HELICAL ANCHORS & FOUNDATIONS

Presented by: Josh Lindberg
Helical Concepts, Inc.
Distributor
CHANCE Civil Construction

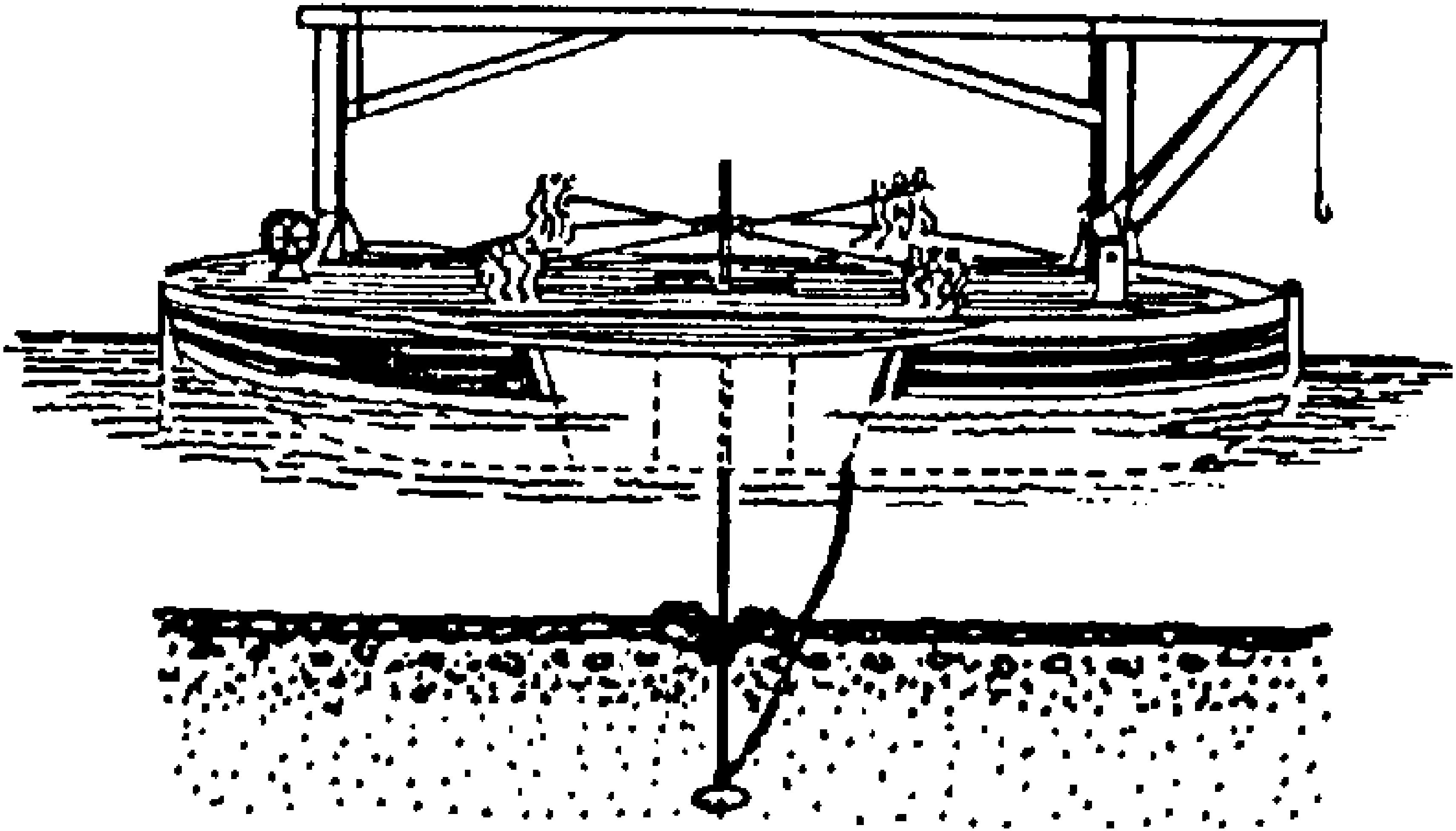
Presentation Preview

- Historical Perspective
- Product Overview
- Determination of Capacity
- Applications
- Installation Methods and Equipment

Historical Perspective

- 1st Recorded use of a Screw Pile was by Alexander Mitchell in 1836 for Moorings and was then applied by Mitchell to Maplin Sands Lighthouse in England in 1838.
- In 1843, the 1st Screw Pile Light House in the U.S. was Constructed by Capt. William H. Swift at Black Rock Harbor in Connecticut. Swift used Mitchell Screw Pile Technology.
- In the 1840's and '50's, More Than 100 Screw Pile Foundation Light Houses were Constructed Along the East Coast, the Florida Coast and the Gulf of Mexico

Manual Installation

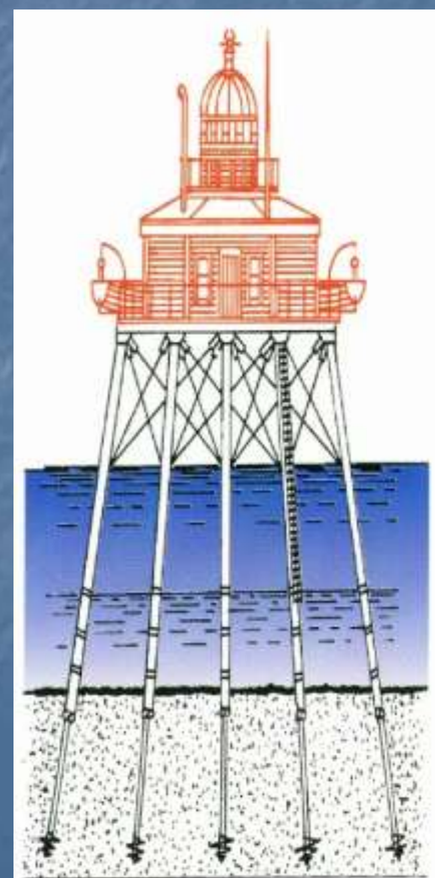


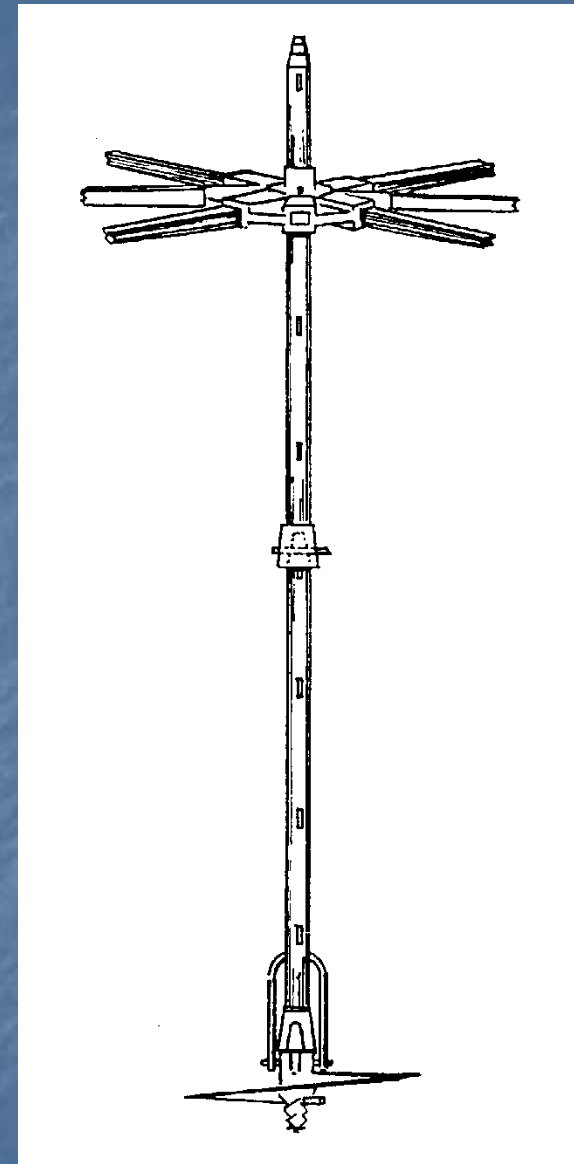
Limited Applications

Mitchell Lighthouse at Hooper's Strait, Maryland

Extracted Cast Iron Screw Pile, ≈ 30" Diameter

Mitchell Screw Pile 1835





A. B. Chance

Historically an Anchor Company

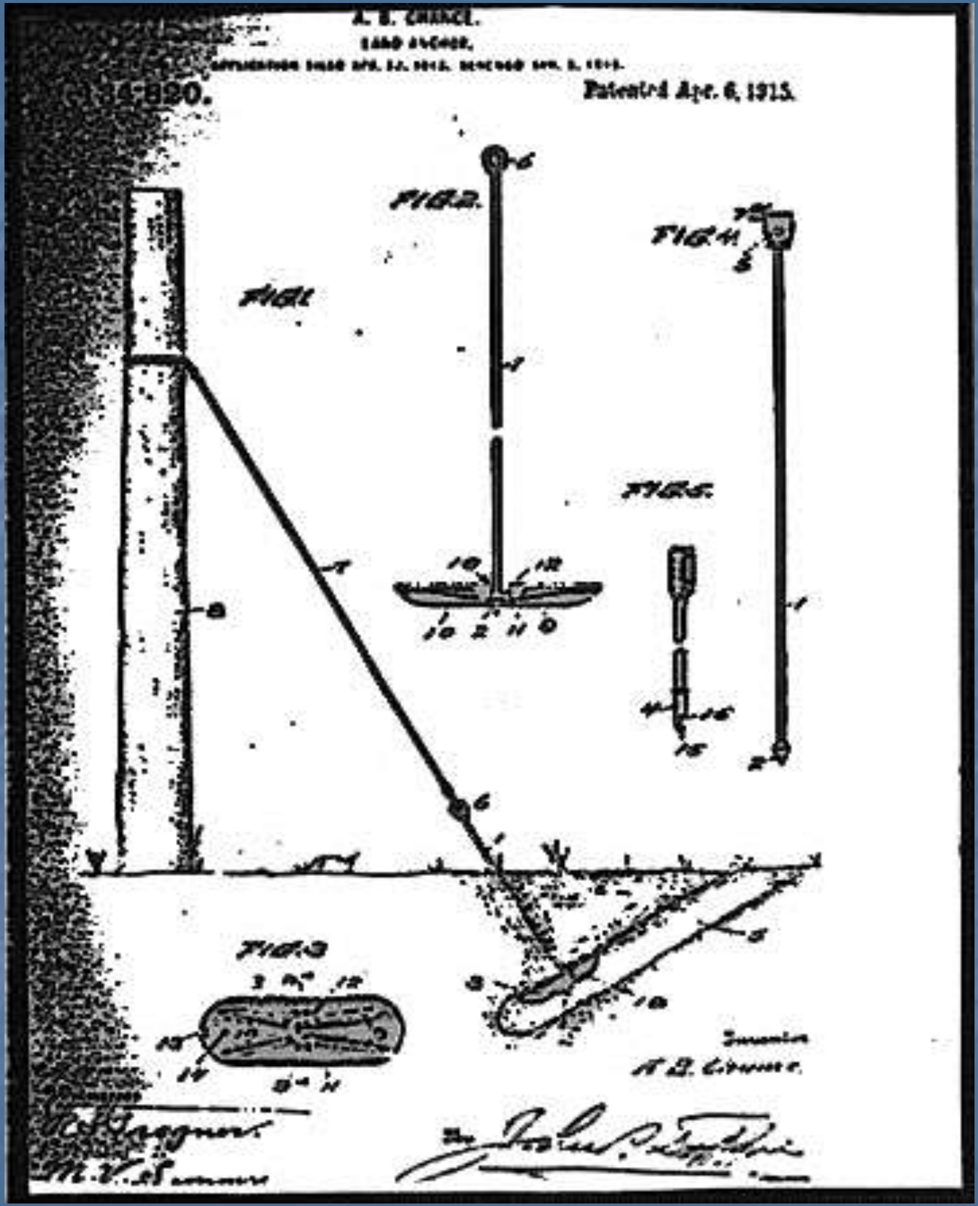
Since 1912


Centralia, MO - 1912

Centralia, MO - 1912

Never Creep Anchor

Copy of Original Never Creep Patent



Early Anchor Pull Test with Office Staff

CHANCE® Civil Construction Products

- Atlas Resistance® Piers
- CHANCE® Helical Anchors
- CHANCE® Helical Piles

APPLICATIONS

- Guy Anchors & Foundations for Towers
- Helical Piles for New Construction
- Underpinning - Residential / Commercial
- Tiebacks for Excavation Bracing
- Soil Screws for Earth Retention
- Slope Stabilization
- Seismic Retro-fit
- Tie-Downs

BUILDING CODE EVALUATION REPORTS

- ICC-ES Legacy Report - 9504B
- ICC-ES Legacy Report - 94-27
- ICC-ES Legacy Report - ER5110
- ICC-ES Acceptance Criteria for Helical Foundation Systems and Devices

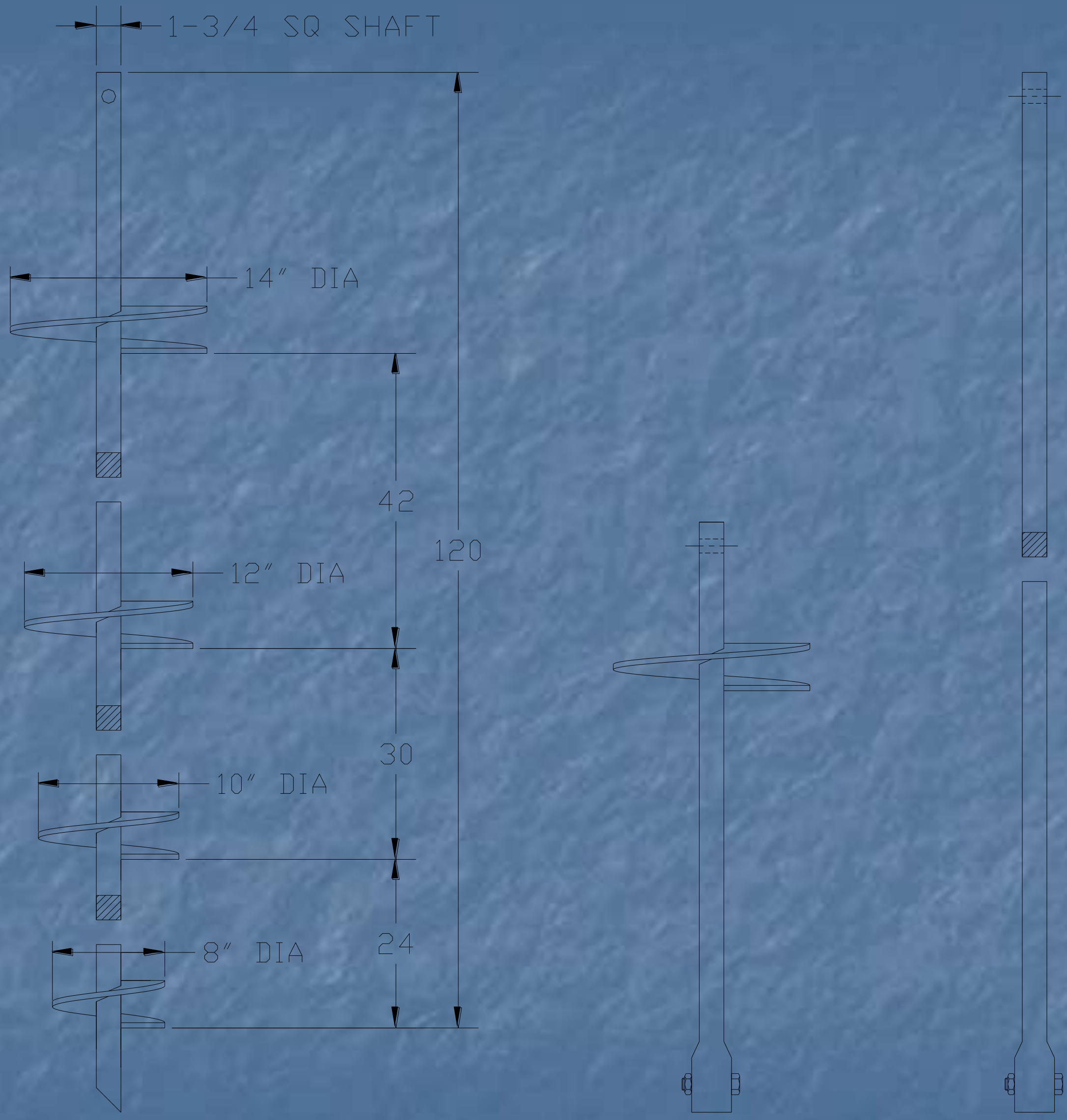
What is a helical pier?

A device used to attach or support a load at or near the surface of the earth.

Consists of Three Parts:

- Termination: Transfers applied load to the shaft
  (Repair Brackets, 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)

Square Shaft Helical Piers

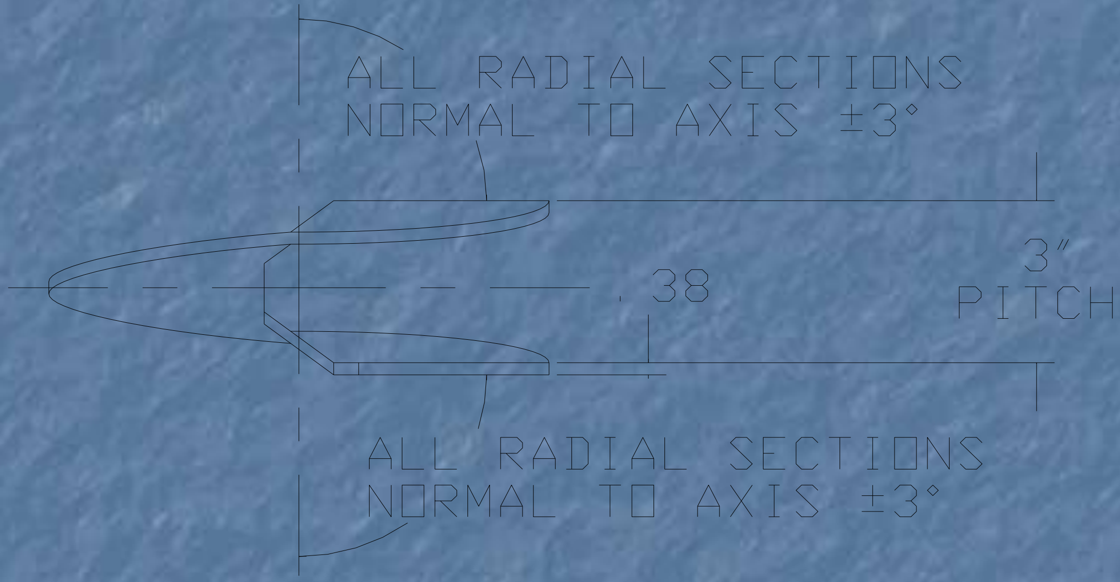


Lead Section

Helical Extension

Extension

Importance of Helix Shape
Side View of True Helix Form



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

Standard Helix Diameters

6-inch
8-inch
10-inch
12-inch
14-inch
16-inch

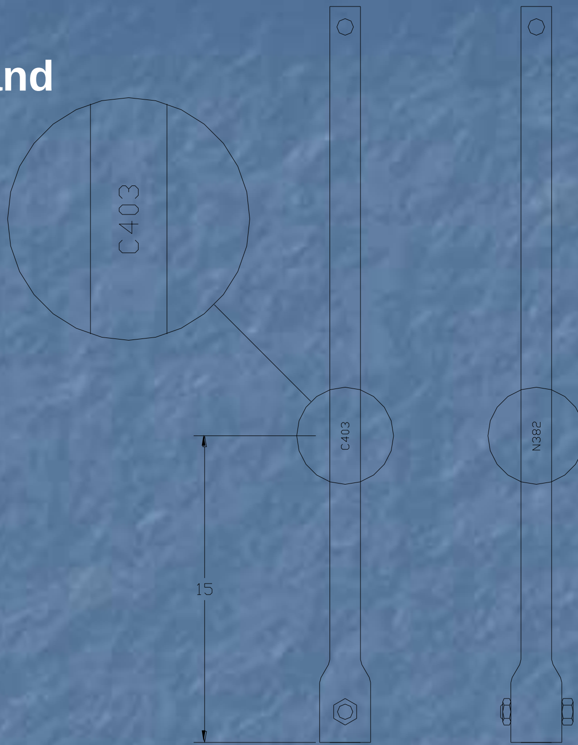
CHANCE Shaft-Material Identification

Lead Sections

There are two rows of numbers and letters stamped on the shaft.

Lead Section Example:
(stamped under drilled hole)
C403
N382

Extension Example:
(stamped on one side)
C403
(stamped at 90º to first side)
N382



Extensions

C403 — C4: Material; 03: Year

N382 — N: Steel Supplier; 382: Heat Number

Material	Code	Product
C4	TT64	SS5
C6	TT76	SS150, SS175 SS200, SS225

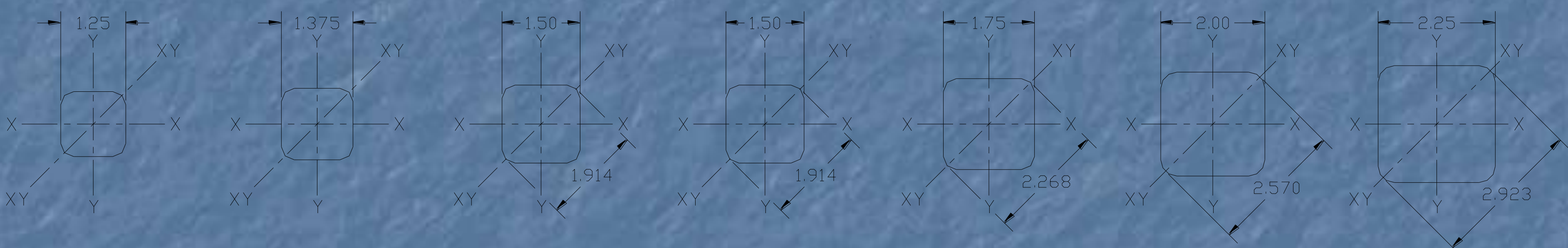
CHANCE is ISO 9001 Certified

Anchor Type

Date of Manufacture

Steel Supplier Heat Run

CHANCE® Helical Anchor Shafts Torsion & Tension Ratings



SS125
4,000 ft-lb
60 kip

SS1375
5,500 ft-lb
75 kip

SS5
5,500 ft-lb
70 kip

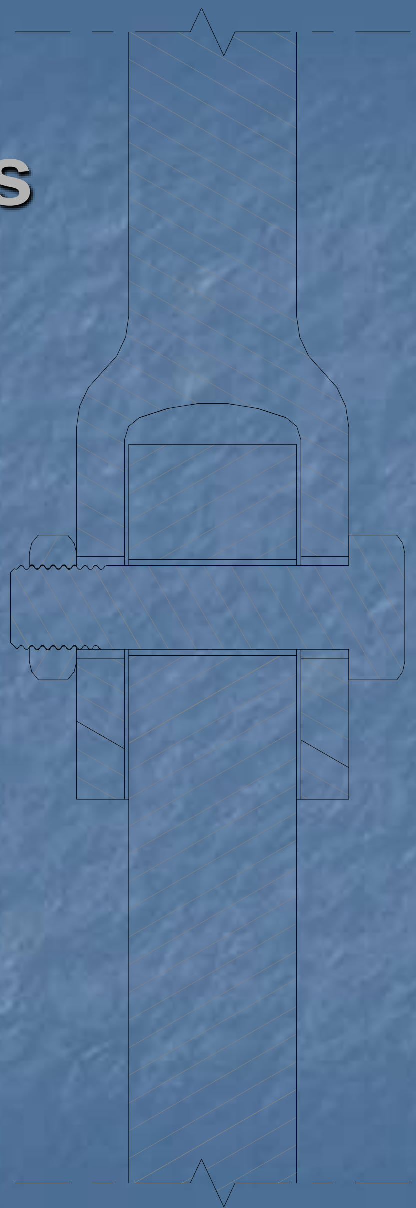
SS150
7,000 ft-lb
70 kip

SS175
11,000 ft-lb
100 kip

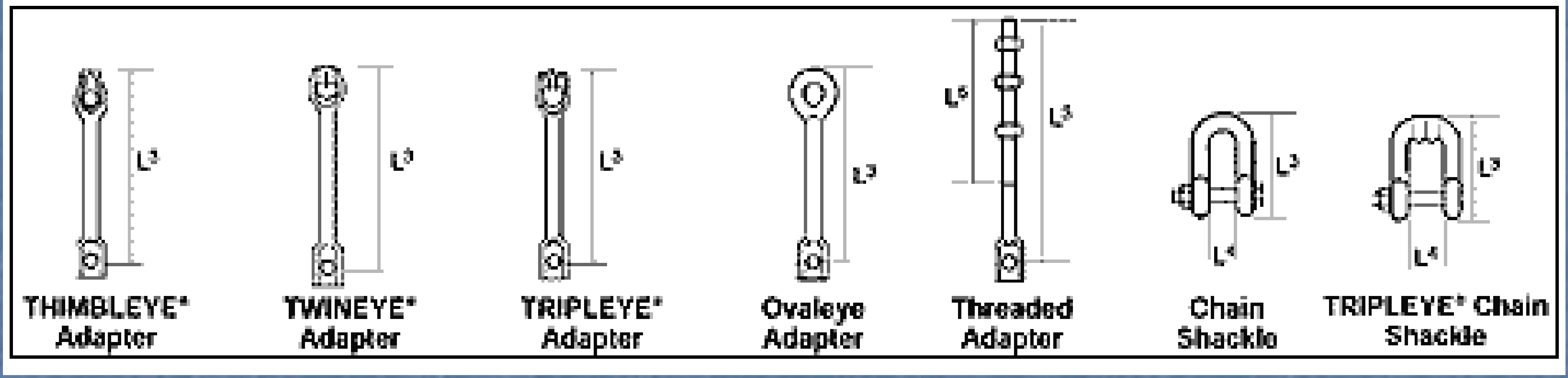
SS200
16,000 ft-lb
150 kip

SS225
23,000 ft-lb
200 kip

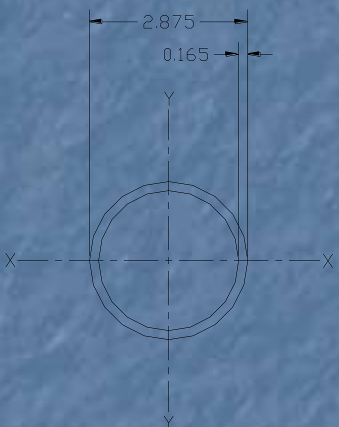
Square Shaft Couplings



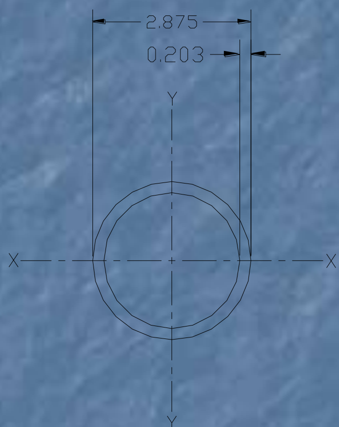
Square Shaft Tension Terminations



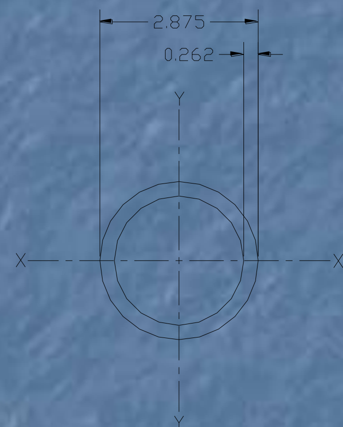
Round Shaft Sizes



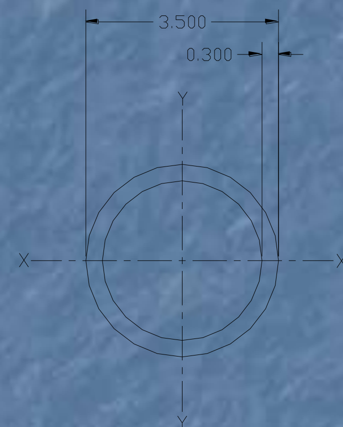
RS2875.165
4,500 ft-lb
50 kip



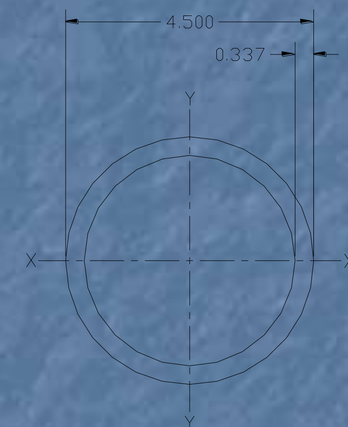
RS2875.203
5,500 ft-lb
60 kip



RS2875.262
7,500 ft-lb
100 kip

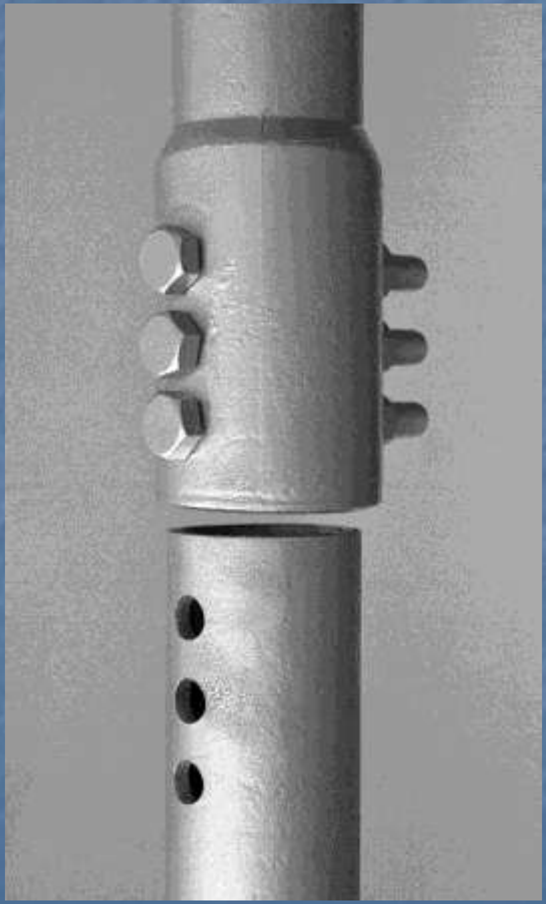


RS3500.300
13,000 ft-lb
120 kip

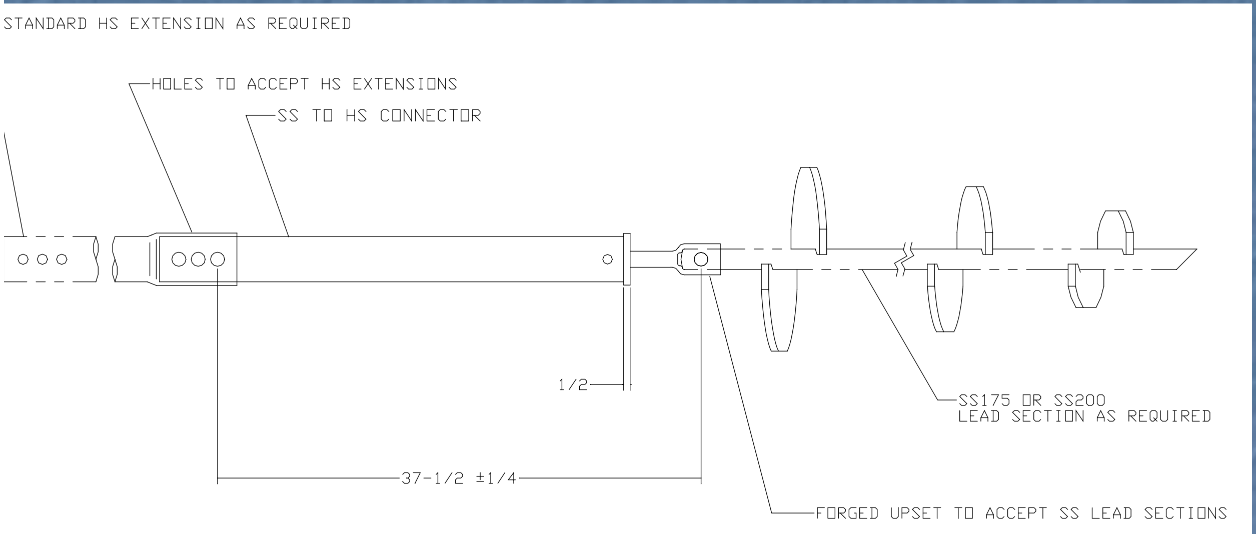


RS4500.337
23,000 ft-lb
140 kip

Helical Pipe Shaft Couplings

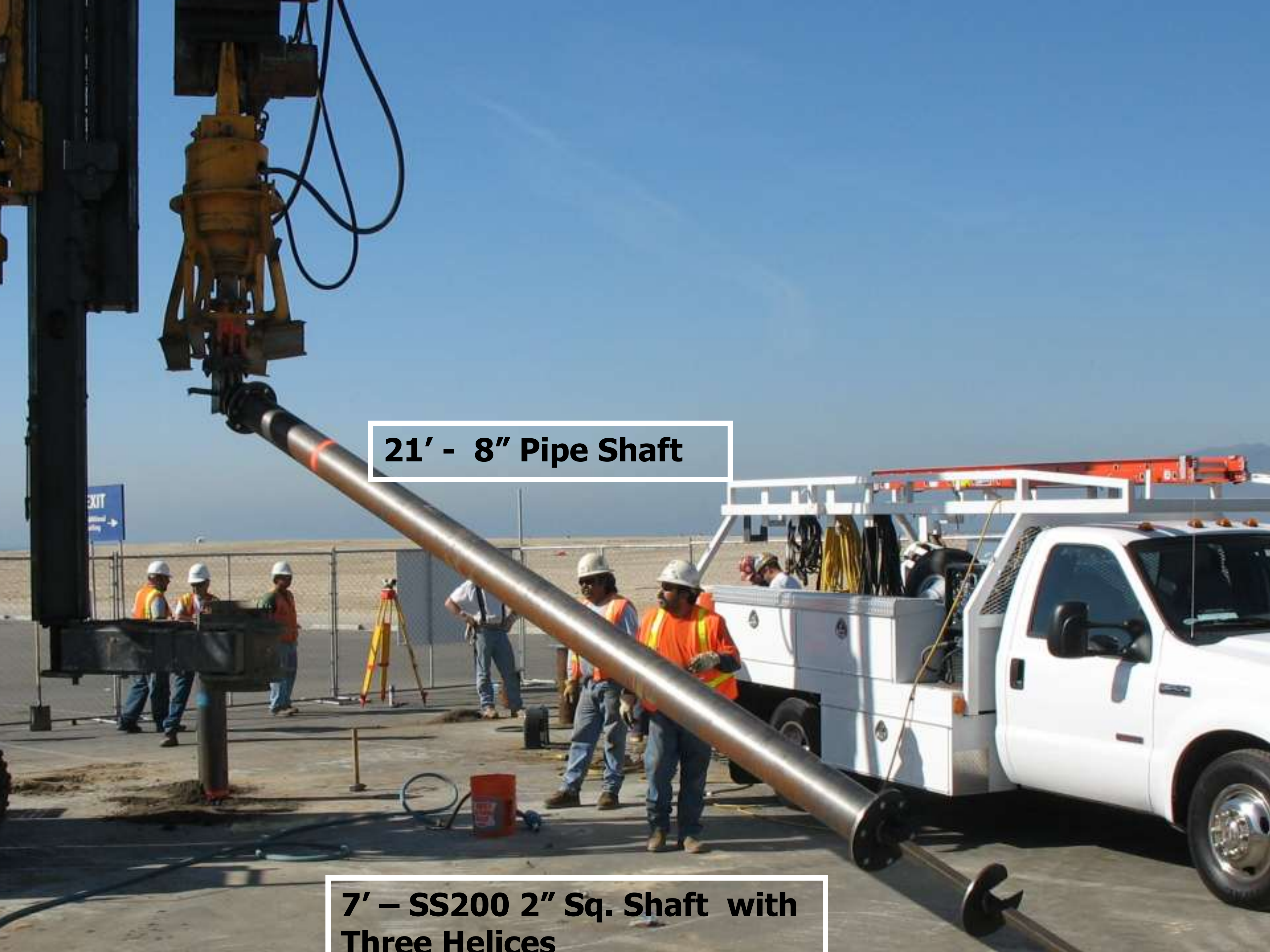


SS to Pipe Shaft



1-1/2 SS to 2-7/8 Pipe
1-3/4 SS to HS (3.5 O.D. x 0.300 Wall)
2 SS to HS
2-1/4 to 4.5 O.D (Atlas)

8″ Pipe Shaft to 2″ Square Shaft with 3 Helixes


21′ - 8″ Pipe Shaft
7′ – SS200 2″ Sq. Shaft with
Three Helices

Large Diameter Pipe Piles

Large Diameter Pipe Piles

Box Coupling

Lead Section

Remedial Repair Bracket Terminations

Determining Capacity Helical Anchor/Foundation In soil

Soil Borings/Calculations

Torque Correlation

Load Test

Bearing Capacity Equation

$$Q_h = A_h (N_c c + q N_q) <= Q_s$$

where:

Q_h = individual helix bearing capacity

A_h = projected helix area

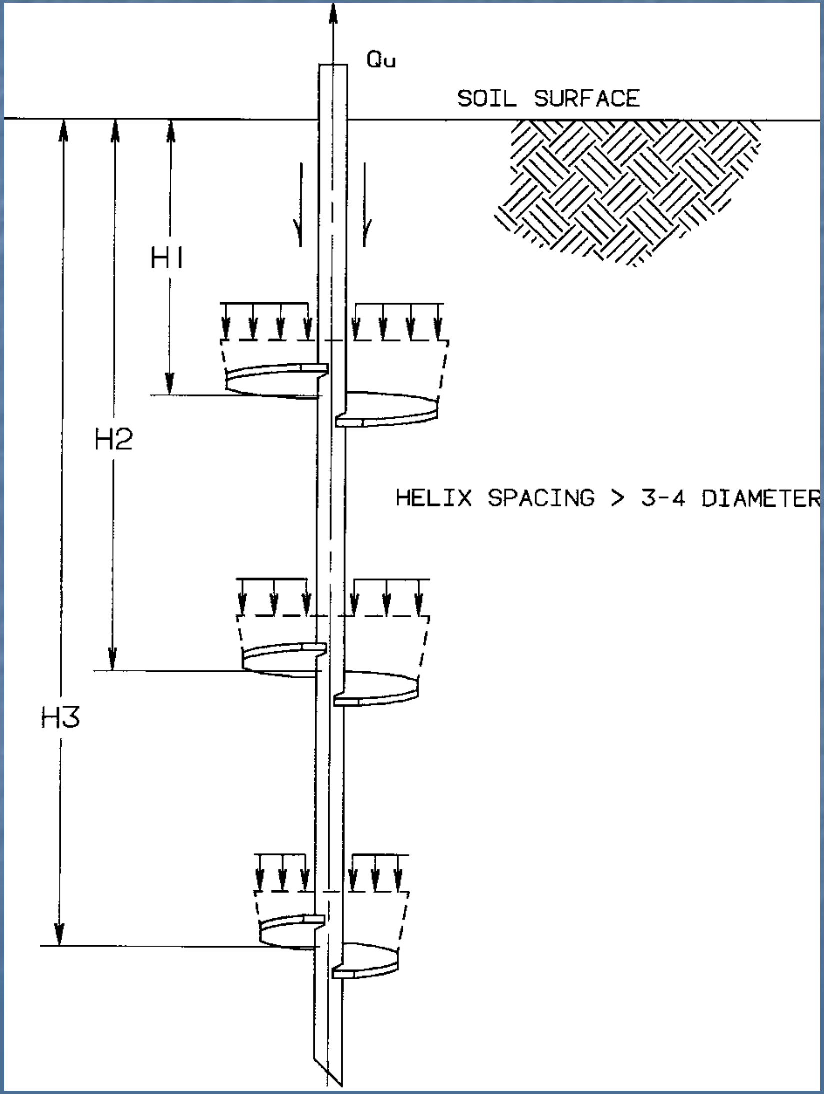
c = cohesion

q = effective overburden pressure

N_q = bearing capacity factor

Q_s = limit determined by strength of helix

Plate Bearing Capacity Model



$Q_{ULT} = \sum Q_H$

- **Shaft Friction = 0**
- **H1 = 5D (minimum)**
- **Helix Spacing = 3D**

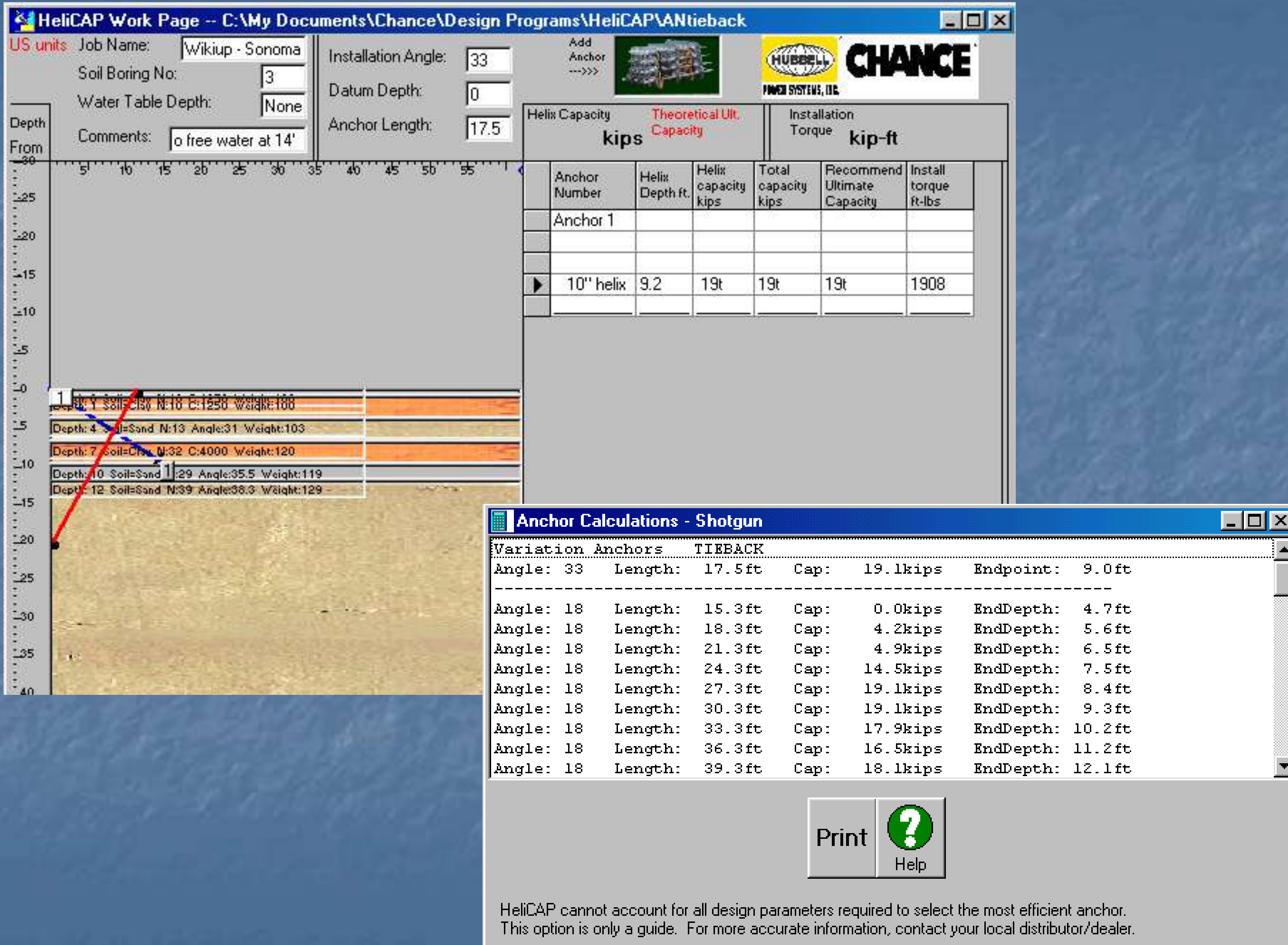
Engineering software for the way you work.

HeliCAP®

Helical Capacity Design Software

Theoretical Bearing Capacity Based on Soil Strength

Available from A. B. Chance Civil Construction Web Site - www.abchance.com


HeliCAP Work Page -- C:\My Documents\Chance\Design Programs\HeliCAP\ANtieback
US units
Job Name: Wikiup - Sonoma
Soil Boring No: 3
Water Table Depth: None
Comments: o free water at 14'
Installation Angle: 33
Datum Depth: 0
Anchor Length: 17.5
Add Anchor --->>>
HUBBELL
POWER SYSTEMS, INC.
CHANCE
Helix Capacity kips
Theoretical Ult. Capacity
Installation Torque kip-ft
Depth From
Anchor Number
Helix Depth ft.
Helix capacity kips
Total capacity kips
Recommend Ultimate Capacity
Install torque ft-lbs
Anchor 1
10" helix 9.2 19t 19t 19t 1908
Depth: 4 Soil=Sand N:13 Angle:31 Weight:103
Depth: 7 Soil=Clay N:32 C:4000 Weight:120
Depth: 10 Soil=Sand N:29 Angle:35.5 Weight:119
Depth: 12 Soil=Sand N:39 Angle:38.3 Weight:129
Anchor Calculations - Shotgun
Variation Anchors TIEBACK
Angle: 33 Length: 17.5ft Cap: 19.1kips Endpoint: 9.0ft
Angle: 18 Length: 15.3ft Cap: 0.0kips EndDepth: 4.7ft
Angle: 18 Length: 18.3ft Cap: 4.2kips EndDepth: 5.6ft
Angle: 18 Length: 21.3ft Cap: 4.9kips EndDepth: 6.5ft
Angle: 18 Length: 24.3ft Cap: 14.5kips EndDepth: 7.5ft
Angle: 18 Length: 27.3ft Cap: 19.1kips EndDepth: 8.4ft
Angle: 18 Length: 30.3ft Cap: 19.1kips EndDepth: 9.3ft
Angle: 18 Length: 33.3ft Cap: 17.9kips EndDepth: 10.2ft
Angle: 18 Length: 36.3ft Cap: 16.5kips EndDepth: 11.2ft
Angle: 18 Length: 39.3ft Cap: 18.1kips EndDepth: 12.1ft
Print
Help
HeliCAP cannot account for all design parameters required to select the most efficient anchor.
This option is only a guide. For more accurate information, contact your local distributor/dealer.

INSTALLATION TORQUE CORRELATION TO CAPACITY

INSTALLATION TORQUE VS. ULTIMATE CAPACITY

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

- $Q_{ult} = K_t T$
  - Where:
    - Qult = 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
    - T = Installation Torque, [ft-lb (kN-m)]

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 Soil Borings or Calculation**
- **Best Suited for On-Site Production Control and Termination Criteria**

TORQUE INDICATORS

- Measuring Installation Torque
  - Shaft Twist
    - Visible Indication of Torque (Square Shaft)
  - Shear Pin Torque Limiter
    - Point-Wise Indicator
    - Simple Design, Easy to Use
  - Mechanical Dial Indicator
    - Continuous Reading Indicator
    - Never Needs Re-calibration
  - Differential Pressure Indicator
    - Continuous Reading Indicator
    - No Moving Parts
  - In-Line Hydraulic Pressure Gauge
    - Simplest, Lowest Cost, Easy to Use
    - Continuous Reading Indicator
    - Least Accurate

Acceptable Shaft Twist

Unacceptable Shaft Twist

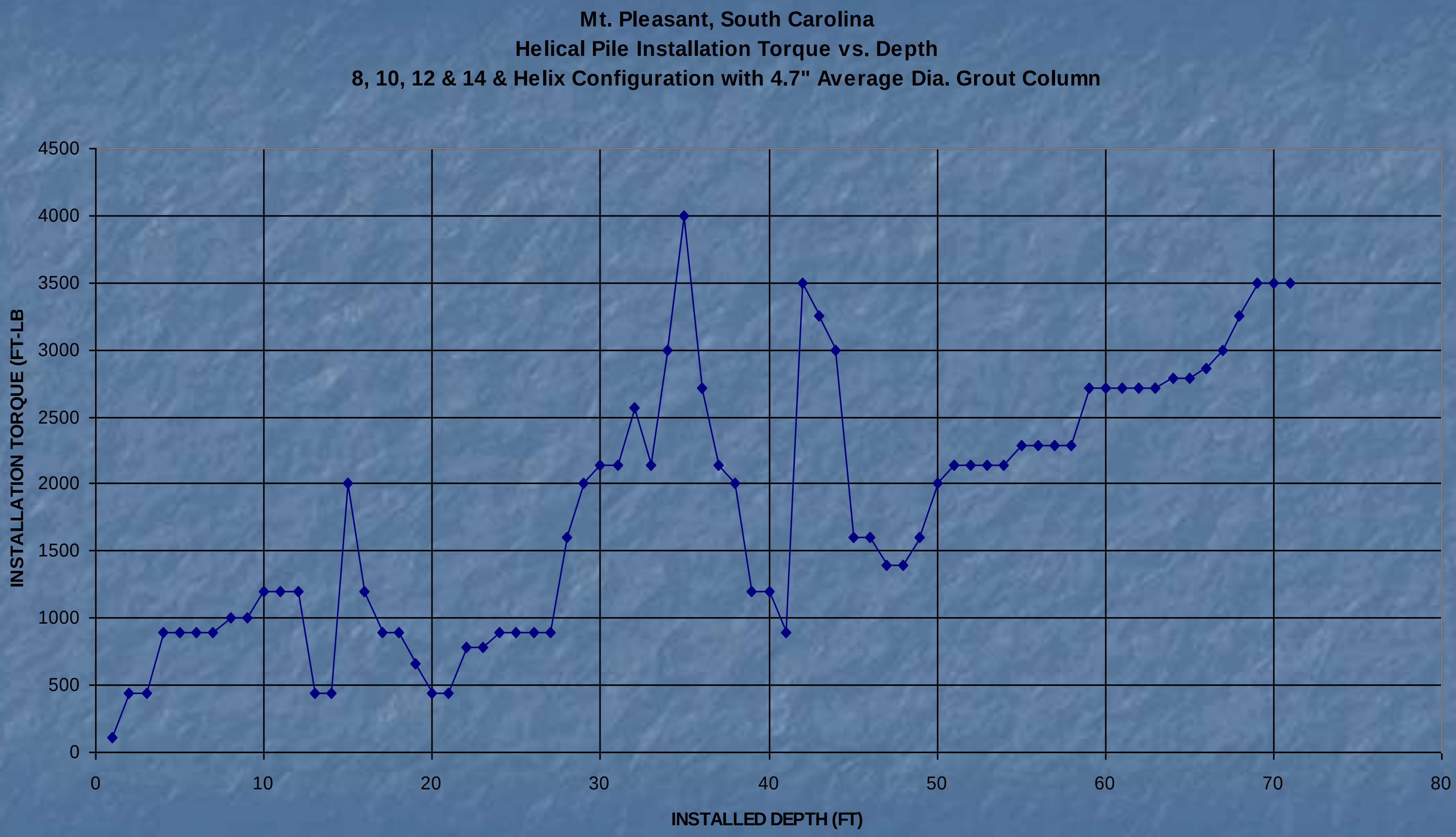
Torque Indicators

Shear Pin Torque Limiter

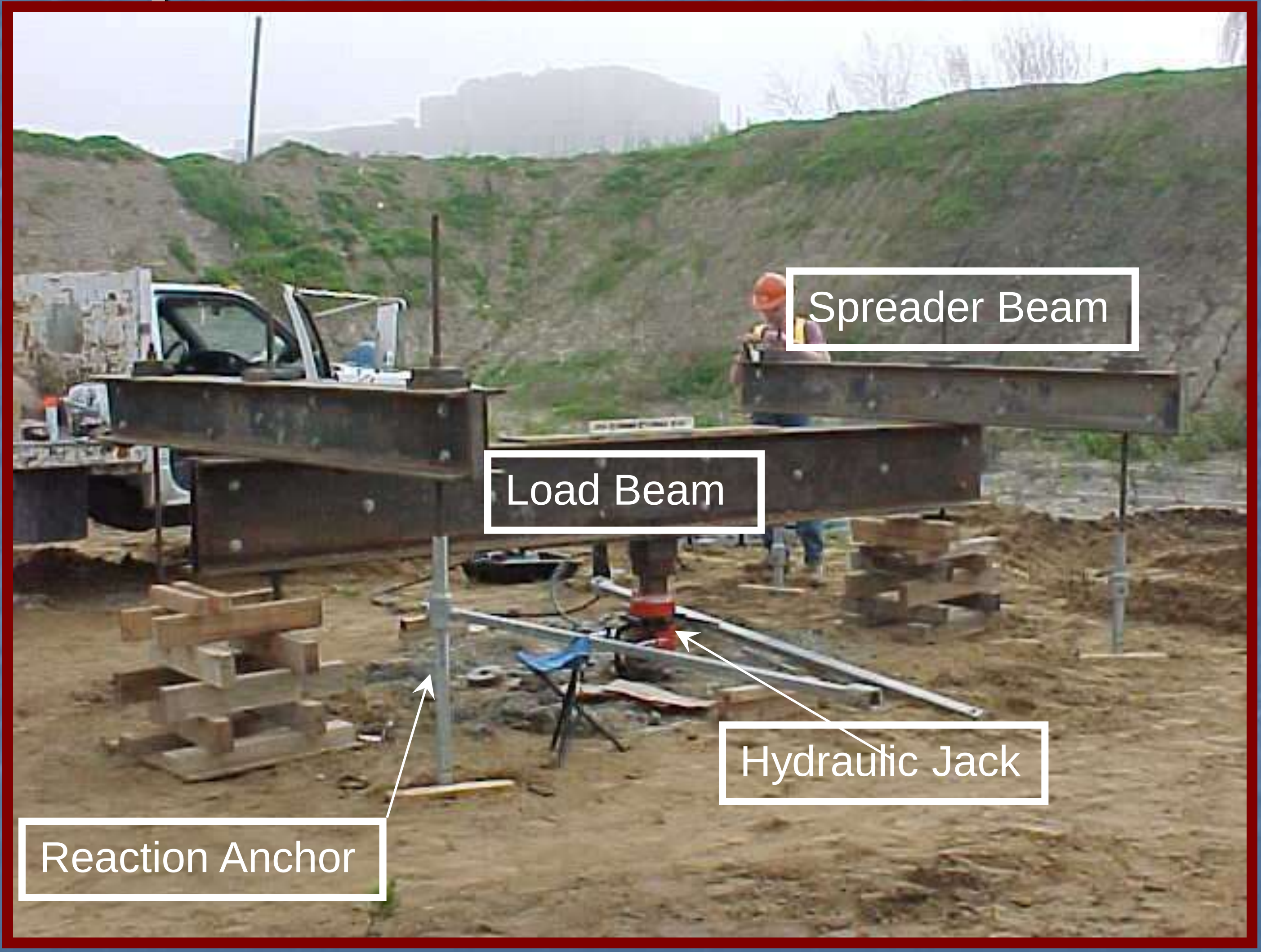
Dial Torque Indicator

Differential Pressure Indicator

LOAD TESTING TO VERIFY CAPACITY

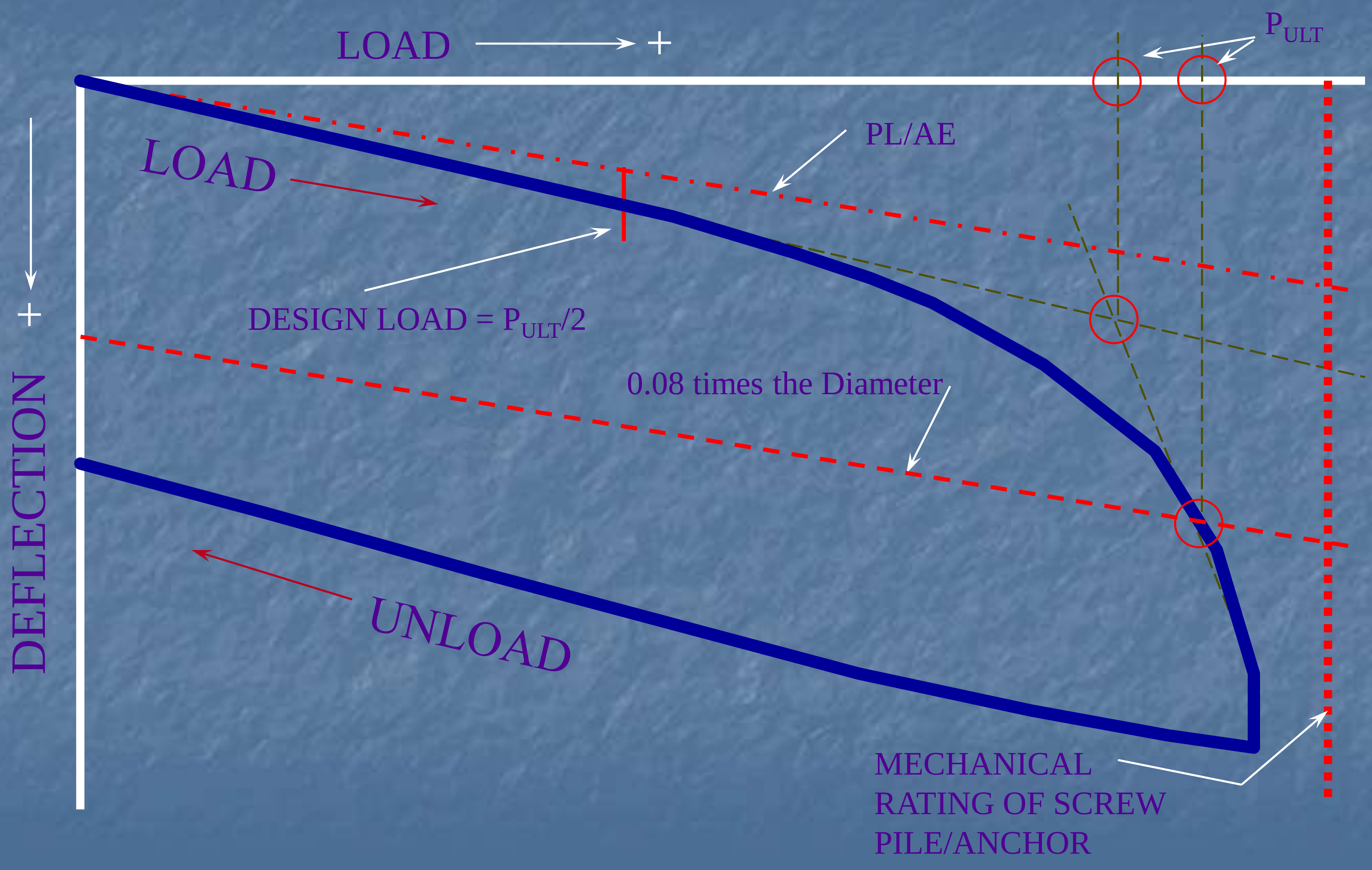

Mt. Pleasant, South Carolina
Helical Pile Installation Torque vs. Depth
8, 10, 12 & 14 & Helix Configuration with 4.7" Average Dia. Grout Column
INSTALLATION TORQUE (FT-LB
INSTALLED DEPTH (FT)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
0
10
20
30
40
50
60
70
80

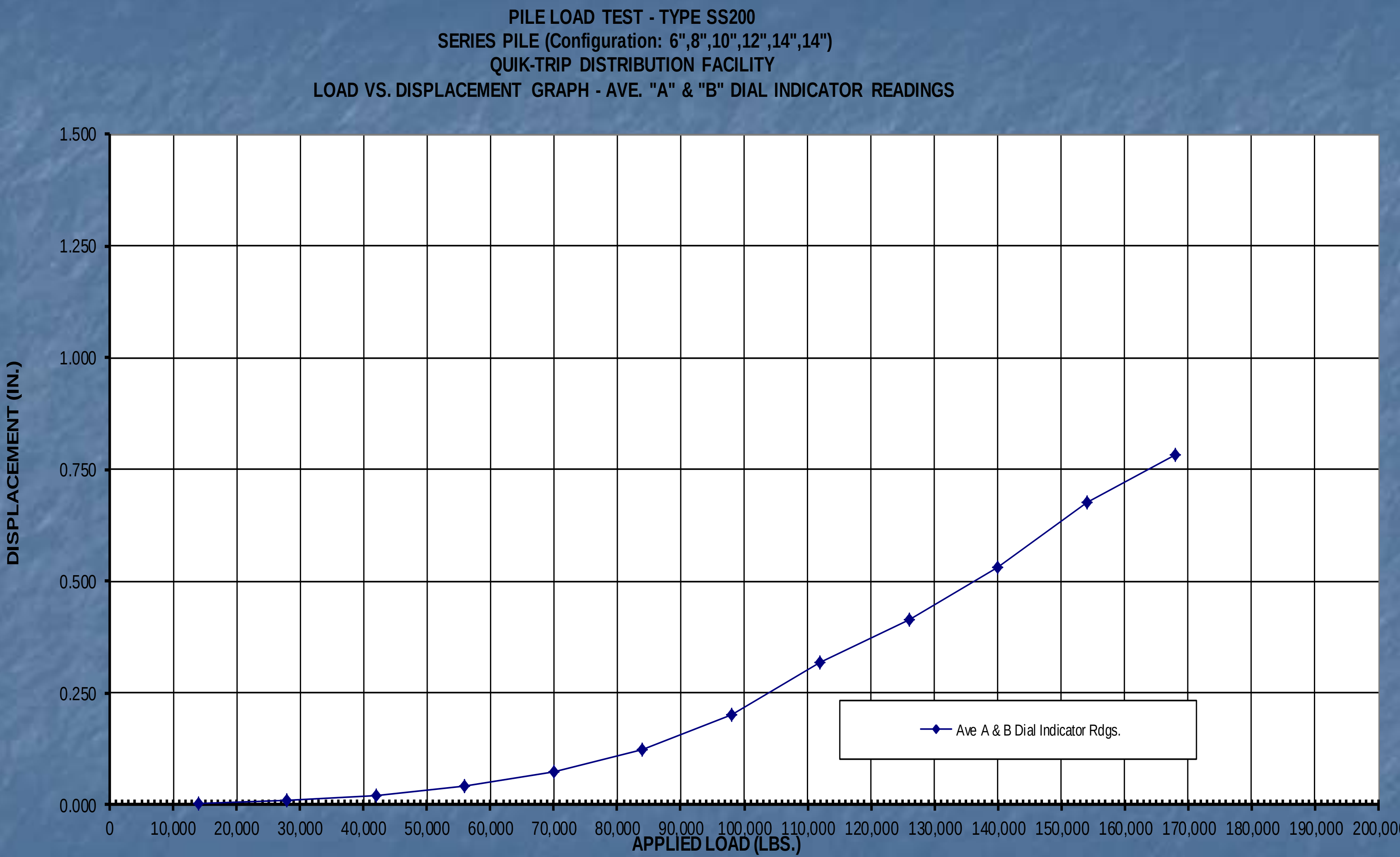
Compression Load Test Set-Up




200LC

Sample Load-Deflection Curve of Compression Test



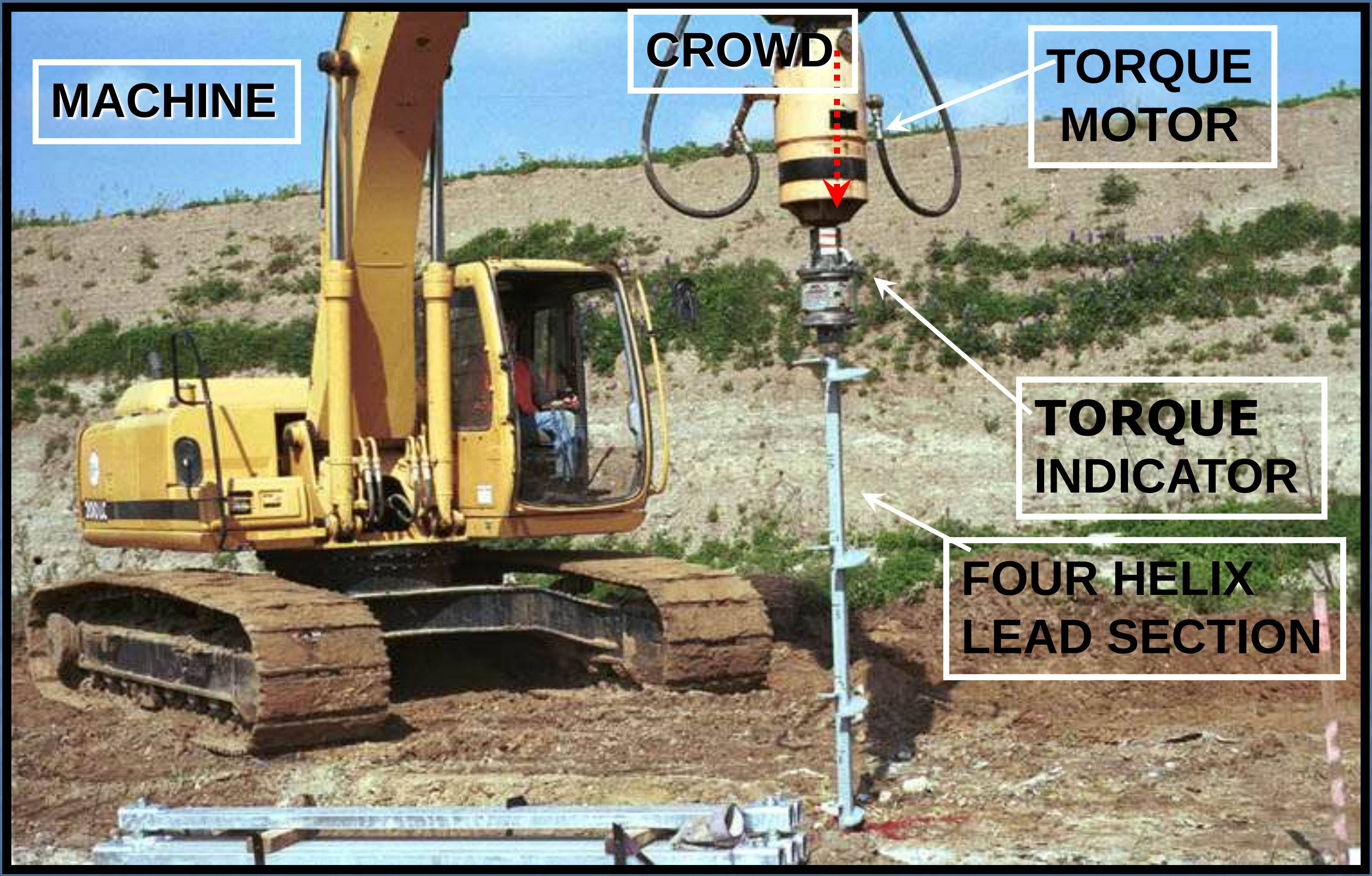

PILE LOAD TEST - TYPE SS200
SERIES PILE (Configuration: 6",8",10",12",14",14")
QUIK-TRIP DISTRIBUTION FACILITY
LOAD VS. DISPLACEMENT GRAPH - AVE. "A" & "B" DIAL INDICATOR READINGS
DISPLACEMENT (IN.)
1.500
1.250
1.000
0.750
0.500
0.250
0.000
Ave A & B Dial Indicator Rdgs.
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
120,000
130,000
140,000
150,000
160,000
170,000
180,000
190,000
200,000
APPLIED LOAD (LBS.)

Corrosion

- Consideration for Permanent Structures
- **"… The data indicate that undisturbed soils are so deficient in oxygen at levels a few feet below ground line or below the water table zone, that steel pilings are not appreciably affected by corrosion, regardless of the soil types or the soil properties." - from National Bureau of Standards Monograph 127 by Romanoff**
- Screw Anchor Components are Hot Dip Galvanized per ASTM A153 or A123.
  - Galvanizing will add between 5% and 20% to the life of the anchor.
- Metal Loss Rates in Disturbed Soils Based on Field Tests Conducted by National Bureau of Standards.
  - CHANCE Bulletin 01-9204 contains metal loss rate data.
- Nillson Resistivity Meters Available from Atlas Systems

Installation Equipment

Torque Motors
3,500 ft-lb
6,000 ft-lb
12,000 ft-lb
20,000 ft-lb

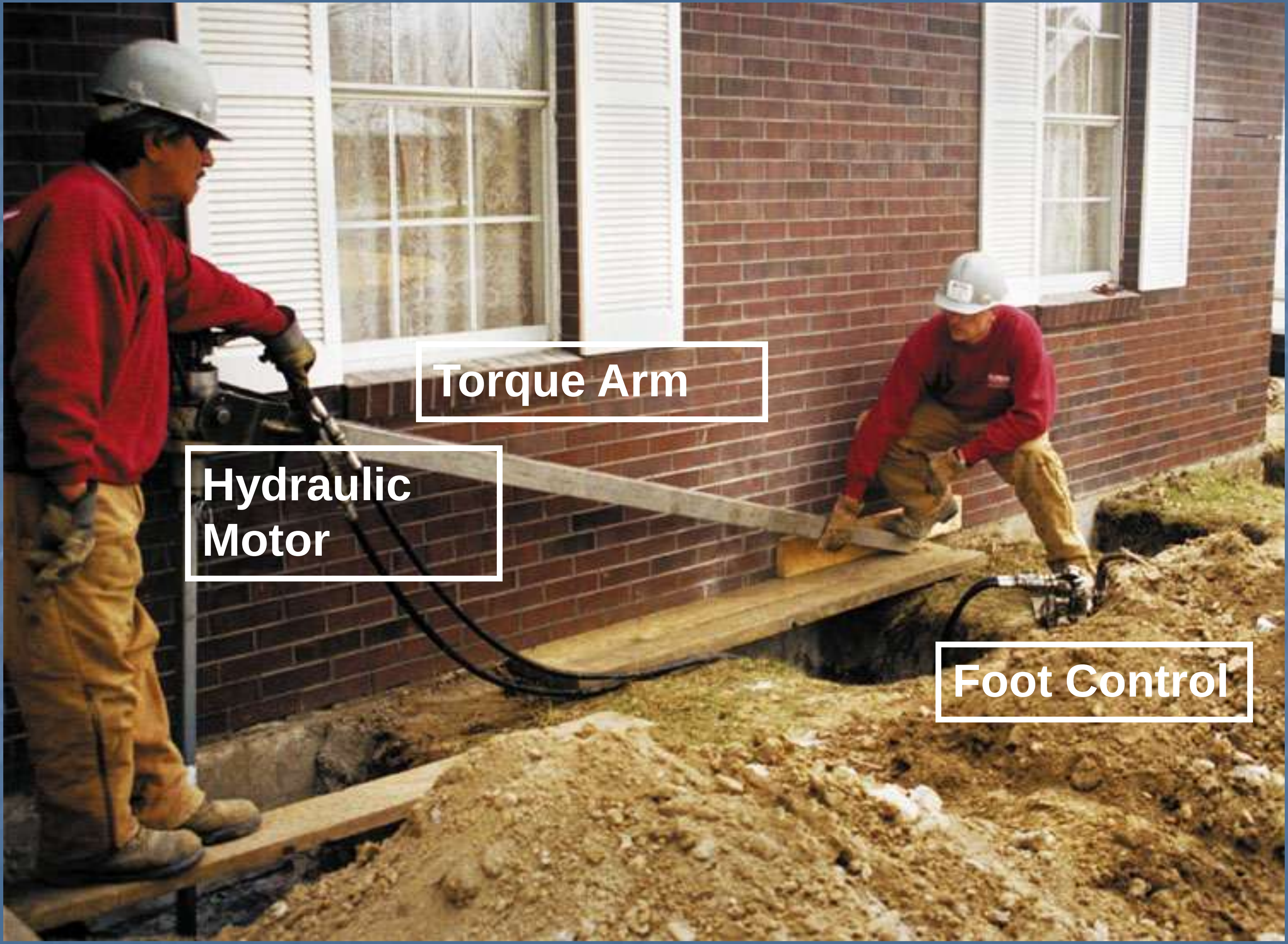

MACHINE
CROWD
TORQUE MOTOR
TORQUE INDICATOR
FOUR HELIX LEAD SECTION

MACHINE INSTALLATION

UP CLOSE

… OR, FAR AWAY!

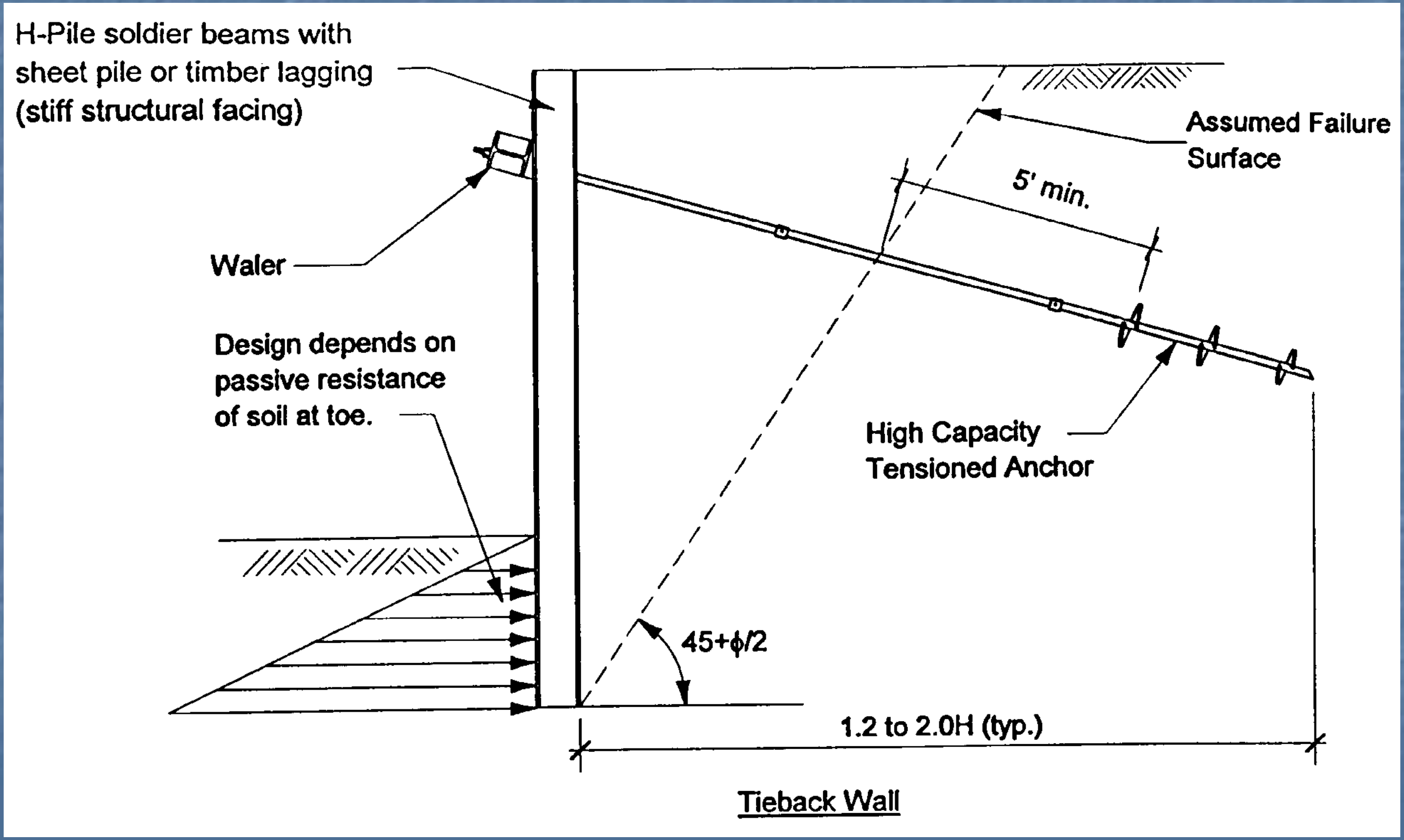
PORTABLE INSTLLATION FOR TIGHT ACCESS


Torque Arm
Hydraulic Motor
Foot Control

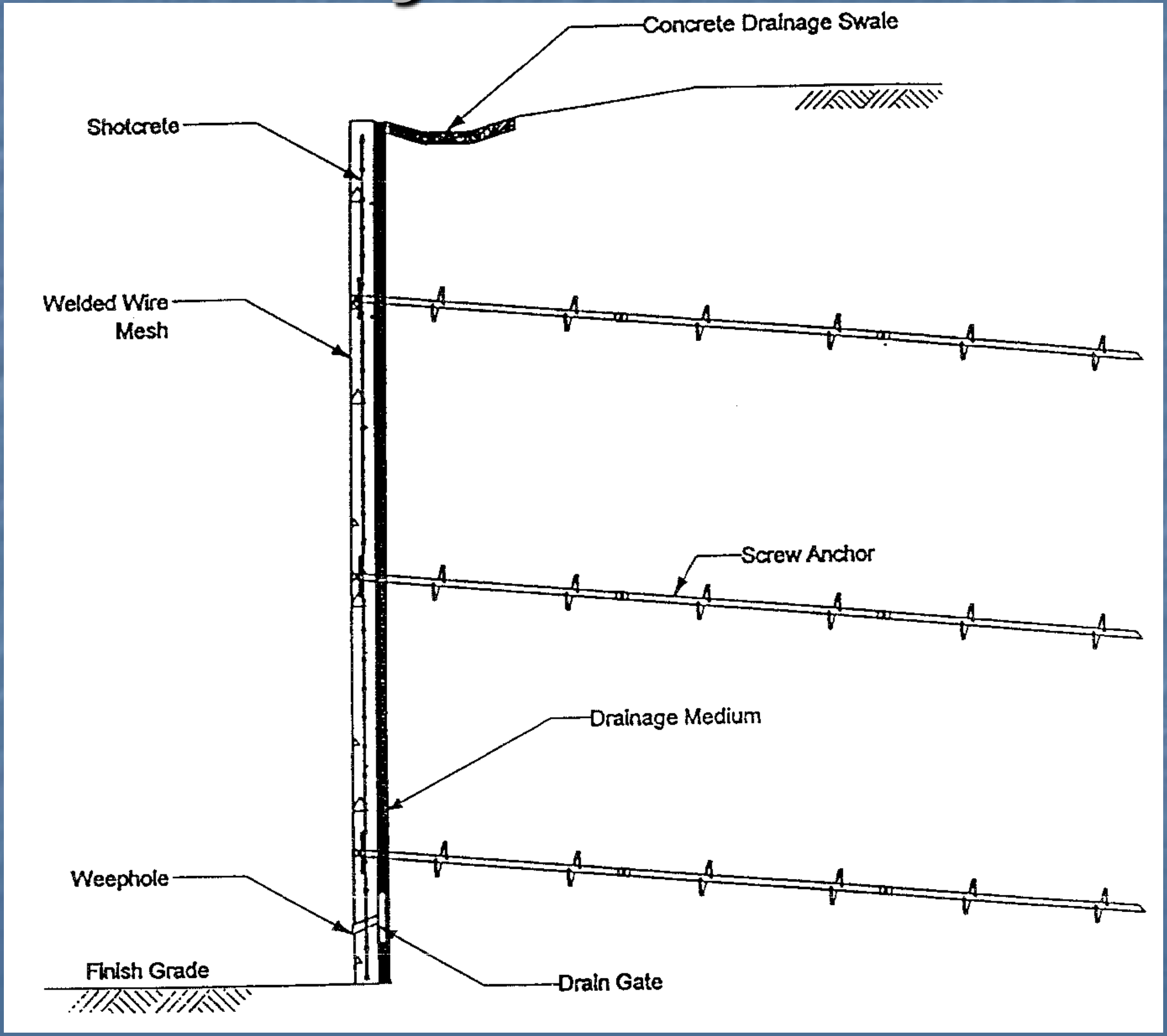
Applications

Tension Anchors

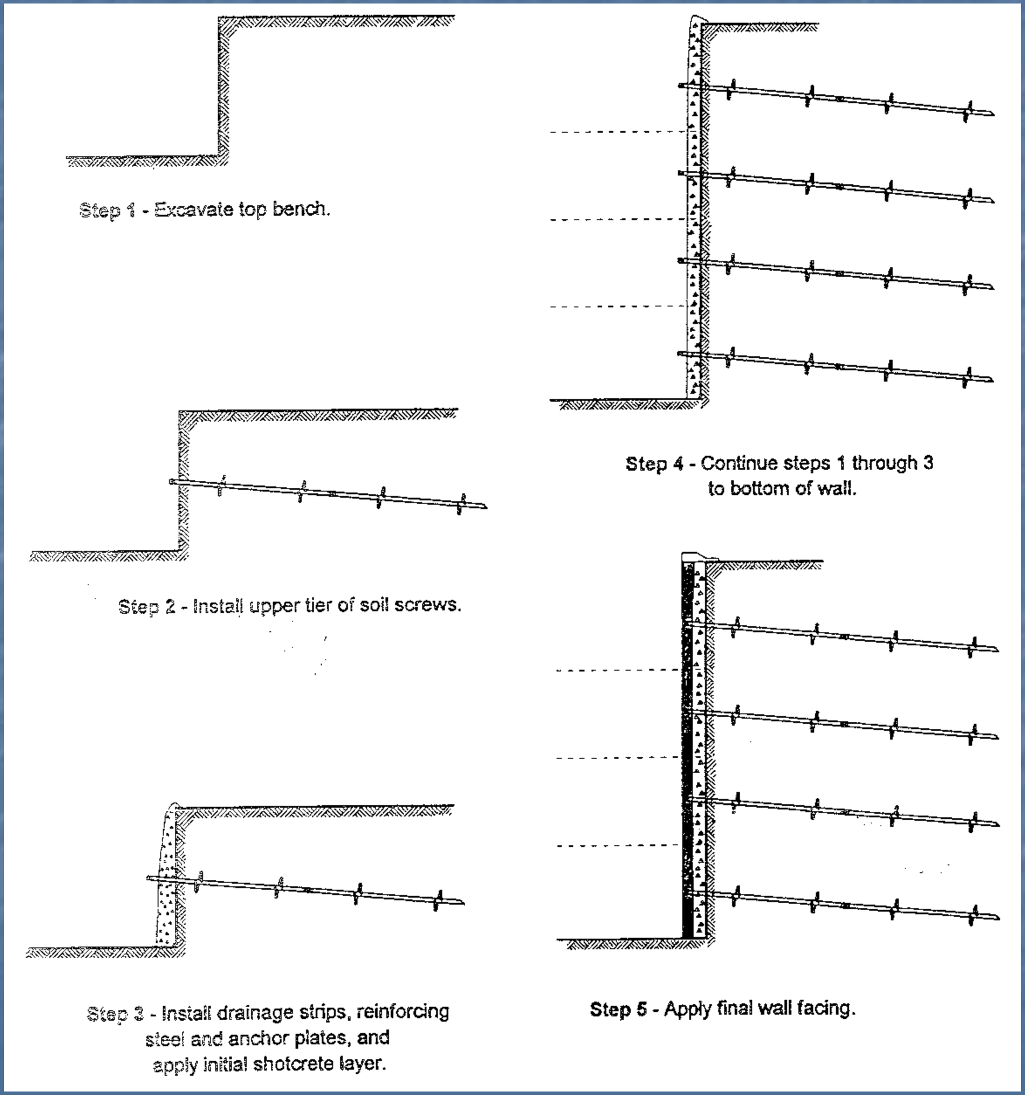
Helical Tiebacks



SOIL SCREW* Retention Wall System



SOIL NAIL Installation Sequence

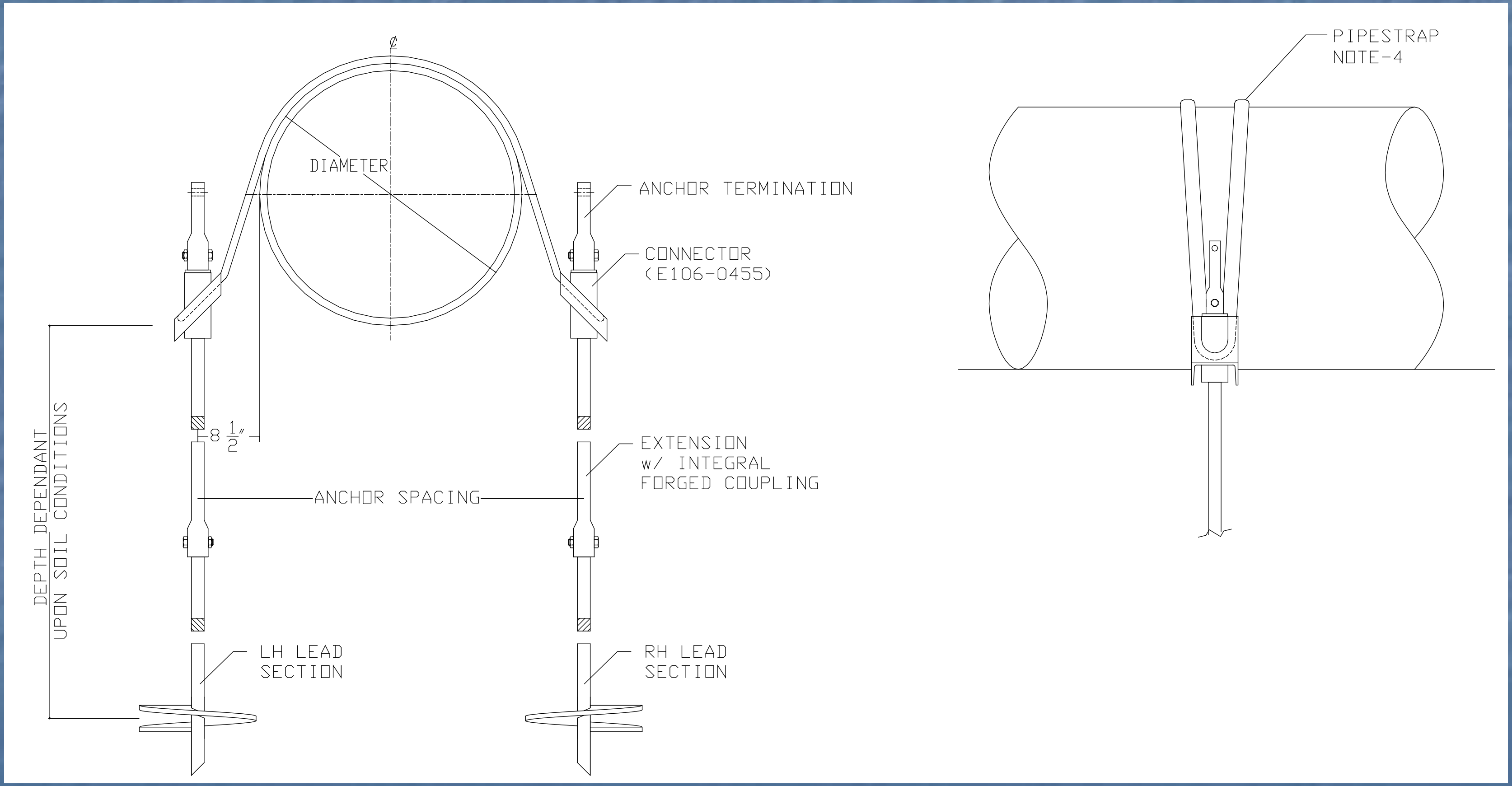


Soil Screw* Retention Wall System

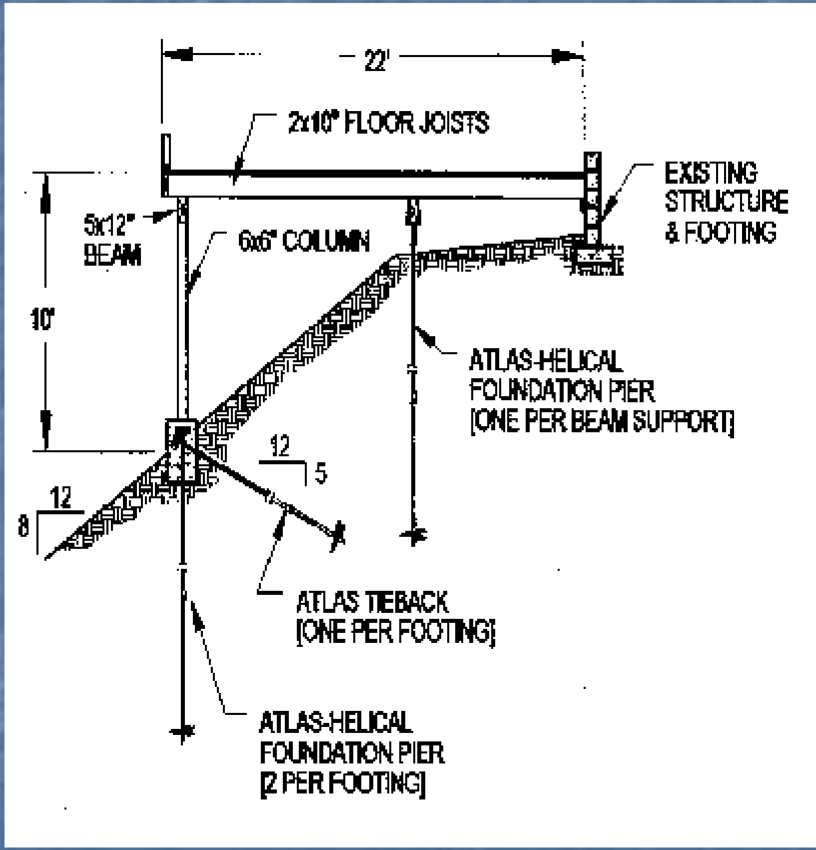

TAKEUCHI
TL26
KEUCHI

Guy Anchors for Telecomm Towers

Pipeline Buoyancy Control Synthetic Band System



Helical New Construction - Vertical and Diagonal for Hillside Application



Compression Anchors

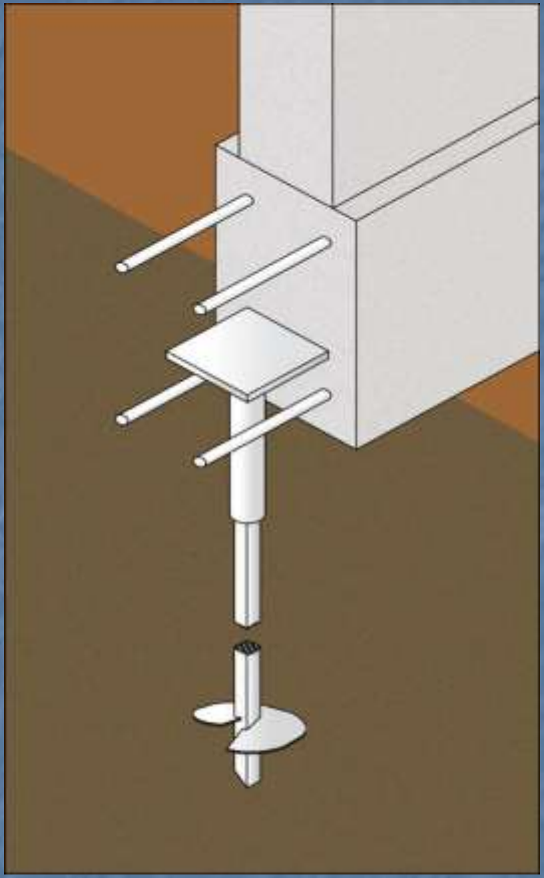
- Residential/Commercial Underpinning
- New Construction
- Helical Pulldown Micro Piles
- Large Capacity Pipe Piles

Foundation Underpinning


HELICAL PIER Foundation Systems
Remedial Repair


USAir

New Construction Bracket



C150 0458 for 1 ½" Square Shaft 40,000 lb design load
C150 0459 for 1 ¾" Square Shaft 60,000 lb design load

New Construction - Slabs and Foundations

Helical Piles Supporting Structural Slab

Access Limitations on Industrial Site


12
13

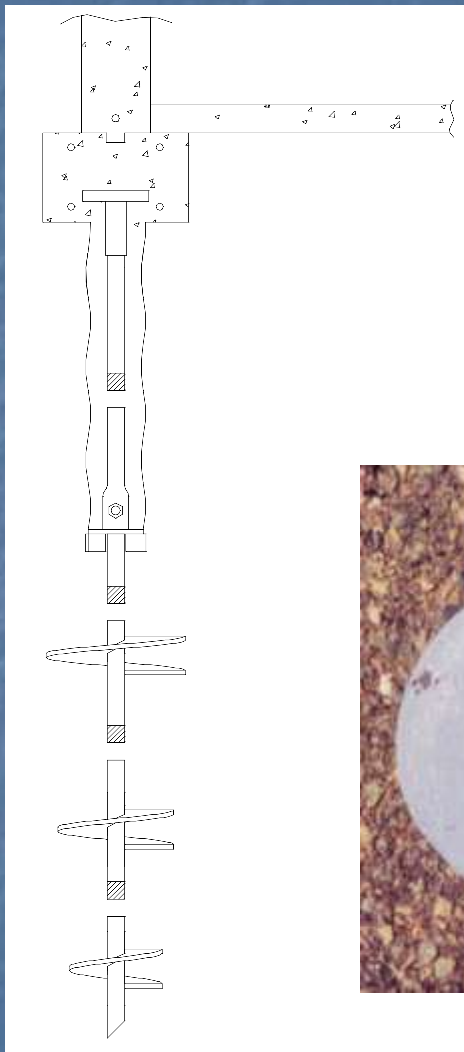
Boardwalk

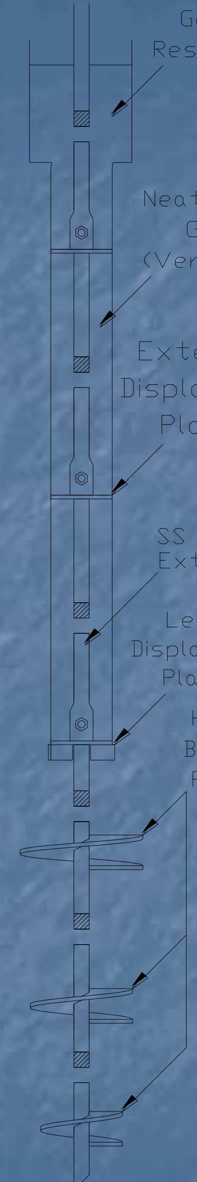
Boardwalk


bobcat
331 bobcat

Walkways for Wetlands

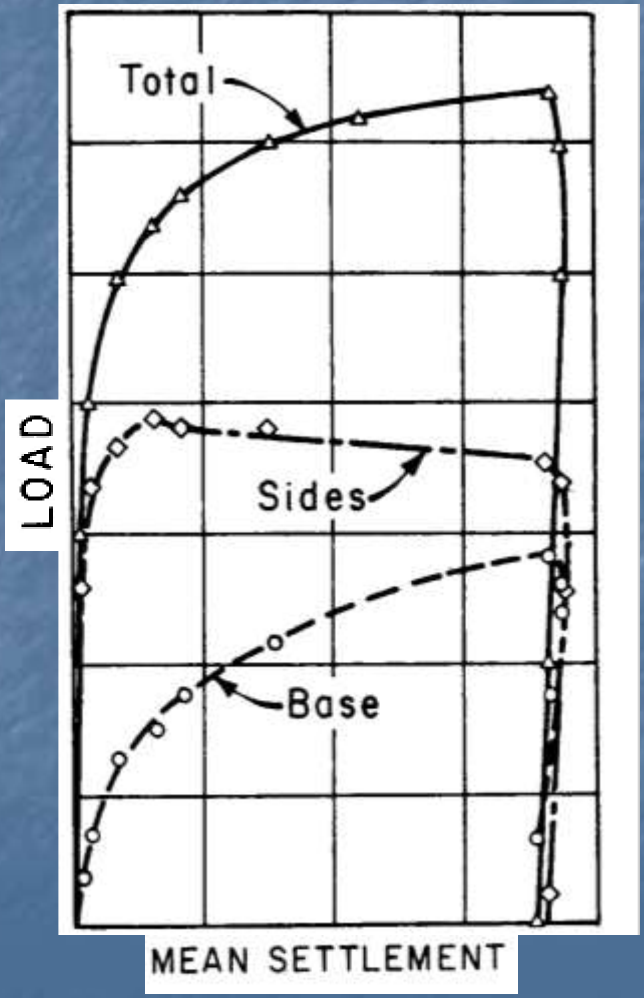
HELICAL PULLDOWN® Micropile





Load-Settlement Curves

Relative Development of Side and Base Resistance



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)].

Design Advantages

Buckling Resistance

- Soft/Loose soils overlying competent bearing strata

Mobilization of Skin Friction

- Total capacity a function of skin friction and end bearing

Additional Corrosion Protection

- Microsil grouts
- Optional casing

Enhanced Load/Deflection Response

- Increases shaft stiffness
- Stiffens load/deflection response

TOTAL CAPACITY

$$Q_t = Q_h + Q_f$$

where:

Q_t = Ultimate Static Resistance of the Screw Pile

End-Bearing Pile

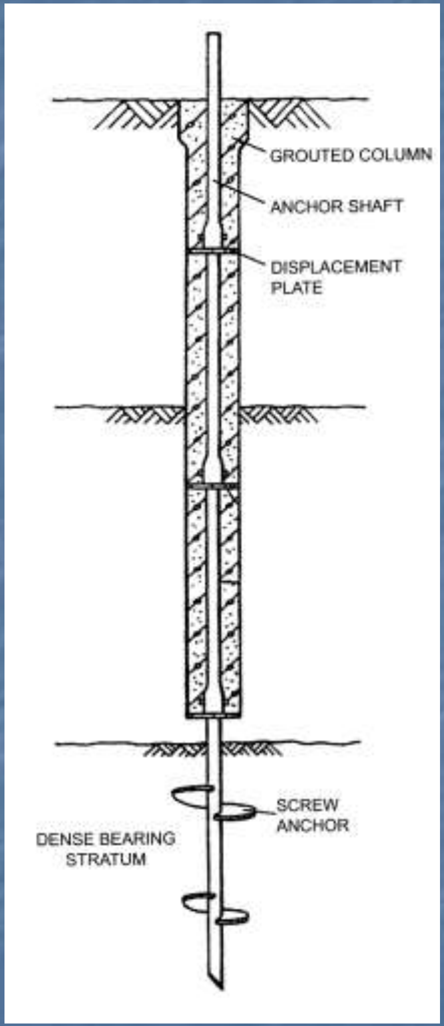
- Majority of Capacity Developed in End-Bearing

Friction Pile

- Majority of Capacity Developed in Skin Friction

Composite Pile

- Significant Capacity in Both End-Bearing and Skin Friction



GENERAL FRICTION CAPACITY EQUATION

$$Q_f = \Sigma[\pi D\ f_s\ \Delta L_f]$$

where:

- D = Diameter of Grouted Pile Column
- f_s = Sum of Friction and Adhesion between Soil and Pile (force/area)
- ΔL_f = Incremental pile length over which π D and f_s are taken as constant

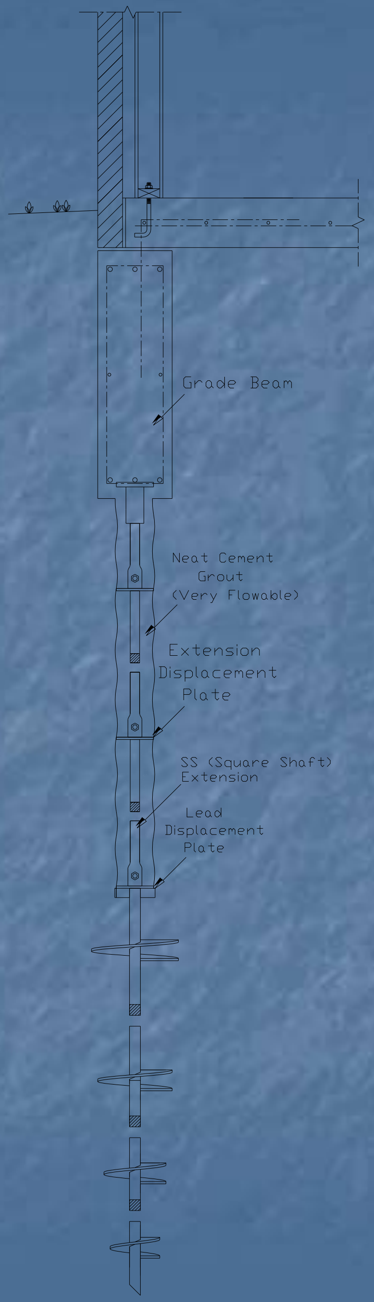

2020
2020

New Construction – HPM
Tasker Homes
Philadelphia, PA

TASKER STREET
FERNON STREET
MORRIS STREET
MOORE STREET
MIFFLIN STREET
SCHUYLKILL EXPRESSWAY
34TH STREET
DOUGLAS STREET
NATRONA STREET
32ND STREET
NAPA STREET
31ST STREET
CORLIES STREET
30TH STREET
HOLLYWOOD STREET
29TH STREET
NEW HOPE STREET
VARE AVENUE
Phase II & III
Phase I
3
4
19A
19
9
10
11
12
13
14
15
16
17
17A
18
18A

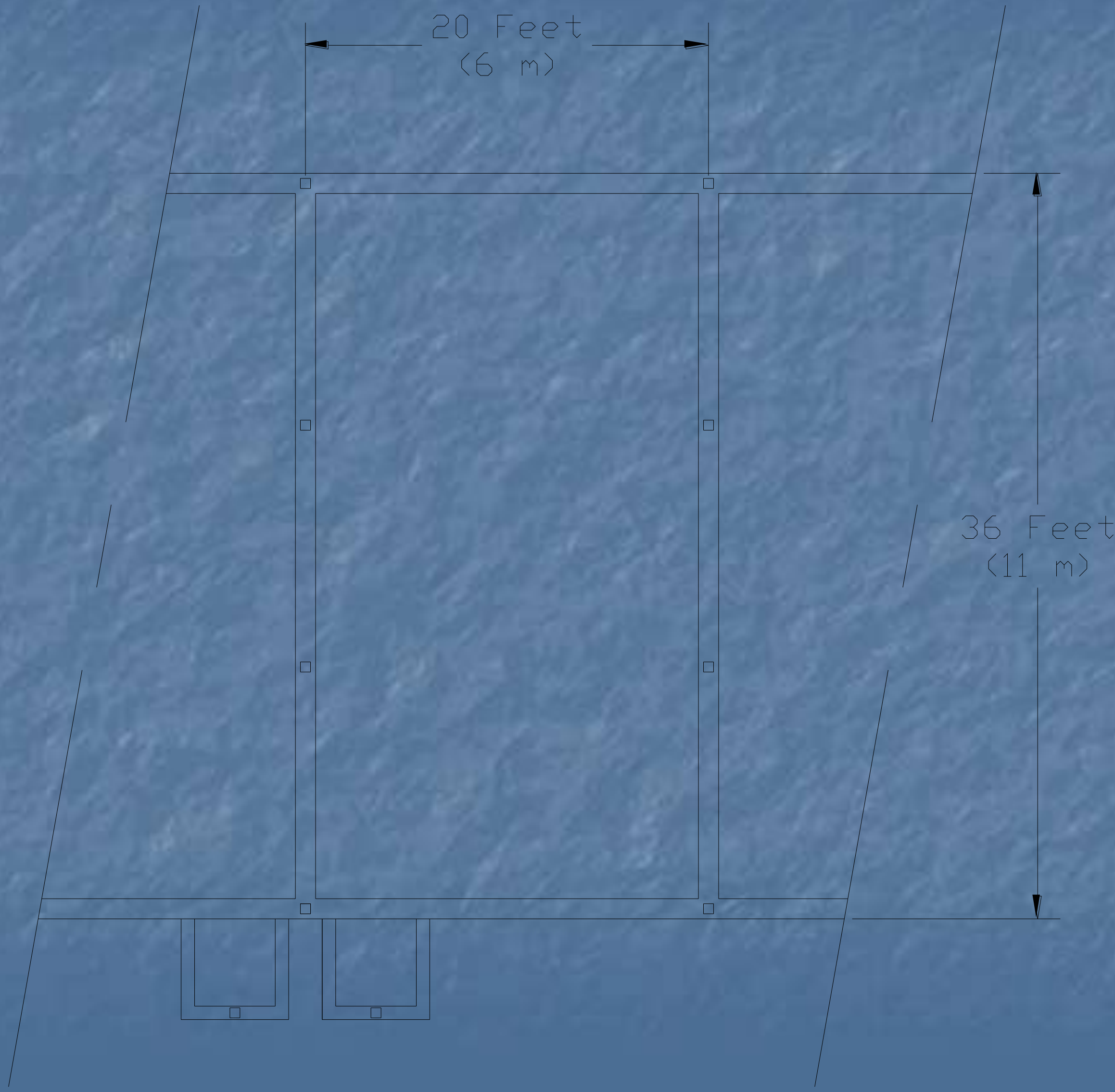
Grade Beam & Helical Pier Detail

3645 Helical Piers Installed
Design Load: 40 Ton (80 Ton Ultimate)
Preproduction Load Tests: 8
Depth: 15 to 60 feet
Production: 20 to 60 Piers/Day/Machine
Soil: Urban Fill underlain by Sand & Gravel

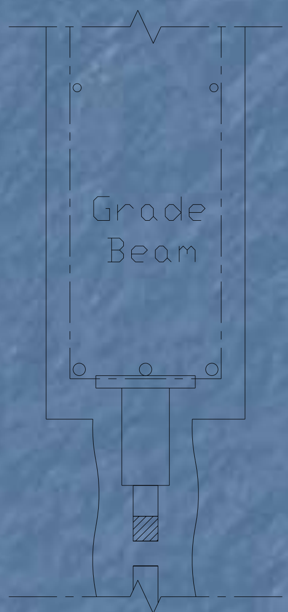


Typical Plan View

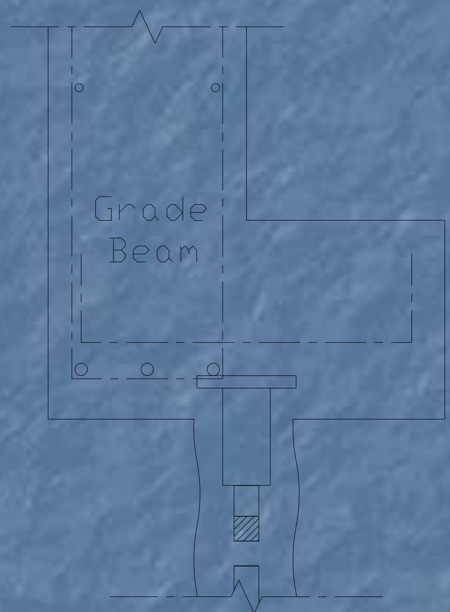
Residential Dwelling Unit



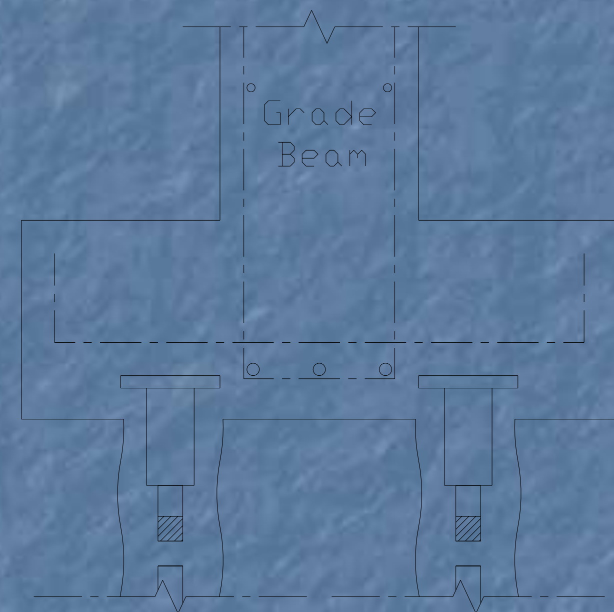
Incorporate Tolerance for Installation Location



± 3 inches
Within Tolerance
(3631 Places or 99.6 %)



± 3 to 9 inches
Out of Tolerance
(14 Places or 0.4 %)



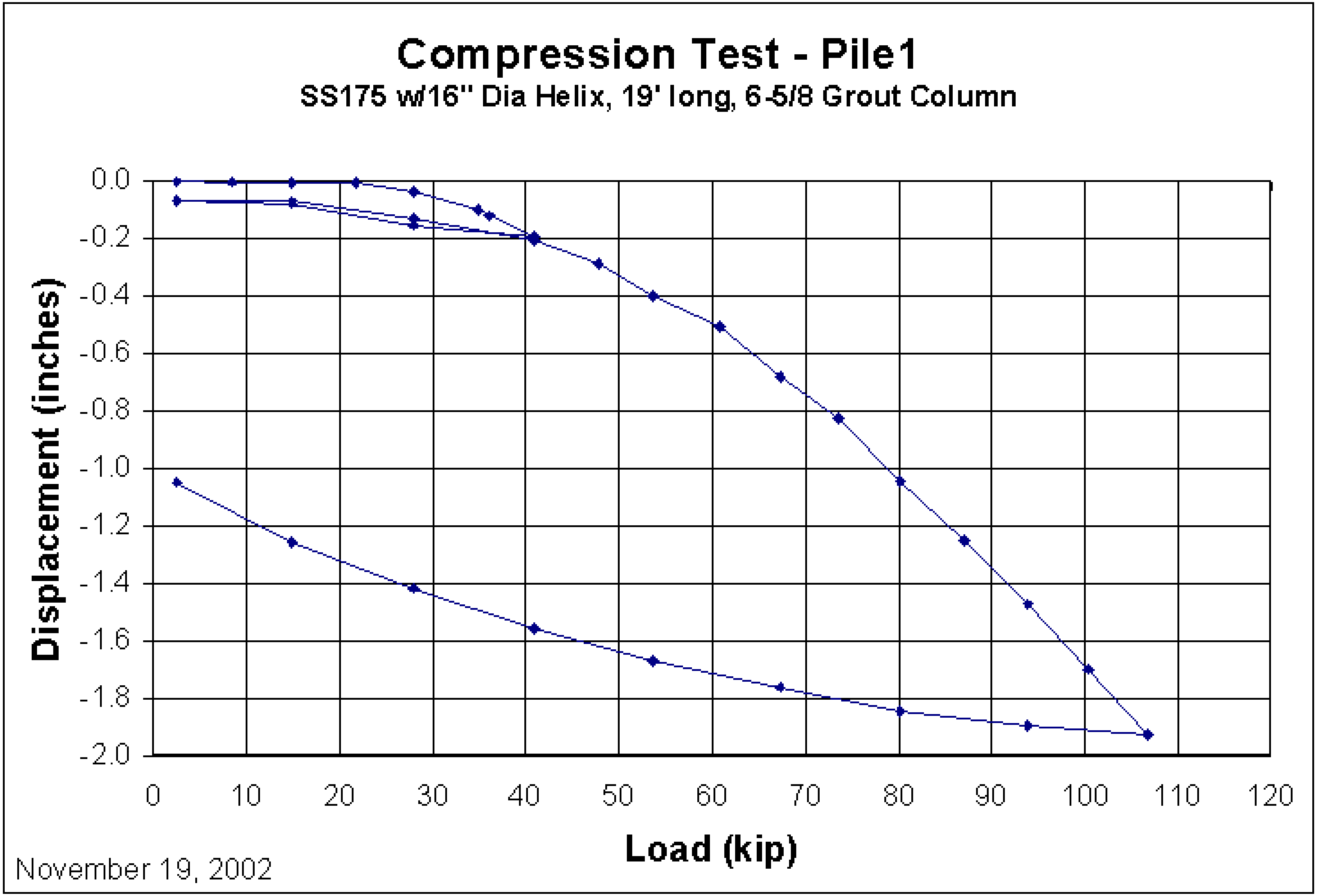
> 9 inches
Out of Tolerance
(0 Places)


D'ANGELO BROS. INC.
E-48
CAT
D'ANGELO BROS. INC.


WATER

HELICAL PULLDOWN® Micropile

Structural Slab Upgrade


Compression Test - Pile1
SS175 w/16" Dia Helix, 19' long, 6-5/8 Grout Column
Displacement (inches)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
0
10
20
30
40
50
60
70
80
90
100
110
120
Load (kip)
November 19, 2002


LAFARGE


Bobcat
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