Chapter 2

Helical Torque Anchors

Installation Guidelines and Testing Procedures

- Hydraulic Torque Motors
- Installation Procedures
- Field Testing of Torque Anchors™
Hydraulic Torque Motors

Helical Torque Anchors™ are usually installed with a hydraulic motor and reduction gear box assembly. Some motors offer a two speed gear box, which allows the installer to increase the advancement the Torque Anchor™ through the upper strata of the soil. Once approximately 75% of the design installation torque has been reached, the rotational speed is reduced to between 5 and 10 rpm until the final torque is maintained for required embedment distance.

Installation Torque

Installation torque on the shaft, the Soil Efficiency Factor (“k”) and Table 12 were introduced and discussed in Chapter 1. These are reproduced for reference below.

Shaft torsion during installation can provide a reasonably accurate estimate of the ultimate capacity of the installed helical screw product. The relationship between the shaft torsion during installation and the ultimate helical product capacity is empirical and was developed from results from thousands of tests. When one applies rotational torsion to the end of the shaft at grade level, some of the torque energy is lost before it reaches the helical plates at the bottom end of the shaft. This loss of torque is due to friction between the shaft and the soil.

In the sketch below, notice that not all of the torque applied to the shaft by the motor reaches the helical plates. The actual torque applied to the helical plates is \( T_{plates} = T_{Motor} - T_{Shaft} \). The friction generated between the surface area of the shaft and the soil is directly related to the tyoe if shaft and shaft size along with the properties of the soil. Because of this loss of torque in transmitting the motor torque to the plates, an empirical Soil Efficiency Factor (“k”) must be employed to arrive at a reasonable estimate of pile or anchor ultimate capacity.

![Figure 2](image.png)

Soil Efficiency Factor – “k”:

This is the relationship between installation torque and ultimate capacity of the installed Torque Anchor™. Estimating the ultimate capacity of helical foundation product based upon the installation torque has been used for many years.

Unless a load test is performed to create a site specific value for the Soil Efficiency Factor (“k”), a value must be estimated when designing. While values for “k” have been reported from 2 to 20, most projects will produce a value of “k” in the 6 to 14 range. Earth Contact Products offers a range of values for Soil Efficiency Factors (“k”) in Table 12. Graph 6 on Page 40 also illustrates this. These values may be used for estimating empirical ultimate capacities of installed Torque Anchors™. These values may be used until a field load test can provide a more accurate site specific value for “k”. Table 12 lists typical values of “k” for successful estimations of ultimate capacities of Torque Anchors™ based upon the output torque at the installation motor shaft.

<table>
<thead>
<tr>
<th>Torque Anchor™ Type</th>
<th>Typically Encountered Range “k”</th>
<th>Suggested Average Value, “k”</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Square Shafts</td>
<td>9 - 11</td>
<td>10</td>
</tr>
<tr>
<td>2-7/8” Diameter</td>
<td>8 - 9</td>
<td>8-1/2</td>
</tr>
<tr>
<td>3-1/2” Diameter</td>
<td>7 - 8</td>
<td>7-1/2</td>
</tr>
<tr>
<td>4-1/2” Diameter</td>
<td>6 - 7</td>
<td>6-1/2</td>
</tr>
</tbody>
</table>

Understand that the value of the Soil Efficiency Factor (“k”) is an estimation of friction loss during installation. The amount of friction loss has a direct relationship to soil properties and the anchor shaft.

The “k” value for square bars is generally higher than for tubular shafts. Keep in mind that the suggested values in Table 12 are only guidelines.

It is also important to refer to Table 2 at the beginning of Chapter 1 for the Useable Torsional Strength that can be applied to a specific anchor shaft. Being mindful of the torsional strength of the shaft will help to avoid shaft fractures during installation.

Failure to verify that the shaft configuration has
sufficient reserve torsional capacity could result in an unexpected shaft fracture during installation especially in soils containing debris, rocks and cobbles.

**Equation 4: Installation Torque**

\[ T = (T_u \text{ or } P_u) / k \text{ or } (T_u \text{ or } P_u) = k \times T \]

Where,
- \( T \) = Final Installation Torque - (ft-lb)  
  (Averaged Over the Final 3 to 5 Feet)  
- \( T_u = P_u = \text{Ultimate Capacity} \) - (lb)  
  (Measured from field load tests)  
- \( k \) = Soil Efficiency Factor - (ft\(^{-1}\))

To determine the site specific Soil Efficiency Factor, (“k”) from field load testing, Equation 4 is rewritten as:

**Equation 4a: Soil Efficiency Factor**

\[ k = (T_u \text{ or } P_u) / T \]

Where,
- \( k \) = Soil Efficiency Factor - (ft\(^{-1}\))  
- \( T_u = P_u = \text{Ultimate Capacity} \) - (lb)  
  (Calculated or measured from field load tests)  
- \( T \) = Final Installation Torque - (ft-lb)

**An appropriate factor of safety must always be applied to the design or working loads when using Equation 4 and 4a.**

---

**Determining Installation Torque**

Shaft torsion can be determined several ways:

- **Twisting of the Solid Square Bar** – This method of torque control is the least accurate method to determine the torsion that is being applied to the shaft. The reason this method is inaccurate and not recommended is because the point at which twisting occurs will vary with fluctuations in the steel chemistry used to make the bar, the differences in torsional strength from bar to bar within a mill run of bars and the tolerances in the steel compositions from mill run to mill run of similar bars. The length of shaft can also affect the number of twists for a given shaft torque. ECP does not recommend using this method to determine installation torque.

- **Shear Pin Hub** – This device uses a hub that attaches between the motor and the anchor shaft. Maximum shaft torsion is determined by inserting a number of shear pins between the flanges of the hub. Each pin usually represents 500 ft-lbs. Based upon the total number of pins used, one can restrict the maximum torsion that can be applied to the shaft. When the desired torsion is reached, the pins shear and the hub no longer transmits torsion to the helical anchor shaft. For this device to accurately predict ultimate capacity, the soil into which the screw anchor is installed must be homogeneous and without obstructions. The shear pin hub, by nature, tends to overestimate the shaft torsion. If, during installation, the helical plates encounter an obstruction or something that causes a spike in the shaft torque, the shear pins become deformed and weakened. In addition, if the target stratum rapidly becomes very dense, the shear pins may break before all plates have been properly embedded. This is especially important in tension applications where the desired shaft torsion should be averaged over a distance of at least three feet before terminating the installation. Earth Contact Products does not endorse the shear pin hub and considers it a less desirable way to measure shaft torsion.

- **Single Pressure Gauge** – Many operators install a single pressure gauge at the inlet to the hydraulic gear motor. This is a dangerous practice and not recommended because in nearly every hydraulic system there is back pressure. This back pressure represents energy that enters the gear motor, but is not used by the motor. The back pressure simply causes the oil to flow back into the system and to the reservoir. Typically, back pressures range from 200 to 500 psi. In some cases it is higher.

  The danger in using a single gauge to estimate shaft torsion is that the back pressure is unknown. As a result, the shaft torsion on the shaft is overestimated, which results in an anchor capacity prediction that is overstated.

  **Anchors installed with a single gauge system, in general, will not produce as much capacity as expected and could fail.**

- **Dual Pressure Gauges** -- One of the most common ways to determine motor output torque is to measure the difference between the input pressure and output pressure across the motor. When using two gauges installed one on each port of the gear motor, the actual pressure drop across the motor is known. This is a theoretical representation of the amount of
hydraulic energy that was used by the motor. Once the pressure differential is determined, the output shaft torque can be estimated from motor performance data that is provided by the motor manufacturer. It is especially important to have the gauges calibrated regularly. Gauges can become damaged and rendered inaccurate in the field.

- **Strain Gauge Monitor (Torque Transducer)**
  This device provides a direct display of installation torque being applied to the shaft; it also provides a recorded history of the shaft torsion through the entire depth of installation. This system consists of three parts; a Torque Analyzer Rotor installed on the flanged coupling between the motor and anchor shaft, a Torque Analyzer PDA indicator and a battery charger.

  The unit is extremely rugged and ideal for field based applications. The strain gauge monitor measures the torque applied between two flanges located between the motor output shaft and the helical anchor shaft. This data is transmitted to a hand held PDA readout device for display and logging. This method of measuring the torque applied is highly accurate (+/- 0.25%). The torque sensor is built into the housing of the flanges and the data is transferred by a wireless transmitter fitted into the housing.

  The data is captured by the PDA and is recorded as a text file that can be viewed or downloaded to any computer software for further analysis such as Microsoft Excel.

  This unit is the most accurate and the most rapid way to monitor and record installation torque. It is highly recommended.

---

**Converting Motor Pressure To Shaft Torque**

When a pressure differential is measured across the motor ports, it must be converted to motor output shaft torque. This can be accomplished by using Torque Motor Output Curves for the specific motor being used on site, or one can use a motor specific Torque Motor Conversion Factor, (“K”). Both are available from the motor manufacturer.

**Torque Motor Conversion Factor – “K”:**

Each motor has a unique Torque Motor Conversion Factor, which is the relationship between the differential pressure measured across the hydraulic ports of the motor and the shaft output torque of the motor. This factor, which is referred to as “K”, may be used to calculate the output torque of a motor. In Table 16 on the following page, hydraulic gear motor manufacturers’ data for several commonly used hydraulic torque motors have been provided. The important column in this table is the Torque Motor Conversion Factor (“K”).

(Do not confuse the Torque Motor Conversion Factor, “K”, with the Soil Efficiency Factor, “k”, which is the measure of the soil friction on the shaft.)

Equation 11 below is used to convert pressure differential into motor shaft output torque.

**Equation 11: Motor Output Torque**

\[ T = K \times \Delta P \]

Where,

- \( T \) = Hydraulic Motor Output Torque - ft-lb
- \( K \) = Torque Motor Conversion Factor – (Table 16)
- \( \Delta P = \rho_{in} - \rho_{out} \) = Motor Pressure Differential

When determining the installation torque from hydraulic pressure differentials, it is imperative that the motor outlet pressure be subtracted from the motor inlet pressure prior to referring to any tables or charts that convert differential motor pressure to output shaft torque.

In Table 16 presents the Torque Motor Conversion Factor, (“K”) for some commonly used hydraulic torque motors.

**Caution:** Determining output shaft torsion when operating at very low motor output torque should be approached with caution. Hydraulic torque motor curves are not exactly linear. Errors are possible at the low end of the motor output curve when using a fixed value of “K”.

**Caution:** It is very important to capture the pressure differential across the motor directly at the motor ports.

If the pressure measurement connections are made at other locations, the differential pressure reading may be inaccurate and could result in incorrect estimates of motor shaft torsions. Finally, the accuracy of the data is only as accurate as the gauges. Calibrate the pressure gauges regularly to insure accurate results.
### Table 16. Hydraulic Torque Motor Specifications

<table>
<thead>
<tr>
<th>Illustration</th>
<th>Model Number</th>
<th>Graph No.</th>
<th>Torque Output ft-lb</th>
<th>Motor Torque Conversion</th>
<th>Maximum Pressure psi</th>
<th>Max. Flow gpm</th>
<th>Output Speed rpm</th>
<th>Hex Output Shaft</th>
<th>Weight lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRO-DIG</strong></td>
<td>L6K5</td>
<td>10</td>
<td>6,335</td>
<td>2.53</td>
<td>2,500</td>
<td>16</td>
<td>13.8</td>
<td>2&quot;</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>L7K5</td>
<td>9</td>
<td>7,644</td>
<td>2.55</td>
<td>3,000</td>
<td>35</td>
<td>32.8</td>
<td>2-1/2</td>
<td>363</td>
</tr>
<tr>
<td></td>
<td>X9K5</td>
<td>9</td>
<td>9,663</td>
<td>3.22</td>
<td>3,000</td>
<td>35</td>
<td>26</td>
<td>2-1/2</td>
<td>365</td>
</tr>
<tr>
<td></td>
<td>X12K5</td>
<td>9</td>
<td>12,612</td>
<td>4.20</td>
<td>3,000</td>
<td>40</td>
<td>23.5</td>
<td>2-1/2&quot;</td>
<td>366</td>
</tr>
<tr>
<td></td>
<td>T12K</td>
<td>10</td>
<td>5,597/12,128</td>
<td>2.24/4.85</td>
<td>2,500</td>
<td>65</td>
<td>70/32</td>
<td>2-1/2&quot; or 2-3/4</td>
<td>382</td>
</tr>
<tr>
<td><strong>Eskridge</strong></td>
<td>B26 16:1</td>
<td>12</td>
<td>4,500</td>
<td>1.5</td>
<td>3,000</td>
<td>10</td>
<td>10</td>
<td>2&quot; Dia Keyed</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>B5016-21F54</td>
<td>12</td>
<td>5,000</td>
<td>1.71</td>
<td>3,000</td>
<td>20</td>
<td>24</td>
<td>2&quot;</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>77BA</td>
<td>13</td>
<td>12,000</td>
<td>5.0</td>
<td>2,400</td>
<td>40</td>
<td>19</td>
<td>2-1/2&quot;</td>
<td>250</td>
</tr>
</tbody>
</table>

**IMPORTANT:** Torque Motor Conversion Factor, "K", tends to become lower than shown in this table when pressure differentials are below 1,000 psi. As a safety guideline, use only 90% of the "K" shown when pressure differentials are between 750 and 900 psi; use 80% of "K" shown for pressure differentials between 500 and 750 psi.

### Torque Motor Accessories

- **DT-150-5**
  - 1.50 inch Sq. Shaft Drive Tool
  - [Image of DT-150-5]

- **DT-175-5**
  - 1.75 inch Sq. Shaft Drive Tool
  - [Image of DT-175-5]

- **DT-200-5**
  - 2 inch Hex Drive Tool
  - [Image of DT-200-5]

- **DT-250-5**
  - 2.50 inch Hex Drive Tool
  - [Image of DT-250-5]

- **DT-288-L-5**
  - 2.88 inch Drive Tool (Two Hole)
  - [Image of DT-288-L-5]

- **DT-288-5**
  - 2.88 inch Drive Tool (Three Hole)
  - [Image of DT-288-5]

- **DT-350-5 & DT-350-7**
  - 3-1/2 inch Dia. Drive Tool
  - [Image of DT-350-5 & DT-350-7]

- **Link Arm**
  - [Image of Link Arm]

- **Pipe Install Tool**
  - [Image of Pipe Install Tool]

- **Hydraulic Motor Pressure Monitor**
  - [Image of Hydraulic Motor Pressure Monitor]

- **Shear Pin Torque Indicator**
  - [Image of Shear Pin Torque Indicator]

- **Smart Anchor Monitor**
  - [Image of Smart Anchor Monitor]

* DT-350-7 Drive Tool. Similar to DT-350-5 but with 7-5/8" flange (Not Shown)
ECP Smart Anchor Monitor (SAM) and Assembly Configuration

The torque transducer is assembled between the hydraulic gear motor and the Torque Anchor™ shaft that is to be monitored during installation. This state of the art tool provides the state of the art helical anchor monitoring and recording.

- Highly accurate (+/-0.25%) torque monitoring capabilities
- Angle and depth monitoring
- GPS data recorder for exact location of the anchor
- Multiple wireless PDA’s can be used to view one drive
- Data can be exported to third party software
- Shaft RPM Indicator
- Calibrated to NIST (National Institute of Standards & Technology Certification)
- Extremely rugged design
- No mechanical parts

This quick reference can be used to estimate the ultimate capacity of a Torque Anchor™ when the motor output torque and the shaft configuration are known.

Caution: When using the Solid Square Shaft curve, do not exceed the “Useable Torsional Strength” of the shaft.

**ECP Hydraulic Torque Motor Performance Curves**

The graphs on the following pages are hydraulic motor performance curves for Pro-Dig and Eskridge gear motors that are normally in stock at ECP and ready for immediate delivery. Motor performance curves provide a quick source for motor torque output based upon the actual pressure differential across the motor ports.
— Structural Compressive Pile and/or Tensile Helical Anchor Installation Procedure —

General Considerations:

- Prepare site for safe working conditions.
- Thoroughly investigate the site for any and all underground utilities before excavating.
- Excavate as required for installation of the product.
- Install ECP Helical Torque Anchor™ to depth and torque specifications
- Cut to length and install the pile cap or wall support assembly as required
- Load test to verify design and capacity of the product and installation
- Remove equipment from work area and clean work area

Installation Plan:

The torque anchors shall be installed as shown on the written new construction or repair plan that was prepared by the engineer or the installer, and submitted to the owner or their representative. The plan shall include, but not be limited to:

- Size and number of placements
- Helical plate configuration on the helical torque anchor™
- Spacing between helical torque anchors™
- Minimum depth of embedment
- Minimum target torque requirement
- Load testing requirements

STEP 1 – Installation Requirements:

- The minimum average installation torque and the minimum length shown on the plans shall be satisfied prior to termination the installation. The installation torque shall be an average of the installation torque recorded during a minimum of the last three feet of installation.
- The torsional strength rating of the torque anchor™ shall not be exceeded during installation. If the torsional strength limit for the torque anchor™ has been reached, but the anchor has not reached the target depth, the following modifications are acceptable:
  A. If the torsional strength limit is achieved prior to reaching the target depth, the installation may be acceptable if reviewed and approved by the engineer and/or owner.
  B. The installer may remove the torque anchor™ and install a new one with fewer and/or smaller diameter helical plates with review and approval by the engineer and/or owner
- If the target is achieved, but the torsional requirement has not been met; the installer may do one of the following subject to the review and approval of the engineer and/or owner:
  A. Install the torque anchor™ deeper to obtain the required installation torsion.
  B. The installer may remove the torque anchor™ and install a new one with an additional helical plate and/or larger diameter helical plates.
  C. Reduce the load capacity of the placement and provide additional helical torque anchors™ at closer spacing to achieve the required total support for the project.
- If the torque anchor™ hits an obstruction or is deflected from its intended path, the installation shall be terminated and the anchor removed. Either the obstruction must be removed or the torque anchor™ relocated as directed by the engineer and/or owner and the installation resumed.
- In no case shall a torque anchor™ be backed out and reinstalled to the same depth. If an anchor must be removed for any reason, it must be installed to a deeper embedment of at least three feet.
- After meeting the installation requirements, the installer may remove the final plain extension section and replace it with a shorter one to obtain the design elevation, or he may cut the extension to length. The cut shall be smooth and at 90 degrees to the axis of the shaft. It is not permissible to reverse the installation to reach the desired coupling elevation.
STEP 2 – Torque Anchor™ Installation:
The hydraulic installation motor shall be installed on a suitable machine capable providing the proper installation angle, reaction against installation torque, and downward force (crowd). The lead section shall be positioned with the shaft at the proper installation angle(s) at the designated location(s). The opposite end shall be attached to the hydraulic installation motor with a pin(s) and retaining clip(s).
If using portable equipment, the torque reaction bar MUST be properly secured against movements in all directions. Torque Anchor™ lead sections shall be placed at the locations indicated on the plans. The lead section shall be advanced into the soil in a smooth and continuous manner using sufficient force for uniform advancement. The installer shall have knowledge of the desired pressure differential that will produce the desired terminal installation torque approved by the engineer before beginning the installation.
Once the lead is installed, the motor shall be unpinned from the lead. One or more extensions shall be installed and securely bolted in place with the hardware supplied by the manufacturer.
The torque anchor™ shall be continued to be driven to the average design torque until the bottom end of the torque anchor™ is at the design depth. Once the design torque at the design depth has been achieved, the installation motor shall be removed from the torque anchor™.

STEP 3 – Documentation:
The installer shall carefully monitor the torque applied to the anchor as it is installed. It is recommended that the installation torque be recorded at one foot intervals, but should never exceed every two feet. The data may be collected from electronic torsion monitoring equipment that has been calibrated to the installation motor being used. Installation torque may also be monitored by noting the differential pressure across the installation motor and determining the torque from the manufacturer’s published torque curves.
At the conclusion of the installation, the raw field data shall be converted into an installation report that includes the location of each placement, the installation depth, installation torque readings at intervals and the averaged installation torque over the final three feet.

STEP 4 – Torque Anchor™ Termination:
- **Pile Cap or Bracket** – The pile cap, slab pier bracket, utility bracket, or porch bracket shall be installed by placing the appropriate sleeve over the torque anchor™ shaft. If the foundation will be subjected to uplift, the pile cap shall be bolted to the torque anchor shaft using bolt(s) and nut(s) supplied by the manufacturer having the same diameter and strength rating as used to couple the pile sections.
- **Transition** – The transition is sometimes used for equipment anchorage. The transition shall be bolted to the end of the torque anchor™ using the hardware supplied by the manufacturer. All-thread bar shall be attached between the transition and the equipment base. If required, the installer may place a center-hole ram over the continuously threaded bar to preload pile in tension as specified. The mounting nuts shall then be tightened securely to maintain the preload. In less critical applications the wall plate nuts may be tightened to a torque specified by the engineer or owner.

STEP 5 – Clean up:
Remove all scrap and other construction debris from the site. Remove all tools and equipment, clean them and store them. Any disturbed soils in the area of work shall be restored to the dimensions and condition specified by the engineer and/or owner. Dispose of all construction debris in a safe and legal manner.

End Procedure
## TORQUE ANCHOR™ INSTALLATION RECORD

<table>
<thead>
<tr>
<th>Job Name:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Address:</td>
<td>Placement Number: (Show On Sketch)</td>
</tr>
</tbody>
</table>

**Installing Crew:**

<table>
<thead>
<tr>
<th>Torque Motor Make:</th>
<th>Model No:</th>
<th>Torque Conversion:</th>
<th>Maximum Motor Output: ft-lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Back Pressure =</td>
<td>psi</td>
<td>Machine Motor is Mounted to:</td>
<td></td>
</tr>
</tbody>
</table>

**ECP Torque Anchor™ Lead Designation:**

<table>
<thead>
<tr>
<th>Depth From Grade To Tip (ft)</th>
<th>Δ □ Pressure (psi)</th>
<th>Torque (ft-lb)</th>
<th>Depth From Grade To Tip (ft)</th>
<th>Δ □ Pressure (psi)</th>
<th>Torque (ft-lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

---

Utility Industry Anchor Design and Maintenance Manual © 2013 Earth Contact Products, L.L.C.

2013-09 Page 46 May be reproduced for ECP installers for the sole purpose of Torque Anchor™ Installation. – All other rights reserved
**Field Test Procedures for Static Axial Compression and Tensile Loads**

Many projects require field testing to verify capacity, in other cases a field test can provide valuable information. Not only will the load test verify that the anchor or pile has achieved the capacity requirement, a field load test on the job site can provide a precise *Soil Efficiency Factor*, “*k*”, for the particular shaft configuration being installed at this specific site.

In the utility industry, guy anchors do not have to meet such stringent requirements as permanent structural supports. In general, the amount of creep allowed in guy wire applications is typically four to six inches. When testing support for permanent structures, a factor of safety of 2.0 is most commonly accepted by engineers for building foundations, structural supports and other permanent anchorages such as retaining walls. The testing procedures are the same, whether the maximum movement of the anchor of four inches is allowed for guy applications or the ECP recommended allowable maximum of one inch of movement for permanent structural support applications.

In this section the test procedures closely conform to ASTM D1143 and D3689 specifications.

---

**It is recommended that any field load test for compressive bearing or tension anchor resistance be conducted under the supervision of a Registered Professional Engineer.**

---

The increments and failure criteria provided below in our “*Basic Procedure for Quick Tests*” outlines are conservative and designed for tests on supports for permanent buildings and retaining walls.

When determining acceptable criteria for guy wire anchorage or for other temporary anchorages, the failure criterion could differ from the test procedures presented here because significantly more creep is usually acceptable in guy anchor applications. For this reason, the engineer in charge should be consulted to modify the test procedure, the load increments, time intervals, measurement procedures, and the acceptable ultimate deflection that is consistent with the specific project and load conditions. If the result of load testing suggests less than the ultimate load requirement has been achieved, the responsible engineer may choose to adjust the product spacing and/or increase the depth of anchor installation and/or modify the projected helical plate area on the shaft in order to achieve a higher capacity and/or the desired factor of safety and acceptable shaft deflection.

The first procedural outline is based closely on the ASTM D1143 and D3689 testing procedures. The “Quick Test” procedure outlined below will more quickly produce an estimate of actual anchor performance on the job site. This load test will provide a more accurate ultimate load capacity than by relying only upon the *Soil Efficiency Factor*, “*k*” of the shaft as it penetrates the soil.
Basic Procedure for Quick Tension or Compression Tests

1. Determine the depth to the target stratum of soil from the geotechnical site investigation report that includes boring logs. Use this data to select a pile design capacity, ultimate capacity and estimate the installation torque at the target stratum and depth.

2. Set the spacing and install the four reaction piles at the test site. The recommended spacing between the test pile and the reaction piles is 5D where D = diameter of the largest helical plate.

3. Install the test helical product pile at the center between the reaction piles to the target depth and torque resistance.

4. Mount the two anchor beams on the four reaction piles and the reaction beam between the anchor beams and level.

5. Install a load cell (or certified pressure gauge) and hydraulic ram. The center-hole load ram must be mounted below the reaction beam for a bearing (compression) test and above the reaction beam for an anchor (tension) test.

6. Set the deflection measuring devices. Deflection measuring devices can include dial gauges (accuracy to 0.001”) with minimum travel of one inch greater than the acceptable deflection mounted on a reference beam, a transit level surveying system, or other types of devices as may be specified by the Engineer.

7. Apply a small seating/alignment load, usually 5% of the ultimate load. Hold the seating load constant for a minimum of four minutes or until no further displacement is measured.

8. Set the deflection measuring device(s) to zero in preparation to starting the test.

9. Apply the first load increment of 5% of the ultimate load and hold that load constant for a minimum of four minutes to a maximum of 15 minutes. Monitor the incremental deflection (Δd) at intervals of 30 sec., 1, 2, and 4 minutes (per the “quick” test procedure of ASTM) and at longer intervals of 8 and 15 minutes when permitted. The monitoring may be stopped after 4 or 15 minutes as long as the rate of deflection is less than 0.002” per minute. If Δd (at 15 minutes) < 0.330”, proceed to the next 5% load increment and repeat Step 9 until the ultimate load is reached or failure occurs by excessive deflection (vertical deformation).

10. Once the maximum loading condition is reached, unloading commences with two to five unloading decrements that are approximately equal. Hold each decrement for a minimum of four minutes to a maximum of 15 minutes recording the movement at each decrement. A frequently used failure criteria for permanent support of physical structures is “d” > 1.0” to define the ultimate acceptable load with a permanent deflection of “d” < 0.5” after unloading.

A failure criterion is often different than outlined in this typical procedure. The failure criteria should be reviewed and established by the project engineer prior to testing. He can provide project specific test acceptance conditions for the installation. Acceptance criteria are sometimes quite different for applications such as guy wire anchorage and for temporary tension anchors. Discuss test procedures with the Engineer of Record on the project.

A plot of load versus pile deflection “d” is often prepared after testing to determine the acceptable ultimate and working load capacities of the anchor, and for review of the actual performance of the helical pile or anchor in the soil under changing load conditions.

End Test Procedure
**FIELD LOAD TEST REPORT**

<table>
<thead>
<tr>
<th>PROJECT DATA</th>
<th>Load Test Log No.</th>
<th>Date:</th>
<th>Zip Code:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Name:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load Type:</td>
<td>(Compression, Tension or Lateral)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Ultimate Load:</td>
<td></td>
<td>Project Working Load:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRODUCT TESTED</th>
<th>Helical Product No.:</th>
<th>Shaft Size:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part No.</td>
<td>Part No.</td>
<td></td>
</tr>
<tr>
<td>Part No.</td>
<td>Part No.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOAD TEST EQUIPMENT INFORMATION</th>
<th>Load Test Cylinder Capacity:</th>
<th>Effective Cylinder Area:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>Cylinder Part Number:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Load Increment Number</th>
<th>Load Force (lbs)</th>
<th>Hydr. Press. (psi)</th>
<th>Load Cell Reading</th>
<th>Initial Dial Reading</th>
<th>Instrument Reading or Dial Gauge Reading (.001 in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30 sec.</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FAILURE LOAD</th>
<th>lbs.</th>
<th>MODE OF FAILURE:</th>
</tr>
</thead>
</table>

| COMMENTS: |

---

Page 49