Effective Anchoring

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Product Manager
Hubbell Power Systems
Anchoring - Outline

- Introduction
- How to pick the correct anchor
- Types of anchors
- Anchoring tips
- Questions
Anchor Failure

An anchor will fail if not:

- Properly selected
- Properly installed
Anchor Holding Capacity

- Mechanical strength of anchor/rod
- Installation technique
- Type of soil
What type of Anchor to use?

Soil Type
• Soil Classification Chart
• Load Requirement

Guy Load
• Angle of Guy
• Number of Guys
• Safety Factor
Soil Types

- Hard Rock
- Sandstone
- Boulder Clay
- Shales
- Gravel
- Coarse Sand
- Lake Clays
- Peat
## Soil Classification Data

<table>
<thead>
<tr>
<th>Class</th>
<th>Common Soil-Type Description</th>
<th>Geological Soil Classification</th>
<th>Probe Values in.-lb. (NM)</th>
<th>Typical Blow Count &quot;N&quot; per ASTM-D1586</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Sound hard rock, unweathered</td>
<td>Granite, Basalt, Massive Limestone</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>1</td>
<td>Very dense and/or cemented sands; coarse gravel and cobbles</td>
<td>Caliche, (Nitrate-bearing gravel/rock), ripples</td>
<td>750 - 1600 (85 - 181)</td>
<td>60-100+</td>
</tr>
<tr>
<td>2</td>
<td>Dense fine sands; very hard silts and clays (may be preloaded)</td>
<td>Basal till; boulder clay; caliche; weathered laminated rock</td>
<td>600-750 (68 - 85)</td>
<td>45-60</td>
</tr>
<tr>
<td>3</td>
<td>Dense sands and gravel; hard silts and clays</td>
<td>Glacial till; weathered shales, schist, gneiss and siltstone</td>
<td>500 - 600 (56 - 68)</td>
<td>35-50</td>
</tr>
<tr>
<td>4</td>
<td>Medium dense sand and gravel; very stiff to hard silts and clays</td>
<td>Glacial till; hardpan; marls</td>
<td>400 - 500 (45 - 56)</td>
<td>24-40</td>
</tr>
<tr>
<td>5</td>
<td>Medium dense coarse sands and sandy gravels; stiff to very stiff silts and clays</td>
<td>Saprolites, residual soils</td>
<td>300 - 400 (34 - 45)</td>
<td>14-25</td>
</tr>
<tr>
<td>6</td>
<td>Loose to medium dense fine to coarse sands to stiff clays and silts</td>
<td>Dense hydraulic fill; compacted fill; residual soils</td>
<td>200 - 300 (23 - 34)</td>
<td>7-14</td>
</tr>
<tr>
<td><strong>7</strong></td>
<td>Loose fine sands; Alluvium; loess; medium - stiff and varied clays; fill</td>
<td>Flood plain soils; lake clays; adobe; gumbo, fill</td>
<td>100 - 200 (11 - 23)</td>
<td>4-8</td>
</tr>
<tr>
<td><strong>8</strong></td>
<td>Peat, organic silts; inundated silts, fly ash very loose sands, very soft to soft clays</td>
<td>Miscellaneous fill, swamp marsh</td>
<td>less than 100 (0 - 11)</td>
<td>0-5</td>
</tr>
</tbody>
</table>

Class 1 soils are difficult to probe consistently and the ASTM blow count may be of questionable value.

**It is advisable to install anchors deep enough, by the use of extensions, to penetrate a Class 5 or 6, underlying the Class 7 or 8 Soils.**
Holding Capacity Charts

Screw Anchor Holding Capacity

<table>
<thead>
<tr>
<th>Helix Combinations</th>
<th>Installation Torque (ft-lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,500</td>
</tr>
<tr>
<td>8&quot; - 10&quot;</td>
<td>17,000</td>
</tr>
<tr>
<td>10&quot; - 12&quot;</td>
<td>18,000</td>
</tr>
<tr>
<td>8&quot; - 10&quot; - 12&quot;</td>
<td>19,000</td>
</tr>
<tr>
<td>10&quot; - 12&quot; - 14&quot;</td>
<td>20,000</td>
</tr>
<tr>
<td>8&quot; - 10&quot; - 12&quot; - 14&quot;</td>
<td>20,000</td>
</tr>
<tr>
<td>10&quot; - 12&quot; - 14&quot; - 14&quot;</td>
<td>21,000</td>
</tr>
</tbody>
</table>
Guy Anchor Products
# Expanding Anchors

<table>
<thead>
<tr>
<th>Anchor Hole Size</th>
<th>Area Sq. In.</th>
<th>Rod Size (Order Separately)</th>
<th>8-Way Anchor Holding Capacity - (lbs.) vs Soil Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>70</td>
<td>5/8&quot;</td>
<td>Class 3: 16000, Class 4: 14000, Class 5: 11000, Class 6: 8500, Class 7: 5000</td>
</tr>
<tr>
<td>8&quot;</td>
<td>135</td>
<td>5/8&quot; or 3/4&quot;</td>
<td>Class 3: 26500†, Class 4: 22000†, Class 5: 18000†, Class 6: 15000, Class 7: 10000</td>
</tr>
<tr>
<td>10&quot;</td>
<td>200</td>
<td>1&quot;</td>
<td>Class 3: 31000, Class 4: 26500, Class 5: 21000, Class 6: 16500, Class 7: 12000</td>
</tr>
<tr>
<td>10&quot;</td>
<td>200</td>
<td>3/4&quot;</td>
<td>Class 3: 31000†, Class 4: 26500†, Class 5: 21000, Class 6: 16500, Class 7: 12000</td>
</tr>
<tr>
<td>12&quot;</td>
<td>300</td>
<td>1 1/4&quot;</td>
<td>Class 3: 40000, Class 4: 34000, Class 5: 26500, Class 6: 21500, Class 7: 16000</td>
</tr>
<tr>
<td>12&quot;</td>
<td>300</td>
<td>1&quot;</td>
<td>Class 3: 40000†, Class 4: 34000, Class 5: 26500, Class 6: 21500, Class 7: 16000</td>
</tr>
</tbody>
</table>
Cross-Plate Anchor

<table>
<thead>
<tr>
<th>Hole Size</th>
<th>Holding Capacity - (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(No Safety Factors Included)</td>
</tr>
<tr>
<td></td>
<td>vs Soil Class</td>
</tr>
<tr>
<td></td>
<td>Class 3</td>
</tr>
<tr>
<td>16&quot;</td>
<td>26500‡</td>
</tr>
<tr>
<td>20&quot;</td>
<td>34000‡</td>
</tr>
<tr>
<td>20&quot;</td>
<td>34000</td>
</tr>
<tr>
<td>24&quot;</td>
<td>45000‡</td>
</tr>
<tr>
<td>24&quot;</td>
<td>45000‡</td>
</tr>
<tr>
<td>24&quot;</td>
<td>45000</td>
</tr>
</tbody>
</table>

†Typical holding capacity.
Forged Anchor Rods

<table>
<thead>
<tr>
<th>Diameter (in)</th>
<th>Tensile Rating (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.500”</td>
<td>10,000</td>
</tr>
<tr>
<td>0.625”</td>
<td>16,000</td>
</tr>
<tr>
<td>0.750”</td>
<td>23,000</td>
</tr>
<tr>
<td>1.000”</td>
<td>36,000</td>
</tr>
<tr>
<td>1.250”</td>
<td>58,000</td>
</tr>
</tbody>
</table>

Includes square nut
Anchor Rod Extension

- Extension to keep guy out of dirt
- Guys and grips corrode quickly
- Caused by
  - Road grading
  - Swamp conditions

<table>
<thead>
<tr>
<th>Rod Dia.</th>
<th>Rod Length</th>
<th>Holding Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>15&quot;-96&quot;</td>
<td>23,000 lbs.</td>
</tr>
<tr>
<td>1&quot;</td>
<td>15&quot;-96&quot;</td>
<td>36,000 lbs.</td>
</tr>
</tbody>
</table>
Expanding Rock Anchor

<table>
<thead>
<tr>
<th>Rod Dia.</th>
<th>Hole Size</th>
<th>Rod Length</th>
<th>Holding Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>2&quot;</td>
<td>15&quot;-96&quot;</td>
<td>23,000 lbs.</td>
</tr>
<tr>
<td>1&quot;</td>
<td>2.5&quot;</td>
<td>15&quot;-96&quot;</td>
<td>36,000 lbs.</td>
</tr>
</tbody>
</table>

- Must be installed in solid rock
- Grout not required for strength
- Grout recommend to protect rock

... or with power tool
... push anchor into hole
... turn rod to expand.
Anchor Corrosion

Causes of Corrosion

Dissimilar Metals

Guy Wire Stray Current

Differential Aeration

Copper Rod

Soluble Salts

• Pipelines (cathodic protection)
• Acidic/high alkaline soils
• Feedlots

Clays
Fine grain soils

Cathode

Anode
Anchor Corrosion

Corroded Anchor Rod

2 yrs old
near substation
Anchor Rod Corrosion

Pipeline Damage

Salt Spray
Anchor Corrosion Protection

- Sacrificial anodes (magnesium or zinc bags)
- Tape Coatings
- Hot dipped galvanizing
- Sacrificial loss of steel (bigger anchor rod or SS anchor)
- Reduce stray current in guy with strain insulator (if construction practices allow)
Corrosion-Resistant Anchor

<table>
<thead>
<tr>
<th>Anchor Diameter</th>
<th>Anchor Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>16”</td>
<td>.187”</td>
</tr>
<tr>
<td>16”</td>
<td>.250”</td>
</tr>
<tr>
<td>20”</td>
<td>.187”</td>
</tr>
<tr>
<td>20”</td>
<td>.250”</td>
</tr>
<tr>
<td>24”</td>
<td>.187”</td>
</tr>
<tr>
<td>24”</td>
<td>.250”</td>
</tr>
<tr>
<td>30”</td>
<td>.375”</td>
</tr>
</tbody>
</table>
Power Installed Screw Anchors

• Lower Installed Cost Than Expanding Anchor

• Developed in the Late 1950’s under contract with Western Electric

• Hollow Square Bar Wrench transmits torque to anchor

• Threaded Eye-Nut
Power Installed Screw Anchors

Socket Style
- Drive Wrench fit inside socket
- Maximum torque rating = 15,000 ft-lbs

Square Hub
- Drive Wrench fits over square bar
- Maximum torque rating = 7,000 ft-lbs
SCREW ANCHOR ROD

• Rod Diameter
  • 5/8” diameter (5/8” threads)
  • ¾” diameter (1” threads)
  • 1” diameter (1” threads)

• Threaded on both ends

• Cannot use with bust/cross plate anchors.
Power Installed Anchor Holding Capacity

![Graph showing soil class vs. holding capacity for different anchor sizes and strengths.](image)
Power Installed Anchor Holding Capacity

![Graph showing installation torque versus holding capacity for different types and sizes of anchors, including 1" High Strength Rod*, 1" Rod* Strength, 3/4" Rod* Strength, 5/8" Rod* Strength, Twin 8" or Twin 10" Helices†, 12" or 14" Helix!, 8" Helix†, 10" Helix†, MID-STRENGTH SERIES, TOUGH ONE® SERIES, and STANDARD-STRENGTH SERIES.](chart-url)
Screw Anchor Tooling System

**Standard Tools**
- 10,000 ft.-lbs.
- 1 - 3/8” Solid Hub
- 2 - 1/4 Socket Hub

**Heavy Duty Tools**
- 15,000 ft.-lbs.
- 1 - 1/2” Solid Hub
- 2 - 1/2 Socket Hub

Kelly Bar Adapter
Locking Dog Assembly
Drive Wrench
Digital Wireless Torque Indicator
Torque Rating to 30,000 ft-lb

- Torque displayed on base unit, Wireless Dislay and Data Logger
- Data recorded on Data Logger
  - Torque readings every 2 sec
  - GPS
  - Time and Date stamp
  - Record anchor number and mark depth.
  - Download text file via UPS cable
- Operational temperature range:
  -22° to 175° F
- Accuracy: ±500 ft.-lb. at any reading.
- Torque is measured using strain gauges.
- Powered by a standard 9V battery
- Solid one-piece spool
Shear Pin Torque Limiter

Each Shear Pin = 500 ft-lb of Torque

Accurate within ± 5% if kept in good working condition

Shear Pin

Relatively Inexpensive
## Square Shaft Screw Anchors

- Helix diameter: 8” 10” 12” 14”
- Can install to any depth by adding extensions.

<table>
<thead>
<tr>
<th>Torque Capacity (Ft-lbs)</th>
<th>Min. Ult Tensile (LBS)</th>
<th>Square Shaft Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,500</td>
<td>70,000</td>
<td>1.5”</td>
</tr>
<tr>
<td>7,000</td>
<td>70,000</td>
<td>1.5”</td>
</tr>
<tr>
<td>10,500</td>
<td>100,000</td>
<td>1.75”</td>
</tr>
<tr>
<td>16,000</td>
<td>150,000</td>
<td>2.0”</td>
</tr>
<tr>
<td>23,000</td>
<td>200,000</td>
<td>2.25”</td>
</tr>
</tbody>
</table>
Chalmette Refinery --- Trial Probe using 8", 10", 12" lead and 120ft of plain extension
SS Anchor Twist

1-1/2 twist in a 5’ section
Square Shaft Tooling System

**Standard SS Drive Tool**
Bolts Directly to Kelly Bar Adapter

**SS Adapter for PISA Tools**
Fits into Locking Dog Assembly

**SS Drive Tool with Integral Dogs**
Bolts Directly to Kelly Bar Adapter
Anchoring Tips
Anchor Tips

Guy Anchor
Vertical Depth

5D or 5 ft. Recommended
Anchor Tips

Anchor Spacing

5 times diameter of largest helix or 5 ft.
Anchor Tips

Angle Tolerance

Recommended Guy Wire/Anchor Rod Angle Tolerance: ±5°
Anchor Tips

Before

After

- Anchor rods bend/break
- Conductor sags
- Poles bend/break
- Bolts bend/break
Anchor Tips

Misalignment caused this 1” rod to break
Anchor distance from pole

Shorter guy leads require more anchor holding capacity

Assume guy attachment 30’
45° Lead length = 30’
20° Lead length = 11’

10,000 lb line load

14,200 lbs
29,300 lbs
Anchor Tips

ANCHOR INSTALLATION

• Let the anchor work itself down
• Keep down pressure on tooling
• Don’t get in a big hurry
• Never let the anchor spin in place
Additional Resources

• Website www.hubbellpowersystems.com
• Online Catalog
• Anchor Encyclopedia
• Anchor Tool Maintenance
• Brochures
• Videos
Any Questions?