O.P. Jindal Group

JINDAL SAW LTD.
TOTAL PIPE SOLUTIONS

# HelicalAnchors,Inc.

# JINDAL SAW PLANT LOCATIONS

# At A Glance : Company Overview

Helical Anchors Inc and Tube Technologies Inc are the step down company of World Transload & Logistics LLC 'WTL' . WTL is acting as an Investment holding company and the part of the US $ 22 billion OP Jindal Group

All Minnesota based companies with decades of experience serving the oil and gas, water well, mining, geothermal and civil construction industries with advanced piping, hole drilling, soil stabilization and other services, products and technologies at our 125,000 square foot facility on approximately 18 acres of land at New Hope city.

**Jindal Saw Limited**

**World Transload and Logistics LLC 'WTL'**

**Helical Anchors, Inc. 'HAI'**

**Tube Technologies Inc 'TT'**

## Helical Anchor Inc.

Helical Anchors Inc. is centrally located in Minneapolis, Minnesota. With over 40 years of experience in the soil stabilization and foundation industry, we are bringing new solutions that apply state of the art technology and expertise to change the way foundation piles and anchors are installed.

Helical Anchors are more commonly used when the upper soil is not suitable for the load required. Helical anchors transfer load from the top down to a suitable soil. It can be as short as 15' or as deep as 130'beyond.

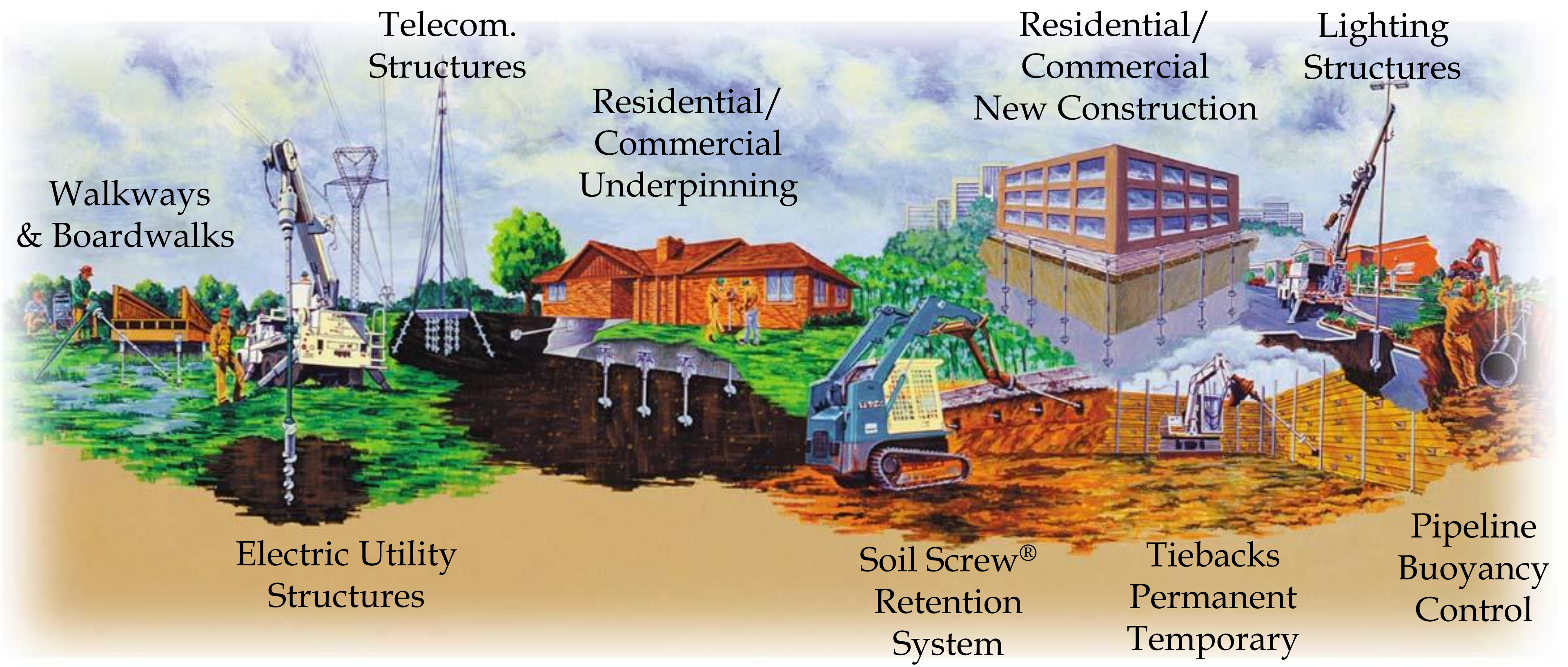
HAI has a US patented product which uses inertia welding process in the tube anchor system making it a premier product giving better strength and higher torque capacity. We also offer custom made anchors for project based design and load structures.

## Product Profile :

| Product size range - In Inches | | | |
|---|---|---|---|
| **Products** | **OD - Inch** | **WT - Inch** | **Length - feet** |
| Lead | 2.375 to 12 3/4 | 0.190 -0.500 | 3 to 25 |
| Extension | 2.375 to 12 3/4 | 0.190 -0.498 | 3 to 25 |
| Push Piers | 2 7/8 - 3.0 | 0.125 to 0.250 | 3 |
| Construction Caps | 2.3/8 to 12 3/4 | 0.190 -0.498 | Custom Designed |
| Standard Bracket with T Pipe | 2 3/8 to 4 1/2 | NA | Custom Designed |

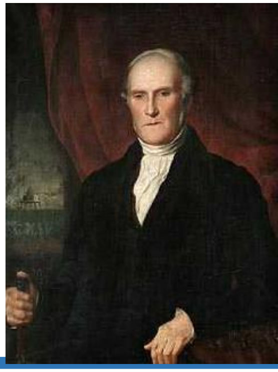
*Note: Tube above 7 inches is hand welded*

# APPLICATIONS & USES



# Historical Perspective

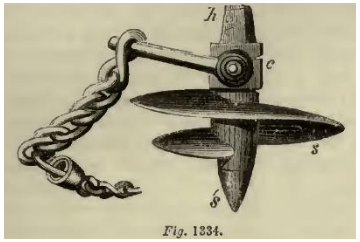
***… It has been more than 180 years since the first Helical Pile was installed!***

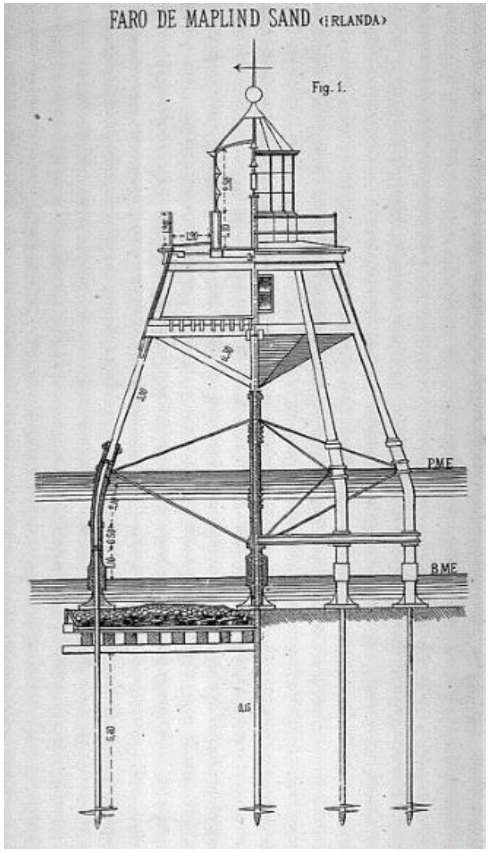


- First Recorded Screw Pile was by Alexander Mitchell in 1836 for Moorings and then applied by Mitchell to Maplin Sands Lighthouse in England in 1838.

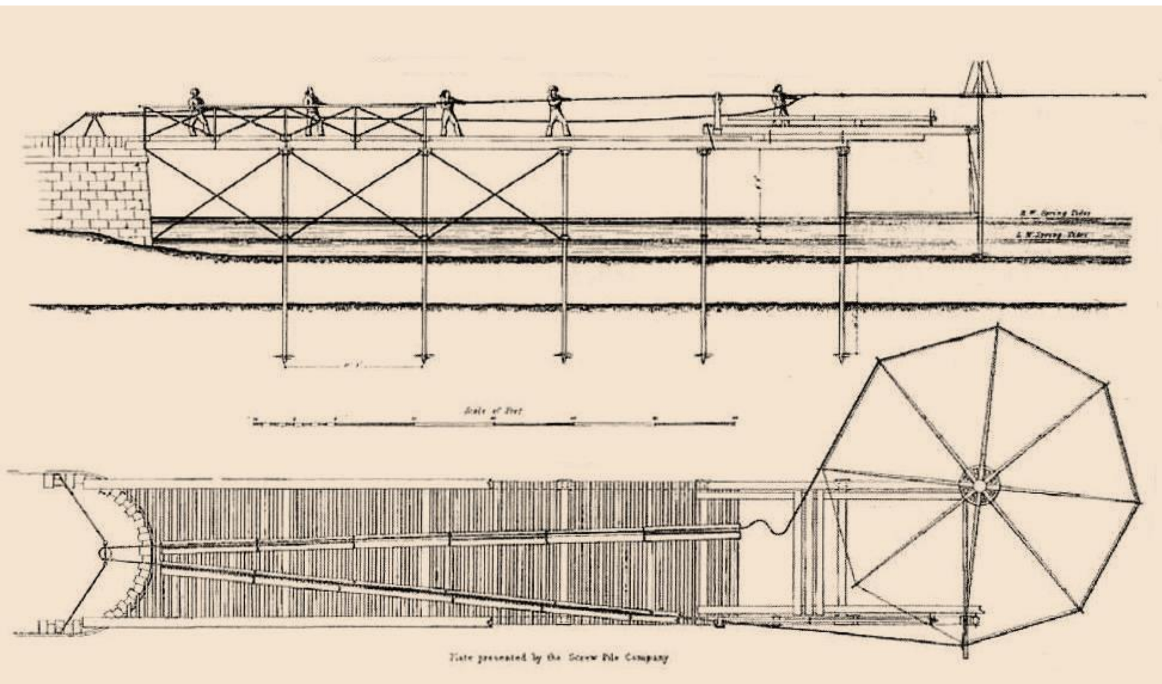
- In 1843 first recorded helical pile was installed in the USA. It’s application was to supported a lighthouse structures in Port Rock Harbor en Connecticut.

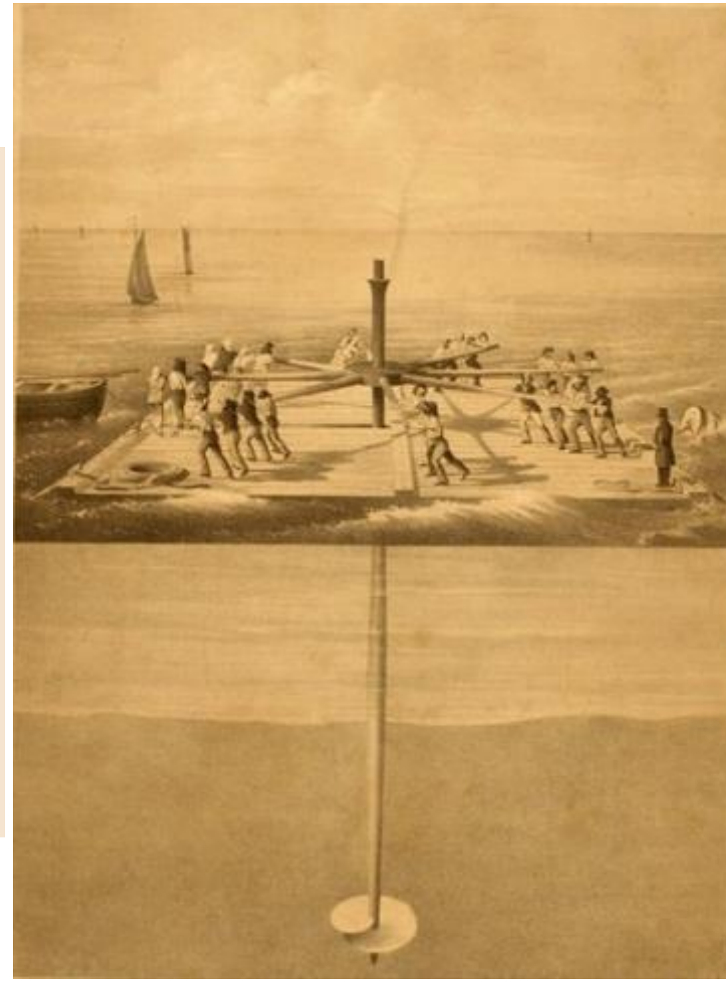
- Between 1840 – 1850 more than 100 light houses were constructed alog the East coast, the Florida coast and the gulf of Mexico using helical pile foundations.

# First Installations Process



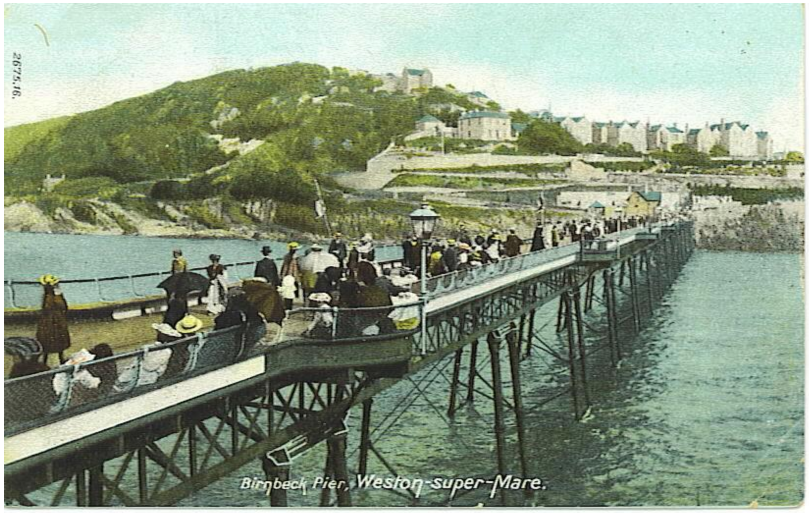



PIER WESTON-SUPER-MARE-UK

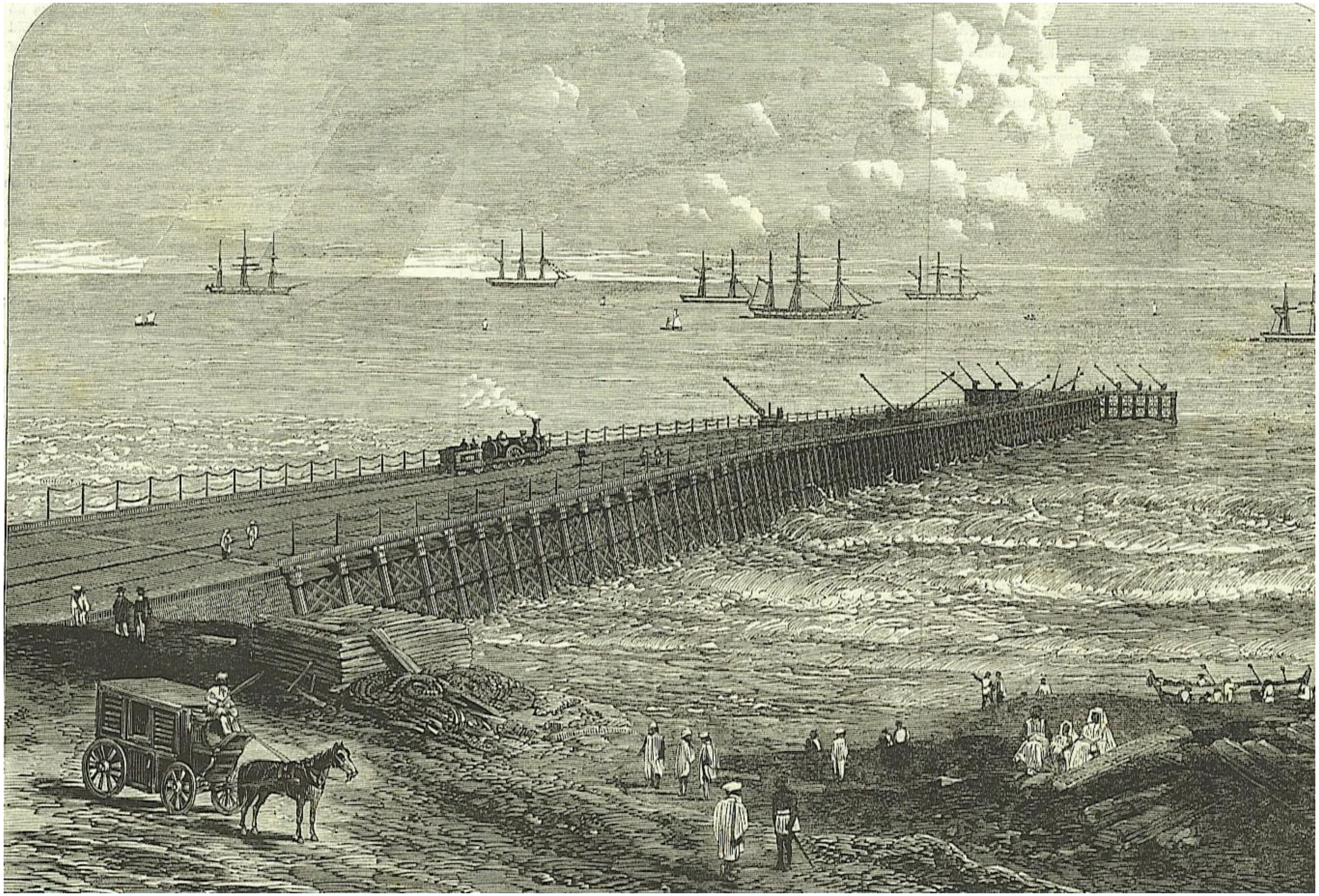
- Constructed1903 - 1904
- Lenght – 400m (1,300 ft.)
- Supported by 600 tubular helical piles


# Pier Pleasure- Southern UK



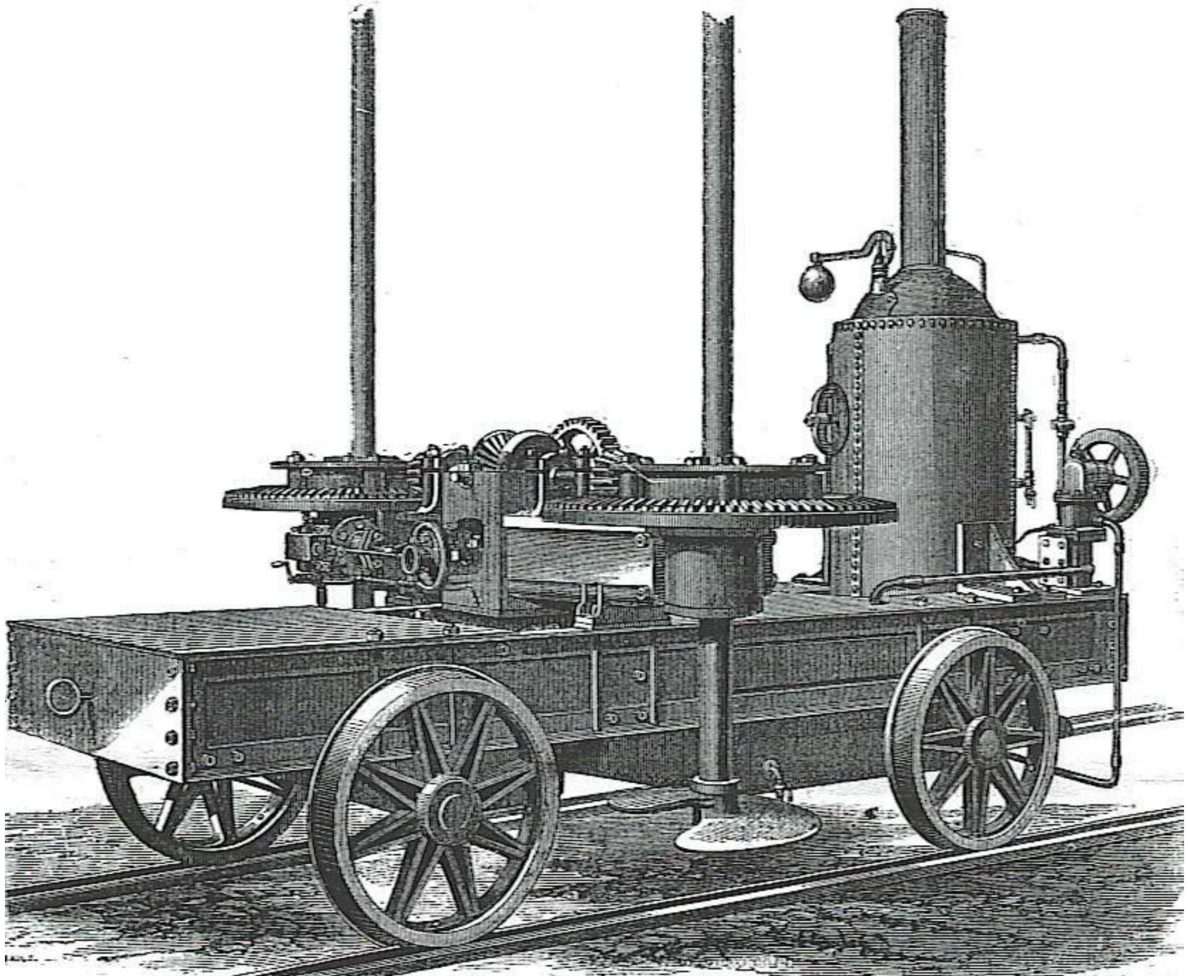



# Pier-Madras (India)



# Brighton Pier - 2007


# Installation Machine



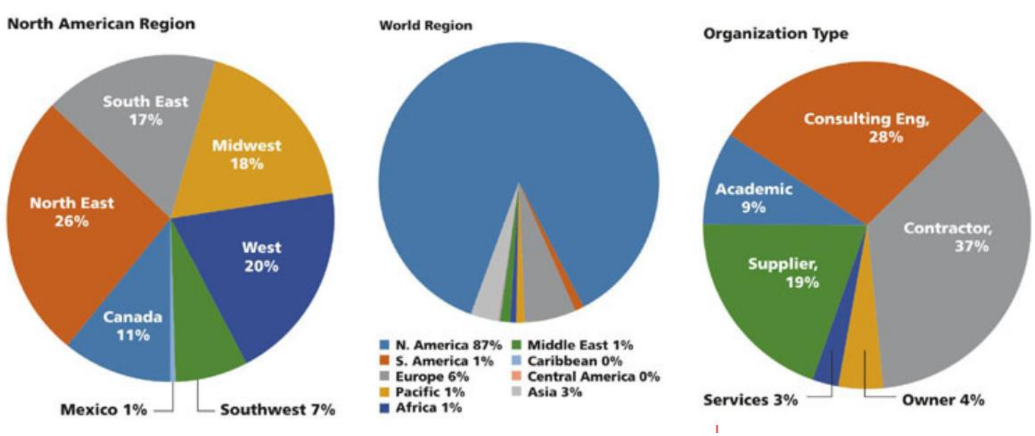
APPARATUS FOR SINKING SCREW PILES BY STEAM.

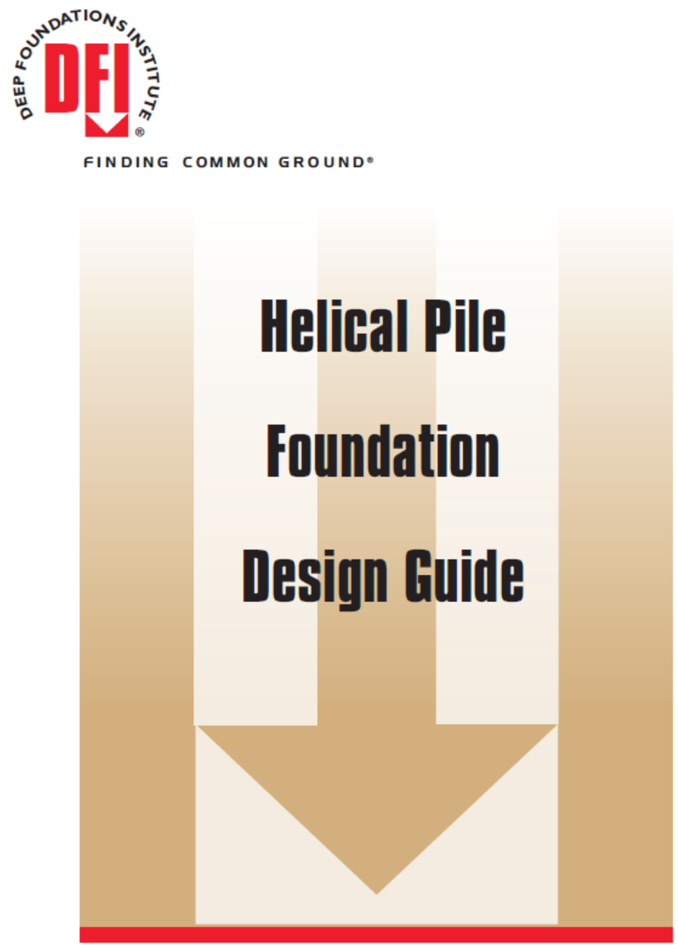
part motion to two large horizontal wheels; with a mean pressure of 90 lbs. steam in the boiler; and to lake which contains free nitric acid. Al

# HELICAL PILES- WORLDWIDE STANDARDS

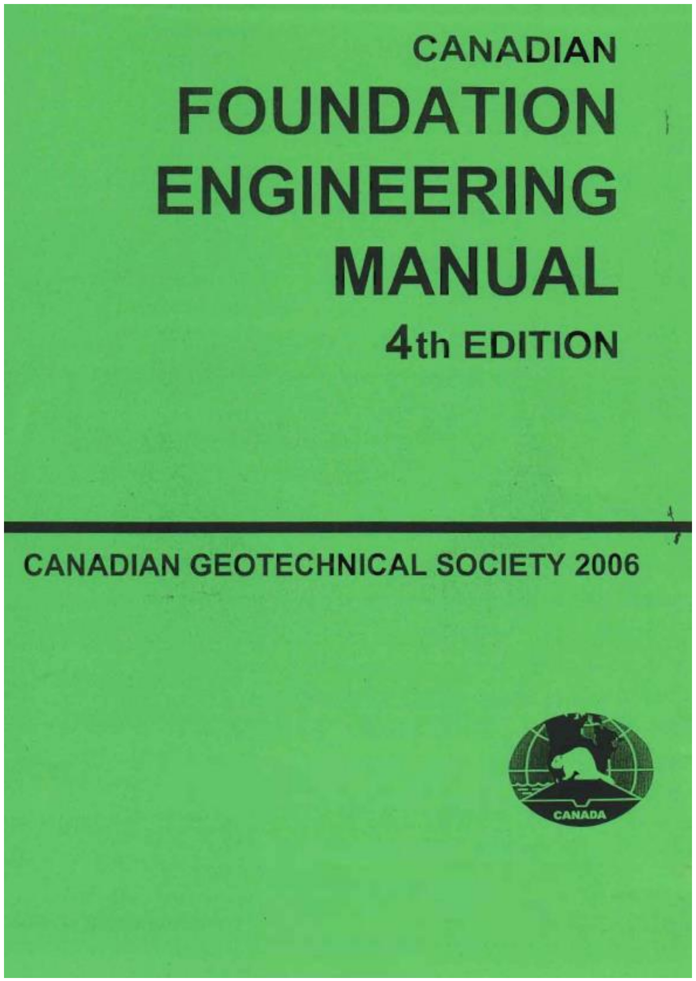
DEEP FOUNDATIONS INSTITUTE DFI®

FINDING COMMON GROUND®



# HELICAL PILES-STANDARDS, CANADA & JAPON





**18.2.1.4 Helical (Screw) Piles**

The basic form of a helical pile or anchor for construction applications consists of a helically shaped bearing plate or multiple plates attached to a central shaft. Historically, helical piles or anchors have been used in relatively light load applications, with shaft diameters and helix diameters typically less than 100 mm and 400 mm respectively.

Recently however, through the development of high-capacity torque drives (in excess of 50,000 ft-lbs) that are used for helical pile installation, larger diameter shafts and helixes have been constructed and installed.

When installed to proper depth and torque, the helical plates act as individual bearing elements to support a load. The helical pile is therefore a deep, end-bearing foundation that can be used to resist both compressive and tension loads. Installation of helical piles is accomplished by hydraulic torque drives that can be mounted to just about any type of machine (e.g. bed-mounted drill rigs, rubber-tired backhoes, skid-steer loaders, mini-excavators, and track-hoe excavators).

The total capacity of the helical pile or anchor equals the bearing capacity of the soil applied to the individual helical plate(s) and, in some instances, the skin friction of the shaft. This is:

$$R = Q_t + Q_f \qquad (18.10)$$

where

$Q_t$ = Total multi-helix pile capacity
$Q_f$ = Capacity due pile shaft skin friction

The evaluation of these components is described further below.

The factored geotechnical axial resistance at ultimate limit states is taken as the ultimate axial capacity (R) multiplied by the geotechnical resistance factor (Φ) of 0.4 for compression and 0.3 for uplift (Tables 8.1 and 8.2 in Chapter 8).

# HELICAL PILES-STANDARDS NEW ZEALAND

www.ipenz.nz

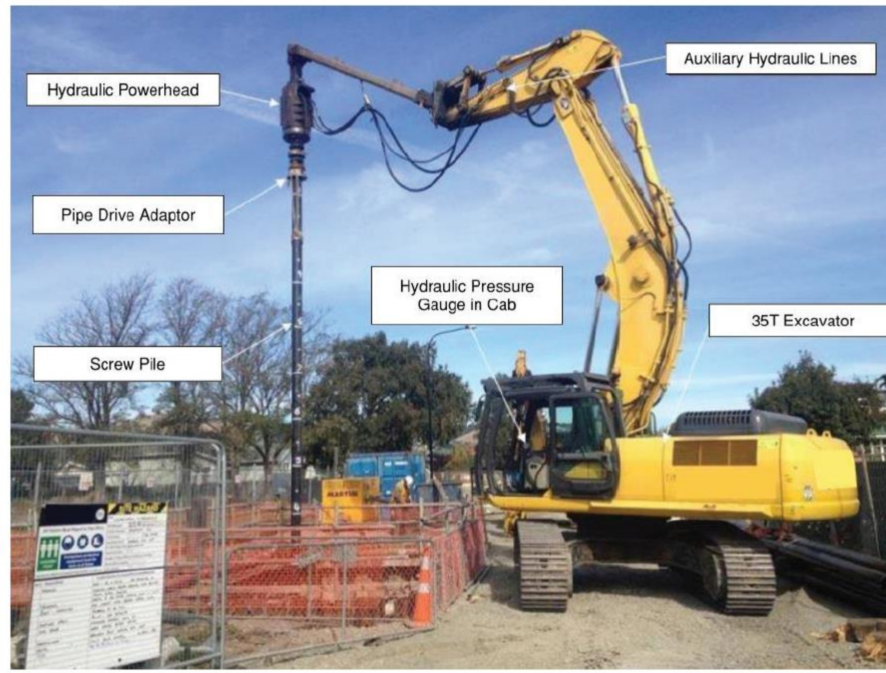
IPENZ ENGINEERS NEW ZEALAND

Practice Note 28

**Screw Piles: Guidelines for Design, Construction & Installation**

**Engineering Practice**

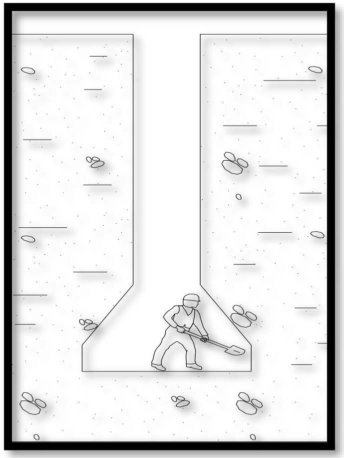
ISSN 1176-0907
October 2015



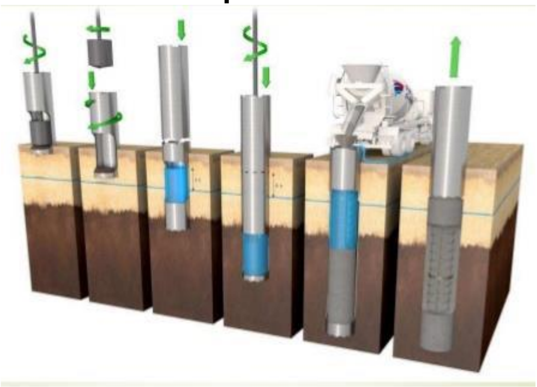
# WHAT IS A HELICAL/SCREW PILE

# FOUNDATION TYPES

Caisson



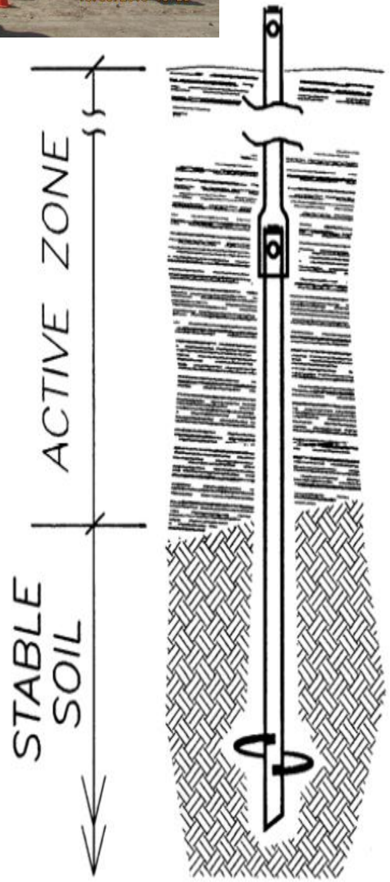
Micropiles



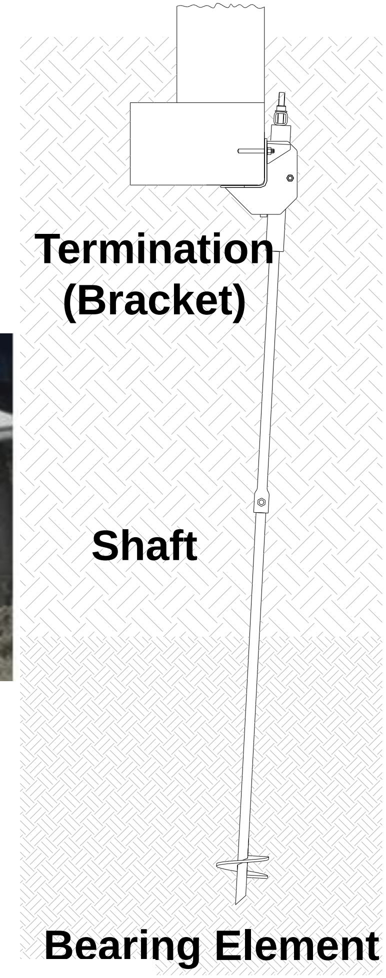
Driven Piles

Footings

Helical Piles



# Components of Helical Piles




**Three Parts:**

- **Termination: Transfers applied load to the shaft (Repair Brackets, Pile cap, concrete Cap, Steel grillage, Guy Adapters, Shackles, etc.)**

- **Shaft or Rod: Transfers load to bearing element (Square Shaft or Round Pipe)**
- **Bearing Element: Transfers applied load to soil (Helix or Starter Section for Resistance Pier)**

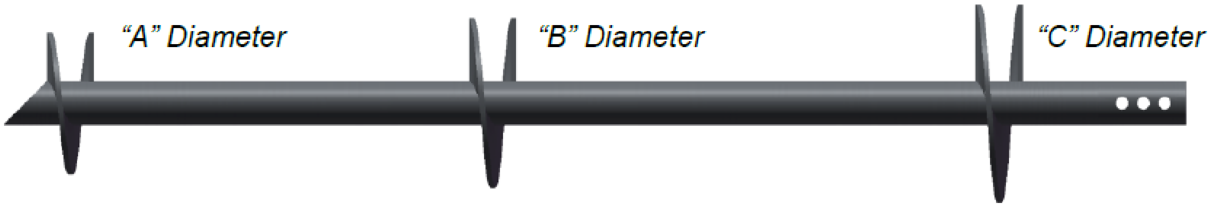
**Anchor = tension application**

**Pile = compression application**

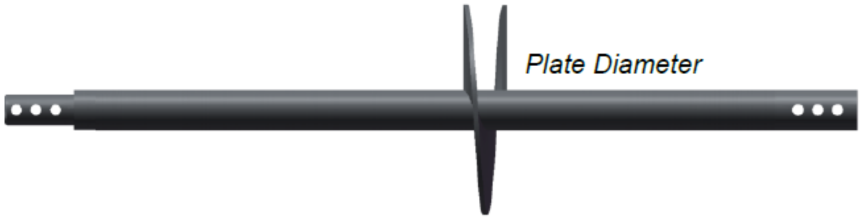
Repair Bracket

# Helical Pile Components

Lead Section

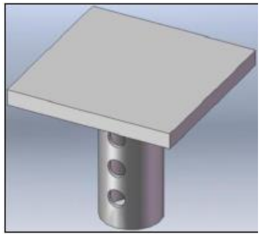



Extension with single helix

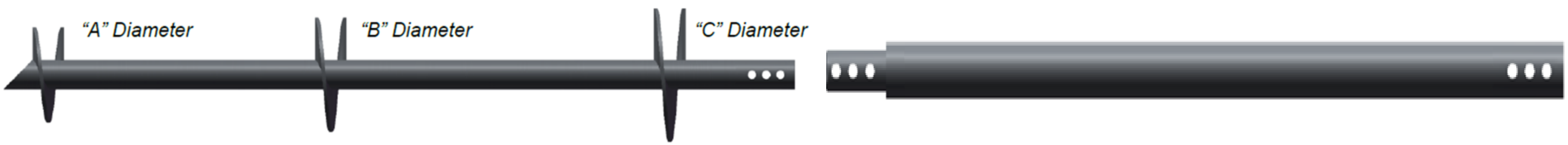


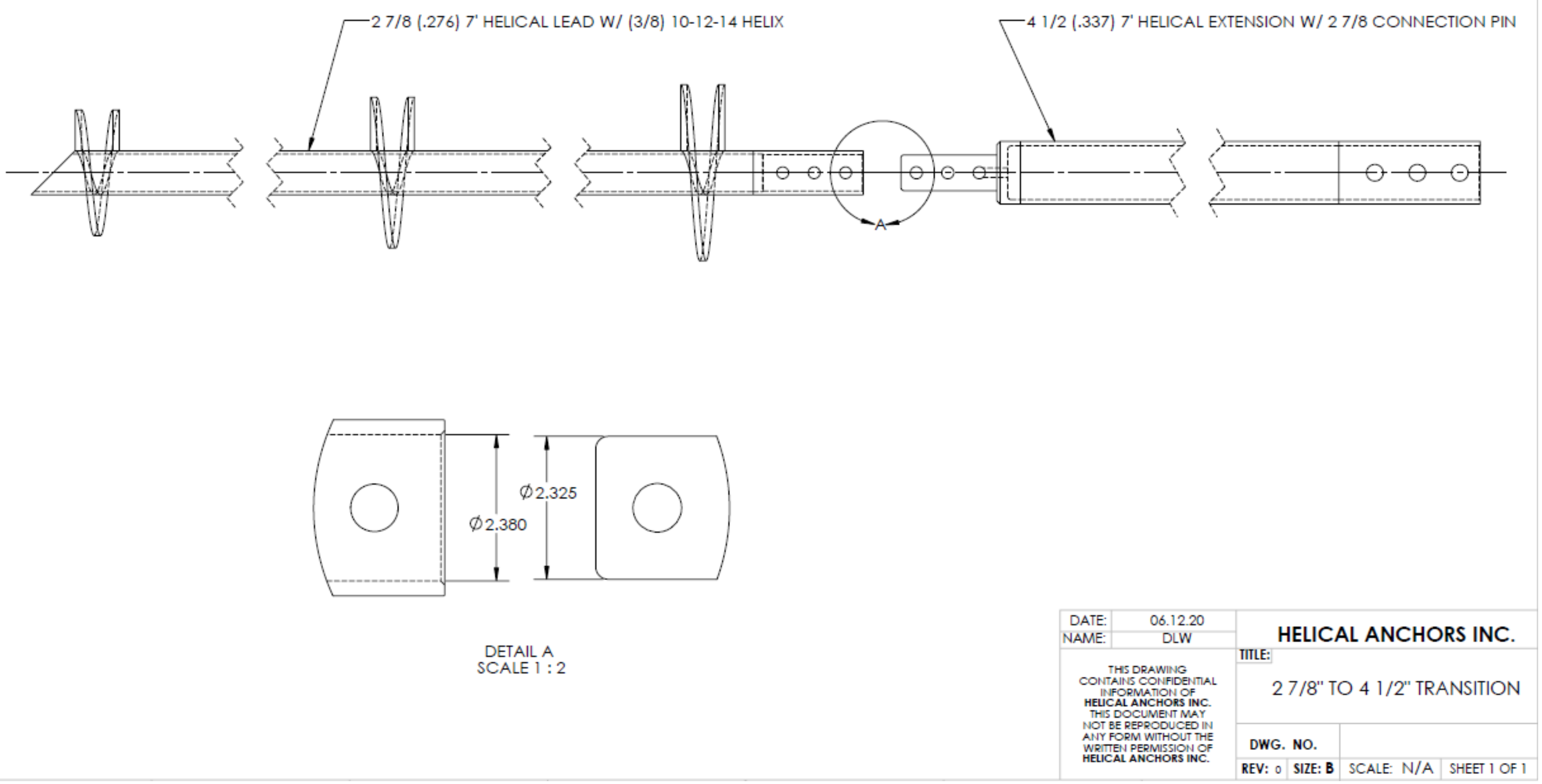

Simple Extension

New Construction Pile CAP



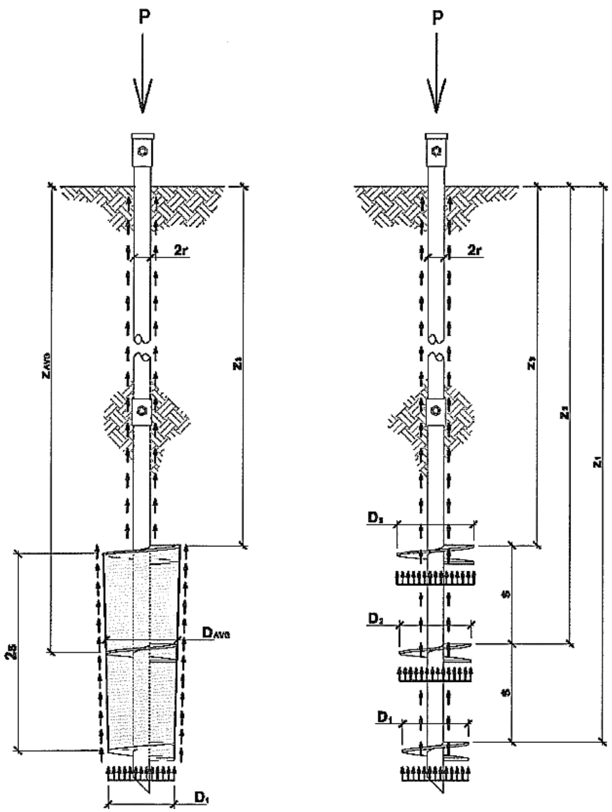
# Combo Helical Pile



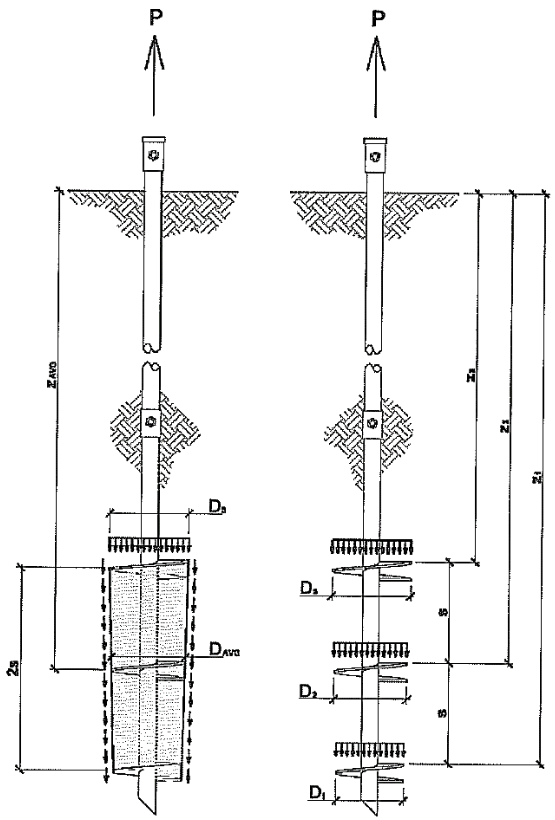



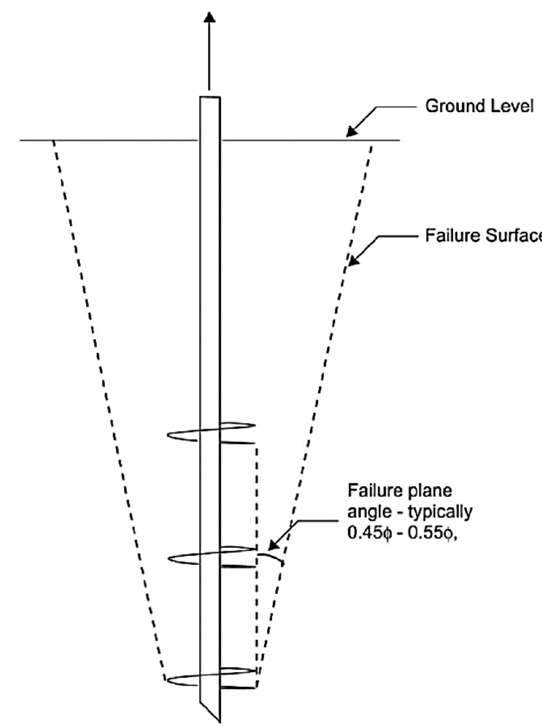
# HELICAL PILES DESIGN

COMPRESSIÓN




TENSION

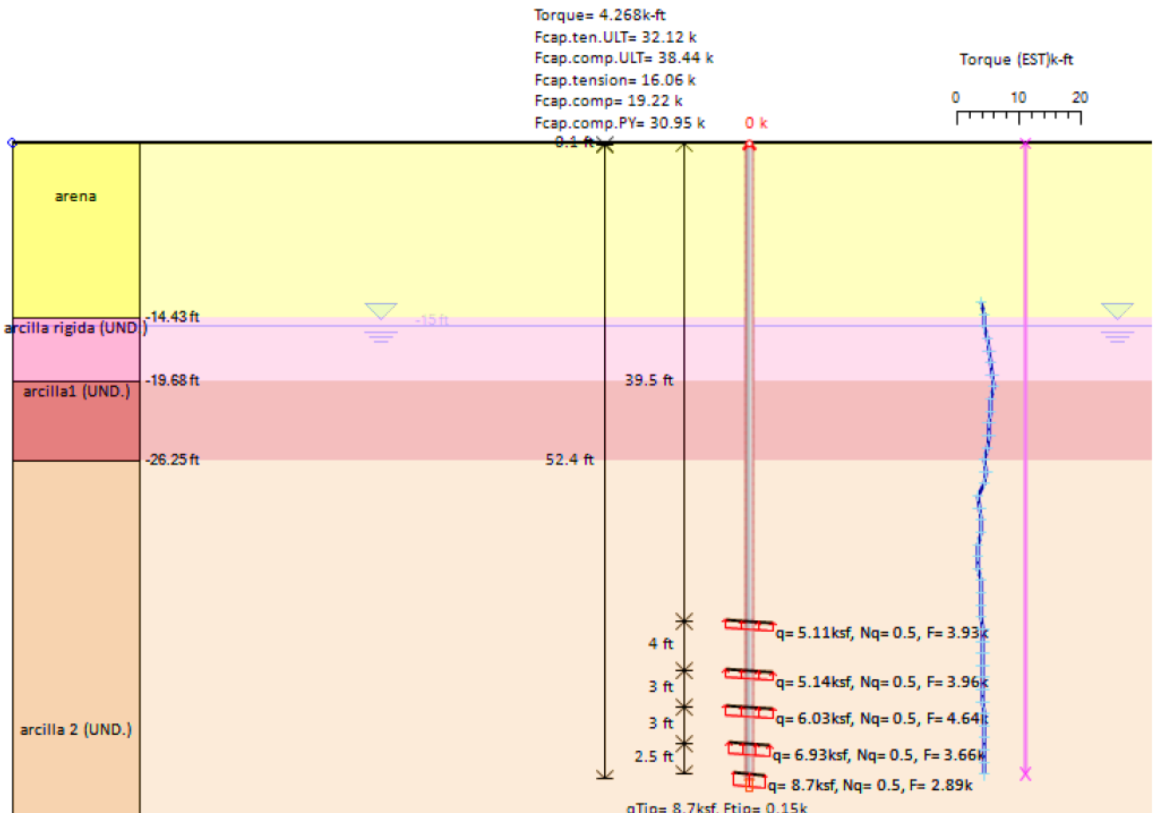


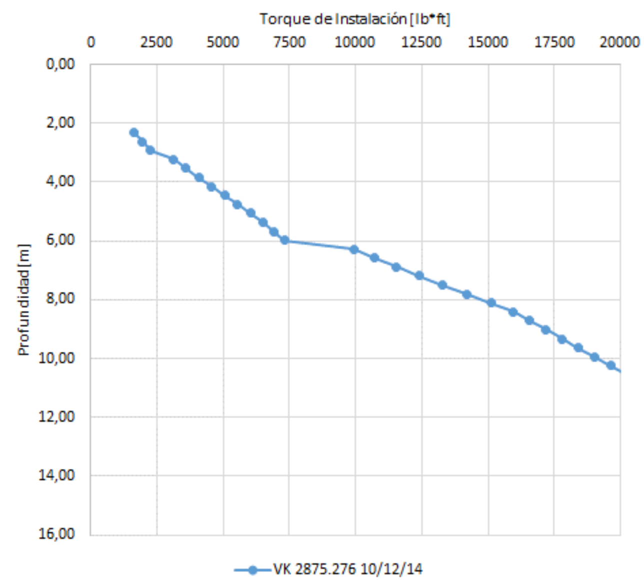



# HELICAL PILES DESIGN

## DESIGN AND CALCULATION OF SUPPORT CAPACITY (INSTALLATION TORQUE)

| Soil | γt | c' | Su | Φ' | E , exp | Ksub | e50 | Qu | RQD | krm |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | (pcf) | (psf) | (psf) | (deg) | E= ksf | (pci) | - | (ksf) | (%) | - |
| arena | 130 | 0 | - | 33 | E= 300, - | 30 | - | - | - | - |
| arcilla rigida (UND.) | 129 | - | 2800 | 0 | E= 300, - | - | 0 | - | - | - |
| arcilla1 (UND.) | 129 | - | 800 | 0 | E= 300, - | - | 0 | - | - | - |
| arcilla 2 (UND.) | 120 | - | 1700 | 0 | E= 300, - | - | 0 | - | - | - |



# "WHY ARE WE DIFFERENT"
# MANUFACTURING

- Helical Pile with **highest Capacity** in the Market:
  - High Quality Steel, under norms ASTM.
  - Inertia Welding (patent system).
  - System of  "Pin" connection of high strenght Steel between sections.
    - CNC machined couplers
    - Manufactured to .005
  - Hot Deep Galvanize under norms ASTM A123.

- Quality certifications:
  - ISO 9001:2015.
  - ISO 45001:2018.
  - AC358.
  - ICC (International Code of Counsel)

ISO 9001:2008 Certified
Quality Management System

ESR-3982

# “WHY ARE WE DIFFERENT”
## MANUFACTURING

- **Plants in Minneapolis, MN:**
  - 4 Line production.
  - **300 piles x day x líne.**
  - 75 - 150 employees (MN)
  - Facilities:
    - Total: 61.000 [m2].
    - Plant: 30.500 [m2].

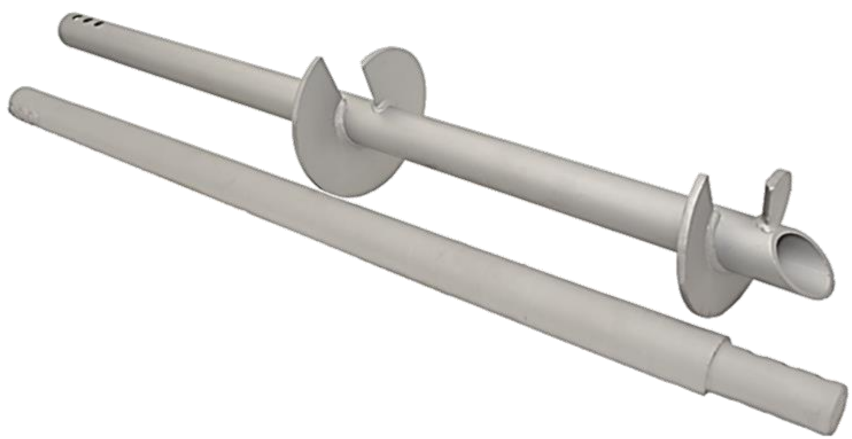
- **Plants in Houston, TX:**
  - Facilities:
    - Total: 81.000 [m2].

- **Plant in Gujarat, India:**
  - 2 Line productions.
  - **600 piles x day x líne.**
  - 130 employees
  - Operations:
  - 6 days x week.
  - 24 hours x day.
  - Facilities:
    - Total: 20.000 [m2]

HelicalAnchors,Inc.

# "WHY ARE WE DIFFERENT"
# STEEL GRADES AND COUPLINGS

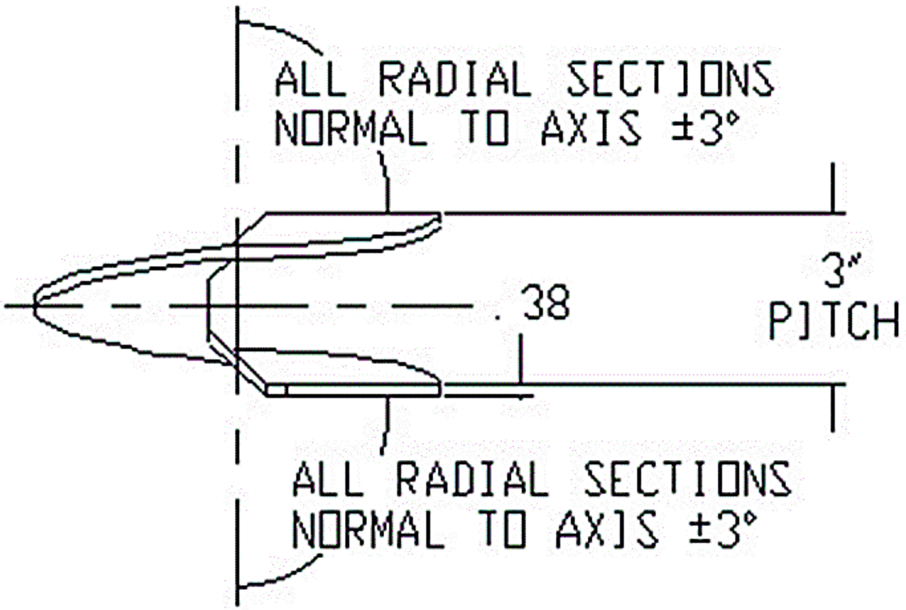
- **Steel Grade:**
  - Shaft: 80 [ksi] mín. (552 [MPa]).
    - Other manufactures use 50 [ksi].
  - Box connection: 107 [ksi] mín. (738 [MPa]).
  - Pin connection: 4140 Alloy .

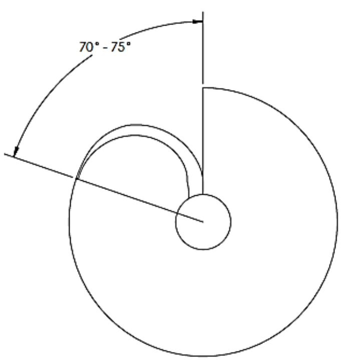


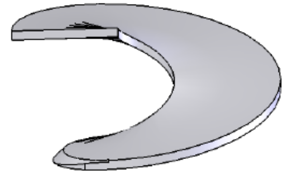
- **Joint Couplings:**
  - CNC Machined Couplers
  - Precision connection between sections.
  - Faster installation

# "WHY ARE WE DIFFERENT"
# HELICES AND THEIR VARIATIONS

**Helix formed by matching metal die so that soil disturbance is minimized.**

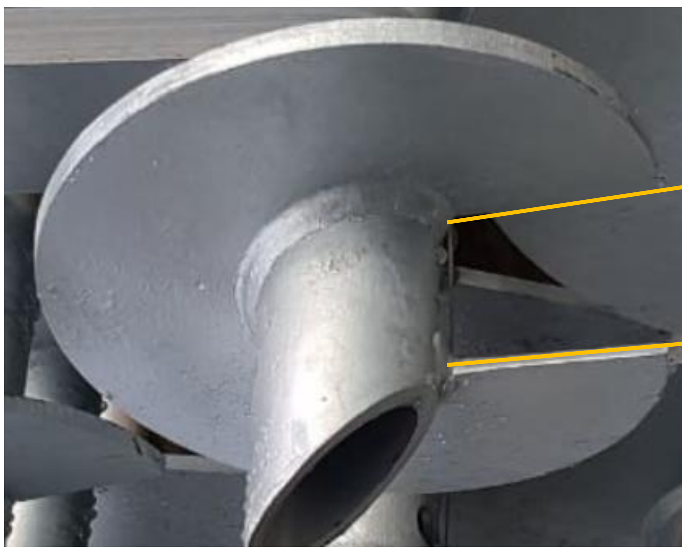


# ”WHY ARE WE DIFFERENT”

# HELICES AND THEIR VARIATIONS



3”
Pitch

COMPETITOR

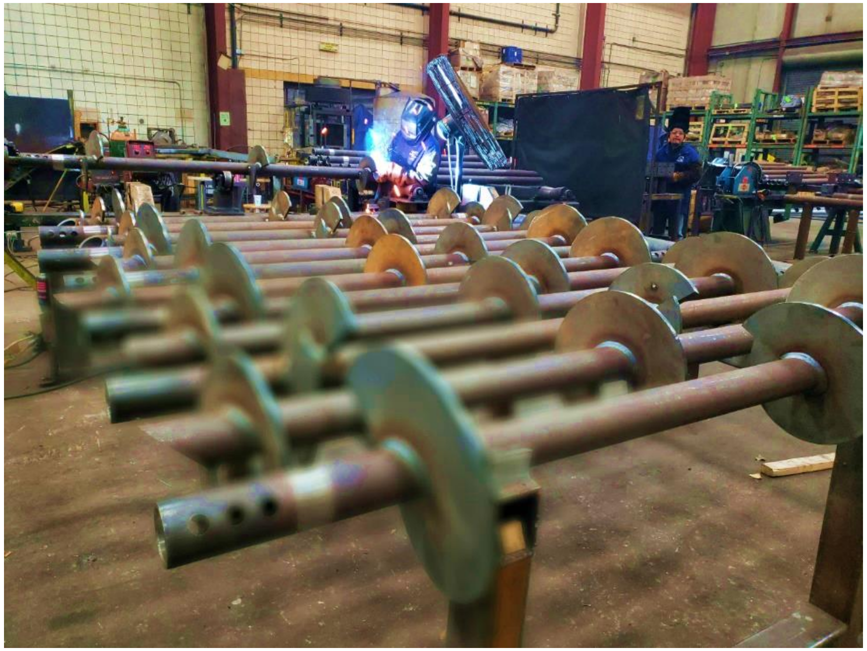
Helix Form and Shape Affect Soil Disturbance and Capacity

# "WHY ARE WE DIFFERENT"
# MANUFACTURING QUALITY CONTROL

- Quality Steel Certificate per Norms **ASTM**:
  - Tubalar Pipe.
  - Hélices.
  - Pin.

ASTM INTERNATIONAL

- Certification and control of the welding process in the manufacture of helical piles:
  - Inertia welding (**ANSI/AWS C6.1**).
  - Standard for Welding Procedure and Performance Qualification (**ANSI/AWS B2.1-00**).
  - Welders certification every two years.



- Galvanize Quality Control per **ASTM**.

# "WHY ARE WE DIFFERENT"
# MANUFACTURING QUALITY CONTROL

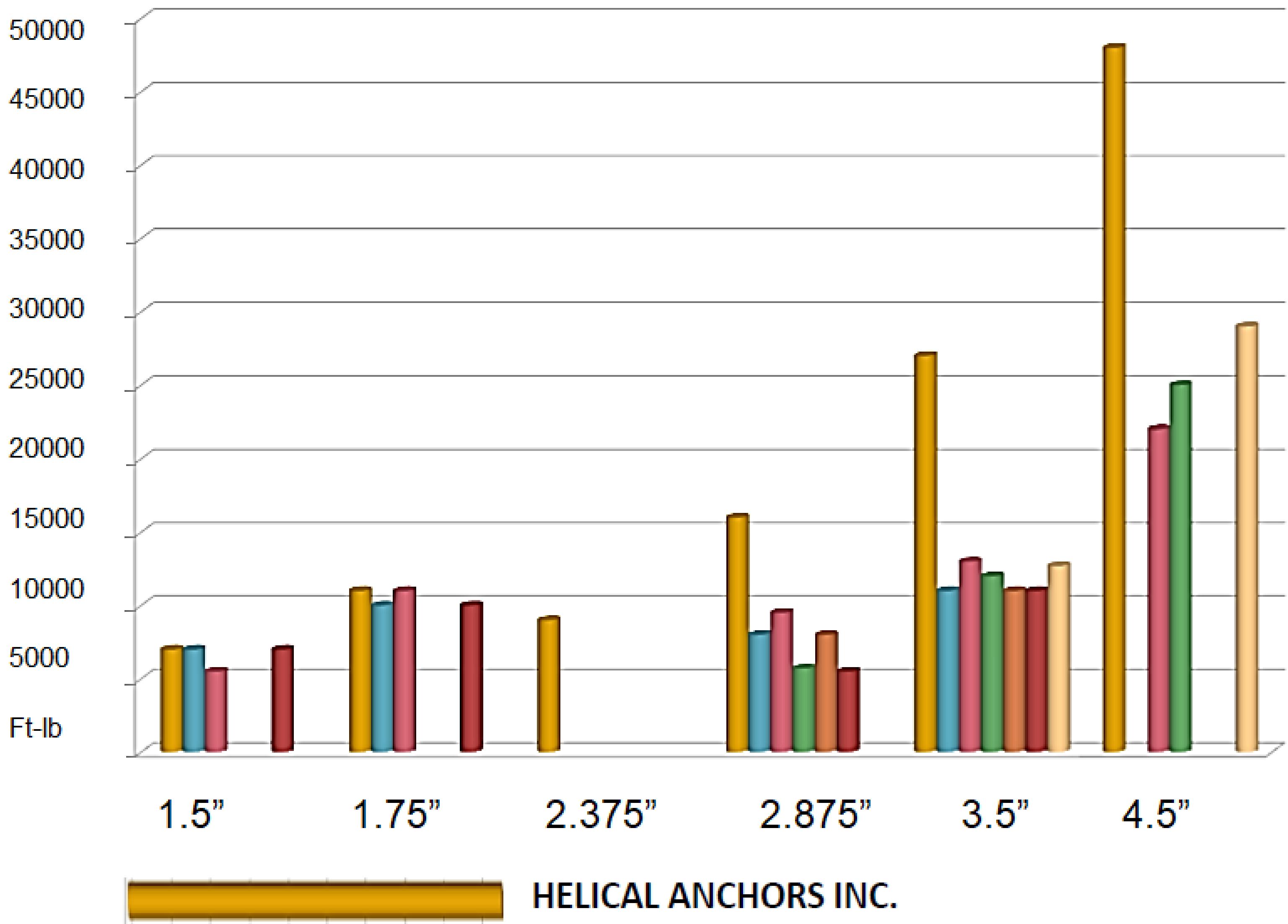
- Execution of quality control tests:
  - **Torque test** on samples of each production batch.
  - **Compression test on helices** on each production batach.
  - Issuance of reports with the results of the tests.

Tubular System-Products Classifications

| Table A1: Helical Anchors Product Rating | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Helical Anchors Products** | **Shaft Size (in)** | **Wall Thickness (in)** | **Ultimate Tension Strength (lbs)** | **Compression Load Limit (lbs)** | **Ultimate Torsional Strength (ft-lb)** | **Installation Torque Factor (k)** | **Capacity Based on Torsional Strength (lbs)** |
| **TS238190** | 2.375 OD | 0.190 | 125,000 | 100,000 | 6,000 | 9 - 10 | 60,000 |
| **TS238254** | 2.375 OD | 0.254 | 125,000 | 135,000 | 9,000 | 9 - 10 | 90,000 |
| **TS278217** | 2.875 OD | 0.217 | 180,000 | 140,000 | 13,000 | 8 - 9 | 117,000 |
| **TS278276** | 2.875 OD | 0.276 | 180,000 | 180,000 | 16,000 | 8 - 9 | 144,000 |
| **TS312254** | 3.50 OD | 0.254 | 250,000 | 210,000 | 18,000 | 6.5-8 | 144,000 |
| **TS312368** | 3.50 OD | 0.368 | 250,000 | 290,000 | 27,000 | 6.5-8 | 216,000 |
| **TS412250** | 4.50 OD | 0.250 | 275,000 | 260,000 | 30,000 | 5-6.5 | 195,000 |
| **TS412337** | 4.50 OD | 0.337 | 360,000 | 350,000 | 48,000 | 5-6.5 | 312,000 |
| **TS500362** | 5.00 OD | 0.362 | 413,000 | 413,000 | 74000* | 4.5-6 | 413,000 |
| **TS512361** | 5.50 OD | 0.361 | 510,000 | 466,000 | 90700* | 4-5.5 | 466,000 |
| **TS700498** | 7.00 OD | 0.498 | 999,000 | 814,000 | 200000* | 3-4.5 | 814,000 |

# "WHY ARE WE DIFFERENT"

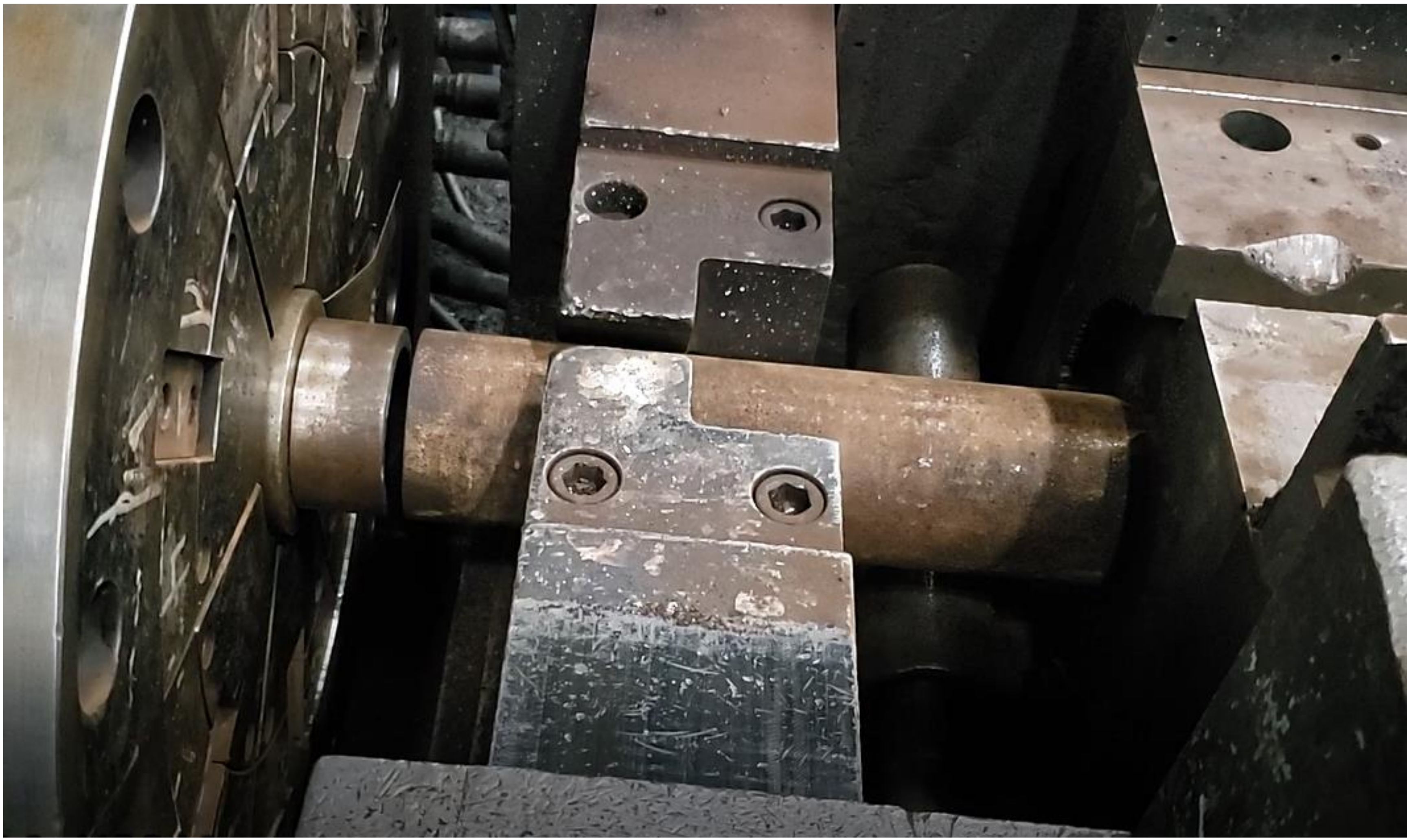
## CAPACITY V/S INSTALLATION TORQUE



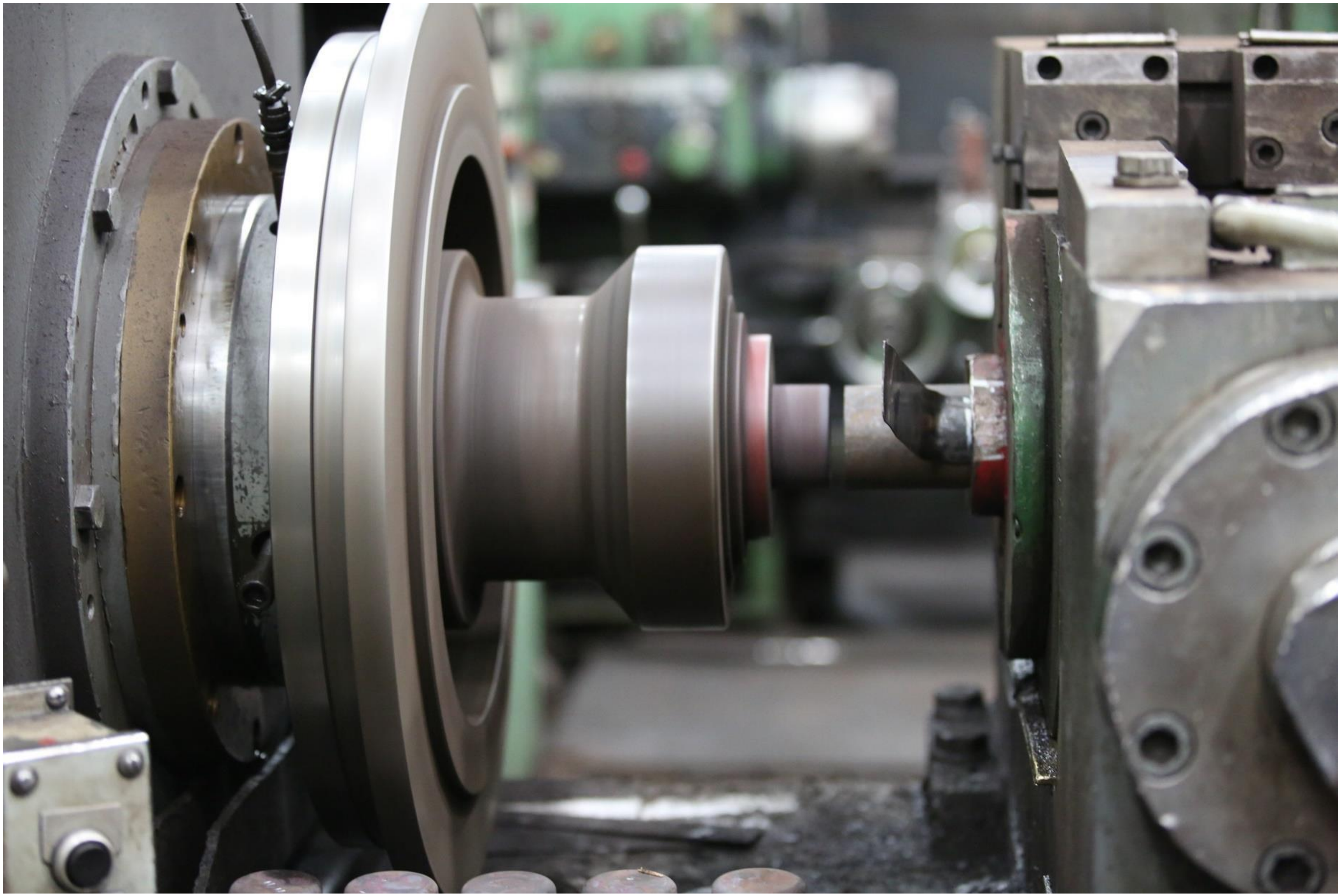
# "WHY ARE WE DIFFERENT"
# INERTIA WELDING

- **PATENTED and EXCLUSIVE system from HELICAL ANCHORS INC.**
  - Improves the strenght of connections.
  - Increases the Torque capacity of helical piles.
- **Four Components:**
  - Weight.
  - Rotation.
  - Pressure.
  - Time.
- **Piles available via Inertia welding**
  - 2 7/8" – 7"
- **Sleeve design**
  - 8 5/8"- 16"
- Bigger diameter base on customer requirements

# ”WHY ARE WE DIFFERENT”
## INERTIA WELDING

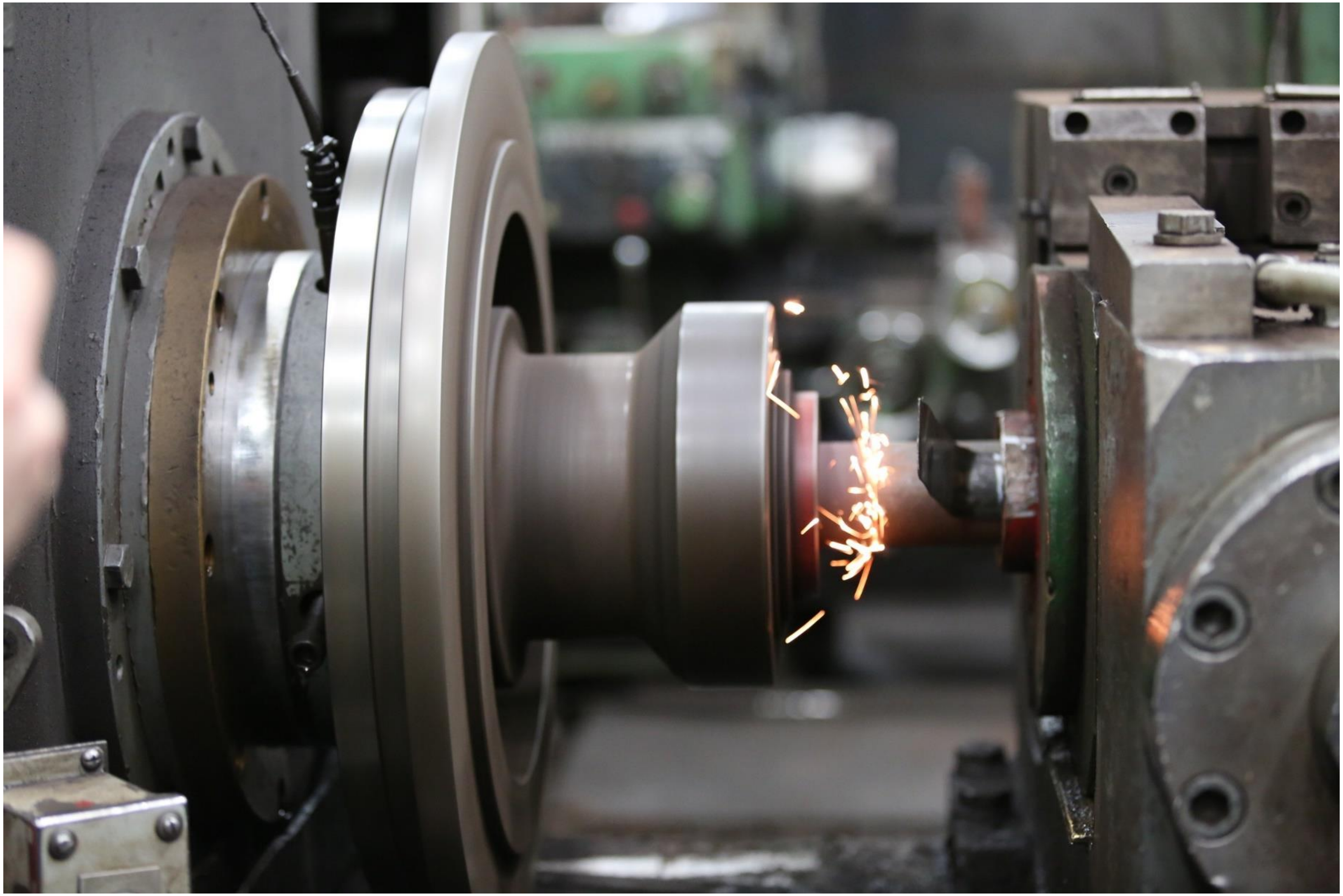


# ”WHY ARE WE DIFFERENT”
# INERTIA WELDING



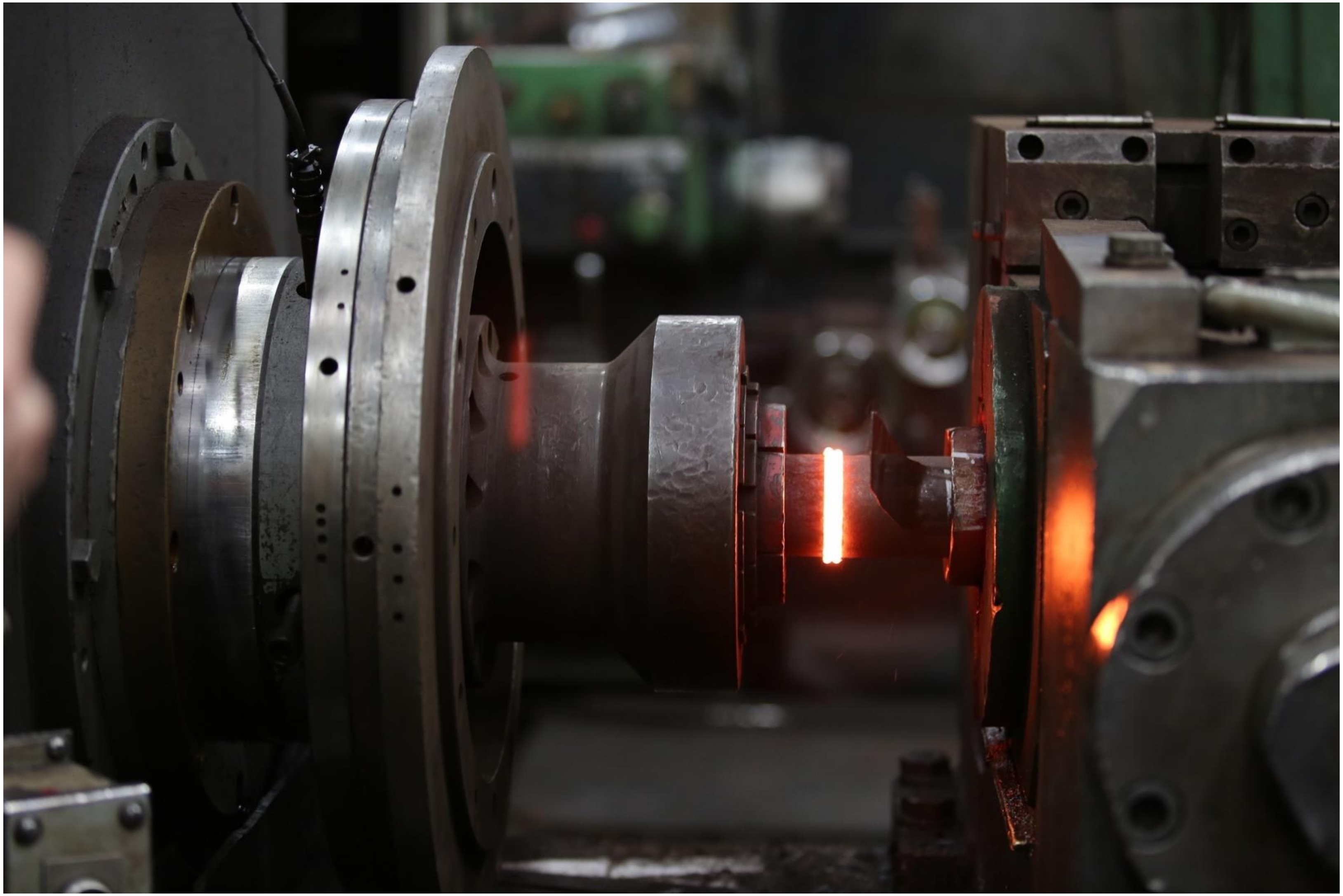
# ”WHY ARE WE DIFFERENT”

## INERTIA WELDING

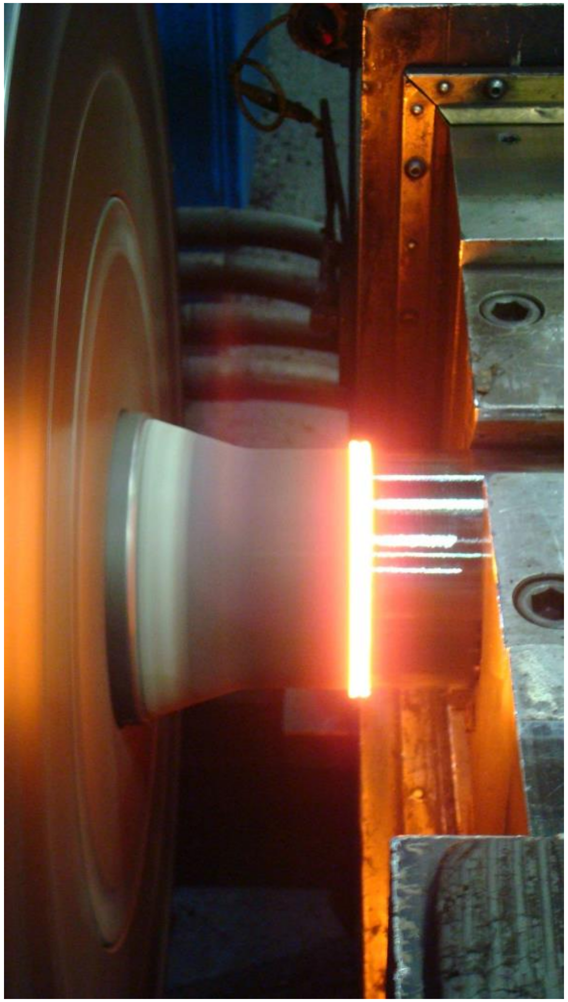


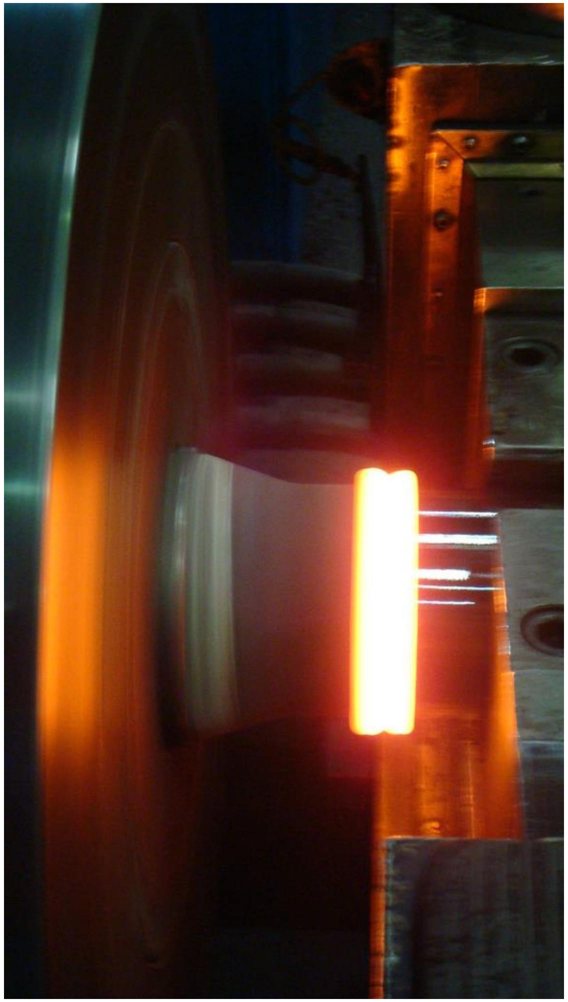
# ”WHY ARE WE DIFFERENT”

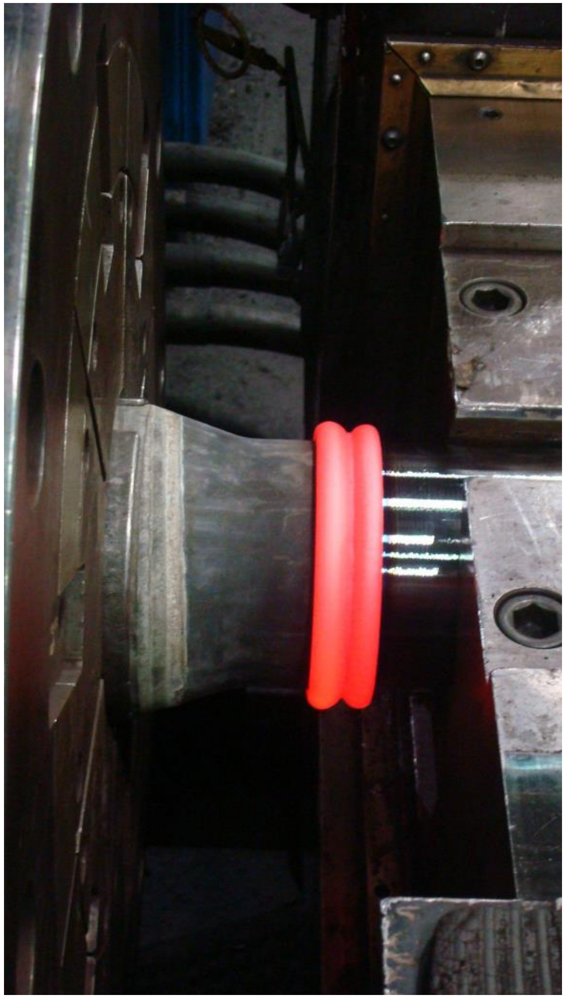
## INERTIA WELDING



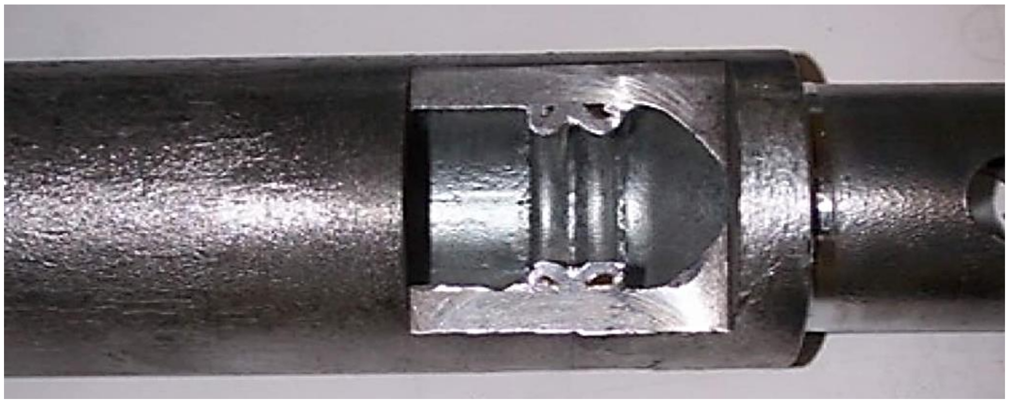
# ”WHY ARE WE DIFFERENT”
## INERTIA WELDING







# "WHY ARE WE DIFFERENT"
## INERTIA WELDING



# "WHY ARE WE DIFFERENT"
## INERTIA WELDING

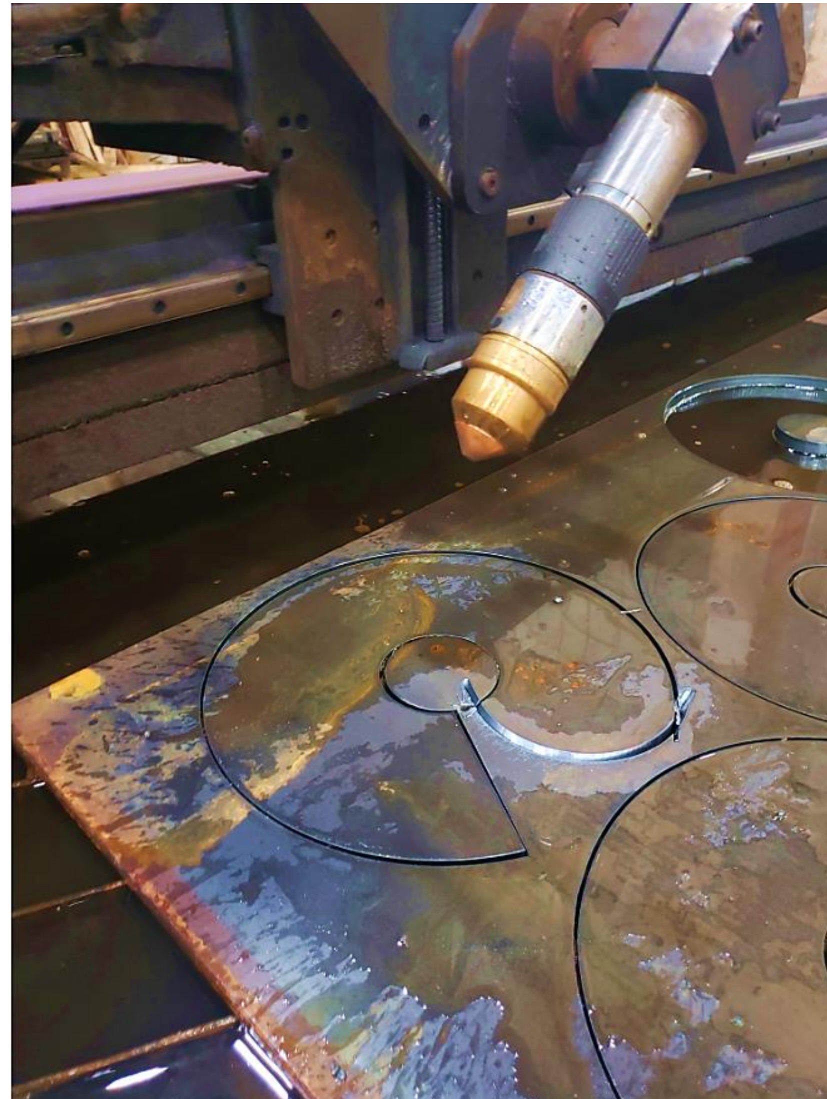
# "WHY ARE WE DIFFERENT"
# INERTIA WELDING

True connection and Zero lateral movement

# MANUFACTURING PLANTS
# PRODUCTION AND TECHNOLOGY


# MANUFACTURING PLANTS PRODUCTION AND TECHNOLOGY

# MANUFACTURING PLANTS PRODUCTION AND TECHNOLOGY

# MANUFACTURING PLANTS
# PRODUCTION AND TECHNOLOGY

# PROTECTION AGAINST CORROSION
# HOT DEEP GALVANIZED (ASTM)

- Main factors influencing the corrosión process:
  - Chlorides.
  - Humidity.
  - pH.
  - Resistivity.

- Hot Deep GALVANIZING is applied to all parts under the standard norm **ASTM A123**.
  - Standard requirements:
    - Industry mínimum requirement: 3.5 [mils].
    - Helical Anchors Inc.: 4.0  to 5.0 [mils].
  - Process:
    - Cleaning.
    - Acid bath.
    - Zinc bath.

AGA
Zn
American Galvanizers Association
*Protecting Steel for a Sustainable Future*

1 = 0.0254
Mil Milímetro

ASTM INTERNATIONAL

# PROTECTION AGAINST CORROSION HOT DEEP GALVANIZED (ASTM)

- **Typical Life Expectancy for Galvanized Steel Helical Pile in Soil Exceeds 100 Years**
  - Based on soils that are considered mildly corrosive
  - 1/8 inch (3.2 mm) loss of material on shaft

- **Sacrificial loss of steel**
  - Corrosion allowance
- **Hot dipped galvanizing or other coatings (passive control)**
  - Zinc
  - Nylon coated bolts
  - Bituminous or asphaltic coatings
- **Sacrificial anodes (active control)**
  - Magnesium or zinc bags

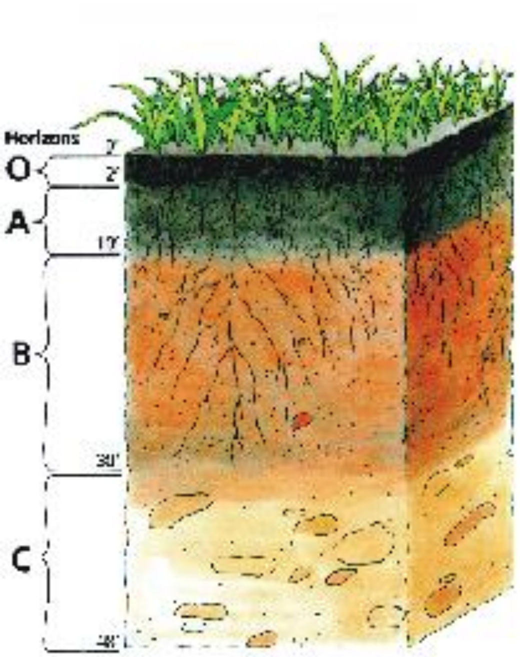
# Determining Capacity Of Helical Pile In soil

**Soil Borings/Calculations**

**Torque vs Capacity**

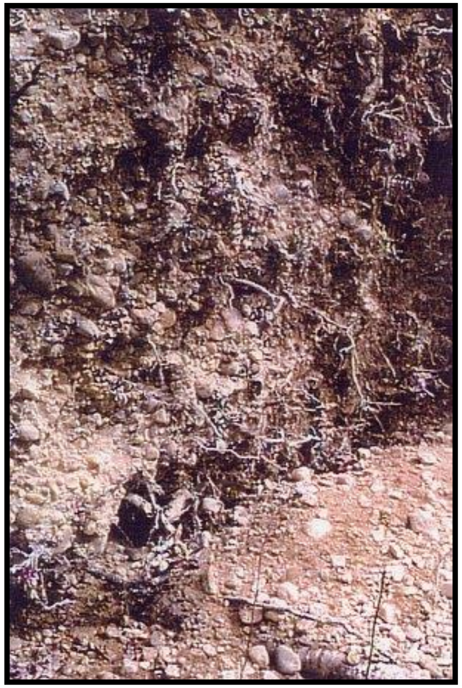
**Load Test**

## Soil Layers




## Residual Soil

## Transported Soil



- “O” Horizon: Both Fresh & Decaying Plant Materials
- “A” Horizon: Mix Of Humus & Minerals, Usually Black
- “B” Horizon: Mineral Horizon – Usually Red or Brown
- “C” Horizon: Mineral Horizon – Usually Gravel, Silt or Clay
- “R” Horizon: Underlying Rock

HELICAL PILES WILL NOT WORK IN ROCK

# Anchor Application Information

## SOIL CLASSIFICATION DATA

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

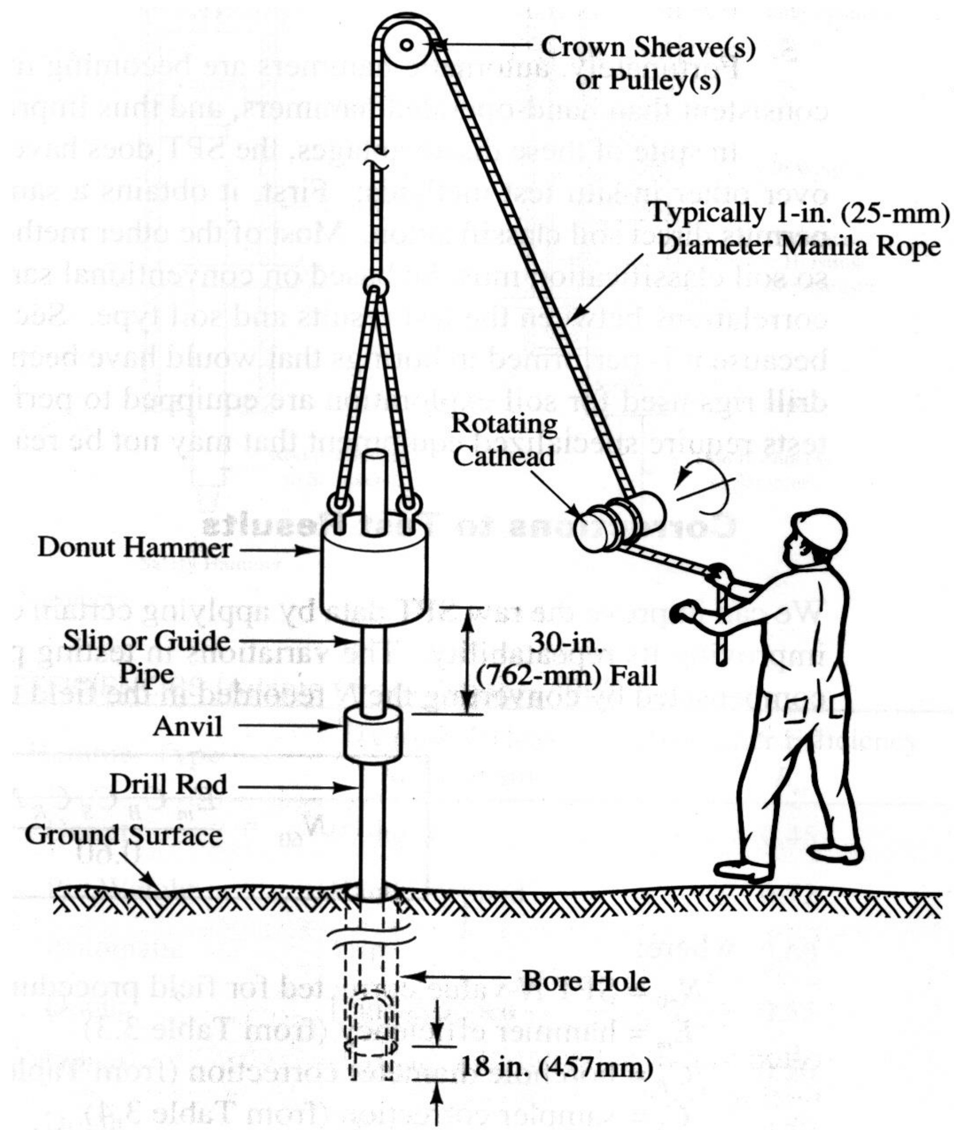
Class 1 soils are difficult to probe consistently and the ASTM blow count may be of questionable value.
**It is advisable to install anchors deep enough, by the use of extensions, to penetrate a Class 5 ot 6, underlying the Class 7 or 8 Soils.

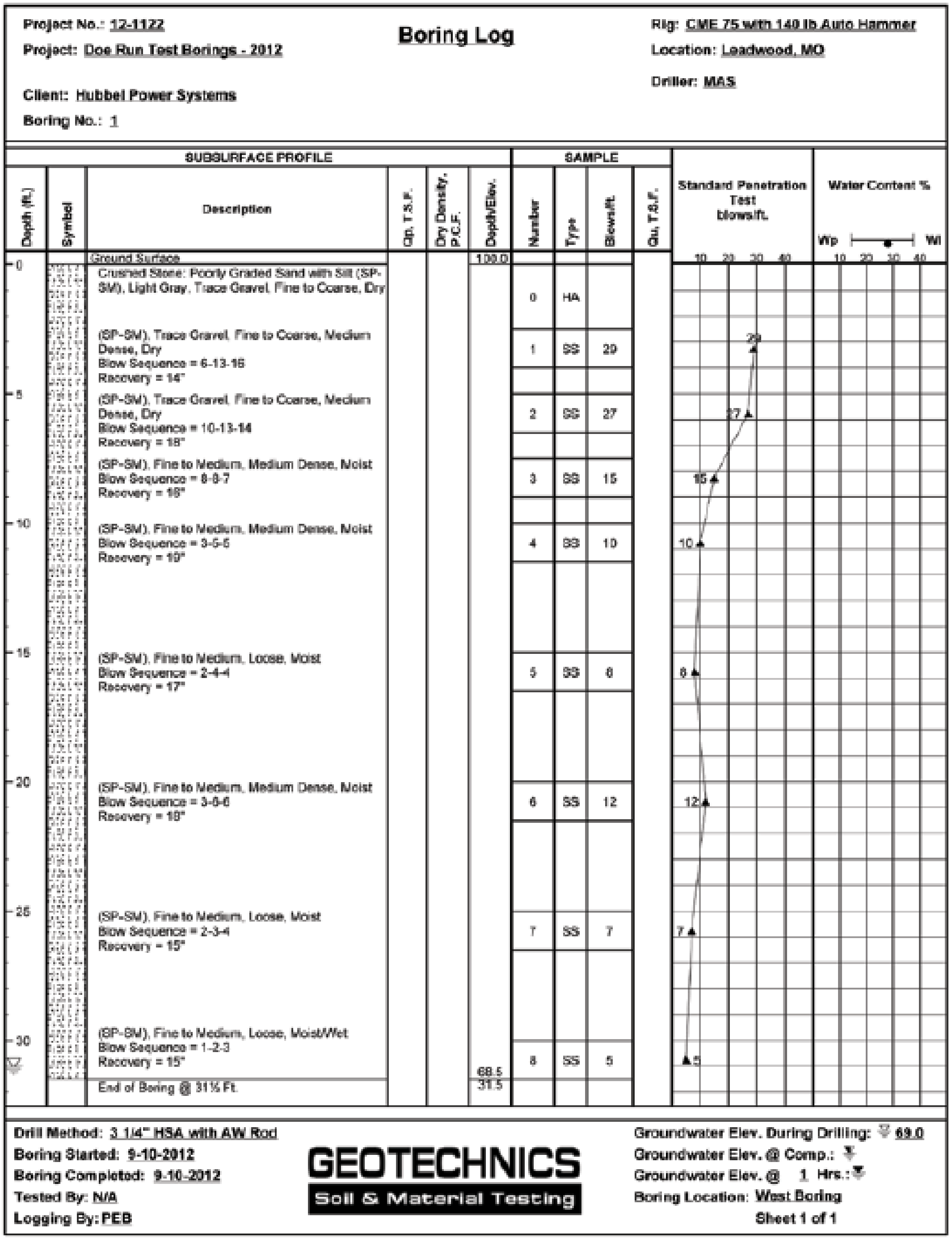
# SPT “N-Value”/Blow Count

## SPT “N-value”

**IS NUMBER OF BLOWS OF SPECIAL HAMMER REQUIRED TO PENETRATE STANDARD SAMPLER 12 INCHES (300 MM)**

- 140-lb (63.5 kg) hammer
- 30-inch (762 mm) drop
- Penetrate total distance of 18-inches (457 mm), measure the number of blows required for each 6-inch (150 mm) increment
- Compute “N-value” by summing number of blows for last 12-inches (300 mm) of penetration
- Blow Count must be corrected if using sampler other than standard ASTM D-1586 sampler.





Project No.: 12-1122
Project: Doe Run Test Borings - 2012
Client: Hubbel Power Systems
Boring No.: 1

Boring Log

Rig: CME 75 with 140 lb Auto Hammer
Location: Leadwood, MO
Driller: MAS

| Depth (ft.) | Description | Depth/Elev. | Sample Number | Type | Blows/ft. |
|---|---|---|---|---|---|
| 0 | Ground Surface | 100.0 | | | |
| | Crushed Stone: Poorly Graded Sand with Silt (SP-SM), Light Gray, Trace Gravel, Fine to Coarse, Dry | | 0 | HA | |
| | (SP-SM), Trace Gravel, Fine to Coarse, Medium Dense, Dry; Blow Sequence = 6-13-16; Recovery = 14" | | 1 | SS | 29 |
| 5 | (SP-SM), Trace Gravel, Fine to Coarse, Medium Dense, Dry; Blow Sequence = 10-13-14; Recovery = 18" | | 2 | SS | 27 |
| | (SP-SM), Fine to Medium, Medium Dense, Moist; Blow Sequence = 8-8-7; Recovery = 18" | | 3 | SS | 15 |
| 10 | (SP-SM), Fine to Medium, Medium Dense, Moist; Blow Sequence = 3-5-5; Recovery = 10" | | 4 | SS | 10 |
| 15 | (SP-SM), Fine to Medium, Loose, Moist; Blow Sequence = 2-4-4; Recovery = 17" | | 5 | SS | 8 |
| 20 | (SP-SM), Fine to Medium, Medium Dense, Moist; Blow Sequence = 3-6-6; Recovery = 18" | | 6 | SS | 12 |
| 25 | (SP-SM), Fine to Medium, Loose, Moist; Blow Sequence = 2-3-4; Recovery = 15" | | 7 | SS | 7 |
| 30 | (SP-SM), Fine to Medium, Loose, Moist/Wet; Blow Sequence = 1-2-3; Recovery = 15" | 68.5 | 8 | SS | 5 |
| | End of Boring @ 31½ Ft. | 31.5 | | | |

Drill Method: 3 1/4" HSA with AW Rod
Boring Started: 9-10-2012
Boring Completed: 9-10-2012
Tested By: N/A
Logging By: PEB

GEOTECHNICS
Soil & Material Testing

Groundwater Elev. During Drilling: 69.0
Groundwater Elev. @ Comp.:
Groundwater Elev. @ 1 Hrs.:
Boring Location: West Boring
Sheet 1 of 1

# Geotechnical Report with Bore Logs

## Standard Penetration Test ASTM – D1586

N-Value

Number of blows required to drive a 2" O.D. split spoon sampler 12 inches after it has been seated 6 inches.

- Driven by
- 140 lb. Hammer
- Dropped 30 inches
- Each hit by the hammer is one blow

# BEARING CAPACITY EQUATION OF HELICAL PILE

$$Q_{ULT} = \Sigma Q_H$$

$Q_{ULT}$ = Total Multi-Helix Anchor Capacity

$Q_H$ = Individual Helix Capacity

$$Q_H = A_H(cN_C + qN_q) \leq Q_s$$

$A_H$ = Projected Helix Area

c = Cohesion

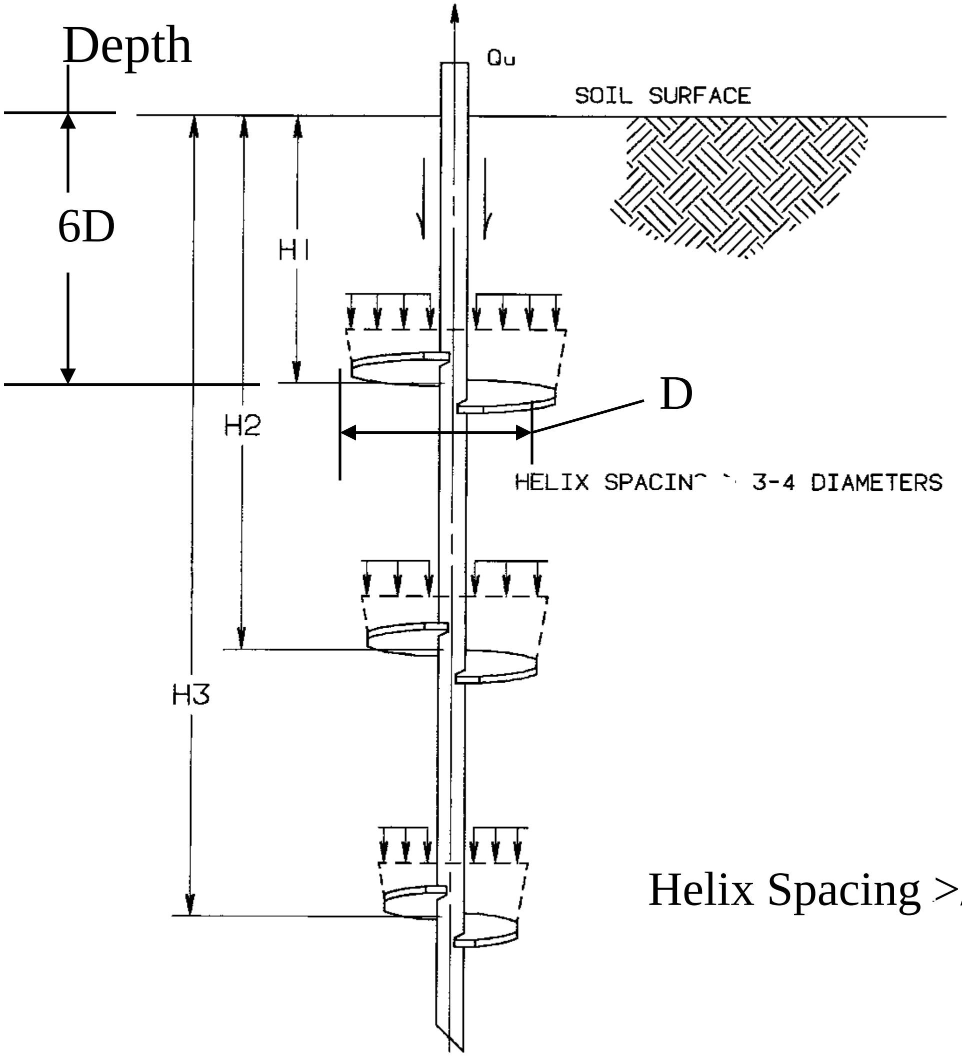
q = Effective Overburden Pressure

Nc, Nq = Bearing Capacity Factors

$Q_S$ = Upper Limit Determined by Helix Strength

# Plate Bearing Capacity Model

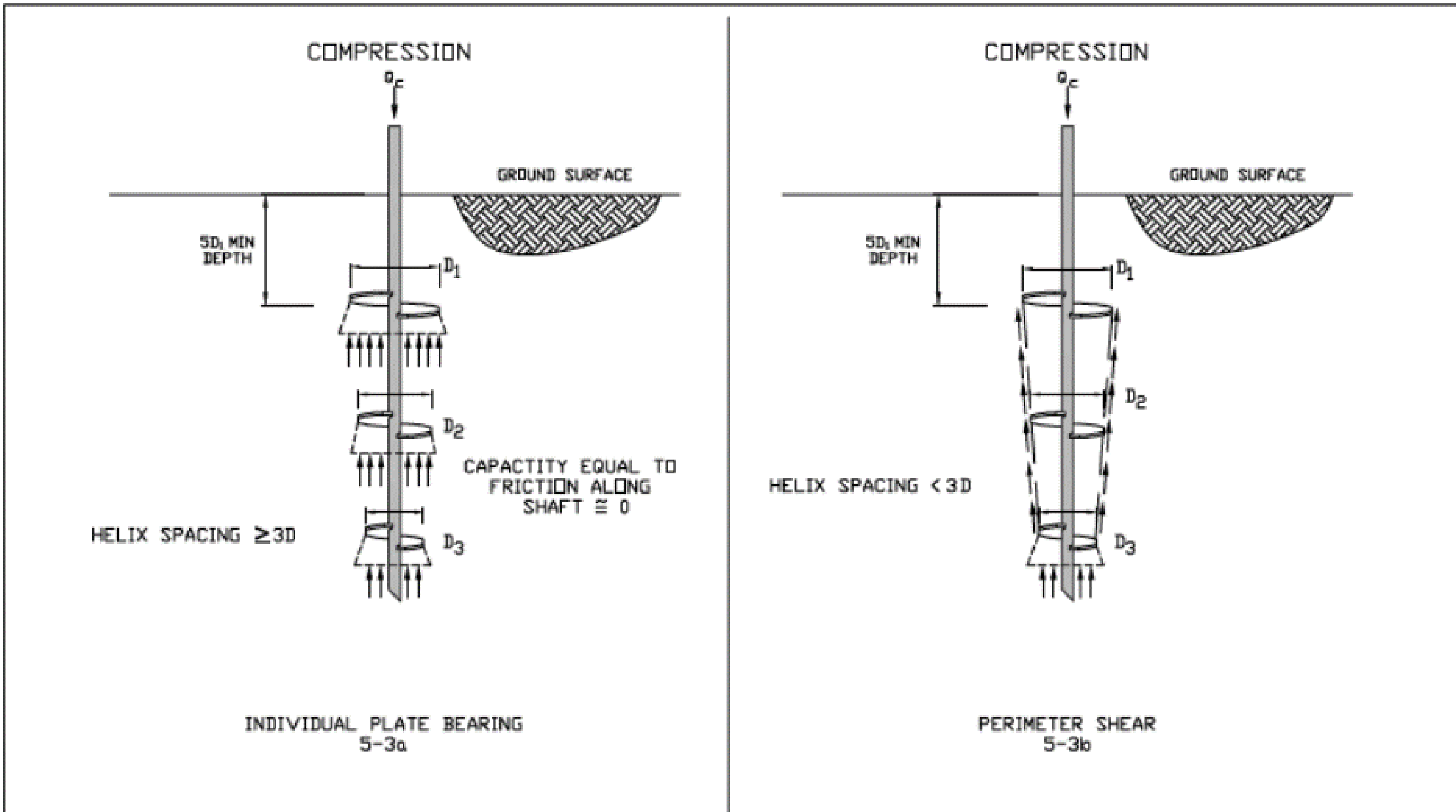
## for a Deep Foundation



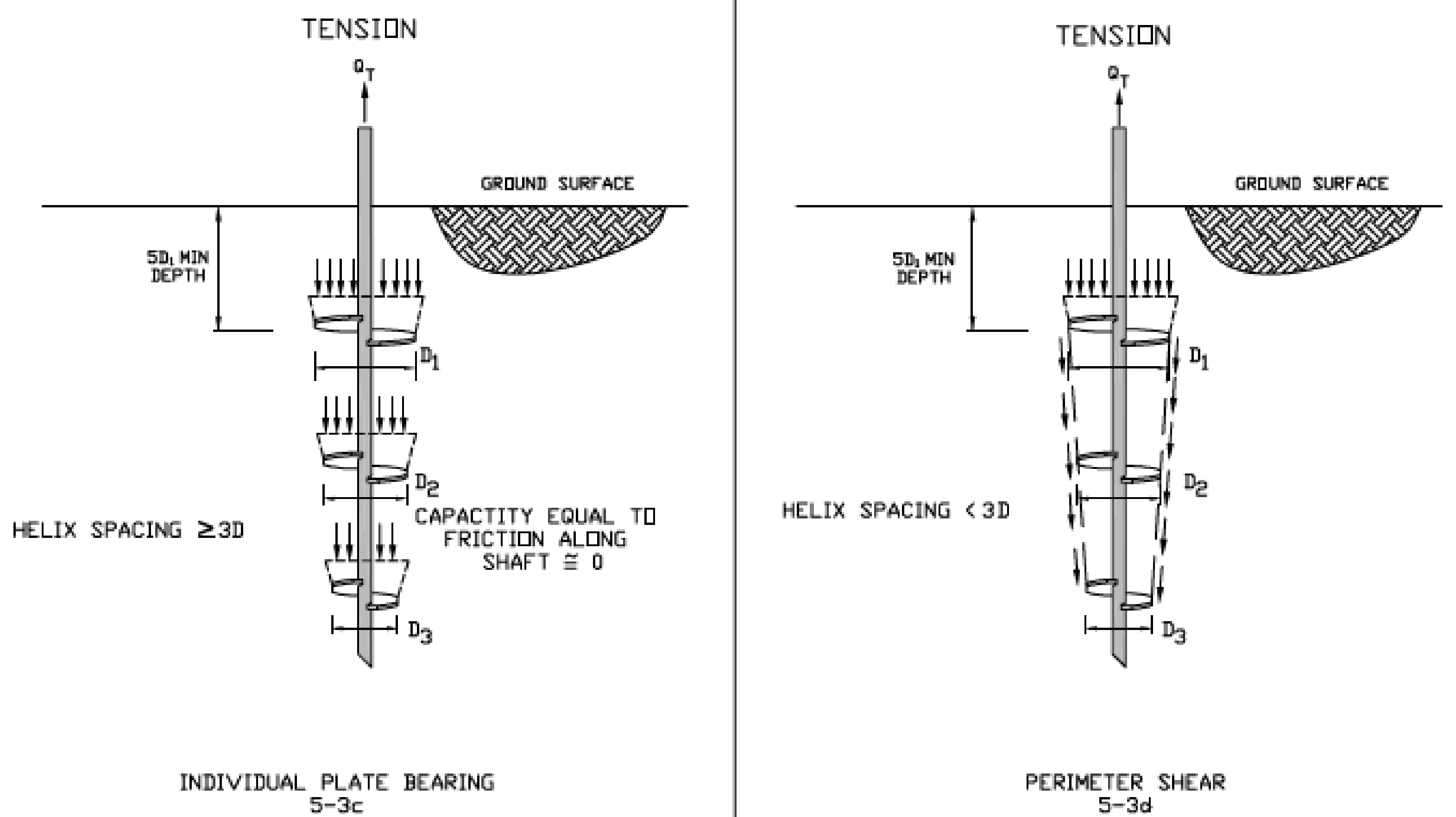

- Total Capacity Equal to Sum of Individual Helix Bearing Capacities
- Capacity Due to Friction Along Shaft ≅ Zero

Helix Spacing >/= 3D minimum

# COMPRESSION



# TENSION

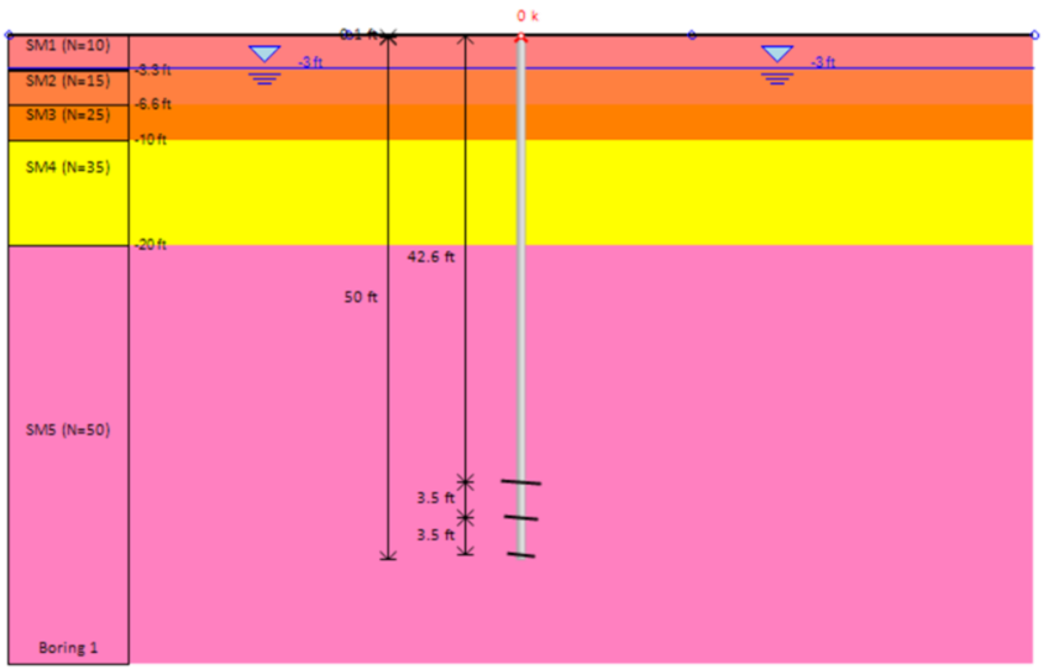



Individual Bearing and Perimerter Shear Models for Helical Piles with Slender Shafts

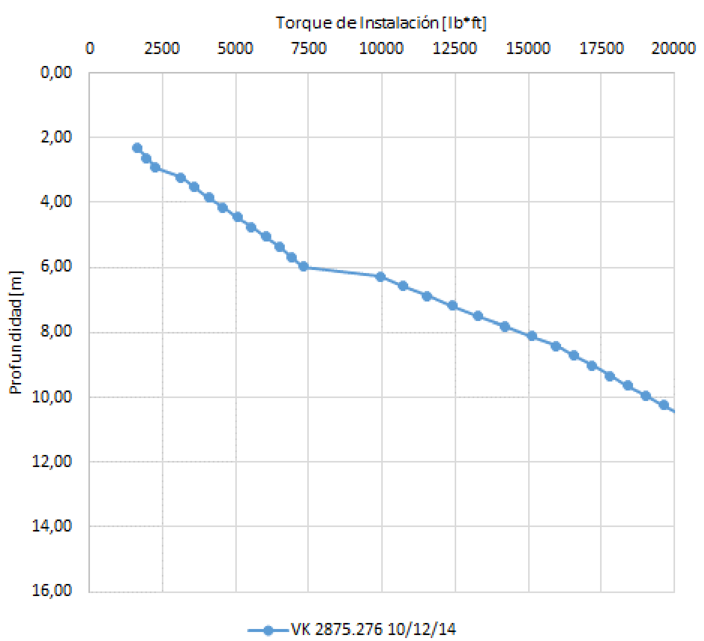
# Bearing Capacity Design

| Soil | γt | c' | Su | Φ' | Ksub | e50 | Qu | RQD | krm |
|---|---|---|---|---|---|---|---|---|---|
| Name | (pcf) | (psf) | (psf) | (deg) | (pci) | - | (ksf) | (%) | - |
| SM1 (N=10) | 113 | 0 | - | 29.9 | 30 | - | - | - | - |
| SM2 (N=15) | 118 | 0 | - | 31.6 | 30 | - | - | - | - |
| SM3 (N=25) | 126 | 0 | - | 34.6 | 30 | - | - | - | - |
| SM4 (N=35) | 132 | 0 | - | 37.2 | 30 | - | - | - | - |
| SM5 (N=50) | 132 | 0 | - | 40.5 | 30 | - | - | - | - |

HelixPile




Torque Curve Installation of a Helical piles
RS2875. 276
With 3 Helices of10"/12"/14"
(Soil Type 6, Sands)



# Lateral Capacity Load

**SCREW PILES: GUIDELINES FOR DESIGN, CONSTRUCTION & INSTALLATION, IPENZ (2015)**

## 6.4 Lateral capacity

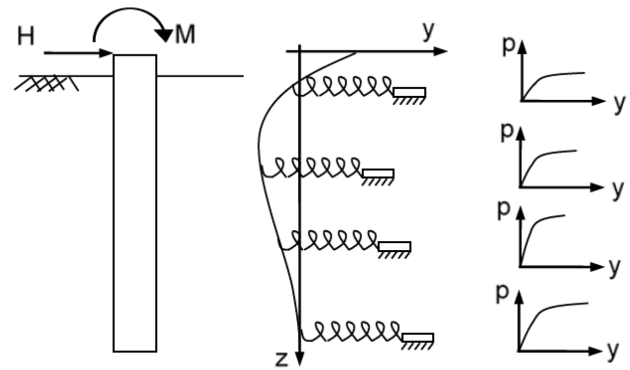
Lateral capacity-related failure mechanisms are overturning failures and translational/sliding failures. Analyses such as *Brom's methods* [9] or software such as LPILE or GROUP can be used where design for lateral loading is critical. Some recommendations to minimize the likelihood of lateral capacity failures are provided in *New Zealand Building Code, Structure Foundations, Verification Method* (B1/VM4) [10].

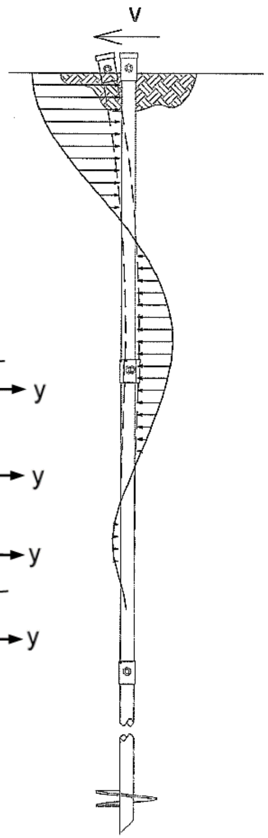
**A PRACTICAL GUIDE TO DESIGN AND INSTALLATION, HOWARD A. PERKO (2009)**

### 10.2 FLEXIBLE PILE ANALYSIS

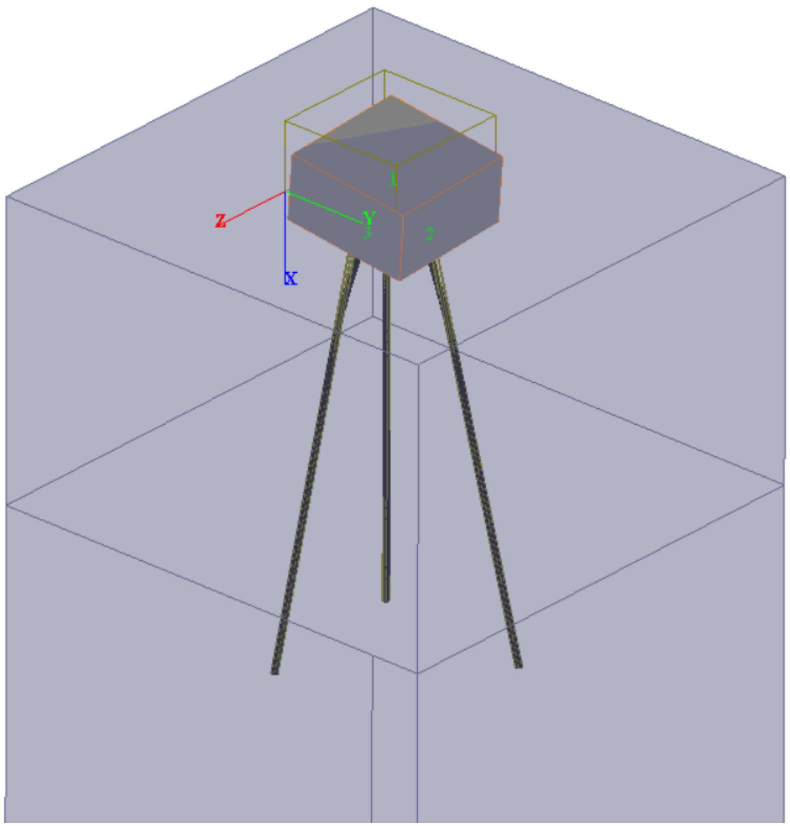
The analysis of a deeply embedded pile differs from that given in the preceding section in that the structural properties and stiffness of the pile shaft are taken into account. An example diagram showing the soil stress distribution on a deeply embedded, flexible helical pile is shown in Figure 10.3. As can be seen in the figure, the pile shaft exhibits flexure rather than rigid body rotation.

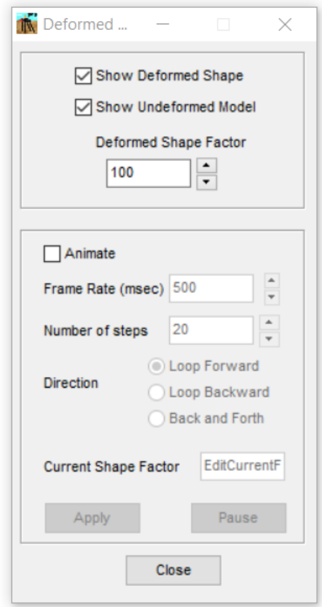
One of the simple methods to perform analysis of deeply embedded, flexible piles is a software program called L-Pile™ from Ensoft, Inc. L-Pile was originally developed by a prominent researcher named Lymon C. Reese of the University of Texas at Austin. The software uses discrete elements to solve the conventional p-y method of analysis and has several predefined p-y curves for different soil and rock types. The user must



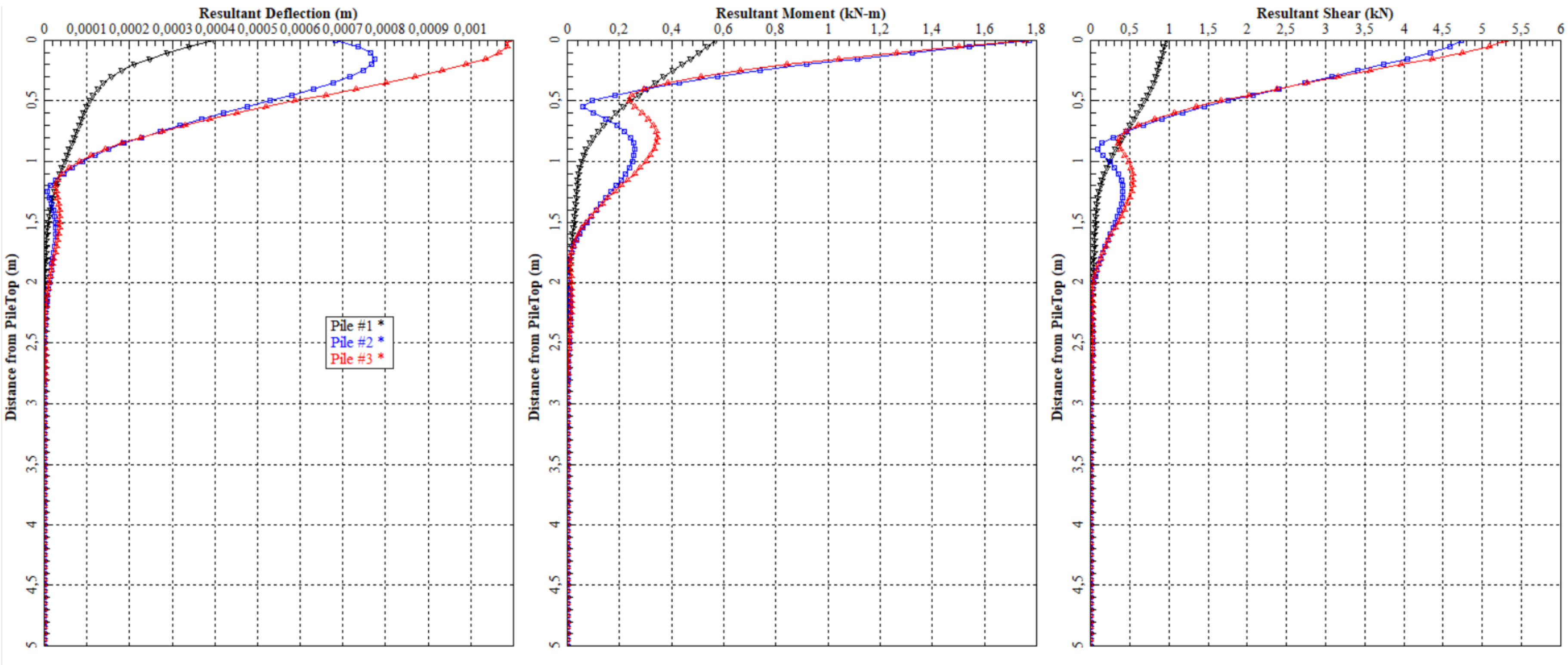



# Design for Structural capacity



# Structural capacity design



# Helical Pile Design Software

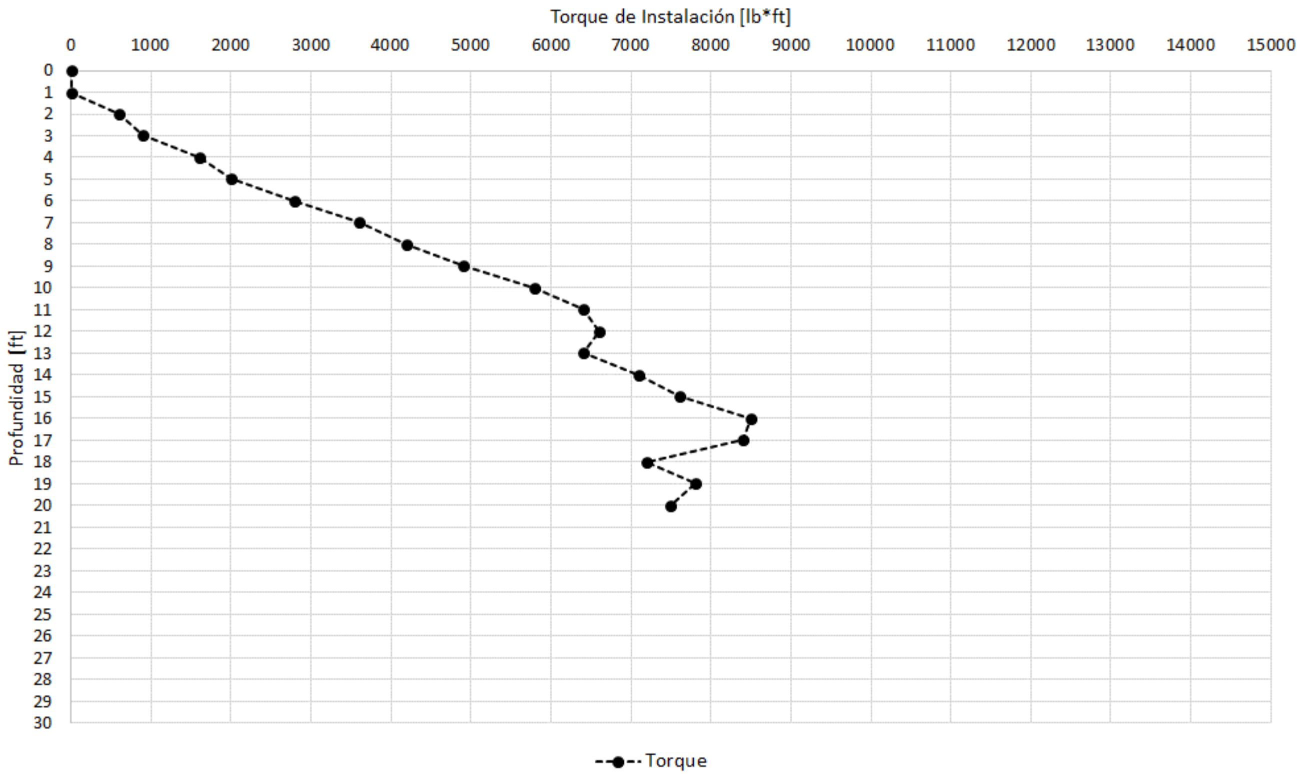
- For helical pile design, following softwares are recommended:
    - **Bearing Capacity in Soils:**
        - ➢ **HelixPile (Deep Excavation®)**
    - **Structural Capacity:**
        - ➢ **GROUP (ENSOFT®)**

# HELICAL PILES INSTALLATION
# INSTALLATION TORQUE

FIELD INSTALLATION TORQUE RECORD

- Excellent method of quality control of the installation.
- **Empirically relates the axial capacity of each pile.**
    - $Q_{ult} = K_t T$
        - Where:
            - Qult = Ultimate Capacity [lb (kN)]
- Torque Reading is done on All piles

# TORQUE QUALITY CONTROL DURING INSTALLATION



# HELICAL PILES INSTALLATIONS QUALITY CONTROL AND LOAD TEST

- **FILED QUALITY CONTROL:**
  - Torque installation records of all installed piles in the project.
  - Field testing of piles in compression and tension.
    - This test is carried out following the general guidelines of the ASTM D3689-07 standard and is adjusted according to the particular requirements of the client and installer recommendations.

# Safety Factor

Once the design load on a structure has been determined, an appropriate factor of safety is used to multiply the design load by the safety factor to calculate the ultimate load required. Typical safety factors range from 1.25 to 4, depending on the intended use of the structure and consequences of failure.

## Example

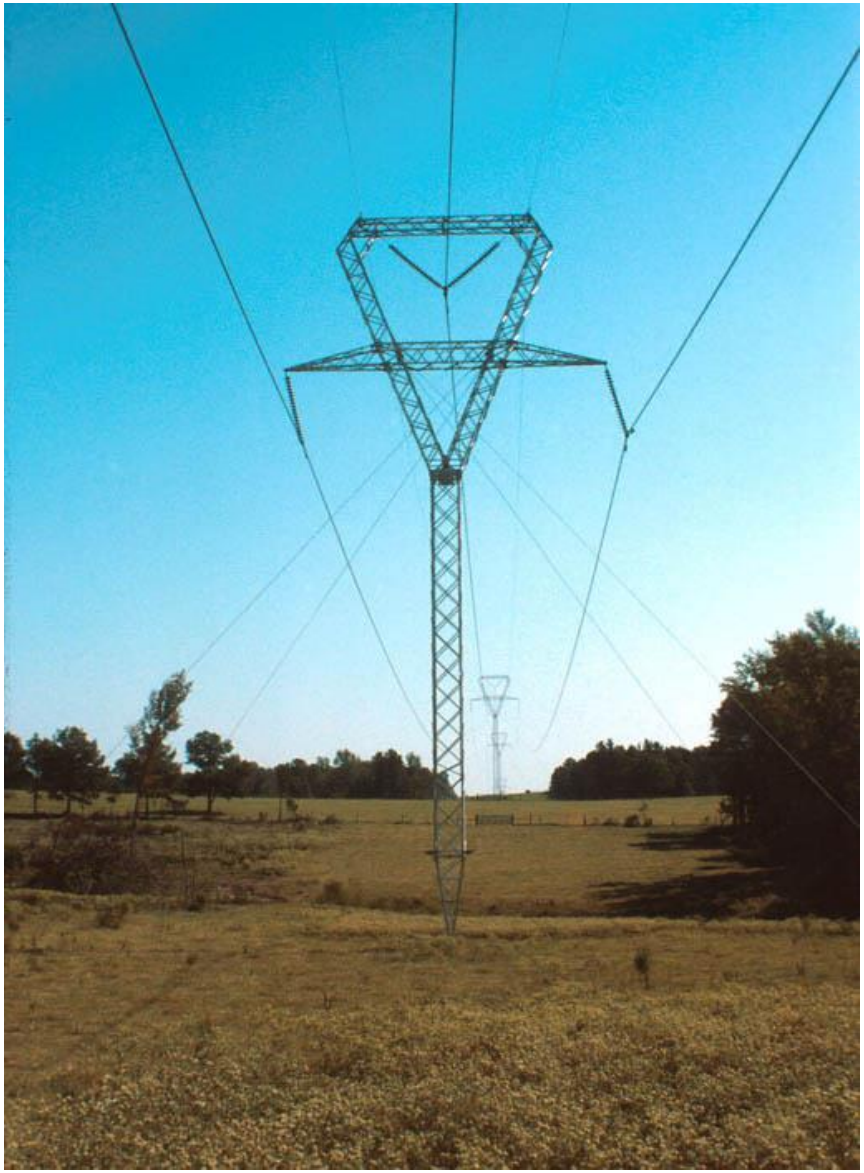
Design Load x Safety Factor = Ultimate Load

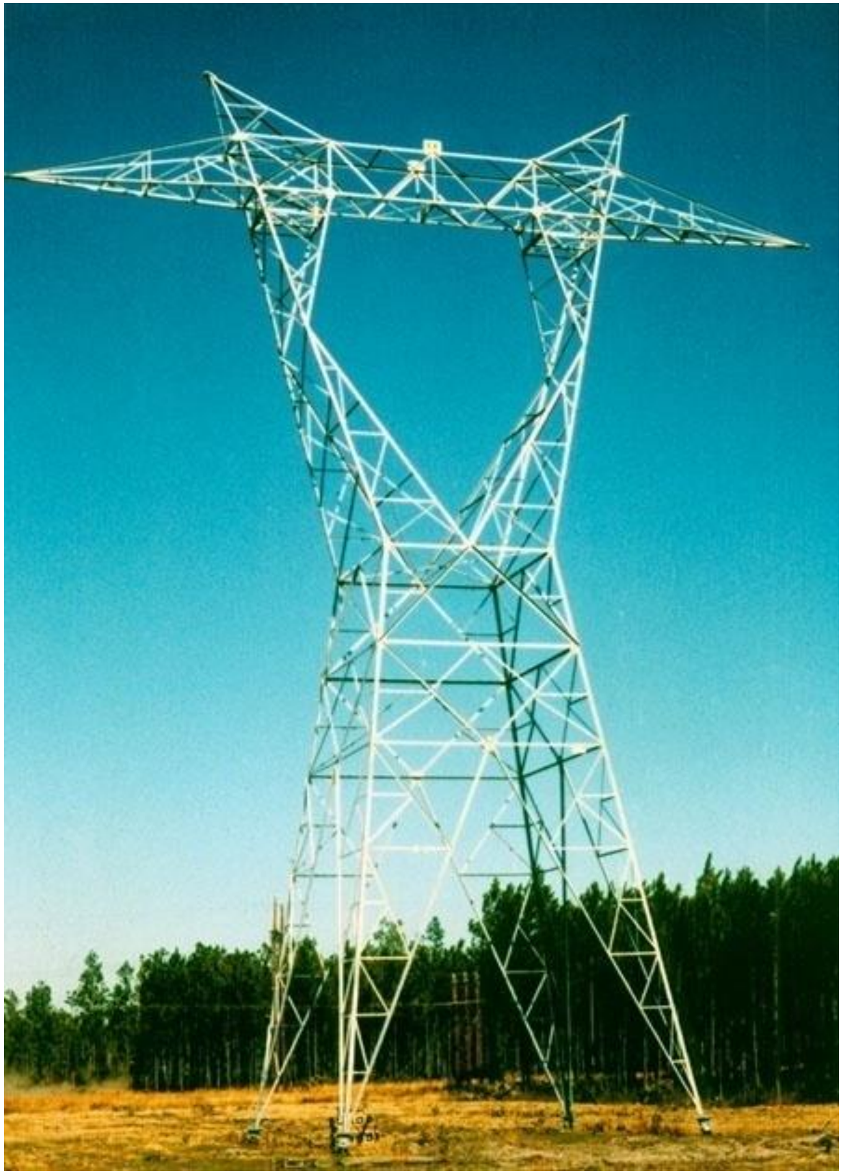
175 kN x 2 = 350 kN

HelicalAnchors,Inc.

# Projects Reference

# Transmission





# CHILE
# L.T. 220kV S.E. LAGUNILLAS – PLANTA ARAUCO (MAPA)

Transmission Line Capacity 220kV – One section of 66kV

# CHILE
# L.T. 220kV S.E. LAGUNILLAS – PLANTA ARAUCO (MAPA)

Transmission Line Capacity 220kV – One section of 66kV

# CHILE
# L.T. 500kV PICHIRROPULLI – TINEO

Transmission Line capacity 500 kV – ongoing project

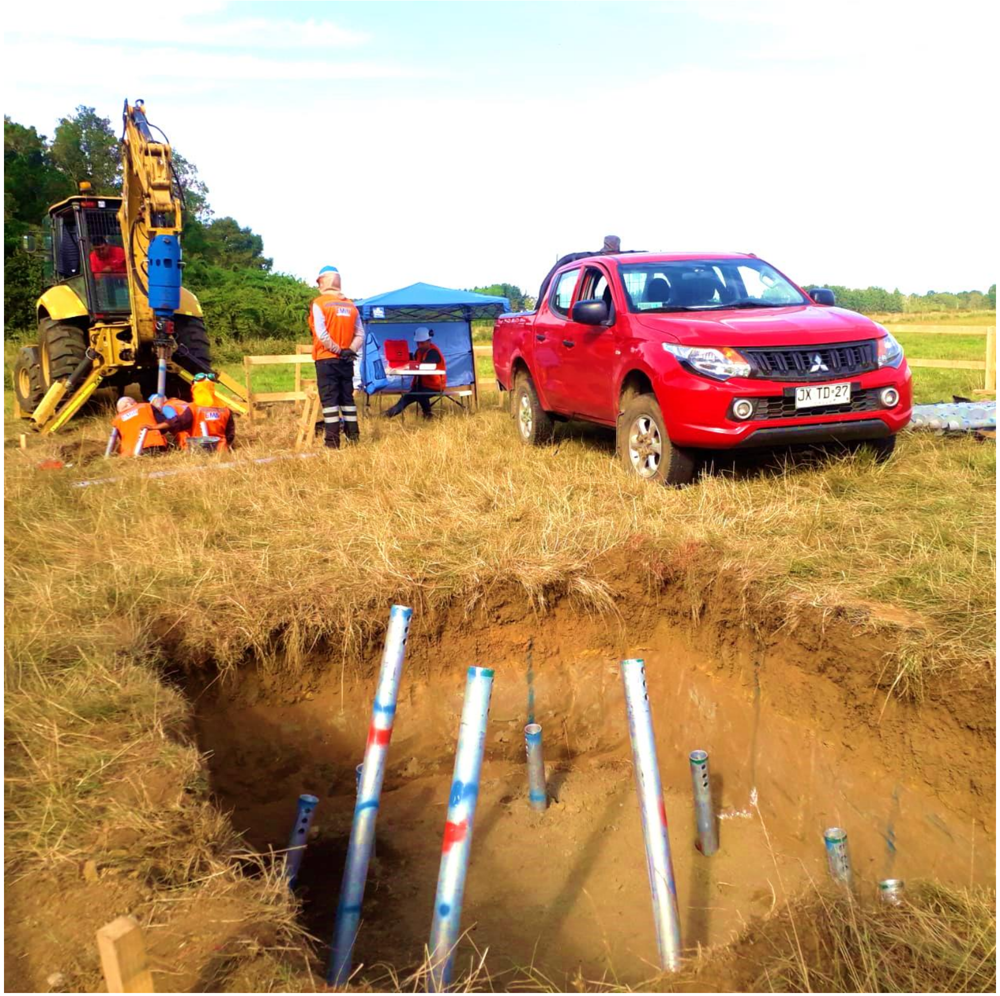

# Chile
# L.T. 500kV PICHIRROPULLI – TINEO

Transmission line Capacity 500 kV – ongoing project

# Chile- Installation via connecting Grillage 500kv Transmission Line

# Chile
# Transmission Line Capacity 220kV RAHUE – TINEO


# Chile
# Transmission Line Capacity 220kV RAHUE – TINEO



# Chile

## Transmission Line Capacity 220kV PUELCHE SUR

# Chile
# Transmission Line- 220kv, Quebrada Blanca

# ESTUDIO DE CASO DE UNA LÍNEA DE TRANSMISSIÓN

**Estudio de Caso y Resumen del Proyecto:**
Torres de Línea de Transmisión en Amazonas

**Ubicación del Proyecto:**
Iquitos, Peru

**Fecha:**
18.1.2016



7615 Smetana Ln, Ste 140
Eden Prairie, MN 55344
Office: 800-733-3801
Fax: 952-941-4633
www.vikinghelicalanchors.com


Peru, Transmission Line
Iquitos


DEERE

# RESUMEN

La planificación y el trabajo de equipo son esenciales para mejorar el desempeño y la eficiencia. Tan pronto como el equipo de Viking llegó al lugar de instalación, su enfoque fue el entrenamiento, el montaje de equipamiento, y las técnicas de instalación adecuadas. Las torres de mayor urgencia fueron situadas en la cuenca del rio, y el comienzo de la época de lluvias se acercaba rápidamente. El equipo recientemente entrenado instaló exitosamente 120 pilotes en 18 días.

## Un Desafiante Entorno de Obra

Uno de los mayores desafíos que presentan las cimentaciones de torres en el campo es el alineamiento y la orientación de la posición de los pilotes. Sin el apoyo de técnicos de campo cualificados, este procedimiento puede seria difícil en el mejor de los casos.

El proyecto de Iquitos, Perú, se destacaba por su acceso remoto, con labor mayormente manual en un ambiente húmedo y con un contratista que nunca antes había instalado pilotes helicoidales.

Viking Helical Anchors se asoció con TruTorque Corporation para suministrar el montaje de equipamientos, entrenamiento de instalación y seguridad, y la supervisión de la producción de pilotes.

TruTorque ha suministrado apoyo de campo y supervisión en los sitios de obra de pilotes helicoidales por más de 30 años. Más de 25.000 pilotes helicoidales han sido instalados bajo la supervisión de sus técnicos de campo.

## Instalación y Entrenamiento

En su primera visita a la obra, Viking y TruTorque se dedicaron al montaje correcto de la retroexcavadora, el motor hidráulico, y el sistema de monitoreo de torque. Y siguieron con el entrenamiento de instalación y finamente la prueba de carga de los pilotes de acuerdo con las normas de ASTM.

La segunda visita fue dedicada al entrenamiento y la asistencia a los equipos de instalación con los pilotes de producción en las zonas de humedales antes de la llegada de la estación lluviosa.

Las cimentaciones de torres de mayor urgencia fueron colocadas en la cuenca fluvial adyacente al punto de confluencia de los ríos Amazonas y Nanay, e incluyendo torres con las cargas estructurales más altas.

A pesar de lo desafíos de las condiciones de campo, el contratista local fue capaz de instalar 120 pilotes en 18 días con la asistencia de los técnicos de campo de TruTorque.


# BRAZIL-Transmission Line Project-500kv & 600kv


CRAVAÇÃO DE ESTACAS HELICOIDAIS NA TORRE 699/2 – RIO VERMELHO

# Chile-Project LT. Entre Rios

## LÍNEA DE TRANSMISIÓN S.E. ENTRE RÍOS (PEMUCO) – S.E. CHARRÚA (CHARRÚA

Tabla 1: Resumen de las torres que serán apoyadas con pilas helicoidales CHANCE®.

| Torre | Tipo | Cantidad |
|---|---|---|
| Anclaje | 22AD30.1 | 5 |
| | 22AD70.1 | 1 |
| | 22FD.N2 | 2 |
| | 22RD90.5 | 4 |
| Suspensión | 22SD1.1 | 33 + 1 = 34 |


CAT
416F2
FINNING
T29


T 16



T29

# Costa Rica-Substation and Transmission APM Terminal


CAT

# Costa Rica-LT Zona Sur

- 230kv line,
- Monopoles and Lattice towers

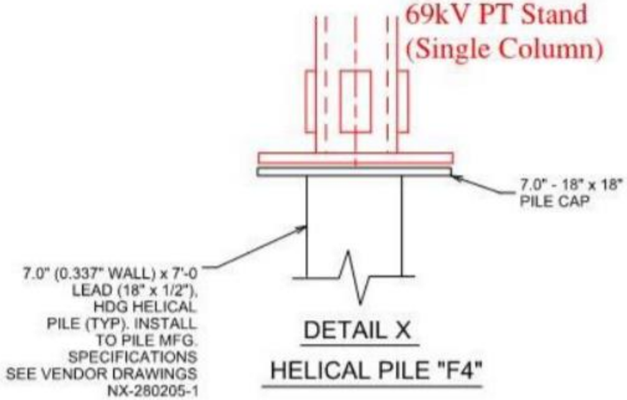
# Waterville Substation-Repair of foundations and New construction

- Most of the original foundations had settlement

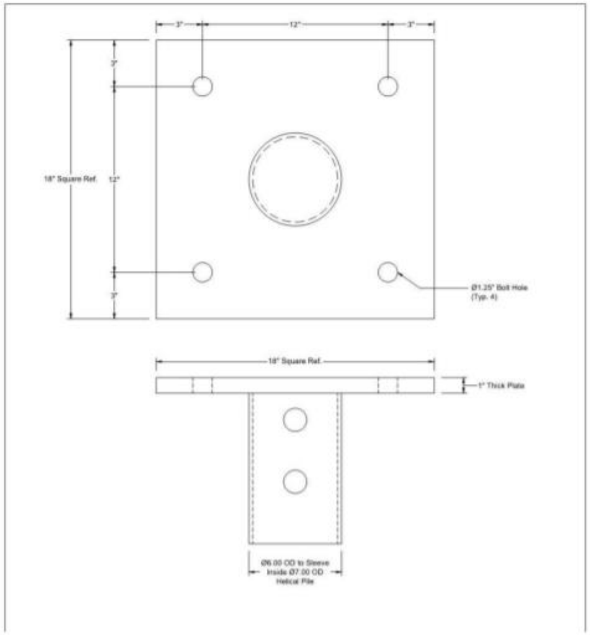


- Best Solution
    - Helical Piles, faster installation, clean and economically

# Steel to Steel bolted Connection





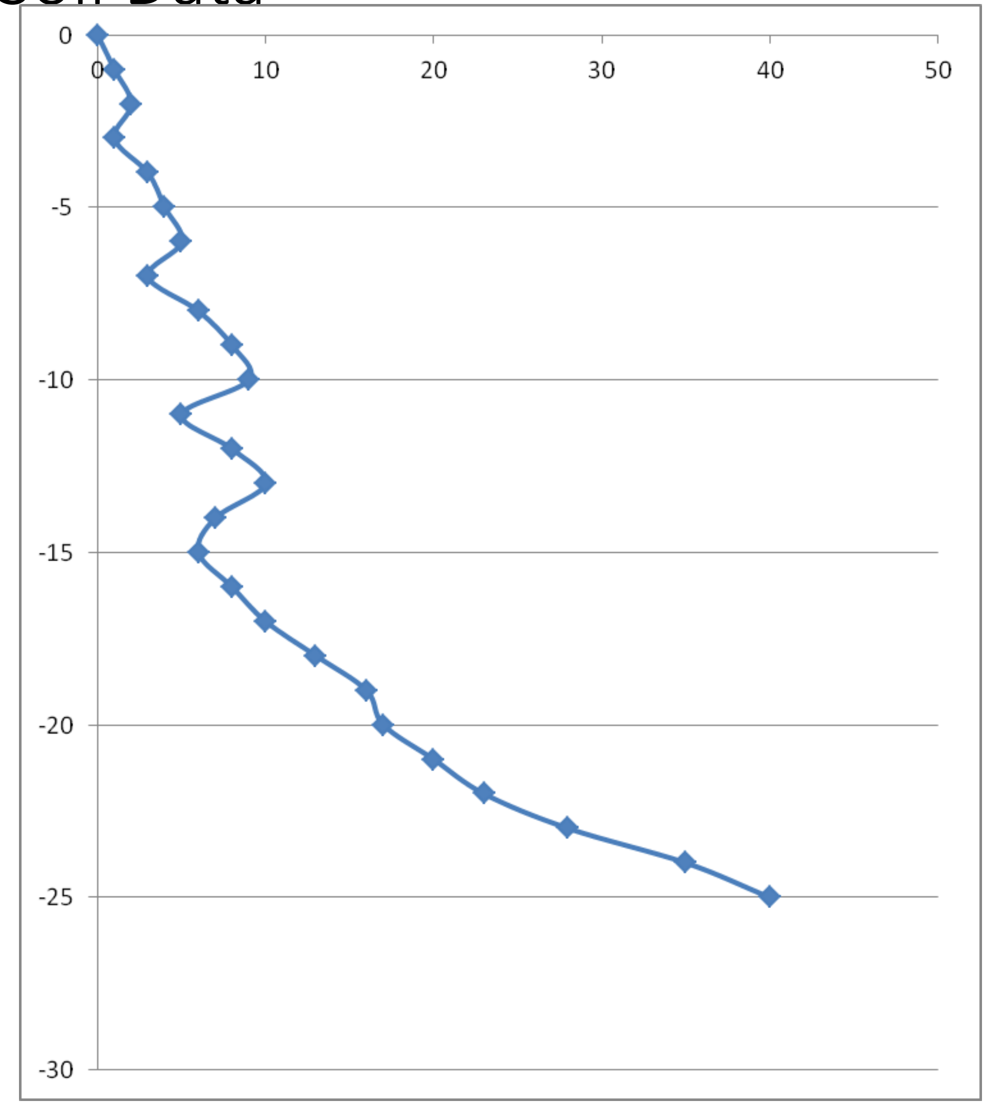


Substation addition-expansion

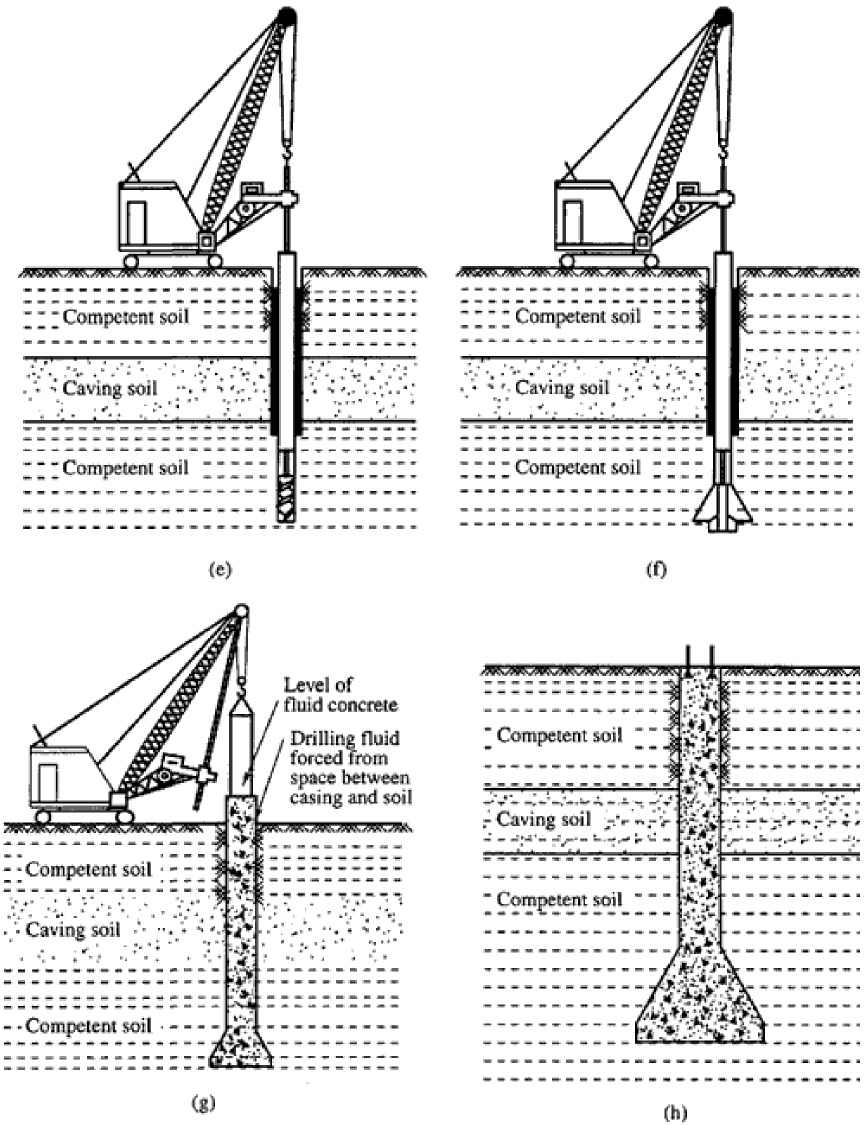
# Project Comparison: Drill Shaft vs Helical Piles

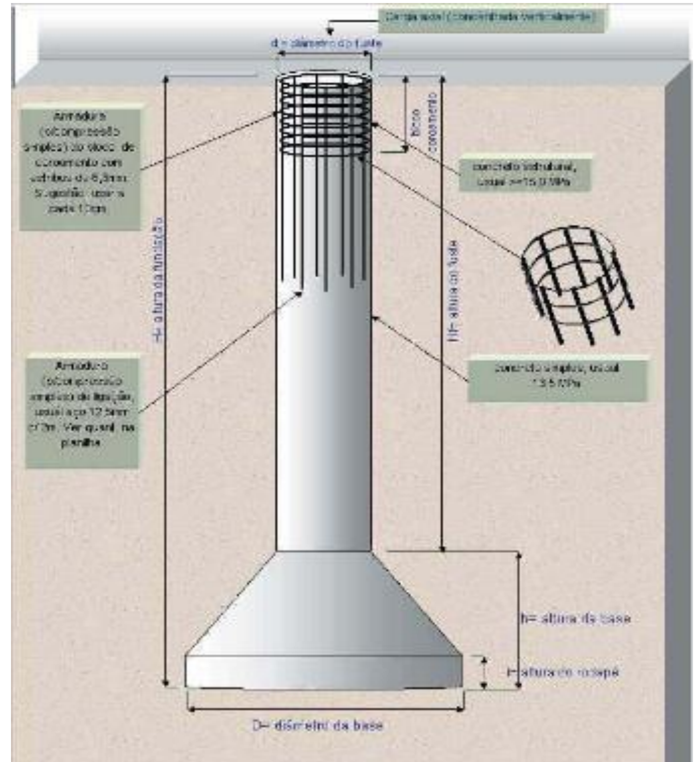
## Soil Data

| Depth [m] | Blow Count | Soil ID |
|---|---|---|
| 0 | 0 | Sand |
| -1 | 1 | Sand |
| -2 | 2 | Sand |
| -3 | 1 | Sand |
| -4 | 3 | Sand |
| -5 | 4 | Sand |
| -6 | 5 | Sand |
| -7 | 3 | Sand |
| -8 | 6 | Sand |
| -9 | 8 | Sand |
| -10 | 9 | Sand |
| -11 | 5 | Sand |
| -12 | 8 | Sand |
| -13 | 10 | Sand |
| -14 | 7 | Sand |
| -15 | 6 | Sand |
| -16 | 8 | Sand |
| -17 | 10 | Sand |
| -18 | 13 | Sand |
| -19 | 16 | Sand |
| -20 | 17 | Sand |
| -21 | 20 | Sand |
| -22 | 23 | Sand |
| -23 | 28 | Sand |
| -24 | 35 | Sand |
| -25 | 40 | Sand |



# Drill Shaft – Installation Process




# Drill Shaft – Requirement for 120 metric tons structure

- Φ=0,6m
- L=10m

- Ultimate load: 135tons

- One pile require to support loads per leg/tower

- Concrete volume: $12m^3$/leg/tower

- Time to pour the concrete: 4 days / tower

# Helical Pile – Option

# Drill Shaft – Requirment for 120 metric tons structure

- Tubular Pile RS3500 with five helical configuration of 8”-10”-12”-14”-14”-14”
- Ultimate load calculations:
    - Load capacity per pile: 88kip=40tons (11.000ft-lb)
- 120/40=3piles/leg/tower
- Requirement of 3 helical piles at depth of 20m
- Concrete volume: 2.5$m^3$
- Time to pour the concrete: 1hour
- Time to install Helical Piles: 2 days

# Summary: Drill Shaft vs Helical Pile

| | DRILL SHAFT | HELICAL PILE |
|---|---|---|
| CONCRETE VOLUME | $12m^3$ | $2.5m^3$ |
| DAYS TO COMPLETE ONE TOWER | 4 days | 2 days |
| PEOPLE TO EXECUTE | 10 | 4 |
| EQUIPMENT TO EXECUTE | Drill machine, pumps, safety equipmet, concrete truck, | Backhoe, concrete truck |

# "AND WHAT ARE ITS BENEFITS"

## INSTALLATION

- Fast and Simple.
- Easy to install in confined spaces.
- NO vibration
- NO Pridrilling is required

## COST

- Low mobilization of Equipment and overall execution cost
- NO heavy Equipment/Machinery is require for installation

## APPLICATIONS

- Versatility of uses. It is a modular system.
- Applicable in Temporary and Permanent solutions.
- Immediate Results after Installation.

# ADVANTAGES
# HELICAL PILES/ANCHORS

- Quick, Easy Turnkey Installation
- Immediate Loading
- Small Installation Equipment – Low Mobilization Costs
- 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
- No Concrete

“QUESTIONS”