 500 ft-lb of torque per pin. Required torque can be achieved by loading the shear halves with the appropriate number of pins, i.e., 4000 ft-lb = 8 pins. The shear pin torque limiter is mounted in line with the torque motor and pile/anchor tooling.

Advantages:

- Simple design, easy to use.
- Tough and durable, will take a lot of abuse and keep working.
- Accurate within ± 5% if kept in good working condition.
- Torque limiter - used to prevent exceeding a specified torque.
- Relatively inexpensive to buy and maintain.
- Easy interchange from one machine to another.

Disadvantages:

- Point-wise torque indicator, i.e., indicates torque at separate points, not continuously.
- Requires constant unloading and reloading of shear pins.
- Limited to 10,000 ft-lb.
- Sudden release of torsional (back-lash) energy when pins shear.
- Fits tools with 5-1/4" bolt circle only.

• Digital Torque Indicator

A digital torque indicator is a device consisting of strain gauges mounted to a torsion bar located between two bolt flanges (see Figure 6-12). This tool measures installation torque by measuring the shear strain of the torsion bar. The digital display reads torque directly. The digital torque indicator is mounted in-line with the torque motor and pile/anchor tooling.

Advantages:

- Simple torsion bar & strain gauge design, easy to use.
- Continuous reading torque indicator.
- Digital display reads torque directly.

Mechanical Dial Torque Indicator
Figure 6-12

Wireless Remote Display
Figure 6-13

Remote Data Logger
Figure 6-14

- Accurate within ± 2% if kept in good working condition.
- Fits tools with 5-1/4" and 7-5/8" bolt circles.
- Calibrated with equipment traceable to US Bureau of Standards before leaving plant.
- Can be used as a calibration tool for other types of torque indicators.
- Easy interchange from one machine to another.
- Reliable, continuous duty torque indicator.
- Comes with wireless remote display and an optional remote data logger.

Disadvantages:

- Drive tools must be switched out when installing different types of helical pile/anchor.

• <u>DP-1 Differential Pressure Torque Indicator</u>

A differential pressure torque indicator is a hydraulic device consisting of back-to-back hydraulic pistons; hoses, couplings, and a gauge (see Figure 6-15). Its' operation is based on the principle that the work output of a hydraulic torque motor is directly related to the pressure drop across the motor. The DP-1 hydraulically or mechanically "subtracts" the low pressure from the high to obtain the "differential" pressure. Installation torque is calculated using the cubic inch displacement and gear ratio of the torque motor. The DP-1 piston block and gauge can be mounted anywhere on the machine. Hydraulic hoses must be connected to the high and low pressure lines at the torque motor.

Advantages:

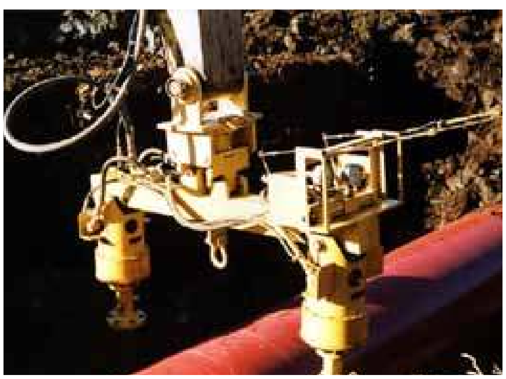
- Indicates torque by measuring pressure drop across hydraulic torque motor.
- No moving parts.
- Continuous reading torque indicator.
- Very durable - the unit is not in the tool string.
- Pressure gauge can be located anywhere on the machine.
- Analog type gauge eliminates "transient" torque peaks.

 |

- Pressure gauge can be overlaid to read torque (ft-lb) instead of pressure (psi).
- Accurate within ± 5% if kept in good working condition.
- After mounting, it is always ready for use.
- Can be provided with multiple readout gauges.

Disadvantages:

- Requires significant initial installation setup time and material, i.e., hydraulic fittings, hoses, oil.
- Requires a hydraulic pressure-to-torque correlation based on the torque motor's cubic inch displacement (CID) and gear ratio.
- For two-speed torque motors, pressure-to-torque correlation changes depending on which speed the motor is in (high or low).
- Requires periodic recalibration against a known standard, such as the digital torque indicator, or shear pin torque limiter.
- Sensitive to hydraulic leaks in the lines that connect the indicator to the torque motor.
- Relatively expensive.
- Difficult interchange from one machine to another.



Differential Pressure
Torque Indicator
Figure 6-15

TORQUE INDICATOR and MOTOR CALIBRATION

All torque indicators require periodic calibration. Hubbell Power Systems, Inc. recommends that torque indicators be calibrated at least once per year. The digital torque indicator can be used in the field to calibrate other indicators, such as hydraulic pressure gauges and the DP-1. As torque motors age, the relationship between hydraulic pressure and installation torque will change. Therefore, it is recommended that hydraulic torque motors be periodically checked for pressure/torque relationship throughout their service life. Hubbell Power Systems, Inc. has torque test equipment available to recalibrate torque indicators and torque motors.

INSTALLATION TERMINATION CRITERIA

The Engineer of Record can use the relationship between installation torque and ultimate load capacity to establish minimum torque criteria for the installation of production helical piles/anchor. The recommended default values for K_t of [10ft^{-1} (33m^{-1})] for CHANCE® Type SS, [9ft^{-1} (30m^{-1})] for Type RS2875, [7ft^{-1} (23m^{-1})] for Type RS3500 and [6ft^{-1} (20m^{-1})] for Type RS4500 will typically provide conservative results.

For large projects that merit the additional effort, a pre-production test program can be used to establish the appropriate torque correlation factor (K_t) for the existing project soils. It is recommended that K_t be determined by dividing the ultimate load capacity determined by load test by the average installation (effective) torque taken over the last 3 feet (1 meter) of penetration into the bearing strata. The minimum effective torsional resistance criterion applies to the "background" resistance; torque spikes resulting from encounters with obstacles in the ground must be ignored in determining whether the torsional resistance criterion has been satisfied. The minimum effective torsional resistance criterion (the average installation torque taken over the last 3 feet of penetration) may not be applicable in certain soil profiles, such as, a relatively soft stratum overlying a very hard stratum. Engineering judgment must be exercised. See Appendix B for more detailed explanation of full-scale load tests. Large-scale projects warrant more than one pre-production test.

Whatever method is used to determine K_t, the production helical piles/anchors should be installed to a specified minimum torque and overall minimum depth. These termination criteria should be written into the construction documents. See www.abchance.com for model specifications that contain sections on recommended termination criteria for helical piles/anchors.

ICC-Evaluation Services ESR-2794 requires the following installation termination criteria:

- When installing single-helix anchors/piles that will be loaded in tension and all multi-helix anchors/piles, torsional resistance must be recorded at the final tip embedment minus 2 feet (710 mm) and final embedment minus 1 foot (305 mm), in addition to the resistance at final embedment.
- For single-helix compression piles, the final torsional resistance reading must be equal to or exceed the specified minimum.
- For multi-helix anchors and piles, the average of the final three torsional resistance readings must be equal to or exceed the specified minimum.
- The tip embedment and torsional resistance readings must be verified to meet or exceed the specified termination criteria before terminating installation.

Minimum Bearing Depth of Top-Most Helix

For deep foundation behavior, Hubbell Power Systems, Inc. recommends the minimum vertical depth of the top-most helix plate should be at least five times the diameter of the top-most helix. Natural factors such as frost depth and active zones (expansive soil) can also affect minimum depth. Hubbell Power Systems, Inc. recommends the minimum vertical depth of the top-most helix plate should be at least three times the diameter of the top most helix below the maximum frost depth or depth of active zone. For example, if the frost depth is 4 feet and the top-most helix plate is 12 in (305 mm), then the minimum depth to the top-most helix is 4 + 3 x (12 in) = 7 ft (2.1 m).

Tolerances

It is possible to install helical piles/anchors within reasonable tolerance ranges. For example, it is common to locate and install an pile/anchor within 1 inch (25 mm) of the staked location. Plumbness can usually be held within ± 1° of design alignment. For vertical installations a visual plumbness check is typically all that's required. For battered installations, an inclinometer can be used to establish the required angle. See www.abchance.com for model specifications that contain sections on recommended termination criteria for helical piles/anchors.

Torque Strength Rating

Torque strength is important when choosing the correct helical pile/anchor for a given project. It is a practical limit since the torque strength must be greater than the resistance generated during installation. In fact, the central steel shaft is more highly stressed during installation than at any other time during the life of the helical pile/anchor. This is why it is important to control both material strength variation and process capability in the fabrication process. Hubbell Power Systems, Inc. designs and manufactures helical piles/anchors to achieve the torque ratings published in the product family sections in Section 7. The ratings are listed based on product series, such as SS5, SS175, RS3500, etc.

The torque rating is defined as the maximum torque energy that should be applied to the helical pile/anchor during installation in soil. It is not the ultimate torque strength, defined as the point where the central shaft experiences torsion fracture. It is best described as an allowable limit, or "safe torque" that can be applied to the helical pile/anchor. Some other manufacturers publish torque ratings based on ultimate torque strength.

The designer should select the product series that provides a torque strength rating that meets or exceeds the anticipated torsion resistance expected during the installation. HeliCAP® Engineering Software (see Section 5) generates installation torque vs. depth plots that estimate the torque resistance of the defined soil profile. The plotted torque values are based on a K_t of 10 for Type SS and 9, 7 or 6 for Type RS. The torque ratings published in the product family sections in Section 7 are superimposed on the HeliCAP® Torque vs Depth plot, so the user can see at a glance when the estimated torque resistance equals or exceeds the torque rating of a given product series.

In some instances, it may be necessary to exceed the torque rating in order to achieve the minimum specified depth, or to install the helical pile/anchor slightly deeper to locate the helix plates farther into bearing stratum. This "finishing torque limit" should never exceed the published torque rating by more than 10%. To avoid fracture under impact loading due to obstruction laden soils, choose a helical product series with at least 30% more torque strength rating than the expected torque resistance. Note that the possibility of torsion fracture increases significantly as the applied torque increases beyond the published ratings. The need to install helical pile/anchors deeper is better accomplished by reducing the size and/or number of helix plates, or by choosing a helical product series with a higher torque rating.

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PRODUCT DRAWINGS AND RATINGS
Section 7

CONTENTS

DISCLAIMER

The information in this manual is provided as a guide to assist you with your design and in writing your own specifications.

Installation conditions, including soil and structure conditions, vary widely from location to location and from point to point on a site.

Independent engineering analysis and consulting state and local building codes and authorities should be conducted prior to any installation to ascertain and verify compliance to relevant rules, regulations and requirements.

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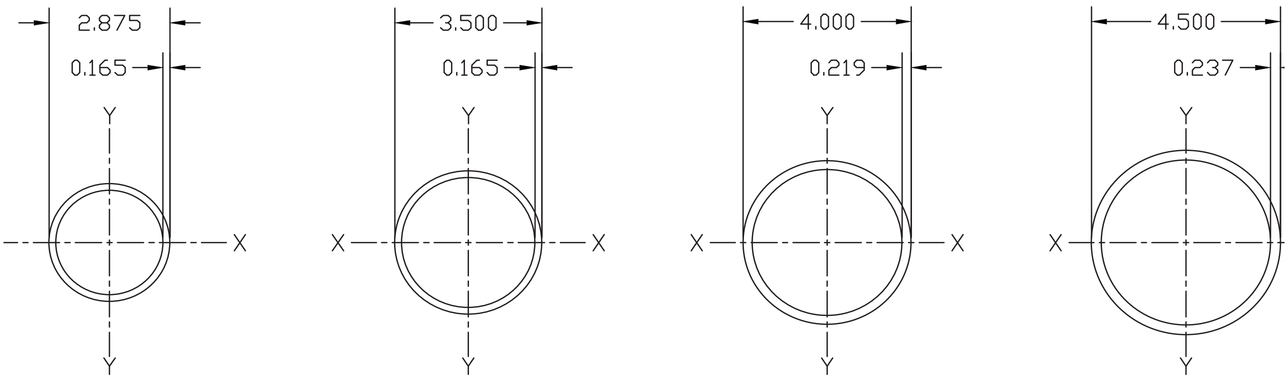
Hubbell Power Systems, Inc., does NOT warrant the work of its dealers/installing contractors in the installation of CHANCE® Civil Construction foundation support products.

ATLAS RESISTANCE® PIERS

The ATLAS RESISTANCE® Pier is an assembly of structural steel components that includes a steel bracket attached to the foundation or slab, which is then mounted on a steel pier that is installed to bedrock or firm bearing stratum. The lead pier starter section includes a unique friction reduction collar that reduces skin friction on the pier pipe during installation. Hubbell Power Systems, Inc. offers a broad range of pier pipe sizes and remedial repair brackets for both foundation and slab underpinning applications. This section will discuss those products in detail along with their capacity ratings.

PIER PIPE SHAFTS

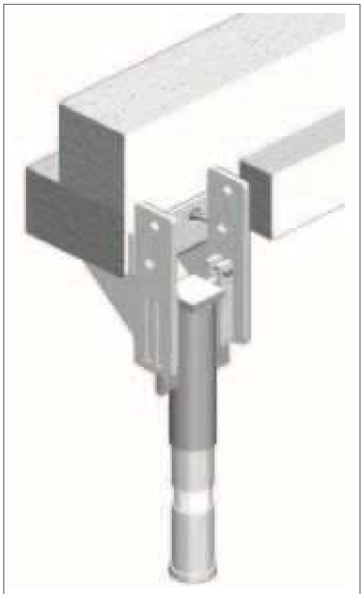


ATLAS RESISTANCE Pier Cross Section Drawings, Figure 7-1

ATLAS RESISTANCE® Pier Section Properties, Table 7-1

PRODUCT SERIES	SHAFT SIZE in (mm)	WALL THICKNESS in (mm)	METAL AREA in^2 (cm^2)	PERIMETER in (cm)	MOMENT OF INERTIA in^4 (cm^4) I_{x-x}, I_{y-y}, I_{x-y}	SECTION MODULUS in^3 (cm^3)	
						S_{x-x} S_{y-y}	S_{x-y}
RS2875.165	2.875 (73)	0.165 (4.2)	1.4 (9.0)	9.0 (22.9)	1.29 (53.7)	0.90 (14.7)	0.90 (14.7)
RS3500.165	3.5 (89)	0.165 (4.2)	1.7 (11.0)	11.0 (27.9)	2.41 (100.3)	1.38 (22.6)	1.38 (22.6)
RS4000.219	4.0 (101)	0.219 (5.6)	2.6 (16.8)	12.6 (32.0)	4.66 (194.0)	2.33 (38.2)	2.33 (38.2)
RS4500.237	4.5 (114)	0.237 (6.0)	3.2 (20.6)	14.1 (35.9)	7.23 (301.0)	3.21 (52.6)	3.21 (52.6)

REMEDIAL REPAIR BRACKETS for ATLAS RESISTANCE® PIERS



ATLAS RESISTANCE® Standard and Modified 2-Piece Systems

· Use for lifts up to 4”
· All 2-piece pier systems include:
  · Pier bracket
  · Top pier platform
  · Pier Starter with Friction Reduction Collar
  · Pier Section
  · “M” designates one modified sleeve included

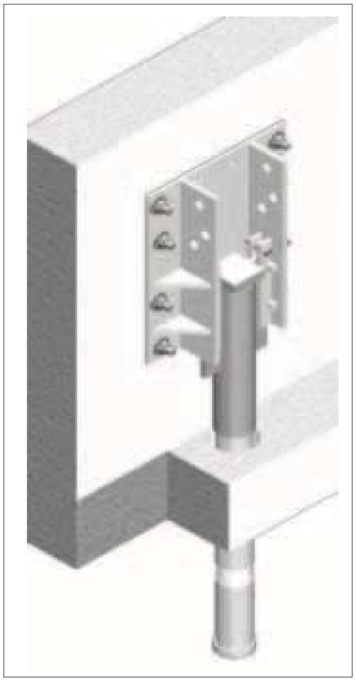
Order Separately: Two pier pins (two Grade 8 bolts for 4-1/2” pier) and pier shims. Each pier requires a minimum of four anchor bolts. NOTE: Anchor bolts not supplied by Hubbell Power Systems, Inc.

See Note 3 at bottom of table for available finishes.

ATLAS RESISTANCE® STANDARD AND MODIFIED 2-PIECE PIER DESIGNATORS				
Pier Designation	**Ultimate Capacity[1]**	**Max Working Capacity[1]**	**Pier Dia**	**Features**
AP-2-UF-2875.165	60,000#	30,000#	2-7/8”	Lowest cost
AP-2-UF-2875.165M	70,000#	35,000#	2-7/8”	Lowest cost, Increased rotational stiffness, Recommended for weak surface soils
AP-2-UF-3500.165	85,000#	42,500#	3-1/2”	“Flow Coat” pier pipe standard (NER579)[2]
AP-2-UFVL-3500.165	86,000#	43,000#	3-1/2”	Has additional mounting plate for two additional anchor bolts
AP-2-UF-3500.165M	91,000#	45,500#	3-1/2”	“Flow Coat” pier pipe standard (NER579)[2], Increased rotational stiffness. Recommended for weak surface soils
AP-2-UFVL-3500.165M	91,000#	45,500#	3-1/2”	Has additional mounting plate for two additional anchor bolts, Increased rotational stiffness
AP-2-UF-4000.219	98,000#	49,000#	4”	Higher capacity, Easier installation than AP2-3500M
AP-2-UFVL-4000.219	110,000#	55,000#	4”	Has additional mounting plate for two additional anchor bolts
AP-2-UF-4500.237	141,000#	70,500#	4-1/2”	Highest capacity

Notes:

1. Capacities based upon maximum pipe exposure of 2 feet and soil strength having a minimum Standard Penetration Test (SPT) Blow Count “N” of 4. The capacities are based on a pier depth to fixity of 5’-6.
2. Complies with the structural provisions of the most recent editions of BOCA National Code, ICBO Uniform Code, SBCCI Standard Code and 2000 International Building and Residential Code (2002 Accumulative Supplement).
3. Available finishes: P = Entire product supplied mill finish steel. G = Entire product supplied galvanized. PA = Plain steel bracket assy; “Flow Coat” corrosion protection on pier pipe. GA = HDG bracket assy; “Flow Coat” corrosion protection on pier pipe.



ATLAS RESISTANCE® 2-Piece Plate Pier Systems

- Easy surface mount installation.
- May be used for round columns (custom manufactured - see information below).
- Use for lifts up to 4”
- All plate pier systems include:
  - Pier bracket
  - Top pier platform
  - Pier Starter with Friction Reduction Collar
  - Pier Section

Order separately: Two pier pins (two Grade 8 bolts for 4-1/2” pier) and pier shims. Six or eight anchor bolts per pier are required (consult specification drawings on abchance.com for anchor bolt specifications). NOTE: Anchor bolts not supplied by Hubbell Power Systems, Inc.

See Note 3 at bottom of table for available finishes.

ATLAS RESISTANCE® 2-PIECE PIER PLATE PIER DESIGNATORS

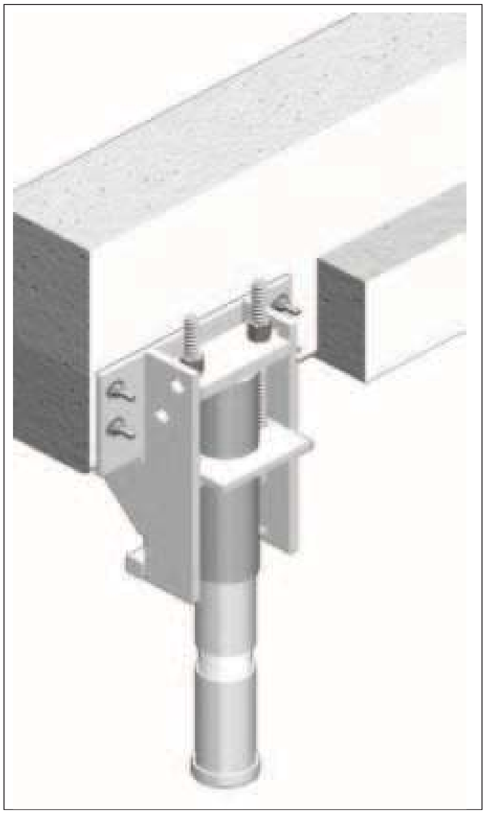
Pier Designation	Ultimate Capacity[1]	Max Working Capacity[1]	Pier Dia	Features
AP-2-PP-2875.165	60,000#	30,000#	2-7/8”	Lowest cost
AP-2-PP-2875.165M	70,000#	35,000#	2-7/8”	Lowest cost, Increased rotational stiffness, Recommended for weak surface soils
AP-2-PP-3500.165	86,000#	43,000#	3-1/2”	Standard pier for most applications, “Flow Coat” pier pipe standard
AP-2-PP-3500.165M	90,000#	45,000#	3-1/2”	“Flow Coat” pier pipe standard, Increased rotational stiffness, Recommended for weak surface soils
AP-2-PP-4000.219	103,000#	51,500#	4”	Larger pier pipe, Higher capacity
AP-2-PP-4500.237	112,000#	56,000#	4-1/2”	Commercial and Industrial applications, Greater pier pipe diameter, Highest capacity

Notes:

1. Capacities based upon maximum pipe exposure of 2 feet and soil strength having a minimum Standard Penetration Test (SPT) Blow Count “N” of 4. The capacities are based on a pier depth to fixity of 5’-6.
2. Mounting distance from bottom of stem wall to bottom of plate pier bracket must be greater than 5”.
3. Available Finishes: P = Entire product supplied mill finish steel. G = Entire product supplied galvanized. PA = Plain steel bracket assy; “Flow Coat” corrosion protection on pier pipe. GA = HDG bracket assy; “Flow Coat” corrosion protection on pier pipe.

ROUND COLUMN APPLICATIONS

Where a plate pier must be attached to a round column, the pier bracket can be custom manufactured at extra cost to match the radius of the column and the side rail width will be extended for clearance. Please provide diameter of column when ordering. Specify: AP-2-PPRC-2875.165, AP-2-PPRC-3500.165M or AP-2-PPRC-4000.219.



ATLAS RESISTANCE® Continuous Lift Pier Systems

· Use for lifts exceeding 4”
· Exceptional, extended lift capabilities
· All Continuous Lift Pier Systems include:
    · Continuous lift pier bracket assembly
    · Cap plate assembly
    · Top pier sleeve (Not applicable on AP-CL-UF-4000.219)
    · Pier Starter with Friction Reduction Collar
    · Pier Section

Order separately: Re-useable lift head, continuous thread rebar, nuts, and 6 anchor bolts.

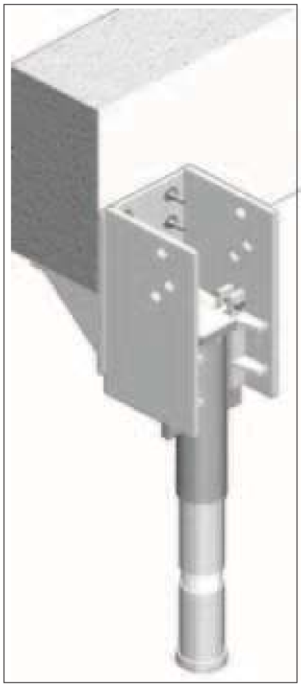
See Note 2 at bottom of table for available finishes.

ATLAS RESISTANCE® Continuous Lift Pier Designators

Pier Designation	Ultimate Capacity[1]	Max Working Capacity[1]	Pier Dia	Features
AP-CL-UF-2875.165	40,000#	20,000#	2-7/8”	Lowest cost
AP-CL-UF-3500.165	61,000#	30,500#	3-1/2”	“Flow Coat” pier pipe standard
AP-CL-UF-4000.219 (Similar to illustration)	100,000#	50,000#	4”	Higher capacity

Notes:

1. Capacities based upon maximum pipe exposure of 2 feet and soil strength having a minimum Standard Penetration Test (SPT) Blow Count “N” of 4. The capacities are based on a pier depth to fixity of 5’-6.
2. Available Finishes: P = Entire product supplied mill finish steel. G = Entire product supplied galvanized. PA = Plain steel bracket assy; “Flow Coat” corrosion protection on pier pipe. GA = HDG bracket assy; “Flow Coat” corrosion protection on pier pipe.



ATLAS RESISTANCE® 2-Piece Predrilled Pier Systems

· Use for lifts up to 4”
· Drilled pier access hole required where unsuitable rock is near surface
· Use where designer requires penetration into bearing rock
· Eccentricity from wall to C-L pipe is 6-3/4”
  · All pre-drilled piers include:
  · Pier bracket
  · Top pier platform
  · Pier Starter with Friction Reduction Collar
  · Pier Section

Order separately: Two pier pins and four anchor bolts per pier, and shims as required.

See Note 2 at bottom of table for available finishes.

ATLAS RESISTANCE® 2-Piece Predrilled Pier Designators

Pier Designation	Ultimate Capacity[1]	Max Working Capacity[1]	Pier Dia	Features
AP-2-UFPDVL-2875.165M	58,000#	29,000#	2-7/8”	Lowest cost
AP-2-UFPDVL-3500.165M	62,000#	31,000#	3-1/2”	Low cost, Corrosion resistant, “Flow Coat” pier pipe standard
AP-2-UFPDVL-4000.219	76,000#	38,000#	4”	Higher capacity
AP-2-UFPD-4500.237	92,000#	46,000#	4-1/2”	Highest capacity, Commercial and Industrial applications

Notes:

1. Capacities based upon maximum pipe exposure of 2 feet and soil strength having a minimum Standard Penetration Blow Count (SPT) of 4. The capacities are based on a pier depth to fixity of 5’-6.
2. Available Finishes: P = Entire product supplied mill finish steel. G = Entire product supplied galvanized. PA = Plain steel bracket assy; “Flow Coat” corrosion protection on pier pipe. GA = HDG bracket assy; “Flow Coat” corrosion protection on pier pipe.

ATLAS RESISTANCE® 2-Piece Predrilled Plate Pier Designators (Special Order-Not Shown)

Note: Mounting distance from bottom of stem wall to bottom of plate pier bracket must be greater than 5”.

AP-2-PPPD-3500.165	76,000#	38,000#	3-1/2”	Lowest cost, Corrosion resistant, “Flow Coat” pier pipe standard
AP-2-PPPD-3500.165M	80,000#	40,000#	3-1/2”	Low cost, Corrosion resistant, “Flow Coat” pier pipe standard
AP-2-PPPD-4000.219	83,000#	41,500#	4”	Higher capacity
AP-2-PPPD-4500.237	95,000#	47,500#	4-1/2”	Highest capacity, Commercial and Industrial applications

Pipe Shaft Pile   Square Shaft Pile/Anchor

CHANCE® HELICAL PILES/ANCHORS

Introduction

A helical pile/anchor is a factory-manufactured steel deep foundation system designed to resist axial compression, axial tension, and/or lateral loads from structures. It consists of a central steel shaft with one or more helical-shaped bearing plates welded to the central steel shaft. The central steel shaft can be one-piece (non-extendable) or fully extendable with one or more extension shafts, couplings, and a bracket/termination that allows for connection to building structures. A helical pile/anchor is screwed into the ground by application of torsion and can be extended until a required depth or a suitable bearing soil stratum is reached. Load is transferred to the soil through the helix bearing plates. Central steel shafts are available in either Type SS (Square Shaft) series or Type RS (Round Shaft) series. The Type SS series are available in 1-1/4" to 2-1/4" square sizes. The Type RS series are available in 2-7/8" to 8" diameter sizes. Type SS/RS Combo Piles are available for compression applications in soil conditions where dense/hard soils must be penetrated with softer/loose soils above the bearing strata. The grouted shaft CHANCE HELICAL PULLDOWN® Micropile series is also used in applications similar to those requiring the use of the Type SS/RS Combo Piles, but have the additional benefit of generating capacity via skin friction along the grout-soil interface in a suitable bond zone stratum. For a complete list of mechanical ratings and section properties of the central steel shafts, see the Tables found in each helical pile/anchor Product Family in this Section. Refer to Section 3, Product Feasibility and Section 6, Installation Methodology for guidelines on the proper shaft selection based on application, soil conditions, site accessibility, etc.

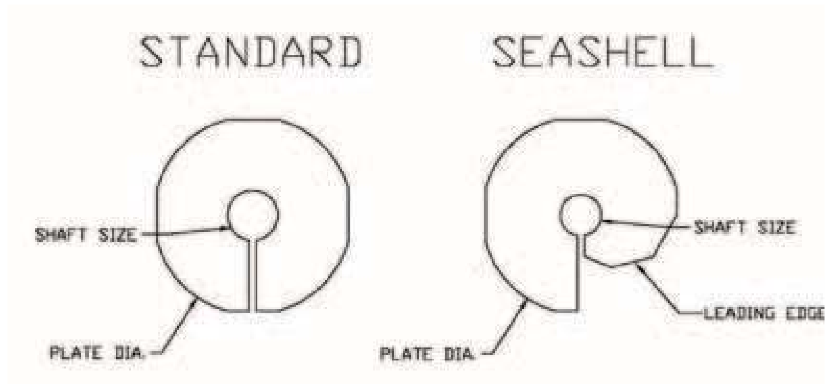
Helical pile/anchor sections are joined with bolted couplings. Installation depth is limited only by soil density and practicality based on economics. A helical bearing plate or "helix" is one pitch of a screw thread. Most helical piles include more than one helix plate, and the plates are arranged in a "tapered" configuration with the smallest helix being in the bottom and the largest helix being on the top. The large majority of CHANCE® helix plates, regardless of their diameter, have a standard 3" pitch. Being a true helical shape, the helix plates do not auger into the soil but rather screw into it with minimal soil disturbance. CHANCE helix plates are "pre-qualified" per the requirements of Table 3 in ICC-ES AC358 Acceptance Criteria for Helical Pile Systems and Devices, meaning they are generally circular in plan, have a true helix shape, and are attached perpendicular to the central steel shaft with the leading and trailing edges parallel. Helix plates are spaced at distances far enough apart that they function independently as individual bearing elements; consequently, the capacity of a particular helix on a helical pile/anchor shaft is not influenced by the helix above or below it.

Lead Section and Extensions

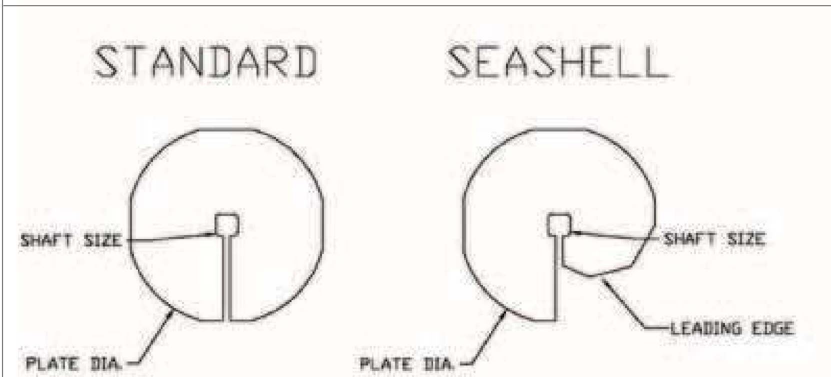
The starter section or "lead" section contains the helix plates. This lead section can consist of a single helix or up to four helices. Additional helix plates can be added, if required, with the use of helical extensions. Standard helix sizes and areas are shown in Table 7-2 and 7-3 below. Tables 7-2 and 7-3 provide the projected areas of the most common helix plate diameters. Table 7-2 provides helix areas for Type Square Shaft Helical Piles, and Table 7-3 provides helix areas for Type Round Shaft Helical Piles. The full plate projected area includes the area occupied by the central steel shaft. The "area less shaft" is the projected area of the helix plates less the area occupied by the center shaft. Most all CHANCE® helix plates are provided with a sharp leading edge, which is the front edge of the helix that penetrates the soils as the helical anchor/pile is advanced clockwise though soil. The sharp leading edge enables the helix to better slice through tough soils, roots, and seasonally frozen ground. Hubbell Power Systems, Inc. offers several helix plates with "sea shell" leading edges as special options to the product series. Our standard "sea shell" configuration that works best in most tough soils conditions is the 90° design as shown below. The sea shell cut is a leading edge with a "spiral" cut that is very effective when installing helical piles/anchors in debris laden soils, cobbles, and weathered rock.

However, it is important to remember that the bearing capacity of the helical pile/anchor is reduced because the bearing surface area is reduced. Therefore, larger helix diameters or additional helix plates may be required when using "sea shell" cut plates. Tables 7-2 and 7-3 include the projected areas of helix plates offered with the sea shell cut. The helix plates are arranged on the shaft such that their diameters increase as they get farther from the pilot point. The practical limits on the number of helices per pile/anchor is four to five if placed in a cohesive soil and six if placed in a cohesionless or granular soil.

Plain extensions are then added in standard lengths of 3, 5, 7 and 10 feet until the lead section penetrates into the bearing strata. Standard helix configurations are provided in the product series tables in this section. Note that lead time will be significantly reduced if a standard helix configuration is selected.



Pipe Shaft



Square Shaft

Figure 7-2

Table 7-2: CHANCE® Square Shaft Helix Plate Sizes and Projected Areas by Product Family

		SQUARE SHAFTS			
		STANDARD		SEASHELL	
	Diameter in. (mm)	AREA w/o HOLE ft² (m²)	FULL PLATE AREA ft² (m²)	AREA w/o HOLE ft² (m²)	FULL PLATE AREA ft² (m²)
SS125	6 (150)	0.174 (0.0162)	0.185 (0.0172)	N/A	N/A
	8 (200)	0.324 (0.0301)	0.336 (0.0312)	0.304 (0.0282)	0.316 (0.0294)
	10 (250)	0.519 (0.0482)	0.531 (0.0493)	0.468 (0.0435)	0.479 (0.0445)
	12 (300)	0.759 (0.0705)	0.771 (0.0716)	0.668 (0.0621)	0.679 (0.0631)
	14 (350)	1.037 (0.0963)	1.049 (0.0975)	0.903 (0.0839)	0.915 (0.0850)
	16 (406)	1.366 (0.1269)	1.378 (0.128)	N/A	N/A
SS5/ SS150	6 (150)	0.169 (0.0157)	0.185 (0.0172)	0.156 (0.0145)	0.172 (0.0160)
	8 (200)	0.320 (0.0297)	0.336 (0.0312)	0.300 (0.0279)	0.316 (0.0294)
	10 (250)	0.515 (0.048)	0.531 (0.0493)	0.463 (0.0430)	0.479 (0.0445)
	12 (300)	0.755 (0.0701)	0.771 (0.0716)	0.663 (0.0616)	0.679 (0.0631)
	14 (350)	1.033 (0.0960)	1.049 (0.0975)	0.899 (0.0835)	0.915 (0.0850)
	16 (406)	1.362 (0.1265)	1.378 (0.128)	N/A	N/A
SS175	6 (150)	0.163 (0.151)	0.185 (0.0172)	N/A	N/A
	8 (200)	0.314 (0.0292)	0.336 (0.0312)	0.293 (0.0272)	0.316 (0.0294)
	10 (250)	0.509 (0.0473)	0.531 (0.0493)	0.457 (0.0425)	0.479 (0.0445)
	12 (300)	0.749 (0.0696)	0.771 (0.0716)	0.658 (0.0611)	0.679 (0.0631)
	14 (350)	1.027 (0.0954)	1.049 (0.0975)	N/A	N/A
	16 (406)	1.356 (0.126)	1.378 (0.128)	N/A	N/A
SS200	6 (150)	0.154 (0.0143)	0.185 (0.0172)	0.143 (0.0133)	0.172 (0.0160)
	8 (200)	0.305 (0.0283)	0.336 (0.0312)	N/A	N/A
	10 (250)	0.500 (0.0465)	0.531 (0.0493)	0.450 (0.0418)	0.479 (0.0445)
	12 (300)	0.740 (0.0687)	0.771 (0.0716)	N/A	N/A
	14 (350)	1.018 (0.0946)	1.049 (0.0975)	N/A	N/A
	16 (406)	1.349 (0.1253)	1.378 (0.128)	N/A	N/A
SS225	6 (150)	0.149 (0.0138)	0.185 (0.0172)	N/A	N/A
	8 (200)	0.300 (0.0279)	0.336 (0.0312)	N/A	N/A
	10 (250)	0.495 (0.0460)	0.531 (0.0493)	N/A	N/A
	12 (300)	0.735 (0.0683)	0.771 (0.0716)	N/A	N/A
	14 (350)	1.013 (0.0941)	1.049 (.0975)	N/A	N/A
	16 (406)	1.341 (0.125)	1.378 (0.128)	N/A	N/A

Table 7-3: CHANCE® Pipe Shaft Helix Plate Sizes and Projected Areas by Product Family

		PIPE SHAFTS			
		STANDARD		SEASHELL	
	Diameter in. (mm)	AREA w/o HOLE ft^2 (m^2)	FULL PLATE AREA ft^2 (m^2)	AREA w/o HOLE ft^2 (m^2)	FULL PLATE AREA ft^2 (m^2)
RS2875	8 (200)	0.290 (0.0269)	0.336 (0.0312)	0.270 (0.0251)	0.316 (0.0294)
	10 (250)	0.485 (0.0451)	0.531 (0.0493)	0.433 (0.0402)	0.479 (0.0445)
	12 (300)	0.725 (0.0674)	0.771 (0.0716)	0.633 (0.0588)	0.680 (0.0632)
	14 (350)	1.003 (0.0932)	1.049 (0.0975)	0.869 (0.0807)	0.915 (0.0850)
	16 (406)	1.31 (0.122)	1.378 (0.128)	N/A	N/A
RS3500	8 (200)	0.268 (0.0249)	0.336 (0.0312)	N/A	N/A
	10 (250)	0.463 (0.0430)	0.531 (0.0493)	N/A	N/A
	12 (300)	0.703 (0.0653)	0.771 (0.0716)	0.612 (0.0569)	0.680 (0.0632)
	14 (350)	0.981 (0.0911)	1.049 (0.0975)	N/A	N/A
	16 (406)	1.312 (0.122)	1.378 (0.128)	N/A	N/A
RS4500	8 (200)	0.224 (0.0208)	0.336 (0.0312)	N/A	N/A
	10 (250)	0.419 (0.0389)	0.531 (0.0493)	0.367 (0.0341)	0.479 (0.0445)
	12 (300)	0.659 (0.0612)	0.771 (0.0716)	N/A	N/A
	14 (350)	0.937 (0.0871)	1.049 (0.0975)	N/A	N/A
	16 (406)	1.266 (0.1176)	1.378 (0.128)	N/A	N/A
	20 (508)	2.034 (0.1889)	2.146 (0.1994)	N/A	N/A

Table 7-4 is a quick reference guide for the design professional. It relates ASTM D1586 SPT "N_{60}" values for cohesive and non-cohesive soils to the expected load capacity of various CHANCE Type Square Shaft (SS) and Round Shaft (RS) Helical Piles. It is intended to be used as a reference guide to enable the designer to quickly determine which helical pile systems to use for project specific soil conditions and load requirements.

Table 7-4: CHANCE® Helical Pile/Anchor Load Capacity Table

Soil Type		Product Family		Axial Compression / Tension Capacity*	
"N_{60}"- Value** Cohesive	"N_{60}"-Value** Non-Cohesive	Helical Pile Shaft Size Inches (mm)	Torque Rating Ft-lb (N-m)	Ultimate Capacity [P_u] Kip (kN)	Allowable Capacity [$P_a = 0.5\ P_u$] Kip (kN)
25 – 35	25 - 30	SS5 1-1/2 (38)	5,700 (7,730)	57 (254)	28.5 (127)
25 - 40	25 - 35	SS150 1-1/2 (38)	7,000 (9,500)	70 (312)	35 (156)
35 - 50	35 -40	SS175 1-3/4 (44)	10,500 (14,200)	105 (467)	52.5 (234)
50 - 70	40 - 60	SS200 2 (51)	16,000 (21,700)	160 (712)	80 (356)
70 - 90	60 - 80	SS225 2-1/4 (57)	21,000 (28,475)	210 (934)	105 (467)
20 - 25	15 - 20	RS2875.203 2-7/8 (73)	5,500 (7,500)	49.5 (220)	24.75 (110)
25 - 35	20 - 30	RS2875.276 2-7/8 (73)	8,000 (10,850)	72 (320)	36 (160)
35 - 40	30 – 35	RS3500.300 3-1/2 (89)	13,000 (17,600)	91 (405)	45.5 (202)
35 – 40	30 – 35	RS4500.337 4-1/2 (114)	23,000 (31,200)	138 (614)	69 (307)

* Based on Torque Rating – Axial Compression / Tension Capacity = Torque Rating x K_t. Well documented correlations with installation torque are recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. "Default" K_t for Type SS = 10 ft^{-1} (33 m^{-1}). "Default" K_t for Type RS2875 Series = 9 ft^{-1} (30 m^{-1}); for Type RS3500.300 = 7 ft^{-1} (23 m^{-1}); for Type RS4500.337 = 6 ft^{-1} (20 m^{-1}).

** "N_{60}" Values or Blow Count from the Standard Penetration Test per ASTM D1586.

NOTES:

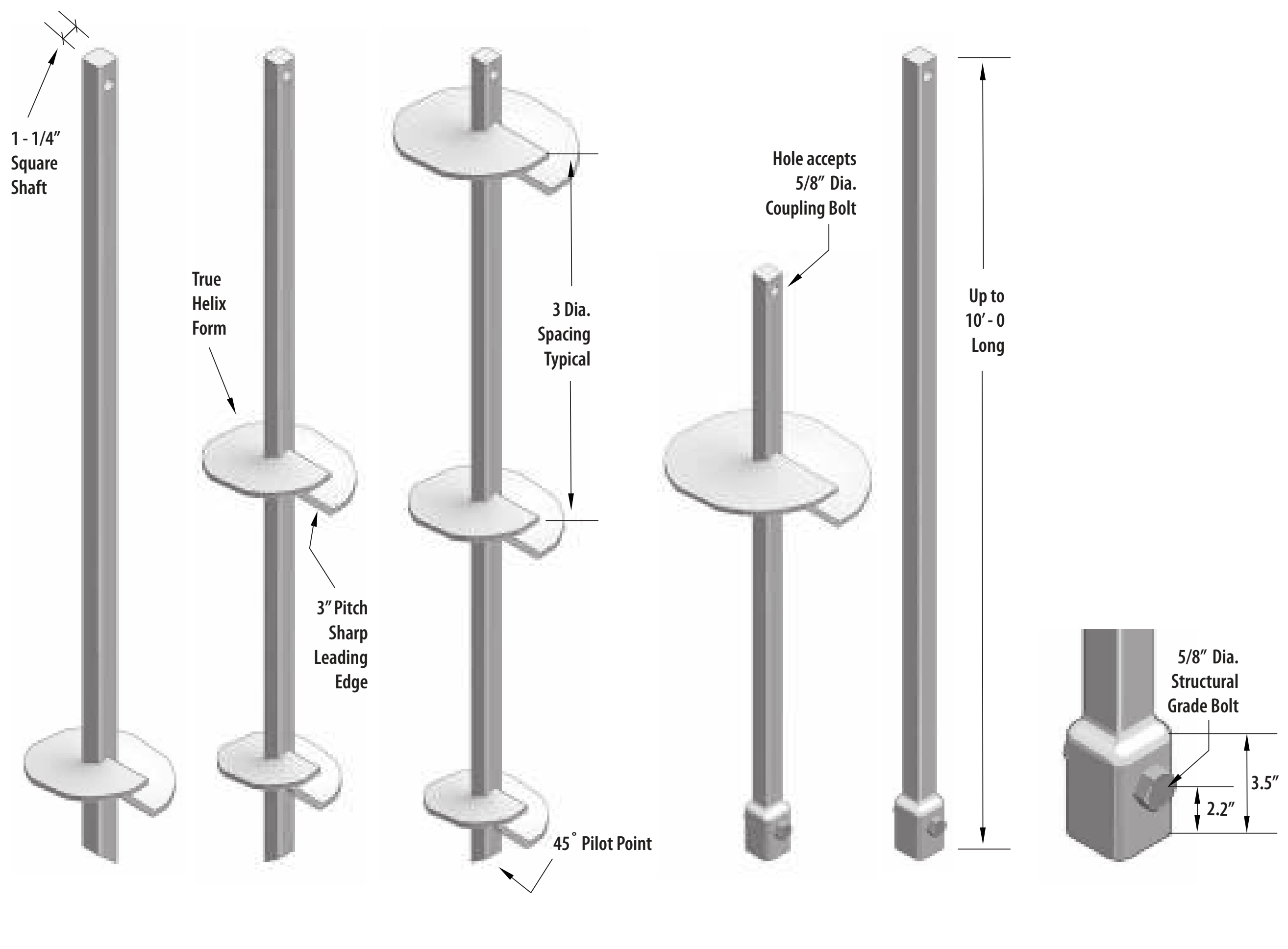
1. The table above is given as a guideline only. The capacity of CHANCE Helical Pile/Anchors may vary depending on, but not limited to, water table elevation and changes to that elevation, changes in soil conditions and soil layer thicknesses.
2. Achievable capacities could be higher or lower than stated in the table depending on:
   a. Site specific conditions
   b. On-site testing verification
   c. HELICAL PULLDOWN® Micropiles can achieve higher capacities in compression. On-site testing should be performed to verify additional pile capacity.
   d. This chart is to be used for preliminary design assessment only. Capacities should be verified on per project, site-specific basis by a registered design professional.
3. The above chart represents the hardest or densest soil conditions that the helical pile can be installed into. The helical pile will likely achieve its torque rating quickly upon encountering the highest N values indicated above.

CHANCE® Type SS125 Helical Piles and Anchors

40 kip Ultimate – 20 kip Allowable Capacity
Installation Torque Rating – 4,000 ft-lb
Multi-Purpose 1-1/4 inch Solid Round-Cornered-Square Steel Shaft with integrally formed square upset sockets

Description:

Hubbell Power Systems, Inc., CHANCE Type SS125 Helical Piles and Anchors have 40 kip ultimate capacity and 20 kip working or allowable capacity in compression or tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Solid square shaft helical piles and anchors provide greater penetration into bearing soils and increased axial capacity in firm soils compared to pipe shaft helical piles with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type SS Helical Piles and Anchors have a longer service life than do pipe shaft piles because of their reduced surface area. CHANCE Type SS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with "sea-shell" cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



Single Helix Lead Section	Twin Helix Lead Section	Triple Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

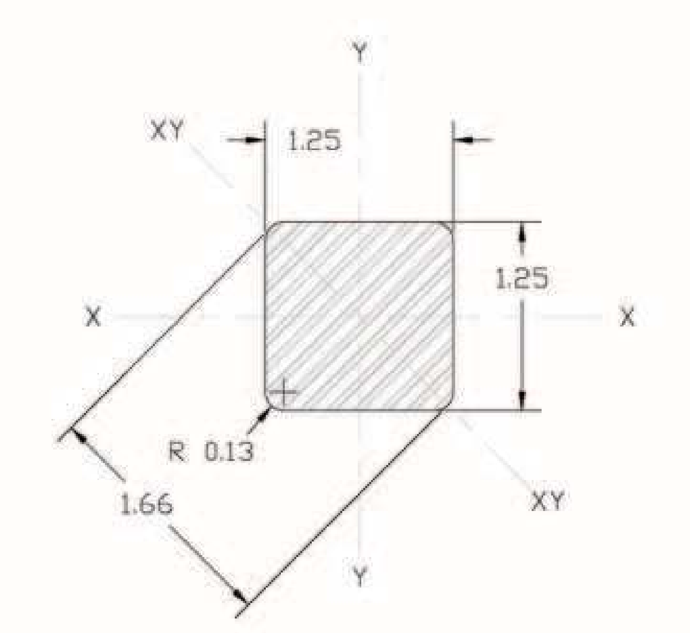
SS125 Helical Pile and Anchor Specifications & Available Configurations

Shaft – Round-Cornered-Square (RCS) 1-1/4 inch solid steel shaft produced exclusively for CHANCE products.
Coupling - forged as a deep socket from the steel shaft material as an integral part of the extension, connected with structural bolts.
Helix - 3/8 inch Thick: ASTM A572, or A1018, or A656 with minimum yield strength of 50 ksi.
3 inch Helix Pitch – a standard established by Hubbell Power Systems, Inc. for Helical Piles and Anchors.
Available Helix Diameters: 6, 8, 10, 12, or 14 inches.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The standard helix plate has straight sharpened leading edges or can be ordered with a "sea shell" cut. The "sea shell" cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:

- Single, double, and triple Lead Sections, 1 and 5 feet long
- Plain Extensions, 3, 5, 7, and 10 feet long
- Extensions with Helix Plates, 3-1/2 feet long, single and double helix

Helical products are Hot Dip Galvanized per ASTM A153 Class B-1.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type SS125
Helical Pile Shaft Cross-Section
Figure 7-3

Nominal, LRFD Design and ASD Allowable Strengths of SS125 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength kip (kN)	LRFD Design Strength kip (kN)	ASD Allowable Strength kip (kN)
6 (150)	0.375 (9.5)	37.4 (166.3)	33.7 (149.9)	18.7 (83.2)
8 (200)	0.375 (9.5)	37.4 (166.3)	33.7 (149.9)	18.7 (83.2)
10 (250)	0.375 (9.5)	46.6 (207.3)	41.9 (186.4)	23.3 (103.6)
12 (300)	0.375 (9.5)	44.1 (196.2)	39.7 (176.6)	22.1 (98.3)
14 (350)	0.375 (9.5)	36.0 (160.1)	32.4 (144.1)	18.0 (80.1)

For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

Nominal and LRFD Design Compression Strengths of CHANCE® Type SS125 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	Nominal & LRFD Design Compression Strengths kip (kN)							
	Firm Soil				Soft Soil			
	Fixed		Pinned		Fixed		Pinned	
	Nominal	Design	Nominal	Design	Nominal	Design	Nominal	Design
Lead, Single Helix	*See Helix Strength Table*		27.3 (121.4)	24.6 (109.4)	13.4 (59.6)	12.0 (53.4)	6.8 (30.2)	6.2 (27.6)
Lead, Multi-Helix	53.6 (238.4)	48.2 (214.4)	27.3 (121.4)	24.6 (109.4)	13.4 (59.6)	12.0 (53.4)	6.8 (30.2)	6.2 (27.6)
Extension	53.6 (238.4)	48.2 (214.4)	27.3 (121.4)	24.6 (109.4)				

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

SS125 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled Round-Cornered-Square (RCS) Solid Steel Bars per ASTM A29; modified AISI 1530 with 90 ksi minimum yield strength			
Shaft Size	1.25 in	32 mm	Corroded	
			1.237 in	31.4 mm
Moment of Inertia (I)	0.20 in^4	8.3 cm^4	Corroded	
			0.191 in^4	7.95 cm^4
Shaft Area (A)	1.55 in^2	10.0 cm^2	Corroded	
			1.52 in^2	9.81 cm^2
Section Modulus (S_{x-x})	0.32 in^3	5.3 cm^3	Corroded	
			0.31 in^3	5.1 cm^3
Perimeter	4.79 in	12.17 cm	Corroded	
			4.74 in	12.0 cm
Coupling	Integral Forged Square Deep Socket			
Coupling Bolts	One 5/8 inch Diameter ASTM A325 Type 1 Hex Head Bolt with Threads Excluded from Shear Planes			
Helix Plates	0.375 inch Thick, Formed on Matching Metal Dies, ASTM A572 Grade 50 or better			
Coatings	Hot Dip Galvanized per ASTM A153 Class B-1, 3.1 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	10 ft^{-1}		33 m^{-1}	
Torque Rating	4,000 ft-lb		5,400 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	50 kip	222 kN	37.5 kip	167 kN
Allowable Tension Strength	25 kip		111 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	40 kip	178 kN	20 kip	89 kN

Assembly of SS125
Figure 7-4

ASD Allowable Compression Strengths of CHANCE® Type SS125 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength kip (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	*See Helix Strength Table*	16.4 (72.9)	8.0 (35.6)	4.1 (18.2)
Lead, Multi-Helix	32.1 (142.8)	16.4 (72.9)	8.0 (35.6)	4.1 (18.2)
Extension	32.1 (142.8)	16.4 (72.9)	8.0 (35.6)	4.1 (18.2)

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

CHANCE® Type SS5 Helical Piles and Anchors

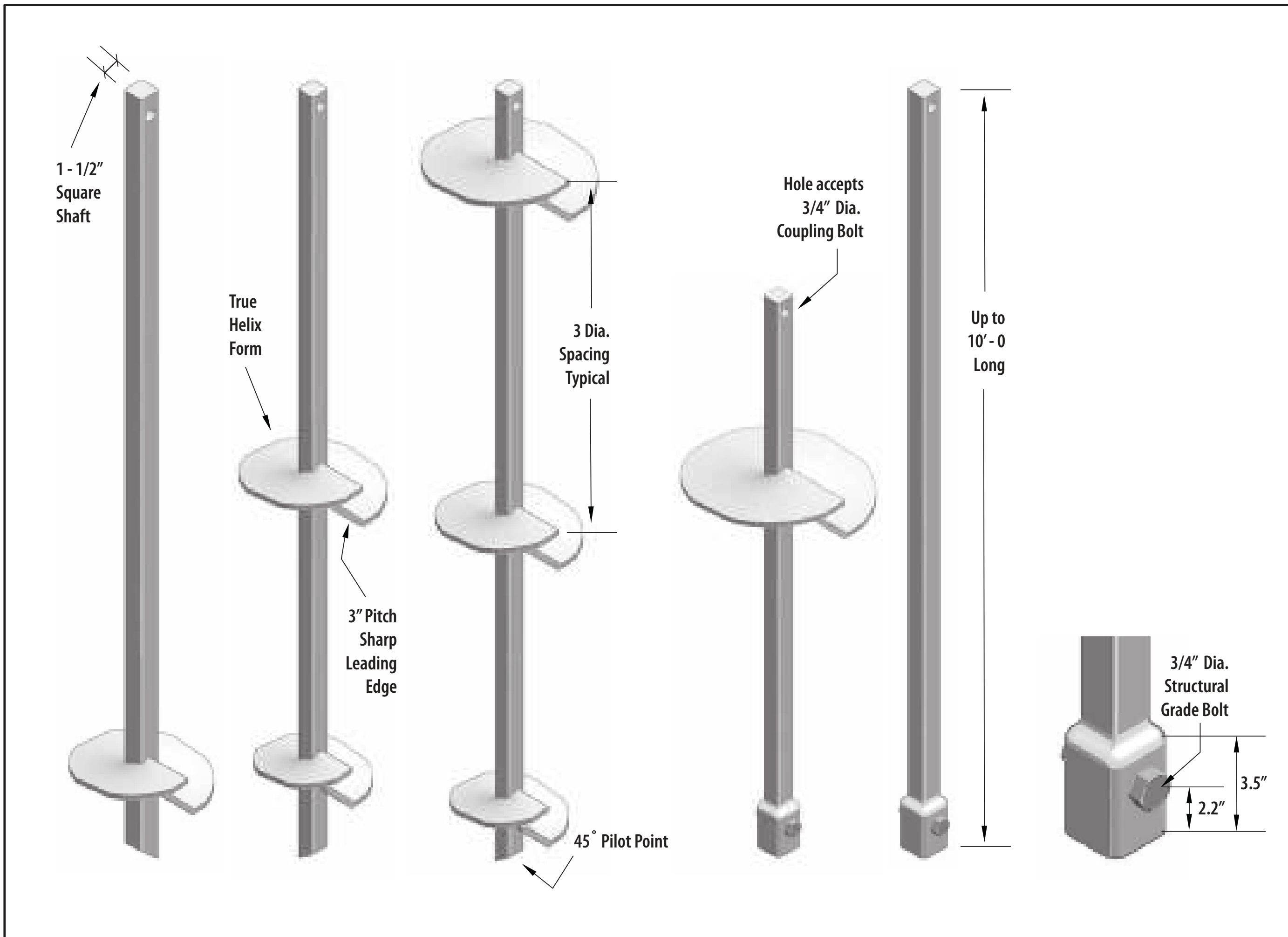
57 kip Ultimate – 28.5 kip Allowable Capacity

Installation Torque Rating – 5,700 ft-lb

Multi-Purpose 1-1/2 inch Solid Round-Cornered-Square Steel Shaft with integrally formed square upset sockets

Description:

Hubbell Power Systems, Inc., CHANCE Type SS5 Helical Piles and Anchors have 57 kip ultimate capacity and 28.5 kip working or allowable capacity in compression or tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Solid square shaft helical piles and anchors provide greater penetration into bearing soils and increased axial capacity in firm soils compared to pipe shaft helical piles with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type SS Helical Piles and Anchors have a longer service life than do pipe shaft piles because of their reduced surface area. CHANCE Type SS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with "sea-shell" cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



Single Helix Lead Section	Twin Helix Lead Section	Triple Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

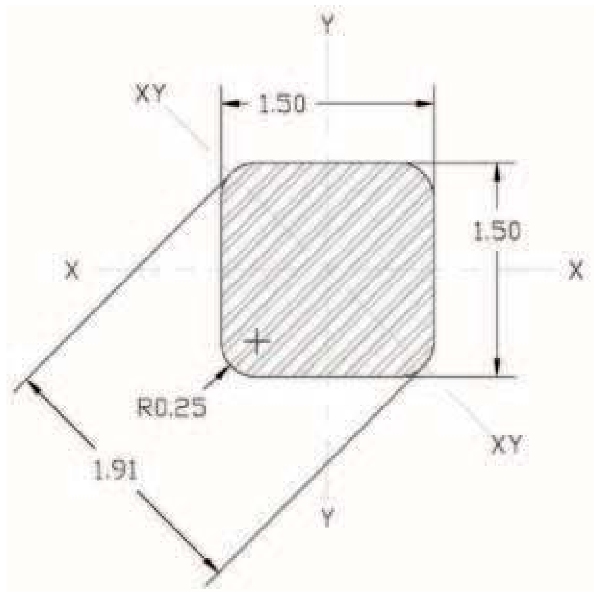
SS5 Helical Pile and Anchor Specifications & Available Configurations

Shaft – Round-Cornered-Square (RCS) 1-1/2 inch solid steel shaft produced exclusively for CHANCE products.
Coupling - forged as a deep socket from the steel shaft material as an integral part of the extension, connected with structural bolts.
Helix - 3/8 inch Thick: ASTM A572, or A1018, or A656 with minimum yield strength of 50 ksi.
3 inch Helix Pitch – a standard established by Hubbell Power Systems, Inc. for Helical Piles and Anchors.
Available Helix Diameters: 6, 8, 10, 12, 14, or 16 inches.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The standard helix plate has straight sharpened leading edges or can be ordered with a "sea shell" cut. The "sea shell" cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:

- Single, double, triple, and quad helix Lead Sections, 3, 5, 7, and 10 feet long
- Plain Extensions, 3, 5, 7, and 10 feet long
- Extensions with Helix Plates, 3 and 5 feet long, single helix

Helical products are Hot Dip Galvanized per ASTM A153 Class B-1.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type SS5
Helical Pile Shaft Cross-Section
Figure 7-5

Nominal, LRFD Design and ASD Allowable Strengths of SS5 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength kip (kN)	LRFD Design Strength kip (kN)	ASD Allowable Strength kip (kN)
6 (150)	0.375 (9.5)	57.3 (254.9)	51.6 (229.5)	28.7 (127.7)
8 (200)	0.375 (9.5)	57.3 (254.9)	51.6 (229.5)	28.7 (127.7)
10 (250)	0.375 (9.5)	47.7 (212.2)	42.9 (190.8)	23.8 (105.6)
12 (300)	0.375 (9.5)	44.2 (196.6)	39.8 (177.0)	22.1 (98.3)
14 (350)	0.375 (9.5)	54.1 (240.7)	48.7 (216.6)	27.1 (120.6)

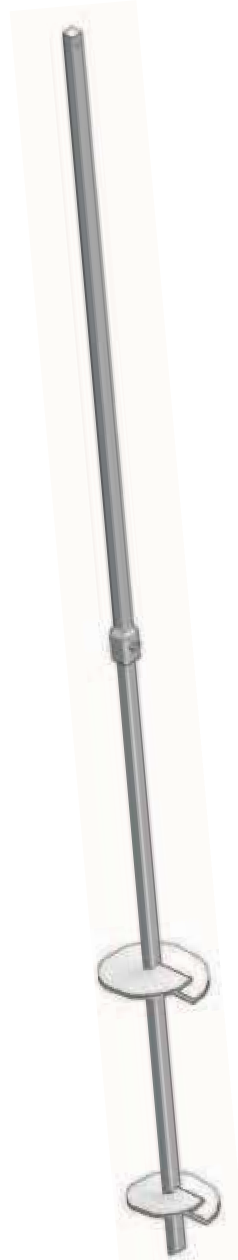
For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

Nominal and LRFD Design Compression Strengths of CHANCE® Type SS5 Helical Pile Lead & Extension Sections[1,2]

<table>
<tr><th rowspan="4">Section Type & Helix Count</th><th colspan="8">Nominal & LRFD Design Compression Strengths kip (kN)</th></tr>
<tr><th colspan="4">Firm Soil</th><th colspan="4">Soft Soil</th></tr>
<tr><th colspan="2">Fixed</th><th colspan="2">Pinned</th><th colspan="2">Fixed</th><th colspan="2">Pinned</th></tr>
<tr><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th></tr>
<tr><td rowspan="2">Lead, Single Helix</td><td colspan="2" rowspan="2">See Helix Strength Table</td><td>Single 6 & 8 in 54.4 (242.0)</td><td>Single 6 & 8 in 48.9 (217.5)</td><td rowspan="2">26.6 (118.3)</td><td rowspan="2">24.0 (106.8)</td><td rowspan="2">13.6 (60.5)</td><td rowspan="2">12.2 (54.3)</td></tr>
<tr><td colspan="2">For Other Helix Diameters, See Helix Strength Table</td></tr>
<tr><td>Lead, Multi-Helix</td><td>89.8 (399.5)</td><td>80.8 (359.4)</td><td>54.4 (242.0)</td><td>48.9 (219.5)</td><td rowspan="2">26.6 (118.3)</td><td rowspan="2">24.0 (106.8)</td><td rowspan="2">13.6 (60.5)</td><td rowspan="2">12.2 (54.3)</td></tr>
<tr><td>Extension</td><td>89.8 (399.5)</td><td>80.8 (359.4)</td><td>54.4 (242.0)</td><td>48.9 (219.5)</td></tr>
</table>

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

SS5 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled Round-Cornered-Square (RCS) Solid Steel Bars per ASTM A29; modified AISI 1044 with 70 ksi minimum yield strength			
Shaft Size	1.50 in	38 mm	Corroded 1.487 in	37.8 mm
Moment of Inertia (I)	0.40 in^4	16.5 cm^4	Corroded 0.38 in^4	15.6 cm^4
Shaft Area (A)	2.2 in^2	14.2 cm^2	Corroded 2.16 in^2	13.94 cm^2
Section Modulus (S_{x-x})	0.53 in^3	8.7 cm^3	Corroded 0.40 in^3	6.6 cm^3
Perimeter	5.6 in	14.2 cm	Corroded 5.5 in	14 cm
Coupling	Integral Forged Square Deep Socket			
Coupling Bolts	One ¾ inch Diameter ASTM A325 Type 1 Hex Head Bolt with Threads Excluded from Shear Planes			
Helix Plates	0.375 inch Thick, Formed on Matching Metal Dies, ASTM A572 Grade 50 or better			
Coatings	Hot Dip Galvanized per ASTM A153 Class B-1, 3.1 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	10 ft^{-1}		33 m^{-1}	
Torque Rating	5,700 ft-lb		7,730 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal 70 kip	312 kN	LRFD Design 52.5 kip	234 kN
Allowable Tension Strength	35 kip		156 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate 57 kip	254 kN	Allowable 28.5 kip	127 kN



Assembly of SS5
Figure 7-6

ASD Allowable Compression Strengths of CHANCE® Type SS5 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength kip (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	*See Helix Strength Table*	*See Helix Strength Table*	16 (71.2)	8.1 (36.0)
Lead, 2-Helix 8”-10”	52.5 (233.5)	32.6 (145.0)	16 (71.2)	8.1 (36.0)
Lead, 2-Helix 10”-12”	45.9 (204.2)			
Lead, 2-Helix 12”-14”	49.9 (222.0)			
Lead, 2-Helix 14”-14”	53.8 (239.3)			
Lead, Multi-Helix	53.8 (239.3)	32.6 (145.0)	16 (71.2)	8.1 (36.0)
Extension	53.8 (239.3)	32.6 (145.0)	16 (71.2)	8.1 (36.0)

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

CHANCE® Type SS150 Helical Piles and Anchors

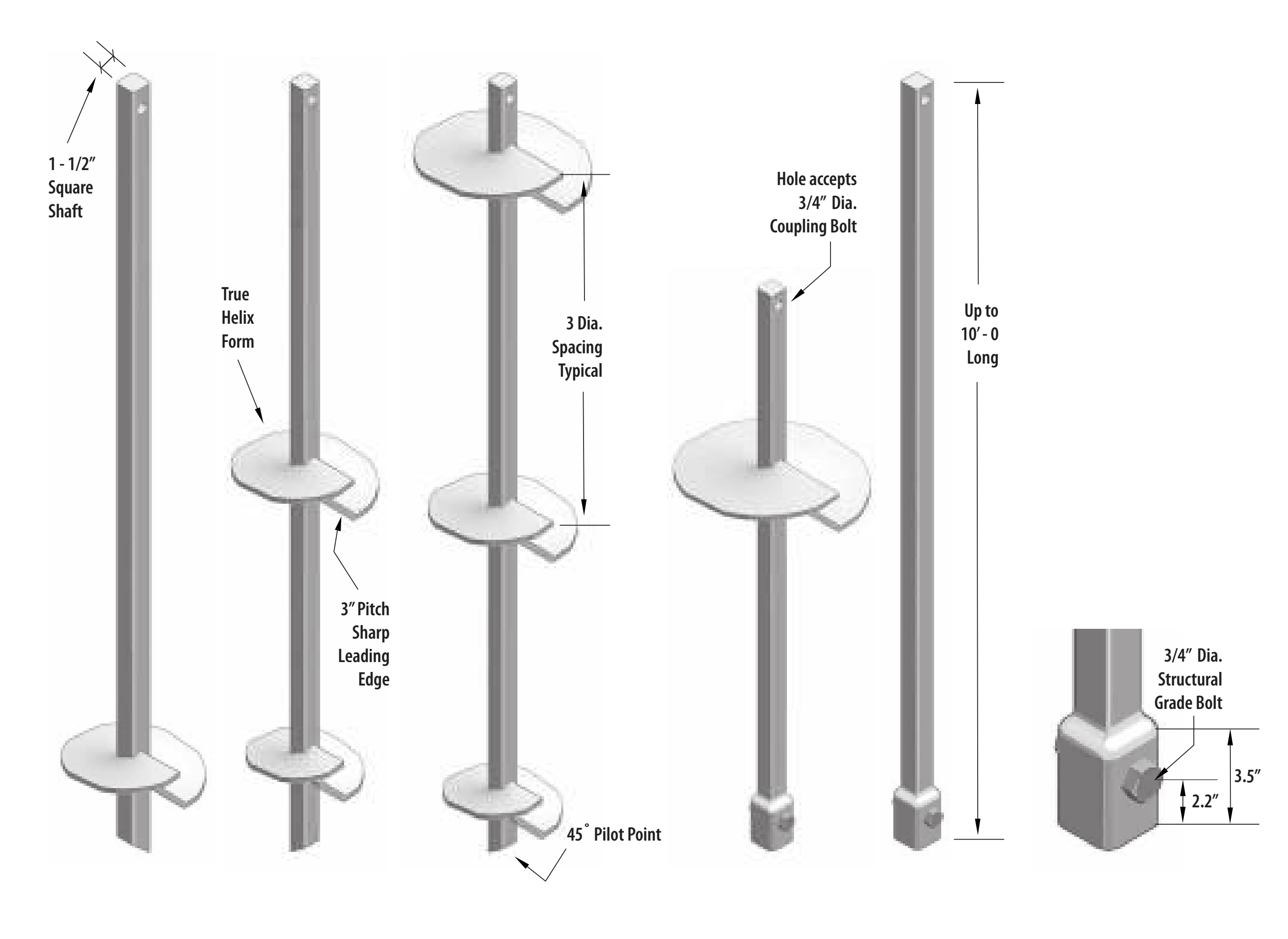
70 kip Ultimate – 35 kip Allowable Capacity

Installation Torque Rating – 7,000 ft-lb

Multi-Purpose 1-1/2 inch Solid Round-Cornered-Square Steel Shaft with integrally formed square upset sockets

Description:

Hubbell Power Systems, Inc., CHANCE Type SS150 Helical Piles and Anchors have 70 kip ultimate capacity and 35 kip working or allowable capacity in compression or tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Solid square shaft helical piles and anchors provide greater penetration into bearing soils and increased axial capacity in firm soils compared to pipe shaft helical piles with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type SS Helical Piles and Anchors have a longer service life than do pipe shaft piles because of their reduced surface area. CHANCE Type SS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with "sea-shell" cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



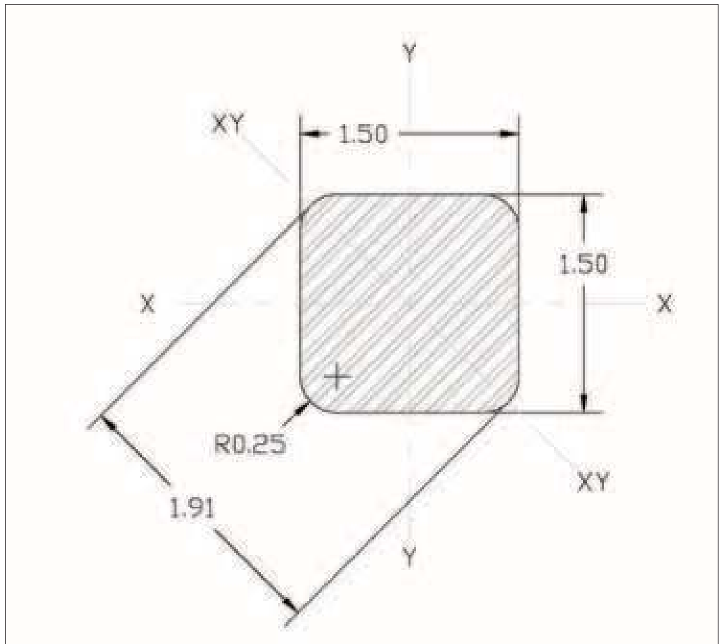
Single Helix Lead Section	Twin Helix Lead Section	Triple Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

SS150 Helical Pile and Anchor Specifications & Available Configurations

Shaft – Round-Cornered-Square (RCS) 1-1/2 inch solid steel shaft produced exclusively for CHANCE products.
Coupling - forged as a deep socket from the steel shaft material as an integral part of the extension, connected with structural bolts.
Helix - 3/8 inch Thick: ASTM A656 or A1018, with minimum yield strength of 80 ksi.
3 inch Helix Pitch – a standard established by Hubbell Power Systems, Inc. for Helical Piles and Anchors.
Available Helix Diameters: 6, 8, 10, 12, and 14 inch.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The standard helix plate has straight sharpened leading edges or can be ordered with a "sea shell" cut. The "sea shell" cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Single, double, triple, and quad helix Lead Sections, 3, 5, 7, and 10 feet long
Plain Extensions, 3, 5, 7, and 10 feet long
Extensions with Helix Plates, 5, 7, and 10 feet long, single and multi-helix
Helical products are Hot Dip Galvanized per ASTM A153 Class B-1.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Axial Deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type SS150
Helical Pile Shaft Cross-Section
Figure 7-7

Nominal, LRFD Design and ASD Allowable Strengths of SS150 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength, kip (kN)	LRFD Design Strength, kip (kN)	ASD Allowable Strength, kip (kN)
6 (150)	0.375 (9.5)	57.7 (257)	51.9 (231)	28.8 (128)
8 (200)	0.375 (9.5)	57.7 (257)	51.9 (231)	28.8 (128)
10 (250)	0.375 (9.5)	61.9 (275)	55.7 (248)	30.9 (137)
12 (300)	0.375 (9.5)	49.7 (221)	44.7 (199)	24.8 (110)
14 (350)	0.375 (9.5)	52.9 (235)	47.7 (212)	26.5 (118)

For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

Nominal and LRFD Design Compression Strengths of CHANCE® Type SS150 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	Nominal & LRFD Design Compression Strengths, kip (kN)							
	Firm Soil				Soft Soil			
	Fixed		Pinned		Fixed		Pinned	
	Nominal	Design	Nominal	Design	Nominal	Design	Nominal	Design
Lead, Single Helix	*See Helix Strength Table*		Single 6, 8, or 10 inch – 54.4 (242) *For Other Helix Diameters, See Helix Strength Table*	Single 6, 8, or 10 inch – 48.9 (218)	26.6 (118)	24.0 (107)	13.6 (60.5)	12.2 (54)
Lead, Multi-Helix Extension	99.5 (443)	89.5 (398)	54.4 (242)	48.9 (218)	26.6 (118)	24.0 (107)	13.6 (60.5)	12.2 (54)

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

SS150 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled Round-Cornered-Square (RCS) Solid Steel Bars per ASTM A29; modified AISI 1530 with 90 ksi minimum yield strength			
Shaft Size	1.50 in	38 mm	Corroded	
			1.487 in	37.8 mm
Moment of Inertia (I)	0.40 in^4	16.5 cm^4	Corroded	
			0.38 in^4	15.6 cm^4
Shaft Area (A)	2.2 in^2	14.2 cm^2	Corroded	
			2.16 in^2	13.94 cm^2
Section Modulus (S_{x-x})	0.53 in^3	8.7 cm^3	Corroded	
			0.40 in^3	6.6 cm^3
Perimeter	5.6 in	14.2 cm	Corroded	
			5.5 in	14.0 cm
Coupling	Integral Forged Square Deep Socket			
Coupling Bolts	One 3/4 inch Diameter ASTM A325 Type 1 Hex Head Bolt with Threads Excluded from Shear Planes			
Helix Plates	0.375 inch Thick, Formed on Matching Metal Dies, ASTM A656 Grade 80 or better			
Coatings	Hot Dip Galvanized per ASTM A153 Class B-1, 3.1 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	10 ft^{-1}		33 m^{-1}	
Torque Rating	7,000 ft-lb		9,500 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	70 kip	312 kN	52.5 kip	234 kN
Allowable Tension Strength	35 kip		156 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	70 kip	312 kN	35 kip	156 kN

Assembly of SS150
Figure 7-8

DRAWINGS & RATINGS

ASD Allowable Compression Strengths of CHANCE® Type SS150 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength, kip (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	See Helix Strength Table Above	See Helix Strength Table Above	16 (71)	8.1 (36)
Lead, 2-Helix 8”-10”	59.6 (265)	32.6 (145)	16 (71)	8.1 (36)
Lead, 2-Helix 10”-12”	55.7 (248)			
Lead, 2-Helix 12”-14”	51.3 (228)			
Lead, 2-Helix 14”-14”	53.0 (236)			
Lead, Multi-Helix	59.6 (265)			
Extension	59.6 (265)			

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

CHANCE® Type SS175 Helical Piles and Anchors

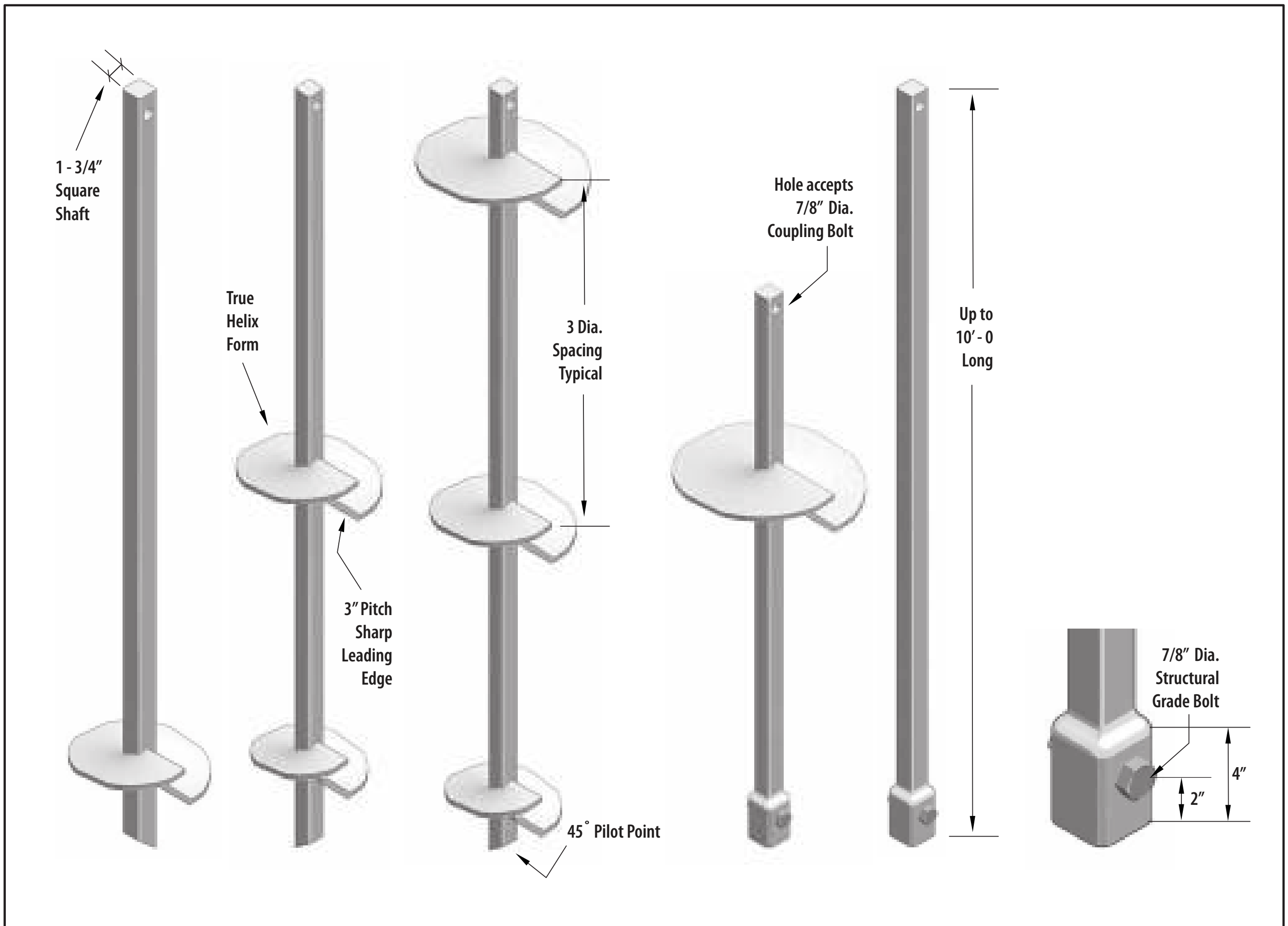
105 kip Ultimate – 52.5 kip Allowable Capacity

Installation Torque Rating – 10,500 ft-lb

Multi-Purpose 1-3/4 inch Solid Round-Cornered-Square Steel Shaft with integrally formed square upset sockets

Description:

Hubbell Power Systems, Inc., CHANCE Type SS175 Helical Piles and Anchors have 105 kip ultimate capacity and 52.5 kip working or allowable capacity in compression and 100 kip ultimate capacity and 50 kip working or allowable capacity in tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Solid square shaft helical piles and anchors provide greater penetration into bearing soils and increased axial capacity in firm soils compared to pipe shaft helical piles with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type SS Helical Piles and Anchors have a longer service life than do pipe shaft piles because of their reduced surface area. CHANCE Type SS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with "sea-shell" cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



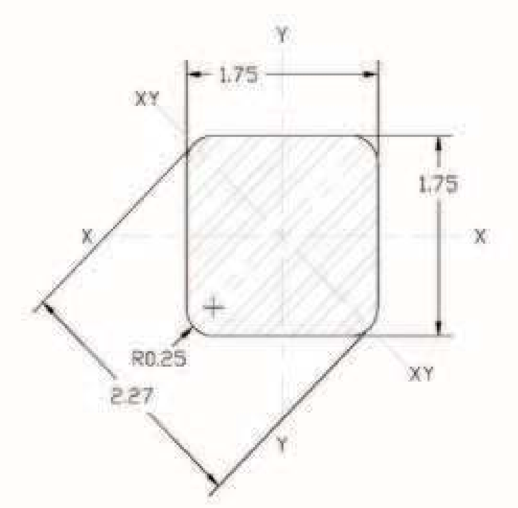
Single Helix Lead Section	Twin Helix Lead Section	Triple Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

SS175 Helical Pile and Anchor Specifications & Available Configurations

Shaft – Round-Cornered-Square (RCS) 1-3/4 inch solid steel shaft produced exclusively for CHANCE products.
Coupling – forged as a deep socket from the steel shaft material as an integral part of the extension, connected with structural bolts.
Helix - 3/8 & 1/2 inch Thick: ASTM A656, or A1018 with minimum yield strength of 80 ksi.
3 inch Helix Pitch – a standard established by Hubbell Power Systems, Inc. for Helical Piles and Anchors.
Available Helix Diameters: 6, 8, 10, 12, or 14 inches.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The standard helix plate has straight sharpened leading edges or can be ordered with a "sea shell" cut. The "sea shell" cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Single, double, triple, and quad helix Lead Sections, 3, 5, 7, and 10 feet long
Plain Extensions, 3, 5, 7, and 10 feet long
Extensions with Helix Plates, 3, 5, 7, and 10 feet long, single and multi-helix
Helical products are Hot Dip Galvanized per ASTM A153 Class B-1.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type SS175
Helical Pile Shaft Cross-Section
Figure 7-9

Nominal, LRFD Design and ASD Allowable Strengths of SS175 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength, kip (kN)	LRFD Design Strength, kip (kN)	ASD Allowable Strength, kip (kN)
6 (150)	0.5 (13)	123.3 (548.5)	111 (493.8)	61.6 (274)
8 (200)	0.5 (13)	123.3 (548.5)	111 (493.8)	61.6 (274)
10 (250)	0.375 (9.5)	66.1 (294)	59.5 (264.7)	33.1 (147.2)
12 (300)	0.375 (9.5)	57.5 (255.8)	51.7 (230)	28.7 (127.7)
14 (350)	0.375 (9.5)	51.8 (230.4)	46.7 (207.7)	25.9 (115.2)

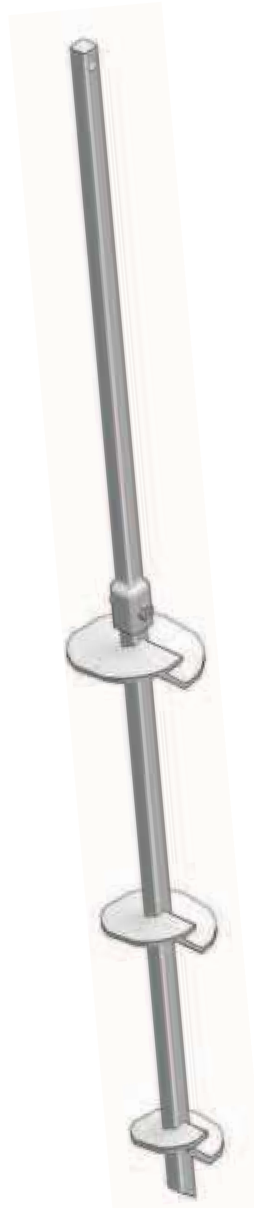
For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

Nominal and LRFD Design Compression Strengths of CHANCE® Type SS175 Helical Pile Lead & Extension Sections[1,2]

<table>
<tr><th rowspan="4">Section Type & Helix Count</th><th colspan="8">Nominal & LRFD Design Compression Strengths, kip (kN)</th></tr>
<tr><th colspan="4">Firm Soil</th><th colspan="4">Soft Soil</th></tr>
<tr><th colspan="2">Fixed</th><th colspan="2">Pinned</th><th colspan="2">Fixed</th><th colspan="2">Pinned</th></tr>
<tr><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th></tr>
<tr><td>Lead, Single Helix</td><td colspan="2">See Helix Strength Table</td><td colspan="2">See Helix Strength Table</td><td>50.5 (224.6)</td><td>45.4 (201.9)</td><td>25.8 (114.8)</td><td>23.2 (103.2)</td></tr>
<tr><td>Lead, 2-Helix 8"-10"</td><td>164.3 (730.8)</td><td>147.8 (657.4)</td><td rowspan="6">103.0 (458.2)</td><td rowspan="6">92.7 (412.4)</td><td rowspan="6">50.5 (224.6)</td><td rowspan="6">45.4 (201.9)</td><td rowspan="6">25.8 (114.8)</td><td rowspan="6">23.2 (103.2)</td></tr>
<tr><td>Lead, 2-Helix 10"-12"</td><td>123.6 (549.8)</td><td>111.2 (494.6)</td></tr>
<tr><td>Lead, 2-Helix 12"-14"</td><td>109.3 (486.2)</td><td>98.4 (437.7)</td></tr>
<tr><td>Lead, 2-Helix 14"-14"</td><td>103.6 (460.8)</td><td>93.4 (415.5)</td></tr>
<tr><td>Lead, Multi-Helix</td><td>164.3 (730.8)</td><td>147.8 (657.4)</td></tr>
<tr><td>Extension</td><td>164.3 (730.8)</td><td>147.8 (657.4)</td></tr>
</table>

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

SS175 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled Round-Cornered-Square (RCS) Solid Steel Bars per ASTM A29; modified AISI 1530 with 90 ksi minimum yield strength			
Shaft Size	1.75 in	44.4 mm	Corroded 1.737 in	Corroded 44 mm
Moment of Inertia (I)	0.75 in^4	31.1 cm^4	Corroded 0.725 in^4	Corroded 30.1 cm^4
Shaft Area (A)	3.1 in^2	19.4 cm^2	Corroded 2.97 in^2	Corroded 19.16 cm^2
Section Modulus (S_{x-x})	0.85 in^3	13.9 cm^3	Corroded 0.835 in^3	Corroded 13.65 cm^3
Perimeter	6.6 in	16.7 cm	Corroded 6.5 in	Corroded 16.5 cm
Coupling	Integral Forged Square Deep Socket			
Coupling Bolts	One 7/8 inch Diameter ASTM A193 Grade B7 Hex Head Bolt with Threads Excluded from Shear Planes			
Helix Plates	0.375 & 0.5 inch Thick, Formed on Matching Metal Dies, ASTM A656 Grade 80 or better			
Coatings	Hot Dip Galvanized per ASTM A153 Class B-1, 3.1 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	10 ft^{-1}		33 m^{-1}	
Torque Rating	10,500 ft-lb		14,240 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	100 kip	445 kN	75 kip	334 kN
Allowable Tension Strength	50 kip		222 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	105 kip	467 kN	52.5 kip	234 kN



Assembly of SS175
Figure 7-10

ASD Allowable Compression Strengths of CHANCE® Type SS150 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength, kip (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	See Helix Strength Table Above	See Helix Strength Table Above	30.2 (134.3)	15.4 (68.5)
Lead, Single 12” Helix			28.7 (127.7)	
Lead, Single 14” Helix			25.9 (115.2)	
Lead, 2-Helix 8”-10”	94.7 (421.2)	61.7 (274.5)	30.2 (134.3)	15.4 (68.5)
Lead, 2-Helix 10”-12”	61.8 (274.9)	61.7 (274.5)		
Lead, 2-Helix 12”-14”	54.6 (242.9)	54.6 (242.9)		
Lead, 2-Helix 14”-14”	51.8 (230.4)	51.8 (230.4)		
Lead, Multi-Helix	98.4 (437.7)	61.7 (274.5)	30.2 (134.3)	15.4 (68.5)
Extension	98.4 (437.7)	61.7 (274.5)	30.2 (134.3)	15.4 (68.5)

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

CHANCE® Type SS200 Helical Piles and Anchors

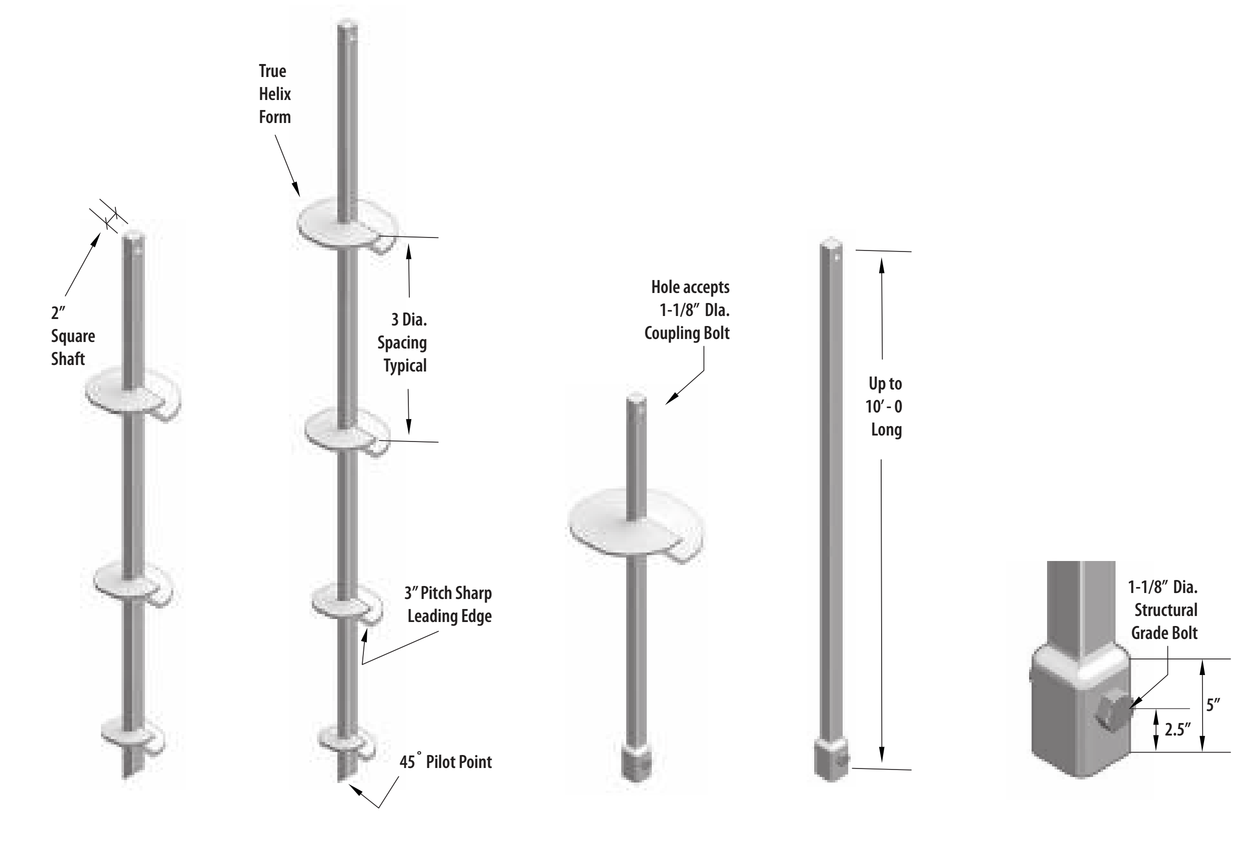
160 kip Ultimate – 80 kip Allowable Capacity

Installation Torque Rating – 16,000 ft-lb

Multi-Purpose 2 inch Solid Round-Cornered-Square Steel Shaft with integrally formed square upset sockets

Description:

Hubbell Power Systems, Inc.,CHANCE Type SS200 Helical Piles and Anchors have 160 kip ultimate capacity and 80 kip working or allowable capacity in compression and 150 kip ultimate capacity and 75 kip working or allowable capacity in tension. This capacity is based on structural strength ratings and well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Solid square shaft helical piles and anchors provide greater penetration into bearing soils and increased axial capacity in firm soils compared to pipe shaft helical piles with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type SS Helical Piles and Anchors have a longer service life than do pipe shaft piles because of their reduced surface area. CHANCE Type SS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with "sea-shell" cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



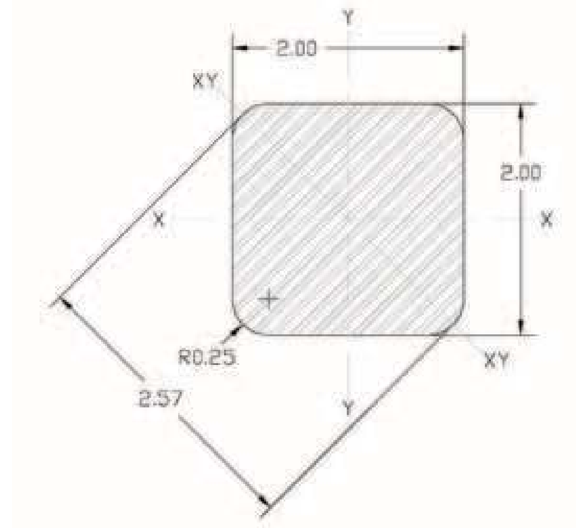
Triple Helix Lead Section	Quad Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

SS200 Helical Pile and Anchor Specifications & Available Configurations

Shaft – Round-Cornered-Square (RCS) 2 inch solid steel shaft produced exclusively for CHANCE products.
Coupling - forged as a deep socket from the steel shaft material as an integral part of the extension, connected with structural bolts.
Helix – ½ inch Thick: ASTM A656, or A1018 with minimum yield strength of 80 ksi.
3 inch Helix Pitch – a standard established by Hubbell Power Systems, Inc. for Helical Piles and Anchors.
Available Helix Diameters: 6, 8, 10, 12, and 14 inch.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The standard helix plate has straight sharpened leading edges or can be ordered with a "sea shell" cut. The "sea shell" cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Triple, and quad helix Lead Sections, 5, 7, 8, and 10 feet long
Plain Extensions, 3, 5, 7, and 10 feet long
Extensions with Helix Plates, 3, 7, and 10 feet long, single and multi-helix
Helical products are Hot Dip Galvanized per ASTM A153 Class B-1.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Axial deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type SS200
Helical Pile Shaft Cross-Section
Figure 7-11

Nominal, LRFD Design and ASD Allowable Strengths of SS220 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength, kip (kN)	LRFD Design Strength, kip (kN)	ASD Allowable Strength, kip (kN)
6 (150)	0.5 (13)	154 (685)	138.5 (616.1)	77 (342.5)
8 (200)	0.5 (13)	154 (685)	138.5 (616.1)	77 (342.5)
10 (250)	0.5 (13)	122.8 (546.2)	110.5 (491.5)	61.4 (273.1)
12 (300)	0.5 (13)	131.3 (584)	118.1 (525.3)	65.6 (291.8)
14 (350)	0.5 (13)	115.3 (512.9)	103.8 (461.7)	57.6 (256.2)

For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

Nominal and LRFD Design Compression Strengths of CHANCE® Type SS200 Helical Pile Lead & Extension Sections[1,2]

<table>
<tr><th rowspan="4">Section Type & Helix Count</th><th colspan="8">Nominal & LRFD Design Compression Strengths, kip (kN)</th></tr>
<tr><th colspan="4">Firm Soil</th><th colspan="4">Soft Soil</th></tr>
<tr><th colspan="2">Fixed</th><th colspan="2">Pinned</th><th colspan="2">Fixed</th><th colspan="2">Pinned</th></tr>
<tr><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th></tr>
<tr><td>Lead, Single Helix</td><td colspan="2">See Helix Strength Table</td><td colspan="2">See Helix Strength Table</td><td>85.6 (380.8)</td><td>77.1 (342.9)</td><td>43.7 (194.4)</td><td>39.3 (174.8)</td></tr>
<tr><td>Lead, 2-Helix 8"-10"</td><td>239.6 (1065.8)</td><td>215.6 (959)</td><td rowspan="6">167.5 (745)</td><td rowspan="6">150.8 (670.8)</td><td rowspan="6">86.6 (385.2)</td><td rowspan="6">77.1 (342.9)</td><td rowspan="6">43.7 (194.4)</td><td rowspan="6">39.3 (174.8)</td></tr>
<tr><td>Lead, 2-Helix 10"-12"</td><td>239.6 (1065.8)</td><td>215.6 (959)</td></tr>
<tr><td>Lead, 2-Helix 12"-14"</td><td>239.6 (1065.8)</td><td>215.6 (959)</td></tr>
<tr><td>Lead, 2-Helix 14"-14"</td><td>230.6 (1025.8)</td><td>207.6 (923.5)</td></tr>
<tr><td>Lead, Multi-Helix</td><td>239.6 (1065.8)</td><td>215.6 (959)</td></tr>
<tr><td>Extension</td><td>239.6 (1065.8)</td><td>215.6 (959)</td></tr>
</table>

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

SS200 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled Round-Cornered-Square (RCS) Solid Steel Bars per ASTM A29; modified AISI 1530 with 90 ksi minimum yield strength			
Shaft Size	2 in	51 mm	Corroded	
			1.971 in	50 mm
Moment of Inertia (I)	1.26 in^4	52.4 cm^4	Corroded	
			1.19 in^4	49.53 cm^4
Shaft Area (A)	3.9 in^2	25.3 cm^2	Corroded	
			3.81 in^2	24.58 cm^2
Section Modulus (S_{x-x})	1.26 in^3	20.6 cm^3	Corroded	
			1.21 in^3	19.83 cm^3
Perimeter	7.5 in	18.9 cm	Corroded	
			7.36 in	18.69 cm
Coupling	Integral Forged Square Deep Socket			
Coupling Bolts	One 1-1/8 inch Diameter ASTM A193 Grade B7 Hex Head Bolt with Threads Excluded from Shear Planes			
Helix Plates	0.5 inch Thick, Formed on Matching Metal Dies, ASTM A656 or A1018 Grade 80			
Coatings	Hot Dip Galvanized per ASTM A153 Class B-1, 3.1 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	10 ft^{-1}		33 m^{-1}	
Torque Rating	16,000 ft-lb		21,700 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	150 kip	668 kN	112.5 kip	500 kN
Allowable Tension Strength	75 kip		334 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	160 kip	712 kN	80 kip	356 kN

Assembly of SS200
Figure 7-12

ASD Allowable Compression Strengths of CHANCE® Type SS200 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength kip (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	See Helix Strength Table Above	See Helix Strength Table Above	51.3 (228.2)	26.2 (116.5)
Lead, 2-Helix 8”-10”	138.4 (615.6)	100.3 (446.1)	51.3 (228.2)	26.2 (116.5)
Lead, 2-Helix 10”-12”	127.0 (765.1)			
Lead, 2-Helix 12”-14”	123.2 (548)			
Lead, 2-Helix 14”-14”	115.2 (512.4)			
Lead, Multi-Helix	143.5 (638.3)	100.3 (446.1)	51.3 (228.2)	26.2 (116.5)
Extension	143.5 (638.3)	100.3 (446.1)	51.3 (228.2)	26.2 (116.5)

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

CHANCE® Type SS225 Helical Piles and Anchors

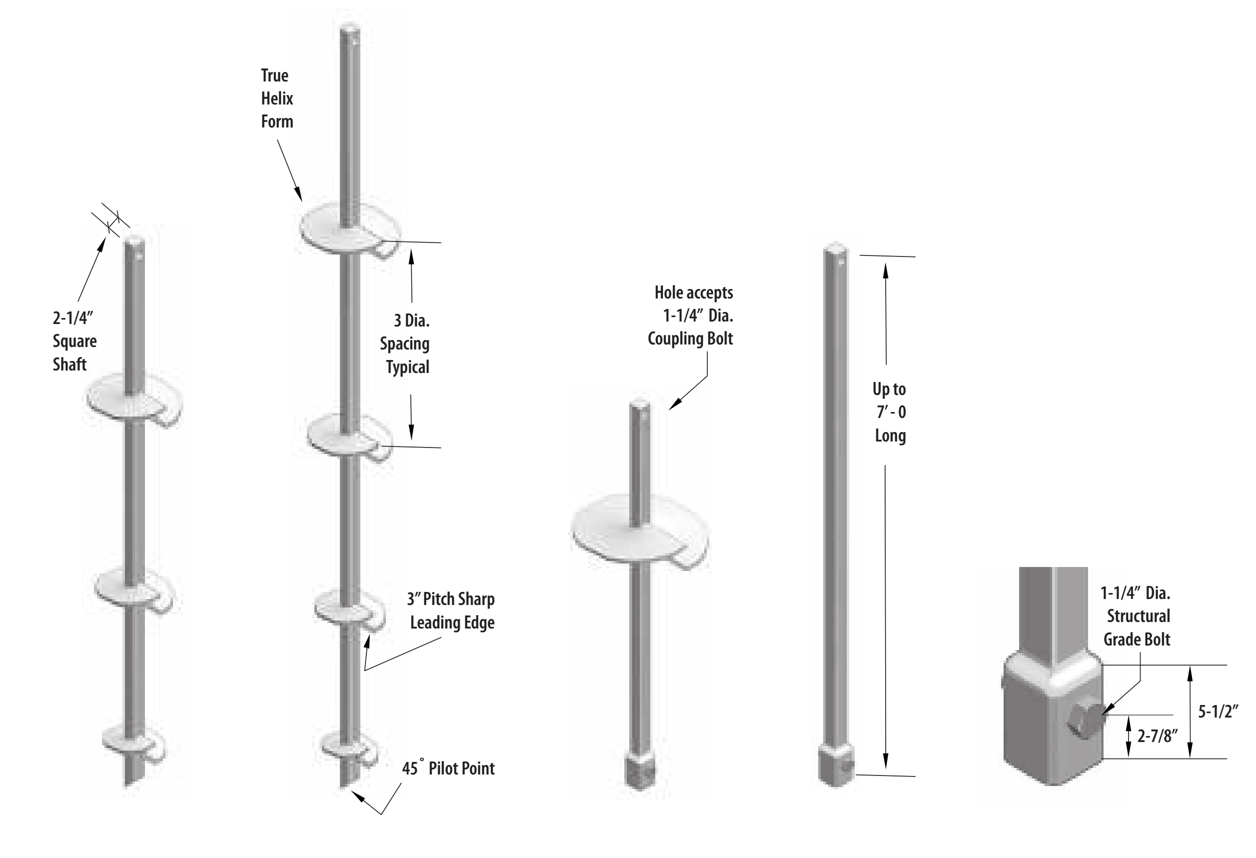
210 kip Ultimate – 105 kip Allowable Capacity

Installation Torque Rating – 21,000 ft-lb

Multi-Purpose 2-1/4 inch Solid Round-Cornered-Square Steel Shaft with integrally formed square upset sockets

Description:

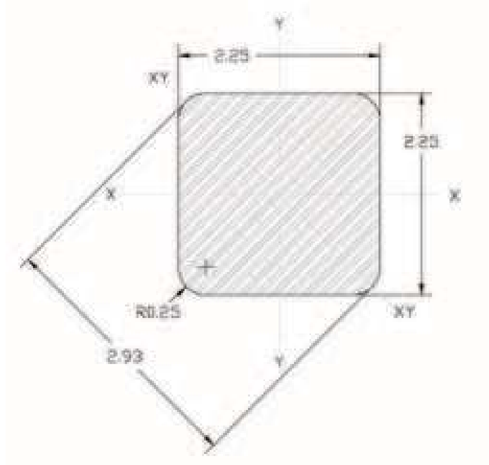
Hubbell Power Systems, Inc., CHANCE Type SS225 Helical Piles and Anchors have 210 kip ultimate capacity and 105 kip working or allowable capacity in compression and 200 kip ultimate capacity and 100 kip working or allowable capacity in tension. This capacity is based on structural strength ratings and well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Solid square shaft helical piles and anchors provide greater penetration into bearing soils and increased axial capacity in firm soils compared to pipe shaft helical piles with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type SS Helical Piles and Anchors have a longer service life than do pipe shaft piles because of their reduced surface area. CHANCE Type SS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with “sea-shell” cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



Triple Helix Lead Section	Quad Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

SS225 Helical Pile and Anchor Specifications & Available Configurations



CHANCE Type SS225
Helical Pile Shaft Cross-Section
Figure 7-13

Shaft – Round-Cornered-Square (RCS) 2-1/4 inch solid steel shaft produced exclusively for CHANCE products.
Coupling - forged as a deep socket from the steel shaft material as an integral part of the extension, connected with structural bolts.
Helix - ½ inch Thick: ASTM A656, or A1018 with minimum yield strength of 80 ksi.
3 inch Helix Pitch – a standard established by Hubbell Power Systems, Inc. for Helical Piles and Anchors.
Available Helix Diameters: 6, 8, 10, 12, and 14 inch.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The standard helix plate has straight sharpened leading edges or can be ordered with a “sea shell” cut. The “sea shell” cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Triple, and quad helix Lead Sections, 5, 7 and 10 feet long
Plain Extensions, 5 and 7 feet long
Extensions with Helix Plates, 5, and 7 feet long, single and multi-helix
Helical products are Hot Dip Galvanized per ASTM A153 Class B-1.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Axial deflections of 0.25 to 0.50 inches are typical at allowable capacity.

Nominal, LRFD Design and ASD Allowable Strengths of SS225 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength kip (kN)	LRFD Design Strength kip (kN)	ASD Allowable Strength kip (kN)
6 (150)	0.5 (13)	188 (836.3)	169.1 (752.2)	94 (418.1)
8 (200)	0.5 (13)	188 (836.3)	169.1 (752.2)	94 (418.1)
10 (250)	0.5 (13)	151.8 (675.2)	136.6 (607.6)	75.9 (337.6)
12 (300)	0.5 (13)	141.3 (628.5)	127.2 (565.8)	70.6 (314)
14 (350)	0.5 (13)	126.3 (561.8)	113.7 (505.8)	63.2 (281.1)

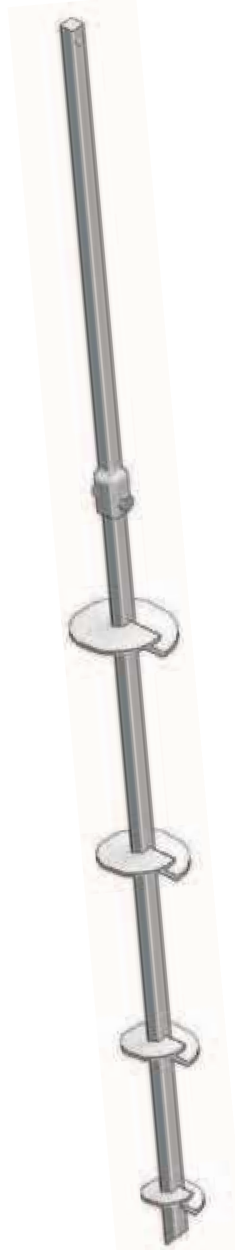
For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

Nominal and LRFD Design Compression Strengths of CHANCE® Type SS225 Helical Pile Lead & Extension Sections[1,2]

<table>
<tr><th rowspan="4">Section Type & Helix Count</th><th colspan="8">Nominal & LRFD Design Compression Strengths, kip (kN)</th></tr>
<tr><th colspan="4">Firm Soil</th><th colspan="4">Soft Soil</th></tr>
<tr><th colspan="2">Fixed</th><th colspan="2">Pinned</th><th colspan="2">Fixed</th><th colspan="2">Pinned</th></tr>
<tr><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th></tr>
<tr><td rowspan="2">Lead, Single Helix</td><td colspan="2" rowspan="2">See Helix Strength Table</td><td colspan="2" rowspan="2">See Helix Strength Table</td><td>139.0 (618.3)</td><td>125.1 (556.5)</td><td rowspan="2">70.9 (315.4)</td><td rowspan="2">63.8 (283.8)</td></tr>
<tr><td>Single 14 inch – 126.3 (561.8)</td><td>Single 14 inch – 113.7 (505.8)</td></tr>
<tr><td>Lead, 2-Helix 8”-10”</td><td>331.6 (1475)</td><td>298.4 (1327.3)</td><td rowspan="6">250.1 (1112.5)</td><td rowspan="6">225.1 (1001.3)</td><td rowspan="6">139.0 (618.3)</td><td rowspan="6">125.1 (556.5)</td><td rowspan="6">70.9 (315.4)</td><td rowspan="6">63.8 (283.8)</td></tr>
<tr><td>Lead, 2-Helix 10”-12”</td><td>293.1 (1303.8)</td><td>263.8 (1173.4)</td></tr>
<tr><td>Lead, 2-Helix 12”-14”</td><td>267.6 (1190.3)</td><td>240.9 (1071.6)</td></tr>
<tr><td>Lead, 2-Helix 14”-14”</td><td>252.6 (1123.6)</td><td>227.4 (1011.5)</td></tr>
<tr><td>Lead, Multi-Helix</td><td>331.6 (1475)</td><td>298.4 (1327.3)</td></tr>
<tr><td>Extension</td><td>331.6 (1475)</td><td>298.4 (1327.3)</td></tr>
</table>

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

SS225 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled Round-Cornered-Square (RCS) Solid Steel Bars per ASTM A29; modified AISI 1530 with 90 ksi minimum yield strength			
Shaft Size	2.25 in	57 mm	Corroded	
			2.237 in	56.8 mm
Moment of Inertia (I)	2.04 in^4	84.9 cm^4	Corroded	
			1.99 in^4	82.83 cm^4
Shaft Area (A)	5.0 in^2	32.1 cm^2	Corroded	
			4.93 in^2	31.81 cm^2
Section Modulus (S_{x-x})	1.81 in^3	29.7 cm^3	Corroded	
			1.79 in^3	29.37 cm^3
Perimeter	8.5 in	21.5 cm	Corroded	
			8.43 in	21.41 cm
Coupling	Integral Forged Square Deep Socket			
Coupling Bolts	One 1-1/4 inch Diameter ASTM A193 Grade B7 Hex Head Bolt with Threads Excluded from Shear Planes			
Helix Plates	0.5 inch Thick, Formed on Matching Metal Dies, ASTM A656 or A1018 Grade 80			
Coatings	Hot Dip Galvanized per ASTM A153 Class B-1, 3.1 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	10 ft^{-1}		33 m^{-1}	
Torque Rating	21,000 ft-lb		28,475 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	200 kip	890 kN	150 kip	667 kN
Allowable Tension Strength	100 kip		445 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	210 kip	934 kN	105 kip	467 kN



Assembly of SS225
Figure 7-14

ASD Allowable Compression Strengths of CHANCE® Type SS225 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength kip (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	See Helix Strength Table Above	See Helix Strength Table Above	See Helix Strength Table Above, except single 6 & 8 inch - 83.2 (370.1)	42.5 (189)
Lead, 2-Helix 8”-10”	169.9 (755.8)	149.8 (666.3)	83.2 (370.1)	42.5 (189)
Lead, 2-Helix 10”-12”	146.5 (651.6)	146.5 (650.7)		
Lead, 2-Helix 12”-14”	133.8 (595.1)	133.8 (595.1)		
Lead, 2-Helix 14”-14”	126.4 (562.2)	126.4 (562.3)		
Lead, Multi-Helix	198.6 (883.4)	149.8 (666.3)	83.2 (370.1)	42.5 (189)
Extension	198.6 (883.4)	149.8 (666.3)	83.2 (370.1)	42.5 (189)

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

CHANCE® Type RS2875.203 Helical Piles

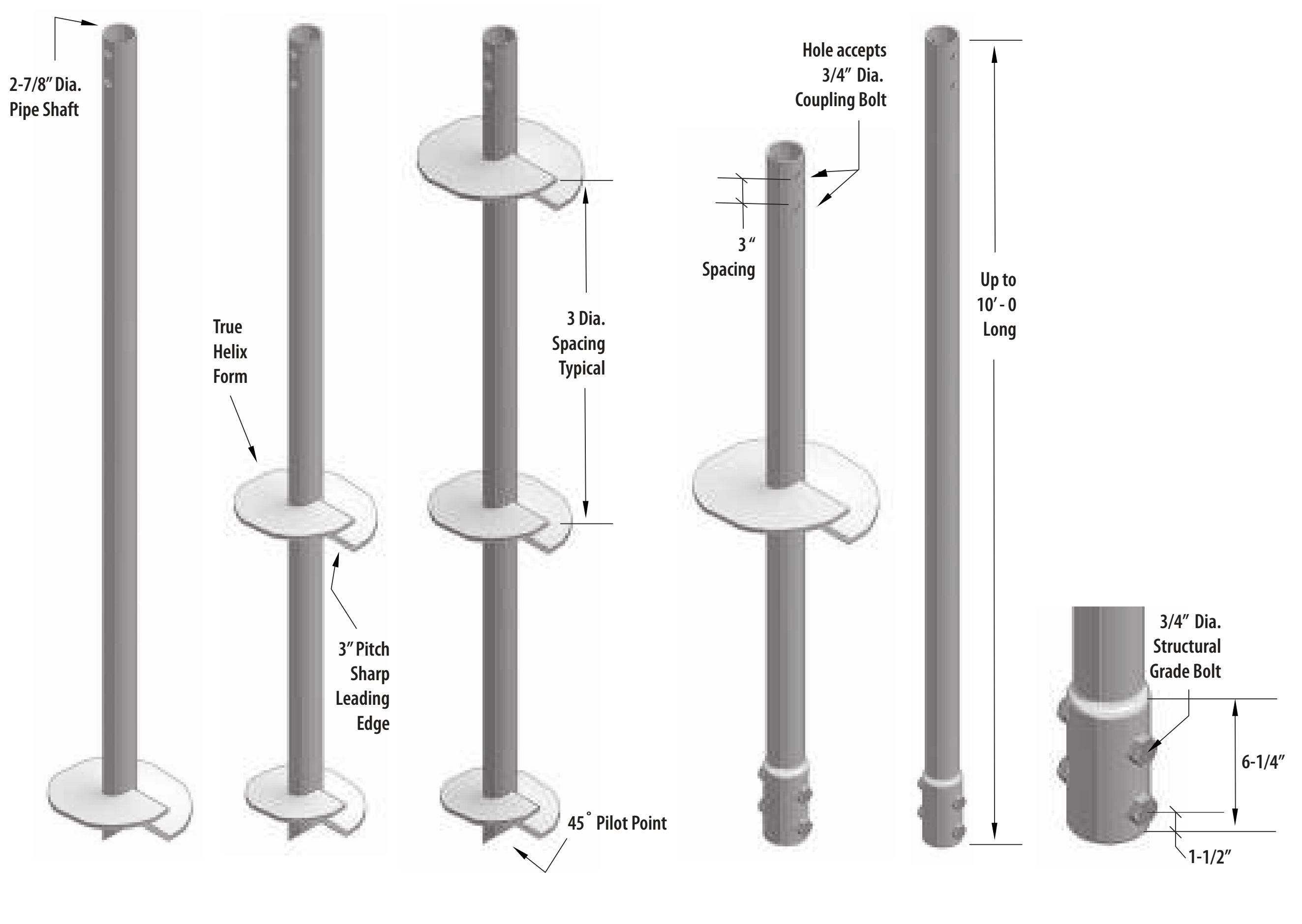
49.5 kip Ultimate – 24.75 kip Allowable Capacity

Installation Torque Rating – 5,500 ft-lb

Multi-Purpose 2-7/8” Diameter, 0.203” Wall, Round HSS Shaft with integrally formed upset sockets

Description:

Hubbell Power Systems, Inc., CHANCE Type RS2875.203 Helical Piles have 49.5 kip ultimate capacity and 24.75 kip working or allowable capacity in compression or tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Round shaft helical piles offer increased lateral and buckling resistance compared to solid square shafts with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type RS Helical Piles can be coupled with square shaft lead sections (Combo Piles) to provide greater penetration into bearing soils. CHANCE Type RS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with “sea-shell” cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



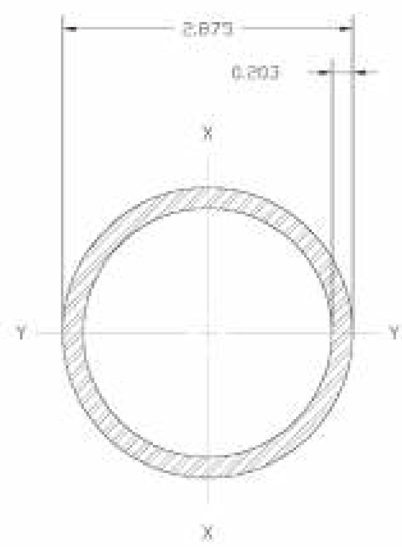
Single Helix Lead Section	Twin Helix Lead Section	Triple Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

RS2875.203 Helical Pile Specifications & Available Configurations

Shaft – HSS 2-7/8 inch OD x 0.203 inch (schedule 40) wall steel shaft produced exclusively for CHANCE products.
Coupling – forged as an integral part of the plain and helical extension material as round deep sockets connected with multiple structural bolts.
Helix – 3/8 inch Thick: ASTM A572, or A1018, or A656 with minimum yield strength of 50 ksi.
3 inch Helix Pitch – a standard established by Hubbell Power Systems, Inc. for Helical Piles and Anchors.
Available Helix Diameters: 8, 10, 12, or 14 inches.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The standard helix plate has straight sharpened leading edges or can be ordered with a "sea shell" cut. The "sea shell" cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Single, double, and triple helix Lead Sections, 5, 7, and 10 feet long
Plain Extensions, 3, 5, 7, and 10 feet long
Extensions with Helix Plates, 5 and 7 feet long
Helical products are Hot Dip Galvanized per ASTM A153 Class B-1.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type RS2875.203
Helical Pile Shaft Cross-Section
Figure 7-15

Nominal, LRFD Design and ASD Allowable Strengths of RS2875.203 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength kip (kN)	LRFD Design Strength kip (kN)	ASD Allowable Strength kip (kN)
8 (200)	0.375 (9.5)	85.8 (381.7)	77.2 (343.4)	42.9 (190.8)
10 (250)	0.375 (9.5)	73.6 (327.4)	66.3 (294.9)	36.8 (163.7)
12 (300)	0.375 (9.5)	75.6 (336.3)	68.0 (302.5)	37.8 (168.1)
14 (350)	0.375 (9.5)	61.0 (271.3)	54.9 (244.2)	30.5 (135.7)

For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

Nominal and LRFD Design Compression Strengths of CHANCE® Type RS2875.203 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	Nominal & LRFD Design Compression Strengths kips (kN)							
	Firm Soil				Soft Soil			
	Fixed		Pinned		Fixed		Pinned	
	Nominal	Design	Nominal	Design	Nominal	Design	Nominal	Design
Lead, Single Helix	69.0 (306.9)	62.1 (276.2)	64.3 (286.0)	57.9 (257.6)	55.5 (246.9)	49.9 (222.0)	42.0 (186.8)	37.8 (168.1)
	For Single 14"– 61 (271.3)	For Single 14"– 54.9 (244.2)	For Single 14"– 61.0 (271.3)	For Single 14"– 57.9 (257.6)				
Lead, Multi-Helix	69.0 (306.9)	62.1 (276.2)	64.3 (286.0)	57.9 (257.6)	55.5 (246.9)	49.9 (222.0)	42.0 (186.8)	37.8 (168.1)
Extension	69.0 (306.9)	62.1 (276.2)	64.3 (286.0)	57.9 (257.6)				

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

RS2875.203 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled HSS 2-1/2 inch Nominal Schedule 40 (0.203 inch nominal wall) per ASTM A500 Grade B/C with 50 ksi minimum yield strength			
Shaft Size, OD	2.875 in	73 mm	Corroded: 2.862 in	Corroded: 72.7 mm
Shaft Size, ID*	2.497 in	63.4 mm	Corroded: 2.510 in	Corroded: 63.75 mm
Moment of Inertia (I)*	1.44 in^4	59.9 cm^4	Corroded: 1.344 in^4	Corroded: 55.9 cm^4
Shaft Area (A)*	1.59 in^2	10.3 cm^2	Corroded: 1.48 in^2	Corroded: 9.57 cm^2
Section Modulus ($S_{x\text{-}x}$)*	1.0 in^3	16.4 cm^3	Corroded: 0.939 in^3	Corroded: 15.4 cm^3
Perimeter	9.0 in	22.8 cm	Corroded: 8.99 in	Corroded: 22.8 cm
Coupling	Integral Forged Round Deep Socket Sleeve			
Coupling Bolts	Two ¾ in Diameter SAE J429 Grade 5 Hex Head Bolts with Threads Excluded from Shear Planes			
Helix Plates	0.375 inch Thick, Formed on Matching Metal Dies, ASTM A572 Grade 50 or better			
Coatings	Hot Dip Galvanized per ASTM A153 Class B-1, 3.1 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	9 ft^{-1}		30 m^{-1}	
Torque Rating	5,500 ft-lb		7,500 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	60 kip	267 kN	45 kip	200 kN
Allowable Tension Strength	30 kip		133 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	49.5 kip	220 kN	24.75 kip	110 kN

* computed with 93% of wall thickness per AISC 360-10, B4.2

Assembly of RS2875.203
Figure 7-16

ASD Allowable Compression Strengths of CHANCE® Type RS2875.203 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength kips (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	**For Single 8" – 41.3 (183.7)** See Helix Strength Table Above for 10", 12" & 14"	**For Single 8" – 38.5 (171.3)** See Helix Strength Table Above for 10", 12" & 14"	**33.2 (147.7)** For Single 14" – 30.5 (135.7)	**25.1 (111.7)**
Lead, 2-Helix 8"-10" Lead, 2-Helix 10"-12" Lead, 2-Helix 12"-14" Lead, 2-Helix 14"-14"	41.3 (183.7)	38.5 (171.3)	33.2 (147.7)	25.1 (111.7)
Lead, Multi-Helix	41.3 (183.7)	38.5 (171.3)	33.2 (147.7)	25.1 (111.7)
Extension	41.3 (183.7)	38.5 (171.3)	33.2 (147.7)	25.1 (111.7)

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

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CHANCE® Type RS2875.276 Helical Piles

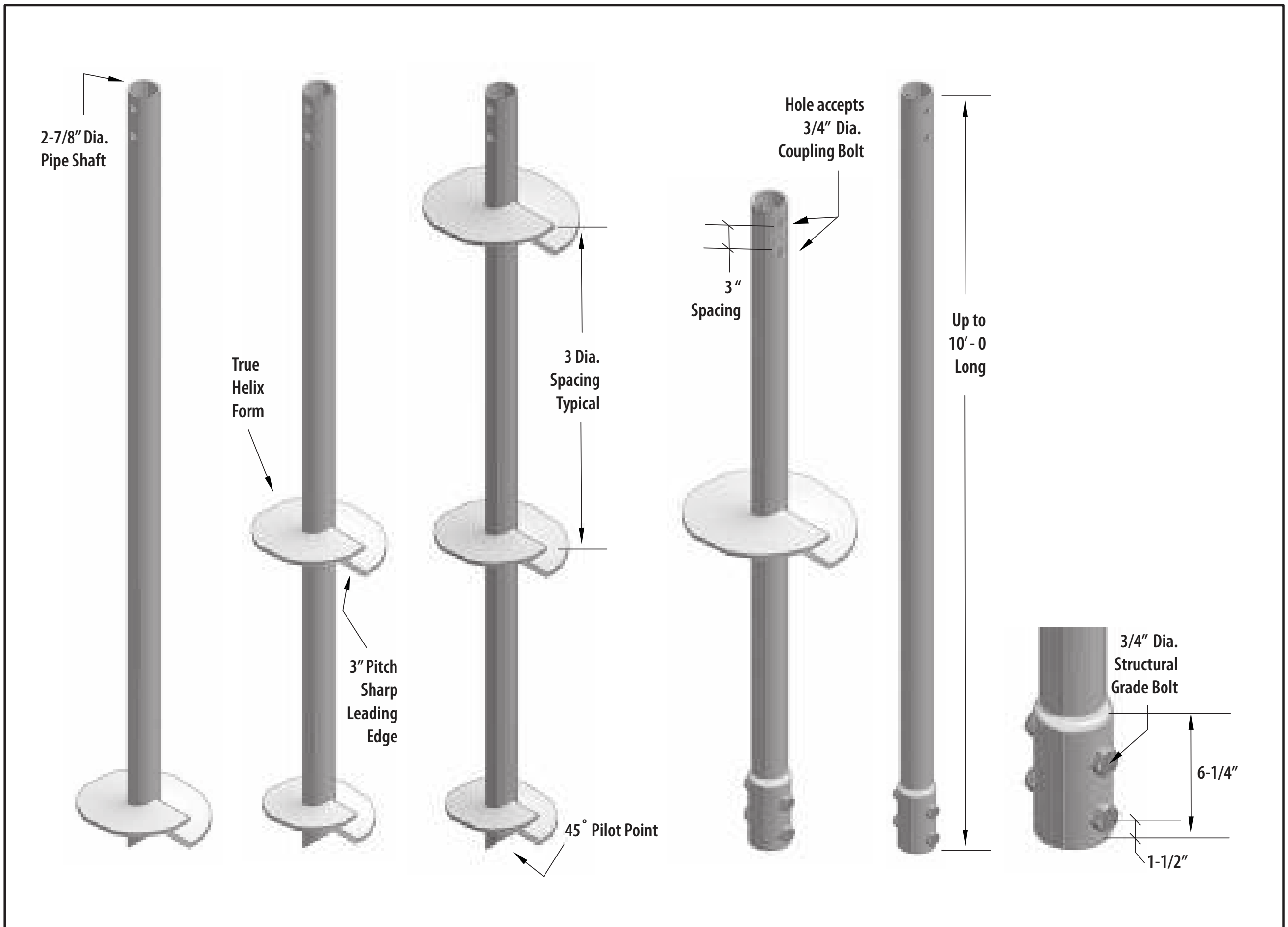
72 kip Ultimate – 36 kip Allowable Capacity

Installation Torque Rating – 8,000 ft-lb

Multi-Purpose 2-7/8” Diameter, 0.276” Wall, Round HSS Shaft with integrally formed upset sockets

Description:

Hubbell Power Systems, Inc., CHANCE Type RS2875.276 Helical Piles have 72 kip ultimate capacity and 36 kip working or allowable capacity in compression or tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Round shaft helical piles offer increased lateral and buckling resistance compared to solid square shafts with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type RS Helical Piles can be coupled with square shaft lead sections (Combo Piles) to provide greater penetration into bearing soils. CHANCE Type RS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with “sea-shell” cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



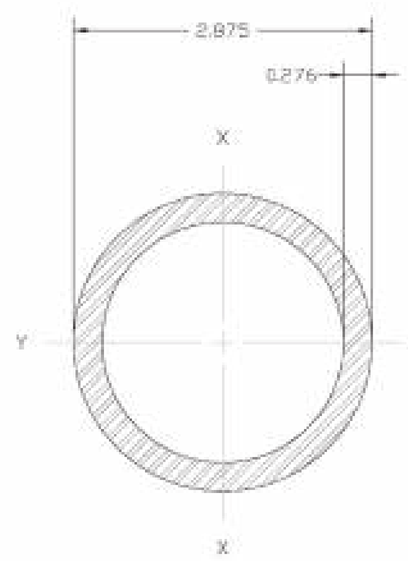
Single Helix Lead Section	Twin Helix Lead Section	Triple Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

RS2875.276 Helical Pile Specifications & Available Configurations

Shaft – HSS 2-7/8 inch OD x 0.276 inch (schedule 80) wall steel shaft produced exclusively for CHANCE products.
Coupling – forged as an integral part of the plain and helical extension material as round deep sockets connected with multiple structural bolts.
Helix – 3/8 inch Thick: ASTM A656, or A1018 with minimum yield strength of 80 ksi.
3 inch Helix Pitch – a standard established by Hubbell Power Systems, Inc. for CHANCE Helical Piles and Anchors.
Available Helix Diameters: 8, 10, 12, or 14 inches.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The standard helix plate has straight sharpened leading edges or can be ordered with a "sea shell" cut. The "sea shell" cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Single, double, and triple and quad helix Lead Sections, 3.5, 5, 7, and 10 feet long
Plain Extensions, 3, 5, 7, and 10 feet long
Extensions with Helix Plates, 3 feet long
Helical products are Hot Dip Galvanized per ASTM A153 Class B-1.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type RS2875.276 Helical Pile Shaft Cross-Section
Figure 7-17

Nominal, LRFD Design and ASD Allowable Strengths of RS2875.276 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength kip (kN)	LRFD Design Strength kip (kN)	ASD Allowable Strength kip (kN)
8 (200)	0.375 (9.5)	121.4 (540.0)	109.3 (486.2)	60.7 (270.0)
10 (250)	0.375 (9.5)	98.9 (439.9)	89.0 (395.9)	49.5 (220.2)
12 (300)	0.375 (9.5)	85.3 (379.4)	76.8 (341.6)	42.7 (189.9)
14 (350)	0.375 (9.5)	53.7 (238.9)	48.3 (214.9)	26.9 (119.7)

For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

Nominal and LRFD Design Compression Strengths of CHANCE® Type RS2875.276 Helical Pile Lead & Extension Sections[1,2]

<table>
<tr><th rowspan="4">Section Type & Helix Count</th><th colspan="8">Nominal & LRFD Design Compression Strengths kips (kN)</th></tr>
<tr><th colspan="4">Firm Soil</th><th colspan="4">Soft Soil</th></tr>
<tr><th colspan="2">Fixed</th><th colspan="2">Pinned</th><th colspan="2">Fixed</th><th colspan="2">Pinned</th></tr>
<tr><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th></tr>
<tr><td rowspan="2">Lead, Single Helix</td><td>92.9 (413.2)</td><td>83.6 (371.9)</td><td>86.3 (383.9)</td><td>77.7 (345.6)</td><td>73.9 (328.7)</td><td>66.5 (295.8)</td><td>55.2 (245.5)</td><td>49.7 (221.1)</td></tr>
<tr><td colspan="4">See Helix Table Above For Single 12" & 14"</td><td colspan="4">See Helix Table Above For Single 14"</td></tr>
<tr><td>Lead, Multi-Helix</td><td>92.9 (413.2)</td><td>83.6 (371.9)</td><td>86.3 (383.9)</td><td>77.7 (345.6)</td><td rowspan="2">73.9 (328.7)</td><td rowspan="2">66.5 (295.8)</td><td rowspan="2">55.2 (245.5)</td><td rowspan="2">49.7 (221.1)</td></tr>
<tr><td>Extension</td><td>92.9 (413.2)</td><td>83.6 (371.9)</td><td>86.3 (383.9)</td><td>77.7 (345.6)</td></tr>
</table>

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

RS2875.276 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled HSS 2-1/2 inch Nominal Schedule 80 (0.276 inch nominal wall) per ASTM A500 Grade B/C with 50 ksi minimum yield strength			
Shaft Size, OD	2.875 in	73 mm	Corroded	
			2.862 in	72.7 mm
Shaft Size, ID*	2.36 in	60 mm	Corroded	
			2.375 in	60.3 mm
Moment of Inertia (I)*	1.83 in^4	76.2 cm^4	Corroded	
			1.733 in^4	72.1 cm^4
Shaft Area (A)*	2.11 in^2	13.6 cm^2	Corroded	
			2.0 in^2	12.9 cm^2
Section Modulus (S_{x-x})*	1.27 in^3	20.8 cm^3	Corroded	
			1.21 in^3	19.8 cm^3
Perimeter	9.0 in	22.8 cm	Corroded	
			8.99 in	22.8 cm
Coupling	Integral Forged Round Deep Socket Sleeve			
Coupling Bolts	Two ¾ in Diameter SAE J429 Grade 5 Hex Head Bolts with Threads Excluded from Shear Planes			
Helix Plates	0.375 inch Thick, Formed on Matching Metal Dies, ASTM A656 Grade 80 or better			
Coatings	Hot Dip Galvanized per ASTM A153 Class B-1, 3.1 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	9 ft^{-1}		30 m^{-1}	
Torque Rating	8,000 ft-lb		10,846 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	90 kip	400 kN	67.5 kip	300 kN
Allowable Tension Strength	45 kip		200 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	72 kip	320 kN	36 kip	160 kN

* computed with 93% of wall thickness per AISC 360-10, B4.2

Assembly of RS2875.276
Figure 7-18

ASD Allowable Compression Strengths of CHANCE® Type RS2875.276 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength kips (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	For Single 8” – 55.6 (247.3)	For Single 8” – 51.7 (230.0)	44.3 (197.1)	33.0 (146.8)
	See Helix Strength Table Above for 10”, 12” & 14”	See Helix Strength Table Above for 10”, 12” & 14”	See Helix Strength Table Above for 12” & 14”	For Single 14” – 26.9
Lead, 2-Helix 8”-10”	55.6 (247.3)	51.7 (230.0)	44.3 (197.1)	33.0 (146.8)
Lead, 2-Helix 10”-12”				
Lead, 2-Helix 12”-14”				
Lead, 2-Helix 14”-14”				
Lead, Multi-Helix	55.6 (247.3)	51.7 (230.0)	44.3 (197.1)	33.0 (146.8)
Extension	55.6 (247.3)	51.7 (230.0)	44.3 (197.1)	33.0 (146.8)

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

CHANCE® Type RS3500.300 Helical Piles

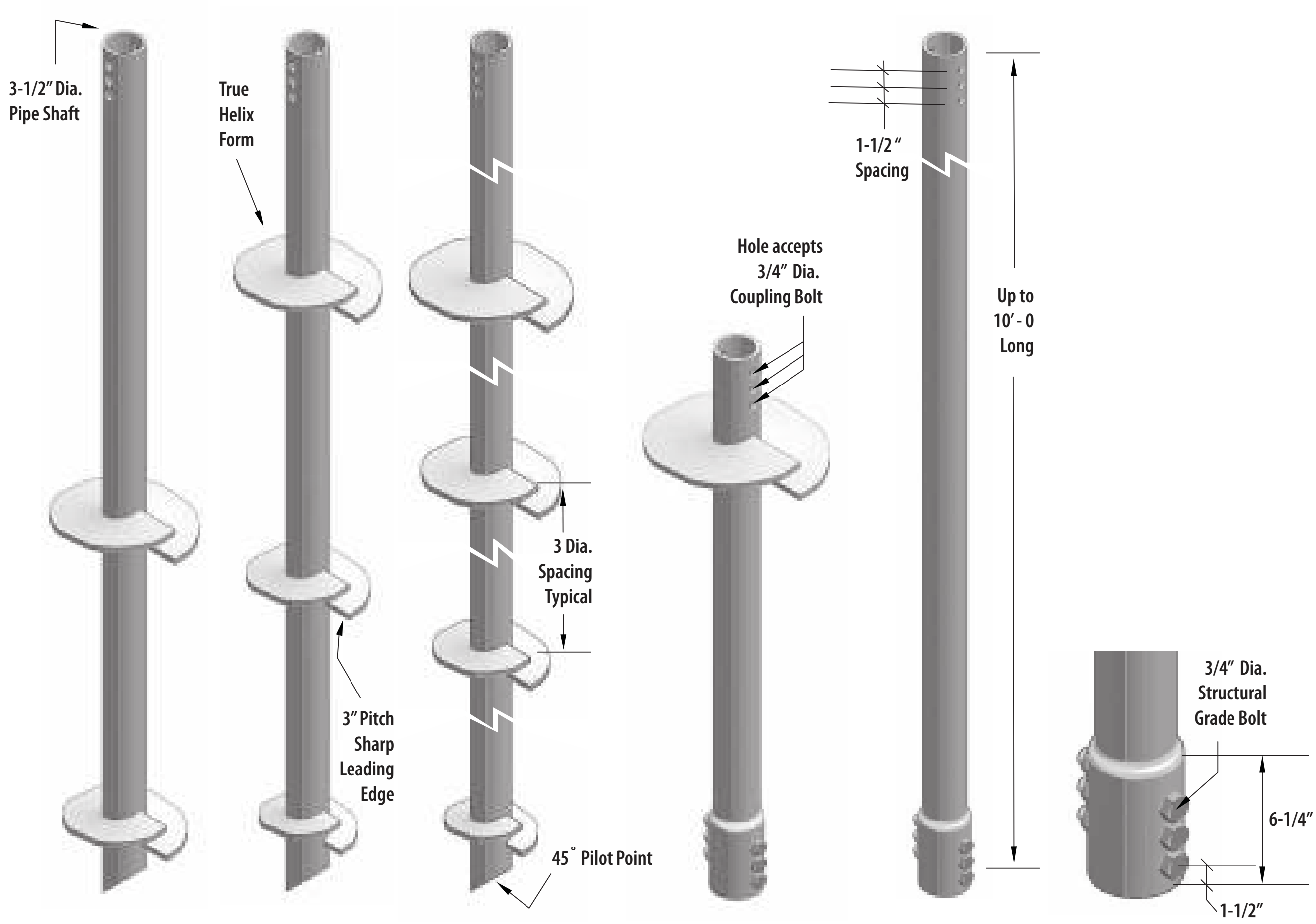
91 kip Ultimate – 45.5 kip Allowable Capacity

Installation Torque Rating – 13,000 ft-lb

Multi-Purpose 3-1/2" Diameter, 0.300" Wall, Round HSS Shaft with integrally formed upset sockets

Description:

Hubbell Power Systems, Inc., CHANCE Type RS3500.300 Helical Piles have 91 kip ultimate capacity and 45.5 kip working or allowable capacity in compression or tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Round shaft helical piles offer increased lateral and buckling resistance compared to solid square shafts with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type RS Helical Piles can be coupled with square shaft lead sections (Combo Piles) to provide greater penetration into bearing soils. CHANCE Type RS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with "sea-shell" cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



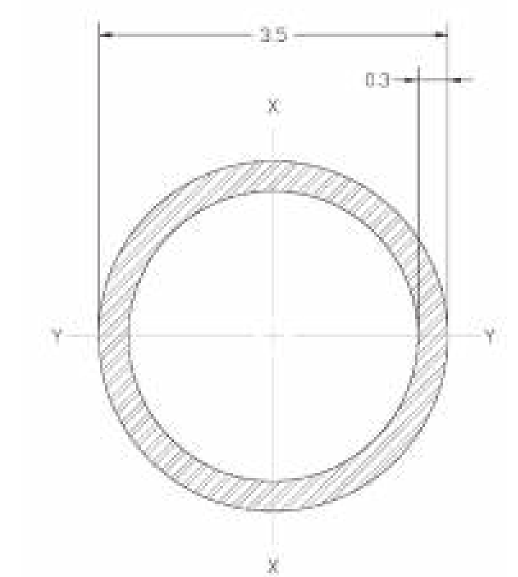
Twin Helix Lead Section	Triple Helix Lead Section	Quad Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

RS3500.300 Helical Pile Specifications & Available Configurations

Shaft – HSS 3-1/2 inch OD x 0.300 inch (schedule 80) wall steel shaft produced exclusively for CHANCE products.
Coupling - forged as an integral part of the plain and helical extension material as round deep sockets connected with multiple structural bolts.
Helix – 1/2 inch Thick: ASTM A572, or A1018, or A656 with minimum yield strength of 50 ksi.
3 inch Helix Pitch – a Standard established by Hubbell Power Systems, Inc. for CHANCE Helical Piles and Anchors.
Available Helix Diameters: 8, 10, 12, 14 or 16 inches.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The standard helix plate has straight sharpened leading edges or can be ordered with a “sea shell” cut. The “sea shell” cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Single, double, triple, and quad helix Lead Sections, 3, 5, 7, and 10 feet long
Plain Extensions, 3, 5, 7, and 10 feet long
Extensions with Helix Plates, 3-1/2 7 and 10 feet long
Helical products are Hot Dip Galvanized per ASTM A123 Grade 75.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type RS3500.300 Helical Pile Shaft Cross-Section
Figure 7-19

Nominal, LRFD Design and ASD Allowable Strengths of RS3500.300 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength kip (kN)	LRFD Design Strength kip (kN)	ASD Allowable Strength kip (kN)
8 (200)	0.5 (13)	158.3 (704.2)	142.4 (633.4)	79.1 (351.9)
10 (250)	0.5 (13)	132.5 (589.3)	119.3 (530.7)	66.3 (294.9)
12 (300)	0.5 (13)	98.4 (437.7)	88.6 (394.1)	49.2 (187.7)
14 (350)	0.5 (13)	132.3 (588.5)	119.0 (529.3)	66.2 (294.5)

For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

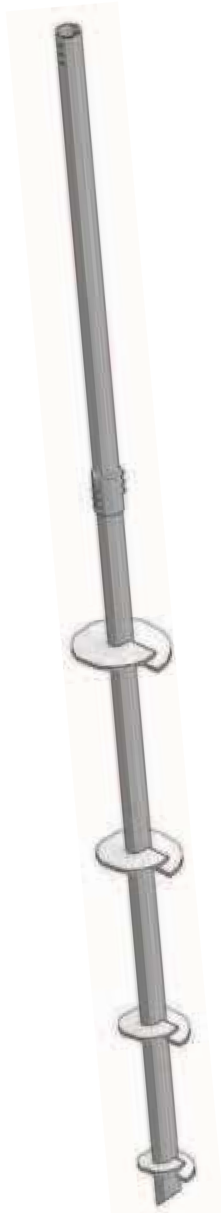
Nominal and LRFD Design Compression Strengths of CHANCE® Type RS3500.300 Helical Pile Lead & Extension Sections[1,2]

<table>
<tr><th rowspan="4">Section Type & Helix Count</th><th colspan="8">Nominal & LRFD Design Compression Strengths kips (kN)</th></tr>
<tr><th colspan="4">Firm Soil</th><th colspan="4">Soft Soil</th></tr>
<tr><th colspan="2">Fixed</th><th colspan="2">Pinned</th><th colspan="2">Fixed</th><th colspan="2">Pinned</th></tr>
<tr><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th><th>Nominal</th><th>Design</th></tr>
<tr><td rowspan="2">Lead, Single Helix</td><td>128.0 (569.4)</td><td>115.2 (512.4)</td><td>121.9 (542.2)</td><td>109.7 (488.0)</td><td>110.0 (489.3)</td><td>99.0 (440.3)</td><td rowspan="2">90.7 (403.5)</td><td rowspan="2">81.6 (363.0)</td></tr>
<tr><td>For Single 12” – 98.4 (437.7)</td><td>For Single 12” – 88.6 (394.1)</td><td>For Single 12” – 98.4 (437.7)</td><td>For Single 12” – 88.6 (394.1)</td><td>For Single 12” – 98.4 (437.7)</td><td>For Single 12” – 88.6 (394.1)</td></tr>
<tr><td>Lead, Multi-Helix</td><td>128 (569.4)</td><td>115.2 (512.4)</td><td>121.9 (542.2)</td><td>109.7 (488.0)</td><td rowspan="2">110.0 (489.3)</td><td rowspan="2">99.0 (440.4)</td><td rowspan="2">90.7 (403.5)</td><td rowspan="2">81.6 (363.0)</td></tr>
<tr><td>Extension</td><td>128.0 (569.4)</td><td>115.2 (512.4)</td><td>121.9 (542.2)</td><td>109.7 (488.0)</td></tr>
</table>

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

RS3500.300 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled HSS 3 inch Nominal Schedule 80 (0.300 inch nominal wall) per ASTM A500 Grade B/C with 50 ksi minimum yield strength			
Shaft Size, OD	3.5 in	89 mm	Corroded 3.487 in	Corroded 63.2 mm
Shaft Size, ID*	2.942 in	74.7 mm	Corroded 2.955 in	Corroded 75.1 mm
Moment of Inertia (I)*	3.69 in^4	153.6 cm^4	Corroded 3.514 in^4	Corroded 146.3 cm^4
Shaft Area (A)*	2.82 in^2	18.2 cm^2	Corroded 2.692 in^2	Corroded 17.4 cm^2
Section Modulus (S_{x-x})*	2.11 in^3	34.5 cm^3	Corroded 2.016 in^3	Corroded 33.0 cm^3
Perimeter	11.0 in	27.9 cm	Corroded 10.95 in	Corroded 27.8 cm
Coupling	Integral Forged Round Deep Socket Sleeve			
Coupling Bolts	Three ¾ in Dia. SAE J429 Grade 5 Hex Head Bolts with Threads Excluded from Shear Planes			
Helix Plates	0.5 inch Thick, Formed on Matching Metal Dies, ASTM A572 Grade 50 or better			
Coatings	Hot Dip Galvanized per ASTM A123 Grade 75, 3.0 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	7 ft^{-1}		23 m^{-1}	
Torque Rating	13,000 ft-lb		17,600 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal 120 kip	Nominal 534 kN	LRFD Design 90 kip	LRFD Design 400 kN
Allowable Tension Strength	60 kip		261 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate 91 kip	Ultimate 405 kN	Allowable 45.5 kip	Allowable 202.5 kN

* computed with 93% of wall thickness per AISC 360-10, B4.2



Assembly of RS3500.300
Figure 7-20

ASD Allowable Compression Strengths of CHANCE® Type RS3500.300 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength kips (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	For Single 8" – 76.6 (340.7)	For Single 8" – 73.0 (324.7)	65.9 (293.1)	54.3 (241.5)
	See Helix Strength Table Above for 10", 12" & 14"	See Helix Strength Table Above for 10", 12" & 14"	For Single 12" – 49.2 (218.9)	For Single 12" – 49.2 (218.9)
Lead, 2-Helix 8"-10"	76.6 (340.7)	73.0 (324.7)	65.9 (293.1)	54.3 (241.5)
Lead, 2-Helix 10"-12"				
Lead, 2-Helix 12"-14"				
Lead, 2-Helix 14"-14"				
Lead, Multi-Helix	76.6 (340.7)	73.0 (324.7)	65.9 (293.1)	54.3 (241.5)
Extension	76.6 (340.7)	73.0 (324.7)	65.9 (293.1)	54.3 (241.5)

For SI: 1 kip = 4.448 kN.

[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.

[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

CHANCE® Type RS4500.337 Helical Piles

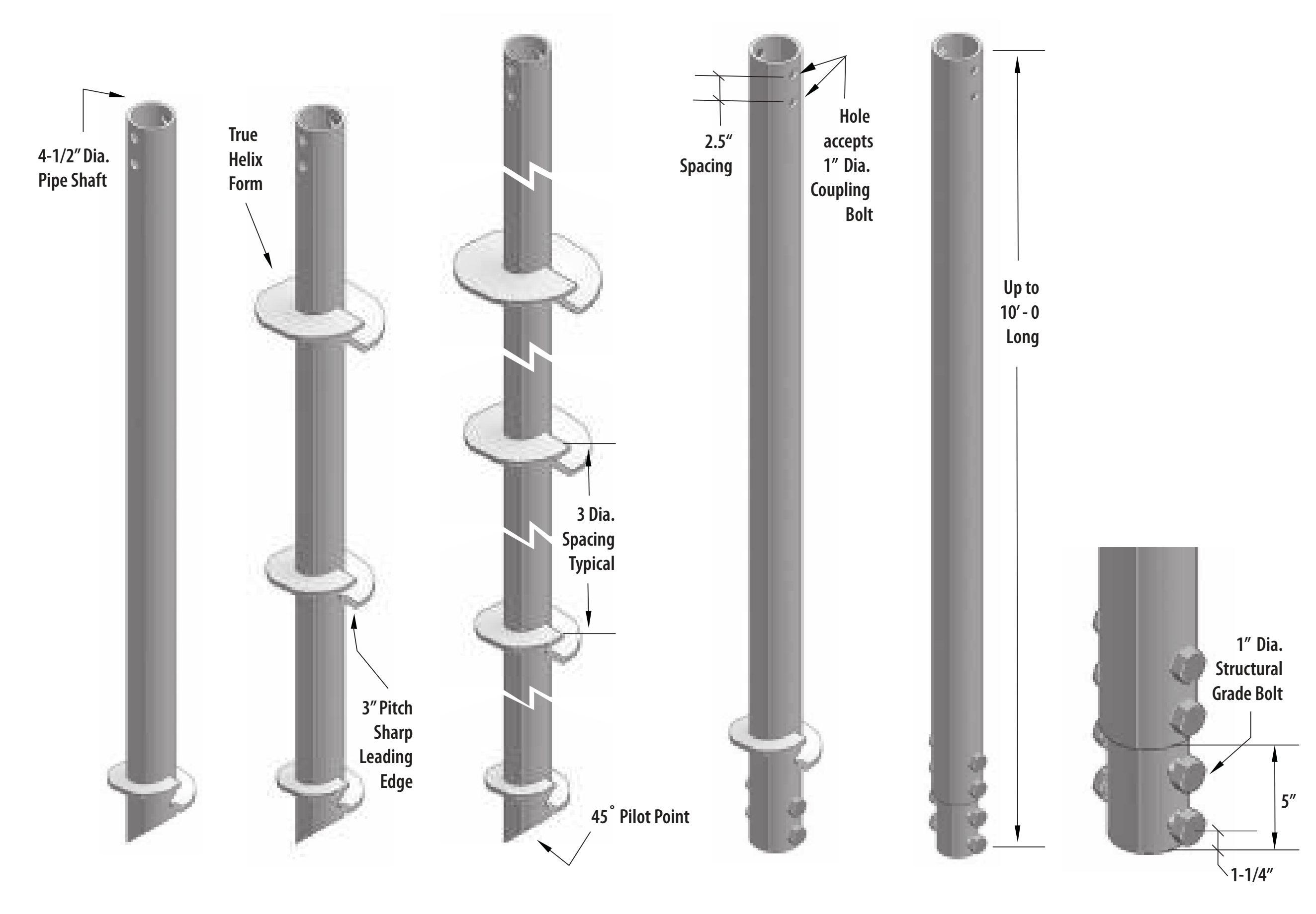
138 kip Ultimate – 69 kip Allowable Capacity

Installation Torque Rating – 23,000 ft-lb

Multi-Purpose 4-1/2" Diameter, 0.337" Wall, Round HSS Shaft with integrally formed upset sockets

Description:

Hubbell Power Systems, Inc., CHANCE Type RS4500.337 Helical Piles have 138 kip ultimate capacity and 69 kip working or allowable capacity in compression or tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Round shaft helical piles offer increased lateral and buckling resistance compared to solid square shafts with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type RS Helical Piles can be coupled with square shaft lead sections (Combo Piles) to provide greater penetration into bearing soils. CHANCE Type RS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with "sea-shell" cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



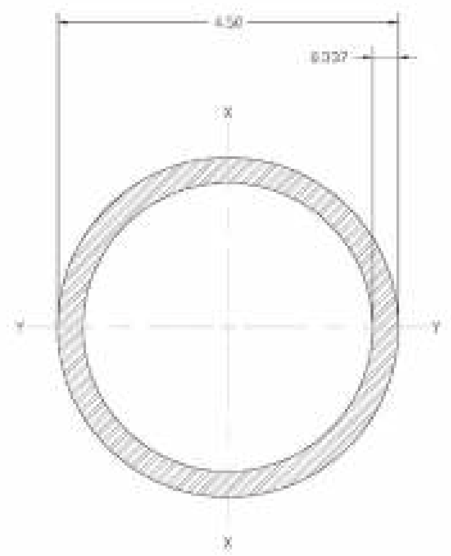
Single Helix Lead Section	Triple Helix Lead Section	Quad Helix Lead Section	Helical Extension Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

RS4500.337 Helical Pile Specifications & Available Configurations

Shaft – HSS 4-1/2 inch OD x 0.337 inch (schedule 80) wall steel shaft produced exclusively for CHANCE products.
Coupling – internal sleeve consisting of precision matched steel tube section connected with multiple structural bolts.
Helix – 1/2 inch Thick: ASTM A572, or A1018, or A656 with minimum yield strength of 80 ksi.
3 inch Helix Pitch – a Standard established by Hubbell Power Systems, Inc. for CHANCE Helical Piles and Anchors.
Available Helix Diameters: 8, 10, 12, 14, 16, or 20 inches.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The Standard helix plate has straight sharpened leading edges or can be ordered with a “sea shell” cut. The “sea shell” cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Single, double, triple, and quad helix Lead Sections, 7 and 10 feet long
Plain Extensions, 3, 5, 7, and 10 feet long
Extensions with Helix Plates, 5, 7 and 10 feet long
Helical products are Hot Dip Galvanized per ASTM A123 Grade 75.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type RS4500.337 Helical Pile Shaft Cross-Section
Figure 7-21

Nominal, LRFD Design and ASD Allowable Strengths of RS4500.337 Helix Plates for Shaft Axial Tension and Compression[1]

Helix Diameter in (mm)	Thickness in (mm)	Nominal Strength kip (kN)	LRFD Design Strength kip (kN)	ASD Allowable Strength kip (kN)
8 (200)	0.5 (13)	244.5 (1087.6)	220.1 (979.1)	122.3 (499.5)
10 (250)	0.5 (13)	200.3 (891.0)	180.3 (802.0)	100.2 (445.7)
12 (300)	0.5 (13)	168.5 (749.5)	151.7 (674.8)	84.3 (375.0)
14 (350)	0.5 (13)	133.0 (591.6)	119.7 (532.5)	66.5 (295.8)

For SI: 1 kip = 4.448 kN.
[1]Capacities based on a design corrosion level of 50-years.

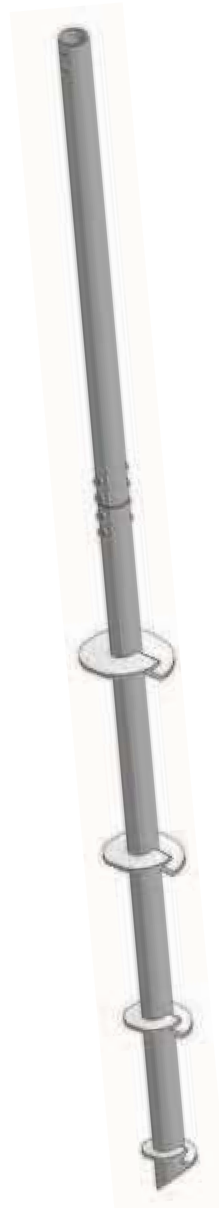
Nominal and LRFD Design Compression Strengths of CHANCE® Type RS4500.337 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	Nominal & LRFD Design Compression Strengths kips (kN)							
	Firm Soil				Soft Soil			
	Fixed		Pinned		Fixed		Pinned	
	Nominal	Design	Nominal	Design	Nominal	Design	Nominal	Design
Lead, Single Helix	191.7 (852.7)	172.6 (767.7)	186.3 (828.7)	167.7 (746.0)	175.3 (779.8)	157.8 (701.9)	156.3 (695.3)	140.7 (625.9)
	See Helix Strength Table Above For Single 12” & 14”						For Single 14” – 133.0 (591.6)	For Single 14” – 119.7 (532.5)
Lead, Multi-Helix	191.7 (852.7)	172.6 (767.8)	186.3 (828.7)	167.7 (746.0)	175.3 (779.8)	157.8 (701.9)	156.3 (695.3)	140.7 (625.9)
Extension	191.7 (852.7)	172.6 (767.8)	186.3 (828.7)	167.7 (746.0)				

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

RS4500.337 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled HSS 4 inch Nominal Schedule 80 (0.337 inch nominal wall) per ASTM A500 Grade B/C with 50 ksi minimum yield strength			
Shaft Size, OD	4.5 in	114 mm	Corroded: 4.487 in	114 mm
Shaft Size, ID*	3.874 in	98.4 mm	Corroded: 3.886 in	98.7 mm
Moment of Inertia (I)*	9.07 in^4	377.5 cm^4	Corroded: 8.701 in^4	362.2 cm^4
Shaft Area (A)*	4.12 in^2	26.6 cm^2	Corroded: 3.951 in^2	25.5 cm^2
Section Modulus (S_{x-x})*	4.03 in^3	66.1 cm^3	Corroded: 3.878 in^3	63.6 cm^3
Perimeter	14.1 in	35.9 cm	Corroded: 14.09 in	35.8 cm
Coupling	Internal Sleeve Steel Tube Section			
Coupling Bolts	Four 1 in Dia. SAE J429 Grade 8 Hex Head Bolts			
Helix Plates	0.5 inch Thick, Formed on Matching Metal Dies, ASTM A572 Grade 80 or better			
Coatings	Hot Dip Galvanized per ASTM A123 Grade 75, 3.0 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	6 ft^{-1}		20 m^{-1}	
Torque Rating	23,000 ft-lb		31,200 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	160 kip	712 kN	120 kip	534 kN
Allowable Tension Strength	80 kip		356 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	138 kip	614 kN	69 kip	307 kN

* computed with 93% of wall thickness per AISC 360-10, B4.2



Assembly of RS4500.337
Figure 7-22

ASD Allowable Compression Strengths of CHANCE® Type RS4500.337 Helical Pile Lead & Extension Sections[1,2]

Section Type & Helix Count	ASD Allowable Axial Compression Strength kips (kN)			
	Firm Soil		Soft Soil	
	Fixed	Pinned	Fixed	Pinned
Lead, Single Helix	For Single 8" – 114.8 (551.7)	For Single 8" – 111.6 (496.4)	105.0 (467.1)	93.6 (416.4)
	See Helix Strength Table Above for 10", 12" & 14"	See Helix Strength Table Above for 10", 12" & 14"	See Helix Strength Table Above for 10", 12" & 14"	See Helix Strength Table Above for 12" & 14"
Lead, 2-Helix 8"-10" Lead, 2-Helix 10"-12" Lead, 2-Helix 12"-14" Lead, 2-Helix 14"-14"	114.8 (551.7)	111.6 (496.4)	105.0 (467.1)	93.6 (416.4)
Lead, Multi-Helix	114.8 (551.7)	111.6 (496.4)	105.0 (467.1)	93.6 (416.4)
Extension	114.8 (551.7)	111.6 (496.4)	105.0 (467.1)	93.6 (416.4)

For SI: 1 kip = 4.448 kN.
[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

CHANCE® Type RS6625.280 Helical Piles

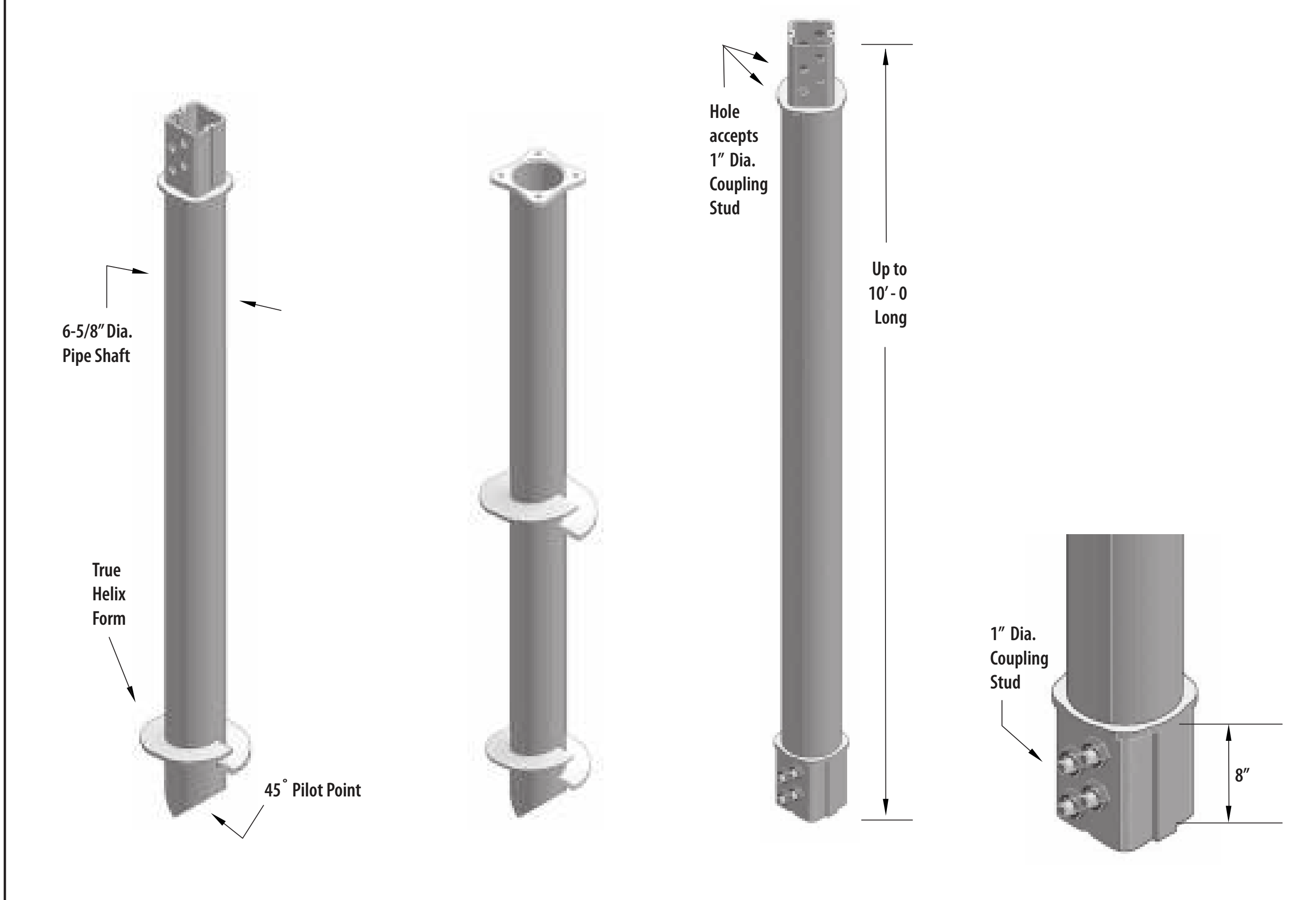
200 kip Ultimate – 100 kip Allowable Capacity

Installation Torque Rating – 40,000 ft-lb

Multi-Purpose 6-5/8" Diameter, 0.280" Wall, Round HSS Shaft with welded square formed couplings

Description:

Hubbell Power Systems, Inc., CHANCE Type RS6625.280 Helical Piles have 200 kip ultimate capacity and 100 kip working or allowable capacity in compression or tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Round shaft helical piles offer increased lateral and buckling resistance compared to solid square shafts with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type RS Helical Piles can be coupled with square shaft lead sections (Combo Piles) to provide greater penetration into bearing soils. CHANCE Type RS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with "sea-shell" cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.



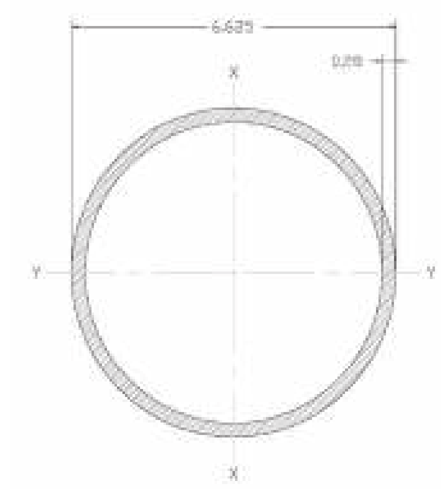
Single Helix Lead Section	Twin Helix Lead Section w/ Plate Coupling	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

RS6625.280 Helical Pile Specifications & Available Configurations

Shaft – HSS 6-5/8 inch OD x 0.280 inch (schedule 40) wall steel shaft produced exclusively for CHANCE products.
Coupling – formed and welded as a deep square socket, connected with multiple threaded studs & nuts.
Helix – 1/2 inch Thick: ASTM A572, or A1018, or A656 with minimum yield strength of 80 ksi.
3 inch Helix Pitch – a Standard established by Hubbell Power Systems, Inc. for CHANCE Helical Piles and Anchors.
Available Helix Diameters: 12, 14, and 16 inches.
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The Standard helix plate has straight sharpened leading edges or can be ordered with a "sea shell" cut. The "sea shell" cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Single, double, triple, Lead Sections, 7, 10, and 15 feet long
Plain Extensions, 5, 7, and 10 feet long
Extensions with Helix Plates, 5, 7 and 10 feet long
Helical products are Hot Dip Galvanized per ASTM A123 Grade 75.

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.



CHANCE Type RS6625.280
Helical Pile Shaft Cross-Section
Figure 7-23

RS6625.280 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled HSS 6 inch Nominal Schedule 40 (0.280 inch nominal wall) per ASTM A500 Grade B/C with 50 ksi minimum yield strength			
Shaft Size, OD	6.625 in	168 mm	Corroded 6.612 in	Corroded 167.95 mm
Shaft Size, ID*	6.10 in	155.1 mm	Corroded 6.118 in	Corroded 155.4 mm
Moment of Inertia (I)*	26.37 in^4	1096.1 cm^4	Corroded 25.05 in^4	Corroded 1041.2 cm^4
Shaft Area (A)*	5.2 in^2	33.55 cm^2	Corroded 4.94 in^2	Corroded 31.9 cm^2
Section Modulus (S_{x-x})*	7.96 in^3	130.2 cm^3	Corroded 7.58 in^3	Corroded 124 cm^3
Perimeter	20.8 in	52.8 cm	Corroded 20.77 in	Corroded 52.7 cm
Coupling	Formed and Welded Square Socket			
Coupling Bolts	Four 1 in Dia. Grade 2 Studs			
Helix Plates	0.5 inch Thick, Formed on Matching Metal Dies, ASTM A572 Grade 80 or better			
Coatings	Hot Dip Galvanized per ASTM A123 Grade 75, 3.0 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	5 ft^{-1}		13 m^{-1}	
Torque Rating	40,000 ft-lb		54,233 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	200 kip	890 kN	150 kip	667 kN
Allowable Tension Strength	100 kip		445 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	200 kip	890 kN	100 kip	445 Kn

* computed with 93% of wall thickness per AISC 360-10, B4.2

Assembly of RS6625.280
Figure 7-24

CHANCE® Type RS8625.250 Helical Piles

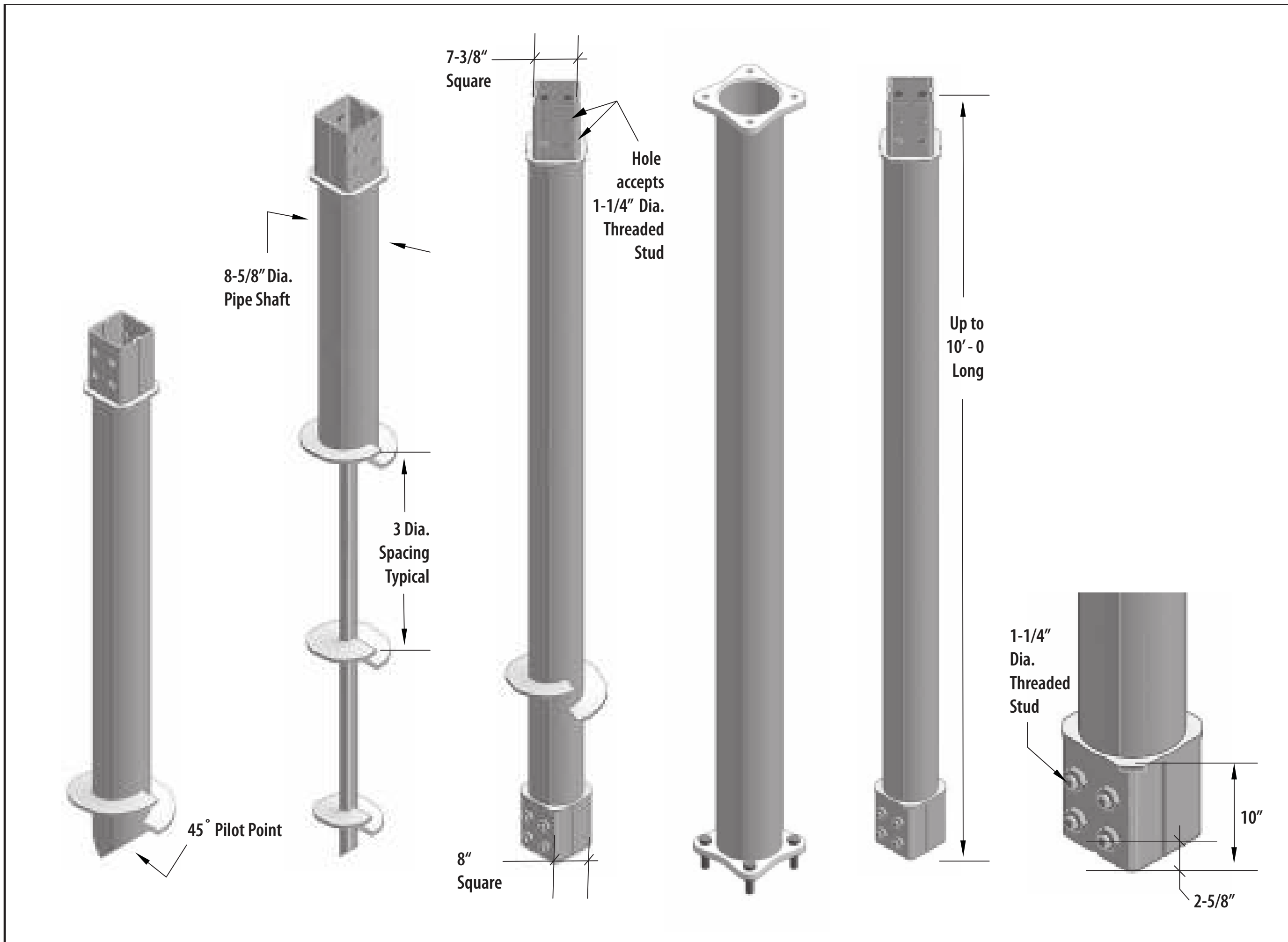
300 kip Ultimate – 150 kip Allowable Capacity

Installation Torque Rating – 60,000 ft-lb

Multi-Purpose 8-5/8" Diameter, 0.250" Wall, Round HSS Shaft with welded square formed couplings

Description:

Hubbell Power Systems, Inc. , CHANCE Type RS8625.280 Helical Piles have 300 kip ultimate capacity and 150 kip working or allowable capacity in compression or tension. This capacity is based on well documented correlations with installation torque, which is recognized as one method to determine capacity per IBC Section 1810.3.3.1.9. Lead sections and extensions couple together to extend the helix bearing plates to the required load bearing stratum. Round shaft helical piles offer increased lateral and buckling resistance compared to solid square shafts with similar torque strength. Strength calculations are based on a design corrosion level of 50 years for most soil conditions. CHANCE Type RS Helical Piles can be coupled with square shaft lead sections (Combo Piles) to provide greater penetration into bearing soils. CHANCE Type RS Helical Piles and Anchors feature sharpened leading edge helix plates that are circular in plan to provide uniform load bearing in most soil conditions. Helix plates can be equipped with "sea-shell" cuts on the leading edge to enhance penetration through dense soils with occasional cobbles and debris. Custom lengths and helix configurations are available upon request. See below for additional information and other sections of this Technical Manual for specifications and design details.

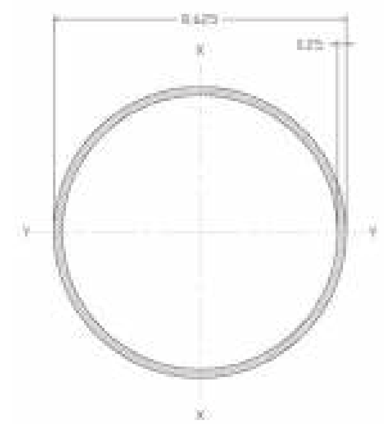


Single Helix Lead Section	Triple Helix Lead Section	Helical Extension Section	Plate Coupling Detail Section	Plain Exension Section	Coupling Detail

All Hubbell Power Systems, Inc. CHANCE Helical Products are MADE IN THE U.S.A.

RS8625.250 Helical Pile Specifications & Available Configurations

Shaft – HSS 8-5/8 inch OD x 0.250 inch (schedule 20) wall steel shaft produced exclusively for CHANCE products.
Coupling – formed and welded as a deep square socket, connected with multiple threaded studs and nuts.
Helix – ½, 5/8, and 3/4 inch Thick: ASTM A572, or A1018, or A656 with minimum yield strength of 50 and 80 ksi, depending on helix diameter.
6 inch Helix Pitch – a standard established by Hubbell Power Systems, Inc. for larger diameter CHANCE Helical Anchors and Piles.
Available Helix Diameters: 16, 18, and 24 inches
All helix plates are spaced 3 times the diameter of the preceding (lower) helix unless otherwise specified.
The Standard helix plate has straight sharpened leading edges or can be ordered with a "sea shell" cut. The "sea shell" cut is best suited when it is necessary to penetrate soils with fill debris, cobbles, or fractured rock.
Configurations:
Single, double, triple, Lead Sections, 5, 7, 10, 15, and 20 feet long
Plain Extensions, 5, 7, 10, 15, and 10 feet long
Extensions with Helix Plates, 10 feet long
Helical products are Hot Dip Galvanized per ASTM A123 Grade 75.

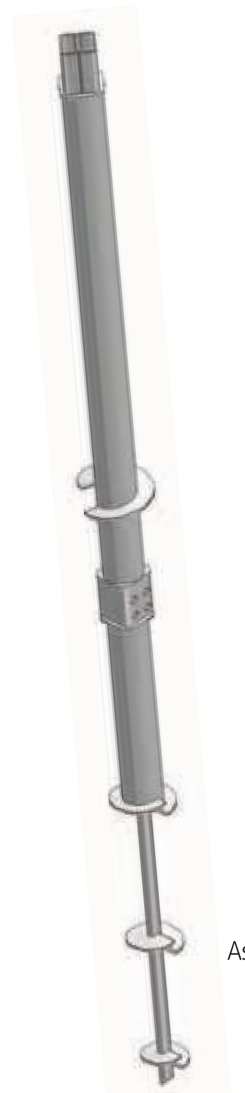


CHANCE Type RS8625.250
Helical Pile Shaft Cross-Section
Figure 7-25

NOTE: Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 is recommended for determining allowable capacity from correlations. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.

RS8625.250 HELICAL PILE AND ANCHOR PRODUCT SPECIFICATIONS				
SHAFT	Hot Rolled HSS 8 inch Nominal Schedule 20 (0.250 inch nominal wall) per ASTM A500 Grade B/C with 50 ksi minimum yield strength			
Shaft Size, OD	8.625 in	219 mm	Corroded	
			8.612 in	218.7 mm
Shaft Size, ID*	8.16 in	207.3 mm	Corroded	
			8.172 in	207.5 mm
Moment of Inertia (I)*	54.12 in^4	2249.5 cm^4	Corroded	
			51.09 in^4	2123.6 cm^4
Shaft Area (A)*	6.14 in^2	39.6 cm^2	Corroded	
			5.80 in^2	37.4 cm^2
Section Modulus (S_{x-x})*	12.55 in^3	205.2 cm^3	Corroded	
			11.87 in^3	194.1 cm^3
Perimeter	27.1 in	68.8 cm	Corroded	
			27.05 in	68.1 cm
Coupling	Formed and Welded Square Socket			
Coupling Bolts	Four 1-1/4 in Dia. Grade 2 Studs			
Helix Plates	0.5 - 0.75 inch Thick, Formed on Matching Metal Dies, ASTM A572 Grade 80 or better			
Coatings	Hot Dip Galvanized per ASTM A123 Grade 75, 3.0 mil minimum thickness or Bare Steel			
TORQUE PROPERTIES				
Torque Correlation Factor	5 ft^{-1}		13 m^{-1}	
Torque Rating	60,000 ft-lb		81,349 N-m	
STRUCTURAL CAPACITY				
Tension Strength	Nominal		LRFD Design	
	300 kip	1334 kN	225 kip	1001 kN
Allowable Tension Strength	150 kip		667 kN	
TORQUE CORRELATED CAPACITY				
Capacity Limit Based on Torque Correlation, Tension / Compression	Ultimate		Allowable	
	300 kip	1334 kN	150 kip	667 kN

* computed with 93% of wall thickness per AISC 360-10, B4.2



Assembly of RS8625.250
Figure 7-26

TYPE SS/RS COMBINATION HELICAL PILES

CHANCE® Helical Transition Coupler

Adapts Type SS to Type RS Pile Shafts

The Type SS/RS Combination Pile is used mainly in compression applications in areas where soft/loose soils are located above the bearing strata (hard/dense soils) for the helices. The Type RS material with its much greater section modulus will resist columnar buckling in the soft/loose soil. Its larger shaft diameter also provides for lateral load resistance. Due to its slender size, the Type SS material provides the means for the helix plates to penetrate deeper into hard/dense soil stratum than if the helical pile shaft was pipe shaft only. For a given helix configuration and same available installation energy (i.e. machine), a small displacement shaft will penetrate farther into a soil bearing strata than a large displacement shaft and will disturb less soil.

It is recommended that a CHANCE SS/RS Combination Helical Pile be used in all projects where pipe shaft is being used. The square shaft lead section will provide better load capacity and less settlement than a comparable straight pipe shaft pile.

The transition section (see Figure 7-27) adapts Type SS helical lead sections to Type RS plain extensions. Installation of this combination pile is the same as a standard helical pile. Table 7-9 provides the various standard transition couplers that are available along with their ratings. Special transition couplers, such as RS2875 to RS4500, are also available. Please contact your area CHANCE® Distributor for availability and delivery times.

Pile Assembly with Transition Coupler Figure 7-27

Table 7-5: Transition Couplers

CATALOG NUMBER	DESCRIPTION	TORQUE RATINGS
C1500896	SS5/SS150 square shaft to a RS2875.203 round shaft	5,500 ft-lb
C1500896	SS5/SS150 square shaft to a RS2875.276 round shaft	7,000 ft-lb
C1500895	SS175 square shaft to a RS3500.300 dia round shaft	10,500 ft-lb
C1500937	SS200 square shaft to a RS3500.300 dia round shaft	13,000 ft-lb

CHANCE HELICAL PULLDOWN® Micropiles

The CHANCE HELICAL PULLDOWN® Micropile (HPM) is a patented (U.S. patent 5,707,180) method used to form a grout column around the shaft of a standard square shaft or pipe shaft helical pile/anchor. The installation process can employ grout only (see Figure 7-28) or grout in combination with either steel or PVC casing (see Figure 7-29). The result is a helical pile with grouted shaft similar, in terms of installation, to drilled and grouted anchors or auger cast-in-place piles using gravity grouting.

The initial reason for developing the HPM was to design a helical pile with sufficient shaft size to resist buckling. However, since its inception, the method has demonstrated more advantages than simply buckling resistance. The advantages and limitations, based on the results of field tests, are summarized herein:

1. Increase buckling capacity of a helical pile shaft in soft/loose overburden soils to the point that end-bearing controls failure.
2. Increased compression capacity due to the mobilization of skin friction at the grout/soil interface. Total capacity is a function of both skin friction and end-bearing.

3. Provides additional corrosion protection to anchor shaft in aggressive soils. The grout column provides additional corrosion protection to the steel pile shaft from naturally occurring aggressive soils with high metal loss rates, organic soils such as peat or other corrosive environments like slag, ash, swamp, chemical waste, or other man-made material.
4. Stiffens the load/deflection response of helical piles. Axial deflection per unit load is typically less than with un-grouted shafts.

The installation procedure for CHANCE HELICAL PULLDOWN® Micropiles is rather unique in that the soil along the sides of the shaft is displaced laterally and then replaced and continuously supported by the flowable grout as the pile is installed. To begin the installation process, a helical pile/anchor is placed into the soil by applying torque to the shaft. The helical shape of the bearing plates creates a significant downward force that keeps the pile advancing into the soil. After the Lead Section with the helical plates penetrates the soil, a Lead Displacement Plate and Extension are placed onto the shaft. Resuming torque on the assembly advances the helical plates and pulls the displacement plate downward, forcing soil outward to create a cylindrical void around the shaft. From a reservoir at the surface, a flowable grout is gravity fed and immediately fills the void surrounding the shaft. Additional extensions and displacement plates are added until the helical bearing plates reach the minimum depth required or competent load-bearing soil. This displacement pile system does not require removing spoils from the site.

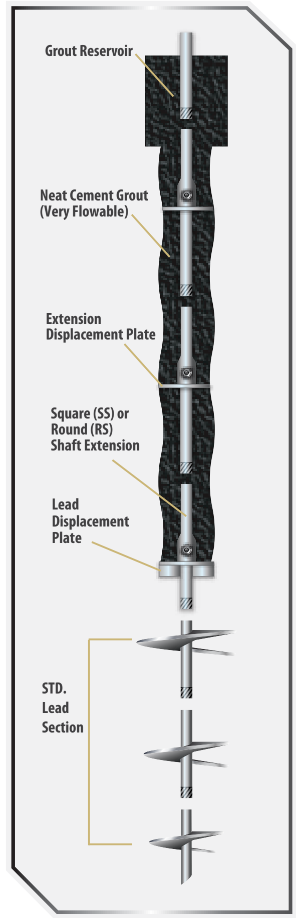


Figure 7-28

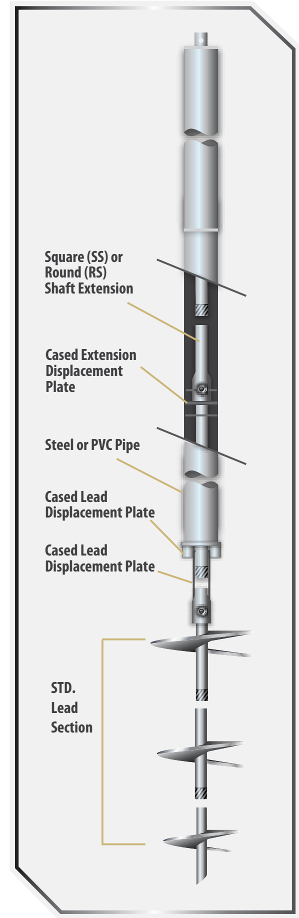


Figure 7-29

THEORETICAL GROUT VOLUME PER FOOT (METER)

Grout Column Diameter inches (mm)	Pile Shaft Size inches (mm)	Grout Volume ft^3/ft (m^3/m)
4 (102)	1-1/2 (38) solid square	0.071 (0.007)
5 (127)	1-1/2 (38) solid square	0.120 (0.011)
	1-3/4 (44) solid square	0.115 (0.011
6 (152)	1-1/2 (38) solid square	0.181 (0.017)
	1-3/4 (44)solid square	0.175 (0.016)
	2 (51) solid square	0.169 (0.016)
	2-1/4 (57) solid square	0.161 (0.015)
	2-7/8 x 0.203 (73 x 5.2) pipe shaft	0.185 (0.017)
	2-7/8 x 0.276 (73 x 7) pipe shaft	0.181 (0.017)
	3-1/2 x 0.300 (89 x 7.6) pipe shaft	0.176 (0.016)
	4-1/2 x 0.337 (114 x 8.6) pipe shaft	0.166 (0.015)
7 (178)	1-1/2 (38) solid square	0.249 (0.023)
	1-3/4 (44) solid square	0.246 (0.023)
	2 (51) solid square	0.240 (0.022)
	2-1/4 (57) solid square	0.232 (0.022)
	3-1/2 x 0.300 (89 x 7.6) pipe shaft	0.246 (0.023)
	4-1/2 x 0.337 (114 x 8.6) pipe shaft	0.237 (0.022)
8 (203)	1-3/4 (44) solid square	0.328 (0.030)
	2-7/8 x 0.203 (73 x 5.2) pipe shaft	0.337 (0.031)
	2-7/8 x 0.276 (73 x 7) pipe shaft	0.333 (0.031)
	3-1/2 x 0.300 (89 x 7.6) pipe shaft	0.328 (0.030)
	4-1/2 x 0.337 (114 x 8.6) pipe shaft	0.319 (0.029)
8.5 (216)	2 (51) solid square	0.367 (0.034)
	2-1/4 (57) solid square	0.359 (0.033)
10 (254)	1-3/4 (44) solid square	0.524 (0.049)
	2 (51) solid square	0.517 (0.048)
	2-1/4 (57) solid square	0.511 (0.047)
	3-1/2 x 0.300 (89 x 7.6) pipe shaft	0.525 (0.049)
	4-1/2 x 0.337 (114 x 8.6) pipe shaft	0.515 (0.048)

Multiply volume in chart by grout column length to get total volume.

Grout volume per length of shaft extension can easily be calculated by multiplying the shaft length by the volume in the chart. Be sure to convert your units to feet or meters.

Note that if the piles are un-cased, more grout may be required due to irregularities in the column, and subsurface voids. Also, don't forget to add for the grout bath and waste when bidding the job.

Higher Compression Strengths with Grouted Shafts

The following tables provide the nominal, LRFD design, and ASD allowable compression strengths of helical piles with various diameter grouted shafts. The strengths listed are based on an unsupported shaft length of 10 feet (3 meters) with either a fixed or pinned end condition at the pile head. The grout column diameters listed are the most common used per each helical product family. Each table includes the compression strengths of shafts without grout for comparison.

Per the International Building Code (IBC) 2006 Section 1808.2.9.2 & IBC 2009 Section 1810.2.1, the depth to fixity of piles driven into soft ground can be considered fixed and laterally supported at 10 feet below the ground surface.

Nominal, LRFD Design, and ASD Allowable Compression Strengths of CHANCE® Type SS5 Grouted Shaft Piles in Soft Soil[1,2,3]

Grout Column Diameter	Nominal, LRFD Design, and ASD Allowable Compression Strengths kip (kN)					
	Soft Soil					
	Pinned			Fixed		
	Nominal	Design	Allowable	Nominal	Design	Allowable
No Grout	13.6 (60)	12.2 (54)	8.1 (36)	26.6 (118)	24.0 (107)	16.0 (71)
4″ OD	30.2 (134)	22.6 (101)	15.1 (67)	59.2 (263)	44.4 (198)	29.6 (132)
5″ OD	54.9 (244)	41.2 (183)	27.4 (122)	104.5 (465)	78.3 (348)	52.2 (232)
6″ OD	86.2 (383)	64.6 (287)	43.1 (192)	148.3 (660)	111.2 (495)	74.1 (330)
7″ OD	126.2 (561)	94.6 (421)	63.1 (281)	194.6 (866)	145.9 (649)	97.3 (433)

Nominal, LRFD Design, and ASD Allowable Compression Strengths of CHANCE® Type SS150 Grouted Shaft Piles in Soft Soil[1,2,3]

Grout Column Diameter	Nominal, LRFD Design, and ASD Allowable Compression Strengths kip (kN)					
	Soft Soil					
	Pinned			Fixed		
	Nominal	Design	Allowable	Nominal	Design	Allowable
No Grout	13.6 (60)	12.2 (54)	8.1 (36)	26.6 (118)	24.0 (107)	16.0 (71)
4″ OD	30.2 (134)	22.6 (101)	15.1 (67)	59.2 (263)	44.4 (198)	29.6 (132)
5″ OD	54.9 (244)	41.2 (183)	27.4 (122)	104.5 (465)	78.3 (348)	52.2 (232)
6″ OD	86.2 (383)	64.6 (287)	43.1 (192)	148.3 (660)	111.2 (495)	74.1 (330)
7″ OD	126.8 (564)	95.1 (423)	63.4 (282)	208.4 (927)	156.3 (695)	104.2 (464)

Nominal, LRFD Design, and ASD Allowable Compression Strengths of CHANCE® Type SS175 Grouted Shaft Piles in Soft Soil[1,2,3]

Grout Column Diameter	Nominal, LRFD Design, and ASD Allowable Compression Strengths kip (kN)					
	Soft Soil					
	Pinned			Fixed		
	Nominal	Design	Allowable	Nominal	Design	Allowable
No Grout	25.8 (115)	23.2 (103)	15.4 (69)	50.5 (225)	45.4 (202)	30.2 (134)
5″ OD	66.6 (296)	49.9 (222)	33.3 (148)	127.2 (566)	95.4 (424)	63.6 (283)
6″ OD	111.5 (496)	83.6 (372)	55.7 (248)	185.6 (826)	139.2 (619)	92.8 (413)
7″ OD	158.3 (704)	118.7 (528)	79.1 (352)	236.2 (1051)	177.2 (788)	118.1 (525)
8″ OD	209.2 (931)	156.9 (698)	104.6 (465)	290.4 (1292)	217.8 (969)	145.2 (646)

Nominal, LRFD Design, and ASD Allowable Compression Strengths of CHANCE® Type SS200 Grouted Shaft Piles in Soft Soil[1,2,3]

Grout Column Diameter	Nominal, LRFD Design, and ASD Allowable Compression Strengths kip (kN)					
	Soft Soil					
	Pinned			Fixed		
	Nominal	Design	Allowable	Nominal	Design	Allowable
No Grout	43.7 (194)	39.3 (175)	26.2 (117)	85.6 (381)	77.1 (343)	51.3 (228)
6″ OD	128.7 (572)	96.6 (430)	64.4 (286)	233.9 (1040)	175.4 (780)	116.9 (520)
7″ OD	201.9 (898)	151.4 (673)	101.0 (449)	312.9 (1392)	234.6 (1044)	156.4 (696)
8.5″ OD	294.7 (1311)	221.0 (983)	147.4 (656)	407.6 (1813)	305.7 (1360)	203.8 (907)
10″ OD	401.4 (1786)	301.1 (1339)	200.7 (893)	513.6 (2285)	385.2 (1713)	256.8 (1142)

Nominal, LRFD Design, and ASD Allowable Compression Strengths of CHANCE® Type SS225 Grouted Shaft Piles in Soft Soil[1,2,3]

Grout Column Diameter	Nominal, LRFD Design, and ASD Allowable Compression Strengths kip (kN)					
	Soft Soil					
	Pinned			Fixed		
	Nominal	Design	Allowable	Nominal	Design	Allowable
No Grout	70.9 (315)	63.8 (284)	42.5 (189)	139.0 (618)	125.1 (556)	83.2 (370)
6″ OD	154.9 (689)	116.2 (517)	77.5 (345)	281.8 (1254)	211.4 (940)	140.9 (627)
7″ OD	228.8 (1018)	171.6 (763)	114.4 (509)	363.2 (1171)	272.4 (1212)	181.6 (808)
8.5″ OD	354.3 (1576)	265.7 (1182)	177.1 (788)	482.3 (2145)	361.7 (1609)	241.1 (1072)
10″ OD	466.1 (2073)	349.6 (1555)	233.1 (1037)	591.3 (2630)	443.5 (1973)	295.7 (1315)

Nominal, LRFD Design, and ASD Allowable Compression Strengths of CHANCE® Type RS2875.203 Grouted Shaft Piles in Soft Soil[1,2,3]

Grout Column Diameter	Nominal, LRFD Design, and ASD Allowable Compression Strengths kip (kN)					
	Soft Soil					
	Pinned			Fixed		
	Nominal	Design	Allowable	Nominal	Design	Allowable
No Grout	42.0 (187)	37.8 (168)	25.1 (112)	55.5 (247)	49.9 (222)	33.2 (148)
6″ OD	95.7 (426)	71.8 (319)	47.8 (213)	125.7 (559)	94.3 (419)	62.8 (279)
8″ OD	160.1 (712)	120.1 (534)	80.1 (356)	203.2 (904)	152.4 (678)	101.6 (452)

Nominal, LRFD Design, and ASD Allowable Compression Strengths of CHANCE® Type RS2875.276 Grouted Shaft Piles in Soft Soil[1,2,3]

Grout Column Diameter	*Nominal, LRFD Design, and ASD Allowable Compression Strengths kip (kN)*					
	Soft Soil					
	Pinned			*Fixed*		
	Nominal	*Design*	*Allowable*	*Nominal*	*Design*	*Allowable*
No Grout	55.2 (246)	49.7 (221)	33.0 (147)	73.9 (329)	66.5 (296)	44.3 (197)
6″ OD	114.3 (508)	85.7 (381)	57.1 (254)	147.7 (657)	110.8 (493)	73.9 (329)
8″ OD	181.4 (807)	136.0 (605)	90.7 (403)	226.9 (1009)	170.2 (757)	113.5 (505)

Nominal, LRFD Design, and ASD Allowable Compression Strengths of CHANCE® Type RS3500.300 Grouted Shaft Piles in Soft Soil[1,2,3]

Grout Column Diameter	Nominal, LRFD Design, and ASD Allowable Compression Strengths kip (kN)					
	Soft Soil					
	Pinned			Fixed		
	Nominal	Design	Allowable	Nominal	Design	Allowable
No Grout	90.7 (403)	81.6 (363)	54.3 (242)	110.0 (49)	99.0 (440)	65.9 (293)
6″ OD	145.1 (645)	108.8 (484)	72.5 (322)	175.6 (781)	131.7 (586)	87.8 (391)
7″ OD	179.3 (798)	134.4 (598)	89.6 (399)	214.1 (952)	160.6 (714)	107.0 (476)
8″ OD	216.7 (964)	162.5 (723)	108.4 (482)	257.3 (1145)	193.0 (859)	128.6 (572)
10″ OD	314.4 (1399)	235.8 (1049)	157.2 (699)	365.6 (1626)	274.2 (1220)	182.8 (813)

Nominal, LRFD Design, and ASD Allowable Compression Strengths of CHANCE® Type RS4500.337 Grouted Shaft Piles in Soft Soil[1,2,3]

Grout Column Diameter	Nominal, LRFD Design, and ASD Allowable Compression Strengths kip (kN)					
	Soft Soil					
	Pinned			Fixed		
	Nominal	Design	Allowable	Nominal	Design	Allowable
No Grout	156.3 (695)	140.7 (626)	93.6 (416)	175.3 (780)	157.8 (702)	105.0 (467)
6″ OD	195.3 (869)	146.5 (652)	97.6 (434)	220.6 (981)	165.5 (736)	110.3 (491)
7″ OD	230.4 (1025)	172.8 (769)	115.2 (512)	259.6 (1155)	194.7 (866)	129.8 (577)
8″ OD	274.2 (1220)	205.6 (915)	137.1 (610)	306.4 (1363)	229.8 (1022)	153.2 (681)
10″ OD	372.8 (1658)	279.6 (1244)	186.4 (829)	415.0 (1846)	311.3 (1385)	207.5 (923)

For SI: 1 kip = 4.448 kN.

[1] Refer to Section 4.1.3 of ESR-2794 for descriptions of fixed condition, pinned condition, soft soil.

[2] Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with IBC Section 1808.2.5, and the lead section with which the extension is used will provide sufficient helix capacity to develop the full shaft capacity.

[3] Column length to "fixity" of shaft in soil = 10 feet (3 meters)

REMEDIAL REPAIR BRACKETS for CHANCE® HELICAL PILES

CHANCE® Helical C1500121 Standard Bracket and T-pipe System

- Used with CHANCE Type SS5 & SS150 1-1/2" Square Shaft Helical Piles and Type RS2875.203 and RS2875.276 2-7/8" OD Pipe Shaft Helical Piles
- Use for lifts up to 4" (10 cm)
- All C1500121 Standard Systems include:
  - Foundation bracket
  - T-pipe
  - Hardware

Order separately: Two 5/8" (16 mm) diameter concrete anchor bolts per pile as required.

Standard finish is Hot-Dip Galvanized per ASTM A153.

Ultimate mechanical strength of bracket body is 80,000 lbs (356 kN). Working mechanical strength of bracket body is 40,000 lbs (178kN).

See table below for system (bracket/pile shaft) ratings.

CHANCE® Helical C1500121 Standard Bracket and T-Pipe Ratings

T-Pipe Designations for the C150-0121 Bracket	Ultimate Mechanical Strength[1,3] lbs (kN)	Pile Size in (mm)	Product Series	Max Working Capacity[2,3] based on Product Series lbs (kN)	Features
C150-0486	40,000 (178)	1-1/2 (38) Square	SS5 SS150	20,000 (89) 20,000 (89)	Lowest cost with square shaft.
C150-0487	80,000 (356)	1-1/2 (38) Square	SS5 SS150	20,000 (89) 25,000 (111)	Higher capacity with SS150.
C278-0001	40,000 (178)	2-7/8 (73) Round	RS2875.203	20,000 (89)	Lowest cost with round shaft.
C278-0002	80,000 (356)	2-7/8 (73) Round	RS2875.203	25,000 (111)	Higher capacity with stronger T-pipe
C278-8012	40,000 (178)	2-7/8 (73) Round	RS2875.276	20,000 (133)	Higher capacity with RS2875.203
C278-8011	80,000 (356)	2-7/8 (73) Round	RS2875.276	30,000 (133)	Higher capacity with RS2875.276

Notes:

1. Ultimate mechanical strength is for the bracket body and T-pipe combination.
2. The capacity of CHANCE® Helical Pile Systems is a function of many individual elements, including the capacity of the foundation, bracket, pile shaft, helix plate and bearing stratum, as well as the strength of the foundation-to-bracket connection, and the quality of the helical pile installation. The fifth column shows typical working capacities of the CHANCE® Helical Pile System based upon maximum shaft exposure of 2 feet and soil strength having a minimum Standard Penetration Test (SPT) Blow Count "N_{60}" of 4. Actual capacities could be higher or lower depending on the above factors.
3. The ultimate capacity of the system, i.e., bracket, T-pipe, and pile shaft, can be increased to the pile shaft compression capacity limit as shown on the product data pages provided the pile shaft is reinforced using a pipe sleeve or grout column. The maximum working capacity shall not be greater than one half the ultimate mechanical strength of the bracket and t-pipe combination given above.

Building Code Compliance per ICC-ES ESR-2794

The following tables provide the nominal, LRFD design, and ASD allowable compression strengths of C150-0121 Foundation Repair Brackets, T-pipes, and both Type SS5 and SS150 helical piles as evaluated per ICC-ES Acceptance Criteria AC358. These strengths are published in ICC-ES ESR-2794. The strengths listed are based on three different concrete foundation strengths, two different soils conditions - firm and soft. The pile head is assumed to be fixed within the bracket assembly, and the piles are assumed to be braced.

Per the International Building Code (IBC) 2006 Section 1808.2.9.2 & IBC 2009 Section 1810.2.1, the depth to fixity of piles driven into firm ground can be considered fixed and laterally supported at 5 feet below the ground surface and in soft material at 10 feet.

Nominal Strengths of C1500121 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	Nominal Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500121	C1500486	SS5/150	36.3 (161)	26.6 (118)	36.3 (161)	26.6 (118)	36.3 (161)	26.6 (118)
C1500121	C1500487	SS5	74.6 (332)	26.6 (118)	82.9 (369)	26.6 (118)	89.8 (399)	26.6 (118)
C1500121	C1500487	SS150	78.7 (350)	26.6 (118)	87.1 (387)	26.6 (118)	99.5 (443)	26.6 (118)

LRFD Design Strengths of C150-0121 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	LRFD Design Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500121	C1500486	SS5/150	32.6 (145)	24.0 (107)	32.6 (145)	24.0 (107)	32.6 (145)	24.0 (107)
C1500121	C1500487	SS5	52.2 (232)	24.0 (107)	58.0 (258)	24.0 (107)	62.8 (279)	24.0 (107)
C1500121	C1500487	SS150	55.1 (245)	24.0 (107)	60.9 (271)	24.0 (107)	69.6 (310)	24.0 (107)

ASD Allowable Strengths of C150-0121 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	ASD Allowable Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500121	C1500486	SS5/150	21.7 (97)	16.0 (71)	21.7 (97)	16.0 (71)	21.7 (97)	16.0 (71)
C1500121	C1500487	SS5	32.8 (146)	16.0 (71)	36.4 (162)	16.0 (71)	39.4 (175)	16.0 (71)
C1500121	C1500487	SS150	34.6 (154)	16.0 (71)	38.2 (170)	16.0 (71)	43.7 (194)	16.0 (71)

For SI: 1 kip = 4.448 Kn.

[1]Refer to Section 4.1.3 of ICC-ES ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2]Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with Section 1810.2.2 of the 2012 & 2009 IBC (Section 1808.2.5 of the 2006 IBC).
[3]Strength ratings apply to the specific bracket, T-pipe and pile/anchor models listed.
[4]See Section 4.1.2 of ICC-ES ESR-2794 for applicable limit states that must be evaluated by a registered design professional.
[5]Refer to the specified compressive strength of concrete at 28 days.

CHANCE® Helical C1500299 Standard Bracket and T-Pipe System

- Used with CHANCE Type SS175 1-3/4" Square Shaft Helical Piles
- Use for lifts up to 4" (10 cm)
- All C1500299 Standard Systems include:
  - Foundation bracket
  - T-pipe
  - Hardware

Order separately: Two 5/8" (16 mm) diameter concrete anchor bolts per pile as required.

Standard finish is Hot-Dip Galvanized per ASTM A153.

Ultimate mechanical strength of bracket body is 80,000 lbs (356 kN). Working mechanical strength of bracket body is 40,000 lbs (178kN).

See table below for system (bracket/pile shaft) ratings.

CHANCE® Helical C1500299 Standard Bracket and T-Pipe Ratings

T-Pipe Designations for the C150-0299 Bracket	Ultimate Mechanical Strength[1,3] lbs (kN)	Pile Size in (mm)	Product Series	Max Working Capacity[2,3] based on Product Series lbs (kN)	Features
C150-0488	80,000 (356)	1-3/4 (44) Square	SS175	30,000 (133)	Lowest cost with Type SS175 Product Series.

Notes:

1. Ultimate mechanical strength is for the bracket body and T-pipe combination.
2. The capacity of CHANCE® Helical Pile Systems is a function of many individual elements, including the capacity of the foundation, bracket, pile shaft, helix plate and bearing stratum, as well as the strength of the foundation-to-bracket connection, and the quality of the helical pile installation. The fifth column shows typical working capacities of the CHANCE® Helical Pile System based upon maximum shaft exposure of 2 feet and soil strength having a minimum Standard Penetration Test (SPT) Blow Count " N_{60}" of 4. Actual capacities could be higher or lower depending on the above factors.
3. The ultimate capacity of the system, i.e., bracket, T-pipe, and pile shaft, can be increased to the pile shaft compression capacity limit as shown on the product data pages provided the pile shaft is reinforced using a pipe sleeve or grout column. The maximum working capacity shall not be greater than one half the ultimate mechanical strength of the bracket and t-pipe combination given above.

Building Code Compliance per ICC-ES ESR-2794

The following tables provide the nominal, LRFD design, and ASD allowable compression strengths of C1500299 Foundation Repair Brackets, T-pipes, and Type SS175 Helical Piles as evaluated per ICC-ES Acceptance Criteria AC358. These strengths are published in ICC-ES ESR-2794. The strengths listed are based on three different concrete foundation strengths, two different soils conditions - firm and soft. The pile head is assumed to be fixed within the bracket assembly, and the piles are assumed to be braced.

Per the International Building Code (IBC) 2006 Section 1808.2.9.2 & IBC 2009 Section 1810.2.1, the depth to fixity of piles driven into firm ground can be considered fixed and laterally supported at 5 feet below the ground surface and in soft material at 10 feet.

Nominal Strengths of C1500299 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	Nominal Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500299	C1500488	SS175	83.8 (373)	50.5 (225)	91.4 (407)	50.5 (225)	99.0 (440)	50.5 (225)

LRFD Design Strengths of C1500299 Remedial Repair Brackets & Helical Piles[1,2,3,4]

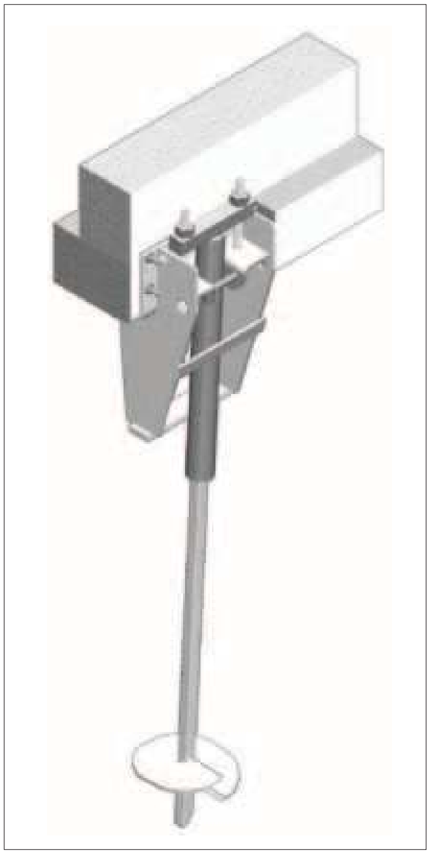
Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	LRFD Design Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500299	C1500488	SS175	58.6 (261)	42.9 (191)	66.5 (296)	45.4 (202)	74.2 (330)	45.4 (202)

ASD Allowable Strengths of C1500299 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	ASD Allowable Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500299	C1500488	SS175	36.8 (164)	27.7 (123)	41.7 (185)	30.2 (134)	49.5 (220)	30.2 (134)

For SI: 1 kip = 4.448 Kn.

[1]Refer to Section 4.1.3 of ICC-ES ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2]Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with Section 1810.2.2 of the 2012 & 2009 IBC (Section 1808.2.5 of the 2006 IBC).
[3]Strength ratings apply to the specific bracket, T-pipe and pile/anchor models listed.
[4]See Section 4.1.2 of ICC-ES ESR-2794 for applicable limit states that must be evaluated by a registered design professional.
[5]Refer to the specified compressive strength of concrete at 28 days.



CHANCE® Helical C1500147 Heavy Duty Bracket and T-Pipe System

- Used with CHANCE Type SS175 1-3/4" Square Shaft Helical Piles, Type SS200 2" Square Shaft Helical Piles, and Type RS3500.300 3-1/2" OD Round Shaft Helical Piles
- Use for lifts up to 4" (10 cm)
- All C150-0147 Standard Systems include:
  - Foundation bracket
  - T-pipe
  - Hardware

Order separately: Four 5/8" (16 mm) diameter concrete anchor bolts per pile as required.

Standard finish is HOT-DIP GALVANIZED per ASTM A153.

Ultimate mechanical strength of bracket body is 120,000 lbs (534 kN).
Working mechanical strength of bracket body is 60,000 lbs (267kN).

See table below for system (bracket/pile shaft) ratings.

CHANCE® Helical C1500147 Standard Bracket and T-Pipe Ratings

T-Pipe Designations for the C150-0147 Bracket	Ultimate Mechanical Strength[1,3] lbs (kN)	Pile Size in (mm)	Product Series	Max Working Capacity [2,3] based on Product Series lbs (kN)	Features
C1500474	120,000 (534)	1-3/4 (44) Square	SS175	40,000 (178)	Lowest cost with square shaft.
C1500475	120,000 (534)	3-1/2 (89) Round	RS3500.300	50,000 (222)	Higher capacity with RS3500.300.
C1500508	120,000 (534)	2 (51) Square	SS200	50,000 (222)	Highest capacity with square shaft.

Notes:

1. Ultimate mechanical strength is for the Bracket Body and T-Pipe combination.
2. The capacity of CHANCE® Helical Pile Systems is a function of many individual elements, including the capacity of the foundation, bracket, pile shaft, helix plate and bearing stratum, as well as the strength of the foundation-to-bracket connection, and the quality of the helical pile installation. The fifth column shows typical working capacities of the CHANCE® Helical Pile System based upon maximum shaft exposure of 2 feet and soil strength having a minimum Standard Penetration Test (SPT) Blow Count " N_{60}" of 4. Actual capacities could be higher or lower depending on the above factors.
3. The ultimate capacity of the system, i.e., bracket, T-pipe, and pile shaft, can be increased to the pile shaft compression capacity limit as shown on the product data pages provided the pile shaft is reinforced using a pipe sleeve or grout column. The maximum working capacity shall not be greater than one half the ultimate mechanical strength of the bracket and t-pipe combination given above.

Building Code Compliance per ICC-ES ESR-2794

The following tables provide the nominal, LRFD design, and ASD allowable compression strengths of C150-0147 Foundation Repair Brackets, T-pipes, and Type SS175 Helical Piles as evaluated per ICC-ES Acceptance Criteria AC358. These strengths are published in ICC-ES ESR-2794. The strengths listed are based on three different concrete foundation strengths, two different soils conditions - firm and soft. The pile head is assumed to be fixed within the bracket assembly, and the piles are assumed to be braced.

Per the International Building Code (IBC) 2006 Section 1808.2.9.2 & IBC 2009 Section 1810.2.1, the depth to fixity of piles driven into firm ground can be considered fixed and laterally supported at 5 feet below the ground surface and in soft material at 10 feet.

Nominal Strengths of C150-0147 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	Nominal Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500147	C1500474	SS175	100 (445)	50.5 (225)	100 (445)	50.5 (225)	100 (445)	50.5 (225)

LRFD Design Strengths of C150-0147 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	LRFD Design Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500147	C1500474	SS175	86.7 (386)	45.4 (202)	88.4 (393)	45.4 (202)	90 (400)	45.4 (202)

ASD Allowable Strengths of C150-0147 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	ASD Allowable Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500147	C1500474	SS175	54.4 (242)	30.2 (134)	57.0 (254)	30.2 (134)	60.0 (267)	30.2 (134)

For SI: 1 kip = 4.448 Kn.

[1]Refer to Section 4.1.3 of ICC-ES ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2]Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with Section 1810.2.2 of the 2012 & 2009 IBC (Section 1808.2.5 of the 2006 IBC).
[3]Strength ratings apply to the specific bracket, T-pipe and pile/anchor models listed.
[4]See Section 4.1.2 of ICC-ES ESR-2794 for applicable limit states that must be evaluated by a registered design professional.
[5]Refer to the specified compressive strength of concrete at 28 days.

CHANCE® Helical PSAC1500499 Low Profile Bracket and T-Pipe System

• Used with CHANCE Type SS5 & SS150 1-1/2" Square Shaft Helical Piles and Type • RS2875.203 and RS2875.276 2-7/8" OD Pipe Shaft Helical Piles
• Use for lifts up to 4" (10 cm)

All PSAC1501500499 Low Profile Systems include:

- Foundation bracket
- T-pipe
- Hardware

Order separately: Two 1/2" (13 mm) diameter concrete anchor bolts per pile as required.

Standard finish is Hot-Dip Galvanized per ASTM A153.

Ultimate mechanical strength of bracket body is 30,000 lbs (133 kN). Working mechanical strength of bracket body is 15,000 lbs (67 kN).

See table below for system (bracket/pile shaft) ratings.

CHANCE® Helical PSAC1500499 Low Profile Bracket and T-Pipe Ratings

T-Pipe Designations for the PSA1500499 Bracket	Ultimate Mechanical Strength[1,3] lbs (kN)	Pile Size in (mm)	Product Series	Max Working Capacity[2,3] based on Product Series lbs (kN)	Features
PSAC150-0503	30,000 (133)	1-1/2 (38) Square	SS5 SS150	15,000 (67)	Lowest cost with Type SS5 Product Series
PSAC278-0003	30,000 (133)	2-7/8 (73) Round	RS2875.203	15,000 (67)	Lowest cost with Type RS2875.203 Product Series

Notes:

1. Ultimate mechanical strength is for the bracket body and T-pipe combination.
2. The capacity of CHANCE® Helical Pile Systems is a function of many individual elements, including the capacity of the foundation, bracket, pile shaft, helix plate and bearing stratum, as well as the strength of the foundation-to-bracket connection, and the quality of the helical pile installation. The fifth column shows typical working capacities of the CHANCE® Helical Pile System based upon maximum shaft exposure of 2 feet and soil strength having a minimum Standard Penetration Test (SPT) Blow Count " N_{60}" of 4. Actual capacities could be higher or lower depending on the above factors.
3. The ultimate capacity of the system, i.e., bracket, T-pipe, and pile shaft, can be increased to the pile shaft compression capacity limit as shown on the product data pages provided the pile shaft is reinforced using a pipe sleeve or grout column. The maximum working capacity shall not be greater than one half the ultimate mechanical strength of the bracket and t-pipe combination given above.

CHANCE® Helical Direct Jack Underpinning Brackets

- Used with CHANCE Type SS5 & SS150 1-1/2" and SS175 1-3/4" Square Shaft Helical Piles, Type RS2875.276 2-7/8" OD Pipe Shaft Helical Piles, and Type RS3500.300 3-1/2" OD Pipe Shaft Helical Piles
- Use for lifts up to 4" (10 cm)
- All Direct Jack Underpinning Brackets include:
    - Foundation bracket
    - T-pipe
    - Two Thread Bar Nuts

Order separately: Two 1/2" (13 mm) diameter concrete anchor bolts per pile as required.

Standard finish is Hot-Dip Galvanized per ASTM A153

The bracket body and T-pipe are packaged together.

See table below for system (bracket/pile shaft) ratings.

CHANCE® Helical Direct Jack Underpinning Brackets

Direct Jack Catalog Number	Ultimate Mechanical Strength[1,3] lbs (kN)	Pile Size in (mm)	Product Series	Max Working Capacity [2,3] based on Product Series lbs (kN)	Features
C150-0738	70,000 (356)	1-1/2 (38) Square	SS5 SS150	35,000 (133)	Lowest cost
C150-0733	100,000 (445)	1-3/4 (44) Square	SS175	50,000 (222)	Highest Capacity
C150-0840	72,000 (320)	2-7/8 (73) Round	RS2875.276	36,000 (160)	
C150-0841	91,000 (405)	3-1/2 (89) Round	RS3500.300	45,500 (202)	

Notes:

1. Ultimate mechanical strength is for the bracket body and T-pipe combination.
2. The capacity of CHANCE® Helical Pile Systems is a function of many individual elements, including the capacity of the foundation, bracket, pile shaft, helix plate and bearing stratum, as well as the strength of the foundation-to-bracket connection, and the quality of the helical pile installation. The fifth column shows typical working capacities of the CHANCE® Helical Pile System based upon maximum shaft exposure of 2 feet and soil strength having a minimum Standard Penetration Test (SPT) Blow Count " N_{60}" of 4. Actual capacities could be higher or lower depending on the above factors.
3. The ultimate capacity of the system, i.e., bracket, T-pipe, and pile shaft, can be increased to the pile shaft compression capacity limit as shown on the product data pages provided the pile shaft is reinforced using a pipe sleeve or grout column. The maximum working capacity shall not be greater than one half the ultimate mechanical strength of the bracket and t-pipe combination given above.

Building Code Compliance per ICC-ES ESR-2794

The following tables provide the nominal, LRFD design, and ASD allowable compression strengths of C1500738 Foundation Repair Bracket, T-pipe, and Type SS5 Helical Piles as evaluated per ICC-ES Acceptance Criteria AC358. These strengths are published in ICC-ES ESR-2794. The strengths listed are based on three different concrete foundation strengths, two different soils conditions - firm and soft. The pile head is assumed to be fixed within the bracket assembly, and the piles are assumed to be braced.

Per the International Building Code (IBC) 2006 Section 1808.2.9.2 & IBC 2009 Section 1810.2.1, the depth to fixity of piles driven into firm ground can be considered fixed and laterally supported at 5 feet below the ground surface and in soft material at 10 feet.

Nominal Strengths of C1500738 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	Nominal Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500738	Incl w/ Brkt	SS5	50.9 (226)	23.1 (103)	50.9 (226)	23.1 (103)	50.9 (226)	23.1 (103)

LRFD Design Strengths of C1500738 Remedial Repair Brackets & Helical Piles[1,2,3,4]

Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	LRFD Design Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500738	Incl w/ Brkt	SS5	45.8 (204)	20.8 (93)	45.8 (204)	20.8 (93)	45.8 (204)	20.8 (93)

ASD Allowable Strengths of C1500738 Remedial Repair Brackets & Helical Piles[1,2,3,4]

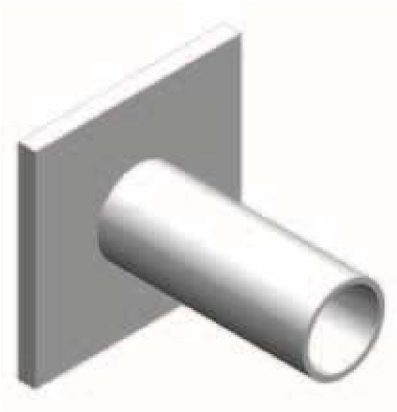
Bracket Catalog Number	T-Pipe Catalog Number	Pile Model	ASD Allowable Strength in Axial Compression kip (kN)					
			2500 psi Concrete[5]		3000 psi Concrete[5]		4000 psi Concrete[5]	
			Firm Soil	Soft Soil	Firm Soil	Soft Soil	Firm Soil	Soft Soil
C1500738	Incl w/ Brkt	SS5	30.5 (136)	13.8 (61)	30.5 (136)	13.8 (61)	30.5 (136)	13.8 (61)

For SI: 1 kip = 4.448 Kn.

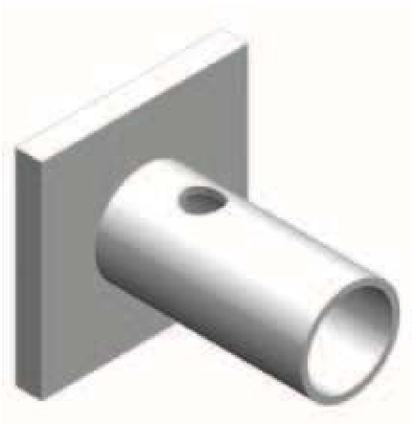
[1]Refer to Section 4.1.3 of ICC-ES ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2]Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with Section 1810.2.2 of the 2012 & 2009 IBC (Section 1808.2.5 of the 2006 IBC).
[3]Strength ratings apply to the specific bracket, T-pipe and pile/anchor models listed.
[4]See Section 4.1.2 of ICC-ES ESR-2794 for applicable limit states that must be evaluated by a registered design professional.
[5]Refer to the specified compressive strength of concrete at 28 days.

NEW CONSTRUCTION PILE CAPS

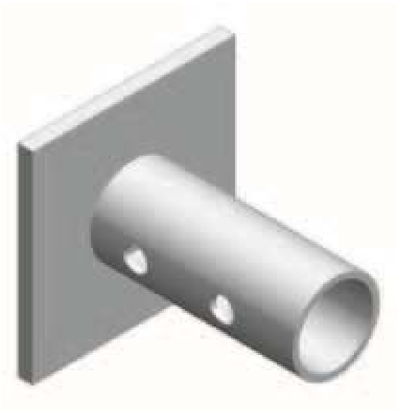
The CHANCE® New Construction Pile Caps are designed for use with the CHANCE® Type SS Square Shaft and RS Round Shaft helical piles and for embedment in cast-in-place concrete foundations. Each new construction pile cap consists of either one bearing plate and one steel tube sleeve that are factory-welded together to form the cap, or one bearing plate, two re-bars and one steel tube sleeve that are factory-welded together. The plate type pile caps are designed to be used in spread footings, grade beams, structural slabs, and reinforced concrete pile caps. The re-bar cap is designed to be used in grade beams and reinforced pile caps. The concrete foundation and interaction of pile shaft, new construction pile cap, and concrete footing for moment transfer, as applicable, must be designed and justified with due consideration to all applicable limit states and the direction and eccentricity of applied loads, including reactions provided by the brackets, acting on the concrete foundation. For preliminary design guidelines for reinforced pile caps refer to Section 4.



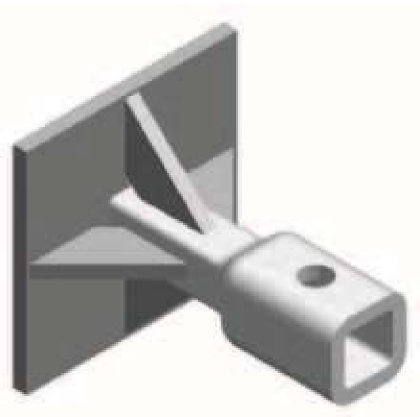
New Construction Cap for Type SS Shafts
Compression Only



New Construction Cap for Type SS Shafts
Compression and Uplift



New Construction Cap for Type RS Shafts
Compression and Uplift



New Construction Cap for Type SS Shafts
Equal Compression and Uplift Capacity

 |

CHANCE® Helical New Construction Pile Caps				
Pile Cap Designation	**Design (Working) Load kip (kN)**	**Plate Size (square)**	**Pipe OD & Length**	**Description**
C150-0458	40 (178) compression	6" x 6" x 1/2"	2-1/2" x 6"	Fits SS5/SS150 and RS2875.165/RS2875.203; use for compression only.
C150-0459	60 (267) compression	6" x 6" x 3/4"	3" x 6"	Fits SS175; use for compression only.
C150-0465	40 (178) compression 20 (89) uplift	6" x 6" x 1/2"	2-1/2" x 6"	Fits SS5/SS150; use for uplift and compression.
C150-0467	60 (267) compression 30 (133) uplift	6" x 6" x 3/4"	3" x 6"	Fits SS175; use for uplift and compression.
C150-0777	35 (156) compression	7" x 7" x 1/2"	2-1/2" x 6"	Fits SS5/SS150; use for compression only
C150-0778	52.5 (234) compression	8" x 8" x 1/2"	2-7/8" x 6"	Fits SS175; use for compression only
C150-0779	75 (334) compression	12" x 12" x 1/2"	3-1/2" x 6"	Fits SS200; use for compression only
C150-0780	100 (445) compression	12" x12" x 1/2"	3-1/2" x 6"	Fits SS225; use for compression only
C150-0781	36 (160) compression	7" x 7" x 1/2"	3-1/2" x 6"	Fits RS2875; use for compression only
C150-0782	50 (222) compression	10" x 10" x 1/2"	4-1/2" x 6"	Fits RS3500; use for compression only
C150-0783	70 (311) compression	12" x 12" x 1/2"	5-9/16" x 6"	Fits RS4500; use for compression only
C150-0793	35 (156) compression 23 (102) uplift	7" x 7" x 1/2"	2-1/2" x 6"	Fits SS5/150: use for uplift and compression
C150-0794	52.5 (234) compression 37 (165) uplift	8" x 8" x 1/2"	2-7/8" x 6"	Fits SS175: use for uplift and compression
C150-0795	75 (334) compression 45 (200) uplift	12" x 12" x 1/2"	3-1/2" x 6"	Fits SS200; use for uplift and compression
C150-0796	100 (445) compression 40 (178) uplift	12" x 12" x 1/2"	3-1/2" x 6"	Fits SS225; use for uplift and compression
C150-0797	36 (160) compression 36 (160) uplift	7" x 7" x 1/2"	3-1/2"	Fits RS2875; use for uplift and compression
C150-0798	50 (222) compression 50 (222) uplift	10" x 10" x 1/2"	4-1/2"	Fits RS3500; use for uplift and compression
C150-0799	70 (311) compression 70 (311) uplift	12" x 12" x 1/2"	5-9/16"	Fits RS4500; use for uplift and compression

Building Code Compliance per ICC-ES ESR-2794

The following tables provide the nominal, LRFD design, and ASD allowable compression strengths of C1500458G and C1500465G pile caps used with Type SS5 helical piles; and the C1500459G and C1500467G pile caps used with Type SS175 helical piles as evaluated per ICC-ES Acceptance Criteria AC358. The last table on page 7-64 provides the nominal, LRFD design, and ASD allowable tension strengths of C1500465G pile cap used with Type SS5 helical piles; and C1500467G pile cap used with Type SS175 helical piles as evaluated per ICC-ES Acceptance Criteria AC358. These strengths are published in ICC-ES ESR-2794. The strengths listed are based on three different concrete foundation strengths, two different soils conditions - firm and soft. The pile head is assumed to be either pinned or fixed within the concrete foundation depending on cover and reinforcing; and the piles are assumed to be braced. The helical pile must be embedded at least 7.5 inches into the concrete foundation when designed as fixed end condition.

Per the International Building Code (IBC) 2006 Section 1808.2.9.2 & IBC 2009 Section 1810.2.1, the depth to fixity of piles driven into firm ground can be considered fixed and laterally supported at 5 feet below the ground surface and in soft material at 10 feet.

Nominal Strengths of New Construction Pile Caps Loaded in Compression[1,2,3,4,5,6]

Catalog Number	Pile Model	Nominal Compression Strength kip (kN)											
		2500 psi Concrete[6]				3000 psi Concrete[6]				4000 psi Concrete[6]			
		Firm Soil		Soft Soil		Firm Soil		Soft Soil		Firm Soil		Soft Soil	
		Pinned	Fixed	Pinned	Fixed	Pinned	Fixed	Pinned	Fixed	Pinned	Fixed	Pinned	Fixed
C150-0458G	SS5	54.4 (242)	60.0 (267)	13.6 (60)	26.6 (118)	54.4 (242)	62.3 (277)	13.6 (60)	26.6 (118)	54.4 (242)	66.9 (298)	13.6 (60)	26.6 (118)
C150-0459G	SS175	100 (445)	100 (445)	25.8 (115)	50.5 (225)	100 (445)	100 (445)	25.8 (115)	50.5 (225)	100 (445)	100 (445)	25.8 (115)	50.5 (225)
C150-0465G	SS5	54.4 (242)	60.0 (267)	13.6 (60)	26.6 (118)	54.4 (242)	62.3 (277)	13.6 (60)	26.6 (118)	54.4 (242)	66.9 (298)	13.6 (60)	26.6 (118)
C150-0467G	SS175	100 (445)	100 (445)	25.8 (115)	50.5 (225)	100 (445)	100 (445)	25.8 (115)	50.5 (225)	100 (445)	100 (445)	25.8 (115)	50.5 (225)

LRFD Design Strengths of New Construction Pile Caps Loaded in Compression[1,2,3,4,5,6]

Catalog Number	Pile Model	LRFD Design Compression Strength kip (kN)											
		2500 psi Concrete[6]				3000 psi Concrete[6]				4000 psi Concrete[6]			
		Firm Soil		Soft Soil		Firm Soil		Soft Soil		Firm Soil		Soft Soil	
		Pinned	Fixed	Pinned	Fixed	Pinned	Fixed	Pinned	Fixed	Pinned	Fixed	Pinned	Fixed
C150-0458G	SS5	48.9 (218)	50.6 (225)	12.2 (54)	24.0 (107)	48.9 (218)	52.0 (231)	12.2 (54)	24.0 (107)	48.9 (218)	54.7 (243)	12.2 (54)	24.0 (107)
C150-0459G	SS175	79.2 (352)	79.2 (352)	23.2 (103)	45.4 (202)	90 (400)	90 (400)	23.2 (103)	45.4 (202)	90 (400)	90 (400)	23.2 (103)	45.4 (202)
C150-0465G	SS5	48.9 (218)	50.6 (225)	12.2 (54)	24.0 (107)	48.9 (218)	52.0 (231)	12.2 (54)	24.0 (107)	48.9 (218)	54.7 (243)	12.2 (54)	24.0 (107)
C150-0467G	SS175	79.2 (352)	79.2 (352)	23.2 (103)	45.4 (202)	90 (400)	90 (400)	23.2 (103)	45.4 (202)	90 (400)	90 (400)	23.2 (103)	45.4 (202)

ASD Allowable Strengths of New Construction Pile Caps Loaded in Compression[1,2,3,4,5,6]

Catalog Number	Pile Model	ASD Allowable Compression Strength kip (kN)											
		2500 psi Concrete[6]				3000 psi Concrete[6]				4000 psi Concrete[6]			
		Firm Soil		Soft Soil		Firm Soil		Soft Soil		Firm Soil		Soft Soil	
		Pinned	Fixed	Pinned	Fixed	Pinned	Fixed	Pinned	Fixed	Pinned	Fixed	Pinned	Fixed
C1500458G	SS5	32.6 (145)	33.7 (150)	8.1 (36)	16.0 (71)	32.6 (145)	34.6 (154)	8.1 (36)	16.0 (71)	32.6 (145)	36.4 (162)	8.1 (36)	16.0 (71)
C1500459G	SS175	52.7 (234)	52.7 (234)	15.4 (69)	30.2 (134)	60.0 (267)	60.0 (267)	15.4 (69)	30.2 (134)	60.0 (267)	60.0 (267)	15.4 (69)	30.2 (134)
C1500465G	SS5	32.6 (145)	33.7 (150)	8.1 (36)	16.0 (71)	32.6 (145)	34.6 (154)	8.1 (36)	16.0 (71)	32.6 (145)	36.4 (162)	8.1 (36)	16.0 (71)
C1500467G	SS175	52.7 (234)	52.7 (234)	15.4 (69)	30.2 (134)	60.0 (267)	60.0 (267)	15.4 (69)	30.2 (134)	60.0 (267)	60.0 (267)	15.4 (69)	30.2 (134)

For SI: 1 inch = 25.4 mm, 1 kip = 4.448 kN, 1lbf-ft = 1.356 N-m.

[1]Refer to Section 4.1.3 of ICC-ES ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2]Strength ratings are based on a design corrosion level of 50-years and presume the supported structure is braced in accordance with Section 1810.2.2 of the 2012 & 2009 IBC (Section 1808.2.5 of the 2006 IBC).
[3]Capacities apply to the specific pile cap and pile models listed.
[4]The fixed end condition requires that the foundation itself be fixed and that pile and pile cap be embedded in the foundation with adequate concrete cover and reinforcing to resist 56.4 kip-in or 116 kip-in nominal bending moment for SS5 and SS175 pile models, respectively. The center of shaft must be at least 6-in away from the end/corner of the concrete footing.
[5]See Section 4.1.2 of ICC-ES ESR-2794 for applicable limit states that must be evaluated by a registered design professional.
[6]Refer to the specified compressive strength of concrete at 28 days.

Nominal, LRFD Design and ASD Allowable Strengths of New Construction Pile Caps Loaded in Tension[1,2,3,4]

Catalog Number	Pile Model	Nominal, LRFD Design and ASD Allowable Strengths in Tension kip (kN)								
		2500 psi Concrete[5]			3000 psi Concrete[5]			4000 psi Concrete[5]		
		Nom Str	Design Str	Allow Str	Nom Str	Design Str	Allow Str	Nom Str	Design Str	Allow Str
C1500465G	SS5	56.2 (250)	42.1 (187)	28.1 (125)	56.2 (250)	42.1 (187)	28.1 (125)	56.2 (250)	42.1 (187)	28.1 (125)
C1500467G	SS175	78.9 (351)	59.2 (263)	39.5 (176)	78.9 (351)	59.2 (263)	39.5 (176)	78.9 (351)	59.2 (263)	39.5 (176)

For SI: 1 inch = 25.4 mm, 1 kip = 4.448 kN.

[1]Refer to Section 4.1.3 of ICC-ES ESR-2794 for descriptions of fixed condition, pinned condition, soft soil and firm soil.
[2]Strength ratings are based on a design corrosion level of 50-years.
[3]Capacities apply to the specific pile cap and pile models listed.
[4]See Section 4.1.2 of ICC-ES ESR-2794 for applicable limit states that must be evaluated by a registered design professional.
[5]Refer to the specified compressive strength of concrete at 28 days.

DESIGN EXAMPLES
SECTION 8

CONTENTS

SYMBOLS USED IN THIS SECTION

(Symbols Used are listed separately for each Design Example)

DESIGN EXAMPLES

DISCLAIMER

The information in this manual is provided as a guide to assist you with your design and in writing your own specifications.

Installation conditions, including soil and structure conditions, vary widely from location to location and from point to point on a site.

Independent engineering analysis and consulting state and local building codes and authorities should be conducted prior to any installation to ascertain and verify compliance to relevant rules, regulations and requirements.

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Hubbell Power Systems, Inc., does NOT warrant the work of its dealers/installing contractors in the installation of CHANCE® Civil Construction foundation support products.

DESIGN EXAMPLE 1
ATLAS RESISTANCE® PIERS

SYMBOLS USED IN THIS DESIGN EXAMPLE

SPT	Standard Penetration Test	8-4
N	Standard Penetration Test Blow Count	8-4
P	Total Live Load	8-5
DL	Dead Load	8-5
LL	Live Load	8-5
SL	Snow Load	8-5
W	Soil Load	8-5
S_K	Snow Load Requirement Factor	8-5
P_W	Working Pier Load	8-5
x	Pier Spacing	8-5
FS	Factor of Safety	8-5
FS_h	Factor of Safety for Mechanical Strength of Hardware	8-5
$R_{w\ ULT}$	Ultimate Hardware Strength based on Structural Weight	8-5
$R_{h\ ULT}$	Ultimate Hardware Strength	8-5
x_{max}	Maximum Pier Spacing Based on Hardware Capacity	8-5
FS_p	Proof Load Factor of Safety	8-6
R_p	Installation Force to Achieve Proof Load	8-6
$R_{h\ MAX}$	Maximum Installation Force Based on Ultimate Capacity of Hardware	8-6
$L_{p\ MAX}$	Maximum Free Span Between Piers	8-6

Type of Structure

The structure is a two-story, 20' x 40' frame residence with full brick veneer siding located in the Midwest. The house sits on 8" thick by 8' high cast concrete basement walls with steel reinforced concrete footings 1'-8" wide by 1'-0 thick. The roof is composition shingles over 1/2" plywood decking and felt underlayment. There is six feet of peaty clay soil overburden present.

Preliminary Investigation

Settlement is evident in portions of the structure of 2-1/2". Checking with local building officials reveals no special controlling codes for underpinning existing structures that must be observed. Preliminary geotechnical information indicates the footing is situated in peaty clay type soil with Standard Penetration Test (SPT) "N" values of six and higher. This soil extends to a depth of 15 feet where a dense glacial till exists. It is determined that the glacial till layer will serve as an adequate bearing stratum for the ATLAS RESISTANCE® Piers.

Preliminary Estimate of Total Live Load on Footing

P = Dead Load (DL) + Live Load (LL) + Snow Load (SL) + Soil Load (W) **Equation 8-1**

P = (1,890 + 667 + 120 + 2,310) = 4,987 lb/ft

(See Tables 4-2, 4-4 and 4-5 in Section 4 for DL, LL and W).

where:	DL	=	1,890 lb/ft
	LL	=	667 lb/ft
	SL	=	S_K x [(l x w) / 2 (l + w)] where l and w are the building dimensions
	S_K	=	Snow load requirement factor = 18 lb/ft^2 (for this example)
	SL	=	18 lb/ft2 x (800 / 120) ft = 120 lb/ft
	W	=	$W_1 + W_2$ = (330 + 1,980) lb/ft = 2,310 lb/ft

ATLAS RESISTANCE® Pier Selection

While the ATLAS RESISTANCE® Continuous Lift Pier could be used for this application, the small lift required makes it unnecessary. The ATLAS RESISTANCE® Predrilled Pier is not a good choice here due to the absence of a hard, impenetrable layer above the intended bearing stratum. Therefore, the ATLAS RESISTANCE® 2-Piece Standard Pier is selected for strength and economy. The more expensive ATLAS RESISTANCE® Plate Pier could also be attached to the concrete basement wall and used for this application. Since there are suitable soils with "N" counts above four, there is no need to sleeve the pier pipe for added stiffness.

Pier Spacing

Using the information obtained about the stem wall and footing to be supported, and applying sound engineering judgment, the nominal pier spacing based on the foundation system's ability to span between piers is estimated at about eight feet. This puts the nominal working pier load (P_W) at:

P_W = (x) x (P) = 8 ft x 4,987 lb/ft = 39,896 lbs **Equation 8-2**

where:	x	=	Selected pier spacing = 8 ft
	P	=	Line load on footing = 4,987 lb/ft

Factor of Safety

Hubbell Power Systems, Inc. recommends a minimum Factor of Safety (FS) for the mechanical strength of the hardware of 2.0.

FS_h	=	2.0 (may be varied based on engineering judgment)	
$R_{W\ ULT}$	=	Minimum ultimate hardware strength requirement based on structural weight	
	=	P_W x FS_h = (39,896 lb) x 2 = 79,792 lb	**Equation 8-3**

Select a pier system with an adequate minimum ultimate strength rating:

$R_{h\ ULT}$	=	86,000 lb - Choose AP-2-UFVL3500.165M[*][14'-0] Modified 2-Piece Pier System	
X_{max}	=	Maximum pier spacing based on hardware capacity	
	=	($R_{h\ ULT}$) / [(FS_h) x (P)]	**Equation 8-4**
	=	(86,000 lb) / [(2) x (4,987)]	
	=	8.6 ft (Use 9.0 ft. Wall and footing are judged able to span this distance)	

DESIGN EXAMPLES

Proof Load

Hubbell Power Systems, Inc. recommends a minimum Factor of Safety of 1.5 at installation unless structural lift occurs first.

FS_p	=	Proof Load Factor of Safety[1] = 1.5	**Equation 8-5**
R_p	=	Installation force based on weight of structure to achieve Proof Load verification	
	=	$(FS_p) \times (P_W) = (1.5 (8.6 \times 4987) = 64{,}332$ lb	
$R_{h\ MAX}$	=	Maximum installation force based on hardware ultimate capacity[2]	
	=	$(Rh_{ULT}/2)\ (1.65) = (86{,}000/2)\ (1.65) = 70{,}950$ lb $R_{W\ MIN} < R_{h\ MAX}$ = OK, where $R_{W\ MIN} = R_p$	

1 Experience has shown that in most cases the footing and stem wall foundation system that will withstand a given long term working load will withstand a pier installation force of up to 1.5 times that long term working load. If footing damage occurs during installation, the free span ($L_{P\ MAX}$) may be excessive.

2 It is recommended that RhMAX not exceed $(R_{h\ ULT} / 2) \times (1.65)$ during installation without engineering approval.

Design Recommendations

The result of the analysis provides the following design specifications:

- Underpinning product: ATLAS RESISTANCE® Modified 2-Piece Pier AP-2-UF-3500.165M[*][14’-0]
- Pier spacing: 8.6’ on center
- Installation Proof Load: 64,332 lbs ± (unless lift of the structure occurs first)
- Working load is anticipated to be 42,900 lbs ± (4,987 lb/ft x 8.6 ft)
- Anticipated pier depths: 15 ft ±

DESIGN EXAMPLE 2
ATLAS RESISTANCE® PIERS WITH INTEGRATED TIEBACK
SYMBOLS USED IN THIS DESIGN EXAMPLE

kip	Kilopound	8-8
SPT	Standard Penetration Test	8-8
N	SPT Blow Count	8-8
bpf	Blows per Foot	8-8
bgs	Below Ground Surface	8-8
P	Compression Loading	8-8
x	Pier Spacing	8-8
$P_{w\ min}$	Minimum Working Pier Load	8-8
klf	Thousand per Lineal Foot	8-8
DL_h	Horizontal Design Load	8-8
D	Diameter(s)	8-8
c	Cohesion	8-8
φ	Friction Angle	8-8
N_q	Bearing Capacity Factor	8-8
γ	Unit Weight of Soil	8-8
pcf	Pounds per Cubic Foot	8-8
FS	Factor of Safety	8-8
UC_r	Ultimate Tension Capacity	8-8
Q_t	Ultimate Bearing Capacity	8-8
T_u	Ultimate Capacity of Helical Tieback	8-9
A_h	Area of Helix	8-9
K_t	Empirical Torque Factor	8-9
R_p	Proof Load	8-9
FS_p	Proof Load Factor of Safety	8-9
DS	Minimum Installing Force	8-9
$R_{h\ max}$	Maximum Installation Force	8-9
FS_h	Hardware Factor of Safety	8-9

Project Information

An existing three-story commercial building located within a hurricane prone region requires foundation retrofitting for potential scour activity and lateral load forces from hurricane force winds. The structure sits on a shallow foundation system consisting of a 4' high 10" thick stem wall and a 4' wide 12" thick spread footing with three #5 reinforcement bars (Grade 60). The structural Engineer of Record has requested a new foundation system capable of withstanding 2 kips per lineal foot design lateral forces and temporary scour depths to 1' below the existing spread footing. The estimated design compression loading is 5 kips per lineal ft for the existing structure. The structural engineer has determined that the existing foundation system can handle underpinning support spans of 8' or less.

Geotechnical Investigation

A geotechnical investigation was performed to determine the soil types and strengths at the project location. The soil borings advanced near the project location show medium dense silty sand with SPT "N" values ranging from 15 to 25 bpf to a depth of 20 ft bgs. This medium dense silty sand layer is underlain by dense sand and weathered limestone bedrock with SPT "N" values greater than 40 bpf. Groundwater was observed at 18' bgs during the investigation.

Underpinning System Selection

The availability of a dense stratum with "N" values greater than 40 bpf allows the use of the ATLAS RESISTANCE® Pier. The additional lateral loading can be designed for using a helical tieback anchor and the integrated ATLAS RESISTANCE® Pier bracket. Based on the design compression loading (P) of 5 kips per lineal ft and the allowable pier spacing (x) of 8' the required minimum design capacity of the ATLAS RESISTANCE® Pier ($P_{w\ min}$) is (x) x (P) = 8.0 x 5.0 or 40 kips.

The AP-2-UF-3500.165 system could be used since it has a maximum working (design) capacity of 42.5 kips. However, due to the possibility of scour and subsequent lack of soil support the modified pier with a working capacity of 45.5 kips is recommended (AP-2-UF-3500.165M) with at least three modified pier sections to increase the rotational stiffness of the bracket.

Helical Tieback Design and Installation

With a maximum spacing of 8' and an estimated design lateral line load of 2 klf, the horizontal design load (DL_h) at the tieback anchor location is 16 kips. The tieback anchors are typically installed between 15° to 25° from horizontal. An installation angle of 20o was chosen after determining that there are no underground structures/ conduits that may interfere with the tieback installation. The tieback must be designed with a minimum embedment depth of 5D (distance from the last helical plate to the ground surface) where D = diameter of the helical plate. The tieback will be designed to bear in the silty sand with "N" values of 20 bpf observed at 5 to 10 feet bgs. Based on the SPT "N" values and soil descriptions, the following parameters are used in the design:

- Cohesion (c) = 0
- Friction angle (φ) = 34°
- Bearing capacity factor (N_q) = 21
- Unit weight of soil (γ) = 115 pcf

Using a Factor of Safety (FS) = 2 on the design load and an installation angle of 20°, the required ultimate tension capacity of the tieback (UC_r) is (FS x DL_h) / cos 20° = (2 x 16) / cos 20° = 34 kip. The ultimate bearing capacity (Q_t) of a helical tieback can be determined from:

$Q_t = A_n\ (cN_c + qN_q)$ **Equation 8-6**

Try a Type SS5 series (12"-14" Lead) with a length of 15 ft:

Check depth criteria based on:

- A starting depth of 4 ft below the ground surface
- tieback length of 15 ft
- An installation angle of 20°

The length to the top of the lead helix is 15 ft - 3(12/12) - 4/12 = 11.7 ft. The depth of embedment would be 4 + 11.7sin (20) = 4 ft + 4 ft = 8 ft which is greater than 5D (6 ft), so the depth criteria is met.

Check the ultimate capacity of the helical tieback (T_u) using:

- $N_q = 21$

$$d_{avg} = 4\text{ ft} + \left[15\text{ ft} - \frac{1}{2}\left[\frac{3\,(12\text{in}) + 4\text{ in}}{(12\text{ in/ft})}\right]\right]\sin(20) = 8.6\text{ ft}$$ **Equation 8-7**

- $\gamma' = 115$ pcf
- $\Sigma A_h = A_{12} + A_{14} = 0.77\text{ ft}^2 + 1.05\text{ ft}^2 = 1.82\text{ ft}^2$

$$Q_t = 1.82\text{ ft}^2\ (8.6\text{ ft})(115\text{pcf})(21) = 37.8\text{ kips}$$ **Equation 8-8**

Since the ultimate bearing capacity (37.8 kips) is greater than the required ultimate capacity of 34 kips, the Type SS5 (12"-14") tieback is acceptable. The average minimum installation torque would be UC_r/K_t or 34,000/10 = 3400 ft-lbs. This minimum installation torque is less than the torque rating of the SS5 and SS125 bar; therefore, either shaft size would be acceptable. K_t = empirical torque factor (default value = 10 for the SS series).

The distance from the assumed "active" failure plane to the 14" helix must be at least 5 times its diameter or 6'-0. Both the minimum length and estimated installation torque must be satisfied prior to the termination of tieback installation.

ATLAS RESISTANCE® Pier Underpinning Installation

Given a design load of 40 kips and the potential for 1 ft of temporary exposed pier section due to scour, use the AP-2-UF-3500.165[M]:

- The AP-2-UF-3500.165M pier has a working (design) load capacity of 45.5 kips. The estimated line load (P) is 5 klf, therefore with a maximum pier c-to-c spacing (x) of 8 ft, the piers will experience a design load (P_w) of 40 kips. The spacing may need to be decreased based upon field conditions.
- Use a minimum 3 modified pier sections (10.5 ft) offset halfway from the inner sleeve sections
- The depth to a suitable stratum for ATLAS RESISTANCE® Pier placement is approximately 20 ft bgs
- Install each pier to a minimum installing force, (Proof Load) $R_p = 1.50 \times P_w$ (estimated Factor of Safety (FS_p) of 1.5 on the design load) which makes the minimum installing force DS=60,000 lbs (based on an 8 ft spacing) or imminent lift, whichever occurs first. The maximum installation force ($R_{h\ max}$) shall not exceed $R_{h\ ULT}/2 \times F_{sh}$ or (91,000/2) x 1.65 = 75,000 lbs (estimated Factor of Safety (FS_h) of 1.65 of the design load for hardware).

DESIGN EXAMPLE 3
HELICAL PILE FOUNDATION FOR NEW CONSTRUCTION

SYMBOLS USED IN THIS DESIGN EXAMPLE

L/W	Length to Width Ratio	8-10
P	Total Live Load	8-10
DL	Dead Load	8-10
LL	Live Load	8-10
SL	Snow Load	8-10
FS	Factor of Safety	8-10
P_w	Working Pier Load	8-10
x	Pile Spacing	8-10
Q_t	Ultimate Pile Capacity	8-11
A	Area of Helix Plate	8-11
c	Cohesion of Soil	8-11
N_c	Bearing Capacity	8-11
T	Torque	8-11
K_t	Empirical Torque Factor	8-11

Building Type

- Two story residence
- Slab on grade
- Masonry wall, wood frame
- Width = 30 ft, L/W = 1-1/2

Structural Loads

- Total Live Load on perimeter footing = P **Equation 8-9**
- P = Dead Load (DL) + Live Load (LL) + Snow Load (SL)
- P = 1540 + 346 + 162 = 2,048 lbs/ft (See Tables 4-1 and 4-4 in Section 4 for DL and LL)
- Factor of Safety (FS) = 2.0 (minimum)

Pile Spacing

- Estimated working load (P_w) = (x) x (P) **Equation 8-10**
- Estimated pile spacing (x) = 6.0 ft
- P_w = 6.0 x 2,048 = 12,288 lbs

CHANCE® Helical Pile Selection

RS2875.203 with 8-10-12 helix configuration

Ultimate Pile Capacity

- $Q_t = (A_8 + A_{10} + A_{12})\ c\ N_c$ **Equation 8-11**

  A_8, A_{10}, A_{12} = Projected area of helical plates

  $A_8 = 0.34\ ft^2$ $A_{10} = 0.53\ ft^2$ $A_{12} = 0.77\ ft^2$

  c = 2,000 psf (based on N=16 – Equation, 5-35)

  N_c = Bearing capacity = 9.0
- Q_t = (1.64) (2,000) (9.0)
- Q_t = 29,520 lb (installation depth is over 20 ft)

Check Q_t

- Conduct Field Load Test (if required per specifications)

Estimate Installation Torque

$T = (P_W \times FS)/K_t$ = (12,288 x 2)/9 = 2,750 ft-lb **Equation 8-12**

K_t = empirical torque factor (default value = 9 for the R2875 series)

The rated installation torque of the RS2875.203 series is 5500 ft-lb, which is greater than the required estimated installation torque of 2,750 ft-lb. (OK)

NOTE: If during installation T = 2,750 ft-lb. is not achieved, then two options are available: (1) reduce pile spacing (x), or (2) change helix configuration to a larger combination, i.e., (10”-12”-14”)

Factor of Safety

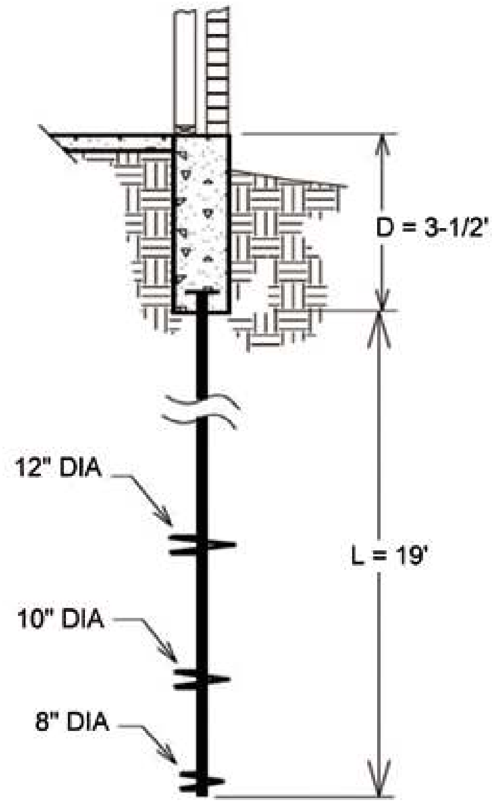
- Theoretical Ultimate Capacity: **Equation 8-13**

  $FS = (Q_t / P_W)$

  FS = 29,520/12,288 = 2.4 (OK)
- Torque Correlation:

  $FS = (T \times Kt)/P_W$

  FS = (2,750 x 9) /12,288 = 2.01 (OK)



Graphic Log	Soil Classification	Depth	USCS Symbol	SPT - N Blows/ft
	Topsoil		OH	
	Silty Clay Soft	5	CH	2
	Sandy Silty Clay Stiff γ = 118 pcf ϕ = 0°	10	SC	5
		15		12
		20		16

Helical Pile Foundation
Figure 8-1

DESIGN EXAMPLE 4
LIGHT COMMERCIAL STRUCTURE
SYMBOLS USED IN THIS DESIGN EXAMPLE

CH	Highly Plastic Clay	8-13
PI	Plasticity Index	8-13
c	Cohesion of Soil	8-13
γ	Unit Weight of Soil	8-13
pcf	Pounds per Cubic Foot	8-13
CL	Low Plasticity Clay	8-13
SPT	Standard Penetration Test	8-13
N	SPT Blow Count	8-13
kip	Kilopound	8-13
P	Total Live Load	8-13
P_w	Working Load	8-13
FS	Factor of Safety	8-13
U_{Cr}	Required Ultimate Capacity	8-13
Q_{ult}	Ultimate Bearing Capacity	8-14
A_h	Area of Helix	8-14
N_c	Bearing Capacity	8-14
N_q	Bearing Capacity Factor	8-14
B	Footing Width	8-14
φ	Angle of Internal Friction	8-14
ksf	Kilo Square Feet	8-14
CMP	Corrugated Metal Pipe	8-15
DOT	Department of Transportation	8-15
K_t	Torque Factor	8-15
T	Torque	8-16

Problem

Build a new (lightly loaded single story) commercial building on a typical clay soil profile as given on a single boring. The profile consists of the upper 10'-0 of highly plastic clay (CH), Plasticity Index (PI) = 35; cohesion (c) = 2000 psf; unit weight (γ) of 105 pcf. The swell potential of this layer is estimated to be 2". The top 10'-0 layer is underlain by 20' of stiff to very stiff low plasticity clay (CL) that has an Standard Penetration Test (SPT) blow count "N" = 20. The boring was terminated at 30 feet without encountering the water table. No further soil parameters or lab data given.

Possible Solution

Support the structure on a grade beam and structural slab, which is in turn supported by helical piles. Isolate the foundation and slab from the expansive subgrade by forming a 2" void, using a cardboard void form. Assume the water table is at the soil boring termination depth. This is typically a conservative design assumption when the water table is not encountered. The stiff to very stiff clay soil in the 20-foot thick layer is probably at or near 100% saturation (volume of water is the same as the volume of the voids).

Step 1: Feasibility

- Site Access – The site is road accessible, with no overhead or underground obstructions, but the owner is concerned about potential damage to neighboring sites due to vibration and noise.
- Working Loads – The structure is single story, so the working loads are probably considerably less than 100 kip per pile.
- Soils – Boulders, large cobbles, or other major obstructions are not present in the bearing stratum. The clay soil does not appear to be too hard to penetrate with helical piles. See Table 3-1 (Helical Shaft Series Selection) or Figure 3-1 (Product Selection Guide) in Section 3 to determine if helical piles are feasible, and if so, which product series to use.
- Qualified Installers – Local Certified CHANCE® Installers are available and can get competitive bids from a second certified installer 20 miles away.
- Codes – Local building codes allow both shallow and deep foundations.

Cost-bid must be competitive with other systems. Owner may pay a small premium to "protect" the investment in the structure.

Step 2: Soil Mechanics

See Problem section above.

Step 3: Loads

- Exterior Grade Beam – The dead and live loads result in a total live load (P) of 3 kips per lineal foot on the perimeter grade beam (12" wide x 18" deep). The grade beam is designed to span between piles on 8'-0 centers. Therefore, the design or working load per pile (P_W) is 3 kip/ft x 8 ft = 24 kip. A Factor of Safety (FS) of 2.0 is recommended. Therefore, the required ultimate capacity (UC_r) per exterior pile is 24 x 2 = 48 kip compression.
- Interior Columns – The dead load results in 9 kips per column. The live load results in 20 kip per column. The total dead and live load per column is 9 + 20 = 29 kip/column design or working load. A Factor of Safety of 2 is recommended. Therefore, the required ultimate capacity per interior pile is 29 x 2 = 58 kip compression. The required ultimate loads for both the exterior grade beam and interior columns are well within the load ratings of the Hubbell Power Systems, Inc., CHANCE® product series.
- Lateral Loads – The piles are not required to resist any lateral loads.

Step 4: Bearing Capacity

Find the ultimate bearing capacity in the stiff to very stiff clay using hand calculations.

Bearing Capacity: $Q_{ult} = A_h (cN_c + q'N_q + 0.5\gamma' BN\gamma)$ **Equation 8-14**

For saturated clay soils, the second term of Equation 8-14 becomes zero since the angle of internal friction (φ) is assumed to be zero for saturated clays, thus Nq = 0. The third term (base term) may be dropped because B is relatively small. The simplified equation becomes:

$Q_{ult} = A_h cN_c = A_h c9$ **Equation 8-15**

c (ksf) = N/8 **Equation 8-16**

From Equation 5-35, c (ksf) = 20/8 = 2.5 ksf. At this point, an iterative process is required. Select a helix configuration that is believed can develop the required ultimate capacity. Try a 10”-12” twin helix with a minimum of 5’-0 embedded into the bearing stratum which is the stiff low plasticity clay starting 10 ft below grade. From Table 8-1, the helix area of a 10” helix is 76.4 in^2 or 0.531 ft^2; the helix area of a 12” helix is 111 in^2 or 0.771 ft^2.

Substituting:

$Q_{10} = 0.531\ ft^2 \times 2.5\ ksf \times 9 = 11.95$ kips **Equation 8-17**

$Q_{12} = 0.771\ ft^2 \times 2.5\ ksf \times 9 = 17.35$ kips

$Q_t = \Sigma Q_h = 11.95 + 17.35 = 29.3$ kips

Standard Helix Sizes, Table 8-1

DIAMETER in (cm)	AREA ft^2 (m^2)
6 (15)	0.185 (0.0172)
8 (20)	0.336 (0.0312)
10 (25)	0.531 (0.0493)
12 (30)	0.771 (0.0716)
14 (35)	1.049 (0.0974)

Another trial is required because the total ultimate capacity (Q_t = 29.3 kip) is less than required. Try a three-helix configuration (10”-12”-14”) with a minimum of 5’-0 embedded in the bearing stratum. From Table 8-1, the helix area of a 14” helix is 151 in^2 or 1.05 ft^2.

$Q_{14} = 1.05\ ft^2 \times 2.5\ ksf \times 9 = 23.63$ kips **Equation 8-18**

$Q_t = \Sigma Q_h = 11.95 + 17.35 + 23.63 = 52.93$ kips

To achieve the necessary Factor of Safety of 2, two helical piles with a 10”-12” helical configuration can be used under the interior columns (29.3 x 2 = 58.6 ≅ 59 kips ultimate capacity) and a single helical pile with a 10”-12”-14” helical configuration can be used under the perimeter grade beam. The termination of the helical pile in a concrete cap or grade beam should be made with an appropriately designed pile cap or an available “new construction” bracket from Hubbell Power Systems, Inc. This will allow the foundation to rise up, should the swell ever exceed the 2” void allowance, but to shrink back and rest on the pile tops.

Checking Bearing Capacity Using HeliCAP® Engineering Software

A sample tabular data printout is shown in Figure 8-2, where the twin helix (10”-12”) Q_{ult} = 29.2 kip ≅ 29.3 kip, OK; and the triple helix (10”-12”-14”) Q_{ult} = 52.8 kip ≅ 52.93 kip, OK

Steps 5 and 6: Lateral Capacity and Buckling

- Lateral Capacity – None is required in the statement of the problem. In reality, horizontal loads due to wind will be resisted by net earth pressure (passive-active) on the grade beam and/or caps. See Section 5 for an explanation of earth pressure resistance.
- Buckling Concerns – The soil density and shear strength is sufficient to provide lateral confinement to the central steel shaft. This is supported by the fact that the SPT blow count is greater than four for the top clay layer. Should analysis be required, the Davisson method described in Section 5 may be used to determine the critical load.

Step 7: Corrosion

No electrochemical properties were given for the clay soil. Generally, undisturbed, i.e., non-fill, material tends to be benign as little oxygen is present and the ions that are present in solution are not washed away due to flowing water or fluctuating water level. In the absence of soil data, a useful guide is to observe the use of corrugated metal pipe (CMP) by the local Department of Transportation (DOT). If the DOT uses CMP, the likelihood is that the local soils are not very aggressive.

Step 8: Product Selection

Ultimate capacity for a 10”-12” configuration per Step 4 above was 29 kip, and the ultimate capacity for a 10”-12”-14” configuration was 53 kip. Table 8-2 shows that both CHANCE® Helical Type SS5 and Type RS2875.276 product series can be used, since 53 kip is within their allowable load range. Note that Table 8-2 assumes a Kt of 10 ft^{-1} for the Type SS product series and K_t of 9 ft^{-1} for the Type RS2875 product series. In this case, use the Type SS5 product series because shaft buckling is not a practical concern and the required capacity can be achieved with less installation torque.

Practical Guidelines for Foundation Selection, Table 8-2

INSTALLATION TORQUE	ULTIMATE LOAD[1]		DESIGN LOAD[2]		HELICAL PILE PRODUCT SERIES
	kip	kN	kip	kN	
5,500	55	244	27.5	110	SS5
5,500	49.5	202	24.75	110	RS2875.203
7,000	70	312	35	156	SS150
8,000	72	320	36	160	RS2875.276

[1] Based on a torque factor (K_t) = 10 for SS Series and K_t = 9 for RS2875 Series.
[2] Based on a Factor of Safety of 2.

For the 10”-12” configuration, the minimum depth of 18’-0 can be achieved by using a lead section, which is the first pile segment installed and includes the helix plates, followed by two or three plain extensions. For the 10”-12”-14” configuration, the minimum depth of 21’-0 can be achieved by using a lead section followed by three or four plain extensions. The exact catalog items to use for a specific project are usually the domain of the contractor. Your Certified CHANCE® Installer is familiar with the standard catalog items and is best able to determine which ones to use based on availability and project constraints. For your reference, catalog numbers with product descriptions are provided in Section 7 of this design manual.

The head of the helical pile is to be approximately 1'-0 below grade in the grade beam or cap excavation, which will put the twin-helix pile tip 18'-0 below the original ground level and the three-helix screw foundation tip 21'-0. These are minimum depths, required to locate the helix plates at least 5'-0 into the bearing stratum. On large projects, it is advisable to add 3% to 5% extra extensions in case the soil borings vary considerably or if widely spaced borings fail to indicate differences in bearing depths.

Step 9: Field Production Control

Use K_t = 10 ft^{-1} for CHANCE® Helical Type SS material if verification testing is not done prior to production work. The minimum depth and minimum installing torque must both be achieved. If the minimum torque requirement is not achieved, the contractor should have the right to load test the helical pile to determine if K_t is greater than 10 ft^{-1}. Verification testing is often done in tension since it's simpler and less costly to do than compression testing, and the compressive capacity is generally higher than tension capacity, which results in a conservative site-specific K_t value.

Estimate installing torque for field production control and specifying the minimum allowable without testing.

$$Q_{ult} = K_t T, \text{ or } T = Q_{ult}/K_t$$ **Equation 8-19**

where: Q_{ult} = UC_r in this example

Interior columns: $T = Q_{ult}/K_t$ = (58,000 lbs/2 piles)/10 ft^{-1} = 2,900 ft-lb ≅ 3,000 ft-lb for the minimum average torque taken over the last three readings.

Perimeter grade beam: $T = Q_{ult}/K_t$ = 48,000 lb/10 ft^{-1} = 4,800 ft-lb for the minimum average torque taken over the last three readings.

Note that the torque rating for the CHANCE® Helical Type SS5 product series is 5,500 ft-lb – OK.

Step 10: Product Specifications

See Section 7, Product Drawings and Ratings and Appendix C for Hubbell Power Systems, Inc. model specifications.

Step 11: Load Test

Since this is a small project with low loads in "normal" soils, it is acceptable to use the torque correlation method as the driving criteria and omit the "optional" load test.

HeliCAP SUMMARY REPORT

Job Name: Design Manual for New Construction

Job Number: Example 2

Boring No: B-1

Anchor Use: Compression

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Water Table Depth: None

Capacity Summary

Anchor Number	Anchor Family	Helix Depth (ft)	Helix Capacity (kips)	Total Anchor Capacity (kips)	Recommended Ultimate Capacity (kips)	Torque (ft-lbs)
Anchor 1	Angle: 90 Datum Depth: 0 Length: 18					
12" helix	SS 5	15	17.3t 17.3c	29.2t	29.2t	2925
10" helix	SS 5	17.5	11.9t 11.9c	29.2c	29.2c	
Anchor 2	Angle: 90 Datum Depth: 0 Length: 21					
14" helix	SS 5	15	23.6t 23.6c			
12" helix	SS 5	18	17.3t 17.3c	52.8t	52.8t	5287
10" helix	SS 5	20.5	11.9t 11.9c	52.8c	52.8c	

Soil Profile

Top of Layer Depth (ft)	Soil Type	Cohesion (lb/ft2)	N	Angle of Internal Friction (Degrees)	Unit Weight (lb/ft3)
0	Clay	2000	0	0	105
10	Clay	2500	20	0	120

HeliCAP® Summary Report
Figure 8-2

DESIGN EXAMPLES

DESIGN EXAMPLE 5
HELICAL PULLDOWN® MICROPILES for NEW CONSTRUCTION

SYMBOLS USED IN THIS DESIGN EXAMPLE

Problem

Determine the capacity of the following CHANCE HELICAL PULLDOWN® Micropile (HPM) installed into the soil described in Figure 8-4.

SS5 1-1/2” x 1-1/2” square shaft

Helix configuration: 8”-10”-12”

Total depth: 40 ft

Grout column: 5” dia x 31 ft

Calculations

End bearing calculations from the HeliCAP® Engineering Software. See Table 8-3 below for the ultimate end bearing capacity of the proposed 8”-10”-12” lead configuration.

Summary: Compression Capacity ($\sum Q_h$) = 44.7 kip

Summary: Friction Capacity (Q_f) = 22.1 kip (see Table 8-4)

Total Capacity (Q_t) = $\sum Q_h$ + Qf = 44.7 + 22.1 = 66.8 kip

Review of Compression Test

Figure 8-3 is a load deflection plot from the actual compression test on the HPM installed into the soil described in Figure 8-4. From the plotted data, the ultimate capacity (based on $0.08D_h$ + PL/AE) was 80 kip, compared to the calculated total capacity of 66.8 kip. This calculated value provides a conservative approach to determining the ultimate capacity of an HPM.

HeliCAP® Summary Report, Table 8-3

Job Name: Medina, MN Demonstration

Job Number: Stannard Soil Anchor Systems   Water Table Depth: 15 ft

Boring No: B-1

Anchor Use: Compression

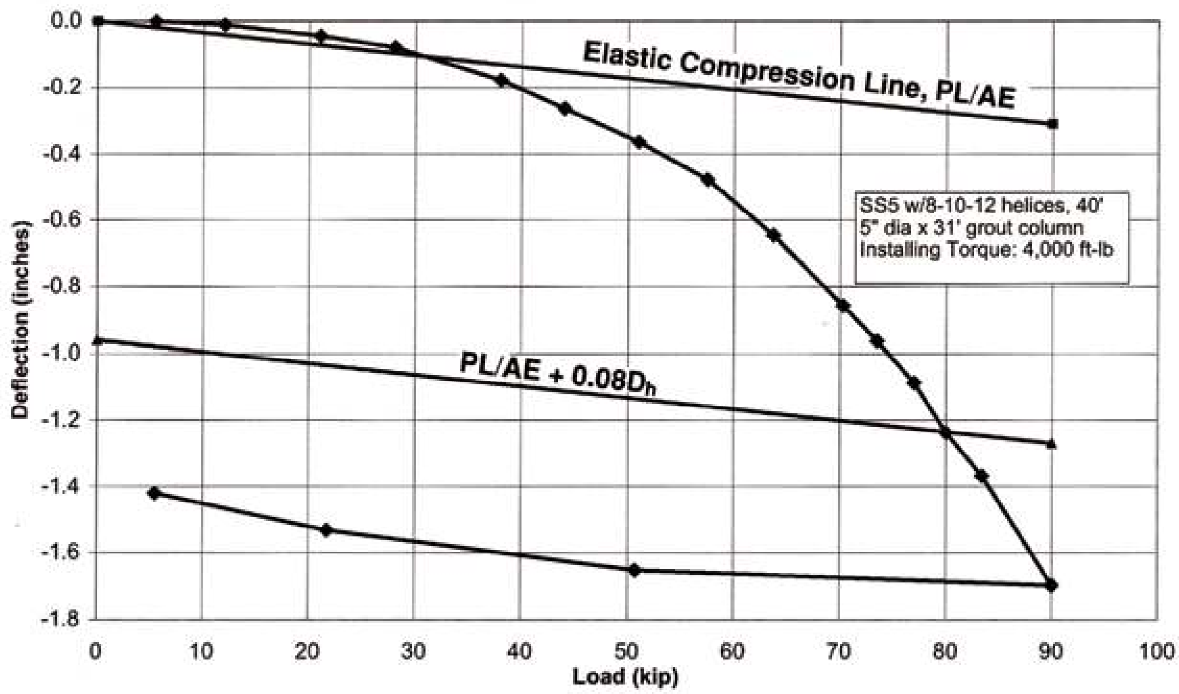
Capacity Summary

Anchor Number	Anchor Family	Helix Depth (ft)	Helix Capacity (kips)	Total Anchor Capacity (kips)	Recommended Ultimate Capacity (kips)	Torque (ft-lbs)
Anchor 1	Angle: 90 Datum Depth: 0 Length: 40					
12" helix	SS 5	35	17.9t 19.9c			
10" helix	SS 5	37.5	14.3t 14.8c	41.9t	41.9t	4263
8" helix	SS 5	39.5	9.6t 9.8c	44.7c	44.7c	

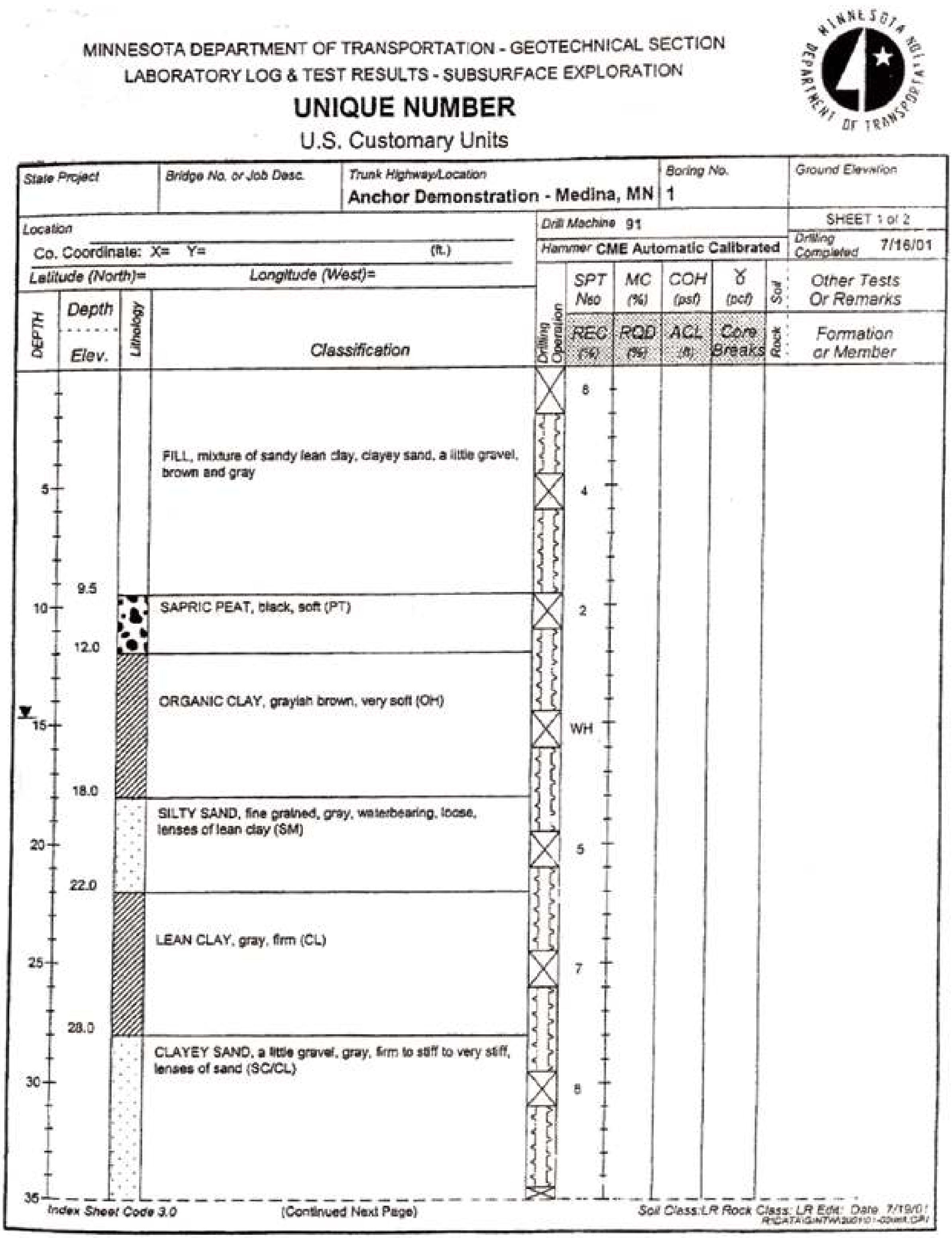
Friction Calculation (See Soil Boring Log in Figure 8-4), Table 8-4

DEPTH (ft)	SOIL	"N"	ESTIMATED COHESION (lb/ft^2)	ESTIMATED φ	EFFECTIVE UNIT WEIGHT (lb/ft^3)	AVERAGE OVERBURDEN (lb/ft^2)	ADHESION/ FRICTION (lb/ft^2)	SIDE FRICTION (lb)
0 -9	CLAY	6	750	-	92	-	682	8040
9 - 15	CLAY	2	250	-	84	-	250	1965
15 - 18	CLAY	1	125	-	20	-	125	491
18 - 22	SAND	5	-	29	23	1438	798	3192
22 - 28	CLAY	7	875	-	32	-	682	5364
28 - 31	SAND	8	-	30	38	1733	1001	3003
							TOTAL	22055

Notes: (1) $\varphi = 0.28N + 27.4$ (2) $c = (N \times 1000) / 8$ (3) Area/ft of pile = $\pi \times d = \pi (5/12) = 1.31 ft^2/ft$



Helical Pulldown® Micropile Compression Test
Figure 8-3



Soil Boring Log
Figure 8-4
(Sheet 1 of 2)

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION
LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER

U.S. Customary Units

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS — SHEET 2 of 2

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		Anchor Demonstration - Medina, MN	1	

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
					11					
40			CLAYEY SAND, a little gravel, gray, firm to stiff to very stiff, lenses of sand (SC/CL)		11					
45					12					
50					15					
55					17					
60					20					
	64.0		Bottom of Hole - 64'							

Soil Class. LR Rock Class. LR Edit: Date: 7/19/01
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Soil Boring Log
Figure 8-4
(Sheet 2 of 2)

DESIGN EXAMPLE 6
HELICAL PILES for BOARDWALKS

SYMBOLS USED IN THIS DESIGN EXAMPLE

SPT	Standard Penetration Test	8-23
N	SPT Blow Count	8-23
WOH	Weight of Hammer	8-23
P_w	Working Pier Load	8-23
FS	Factor of Safety	8-23
UC_r	Required Ultimate Capacity	8-23
Q_h	Ultimate Capacity of Helix Plate	8-24
A	Projected Area of Helix Plate	8-24
D	Vertical Depth to Helix Plate	8-24
γ'	Effective Unit Weight of Soil	8-24
N_q	Bearing Capacity Factor	8-24
K	End Condition Parameter	8-25
P_{crit}	Critical Load	8-25
E	Modulus of Elasticity	8-25
I	Moment of Inertia	8-25
L_u	Unsupported Length	8-25
K_t	Empirical Torque Factor	8-25

Soils

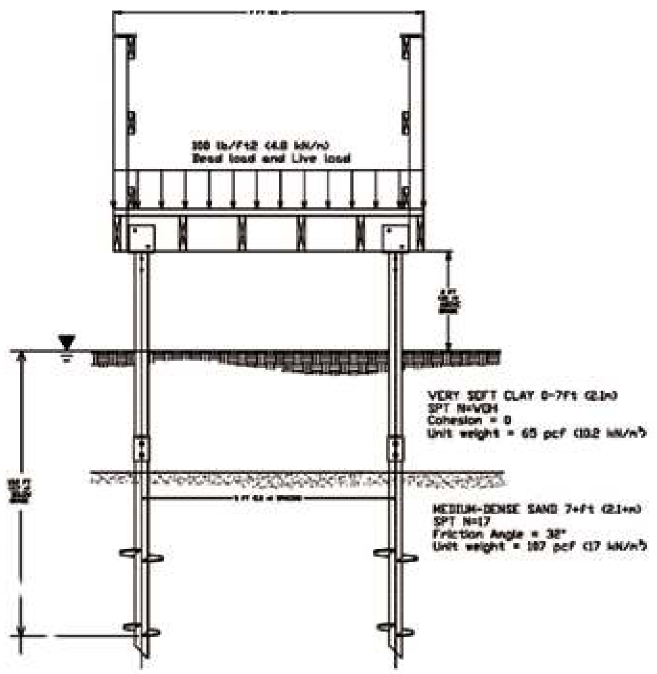
A helical pile foundation is proposed to support a pedestrian walkway. The soil profile consists of 7'-0 (2.1 m) of very soft clay with a reported Standard Penetration Test (SPT) blow count "N" equal to weight of hammer (WOH) and a unit weight of 65 lb/ft^3 (10.2 kN/m^3). Below the very soft clay is a thick layer of medium-dense sand with a SPT blow count value of 17. The correlated friction angle is 32° and the unit weight is 107 lb/ft^3 (16.8 kN/m^3). The water table is located at the surface. The proposed helical pile is connected to the walkway with a CHANCE® Walkway Support Bracket. The helical piles must be checked for lateral stability in the very soft clay.

Walkway

- The helical piles are spaced 5 ft (1.5 m) apart and are exposed 2 ft (0.61 m) above grade as shown in Figure 8-5.
- The walkway is 7 ft (2.1 m) wide; each pile group or "bent" is spaced 10'-0 apart.

Structural Loads

- The dead and live vertical load is 100 lb/ft^2 (4.8 kN/m^2). Lateral loads are negligible.
- The required compression load per helical pile (P_w) is 100 lb/ft^2 x 7'-0 x 10'-0 = 7000 lb/2 helical piles = 3500 lb (15.6 kN) per pile.
- Using a Factor of Safety (FS) of 2, the required ultimate capacity (UC_r) per helical pile is 3500 lb x 2 = 7000 lb (31.1 kN).



Helical Piles for Boardwalks
Figure 8-5

CHANCE® Helical Pile Selection

- Try a twin-helix configuration with 10" (254 mm) and 12" (305 mm) diameters.
- Try either Type SS5 1-1/2" (38 mm) Square Shaft or Type RS2875.203 2-7/8" (73 mm) Round Shaft material.

Ultimate Pile Capacity

The top-most helix should be at least three diameters into a suitable bearing soil; which in this example is the medium-dense sand starting 7 ft (2.1 m) below grade. The spacing between helix plates is also three diameters; which is 3 x 10" = 2.5 ft (0.8 m) for a 10"-12" (254 mm – 305 mm) configuration. Finally, the distance from the bottom-most helix to the pile tip is 0.5 ft (0.15 m). Therefore, the minimum overall length for a 10"-12" helix configuration in this soil profile is 7 ft + (3 x 12 inch) + 2.5 ft + 0.5 ft = 13 ft (4 m). The effective unit weight is the submerged unit weight in this case, because the water table is at the ground surface. The general bearing capacity equation (simplified for cohesionless soils) is:

$$Q_h = AD\gamma' N_q \qquad \textbf{Equation 8-20}$$

where:

- Q_h = Ultimate capacity of helix plate
- A = Projected area of helix plate
- D = Vertical depth to helix plate
- γ' = Effective unit weight of soil = 2.6 lb/ft^3 (0.4 kN/m^3) for the very soft clay and 44.6 lb/ft^3 (7.1 kN/m^3) for the medium-dense sand
- N_q = Bearing capacity factor for cohesionless soils = 17 for 32° sand

For a 10"-12" configuration, the bearing capacity equation is:

$$\Sigma Qh = A_{10}D_{10}\gamma' N_q + A_{12}D_{12}\gamma' N_q \qquad \textbf{Equation 8-21}$$

where:

$$\Sigma Qh = 0.531\ ft^2[(7\ ft \times 2.6\ lb/ft^3) + (5.5\ ft \times 44.6\ lb/ft^3)]17 + 0.771\ ft^2[(7\ ft \times 2.6\ lb/ft^3) + (3\ ft \times 44.6\ lb/ft^3)]17$$

$$\Sigma Qh = 4371\ lb\ (19.4\ kN)$$

4371 lb is less than the required ultimate capacity (7000 lb) needed for the vertical piles. Greater capacity can be obtained by extending the helix plates deeper into the medium-dense sand. Try extending the pile length 3 ft (0.9 m) deeper so that the tip is 16 ft (4.9 m).

$$\Sigma Qh = 0.531\ ft^2[(7\ ft \times 2.6\ lb/ft^3) + (8.5\ ft \times 44.6\ lb/ft^3)]17 + 0.771\ ft^2[(7\ ft \times 2.6\ lb/ft^3) + (6\ ft \times 44.6\ lb/ft^3)]17 \qquad \textbf{Equation 8-22}$$

$$\Sigma Qh = 7332\ lb\ (32.6\ kN)$$

7332 lb is greater than the required ultimate capacity needed for the vertical piles, so 16 ft (4.9 m) pile length will work.

Buckling

Check for buckling on Type SS5 1-1/2" (38 mm) square shaft and Type RS2875.203 2-7/8" (73 mm) OD pipe shaft material with 2 ft (0.61 m) of exposed shaft above grade. Assume a free-fixed (K = 2) end-condition. Assume the very soft clay provides no lateral support, i.e., the pile shaft is unsupported above the sand, so the unsupported (effective) length (L_u) of the "column" is 2 ft + 7 ft = 9 ft (2.7 m).

Euler's Equation: $P_{crit} = \pi^2 EI/[KL_u]^2$

For Type SS5 square shaft material:

$$P_{crit} = \pi^2\ [30\times10^6\ lb/in^2\ ][.396\ in^4]/[2 \times 108\ in]^2 \qquad \textbf{Equation 8-23}$$

$$P_{crit} = 2513\ lb\ (11.2\ kN)$$

The critical load for the Type SS5 series is less than the required 7000 lb (31.1 kN) ultimate capacity, so a shaft with greater stiffness is required.

For Type RS2875.203 pipe shaft material:

$$P_{crit} = \pi^2[30\times10^6\ lb/in^2\ ][1.53\ in^4]/[2 \times 108\ in]^2 \qquad \textbf{Equation 8-24}$$

$$P_{crit} = 9710\ lb\ (42.2\ kN)$$

The critical load for Type RS2875.203 pipe shaft is greater than the required 7000 lb (31.1 kN) ultimate capacity. Use the RS2875.203 series (2-7/8 inch (73 mm) OD pipe shaft material).

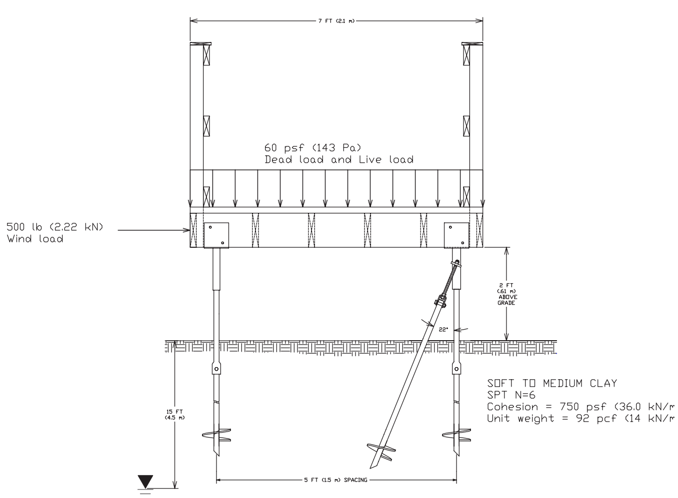
Torque

Torque required	=	Required ultimate capacity/K_t	**Equation 8-25**
where:	=	K_t = 9 (26) for RS2875 round shaft	
Torque required	=	7000 lb / 9	
Torque required	=	778 ft-lb (1186 N-m)	

The torque strength rating for RS2875.203 material is 5,500 ft-lb (7,500 N-m) - OK.

DESIGN EXAMPLE 7
HELICAL PILES for BOARDWALKS with LATERAL SUPPORT
SYMBOLS USED IN THIS DESIGN EXAMPLE

A CHANCE® Helical Type SS5 square shaft is proposed as the foundation for a pedestrian walkway. The pier is connected to the walkway with a CHANCE® Helical Walkway Support Bracket with lateral support. The soil is a soft to medium clay with a Standard Penetration Test (SPT) "N" value of 6, cohesion of 750 psf (36.0 kN/m^2) and unit weight of 92 lb/ft^3 (14 kN/m^3). The ground water table (GWT) is 15 ft (4.5 m) below grade.



Helical Piles for Boardwalks
with Lateral Support
Figure 8-6

Walkway:

- The piles are spaced 5 ft (1.5 m) apart and are exposed 2 ft (0.61 m) above grade.
- The walkway is 7 ft (2.1 m) wide and pier sets are 5 ft (1.5 m) apart.
- The battered pile is at an angle of 22°.

Structural Loads:

- Using a Factor of Safety (FS) of 2, the required ultimate capacity (UC_r) per vertical pile is 4550 lb (20 kN).
- Using a Factor of Safety of 2, the required ultimate capacity (UC_r) per battered pile is 2646 lb (12 kN).

CHANCE® Helical Pile Selection:

- Try a Type SS5 square shaft with a 12" (305 mm) diameter helix.

CHANCE® Helical Pile Selection

- Try a Type SS5 square shaft with a 12" (305 mm) diameter helix.

Ultimate Pile Capacity:

The pile depth needs to be at least 5 diameters into the soft to medium clay layer. Therefore the vertical pile length should be at least 5 ft (1.5 m) below grade.

$$Q_t = AcN_c \qquad \textbf{Equation 8-26}$$

$$Q_t = [.771\ ft^2][750\ psf][9]$$

$$= 5{,}204\ lb\ (23\ kN)$$

where: A = Projected area of helical plates

c = Cohesion of soil

N_c = Bearing capacity

5,204 lb is greater than UC_r for the vertical pile. The battered pile depth needs to be at least 5 diameters below grade. Therefore the battered pile length should be 6 ft (1.8 m) below grade.

Buckling:

Check for buckling on the SS5 square shaft with 2 ft (0.61 m) of exposed shaft above grade. Assume a pin-pin (K = 1) connection.

Euler's Equation:

$$P_{crit} = \pi^2 EI/[KL_u]^2 \qquad \textbf{Equation 8-27}$$

$$P_{crit} = \pi^2[30x10^6\ ][.396]/[1\ x\ 24]^{\ 2}$$

$$P_{crit} = 203{,}354\ lb\ (904\ kN)$$

The critical load is greater than the ultimate vertical load so buckling is not a concern.

Torque:

Torque required = Required load/K_t **Equation 8-28**

where: = K_t = 10 (33) for square shaft

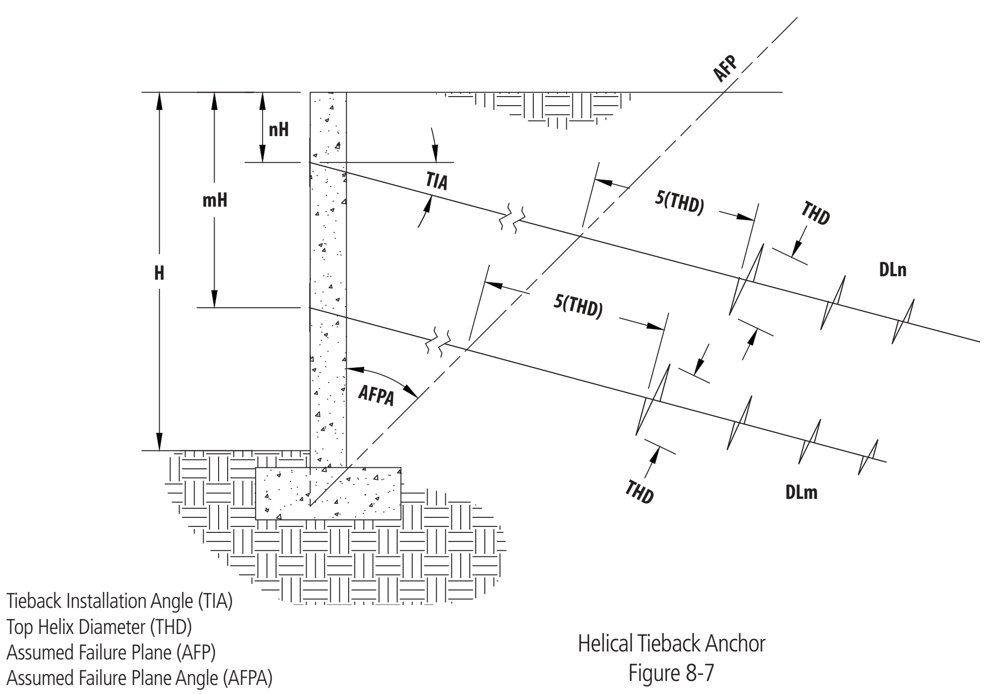
Torque required = 5,204 lb / 10

Torque required = 520 ft-lb (705 N-m)

This does not exceed the SS5 torque rating of 5,500 ft-lb (7,500 N-m).

DESIGN EXAMPLE 8
HELICAL TIEBACK ANCHORS IN CLAY
SYMBOLS USED IN THIS DESIGN EXAMPLE

Symbol	Description	Page
H	Height of Wall	8-29
nH	Height of Upper Anchor	8-29
mH	Height of Lower Anchor	8-29
GWT	Ground Water Table	8-29
DL_N	Design Load for Upper Anchor	8-29
DL_M	Design Load for Lower Anchor	8-29
Q_{tn}	Ultimate Tension Capacity for Upper Anchor	8-29
Q_{tm}	Ultimate Tension Capacity for Lower Anchor	8-29
A	Area of Helix Plate	8-29
N_c	Bearing Capacity Factor	8-29
c	Cohesion of Soil	8-29
T_u	Ultimate Capacity of Anchors	8-29
FS	Factor of Safety	8-30
T_N	Installation Torque for Upper Anchor	8-30
T_M	Installation Torque for Lower Anchor	8-30
K_t	Empirical Torque Factor	8-30



Helical Tieback Anchor
Figure 8-7

Structure Type

- Cast concrete retaining wall
- Height (H) = 18 ft, thickness = 2'-0
- nH = 0.25H = 4.5 ft, mH = 0.63H = 11.3 ft
- Residual soils: stiff clay with N = 28. No ground water table (GWT) present.
- Tieback installation angle = 15°

Structural Design Loads (See Figure 4-6 in Section 4)

- $DL_N/ft = (12 \times H^2) / \cos 15°$
- $DL_N/ft = (12 \times 18^2) / \cos 15°$
- $DL_N/ft = 4{,}025$ lb/lin ft
- $DL_M/ft = (18 \times H^2) / \cos 15°$
- $DL_M/ft = (18 \times 18^2) / \cos 15°$
- $DL_M/ft = 6{,}040$ lb/lin ft

CHANCE® Helical Product Selection

- Wall height ≥ 15 ft; use two rows of tiebacks
- Try Type SS150 series, C150-0169 (8"-10"-12" Lead) for DL_N.
- Try Type SS175 series, C110-0247 (8"-10"-12"-14" Lead) for DL_M.

Ultimate Tension Capacity (Using Bearing Capacity Approach)

Q_{tn} = $(A_8 + A_{10} + A_{12}) \times (c\,N_c)$ **Equation 8-29**

A_8, A_{10}, A_{12} = Projected area of helical plates (8",10", and 12")

N_c = Bearing capacity factor related to the residual soil, clay

A_8 = $0.336\ ft^2$

A_{10} = $0.531\ ft^2$

A_{12} = $0.771\ ft^2$

N_c = 9

c = N / 8 = 28 / 8 = 3.5 ksf or 3,500 psf *(see Equation 5-35)*

Q_{tn} = (0.336 + 0.531 + 0.771) x 3,500 x 9

Q_{tn} = 51,600 lbs

Q_{tm} = $(A_8 + A_{10} + A_{12} + A_{14}) \times (cN_c)$ **Equation 8-30**

$A_8, A_{10}, A_{12}, A_{14}$ = Projected area of helical plates (8",10",12", and 14")

A_{14} = $1.049\ ft^2$

Q_{tm} = (0.336 + 0.531 + 0.771+ 1.049) x 3,500 x 9

Q_{tm} = 84,640 lbs

Check Ultimate Anchor Capacity (T_u)

Compare Q_{tN} and Q_{tM} to field load tension tests if required by specifications.

Tieback Spacing

$Spacing_N$ = $(Q_{tN}$ / FS) / DL_N = (51,600 / 2) / (4,025) = 6.4 ft

$Spacing_M$ = $(Q_{tM}$ / FS) / DL_M = (84,640 / 2) / (6,040) = 7.0 ft
(use 6'-6" center to center spacing for both rows of tiebacks)

where: FS = 2.0

Estimate Installation Torque

T = (DL x Spacing x FS) / K_t **Equation 8-31**

T_N = (DL_N x $Spacing_N$ x FS) / K_t = (4,025 x 6.5 x 2) / 10 = 5,300 ft-lb

T_M = (DL_M x $Spacing_M$ x FS) / K_t = (6,040 x 6.5 x 2) / 10 = 7,850 ft-lb

where: K_t = Empirical torque factor (default value = 10 for Type SS series)

Check Installation Torque Ratings

The rated installation torque of the Type SS150 series is 7,000 ft-lbs, which is greater than the required installation torque (T_N) of 5,300 ft-lbs.

The rated installation torque of the Type SS175 series is 10,500 ft-lbs, which is greater than the required installation torque (T_M) of 7,850 ft-lbs.

Minimum Tieback Length

The distance from the assumed "active" failure plane to the 12" helix must be at least 5 x its diameter or 5'-0. The distance from the assumed "active" failure plane to the 14" helix must be at least 5 x its diameter or 6'-0. Both the minimum length and estimated installation torque must be satisfied prior to the termination of tieback installation.

DESIGN EXAMPLE 9
HELICAL TIEBACK ANCHORS IN SAND

SYMBOLS USED IN THIS DESIGN EXAMPLE

Structure Type

- Cast concrete retaining wall
- Granular backfill for wall φ = 35° γ = 120 pcf
- Height = 15 ft, thickness =1-1/2 ft
- Anchor Height = 1/3H = 5 ft
- Residual soils: silty coarse sand; medium to dense φ = 31° γ = 118 pcf. No ground water table present.
- Tieback installation angle = 25°

Structural Design Loads

- Use backfill φ = 35°
- $K_a = (1 - \sin\varphi) / (1 + \sin\varphi) = 0.27$
- $DL/ft = (1/2\ \gamma\ H^2\ K_a) / \cos 25°$
  $= [1/2\ (120)\ (15)^2\ (0.27)] / \cos 25°$
  $= 4{,}000$ lb/lin ft
- Assume tieback carries 80%; therefore, DLt $/_{ft}$ = 0.80 x 4,000. = 3,200 lb/lin ft

CHANCE® Helical Product Selection

- Wall height ≤ 15 ft; use single row of tiebacks
- Try Type SS5 series, C1500007 (8”-10”-12” Lead)

Ultimate Tension Capacity (Using Bearing Capacity Approach)

Q_t	=	$(A_8 + A_{10} + A_{12}) \times (q_h N_q)$	**Equation 8-32**
A_8, A_{10}, A_{12}	=	Projected area of helical plates (8", 10" and 12")	
N_q	=	Bearing capacity factor related to φ of residual soil (31°)	
A_8	=	0.336 ft^2	
A_{10}	=	0.531 ft^2	
A_{12}	=	0.771 ft^2	
N_q	=	15 (from Equation 5-19)	
q_h	=	$\gamma \times D_h$ (depth of helix below ground line, ft)	
q_8	=	118 pcf (5' + 25' sin 25°) = 1836 psf	
q_{10}	=	118 pcf (5' + 23' sin 25°) = 1736 psf	
q_{12}	=	118 pcf (5' + 20.5' sin 25° = 1612 psf	
Q_t	=	[(0.336 x 1836) + (0.531 x 1736) + (0.771 x 1612)] x 15	
Q_t	=	41,725 lbs	

Check Ultimate Anchor Capacity (T_u)

Compare Q_t to field load tension tests if required by specifications.

Tieback Spacing

$\text{Spacing}_N = (Q_t / FS) / DL_t = (41,725 / 2) / (3,200) = 6.5$ ft (use 6'-6 center to center spacing) **Equation 8-33**

where: FS = 2.0

Estimate Installation Torque

$T = (DL_t \times \text{spacing} \times FS) / K_t = (3,200 \times 6.5 \times 2.0) / 10 = 4,200$ ft-lb **Equation 8-34**

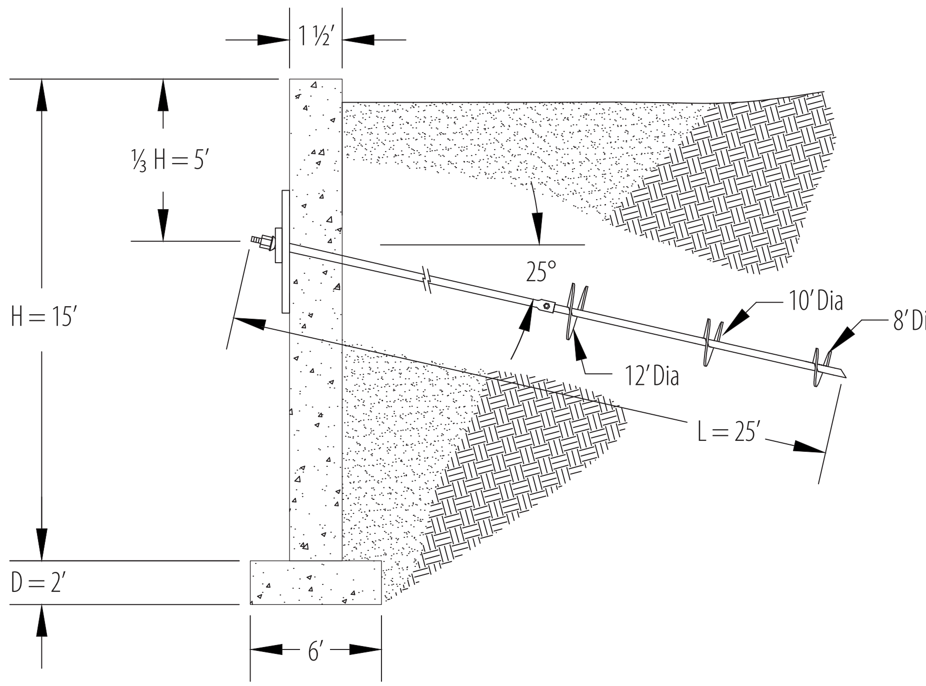
where: K_t = Empirical torque factor (default value = 10 for Type SS series)

Check Installation Torque Ratings

The rated installation torque of the Type SS5 series is 5,500 ft-lbs, which is greater than the required installation torque (T) of 4,200 ft-lbs.

Minimum Tieback Length

The distance from the assumed "active" failure plane to the 12" helix must be at least 5 times its diameter or 5'-0. Both the minimum length and estimated installation torque must be satisfied prior to the termination of tieback installation.



Helical Tieback Anchor
Figure 8-8

SOIL BORING LOG				
Graphic Log	Soil Classification	Depth	USCS Symbol	SPT - N Blows/ft
	Topsoil		OH	
	Silty Sand	5	SM	17
	Silty Coarse Sand γ = 118 pcf ϕ = 31°	10	SM	30
		15		32
		20		34

Soil Boring Log
Figure 8-9

DESIGN EXAMPLE 10

SOIL SCREW® RETENTION WALL SYSTEM

SYMBOLS USED IN THIS DESIGN EXAMPLE

Symbol	Description	Page
S_V	Vertical SOIL SCREW® Spacing	8-35
S_H	Horizontal SOIL SCREW® Spacing	8-35
L	Length of SOIL SCREW® Anchor	8-35
FS	Factor of Safety	8-35
γ	Unit Weight of Soil	8-35
φ	Internal Angle of Friction	8-35
pcf	Pounds per Cubic Foot	8-35
psf	Pounds per Square Foot	8-35
Ω	Ohms	8-35
ppm	Parts per Million	8-35
GWT	Ground Water Table	8-36
H	Height of Wall	8-36
K_a	Active Earth Pressure Coefficient	8-36
F_1	Horizontal Force from Retained Soil	8-36
F_2	Horizontal Force from Surcharge Load	8-36
L_X	Horizontal Length of SOIL SCREW® Anchor	8-37
e	Eccentricity of Vertical Force	8-37
σv	Vertical Stress	8-37
Q_{allow}	Allowable Bearing Capacity	8-37
kip	Kilopound	8-38
N_q	Bearing Capacity Factor	8-39
P	Ultimate Tension Capacity	8-39
A	Area of Helix	8-39
y	Difference in Depth of SOIL SCREW® Anchor from End to End	8-39
θ	Angle of SOIL SCREW® Anchor (from horizontal)	8-39
psi	Pounds per Square Inch	8-40
ksi	Kilopounds per Square Inch	8-40
d	Diameter of Welded Fabric Wire	8-40
D	Diameter of Rebar	8-40
A_s	Area of Steel	8-40
m_v	Vertical Moment Resistance	8-41

T_{FN}	Maximum Helical Anchor Head Load	8-41
C_F	Facing Pressure Factor	8-41
V_N	Punching Shear Strength of Facing	8-41
f'_c	Compressive Strength of Concrete	8-41
h_c	Thickness of Facing	8-41
D'_c	Effective Cone Diameter at Center of Facing	8-41
$FS_{internal}$	Internal Factor of Safety	8-42
FS_{global}	Global Factor of Safety	8-43
M_c	Cantilever Moment	8-43
FS_{MC}	Factor of Safety for Cantilever Moment	8-44
S_c	Shear Force	8-44
FS_{shear}	Factor of Safety for Shear Force	8-44

DESIGN EXAMPLES

Problem

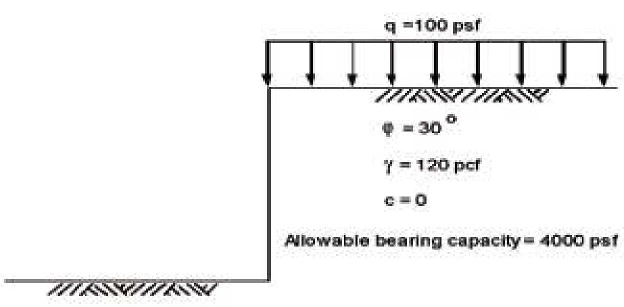
Determine the SOIL SCREW® Anchor spacing (S_V, S_H), SOIL SCREW® Anchor length (L) and facing requirements for an excavation support system for a 23 foot deep excavation in a silty sand. The required design Factor of Safety (FS) for internal stability is 1.5, and for global stability is 1.3.

Step 1 - Define Design Parameters

Given: The unit weight (γ) and friction angle (φ) of the silty sand is 120 pcf and 30° respectively. The allowable bearing capacity of the silty sand at the bottom of the excavation is 4000 psf. The electrochemical properties of the silty sand are listed below:

Resistivity	4000 Ω/cm
pH	7
Chlorides	50 ppm
Sulfates	100 ppm

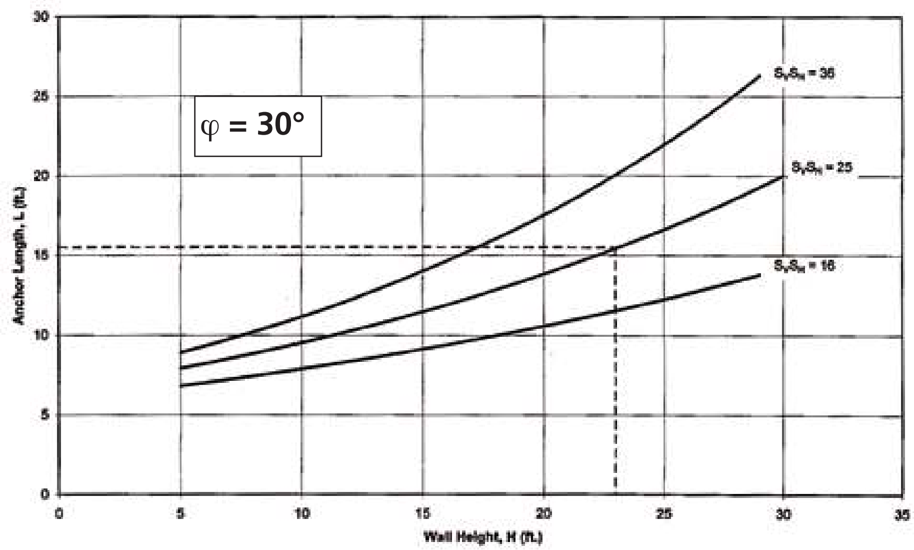
A design live surcharge load of 100 psf is considered to be applied uniformly across the ground surface at the top of the wall. The wall face is vertical. Groundwater is located 60 feet below the ground surface.



Excavation Profile
Figure 8-10

CHANCE® Type SS5 Helical SOIL SCREW® Anchors, for which lead sections and extensions are available in 5' and 7' lengths, are to be used for the SOIL SCREW® Anchors. The design life of the structure is one year. Design SOIL SCREW® Anchor lengths will be governed by the lead and extension pieces and thus will be 10', 12', 14', 15', 17', 19', etc.

Step 2 - Check the Preliminary Feasibility of the SOIL SCREW® Retention Wall System



Preliminary Design Chart
Figure 8-11

The medium dense, silty sands at this site are well suited for the SOIL SCREW® Retention Wall System (i.e., good stand up time). The ground water table (GWT) is well below the bottom of the excavation. The conditions at the site are therefore favorable for the SOIL SCREW® Retention Wall System.

Design charts are used to determine preliminary SOIL SCREW® Anchor spacing and lengths for the given wall geometry, loading and soil conditions. For the soil conditions, φ = 30°, enter the Preliminary Design Chart (Figure 8-11) along the x-axis at a wall height (H) = 23 ft. A typical SOIL SCREW® Anchor spacing for soils with "good" stand up time is 5 ft. x 5 ft. Therefore, use the S_VS_H = 25 curve to determine the preliminary SOIL SCREW® Anchor length (L) = 16 ft.

Step 3 - Determine External Earth Pressures

Use Equation 8-35 to determine the active earth pressure (K_a) at the back of the reinforced soil mass.

K_a = $\tan^2$ [45 - (φ/2)] **Equation 8-35**

K_a = $\tan^2$ [45 - (30/2)] = 0.33

Step 4 - Check Preliminary SOIL SCREW® Anchor Length with Respect to Sliding

Available SOIL SCREW® Anchor lengths for CHANCE® Helical Type SS5 anchors are 10', 12', 14', 15', 17', 19', etc. The 16 foot preliminary length determined in Step 2 does not account for surcharge loading, which tends to increase SOIL SCREW® Anchor lengths. Try 19' SOIL SCREW® Anchors (length to height ratio of 0.83). For preliminary designs for walls with the given soil and loading conditions, a length to height ratio of 0.8 to 1.0 is a starting point for the analysis and appears to be conservative.

The horizontal force from the retained soil (F1) is determined using Equation 8-36.

F_1 = 1/2 $K_a \gamma H^2$ **Equation 8-36**

F_1 = 1/2 (0.33) (120) 23^2 = 10474 lb/lf of wall

The horizontal force from the surcharge load (F2) is determined using Equation 8-37.

F_2 = K_a qH = 0.33 (100) 23 = 759 lb/lf of wall **Equation 8-37**

Using 19' SOIL SCREW® Anchors installed at a 15° angle, the horizontal length (L_X) of the SOIL SCREW® Anchor is determined using Equation 8-38.

$$L_x = L \cos 15°$$ **Equation 8-38**

$$L_x = 19 \cos 15° = 18.4 \text{ ft}$$

The Factor of Safety against sliding is determined using Equation 8-39.

$$FS = \frac{\gamma H L_x \tan \varphi}{F_1 + F_2} = \frac{120\ (23)\ 18.4 \tan 30}{10474 + 759}$$ **Equation 8-39**

$$FS = 2.61$$

Step 5 - Check Required Bearing Capacity at the Base of the Wall

Determine the eccentricity (e) of the resultant vertical force using Equation 8-40.

$$e = \frac{[F1\ (H/3)] + [F2\ (H/2)]}{\gamma H L_x}$$ **Equation 8-40**

$$= \frac{[10474\ (23/3)] + [759\ (23/2)]}{120\ (23)\ 18.4}$$

$$= 1.75 < (L_x/6) = (18.4/6) = 3.06$$

The vertical stress (σ_v) of the bottom of the wall is determined using Equation 8-41.

$$\sigma_v = \frac{\gamma H L_x + q L_x}{L_x - 2e} = \frac{120\ (23)\ 18.4 + 100\ (18.4)}{18.4 - 2\ (1/75)} = 3532 \text{ psf}$$ **Equation 8-41**

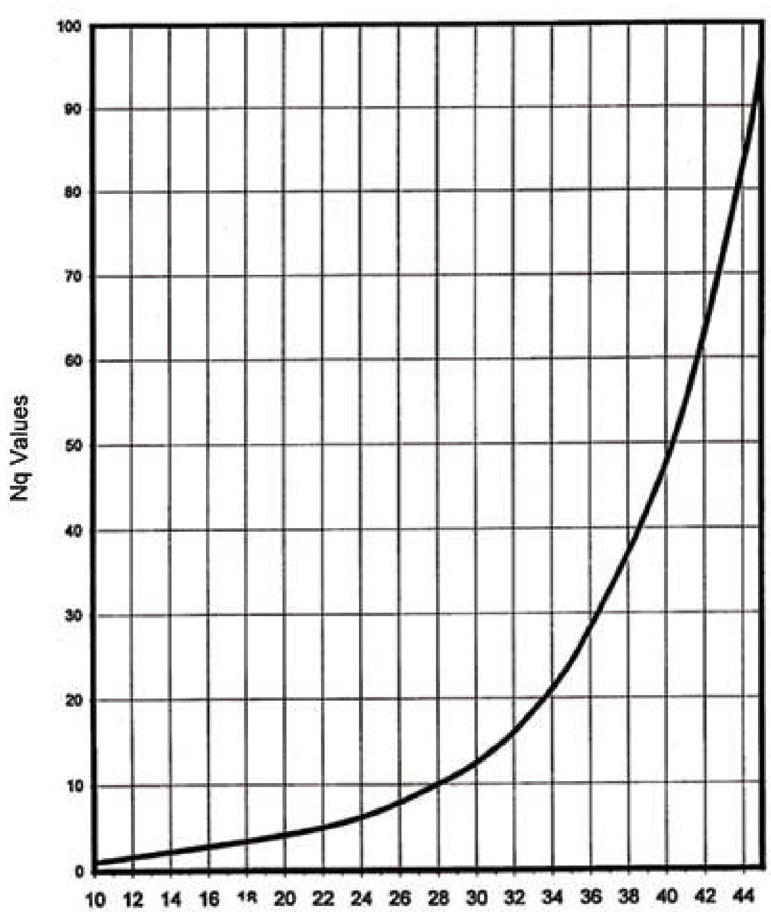
Given the allowable bearing capacity (Q_{allow}) is 4000 psf:

$$Q_{allow} = 4000 \text{ psf} > \sigma_v = 3532 \text{ psf}$$ **Equation 8-42**

Step 6 - Determine the Allowable Helical Anchor Strength

Allowable Design Strength of Type SS5 Helical Anchor (Service Life = 75 Years), Table 8-5

Ta 75 yrs (kips)	V 75 yrs (kips)	ALLOWABLE DESIGN STRENGTH (TEMPORARY STRUCTURES) (kips)	ALLOWABLE DESIGN STRENGTH 75 yrs (kips)
50	37	45	37

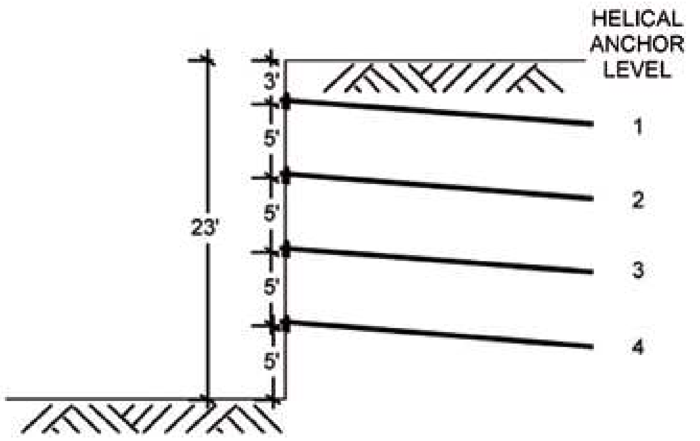


Angle of Internal Friction φ

Bearing Capacity Factor Nq vs Soil Friction Angle φ
Figure 8-12

The SOIL SCREW® Anchor wall is a temporary structure with a design life of one year. From Table 8-5, the allowable design strength of the CHANCE® Helical SS5 Anchor is 45 kips. This table is based on the following electrochemical properties of soil:

Resistivity:	>3000 Ω/cm
pH:	>5<10
Chlorides:	100 ppm
Sulfates:	200 ppm
Organic content:	1% max



Helical Anchor Levels
Figure 8-13

Step 7 - Estimate the Tension Capacity of the SOIL SCREW® Anchors

Determine the bearing capacity factor (N_q) for helical anchors for a sand with an effective friction angle, $\varphi = 30°$. From Figure 8-12, $N_q = 14$. Assumed vertical spacing is 5 feet (see Figure 8-13). Nail pattern is as shown in Figure 8-13. There are eight helices per anchor, as shown in Figure 8-14.

The ultimate tension capacity (P) of the Helical SOIL SCREW® Anchor at Level 1 is determined using Equation 8-43.

$$P = \sum_{i=1}^{8} A_i q_i N_q \qquad \textbf{Equation 8-43}$$

Helical anchors have 8" diameter helixes. The helix area (A) can be calculated using Equation 8-44.

$$A = \pi\,(0.33)^2 \qquad \textbf{Equation 8-44}$$

$$= 0.336\ ft^2 \ \ (\text{use } 0.34\ ft^2)$$

The ultimate tension capacities for the helical anchors at the various levels are determined using Equation 8-45.

$$y = L\,(\sin\theta) \qquad \textbf{Equation 8-45}$$

$$= 19\,(\sin 15^o)$$

$$= 4.9\ ft$$

where:

L = Length of SOIL SCREW® Anchor

θ = Installation angle (from horizontal)

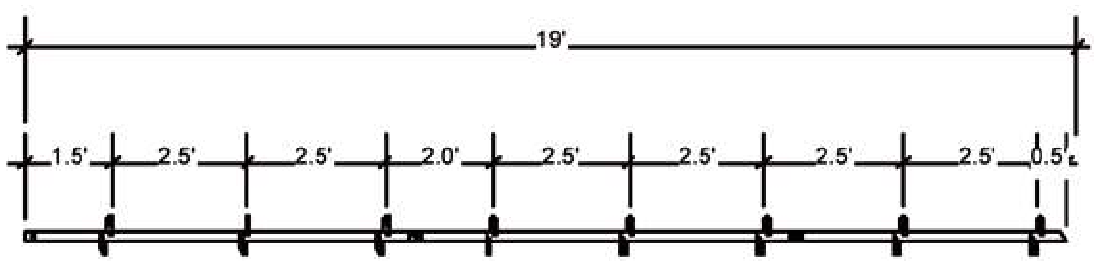
Average Overburden Depth = 3 + (y/2) = 5.5 ft at Level 1

P_{LEVEL1} = 8 (0.34) 5.5 (120) 14 = 25 kips

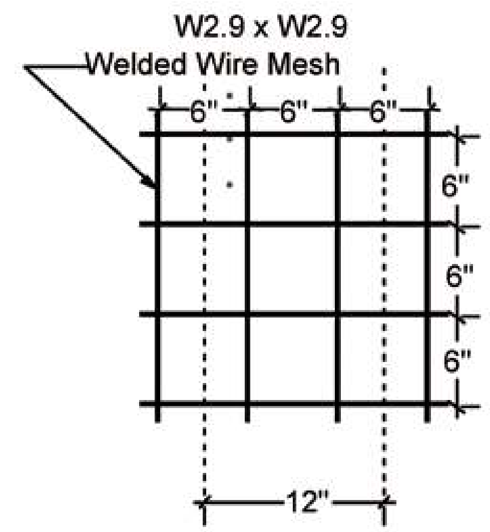
P_{LEVEL2} = 8 (0.34) 10.5 (120) 14 = 48 kips

P_{LEVEL3} = 8 (0.34) 15.5 (120) 14 = 71 kips

P_{LEVEL4} = 8 (0.34) 20.5 (120) 14 = 94 kips



Helical Anchor Helix Spacing
Figure 8-14



Welded Wire Mesh
Figure 8-15

Step 8 - Define a Trial Facing System

Try a 4" thick, 4000 psi shotcrete face with 6 x 6, W2.9 x W2.9 welded wire mesh reinforcing and two #4 vertical rebars at the helical anchor locations. Try a helical anchor spacing of 5 feet vertically and horizontally and an 8" square by 3/4" thick bearing plate with a steel yield stress of 36 ksi.

Step 9 - Determine the Allowable Flexural Strength of the Facing

For typical helical anchor wall construction practice, the facing is analyzed using vertical strips of width equal to the horizontal anchor spacing. For facing systems involving horizontal nail spacings that are larger than the vertical spacing or unit horizontal moment capacities that are less than the vertical unit moment capacities, horizontal strips of width equal to the vertical anchor spacing should be used.

The area of steel (A_s) for a vertical beam of width 5 feet (S_H = 5 feet) with the anchor on the beam's centerline is determined using Equation 8-46. Diameter (d) of the welded fabric wire is 0.192". Diameter (D) of the rebar is 0.500". For a 5 foot wide vertical beam centered between the anchors, the rebars are located at the beam edges and should be ignored. A_s is calculated using Equation 8-47. The corresponding average nominal unit moment resistances are determined using Equation 8-48.

Equation 8-46

$$A_{s,neg} = \left(\frac{pd^2}{4}\right)\left(\frac{in^2}{wire}\right) \times \left(\frac{2\ wires}{ft}\right)(5\ ft)\ \left(\frac{pD^2}{4}\right)\left(\frac{in^2}{rebar}\right) \times \left(\frac{2\ rebars}{5\ ft}\right)(5\ ft)$$

$$= \left(\frac{p\,(0.192^2)}{4}\right)(2)\,(5)\ \left(\frac{p\,(0.500^2)}{4}\right)\ (2)$$

$$= 0.682\ in^2$$

Equation 8-47

$$A_{s,pos} = \left(\frac{\pi D^2}{4}\right)\left(\frac{in^2}{wire}\right) \times \left(\frac{2\ wires}{ft}\right)(5\ ft)$$

$$= \frac{\pi\,(0.192)^2}{4}\ (2)\,(5)$$

$$= 0.289\ in^2$$

Equation 8-48

$$m_v = \frac{A_s F_y \left(d - \frac{A_s F_y}{1.7 f'_c b}\right)}{b}$$

$$m_{v,neg} = \frac{0.682\,(60)\left(2 - \frac{0.682\,(60)}{1.7\,(4)\,(5 \times 12)}\right)}{5\,(12)}$$

$$= 1.30k - in/in$$

$$= 1.30k - ft/ft$$

$$m_{v,pos} = \frac{0.289\,(60)\left(2 - \frac{0.289\,(60)}{1.7\,(4)\,(5 \times 12)}\right)}{5\,(12)}$$

$$= 0.566\ k\text{-}ft/ft$$

Step 10 - Determine the Maximum Helical Anchor Head Load

Determine the maximum helical anchor head load that will produce the allowable moments determined in Step 9 using Equation 8-49. Using Table 8-6, determine the facing pressure factor (C_F) for temporary shotcrete facing 4" thick.

$$T_{FN,\ flexure} = C_F\ (m_{v,neg} + m_{v,pos})\ 8\ (SH/SV) \qquad \textbf{Equation 8-49}$$

$$T_{FN,\ flexure} = 2.0\ (1.30 + 0.57)\ 8\ (5\ ft/5\ ft) = 29.8\ kips$$

Facing Pressure Factor, Table 8-6

NOMINAL FACING THICKNESS (in)	TEMPORARY FACING C_F	PERMANENT FACING C_F
4	2.0	1.0
6	1.5	1.0
8	1.0	1.0

Step 11 - Determine the Allowable Punching Shear Strength of the Facing

The punching shear strength (V_N) is determined using Equation 8-50.

$$V_N = 0.125\ \sqrt{f'_c}\ \ pD'_c\ \ h_c \qquad \textbf{Equation 8-50}$$

$$V_N = 0.125\ \sqrt{4}\ \pi\ (12)\ (4) = 38\ kips$$

where:

f'_c = 4,000 psi = 4 ksi

h_c = 4 in

D'_c = 8 + 4 = 12 in

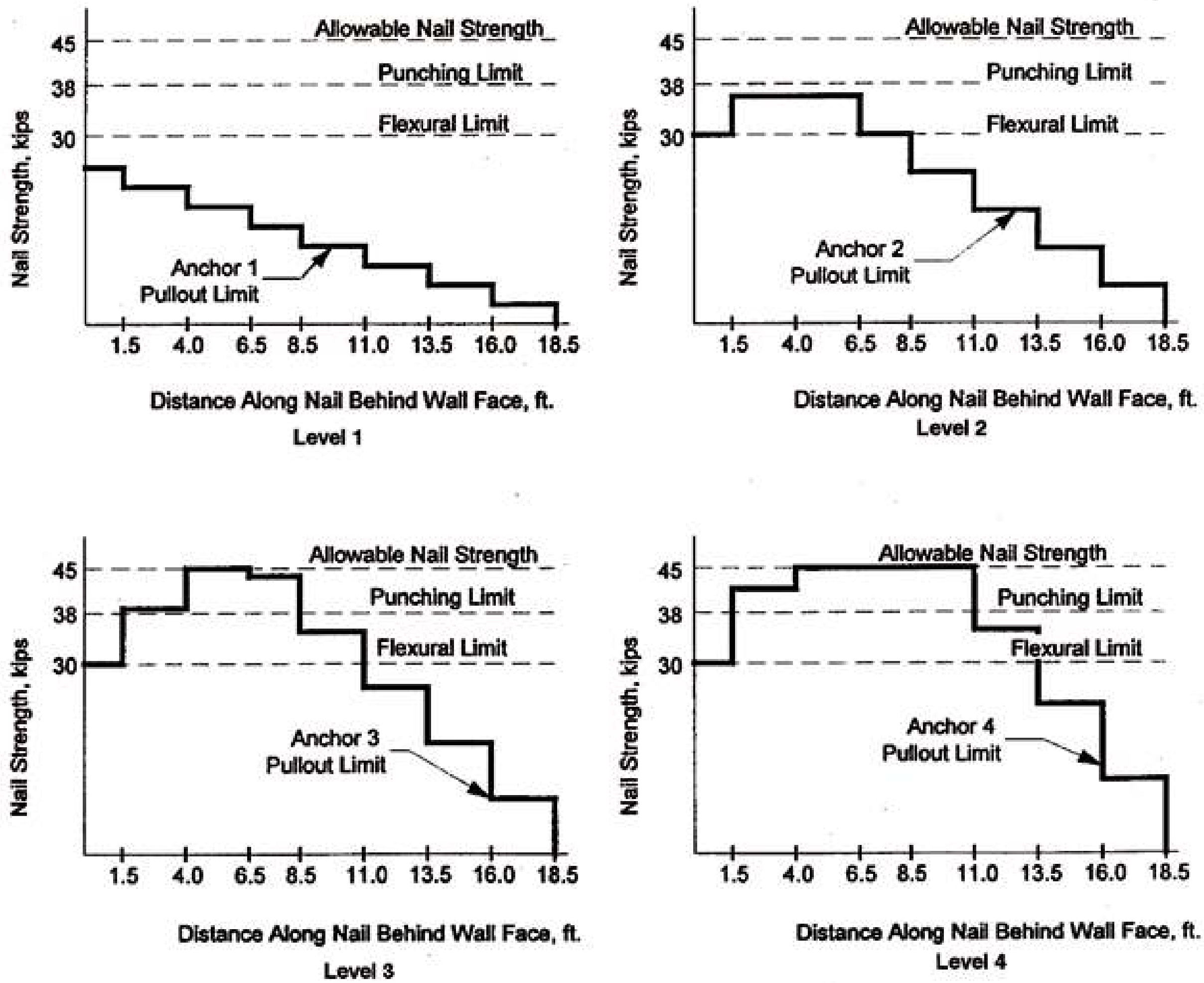
Step 12 - Determine Critical Helical Anchor Head Load for Punching

Determine the critical helical anchor head load (T_{FN}) for punching using Equation 8-51.

$$T_{FN,\ punching} = V_N = 38\ kips \qquad \textbf{Equation 8-51}$$

Step 13 - Construct SOIL SCREW® Anchor Strength Envelope

Construct the strength envelope at each anchor level as shown in Figure 8-16. At the wall face, the anchor head flexural strength is less than the anchor head punching strength and therefore controls. There are eight helices per anchor. Each step in strength equals the single-helix bearing capacity for the anchor layer (Step 7). From the last helix (working from right to left) increase the pullout capacity in a stepwise fashion. If the pullout envelope working from the back of the nail does not intersect the flexural limit line, the strength envelope will look like that shown for Anchor 1. If the pullout envelope working from the back of the nail exceeds the flexural limit, then construct a pullout envelope working from the flexural limit at the head of the nail.



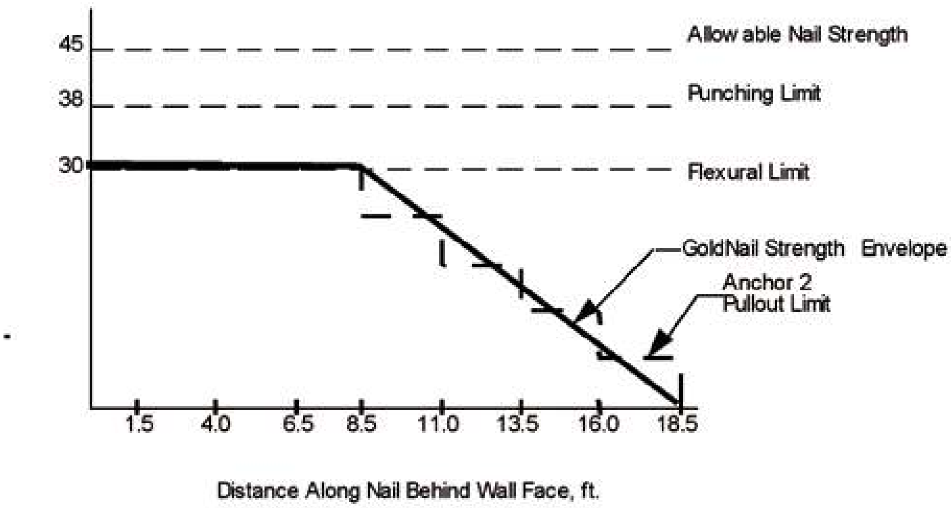
Anchor Pullout Limits
Figure 8-16

Step 14 - Evaluate Internal and Compound Stability

GoldNail 3.11, "A Stability Analysis Computer Program for Soil Nail Wall Design," developed by Golder and Associates, was used to perform the internal and compound stability analysis. Refer to Attachment EX1 in the CHANCE® SOIL SCREW® Retention Wall System Design Manual for printout result of this stability analysis. The following discussion is based on these results.

The anchor strength envelope developed in Step 13 needs to be modified for GoldNail. The increase in pullout capacity along the length of the nail is estimated for GoldNail as straight lines, not step functions. An example of this modification for Anchor Level 2 is shown in Figure 8-17.

Within GoldNail there are several analysis options. The option used for this example is "Factor of Safety." Using this option, the Internal Factor of Safety ($FS_{internal}$) = 2.11 for the anchor pattern defined in Step 7. The GoldNail output printout lists "Global Stability" not "Internal Stability." However, the location of the critical failure surface (Circle #13) indicates an internal mode of failure, as shown on the GoldNail geometry printout.



GoldNail Strength Envelope
Figure 8-17

Step 15 - Check Global Stability

Analysis was performed for the given slope geometry by the computer program PCSTABL6H, developed by Purdue University and modified by Harald Van Aller, and the pre-processor STED, developed by Harald Van Aller. The resulting Global Factor of Safety (FSglobal) = 1.93. Refer to Attachment EX2 in the CHANCE® SOIL SCREW® Retention Wall System Design Manual for printout results of this global stability analysis.

Step 16 - Check Cantilever at Top of Wall

In Step 7 the layout of anchors was assumed. The cantilever at the top of the wall from Step 7 is 3 feet. Check cantilever moment (Mc) using Equation 8-52.

Equation 8-52

$$M_c = K_a\gamma \left[\left(\frac{H_1^2}{2} \right) \left(\frac{H_1}{3} \right) + q \left(\frac{H_1^2}{2} \right) \right]$$

$$= 0.33\ (120) \left[\left(\frac{3^2}{2} \right) \left(\frac{3}{3} \right) + 100 \left(\frac{3^2}{2} \right) \right]$$

$$= 326.7 \text{lb - ft/ft}$$