GRL Engineers, Inc.

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TRANSMITTAL

To: Mr. Kevin Weber	From: Alexander McCaskill
Company: Lunda Construction Co.	No. of Sheets: 48
E-mail: kweber@lundaconstruction.com	Date: June 9, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 18
Winnebago County, Wisconsin

On June 8, 2015, Pier 18 #1, Pier 18 #36, and Pier 18 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on June 9. 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 piles have a required minimum tip elevation of EL 685. 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. The reference elevation for the piles was the top of the cofferdam at EL 740.99. We understand the pier was excavated to an elevation of EL 717.49.

Pier 18 #1 was driven to a depth of 52.6 feet, which corresponds to a pile tip elevation of EL 688.4. The blow count over the final increment of driving was 10 blows for 1 ¾ inches of penetration at an average hammer stroke of 8.7 feet. The blow count at the beginning of restrike was 10 blows per for 1 ½ inches of penetration at an average hammer stroke of 8.3 feet. In an effort to reach the minimum tip, Pier 18 #1 was re-driven a depth of 53.7 feet, which corresponds to a pile tip elevation of EL 687.3. The blow count at the end of re-driving was 10 blows per for 1 ⅜ inches of penetration at an average hammer stroke of 8.1 feet.

Pier 18 #36 was driven to a depth of 62.6 feet, which corresponds to a pile tip elevation of EL 678.4. The blow count over the final increment of driving was 10 blows for 2 ½ inches of penetration at an average hammer stroke of 8.3 feet. The blow count at the beginning of restrike was 10 blows for 1 ⅝ inches of penetration at an average hammer stroke of 8.4 feet.

Pier 18 #44 was driven to a depth of 63.1 feet, which corresponds to a pile tip elevation of EL 677.9. The blow count over the final increment of driving was 10 blows for 2 ½ inches of penetration at an average hammer stroke of 8.5 feet. The blow count at the beginning of restrike was 10 blows for 1 ¾ inch of penetration at an average hammer stroke of 7.8 feet

We recommend that the production piles at Pier 18 of Structure B-70-403, driven with an APE D30-42 hammer PD 0256, obtain the minimum recommended blow count, noted below, based

on the field observed hammer stroke. We recommend maintaining the minimum blow count for **three consecutive inches** of driving at the recommended average hammer stroke.

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)
7.0	5	3
7.5	4	3
8.0	4	3
8.5	4	3
9.0	3	3

After reviewing the dynamic test results, the designer has approved a revised minimum pile tip elevation of EL 690 at Pier 18. 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. If the piles terminate above the minimum pile tip elevation please notify the engineer of record.

These criteria should not be used for acceptance of piles under restrike and/or re-drive conditions. After splicing or any other delays, we recommend not applying the criteria until two feet 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.

Alexander McCaskill

Travis Coleman, P.E.

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

Attachments:

Dynamic Test Results - (pages 3 – 21)
CAPWAP Analysis Results - (pages 22 – 47)

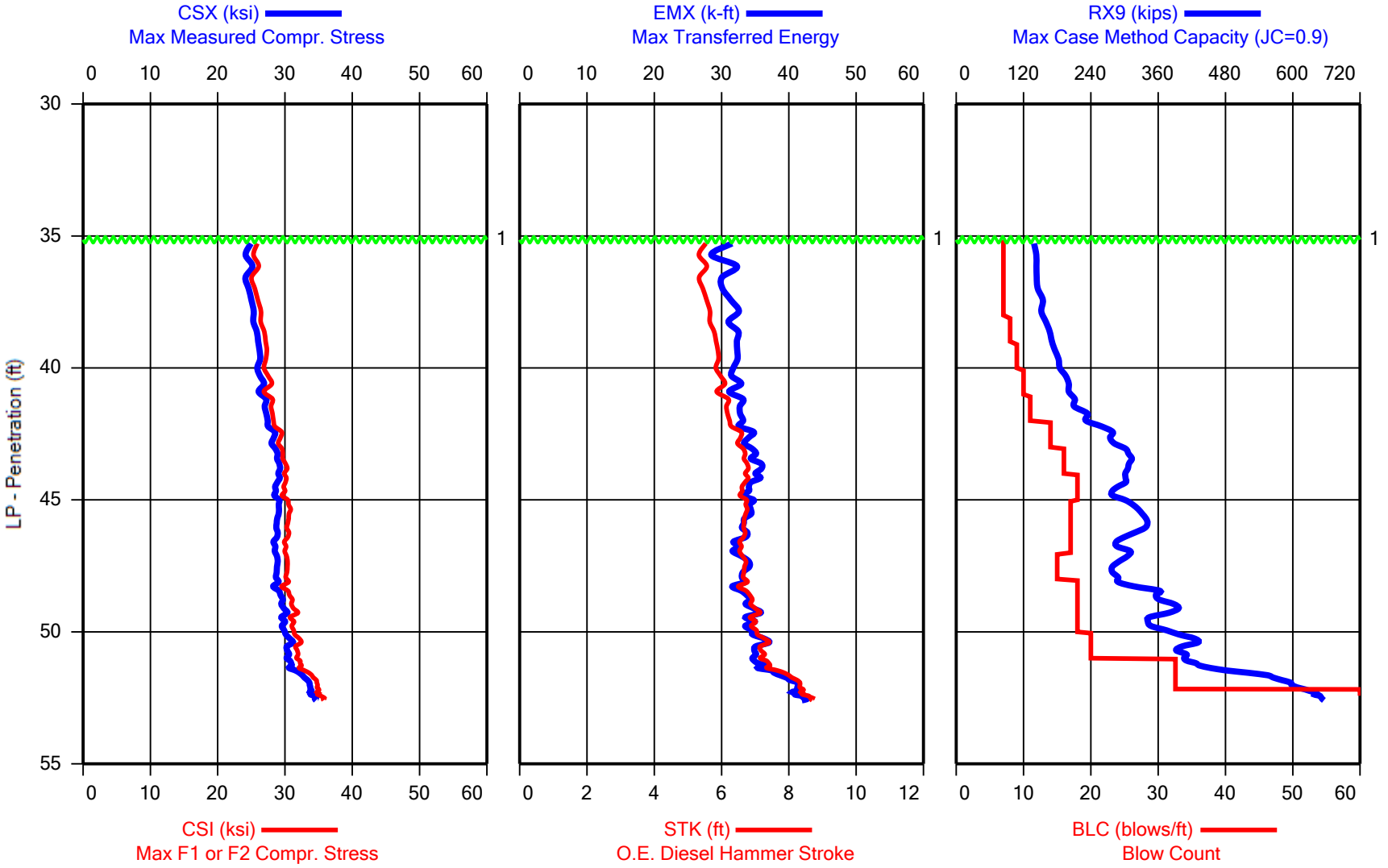
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 10-June-2015

Test started: 08-June-2015

USH 10 over Little Lake Butte des Morts - PIER 18 #1

APE D30-42, HP 14 x 73



1 - Reported reference at El. 740.99

USH 10 over Little Lake Butte des Morts - PIER 18 #1 APE D30-42, HP 14 x 73
OP: AM Date: 08-June-2015

AR: 21.40 in² 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#	Depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	blows/ft		ksi	ksi	k-ft	ft	bpm	kips
7	36.00	7	AV7	24.5	8.0	30	5.4	50.3	141
			STD	0.8	0.3	2	0.2	0.8	2
			MAX	26.2	8.6	33	5.8	51.3	144
			MIN	23.6	7.5	27	5.2	48.7	139
14	37.00	7	AV7	24.6	7.9	31	5.4	50.2	144
			STD	0.6	0.2	2	0.1	0.6	2
			MAX	25.5	8.2	34	5.6	51.1	147
			MIN	23.7	7.7	29	5.2	49.4	140
21	38.00	7	AV7	25.1	8.0	32	5.6	49.6	152
			STD	0.5	0.1	1	0.1	0.6	4
			MAX	25.8	8.2	33	5.8	50.7	158
			MIN	24.2	7.8	30	5.3	48.8	144
29	39.00	8	AV8	25.7	8.6	32	5.7	49.0	164
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	26.2	9.0	34	5.9	49.7	172
			MIN	24.9	8.0	30	5.6	48.4	156
38	40.00	9	AV9	26.2	9.1	32	5.9	48.4	179
			STD	0.4	0.2	1	0.1	0.5	4
			MAX	27.1	9.5	34	6.1	49.0	190
			MIN	25.8	8.7	31	5.7	47.4	173
48	41.00	10	AV10	26.4	9.9	32	6.0	48.1	198
			STD	0.6	0.4	1	0.1	0.6	6
			MAX	27.3	10.6	34	6.2	49.2	209
			MIN	25.2	9.3	30	5.7	47.1	189
59	42.00	11	AV11	27.2	11.1	33	6.2	47.2	221
			STD	0.7	0.4	1	0.2	0.7	11
			MAX	28.4	11.7	35	6.5	48.1	235
			MIN	26.4	10.6	31	6.0	46.1	205
73	43.00	14	AV14	28.0	13.4	34	6.5	46.3	272
			STD	0.7	1.0	1	0.2	0.7	17
			MAX	29.2	14.5	36	6.8	48.1	295
			MIN	26.2	11.2	30	6.0	45.3	233
89	44.00	16	AV16	29.0	14.4	35	6.7	45.4	307
			STD	0.6	0.2	1	0.2	0.6	7
			MAX	30.4	14.7	39	7.1	46.4	321
			MIN	28.0	13.9	33	6.4	44.1	296
107	45.00	18	AV18	28.8	13.9	34	6.7	45.6	291
			STD	0.6	0.4	1	0.2	0.6	11
			MAX	30.1	14.5	37	7.1	46.7	308
			MIN	27.8	12.9	31	6.3	44.3	274
124	46.00	17	AV17	29.0	15.0	34	6.7	45.4	329
			STD	0.5	0.2	1	0.1	0.4	11
			MAX	30.0	15.3	36	7.0	46.3	345
			MIN	28.1	14.3	32	6.5	44.6	307
141	47.00	17	AV17	28.6	14.1	33	6.6	45.8	304

USH 10 over Little Lake Butte des Morts - PIER 18 #1 APE D30-42, HP 14 x 73
OP: AM Date: 08-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			STD	0.4	0.6	1	0.1	0.4	18
			MAX	29.3	15.1	35	6.8	46.5	345
			MIN	27.7	12.9	31	6.4	45.2	279
156	48.00	15	AV15	28.8	13.8	33	6.7	45.6	288
			STD	0.5	0.6	1	0.2	0.5	11
			MAX	29.8	14.8	35	7.0	46.5	315
			MIN	27.8	12.8	31	6.4	44.6	272
174	49.00	18	AV18	29.1	15.0	33	6.8	45.3	346
			STD	0.6	1.3	1	0.2	0.6	36
			MAX	29.9	17.4	35	7.0	46.7	395
			MIN	27.7	13.1	30	6.3	44.5	274
192	50.00	18	AV18	29.8	15.6	35	7.0	44.6	364
			STD	0.4	1.0	1	0.1	0.4	23
			MAX	30.5	17.5	36	7.2	45.5	408
			MIN	28.8	14.3	32	6.7	43.8	333
212	51.00	20	AV20	30.5	17.1	35	7.2	43.9	409
			STD	0.5	0.7	1	0.2	0.5	16
			MAX	31.7	18.8	38	7.6	44.8	443
			MIN	29.5	15.7	33	6.9	42.7	383
250	52.17	33	AV38	32.2	23.1	38	7.9	42.2	519
			STD	1.2	4.9	3	0.4	1.1	73
			MAX	34.0	30.5	42	8.4	44.0	611
			MIN	30.2	16.5	34	7.2	40.8	405
260	52.33	60	AV10	33.8	31.1	41	8.4	40.8	633
			STD	0.2	0.3	1	0.1	0.2	7
			MAX	34.2	31.6	42	8.5	41.2	645
			MIN	33.5	30.6	40	8.2	40.5	620
270	52.48	69	AV10	34.2	31.7	42	8.5	40.5	646
			STD	0.5	0.5	1	0.1	0.3	7
			MAX	34.8	32.7	43	8.7	41.1	654
			MIN	33.3	31.0	40	8.3	40.1	633
279	52.61	69	AV9	34.6	32.7	42	8.7	40.1	653
			STD	0.4	0.4	1	0.1	0.3	6
			MAX	35.2	33.5	44	8.9	40.5	663
			MIN	33.9	32.0	41	8.5	39.7	643
			Average	29.4	16.5	35	6.9	45.1	354
			Std. Dev.	2.7	6.9	3	0.9	2.7	147
			Maximum	35.2	33.5	44	8.9	51.3	663
			Minimum	23.6	7.5	27	5.2	39.7	139

Total number of blows analyzed: 279

BL# Sensors

1-279 F3: [D815] 93.0 (1.00); F4: [K769] 91.9 (1.00); A3: [K3550] 360.0 (1.00); A4: [K3658] 362.0 (1.00)

BL# Comments

1 Reported reference at El. 740.99
2 Mud line at El. 717.49

Time Summary

Drive 6 minutes 11 seconds 12:25 PM - 12:31 PM BN 1 - 279

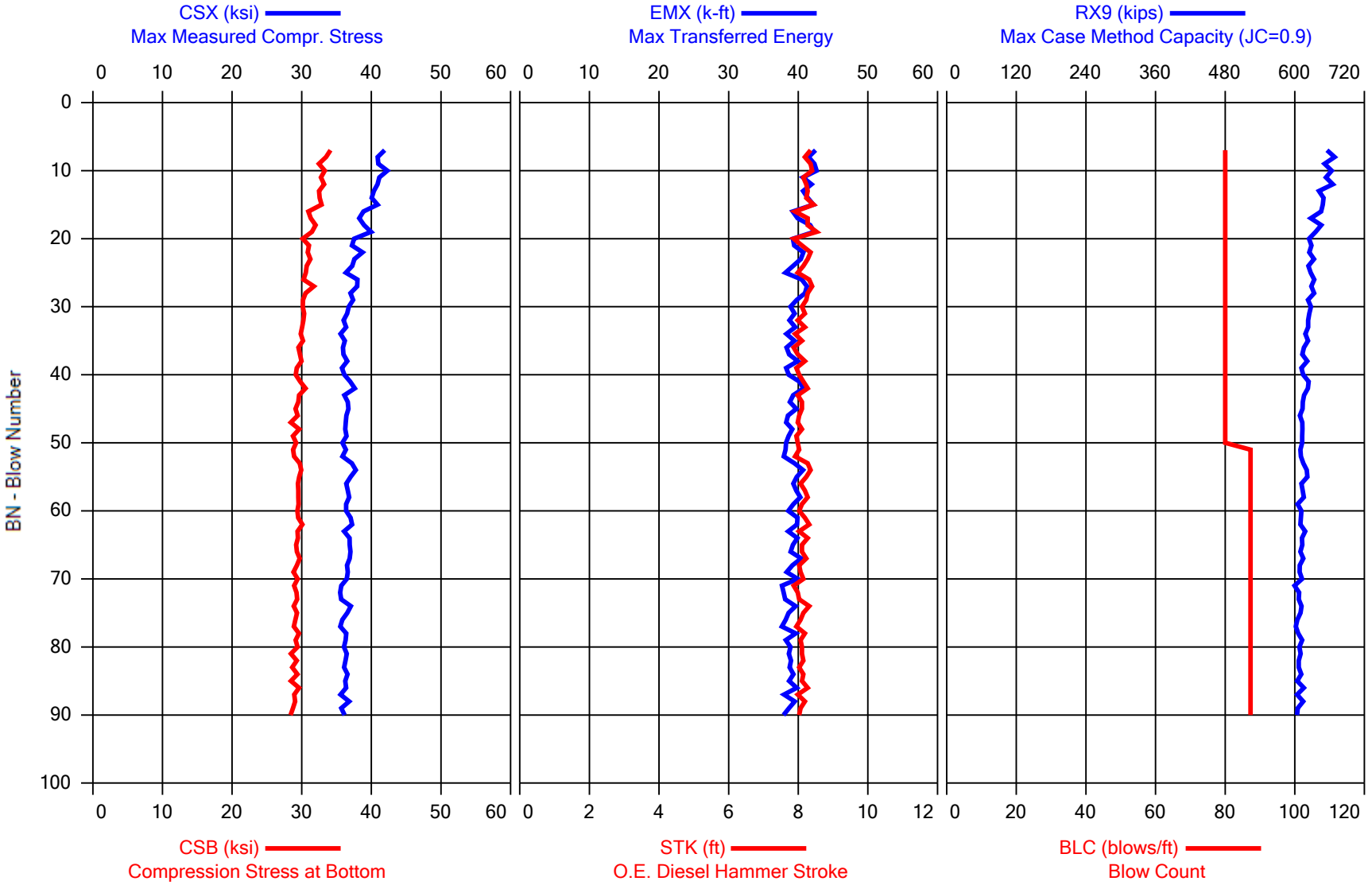
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 09-June-2015

Test started: 09-June-2015

USH 10 over Little Lake Butte des Morts - PIER 18 #1 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - PIER 18 #1 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 09-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 58.00 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#	Depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	blows/ft		ksi	ksi	k-ft	ft	bpm	kips
10	52.75	80	AV4	41.5	33.4	42	8.3	41.0	660
			STD	0.6	0.6	0	0.1	0.2	7
			MAX	42.3	34.1	43	8.4	41.3	669
			MIN	40.9	32.5	41	8.2	40.8	651
20	52.87	80	AV10	39.7	32.0	41	8.2	41.2	644
			STD	1.2	0.9	1	0.2	0.5	12
			MAX	41.1	33.2	42	8.5	42.1	666
			MIN	37.5	30.1	39	7.9	40.5	625
30	53.00	80	AV10	37.4	30.7	40	8.2	41.2	628
			STD	0.7	0.5	1	0.1	0.3	4
			MAX	38.7	31.7	41	8.4	41.8	633
			MIN	36.3	30.2	38	8.0	40.8	623
40	53.12	80	AV10	36.1	29.8	39	8.0	41.7	619
			STD	0.3	0.4	1	0.1	0.3	5
			MAX	36.5	30.3	40	8.2	42.1	625
			MIN	35.6	29.1	38	7.9	41.3	611
50	53.25	80	AV10	36.5	29.4	39	8.1	41.6	615
			STD	0.5	0.6	1	0.1	0.2	4
			MAX	37.6	30.6	41	8.3	41.9	624
			MIN	35.9	28.4	38	7.9	41.1	609
60	53.36	87	AV10	36.7	29.4	39	8.1	41.4	613
			STD	0.5	0.3	1	0.1	0.3	5
			MAX	37.8	29.9	41	8.4	42.0	622
			MIN	35.8	28.8	38	7.9	40.9	605
70	53.48	87	AV10	36.8	29.4	39	8.1	41.4	612
			STD	0.3	0.3	1	0.1	0.2	3
			MAX	37.2	30.1	40	8.3	41.7	618
			MIN	36.1	28.8	38	8.0	41.0	608
80	53.59	87	AV10	36.1	29.2	38	8.1	41.6	607
			STD	0.5	0.2	1	0.1	0.3	4
			MAX	37.1	29.6	40	8.3	42.1	613
			MIN	35.5	28.8	38	7.9	41.0	600
90	53.71	87	AV10	36.2	28.9	39	8.1	41.5	608
			STD	0.4	0.4	1	0.1	0.2	4
			MAX	36.8	29.6	40	8.3	41.8	616
			MIN	35.6	28.4	38	8.0	41.1	604
			Average	37.2	30.0	40	8.1	41.4	620
			Std. Dev.	1.6	1.3	1	0.1	0.4	15
			Maximum	42.3	34.1	43	8.5	42.1	669
			Minimum	35.5	28.4	38	7.9	40.5	600

Total number of blows analyzed: 84

BL# Sensors

1-90 F3: [K769] 91.9 (1.00); F4: [D815] 93.0 (1.00); A3: [K3658] 362.0 (1.00); A4: [K3550] 360.0 (1.00)

Time Summary

Drive 2 minutes 8 seconds 6:19 AM - 6:22 AM BN 1 - 90

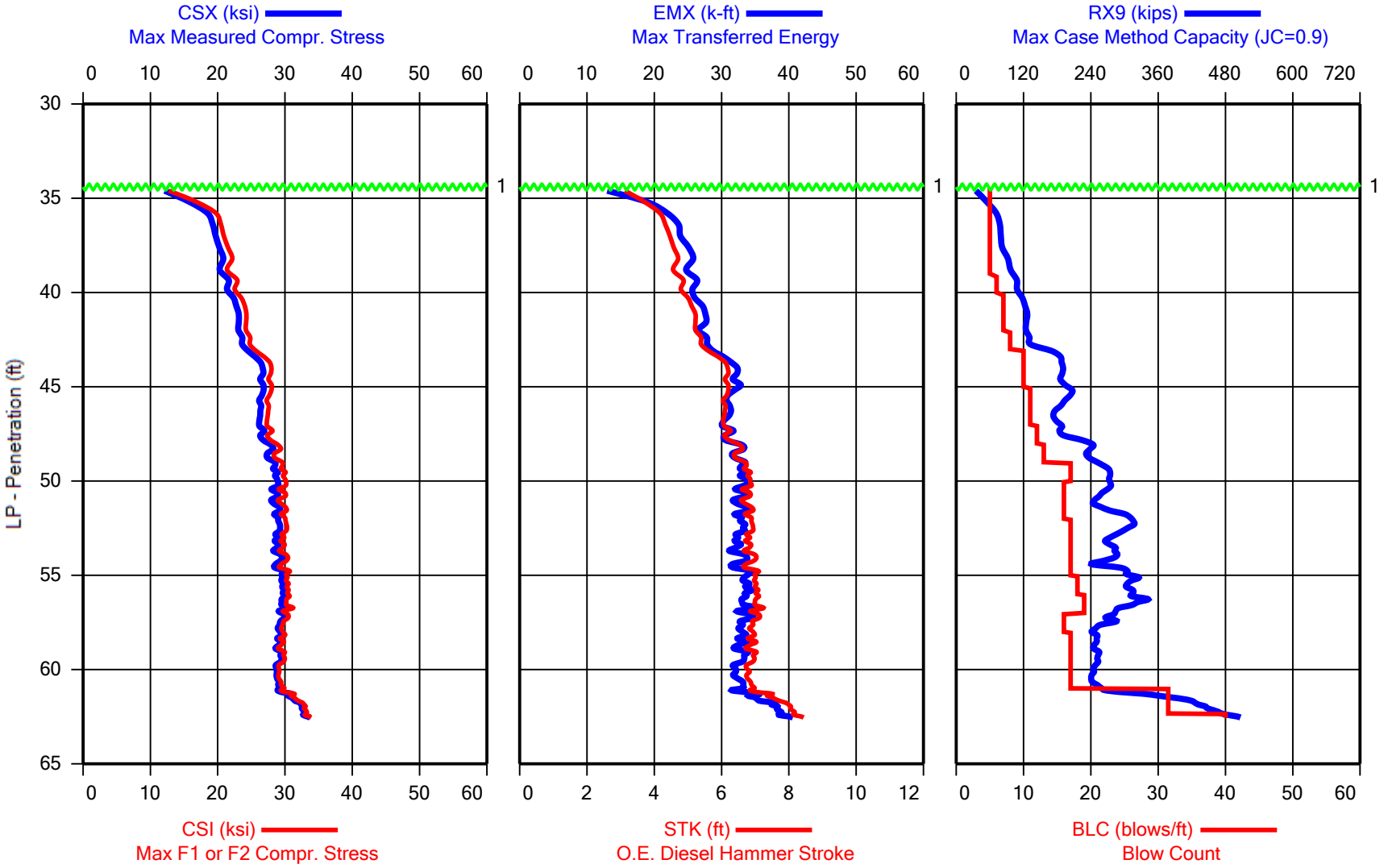
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 08-June-2015

Test started: 08-June-2015

USH 10 over Little Lake Butte des Morts - PIER 18 #36

APE D30-42, HP 14 x 73



1 - Reported reference at El. 740.99

2 - Mud line at El. 717.49

USH 10 over Little Lake Butte des Morts - PIER 18 #36 APE D30-42, HP 14 x 73
OP: AM Date: 08-June-2015

AR: 21.40 in² 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#	Depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	blows/ft		ksi	ksi	k-ft	ft	bpm	kips
10	35.00	5	AV4	12.6	3.0	14	3.2	64.3	37
			STD	1.1	0.2	1	0.1	1.2	4
			MAX	14.1	3.3	16	3.4	65.5	44
			MIN	11.5	2.7	13	3.1	62.3	33
15	36.00	5	AV5	17.8	4.3	21	4.0	57.7	67
			STD	1.0	0.5	1	0.2	1.2	7
			MAX	19.2	5.1	23	4.3	59.3	78
			MIN	16.3	3.7	20	3.8	56.0	56
20	37.00	5	AV5	19.5	5.4	24	4.4	55.6	79
			STD	0.6	0.3	1	0.1	0.8	5
			MAX	20.2	5.8	25	4.5	56.6	85
			MIN	18.8	4.9	23	4.2	54.7	73
25	38.00	5	AV5	20.4	5.4	25	4.6	54.3	83
			STD	0.8	0.1	1	0.2	0.9	7
			MAX	21.5	5.6	26	4.9	55.2	94
			MIN	19.6	5.3	24	4.5	52.9	76
30	39.00	5	AV5	20.4	5.7	25	4.6	54.4	95
			STD	0.5	0.2	1	0.1	0.7	4
			MAX	21.1	5.9	26	4.7	55.6	102
			MIN	19.4	5.4	23	4.4	53.6	91
36	40.00	6	AV6	21.5	6.2	26	4.8	53.1	108
			STD	0.5	0.2	1	0.1	0.6	2
			MAX	22.3	6.4	27	5.0	54.2	111
			MIN	20.8	5.8	25	4.6	52.2	104
43	41.00	7	AV7	22.6	6.4	27	5.1	51.9	121
			STD	0.6	0.1	1	0.1	0.6	3
			MAX	23.4	6.7	29	5.2	52.9	125
			MIN	21.6	6.3	25	4.9	51.1	115
50	42.00	7	AV7	23.2	7.0	27	5.2	51.1	125
			STD	0.3	0.1	1	0.1	0.4	3
			MAX	23.7	7.2	29	5.4	51.8	130
			MIN	22.6	6.8	26	5.1	50.6	122
58	43.00	8	AV8	23.7	8.1	28	5.4	50.4	134
			STD	0.4	0.4	1	0.1	0.5	9
			MAX	24.6	8.7	29	5.6	51.2	155
			MIN	23.0	7.2	26	5.2	49.4	127
68	44.00	10	AV10	25.9	10.2	31	6.0	48.1	186
			STD	0.9	0.5	2	0.2	1.0	7
			MAX	27.0	10.7	33	6.3	49.6	196
			MIN	24.4	9.1	28	5.6	47.0	171
78	45.00	10	AV10	26.6	10.6	32	6.2	47.4	189
			STD	0.5	0.2	1	0.1	0.5	6
			MAX	27.4	10.9	34	6.3	48.3	199
			MIN	25.6	10.3	31	5.9	46.7	181
89	46.00	11	AV11	26.5	11.0	31	6.1	47.5	199

USH 10 over Little Lake Butte des Morts - PIER 18 #36 APE D30-42, HP 14 x 73
OP: AM Date: 08-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			STD	0.5	0.3	1	0.1	0.5	7
			MAX	27.1	11.6	33	6.3	48.7	212
			MIN	25.2	10.7	28	5.8	46.9	186
100	47.00	11	AV11	26.3	10.5	31	6.1	47.6	177
			STD	0.3	0.3	1	0.1	0.3	4
			MAX	26.6	11.1	31	6.2	48.2	184
			MIN	25.6	10.1	30	5.9	47.3	170
112	48.00	12	AV12	26.7	11.3	31	6.2	47.2	202
			STD	0.5	1.0	1	0.1	0.5	21
			MAX	27.6	13.2	33	6.5	48.0	246
			MIN	26.0	10.0	29	6.0	46.1	181
125	49.00	13	AV13	27.9	12.7	33	6.5	46.1	239
			STD	0.6	0.4	1	0.2	0.5	7
			MAX	28.8	13.5	34	6.8	47.0	251
			MIN	27.0	12.0	31	6.3	45.2	231
142	50.00	17	AV17	28.6	14.1	33	6.8	45.2	270
			STD	0.6	0.3	1	0.2	0.6	7
			MAX	29.6	14.5	35	7.1	46.1	278
			MIN	27.6	13.6	31	6.5	44.3	253
158	51.00	16	AV16	28.6	14.2	33	6.8	45.3	264
			STD	0.7	0.4	2	0.2	0.7	11
			MAX	29.6	14.8	35	7.0	46.8	278
			MIN	27.0	13.3	30	6.3	44.4	244
174	52.00	16	AV16	28.8	14.3	33	6.8	45.1	275
			STD	0.5	0.8	1	0.1	0.4	26
			MAX	29.6	15.4	35	7.0	46.0	311
			MIN	27.8	12.7	31	6.5	44.4	242
191	53.00	17	AV17	29.0	14.7	33	6.9	44.9	301
			STD	0.6	0.5	1	0.2	0.5	15
			MAX	30.0	15.7	35	7.1	45.8	321
			MIN	28.0	13.7	31	6.6	44.1	272
208	54.00	17	AV17	28.8	14.2	32	6.8	45.1	279
			STD	0.5	0.4	1	0.2	0.5	8
			MAX	29.7	14.9	35	7.1	46.0	289
			MIN	27.8	13.2	31	6.5	44.1	263
225	55.00	17	AV17	29.2	14.3	33	6.9	44.9	281
			STD	0.8	0.8	2	0.2	0.8	28
			MAX	30.7	15.4	36	7.3	46.0	320
			MIN	27.9	13.1	30	6.5	43.6	234
243	56.00	18	AV18	29.6	15.2	34	7.0	44.5	313
			STD	0.4	0.3	1	0.1	0.3	9
			MAX	30.2	15.7	35	7.2	45.0	336
			MIN	29.1	14.5	32	6.8	44.0	300
262	57.00	19	AV19	29.7	14.8	33	7.0	44.4	309
			STD	0.6	0.6	1	0.2	0.6	20
			MAX	31.2	16.2	36	7.5	45.3	349
			MIN	28.5	13.8	31	6.8	43.1	282
278	58.00	16	AV16	29.4	14.1	33	7.0	44.6	263
			STD	0.6	0.5	1	0.2	0.6	17
			MAX	30.4	14.8	36	7.3	45.9	299
			MIN	28.0	12.9	31	6.6	43.7	237

USH 10 over Little Lake Butte des Morts - PIER 18 #36 APE D30-42, HP 14 x 73
OP: AM Date: 08-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
295	59.00	17	AV17	29.1	14.2	33	6.9	45.0	249
			STD	0.6	0.3	1	0.2	0.6	5
			MAX	29.9	14.8	35	7.1	46.3	257
			MIN	27.6	13.7	31	6.5	44.2	236
312	60.00	17	AV17	29.2	14.5	33	6.9	44.8	251
			STD	0.6	0.5	1	0.2	0.6	5
			MAX	30.2	15.5	35	7.3	45.8	260
			MIN	28.2	13.6	31	6.6	43.7	243
329	61.00	17	AV17	28.9	14.0	33	6.8	45.1	246
			STD	0.5	0.5	1	0.2	0.6	7
			MAX	29.8	14.9	34	7.1	46.0	258
			MIN	27.9	13.4	31	6.5	44.1	235
371	62.33	31	AV42	31.5	20.5	36	7.7	42.6	395
			STD	1.4	3.2	2	0.4	1.2	66
			MAX	33.6	24.6	40	8.4	45.4	476
			MIN	28.6	13.9	31	6.7	40.9	259
380	62.56	40	AV9	33.1	25.7	39	8.3	41.1	493
			STD	0.6	0.7	1	0.2	0.5	12
			MAX	34.1	27.0	41	8.7	41.8	507
			MIN	32.3	24.7	38	8.0	40.2	474
			Average	27.9	13.6	32	6.6	46.3	256
			Std. Dev.	3.5	4.5	4	0.9	3.8	94
			Maximum	34.1	27.0	41	8.7	65.5	507
			Minimum	11.5	2.7	13	3.1	40.2	33

Total number of blows analyzed: 374

BL# Sensors

1-380 F3: [D815] 93.0 (1.00); F4: [K769] 91.9 (1.00); A3: [K3550] 360.0 (1.00); A4: [K3658] 362.0 (1.00)

BL# Comments

7 Reported reference at El. 740.99
8 Mud line at El. 717.49

Time Summary

Drive 8 minutes 28 seconds 12:43 PM - 12:52 PM BN 1 - 380

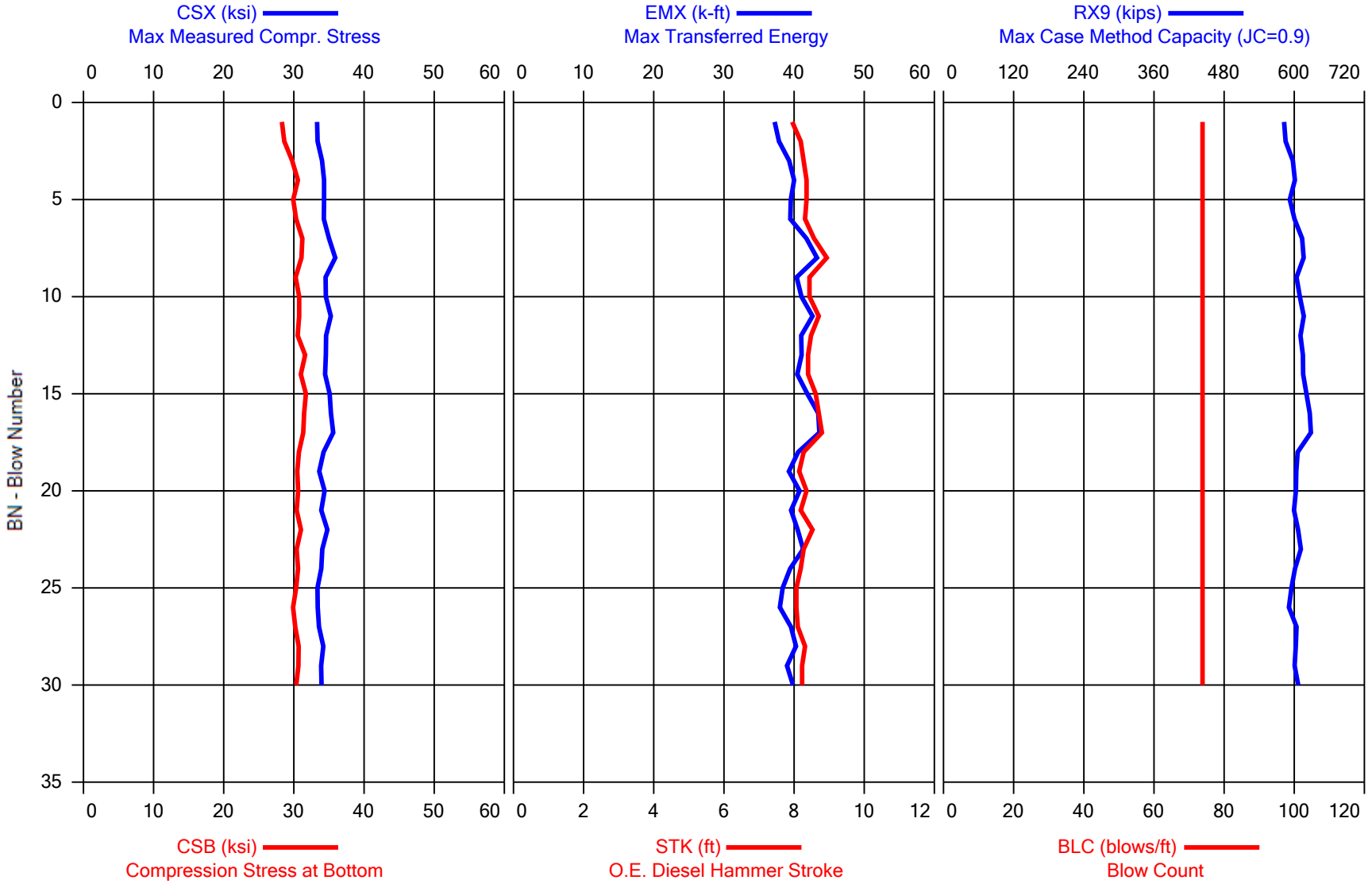
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 09-June-2015

Test started: 09-June-2015

USH 10 over Little Lake Butte des Morts - PIER 18 #36 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - PIER 18 #36 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 09-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 67.00 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#	Depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	blows/ft		ksi	ksi	k-ft	ft	bpm	kips
10	62.72	74	AV10	34.4	30.1	40	8.4	40.9	600
			STD	0.7	0.9	2	0.2	0.6	11
			MAX	35.9	31.2	43	8.9	41.9	616
			MIN	33.3	28.3	37	7.9	39.6	582
20	62.85	74	AV10	34.7	31.0	41	8.5	40.6	614
			STD	0.6	0.4	1	0.2	0.5	9
			MAX	35.6	31.7	44	8.8	41.4	628
			MIN	33.6	30.5	39	8.1	39.9	603
30	62.99	74	AV10	33.9	30.4	40	8.2	41.2	602
			STD	0.4	0.3	1	0.1	0.3	6
			MAX	34.8	31.0	41	8.5	41.6	611
			MIN	33.4	29.9	38	8.1	40.5	591
			Average	34.3	30.5	40	8.4	40.9	605
			Std. Dev.	0.7	0.7	2	0.2	0.5	11
			Maximum	35.9	31.7	44	8.9	41.9	628
			Minimum	33.3	28.3	37	7.9	39.6	582

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [D815] 93.0 (1.00); F4: [K769] 91.9 (1.00); A3: [K3550] 360.0 (1.00); A4: [K3658] 362.0 (1.00)

Time Summary

Drive 42 seconds 6:28 AM - 6:29 AM BN 1 - 30

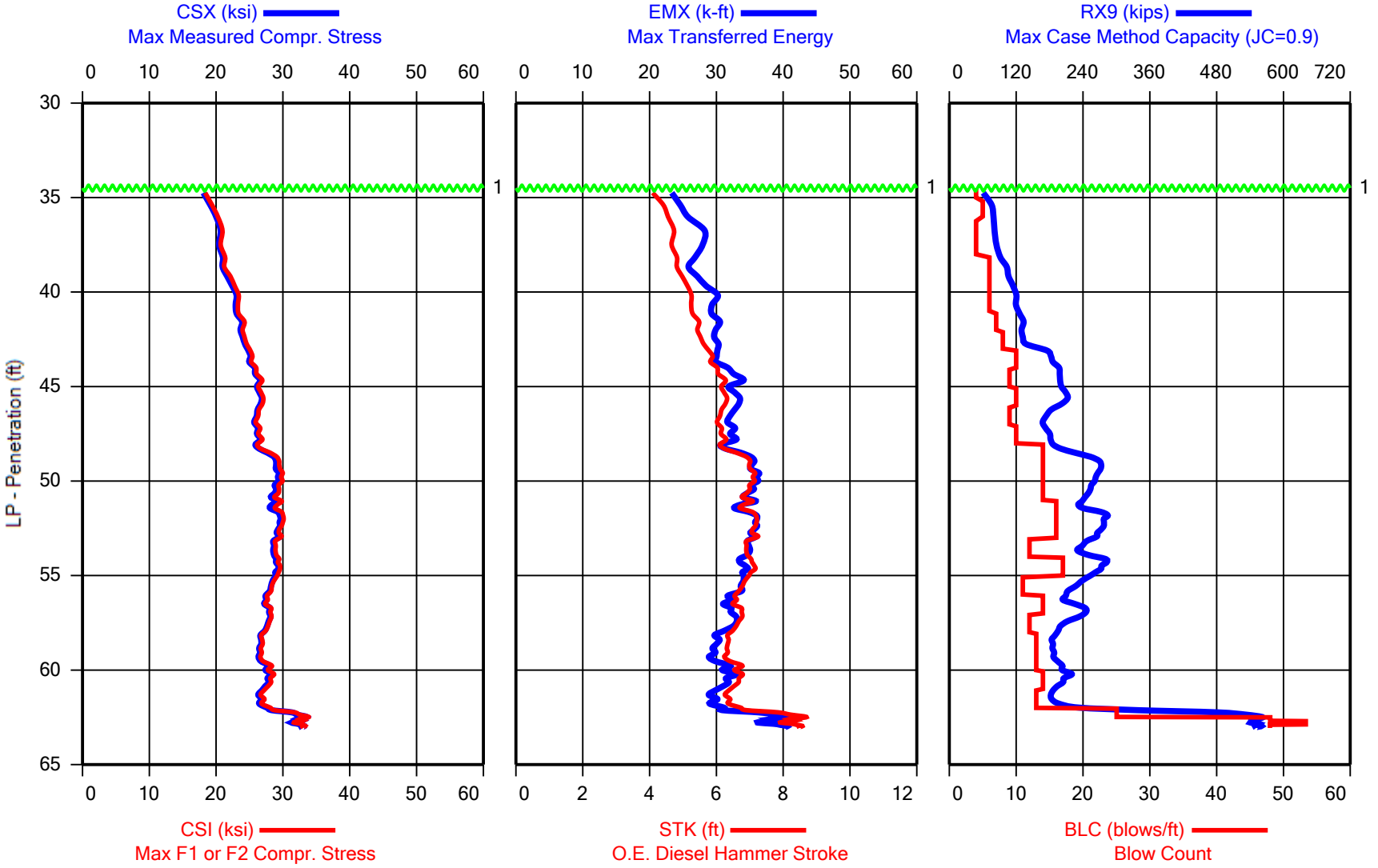
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 08-June-2015

Test started: 08-June-2015

USH 10 over Little Lake Butte des Morts - PIER 18 #44

APE D30-42, HP 14 x 73



1 - Reported reference at El. 740.99

USH 10 over Little Lake Butte des Morts - PIER 18 #44 APE D30-42, HP 14 x 73
OP: AM Date: 08-June-2015

AR: 21.40 in² 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#	Depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	blows/ft		ksi	ksi	k-ft	ft	bpm	kips
8	35.00	4	AV3	18.1	4.5	23	4.1	57.4	61
			STD	0.3	0.1	0	0.0	0.1	0
			MAX	18.3	4.6	24	4.1	57.5	61
			MIN	17.7	4.4	23	4.1	57.3	60
13	36.00	5	AV5	19.4	5.1	25	4.4	55.3	77
			STD	0.8	0.3	1	0.1	0.8	6
			MAX	20.4	5.4	25	4.6	56.7	84
			MIN	18.0	4.6	23	4.2	54.5	66
17	37.00	4	AV4	20.7	5.7	28	4.7	53.6	81
			STD	0.2	0.1	1	0.0	0.2	4
			MAX	20.9	5.8	29	4.8	53.9	86
			MIN	20.5	5.6	28	4.7	53.3	76
21	38.00	4	AV4	20.5	5.7	28	4.7	53.9	84
			STD	0.5	0.1	1	0.1	0.6	2
			MAX	21.2	5.8	29	4.8	54.7	88
			MIN	20.0	5.6	27	4.5	53.1	82
27	39.00	6	AV6	21.2	6.0	26	4.9	53.0	101
			STD	0.4	0.1	1	0.1	0.4	4
			MAX	21.5	6.2	28	5.0	53.4	107
			MIN	20.7	5.8	25	4.8	52.4	95
33	40.00	6	AV6	22.2	6.5	28	5.1	51.9	113
			STD	0.5	0.2	1	0.1	0.6	6
			MAX	23.0	6.8	30	5.3	52.7	120
			MIN	21.4	6.3	26	4.9	51.0	101
39	41.00	6	AV6	22.9	6.9	30	5.2	51.2	120
			STD	0.6	0.1	1	0.1	0.7	2
			MAX	23.8	7.0	32	5.4	52.4	122
			MIN	21.7	6.7	28	5.0	50.2	116
46	42.00	7	AV7	23.9	7.4	30	5.5	50.1	131
			STD	0.3	0.2	0	0.1	0.3	4
			MAX	24.4	7.7	31	5.6	50.4	140
			MIN	23.6	7.2	30	5.4	49.5	127
54	43.00	8	AV8	24.0	8.0	30	5.5	49.8	138
			STD	0.5	0.5	1	0.1	0.6	11
			MAX	24.6	9.1	31	5.7	50.9	164
			MIN	23.0	7.4	28	5.3	49.2	129
64	44.00	10	AV10	25.3	10.0	31	5.9	48.3	186
			STD	0.7	0.3	1	0.2	0.7	8
			MAX	26.5	10.5	33	6.2	49.3	202
			MIN	24.4	9.4	29	5.7	47.1	176
73	45.00	9	AV9	26.1	10.8	33	6.1	47.4	199
			STD	0.5	0.2	1	0.2	0.6	3
			MAX	26.9	11.1	34	6.4	48.4	206
			MIN	25.2	10.4	30	5.9	46.6	196
83	46.00	10	AV10	26.6	11.2	33	6.2	47.0	207

USH 10 over Little Lake Butte des Morts - PIER 18 #44 APE D30-42, HP 14 x 73
OP: AM Date: 08-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			STD	0.4	0.3	1	0.1	0.4	6
			MAX	27.2	11.7	34	6.4	47.8	215
			MIN	25.7	10.8	31	6.0	46.4	199
92	47.00	9	AV9	26.0	10.3	32	6.1	47.6	175
			STD	0.4	0.2	1	0.1	0.4	7
			MAX	26.6	10.7	34	6.3	48.2	188
			MIN	25.5	9.9	31	5.9	46.9	164
102	48.00	10	AV10	26.2	10.3	32	6.2	47.3	178
			STD	0.7	0.3	1	0.2	0.7	5
			MAX	27.8	11.0	35	6.6	48.2	185
			MIN	25.3	9.8	30	5.9	45.7	171
116	49.00	14	AV14	27.7	12.7	34	6.6	45.8	231
			STD	1.2	1.8	2	0.4	1.2	29
			MAX	29.6	15.1	37	7.2	48.0	271
			MIN	25.5	10.0	30	6.0	43.9	189
130	50.00	14	AV14	29.2	14.6	36	7.1	44.3	267
			STD	0.5	0.2	1	0.2	0.5	5
			MAX	30.4	15.0	38	7.5	45.2	276
			MIN	28.3	14.3	34	6.8	43.2	259
144	51.00	14	AV14	28.8	14.0	35	7.0	44.7	251
			STD	0.6	0.3	1	0.2	0.6	6
			MAX	29.7	14.4	38	7.2	45.8	262
			MIN	27.6	13.5	33	6.6	43.9	238
160	52.00	16	AV16	28.9	14.4	35	7.0	44.6	257
			STD	0.7	1.0	1	0.2	0.6	23
			MAX	30.0	15.9	37	7.3	46.1	286
			MIN	27.4	12.8	31	6.5	43.6	226
176	53.00	16	AV16	29.4	14.6	36	7.2	44.1	272
			STD	0.3	0.4	1	0.1	0.3	6
			MAX	30.0	15.3	37	7.4	44.9	280
			MIN	28.5	13.8	34	6.9	43.4	264
188	54.00	12	AV12	28.6	13.3	35	6.9	44.8	241
			STD	0.5	0.5	1	0.1	0.4	9
			MAX	29.4	14.4	36	7.1	45.6	259
			MIN	27.8	12.5	33	6.7	44.3	226
205	55.00	17	AV17	29.1	14.5	34	7.1	44.3	272
			STD	0.5	0.5	1	0.2	0.5	9
			MAX	29.8	15.4	36	7.3	45.2	287
			MIN	28.2	13.4	32	6.8	43.7	255
216	56.00	11	AV11	28.3	13.1	34	6.8	45.2	225
			STD	0.4	0.5	1	0.1	0.4	14
			MAX	29.1	13.8	35	7.0	46.0	245
			MIN	27.6	12.3	33	6.5	44.5	202
230	57.00	14	AV14	27.6	13.3	32	6.6	45.8	227
			STD	0.6	0.9	1	0.2	0.6	17
			MAX	28.9	14.6	34	7.0	46.8	250
			MIN	26.5	12.1	29	6.3	44.4	203
242	58.00	12	AV12	27.7	12.9	32	6.6	45.7	210
			STD	0.5	0.4	1	0.2	0.5	15
			MAX	28.6	13.9	34	6.9	47.0	236
			MIN	26.4	12.4	30	6.3	44.9	192

USH 10 over Little Lake Butte des Morts - PIER 18 #44 APE D30-42, HP 14 x 73
OP: AM Date: 08-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
255	59.00	13	AV13	26.6	12.2	30	6.3	46.7	186
			STD	0.4	0.2	1	0.1	0.5	3
			MAX	27.1	12.7	31	6.5	47.4	193
			MIN	26.1	11.8	28	6.1	46.0	180
268	60.00	13	AV13	27.0	12.9	30	6.5	46.2	195
			STD	0.8	0.6	1	0.2	0.8	7
			MAX	28.6	13.9	34	7.0	47.8	206
			MIN	25.6	12.0	27	6.0	44.5	181
282	61.00	14	AV14	27.7	13.3	32	6.6	45.7	205
			STD	0.7	0.7	2	0.2	0.6	11
			MAX	28.8	14.4	34	6.9	47.0	223
			MIN	26.2	11.9	28	6.3	44.7	185
295	62.00	13	AV13	26.8	12.2	30	6.4	46.5	193
			STD	0.6	0.6	1	0.2	0.6	16
			MAX	28.2	13.4	33	6.9	47.2	235
			MIN	26.1	11.5	28	6.2	44.9	178
307	62.48	25	AV12	30.9	22.7	36	7.7	42.5	451
			STD	2.1	5.2	4	0.7	1.9	108
			MAX	33.7	28.4	43	8.7	45.7	558
			MIN	27.3	13.4	29	6.6	40.1	246
317	62.69	48	AV10	32.7	27.8	40	8.4	40.9	553
			STD	0.8	0.5	2	0.3	0.7	8
			MAX	33.6	28.3	42	8.7	42.2	565
			MIN	31.4	26.8	36	7.8	40.0	539
327	62.87	53	AV10	31.8	27.4	37	8.1	41.6	547
			STD	0.6	0.4	1	0.2	0.5	8
			MAX	32.7	28.2	40	8.4	42.4	561
			MIN	30.8	26.7	35	7.8	40.8	536
336	63.06	48	AV9	33.0	28.1	40	8.5	40.5	555
			STD	0.4	0.2	1	0.1	0.3	6
			MAX	33.6	28.5	41	8.7	41.1	568
			MIN	32.3	27.8	39	8.3	40.1	548
			Average	27.4	13.6	33	6.6	46.2	244
			Std. Dev.	3.1	5.6	4	0.9	3.3	120
			Maximum	33.7	28.5	43	8.7	57.5	568
			Minimum	17.7	4.4	23	4.1	40.0	60

Total number of blows analyzed: 331

BL# Sensors

1-336 F3: [D815] 93.0 (1.00); F4: [K769] 91.9 (1.00); A3: [K3550] 360.0 (1.00); A4: [K3658] 362.0 (1.00)

BL# Comments

6 Reported reference at El. 740.99
7 Mud line at El. 717.49

Time Summary

Drive 7 minutes 30 seconds 1:02 PM - 1:09 PM BN 1 - 336

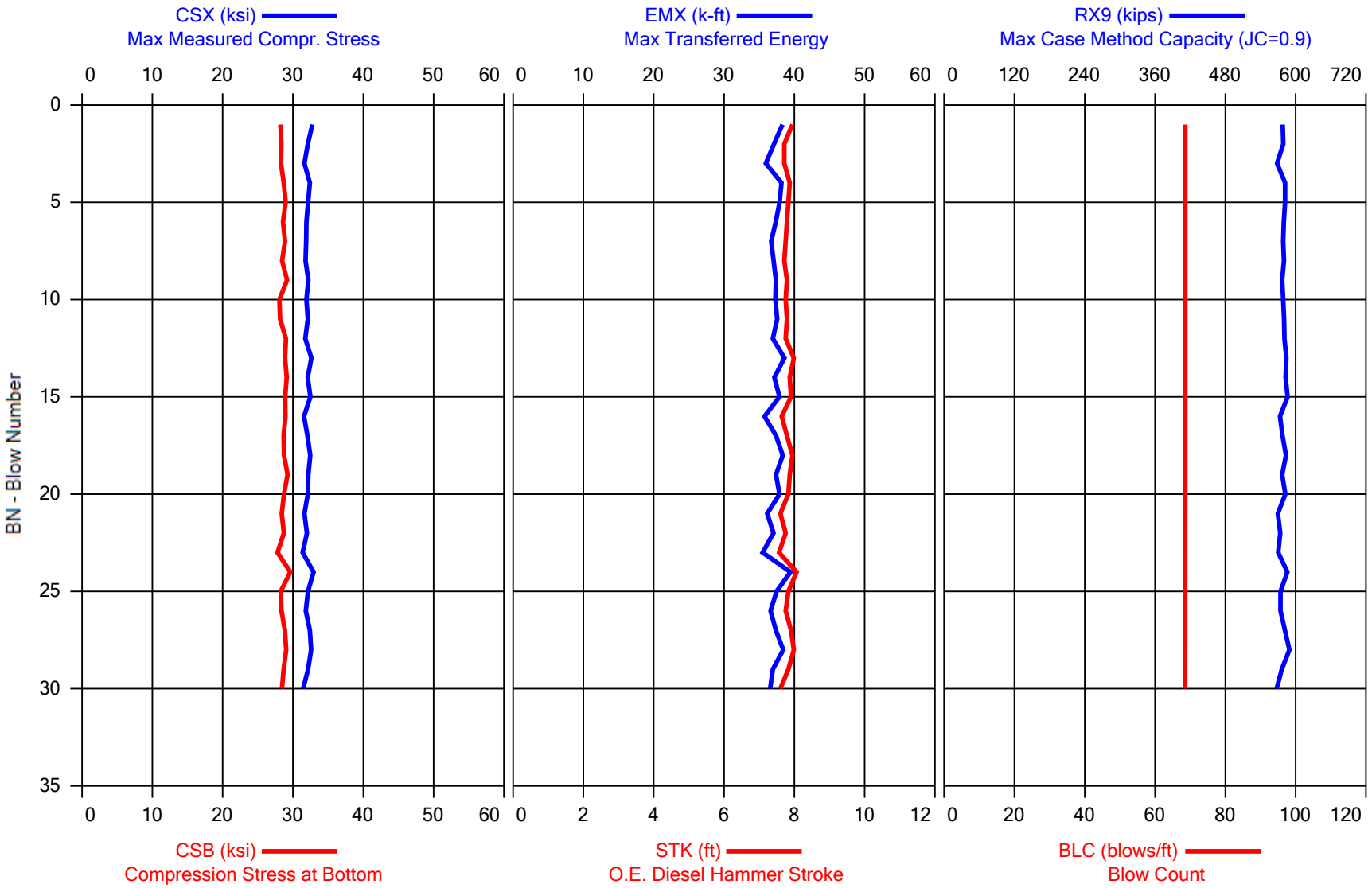
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 09-June-2015

Test started: 09-June-2015

USH 10 over Little Lake Butte des Morts - PIER 18 #44 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - PIER 18 #44 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 09-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 68.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s 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#	Depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	blows/ft		ksi	ksi	k-ft	ft	bpm	kips
10	63.23	69	AV10	32.1	28.6	37	7.8	42.3	578
			STD	0.3	0.3	1	0.1	0.2	4
			MAX	32.8	29.2	38	7.9	42.5	582
			MIN	31.6	28.1	36	7.7	41.9	568
20	63.37	69	AV10	32.1	28.8	37	7.8	42.2	581
			STD	0.3	0.3	1	0.1	0.2	4
			MAX	32.6	29.2	39	8.0	42.7	586
			MIN	31.6	28.2	36	7.6	41.8	573
30	63.52	69	AV10	32.0	28.6	37	7.8	42.3	576
			STD	0.5	0.5	1	0.2	0.4	7
			MAX	32.9	29.6	39	8.1	42.9	589
			MIN	31.4	27.8	35	7.6	41.6	568
			Average	32.1	28.7	37	7.8	42.3	578
			Std. Dev.	0.4	0.4	1	0.1	0.3	5
			Maximum	32.9	29.6	39	8.1	42.9	589
			Minimum	31.4	27.8	35	7.6	41.6	568

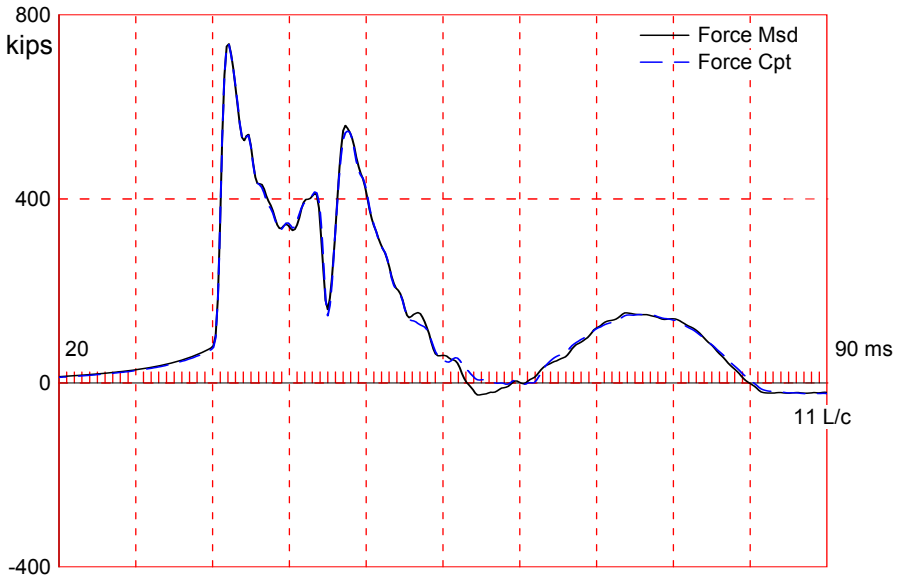
Total number of blows analyzed: 30

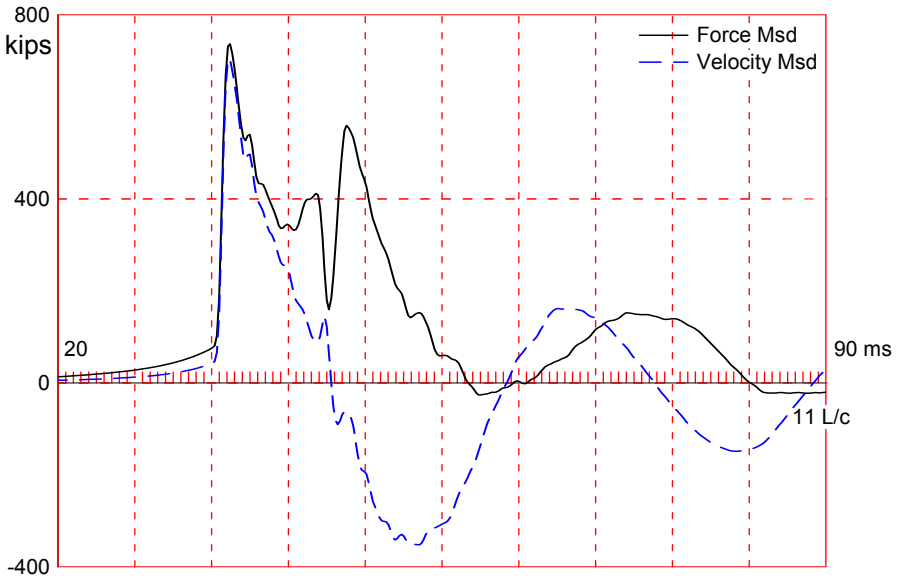
BL# Sensors

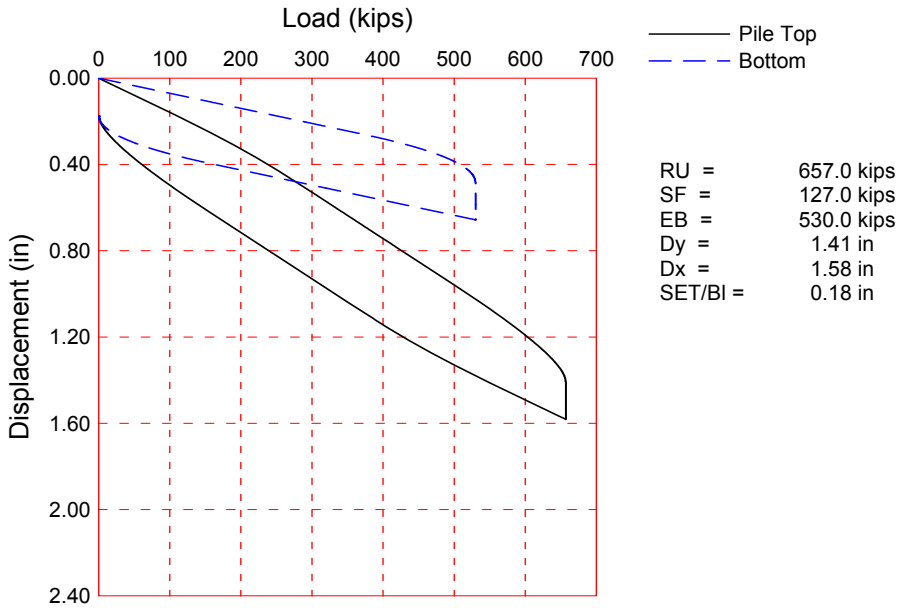
1-30 F3: [K769] 91.9 (1.00); F4: [D815] 93.0 (1.00); A3: [K3658] 362.0 (1.00); A4: [K3550] 360.0 (1.00)

Time Summary

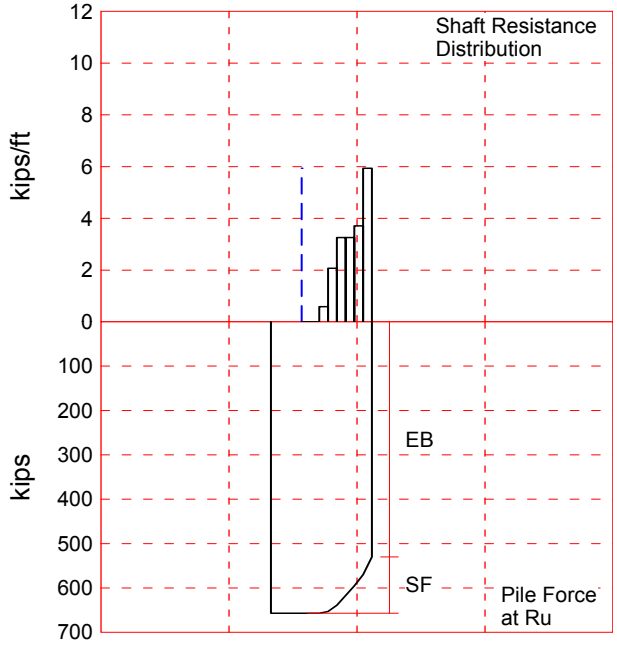
Drive 41 seconds 6:35 AM - 6:35 AM BN 1 - 30







RU =	657.0 kips
SF =	127.0 kips
EB =	530.0 kips
Dy =	1.41 in
Dx =	1.58 in
SET/BI =	0.18 in



Length b. Sensors	77.5 ft
Embedment	52.6 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	1.72
Top Compr. Stress	34.4 ksi
Max Compr. Stress	36.6 ksi
Max Tension Stress	-7.05 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.37 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.07 s/ft

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: 657.0; along Shaft 127.0; at Toe 530.0 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
				657.0				
1	30.3	5.4	0.0	657.0	0.0	0.00	0.00	0.00
2	37.1	12.2	0.0	657.0	0.0	0.00	0.00	0.00
3	43.8	18.9	4.0	653.0	4.0	0.59	0.13	0.25
4	50.5	25.6	14.0	639.0	18.0	2.08	0.44	0.25
5	57.3	32.4	22.0	617.0	40.0	3.26	0.69	0.25
6	64.0	39.1	22.0	595.0	62.0	3.26	0.69	0.25
7	70.8	45.9	25.0	570.0	87.0	3.71	0.79	0.25
8	77.5	52.6	40.0	530.0	127.0	5.94	1.26	0.25
Avg. Shaft			15.9			2.41	0.51	0.25
Toe			530.0				384.48	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.09	0.37
Case Damping Factor		0.83	0.97
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	77	60
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	55	
Resistance Gap (included in Toe Quake)	(in)		0.08
Soil Plug Weight	(kips)	0.040	0.067

CAPWAP match quality = 1.72 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.18 in; Blow Count = 69 b/ft
Computed: Final Set = 0.13 in; Blow Count = 90 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(K769) CAL: 91.9; RF: 1.00
A3(K3550) CAL: 360; RF: 1.00; A4(K3658) CAL: 362; RF: 1.00

max. Top Comp. Stress = 34.4 ksi (T= 35.9 ms, max= 1.065 x Top)
max. Comp. Stress = 36.6 ksi (Z= 50.5 ft, T= 38.7 ms)
max. Tens. Stress = -7.05 ksi (Z= 50.5 ft, T= 60.3 ms)
max. Energy (EMX) = 42.9 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	3.4	736.4	-29.7	34.4	-1.39	42.9	18.4	1.13
2	6.7	737.2	-35.4	34.4	-1.65	42.7	18.4	1.11
4	13.5	739.0	-54.0	34.5	-2.52	41.7	18.4	1.06
5	16.8	739.9	-67.7	34.6	-3.16	41.1	18.3	1.03
6	20.2	741.0	-80.5	34.6	-3.76	40.4	18.3	0.99
7	23.6	742.1	-92.6	34.7	-4.33	39.7	18.3	0.96
8	27.0	743.3	-102.6	34.7	-4.79	39.0	18.2	0.93
9	30.3	744.6	-113.1	34.8	-5.29	38.2	18.2	0.89
10	33.7	746.2	-123.0	34.9	-5.74	37.5	18.1	0.86
11	37.1	750.6	-131.6	35.1	-6.15	36.8	18.0	0.83
12	40.4	757.5	-138.2	35.4	-6.46	35.9	17.8	0.79
13	43.8	769.6	-144.7	36.0	-6.76	35.1	17.5	0.75
14	47.2	766.2	-146.0	35.8	-6.82	33.2	17.0	0.72
15	50.5	784.5	-150.9	36.6	-7.05	32.3	16.6	0.68
16	53.9	738.6	-141.7	34.5	-6.62	28.7	15.9	0.64
17	57.3	757.1	-141.8	35.4	-6.62	27.7	15.4	0.60
18	60.7	681.3	-126.6	31.8	-5.91	23.1	14.7	0.57
19	64.0	710.6	-133.3	33.2	-6.23	22.1	13.9	0.53
20	67.4	627.9	-116.6	29.3	-5.45	18.0	15.0	0.49
21	70.8	642.4	-116.9	30.0	-5.46	17.0	16.7	0.45
22	74.1	632.6	-95.2	29.6	-4.45	13.1	17.6	0.42
23	77.5	650.3	-94.7	30.4	-4.43	9.5	16.5	0.38
Absolute	50.5			36.6			(T =	38.7 ms)
	50.5				-7.05		(T =	60.3 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	784.3	648.3	512.3	376.3	240.2					
RX	858.8	791.8	748.1	704.5	668.6	651.8	635.1	618.3	607.4	607.2
RU	784.3	648.3	512.3	376.3	240.2					

RAU = 600.8 (kips); RA2 = 674.7 (kips)

Current CAPWAP Ru = 657.0 (kips); Corresponding J(RP)= 0.19; J(RX) = 0.94

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
18.8	35.68	717.6	746.9	746.9	1.13	0.16	0.18	43.3	798.1	1828

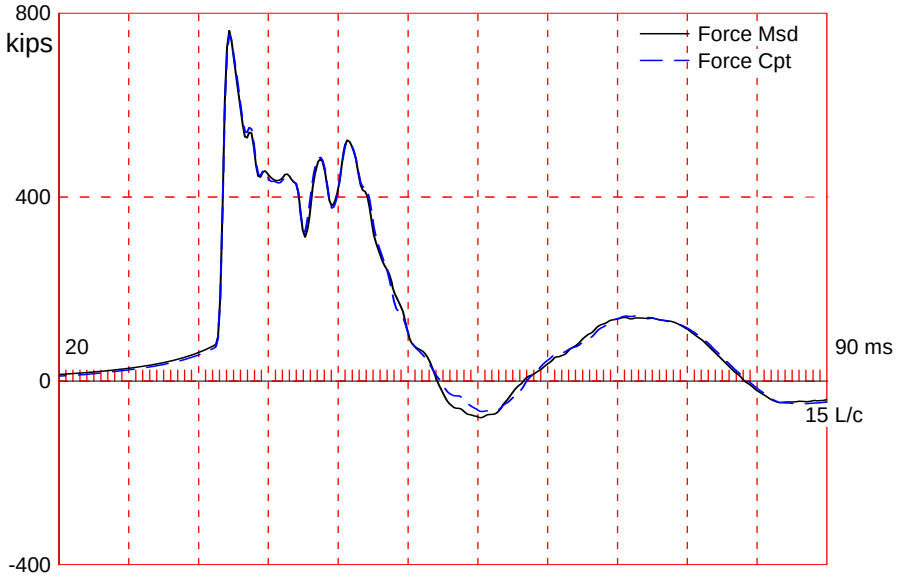
PILE PROFILE AND PILE MODEL

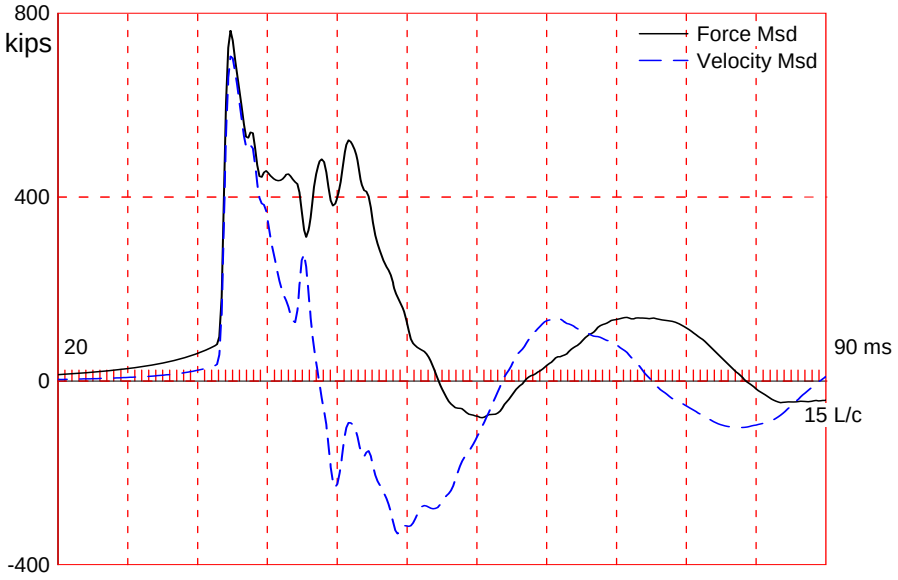
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

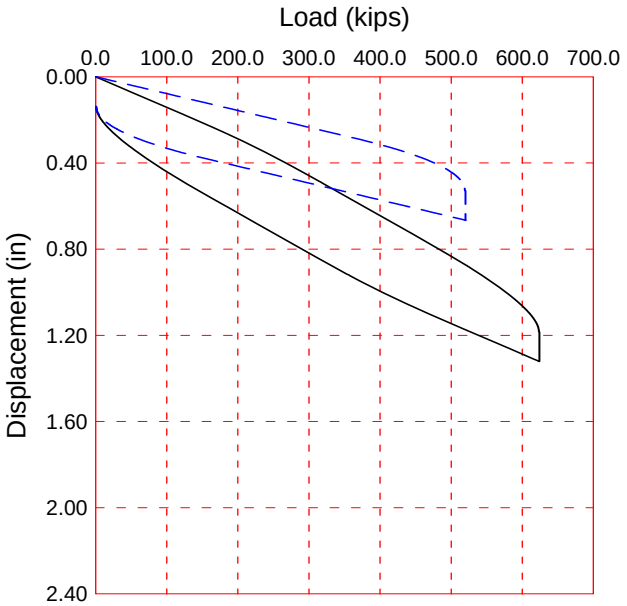
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	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
21	70.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.040
22	74.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

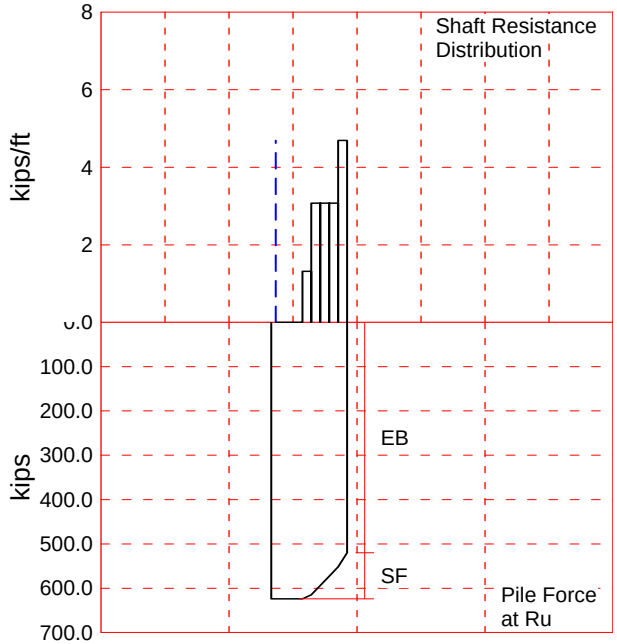
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	624.0 kips
SF =	104.0 kips
EB =	520.0 kips
Dy =	1.18 in
Dx =	1.32 in
SET/Bl =	0.14 in



Length b. Sensors	58.0 ft
Embedment	53.7 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	1.77
Top Compr. Stress	35.3 ksi
Max Compr. Stress	37.1 ksi
Max Tension Stress	-7.29 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.41 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.05 s/ft

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 624.0; along Shaft 104.0; at Toe 520.0 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
				624.0				
1	10.2	5.9	0.0	624.0	0.0	0.00	0.00	0.00
2	17.1	12.7	0.0	624.0	0.0	0.00	0.00	0.00
3	23.9	19.6	0.0	624.0	0.0	0.00	0.00	0.00
4	30.7	26.4	9.0	615.0	9.0	1.32	0.28	0.26
5	37.5	33.2	21.0	594.0	30.0	3.08	0.65	0.26
6	44.4	40.0	21.0	573.0	51.0	3.08	0.65	0.26
7	51.2	46.9	21.0	552.0	72.0	3.08	0.65	0.26
8	58.0	53.7	32.0	520.0	104.0	4.69	1.00	0.26
Avg. Shaft			13.0			1.94	0.41	0.26
Toe			520.0				377.23	0.05

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.14	0.41
Case Damping Factor		0.71	0.68
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	55	62
Unloading Level	(% of Ru)	79	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)		0.042

CAPWAP match quality = 1.77 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.14 in; Blow Count = 87 b/ft
Computed: Final Set = 0.18 in; Blow Count = 68 b/ft
Transducer F3(K769) CAL: 91.9; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K3658) CAL: 362; RF: 1.09; A4(K3550) CAL: 360; RF: 1.09

max. Top Comp. Stress = 35.3 ksi (T= 35.9 ms, max= 1.053 x Top)
max. Comp. Stress = 37.1 ksi (Z= 30.7 ft, T= 37.8 ms)
max. Tens. Stress = -7.29 ksi (Z= 37.5 ft, T= 58.3 ms)
max. Energy (EMX) = 42.1 kip-ft; max. Measured Top Displ. (DMX)= 1.02 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	754.6	-78.1	35.3	-3.65	42.1	18.7	1.01
2	6.8	755.3	-90.4	35.3	-4.22	41.4	18.7	0.98
3	10.2	756.0	-102.4	35.3	-4.79	40.7	18.6	0.95
4	13.6	756.9	-113.0	35.4	-5.28	39.9	18.6	0.91
5	17.1	757.9	-122.2	35.4	-5.71	39.1	18.5	0.88
6	20.5	759.0	-130.5	35.5	-6.09	38.2	18.5	0.84
7	23.9	763.0	-138.3	35.6	-6.46	37.2	18.3	0.80
8	27.3	776.4	-145.4	36.3	-6.79	36.2	18.0	0.76
9	30.7	794.3	-152.3	37.1	-7.12	35.3	17.6	0.73
10	34.1	772.4	-148.6	36.1	-6.94	32.4	16.8	0.69
11	37.5	793.9	-156.0	37.1	-7.29	31.4	16.2	0.65
12	40.9	713.0	-134.5	33.3	-6.28	26.6	15.5	0.61
13	44.4	733.7	-142.9	34.3	-6.67	25.6	15.0	0.57
14	47.8	653.0	-123.1	30.5	-5.75	21.3	15.2	0.54
15	51.2	642.2	-127.5	30.0	-5.96	20.4	16.7	0.50
16	54.6	618.6	-100.5	28.9	-4.69	16.7	17.9	0.47
17	58.0	636.6	-100.0	29.7	-4.67	13.1	17.2	0.43
Absolute	30.7			37.1			(T =	37.8 ms)
	37.5				-7.29		(T =	58.3 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	777.7	634.4	491.2	347.9	204.6					
RX	811.5	759.2	709.1	667.3	645.5	624.3	604.5	594.8	590.5	586.5
RU	777.7	634.4	491.2	347.9	204.6					

RAU = 500.6 (kips); RA2 = 707.3 (kips)

Current CAPWAP Ru = 624.0 (kips); Corresponding J(RP)= 0.21; J(RX) = 1.00

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
18.8	35.73	718.3	775.7	775.7	1.02	0.14	0.14	43.0	888.2	1300

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
58.0	21.4	29992.2	492.000	4.70

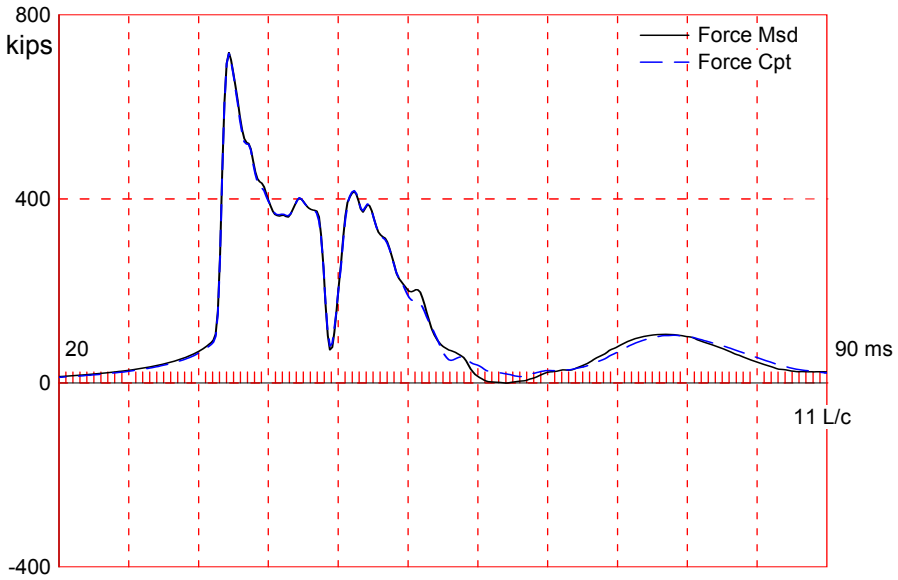
Toe Area 198.5 in^2

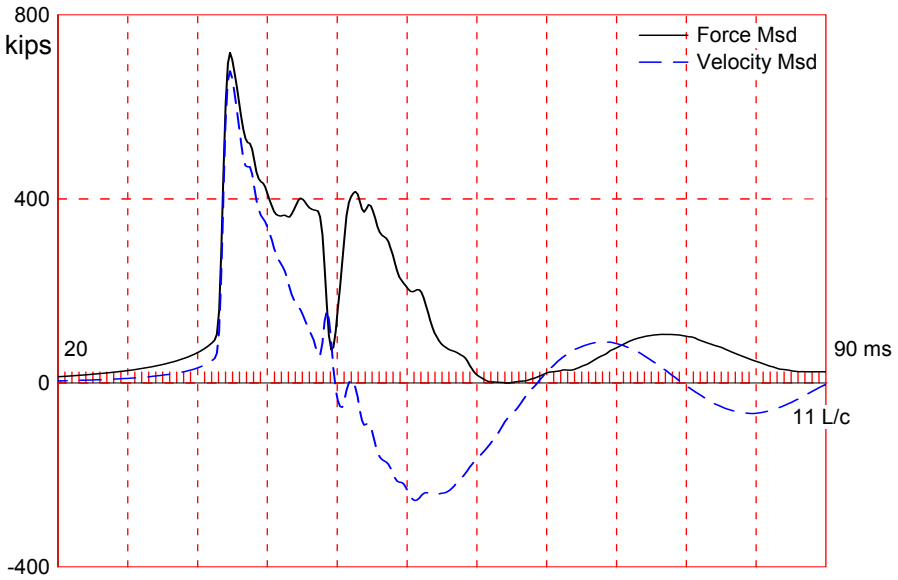
Top Segment Length 3.41 ft, Top Impedance 38 kips/ft/s

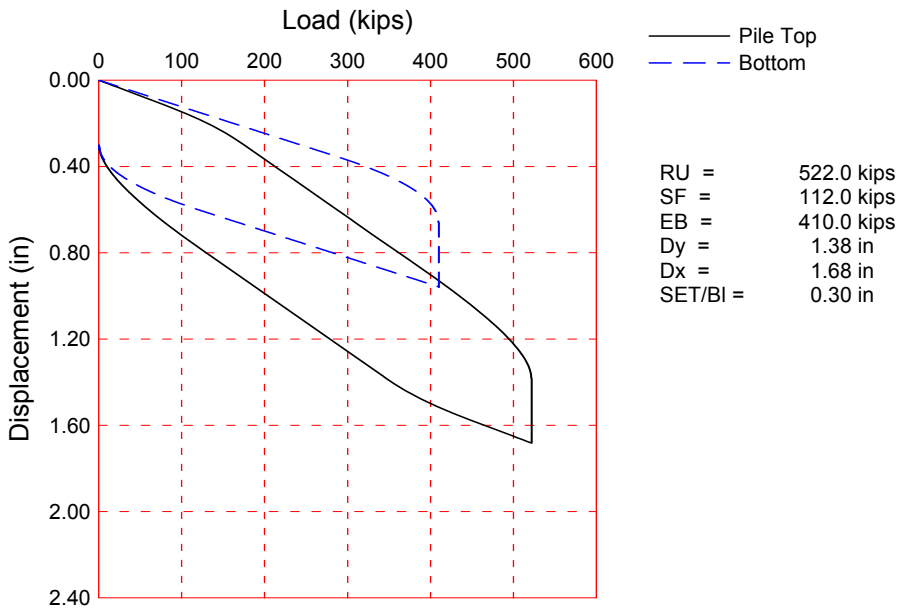
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.203 ms, 2L/c 6.9 ms
Total volume: 8.619 ft^3; Volume ratio considering added impedance: 1.000

DYNAMIC RESISTANCE TABLE

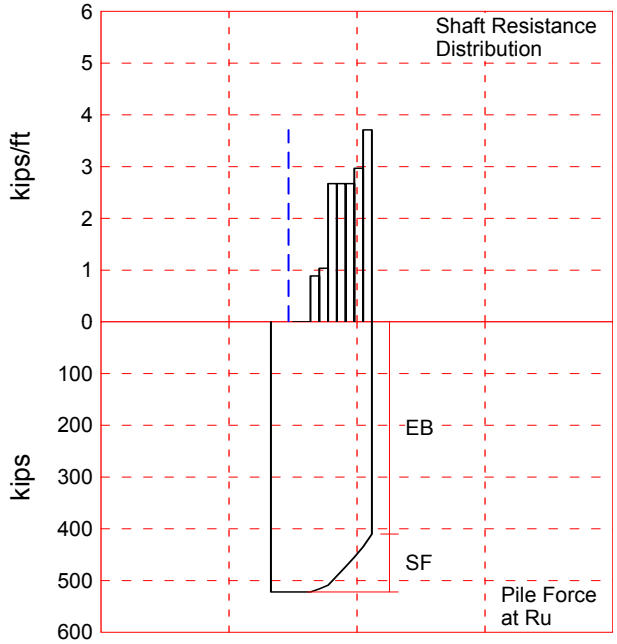
Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Damping Rd at Max. Rt kips	Max Rt (Ru+Rd) kips	Total Unit Rt W. Resp. to Depth kips/ft	Area ksf	Smith Damping Factor s/ft
1	10.2	5.9	0.0	0.0	0.0	0.00	0.00	0.00
2	17.1	12.7	0.0	0.0	0.0	0.00	0.00	0.00
3	23.9	19.6	0.0	0.0	0.0	0.00	0.00	0.00
4	30.7	26.4	9.0	40.8	49.8	7.30	1.55	0.26
5	37.5	33.2	21.0	86.4	107.4	15.74	3.35	0.26
6	44.4	40.0	21.0	78.2	99.2	14.53	3.09	0.26
7	51.2	46.9	21.0	89.8	110.8	16.23	3.45	0.26
8	58.0	53.7	32.0	134.7	166.7	24.44	5.20	0.26
Avg. Shaft			13.0	53.7	66.7	9.95	2.12	0.26
Toe			520.0	49.7	569.7		413.29	0.05
Total					1103.6			







RU =	522.0 kips
SF =	112.0 kips
EB =	410.0 kips
Dy =	1.38 in
Dx =	1.68 in
SET/BI =	0.30 in



Length b. Sensors	77.5 ft
Embedment	62.5 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	1.80
Top Compr. Stress	33.5 ksi
Max Compr. Stress	34.8 ksi
Max Tension Stress	-2.59 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.51 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.06 s/ft

About the CAPWAP Results

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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.

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: 522.0; along Shaft 112.0; at Toe 410.0 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
				522.0				
1	23.6	8.6	0.0	522.0	0.0	0.00	0.00	0.00
2	30.3	15.3	0.0	522.0	0.0	0.00	0.00	0.00
3	37.1	22.1	6.0	516.0	6.0	0.89	0.19	0.25
4	43.8	28.8	7.0	509.0	13.0	1.04	0.22	0.25
5	50.5	35.6	18.0	491.0	31.0	2.67	0.57	0.25
6	57.3	42.3	18.0	473.0	49.0	2.67	0.57	0.25
7	64.0	49.0	18.0	455.0	67.0	2.67	0.57	0.25
8	70.8	55.8	20.0	435.0	87.0	2.97	0.63	0.25
9	77.5	62.5	25.0	410.0	112.0	3.71	0.79	0.25
Avg. Shaft			12.4			1.79	0.38	0.25
Toe			410.0				297.43	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.06	0.51
Case Damping Factor		0.73	0.64
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	53
Reloading Level	(% of Ru)	100	0
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)	0.040	0.000

CAPWAP match quality = 1.80 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.30 in; Blow Count = 40 b/ft
Computed: Final Set = 0.33 in; Blow Count = 36 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(K769) CAL: 91.9; RF: 1.00
A3(K3550) CAL: 360; RF: 0.98; A4(K3658) CAL: 362; RF: 0.98

max. Top Comp. Stress = 33.5 ksi (T= 35.9 ms, max= 1.040 x Top)
max. Comp. Stress = 34.8 ksi (Z= 37.1 ft, T= 37.9 ms)
max. Tens. Stress = -2.59 ksi (Z= 50.5 ft, T= 62.3 ms)
max. Energy (EMX) = 40.6 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	717.3	0.0	33.5	0.00	40.6	17.8	1.09
2	6.7	718.2	-0.1	33.6	-0.00	40.5	17.7	1.08
4	13.5	720.3	-11.2	33.6	-0.52	40.1	17.6	1.04
5	16.8	721.4	-18.8	33.7	-0.88	39.8	17.6	1.02
6	20.2	722.7	-25.9	33.8	-1.21	39.4	17.6	0.99
7	23.6	724.1	-32.1	33.8	-1.50	38.9	17.5	0.97
8	27.0	725.7	-38.0	33.9	-1.77	38.4	17.5	0.94
9	30.3	730.3	-42.6	34.1	-1.99	37.9	17.3	0.91
10	33.7	738.5	-46.4	34.5	-2.17	37.4	17.1	0.89
11	37.1	745.8	-51.1	34.8	-2.39	36.8	16.9	0.86
12	40.4	724.1	-48.1	33.8	-2.25	34.8	16.6	0.83
13	43.8	737.1	-53.9	34.4	-2.52	34.2	16.3	0.80
14	47.2	722.6	-50.0	33.8	-2.34	32.1	15.7	0.77
15	50.5	744.1	-55.4	34.8	-2.59	31.5	15.2	0.74
16	53.9	679.5	-37.5	31.7	-1.75	27.4	14.6	0.71
17	57.3	689.8	-42.1	32.2	-1.97	26.8	14.3	0.68
18	60.7	626.3	-24.3	29.3	-1.13	23.0	13.9	0.65
19	64.0	648.0	-28.2	30.3	-1.32	22.4	13.9	0.62
20	67.4	581.2	-10.6	27.2	-0.49	18.9	15.5	0.59
21	70.8	536.6	-14.2	25.1	-0.66	18.3	16.9	0.56
22	74.1	460.6	-0.0	21.5	-0.00	14.7	17.7	0.53
23	77.5	481.4	-0.0	22.5	-0.00	11.6	17.1	0.51
Absolute	37.1			34.8			(T =	37.9 ms)
	50.5				-2.59		(T =	62.3 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	675.1	603.0	530.8	458.6	386.4	314.2	242.0	169.8	97.7	25.5
RX	717.3	669.2	636.8	607.1	577.4	547.6	530.2	518.1	509.1	501.0
RU	687.0	614.7	542.4	470.0	397.7	325.4	253.1	180.8	108.4	36.1

RAU = 457.4 (kips); RA2 = 568.3 (kips)

Current CAPWAP Ru = 522.0 (kips); Corresponding J(RP)= 0.21; J(RX) = 0.67

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
18.0	35.68	678.2	718.8	724.4	1.07	0.30	0.30	40.8	711.9	854

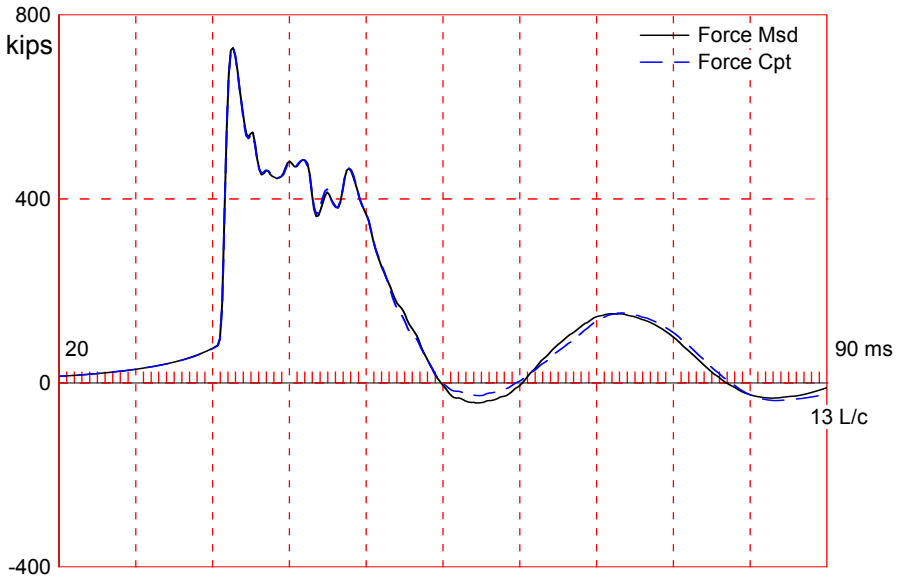
PILE PROFILE AND PILE MODEL

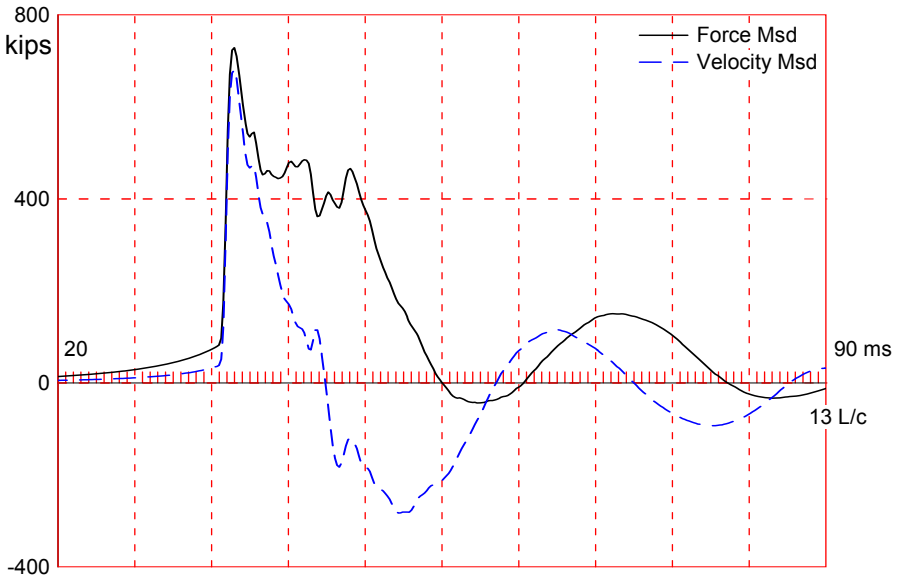
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

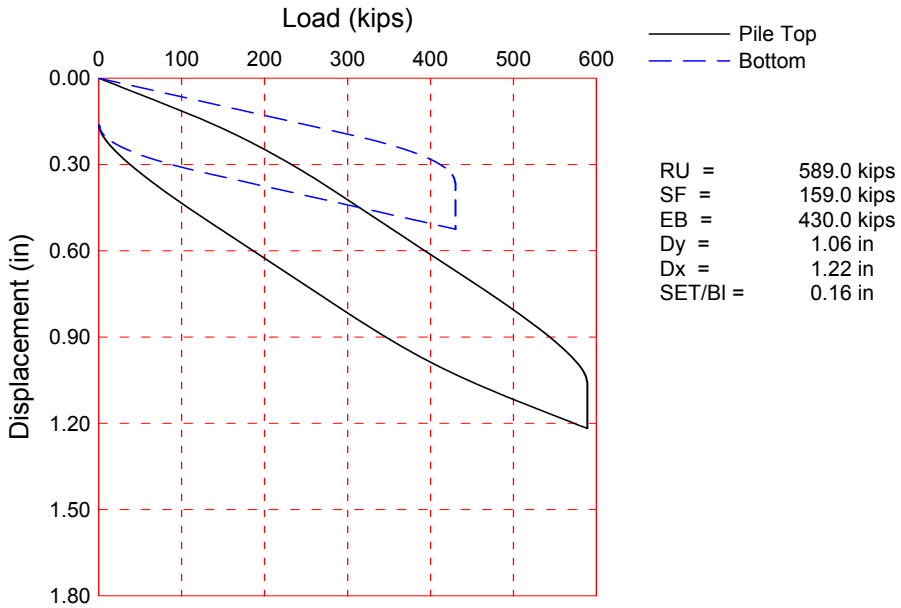
Toe Area 198.5 in^2

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
17	57.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
19	64.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
21	70.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
22	74.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

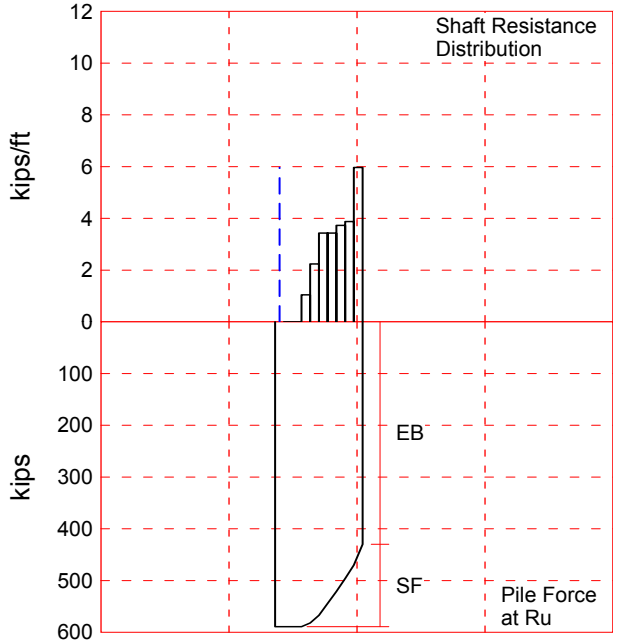
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 $ft^{3;}$ Volume ratio considering added impedance: 1.000







RU =	589.0 kips
SF =	159.0 kips
EB =	430.0 kips
Dy =	1.06 in
Dx =	1.22 in
SET/Bl =	0.16 in



Length b. Sensors	67.0 ft
Embedment	62.6 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	1.98
Top Compr. Stress	34.1 ksi
Max Compr. Stress	36.1 ksi
Max Tension Stress	-4.51 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.28 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.07 s/ft

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.

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 589.0; along Shaft 159.0; at Toe 430.0 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
				589.0				
1	13.4	9.0	0.0	589.0	0.0	0.00	0.00	0.00
2	20.1	15.7	0.0	589.0	0.0	0.00	0.00	0.00
3	26.8	22.4	7.0	582.0	7.0	1.04	0.22	0.29
4	33.5	29.1	15.0	567.0	22.0	2.24	0.48	0.29
5	40.2	35.8	23.0	544.0	45.0	3.43	0.73	0.29
6	46.9	42.5	23.0	521.0	68.0	3.43	0.73	0.29
7	53.6	49.2	25.0	496.0	93.0	3.73	0.79	0.29
8	60.3	55.9	26.0	470.0	119.0	3.88	0.83	0.29
9	67.0	62.6	40.0	430.0	159.0	5.97	1.27	0.29
Avg. Shaft			17.7			2.54	0.54	0.29
Toe			430.0				311.94	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.06	0.28
Case Damping Factor		1.21	0.79
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	99	80
Reloading Level	(% of Ru)	100	0
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)		0.033

CAPWAP match quality = 1.98 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.16 in; Blow Count = 74 b/ft
Computed: Final Set = 0.20 in; Blow Count = 60 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(K769) CAL: 91.9; RF: 1.00
A3(K3550) CAL: 360; RF: 1.00; A4(K3658) CAL: 362; RF: 1.00

max. Top Comp. Stress = 34.1 ksi (T= 36.3 ms, max= 1.058 x Top)
max. Comp. Stress = 36.1 ksi (Z= 33.5 ft, T= 38.1 ms)
max. Tens. Stress = -4.51 ksi (Z= 33.5 ft, T= 58.2 ms)
max. Energy (EMX) = 39.4 kip-ft; max. Measured Top Displ. (DMX)= 0.96 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	730.2	-42.8	34.1	-2.00	39.4	17.8	0.94
2	6.7	731.5	-46.8	34.2	-2.19	38.9	17.7	0.91
3	10.1	733.0	-54.7	34.2	-2.56	38.3	17.7	0.88
4	13.4	734.7	-63.2	34.3	-2.95	37.6	17.6	0.85
5	16.8	736.7	-71.3	34.4	-3.33	36.9	17.6	0.81
6	20.1	744.8	-79.0	34.8	-3.69	36.1	17.3	0.78
7	23.5	755.6	-85.8	35.3	-4.01	35.3	17.1	0.74
8	26.8	771.3	-93.7	36.0	-4.38	34.4	16.7	0.71
9	30.2	751.1	-89.2	35.1	-4.17	32.1	16.1	0.67
10	33.5	772.7	-96.4	36.1	-4.51	31.2	15.6	0.64
11	36.9	719.4	-79.3	33.6	-3.70	27.5	14.8	0.60
12	40.2	740.4	-86.2	34.6	-4.03	26.6	14.3	0.56
13	43.6	651.3	-58.4	30.4	-2.73	22.2	13.5	0.53
14	46.9	673.3	-64.2	31.5	-3.00	21.4	13.0	0.49
15	50.3	590.7	-38.1	27.6	-1.78	17.6	12.3	0.46
16	53.6	612.8	-42.2	28.6	-1.97	16.9	11.8	0.43
17	57.0	535.5	-18.0	25.0	-0.84	13.5	11.7	0.40
18	60.3	555.1	-21.7	25.9	-1.01	12.8	12.9	0.37
19	63.7	525.4	0.0	24.5	0.00	9.9	13.1	0.34
20	67.0	540.6	0.0	25.3	0.00	7.2	12.0	0.31
Absolute	33.5			36.1			(T =	38.1 ms)
	33.5				-4.51		(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	859.5	747.6	635.7	523.8	411.9					
RX	876.6	778.6	703.9	658.3	616.6	588.3	565.0	542.9	528.2	513.5
RU	859.5	747.6	635.7	523.8	411.9					

RAU = 357.5 (kips); RA2 = 687.9 (kips)

Current CAPWAP Ru = 589.0 (kips); Corresponding J(RP)= 0.48; J(RX) = 0.99

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
17.9	36.08	684.8	734.1	734.1	0.96	0.16	0.16	40.0	855.2	1721

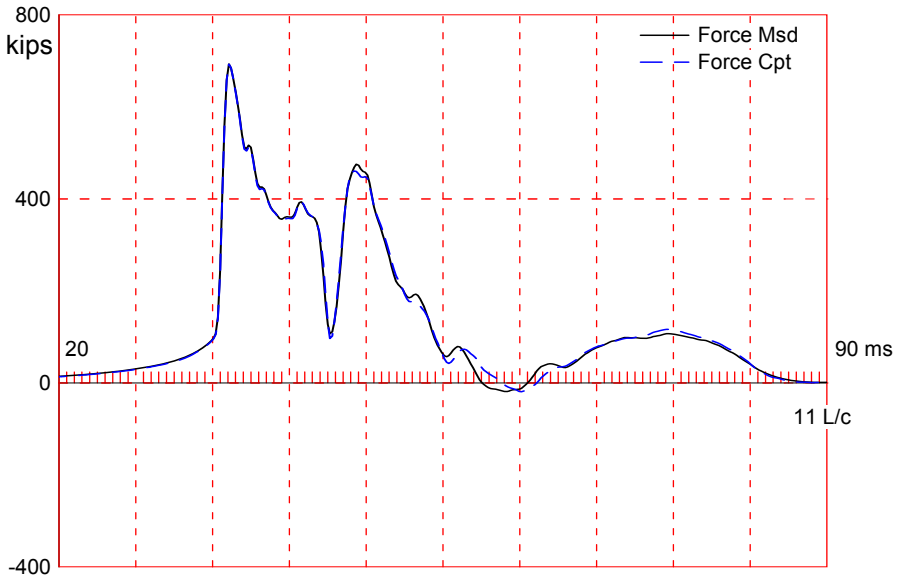
PILE PROFILE AND PILE MODEL

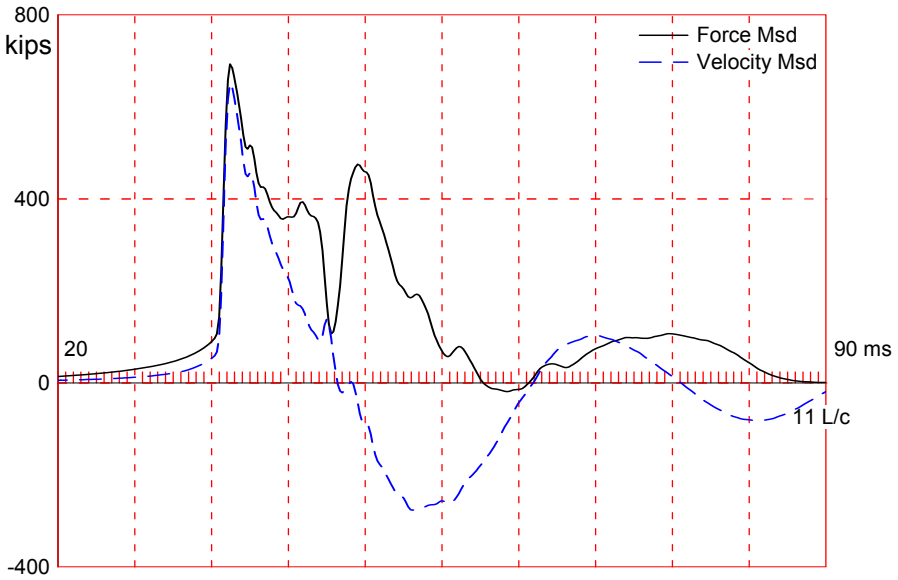
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
67.0	21.4	29992.2	492.000	4.70

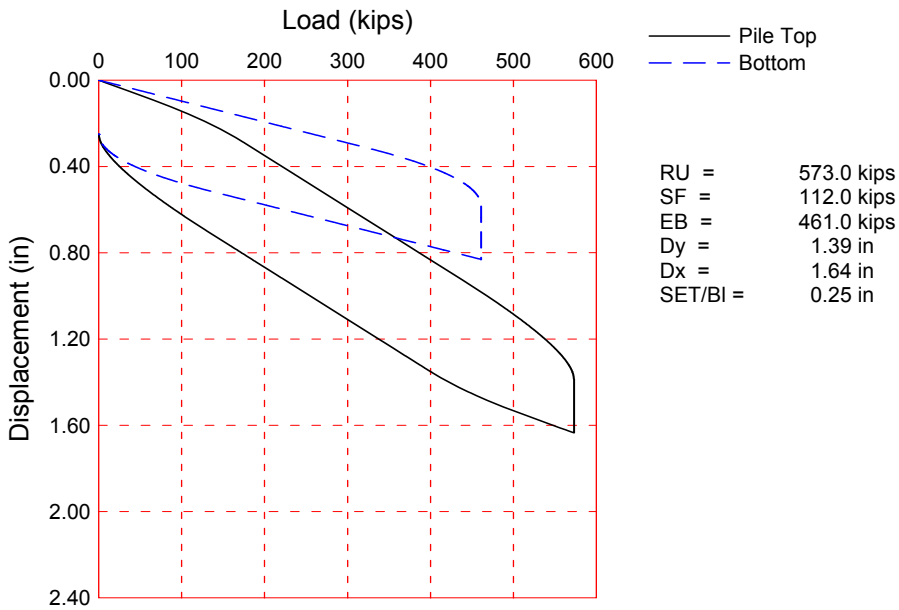
Toe Area 198.5 in^2

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

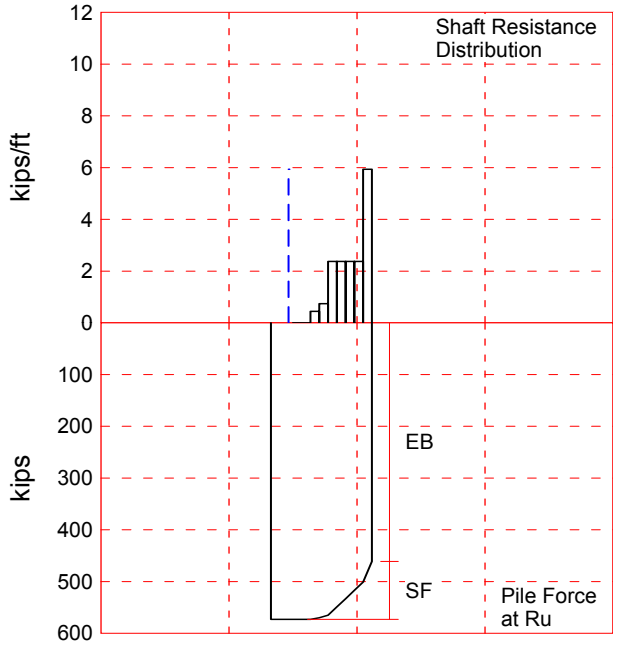
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 8.0 ms
Total volume: 9.957 ft^3; Volume ratio considering added impedance: 1.000







RU =	573.0 kips
SF =	112.0 kips
EB =	461.0 kips
Dy =	1.39 in
Dx =	1.64 in
SET/Bl =	0.25 in



Length b. Sensors	77.5 ft
Embedment	63.0 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	2.00
Top Compr. Stress	32.4 ksi
Max Compr. Stress	34.5 ksi
Max Tension Stress	-5.02 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.45 in
Avg. Shaft Smith Dpg.	0.22 s/ft
Toe Smith Damping	0.05 s/ft

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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: 573.0; along Shaft 112.0; at Toe 461.0 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	Quake in
				573.0					
1	23.6	9.1	0.0	573.0	0.0	0.00	0.00	0.00	0.05
2	30.3	15.8	0.0	573.0	0.0	0.00	0.00	0.00	0.05
3	37.1	22.6	3.0	570.0	3.0	0.45	0.09	0.22	0.05
4	43.8	29.3	5.0	565.0	8.0	0.74	0.16	0.22	0.05
5	50.5	36.1	16.0	549.0	24.0	2.37	0.51	0.22	0.05
6	57.3	42.8	16.0	533.0	40.0	2.37	0.51	0.22	0.05
7	64.0	49.5	16.0	517.0	56.0	2.37	0.51	0.22	0.05
8	70.8	56.3	16.0	501.0	72.0	2.37	0.51	0.22	0.05
9	77.5	63.0	40.0	461.0	112.0	5.94	1.26	0.22	0.05
Avg. Shaft			12.4			1.78	0.38	0.22	0.05
Toe			461.0				334.43	0.05	0.45

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		0.65	0.60
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	34	30
Unloading Level	(% of Ru)	30	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.070	0.036

CAPWAP match quality = 2.00 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.25 in; Blow Count = 48 b/ft
Computed: Final Set = 0.27 in; Blow Count = 45 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.02; F4(K769) CAL: 91.9; RF: 1.02
A3(K3550) CAL: 360; RF: 0.98; A4(K3658) CAL: 362; RF: 0.98

max. Top Comp. Stress = 32.4 ksi (T= 35.9 ms, max= 1.064 x Top)
max. Comp. Stress = 34.5 ksi (Z= 50.5 ft, T= 38.9 ms)
max. Tens. Stress = -5.02 ksi (Z= 43.8 ft, T= 61.3 ms)
max. Energy (EMX) = 39.0 kip-ft; max. Measured Top Displ. (DMX)= 1.08 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	693.8	-27.0	32.4	-1.26	39.0	17.0	1.08
2	6.7	694.6	-36.2	32.5	-1.69	38.9	17.0	1.07
4	13.5	696.5	-54.0	32.5	-2.52	38.5	16.9	1.03
5	16.8	697.5	-61.5	32.6	-2.87	38.1	16.8	1.01
6	20.2	698.7	-69.7	32.6	-3.26	37.7	16.8	0.98
7	23.6	700.1	-77.3	32.7	-3.61	37.2	16.7	0.96
8	27.0	701.6	-84.1	32.8	-3.93	36.7	16.7	0.93
9	30.3	704.2	-91.1	32.9	-4.25	36.1	16.6	0.90
10	33.7	708.9	-98.4	33.1	-4.60	35.5	16.4	0.87
11	37.1	713.6	-104.0	33.3	-4.86	34.9	16.3	0.84
12	40.4	706.3	-105.0	33.0	-4.91	33.6	16.1	0.81
13	43.8	719.4	-107.5	33.6	-5.02	32.9	15.9	0.77
14	47.2	715.9	-104.1	33.4	-4.86	31.2	15.4	0.74
15	50.5	737.9	-103.5	34.5	-4.84	30.5	14.9	0.71
16	53.9	688.1	-92.8	32.1	-4.34	27.0	14.3	0.67
17	57.3	695.5	-93.3	32.5	-4.36	26.2	14.0	0.64
18	60.7	645.1	-83.9	30.1	-3.92	23.0	13.7	0.61
19	64.0	651.5	-87.5	30.4	-4.09	22.3	13.5	0.58
20	67.4	591.3	-83.0	27.6	-3.88	19.3	14.8	0.54
21	70.8	565.9	-84.1	26.4	-3.93	18.6	16.1	0.51
22	74.1	536.9	-72.4	25.1	-3.38	15.8	17.2	0.48
23	77.5	556.9	-71.5	26.0	-3.34	11.5	16.7	0.45
Absolute	50.5			34.5			(T =	38.9 ms)
	43.8				-5.02		(T =	61.3 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	678.0	610.0	542.0	474.1	406.1	338.1	270.2	202.2	134.2	66.3
RX	715.7	689.1	662.5	636.6	620.5	608.8	597.1	585.4	573.7	562.0
RU	678.0	610.0	542.0	474.1	406.1	338.1	270.2	202.2	134.2	66.3

RAU = 466.7 (kips); RA2 = 617.8 (kips)

Current CAPWAP Ru = 573.0 (kips); Corresponding J(RP)= 0.15; J(RX) = 0.81

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
17.2	35.68	657.9	699.7	699.7	1.08	0.25	0.25	39.3	709.8	1048

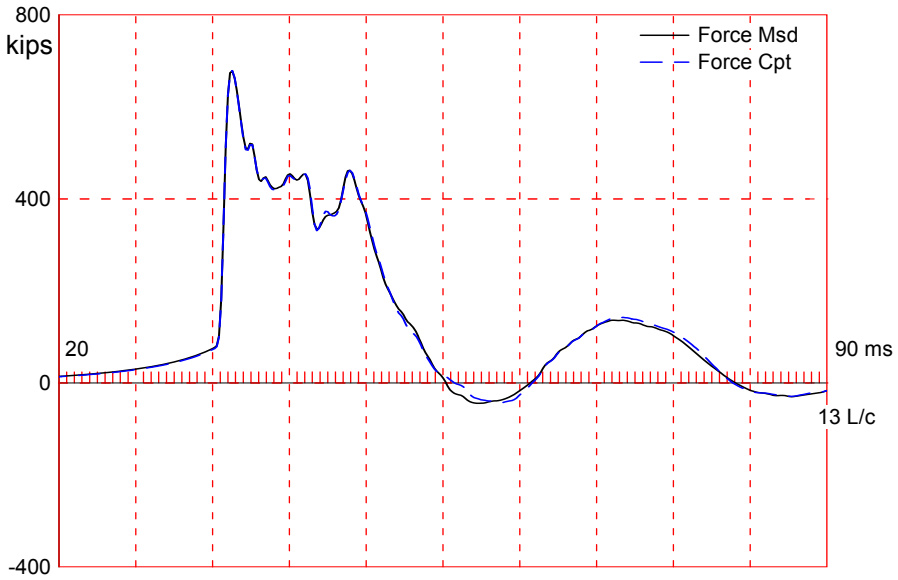
PILE PROFILE AND PILE MODEL

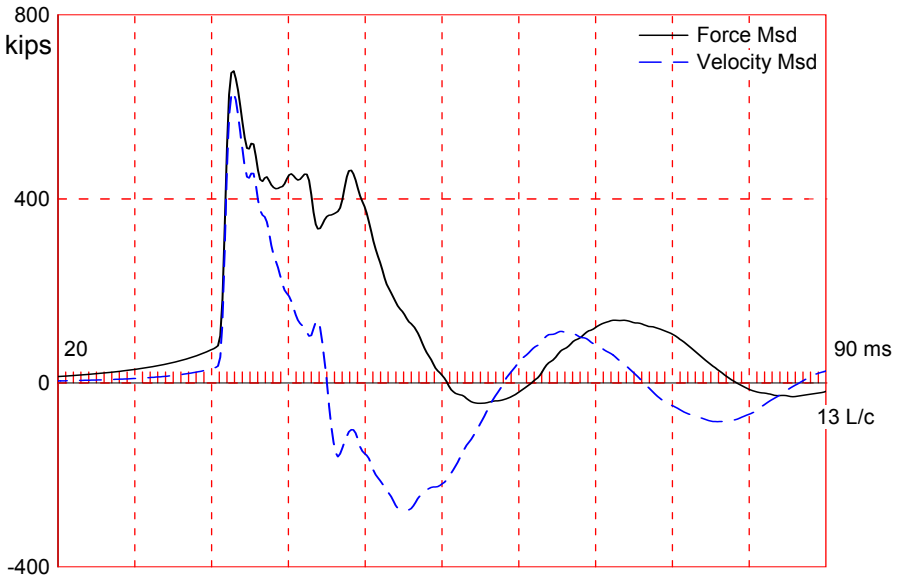
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

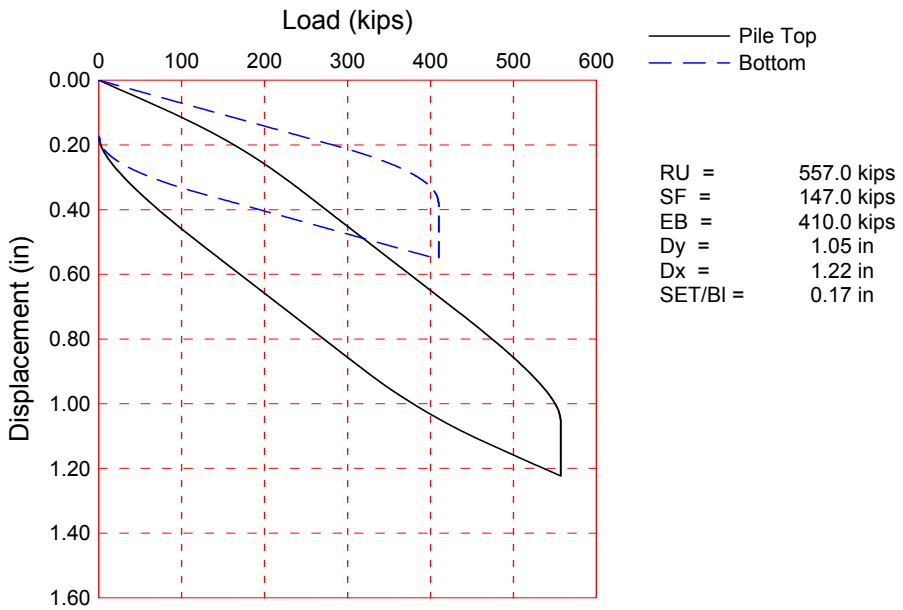
Toe Area 198.5 in^2

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
17	57.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
19	64.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
20	67.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
21	70.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

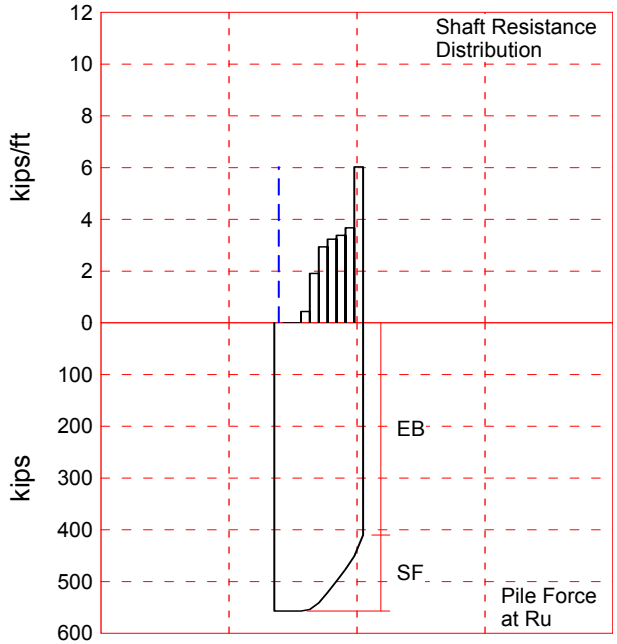
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 $ft^{3;}$ Volume ratio considering added impedance: 1.000







RU =	557.0 kips
SF =	147.0 kips
EB =	410.0 kips
Dy =	1.05 in
Dx =	1.22 in
SET/Bl =	0.17 in



Length b. Sensors	68.0 ft
Embedment	63.2 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	1.40
Top Compr. Stress	31.8 ksi
Max Compr. Stress	33.9 ksi
Max Tension Stress	-5.69 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.29 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.06 s/ft

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: 557.0; along Shaft 147.0; at Toe 410.0 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
				557.0				
1	13.6	8.8	0.0	557.0	0.0	0.00	0.00	0.00
2	20.4	15.6	0.0	557.0	0.0	0.00	0.00	0.00
3	27.2	22.4	3.0	554.0	3.0	0.44	0.09	0.28
4	34.0	29.2	13.0	541.0	16.0	1.91	0.41	0.28
5	40.8	36.0	20.0	521.0	36.0	2.94	0.63	0.28
6	47.6	42.8	22.0	499.0	58.0	3.24	0.69	0.28
7	54.4	49.6	23.0	476.0	81.0	3.38	0.72	0.28
8	61.2	56.4	25.0	451.0	106.0	3.68	0.78	0.28
9	68.0	63.2	41.0	410.0	147.0	6.03	1.28	0.28
Avg. Shaft			16.3			2.33	0.50	0.28
Toe			410.0				297.43	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.05	0.29
Case Damping Factor		1.08	0.64
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	46	33
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	39	
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)		0.026

CAPWAP match quality = 1.40 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.17 in; Blow Count = 69 b/ft
Computed: Final Set = 0.20 in; Blow Count = 59 b/ft
Transducer F3(K769) CAL: 91.9; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K3658) CAL: 362; RF: 1.00; A4(K3550) CAL: 360; RF: 1.00

max. Top Comp. Stress = 31.8 ksi (T= 36.2 ms, max= 1.069 x Top)
max. Comp. Stress = 33.9 ksi (Z= 34.0 ft, T= 38.0 ms)
max. Tens. Stress = -5.69 ksi (Z= 40.8 ft, T= 58.9 ms)
max. Energy (EMX) = 37.2 kip-ft; max. Measured Top Displ. (DMX)= 0.96 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	679.9	-51.8	31.8	-2.42	37.2	16.5	0.95
2	6.8	681.3	-60.8	31.8	-2.84	36.7	16.4	0.92
3	10.2	682.7	-70.8	31.9	-3.31	36.1	16.4	0.89
4	13.6	684.3	-80.3	32.0	-3.75	35.5	16.4	0.86
5	17.0	686.1	-89.2	32.1	-4.17	34.9	16.3	0.83
6	20.4	690.2	-97.8	32.2	-4.57	34.2	16.2	0.80
7	23.8	696.0	-105.7	32.5	-4.94	33.4	16.0	0.76
8	27.2	708.5	-112.4	33.1	-5.25	32.7	15.7	0.73
9	30.6	708.2	-116.1	33.1	-5.42	31.2	15.3	0.69
10	34.0	726.6	-121.3	33.9	-5.67	30.4	14.9	0.66
11	37.4	682.5	-116.3	31.9	-5.43	27.2	14.2	0.62
12	40.8	701.6	-121.8	32.8	-5.69	26.4	13.7	0.59
13	44.2	629.6	-112.7	29.4	-5.26	22.5	13.1	0.55
14	47.6	648.6	-117.4	30.3	-5.49	21.8	12.6	0.52
15	51.0	573.0	-102.7	26.8	-4.80	18.1	12.0	0.49
16	54.4	592.7	-103.1	27.7	-4.82	17.4	11.5	0.45
17	57.8	521.5	-85.9	24.4	-4.01	14.2	11.9	0.42
18	61.2	535.9	-85.9	25.0	-4.01	13.6	13.1	0.39
19	64.6	510.9	-67.2	23.9	-3.14	10.6	13.4	0.37
20	68.0	523.0	-67.0	24.4	-3.13	7.6	12.4	0.34
Absolute	34.0			33.9			(T =	38.0 ms)
	40.8				-5.69		(T =	58.9 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	770.5	660.3	550.1	440.0	329.8					
RX	796.7	717.9	672.8	628.5	594.5	568.6	544.6	520.7	497.5	481.4
RU	770.5	660.3	550.1	440.0	329.8					

RAU = 378.0 (kips); RA2 = 655.4 (kips)

Current CAPWAP Ru = 557.0 (kips); Corresponding J(RP)= 0.39; J(RX) = 1.10

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
16.7	36.01	636.9	684.3	684.3	0.96	0.18	0.17	37.8	797.9	1574

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
68.0	21.4	29992.2	492.000	4.70

Toe Area 198.5 in^2

Top Segment Length 3.40 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 0.202 ms, 2L/c 8.1 ms
Total volume: 10.106 ft^3; Volume ratio considering added impedance: 1.000