Step 8 – CHANCE® Product Selection

A Helical Screw Foundation is a segmented deep foundation system with helical bearing plates welded to a central steel shaft. Load is transferred from the shaft to the soil through these bearing plates. For a complete list of mechanical ratings and section properties, see Table 8.5 at the end of this Step.

Segments or 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. All helices, regardless of their diameter, have a standard 3-inch pitch. Being a true helical shape, the helices do not auger into the soil but rather screw into it with minimal soil disturbance.

Lead Section and Extensions

The first section or *Lead Section* contains the helical plates. This Lead Section can consist of a single helix or up to four helices. Additional helices can be added, if required, with the use of *Helical Extensions*. Standard helix sizes are found in Table 8.1. The helices are arranged on the shaft such that their diameters increase as they get farther from the pilot point. *Plain Extensions* are then added in standard lengths of 3, 5, 7 and 10 feet until the Lead Section penetrates into the bearing strata. For standard helix configurations, refer to the Hubbell/A.B. Chance Co. HeliCAP™ Engineering Software. Note that lead time will be significantly reduced if a standard helix configuration is selected.

Table 8.1
Standard Helix Sizes

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)

Practical Limits on Quantity of Helices

In a cohesive soil, a practical limit is four to five helices. In cohesionless or granular soils, a practical limit is six helices.

Helix Spacing

Helical 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 screw foundation shaft is not influenced by the helix above or below it (see Step 4, Bearing Capacity).

Selection Based on Load Requirements/Installation Torque

The helical screw foundation is selected primarily on the installation torque necessary to obtain the requied ultimate load (see Step 4, Bearing Capacity; and Step 9, Field Production Control). Practical guidance for foundation selection is given in Table 8.2.

Table 8.2 Practical Guideline for Selecting a Foundation

Installation Torque	Ultimate Load* kip (kN)	Design Load† kip (kN)	Minimum Foundation Series
0 – 5,500	0 – 55 (0 – 244)	0 – 27.5 (0 – 110)	SS5
5,500 – 7,000	55 – 70 (244 – 312)	27.5 – 35 (122 – 156)	SS150
7,000 – 10,000	70 – 100 (312 – 445)	35 – 50 (156 – 222)	SS175
10,000 – 15,000	100 – 150 (445 – 668)	50 – 75 (222 – 334)	SS200
15,000 – 20,000	150 – 200 (668 – 890)	75 – 100 (334 – 445)	SS225
0 – 11,000	0 – 77 (0 – 343)	0 – 39 (0 – 173)	HS

*Based on a Torque Factor (K_t) = 10 for SS and K_t = 7 for HS

†Based on a Factor of Safety of two (2)

Selection Based on Soil Parameters

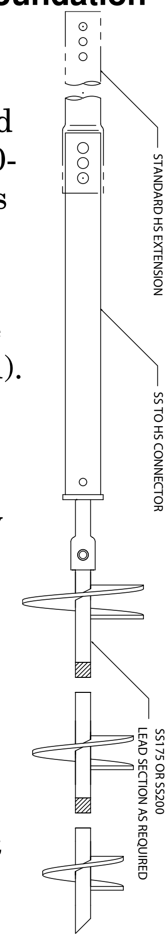
Table 8.3

Shaft Size inches (mm)	Torque Rating ft-lb (N-m)	Max. "N" Value Clay	Max. "N" Value Sand
SS5 1½ (38)	5,500 (7,500)	40	30
SS150 1½ (38)	7,000 (9,500)	60	50
SS175 1¾ (44)	10,000 (13,600)	65	65
SS200 2 (51)	15,000 (20,300)	<80	<80
SS225 2¼ (57)	20,000 (27,100)	<80	<80
HS 3½ (89)	11,000 (14,900)	25	20

"N" value or Blow Count, from Standard Penetration Test per ASTM D 1586, on chart is considered the maximum that a particular Shaft Size will penetrate.

An additional condition that must be evaluated is the ability of the helical screw foundation to penetrate soil to the required depth. For example, a foundation design may require a deep installation that penetrates through a dense fill layer, consisting of compacted construction debris (concrete, rubble, etc.), through a compressible organic layer below the fill and finally into the bearing strata. A foundation with a higher torque rating may be required to adequately penetrate through the fill. Table 8.3 outlines the maximum "Blow Count" or "N" value that a particular shaft will typically penetrate into. Note that the Type SS foundation series with higher strength shaft and helix material will penetrate harder/denser soils than the Type HS foundation series. Penetrating into harder/denser soils is generally required to support larger loads.

Figure 8.1 SS-to-HS Combination Foundation



Difficult Soils

Smaller helices will penetrate difficult soils easier than larger ones. For example, a Lead Section with a 6-8 helix combination (one 6"-diameter helix and one 8"-diameter helix) has approximately the same projected area as a single 10-inch helix; however, the 6-8 combination will penetrate dense gravel and cobbles easier than the single larger helix.

Helical Screw Foundation Efficiency

The SS (Square Shaft) foundations provide the most efficient capacity-to-torque relationship (see Step 4, Bearing Capacity; and Step 9, Field Production Control). This means the SS foundations require less installation torque for a given load than do pipe shaft foundations. As the shaft section increases, the capacity-to-torque relationship is reduced. Type HS and other pipe-shaft foundations are used when buckling is a practical concern (see Step 6) or when the helical screw foundation is required to resist lateral load (see Step 5). The SS foundation is generally easier to install and is more cost effective. The SS foundation series is typically used with the HELICAL PULLDOWN™ Micropile (see Appendix).

Square Shaft or Pipe Shaft Helical Screw Foundations

In general, helical screw foundations have slender shafts; the diameter rarely exceeds 3½". A small diameter is necessary to be energy efficient during installation (see Step 9). Square shaft and pipe shaft foundations each have advantages and disadvantages that enable the designer to choose the best shaft type for a given application.

The two key factors when selecting shaft type are application and site conditions. Table 8.4 compares the general merits of the two shaft types based on several design features. No single shaft type is the best choice in every instance. Table 8.4 provides an easy way to choose the right shaft type based on application and soil conditions.

Table 8.4

Feature	Round Pipe	Square Shaft
• Installation torque related to ultimate bearing capacity	Less bearing capacity for a given installation torque	More bearing capacity for a given installation torque
• Shaft twist	Not obvious without other means of visual reference	Visibly obvious —good indicator of torque
• Installation energy (work)	More: Larger cross section and increased friction due to round shape	Less: Smaller cross section and less friction due to square shape
• Total Load Capacity	End bearing and skin friction (dia. >3")	End bearing only
• Soil disturbance	More: Larger shaft-diameter to helix-diameter ratio, i.e. more disruption and pore pressure build up	Less: Smaller shaft-diameter to helix-diameter ratio, i.e. less disruption and pore pressure build up
• Center-to-center spacing	Must be spaced farther apart due to increased pore pressure build up	Can be spaced closer together due to less pore pressure build up
• Soil penetration	Larger cross section reduces penetration into soils with higher Standard Penetration Test N values	• For a given torque, will penetrate farther into a given bearing strata • Will penetrate soils with higher Standard Penetration Test N values
• Couplings	• Multiple bolts are more difficult to connect in the field • Coupling bolts must resist both torque and axial load • Little slack in couplings applicable for load reversal applications	• Single bolt is easy to connect in the field • Torque transfer across square shape, not coupling bolt • Slack in coupling not applicable for load reversal applications (without alterations)
• Shaft bending resistance	More: Larger shaft size results in larger section properties	Less: Slender shaft results in smaller section properties
• Shaft buckling resistance	Critical buckling load is more for a given soil due to larger shaft size	Critical buckling load is less for a given soil due to slender shaft (practical concern in only the softest soils)
• Lateral shear capacity	Larger shaft size results in more lateral capacity for a given soil	Slender shaft results in less lateral capacity for a given soil
• Column/shaft above grade	Better: Larger shaft has greater stiffness	Limited: Slender shaft has less stiffness
• Corrosion loss potential	More: Hollow pipe shaft means more surface area (both inside and out) exposed to corrosive environments	Less: Solid slender shaft means less surface area exposed to corrosive environments
• Ground water migration	More: Larger cross section results in more disturbed soil acting as a water wick. Hollow shaft allows open conduit to surface water.	Less: Smaller cross section and solid shaft results in less disturbed soil acting as a water wick

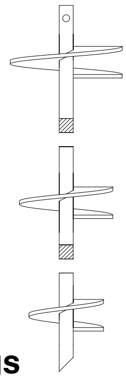
For new construction, square shaft (Type SS) is the material of choice unless the foundation shaft is expected to resist significant lateral loads, or if the confining soils along the shaft are very low strength (i.e. buckling problems).

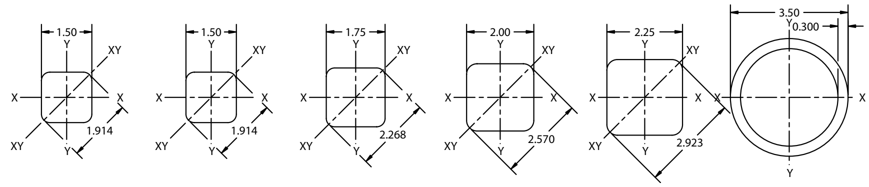
For tiedown applications, square shaft is the material of choice.

SS-to-HS Combination Foundation

A good compromise to address lateral or buckling capacity issues is the SS-to-HS combination foundation (see Figure 8.1). It has the advantage of an SS Lead Section with high strength helix material and an efficient capacity-to-torque relationship combined with the HS Plain Extensions (3.50" O.D. x 0.300" wall pipe shaft). This foundation will penetrate dense/hard soils and provide a large shaft cross section in the softer/looser soils above the bearing strata.

Product Selection
Table 8.5





Mechanical Ratings

		SS5 Square Shaft	SS150 Square Shaft	SS175 Square Shaft	SS200 Square Shaft	SS225 Square Shaft	HS Pipe Shaft
Torsional Strength Rating	**ft-lb (N-m)**	5500 (7,500)	7000 (9,500)	10000 (13,600)	15000 (20,300)	20000 (27,100)	11000 (14.900)
Ultimate Compression Capacity (shaft)	**Kip (kN)**	154 (685)	198 (880)	271 (1210)	351 (1560)	448 (1990)	151 (672)
Allowable Compression Load (shaft)	**Kip (kN)**	62 (276)	79 (352)	108 (481)	140 (623)	179 (797)	60 (267)
Ultimate Capacity* (per standard helix)	**Kip (kN)**	40 (178)	40 (178)	50 (223)	60 (267)	60 (267)	50 (223)
Ultimate Capacity (per high-strength helix)	**Kip (kN)**	50 (223)		60 (267)			
Allowable Load† (per standard helix)	**Kip (kN)**	20 (89)	20 (89)	25 (111)	30 (134)	30 (134)	25 (111)
Allowable Load† (per high-strength helix)	**Kip (kN)**	25 (111)		30 (134)			
Tension Rating (based on bolt strength)	**Kip (kN)**	70 (312)	70 (312)	100 (445)	150 (668)	200 (890)	120 (534)
Allowable Tension Load† (based on bolt strength)	**kip (kN)**	35 (156)	35 (156)	50 (223)	75 (334)	100 (445)	60 (267)
Yield Strength (shaft)	**ksi (Mpa)**	70 (483)	90 (621)	90 (621)	90 (621)	90 (621)	50 (345)
Yield Strength (standard helix material)	**ksi (Mpa)**	50 (345)	80 (552)	80 (552)	80 (552)	80 (552)	36 (248)
Yield Strength (high-strength helix material)	**ksi (MPa)**	80 (552)		80 (552)			

Shaft Section Properties

		SS5	SS150	SS175	SS200	SS225	HS
Area	**in^2 (cm^2)**	2.196 (14.17)	2.196 (14.17)	3.009 (19.41)	3.916 (25.26)	4.979 (32.12)	3.016 (19.46)
Perimeter	**in (cm)**	5.571 (14.15)	5.571 (14.15)	6.571 (16.69)	7.464 (18.96)	8.464 (21.50)	10.996 (27.930)

Moment of Inertia

		SS5	SS150	SS175	SS200	SS225	HS
Ix-x	**in^4 (cm^4)**	0.396 (16.5)	0.396 (16.5)	0.746 (31.1)	1.26 (52.4)	2.04 (84.9)	3.89 (162)
Iy-y	**in^4 (cm^4)**	0.396 (16.5)	0.396 (16.5)	0.746 (31.1)	1.26 (52.4)	2.041 (84.9)	3.89 (162)
Ix-y	**in^4 (cm^4)**	0.396 (16.5)	0.396 (16.5)	0.746 (31.1)	1.26 (52.4)	2.04 (84.9)	3.89 (162)

Section Modulus

		SS5	SS150	SS175	SS200	SS225	HS
Sx-x	**in^4 (cm^4)**	0.528 (22.0)	0.528 (22.0)	0.852 (35.5)	1.26 (52.4)	1.814 (75.5)	2.225 (92.61)
Sy-y	**in^4 (cm^4)**	0.528 (22.0)	0.528 (22.0)	0.852 (35.5)	1.26 (52.4)	1.814 (75.5)	2.225 (92.61)
Sx-y	**in^4 (cm^4)**	0.414 (17.2)	0.414 (17.2)	0.657 (27.3)	0.981 (40.8)	1.396 (58.1)	2.225 (92.61)

*Ultimate Capacity (per standard helix) is for 12-inch (304.8 mm) diameter helices and smaller. Reduce value by 20% for 14-inch helix.
†Based on a Factor of Safety of two (2).

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