ACIP Piles for Bridge Foundations

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DFI ACIP and DD Pile Committee

STGEC – Daytona Beach FL

20 October 2022

APPLICATION OF ACIP AND DD PILES IN TRANSPORTATION MKT – *MORE RECENT*

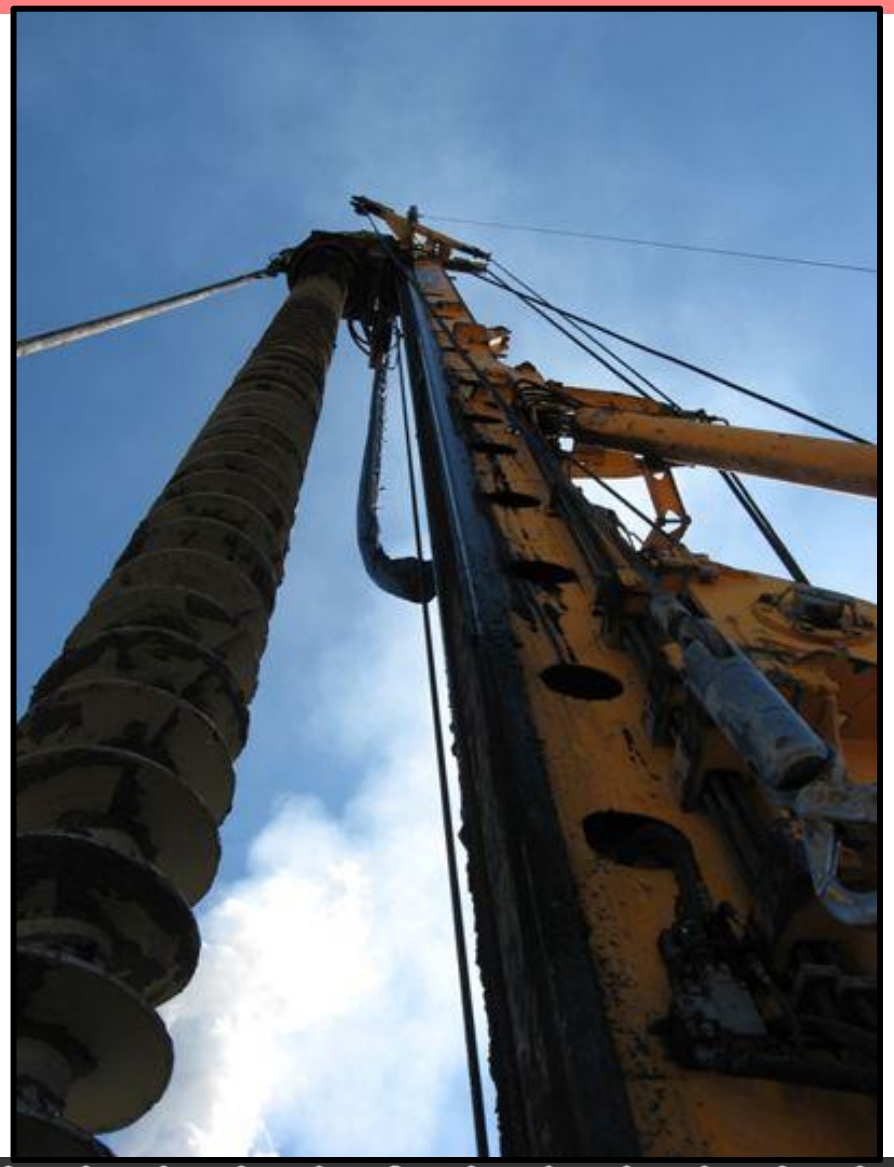
- Soundwalls in numerous states
- Excavation support (secant pile walls)
- Approximately 20 State DOT's & the FHWA Federal Lands Highway Dept. have approved CFA Piles on a project-specific basis
- FHWA's GEC #8 (April 2007) provides a technical guideline providing minimum recommendations for design & construction of CFA Piles
- Bridge Support To Date For FHWA/DOT's
  - I-135 in Salina, Kansas
  - I-135 in Wichita, Kansas
  - 153rd Street Bridge in Seattle, Washington
  - NC Highway 96S in Meadow, North Carolina
  - Guilford County Bridge in Greensboro, North Carolina
  - Krenek Bridge Site in Texas
  - State Highway 7 Bridge in Houston County, Texas
  - Bridge Widening at Ronald Reagan National Airport, Arlington, VA
  - Replacement Structure, District of Columbia

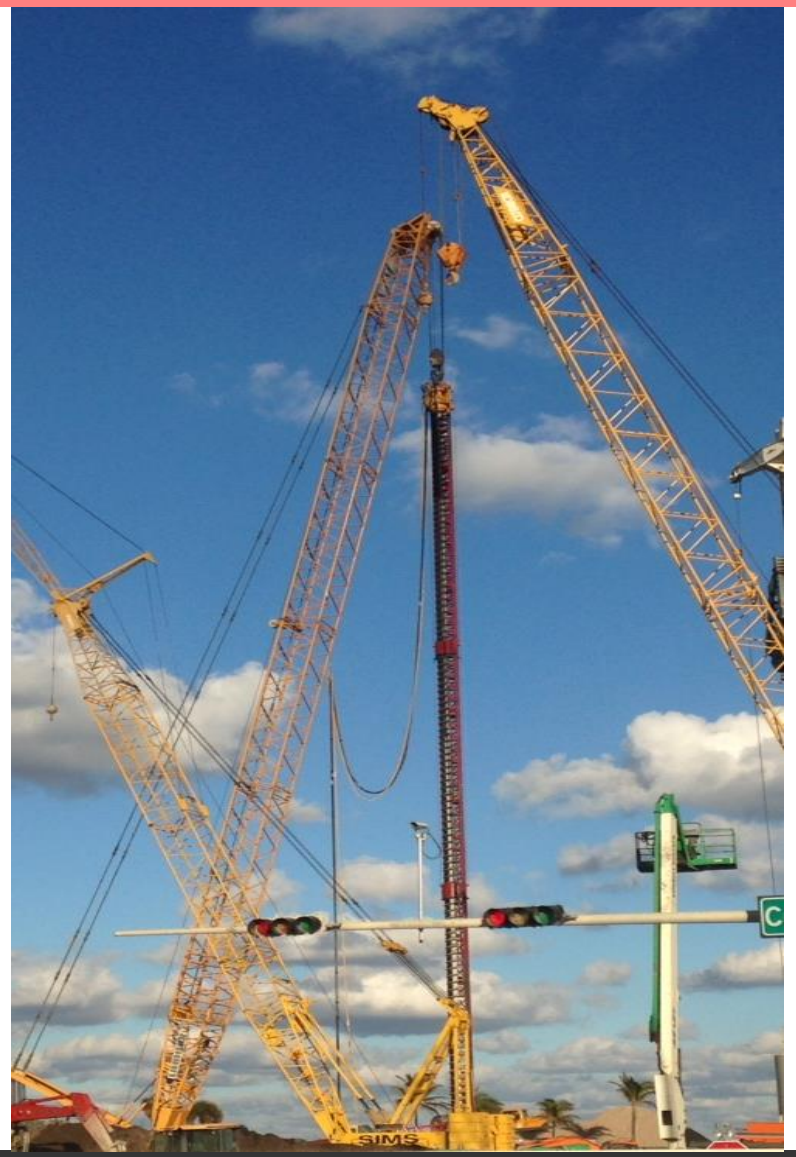
Also, augered grouted elements and displacement elements (Rigid Inclusions) have been used to support highway embankments, soundwalls, and MSE walls

Drilling Platforms

Fixed Mast

CFA





Crane-Supported

ACIP / Augercast

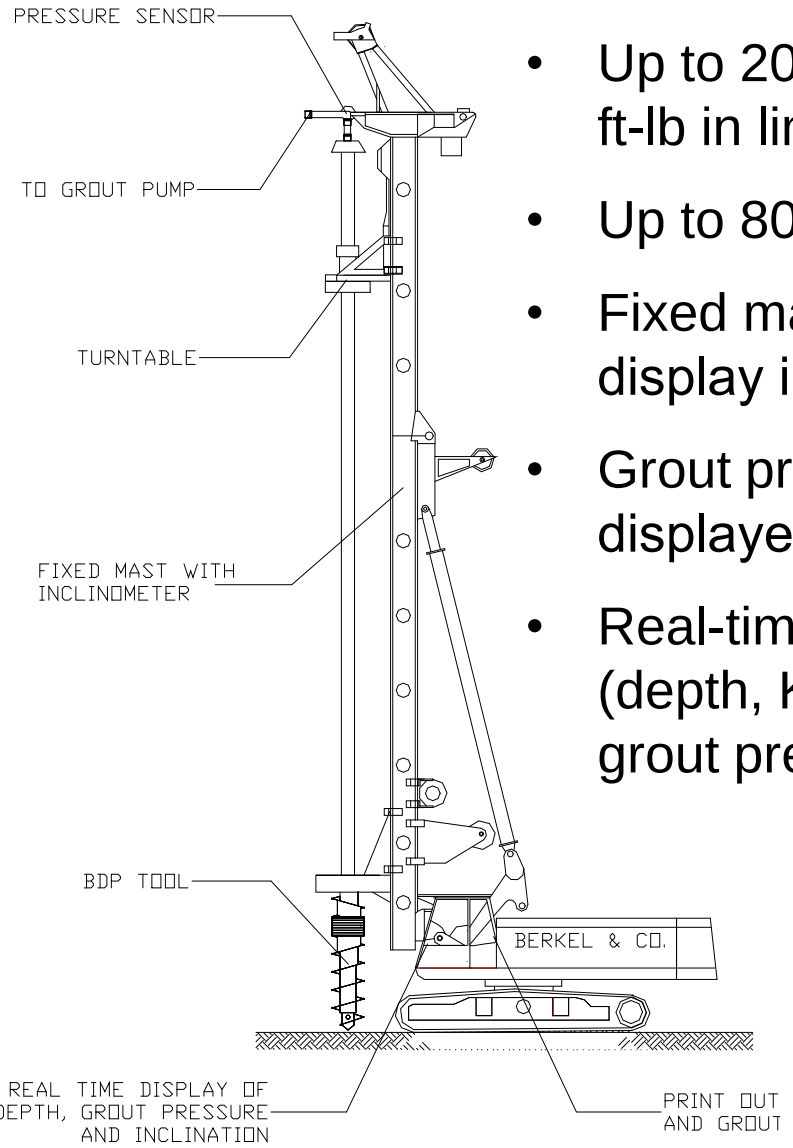
DEEP FOUNDATIONS INSTITUTE
DFI
FINDING COMMON GROUND

Augered Cast-In-Place Pile Manual

(Model Specification with Commentary)

Both treated same per DFI ACIP and DD Pile Committee

INSTALLATION PLATFORM

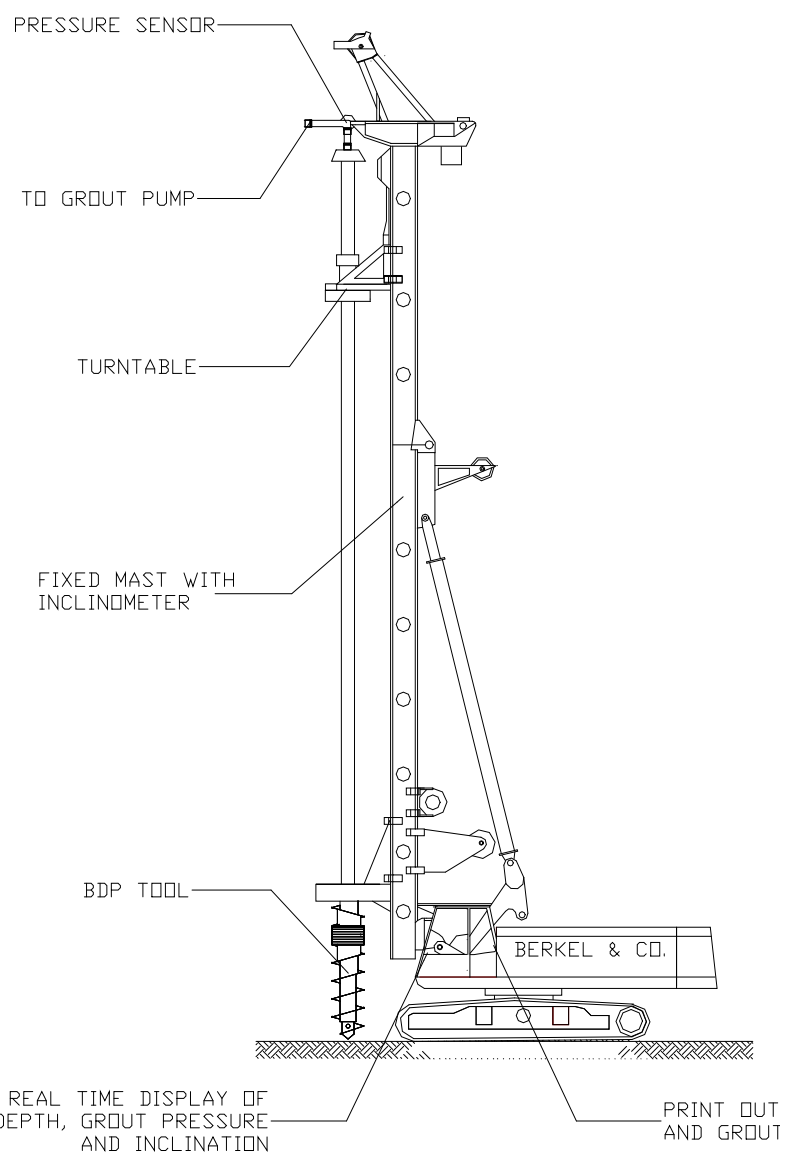


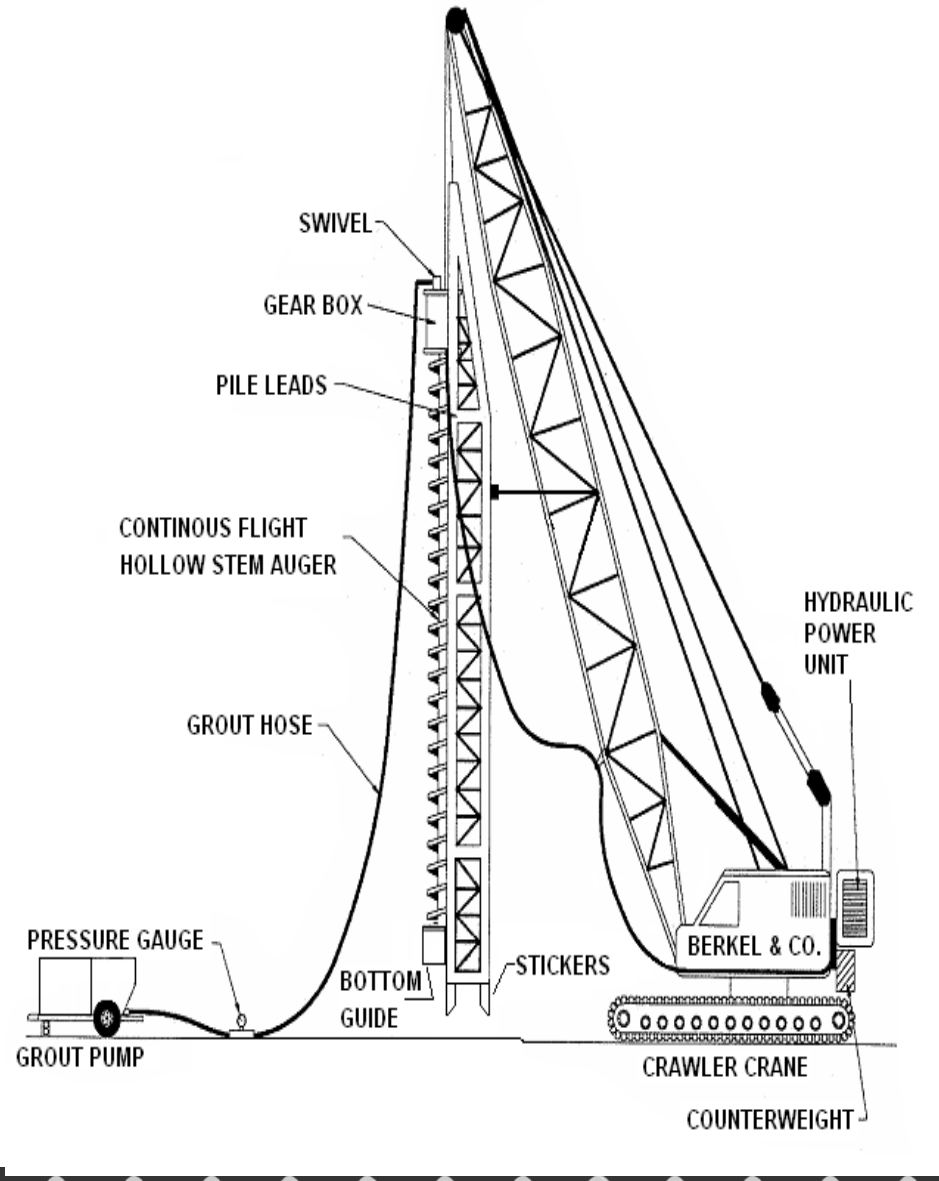
- Up to 200,000 ft-lb torque typical / 350,000 ft-lb in limited quantity
- Up to 80,000 lb crowd or more
- Fixed mast for stability, inclinometer with display in operator's compartment
- Grout pressure, measured at top of tools, is displayed in operator's compartment
- Real-time display of installation parameters (depth, KDK pressure, Installation Effort, grout pressure) pressure

Torques up to 200,000 ft-lbs

Weights up to 80,000 lbs (down force)

INSTALLATION PLATFORM

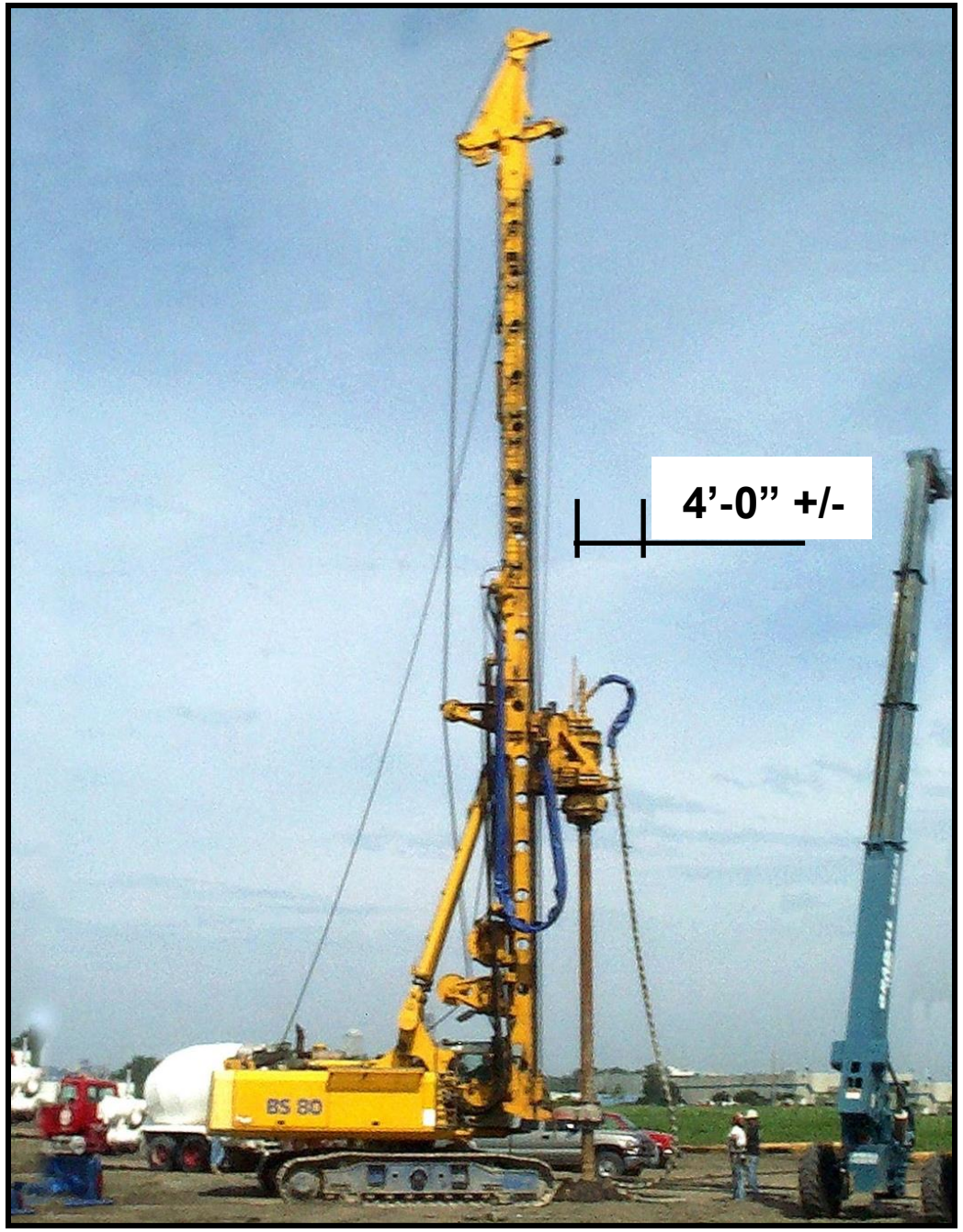




- **Provides hydraulic power turns gearbox/tooling**
- **Horsepower up to 850 hp**

Grout Pump

- Hydraulically operated, positive displacement piston-ball valve pump
- Pump pressures typically around 350 psi at pump outlet
- Stroke displacements typically range from about 0.4 to 1.7 cubic feet per stroke
- Grout hoses typically 2-3 in diameter
- Can pump grout several hundred feet
- Grout typically delivered by ready mix trucks



Fixed-Mast Platform

Crane-Mounted Platform

DFI TEST PROGRAM

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DFI Journal - The Journal of the Deep Foundations Institute

Volume 15, Issue 1, April 2021

DOI: 10.37308/DFIJnl.20200525.218

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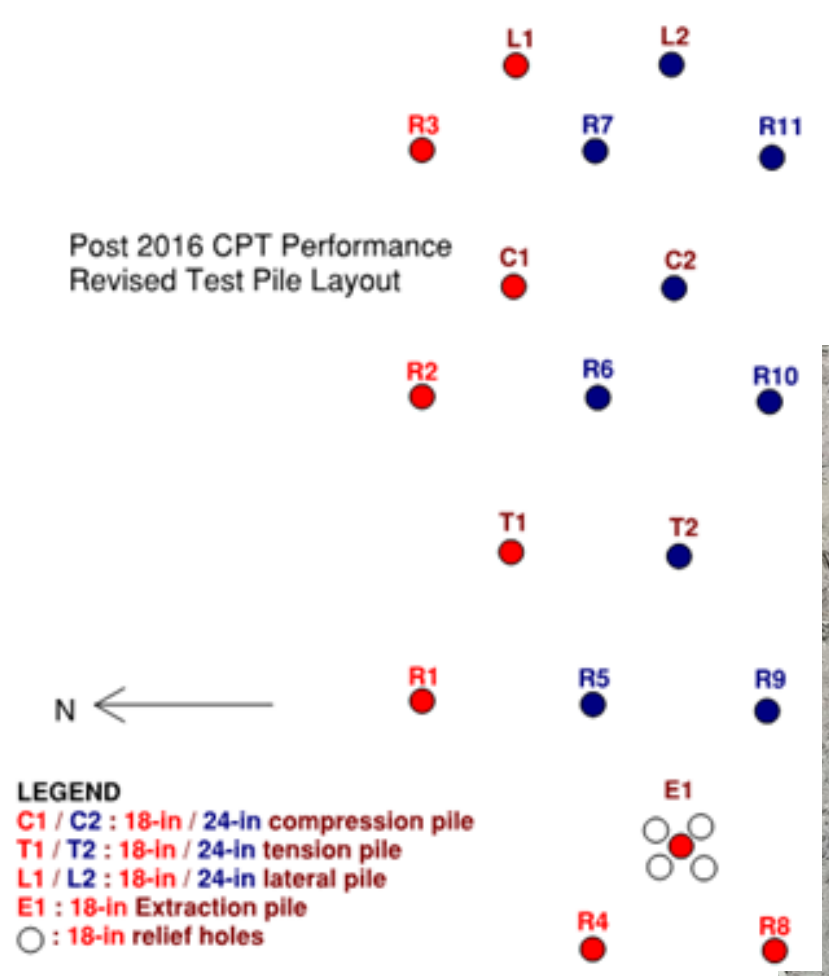
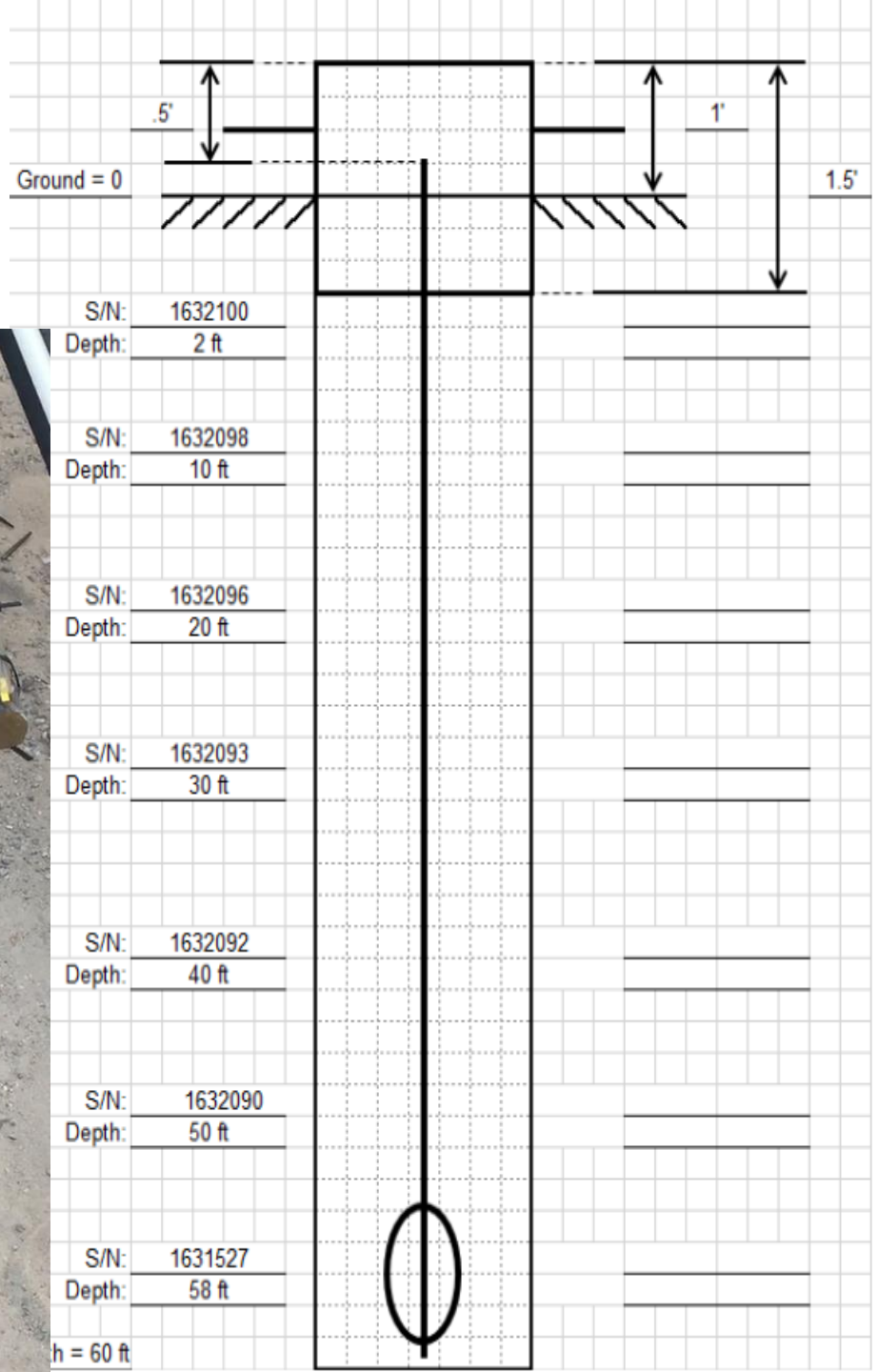
Full-Scale Load Testing and Extraction of Augered Cast-in-Place (ACIP) Piles in Central Florida

Article Type: Research Paper

Marinucci, A., Moghaddam, R. B., & NeSmith, W., Jr.

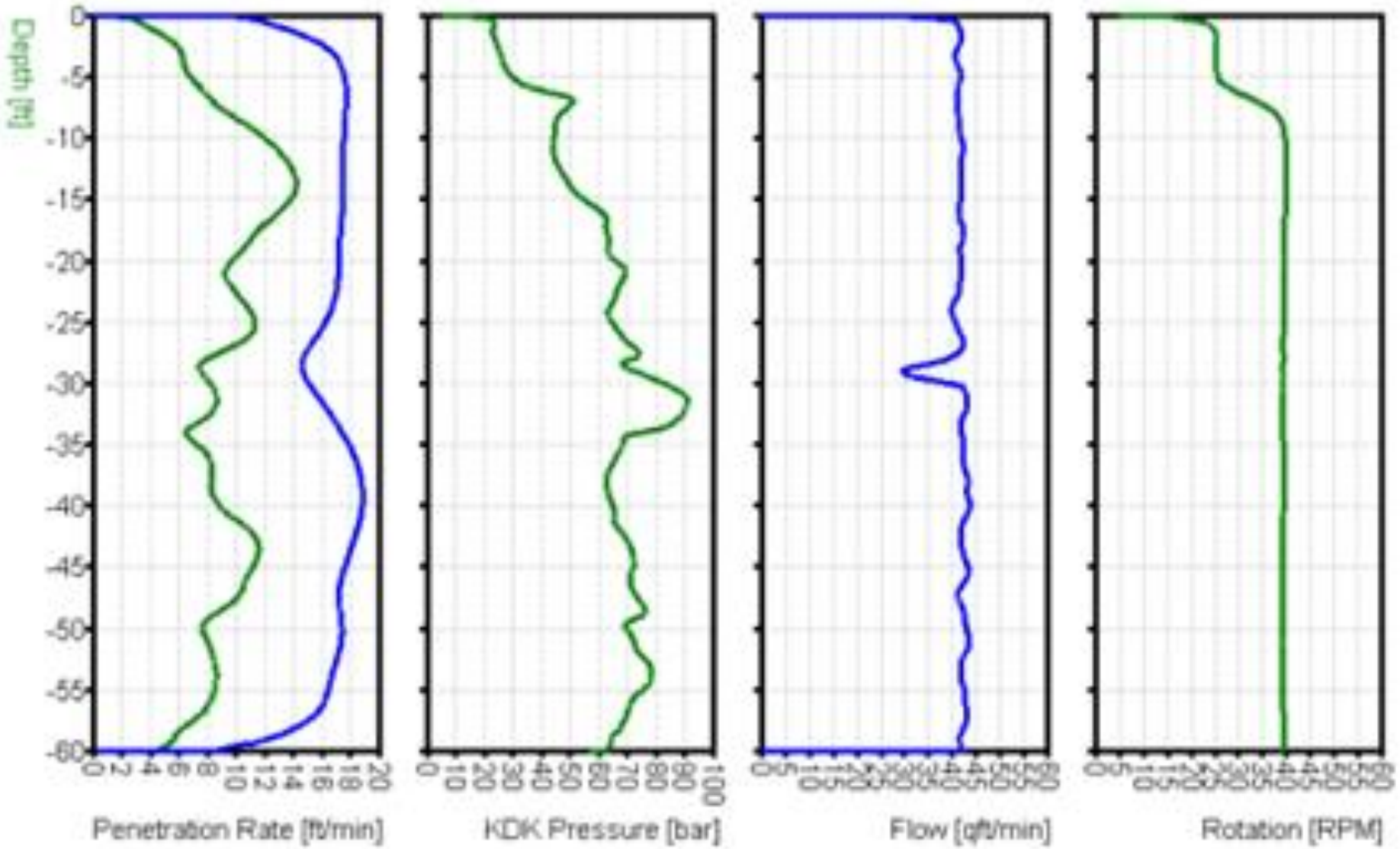

L1
L2
R3
R7
R11
Post 2016 CPT Performance
Revised Test Pile Layout
C1
C2
R2
R6
R10
T1
T2
R1
R5
R9
N
LEGEND
C1 / C2 : 18-in / 24-in compression pile
T1 / T2 : 18-in / 24-in tension pile
L1 / L2 : 18-in / 24-in lateral pile
E1 : 18-in Extraction pile
: 18-in relief holes
E1
R4
R8

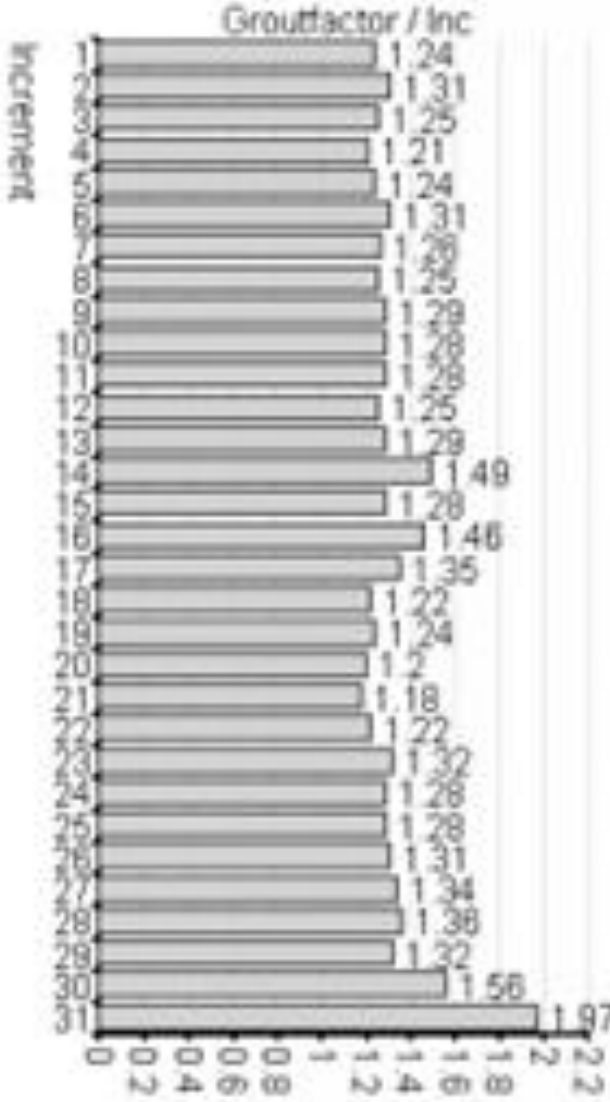

.5'
1'
Ground = 0
1.5'
S/N: 1632100
Depth: 2 ft
S/N: 1632098
Depth: 10 ft
S/N: 1632096
Depth: 20 ft
S/N: 1632093
Depth: 30 ft
S/N: 1632092
Depth: 40 ft
S/N: 1632090
Depth: 50 ft
S/N: 1631527
Depth: 58 ft
h = 60 ft

Time [h:mm:ss] 5

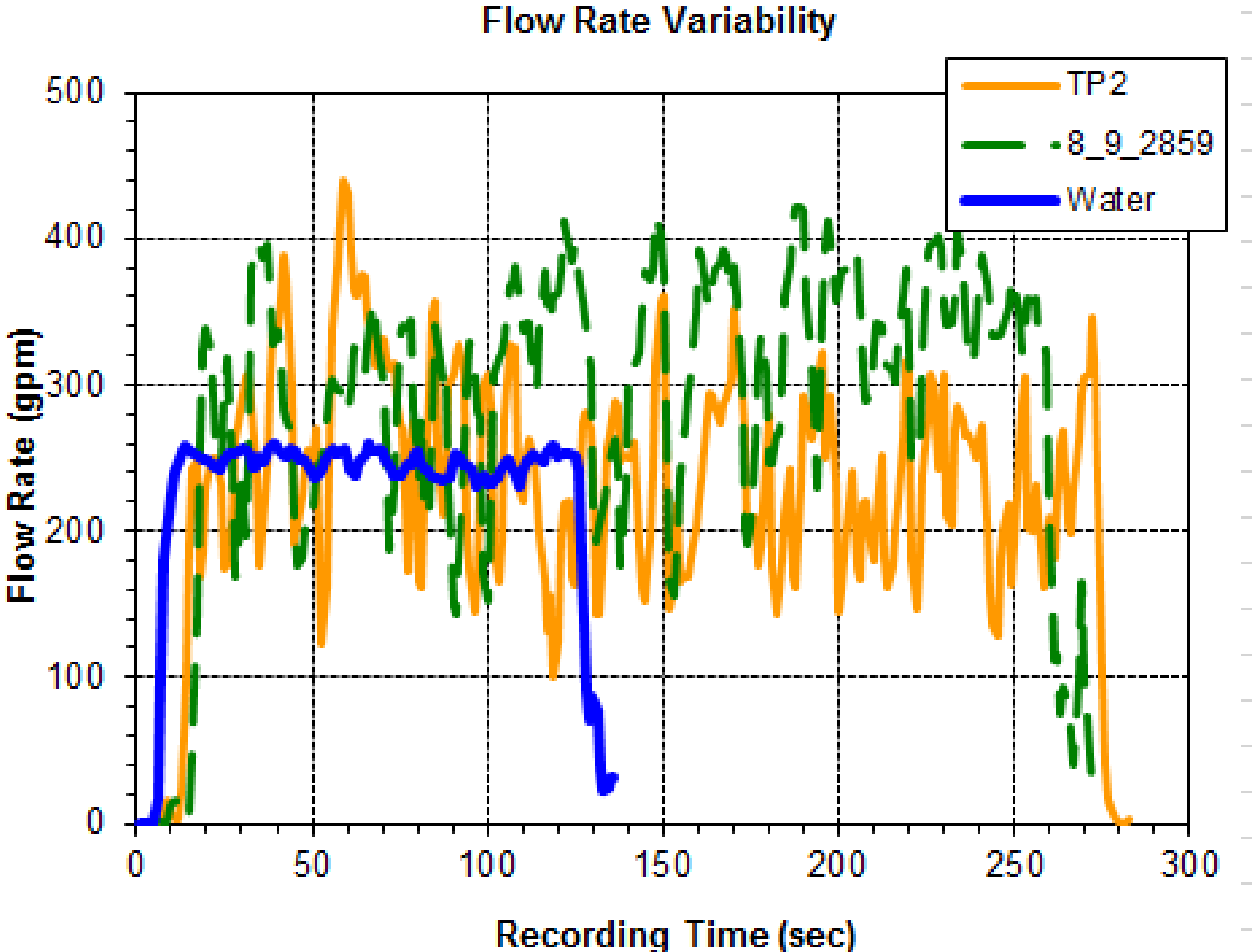
Parameter vs. Depth

penetration withdrawal

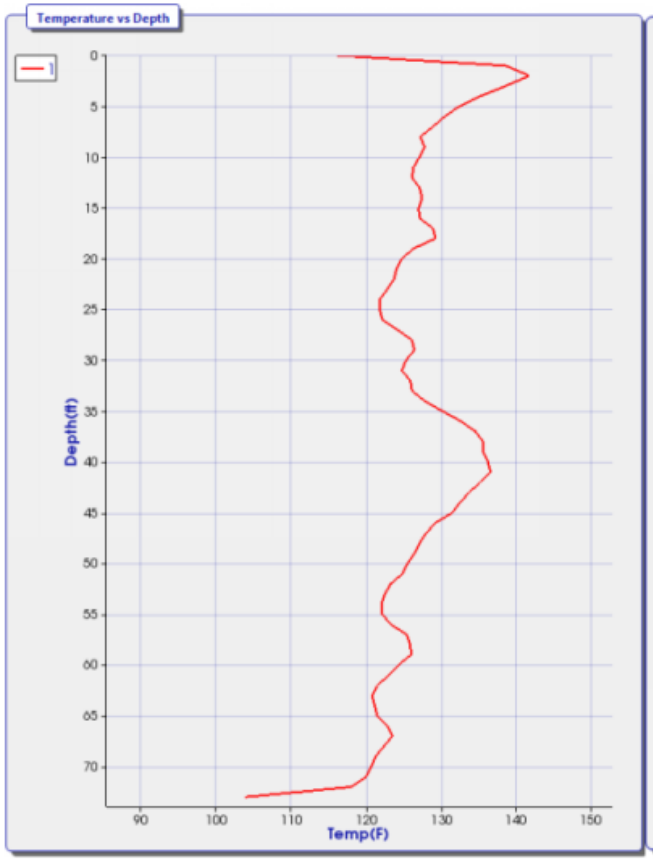


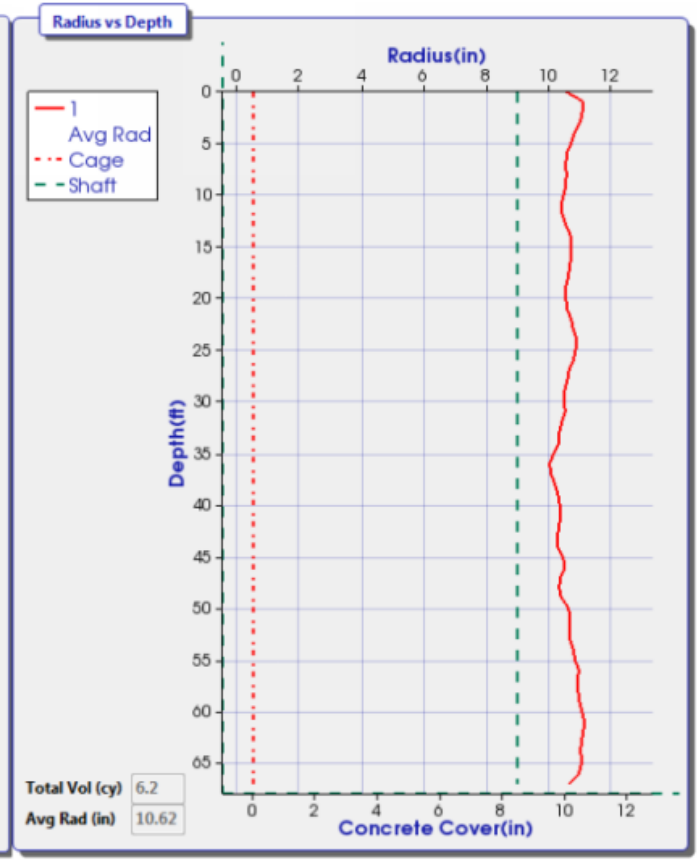


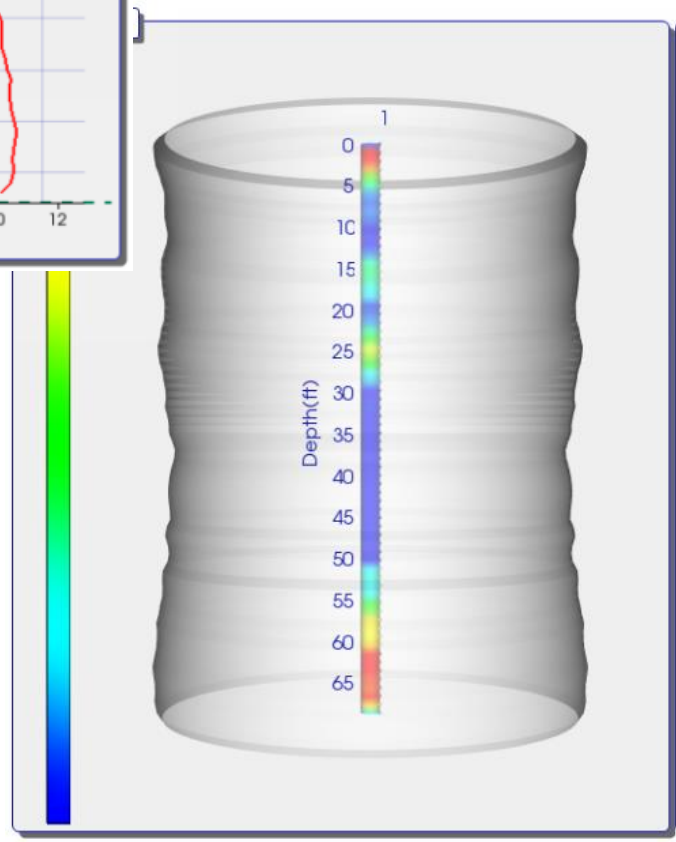
INC 31 = 1 ft INC 30 = 1.6 ft
INC 29 - 1 = 2 ft

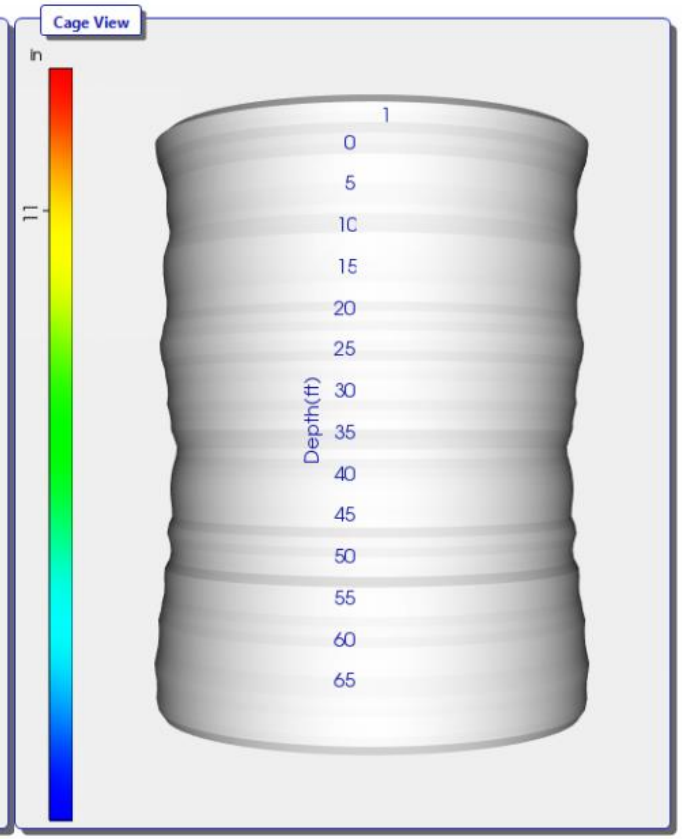

Flow Rate Variability
TP2
8_9_2859
Water
Flow Rate (gpm)
500
400
300
200
100
0
0
50
100
150
200
250
300
Recording Time (sec)

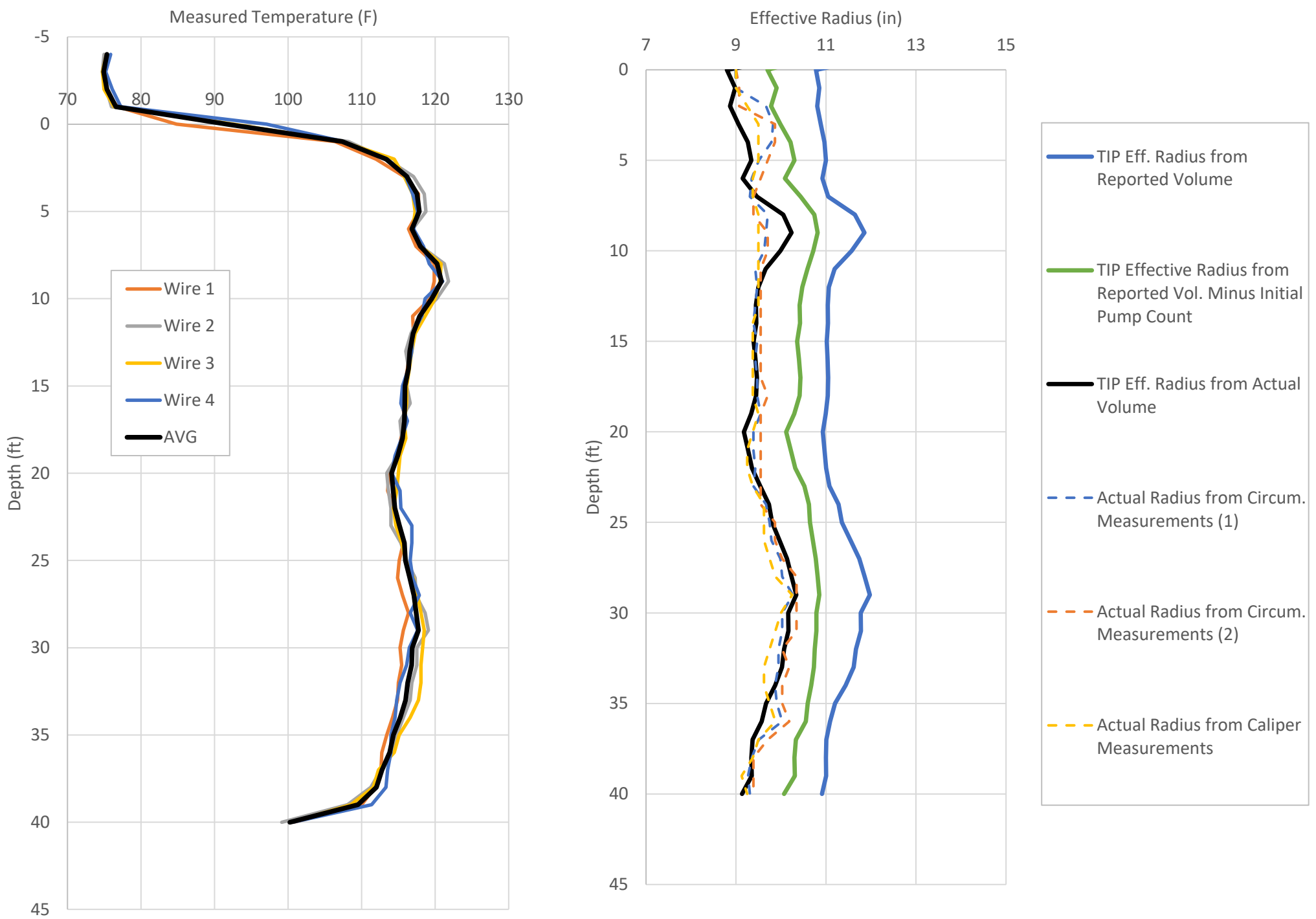
Thermal Integrity Profiling







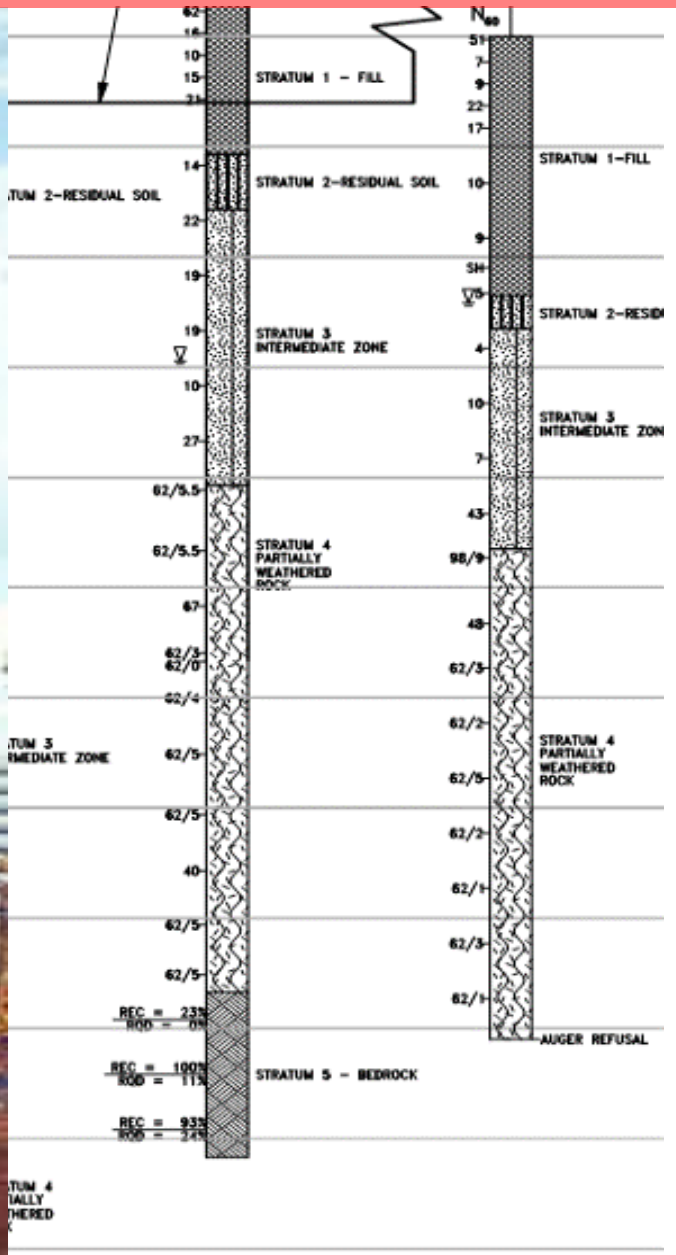


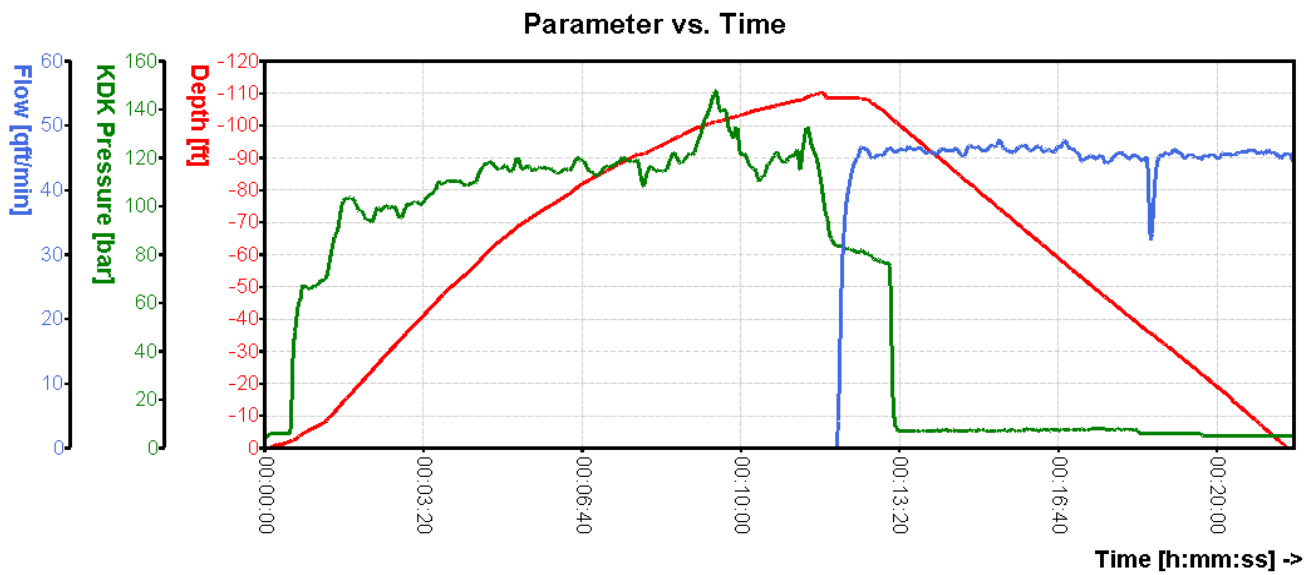

Measured Temperature (F)
-5
0
5
10
15
20
25
30
35
40
45
70
80
90
100
110
120
130
Depth (ft)
Wire 1
Wire 2
Wire 3
Wire 4
AVG
Effective Radius (in)
7
9
11
13
15
0
5
10
15
20
25
30
35
40
45
Depth (ft)
TIP Eff. Radius from Reported Volume
TIP Effective Radius from Reported Vol. Minus Initial Pump Count
TIP Eff. Radius from Actual Volume
Actual Radius from Circum. Measurements (1)
Actual Radius from Circum. Measurements (2)
Actual Radius from Caliper Measurements

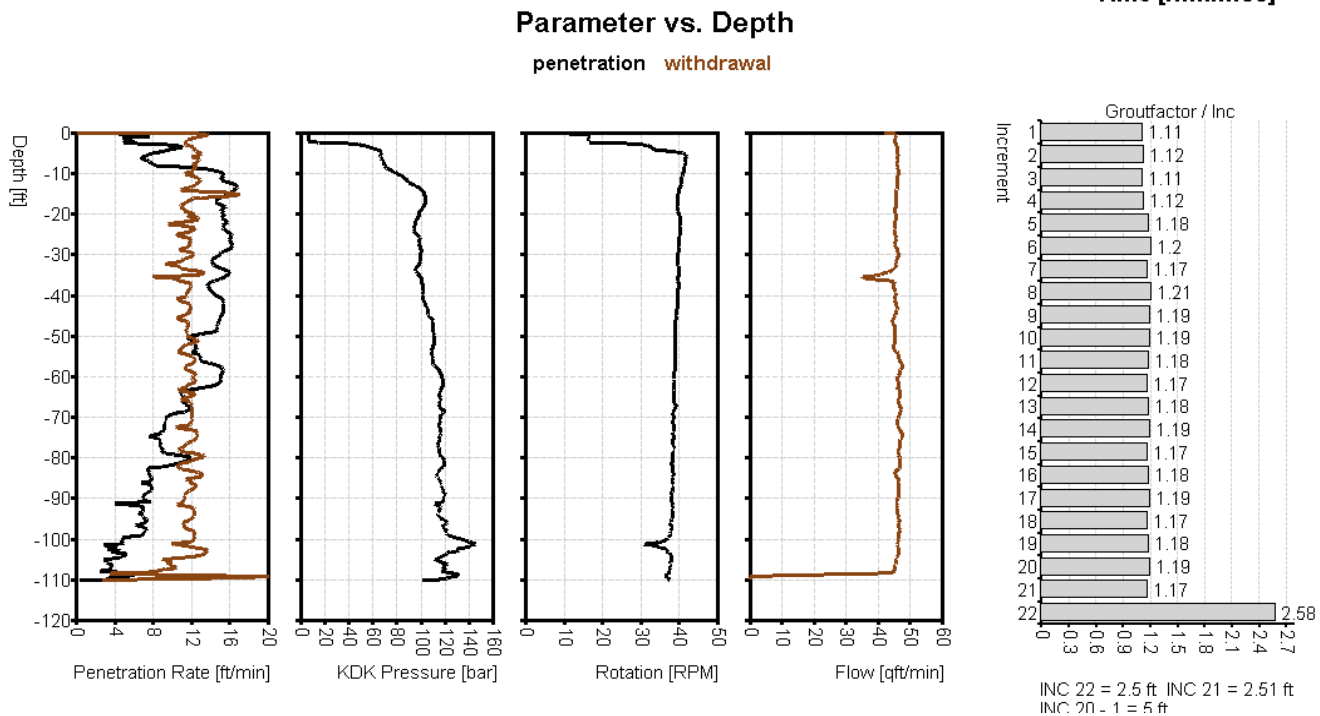
18" Extraction Pile

Pile Increment (ft)	Circumference (in)	Diameter(in)	
1	57	18.1	
2	57	18.1	
3	62	19.7	
4	62	19.7	
5	61	19.4	
6	60	19.1	
7	59	18.8	
8	59	18.8	
9	61	19.4	True Pile Length
10	61	19.4	40-ft 4-in
11	60	19.1	
12	60	19.1	Average Diameter (in)
13	60	19.1	19.4
14	60	19.1	
15	60	19.1	
16	60	19.1	
17	60	19.1	
18	61	19.4	
19	60	19.1	
20	60	19.1	
21	60	19.1	
22	60	19.1	
23	60	19.1	
24	60	19.1	
25	62	19.7	
26	62	19.7	
27	63	20.1	
28	65	20.7	
29	65	20.7	
30	65	20.7	
31	65	20.7	
32	63	20.1	
33	64	20.4	
34	63	20.1	
35	63	20.1	
36	64	20.4	
37	61	19.4	
38	59	18.8	
39	59	18.8	
40	59	18.8	

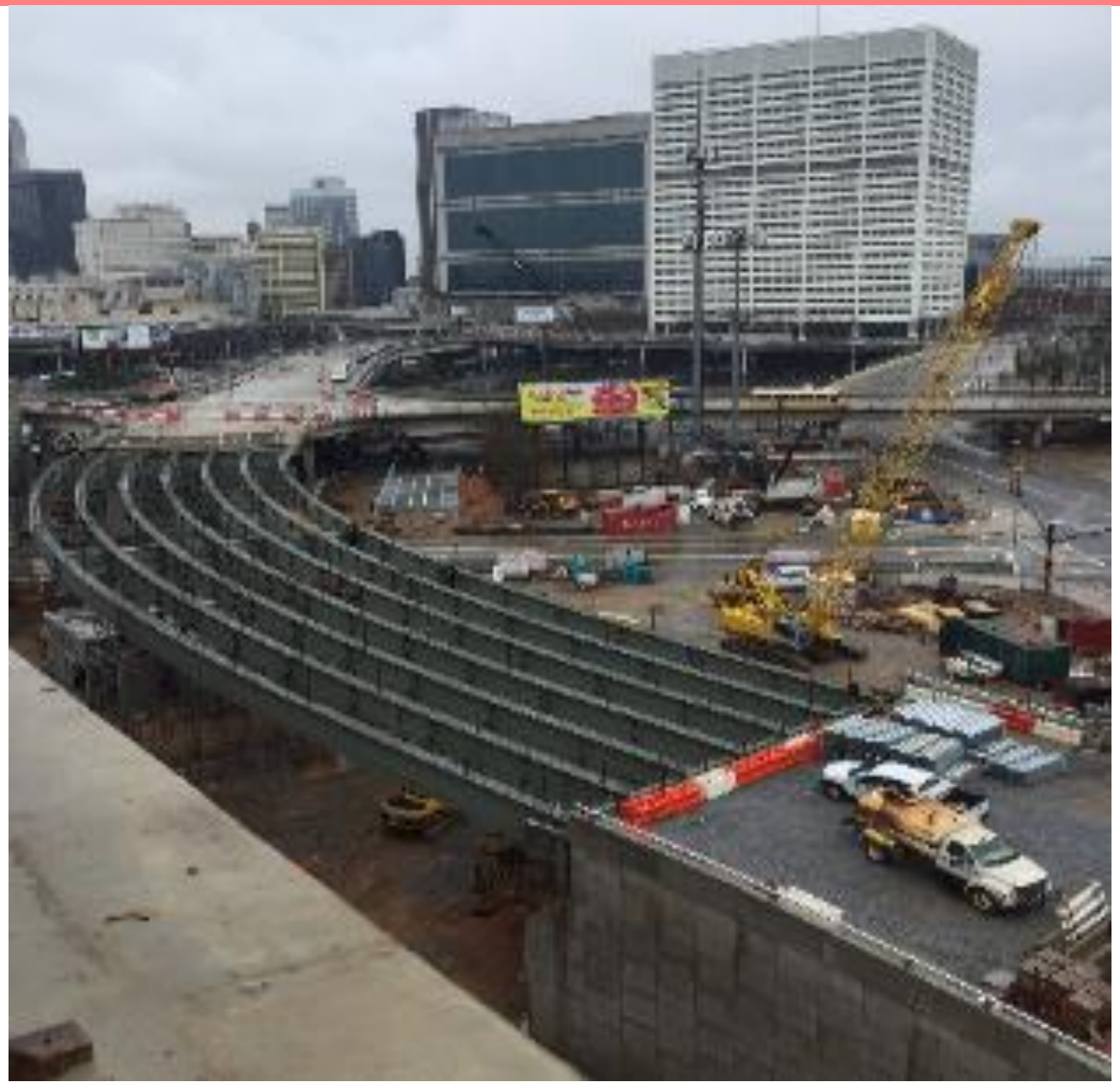
NSP – MLK Bridge – Atlanta GA (City of Atlanta)



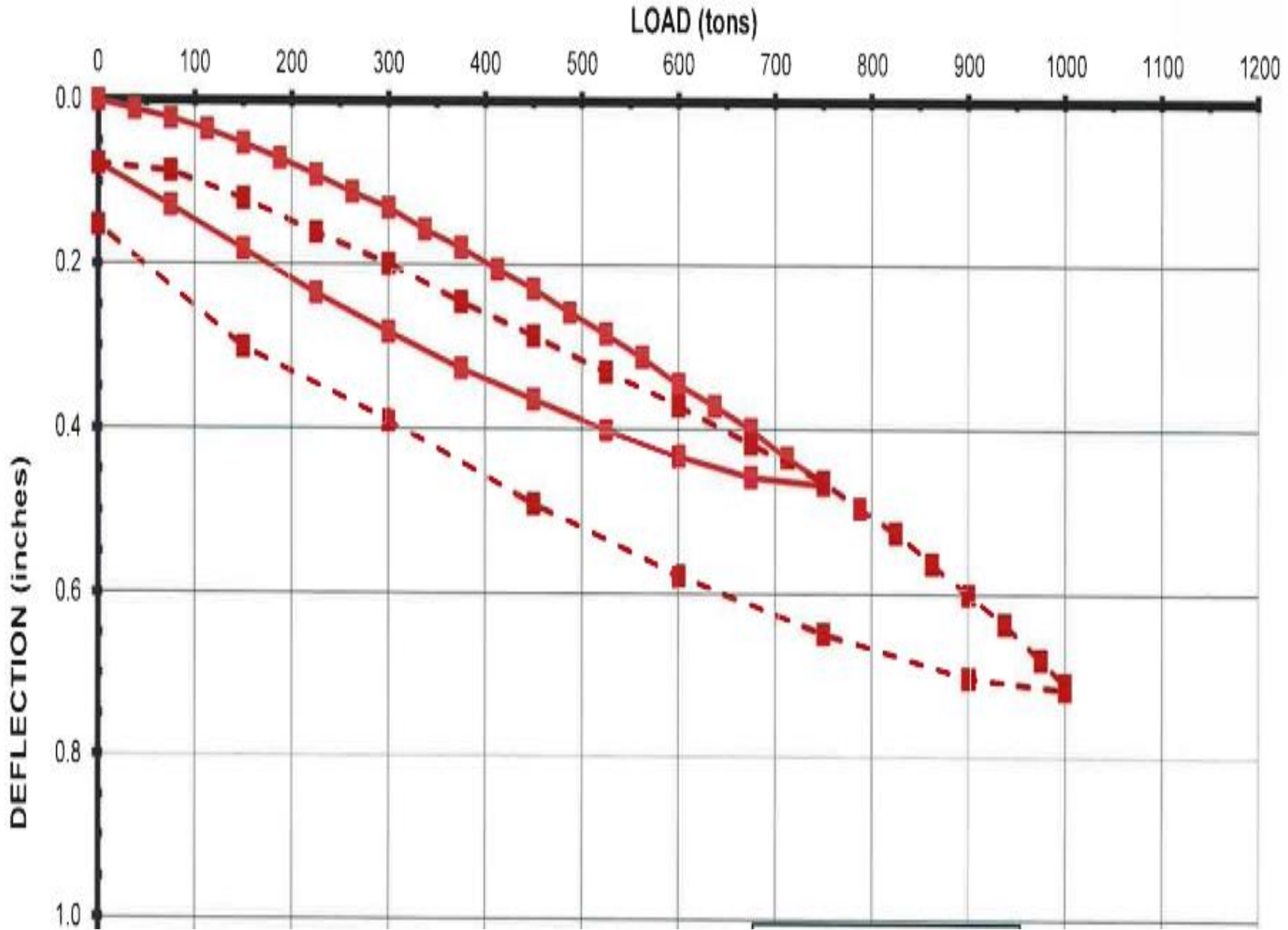


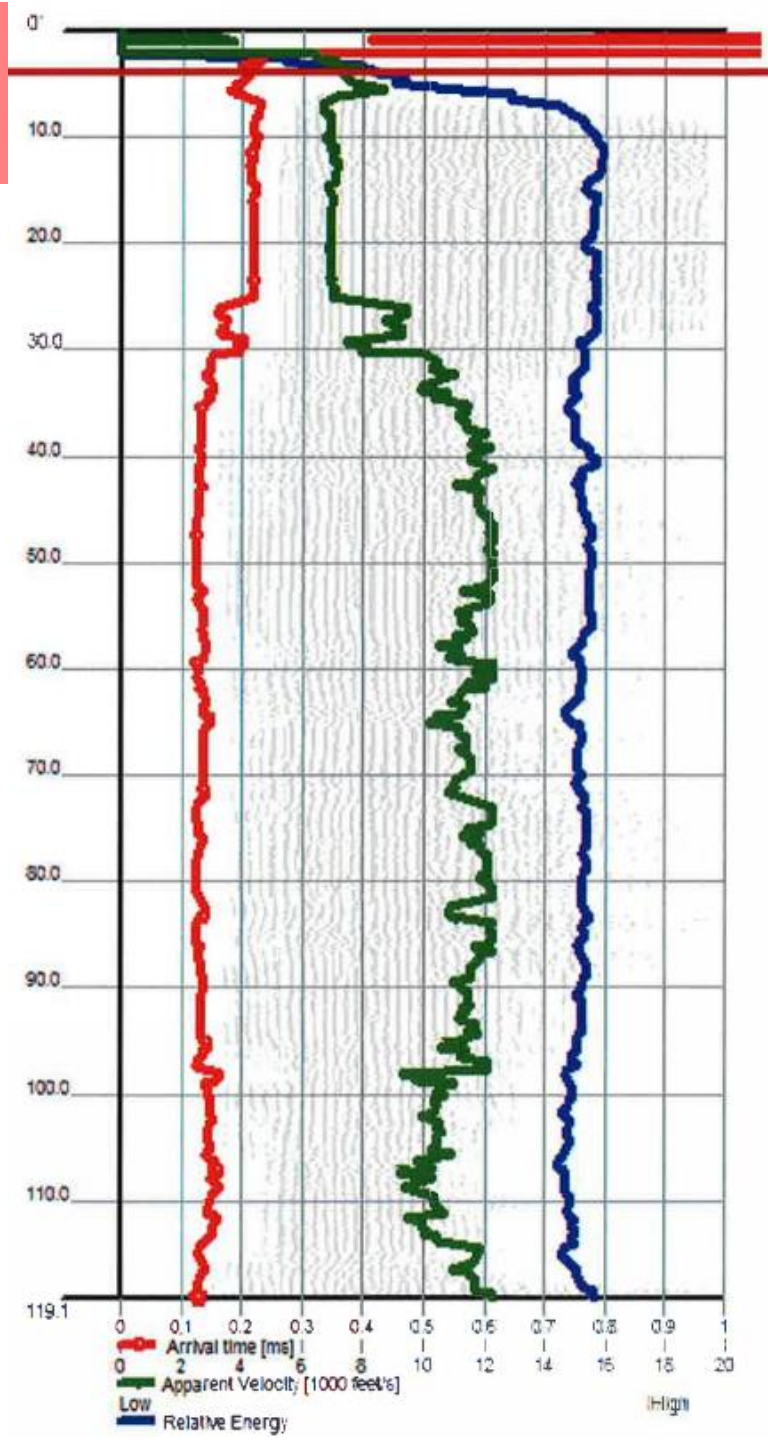


NSP – MLK Bridge – Atlanta GA

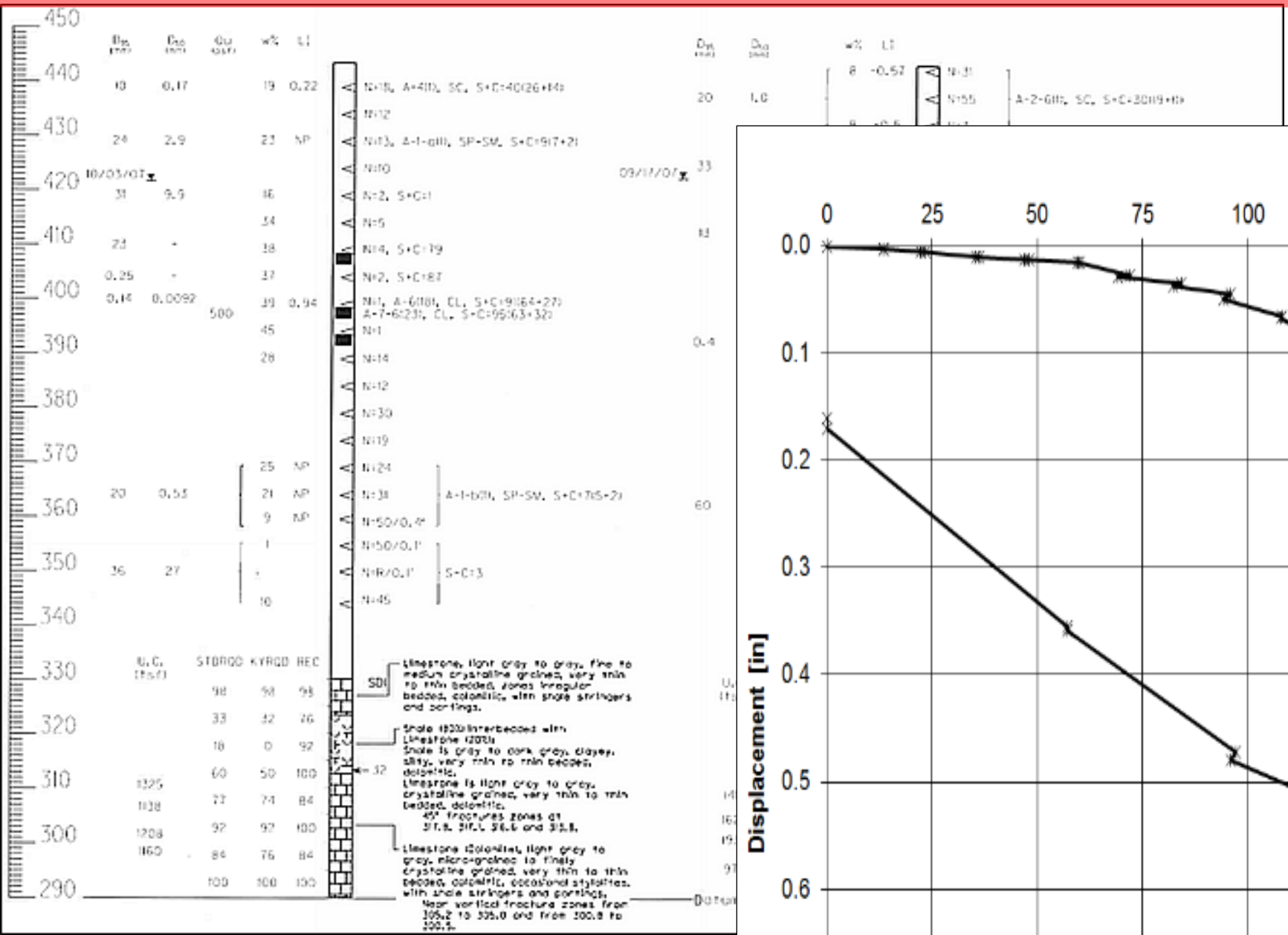


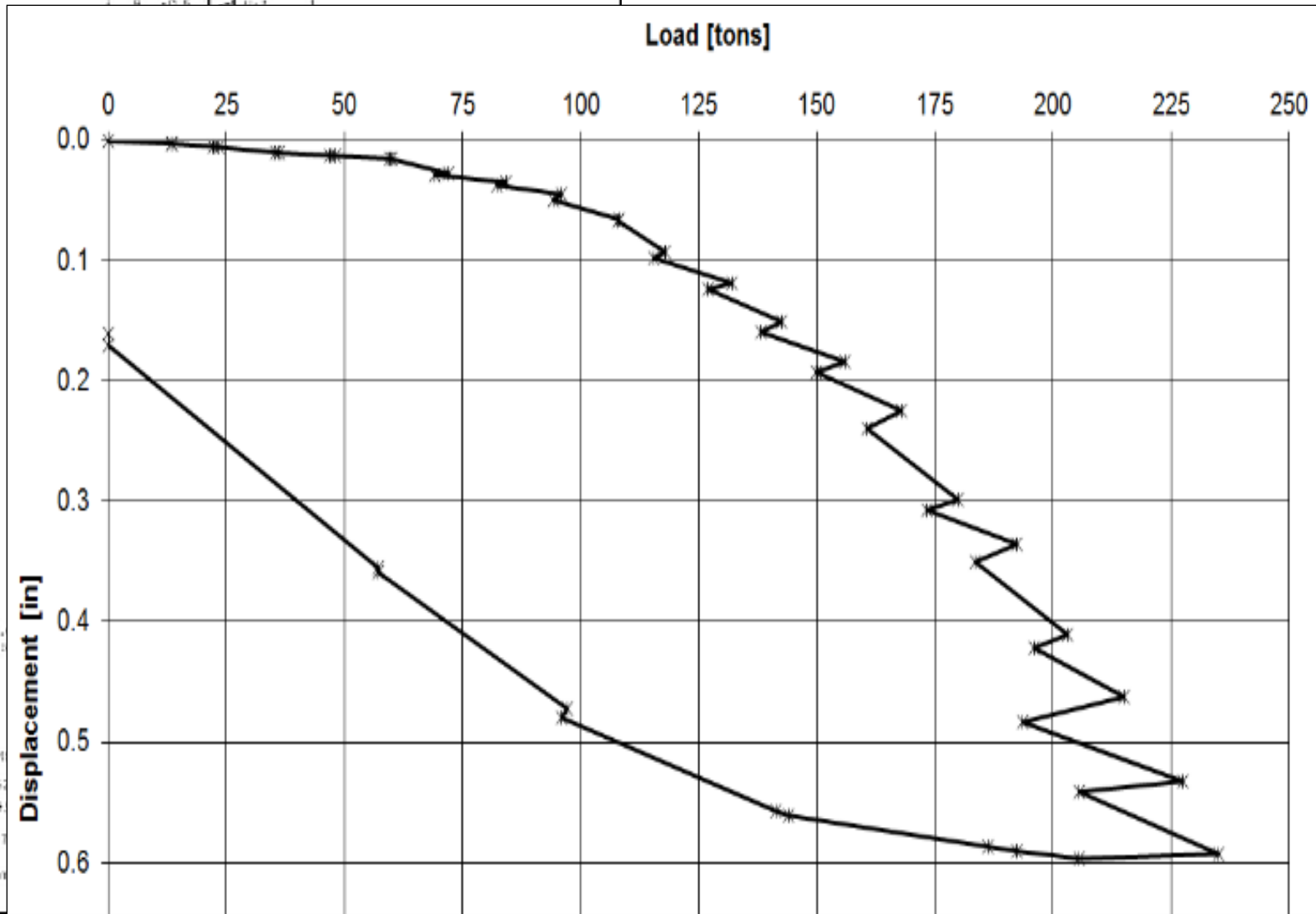
NSP – MLK Bridge – Atlanta GA



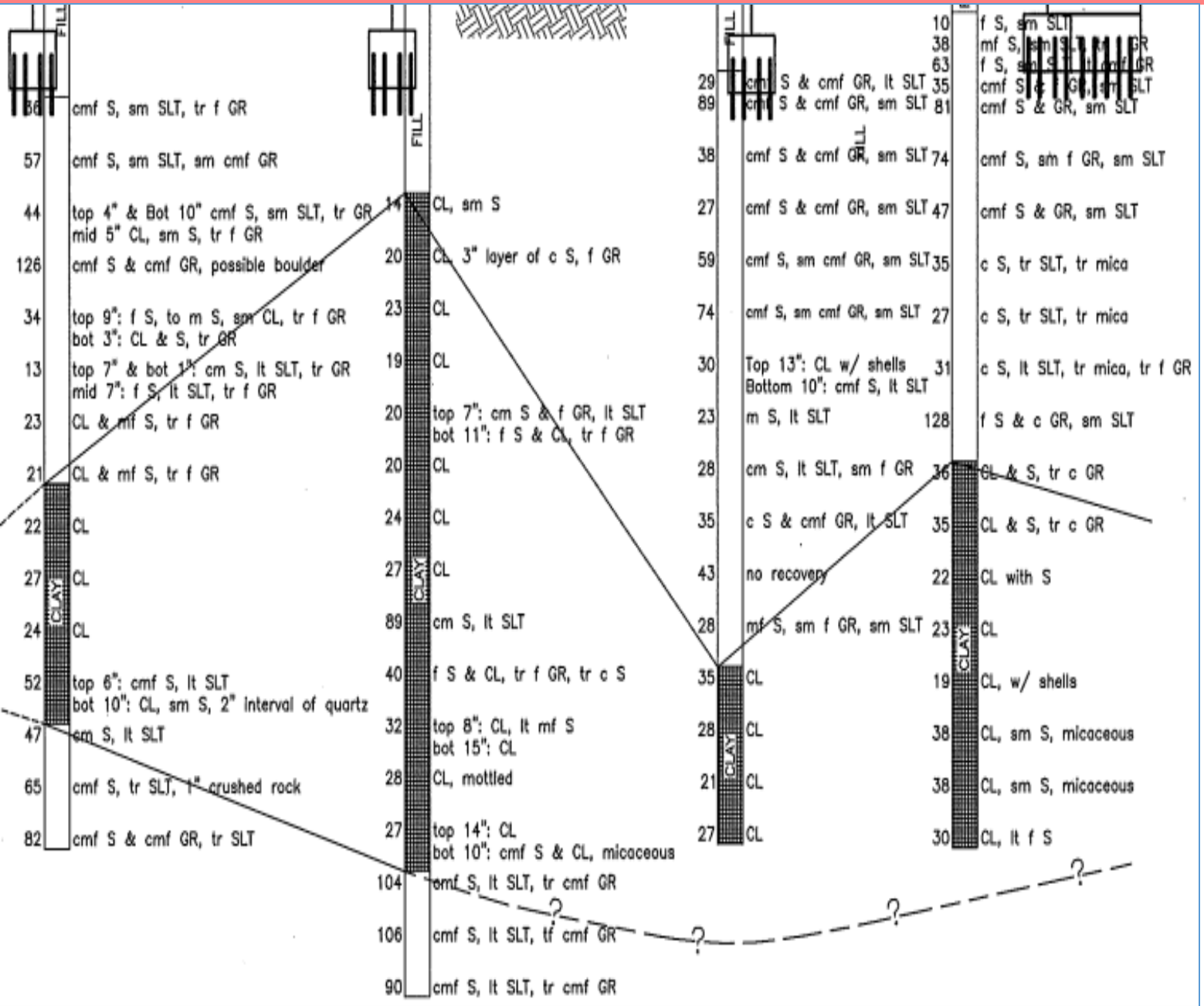


OHIO RIVER BRIDGE – LOUISVILLE KY (KY DOT)
TOWER CRANE SUPPORT





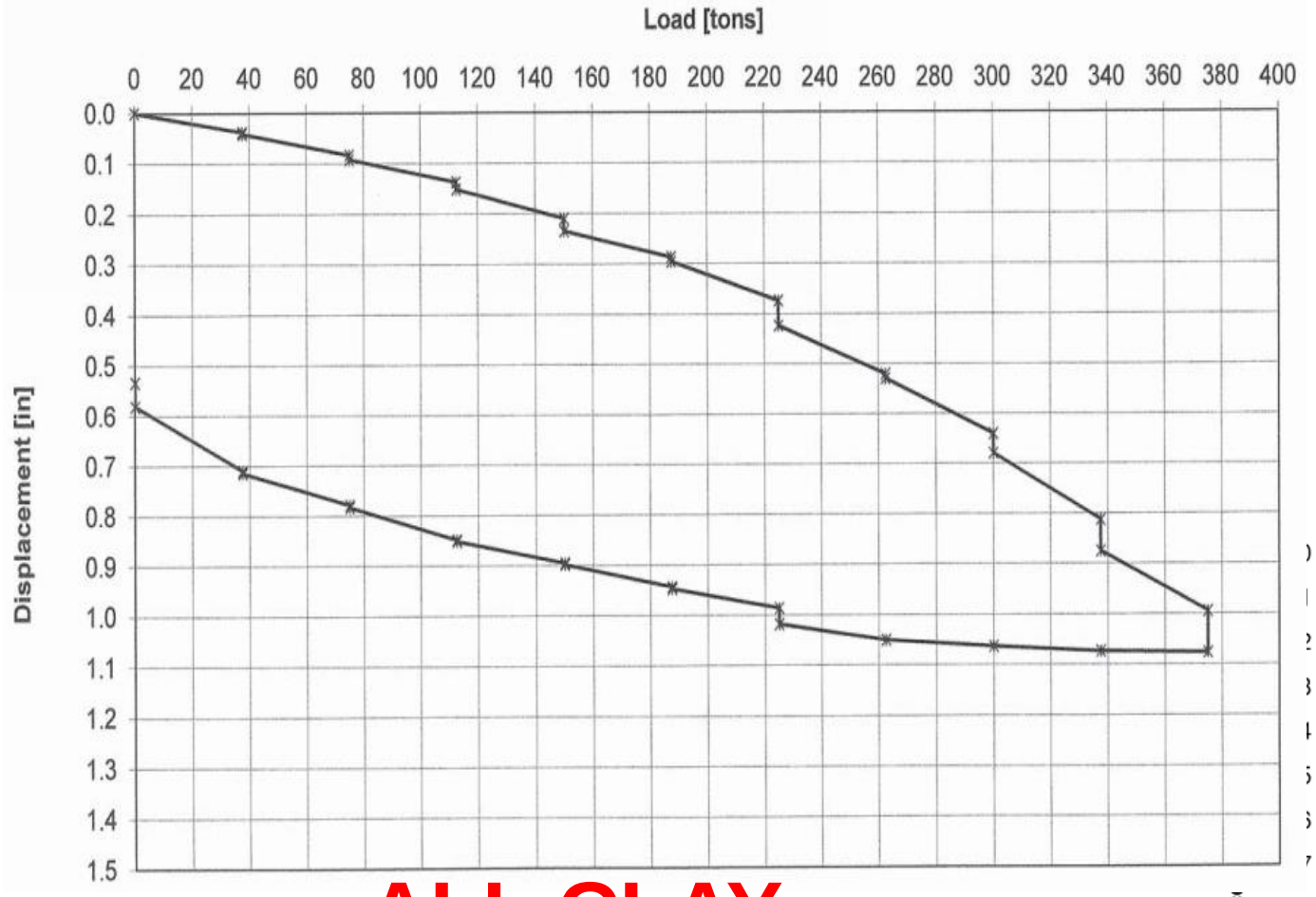
Queens Approach – Bronx Whitestone Bridge – NYC [MTA]



Queens Approach – Bronx Whitestone Bridge - NYC

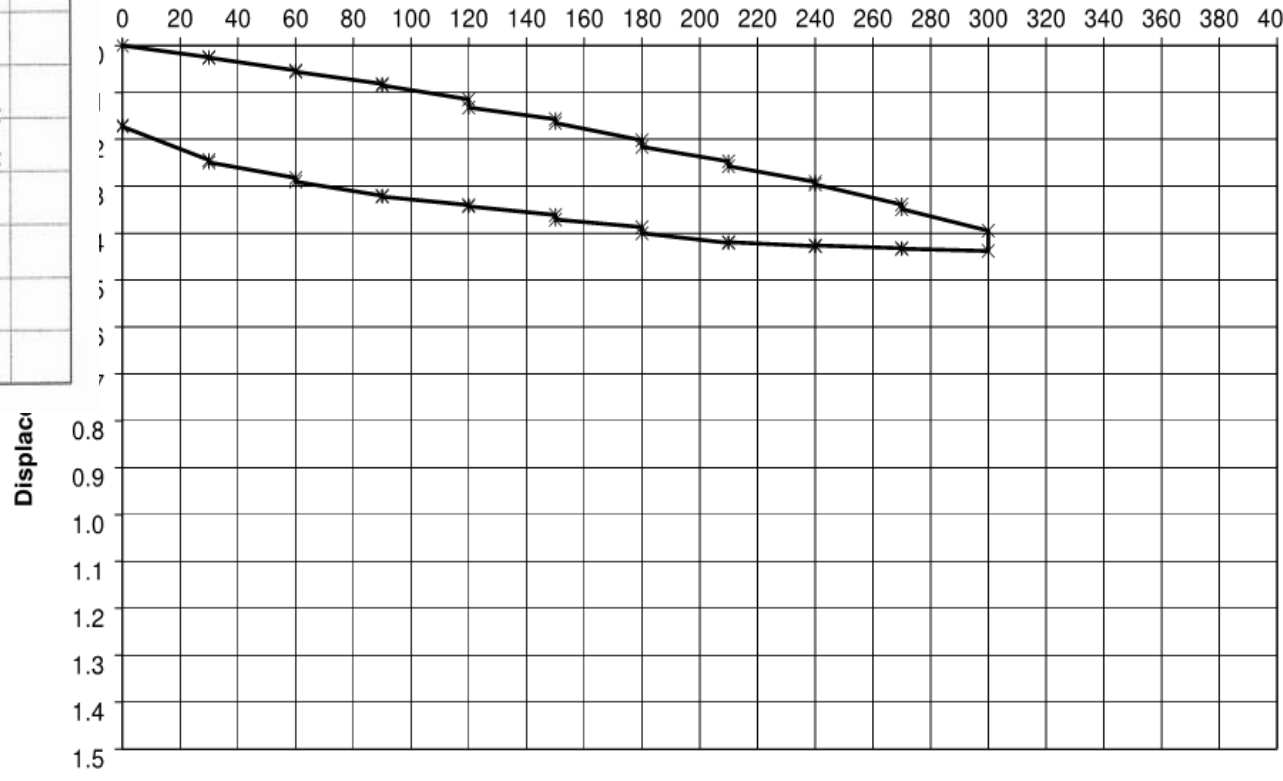
Self-Contained LHR-APG RIG

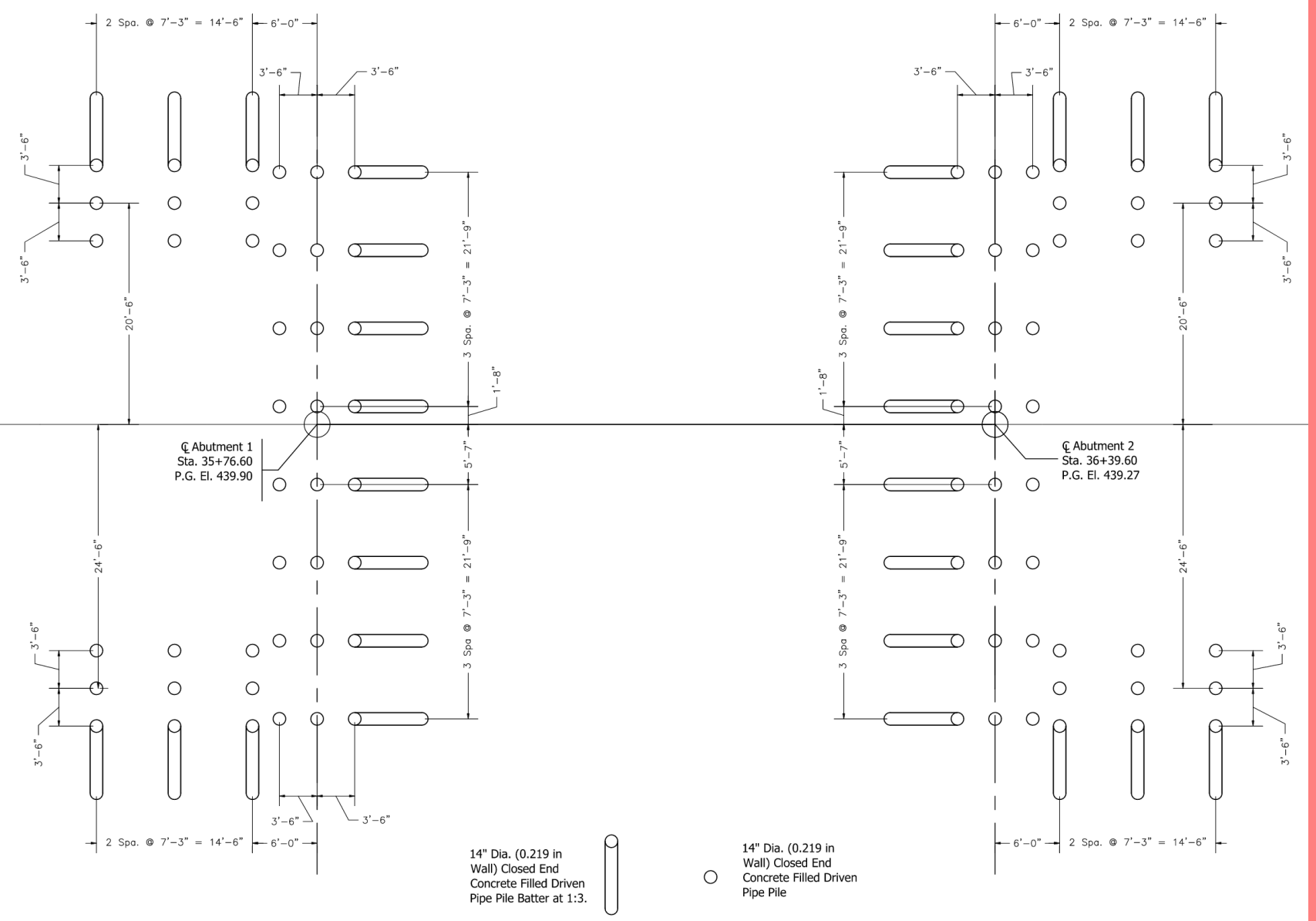
Queens Approach – Bronx Whitestone Bridge - NYC



ALL CLAY

MOSTLY SAND

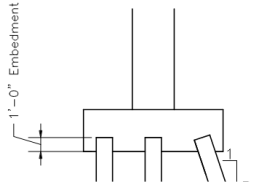




14" Dia. (0.219 in Wall) Closed End Concrete Filled Driven Pipe Pile Batter at 1:3.

14" Dia. (0.219 in Wall) Closed End Concrete Filled Driven Pipe Pile

PLAN

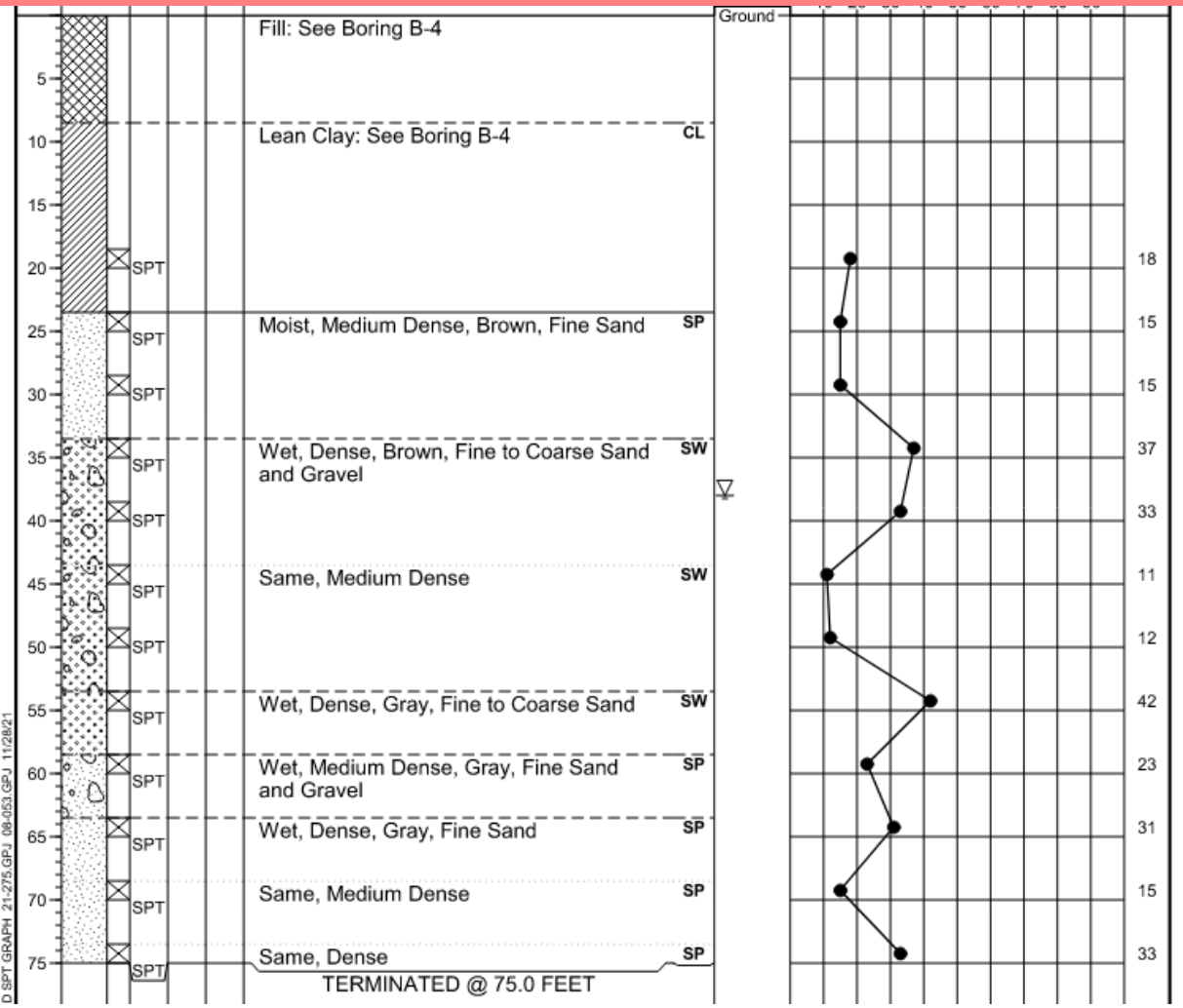


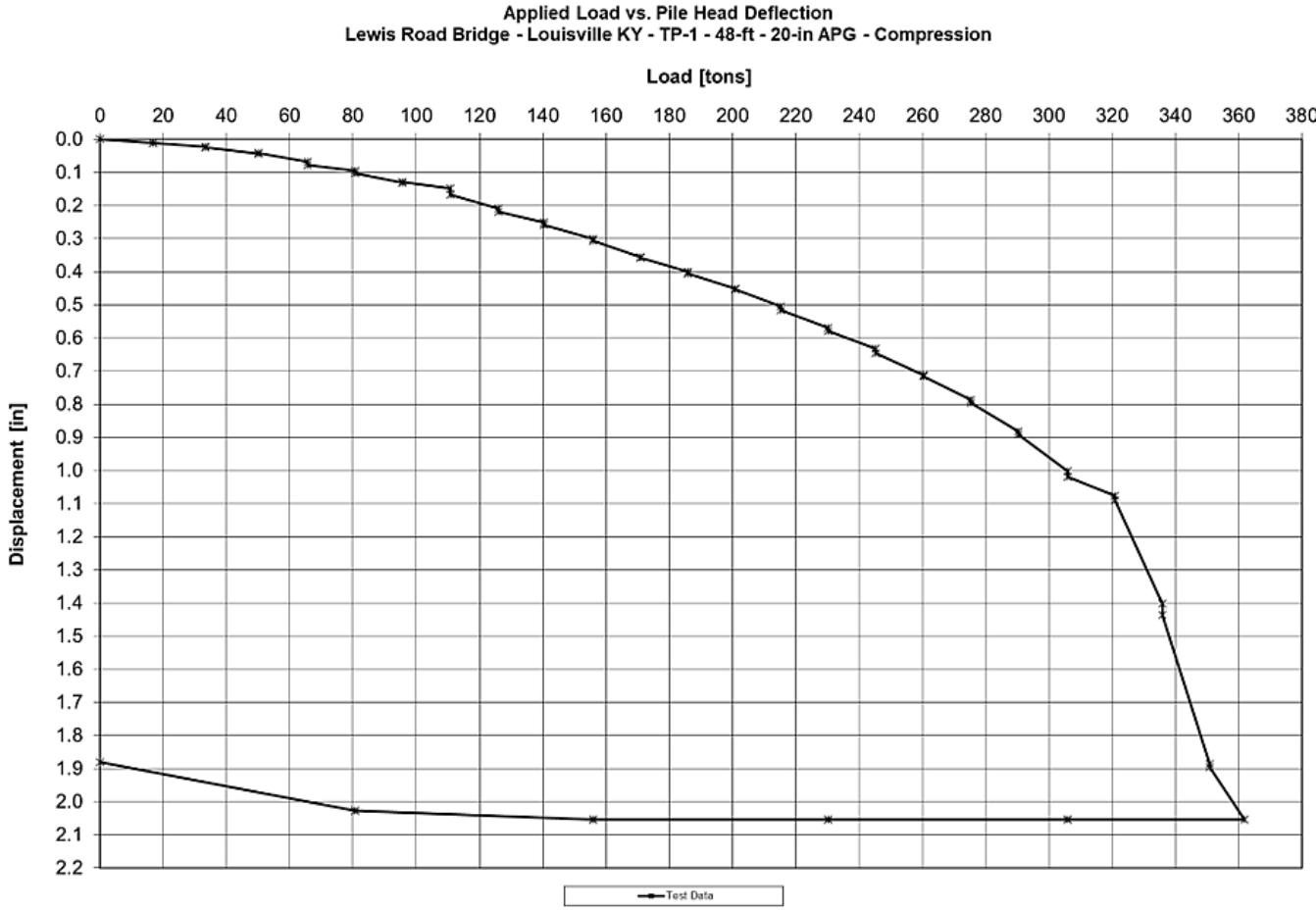
Note:
1. Piles shall be driven to an elevation of 367'. This will correspond with an Factored Load of 190 Kips in compression.

LEWIS ROAD BRIDGE LOUISVILLE KY

LEWIS ROAD BRIDGE – LOUISVILLE KY

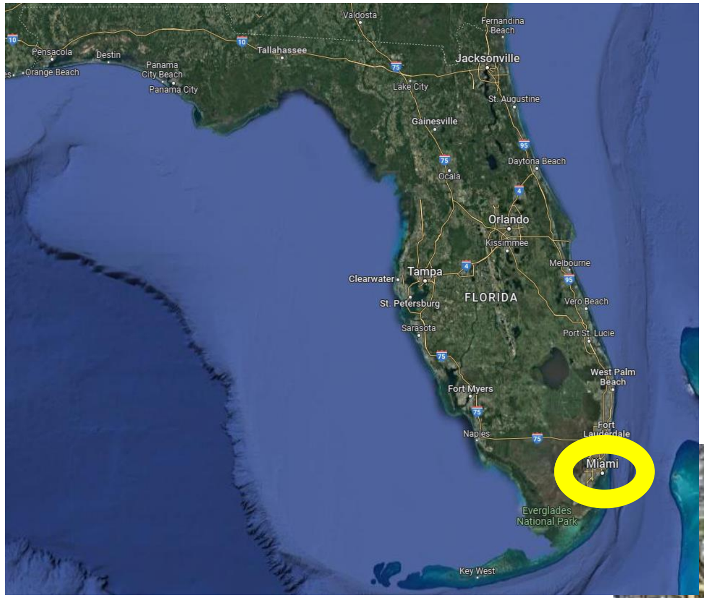
LEWIS ROAD BRIDGE - LOUISVILLE KY

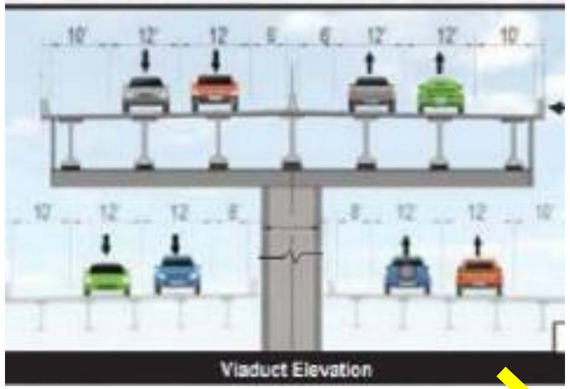


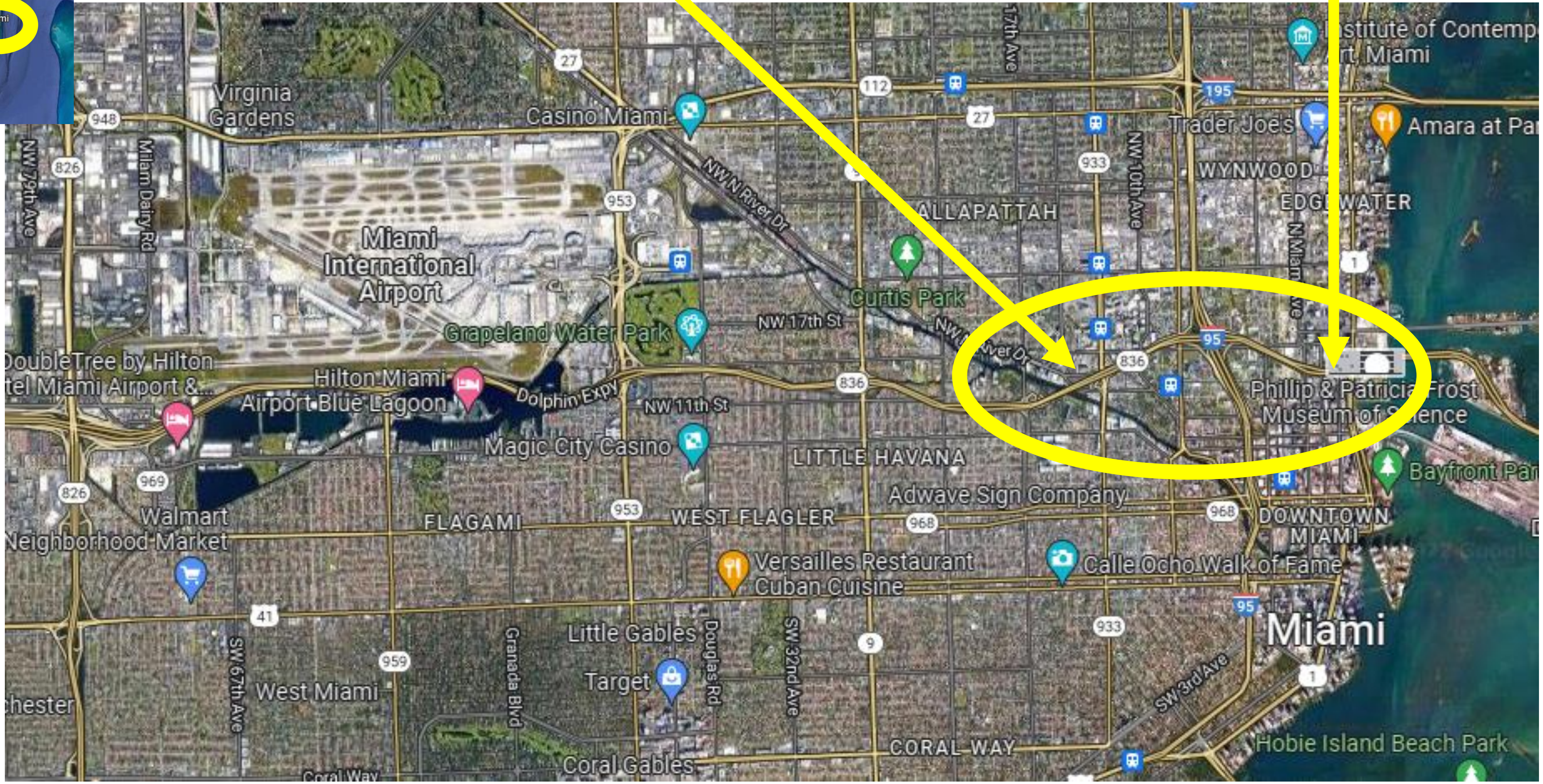


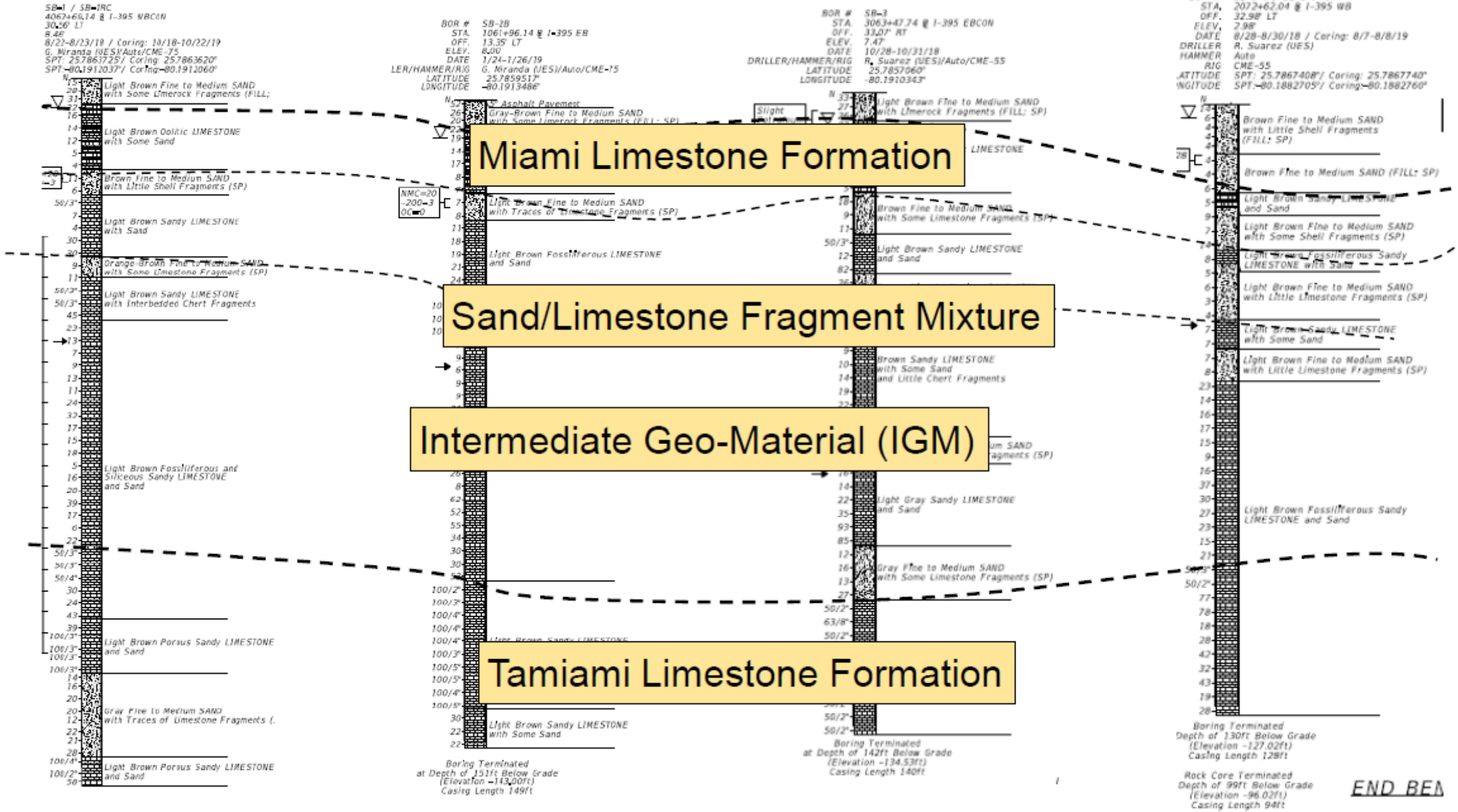
Case History: FDOT Miami Signature Bridge

- Client: Florida Department of Transportation
- General Contractor: Archer Western de Moya JV
- Geotech: Universal Engineering Services (UES)
- Multiple phases: 4-5 year schedule
- Keller Scope:
  - Drill CFA piles to required elevation
  - Pump grout supplied by GC
  - Pick and place pile reinforcing supplied by GC
  - All pile testing by GC

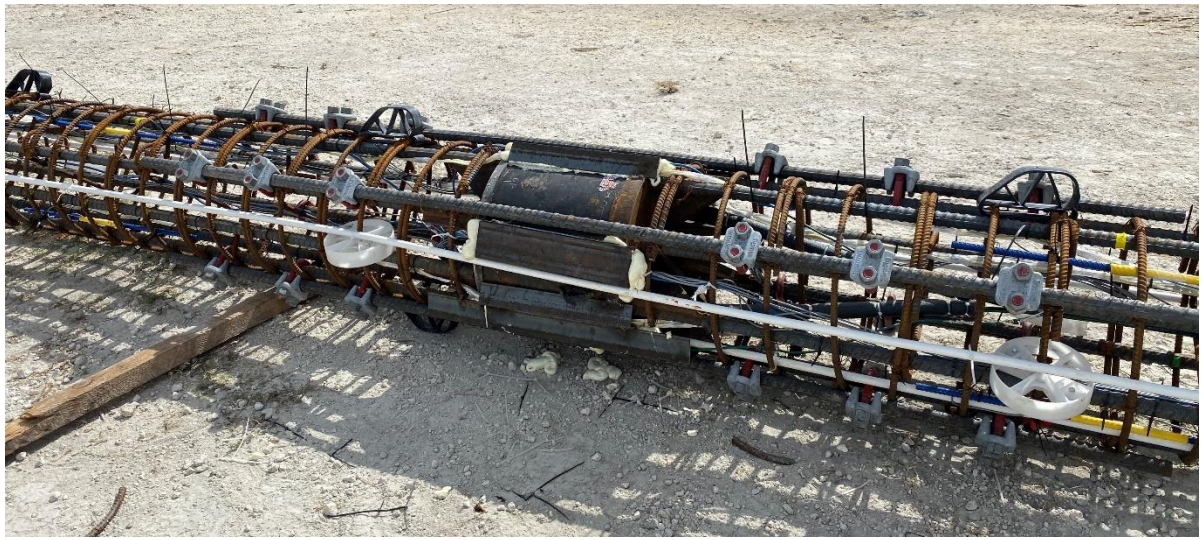

Jacksonville
Tallahassee
Orlando
Tampa
FLORIDA
Miami


Viaduct Elevation


Virginia Gardens
Casino Miami
Miami International Airport
Grapeland Water Park
NW 17th St
NW 11th St
Curtis Park
ALLAPATTAH
WYNWOOD
EDGEWATER
Trader Joe's
DoubleTree by Hilton
Hilton Miami Airport Blue Lagoon
Dolphin Expy
Magic City Casino
LITTLE HAVANA
FLAGAMI
WEST FLAGLER
Walmart Neighborhood Market
Versailles Restaurant Cuban Cuisine
Calle Ocho Walk of Fame
DOWNTOWN MIAMI
Adwave Sign Company
Little Gables
Target
West Miami
CORAL WAY
Coral Gables
Miami
Hobie Island Beach Park
Milam Dairy Rd
NW 79th Ave
NW 10th Ave
SW 67th Ave
Granada Blvd
Douglas Rd
SW 32nd Ave
SW 3rd Ave

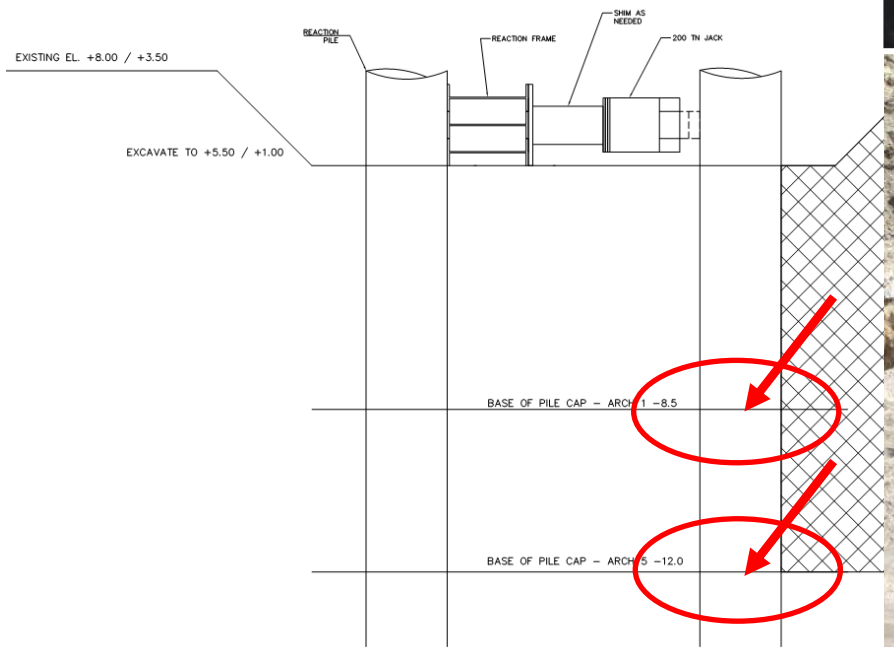

Miami Limestone Formation
Sand/Limestone Fragment Mixture
Intermediate Geo-Material (IGM)
Tamiami Limestone Formation
Light Brown Fine to Medium SAND with Some Limerock Fragments (FILL;
Light Brown Oolitic LIMESTONE with Some Sand
Brown Fine to Medium SAND with Little Shell Fragments (SP)
Light Brown Sandy LIMESTONE with Sand
Orange-Brown Fine to Medium SAND with Some Limestone Fragments (SP)
Light Brown Sandy LIMESTONE with Interbedded Chert Fragments
Light Brown Fossiliferous and Siliceous Sandy LIMESTONE and Sand
Light Brown Porous Sandy LIMESTONE and Sand
Gray Fine to Medium SAND with Traces of Limestone Fragments (
Light Brown Porous Sandy LIMESTONE and Sand
Asphalt Pavement
Gray-Brown Fine to Medium SAND with Some Limerock Fragments (FILL; SP)
Light Brown Fine to Medium SAND with Traces of Limestone Fragments (SP)
Light Brown Fossiliferous LIMESTONE and Sand
Light Brown Sandy LIMESTONE with Some Sand
Boring Terminated at Depth of 151ft Below Grade (Elevation -143.00ft) Casing Length 149ft
Light Brown Fine to Medium SAND with Limerock Fragments (FILL; SP)
Brown Fine to Medium SAND with Some Limestone Fragments (SP)
Light Brown Sandy LIMESTONE and Sand
Brown Sandy LIMESTONE with Some Sand and Little Chert Fragments
Light Gray Sandy LIMESTONE and Sand
Gray Fine to Medium SAND with Some Limestone Fragments (SP)
Boring Terminated at Depth of 142ft Below Grade (Elevation -134.53ft) Casing Length 140ft
Brown Fine to Medium SAND with Little Shell Fragments (FILL; SP)
Brown Fine to Medium SAND (FILL; SP)
Light Brown Fine to Medium SAND with Some Shell Fragments (SP)
Light Brown Fossiliferous Sandy LIMESTONE with Sand
Light Brown Fine to Medium SAND with Little Limestone Fragments (SP)
Light Brown Sandy LIMESTONE with Some Sand
Light Brown Fine to Medium SAND with Little Limestone Fragments (SP)
Light Brown Fossiliferous Sandy LIMESTONE and Sand
Boring Terminated Depth of 130ft Below Grade (Elevation -127.02ft) Casing Length 128ft
Rock Core Terminated Depth of 99ft Below Grade (Elevation -96.02ft) Casing Length 94ft

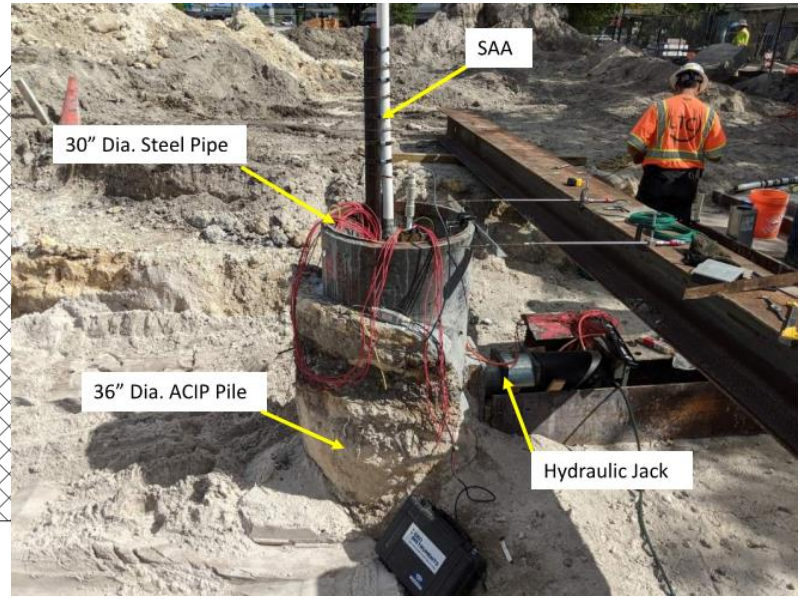
- Load Testing
  - (11) 30-inch diameter CFA test piles with Bi-directional jacks
  - Test loads up to ~4500 kips

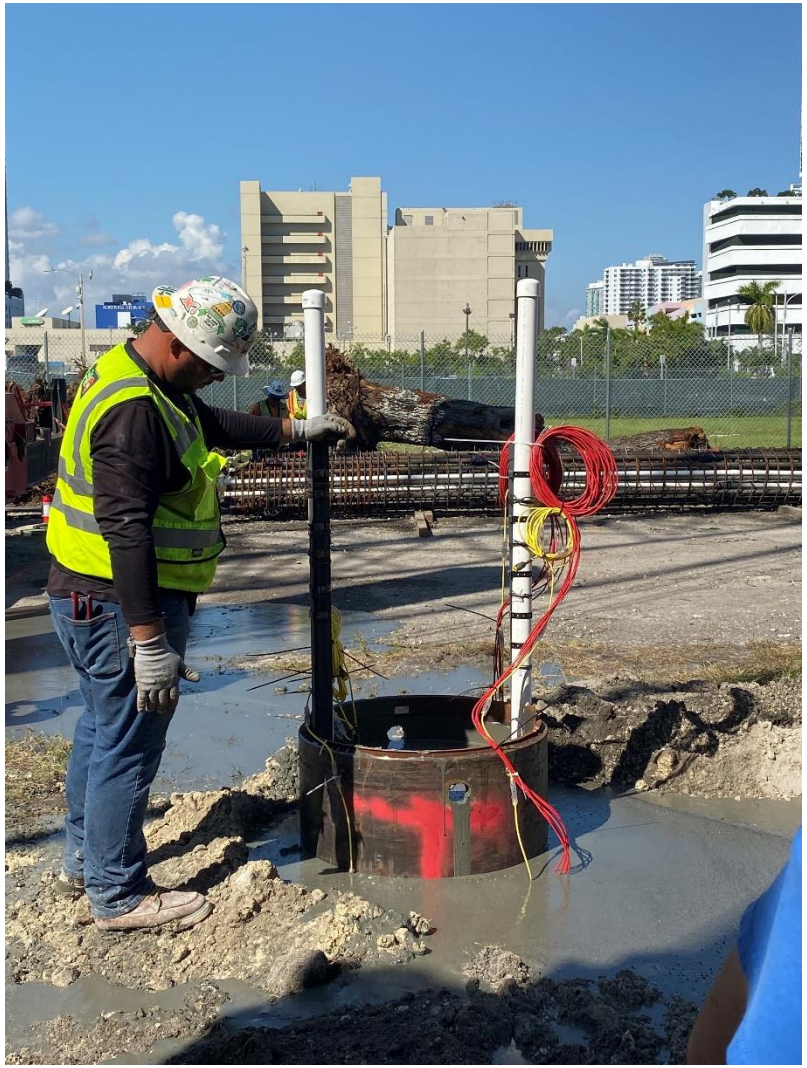


- Lateral Load Testing 36” Diameter CFA – 290 kips

Challenge was to mobilize soil resistance at the cut-off elevation about 15 to 20 ft. below ground







Signature Bridge

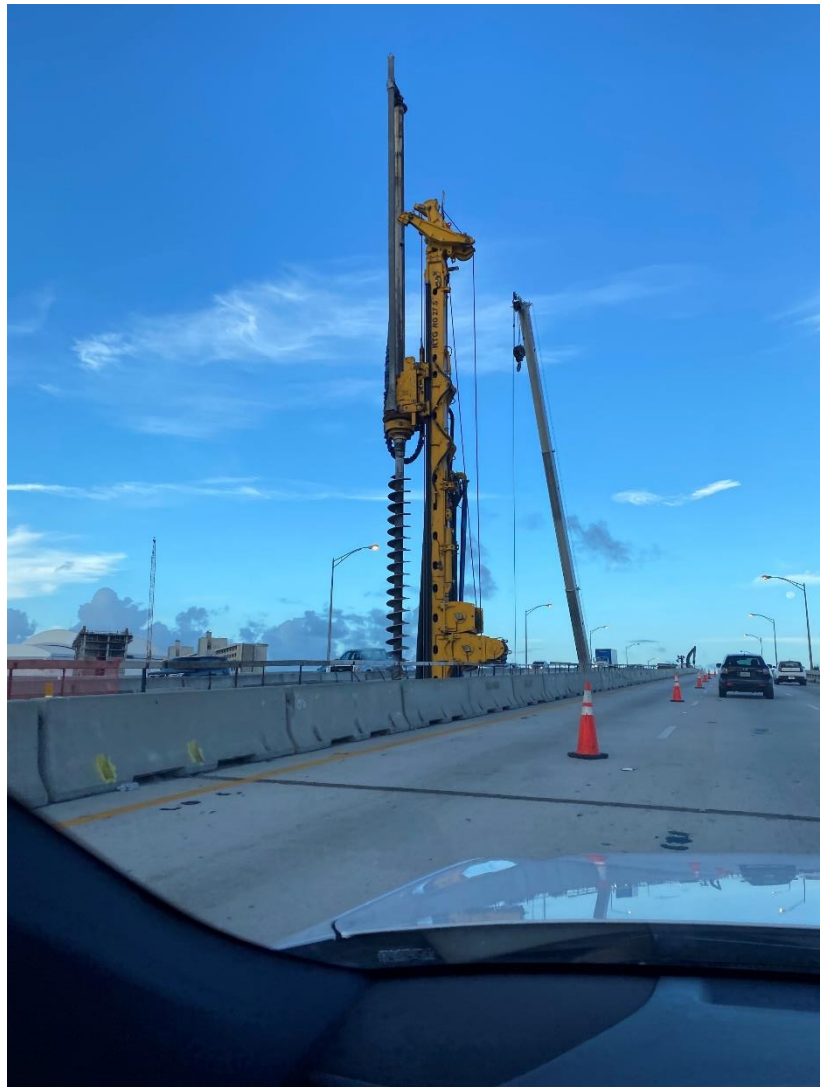
- (484) 36” diameter CFA
- 140’ Max Depth

Crane with fixed lead system

Battered piles

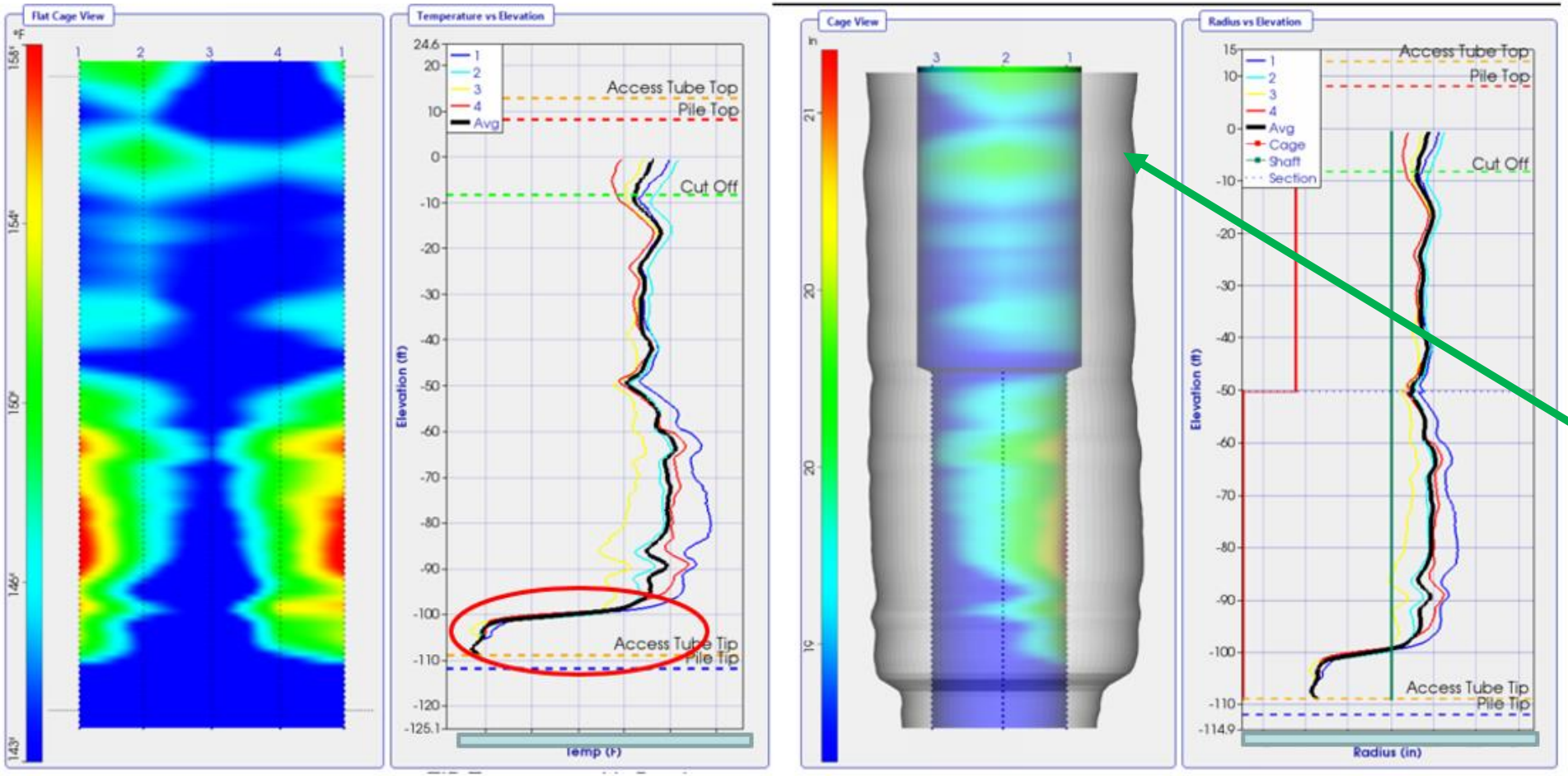
Between overhead bridges (17-ft opening)

- (108) 30” Diameter CFA
- 80’ Depth
- 1:8 Max inclination
- Required for constructability



- **Quality**
  - AME Requirements

- **Quality:**
  - Thermal Integrity Profiling (TIP)



Thermal HAS to be calibrated to onsite conditions, soil borings and actual installation measurements

Good to demonstrate continuity of element, reinforcing cage reaching the tip of the pile or large inclusions

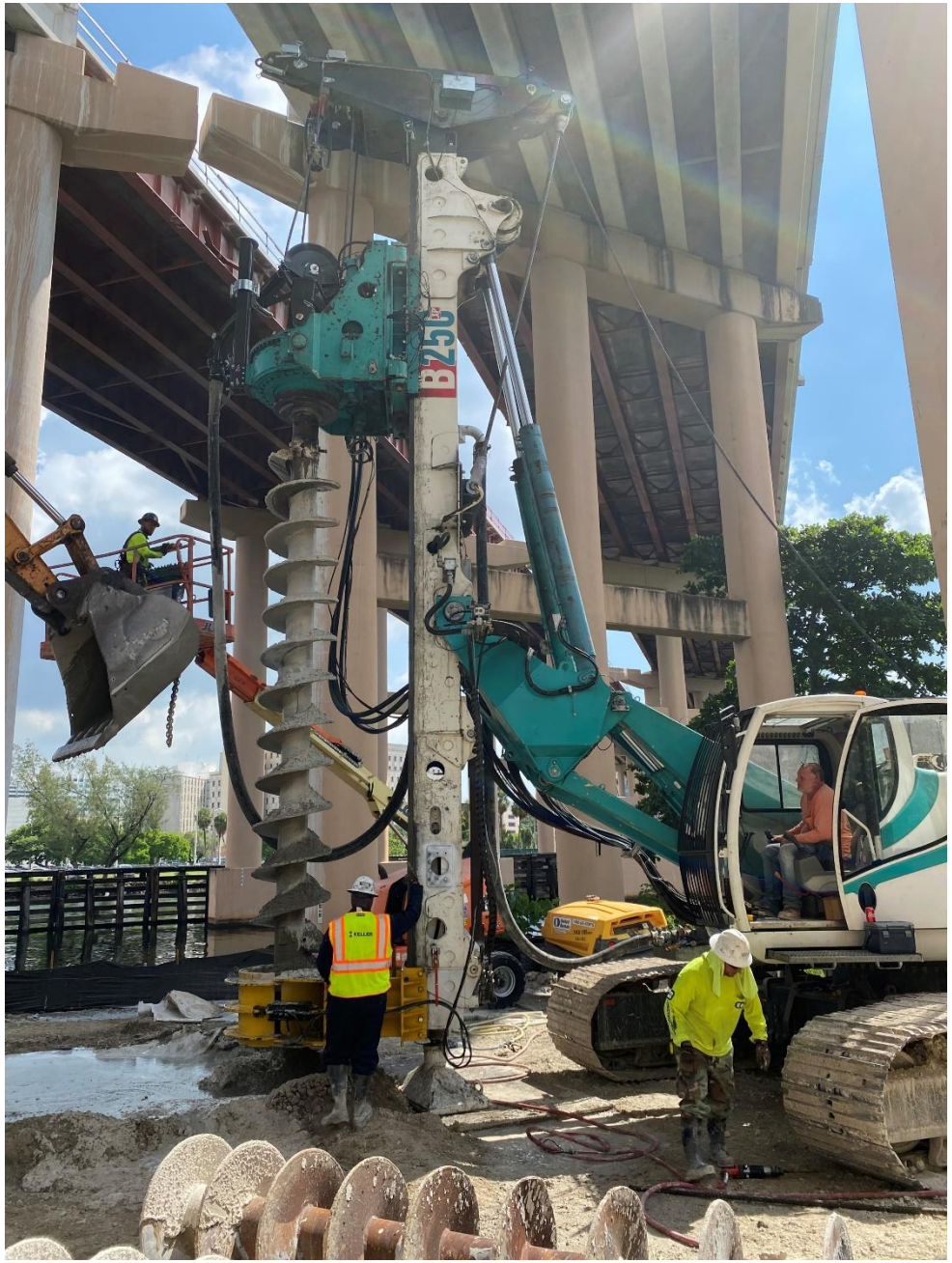

DEERE

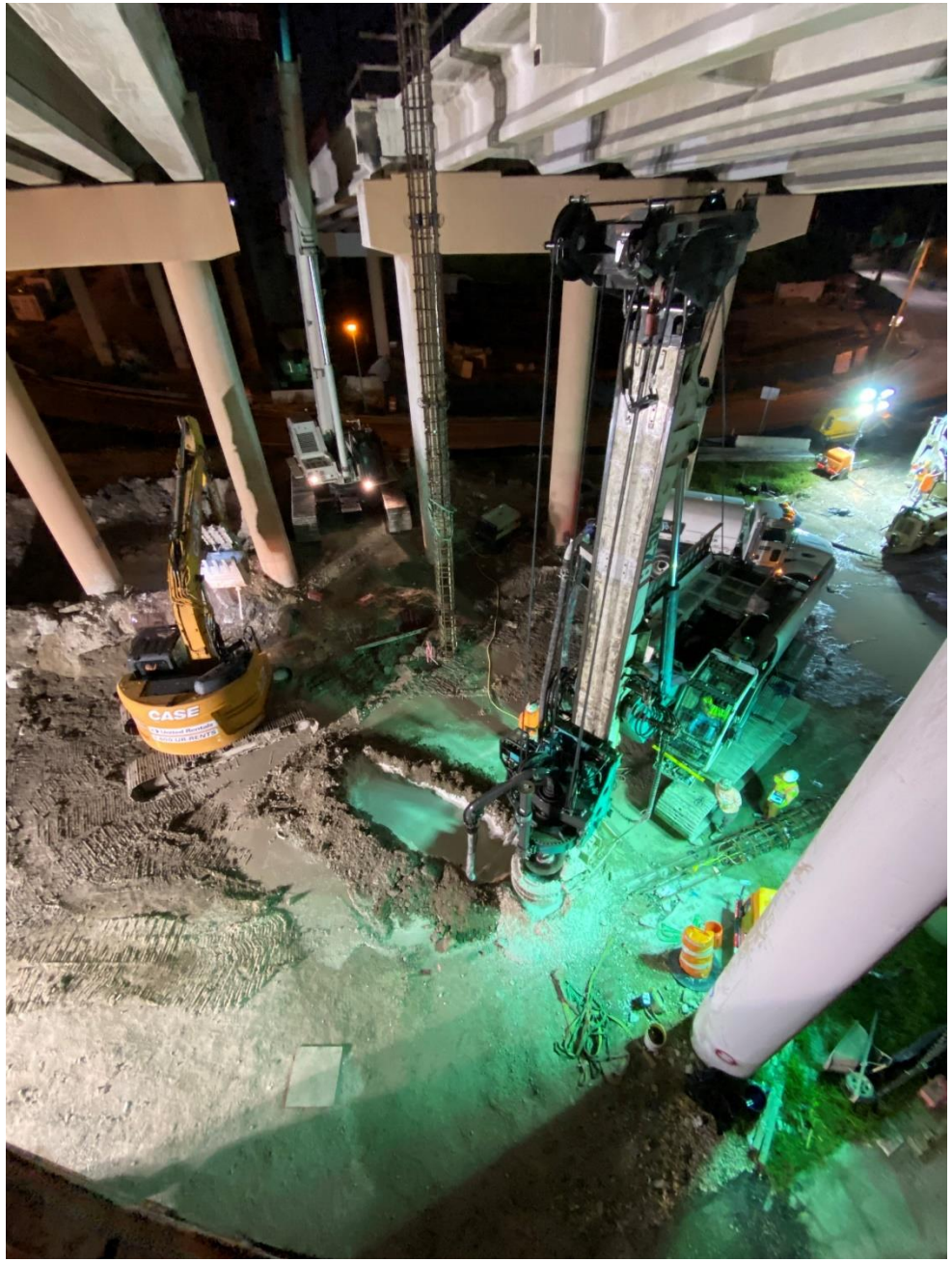
Low Headroom Piles

Min 40-ft of headroom

(36) 30-inch Diameter CFA

Max 85’ Depth





Low Headroom Piles

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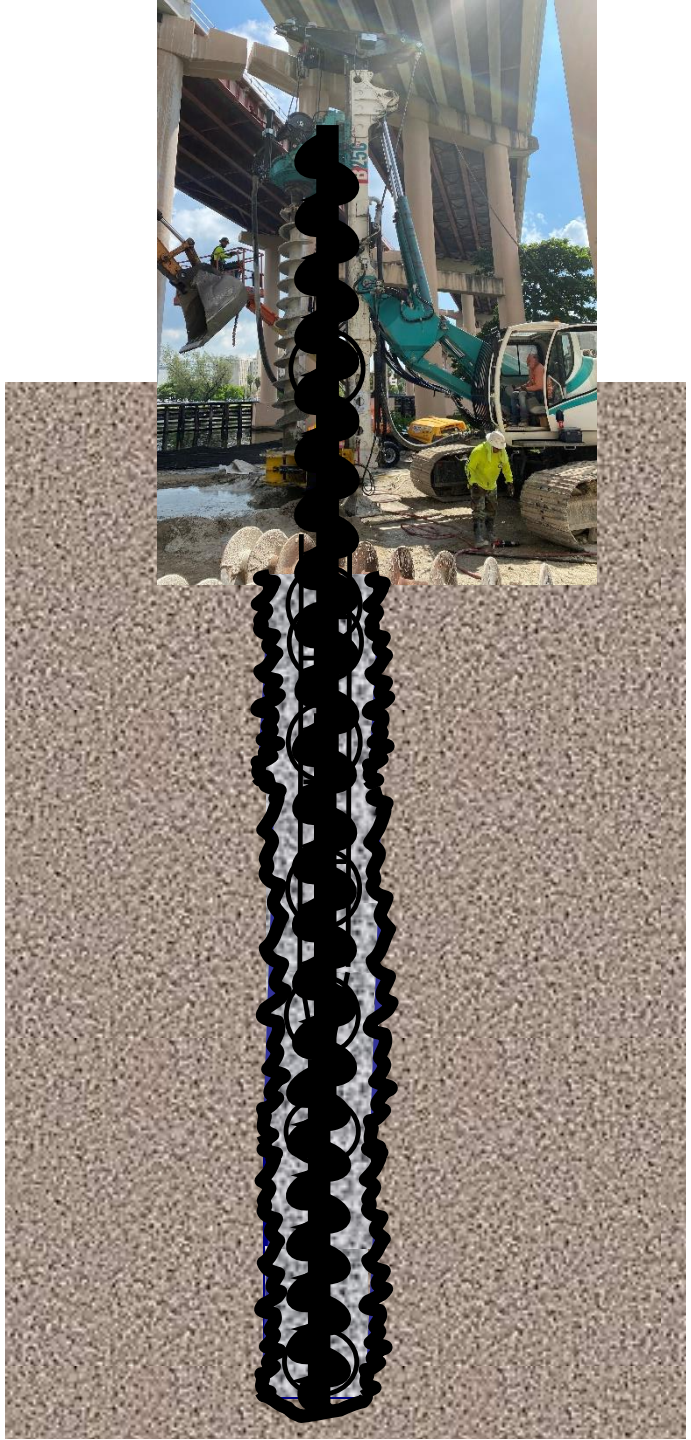
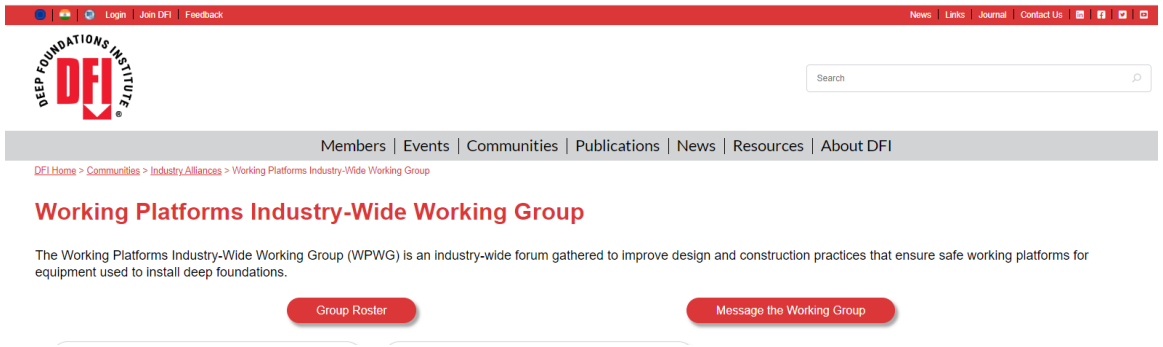


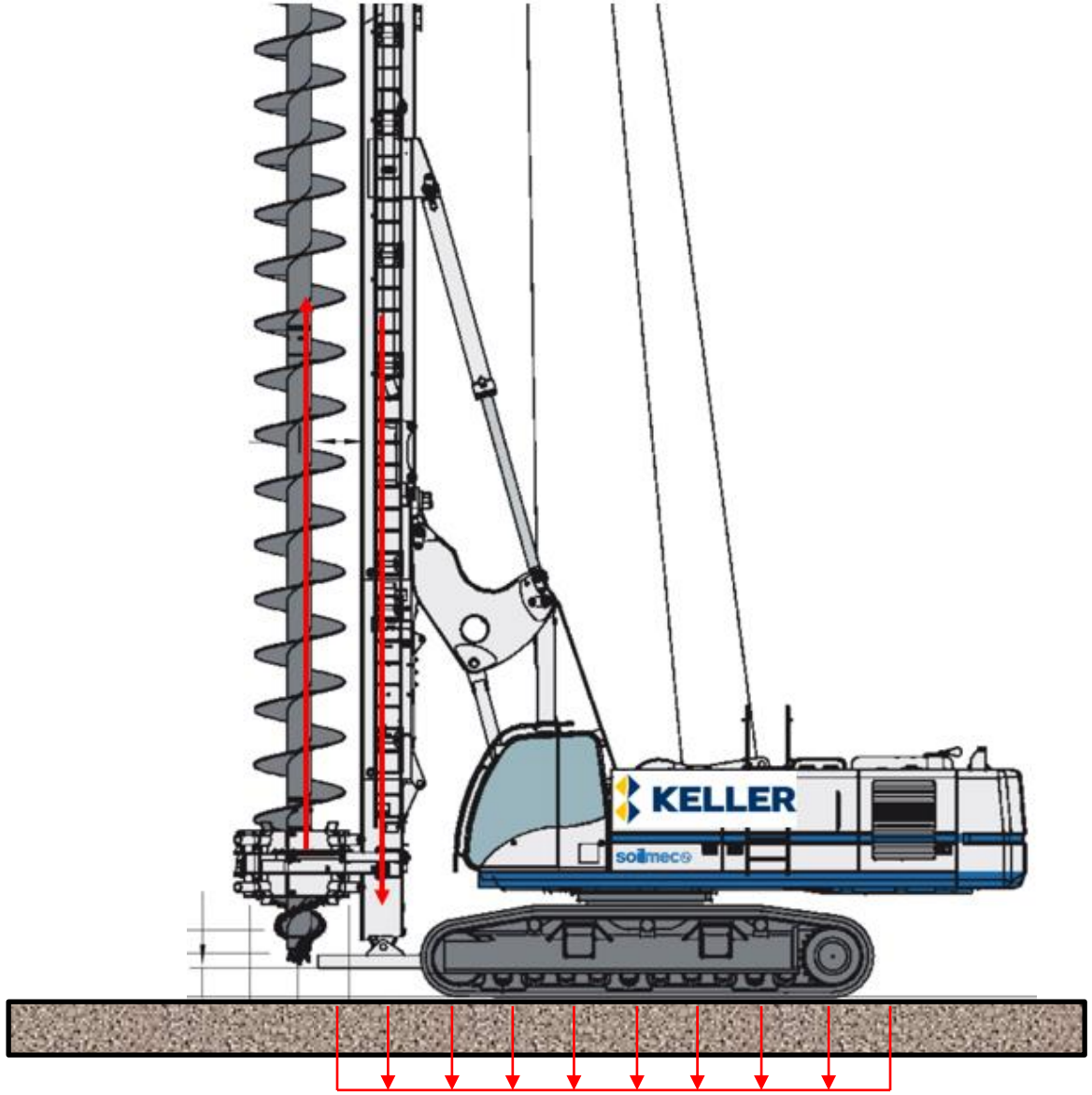
Procedure had to be modified as redrilling 15 ft to restore head is not possible

Working Platform

- Foot pressure is critical, especially during extraction
- Refer to DFI working platform document

https://www.dfi.org/communities/industry-alliances/working-platforms-industry-wide-working-group/





Where to Start: The Industry Position Statement

https://www.adsc-iafd.com/wp-content/uploads/2018/11/WorkingPlatformFINAL11-2018.pdf

"…these associations support the development and adoption of an established policy for the evaluation of working platforms for construction equipment. Furthermore, the responsibility for providing a safe working platform should be acknowledged by controlling entities (general contractors, construction managers, and owners) as being an integral cost for every project. Specialty subcontractors should not be left with the unknown risk and cost of creating safe working platforms **without due consideration**. The goal is to reduce the risk that proper evaluation and preparation may not occur and consequently corresponding safety risks could increase."


MANT
10:10 03/07/2015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Drilling rig topples, misses building

Rig causes minor balcony damage; No injuries reported

Author: Jeff Tavss, Executive Producer, jtavss@local10.com
Ben Candea, Senior Web Producer, bcandea@local10.com

Published On: Nov 05 2013 02:15:20 PM EST | Updated On: Nov 05 2013 06:39:18 PM EST

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Show Transcript

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