Historical Perspective

• 1st Recorded Screw Pile was by Alexander Mitchell in 1836 for Moorings and then applied by Mitchell to Maplin Sands Lighthouse in England in 1838.

• In 1851, a Screw Pile Light House was established as the Bridgeport Harbor Light, Connecticut on the west side of the harbor.

• In the 1850’s, More Than 100 Light Houses were Constructed Along the East Coast, the Florida Coast and the Gulf of Mexico using Screw Pile Foundations.
Mitchell’s Screw Pile - 1836
“on Submarine Foundations; particularly Screw-Pile and Moorings”, by Alexander Mitchell, Civil Engineer and Architects Journal, Vol. 12, 1848.

“whether this broad spiral flange, or “Ground Screw,” as it may be termed, be applied … to support a superincumbent weight, or be employed … to resist an upward strain, its holding power entirely depends upon the area of its disc, the nature of the ground into which it is inserted, and the depth to which it is forced beneath the surface.”
Mitchell Lighthouse at Hooper’s Strait, Maryland
Installed 1870’s
Removed 1960’s
Museum at St. Michael, MD

Extracted Cast Iron Screw Pile, ≈ 30” Diameter
What is a Helical Anchor/Pile?

- A helical anchor/pile consists of one or more helix-shaped bearing plates attached to a central shaft, which is installed by rotating or "torqueing" into the ground. Each helix is attached near the tip, is generally circular in plan, and formed into a helix with a defined pitch. Helical anchors/piles derive their load-carrying capacity through both end bearing on the helix plates and skin friction on the shaft.
Extendable Helical Piles – Either Square or Round Shaft

NO MORE THAN 6 HELICES PER ANCHOR
Standard Helix Diameters

<table>
<thead>
<tr>
<th>DIAMETER</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>in (cm)</td>
<td>ft² (m²)</td>
</tr>
<tr>
<td>6 (15)</td>
<td>0.185 (0.0172)</td>
</tr>
<tr>
<td>8 (20)</td>
<td>0.336 (0.0312)</td>
</tr>
<tr>
<td>10 (25)</td>
<td>0.531 (0.0493)</td>
</tr>
<tr>
<td>12 (30)</td>
<td>0.771 (0.0716)</td>
</tr>
<tr>
<td>14 (35)</td>
<td>1.049 (0.0974)</td>
</tr>
<tr>
<td>16 (40)</td>
<td>1.385 (0.1286)</td>
</tr>
</tbody>
</table>
Type SS Series - Shaft Mechanical Properties

<table>
<thead>
<tr>
<th>Torque Rating (ft-lb)</th>
<th>SS125 Square Shaft</th>
<th>SS1375 Square Shaft</th>
<th>SS5 Square Shaft</th>
<th>SS150 Square Shaft</th>
<th>SS175 Square Shaft</th>
<th>SS200 Square Shaft</th>
<th>SS225 Square Shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5,500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5,500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ultimate Tension Strength Based on Bolt Strength** (*) (kip)

<table>
<thead>
<tr>
<th>60</th>
<th>75</th>
<th>70</th>
<th>70</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
</table>

**Allowable Load Tension Load Based on Bolt Strength** † (kip)

<table>
<thead>
<tr>
<th>30</th>
<th>37.5</th>
<th>35</th>
<th>35</th>
<th>50</th>
<th>75</th>
<th>100</th>
</tr>
</thead>
</table>

**Tension/Compression Capacity Limit Based on Shaft Torque Rating** ** (kip)

<table>
<thead>
<tr>
<th>40</th>
<th>55</th>
<th>55</th>
<th>70</th>
<th>110</th>
<th>150*</th>
<th>200*</th>
</tr>
</thead>
</table>

**Allowable Tension/Compression Load Limit Based on Shaft Torque Rating** † (kip)

<table>
<thead>
<tr>
<th>20</th>
<th>27.5</th>
<th>27.5</th>
<th>35</th>
<th>55</th>
<th>75*</th>
<th>100*</th>
</tr>
</thead>
</table>

* Based on Mechanical Strength of Coupling.
** Based on Shaft Torque Rating – Tension/Compression = Shaft Torque Rating x K_t
*Default * K_t for the SS Series = 10 ft-1
† Allowable Loads are based on a Factor of Safety of two (2).
# Type RS Series - Shaft Mechanical Properties

<table>
<thead>
<tr>
<th>Torque Rating (ft-lb)</th>
<th>4,500</th>
<th>5,500</th>
<th>7,500</th>
<th>13,000</th>
<th>23,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable Load Tension Load Based on Bolt Strength † (kip)</td>
<td>25</td>
<td>30</td>
<td>50</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Ultimate Tension Strength Based on Bolt Strength * (kip)</td>
<td>50</td>
<td>60</td>
<td>100</td>
<td>120</td>
<td>140</td>
</tr>
<tr>
<td>Tension/Compression Capacity Limit Based on Shaft Torque Rating ** (kip)</td>
<td>36</td>
<td>44</td>
<td>60</td>
<td>91</td>
<td>138</td>
</tr>
<tr>
<td>Allowable Tension/Compression Load Limit Based on Shaft Torque Rating † (kip)</td>
<td>18</td>
<td>22</td>
<td>30</td>
<td>45.5</td>
<td>69</td>
</tr>
</tbody>
</table>

* Based on Mechanical Strength of Coupling.
** Based on Shaft Torque Rating – Tension/Compression = Shaft Torque Rating x $K_t$.
* Default $K_t$ for the RS2875.XXX Series = 8 ft⁻¹; for the RS3500.300 Series = 7 ft⁻¹; for the RS4500.337 Series = 6 ft⁻¹.
† Allowable Loads are based on a Factor of Safety of two (2).
TYPE “SS/RS” COMBINATION SERIES
Type SS5/SS150 to RS2875.203 Combination Series and
Type SS175/SS200 to RS3500.300 Combination Series

Pile Assembly with RS Transition Coupler

Transition Couplings - Torque Ratings

<table>
<thead>
<tr>
<th>CATALOG NUMBER</th>
<th>DESCRIPTION</th>
<th>TORQUE RATINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>C278-0150</td>
<td>SS5/SS150 square shaft to a RS2875.203 round shaft</td>
<td>5,500 ft-lbs</td>
</tr>
<tr>
<td>T107-0808</td>
<td>SS175 square shaft to a RS3500.300 round shaft</td>
<td>11,000 ft-lbs</td>
</tr>
<tr>
<td>T107-0809</td>
<td>SS200 square shaft to a RS3500.300 round shaft</td>
<td>13,000 ft-lbs</td>
</tr>
</tbody>
</table>

Mechanical Ratings of Combination Series

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>ULTIMATE TENSION STRENGTH* lbs (kn)</th>
<th>TENSION/COMPRESSION LIMIT** lbs (kn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS5/RS2875.203</td>
<td>60,000. (267)</td>
<td>44,000. (196)</td>
</tr>
<tr>
<td>SS150/RS2875.203</td>
<td>60,000. (267)</td>
<td>44,000. (196)</td>
</tr>
<tr>
<td>SS175/RS3500.300</td>
<td>100,000. (445)</td>
<td>91,000. (405)</td>
</tr>
<tr>
<td>SS200/RS3500.300</td>
<td>120,000. (534)</td>
<td>91,000. (405)</td>
</tr>
</tbody>
</table>

* Based on Mechanical Strength of Coupling.
** Based on Shaft Torque Rating – Tension/Compression = Shaft Torque Rating x Kt
“Default " Kt for the SS Series = 10 ft⁻¹, for the RS2875 Series = 8 ft⁻¹, for the RS3500 Series = 7 ft⁻¹.
ADVANTAGES – HELICAL PILES & ANCHORS

- Quick, Easy Turnkey Installation
- Immediate Loading
- Small Installation Equipment
- Pre-Engineered System
- Easily Field Modified
- Torque-to Capacity Correlation

- Install in Any Weather
- Solution for:
  - Restricted Access Sites
  - High Water Table
  - Weak Surface Soils
- Environmentally Friendly
- No Vibration
- No Spoils to Remove
- No Concrete
Helical Screw Piles for New Construction

Square Shaft Helical Pile

Round Pipe Shaft Helical Pile
Ft. Sill, OK Troop Housing and Headquarters Facilities

- Three manufactured housing companies
- Four different floor plans
- Three different sites
- Three different pile types (RS2875, RS3500, RS4500 and SS5)
- Tension, Compression and Lateral Loads
Ft. Sill Troop Housing
New Construction - Slabs and Foundations

Screw Piles Supporting Structural Slab

Access Limitations
Foundation Underpinning
Remedial Repair Bracket – C150-0121
SS5, SS150 (1-1/2 Square Shaft) & RS2875.203 Round Shaft Pile
Foundation Underpinning with Helical Piles

Screw Foundation Installation with Portable Installer
Foundation Underpinning with Helical Piles

Raising Building with Repair Brackets

Repair Brackets
Foundation Underpinning Brackets

STANDARD-DUTY FOUNDATION REPAIR BRACKET

FOR 1 ½” SHAFT
RATED CAPACITIES:
20,000 LB. WITH SS5 Helical Piles
25,000LB. WITH SS150 Helical Piles

FOR 1 ¾” SHAFT
RATED CAPACITY: 30,000LB.

HEAVY-DUTY FOUNDATION REPAIR BRACKET

FOR 1 ¾” SHAFT
RATED CAPACITY: 40,000LB.
Walkways for Wetlands
Tie Down & Buoyancy Control
Band Shell at the Capitol
Pipeline Buoyancy Control
Pipeline Buoyancy Control
THE QUINCY MA SEWER PIPELINE

- Over 1000 HS Helical Pulldown® Micropiles used
- Soils consisted of mixed soils-organic silt, peat and clay.
CHANCE® Helical Products
(Tension & Compression)
6 Helices Max
Note: Bulkhead or excavation bracing may be soldier pile & lagging (shown), sheet pile, concrete, CIP or PC.
Soil Screws - Section Detail

- Concrete Drainage Swale
- Shotcrete
- Welded Wire Mesh
- Screw Anchor
- Drainage Medium
- Weephole
- Finish Grade
- Drain Gate
Soil Screws for Soil Nail Walls
HELICAL PULLDOWN®
MICROPILES
HELICAL PULLDOWN® MICROPILES

• Screw Pile Foundation Installation Method Used to Increase the Section Modulus of a Standard SS or Pipe Shaft.

• Patent Protected
  – U.S. 5,707,180; Methods and Apparatus
  – Other U.S. and Foreign Patents Pending

• Method of Displacing Soil Around the Anchor Shaft and Replacing with Grout Column.
  – Soil is Displaced by “Lead Displacement Plate”.
  – “Extension Displacement Plates” Serve as Centralizers and Provide the Means for Which the Grout is “Pulled-Down”.
GROUT RESERVOIR

NEAT CEMENT GROUT (VERY FLOWABLE)

EXTENSION DISPLACEMENT PLATE

SQUARE SHAFT EXTENSION

LEAD DISPLACEMENT PLATE

HELIX BEARING PLATES

GROUT RESERVOIR
Installing Lead Case
Installing Top Case
(Grout Reservoir)

Adding Centralizer
Pouring Grout

Joint Packing
Installing Shaft Extension

Grout “Pulled Down”
SOIL CAPACITY - INDIVIDUAL BEARING METHOD
Shallow vs. Deep Helical Anchors/Piles

- **Shallow Foundation**
  - $H < 3D$ to $7D$
- **Deep Foundation**
  - $H > 3D$ to $7D$
  - Chance Default Value = 5D
Soil Stress Distribution

FIGURE 1
Stress Distribution Beneath Deep Buried Circular Plate
Plate Bearing Capacity Model

- Total Capacity Equal to Sum of Individual Helix Bearing Capacities
- Model valid for both tension and compression
- Helix Spacing $\geq 3D_1$
- Min. Depth $\geq 5D$ (also need to be deeper than zone of seasonal moisture fluxuation)
- Capacity ($UC_f$) Due to Friction Along Shaft = Zero.
Individual Bearing (Chance) Method

Determine End Bearing Capacity of Helical Configuration

General Bearing Capacity Equation:

\[ Q_{\text{ult}} = A \left( C N_c + q N_q + \left( \frac{1}{2} \right) \gamma B N_\gamma \right) \]

where:
- \( A \) = Area of footing
- \( C \) = Cohesion
- \( q \) = Overburden Pressure = \( \gamma D \)
  \( D \) = Depth of footing below groundline
- \( \gamma \) = Unit Weight of Soil
- \( B \) = Width of Footing
- \( N_c, N_q, \) & \( N_\gamma \) = Bearing Capacity Factors
  \( N_c = 9 \) for ratio of top helix depth to helix diameter > 5
Individual Bearing (Chance) Method

“Individual Bearing Plate” Method

\[ Q_{\text{ult}} = \sum Q_h \]

where:
- \( Q_{\text{ult}} \) = Total Multi-helix Anchor/Pile Ultimate Capacity
- \( Q_h \) = Individual Helix Ultimate Capacity

\[ Q_h = A_h \left( N_c C + \gamma D N_q \right) \leq Q_s \]

\[ Q_h = A_h \left( 9 C + \gamma D N_q \right) \leq Q_s \]

where:
- \( A_h \) = Projected Area of Helix
- \( N_c = 9 \) for ratio of top helix depth to helix dia. > 5
- \( D \) = Depth of Helix Plate below Groundline
- \( N_q \) = Bearing Capacity Factor for Sand
- \( Q_s \) = Upper Mechanical Limit determined by Helix Strength
Bearing Capacity Factor Curve

- $N_q$ vs. Angle of Internal Friction
- Cohesionless Soils
- Adapted from G. G. Meyerhof Factors for Driven Piles in his paper *Bearing Capacity and Settlement of Pile Foundations*, 1976

- Equation:
  \[ N_q = 0.5 \left( 12^\phi \right) \phi^{54} \]
FACTOR OF SAFETY

• Select an Appropriate Factor of Safety (FS) to Apply to the Ultimate Capacity of the Helical Anchor/Pile to Develop the required Design, or Working Capacity per Anchor/Foundation.

• In general, Chance Civil Construction recommends a minimum FS of 2 for permanent construction and 1.5 for temporary construction.
HeliCAP® v2.0 Helical Capacity Design Software

- Microsoft Windows Based Bearing, Uplift, and Friction Capacity Software
- 4 Types of Helical Applications- Compression, Tension, Tiebacks, and Soil Screws
- Within those applications can also calculate friction capacity of a grout column or steel pipe shaft. New
- Based on soil and anchor/pile inputs the program returns theoretical capacities and installation torque.
INSTALLATION TORQUE CORRELATION TO CAPACITY
Helical Piles & Anchors - HOW THEY WORK

- Low Soil Displacement Foundation Element Specifically Designed to Minimize Disturbance During Installation

- Consists of One or More Helix Plates Attached to a Central Steel Shaft

- Rotated, or “Screwed” into Soil Much Like a Wood Screw Driven into a Piece of Wood
INSTALLATION ENERGY

• Must Equal the Energy Required to Penetrate the Soil, plus the Energy Loss Due to Friction

• Provided by the Machine – Consists of Two Parts:
  – Rotation Energy – Supplied by the Torque Motor
    • Rotation and Inclined Plane of Helix Provides Downward Thrust
    • A.k.a. INSTALLATION TORQUE
  – Downward Force, or Crowd – Supplied by the Machine
MACHINE

CROWD

TORQUE MOTOR

TORQUE INDICATOR

FOUR HELIX LEAD SECTION
INSTALLATION TORQUE VS. ULTIMATE CAPACITY

The Torque Required to Install a Helical Pile or Anchor is Empirically Related to Its Ultimate Capacity.

\[ Q_{\text{ult}} = K_t T \]

- Where:
  - \( Q_{\text{ult}} \) = Ultimate Capacity [lb (kN)]
  - \( K_t \) = Empirical Torque Factor [ft-1 (m-1)]
    - “Default” Value = 10 (33) for Type “SS”
    - “Default” Value = 8 (26) for 2-7/8” Pipe Shaft
    - “Default” Value = 7 (23) for 3-1/2” Pipe Shaft
    - “Default” Value = 6-7 (20-23) for 4-1/2” Pipe Shaft
  - \( T \) = Installation Torque, [ft-lb (kN-m)]
The Value of $K_t$ is not a Constant - May Range from 3 to 20 ft$^{-1}$ (10 to 66 m$^{-1}$). Depends on:

- **Soil Conditions**
  - Type SS
    - Normally Consolidated Clay – $K_t = 10$
    - Overconsolidated Clay – $K_t = 12\text{-}14$
    - Sensitive Clay – $K_t < 10$
    - Sands – $K_t = 12+$

- **Central Steel Shaft/Helix Size**
  - $K_t$ Inversely Related to Shaft and Helix Size

- **Helix Thickness**
  - $K_t$ Inversely Related to Helix Thickness

- **Application (Tension or Compression)**
  - Compression Capacity is Generally Higher Than Tension Capacity
TORQUE - ADVANTAGES

• Provides Excellent Field Control Method of Installation

• Monitors Soil Conditions

➤ Torque is a Direct Measure of Soil Shear Strength

• Predicts Holding Capacity of the Soil

• Helical Piles/Anchors Can be Installed to Specified Torque
TORQUE - REQUIREMENTS

- Requires Competent, Well-Trained Installers
  - CHANCE® Certification Program

- Requires Installation in the Field to Determine Capacity

- Requires Torque Monitoring Equipment
RELIABILITY OF TORQUE/CAPACITY MODEL

- *Uplift Capacity of Helical Anchors in Soil [Hoyt & Clemence 1989]*
  - Analyzed 91 Load Tests
  - 24 Different Test Sites
  - Sand, Silt, and Clay Soils Represented
  - Calculated Capacity Ratio ($Q_{act}/Q_{calc}$)
  - Three Different Load Capacity Models
    - Cylindrical Shear
    - Individual Bearing
    - Torque Correlation

- Torque Correlation Method Yields More Consistent Results than Either of the Other Two Methods
- Best Suited for On-Site Production Control and Termination Criteria
Torque Monitoring Methods/Devices

- **Shaft Twist**
  - Visible Indication of Torque (Square Shaft)

- **Shear Pin Torque Limiter**
  - Point-Wise Indicator
  - Simple Design, Easy to Use
  - Requires Occasional Maintenance

- **Mechanical Dial Indicator**
  - Continuous Reading Indicator
  - Comes with Laboratory Calibration Sheet
  - Fairly Durable

- **Differential Pressure Correlations**
  - Level 1 – Manufacturers Gear Motor Multiplier
  - Level 2 - Certified Gear Motor Test Results (most accurate)
Shaft Twist Approach

Shaft Twist – SS175 Helical Pulldown® Micropile

≈ ½ Twist/ft.
≈ 12,000. ft-lbs
Shaft Twist Approach

SS175 - Average Torque vs. Twist

Shaft Twist at Rating:
75°/ft, or just under 1/4 turn/ft

Torque Strength Rating

Torque Rating based on Shaft Twist only applies to the Type SS Series. It does not apply to the Type RS Series.
Type RS Series Do Not Exhibit Much Shaft Twist Prior to Failure. Torque Must Be Closely Monitored to Avoid Over-Torque.

PIPE SHAFT ELONGATION OF HOLES
Shear Pin Torque (Limiter) Indicator

Shear Torque per pin = 500. ft-lbs.
Max. Torque = 10,000. ft-lbs

Shear halves turn freely when pins shear.
Mechanical Dial Torque Indicator

- Indicates Installation Torque Directly by Measuring the Twist of a Torsion Bar.
- Indicates Installation Torque Directly in ft.-lbs.
- Max. Torque = 20,000 ft lbs
DP-1 (I) - Differential Pressure Torque Indicator

- Measures “Pressure Drop” across a Hydraulic Torque Motor.
- Pressure Drop is Directly Related to the Installation Torque Applied.

Torque to Pressure Correlation based on Cubic Inch Displacement and Gear Ratio of Drive Head Motor
Gear Motor Testing
Control Station and Data Acquisition
Eskridge 77BA – 12,000 ft-lb

\[ \Delta \text{pressure} = 0 \text{ psi} \]

\[ \text{Torque} = 0 \text{ ft-lbs} \]
Gear Motor D – 12,000 ft-lbs
Corrected Torque-ΔPressure Relationship
Eskridge B28-4,500 ft-lb
Gear Motor D
Test 1 All October 18, 2005

\[ y = 5.1702x - 1172.1 \]
\[ R^2 = 0.9978 \]
Corrected \( \Delta \)Pressure-Gear Motor Multiplier Relationship
Eskridge 77BA - 12,000 ft-lb
Gear Motor D
Test 1 All October 18, 2005

\[
y = -8 \times 10^{-13} x^4 + 5 \times 10^{-9} x^3 - 1 \times 10^{-5} x^2 + 0.0162 x - 2.5569
\]
\[
R^2 = 0.9858
\]
INSTALLATION LOG – TORQUE VS. DEPTH
SSI75 w/ 8, 10, 12 & 14 in HELICES, LENGTH 31 FT
VERTICAL INSTALLATION – CLAY SOIL

Torque at Termination: Best if Steady or Increasing
### Installation Torque vs. Ultimate Capacity

**Telecom Tower Site**  
**Guy Anchor Installation Log**  
**SS5 Series w / 8”,10”,12” Lead**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Torque (ft-lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1480</td>
</tr>
<tr>
<td>2</td>
<td>2220</td>
</tr>
<tr>
<td>3</td>
<td>2220</td>
</tr>
<tr>
<td>4</td>
<td>2220</td>
</tr>
<tr>
<td>5</td>
<td>2220</td>
</tr>
<tr>
<td>6</td>
<td>2220</td>
</tr>
<tr>
<td>7</td>
<td>2220</td>
</tr>
<tr>
<td>8</td>
<td>2220</td>
</tr>
<tr>
<td>9</td>
<td>2220</td>
</tr>
<tr>
<td>10</td>
<td>2590</td>
</tr>
<tr>
<td>11</td>
<td>2590</td>
</tr>
<tr>
<td>12</td>
<td>2590</td>
</tr>
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<td>13</td>
<td>2440</td>
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<td>14</td>
<td>2700</td>
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<td>15</td>
<td>3340</td>
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<tr>
<td>16</td>
<td>3340</td>
</tr>
<tr>
<td>17</td>
<td>3170</td>
</tr>
<tr>
<td>18</td>
<td>3700</td>
</tr>
<tr>
<td>19</td>
<td>3700</td>
</tr>
</tbody>
</table>

**Design Load per 7/16” EHS Guywire** = 17,000. lbs.  
**Working Capacity per Anchor** = 17,000. lbs.  
**Minimum Factor of Safety** = 2.0  
**Required Ultimate Capacity (UC)** = 17,000. x 2.0  
= 34,000. lbs.

**Ave. Installation Torque (Ta)** = \((3,170. + 3,700. + 3,700.) / 3\)  
\(Ta = 3,523.0\) ft-lbs.  
**Ultimate Capacity based on Ta** = \(Kt \times Ta\)  
Ultimate Capacity based on Ta = 10 \times 3,523.0  
= 35,230. lbs > 34,000. lbs.
Application Guidelines

- Installation torque should be averaged over the last three diameters of embedment of the largest helix. This provides an indication of capacity based on average soil properties throughout the zone stressed by the helix plates.
- If stronger, denser, etc. stratum overlies the bearing stratum, check installation torque in the stratum to ensure screw anchor/foundation can be installed to final intended depth without torsional overstressing.
- For a given shaft length, use fewer longer extensions rather than many shorter extensions. This will result in fewer connections.
LOAD TESTING HELICAL PILE SYSTEMS
Compression Load Test

- Load Beam
- Spreader Beam
- Hydraulic Jack
- Reaction Anchor
Maximum side resistance (friction) is mobilized after downward displacement of from 0.5 to greater than 3 percent of the shaft (grout column) diameter, with a mean of approximately 2 percent [Reese, Wright (1977)].

This side resistance or friction continues almost equal to the ultimate value during further settlement. No significant difference is found between cohesive and cohesionless soil except that further strain in clay sometimes results in a decrease in shaft resistance to a residual value. In contrast, the point (end bearing) resistance develops slowly with increasing load and does not reach a maximum until settlements have reached on the order of 10 percent of the diameter of the base (largest helix) [Terzaghi, Peck (1948)].
Load Test Acceptance Criteria

• **Intersection of Tangents**
  – Intersection of Lines Tangent to Linear and Non-Linear Portion of Curve
  – Quick Method in Field

• **Davisson Failure Load (DFL)**
  – Offset Parallel to Elastic Compression Line
  – \( \frac{PL}{AE} + (0.15 + \frac{D}{120}) \)
  – Typically Used for Friction Only Piles

• **8% to 10% of Pile Diameter (Diameter Method)**
  – Offset Parallel to Elastic Compression Line
  – \( \frac{PL}{AE} + 0.08D_h \)
  – \( D_h = \text{Largest Helix Diameter} \)
  – Recommended for End-Bearing Screw Piles
Sample Load-Deflection Curve of Compression Test

DESIGN LOAD = \( \frac{P_{\text{ULT}}}{2} \)

MECHANICAL RATING OF SCREW PILE/ANCHOR

0.08 times the Diameter

LOAD

DEFLECTION

LOAD

UNLOAD

\( P_{\text{ULT}} \)
Installed 9/22/04

Caseyville Site - 278 Evaluation
TP-1 - 8"-10"-12" SS5 20' Long

Average Torque = 3,300 ft-lb
Kt = 14.5
Waterhouse Project - WFP Grouted Helical Pile
CHANCE SS175 - Load vs. Pile Head Displacement

Helix Configuration: 8"-10"-12"
Installation Torque: 8300 ft-lb
Overall Length: 36'-0
Grout Column: 5"
THANK YOU