GRL Engineers, Inc.

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TRANSMITTAL

To: Mr. Kevin Weber	From: Al Ziai
Company: Lunda Construction Co.	No. of Sheets: 50
E-mail: kweber@lundaconstruction.com	Date: December 11, 2014

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 3
Winnebago County, Wisconsin

On December 9, 2014, Pier 3 #1, Pier 3 #36, and Pier 3 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on December 10. Project plans indicated the exterior row piles have a required driving resistance, or ultimate capacity, of 480 kips (240 tons) and the interior row piles have a required driving resistance of 400 kips (200 tons). The reference grade at the bottom of the footing excavation was reported to be EL 741.4 for Pier 3 #1 and EL 740.2 for Pier 3 #36 and Pier 3 #44. The piles have a required minimum tip elevation of EL 660. The HP 14x73 H-piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0256) reportedly operated on fuel setting 4.

Pier 3 #1 was driven to a depth of 71.4 feet, which corresponds to a pile tip elevation of EL 670.0. The blow count over the final increment of driving was 27 blows for 8 inches of penetration at an average hammer stroke of 7.7 feet. The blow count at the beginning of restrike was 5 blows for ⅞ inch of penetration at an average hammer stroke of 7.9 feet.

Pier 3 #36 was driven to a depth of 70.6 feet, which corresponds to a pile tip elevation of EL 669.6. The blow count over the final increment of driving was 18 blows for 7 inches of penetration at an average hammer stroke of 7.2 feet. The blow count at the beginning of restrike was 5 blows for 1⅛ inch of penetration at an average hammer stroke of 7.6 feet

Pier 3 #44 was driven to a depth of 72.6 feet, which corresponds to a pile tip elevation of EL 667.6. The blow count over the final increment of driving was 30 blows for 7½ inches of penetration at an average hammer stroke of 7.1 feet. The blow count at the beginning of restrike was 5 blows for ⅞ inch of penetration at an average hammer stroke of 7.3 feet

Our driving recommendations have been prepared on a blows-per-inch basis. The criteria should be applied only after the minimum pile tip elevation is achieved. For the 480 and 400 kips piles driven with an APE D30-42 hammer (PD 0256) in Pier 3 of the USH 10 bridge over Little Lake Butte des Morts we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Exterior Piles (480 kips) Recommended Minimum Blow Count (blows per inch)	Interior Piles (400 kips) Recommended Minimum Blow Count (blows per inch)
6.5	6	5
7.0	5	4
7.5	4	4
8.0	4	3
8.5	4	3
9.0	4	3

We recommend the above blow counts at the required stroke be maintained for **three consecutive inches** of driving. We recommend immediately terminating driving **if the blow counts exceed 10** blows over an increment of one inch or less at hammer strokes of 8.0 feet, after satisfying any minimum tip requirements. We anticipate the production piles will terminate at depths similar to those of the test piles. Please note that all the tested piles had a tip elevation of approximately 10 feet above the minimum required pile tip elevation. Based upon the dynamic test results, the designer allowed the minimum pile tip elevation to be revised to EL 671.

These criteria should not be used for acceptance of piles under restrike and/or redrive conditions. After splicing or any other delays, we recommend not applying the criteria until a full foot of driving has occurred beyond the termination depth associated with the delay, unless the blow count exceeds 10 blows per inch.

Please call if you have any questions on these recommendations.

GRL Engineers, Inc.

Al Ziai

Travis Coleman, P.E.

Cc: Jeff Horsfall – jeffrey.horsfall@dot.wi.gov

Attachments:

Dynamic Test Results - (pages 3 – 20)
CAPWAP Analysis Results - (pages 21 – 50)

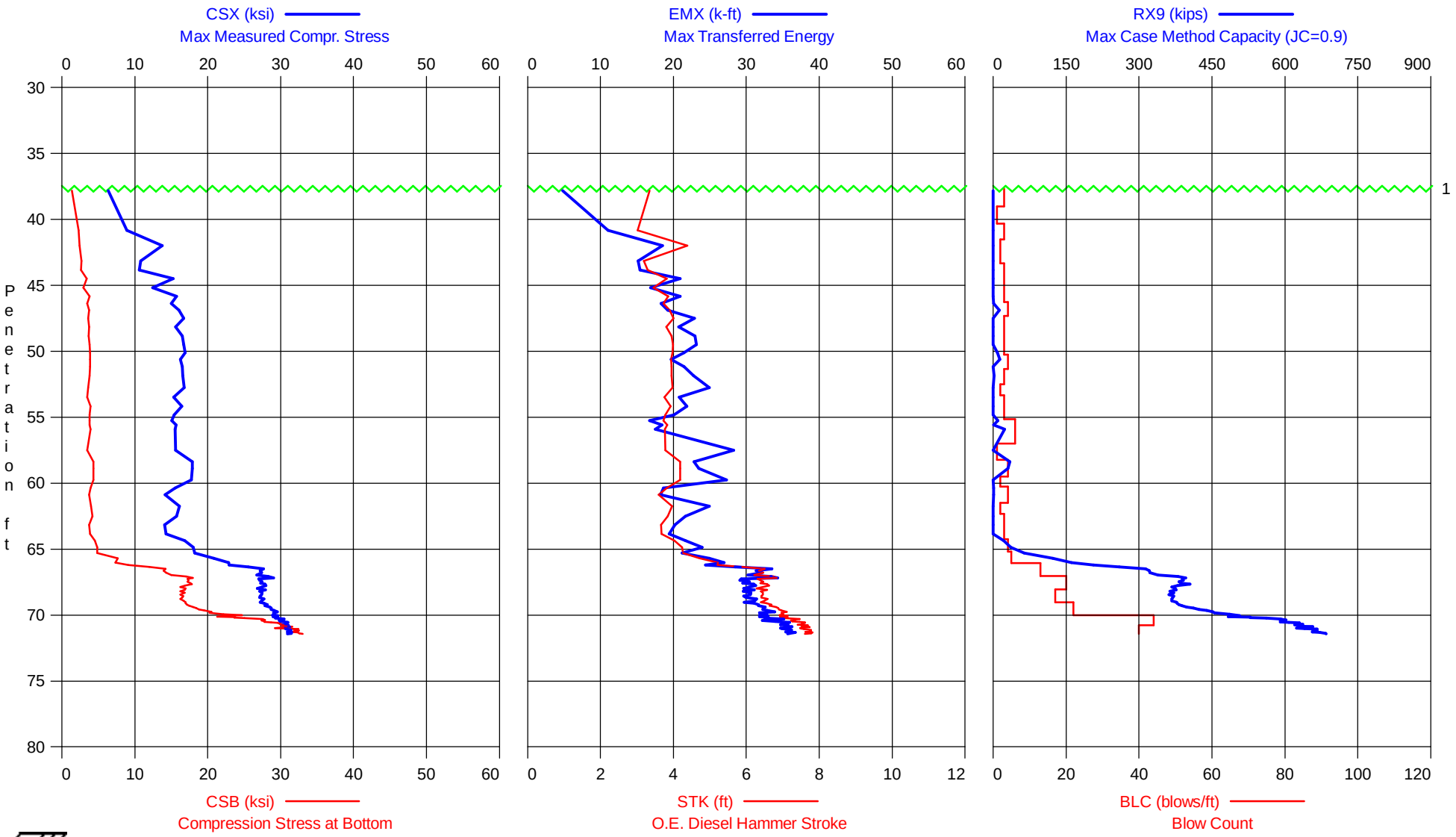
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 10-Dec-2014

Test date: 9-Dec-2014

USH 10 - B-70-403 - Pier 3 #1 - EOID

APE D30-42, HP 14 x 73



1 - Reference Elevation EL 741.41

USH 10 - B-70-403 - Pier 3 #1 - EOID APE D30-42, HP 14 x 73
OP: AZ Test date: 9-Dec-2014

AR: 21.40 in^2 SP: 0.492 k/ft3
LE: 77.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

CSX: Max Measured Compr. Stress EMX: Max Transferred Energy
CSB: Compression Stress at Bottom BPM: Blows per Minute
STK: O.E. Diesel Hammer Stroke RX9: Max Case Method Capacity (JC=0.9)

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
7	34.00	3	AV1	8.2	1.5	3.7	7	60	0
			MAX	8.2	1.6	3.7	7	60	0
			MIN	8.2	1.6	3.7	7	60	0
7	35.00	3	AV1	4.5	1.2	3.0	3	67	0
			MAX	4.5	1.2	3.0	3	67	0
			MIN	4.5	1.2	3.0	3	67	0
9	39.00	1	AV1	12.2	2.8	3.2	15	64	0
			MAX	12.2	2.8	3.2	15	64	0
			MIN	12.2	2.8	3.2	15	64	0
10	40.00	1	AV1	5.7	1.8	2.8	7	68	0
			MAX	5.7	1.8	2.8	7	68	0
			MIN	5.7	1.8	2.8	7	68	0
13	41.00	3	AV1	1.1	0.3	2.7	0	69	0
			MAX	1.1	0.3	2.7	0	69	0
			MIN	1.1	0.3	2.7	0	69	0
17	43.00	2	AV2	20.0	3.8	4.7	28	55	0
			STD	6.4	0.7	1.3	8	8	0
			MAX	26.3	4.5	6.0	37	63	0
			MIN	13.6	3.1	3.4	20	48	0
20	44.00	3	AV3	9.8	2.5	3.2	14	64	0
			STD	1.9	0.3	0.2	4	2	0
			MAX	12.3	2.9	3.5	19	66	0
			MIN	8.0	2.3	3.0	10	62	0
23	45.00	3	AV3	14.3	3.3	3.7	19	60	0
			STD	1.5	0.2	0.2	3	2	0
			MAX	16.0	3.4	4.0	23	63	0
			MIN	12.2	3.0	3.4	16	58	0
26	46.00	3	AV3	14.7	3.5	3.7	20	60	0
			STD	1.4	0.4	0.2	2	1	0
			MAX	15.7	3.9	3.9	21	62	0
			MIN	12.7	2.9	3.5	17	59	0
30	47.00	4	AV4	15.5	3.6	3.8	19	59	6
			STD	0.8	0.2	0.1	1	1	11
			MAX	16.8	3.9	4.0	20	60	25
			MIN	14.8	3.5	3.7	18	58	0
33	48.00	3	AV3	16.5	3.7	4.0	22	58	0
			STD	0.4	0.1	0.1	1	0	0
			MAX	17.0	3.9	4.0	23	59	0
			MIN	16.0	3.6	3.9	21	58	0
36	49.00	3	AV3	16.1	3.6	3.9	22	59	0
			STD	0.9	0.1	0.1	2	1	0
			MAX	17.3	3.8	4.1	24	60	0
			MIN	15.1	3.6	3.7	20	58	0
39	50.00	3	AV3	16.7	3.7	4.0	23	58	0
			STD	0.6	0.1	0.1	1	1	0
			MAX	17.4	3.8	4.1	24	59	0
			MIN	16.0	3.6	3.9	22	57	0
43	51.00	4	AV4	16.4	3.9	3.9	20	58	11
			STD	0.8	0.1	0.1	0	1	11
			MAX	17.2	4.1	4.1	20	60	25
			MIN	15.3	3.8	3.8	19	57	1
46	52.00	3	AV3	16.7	3.8	4.0	23	58	1
			STD	0.7	0.1	0.1	1	1	1
			MAX	17.4	3.9	4.1	24	59	3
			MIN	15.8	3.7	3.8	22	58	0

USH 10 - B-70-403 - Pier 3 #1 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 9-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
48	53.00	2	AV2	16.8	3.6	4.0	25	58	0
			STD	0.3	0.2	0.0	1	0	0
			MAX	17.1	3.8	4.0	25	58	0
			MIN	16.5	3.5	3.9	24	58	0
51	54.00	3	AV3	15.6	3.6	3.8	21	59	0
			STD	0.4	0.2	0.1	0	0	0
			MAX	16.1	3.9	3.9	22	60	0
			MIN	15.2	3.4	3.7	21	59	0
54	55.00	3	AV3	15.9	3.9	3.8	21	59	0
			STD	0.7	0.1	0.1	1	1	0
			MAX	16.7	4.0	4.0	22	60	0
			MIN	15.0	3.7	3.7	20	58	0
60	56.00	6	AV6	15.4	3.8	3.8	18	60	11
			STD	0.7	0.1	0.1	1	1	10
			MAX	16.8	3.9	4.0	20	60	27
			MIN	14.5	3.7	3.7	17	58	0
61	57.00	1	AV1	15.5	3.3	3.8	29	59	0
			MAX	15.5	3.3	3.8	29	59	0
			MIN	15.5	3.3	3.8	29	59	0
62	58.00	1	AV1	15.6	3.6	3.7	28	60	0
			MAX	15.6	3.6	3.7	28	60	0
			MIN	15.6	3.6	3.7	28	60	0
66	59.00	4	AV4	17.9	4.3	4.2	23	57	32
			STD	0.3	0.1	0.0	0	0	4
			MAX	18.2	4.4	4.2	24	57	39
			MIN	17.6	4.2	4.1	23	57	28
68	60.00	2	AV2	17.8	4.3	4.2	27	57	0
			STD	0.3	0.2	0.0	1	0	0
			MAX	18.0	4.5	4.2	28	57	0
			MIN	17.5	4.2	4.1	26	57	0
72	61.00	4	AV4	14.8	3.8	3.7	18	60	1
			STD	0.9	0.1	0.1	1	1	1
			MAX	16.3	4.0	3.9	20	61	2
			MIN	14.1	3.6	3.6	17	59	0
74	62.00	2	AV2	16.1	4.0	4.0	25	58	0
			STD	1.1	0.2	0.2	2	1	0
			MAX	17.2	4.2	4.1	27	60	0
			MIN	15.0	3.8	3.8	23	57	0
77	63.00	3	AV3	15.0	4.0	3.7	21	60	0
			STD	1.0	0.3	0.1	1	1	0
			MAX	15.8	4.3	3.9	23	61	0
			MIN	13.5	3.6	3.6	20	59	0
80	64.00	3	AV3	14.4	3.9	3.7	20	60	0
			STD	0.3	0.1	0.1	1	0	0
			MAX	14.6	3.9	3.8	21	61	0
			MIN	13.9	3.7	3.6	19	60	0
84	65.00	4	AV4	17.5	4.7	4.1	23	57	29
			STD	0.6	0.3	0.1	1	1	13
			MAX	18.1	5.2	4.3	24	58	50
			MIN	16.6	4.4	4.0	21	56	18
89	66.00	5	AV5	20.3	6.6	4.7	25	54	105
			STD	2.3	1.6	0.5	4	3	36
			MAX	23.4	8.7	5.4	31	57	152
			MIN	17.7	4.5	4.2	21	51	51
102	67.00	13	AV13	25.9	12.6	6.0	30	48	284
			STD	1.9	2.6	0.5	3	2	56
			MAX	28.4	15.6	6.7	34	52	355
			MIN	22.3	6.6	5.1	23	46	170
122	68.00	20	AV20	27.6	17.2	6.5	31	46	385
			STD	0.7	0.5	0.2	2	1	11
			MAX	29.1	18.2	6.9	35	47	405
			MIN	26.7	16.0	6.2	28	45	365

USH 10 - B-70-403 - Pier 3 #1 - EOID
OP: AZ
APE D30-42, HP 14 x 73
Test date: 9-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
139	69.00	17	AV17	27.4	16.6	6.5	30	46	369
			STD	0.6	0.3	0.2	1	1	5
			MAX	28.6	16.9	6.9	33	47	379
			MIN	26.6	16.0	6.3	29	45	360
161	70.00	22	AV22	28.6	19.1	6.8	32	45	424
			STD	0.7	2.0	0.2	1	1	41
			MAX	29.6	24.6	7.1	34	47	524
			MIN	27.2	16.8	6.4	30	44	377
194	70.75	44	AV33	30.1	26.9	7.3	34	44	578
			STD	0.7	2.7	0.2	2	1	48
			MAX	31.2	30.7	7.6	36	45	641
			MIN	28.7	20.9	6.9	32	43	475
221	71.42	40	AV27	31.1	31.5	7.7	36	43	654
			STD	0.4	1.1	0.1	1	0	20
			MAX	31.8	33.0	7.9	37	43	686
			MIN	30.4	28.7	7.4	34	42	612
			Average	23.9	15.4	5.8	28	50	306
			Std. Dev.	7.0	10.4	1.6	7	7	251
			Maximum	31.8	33.0	7.9	37	69	686
			Minimum	1.1	0.3	2.7	0	42	0

Total number of blows analyzed: 211

BL#	depth (ft)	Comments
7	37.67	Reference Elevation EL 741.41

Time Summary

Drive 5 minutes 37 seconds 9:53:05 AM - 9:58:42 AM (12/9/2014) BN 1 - 221

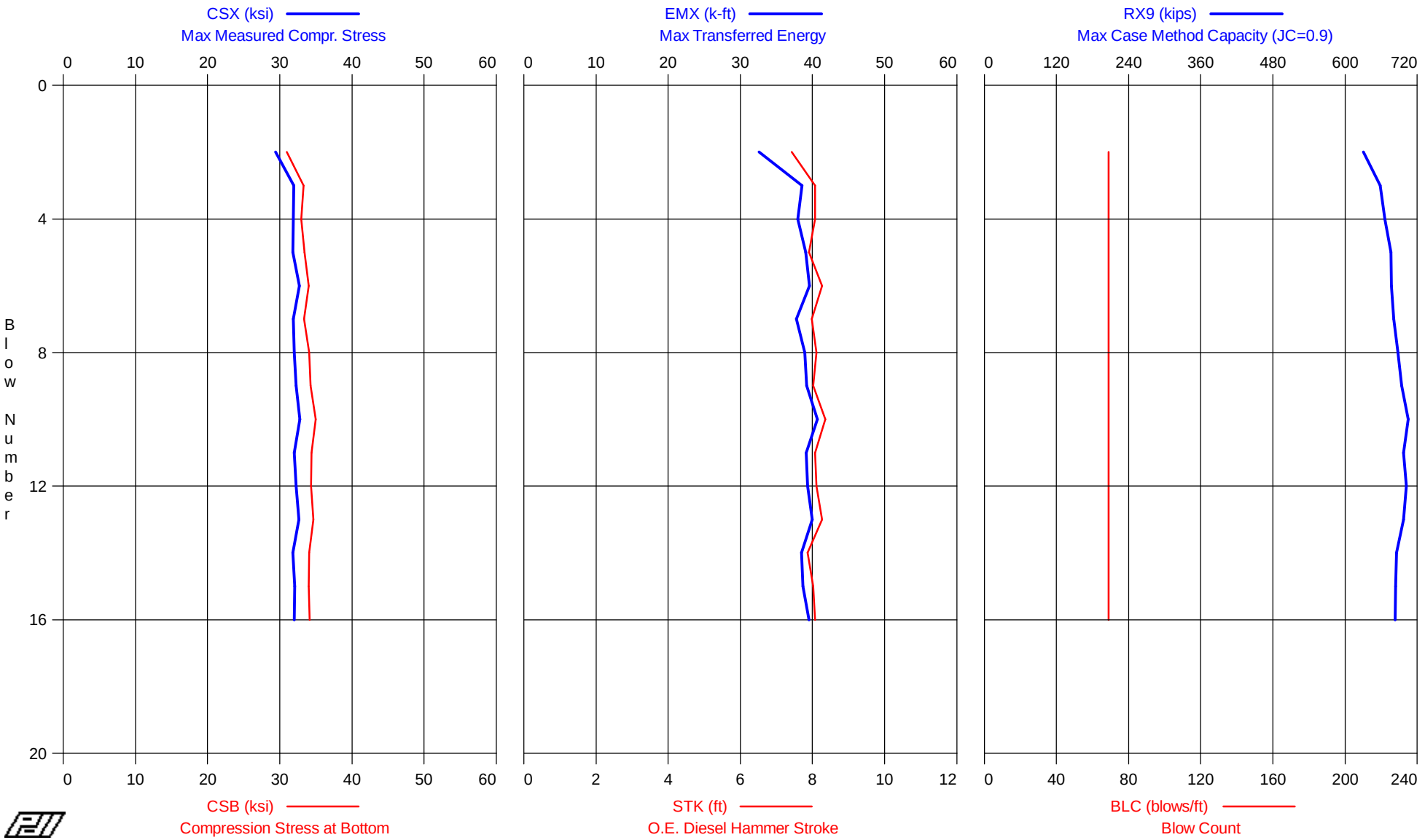
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 10-Dec-2014

Test date: 10-Dec-2014

USH 10 - B-70-403 - Pier 3 #1 - BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 3 #1 - BOR
OP: AZ

APE D30-42, HP 14 x 73
Test date: 10-Dec-2014

AR: 21.40 in^2
LE: 77.00 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke

EMX: Max Transferred Energy
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
6	71.49	69	AV5	31.5	32.9	7.9	38	42	662
			STD	1.1	1.0	0.3	3	1	17
			MAX	32.7	34.0	8.3	40	43	677
			MIN	29.4	31.0	7.4	33	41	631
11	71.57	69	AV5	32.2	34.2	8.1	39	42	693
			STD	0.3	0.5	0.1	1	0	8
			MAX	32.8	35.0	8.4	41	42	705
			MIN	31.9	33.3	8.0	38	41	681
16	71.64	69	AV5	32.2	34.2	8.1	39	42	690
			STD	0.3	0.2	0.1	1	0	8
			MAX	32.7	34.6	8.3	40	42	702
			MIN	31.8	34.0	7.9	39	41	683
			Average	32.0	33.8	8.0	39	42	682
			Std. Dev.	0.7	0.9	0.2	2	1	18
			Maximum	32.8	35.0	8.4	41	43	705
			Minimum	29.4	31.0	7.4	33	41	631

Total number of blows analyzed: 15

Time Summary

Drive 20 seconds 7:42:20 AM - 7:42:40 AM (12/10/2014) BN 2 - 16

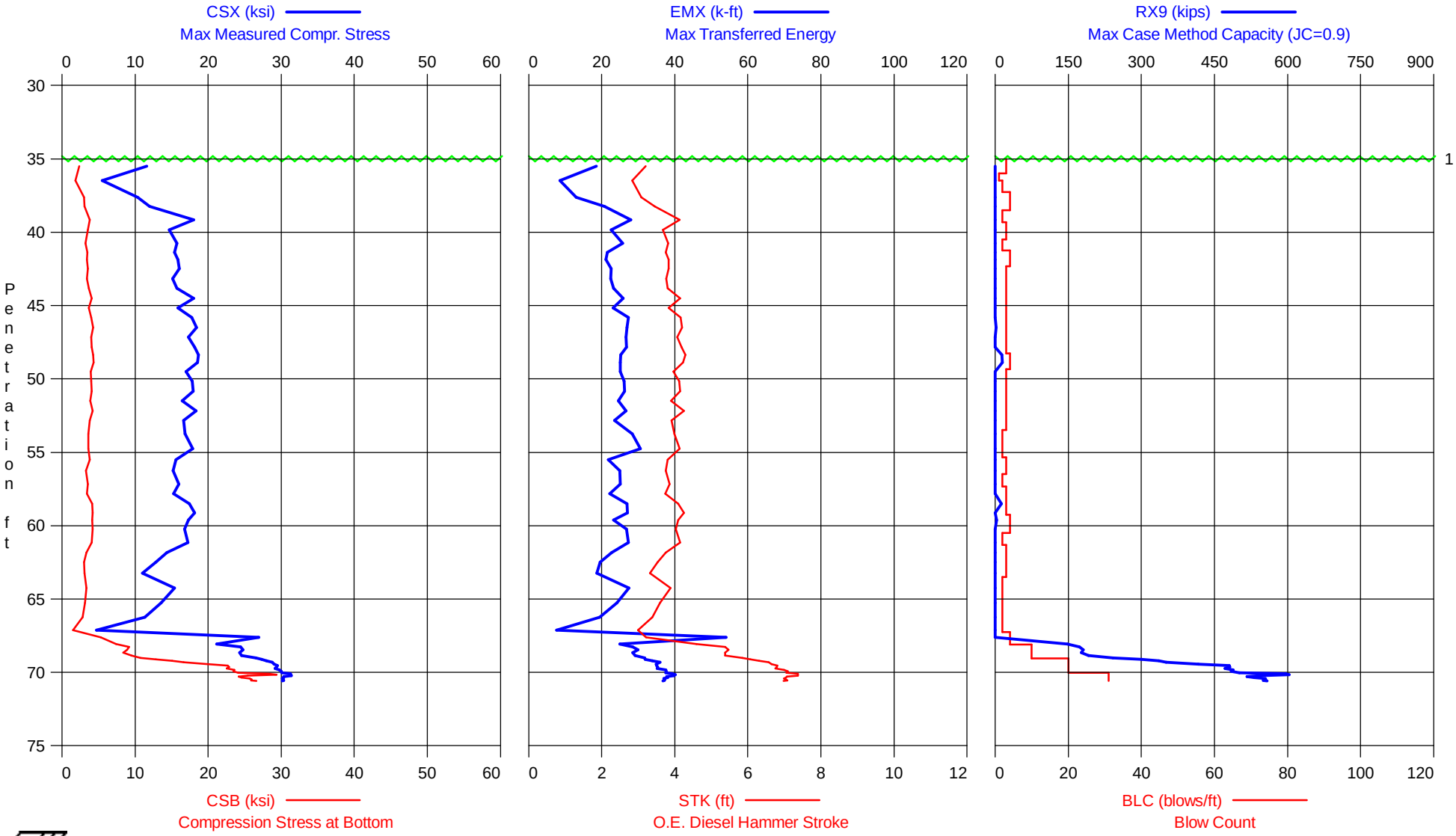
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 10-Dec-2014

Test date: 9-Dec-2014

USH 10 - B-70-403 - Pier 3 #36 - EOID

APE D30-42, HP 14 x 73



1 - Reference Elevation EL 740.16

USH 10 - B-70-403 - Pier 3 #36 - EOID APE D30-42, HP 14 x 73
OP: AZ Test date: 9-Dec-2014

AR: 21.40 in^2 SP: 0.492 k/ft3
LE: 77.58 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

CSX: Max Measured Compr. Stress EMX: Max Transferred Energy
CSB: Compression Stress at Bottom BPM: Blows per Minute
STK: O.E. Diesel Hammer Stroke RX9: Max Case Method Capacity (JC=0.9)

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
7	32.00	3	AV1	13.7	2.9	3.3	19	63	0
			MAX	13.7	2.9	3.3	19	63	0
			MIN	13.7	2.9	3.3	19	63	0
7	33.00	3	AV1	9.4	1.8	3.1	18	65	0
			MAX	9.4	1.8	3.1	18	65	0
			MIN	9.4	1.8	3.1	18	65	0
7	34.00	3	AV1	5.5	1.8	2.8	9	68	0
			MAX	5.5	1.8	2.8	9	68	0
			MIN	5.5	1.8	2.8	9	68	0
10	37.00	2	AV1	12.6	3.4	3.2	16	65	0
			MAX	12.6	3.4	3.2	16	65	0
			MIN	12.6	3.4	3.2	16	65	0
14	38.00	4	AV2	8.6	2.7	3.1	11	66	0
			STD	0.4	0.0	0.1	2	1	0
			MAX	9.1	2.7	3.1	13	66	0
			MIN	8.2	2.6	3.0	10	65	0
16	39.00	2	AV2	17.3	3.6	4.1	31	57	0
			STD	2.3	0.2	0.3	2	2	0
			MAX	19.6	3.8	4.4	33	60	0
			MIN	14.9	3.4	3.8	29	55	0
19	40.00	3	AV3	15.3	3.6	3.7	23	60	0
			STD	0.8	0.1	0.1	0	1	0
			MAX	16.4	3.8	3.9	23	60	0
			MIN	14.6	3.5	3.7	22	59	0
21	41.00	2	AV2	15.7	3.2	3.8	26	59	0
			STD	0.1	0.1	0.0	1	0	0
			MAX	15.8	3.3	3.8	26	59	0
			MIN	15.6	3.1	3.8	25	59	0
25	42.00	4	AV4	15.6	3.5	3.8	21	60	0
			STD	0.7	0.1	0.1	1	1	0
			MAX	16.6	3.6	3.9	23	60	0
			MIN	14.7	3.3	3.7	20	59	0
28	43.00	3	AV3	15.3	3.5	3.7	22	60	0
			STD	1.2	0.1	0.1	1	1	0
			MAX	16.7	3.6	3.9	24	61	0
			MIN	13.7	3.4	3.6	21	59	0
31	44.00	3	AV3	16.0	3.6	3.9	24	59	0
			STD	0.8	0.1	0.1	1	1	0
			MAX	16.6	3.8	4.0	24	60	0
			MIN	14.9	3.5	3.7	23	58	0
34	45.00	3	AV3	17.4	4.0	4.0	25	58	0
			STD	0.9	0.1	0.1	1	1	0
			MAX	18.0	4.1	4.2	26	59	0
			MIN	16.0	3.8	3.8	23	57	0
37	46.00	3	AV3	17.1	3.9	4.0	26	58	0
			STD	1.0	0.3	0.2	2	1	0
			MAX	17.9	4.2	4.2	28	59	0
			MIN	15.7	3.6	3.8	23	57	0
40	47.00	3	AV3	17.8	4.1	4.1	26	57	1
			STD	1.3	0.2	0.2	2	1	2
			MAX	19.6	4.4	4.4	29	59	3
			MIN	16.5	3.9	3.9	25	56	0
43	48.00	3	AV3	18.1	4.1	4.2	27	57	0
			STD	0.3	0.1	0.0	1	0	0
			MAX	18.4	4.3	4.2	28	57	0
			MIN	17.8	3.9	4.1	26	57	0

USH 10 - B-70-403 - Pier 3 #36 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 9-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
47	49.00	4	AV4	18.6	4.3	4.3	25	56	14
			STD	0.3	0.2	0.1	0	0	3
			MAX	18.9	4.5	4.3	26	57	18
			MIN	18.1	4.1	4.1	24	56	9
50	50.00	3	AV3	17.2	4.0	4.0	25	58	0
			STD	0.8	0.2	0.1	1	1	0
			MAX	17.8	4.1	4.1	27	59	0
			MIN	16.2	3.7	3.8	24	57	0
53	51.00	3	AV3	17.9	4.0	4.1	26	57	0
			STD	1.2	0.3	0.2	1	1	0
			MAX	19.5	4.4	4.4	27	59	0
			MIN	16.4	3.7	3.9	25	56	0
56	52.00	3	AV3	17.1	4.0	4.0	25	58	0
			STD	1.0	0.2	0.2	1	1	0
			MAX	18.4	4.3	4.3	27	59	0
			MIN	16.2	3.8	3.9	24	56	0
59	53.00	3	AV3	17.2	3.9	4.0	25	58	0
			STD	0.9	0.2	0.2	2	1	0
			MAX	18.2	4.1	4.2	27	60	0
			MIN	16.0	3.7	3.8	23	57	0
61	54.00	2	AV2	16.8	3.6	4.0	28	58	0
			STD	0.6	0.1	0.1	2	1	0
			MAX	17.5	3.7	4.1	30	59	0
			MIN	16.2	3.5	3.9	27	58	0
63	55.00	2	AV2	17.9	3.6	4.1	31	57	0
			STD	0.6	0.2	0.1	1	1	0
			MAX	18.5	3.8	4.2	32	58	0
			MIN	17.3	3.4	4.0	29	57	0
66	56.00	3	AV3	15.4	3.7	3.8	22	60	0
			STD	0.6	0.2	0.1	1	1	0
			MAX	16.2	3.9	3.9	24	60	0
			MIN	14.9	3.4	3.7	21	59	0
68	57.00	2	AV2	16.2	3.3	3.9	27	59	0
			STD	0.7	0.1	0.1	1	1	0
			MAX	16.9	3.4	4.0	28	60	0
			MIN	15.4	3.1	3.8	26	58	0
71	58.00	3	AV3	15.2	3.5	3.7	22	60	0
			STD	0.7	0.1	0.1	0	1	0
			MAX	16.2	3.6	3.9	23	61	0
			MIN	14.4	3.3	3.6	22	59	0
74	59.00	3	AV3	17.7	4.2	4.1	27	57	8
			STD	1.2	0.4	0.2	1	1	12
			MAX	18.8	4.6	4.3	28	59	25
			MIN	16.1	3.7	3.9	26	56	0
78	60.00	4	AV4	17.3	4.1	4.1	24	57	2
			STD	0.7	0.1	0.1	2	1	3
			MAX	18.0	4.2	4.3	26	58	6
			MIN	16.4	4.0	4.0	22	56	0
80	61.00	2	AV2	17.8	4.3	4.2	31	57	0
			STD	0.7	0.1	0.1	0	1	0
			MAX	18.5	4.4	4.3	31	58	0
			MIN	17.1	4.2	4.1	31	56	0
83	62.00	3	AV3	14.9	3.5	3.8	23	59	0
			STD	0.9	0.3	0.1	1	1	0
			MAX	16.0	3.9	4.0	23	60	0
			MIN	13.8	3.2	3.7	22	58	0
86	63.00	3	AV3	11.8	3.1	3.4	18	63	0
			STD	1.5	0.1	0.2	3	2	0
			MAX	13.3	3.2	3.6	21	65	0
			MIN	9.8	2.9	3.1	15	61	0

USH 10 - B-70-403 - Pier 3 #36 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 9-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
88	64.00	2	AV2	13.5	3.1	3.6	24	61	0
			STD	1.2	0.0	0.2	2	1	0
			MAX	14.7	3.1	3.8	27	62	0
			MIN	12.3	3.1	3.5	22	59	0
90	65.00	2	AV2	15.0	3.4	3.8	26	60	0
			STD	1.1	0.2	0.2	2	1	0
			MAX	16.1	3.6	3.9	28	61	0
			MIN	13.8	3.2	3.6	24	58	0
92	66.00	2	AV2	13.4	3.1	3.6	23	61	0
			STD	0.1	0.0	0.0	1	0	0
			MAX	13.5	3.1	3.6	24	61	0
			MIN	13.3	3.1	3.6	22	61	0
94	67.00	2	AV2	8.3	2.3	3.1	15	65	0
			STD	0.9	0.2	0.0	1	0	0
			MAX	9.1	2.5	3.1	17	66	0
			MIN	7.4	2.2	3.1	14	65	0
98	68.00	4	AV4	18.8	4.6	4.5	33	57	33
			STD	10.2	2.3	1.5	23	8	58
			MAX	27.8	7.1	6.4	59	67	133
			MIN	2.0	0.8	2.9	1	46	0
108	69.00	10	AV10	24.6	9.0	5.4	29	50	182
			STD	0.8	0.8	0.2	2	1	17
			MAX	26.6	10.3	5.9	33	52	213
			MIN	23.0	7.7	5.1	26	49	163
128	70.00	20	AV20	28.9	19.7	6.6	35	46	419
			STD	1.0	4.3	0.4	2	1	77
			MAX	30.2	24.1	7.1	38	49	496
			MIN	26.6	11.2	5.9	31	44	270
146	70.58	31	AV18	30.6	26.1	7.2	38	44	554
			STD	0.6	1.8	0.2	1	1	33
			MAX	32.0	30.8	7.6	41	45	638
			MIN	29.6	23.6	6.9	36	43	506
			Average	20.3	9.3	4.8	28	55	148
			Std. Dev.	6.9	8.8	1.4	8	7	217
			Maximum	32.0	30.8	7.6	59	68	638
			Minimum	2.0	0.8	2.8	1	43	0

Total number of blows analyzed: 138

BL#	depth (ft)	Comments
7	35.00	Reference Elevation EL 740.16

Time Summary

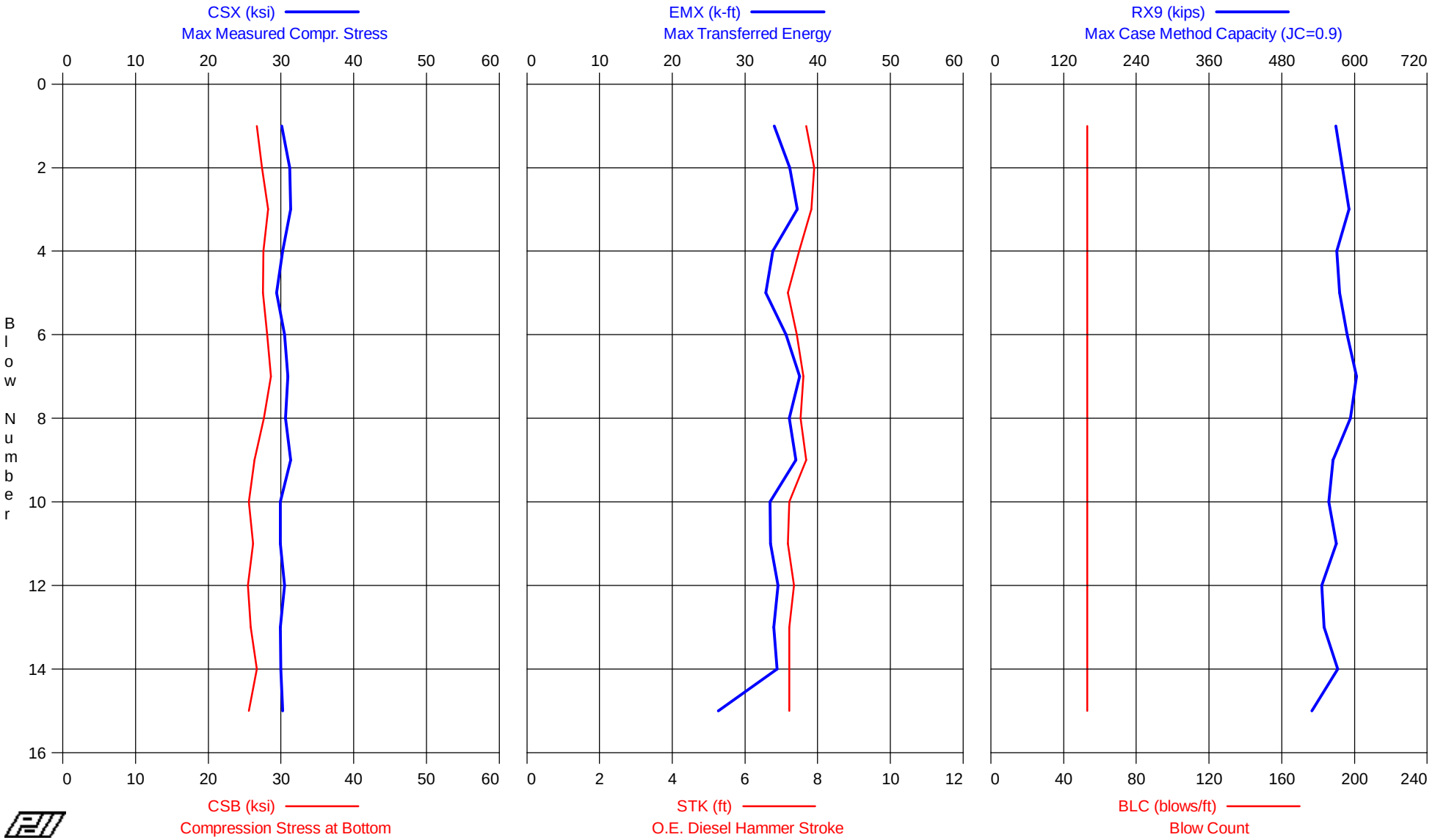
Drive 3 minutes 49 seconds 10:23:33 AM - 10:27:22 AM (12/9/2014) BN 1 - 146

GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 10-Dec-2014

Test date: 10-Dec-2014

USH 10 - B-70-403 - Pier 3 #36 - BOR
APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 3 #36 - BOR
OP: AZ

APE D30-42, HP 14 x 73
Test date: 10-Dec-2014

AR: 21.40 in^2
LE: 77.58 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
EMX: Max Transferred Energy

STK: O.E. Diesel Hammer Stroke
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
5	70.67	53	AV5	30.5	27.5	35	7.6	42.8	577
			STD	0.7	0.5	2	0.3	0.7	8
			MAX	31.3	28.2	37	7.9	44.0	591
			MIN	29.4	26.6	33	7.2	42.0	570
9	70.77	53	AV5	30.7	27.3	36	7.5	43.1	581
			STD	0.5	1.1	1	0.2	0.5	17
			MAX	31.3	28.6	38	7.7	43.9	603
			MIN	29.9	25.6	33	7.2	42.6	558
15	70.86	53	AV5	30.1	25.9	33	7.2	43.8	554
			STD	0.2	0.4	3	0.1	0.2	16
			MAX	30.5	26.7	35	7.4	44.0	572
			MIN	29.9	25.5	26	7.2	43.5	530
			Average	30.4	26.9	34	7.4	43.2	571
			Std. Dev.	0.6	1.0	3	0.2	0.7	19
			Maximum	31.3	28.6	38	7.9	44.0	603
			Minimum	29.4	25.5	26	7.2	42.0	530

Total number of blows analyzed: 15

Time Summary

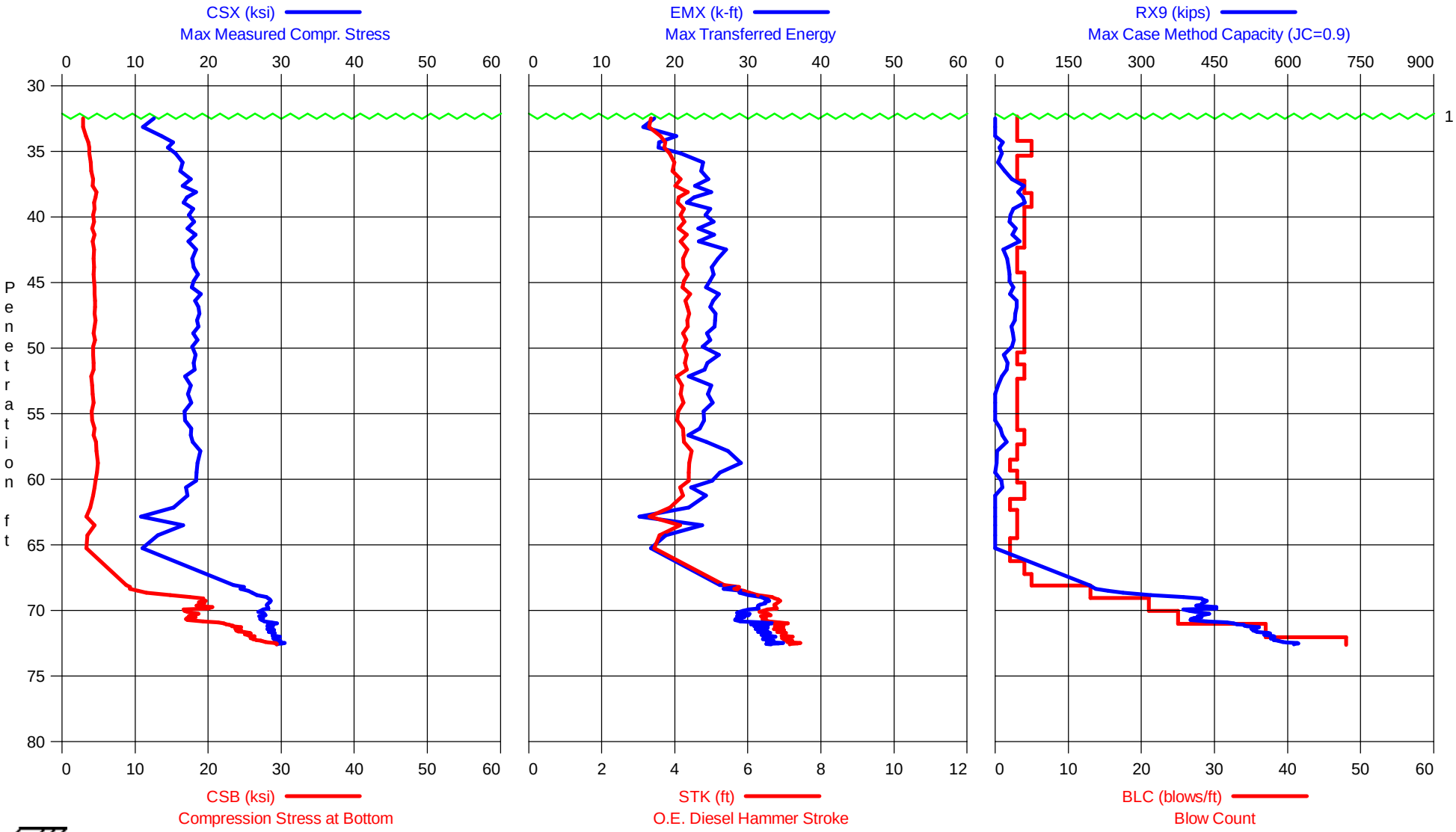
Drive 19 seconds 7:51:46 AM - 7:52:05 AM (12/10/2014) BN 1 - 15

GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 10-Dec-2014

Test date: 9-Dec-2014

USH 10 - B-70-403 - Pier 3 #44 - EOID
APE D30-42, HP 14 x 73



1 - Reference Elevations EL 740.16

USH 10 - B-70-403 - Pier 3 #44 - EOID APE D30-42, HP 14 x 73
OP: AZ Test date: 9-Dec-2014

AR: 21.40 in^2 SP: 0.492 k/ft3
LE: 77.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

CSX: Max Measured Compr. Stress STK: O.E. Diesel Hammer Stroke
CSB: Compression Stress at Bottom BPM: Blows per Minute
EMX: Max Transferred Energy RX9: Max Case Method Capacity (JC=0.9)

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
7	30.00	3	AV1	13.3	3.0	18	3.4	62.9	0
			MAX	13.3	3.0	18	3.4	62.9	0
			MIN	13.3	3.0	18	3.4	62.9	0
7	31.00	3	AV1	11.8	2.8	16	3.3	63.0	0
			MAX	11.8	2.8	16	3.3	63.0	0
			MIN	11.8	2.8	16	3.3	63.0	0
7	32.00	3	AV1	10.3	2.7	14	3.2	64.1	0
			MAX	10.3	2.7	14	3.2	64.1	0
			MIN	10.3	2.7	14	3.2	64.1	0
9	33.00	3	AV1	11.7	3.0	17	3.4	62.8	0
			MAX	11.7	3.0	17	3.4	62.8	0
			MIN	11.7	3.0	17	3.4	62.8	0
12	34.00	3	AV2	13.7	3.2	20	3.6	60.8	0
			STD	1.0	0.2	2	0.1	1.1	0
			MAX	14.6	3.5	22	3.7	61.9	0
			MIN	12.7	3.0	19	3.5	59.8	0
17	35.00	5	AV5	15.0	3.7	18	3.8	59.8	15
			STD	1.0	0.1	1	0.1	1.1	9
			MAX	15.9	3.9	19	3.9	61.7	25
			MIN	13.1	3.5	17	3.5	58.6	0
20	36.00	3	AV3	16.1	3.8	24	3.9	58.5	4
			STD	0.6	0.2	1	0.1	0.7	1
			MAX	16.8	4.0	24	4.1	59.2	6
			MIN	15.4	3.6	23	3.8	57.6	2
23	37.00	3	AV3	16.8	4.1	24	4.0	57.9	22
			STD	0.9	0.1	1	0.1	0.9	4
			MAX	18.0	4.3	26	4.2	58.7	26
			MIN	16.1	3.9	24	3.9	56.6	17
27	38.00	4	AV4	17.2	4.3	24	4.1	57.2	49
			STD	0.9	0.2	2	0.2	1.1	10
			MAX	18.5	4.5	26	4.4	58.5	60
			MIN	16.0	4.1	21	3.9	55.5	38
32	39.00	5	AV5	17.1	4.6	22	4.1	57.2	58
			STD	0.6	0.2	1	0.1	0.6	7
			MAX	18.1	4.8	24	4.3	57.7	67
			MIN	16.4	4.3	22	4.0	56.1	46
36	40.00	4	AV4	17.7	4.4	25	4.2	56.7	34
			STD	0.5	0.1	0	0.1	0.6	4
			MAX	18.6	4.5	25	4.4	57.1	38
			MIN	17.4	4.2	24	4.1	55.7	28
40	41.00	4	AV4	17.6	4.3	24	4.2	56.8	36
			STD	0.7	0.1	1	0.1	0.7	8
			MAX	18.8	4.5	26	4.4	57.4	44
			MIN	17.0	4.1	23	4.1	55.6	23
44	42.00	4	AV4	17.8	4.3	24	4.2	56.5	43
			STD	0.6	0.2	1	0.1	0.7	9
			MAX	18.4	4.5	26	4.4	57.5	58
			MIN	16.8	4.1	23	4.1	55.8	33
47	43.00	3	AV3	18.2	4.3	27	4.3	56.2	19
			STD	0.3	0.1	1	0.1	0.5	5
			MAX	18.4	4.4	27	4.4	56.8	26
			MIN	17.7	4.3	26	4.2	55.7	15
50	44.00	3	AV3	18.0	4.4	25	4.2	56.5	26
			STD	0.4	0.1	1	0.1	0.3	2
			MAX	18.4	4.5	26	4.3	56.9	28
			MIN	17.6	4.3	24	4.2	56.1	23

USH 10 - B-70-403 - Pier 3 #44 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 9-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
54	45.00	4	AV4	18.3	4.3	25	4.3	56.1	29
			STD	0.7	0.0	1	0.1	0.8	3
			MAX	19.4	4.4	26	4.5	57.1	32
			MIN	17.5	4.3	24	4.1	54.9	26
58	46.00	4	AV4	18.4	4.4	25	4.3	56.0	34
			STD	0.9	0.1	1	0.1	0.9	6
			MAX	19.6	4.5	26	4.5	57.3	43
			MIN	17.2	4.4	23	4.1	54.8	29
62	47.00	4	AV4	18.5	4.5	25	4.3	56.1	44
			STD	1.3	0.2	2	0.2	1.3	5
			MAX	19.9	4.7	27	4.5	57.6	50
			MIN	16.9	4.3	23	4.1	54.7	38
66	48.00	4	AV4	18.6	4.5	26	4.4	55.7	40
			STD	0.8	0.2	1	0.1	0.8	5
			MAX	19.7	4.8	27	4.5	56.6	47
			MIN	17.8	4.3	24	4.2	54.7	33
70	49.00	4	AV4	18.3	4.4	25	4.3	56.2	35
			STD	0.6	0.1	1	0.1	0.6	6
			MAX	19.4	4.6	27	4.5	56.6	43
			MIN	17.8	4.3	23	4.2	55.1	29
74	50.00	4	AV4	18.2	4.4	24	4.3	56.3	36
			STD	1.0	0.2	2	0.2	1.1	3
			MAX	19.8	4.7	27	4.6	57.5	39
			MIN	17.3	4.2	23	4.1	54.6	31
77	51.00	3	AV3	18.2	4.3	26	4.3	56.1	19
			STD	0.1	0.1	0	0.0	0.2	2
			MAX	18.3	4.4	26	4.3	56.3	21
			MIN	18.0	4.2	26	4.3	55.9	16
81	52.00	4	AV4	18.0	4.3	23	4.3	56.3	22
			STD	0.6	0.2	1	0.1	0.8	7
			MAX	19.0	4.5	25	4.5	56.9	29
			MIN	17.3	4.1	22	4.2	55.0	11
84	53.00	3	AV3	17.1	4.1	24	4.1	57.3	9
			STD	0.9	0.1	2	0.2	1.0	7
			MAX	18.2	4.2	26	4.3	58.5	16
			MIN	16.0	4.0	21	3.9	56.1	0
87	54.00	3	AV3	17.2	4.2	25	4.2	57.0	0
			STD	0.9	0.1	1	0.1	0.9	0
			MAX	18.3	4.3	26	4.3	58.1	0
			MIN	16.2	4.1	24	4.0	56.0	0
90	55.00	3	AV3	17.2	4.1	24	4.2	57.0	0
			STD	0.6	0.1	1	0.1	0.7	0
			MAX	18.1	4.3	25	4.3	57.8	0
			MIN	16.6	4.0	24	4.0	56.1	0
93	56.00	3	AV3	17.2	4.2	24	4.1	57.2	2
			STD	0.6	0.1	1	0.1	0.6	2
			MAX	18.0	4.5	25	4.3	57.8	5
			MIN	16.6	4.1	24	4.0	56.4	0
97	57.00	4	AV4	17.5	4.4	22	4.2	56.7	13
			STD	0.3	0.1	0	0.1	0.4	3
			MAX	17.9	4.5	22	4.3	57.1	16
			MIN	17.2	4.3	22	4.1	56.1	8
100	58.00	3	AV3	18.8	4.7	27	4.4	55.3	15
			STD	0.2	0.0	0	0.0	0.3	17
			MAX	19.0	4.8	27	4.5	55.7	39
			MIN	18.6	4.7	26	4.4	55.1	0
102	59.00	2	AV2	18.6	4.9	29	4.4	55.5	3
			STD	0.4	0.0	1	0.1	0.6	3
			MAX	18.9	4.9	30	4.5	56.1	6
			MIN	18.2	4.8	28	4.3	55.0	0

USH 10 - B-70-403 - Pier 3 #44 - EOID
OP: AZ
APE D30-42, HP 14 x 73
Test date: 9-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
105	60.00	3	AV3	18.1	4.7	26	4.3	56.0	4
			STD	0.5	0.1	0	0.1	0.7	5
			MAX	18.8	4.8	26	4.5	56.6	11
			MIN	17.6	4.5	26	4.2	55.0	0
109	61.00	4	AV4	17.7	4.5	23	4.3	56.2	11
			STD	1.1	0.1	1	0.2	1.1	8
			MAX	19.2	4.7	24	4.5	57.9	22
			MIN	16.1	4.3	21	4.0	54.7	0
111	62.00	2	AV2	16.4	3.9	25	4.1	57.7	0
			STD	0.4	0.0	1	0.1	0.6	0
			MAX	16.7	4.0	26	4.1	58.3	0
			MIN	16.0	3.9	24	4.0	57.1	0
114	63.00	3	AV3	12.0	3.5	17	3.5	62.1	0
			STD	1.8	0.2	2	0.2	1.8	0
			MAX	14.6	3.8	20	3.8	63.7	0
			MIN	10.6	3.2	15	3.3	59.5	0
117	64.00	3	AV3	15.5	4.2	22	4.0	58.3	0
			STD	2.0	0.4	3	0.3	2.3	0
			MAX	18.1	4.6	26	4.4	60.7	0
			MIN	13.2	3.6	19	3.6	55.3	0
119	65.00	2	AV2	12.0	3.4	18	3.5	61.8	0
			STD	0.9	0.0	1	0.0	0.4	0
			MAX	12.9	3.5	18	3.5	62.2	0
			MIN	11.2	3.4	17	3.4	61.5	0
121	66.00	2	AV1	10.9	3.2	16	3.4	62.3	0
			MAX	10.9	3.2	16	3.4	62.3	0
			MIN	10.9	3.2	16	3.4	62.3	0
130	68.00	5	AV1	22.0	8.7	24	5.0	52.5	183
			MAX	22.0	8.7	24	5.0	52.5	183
			MIN	22.0	8.7	24	5.0	52.5	183
143	69.00	13	AV13	25.8	11.9	29	6.0	47.9	262
			STD	1.3	3.1	2	0.4	1.4	68
			MAX	28.2	18.1	33	6.7	49.6	402
			MIN	24.3	8.8	26	5.6	45.4	198
164	70.00	21	AV21	28.1	19.0	32	6.7	45.4	425
			STD	0.5	1.2	1	0.1	0.5	22
			MAX	29.0	21.4	34	7.0	46.7	477
			MIN	27.0	16.4	29	6.3	44.6	375
189	71.00	25	AV25	27.6	18.4	30	6.5	46.0	428
			STD	0.7	1.7	2	0.2	0.7	27
			MAX	29.5	22.5	34	7.1	46.9	492
			MIN	26.8	16.8	28	6.3	44.2	400
226	72.00	37	AV37	28.8	24.5	32	6.9	44.7	539
			STD	0.5	1.1	1	0.2	0.5	22
			MAX	30.1	26.7	35	7.3	45.6	577
			MIN	27.9	22.2	30	6.7	43.6	490
255	72.60	48	AV29	29.5	27.5	33	7.1	44.2	588
			STD	0.6	1.3	1	0.2	0.5	21
			MAX	30.8	29.7	36	7.5	45.4	630
			MIN	28.3	25.6	31	6.7	43.0	561
			Average	22.9	13.3	28	5.5	51.0	261
			Std. Dev.	5.9	9.5	5	1.4	6.3	241
			Maximum	30.8	29.7	36	7.5	64.1	630
			Minimum	10.3	2.7	14	3.2	43.0	0

Total number of blows analyzed: 240

BL#	depth (ft)	Comments
7	32.33	Reference Elevations EL 740.16

Time Summary

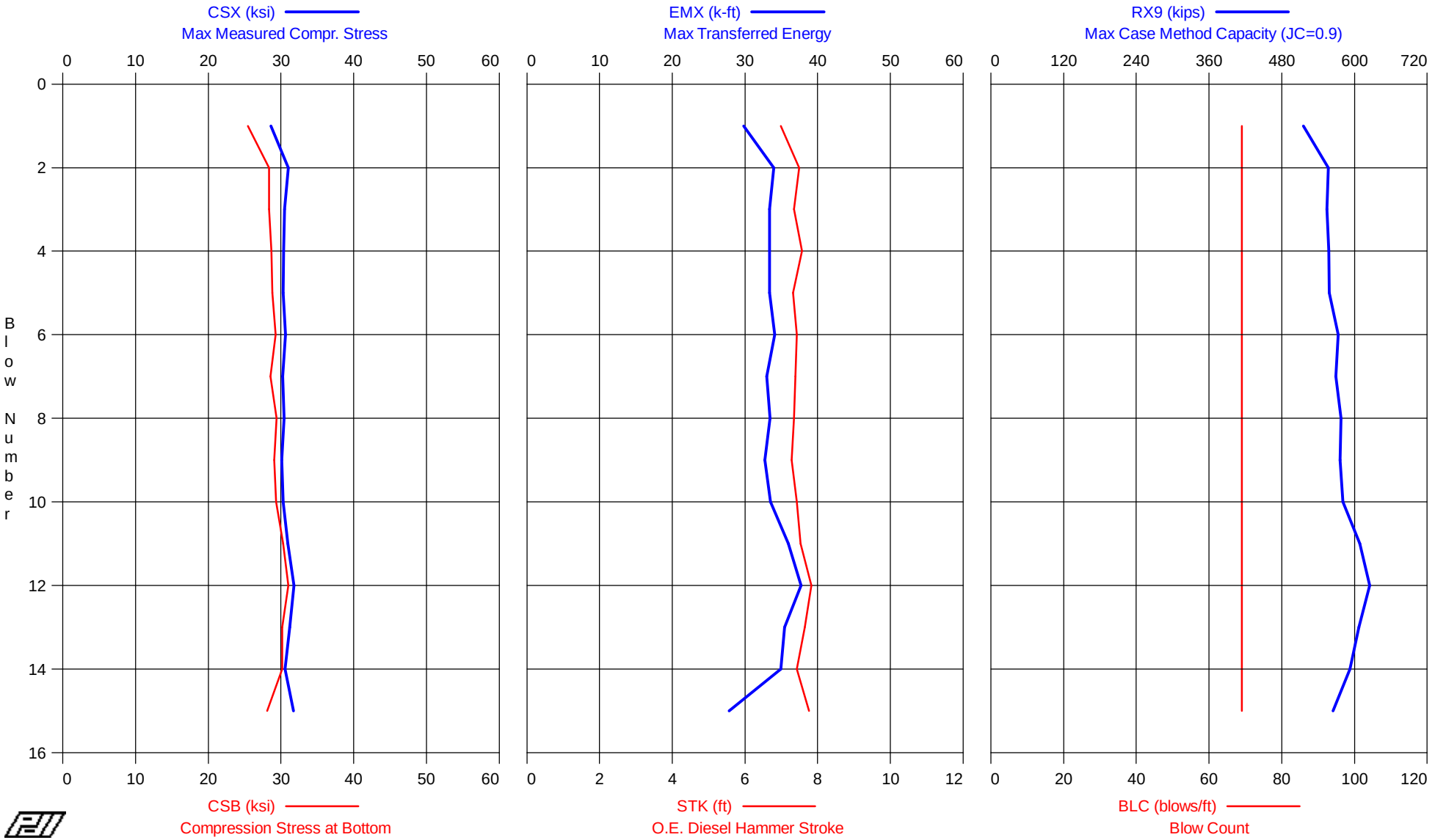
Drive 5 minutes 36 seconds 10:42:26 AM - 10:48:02 AM (12/9/2014) BN 1 - 256

GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 10-Dec-2014

Test date: 10-Dec-2014

USH 10 - B-70-403 - Pier 3 #44 - BOR
APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 3 #44 - BOR
OP: AZ

APE D30-42, HP 14 x 73
Test date: 10-Dec-2014

AR: 21.40 in^2
LE: 77.50 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
EMX: Max Transferred Energy

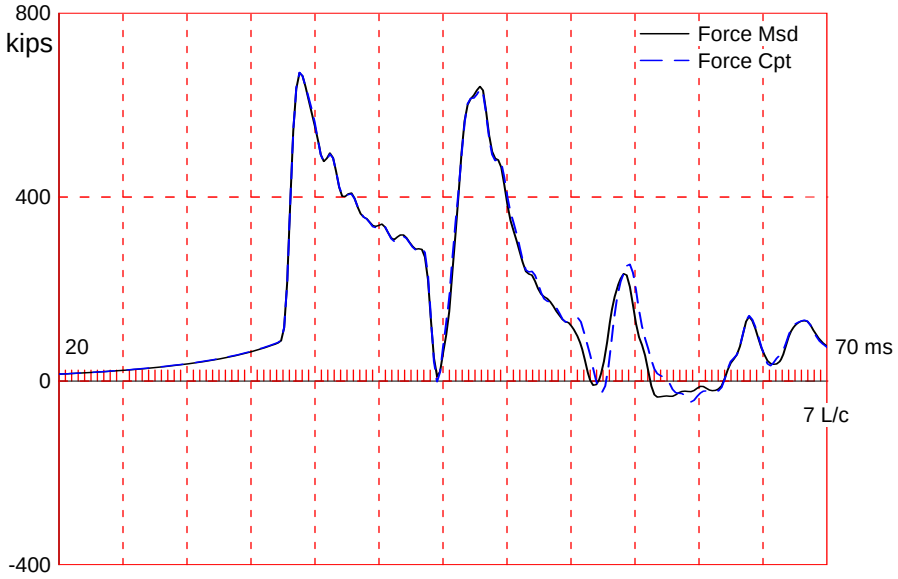
STK: O.E. Diesel Hammer Stroke
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

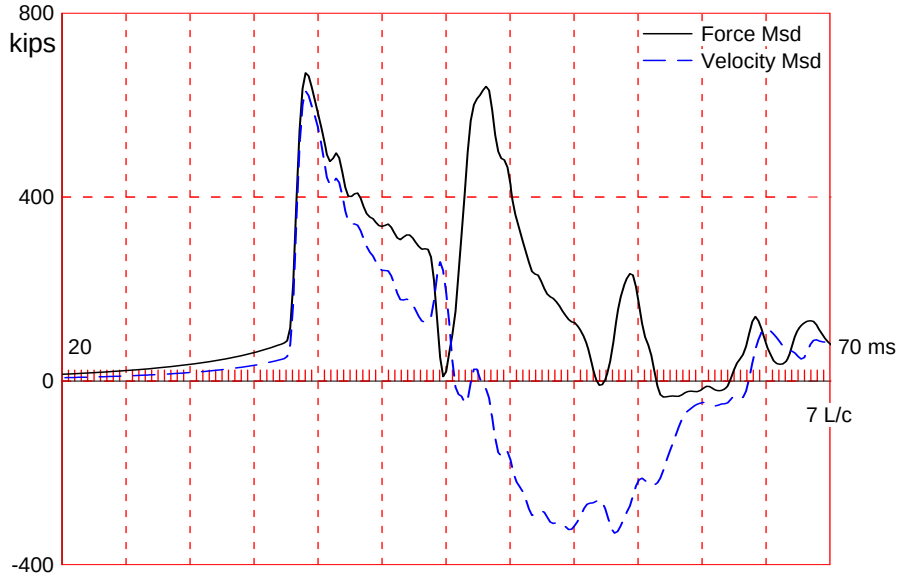
BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
5	72.70	69	AV5	30.1	27.9	33	7.3	43.5	549
			STD	0.8	1.2	1	0.2	0.6	16
			MAX	31.0	28.8	34	7.6	44.6	558
			MIN	28.6	25.5	30	7.0	42.9	516
10	72.78	69	AV5	30.3	29.1	33	7.4	43.4	575
			STD	0.2	0.3	0	0.1	0.2	4
			MAX	30.6	29.4	34	7.4	43.7	581
			MIN	30.1	28.5	33	7.3	43.3	569
15	72.85	69	AV5	31.2	29.9	34	7.6	42.7	600
			STD	0.5	1.0	3	0.1	0.4	20
			MAX	31.8	31.0	38	7.8	43.3	625
			MIN	30.5	28.1	28	7.4	42.2	564
			Average	30.6	29.0	33	7.4	43.2	575
			Std. Dev.	0.7	1.2	2	0.2	0.6	26
			Maximum	31.8	31.0	38	7.8	44.6	625
			Minimum	28.6	25.5	28	7.0	42.2	516

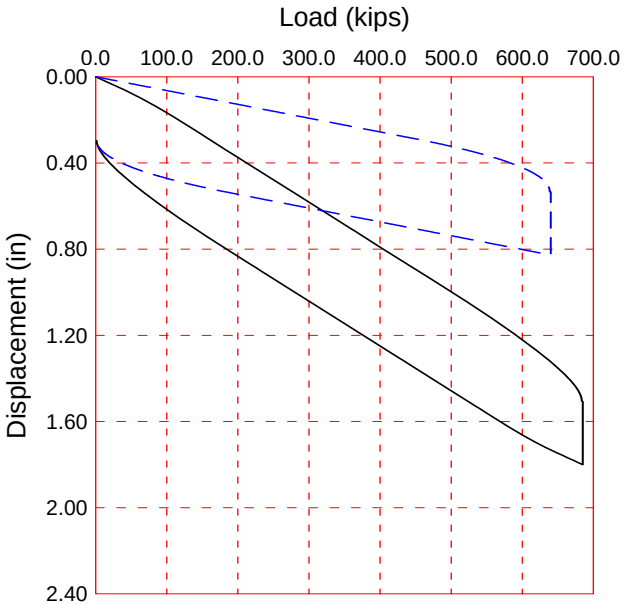
Total number of blows analyzed: 15

Time Summary

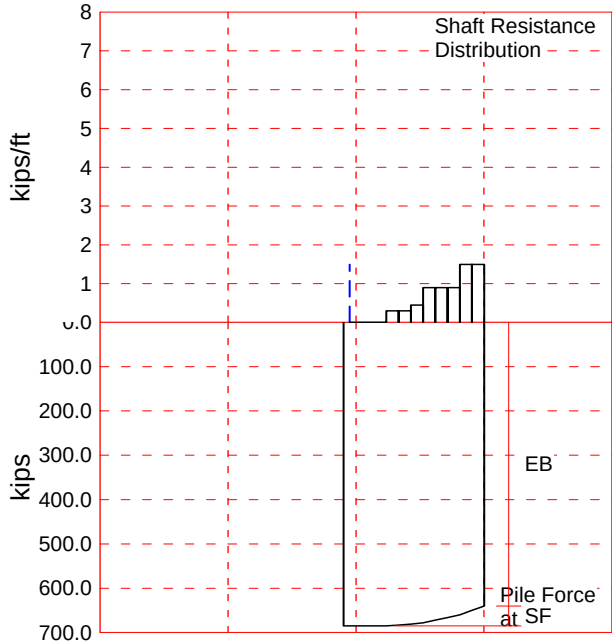
Drive 19 seconds 7:58:45 AM - 7:59:04 AM (12/10/2014) BN 1 - 15







RU =	685.0 kips
SF =	45.0 kips
EB =	640.0 kips
Dy =	1.51 in
Dx =	1.80 in
SET/Bl =	0.29 in



Length b. Sensors	77.0 ft
Embedment	71.4 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	3.56
Top Compr. Stress	31.4 ksi
Max Compr. Stress	32.3 ksi
Max Tension Stress	-6.27 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.41 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.03 s/ft

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About the CAPWAP Results

The CAPWAP program performs a signal matching or reverse analysis based on measurements taken on a deep foundation under an impact load. The program is based on a one-dimensional mathematical model. Under certain conditions, the model only crudely approximates the often complex dynamic situations.

The CAPWAP analysis relies on the input of accurately measured dynamic data plus additional parameters describing pile and soil behavior. If the field measurements of force and velocity are incorrect or were taken under inappropriate conditions (e.g., at an inappropriate time or with too much or too little energy) or if the input pile model is incorrect, then the solution cannot represent the actual soil behavior.

Generally the CAPWAP analysis is used to estimate the axial compressive pile capacity and the soil resistance distribution. The long-term capacity is best evaluated with restrike tests since they incorporate soil strength changes (set-up gains or relaxation losses) that occur after installation. The calculated load settlement graph does not consider creep or long term consolidation settlements. When uplift is a controlling factor in the design, use of the CAPWAP results to assess uplift capacity should be made only after very careful analysis of only good measurement quality, and further used only with longer pile lengths and with nominally higher safety factors.

CAPWAP is also used to evaluate driving stresses along the length of the pile. However, it should be understood that the analysis is one dimensional and does not take into account bending effects or local contact stresses at the pile toe.

Furthermore, if the user of this software was not able to produce a solution with satisfactory signal “match quality” (MQ), then the associated CAPWAP results may be unreliable. There is no absolute scale for solution acceptability but solutions with MQ above 5 are generally considered less reliable than those with lower MQ values and every effort should be made to improve the analysis, for example, by getting help from other independent experts.

Considering the CAPWAP model limitations, the nature of the input parameters, the complexity of the analysis procedure, and the need for a responsible application of the results to actual construction projects, it is recommended that at least one static load test be performed on sites where little experience exists with dynamic behavior of the soil resistance or when the experience of the analyzing engineer with both program use and result application is limited.

Finally, the CAPWAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of structure and other factors. The CAPWAP results should be reviewed by the Engineer of Record with consideration of applicable geotechnical conditions including, but not limited to, group effects, potential settlement from underlying compressible layers, soil resistances provided from any layers unsuitable for long term support, as well as effective stress changes due to soil surcharges, excavation or change in water table elevation.

The CAPWAP analysis software is one of many means by which the capacity of a deep foundation can be assessed. The engineer performing the analysis is responsible for proper software application and the analysis results. Pile Dynamics accepts no liability whatsoever of any kind for the analysis solution and/or the application of the analysis result.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 685.0; along Shaft 45.0; at Toe 640.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				685.0				
1	10.0	4.5	0.0	685.0	0.0	0.00	0.00	0.00
2	16.7	11.1	0.0	685.0	0.0	0.00	0.00	0.00
3	23.4	17.8	0.0	685.0	0.0	0.00	0.00	0.00
4	30.1	24.5	2.0	683.0	2.0	0.30	0.06	0.25
5	36.8	31.2	2.0	681.0	4.0	0.30	0.06	0.25
6	43.5	37.9	3.0	678.0	7.0	0.45	0.10	0.25
7	50.2	44.6	6.0	672.0	13.0	0.90	0.19	0.25
8	56.9	51.3	6.0	666.0	19.0	0.90	0.19	0.25
9	63.6	58.0	6.0	660.0	25.0	0.90	0.19	0.25
10	70.3	64.7	10.0	650.0	35.0	1.49	0.32	0.25
11	77.0	71.4	10.0	640.0	45.0	1.49	0.32	0.25
Avg. Shaft			4.1			0.63	0.13	0.25
Toe			640.0				464.28	0.03

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.04	0.41
Case Damping Factor		0.29	0.50
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	63	30
Reloading Level	(% of Ru)	100	100
Soil Plug Weight	(kips)		0.000

CAPWAP match quality = 3.56 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.29 in; Blow Count = 41 b/ft
Computed: Final Set = 0.03 in; Blow Count = 374 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(F590) CAL: 95.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.06; A4(K2253) CAL: 325; RF: 1.06

max. Top Comp. Stress = 31.4 ksi (T= 36.1 ms, max= 1.028 x Top)
max. Comp. Stress = 32.3 ksi (Z= 77.0 ft, T= 42.6 ms)
max. Tens. Stress = -6.27 ksi (Z= 50.2 ft, T= 58.4 ms)
max. Energy (EMX) = 36.8 kip-ft; max. Measured Top Displ. (DMX)= 1.13 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	672.3	-49.3	31.4	-2.30	36.8	16.5	1.12
2	6.7	672.8	-63.0	31.4	-2.94	36.7	16.4	1.10
4	13.4	674.1	-98.9	31.5	-4.62	36.2	16.4	1.06
5	16.7	674.7	-114.3	31.5	-5.34	35.7	16.3	1.04
6	20.1	675.4	-129.2	31.6	-6.04	35.3	16.3	1.01
7	23.4	676.8	-122.8	31.6	-5.74	34.8	16.2	0.99
8	26.8	679.7	-111.6	31.8	-5.21	34.3	16.1	0.96
9	30.1	682.1	-107.0	31.9	-5.00	33.7	16.1	0.93
10	33.5	674.8	-103.7	31.5	-4.84	32.5	16.0	0.90
11	36.8	677.5	-101.4	31.6	-4.74	31.9	15.9	0.87
12	40.2	671.6	-103.1	31.4	-4.81	30.7	15.7	0.83
13	43.5	676.2	-115.0	31.6	-5.37	29.9	15.6	0.80
14	46.9	668.2	-129.1	31.2	-6.03	28.4	15.4	0.76
15	50.2	674.5	-134.2	31.5	-6.27	27.5	15.3	0.73
16	53.6	652.7	-118.6	30.5	-5.54	25.4	15.1	0.69
17	56.9	659.0	-115.7	30.8	-5.41	24.5	15.5	0.66
18	60.3	637.7	-123.9	29.8	-5.79	22.3	15.4	0.62
19	63.6	646.4	-123.4	30.2	-5.77	21.3	16.7	0.58
20	67.0	642.0	-95.0	30.0	-4.44	19.2	18.3	0.54
21	70.3	665.7	-76.1	31.1	-3.56	18.1	19.6	0.50
22	73.7	675.6	-43.4	31.6	-2.03	15.3	20.2	0.46
23	77.0	691.4	-21.9	32.3	-1.02	14.4	19.1	0.42
Absolute	77.0			32.3			(T =	42.6 ms)
	50.2				-6.27		(T =	58.4 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	590.3	518.1	445.8	373.6	301.4	229.1	156.9	84.7	12.4	0.0
RX	773.6	757.8	742.0	727.6	715.2	703.7	692.2	683.4	680.1	676.8
RU	590.3	518.1	445.8	373.6	301.4	229.1	156.9	84.7	12.4	0.0

RAU = 521.5 (kips); RA2 = 708.9 (kips)

Current CAPWAP Ru = 685.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 0.68

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
16.6	36.05	635.9	676.7	676.7	1.13	0.29	0.29	37.0	624.1	1561

PILE PROFILE AND PILE MODEL

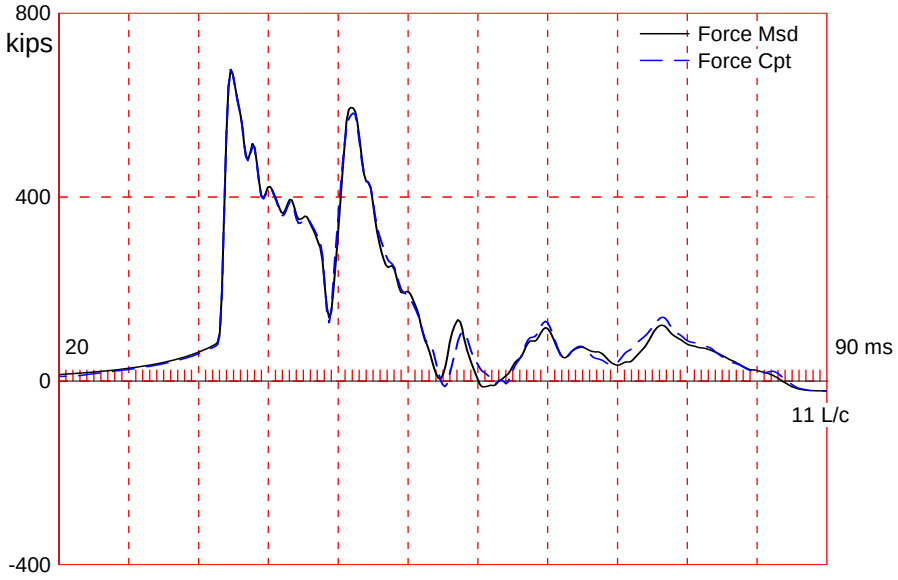
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.0	21.4	29992.2	492.000	4.70

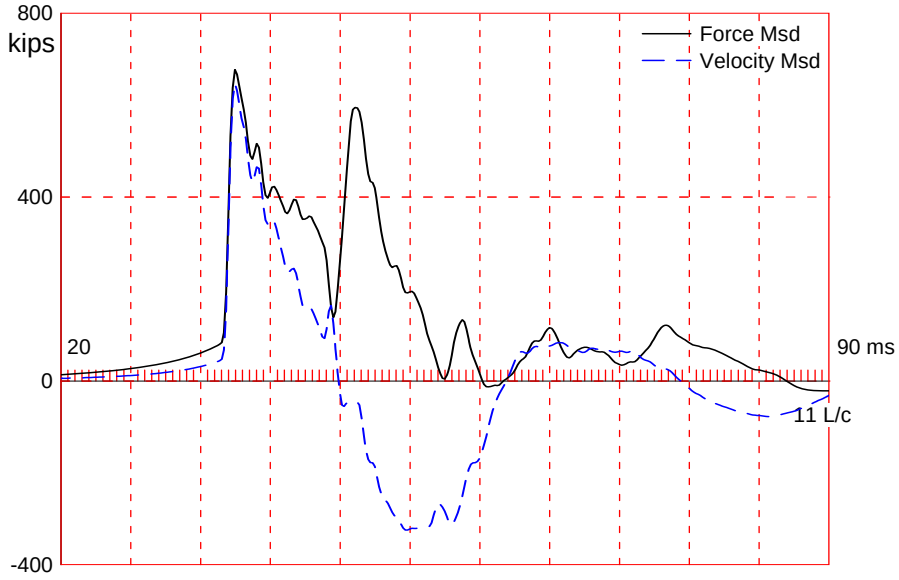
Toe Area 198.5 in^2

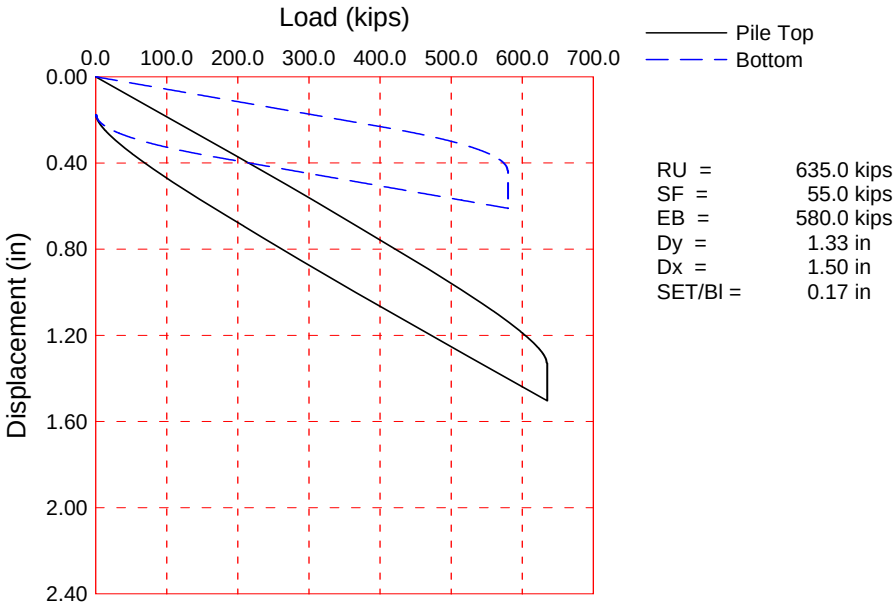
Top Segment Length 3.35 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 9.2 ms

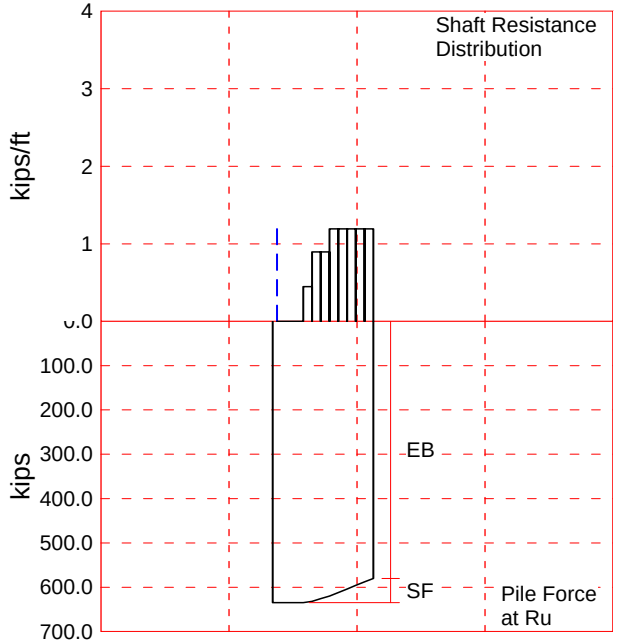
Total volume: 11.443 ft^3; Volume ratio considering added impedance: 1.000







RU =	635.0 kips
SF =	55.0 kips
EB =	580.0 kips
Dy =	1.33 in
Dx =	1.50 in
SET/Bl =	0.17 in



Length b. Sensors	77.0 ft
Embedment	71.4 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.86
Top Compr. Stress	31.7 ksi
Max Compr. Stress	32.5 ksi
Max Tension Stress	-6.45 ksi
Avg. Shaft Quake	0.30 in
Toe Quake	0.34 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.07 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 635.0; along Shaft 55.0; at Toe 580.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				635.0				
1	10.0	4.5	0.0	635.0	0.0	0.00	0.00	0.00
2	16.7	11.2	0.0	635.0	0.0	0.00	0.00	0.00
3	23.4	17.9	0.0	635.0	0.0	0.00	0.00	0.00
4	30.1	24.6	3.0	632.0	3.0	0.45	0.10	0.30
5	36.8	31.3	6.0	626.0	9.0	0.90	0.19	0.30
6	43.5	38.0	6.0	620.0	15.0	0.90	0.19	0.30
7	50.2	44.7	8.0	612.0	23.0	1.19	0.25	0.30
8	56.9	51.4	8.0	604.0	31.0	1.19	0.25	0.30
9	63.6	58.1	8.0	596.0	39.0	1.19	0.25	0.30
10	70.3	64.8	8.0	588.0	47.0	1.19	0.25	0.30
11	77.0	71.4	8.0	580.0	55.0	1.19	0.25	0.30
Avg. Shaft			5.0			0.77	0.16	0.30
Toe			580.0				420.75	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.30	0.34
Case Damping Factor		0.43	1.06
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	30	30
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)		0.005

CAPWAP match quality = 2.86 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.17 in; Blow Count = 69 b/ft
Computed: Final Set = 0.21 in; Blow Count = 58 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.15; A4(K2524) CAL: 360; RF: 1.15

max. Top Comp. Stress = 31.7 ksi (T= 36.1 ms, max= 1.026 x Top)
max. Comp. Stress = 32.5 ksi (Z= 77.0 ft, T= 42.6 ms)
max. Tens. Stress = -6.45 ksi (Z= 50.2 ft, T= 58.2 ms)
max. Energy (EMX) = 38.3 kip-ft; max. Measured Top Displ. (DMX)= 1.07 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	678.6	-31.9	31.7	-1.49	38.3	16.9	1.09
2	6.7	679.1	-35.3	31.7	-1.65	38.1	16.8	1.07
4	13.4	680.2	-64.8	31.8	-3.03	37.4	16.8	1.02
5	16.7	680.9	-78.5	31.8	-3.67	36.9	16.7	1.00
6	20.1	681.6	-95.2	31.8	-4.45	36.4	16.7	0.97
7	23.4	683.5	-100.6	31.9	-4.70	35.8	16.6	0.94
8	26.8	688.3	-99.2	32.2	-4.63	35.1	16.5	0.91
9	30.1	693.4	-93.2	32.4	-4.36	34.4	16.3	0.88
10	33.5	685.6	-92.3	32.0	-4.31	32.9	16.1	0.84
11	36.8	692.6	-113.9	32.4	-5.32	32.1	15.9	0.81
12	40.2	669.2	-113.0	31.3	-5.28	29.8	15.6	0.77
13	43.5	676.8	-125.7	31.6	-5.87	28.9	15.4	0.74
14	46.9	656.6	-135.3	30.7	-6.32	26.7	15.1	0.70
15	50.2	665.3	-138.1	31.1	-6.45	25.8	14.8	0.66
16	53.6	636.1	-119.8	29.7	-5.60	23.3	14.6	0.63
17	56.9	645.0	-113.4	30.1	-5.30	22.4	14.3	0.59
18	60.3	628.1	-89.7	29.3	-4.19	20.0	14.0	0.55
19	63.6	640.5	-79.7	29.9	-3.72	19.0	13.8	0.51
20	67.0	649.2	-59.9	30.3	-2.80	16.9	15.4	0.47
21	70.3	681.8	-52.0	31.9	-2.43	15.9	16.6	0.44
22	73.7	682.8	-27.9	31.9	-1.30	14.0	17.4	0.40
23	77.0	696.5	-18.4	32.5	-0.86	13.4	15.8	0.36
Absolute	77.0			32.5			(T =	42.6 ms)
	50.2				-6.45		(T =	58.2 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	725.2	603.3	481.4	359.5	237.7					
RX	815.7	779.9	744.2	708.4	674.2	646.2	627.8	612.6	598.0	584.7
RU	725.2	603.3	481.4	359.5	237.7					

RAU = 518.7 (kips); RA2 = 677.0 (kips)

Current CAPWAP Ru = 635.0 (kips); Corresponding J(RP)= 0.15; J(RX) = 1.12

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
17.0	35.85	650.8	683.8	683.8	1.07	0.17	0.17	38.5	740.2	1778

PILE PROFILE AND PILE MODEL

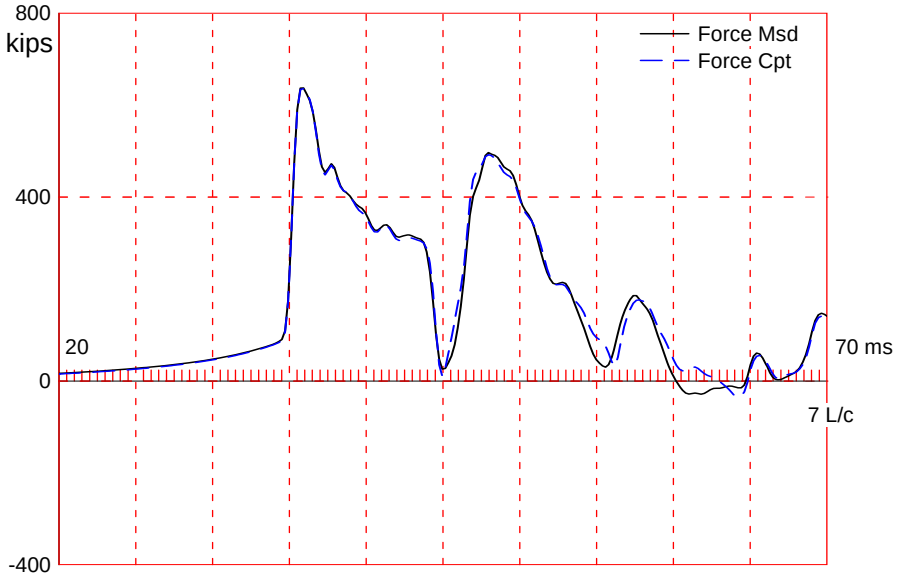
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.0	21.4	29992.2	492.000	4.70

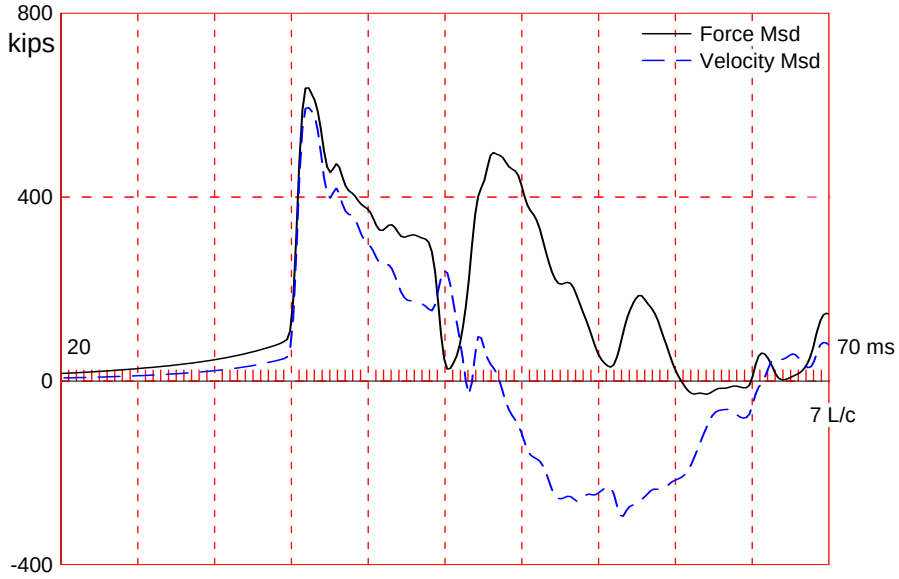
Toe Area 198.5 in^2

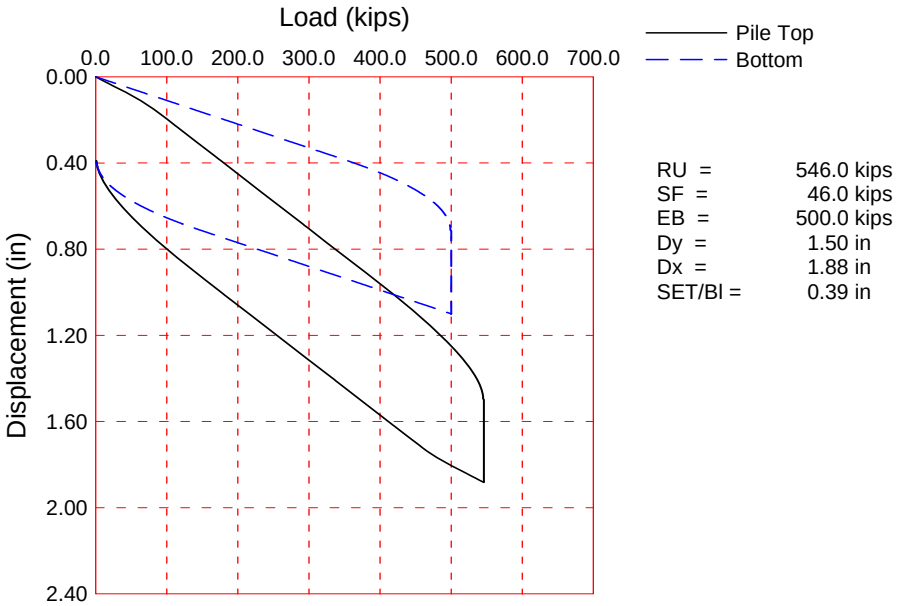
Top Segment Length 3.35 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 9.2 ms

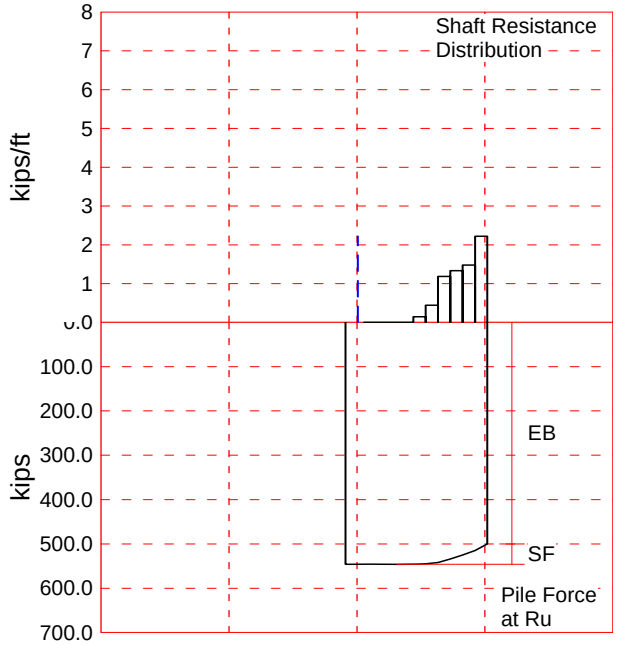
Total volume: 11.443 ft^3; Volume ratio considering added impedance: 1.000







RU =	546.0 kips
SF =	46.0 kips
EB =	500.0 kips
Dy =	1.50 in
Dx =	1.88 in
SET/Bl =	0.39 in



Length b. Sensors	77.6 ft
Embedment	70.6 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	4.59
Top Compr. Stress	29.7 ksi
Max Compr. Stress	31.1 ksi
Max Tension Stress	-5.80 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.55 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.05 s/ft

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About the CAPWAP Results

The CAPWAP program performs a signal matching or reverse analysis based on measurements taken on a deep foundation under an impact load. The program is based on a one-dimensional mathematical model. Under certain conditions, the model only crudely approximates the often complex dynamic situations.

The CAPWAP analysis relies on the input of accurately measured dynamic data plus additional parameters describing pile and soil behavior. If the field measurements of force and velocity are incorrect or were taken under inappropriate conditions (e.g., at an inappropriate time or with too much or too little energy) or if the input pile model is incorrect, then the solution cannot represent the actual soil behavior.

Generally the CAPWAP analysis is used to estimate the axial compressive pile capacity and the soil resistance distribution. The long-term capacity is best evaluated with restrike tests since they incorporate soil strength changes (set-up gains or relaxation losses) that occur after installation. The calculated load settlement graph does not consider creep or long term consolidation settlements. When uplift is a controlling factor in the design, use of the CAPWAP results to assess uplift capacity should be made only after very careful analysis of only good measurement quality, and further used only with longer pile lengths and with nominally higher safety factors.

CAPWAP is also used to evaluate driving stresses along the length of the pile. However, it should be understood that the analysis is one dimensional and does not take into account bending effects or local contact stresses at the pile toe.

Furthermore, if the user of this software was not able to produce a solution with satisfactory signal “match quality” (MQ), then the associated CAPWAP results may be unreliable. There is no absolute scale for solution acceptability but solutions with MQ above 5 are generally considered less reliable than those with lower MQ values and every effort should be made to improve the analysis, for example, by getting help from other independent experts.

Considering the CAPWAP model limitations, the nature of the input parameters, the complexity of the analysis procedure, and the need for a responsible application of the results to actual construction projects, it is recommended that at least one static load test be performed on sites where little experience exists with dynamic behavior of the soil resistance or when the experience of the analyzing engineer with both program use and result application is limited.

Finally, the CAPWAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of structure and other factors. The CAPWAP results should be reviewed by the Engineer of Record with consideration of applicable geotechnical conditions including, but not limited to, group effects, potential settlement from underlying compressible layers, soil resistances provided from any layers unsuitable for long term support, as well as effective stress changes due to soil surcharges, excavation or change in water table elevation.

The CAPWAP analysis software is one of many means by which the capacity of a deep foundation can be assessed. The engineer performing the analysis is responsible for proper software application and the analysis results. Pile Dynamics accepts no liability whatsoever of any kind for the analysis solution and/or the application of the analysis result.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 546.0; along Shaft 46.0; at Toe 500.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				546.0				
1	16.9	9.9	0.0	546.0	0.0	0.00	0.00	0.00
2	23.6	16.6	0.0	546.0	0.0	0.00	0.00	0.00
3	30.4	23.4	0.0	546.0	0.0	0.00	0.00	0.00
4	37.1	30.1	0.0	546.0	0.0	0.00	0.00	0.00
5	43.8	36.8	1.0	545.0	1.0	0.15	0.03	0.27
6	50.6	43.6	3.0	542.0	4.0	0.44	0.09	0.27
7	57.3	50.3	8.0	534.0	12.0	1.19	0.25	0.27
8	64.1	57.1	9.0	525.0	21.0	1.33	0.28	0.27
9	70.8	63.8	10.0	515.0	31.0	1.48	0.32	0.27
10	77.6	70.6	15.0	500.0	46.0	2.22	0.47	0.27
Avg. Shaft			4.6			0.65	0.14	0.27
Toe			500.0				362.72	0.05

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.04	0.55
Case Damping Factor		0.33	0.65
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	46	30
Reloading Level	(% of Ru)	100	100
Soil Plug Weight	(kips)	0.050	0.013

CAPWAP match quality = 4.59 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.39 in; Blow Count = 31 b/ft
Computed: Final Set = 0.04 in; Blow Count = 268 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(F590) CAL: 95.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.16; A4(K2253) CAL: 325; RF: 1.16

max. Top Comp. Stress = 29.7 ksi (T= 36.3 ms, max= 1.047 x Top)
max. Comp. Stress = 31.1 ksi (Z= 50.6 ft, T= 39.1 ms)
max. Tens. Stress = -5.80 ksi (Z= 50.6 ft, T= 64.0 ms)
max. Energy (EMX) = 35.8 kip-ft; max. Measured Top Displ. (DMX)= 1.18 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	636.6	-31.0	29.7	-1.45	35.8	15.6	1.15
2	6.7	637.4	-27.4	29.8	-1.28	35.6	15.6	1.14
4	13.5	639.2	-51.9	29.9	-2.42	35.2	15.5	1.11
5	16.9	640.2	-61.3	29.9	-2.87	35.0	15.5	1.09
6	20.2	641.1	-73.3	30.0	-3.42	34.6	15.5	1.07
7	23.6	642.0	-84.0	30.0	-3.92	34.2	15.4	1.04
8	27.0	643.0	-92.8	30.0	-4.34	33.8	15.4	1.02
9	30.4	644.1	-95.6	30.1	-4.47	33.3	15.4	0.99
10	33.7	645.1	-91.9	30.1	-4.29	32.8	15.4	0.96
11	37.1	646.7	-89.0	30.2	-4.16	32.2	15.3	0.93
12	40.5	650.2	-88.0	30.4	-4.11	31.6	15.2	0.90
13	43.8	658.6	-105.1	30.8	-4.91	31.0	15.0	0.87
14	47.2	660.7	-116.0	30.9	-5.42	30.1	14.8	0.84
15	50.6	666.3	-124.3	31.1	-5.80	29.5	14.7	0.81
16	54.0	659.8	-123.7	30.8	-5.78	28.1	14.4	0.78
17	57.3	665.7	-123.0	31.1	-5.75	27.5	14.6	0.75
18	60.7	630.9	-108.3	29.5	-5.06	25.0	14.7	0.71
19	64.1	634.2	-101.8	29.6	-4.76	24.3	15.0	0.68
20	67.5	595.9	-77.7	27.8	-3.63	21.7	17.3	0.65
21	70.8	558.6	-65.5	26.1	-3.06	21.0	18.9	0.62
22	74.2	544.1	-37.5	25.4	-1.75	18.4	19.4	0.58
23	77.6	556.7	-29.3	26.0	-1.37	16.1	18.9	0.55
Absolute	50.6			31.1			(T =	39.1 ms)
	50.6				-5.80		(T =	64.0 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	515.0	368.3	221.6	74.9	0.0					
RX	620.7	590.7	573.3	560.4	551.9	544.4	538.3	533.2	528.6	524.4
RU	515.0	368.3	221.6	74.9	0.0					

RAU = 462.9 (kips); RA2 = 601.7 (kips)

Current CAPWAP Ru = 546.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 0.96

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
15.7	36.12	600.6	647.8	647.8	1.18	0.39	0.39	36.9	565.2	909

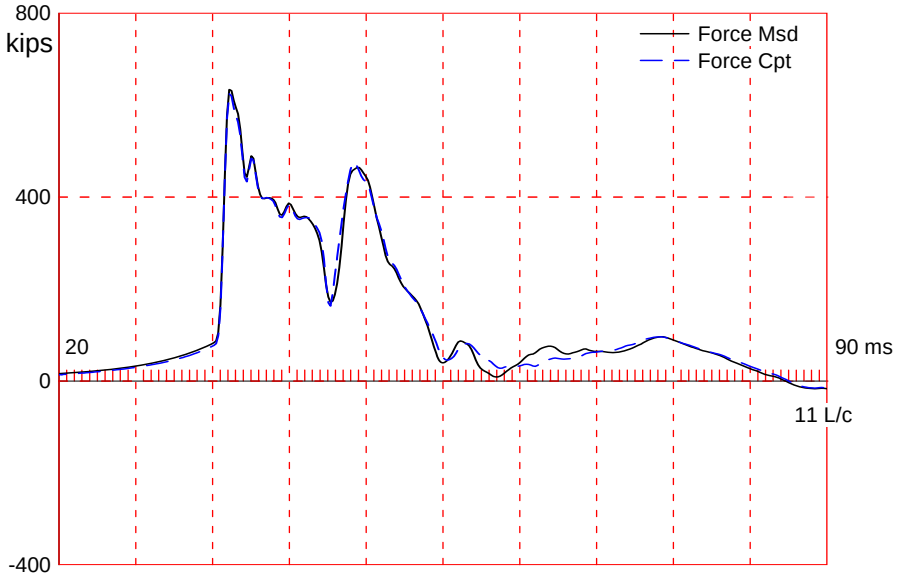
PILE PROFILE AND PILE MODEL

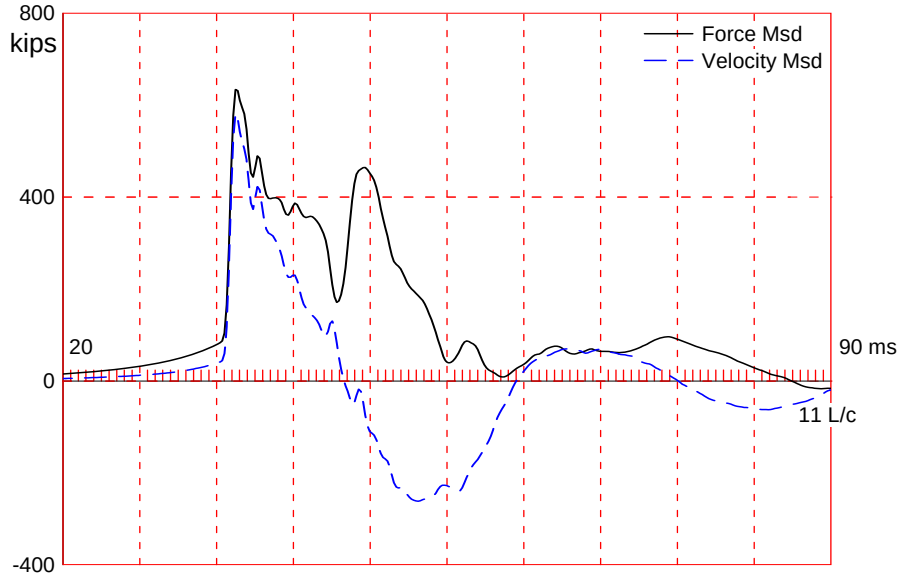
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.6	21.4	29992.2	492.000	4.70

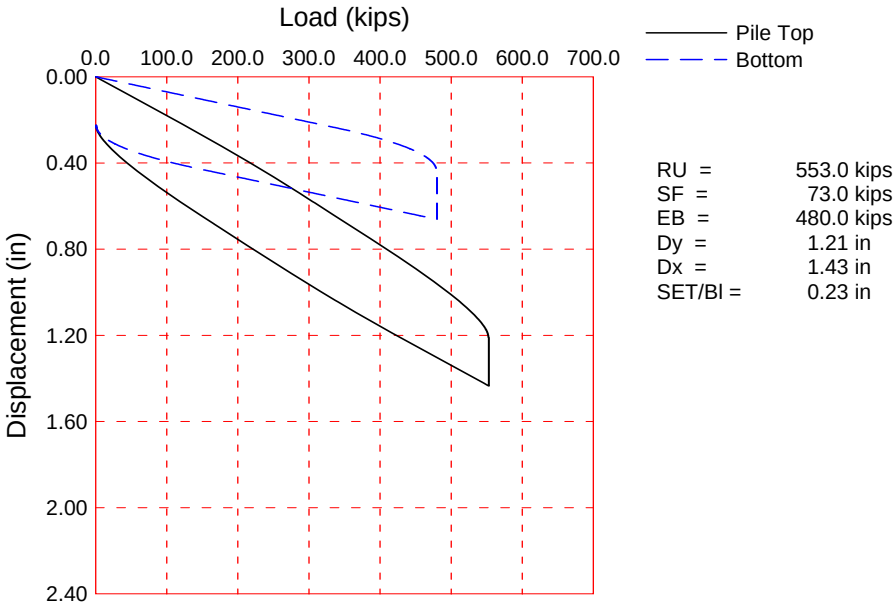
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
15	50.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
20	67.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	77.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

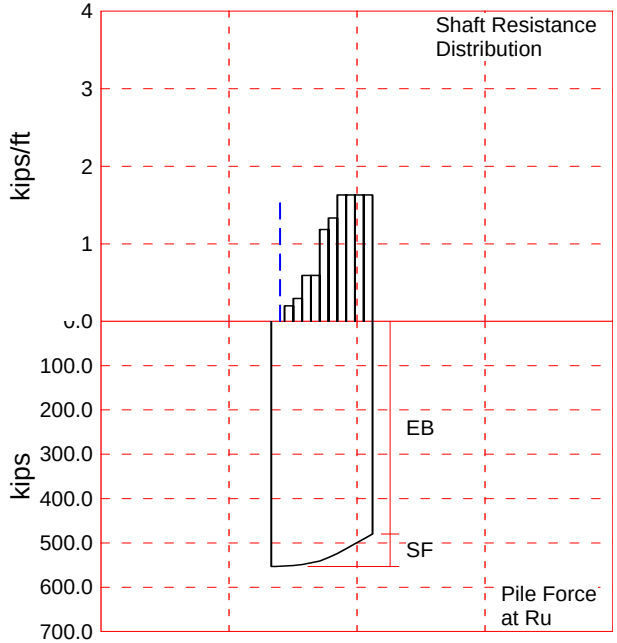
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 9.2 ms
Total volume: 11.529 ft^3; Volume ratio considering added impedance: 1.000







RU =	553.0 kips
SF =	73.0 kips
EB =	480.0 kips
Dy =	1.21 in
Dx =	1.43 in
SET/Bl =	0.23 in



Length b. Sensors	77.6 ft
Embedment	70.7 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.88
Top Compr. Stress	29.3 ksi
Max Compr. Stress	29.6 ksi
Max Tension Stress	-3.57 ksi
Avg. Shaft Quake	0.20 in
Toe Quake	0.34 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.08 s/ft

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Generally the CAPWAP analysis is used to estimate the axial compressive pile capacity and the soil resistance distribution. The long-term capacity is best evaluated with restrike tests since they incorporate soil strength changes (set-up gains or relaxation losses) that occur after installation. The calculated load settlement graph does not consider creep or long term consolidation settlements. When uplift is a controlling factor in the design, use of the CAPWAP results to assess uplift capacity should be made only after very careful analysis of only good measurement quality, and further used only with longer pile lengths and with nominally higher safety factors.

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Furthermore, if the user of this software was not able to produce a solution with satisfactory signal “match quality” (MQ), then the associated CAPWAP results may be unreliable. There is no absolute scale for solution acceptability but solutions with MQ above 5 are generally considered less reliable than those with lower MQ values and every effort should be made to improve the analysis, for example, by getting help from other independent experts.

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 553.0; along Shaft 73.0; at Toe 480.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				553.0			
1	16.9	9.9	2.0	551.0	2.0	0.20	0.04
2	23.6	16.7	2.0	549.0	4.0	0.30	0.06
3	30.4	23.4	4.0	545.0	8.0	0.59	0.13
4	37.1	30.2	4.0	541.0	12.0	0.59	0.13
5	43.8	36.9	8.0	533.0	20.0	1.19	0.25
6	50.6	43.7	9.0	524.0	29.0	1.33	0.28
7	57.3	50.4	11.0	513.0	40.0	1.63	0.35
8	64.1	57.2	11.0	502.0	51.0	1.63	0.35
9	70.8	63.9	11.0	491.0	62.0	1.63	0.35
10	77.6	70.7	11.0	480.0	73.0	1.63	0.35
Avg. Shaft			7.3			1.03	0.22
Toe			480.0				348.21

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.08
Quake	(in)	0.20	0.34
Case Damping Factor		0.57	1.01
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	39	30
Unloading Level	(% of Ru)	48	
Soil Plug Weight	(kips)		0.022

CAPWAP match quality = 2.88 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.03 in; Blow Count = 363 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.12; A4(K2524) CAL: 360; RF: 1.12

max. Top Comp. Stress = 29.3 ksi (T= 35.9 ms, max= 1.011 x Top)
max. Comp. Stress = 29.6 ksi (Z= 16.9 ft, T= 36.7 ms)
max. Tens. Stress = -3.57 ksi (Z= 64.1 ft, T= 59.8 ms)
max. Energy (EMX) = 33.5 kip-ft; max. Measured Top Displ. (DMX)= 0.99 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	626.2	-24.0	29.3	-1.12	33.5	15.4	1.00
2	6.7	626.6	-25.7	29.3	-1.20	33.3	15.4	0.99
4	13.5	630.4	-29.0	29.5	-1.36	32.7	15.2	0.94
5	16.9	633.2	-30.7	29.6	-1.43	32.3	15.1	0.92
6	20.2	625.2	-31.2	29.2	-1.46	31.3	15.0	0.89
7	23.6	628.6	-40.4	29.4	-1.89	30.7	14.9	0.86
8	27.0	623.9	-47.1	29.1	-2.20	29.7	14.7	0.83
9	30.4	629.3	-54.7	29.4	-2.56	29.1	14.6	0.80
10	33.7	614.6	-58.8	28.7	-2.75	27.6	14.4	0.77
11	37.1	622.2	-66.3	29.1	-3.10	26.9	14.2	0.74
12	40.5	612.4	-69.8	28.6	-3.26	25.4	13.9	0.71
13	43.8	621.7	-72.0	29.0	-3.36	24.8	13.7	0.68
14	47.2	594.0	-66.6	27.8	-3.11	22.6	13.4	0.64
15	50.6	604.5	-66.5	28.2	-3.11	21.9	13.1	0.61
16	54.0	575.5	-62.6	26.9	-2.92	19.8	12.8	0.58
17	57.3	586.1	-71.0	27.4	-3.32	19.0	12.5	0.54
18	60.7	550.0	-69.8	25.7	-3.26	16.8	12.2	0.51
19	64.1	560.2	-76.4	26.2	-3.57	16.0	11.9	0.48
20	67.5	532.4	-69.3	24.9	-3.24	14.0	12.9	0.45
21	70.8	560.5	-70.2	26.2	-3.28	13.4	13.7	0.41
22	74.2	556.8	-61.0	26.0	-2.85	11.6	14.7	0.38
23	77.6	567.1	-61.4	26.5	-2.87	10.7	13.9	0.35
Absolute	16.9			29.6			(T =	36.7 ms)
	64.1				-3.57		(T =	59.8 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	662.9	547.4	432.0	316.5	201.1					
RX	701.4	655.7	610.4	594.3	578.8	563.6	548.4	533.2	517.9	502.7
RU	662.9	547.4	432.0	316.5	201.1					

RAU = 423.0 (kips); RA2 = 634.8 (kips)

Current CAPWAP Ru = 553.0 (kips); Corresponding J(RP)= 0.19; J(RX) = 1.14

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
15.5	35.72	592.5	647.5	647.5	0.99	0.23	0.23	33.9	669.0	1427

PILE PROFILE AND PILE MODEL

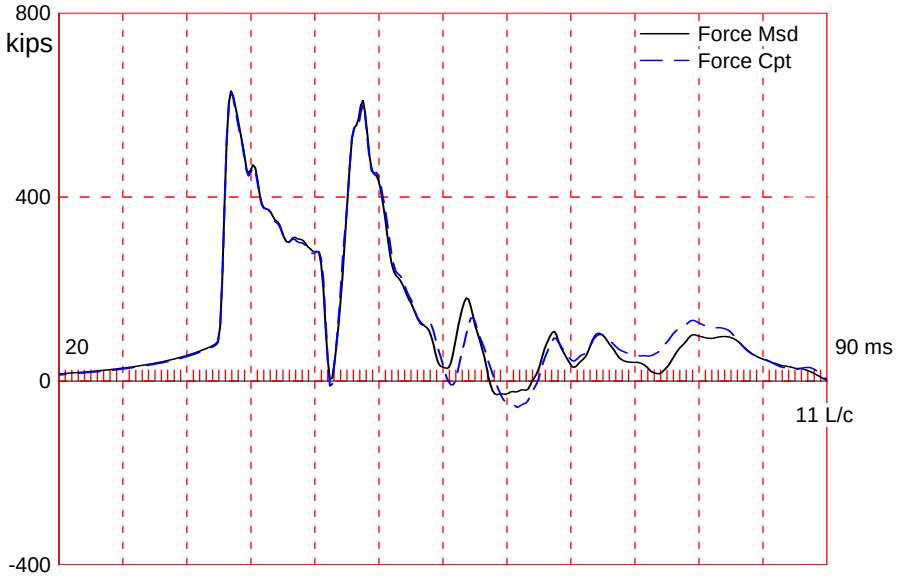
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.6	21.4	29992.2	492.000	4.70

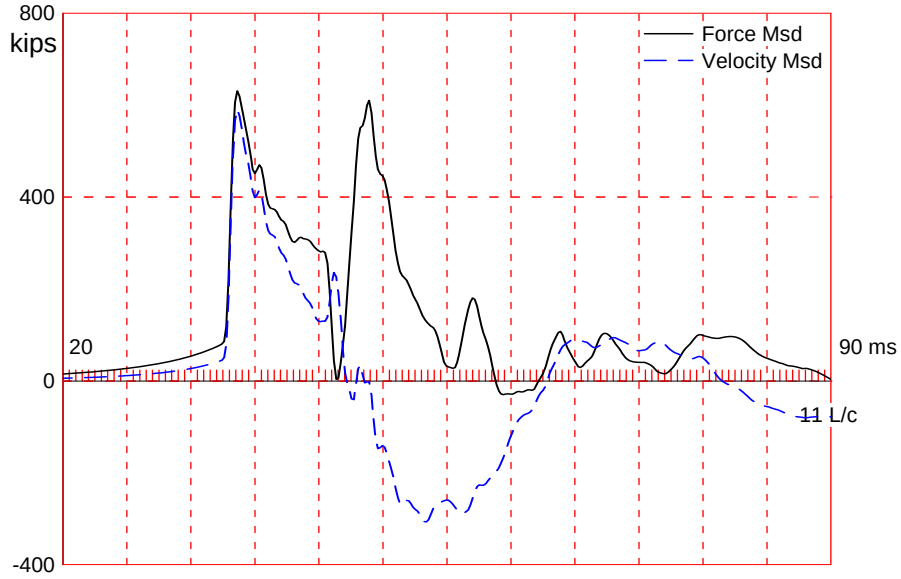
Toe Area 198.5 in^2

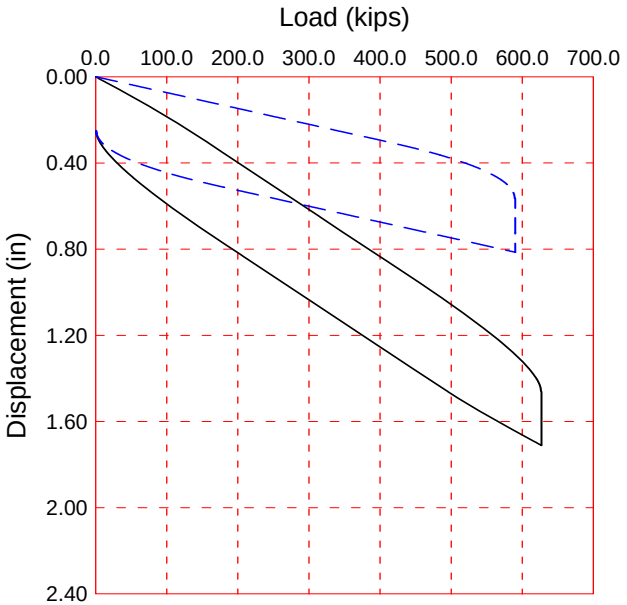
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 9.2 ms

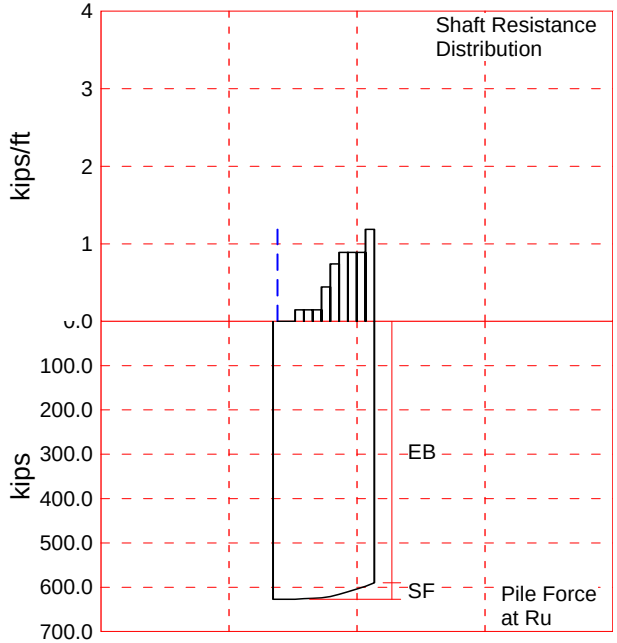
Total volume: 11.529 ft^3; Volume ratio considering added impedance: 1.000







RU =	627.0 kips
SF =	37.0 kips
EB =	590.0 kips
Dy =	1.46 in
Dx =	1.71 in
SET/Bl =	0.25 in



Length b. Sensors	77.5 ft
Embedment	72.6 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	4.59
Top Compr. Stress	29.4 ksi
Max Compr. Stress	29.7 ksi
Max Tension Stress	-5.60 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.43 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.03 s/ft

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About the CAPWAP Results

The CAPWAP program performs a signal matching or reverse analysis based on measurements taken on a deep foundation under an impact load. The program is based on a one-dimensional mathematical model. Under certain conditions, the model only crudely approximates the often complex dynamic situations.

The CAPWAP analysis relies on the input of accurately measured dynamic data plus additional parameters describing pile and soil behavior. If the field measurements of force and velocity are incorrect or were taken under inappropriate conditions (e.g., at an inappropriate time or with too much or too little energy) or if the input pile model is incorrect, then the solution cannot represent the actual soil behavior.

Generally the CAPWAP analysis is used to estimate the axial compressive pile capacity and the soil resistance distribution. The long-term capacity is best evaluated with restrike tests since they incorporate soil strength changes (set-up gains or relaxation losses) that occur after installation. The calculated load settlement graph does not consider creep or long term consolidation settlements. When uplift is a controlling factor in the design, use of the CAPWAP results to assess uplift capacity should be made only after very careful analysis of only good measurement quality, and further used only with longer pile lengths and with nominally higher safety factors.

CAPWAP is also used to evaluate driving stresses along the length of the pile. However, it should be understood that the analysis is one dimensional and does not take into account bending effects or local contact stresses at the pile toe.

Furthermore, if the user of this software was not able to produce a solution with satisfactory signal “match quality” (MQ), then the associated CAPWAP results may be unreliable. There is no absolute scale for solution acceptability but solutions with MQ above 5 are generally considered less reliable than those with lower MQ values and every effort should be made to improve the analysis, for example, by getting help from other independent experts.

Considering the CAPWAP model limitations, the nature of the input parameters, the complexity of the analysis procedure, and the need for a responsible application of the results to actual construction projects, it is recommended that at least one static load test be performed on sites where little experience exists with dynamic behavior of the soil resistance or when the experience of the analyzing engineer with both program use and result application is limited.

Finally, the CAPWAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of structure and other factors. The CAPWAP results should be reviewed by the Engineer of Record with consideration of applicable geotechnical conditions including, but not limited to, group effects, potential settlement from underlying compressible layers, soil resistances provided from any layers unsuitable for long term support, as well as effective stress changes due to soil surcharges, excavation or change in water table elevation.

The CAPWAP analysis software is one of many means by which the capacity of a deep foundation can be assessed. The engineer performing the analysis is responsible for proper software application and the analysis results. Pile Dynamics accepts no liability whatsoever of any kind for the analysis solution and/or the application of the analysis result.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 627.0; along Shaft 37.0; at Toe 590.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				627.0				
1	10.1	5.2	0.0	627.0	0.0	0.00	0.00	0.00
2	16.8	12.0	0.0	627.0	0.0	0.00	0.00	0.00
3	23.6	18.7	1.0	626.0	1.0	0.15	0.03	0.28
4	30.3	25.5	1.0	625.0	2.0	0.15	0.03	0.28
5	37.1	32.2	1.0	624.0	3.0	0.15	0.03	0.28
6	43.8	38.9	3.0	621.0	6.0	0.45	0.09	0.28
7	50.5	45.7	5.0	616.0	11.0	0.74	0.16	0.28
8	57.3	52.4	6.0	610.0	17.0	0.89	0.19	0.28
9	64.0	59.1	6.0	604.0	23.0	0.89	0.19	0.28
10	70.8	65.9	6.0	598.0	29.0	0.89	0.19	0.28
11	77.5	72.6	8.0	590.0	37.0	1.19	0.25	0.28
Avg. Shaft			3.4			0.51	0.11	0.28
Toe			590.0				428.01	0.03

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.08	0.43
Case Damping Factor		0.27	0.46
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	66	30
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	81	
Resistance Gap (included in Toe Quake)	(in)		0.00
Soil Plug Weight	(kips)		0.037

CAPWAP match quality = 4.59 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.25 in; Blow Count = 48 b/ft
Computed: Final Set = 0.04 in; Blow Count = 286 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.07; A4(K2524) CAL: 360; RF: 1.07

max. Top Comp. Stress = 29.4 ksi (T= 36.1 ms, max= 1.012 x Top)
max. Comp. Stress = 29.7 ksi (Z= 43.8 ft, T= 38.5 ms)
max. Tens. Stress = -5.60 ksi (Z= 50.5 ft, T= 58.9 ms)
max. Energy (EMX) = 32.8 kip-ft; max. Measured Top Displ. (DMX)= 1.07 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	628.6	-61.9	29.4	-2.89	32.8	15.5	1.09
2	6.7	629.2	-72.9	29.4	-3.40	32.7	15.5	1.07
4	13.5	630.5	-100.0	29.5	-4.67	32.3	15.4	1.04
5	16.8	631.6	-112.0	29.5	-5.23	32.0	15.4	1.02
6	20.2	633.4	-113.6	29.6	-5.31	31.6	15.3	0.99
7	23.6	635.1	-111.1	29.7	-5.19	31.1	15.3	0.97
8	27.0	631.8	-109.9	29.5	-5.13	30.4	15.2	0.94
9	30.3	633.5	-110.0	29.6	-5.14	29.9	15.1	0.91
10	33.7	630.3	-104.3	29.4	-4.87	29.1	15.1	0.88
11	37.1	632.9	-99.7	29.6	-4.66	28.5	15.0	0.85
12	40.4	632.0	-96.2	29.5	-4.50	27.6	14.8	0.82
13	43.8	636.4	-97.9	29.7	-4.57	27.0	14.7	0.79
14	47.2	627.3	-106.5	29.3	-4.98	25.6	14.5	0.76
15	50.5	632.8	-119.9	29.6	-5.60	24.9	14.4	0.73
16	53.9	615.1	-112.5	28.7	-5.26	23.1	14.2	0.70
17	57.3	620.9	-110.4	29.0	-5.16	22.4	14.9	0.66
18	60.7	598.9	-101.8	28.0	-4.76	20.4	14.9	0.63
19	64.0	604.6	-102.4	28.2	-4.78	19.5	15.3	0.59
20	67.4	586.6	-88.7	27.4	-4.14	17.5	16.7	0.55
21	70.8	600.4	-84.2	28.0	-3.93	16.5	18.0	0.52
22	74.1	617.9	-72.6	28.9	-3.39	14.6	19.1	0.48
23	77.5	632.4	-70.8	29.5	-3.31	14.4	18.4	0.46
Absolute	43.8			29.7			(T =	38.5 ms)
	50.5				-5.60		(T =	58.9 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	511.4	438.9	366.5	294.0	221.6	149.1	76.7	4.2	0.0	0.0
RX	706.8	689.2	674.2	660.9	647.9	639.5	635.3	631.8	628.3	624.7
RU	511.4	438.9	366.5	294.0	221.6	149.1	76.7	4.2	0.0	0.0

RAU = 541.9 (kips); RA2 = 661.9 (kips)

Current CAPWAP Ru = 627.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 0.84

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
15.6	35.89	597.6	638.2	638.2	1.07	0.25	0.25	33.0	601.0	1372

PILE PROFILE AND PILE MODEL

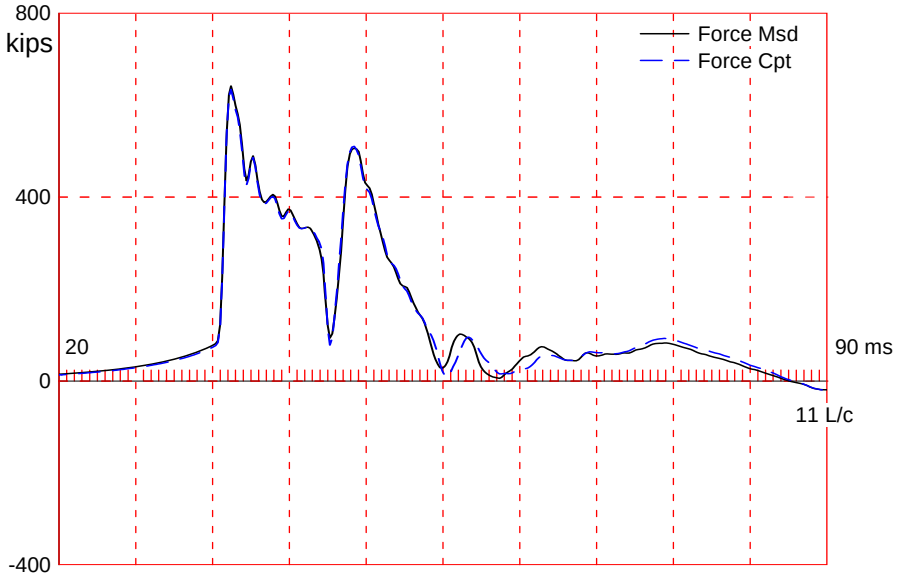
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

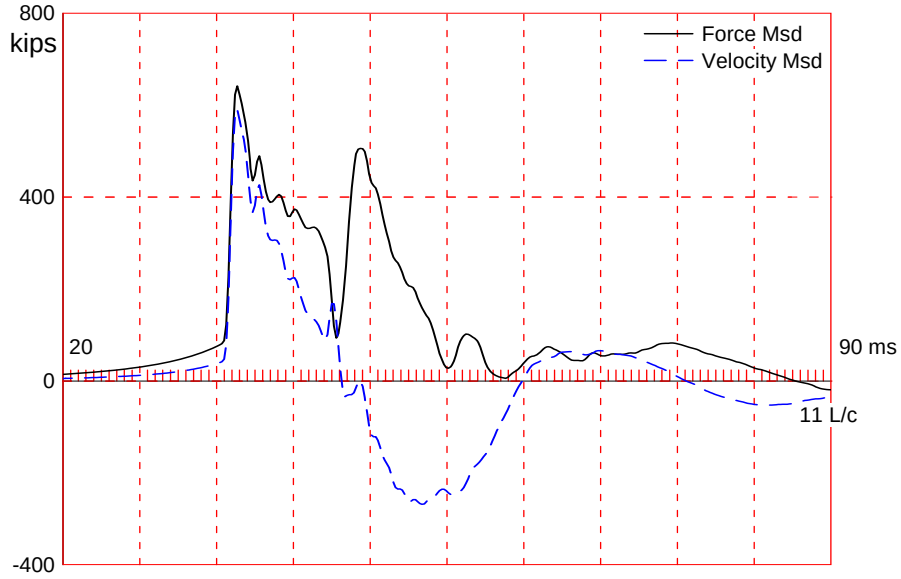
Toe Area 198.5 in^2

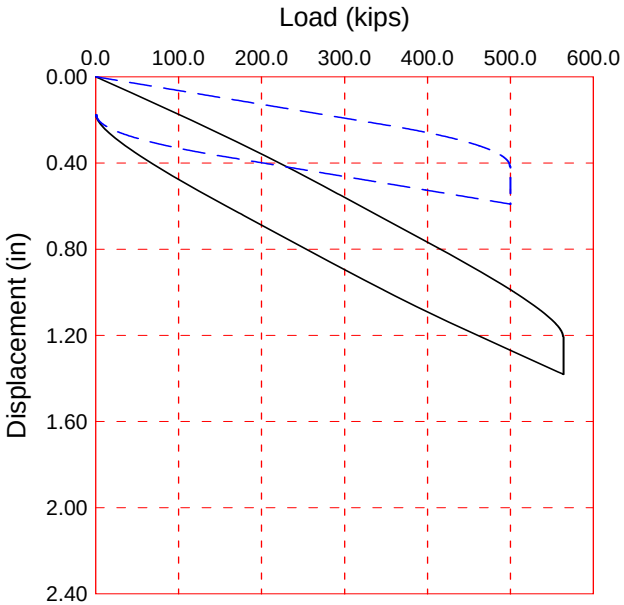
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms

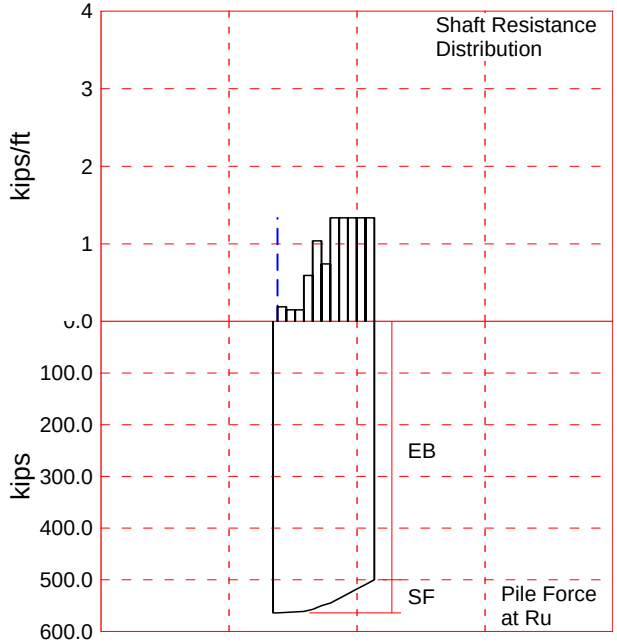
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	564.0 kips
SF =	64.0 kips
EB =	500.0 kips
Dy =	1.21 in
Dx =	1.38 in
SET/Bl =	0.17 in



Length b. Sensors	77.5 ft
Embedment	72.7 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.69
Top Compr. Stress	29.7 ksi
Max Compr. Stress	30.1 ksi
Max Tension Stress	-3.84 ksi
Avg. Shaft Quake	0.17 in
Toe Quake	0.32 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.04 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 564.0; along Shaft 64.0; at Toe 500.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				564.0			
1	10.1	5.3	1.0	563.0	1.0	0.19	0.04
2	16.8	12.0	1.0	562.0	2.0	0.15	0.03
3	23.6	18.8	1.0	561.0	3.0	0.15	0.03
4	30.3	25.5	4.0	557.0	7.0	0.59	0.13
5	37.1	32.3	7.0	550.0	14.0	1.04	0.22
6	43.8	39.0	5.0	545.0	19.0	0.74	0.16
7	50.5	45.7	9.0	536.0	28.0	1.34	0.28
8	57.3	52.5	9.0	527.0	37.0	1.34	0.28
9	64.0	59.2	9.0	518.0	46.0	1.34	0.28
10	70.8	65.9	9.0	509.0	55.0	1.34	0.28
11	77.5	72.7	9.0	500.0	64.0	1.34	0.28
Avg. Shaft			5.8			0.88	0.19
Toe			500.0				362.72

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.04
Quake	(in)	0.17	0.32
Case Damping Factor		0.50	0.52
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	32
Unloading Level	(% of Ru)	46	
Soil Plug Weight	(kips)		0.006

CAPWAP match quality = 2.69 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.17 in; Blow Count = 69 b/ft
Computed: Final Set = 0.07 in; Blow Count = 168 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.10; A4(K2524) CAL: 360; RF: 1.10

max. Top Comp. Stress = 29.7 ksi (T= 36.1 ms, max= 1.015 x Top)
max. Comp. Stress = 30.1 ksi (Z= 30.3 ft, T= 37.7 ms)
max. Tens. Stress = -3.84 ksi (Z= 64.0 ft, T= 59.1 ms)
max. Energy (EMX) = 33.2 kip-ft; max. Measured Top Displ. (DMX)= 0.99 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	635.7	-23.3	29.7	-1.09	33.2	15.6	1.00
2	6.7	637.8	-24.6	29.8	-1.15	33.0	15.6	0.99
4	13.5	636.2	-30.0	29.7	-1.40	32.2	15.4	0.95
5	16.8	638.1	-40.4	29.8	-1.89	31.8	15.4	0.93
6	20.2	634.8	-49.3	29.7	-2.30	31.1	15.3	0.90
7	23.6	638.3	-57.2	29.8	-2.67	30.7	15.2	0.87
8	27.0	638.9	-64.3	29.8	-3.00	29.9	15.0	0.85
9	30.3	645.3	-72.6	30.1	-3.39	29.3	14.8	0.82
10	33.7	633.1	-73.1	29.6	-3.41	27.8	14.6	0.79
11	37.1	640.3	-72.2	29.9	-3.37	27.2	14.4	0.76
12	40.4	610.8	-63.6	28.5	-2.97	25.0	14.2	0.73
13	43.8	618.4	-60.8	28.9	-2.84	24.4	14.0	0.69
14	47.2	604.4	-58.9	28.2	-2.75	22.7	13.7	0.66
15	50.5	613.8	-68.8	28.7	-3.21	22.0	13.4	0.63
16	53.9	581.3	-68.2	27.2	-3.19	19.7	13.1	0.60
17	57.3	590.4	-80.5	27.6	-3.76	19.0	12.9	0.56
18	60.7	559.5	-80.7	26.1	-3.77	16.8	12.6	0.53
19	64.0	568.3	-82.2	26.5	-3.84	16.1	12.6	0.50
20	67.4	545.2	-70.2	25.5	-3.28	14.2	14.8	0.47
21	70.8	584.0	-67.6	27.3	-3.16	13.5	15.8	0.43
22	74.1	582.7	-55.2	27.2	-2.58	11.7	16.8	0.40
23	77.5	584.5	-53.8	27.3	-2.51	11.2	16.0	0.37
Absolute	30.3			30.1			(T =	37.7 ms)
	64.0				-3.84		(T =	59.1 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	624.0	561.5	499.1	436.6	374.2	311.8	249.3	186.9	124.4	62.0
RX	717.2	695.6	674.1	652.5	630.9	609.3	589.2	577.6	567.3	557.4
RU	624.0	561.5	499.1	436.6	374.2	311.8	249.3	186.9	124.4	62.0

RAU = 421.9 (kips); RA2 = 623.6 (kips)

Current CAPWAP Ru = 564.0 (kips); Corresponding J(RP)= 0.10; J(RX) = 0.83

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
15.7	35.89	599.3	649.1	649.1	0.99	0.18	0.17	33.4	687.5	1563

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

Toe Area 198.5 in^2

Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms

Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000