
PRESENTATION OF EB TEST RESULTS IN THE USA

ANTHONY C. BARILA, PE.

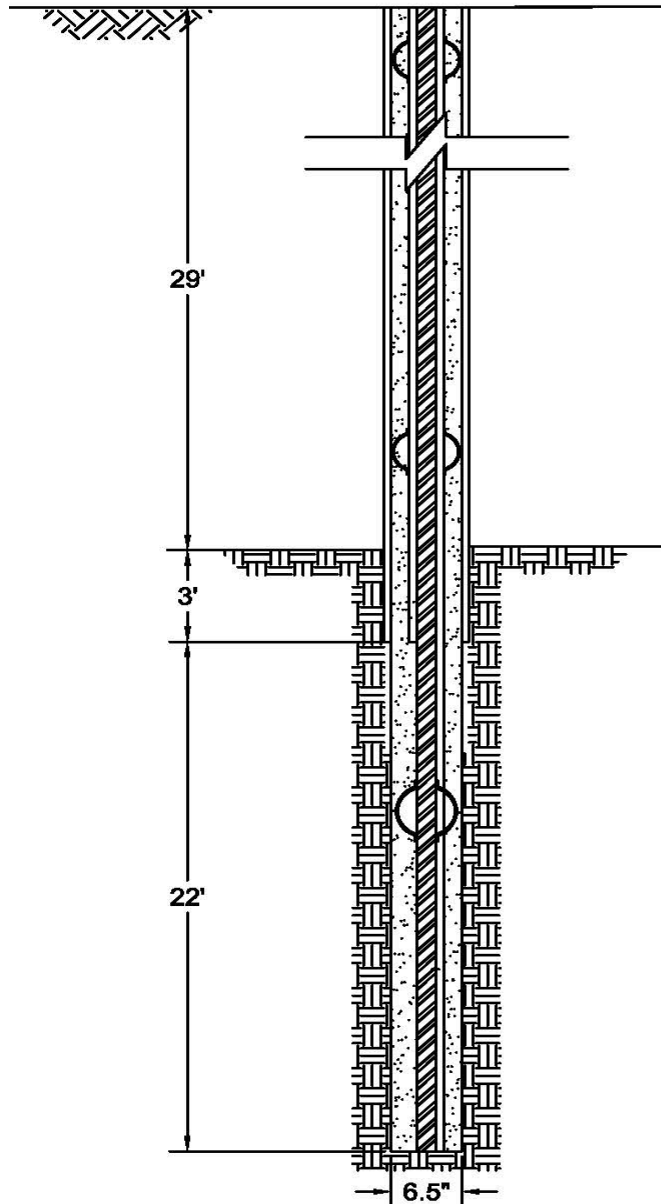
HUB FOUNDATION



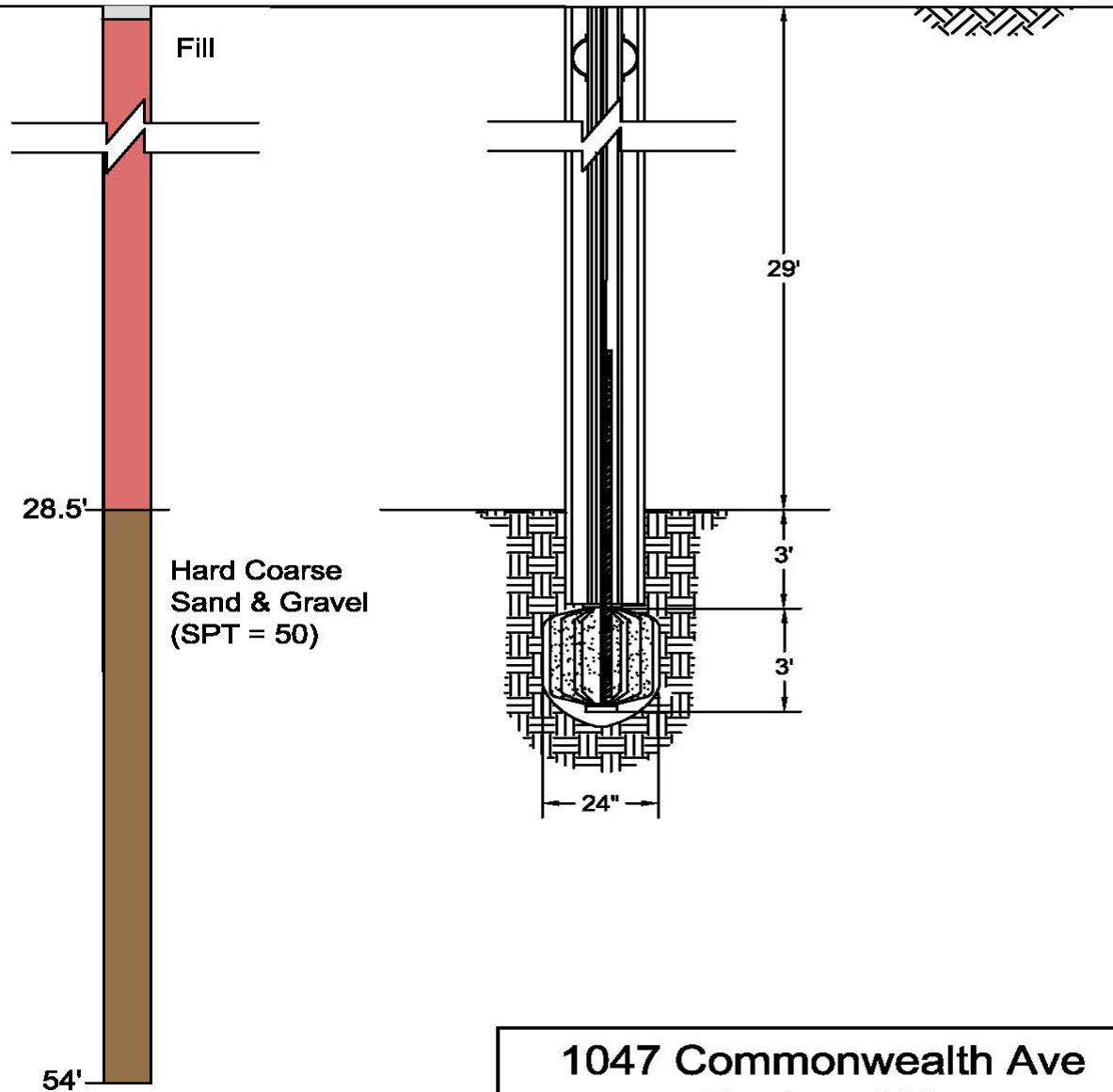
FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

- LOCATION: 1047 Commonwealth Ave, Boston, MA
- GEOTECHNICAL ENGINEER: McPhail Associates
- SUBSURFACE INFO: Urban Fill Layer (20-30 feet) overlying dense sand & gravel
- DRILLED MINIPILE DESIGN: 40 Ton Pile Design, 5.5" OD x 0.415" wall casing, 22 foot bond length in dense sand and gravel

**DRILLED
MINIPILE**



**EXPANDER
BODY**



1047 Commonwealth Ave
Boston, MA

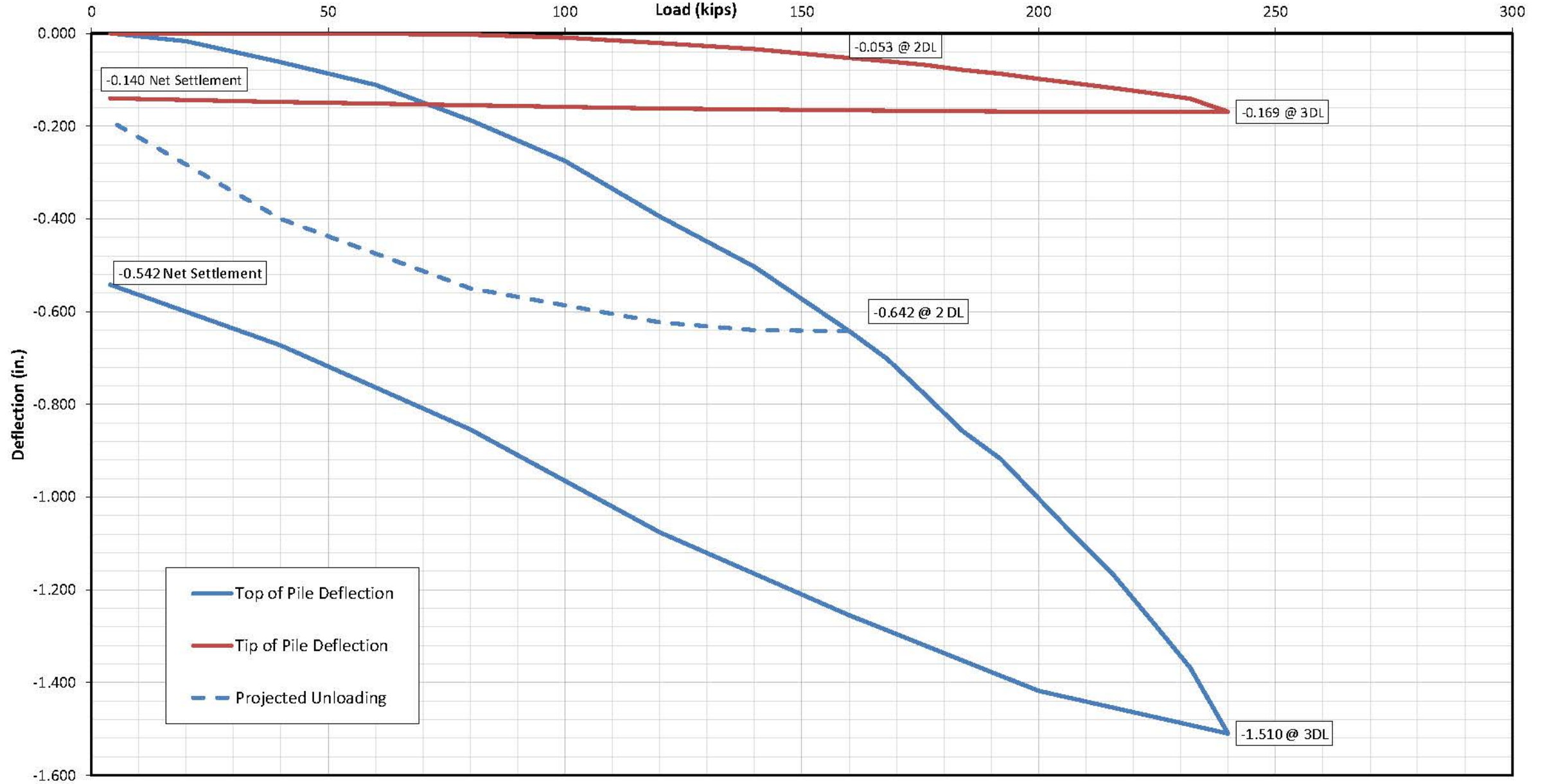
FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

DRILLED MINIPILE

- **PILE LOAD TEST:** Tension test run in accordance with building code, 25% loading increments held for 30 minutes.
- **TEST LOAD:** 80 ton test load; 120 ton maximum test load applied
- **TIP ELONGATION:** 0.053" @ 80 tons with 0.004" creep from 1 to 10 mins;
0.010" creep from 5 to 65 mins
0.169" @ 120 tons with 0.010" creep from 1 to 10 mins,
0.009" creep from 30 to 60mins
- **TIP NET SETTLEMENT:** 0.140"
- **TOP NET SETTLEMENT:** 0.208" @ 80 tons (projected)
0.542" @ 120 tons

Location: 1047 Commonwealth Ave, Boston, MA

1047 Commonwealth Ave, Boston MA
Pile Verification Test 11/19/14
Load vs. Deflection



FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

EXPANDER BODY

- DESIGN: 7 5/8" OD x 0.5" wall casing, 24" diameter EB (600mm) x 36" long
- EXPANSION PRESSURE: 290 psi
- PILE LOAD TEST: Compression test run with 21.5 ton load intervals and 10 minute holding periods
- TEST LOAD: 215 ton maximum test load applied
- TIP ELONGATION: 0.001" @ 82.5 tons with 0.000" creep from 1 to 10 mins;
0.015" @ 123 tons with 0.015" creep from 1 to 10 mins
0.305" @ 215 tons with 0.019" creep from 1 to 10 mins,
- TIP NET SETTLEMENT: 0.324"
- TOP NET SETTLEMENT: 0.256" @ 215 tons

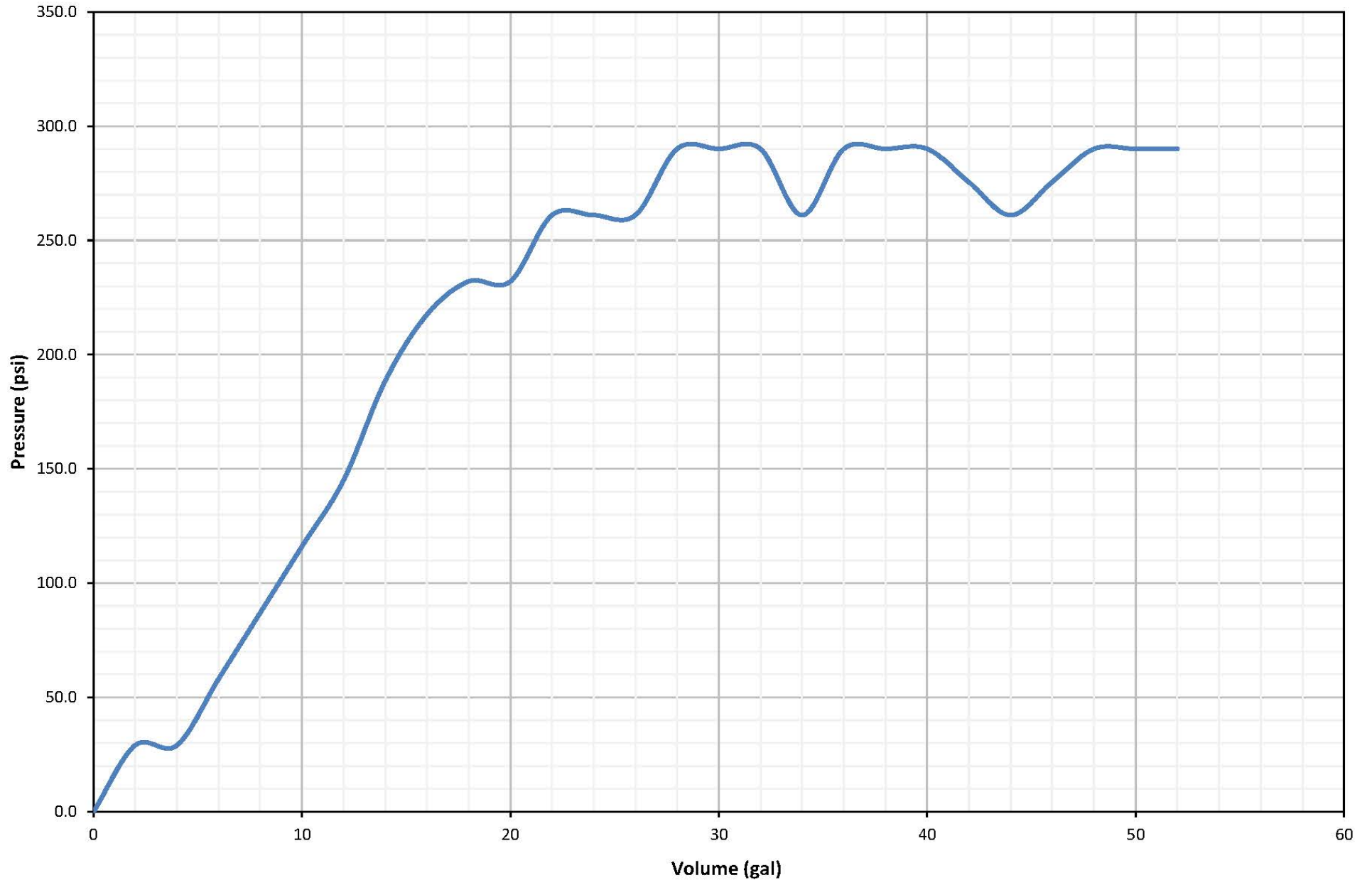
Location: 1047 Commonwealth Ave, Boston, MA

1047 Commonwealth Ave, Boston, MA

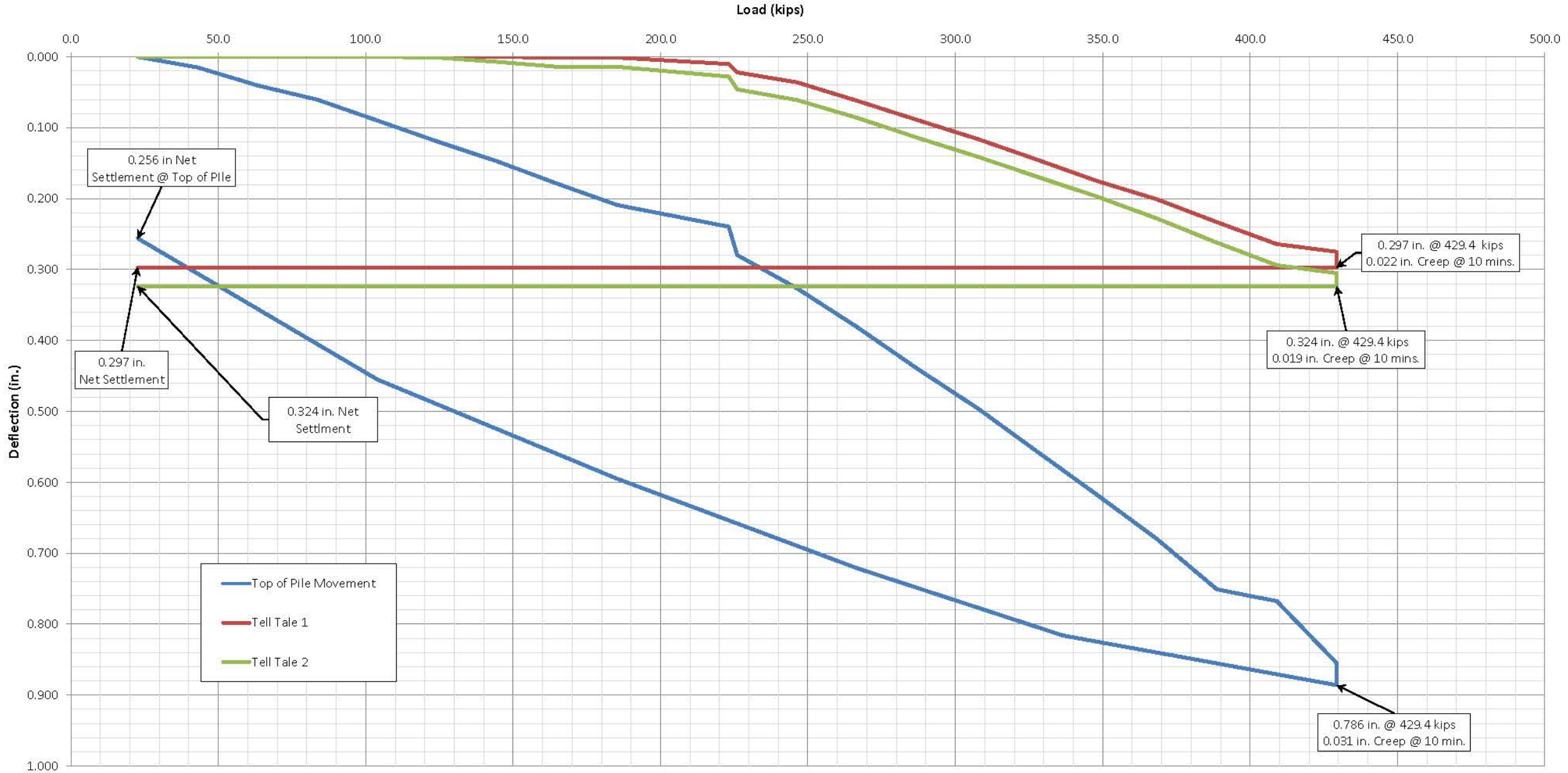
Drilled Expander Body

Primary Grouting

Primary Grouting	
Volume (gal)	Pressure (psi)
0	0.0
2	29.0
4	29.0
6	58.0
8	87.0
10	116.0
12	145.0
14	188.5
16	217.6
18	232.1
20	232.1
22	261.1
24	261.1
26	261.1
28	290.1
30	290.1
32	290.1
34	261.1
36	290.1
38	290.1
40	290.1
42	275.6
44	261.1
46	275.6
48	290.1
50	290.1
52	290.1



1047 Commonwealth Ave, Boston MA Drilled Expander Body Pile Load Test Load vs. Deflection



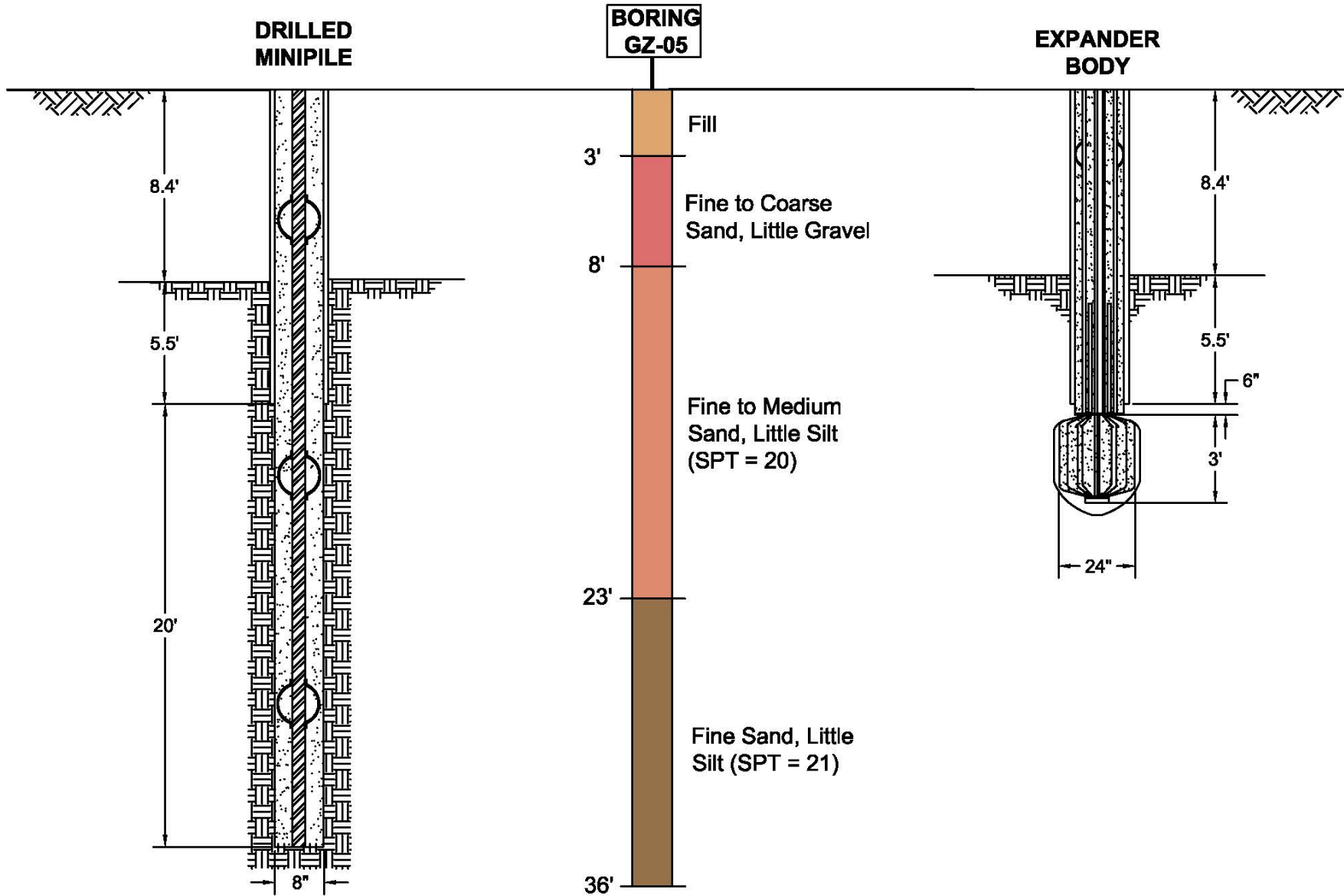
❖ SUMMARY

	Drilled Minipile	Expander Body
Maximum Test Load	120 tons	215 tons
Top Movement @ 80 tons	0.642"	0.176"
Top Movement @ 120 tons	1.510"	0.310"
Top Movement @ 215 tons	-	0.786"
Tip Movement @ 80 tons	0.053"	0.009"
Tip Movement @ 120 tons	0.169"	0.015"
Tip Movement @ 215 tons	-	0.305"
Net Settlement @ Top @ 80 tons	0.208"	-
Net Settlement @ Top @ 120 tons	0.542"	-
Net Settlement @ Top @ 215 tons	-	0.256"
Maximum Gout Pressure	-	290 psi
Maximum Grout Volume	-	52 gallons

Location: 1047 Commonwealth Ave, Boston, MA

FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

- LOCATION: Kingston Amtrak Station, 1 Railroad Ave, Kingston, RI
- GEOTECHNICAL ENGINEER: GZA
- SUBSURFACE INFO: Fill (0-3 ft) – Coarse Sand (3-8 ft) – Medium Sand (8-23 ft) – Fine Sand (>23 ft)
- DRILLED MINIPILE DESIGN: 45 ton pile design, 7.0” OD x 0.408” wall casing, 20 foot bond length in sand



Amtrak Kingston Capacity Improvement
Kingston, RI

FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

DRILLED MINIPILE

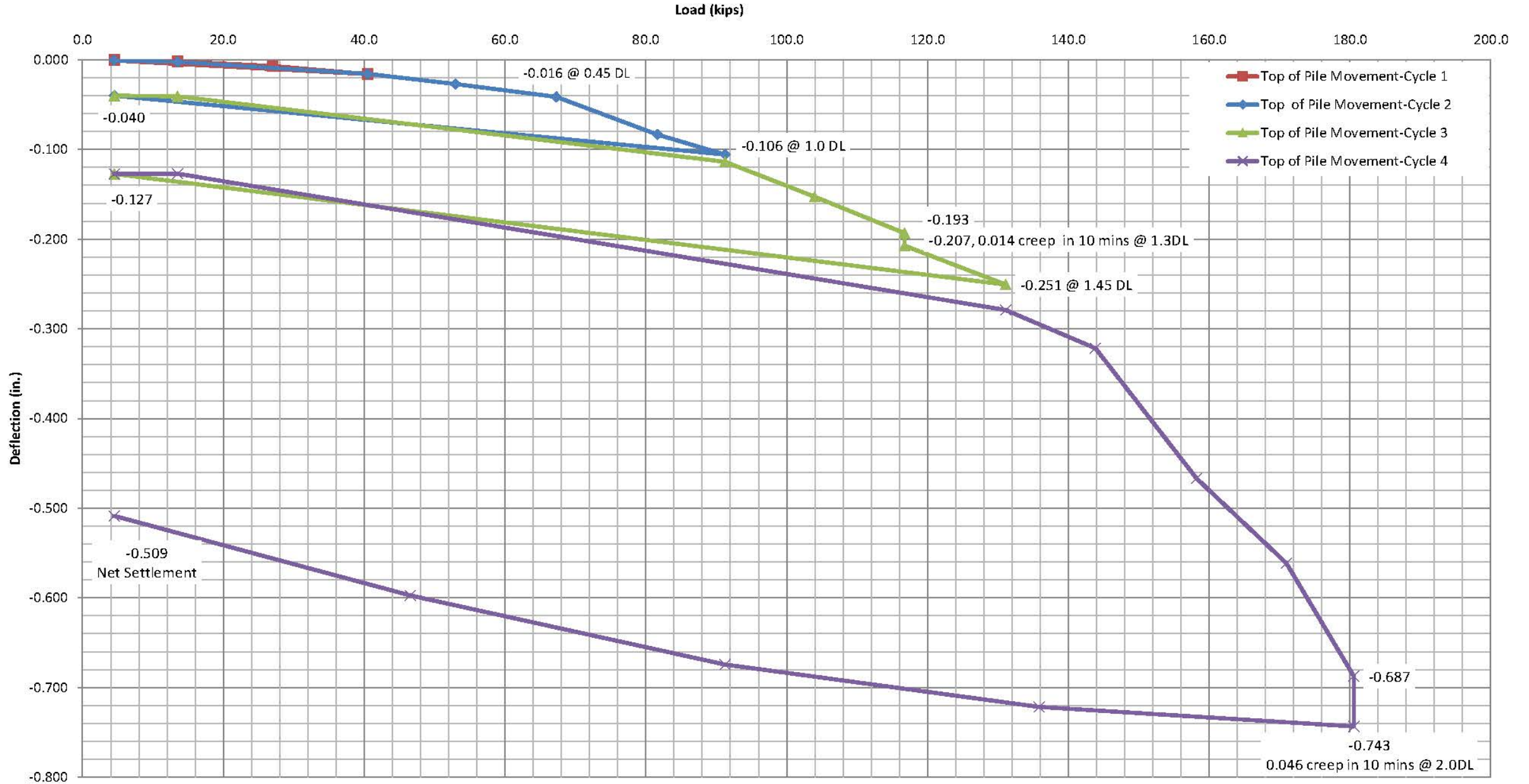
- PILE LOAD TEST: Tension test run to specification, four loading cycles
- TEST LOAD: 90 ton test load
- TOP PILE ELONGATION: 0.106" @ 45 tons
0.687" @ 90 tons with 0.057" creep from 1 to 10 mins,
- TOP PILE NET SETTLEMENT: 0.040" @ 45 tons
0.509" @ 90 tons

Location: Kingston Amtrak Station, Kingston, RI

Amtrak Kingston Station Capacity Improvement, Kingston RI

Verification Test to 2DL 9/14/15

Load vs. Deflection



FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

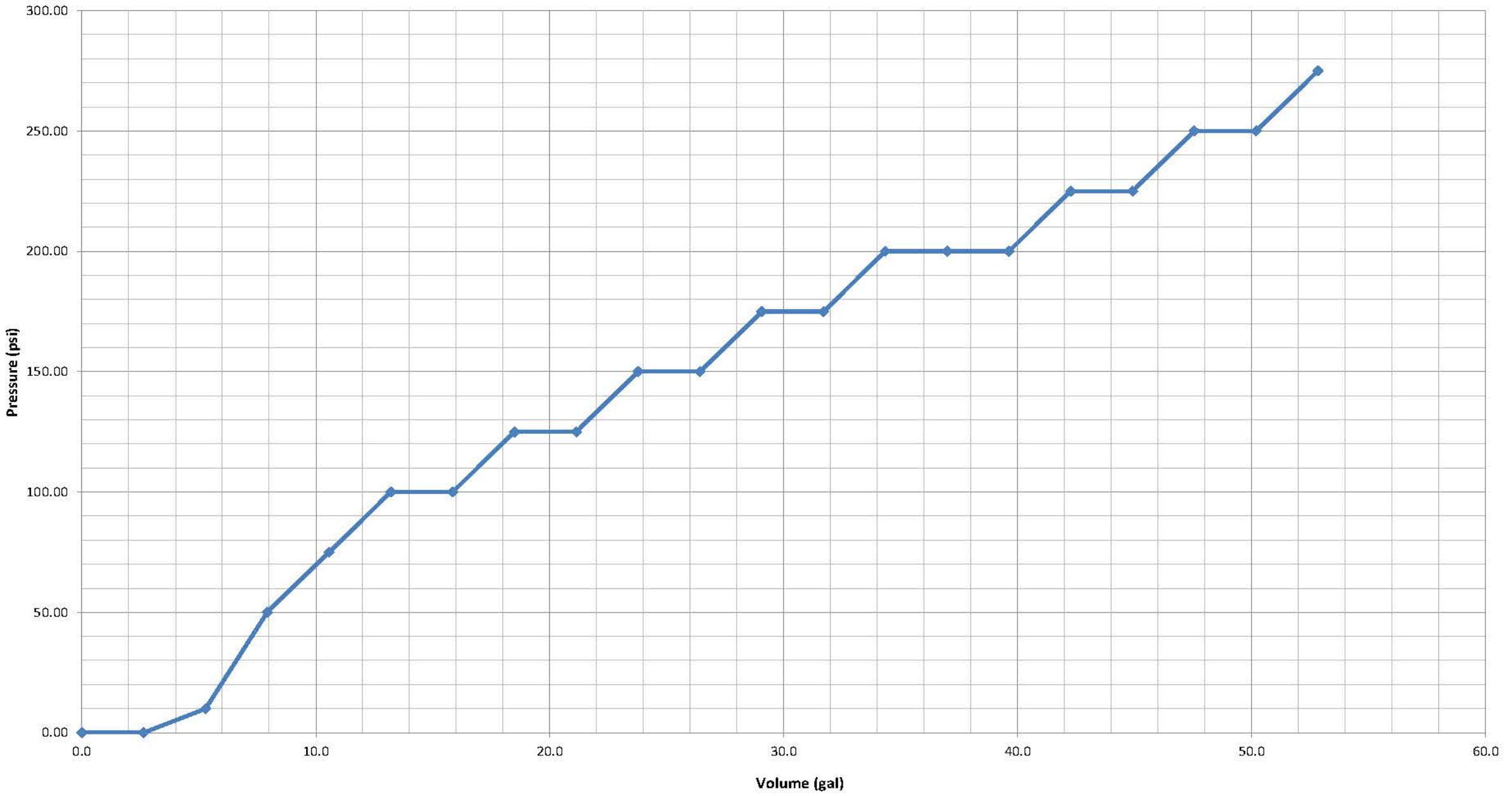
EXPANDER BODY

- DESIGN: 7 5/8" OD x 0.5" wall casing, 24" diameter EB (600mm) x 36" long
- EXPANSION PRESSURE: 275 psi
- PILE LOAD TEST: Compression test run with 10 ton load intervals with 2.5 minute holding periods
- TEST LOAD: 90 ton maximum test load applied
- TOP PILE ELONGATION: 0.087" @ 50 tons with 0.001" creep from 1 to 2.5 mins
0.442" @ 90 tons with 0.033" creep from 1 to 10 mins
- TOP NET SETTLEMENT: 0.475" @ 90 tons

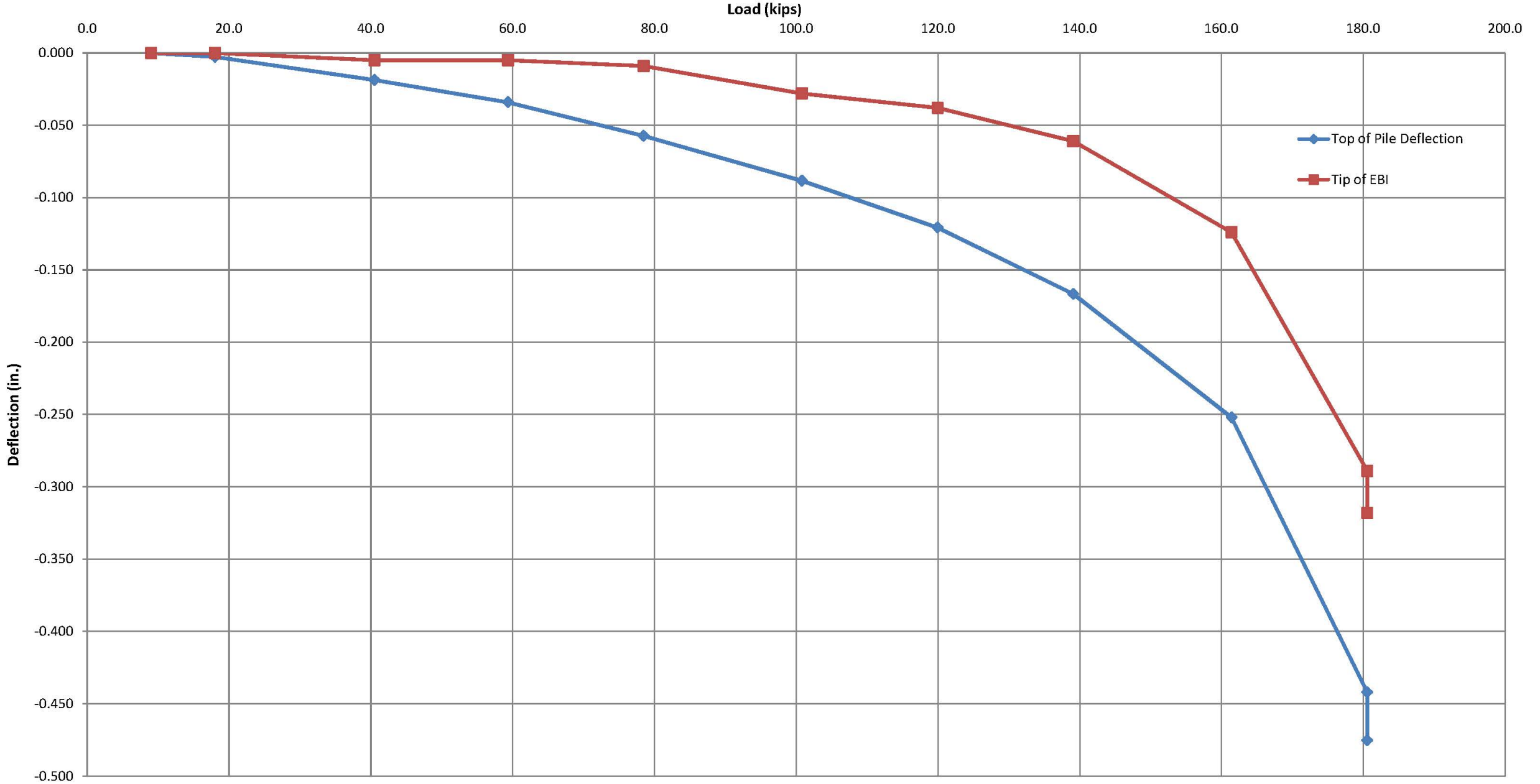
Location: Kingston Amtrak Station, Kingston, RI

Kingstown Amtrak Station, Kingstown RI

EBI Primary Injection 10/1/15



Kingston Amtrak Station, Kingston RI
EBI Pile Load Test 10/28/2015
Load vs. Deflection



FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

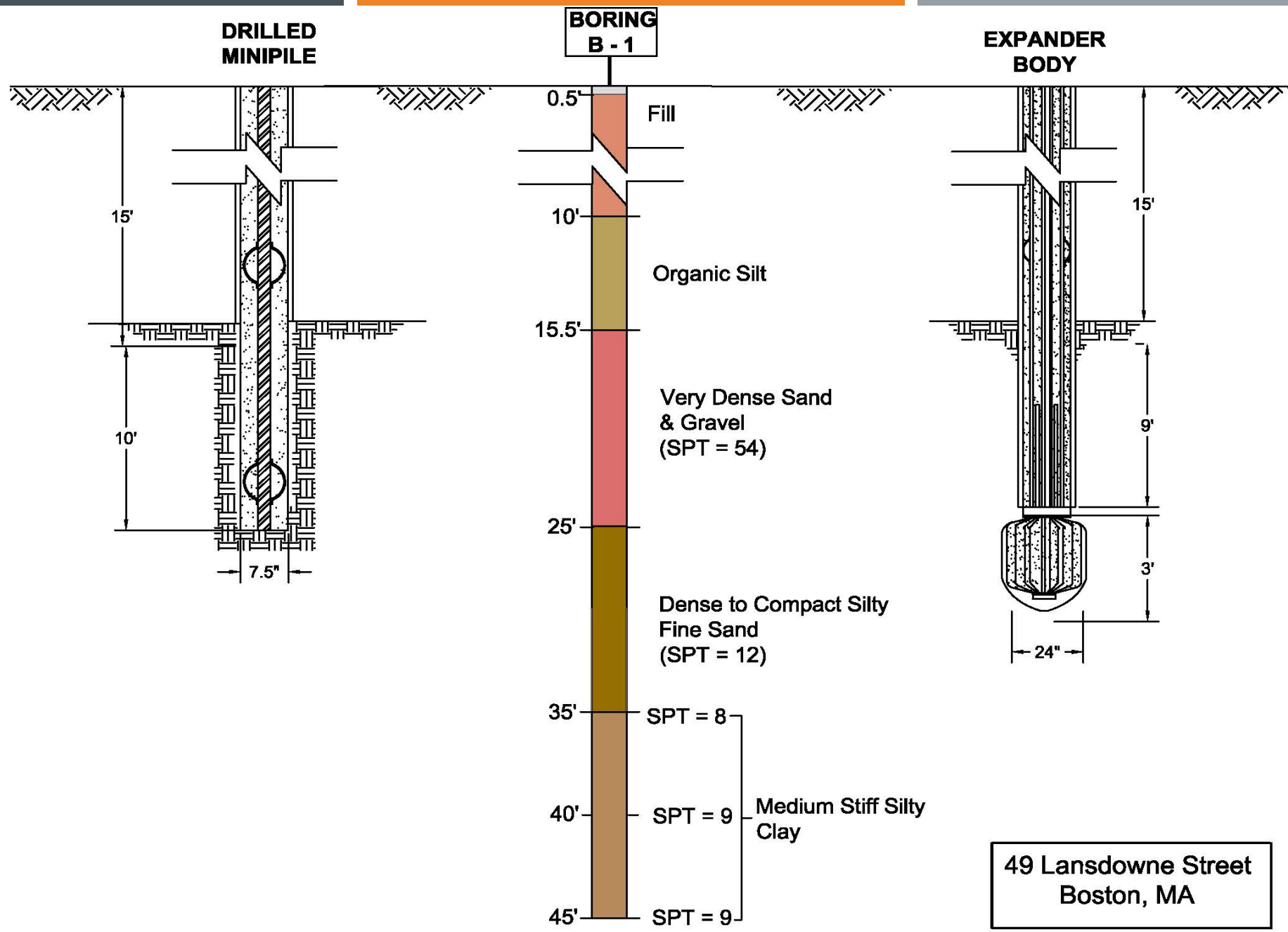
❖ SUMMARY

	Drilled Minipile	Expander Body
Maximum Test Load	90 tons	90 tons
Top Pile Movement @ 45 tons	0.106"	0.087"
Top Pile Movement @ 90 tons	0.687"	0.442"
Top Pile Net Settlement @ 45 tons	0.040"	-
Top Pile Net Settlement @ 90 tons	0.509"	0.475" (projected max)
Maximum Gout Pressure	-	275 psi
Maximum Grout Volume	-	52 gallons

Location: Kingston Amtrak Station, Kingston, RI

FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

- LOCATION: 49 Lansdowne Street. Boston, MA
- GEOTECHNICAL ENGINEER: McPhail Associates for DMPs and Haley & Aldrich for EBs
- SUBSURFACE INFO: Fill (0-10 ft) - Organic silt (10-15 ft) – Dense sand and gravel (15 to 30 ft) – Marine deposits (>30 ft)
- DRILLED MINIPILE DESIGN: 30 ton pile design, 7” OD x 0.408” wall casing, 10 foot bond length in marine deposits





Legend

- Drilled Expander Body Pile
- Drilled Minipile (Tie Down Anchor)

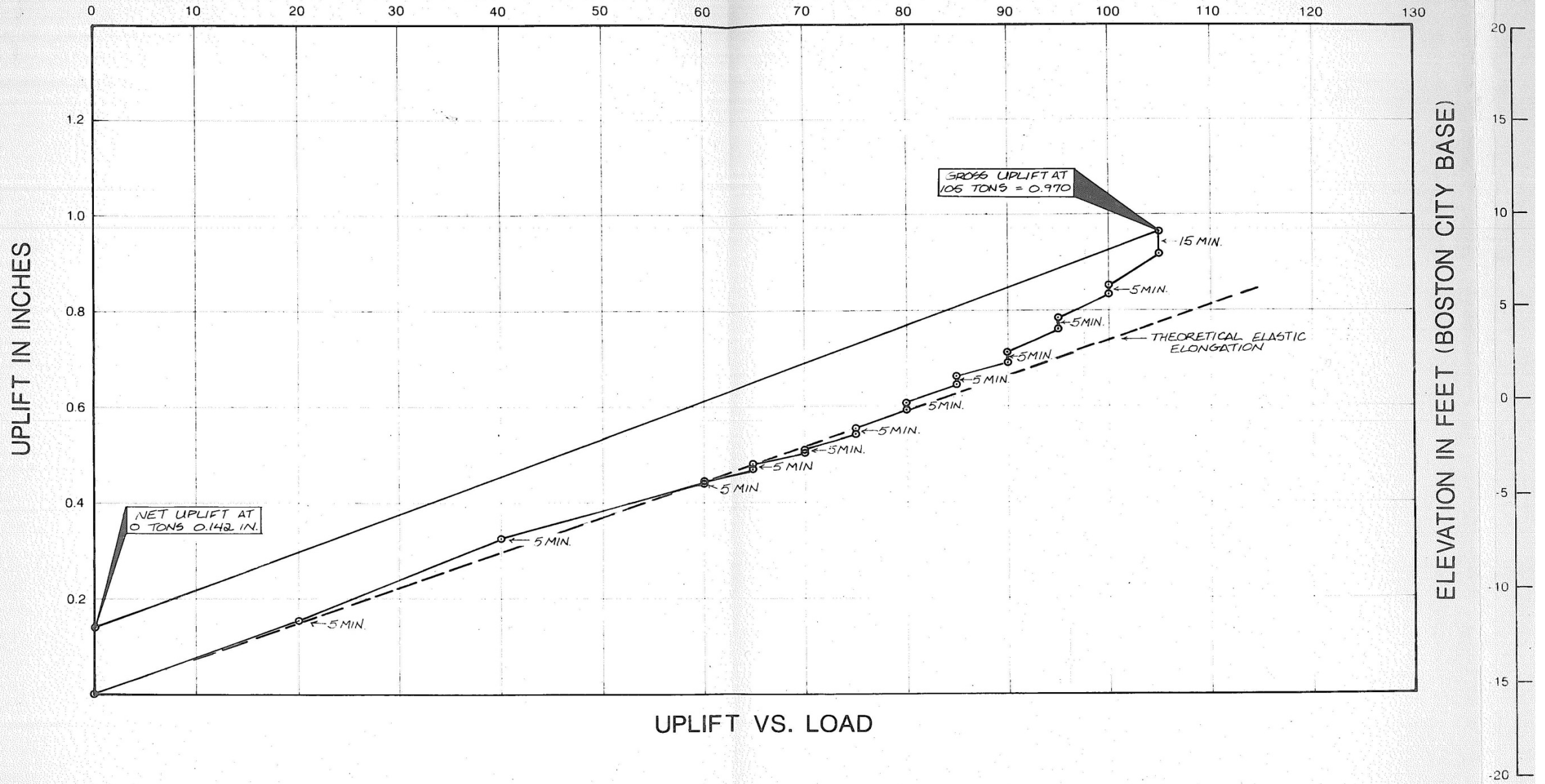
FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

DRILLED MINIPILE

- PERFORMED BY: Terra Drilling in 1987
- DESIGN: 30 ton pile design, 7.125" OD x 0.125" wall casing, 15' bond in sand and clay
- PILE LOAD TEST: Tension test run with 5 ton load intervals and 5 minute holding periods
- TEST LOAD: 105 ton maximum test load applied
- TOP PILE ELONGATION: 0.920" @ 105 tons with 0.050" creep from 1 to 15 mins,
- TOP PILE NET SETTLEMENT: 0.142"

Location: 49 Lansdowne Street, Boston, MA

LOAD IN TONS



UPLIFT VS. LOAD

CENTER FIELD SCORE BOARD @ FENWAY PARK
PILE VERIFICATION TEST, 10/29/87

FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

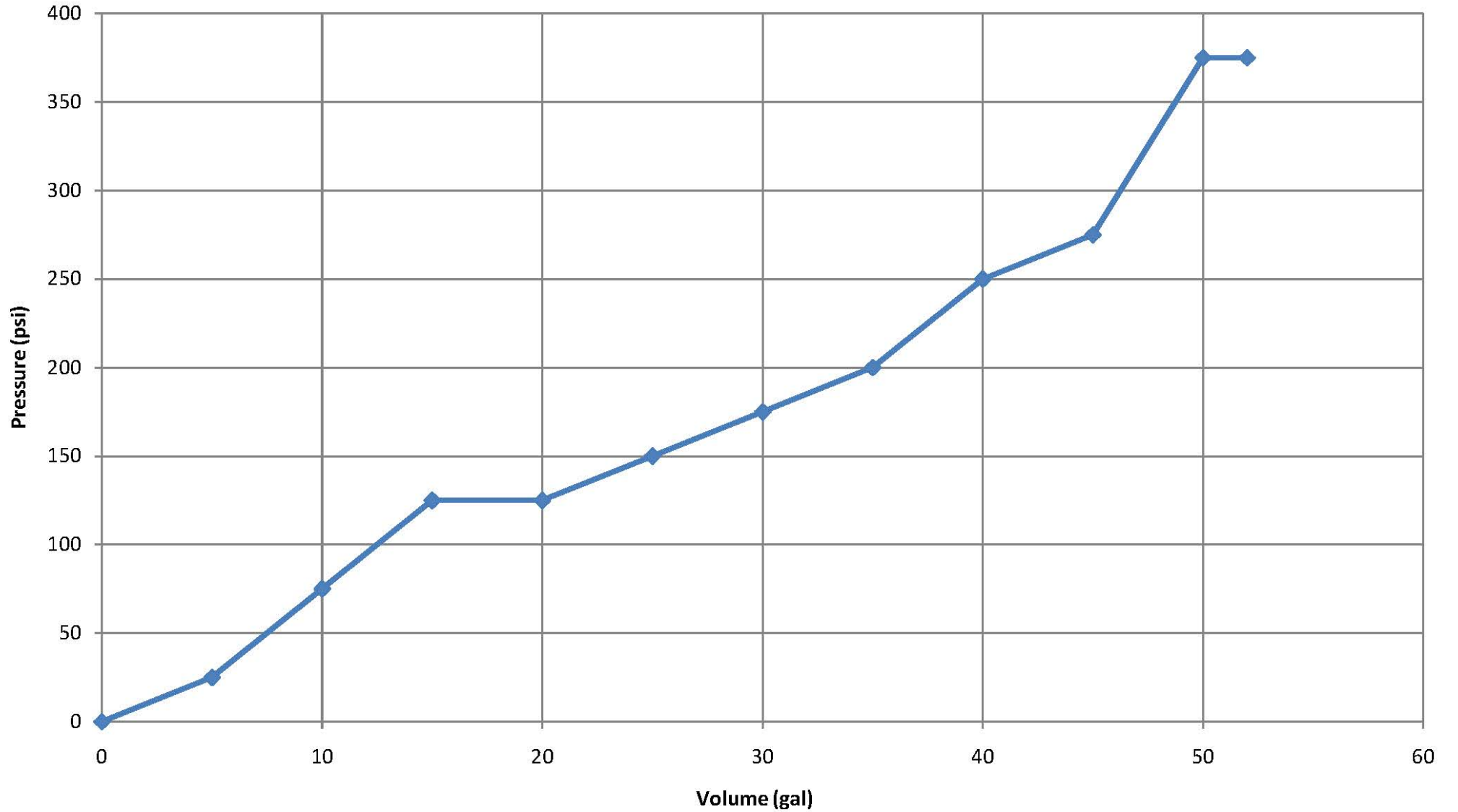
EXPANDER BODY

- DESIGN: 7" OD x 0.415" wall casing, 24" diameter EB (600mm) x 36" long
- EXPANSION PRESSURE: 275 psi
- PILE LOAD TEST: Compression test run in accordance with the Massachusetts Building Code, 25% load intervals held for 30 minutes
- TEST LOAD: 132 ton maximum test load applied
- TOP PILE ELONGATION: 0.237" @ 90 tons with 0.005" creep from 1 to 5 mins
0.908" @ 132 tons with 0.059" creep from 1 to 5 mins
- TIP PILE SETTLEMENT: 0.099" @ 90 tons with 0.006" creep from 1 to 5 mins
0.667" @ 132 tons with 0.055" creep from 1 to 5 mins
- TOP NET SETTLEMENT: 0.461"
- TIP NET SETTLEMENT: 0.417"

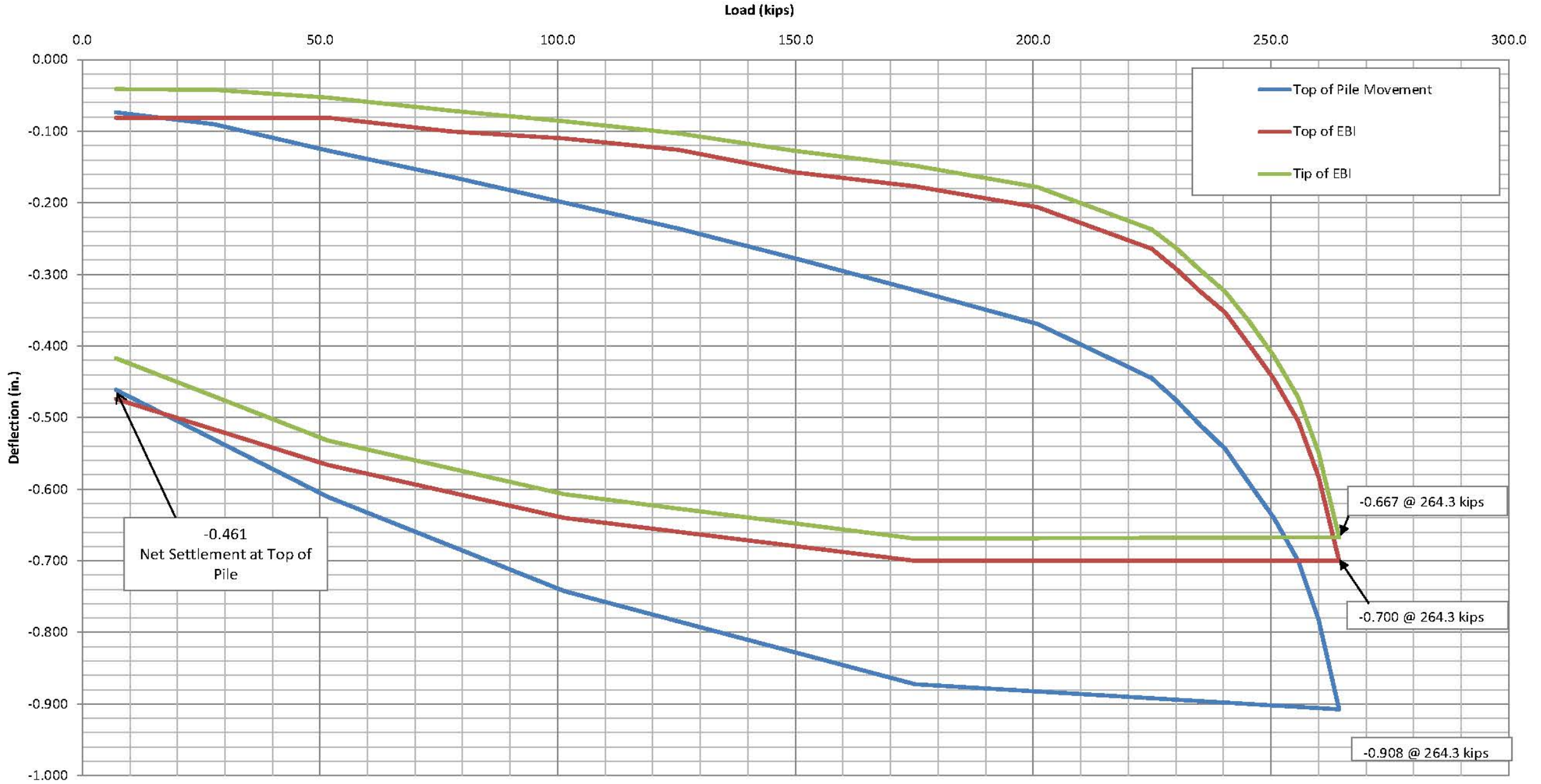
Location: 49 Lansdowne Street, Boston, MA

49 Lansdowne Street, Boston, MA
Drilled Expander Body
Primary Grouting

Primary Grouting	
Volume (gal)	Pressure (psi)
0	0
5	25
10	75
15	125
20	125
25	150
30	175
35	200
40	250
45	275
50	375
52	375



49 Lansdowne Street, Boston, MA Drilled Expander Body Pile Load Test Load vs. Deflection



FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

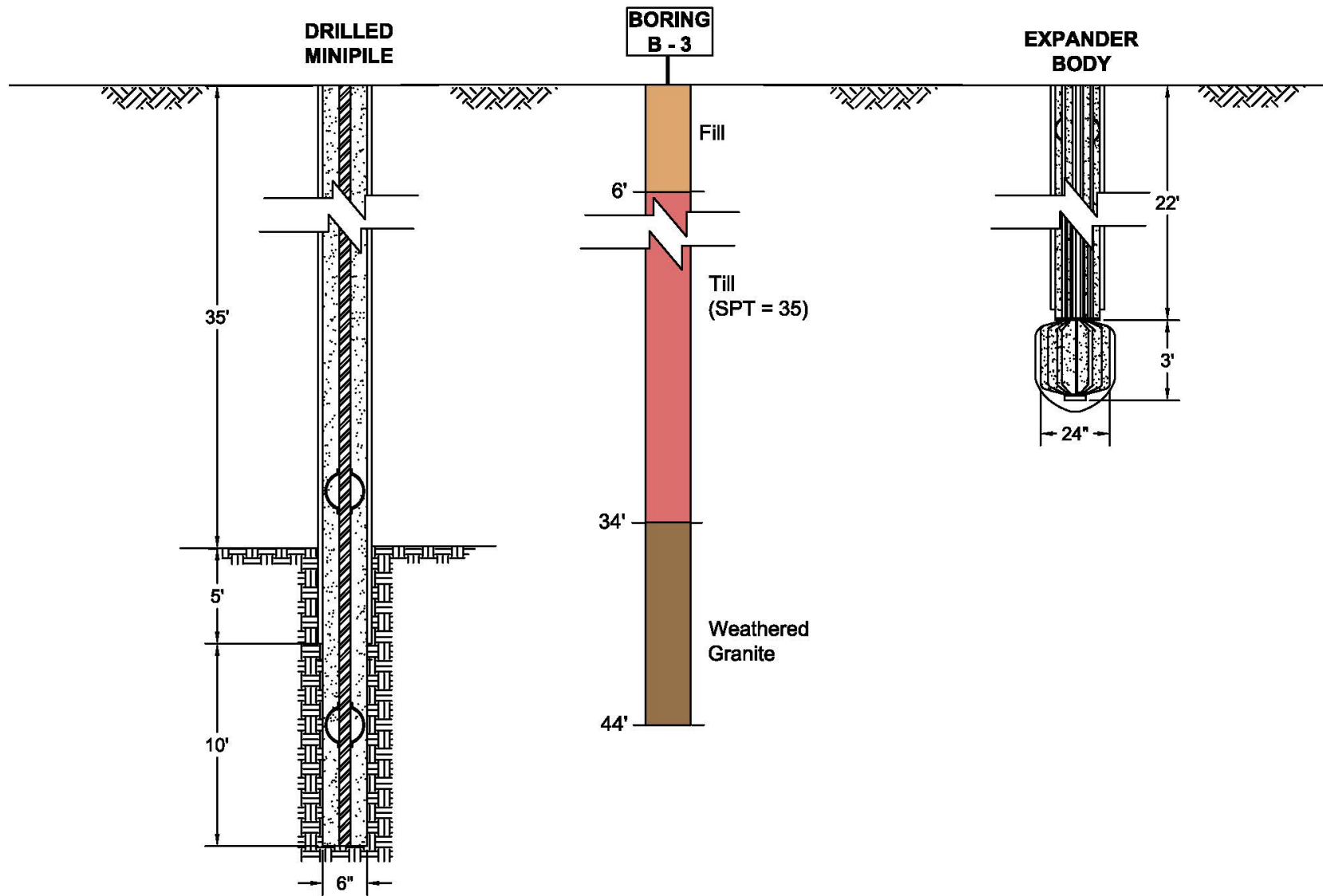
❖ SUMMARY

	Drilled Minipile	Expander Body
Maximum Test Load	105 tons	132 tons
Top Movement @ 90 tons	0.700"	0.237"
Top Movement @ 105 tons	0.920"	0.400"
Top Movement @ 132 tons	-	0.908"
Top Pile Net Settlement @ 105 ton	0.142"	-
Top Pile Net Settlement @ 115 ton	-	0.075"
Top Pile Net Settlement @ 132 ton	-	0.461"
Maximum Grout Pressure	-	375 psi
Maximum Grout Volume	-	52 gallons

Location: 49 Lansdowne Street, Boston, MA

FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

- LOCATION: Wachusett MBTA Bridge 51.29 Fitchburg, MA
- GEOTECHNICAL ENGINEER: HNTB
- SUBSURFACE INFO: Dense sand and gravel (0-35 ft); Granite
- DRILLED MINIPILE DESIGN: 212.5 ton pile design, 7 5/8" OD x 0.5" wall casing, 10 foot rock socket



MBTA Bridge 51.29
Wachusett, MA

FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

DRILLED MINIPILE

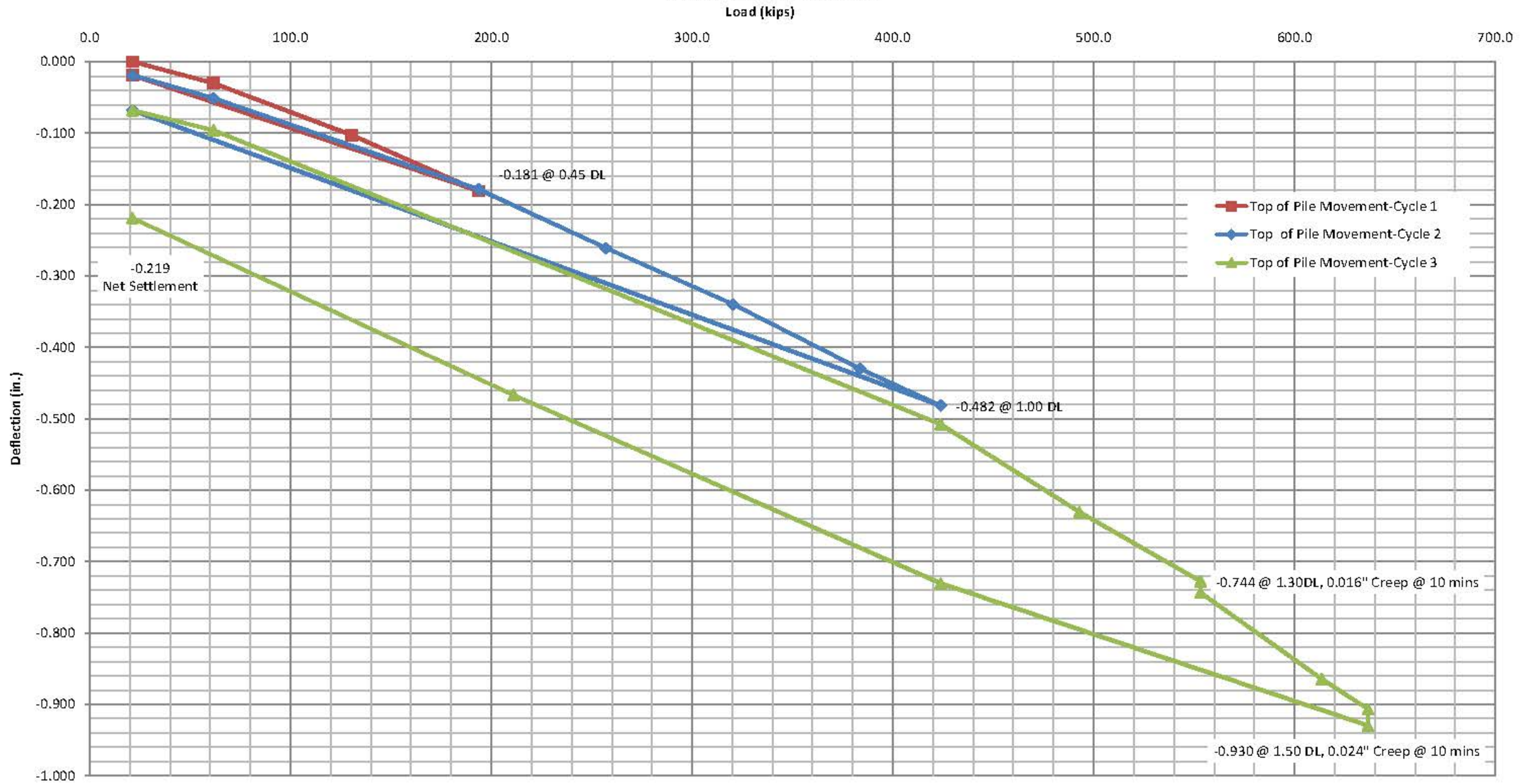
- PILE LOAD TEST: Tension test run to specification, three loading cycles
- TEST LOAD: 319 ton test load
- TOP PILE ELONGATION: 0.482" @ 212.5 tons
0.907" @ 319 tons with 0.027" creep from 1 to 10 mins,
- TOP PILE NET SETTLEMENT: 0.220" @ 319 tons

Location: Wachusett MBTA Bridge 51.29 Fitchburg, MA

Wachusett MBTA Extension Project, Bridge No.51.29, Fitchburg, MA

Pile Verification Test to 1.5 DL 10/26/15

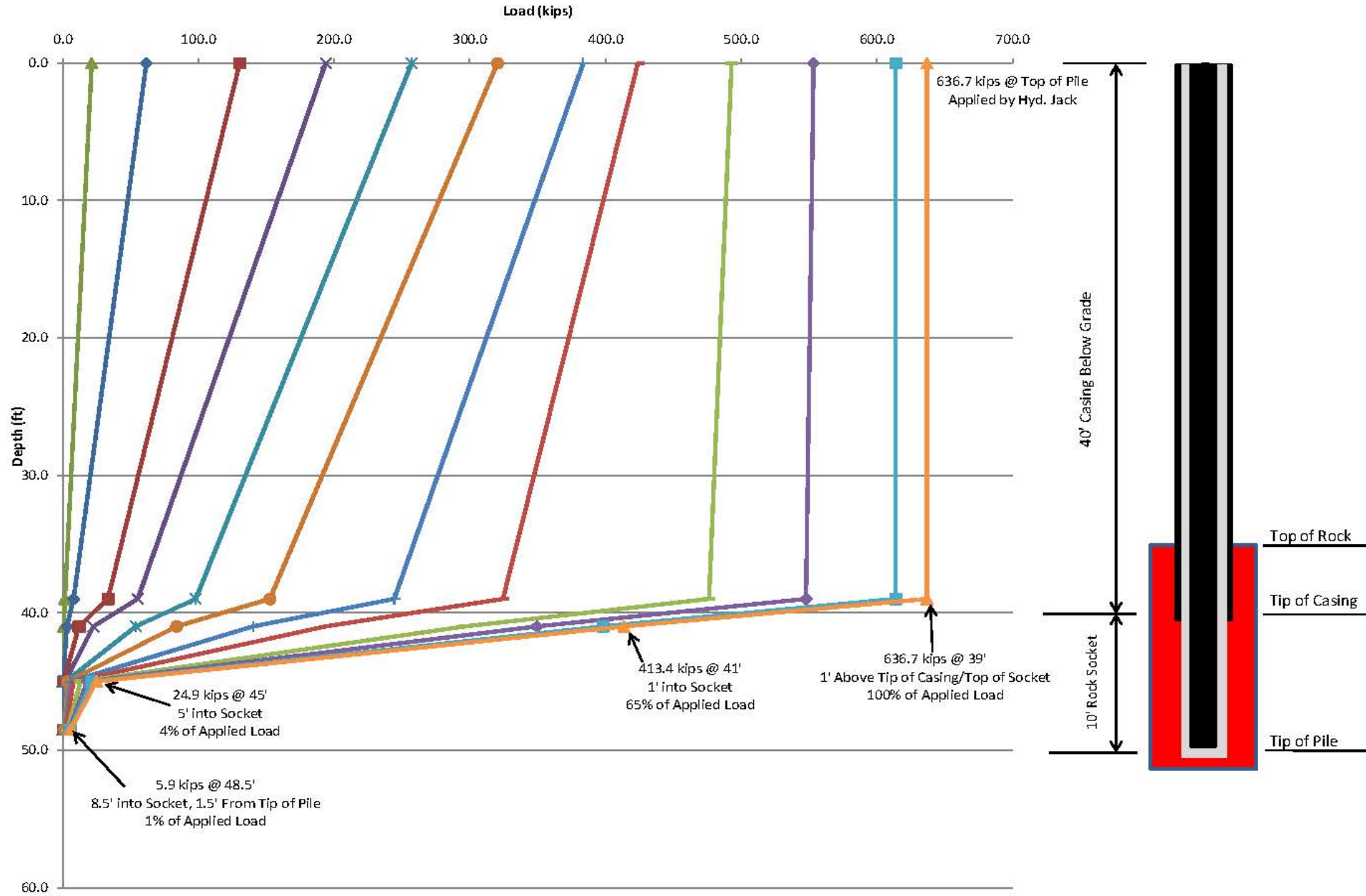
Load vs. Deflection



Wachusett MBTA Extension Project, Bridge No.51.29, Fitchburg, MA

Pile Verification Test to 1.5 DL 10/26/15

Load Distribution thru Pile



FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

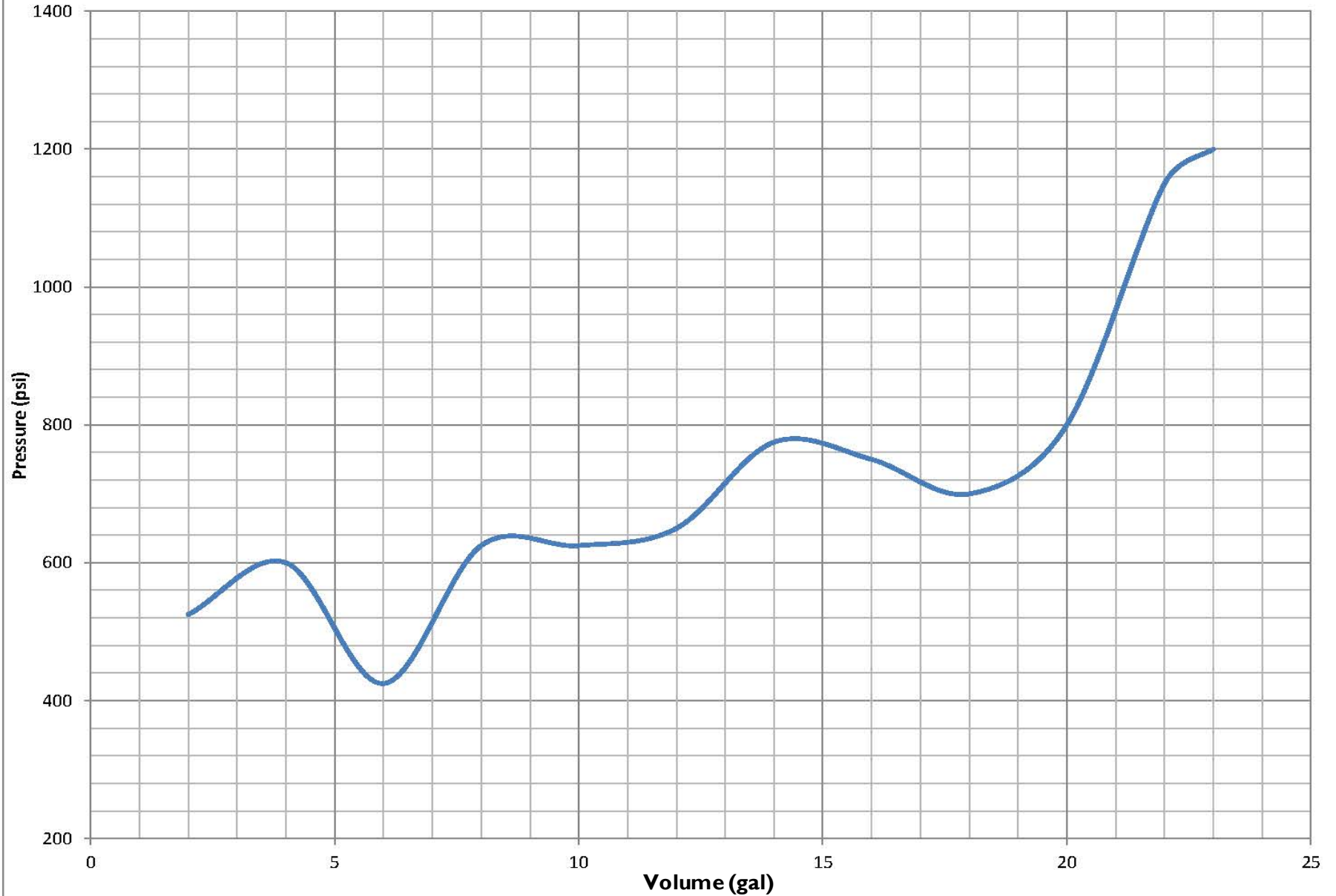
EXPANDER BODY

- DESIGN: 7 5/8" OD x 0.5" wall casing, 24" diameter EB (600mm) x 36" long
- BEARING STRATUM: Till
- EXPANSION PRESSURE: 1200 psi
- PILE LOAD TEST: Compression test run with 15 ton load intervals and 2.5 minute holding periods
- TEST LOAD: 269 ton maximum test load applied
- TOP PILE ELONGATION: 0.208" @ 209 tons
0.520" @ 269 tons with 0.024" creep from 1 to 2.5 mins
- TOP NET SETTLEMENT: Not recorded

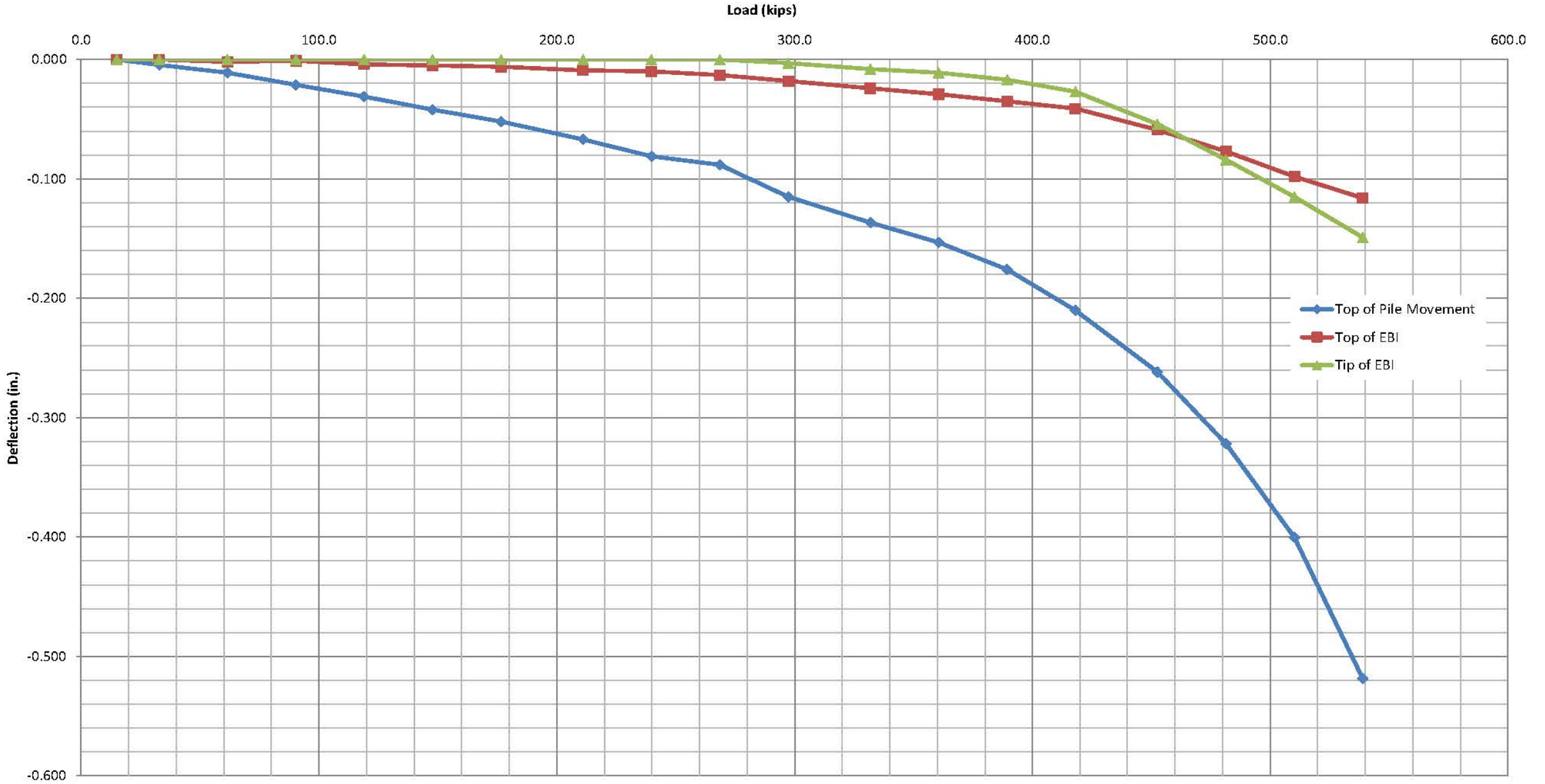
Location: Wachusett MBTA Bridge 51.29, Fitchburg, MA

Wachusett MBTA Extension Project, Bridge No.51.29, Fitchburg, MA
Drilled Expander Body
Primary Grouting

Primary Grouting	
Volume (gal)	Pressure (psi)
2	525
4	600
6	425
8	625
10	625
12	650
14	775
16	750
18	700
20	800
22	1150
23	1200



Wachusett MBTA Extension Project, Bridge No.51.29, Fitchburg, MA
Drilled Expander Body Pile Verification Test to 1.5 DL, 10/26/15
Load vs. Deflection



FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY PILES (EBI)

❖ SUMMARY

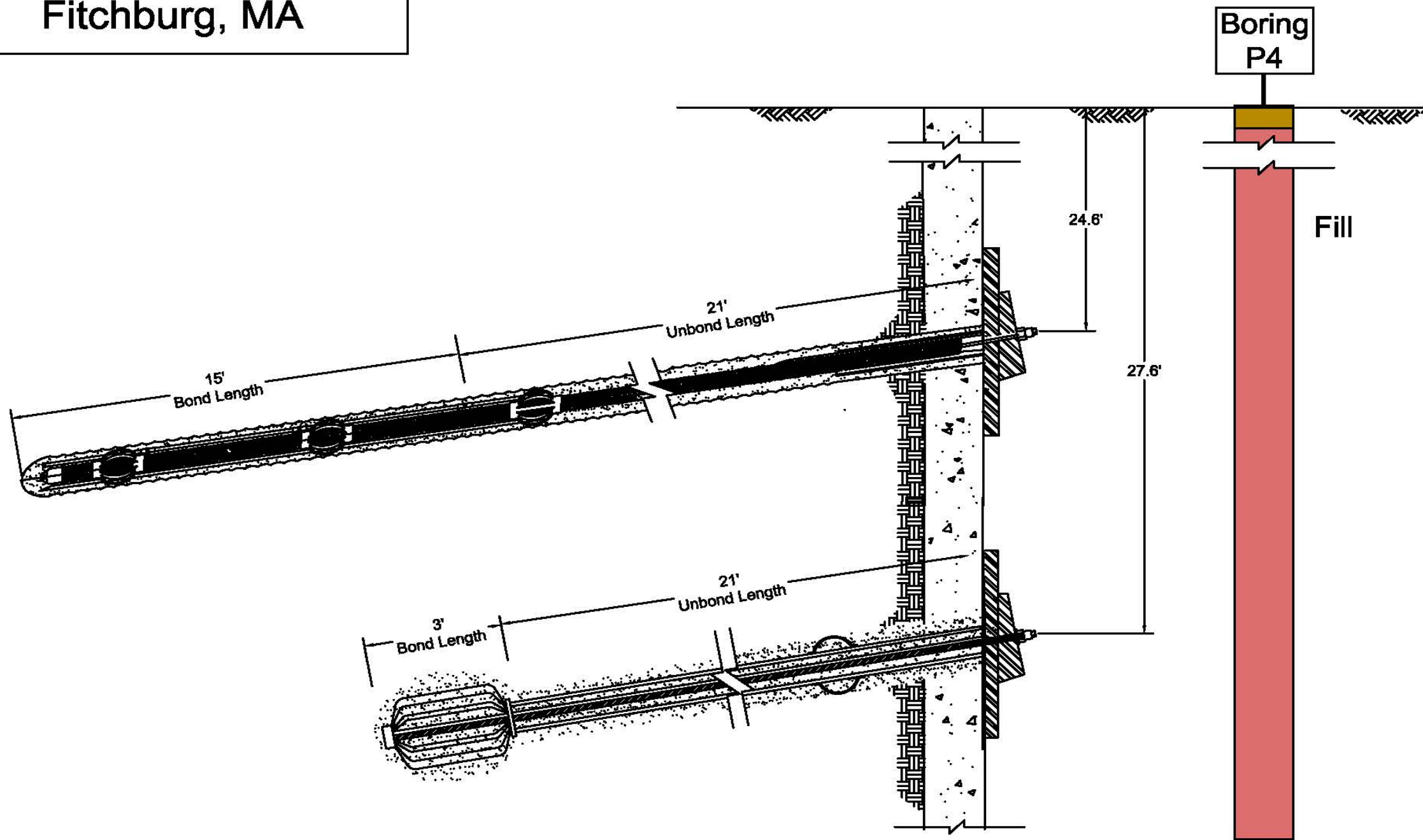
	Drilled Minipile	Expander Body
Maximum Test Load	319 tons	269 tons
Top Pile Movement @ 212.5 tons	0.482"	-
Top Pile Movement @ 319 tons	0.907"	-
Top Pile Movement @ 209 tons	-	0.208"
Top Pile Movement @ 269 tons	-	0.520"
Maximum Grout Volume	-	23 gal
Maximum Grout Pressure	-	1200 psi

Location: Wachusett MBTA Bridge 51.29 Fitchburg, MA

FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY TIEBACK (EBI)

- LOCATION: Wachusett MBTA Bridge 53.08 Fitchburg, MA
- GEOTECHNICAL ENGINEER: HNTB
- SUBSURFACE INFO: Fill (0-25 ft)
- TIEBACK DESIGN: 46 kips design load, 6.0" diameter, 10° angle, 21' unbonded length, 15' bond length, 2 strands

**MBTA Bridge 53.08
Fitchburg, MA**



FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY TIEBACK (EBI)

TIEBACK

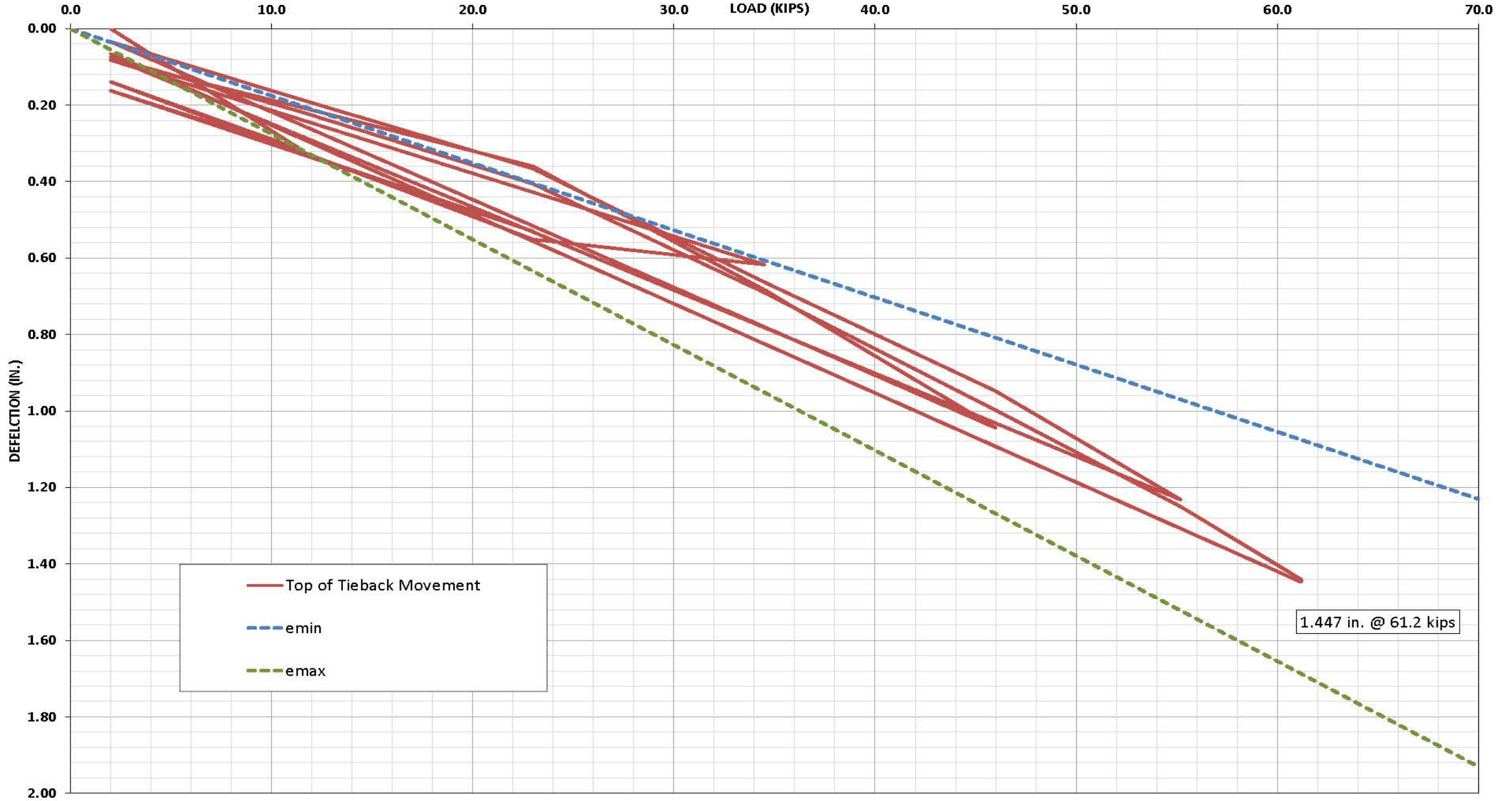
- TIEBACK LOAD TEST: Performance test run to specification, six loading cycles
- TEST LOAD: 61.2 maximum test load
- TIEBACK DEFLECTION: 0.998" @ 46 kips
1.447" @ 61.2 kips with 0.006" creep from 1 to 10 mins,

Location: Wachusett MBTA Bridge 53.08, Fitchburg, MA

Wachusett Bridges, Bridge No. 53.08, Fitchburg MA

Performance Tieback Test

03/03/2016



FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY TIEBACK (EBI)

EXPANDER BODY

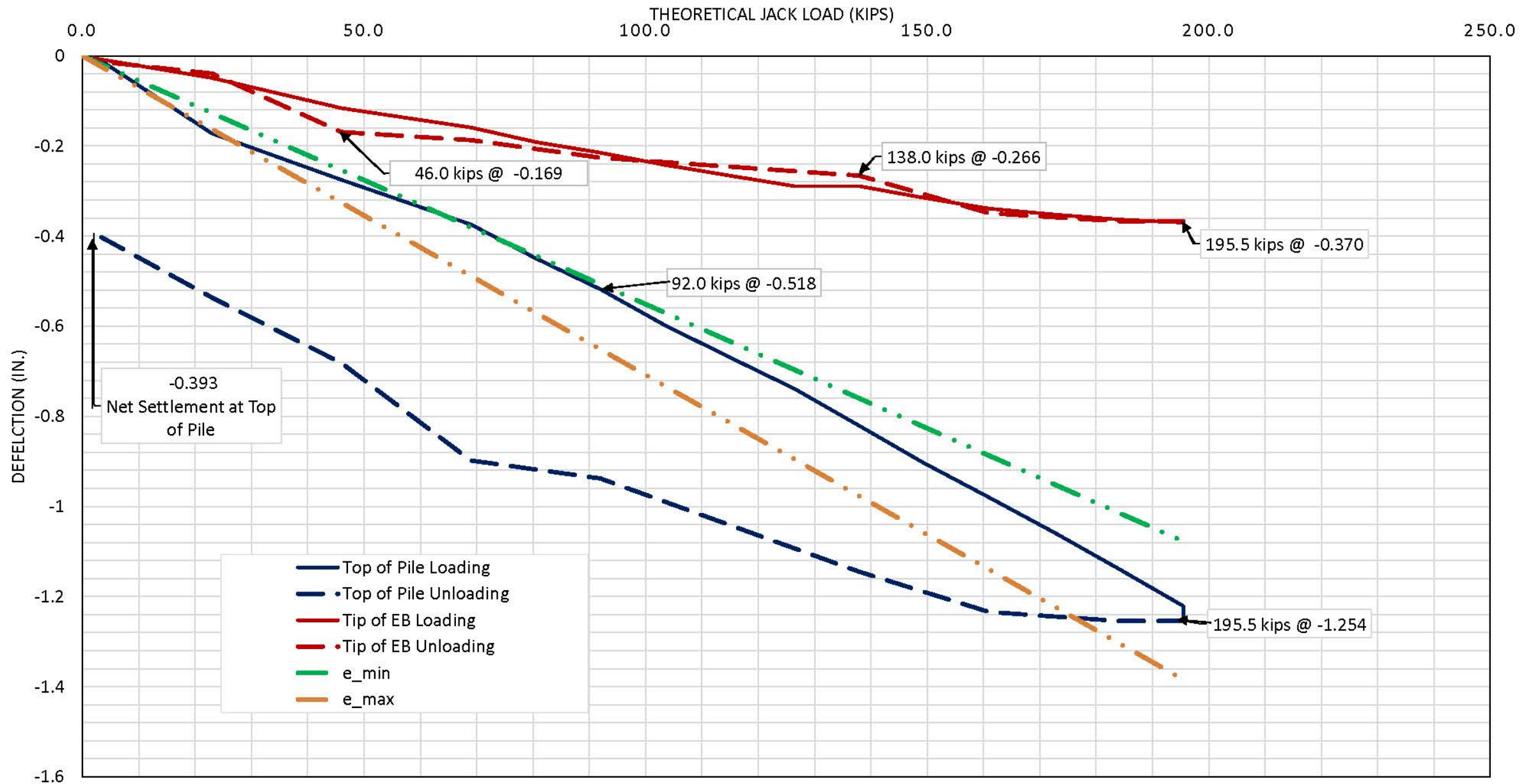
- DESIGN: 24" diameter EB (600mm) x 36" long, 21' unbonded length
- TIEBACK LOAD TEST: Performance test run to specification, six loading cycles
- TEST LOAD: 195.5 kips maximum test load applied
- TOP DEFLECTION: 0.328" @ 61.2 kips with 0.000" creep from 1 to 10 mins
1.254" @ 195.5 kips with 0.033" creep from 1 to 10 mins
- TIP DEFLECTION: 0.141" @ 61.2 kips with 0.000" creep from 1 to 10 mins
0.370" @ 195.5 kips with 0.003" creep from 1 to 10 mins
- TOP NET SETTLEMENT: 0.011"
- TIP NET SETTLEMENT: 0.393"

Location: Wachusett MBTA Bridge 53.08, Fitchburg, MA

Wachusett Bridges, Bridge No. 53.08, Fitchburg MA

Expanded Body Performance Tieback Test

3/16/2016



FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY TIEBACK (EBI)

❖ SUMMARY

	Tieback	Expander Body
Maximum Test Load	61.2 kips	195.5 kips
Maximum Top Elongation @ 46 kips	0.998"	0.280"
Maximum Top Elongation @ 61.2 kips	1.447"	0.328"
Maximum Top Elongation @ 195.5 kips	-	1.254"

Location: Wachusett MBTA Bridge 53.08, Fitchburg, MA

FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY TIEBACK (EBI)

CONCLUSION

- ALL THE EXPANDER BODY TESTS PERFORMED CLOSE TO (KINGSTON, RI) OR SIGNIFICANTLY BETTER THAN ALL OF THE CONVENTIONAL TESTS THAT WERE PERFORMED
- THE KEY FACTOR IS THAT IN ALL CASES THE TOTAL LENGTH OF THE ELEMENT IS SIGNIFICANTLY LESS FOR AN EB
- THIS TRANSLATES TO SIGNIFICANT REDUCTION IN DRILLING TIME
- ALSO THIS RESULTS IN SIGNIFICANTLY LESS DRILL SPOILS (ESPECIALLY IN CLAY) WHICH CAN REDUCE OTHER COSTS TO THE PROJECT

FIRST INTERNATIONAL SEMINAR ON EXPANDER BODY TIEBACK (EBI)

FUTURE APPLICATIONS

- THE OBVIOUS FIRST APPLICATION IS WHERE PIF'S OR FRANKI PILES ARE CURRENTLY INSTALLED. THE BENEFIT IS THAT WERE EB'S ARE INSTALLED WITHOUT NOISE OR VIBRATION.
- WE ARE LOOKING FOR A TEST SITE WHERE THE EB CAN BE LOCATED WITHIN A CLAY LAYER. WE ARE LOOKING FOR YOUR ASSISTANCE IN THIS REGARD IS HIGHLY APPRECIATED.
- EB'S HAVE BEEN INSTALLED IN OTHER COUNTRIES IN ALL TYPES OF GRANULAR SOILS, CLAY LAYERS, AND SOFT ROCK.
- WE FORESEE AS THE VOLUME OF EB'S INCREASES THAT THIS PRODUCT WILL BE COMPETATIVE AGAINST CONVENTIONAL DEEP DRIVEN PILES.

HUB
FOUNDATION

incotec
Ingeniería y construcción



THANK YOU

