GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Travis Coleman
Company: Lunda Construction Co.	No. of Sheets: 29
E-mail: kweber@lundaconstruction.com	Date: March 12, 2015

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

On March 10, 2015, East Abutment #3 and East Abutment #9 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on March 11. Project plans indicated the piles have a required driving resistance, or ultimate capacity, of 480 kips (240 tons) and are oriented vertically and 1H:4V battered. The piles have a required minimum tip elevation of EL 700. The HP 14x73 H-piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0234) reportedly operated on fuel setting 4.

East Abutment #3 was driven from a surface grade of EL 765.8 to a depth of 61.8 feet, which corresponds to a pile tip elevation of EL 704.0. The blow count over the final increment of driving was 10 blows for 2.125 inches of penetration at an average hammer stroke of 8.4 feet. The blow count at the beginning of restrike was 5 blows for 0.75 inches of penetration at an average hammer stroke of 8.9 feet.

East Abutment #9 was driven from a surface grade of EL 768.0 to a depth of 64.1 feet, which corresponds to a pile tip elevation of EL 703.9. The blow count over the final increment of driving was 37 blows per foot at an average hammer stroke of 8.7 feet. The blow count at the beginning of restrike was 5 blows for 0.875 inches of penetration at an average hammer stroke of 9.3 feet.

Our driving recommendations have been prepared on a blows-per-foot basis. For the 480 kip piles driven with an APE D30-42 hammer (PD 0234) in the East Abutment of the USH 10 bridge over Little Lake Butte des Morts we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Vertical Piles Recommended Minimum Blow Count (blows per foot)	1H:4V Batter Piles Recommended Minimum Blow Count (blows per foot)
7.5	46	48
8.0	44	43
8.5	36	38
9.0	33	34

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TRANSMITTAL

To: Mr. Kevin Weber	From: Mark Rawlings
Company: Lunda Construction Co.	No. of Sheets: 51
E-mail: kweber@lundaconstruction.com	Date: November 24, 2014

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 1
Winnebago County, Wisconsin

On November 19, 2014, Pier 1 #1, Pier 1 #36, and Pier 1 #44 at the above structure were dynamically tested during initial driving. 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 or ultimate capacity of 400 kips (200 tons). The reference grade at the bottom of the footing excavations was reported to be at elevation El. 749. The piles have a required minimum tip elevation of El. 691. The 80.5 foot long HP 14 x 73 H-piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0256) operated on fuel setting 4.

Pier 1 #1 was driven to a depth of 73.5 feet which corresponds to a pile tip elevation of El. 675.5. The reported pile set over the final ten blows of driving was 1.5 inches. The average hammer stroke over this increment was 7.4 feet. Pier 1 #36 was driven to a depth of 70.3 feet which corresponds to a pile tip elevation of El. 678.7. The reported pile set over the final ten blows was 2.5 inches. The average hammer stroke over this increment was 7.0 feet. Pier 1 #44 was driven to a depth of 68.8 feet which corresponds to a pile tip elevation of El. 680.2. The reported pile set over the final ten blows was 1.6 inches. The average hammer stroke over this increment was 7.3 feet.

Restrike testing was performed on these three piles on November 20. Pier 1 #1 was driven approximately 4.5 inches during the restrike testing. The reported pile set was ¼ inch for five blows at the beginning and ½ inch for seven blows at the end of the restrike. The average hammer stroke was 7.5 feet at the beginning and 7.3 feet at the end of the restrike event. Pier 1 #36 was driven approximately 3.6 inches during the restrike test. The reported pile set was ¾ inch for five blows at the beginning of restrike and 1 inch for five blows at the end of restrike. The average hammer strokes at the beginning and end of restrike were 7.2 and 7.1 feet, respectively. Pier 1 #44 was driven approximately 2.6 feet during the restrike test due to an indicated decrease in capacity from the prior day's results. The reported pile set was ½ inch for five blows at the beginning and 1⅛ inches for ten blows at the end of the restrike. The average hammer stroke was 7.1 feet at the beginning and 7.5 feet at the end of the restrike event.

The dynamic test data indicated the piles were not driven to solid bedrock. 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 kip piles driven with APE D30-42 hammer (PD 0256) in Pier 1 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	8	5
7.0	6	4
7.5	6	4
8.0	5	4
8.5	5	4
9.0	5	4
9.5	5	4
10.0	5	4

We recommend the above blow counts at the required stroke be maintained for **three consecutive inches** of driving. Driving may be halted if the required blow count is achieved in less than a full foot of driving. Driving should be halted if a blow count of 10 blows per inch at a 9 foot stroke or higher is achieved prior to attaining the requisite blows in the foot. We anticipate the production piles will terminate at depths similar to those of the test pile.

Please call if you have any questions on these recommendations.

GRL Engineers, Inc.

Mark A. Rawlings

Mark Rawlings

Travis Coleman, P.E.

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

Attachments:

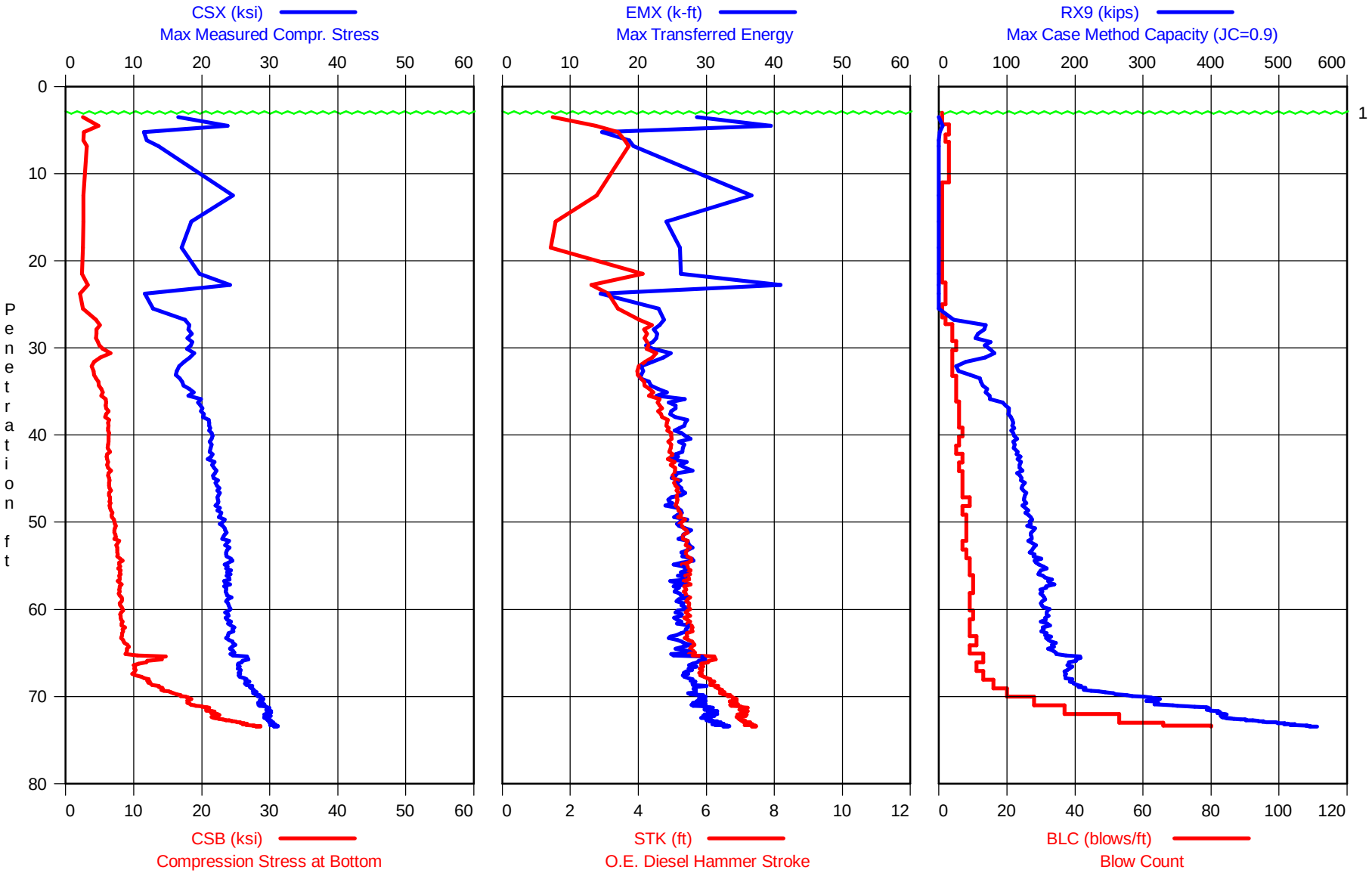
Dynamic Test Results - (pages 3 – 31)
CAPWAP Analysis Results - (pages 32 – 51)

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

PDIPLOT Ver. 2014.1 - Printed: 24-Nov-2014

Test date: 19-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 1 #1
APE D30-42, HP 14 x 73



1 - Reported excavation reference grade at El. 749

USH 10 over Little Lake Butte des Morts - Pier 1 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-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: 1.20

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
1	3.00	1	AV1	21.6	2.9	37	**	**	0
			MAX	21.6	2.9	37	**	**	0
			MIN	21.6	2.9	37	**	**	0
2	4.00	1	AV1	11.5	2.1	20	3.0	66.7	0
			MAX	11.5	2.1	20	3.0	66.7	0
			MIN	11.5	2.1	20	3.0	66.7	0
5	5.00	3	AV3	20.7	4.3	32	4.6	55.4	4
			STD	4.4	0.8	11	0.9	5.4	5
			MAX	24.0	5.0	45	5.5	60.8	12
			MIN	14.5	3.2	18	3.6	50.0	0
7	6.00	2	AV2	9.1	2.2	13	3.3	63.8	1
			STD	0.5	0.0	2	0.1	0.6	1
			MAX	9.6	2.2	14	3.3	64.4	2
			MIN	8.6	2.2	11	3.2	63.2	0
10	7.00	3	AV3	13.8	3.0	21	3.8	59.7	0
			STD	1.5	0.5	3	0.2	1.4	0
			MAX	15.5	3.7	23	3.9	61.6	0
			MIN	11.8	2.5	16	3.5	58.5	0
10	8.00	3	AV1	22.2	2.9	36	**	**	0
			MAX	22.2	2.9	36	**	**	0
			MIN	22.2	2.9	36	**	**	0
10	9.00	3	AV1	26.9	2.3	38	5.6	49.7	0
			MAX	26.9	2.3	38	5.6	49.7	0
			MIN	26.9	2.3	38	5.6	49.7	0
10	10.00	3	AV1	23.3	3.2	32	**	**	0
			MAX	23.3	3.2	32	**	**	0
			MIN	23.3	3.2	32	**	**	0
11	11.00	1	AV1	13.7	2.0	17	3.1	64.9	0
			MAX	13.7	2.0	17	3.1	64.9	0
			MIN	13.7	2.0	17	3.1	64.9	0
11	12.00	1	AV1	11.1	1.5	12	2.8	67.8	0
			MAX	11.1	1.5	12	2.9	67.8	0
			MIN	11.1	1.5	12	2.9	67.8	0
11	13.00	1	AV1	22.9	3.6	40	**	**	0
			MAX	22.9	3.6	40	**	**	0
			MIN	22.9	3.6	40	**	**	0
12	14.00	1	AV1	25.3	3.0	35	5.3	50.7	0
			MAX	25.3	3.0	35	5.3	50.7	0
			MIN	25.3	3.0	35	5.3	50.7	0
13	15.00	1	AV1	14.1	1.8	17	2.9	67.0	0
			MAX	14.1	1.8	17	2.9	67.0	0
			MIN	14.1	1.8	17	2.9	67.0	0

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
14	16.00	1	AV1	23.8	3.2	46	**	**	0
			MAX	23.8	3.2	46	**	**	0
			MIN	23.8	3.2	46	**	**	0
14	17.00	1	AV1	24.5	3.4	36	5.2	51.1	0
			MAX	24.5	3.4	36	5.2	51.1	0
			MIN	24.5	3.4	36	5.2	51.1	0
15	18.00	1	AV1	13.1	2.3	16	3.2	64.7	0
			MAX	13.1	2.3	16	3.2	64.7	0
			MIN	13.1	2.3	16	3.2	64.7	0
16	19.00	1	AV1	10.2	2.0	13	3.1	65.6	0
			MAX	10.2	2.0	13	3.1	65.6	0
			MIN	10.2	2.0	13	3.1	65.6	0
16	20.00	1	AV1	11.2	1.9	19	3.2	64.1	0
			MAX	11.2	1.9	19	3.2	64.1	0
			MIN	11.2	1.9	19	3.2	64.1	0
17	21.00	1	AV1	14.5	3.2	27	3.6	61.0	0
			MAX	14.5	3.2	27	3.6	61.0	0
			MIN	14.5	3.2	27	3.6	61.0	0
18	22.00	1	AV1	18.0	4.1	25	4.0	57.7	0
			MAX	18.0	4.1	25	4.0	57.7	0
			MIN	18.0	4.1	25	4.0	57.7	0
20	23.00	2	AV1	17.1	4.8	22	4.0	57.9	44
			MAX	17.1	4.8	22	4.0	57.9	44
			MIN	17.1	4.8	22	4.0	57.9	44
22	24.00	2	AV1	17.2	5.1	22	4.3	56.4	70
			MAX	17.2	5.1	22	4.3	56.4	70
			MIN	17.2	5.1	22	4.3	56.4	70
23	25.00	1	AV1	19.1	5.0	25	4.5	54.7	68
			MAX	19.1	5.0	25	4.5	54.7	68
			MIN	19.1	5.0	25	4.5	54.7	68
24	26.00	1	AV1	18.5	4.8	23	4.3	56.3	59
			MAX	18.5	4.8	23	4.3	56.3	59
			MIN	18.5	4.8	23	4.3	56.3	59
26	27.00	2	AV1	17.5	4.3	21	4.1	57.5	74
			MAX	17.5	4.3	21	4.1	57.5	74
			MIN	17.5	4.3	21	4.1	57.5	74
30	28.00	4	AV1	18.7	4.5	23	4.3	55.8	59
			MAX	18.7	4.5	23	4.4	55.8	59
			MIN	18.7	4.5	23	4.4	55.8	59
34	29.00	4	AV3	18.0	4.5	22	4.2	56.9	55
			STD	0.5	0.1	1	0.1	0.5	8
			MAX	18.4	4.5	24	4.3	57.4	64
			MIN	17.4	4.4	22	4.1	56.3	44
39	30.00	5	AV5	18.3	4.9	21	4.2	56.5	71
			STD	0.6	0.1	1	0.1	0.5	4
			MAX	18.7	5.0	22	4.4	57.3	77
			MIN	17.2	4.6	20	4.1	55.8	65
43	31.00	4	AV4	18.8	6.2	25	4.5	55.0	77
			STD	0.2	0.6	1	0.1	0.4	7
			MAX	19.0	7.2	25	4.6	55.7	87
			MIN	18.4	5.5	23	4.4	54.6	68

USH 10 over Little Lake Butte des Morts - Pier 1 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
47	32.00	4	AV4	17.4	4.2	22	4.2	56.8	44
			STD	0.2	0.5	1	0.1	0.6	17
			MAX	17.6	4.7	23	4.3	57.7	68
			MIN	17.0	3.7	20	4.0	56.1	27
51	33.00	4	AV4	16.1	4.1	21	4.0	58.4	29
			STD	0.5	0.2	0	0.0	0.3	4
			MAX	16.5	4.5	21	4.0	58.8	33
			MIN	15.2	3.8	20	3.9	58.2	24
56	34.00	5	AV5	17.0	4.6	21	4.1	57.3	60
			STD	0.6	0.3	1	0.1	0.6	4
			MAX	18.0	4.9	22	4.3	57.8	68
			MIN	16.3	4.2	20	4.0	56.1	56
61	35.00	5	AV5	17.9	5.1	23	4.3	56.2	68
			STD	0.7	0.2	1	0.1	0.7	6
			MAX	18.8	5.3	23	4.4	57.2	75
			MIN	16.9	4.8	22	4.1	55.3	58
66	36.00	5	AV5	19.0	5.6	25	4.5	55.1	74
			STD	0.9	0.3	2	0.1	0.9	4
			MAX	20.0	5.9	27	4.6	56.5	78
			MIN	17.5	5.1	23	4.2	54.1	69
72	37.00	6	AV6	19.8	5.9	25	4.6	54.2	98
			STD	0.4	0.1	1	0.1	0.4	4
			MAX	20.7	6.0	27	4.8	54.7	104
			MIN	19.3	5.8	24	4.5	53.4	93
78	38.00	6	AV6	20.1	6.0	25	4.7	54.1	104
			STD	0.3	0.2	1	0.1	0.4	2
			MAX	20.5	6.5	26	4.8	54.7	107
			MIN	19.8	5.8	24	4.5	53.5	102
84	39.00	6	AV6	21.1	6.3	27	4.8	53.1	108
			STD	0.2	0.2	0	0.1	0.3	2
			MAX	21.4	6.7	28	4.9	53.4	113
			MIN	20.9	6.0	26	4.8	52.6	106
91	40.00	7	AV7	21.3	6.3	26	4.9	52.7	109
			STD	0.3	0.3	1	0.1	0.3	3
			MAX	21.6	6.8	27	5.0	53.1	112
			MIN	20.8	5.9	25	4.8	52.2	103
97	41.00	6	AV6	21.4	6.2	27	5.0	52.5	112
			STD	0.3	0.3	1	0.1	0.3	3
			MAX	21.8	6.7	28	5.0	53.1	116
			MIN	21.0	5.9	26	4.8	52.3	107
102	42.00	5	AV5	21.3	6.3	27	4.9	52.6	113
			STD	0.2	0.3	0	0.0	0.2	4
			MAX	21.6	6.7	27	5.0	53.0	118
			MIN	20.9	5.9	26	4.9	52.3	107
109	43.00	7	AV7	21.4	6.1	26	5.0	52.5	117
			STD	0.4	0.1	1	0.1	0.5	4
			MAX	21.8	6.2	27	5.1	53.4	120
			MIN	20.5	5.9	24	4.8	51.8	111
115	44.00	6	AV6	21.9	6.3	27	5.0	52.1	120
			STD	0.4	0.2	1	0.1	0.4	4
			MAX	22.5	6.7	29	5.1	52.9	125
			MIN	21.1	5.9	26	4.9	51.6	115

USH 10 over Little Lake Butte des Morts - Pier 1 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
122	45.00	7	AV7	21.8	6.4	26	5.0	52.1	119
			STD	0.5	0.2	1	0.1	0.6	6
			MAX	22.6	6.7	27	5.2	53.0	126
			MIN	20.9	6.2	24	4.9	51.4	109
129	46.00	7	AV7	22.3	6.4	26	5.1	51.7	123
			STD	0.6	0.1	1	0.1	0.6	4
			MAX	23.1	6.6	27	5.3	52.7	132
			MIN	21.4	6.3	25	4.9	51.0	118
136	47.00	7	AV7	22.4	6.5	26	5.1	51.6	125
			STD	0.3	0.2	1	0.1	0.3	4
			MAX	22.9	6.9	27	5.2	52.0	130
			MIN	22.0	6.3	26	5.1	51.1	120
145	48.00	9	AV9	22.4	6.5	25	5.2	51.5	126
			STD	0.3	0.1	0	0.1	0.3	2
			MAX	23.0	6.7	25	5.3	51.9	131
			MIN	22.2	6.3	24	5.1	50.9	122
152	49.00	7	AV7	22.4	6.6	26	5.1	51.6	128
			STD	0.8	0.3	1	0.1	0.7	3
			MAX	23.2	7.0	28	5.4	52.8	133
			MIN	21.0	6.2	23	4.9	50.6	124
160	50.00	8	AV8	23.0	6.9	26	5.3	51.0	134
			STD	0.4	0.2	1	0.1	0.4	4
			MAX	23.4	7.3	27	5.4	51.5	140
			MIN	22.2	6.7	25	5.2	50.5	129
168	51.00	8	AV8	23.2	7.3	27	5.3	50.8	137
			STD	0.5	0.2	1	0.1	0.5	5
			MAX	24.1	7.6	29	5.6	51.7	143
			MIN	22.4	7.1	25	5.1	49.7	127
176	52.00	8	AV8	23.3	7.3	27	5.3	50.6	136
			STD	0.3	0.1	1	0.1	0.3	2
			MAX	23.8	7.5	27	5.5	51.0	139
			MIN	23.0	7.0	26	5.3	50.1	132
183	53.00	7	AV5	23.8	7.6	28	5.5	50.1	139
			STD	0.3	0.2	1	0.1	0.4	5
			MAX	24.3	7.9	29	5.6	50.8	146
			MIN	23.4	7.4	27	5.3	49.6	131
191	54.00	8	AV8	23.7	7.6	27	5.4	50.3	137
			STD	0.3	0.1	1	0.1	0.3	3
			MAX	24.3	7.8	28	5.6	50.8	141
			MIN	23.1	7.4	26	5.3	49.7	132
200	55.00	9	AV9	24.0	8.0	27	5.5	50.1	146
			STD	0.5	0.2	1	0.1	0.6	6
			MAX	24.6	8.5	28	5.7	50.9	156
			MIN	23.2	7.8	25	5.3	49.3	139
209	56.00	9	AV9	23.9	8.0	27	5.5	50.0	151
			STD	0.5	0.3	1	0.1	0.4	7
			MAX	24.4	8.4	28	5.6	50.7	167
			MIN	23.0	7.6	25	5.3	49.5	143
219	57.00	10	AV10	23.7	7.9	26	5.4	50.3	160
			STD	0.5	0.2	1	0.1	0.4	7
			MAX	24.3	8.1	28	5.6	51.1	170
			MIN	22.8	7.6	24	5.2	49.7	147

USH 10 over Little Lake Butte des Morts - Pier 1 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
229	58.00	10	AV10	23.6	8.0	26	5.4	50.4	157
			STD	0.4	0.2	1	0.1	0.4	9
			MAX	24.2	8.3	27	5.6	51.1	170
			MIN	23.0	7.7	25	5.2	49.6	145
238	59.00	9	AV9	23.9	8.1	26	5.4	50.3	154
			STD	0.3	0.3	1	0.1	0.3	5
			MAX	24.4	8.6	28	5.5	50.6	161
			MIN	23.5	7.5	25	5.4	49.8	148
247	60.00	9	AV9	24.0	8.1	27	5.5	50.0	154
			STD	0.2	0.2	1	0.1	0.2	6
			MAX	24.5	8.5	28	5.6	50.3	165
			MIN	23.7	7.9	26	5.4	49.6	146
257	61.00	10	AV10	23.8	8.1	26	5.4	50.2	159
			STD	0.3	0.2	1	0.1	0.3	4
			MAX	24.1	8.6	27	5.5	50.8	165
			MIN	23.3	7.9	25	5.3	49.8	151
266	62.00	9	AV9	24.1	8.3	26	5.5	50.0	157
			STD	0.4	0.2	1	0.1	0.4	6
			MAX	24.6	8.6	28	5.6	50.8	168
			MIN	23.2	7.9	24	5.3	49.6	144
275	63.00	9	AV9	24.3	8.4	27	5.5	49.9	154
			STD	0.5	0.2	1	0.1	0.4	5
			MAX	25.0	8.8	28	5.7	50.6	161
			MIN	23.5	8.3	25	5.4	49.3	145
286	64.00	11	AV11	24.1	8.4	26	5.5	50.0	165
			STD	0.6	0.3	1	0.1	0.5	5
			MAX	25.4	9.0	28	5.8	50.7	175
			MIN	23.4	8.0	24	5.3	48.8	156
295	65.00	9	AV9	24.6	9.1	27	5.6	49.5	166
			STD	0.5	0.3	1	0.1	0.4	5
			MAX	25.3	9.4	28	5.7	50.5	173
			MIN	23.6	8.6	24	5.4	49.1	159
308	66.00	13	AV13	25.8	12.2	28	6.0	48.0	196
			STD	1.1	2.1	2	0.3	1.3	13
			MAX	27.1	15.1	31	6.4	50.7	210
			MIN	23.6	8.7	24	5.3	46.5	169
319	67.00	11	AV11	25.5	10.4	28	5.9	48.4	191
			STD	0.4	0.6	1	0.1	0.5	4
			MAX	26.3	12.0	29	6.1	49.2	199
			MIN	24.8	9.9	27	5.7	47.7	183
332	68.00	13	AV13	25.8	10.6	27	5.9	48.3	186
			STD	0.6	0.8	1	0.1	0.5	4
			MAX	26.7	12.2	28	6.1	49.5	194
			MIN	24.5	9.7	25	5.6	47.5	180
348	69.00	16	AV16	26.7	12.8	28	6.2	47.2	200
			STD	0.4	0.7	1	0.1	0.4	6
			MAX	27.5	14.0	30	6.4	47.8	211
			MIN	26.2	11.8	27	6.0	46.6	189
368	70.00	20	AV20	27.9	15.5	28	6.5	46.1	247
			STD	0.4	1.1	1	0.1	0.4	27
			MAX	28.8	17.6	31	6.8	46.7	295
			MIN	27.4	13.9	27	6.3	45.1	210

USH 10 over Little Lake Butte des Morts - Pier 1 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
396	71.00	28	AV28	28.7	18.1	29	6.8	45.1	318
			STD	0.4	0.3	1	0.1	0.3	8
			MAX	29.6	18.7	31	7.1	45.7	334
			MIN	27.7	17.5	27	6.6	44.1	300
433	72.00	37	AV37	29.6	21.0	30	7.1	44.4	396
			STD	0.5	0.9	1	0.1	0.5	19
			MAX	30.6	22.7	32	7.4	45.4	420
			MIN	28.4	19.1	28	6.7	43.5	346
486	73.00	53	AV53	29.8	23.0	31	7.1	44.4	441
			STD	0.4	1.3	1	0.1	0.3	26
			MAX	30.6	25.6	32	7.3	45.1	502
			MIN	28.9	21.4	29	6.8	43.6	411
508	73.33	66	AV22	30.3	26.4	32	7.2	43.9	515
			STD	0.4	0.4	1	0.1	0.3	11
			MAX	31.1	27.5	33	7.5	44.4	535
			MIN	29.7	25.7	30	7.0	43.2	495
518	73.46	80	AV10	31.0	28.1	33	7.4	43.3	545
			STD	0.4	0.5	1	0.1	0.4	5
			MAX	31.8	28.8	34	7.7	43.7	556
			MIN	30.6	27.2	32	7.3	42.6	539
			Average	24.8	12.1	27	5.8	49.4	219
			Std. Dev.	4.3	7.3	4	1.0	4.5	146
			Maximum	31.8	28.8	46	7.7	67.8	556
			Minimum	8.6	1.5	11	2.9	42.6	0

Total number of blows analyzed: 516

BL#	depth (ft)	Comments
1	3.00	Reported excavation reference grade at El. 749

Time Summary

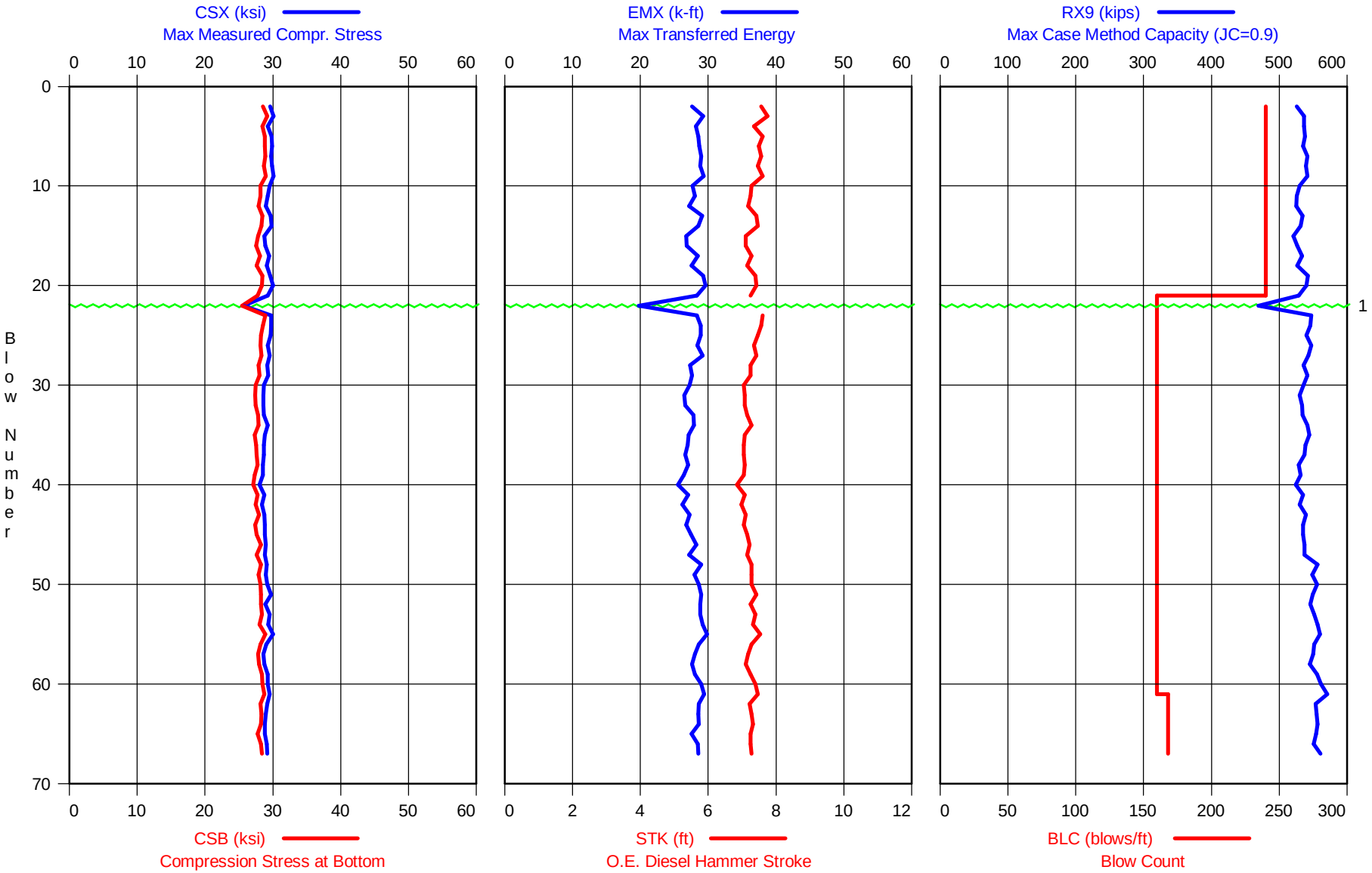
Drive	17 minutes 16 seconds	1:22:46 PM - 1:40:02 PM (11/19/2014) BN 1 - 518

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

PDIPLOT Ver. 2014.1 - Printed: 24-Nov-2014

Test date: 20-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 1 #1 Restrike
APE D30-42, HP 14 x 73



1 - End of restrike. Continue driving

USH 10 over Little Lake Butte des Morts - Pier 1 #1 Restrike APE D30-42, HP 14 x 73
OP: MR Test date: 20-Nov-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: 1.20

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
10	73.50	240	AV9	29.8	28.7	29	7.5	43.0	536
			STD	0.3	0.3	1	0.1	0.4	5
			MAX	30.1	29.2	29	7.8	43.7	542
			MIN	29.2	28.1	28	7.3	42.4	526
20	73.54	240	AV10	29.4	28.1	28	7.3	43.7	531
			STD	0.4	0.3	1	0.1	0.4	7
			MAX	30.0	28.5	30	7.5	44.2	542
			MIN	28.8	27.6	27	7.1	43.2	521
30	73.60	160	AV10	29.0	27.9	27	7.4	43.5	534
			STD	1.2	0.9	3	0.2	0.5	22
			MAX	29.7	28.9	29	7.6	44.4	548
			MIN	25.7	25.4	20	7.0	42.8	469
40	73.67	160	AV10	28.6	27.5	27	7.1	44.3	535
			STD	0.3	0.2	1	0.1	0.3	6
			MAX	29.2	27.9	28	7.3	45.0	544
			MIN	28.0	27.1	26	6.9	43.7	524
50	73.73	160	AV10	28.8	27.8	28	7.2	44.1	541
			STD	0.2	0.3	1	0.1	0.3	9
			MAX	29.1	28.2	29	7.3	44.6	557
			MIN	28.4	27.4	26	7.0	43.7	530
60	73.79	160	AV10	29.2	28.3	29	7.3	43.6	553
			STD	0.4	0.3	1	0.1	0.3	5
			MAX	30.0	28.9	30	7.5	44.2	562
			MIN	28.6	27.8	28	7.1	43.0	545
67	73.83	168	AV7	29.1	28.3	29	7.3	43.7	558
			STD	0.2	0.3	0	0.1	0.2	6
			MAX	29.5	28.8	29	7.5	43.9	571
			MIN	28.8	27.8	28	7.2	43.2	551
			Average	29.1	28.1	28	7.3	43.7	540
			Std. Dev.	0.6	0.6	1	0.2	0.5	14
			Maximum	30.1	29.2	30	7.8	45.0	571
			Minimum	25.7	25.4	20	6.9	42.4	469

Total number of blows analyzed: 66

BL#	depth (ft)	Comments
22	73.55	End of restrike. Continue driving

Time Summary

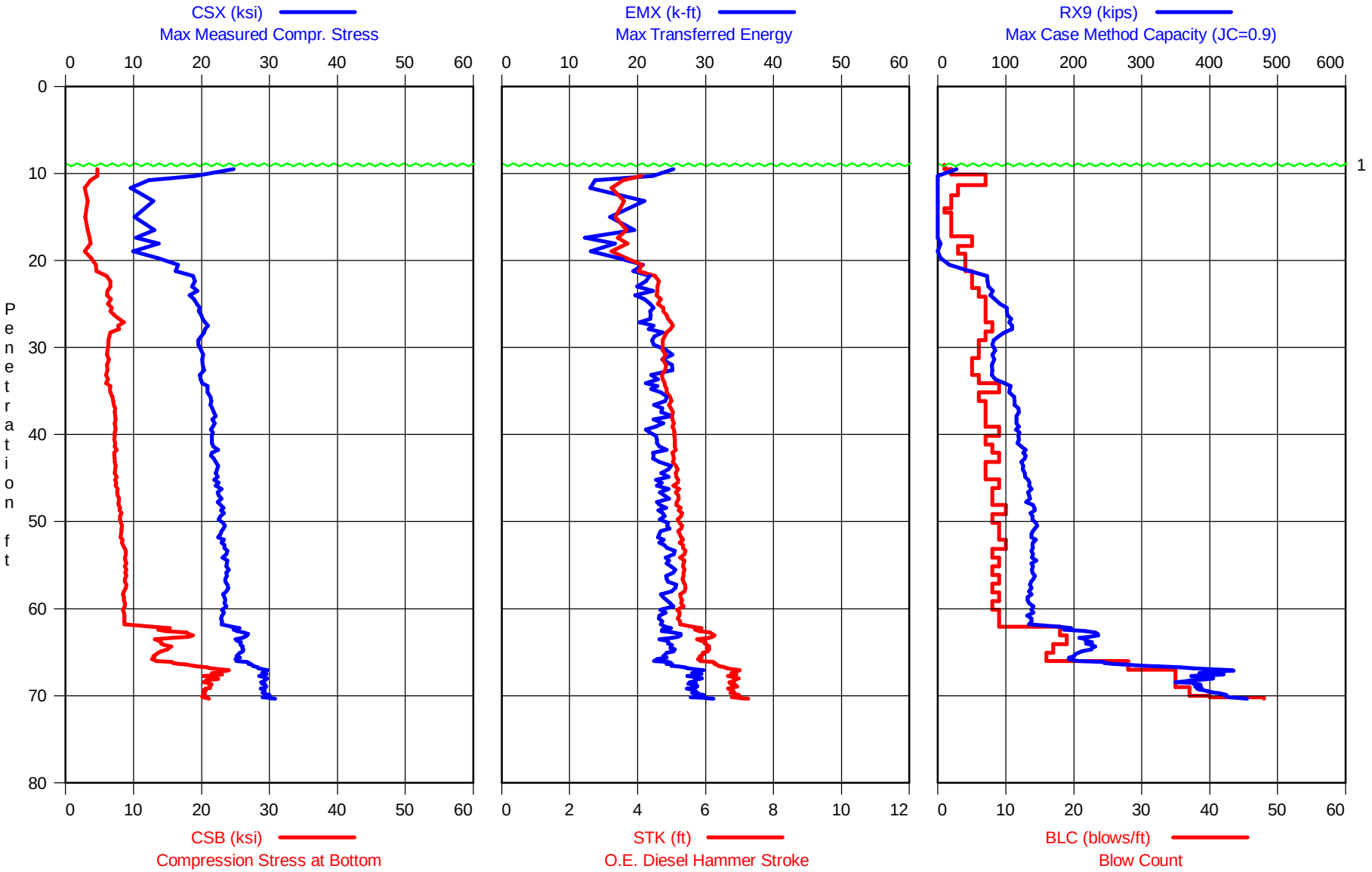
Drive 4 minutes 46 seconds 8:07:39 AM - 8:12:25 AM (11/20/2014) BN 1 - 67

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

PDIPLOT Ver. 2014.1 - Printed: 21-Nov-2014

Test date: 19-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 1 #36
APE D30-42, HP 14 x 73



1 - Reported excavation reference grade at El. 749

USH 10 over Little Lake Butte des Morts - Pier 1 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-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: 1.20

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
1	9.00	1	AV1	24.3	3.4	27	**	**	0
			MAX	24.3	3.4	27	**	**	0
			MIN	24.3	3.4	27	**	**	0
3	10.00	2	AV2	25.0	5.3	24	**	**	42
			STD	0.1	0.1	2	**	**	6
			MAX	25.1	5.4	26	**	**	47
			MIN	24.8	5.2	22	**	**	36
10	11.00	7	AV6	15.7	4.2	18	3.8	59.7	0
			STD	4.8	0.6	6	0.4	2.4	0
			MAX	25.0	5.0	29	4.5	61.6	0
			MIN	11.9	3.1	13	3.5	55.0	0
13	12.00	3	AV3	9.6	2.8	13	3.2	64.1	0
			STD	1.2	0.2	1	0.1	0.9	0
			MAX	11.3	3.1	14	3.3	65.3	0
			MIN	8.6	2.6	12	3.1	63.4	0
15	13.00	2	AV2	12.8	3.3	19	3.6	61.3	0
			STD	1.4	0.2	2	0.2	1.6	0
			MAX	14.1	3.5	21	3.8	62.9	0
			MIN	11.4	3.1	18	3.4	59.7	0
16	14.00	1	AV1	13.3	3.0	24	3.7	60.2	0
			MAX	13.3	3.0	24	3.7	60.2	0
			MIN	13.3	3.0	24	3.7	60.2	0
18	15.00	2	AV2	9.7	2.8	15	3.3	63.4	0
			STD	1.1	0.2	1	0.1	1.0	0
			MAX	10.8	3.0	16	3.4	64.4	0
			MIN	8.6	2.7	15	3.2	62.4	0
20	16.00	2	AV2	12.5	3.3	20	3.6	61.0	0
			STD	1.5	0.3	2	0.2	1.4	0
			MAX	14.0	3.6	22	3.8	62.4	0
			MIN	11.0	3.0	18	3.4	59.6	0
22	17.00	2	AV2	12.6	3.1	18	3.6	60.8	0
			STD	1.2	0.1	2	0.2	1.3	0
			MAX	13.8	3.2	20	3.8	62.0	0
			MIN	11.5	3.0	16	3.5	59.5	0
27	18.00	5	AV5	11.8	3.6	14	3.5	61.5	2
			STD	2.1	0.5	2	0.2	1.9	4
			MAX	14.2	4.3	18	3.7	64.6	11
			MIN	8.6	2.8	11	3.2	59.9	0
30	19.00	3	AV3	11.1	3.0	14	3.4	62.7	0
			STD	1.5	0.2	2	0.2	1.7	0
			MAX	13.1	3.4	17	3.7	64.6	0
			MIN	9.5	2.8	13	3.2	60.5	0
34	20.00	4	AV4	12.6	3.5	16	3.5	61.5	3
			STD	2.2	0.5	2	0.3	2.2	5
			MAX	15.7	4.2	19	4.0	64.5	11
			MIN	9.6	2.9	13	3.2	58.3	0

USH 10 over Little Lake Butte des Morts - Pier 1 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
38	21.00	4	AV4	16.7	4.5	21	4.1	57.1	18
			STD	0.4	0.0	0	0.1	0.5	4
			MAX	17.1	4.5	21	4.2	57.9	22
			MIN	16.1	4.4	20	4.0	56.7	14
43	22.00	5	AV5	17.5	5.4	20	4.3	56.3	67
			STD	1.5	0.8	2	0.3	1.8	10
			MAX	19.1	6.3	23	4.6	58.6	84
			MIN	15.7	4.4	18	3.9	54.5	55
48	23.00	5	AV5	18.8	6.6	21	4.6	54.4	74
			STD	0.5	0.7	1	0.1	0.4	2
			MAX	19.4	7.6	22	4.7	55.0	78
			MIN	17.9	5.7	19	4.5	53.7	71
54	24.00	6	AV6	18.9	6.2	21	4.6	49.2	77
			STD	0.6	0.4	1	0.1	11.8	8
			MAX	19.5	6.7	23	4.7	55.1	89
			MIN	17.7	5.6	19	4.5	22.9	64
61	25.00	7	AV6	19.0	6.4	21	4.7	49.0	86
			STD	0.4	0.5	2	0.1	11.3	5
			MAX	19.5	7.2	24	4.8	54.4	95
			MIN	18.4	5.9	19	4.6	23.7	80
68	26.00	7	AV7	19.6	6.7	22	4.7	53.7	100
			STD	0.4	0.5	1	0.1	0.4	7
			MAX	20.2	7.4	24	4.8	54.6	111
			MIN	19.1	6.1	21	4.6	53.3	92
75	27.00	7	AV7	20.1	7.7	22	4.9	52.8	105
			STD	0.3	0.8	1	0.0	0.2	3
			MAX	20.6	8.8	24	5.0	53.3	109
			MIN	19.8	6.5	21	4.8	52.5	100
83	28.00	8	AV8	20.7	8.0	21	5.0	43.4	108
			STD	0.4	0.6	1	0.1	15.4	5
			MAX	21.1	8.7	23	5.1	52.9	116
			MIN	20.2	7.2	19	4.9	16.0	102
90	29.00	7	AV7	20.1	6.5	23	4.8	53.2	93
			STD	0.4	0.3	1	0.1	0.4	7
			MAX	20.8	7.0	24	4.9	53.7	109
			MIN	19.6	6.2	21	4.7	52.7	87
96	30.00	6	AV5	19.5	6.3	22	4.7	53.6	80
			STD	0.2	0.2	1	0.0	0.2	1
			MAX	19.7	6.8	23	4.8	53.8	81
			MIN	19.3	6.1	21	4.7	53.3	78
102	31.00	6	AV6	20.1	6.2	25	4.8	48.9	82
			STD	0.3	0.1	1	0.1	10.0	3
			MAX	20.5	6.2	26	4.9	53.7	86
			MIN	19.7	6.0	24	4.7	26.6	78
107	32.00	5	AV5	20.1	6.3	24	4.8	53.4	81
			STD	0.3	0.4	1	0.1	0.3	3
			MAX	20.7	6.9	26	4.9	53.6	84
			MIN	19.8	5.9	22	4.7	52.7	79
112	33.00	5	AV5	20.2	6.0	25	4.8	48.1	79
			STD	0.3	0.2	1	0.1	10.7	2
			MAX	20.6	6.2	26	4.8	54.0	83
			MIN	19.6	5.7	23	4.7	26.7	76

USH 10 over Little Lake Butte des Morts - Pier 1 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
118	34.00	6	AV6	19.9	6.1	22	4.7	53.5	83
			STD	0.1	0.2	1	0.0	0.2	2
			MAX	20.0	6.4	24	4.8	53.7	86
			MIN	19.7	5.9	21	4.7	53.3	80
127	35.00	9	AV9	20.7	6.4	22	4.8	45.3	106
			STD	0.4	0.3	1	0.0	14.7	3
			MAX	21.4	7.0	24	4.9	53.5	114
			MIN	20.0	5.8	20	4.8	17.7	100
133	36.00	6	AV6	21.3	6.8	25	4.9	52.5	109
			STD	0.3	0.2	1	0.0	0.2	4
			MAX	21.7	7.0	26	5.0	52.9	115
			MIN	20.8	6.5	23	4.9	52.2	104
140	37.00	7	AV7	21.4	7.1	23	5.0	48.7	114
			STD	0.2	0.2	1	0.0	9.2	3
			MAX	21.5	7.4	25	5.0	52.8	118
			MIN	21.0	6.9	21	4.9	26.1	110
147	38.00	7	AV7	21.9	7.2	24	5.0	47.2	118
			STD	0.3	0.1	1	0.1	12.1	3
			MAX	22.5	7.3	25	5.1	52.5	124
			MIN	21.5	7.1	23	5.0	17.5	114
154	39.00	7	AV7	21.7	7.3	23	5.0	52.1	116
			STD	0.3	0.1	1	0.0	0.2	2
			MAX	22.2	7.5	24	5.1	52.3	120
			MIN	21.3	7.2	21	5.0	51.6	112
163	40.00	9	AV9	21.6	7.3	22	5.1	41.2	118
			STD	0.4	0.1	1	0.0	15.4	3
			MAX	22.2	7.5	24	5.2	52.2	122
			MIN	21.1	7.1	20	5.0	15.9	114
170	41.00	7	AV7	21.5	7.2	23	5.1	46.9	118
			STD	0.3	0.1	1	0.0	12.1	3
			MAX	21.9	7.4	24	5.2	52.0	122
			MIN	21.1	7.0	22	5.1	17.3	111
178	42.00	8	AV8	21.9	7.3	23	5.1	46.9	124
			STD	0.6	0.2	1	0.1	12.1	5
			MAX	23.2	7.8	25	5.2	52.5	137
			MIN	21.2	7.0	22	5.0	17.2	118
187	43.00	9	AV9	21.7	7.2	22	5.1	45.2	128
			STD	0.5	0.2	1	0.0	12.8	5
			MAX	22.3	7.4	23	5.1	52.1	136
			MIN	20.7	7.0	21	5.0	17.2	120
194	44.00	7	AV7	22.4	7.3	25	5.1	51.7	125
			STD	0.4	0.1	1	0.1	0.4	3
			MAX	23.1	7.5	26	5.3	52.2	129
			MIN	22.0	7.2	23	5.0	51.0	119
201	45.00	7	AV7	22.2	7.3	24	5.1	48.0	127
			STD	0.5	0.2	1	0.1	9.0	4
			MAX	22.6	7.6	25	5.2	52.1	133
			MIN	21.1	7.0	22	5.0	25.9	121
210	46.00	9	AV9	22.2	7.4	23	5.1	45.9	134
			STD	0.4	0.1	1	0.1	10.8	4
			MAX	22.8	7.6	24	5.3	52.6	142
			MIN	21.3	7.2	22	4.9	25.6	126

USH 10 over Little Lake Butte des Morts - Pier 1 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
218	47.00	8	AV8	22.6	7.6	24	5.2	51.4	135
			STD	0.4	0.1	1	0.1	0.4	3
			MAX	23.1	7.8	25	5.2	52.3	139
			MIN	21.8	7.5	23	5.0	51.1	129
226	48.00	8	AV8	22.6	7.8	24	5.2	51.4	133
			STD	0.3	0.1	1	0.0	0.2	3
			MAX	23.0	7.9	25	5.2	51.8	138
			MIN	22.2	7.5	22	5.1	51.2	129
236	49.00	10	AV10	23.1	8.0	23	5.2	51.2	141
			STD	0.4	0.2	1	0.1	0.3	4
			MAX	23.5	8.3	25	5.3	51.7	145
			MIN	22.5	7.8	22	5.1	50.7	136
244	50.00	8	AV8	22.8	8.0	24	5.2	47.9	140
			STD	0.3	0.1	1	0.1	8.4	5
			MAX	23.5	8.1	25	5.3	51.7	146
			MIN	22.2	7.9	23	5.1	25.7	134
253	51.00	9	AV9	23.4	8.3	25	5.3	50.9	144
			STD	0.2	0.1	0	0.1	0.3	3
			MAX	23.7	8.4	26	5.4	51.8	148
			MIN	23.2	8.1	24	5.1	50.5	138
262	52.00	9	AV9	22.8	8.2	23	5.3	51.1	139
			STD	0.4	0.1	1	0.1	0.5	4
			MAX	23.7	8.4	25	5.4	51.7	145
			MIN	22.3	8.1	22	5.1	50.4	133
272	53.00	10	AV10	23.1	8.4	24	5.3	50.9	141
			STD	0.6	0.2	1	0.1	0.3	4
			MAX	24.1	8.7	25	5.4	51.4	146
			MIN	21.8	8.1	21	5.2	50.3	135
280	54.00	8	AV8	23.6	8.8	25	5.4	50.5	138
			STD	0.4	0.1	0	0.1	0.3	2
			MAX	24.1	9.0	26	5.4	51.0	141
			MIN	23.1	8.6	25	5.3	50.2	136
289	55.00	9	AV9	23.6	8.8	24	5.3	50.7	140
			STD	0.4	0.1	1	0.1	0.4	4
			MAX	24.2	9.0	25	5.5	51.4	148
			MIN	22.7	8.6	24	5.2	50.0	134
297	56.00	8	AV8	23.8	8.8	25	5.4	50.5	139
			STD	0.2	0.1	0	0.0	0.2	4
			MAX	24.3	9.0	26	5.4	50.8	144
			MIN	23.6	8.6	25	5.3	50.3	134
306	57.00	9	AV9	23.6	8.8	24	5.3	50.7	140
			STD	0.3	0.1	0	0.1	0.3	5
			MAX	24.0	9.0	25	5.4	51.1	148
			MIN	23.2	8.6	24	5.2	50.2	133
314	58.00	8	AV8	23.9	8.9	26	5.4	50.4	137
			STD	0.3	0.1	1	0.1	0.3	3
			MAX	24.4	9.0	27	5.5	51.0	140
			MIN	23.2	8.6	24	5.3	49.9	131
323	59.00	9	AV9	23.4	8.5	24	5.3	50.9	134
			STD	0.4	0.1	1	0.1	0.3	3
			MAX	23.8	8.7	25	5.4	51.4	140
			MIN	22.5	8.2	23	5.2	50.5	130

USH 10 over Little Lake Butte des Morts - Pier 1 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
331	60.00	8	AV8	23.4	8.7	25	5.3	50.9	136
			STD	0.3	0.2	1	0.1	0.3	5
			MAX	23.9	8.9	25	5.4	51.5	144
			MIN	23.0	8.4	24	5.2	50.4	129
340	61.00	9	AV9	23.1	8.6	24	5.2	51.3	137
			STD	0.5	0.1	1	0.1	0.5	6
			MAX	23.8	8.8	25	5.4	51.9	145
			MIN	22.3	8.4	22	5.1	50.5	126
349	62.00	9	AV9	23.0	8.7	23	5.2	51.1	138
			STD	0.3	0.3	1	0.1	0.4	6
			MAX	23.6	9.6	24	5.4	51.6	150
			MIN	22.6	8.5	23	5.1	50.3	128
367	63.00	18	AV18	25.7	15.9	25	5.9	48.2	212
			STD	0.9	2.2	1	0.2	0.9	21
			MAX	27.5	19.0	28	6.3	49.7	243
			MIN	23.9	12.4	23	5.6	46.7	177
386	64.00	19	AV19	25.8	15.3	25	6.0	47.9	221
			STD	0.6	2.2	1	0.2	0.7	10
			MAX	26.9	19.1	27	6.3	49.4	238
			MIN	24.6	12.4	22	5.6	46.8	192
403	65.00	17	AV17	26.0	14.7	25	6.1	47.7	224
			STD	0.3	0.7	1	0.1	0.3	9
			MAX	26.7	15.8	26	6.3	48.2	244
			MIN	25.4	13.6	24	5.9	47.0	207
419	66.00	16	AV16	25.3	13.1	24	5.9	47.0	198
			STD	0.4	0.4	1	0.1	5.9	6
			MAX	26.1	13.8	26	6.1	49.3	207
			MIN	24.4	12.6	21	5.7	24.1	190
447	67.00	28	AV28	27.6	18.6	26	6.4	46.5	306
			STD	1.0	2.6	2	0.2	0.8	58
			MAX	29.9	23.3	30	7.0	48.4	423
			MIN	25.0	14.0	22	5.9	44.5	220
482	68.00	35	AV35	29.3	22.2	29	6.9	45.0	401
			STD	0.4	1.1	1	0.1	0.4	21
			MAX	30.1	24.7	31	7.1	46.0	442
			MIN	28.1	20.2	26	6.5	44.2	371
517	69.00	35	AV35	29.3	21.2	28	6.8	45.0	379
			STD	0.3	0.6	1	0.1	0.3	15
			MAX	29.8	22.6	30	7.0	45.7	411
			MIN	28.5	20.2	26	6.6	44.4	344
554	70.00	37	AV37	29.3	20.5	28	6.8	45.1	401
			STD	0.4	0.4	1	0.1	0.4	15
			MAX	30.4	21.4	30	7.1	45.9	426
			MIN	28.3	20.0	27	6.6	44.3	379
559	70.12	40	AV5	29.1	20.1	28	6.8	45.1	423
			STD	0.5	0.2	1	0.1	0.4	3
			MAX	29.6	20.4	29	6.9	45.9	428
			MIN	28.1	19.8	26	6.6	44.7	419
569	70.33	48	AV10	30.1	20.8	30	7.0	44.4	444
			STD	0.5	0.3	1	0.1	0.4	8
			MAX	31.1	21.2	31	7.4	45.0	456
			MIN	29.5	20.0	28	6.9	43.5	432

USH 10 over Little Lake Butte des Morts - Pier 1 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

	CSX	CSB	EMX	STK	BPM	RX9
	ksi	ksi	k-ft	ft	**	kips
Average	23.7	11.7	24	5.6	49.0	194
Std. Dev.	4.4	6.2	3	0.9	6.9	125
Maximum	31.1	24.7	31	7.4	65.3	456
Minimum	8.6	2.6	11	3.1	15.9	0

Total number of blows analyzed: 566

BL#	depth (ft)	Comments
1	9.00	Reported excavation reference grade at El. 749

Time Summary

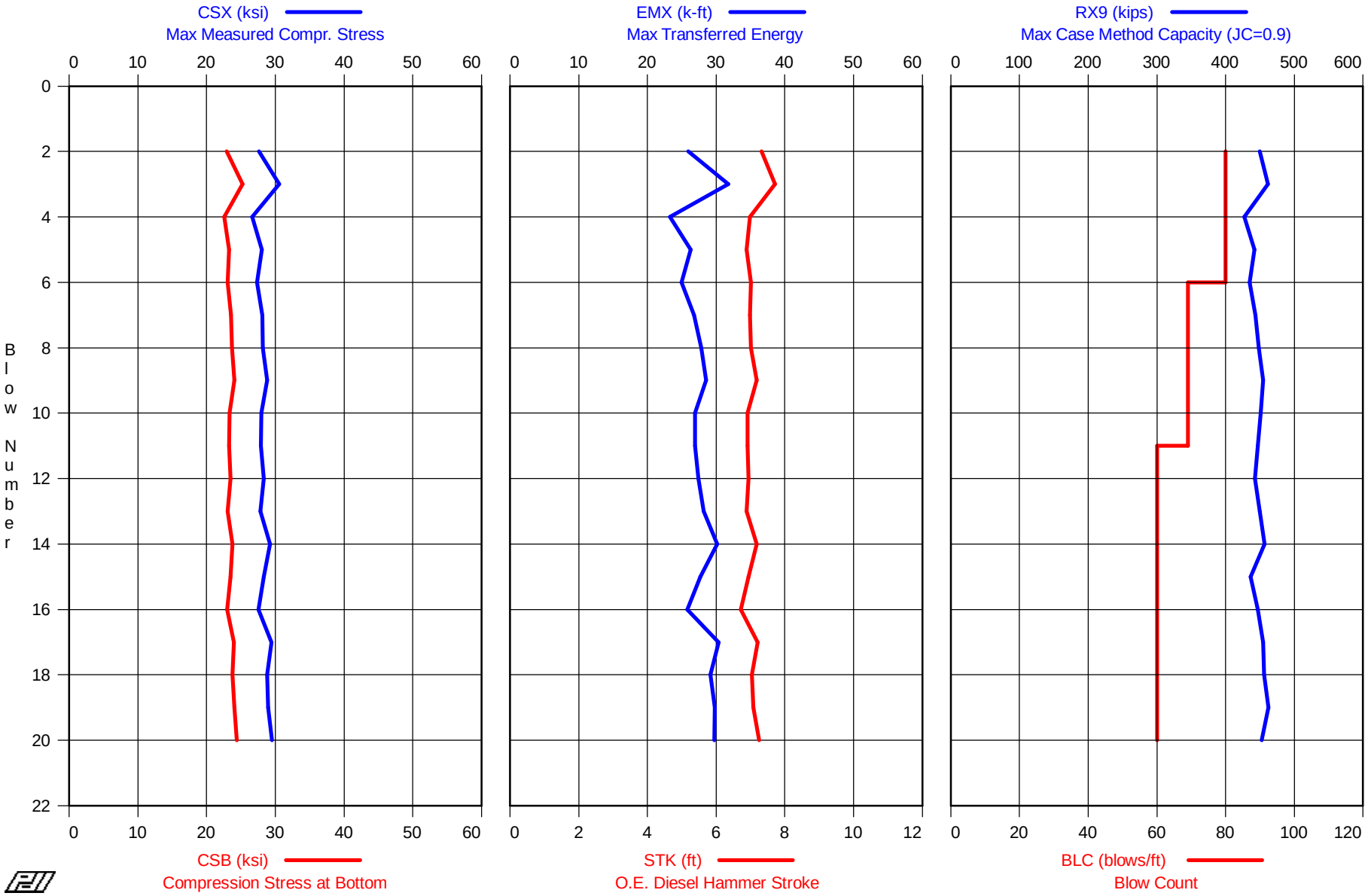
Drive	12 minutes 19 seconds	12:46:19 PM - 12:58:38 PM (11/19/2014) BN 1 - 569

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

PDIPLOT Ver. 2014.1 - Printed: 21-Nov-2014

Test date: 20-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 1 #36 Restrike
APE D30-42, HP 14 x 73



Case Method & iCAP® Results PDIPLOT Ver. 2014.1 - Printed: 21-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 1 #36 Restrike APE D30-42, HP 14 x 73
OP: MR Test date: 20-Nov-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: 1.20

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	70.40	80	AV4	28.2	23.5	27	7.2	43.9	445
			STD	1.4	1.0	3	0.3	0.9	12
			MAX	30.5	25.2	32	7.7	44.9	461
			MIN	26.6	22.5	23	6.9	42.5	427
10	70.47	69	AV5	28.1	23.5	27	7.0	44.5	446
			STD	0.5	0.3	1	0.1	0.3	7
			MAX	28.8	24.0	29	7.2	44.8	455
			MIN	27.4	23.1	25	6.9	44.0	435
15	70.55	60	AV5	28.3	23.4	28	7.0	44.6	447
			STD	0.5	0.2	1	0.1	0.3	7
			MAX	29.2	23.8	30	7.2	44.9	456
			MIN	27.8	23.0	27	6.9	44.0	437
20	70.64	60	AV5	28.8	23.8	29	7.1	44.4	454
			STD	0.7	0.5	2	0.2	0.6	5
			MAX	29.5	24.4	30	7.2	45.4	462
			MIN	27.5	23.0	26	6.7	43.8	447
			Average	28.4	23.6	28	7.1	44.4	448
			Std. Dev.	0.9	0.6	2	0.2	0.6	9
			Maximum	30.5	25.2	32	7.7	45.4	462
			Minimum	26.6	22.5	23	6.7	42.5	427

Total number of blows analyzed: 19

Time Summary

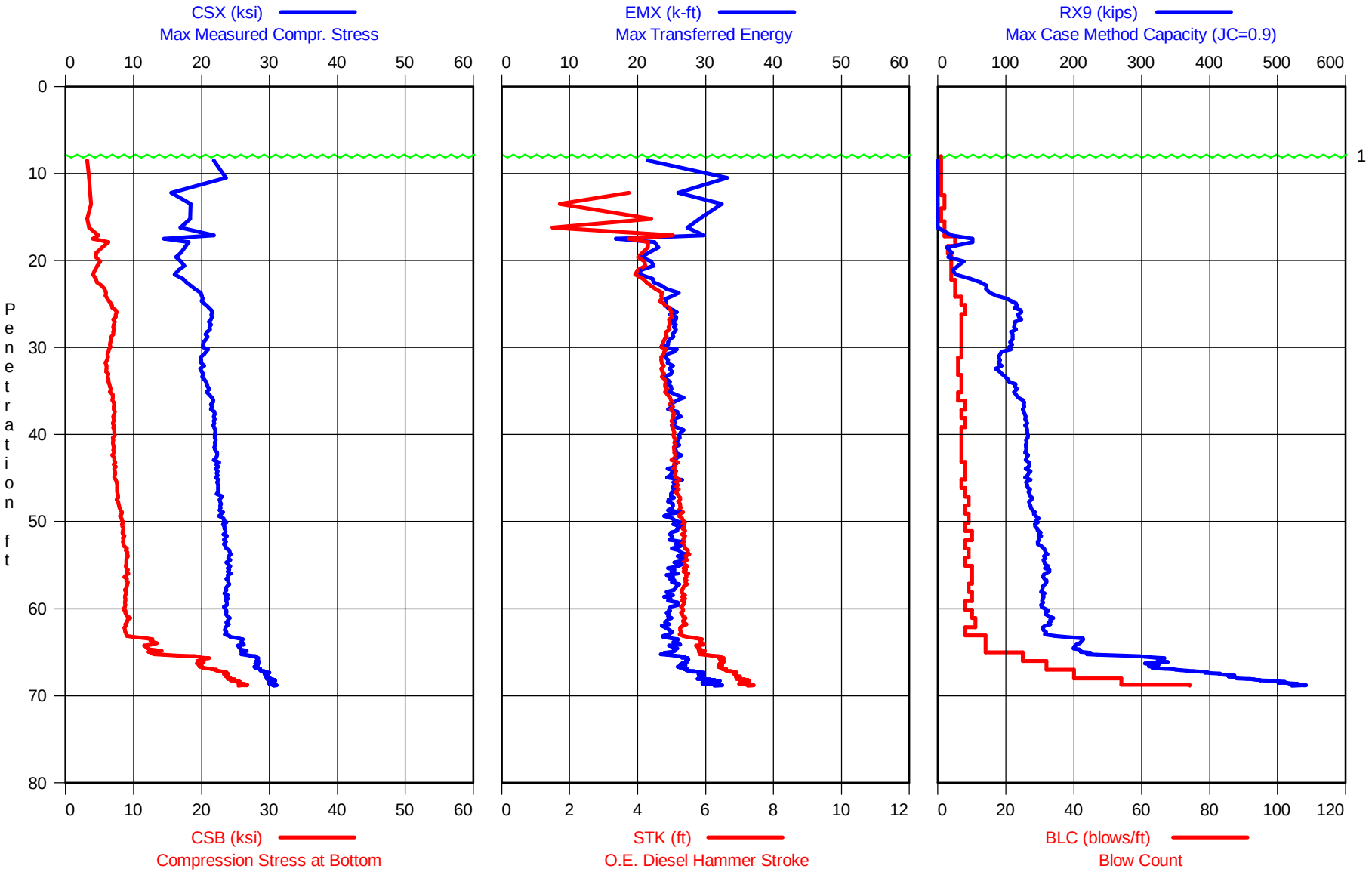
Drive 25 seconds 7:33:49 AM - 7:34:14 AM (11/20/2014) BN 1 - 20

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

PDIPLOT Ver. 2014.1 - Printed: 24-Nov-2014

Test date: 19-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 1 #44
APE D30-42, HP 14 x 73



1 - Reported excavation reference grade at El. 749

USH 10 over Little Lake Butte des Morts - Pier 1 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-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: 1.20

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
1	8.00	1	AV1	20.9	3.5	18	**	**	0
			MAX	20.9	3.5	18	**	**	0
			MIN	20.9	3.5	18	**	**	0
2	9.00	1	AV1	22.6	2.8	25	**	**	0
			MAX	22.6	2.8	25	**	**	0
			MIN	22.6	2.8	25	**	**	0
3	10.00	1	AV1	23.5	3.1	27	**	**	0
			MAX	23.5	3.1	27	**	**	0
			MIN	23.5	3.1	27	**	**	0
4	11.00	1	AV1	23.7	3.9	39	**	**	0
			MAX	23.7	3.9	39	**	**	0
			MIN	23.7	3.9	39	**	**	0
5	12.00	1	AV1	15.4	3.0	30	3.7	60.3	0
			MAX	15.4	3.0	30	3.7	60.3	0
			MIN	15.4	3.0	30	3.7	60.3	0
7	13.00	2	AV2	14.0	3.6	19	3.6	61.0	0
			STD	1.8	0.6	3	0.2	1.6	0
			MAX	15.7	4.2	22	3.8	62.5	0
			MIN	12.2	3.0	16	3.4	59.4	0
8	14.00	1	AV1	24.5	4.5	49	**	**	0
			MAX	24.5	4.5	49	**	**	0
			MIN	24.5	4.5	49	**	**	0
9	15.00	1	AV1	23.0	3.5	40	5.3	50.7	0
			MAX	23.0	3.5	40	5.3	50.7	0
			MIN	23.0	3.5	40	5.3	50.7	0
11	16.00	2	AV2	11.5	2.7	15	3.2	64.1	0
			STD	2.2	0.1	3	0.2	2.1	0
			MAX	13.6	2.8	18	3.5	66.2	0
			MIN	9.3	2.6	12	3.0	62.0	0
13	17.00	2	AV2	25.2	4.7	42	6.1	47.7	0
			STD	0.7	0.3	1	0.0	0.0	0
			MAX	25.9	5.0	43	6.1	47.7	0
			MIN	24.5	4.4	41	6.1	47.7	0
18	18.00	5	AV5	16.6	5.0	19	4.0	57.9	49
			STD	1.7	1.1	3	0.3	1.8	4
			MAX	18.5	6.9	23	4.4	59.9	52
			MIN	14.4	3.8	16	3.7	55.5	41
21	19.00	3	AV3	17.3	5.2	23	4.2	56.5	11
			STD	0.4	0.4	1	0.1	0.6	3
			MAX	17.9	5.6	24	4.4	57.1	14
			MIN	16.9	4.7	22	4.1	55.7	7
25	20.00	4	AV4	16.8	4.7	21	4.1	57.3	26
			STD	0.5	0.6	1	0.1	0.7	11
			MAX	17.4	5.5	22	4.3	58.2	40
			MIN	16.1	3.9	20	4.0	56.4	13

USH 10 over Little Lake Butte des Morts - Pier 1 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
29	21.00	4	AV4	17.0	4.6	22	4.1	57.1	28
			STD	0.5	0.2	1	0.1	0.7	9
			MAX	17.8	4.7	23	4.3	58.2	37
			MIN	16.5	4.3	21	4.0	56.2	14
33	22.00	4	AV4	16.4	4.2	21	4.0	58.1	30
			STD	0.7	0.3	1	0.1	0.9	5
			MAX	17.0	4.5	22	4.1	59.6	37
			MIN	15.2	3.8	19	3.8	57.4	23
38	23.00	5	AV5	18.0	4.8	23	4.3	56.1	65
			STD	0.4	0.4	1	0.1	0.5	7
			MAX	18.5	5.5	24	4.4	56.8	77
			MIN	17.3	4.4	22	4.2	55.6	59
43	24.00	5	AV5	19.5	5.8	25	4.6	54.2	75
			STD	0.5	0.2	1	0.1	0.5	5
			MAX	20.3	6.0	26	4.8	54.8	82
			MIN	19.0	5.6	24	4.5	53.4	70
50	25.00	7	AV7	20.2	6.4	24	4.7	53.7	106
			STD	0.3	0.2	0	0.1	0.3	7
			MAX	20.6	6.8	25	4.8	54.2	116
			MIN	19.8	6.0	24	4.6	53.3	94
58	26.00	8	AV8	21.2	7.2	25	4.9	52.6	119
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	21.7	7.5	26	5.0	53.3	127
			MIN	20.7	6.7	24	4.8	52.2	112
65	27.00	7	AV7	21.4	7.2	25	5.0	52.4	120
			STD	0.4	0.2	1	0.1	0.4	6
			MAX	22.2	7.6	27	5.1	53.0	128
			MIN	20.7	6.9	24	4.9	51.8	108
72	28.00	7	AV7	21.2	7.1	25	4.9	52.6	113
			STD	0.1	0.1	0	0.0	0.1	3
			MAX	21.4	7.4	26	5.0	52.7	116
			MIN	21.0	7.0	25	4.9	52.5	108
79	29.00	7	AV7	20.8	6.8	25	4.8	53.1	110
			STD	0.2	0.2	0	0.0	0.2	3
			MAX	21.0	7.0	26	4.9	53.4	114
			MIN	20.4	6.5	25	4.8	52.8	106
86	30.00	7	AV7	20.3	6.6	24	4.7	53.6	107
			STD	0.3	0.2	1	0.1	0.4	2
			MAX	20.8	7.0	25	4.8	54.2	110
			MIN	19.9	6.4	23	4.6	53.2	103
93	31.00	7	AV7	20.5	6.3	25	4.8	53.4	97
			STD	0.6	0.1	1	0.1	0.4	7
			MAX	21.3	6.5	26	4.9	54.0	110
			MIN	19.4	6.1	23	4.7	52.8	88
99	32.00	6	AV6	20.2	6.1	25	4.7	53.6	92
			STD	0.4	0.1	0	0.1	0.3	6
			MAX	20.9	6.3	26	4.9	53.9	102
			MIN	19.8	5.9	24	4.7	53.0	85
105	33.00	6	AV6	20.0	6.0	25	4.7	53.8	88
			STD	0.3	0.1	1	0.1	0.3	2
			MAX	20.2	6.2	26	4.8	54.4	92
			MIN	19.4	5.9	24	4.6	53.3	85

USH 10 over Little Lake Butte des Morts - Pier 1 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
112	34.00	7	AV7	20.4	6.3	24	4.8	53.4	103
			STD	0.3	0.1	0	0.1	0.3	3
			MAX	20.9	6.4	25	4.9	53.9	109
			MIN	19.9	6.1	23	4.7	52.9	97
119	35.00	7	AV7	20.9	6.5	25	4.8	53.2	114
			STD	0.3	0.1	1	0.1	0.3	2
			MAX	21.2	6.6	26	4.9	53.7	117
			MIN	20.4	6.3	24	4.7	52.7	111
125	36.00	6	AV6	21.4	6.9	26	4.9	52.6	117
			STD	0.3	0.1	1	0.0	0.2	4
			MAX	21.8	7.1	27	5.0	53.0	123
			MIN	21.0	6.6	26	4.9	52.3	112
133	37.00	8	AV8	21.5	7.1	25	5.0	52.3	126
			STD	0.2	0.1	1	0.1	0.3	2
			MAX	21.8	7.2	26	5.1	52.7	128
			MIN	21.0	6.9	23	4.9	51.9	123
140	38.00	7	AV7	21.9	7.1	26	5.0	52.0	128
			STD	0.2	0.2	0	0.0	0.2	2
			MAX	22.3	7.3	27	5.1	52.3	130
			MIN	21.5	6.9	26	5.0	51.8	126
148	39.00	8	AV8	21.8	7.1	25	5.0	52.1	130
			STD	0.2	0.1	0	0.0	0.2	2
			MAX	22.1	7.2	26	5.1	52.4	133
			MIN	21.6	6.8	25	5.0	51.9	125
155	40.00	7	AV7	21.9	7.1	26	5.0	52.1	131
			STD	0.3	0.1	1	0.1	0.3	2
			MAX	22.4	7.4	27	5.1	52.6	134
			MIN	21.4	7.0	26	4.9	51.6	128
162	41.00	7	AV7	22.1	7.0	26	5.1	51.8	131
			STD	0.2	0.1	1	0.0	0.2	2
			MAX	22.5	7.2	27	5.2	52.0	134
			MIN	21.8	6.9	25	5.1	51.5	128
169	42.00	7	AV7	22.1	7.1	26	5.1	51.8	130
			STD	0.4	0.2	1	0.1	0.4	1
			MAX	22.7	7.3	26	5.2	52.5	132
			MIN	21.4	6.8	25	5.0	51.4	129
176	43.00	7	AV7	22.1	7.1	26	5.1	52.0	130
			STD	0.5	0.2	1	0.1	0.6	3
			MAX	23.0	7.4	27	5.3	52.8	133
			MIN	21.3	6.8	24	4.9	50.9	125
184	44.00	8	AV8	22.3	7.2	25	5.1	51.8	133
			STD	0.3	0.1	1	0.1	0.3	3
			MAX	23.0	7.4	26	5.2	52.2	137
			MIN	22.0	7.1	24	5.0	51.1	125
192	45.00	8	AV8	22.3	7.2	25	5.1	51.7	133
			STD	0.4	0.2	1	0.1	0.3	3
			MAX	22.9	7.6	26	5.2	52.3	140
			MIN	21.7	7.1	24	5.0	51.2	128
199	46.00	7	AV7	22.5	7.5	26	5.2	51.4	132
			STD	0.1	0.1	1	0.0	0.2	3
			MAX	22.6	7.8	27	5.2	51.8	137
			MIN	22.3	7.3	25	5.1	51.1	128

USH 10 over Little Lake Butte des Morts - Pier 1 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
207	47.00	8	AV8	22.6	7.6	25	5.2	51.4	135
			STD	0.5	0.2	0	0.1	0.3	2
			MAX	23.7	8.0	26	5.3	51.8	138
			MIN	22.2	7.4	24	5.1	50.9	131
216	48.00	9	AV9	22.7	7.7	25	5.2	51.2	136
			STD	0.3	0.2	1	0.1	0.4	2
			MAX	23.0	7.9	25	5.4	51.7	141
			MIN	22.3	7.5	24	5.1	50.5	134
224	49.00	8	AV8	22.8	8.1	25	5.3	51.0	139
			STD	0.4	0.2	1	0.1	0.4	3
			MAX	23.4	8.4	27	5.4	51.6	145
			MIN	22.2	7.7	24	5.1	50.4	135
233	50.00	9	AV9	23.1	8.2	25	5.3	50.9	145
			STD	0.4	0.2	1	0.1	0.3	3
			MAX	23.5	8.5	26	5.4	51.2	151
			MIN	22.3	7.8	24	5.2	50.5	141
241	51.00	8	AV8	23.4	8.4	26	5.4	50.6	144
			STD	0.3	0.2	1	0.1	0.3	2
			MAX	23.8	8.6	27	5.4	51.2	150
			MIN	22.9	8.1	25	5.2	50.2	142
251	52.00	10	AV10	23.5	8.5	25	5.4	50.5	150
			STD	0.3	0.1	0	0.0	0.2	2
			MAX	23.9	8.8	26	5.4	51.0	153
			MIN	23.2	8.3	24	5.3	50.3	148
259	53.00	8	AV8	23.4	8.5	26	5.3	50.7	149
			STD	0.3	0.2	1	0.1	0.3	3
			MAX	23.7	8.8	27	5.4	51.2	154
			MIN	22.8	8.3	24	5.2	50.4	146
268	54.00	9	AV9	24.1	9.1	26	5.5	50.1	158
			STD	0.3	0.2	1	0.1	0.3	3
			MAX	24.7	9.3	28	5.6	50.4	165
			MIN	23.6	8.8	25	5.4	49.7	156
276	55.00	8	AV8	23.9	9.0	26	5.4	50.4	157
			STD	0.3	0.1	1	0.1	0.2	1
			MAX	24.4	9.1	27	5.5	50.7	159
			MIN	23.5	8.8	25	5.3	50.0	155
286	56.00	10	AV10	24.1	9.0	25	5.4	50.3	161
			STD	0.4	0.2	1	0.1	0.4	4
			MAX	24.8	9.3	26	5.6	51.2	165
			MIN	23.3	8.6	24	5.2	49.7	154
296	57.00	10	AV10	23.9	8.9	25	5.4	50.3	157
			STD	0.2	0.2	0	0.0	0.2	4
			MAX	24.1	9.2	26	5.5	50.6	165
			MIN	23.6	8.6	24	5.4	50.0	152
305	58.00	9	AV9	23.8	8.9	26	5.4	50.6	155
			STD	0.2	0.2	1	0.1	0.3	3
			MAX	24.3	9.2	26	5.5	51.0	162
			MIN	23.5	8.6	25	5.3	49.9	151
315	59.00	10	AV10	23.6	8.8	24	5.3	50.7	155
			STD	0.3	0.1	1	0.1	0.3	2
			MAX	24.2	9.0	25	5.4	51.0	159
			MIN	23.1	8.6	24	5.3	50.2	150

USH 10 over Little Lake Butte des Morts - Pier 1 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
323	60.00	8	AV8	23.6	8.7	26	5.3	50.7	154
			STD	0.2	0.1	1	0.0	0.2	3
			MAX	23.9	8.9	27	5.4	51.1	158
			MIN	23.1	8.5	25	5.2	50.4	147
333	61.00	10	AV10	23.7	8.9	24	5.3	50.7	162
			STD	0.2	0.3	1	0.0	0.2	4
			MAX	24.1	9.5	26	5.4	51.1	168
			MIN	23.2	8.6	23	5.2	50.4	156
344	62.00	11	AV11	23.9	9.0	24	5.4	50.5	164
			STD	0.3	0.2	1	0.1	0.2	4
			MAX	24.5	9.5	25	5.5	50.8	171
			MIN	23.5	8.6	23	5.3	50.1	157
352	63.00	8	AV8	23.5	8.8	25	5.3	51.0	157
			STD	0.2	0.1	1	0.0	0.2	2
			MAX	24.0	8.9	25	5.3	51.4	160
			MIN	23.2	8.6	23	5.2	50.8	153
366	64.00	14	AV14	25.4	11.8	25	5.7	49.1	203
			STD	0.8	1.6	1	0.2	0.9	16
			MAX	26.4	13.7	27	6.0	50.8	217
			MIN	24.0	8.9	23	5.3	48.1	170
380	65.00	14	AV14	25.9	12.4	25	5.8	48.6	205
			STD	0.5	0.9	1	0.1	0.4	5
			MAX	26.8	15.3	27	6.0	49.6	215
			MIN	24.9	11.3	24	5.6	48.0	195
405	66.00	25	AV25	27.5	17.5	26	6.3	47.0	286
			STD	1.0	3.1	2	0.3	0.9	45
			MAX	28.7	21.6	28	6.6	48.6	341
			MIN	25.8	12.5	23	5.8	45.8	213
437	67.00	32	AV32	28.2	20.2	27	6.5	46.3	322
			STD	0.4	0.8	1	0.1	0.3	13
			MAX	28.8	22.2	28	6.6	47.0	350
			MIN	27.2	19.0	25	6.3	45.7	304
477	68.00	40	AV40	29.5	23.5	29	6.8	45.0	409
			STD	0.5	0.6	1	0.1	0.4	26
			MAX	30.4	24.4	30	7.1	46.2	442
			MIN	28.3	21.8	27	6.5	44.3	351
515	68.70	54	AV38	30.2	25.2	30	7.1	44.2	495
			STD	0.4	0.7	1	0.1	0.4	25
			MAX	31.1	26.8	32	7.3	45.3	536
			MIN	29.1	23.3	28	6.8	43.6	445
525	68.83	74	AV10	30.8	26.3	32	7.3	43.6	535
			STD	0.3	0.5	0	0.1	0.2	7
			MAX	31.3	26.9	33	7.5	43.9	542
			MIN	30.4	25.4	31	7.2	43.2	521
			Average	24.1	11.8	26	5.6	50.1	203
			Std. Dev.	3.7	7.0	3	0.9	3.6	136
			Maximum	31.3	26.9	49	7.5	66.2	542
			Minimum	9.3	2.6	12	3.0	43.2	0

Total number of blows analyzed: 525

BL#	depth (ft)	Comments
1	8.00	Reported excavation reference grade at El. 749

Time Summary

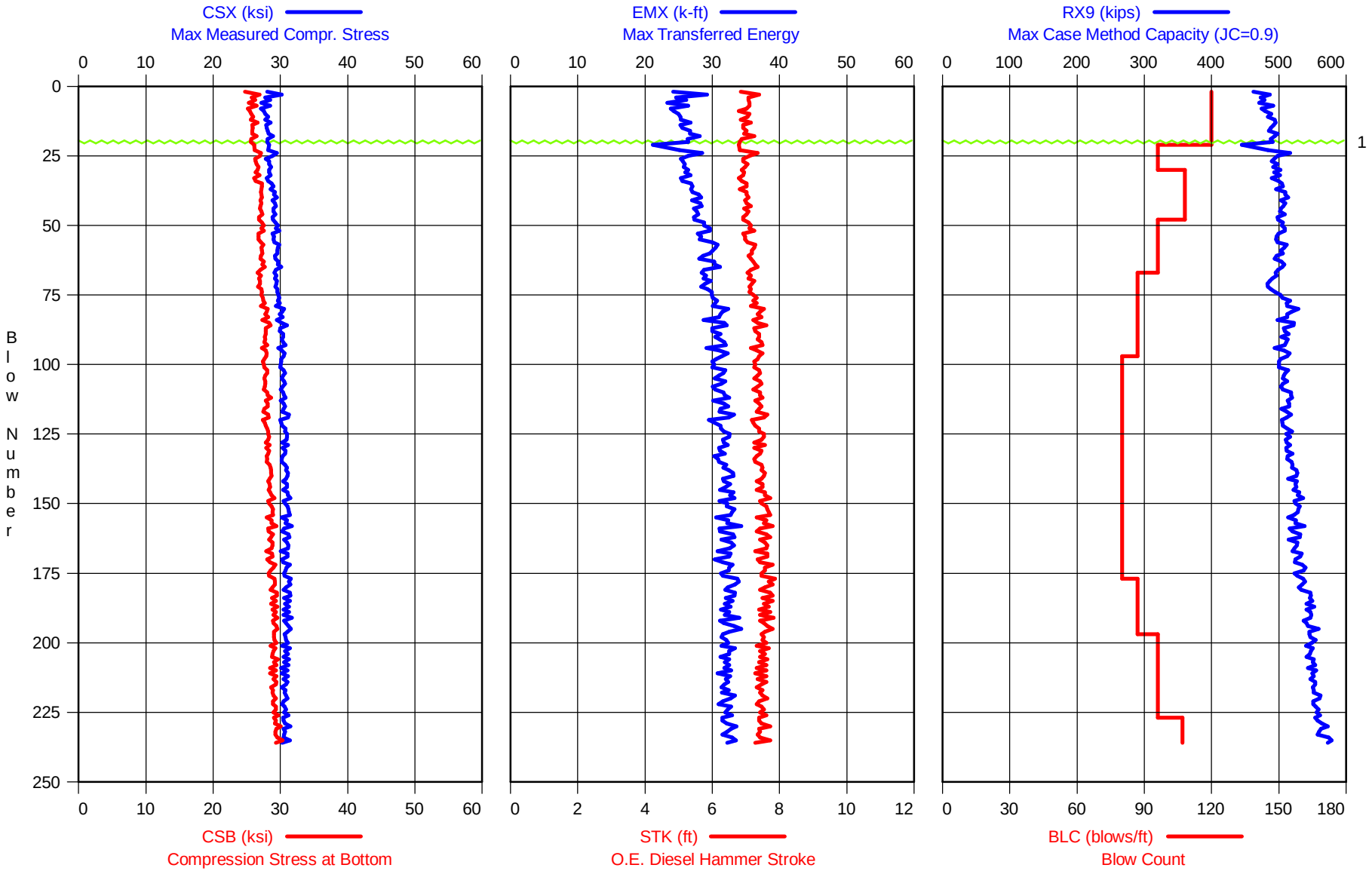
Drive	13 minutes 21 seconds	11:58:12 AM - 12:11:33 PM (11/19/2014)	BN 1 - 525

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

PDIPLOT Ver. 2014.1 - Printed: 24-Nov-2014

Test date: 20-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 1 #44 Restrike
APE D30-42, HP 14 x 73



1 - End of Restrike. Continue driving

USH 10 over Little Lake Butte des Morts - Pier 1 #44 Restrike
OP: MR

APE D30-42, HP 14 x 73
Test date: 20-Nov-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: 1.20

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	68.88	120	AV4	28.6	25.9	26	7.1	44.3	475
			STD	1.0	0.8	2	0.2	0.6	9
			MAX	30.2	26.9	29	7.4	45.0	487
			MIN	27.7	24.7	24	6.9	43.4	462
10	68.92	120	AV5	27.6	25.6	25	7.0	44.5	481
			STD	0.5	0.4	1	0.1	0.4	8
			MAX	28.5	26.4	26	7.1	45.2	492
			MIN	27.1	25.2	23	6.8	44.2	471
15	68.96	120	AV5	28.1	26.0	26	7.0	44.6	491
			STD	0.3	0.3	1	0.1	0.3	4
			MAX	28.5	26.6	27	7.1	45.0	495
			MIN	27.8	25.6	25	6.9	44.1	484
20	69.00	120	AV5	28.3	25.9	27	7.0	44.6	491
			STD	0.3	0.3	1	0.1	0.4	4
			MAX	28.9	26.4	28	7.2	45.1	498
			MIN	28.0	25.6	26	6.8	43.8	485
29	69.09	96	AV8	28.5	26.5	25	7.0	44.6	490
			STD	0.5	0.3	2	0.2	0.5	19
			MAX	29.5	27.1	28	7.4	45.2	517
			MIN	27.8	26.1	21	6.8	43.5	445
38	69.18	108	AV9	28.5	26.8	26	6.9	44.8	500
			STD	0.4	0.4	1	0.1	0.2	6
			MAX	29.2	27.2	27	7.0	45.2	509
			MIN	28.0	26.1	25	6.8	44.5	490
47	69.26	108	AV9	29.1	27.1	28	7.0	44.5	506
			STD	0.2	0.1	0	0.1	0.2	5
			MAX	29.5	27.3	28	7.1	44.8	514
			MIN	28.8	26.9	27	6.9	44.1	498
56	69.35	96	AV9	29.2	27.1	29	7.0	44.4	502
			STD	0.3	0.3	1	0.1	0.3	5
			MAX	29.8	27.5	30	7.2	44.8	509
			MIN	28.9	26.8	27	6.9	43.8	496
66	69.46	96	AV10	29.6	27.3	30	7.2	43.9	504
			STD	0.3	0.2	1	0.1	0.2	5
			MAX	30.1	27.7	31	7.4	44.3	512
			MIN	29.2	27.1	28	7.1	43.5	494
76	69.57	87	AV10	29.5	27.0	29	7.2	44.1	492
			STD	0.2	0.3	1	0.1	0.2	7
			MAX	29.8	27.4	30	7.3	44.4	505
			MIN	29.1	26.6	28	7.0	43.6	483
85	69.69	87	AV10	30.1	27.9	31	7.4	43.5	516
			STD	0.5	0.4	1	0.1	0.4	8
			MAX	30.9	28.5	32	7.6	44.1	529
			MIN	29.3	27.1	29	7.1	42.8	498
96	69.80	87	AV10	30.3	27.8	31	7.4	43.5	509
			STD	0.3	0.2	1	0.1	0.3	6
			MAX	30.8	28.0	32	7.5	44.1	516
			MIN	29.7	27.3	29	7.1	43.1	494

USH 10 over Little Lake Butte des Morts - Pier 1 #44 Restrike
OP: MR

APE D30-42, HP 14 x 73
Test date: 20-Nov-2014

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
106	69.93	80	AV10	30.3	27.7	31	7.3	43.5	506
			STD	0.2	0.2	1	0.1	0.2	5
			MAX	30.7	28.1	32	7.4	43.8	514
			MIN	30.0	27.4	30	7.2	43.3	500
116	70.05	80	AV10	30.5	27.9	31	7.4	43.4	512
			STD	0.2	0.3	1	0.1	0.2	6
			MAX	30.8	28.6	32	7.5	43.9	520
			MIN	30.1	27.5	30	7.2	43.1	503
126	70.18	80	AV10	30.7	28.0	32	7.4	43.4	512
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	31.3	28.4	33	7.6	44.0	519
			MIN	30.0	27.4	30	7.2	42.7	505
136	70.30	80	AV10	30.6	28.1	31	7.4	43.5	515
			STD	0.3	0.2	1	0.1	0.3	4
			MAX	31.1	28.4	32	7.6	43.8	521
			MIN	30.2	27.8	30	7.2	42.9	510
146	70.43	80	AV10	30.9	28.5	32	7.5	43.2	524
			STD	0.2	0.2	1	0.1	0.2	5
			MAX	31.1	28.7	33	7.6	43.6	530
			MIN	30.4	28.2	31	7.3	42.9	514
156	70.55	80	AV10	31.0	28.6	32	7.6	42.9	526
			STD	0.4	0.3	1	0.1	0.3	6
			MAX	31.5	29.1	33	7.7	43.6	536
			MIN	30.2	27.9	31	7.3	42.5	514
166	70.68	80	AV10	31.0	28.7	33	7.6	42.9	526
			STD	0.4	0.3	1	0.1	0.4	7
			MAX	31.7	29.4	34	7.8	43.6	538
			MIN	30.3	28.2	31	7.3	42.3	515
176	70.80	80	AV10	30.7	28.5	32	7.5	43.0	530
			STD	0.4	0.4	1	0.1	0.4	6
			MAX	31.4	29.3	33	7.8	43.7	540
			MIN	30.0	27.9	30	7.3	42.3	520
186	70.92	87	AV10	31.1	29.1	33	7.7	42.6	541
			STD	0.4	0.3	1	0.1	0.4	7
			MAX	31.6	29.5	34	7.9	43.3	550
			MIN	30.5	28.5	32	7.4	42.1	530
196	71.03	87	AV10	31.0	29.2	33	7.6	42.8	546
			STD	0.4	0.3	1	0.2	0.4	6
			MAX	31.7	29.6	34	7.8	43.4	559
			MIN	30.5	28.9	31	7.4	42.2	537
206	71.14	96	AV10	30.9	29.1	32	7.5	43.0	547
			STD	0.4	0.3	1	0.1	0.3	4
			MAX	31.4	29.6	33	7.7	43.6	555
			MIN	30.2	28.6	31	7.3	42.6	540
216	71.24	96	AV10	30.7	29.1	32	7.5	43.2	551
			STD	0.4	0.4	1	0.1	0.4	4
			MAX	31.2	29.4	33	7.6	43.7	555
			MIN	30.1	28.5	31	7.3	42.8	543
226	71.34	96	AV10	30.7	29.1	32	7.5	43.2	556
			STD	0.3	0.3	1	0.1	0.3	4
			MAX	31.2	29.7	33	7.6	43.6	562
			MIN	30.3	28.9	31	7.3	42.7	551

USH 10 over Little Lake Butte des Morts - Pier 1 #44 Restrike
APE D30-42, HP 14 x 73
OP: MR
Test date: 20-Nov-2014

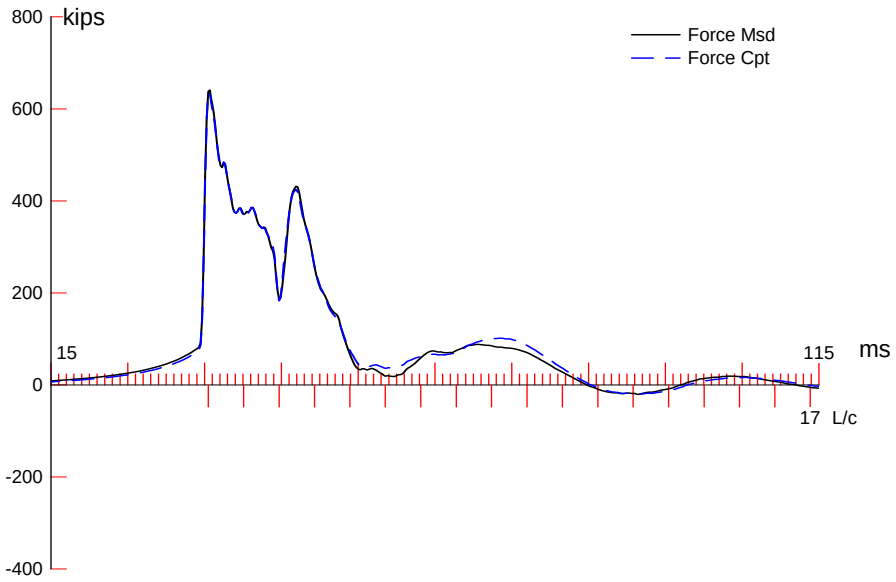
BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
236	71.44	107	AV10	30.7	29.5	32	7.5	43.2	565
			STD	0.4	0.4	1	0.1	0.4	8
			MAX	31.5	30.4	34	7.7	43.7	578
			MIN	30.3	29.1	31	7.3	42.5	554
			Average	30.1	28.0	30	7.3	43.6	519
			Std. Dev.	1.0	1.1	3	0.2	0.7	23
			Maximum	31.7	30.4	34	7.9	45.2	578
			Minimum	27.1	24.7	21	6.8	42.1	445

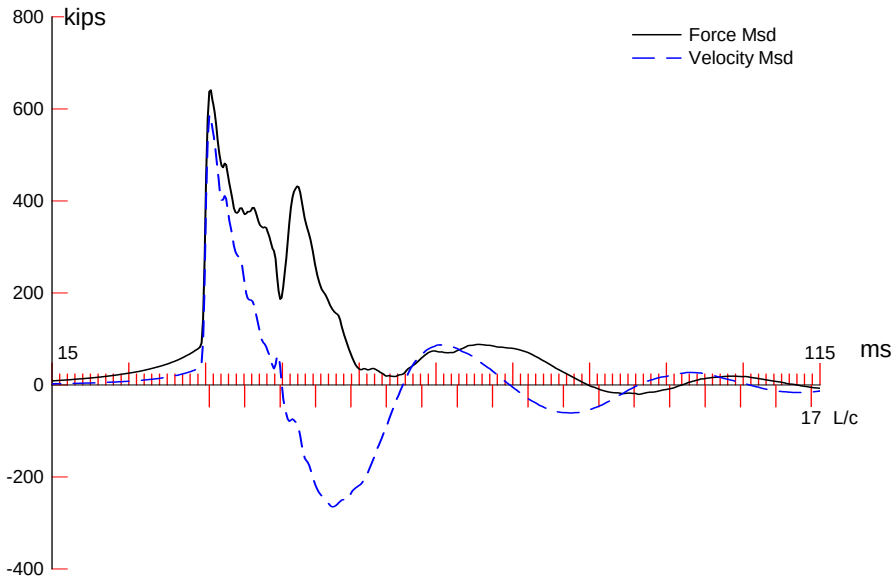
Total number of blows analyzed: 234

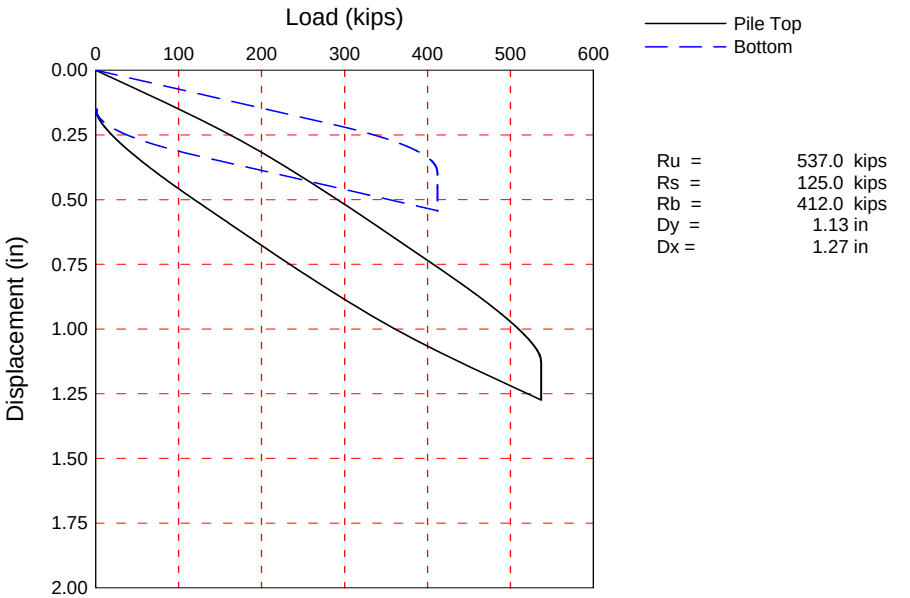
BL#	depth (ft)	Comments
20	69.00	End of Restrike. Continue driving

Time Summary

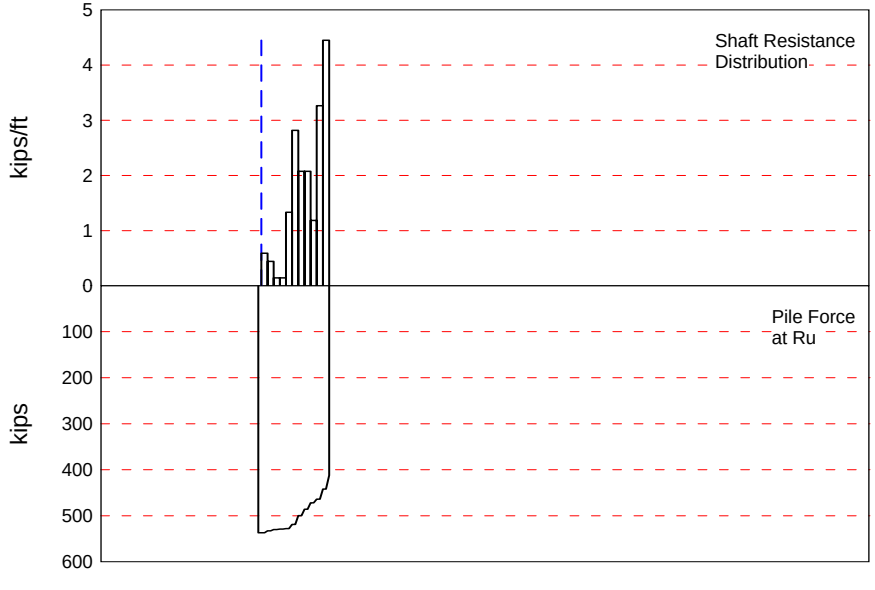
Drive	7 minutes 30 seconds	7:44:20 AM - 7:51:50 AM (11/20/2014) BN 1 - 236







Ru	=	537.0 kips
Rs	=	125.0 kips
Rb	=	412.0 kips
Dy	=	1.13 in
Dx	=	1.27 in



CAPWAP(R) 2006-3 Licensed to GRL Engineers, Inc.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 537.0; along Shaft 125.0; at Toe 412.0 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
				537.0				
1	10.1	6.0	4.0	533.0	4.0	0.66	0.14	0.248
2	16.8	12.8	3.0	530.0	7.0	0.45	0.09	0.248
3	23.6	19.5	1.0	529.0	8.0	0.15	0.03	0.248
4	30.3	26.3	1.0	528.0	9.0	0.15	0.03	0.248
5	37.1	33.0	9.0	519.0	18.0	1.34	0.28	0.248
6	43.8	39.7	19.0	500.0	37.0	2.82	0.60	0.248
7	50.5	46.5	14.0	486.0	51.0	2.08	0.44	0.248
8	57.3	53.2	14.0	472.0	65.0	2.08	0.44	0.248
9	64.0	60.0	8.0	464.0	73.0	1.19	0.25	0.248
10	70.8	66.7	22.0	442.0	95.0	3.26	0.69	0.248
11	77.5	73.4	30.0	412.0	125.0	4.45	0.95	0.248
Avg. Shaft			11.4			1.70	0.36	0.248
Toe			412.0				298.88	0.090

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.127	0.302
Case Damping Factor		0.812	0.969
Damping Type			Smith
Unloading Quake	(% of loading quake)	100	99
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.017
Soil Plug Weight	(kips)		0.08

CAPWAP match quality = 2.21 (Wave Up Match) ; RSA = 0
Observed: final set = 0.150 in; blow count = 80 b/ft
Computed: final set = 0.111 in; blow count = 108 b/ft

max. Top Comp. Stress = 29.7 ksi (T= 36.1 ms, max= 1.018 x Top)
max. Comp. Stress = 30.2 ksi (Z= 37.1 ft, T= 38.1 ms)
max. Tens. Stress = -1.47 ksi (Z= 37.1 ft, T= 58.5 ms)
max. Energy (EMX) = 32.0 kip-ft; max. Measured Top Displ. (DMX)= 0.90 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	635.8	-22.0	29.7	-1.03	31.96	15.4	0.916
2	6.7	641.3	-23.5	30.0	-1.10	31.77	15.3	0.899
4	13.5	630.3	-22.7	29.4	-1.06	30.35	15.0	0.859
5	16.8	632.7	-24.5	29.6	-1.14	30.03	14.9	0.837
6	20.2	621.0	-23.0	29.0	-1.08	29.02	14.9	0.813
7	23.6	623.1	-24.7	29.1	-1.15	28.59	14.8	0.788
8	27.0	621.1	-25.1	29.0	-1.17	27.93	14.7	0.761
9	30.3	627.6	-26.6	29.3	-1.24	27.44	14.6	0.734
10	33.7	633.9	-27.1	29.6	-1.27	26.74	14.3	0.705
11	37.1	647.0	-31.4	30.2	-1.47	26.16	14.0	0.676
12	40.4	626.7	-23.0	29.3	-1.07	24.12	13.5	0.646
13	43.8	640.0	-29.7	29.9	-1.39	23.48	13.1	0.615
14	47.2	574.6	-7.4	26.8	-0.35	20.19	12.7	0.584
15	50.5	586.3	-14.1	27.4	-0.66	19.55	12.4	0.553
16	53.9	543.2	-0.1	25.4	-0.01	17.18	12.1	0.522
17	57.3	552.5	-6.2	25.8	-0.29	16.54	11.8	0.491
18	60.7	506.4	0.0	23.7	0.00	14.39	11.6	0.461
19	64.0	518.5	0.0	24.2	0.00	13.79	11.3	0.431
20	67.4	506.0	0.0	23.6	0.00	12.47	11.2	0.401
21	70.8	524.1	0.0	24.5	0.00	11.89	12.3	0.372
22	74.1	505.8	0.0	23.6	0.00	9.64	13.1	0.343
23	77.5	517.8	0.0	24.2	0.00	7.80	12.7	0.315
Absolute	37.1			30.2			(T =	38.1 ms)
	37.1				-1.47		(T =	58.5 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	712.5	658.2	604.0	549.8	495.5	441.3	387.1	332.8	278.6	224.4
RX	726.7	689.6	670.0	650.4	630.7	611.6	592.8	575.1	558.2	543.6
RU	712.5	658.2	604.0	549.8	495.5	441.3	387.1	332.8	278.6	224.4

RAU = 384.0 (kips); RA2 = 592.4 (kips)

Current CAPWAP Ru = 537.0 (kips); Corresponding J(RP)= 0.32; matches RX9 within 5%

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
15.71	35.68	599.9	654.9	654.9	0.900	0.152	0.150	32.2	736.6

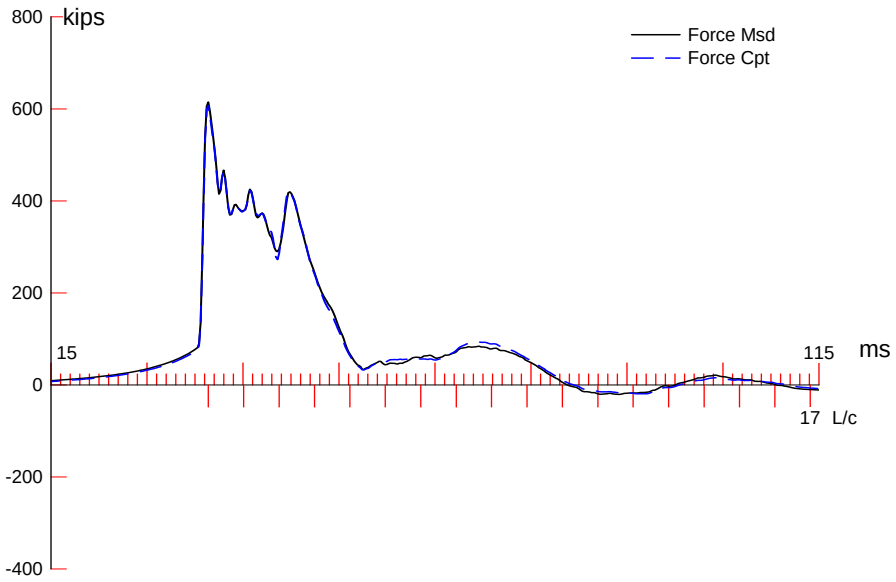
PILE PROFILE AND PILE MODEL

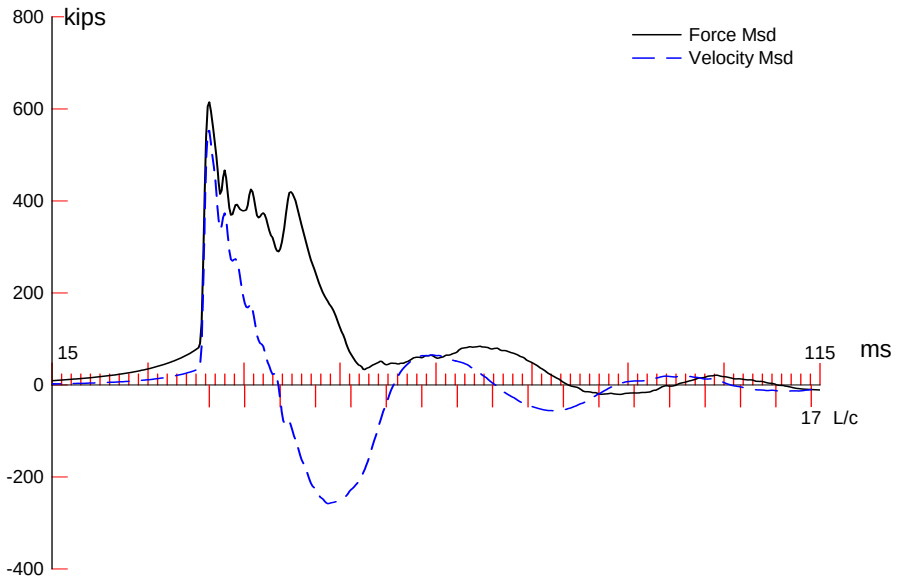
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	21.40	29992.2	492.000	4.699
77.50	21.40	29992.2	492.000	4.699

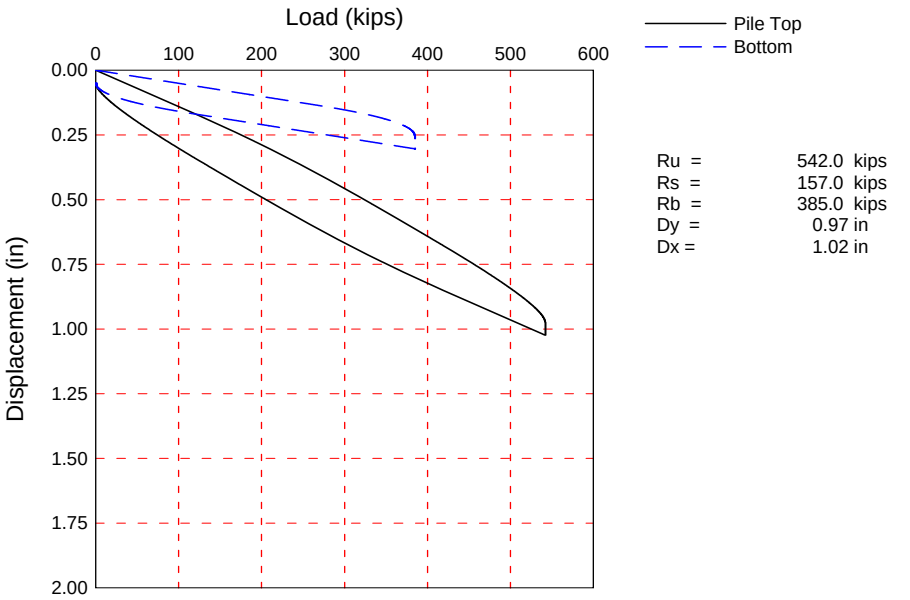
Toe Area 1.378 ft^2

Top Segment Length 3.37 ft, Top Impedance 38.20 kips/ft/s

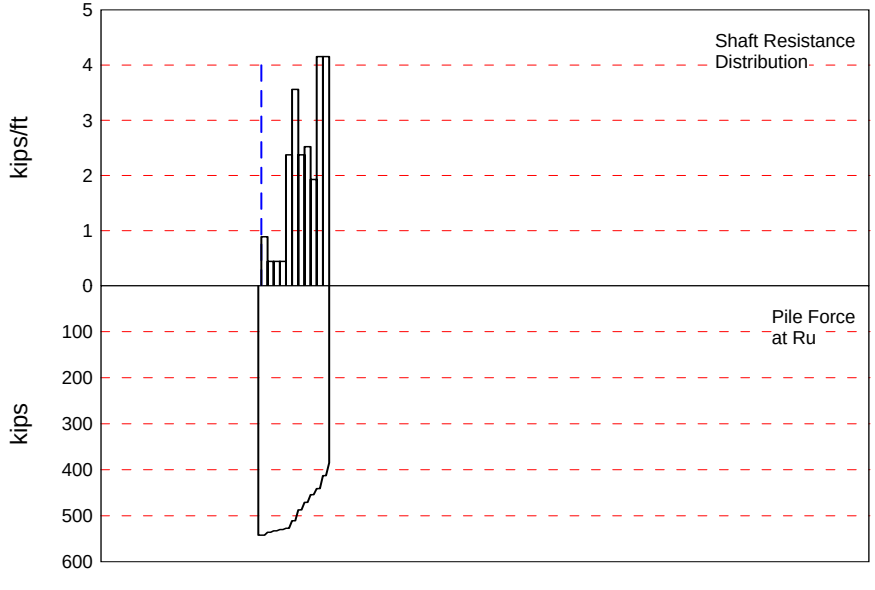
Pile Damping 1.0 %, Time Incr 0.200 ms, Wave Speed 16807.9 ft/s, 2L/c 9.2 ms







Ru = 542.0 kips
Rs = 157.0 kips
Rb = 385.0 kips
Dy = 0.97 in
Dx = 1.02 in



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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 542.0; along Shaft 157.0; at Toe 385.0 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
				542.0				
1	10.1	6.1	6.0	536.0	6.0	0.99	0.21	0.247
2	16.8	12.8	3.0	533.0	9.0	0.45	0.09	0.247
3	23.6	19.6	3.0	530.0	12.0	0.45	0.09	0.247
4	30.3	26.3	3.0	527.0	15.0	0.45	0.09	0.247
5	37.1	33.0	16.0	511.0	31.0	2.37	0.51	0.247
6	43.8	39.8	24.0	487.0	55.0	3.56	0.76	0.247
7	50.5	46.5	16.0	471.0	71.0	2.37	0.51	0.247
8	57.3	53.3	17.0	454.0	88.0	2.52	0.54	0.247
9	64.0	60.0	13.0	441.0	101.0	1.93	0.41	0.247
10	70.8	66.7	28.0	413.0	129.0	4.15	0.88	0.247
11	77.5	73.5	28.0	385.0	157.0	4.15	0.88	0.247
Avg. Shaft			14.3			2.14	0.45	0.247
Toe			385.0				279.29	0.119

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.160	0.195
Case Damping Factor		1.015	1.201
Damping Type			Smith
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	75	
Soil Plug Weight	(kips)		0.07

CAPWAP match quality = 1.52 (Wave Up Match) ; RSA = 0
Observed: final set = 0.050 in; blow count = 240 b/ft
Computed: final set = 0.055 in; blow count = 220 b/ft

max. Top Comp. Stress = 28.5 ksi (T= 35.9 ms, max= 1.019 x Top)
max. Comp. Stress = 29.1 ksi (Z= 10.1 ft, T= 36.3 ms)
max. Tens. Stress = -1.63 ksi (Z= 37.1 ft, T= 58.1 ms)
max. Energy (EMX) = 27.8 kip-ft; max. Measured Top Displ. (DMX)= 0.81 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	610.8	-19.8	28.5	-0.93	27.83	14.6	0.814
2	6.7	617.8	-20.1	28.9	-0.94	27.56	14.4	0.793
4	13.5	599.7	-18.4	28.0	-0.86	25.84	14.2	0.749
5	16.8	603.5	-20.3	28.2	-0.95	25.45	14.0	0.725
6	20.2	594.4	-19.5	27.8	-0.91	24.50	13.9	0.699
7	23.6	598.3	-21.1	28.0	-0.99	23.99	13.8	0.671
8	27.0	589.7	-20.2	27.5	-0.94	23.02	13.7	0.643
9	30.3	599.1	-25.2	28.0	-1.18	22.48	13.4	0.615
10	33.7	602.4	-28.1	28.1	-1.31	21.50	13.0	0.585
11	37.1	618.8	-34.9	28.9	-1.63	20.86	12.6	0.554
12	40.4	577.4	-20.7	27.0	-0.97	18.39	12.0	0.523
13	43.8	592.3	-27.2	27.7	-1.27	17.72	11.6	0.491
14	47.2	520.3	-4.7	24.3	-0.22	14.76	11.3	0.460
15	50.5	532.3	-10.8	24.9	-0.51	14.14	10.9	0.430
16	53.9	492.2	0.0	23.0	0.00	12.20	10.6	0.400
17	57.3	502.7	-4.8	23.5	-0.22	11.60	10.3	0.369
18	60.7	472.4	0.0	22.1	0.00	9.86	10.0	0.340
19	64.0	472.8	0.0	22.1	0.00	9.31	9.7	0.312
20	67.4	477.8	0.0	22.3	0.00	8.07	9.2	0.284
21	70.8	488.8	0.0	22.8	0.00	7.55	9.6	0.256
22	74.1	463.6	0.0	21.7	0.00	5.88	10.4	0.229
23	77.5	469.9	0.0	22.0	0.00	4.95	9.8	0.203
Absolute	10.1			29.1			(T =	36.3 ms)
	37.1				-1.63		(T =	58.1 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	751.7	707.8	664.0	620.1	576.2	532.3	488.4	444.5	400.7	356.8
RX	760.3	717.6	680.8	648.5	619.7	603.1	586.4	569.7	553.0	536.3
RU	752.3	708.4	664.6	620.8	576.9	533.1	489.3	445.4	401.6	357.8

RAU = 359.9 (kips); RA2 = 597.5 (kips)

Current CAPWAP Ru = 542.0 (kips); Corresponding J(RP)= 0.48; J(RX) = 0.87

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
14.80	35.68	565.4	625.2	625.2	0.809	0.052	0.050	28.2	788.0

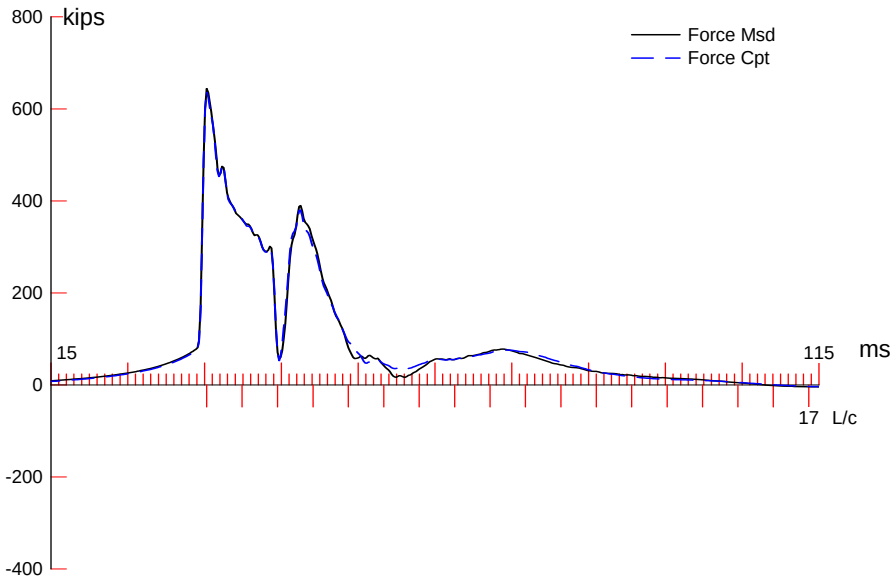
PILE PROFILE AND PILE MODEL

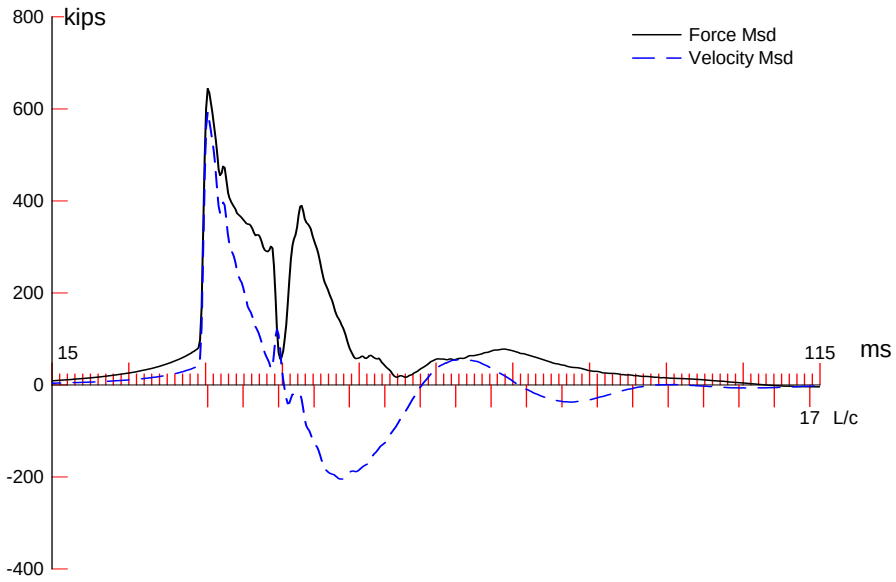
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	21.40	29992.2	492.000	4.699
77.50	21.40	29992.2	492.000	4.699

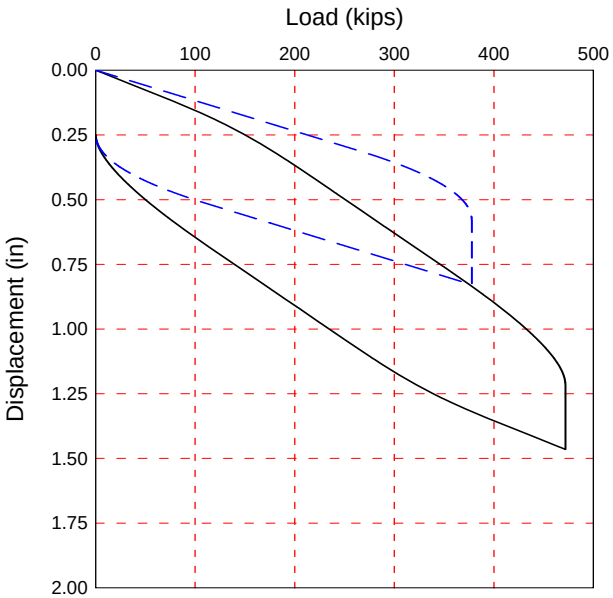
Toe Area 1.378 ft^2

Top Segment Length 3.37 ft, Top Impedance 38.20 kips/ft/s

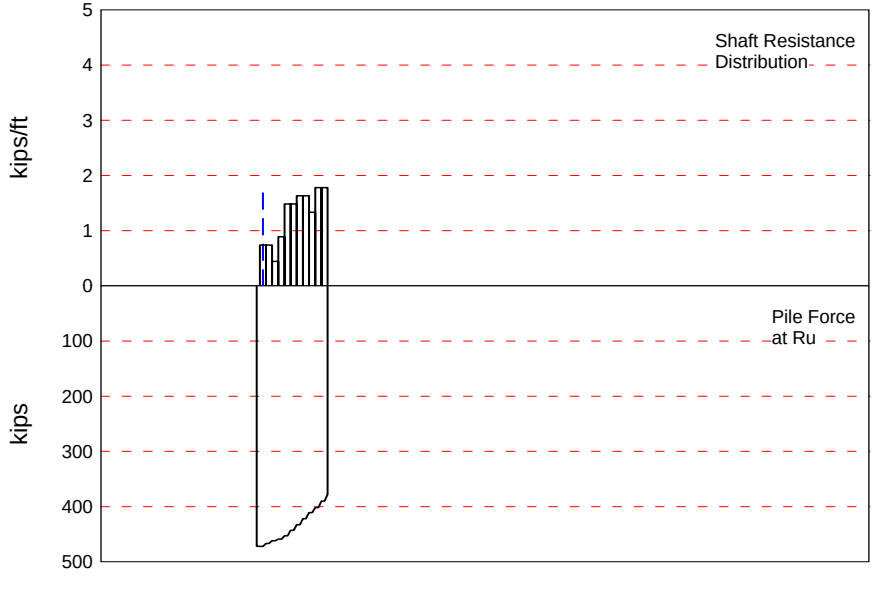
Pile Damping 1.0 %, Time Incr 0.200 ms, Wave Speed 16807.9 ft/s, 2L/c 9.2 ms







Ru = 472.0 kips
Rs = 94.0 kips
Rb = 378.0 kips
Dy = 1.22 in
Dx = 1.47 in



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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 472.0; along Shaft 94.0; at Toe 378.0 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
				472.0				
1	10.1	2.9	5.0	467.0	5.0	1.70	0.36	0.269
2	16.8	9.7	5.0	462.0	10.0	0.74	0.16	0.269
3	23.6	16.4	3.0	459.0	13.0	0.45	0.09	0.269
4	30.3	23.2	6.0	453.0	19.0	0.89	0.19	0.269
5	37.1	29.9	10.0	443.0	29.0	1.48	0.32	0.269
6	43.8	36.6	10.0	433.0	39.0	1.48	0.32	0.269
7	50.5	43.4	11.0	422.0	50.0	1.63	0.35	0.269
8	57.3	50.1	11.0	411.0	61.0	1.63	0.35	0.269
9	64.0	56.9	9.0	402.0	70.0	1.34	0.28	0.269
10	70.8	63.6	12.0	390.0	82.0	1.78	0.38	0.269
11	77.5	70.3	12.0	378.0	94.0	1.78	0.38	0.269
Avg. Shaft			8.5			1.34	0.28	0.269
Toe			378.0				274.21	0.073

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.119	0.445
Case Damping Factor		0.662	0.722
Damping Type			Smith
Unloading Quake	(% of loading quake)	100	76
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.048
Soil Plug Weight	(kips)		0.11

CAPWAP match quality = 1.77 (Wave Up Match) ; RSA = 0
Observed: final set = 0.250 in; blow count = 48 b/ft
Computed: final set = 0.229 in; blow count = 52 b/ft

max. Top Comp. Stress = 29.9 ksi (T= 35.7 ms, max= 1.017 x Top)
max. Comp. Stress = 30.4 ksi (Z= 10.1 ft, T= 36.1 ms)
max. Tens. Stress = -0.48 ksi (Z= 10.1 ft, T= 191.7 ms)
max. Energy (EMX) = 30.7 kip-ft; max. Measured Top Displ. (DMX)= 0.91 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	639.7	-10.2	29.9	-0.47	30.70	15.6	0.921
2	6.7	646.1	-10.2	30.2	-0.48	30.64	15.5	0.912
4	13.5	631.2	-5.3	29.5	-0.25	29.21	15.1	0.884
5	16.8	635.2	-5.3	29.7	-0.25	28.98	15.0	0.865
6	20.2	614.0	-0.4	28.7	-0.02	27.61	14.9	0.845
7	23.6	617.6	-0.4	28.9	-0.02	27.33	14.8	0.825
8	27.0	609.7	0.0	28.5	0.00	26.42	14.6	0.804
9	30.3	615.9	0.0	28.8	0.00	26.12	14.4	0.783
10	33.7	597.5	0.0	27.9	0.00	24.62	14.1	0.761
11	37.1	605.9	0.0	28.3	0.00	24.28	13.8	0.738
12	40.4	570.5	0.0	26.7	0.00	22.12	13.5	0.716
13	43.8	580.3	0.0	27.1	0.00	21.74	13.2	0.692
14	47.2	548.3	0.0	25.6	0.00	19.67	12.9	0.668
15	50.5	557.8	0.0	26.1	0.00	19.27	12.6	0.643
16	53.9	522.2	0.0	24.4	0.00	17.16	12.3	0.619
17	57.3	530.2	0.0	24.8	0.00	16.75	12.0	0.594
18	60.7	493.8	0.0	23.1	0.00	14.76	11.9	0.570
19	64.0	506.1	0.0	23.6	0.00	14.35	11.7	0.545
20	67.4	492.9	0.0	23.0	0.00	12.74	13.1	0.520
21	70.8	487.4	0.0	22.8	0.00	12.33	14.3	0.495
22	74.1	423.6	0.0	19.8	0.00	10.45	15.2	0.471
23	77.5	441.7	-0.0	20.6	-0.00	9.25	15.5	0.446
Absolute	10.1			30.4			(T =	36.1 ms)
	10.1				-0.48		(T =	191.7 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	604.0	538.9	473.8	408.7	343.6	278.5	213.5	148.4	83.3	18.2
RX	617.0	589.8	562.6	535.4	509.1	498.1	487.5	476.8	466.1	455.4
RU	604.0	538.9	473.8	408.7	343.6	278.5	213.5	148.4	83.3	18.2

RAU = 346.7 (kips); RA2 = 551.6 (kips)

Current CAPWAP Ru = 472.0 (kips); Corresponding J(RP)= 0.20; J(RX) = 0.74

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
15.80	35.48	603.5	651.3	654.4	0.908	0.252	0.250	30.8	638.7

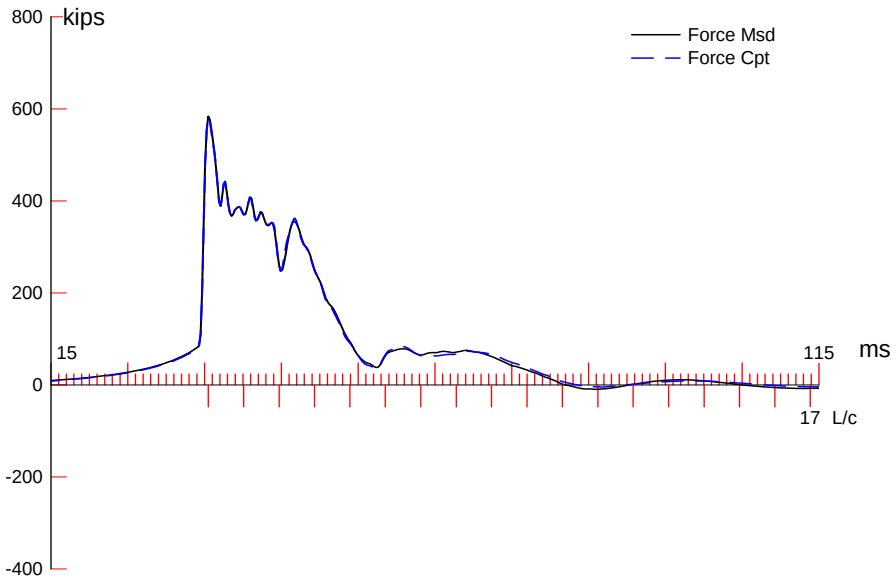
PILE PROFILE AND PILE MODEL

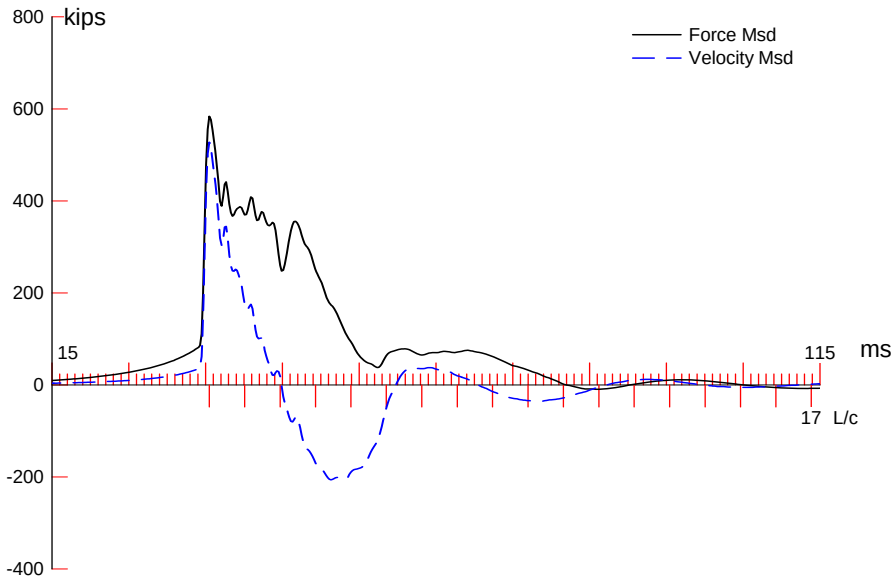
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	21.40	29992.2	492.000	4.699
77.50	21.40	29992.2	492.000	4.699

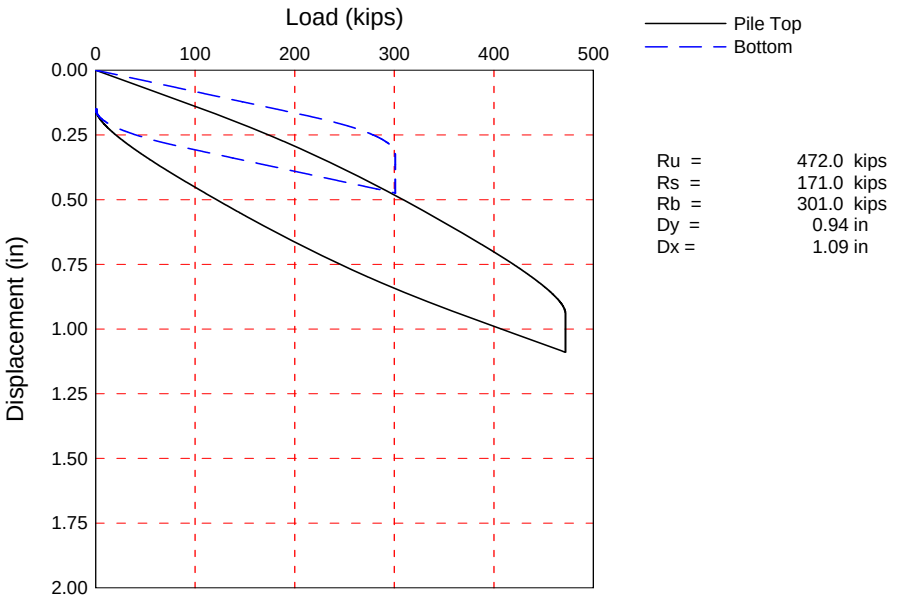
Toe Area 1.378 ft^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Soil Plug kips
1	3.37	38.20	0.00	0.000	0.000	-0.000	0.000	4.699	0.00
22	74.13	38.20	0.00	0.000	0.000	-0.000	0.000	4.699	0.04
23	77.50	38.20	0.00	0.000	0.000	-0.000	0.000	4.699	0.00

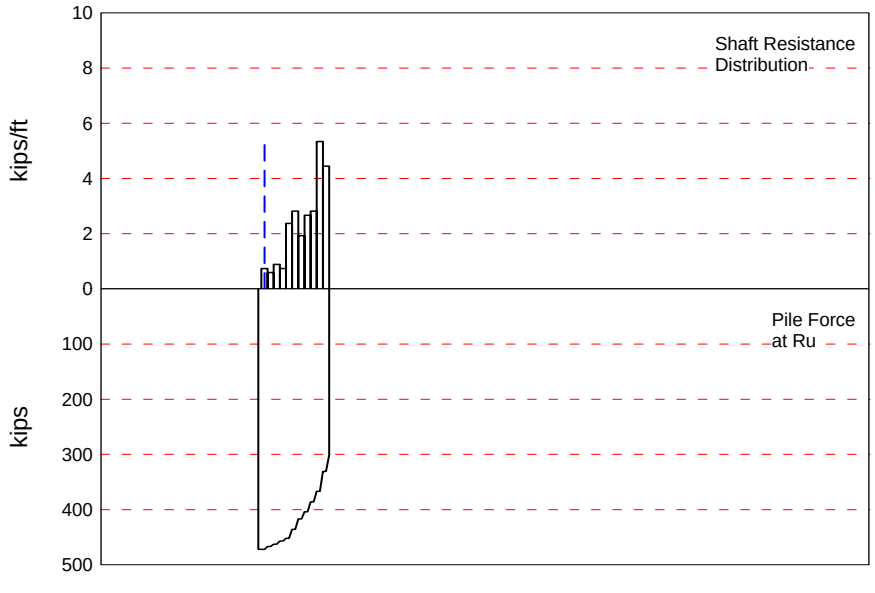
Pile Damping 1.0 %, Time Incr 0.200 ms, Wave Speed 16807.9 ft/s, 2L/c 9.2 ms







Ru	=	472.0 kips
Rs	=	171.0 kips
Rb	=	301.0 kips
Dy	=	0.94 in
Dx	=	1.09 in



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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 472.0; along Shaft 171.0; at Toe 301.0 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
				472.0				
1	10.1	3.0	5.0	467.0	5.0	1.69	0.36	0.255
2	16.8	9.7	4.0	463.0	9.0	0.59	0.13	0.255
3	23.6	16.4	6.0	457.0	15.0	0.89	0.19	0.255
4	30.3	23.2	5.0	452.0	20.0	0.74	0.16	0.255
5	37.1	29.9	16.0	436.0	36.0	2.37	0.51	0.255
6	43.8	36.7	19.0	417.0	55.0	2.82	0.60	0.255
7	50.5	43.4	13.0	404.0	68.0	1.93	0.41	0.255
8	57.3	50.1	18.0	386.0	86.0	2.67	0.57	0.255
9	64.0	56.9	19.0	367.0	105.0	2.82	0.60	0.255
10	70.8	63.6	36.0	331.0	141.0	5.34	1.14	0.255
11	77.5	70.4	30.0	301.0	171.0	4.45	0.95	0.255
Avg. Shaft			15.5			2.43	0.52	0.255
Toe			301.0				218.36	0.111

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.142	0.249
Case Damping Factor		1.142	0.874
Damping Type			Smith
Unloading Quake	(% of loading quake)	100	100
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	84	
Resistance Gap (included in Toe Quake)	(in)		0.002
Soil Plug Weight	(kips)		0.19

CAPWAP match quality = 1.17 (Wave Up Match) ; RSA = 0
Observed: final set = 0.150 in; blow count = 80 b/ft
Computed: final set = 0.117 in; blow count = 103 b/ft

max. Top Comp. Stress = 27.2 ksi (T= 35.9 ms, max= 1.018 x Top)
max. Comp. Stress = 27.7 ksi (Z= 10.1 ft, T= 36.3 ms)
max. Tens. Stress = -0.57 ksi (Z= 10.1 ft, T= 170.6 ms)
max. Energy (EMX) = 25.7 kip-ft; max. Measured Top Displ. (DMX)= 0.79 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	583.1	-12.1	27.2	-0.57	25.65	13.8	0.785
2	6.7	589.0	-12.1	27.5	-0.57	25.42	13.7	0.766
4	13.5	576.3	-8.0	26.9	-0.37	23.95	13.4	0.722
5	16.8	581.2	-8.0	27.2	-0.37	23.59	13.2	0.699
6	20.2	570.4	-4.7	26.6	-0.22	22.60	13.1	0.675
7	23.6	576.1	-4.7	26.9	-0.22	22.21	12.9	0.651
8	27.0	556.2	0.0	26.0	0.00	20.96	12.7	0.626
9	30.3	566.3	0.0	26.5	0.00	20.52	12.5	0.600
10	33.7	560.0	0.0	26.2	0.00	19.42	12.1	0.573
11	37.1	575.8	0.0	26.9	0.00	18.93	11.7	0.546
12	40.4	529.1	0.0	24.7	0.00	16.75	11.3	0.521
13	43.8	541.7	0.0	25.3	0.00	16.30	10.9	0.495
14	47.2	483.7	0.0	22.6	0.00	14.06	10.6	0.469
15	50.5	496.7	0.0	23.2	0.00	13.62	10.4	0.443
16	53.9	465.2	0.0	21.7	0.00	12.14	10.0	0.418
17	57.3	478.9	0.0	22.4	0.00	11.72	9.7	0.393
18	60.7	435.4	0.0	20.3	0.00	10.08	9.3	0.369
19	64.0	454.8	0.0	21.2	0.00	9.71	8.9	0.345
20	67.4	420.2	0.0	19.6	0.00	8.25	8.3	0.322
21	70.8	430.1	0.0	20.1	0.00	7.88	8.4	0.299
22	74.1	366.8	0.0	17.1	0.00	5.88	9.4	0.277
23	77.5	370.9	0.0	17.3	0.00	4.62	9.7	0.257
Absolute	10.1			27.7			(T =	36.3 ms)
	10.1				-0.57		(T =	170.6 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	680.4	636.0	591.6	547.2	502.8	458.4	414.0	369.6	325.2	280.8
RX	681.3	637.3	594.4	555.1	536.1	517.1	498.1	479.1	460.2	449.3
RU	680.4	636.0	591.6	547.2	502.8	458.4	414.0	369.6	325.2	280.8

RAU = 274.6 (kips); RA2 = 545.1 (kips)

Current CAPWAP Ru = 472.0 (kips); Corresponding J(RP)= 0.47; J(RX) = 0.74

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
13.98	35.68	533.8	590.5	590.5	0.789	0.149	0.150	26.0	663.7

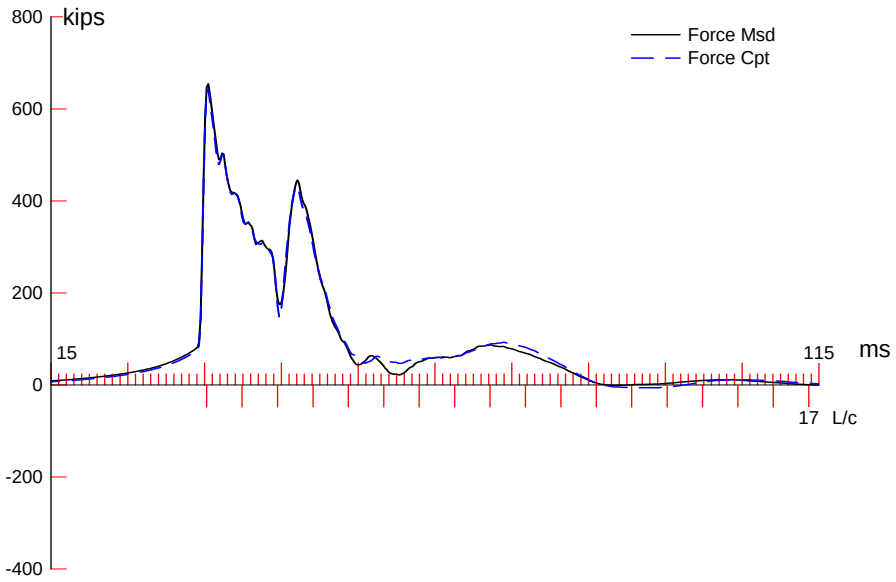
PILE PROFILE AND PILE MODEL

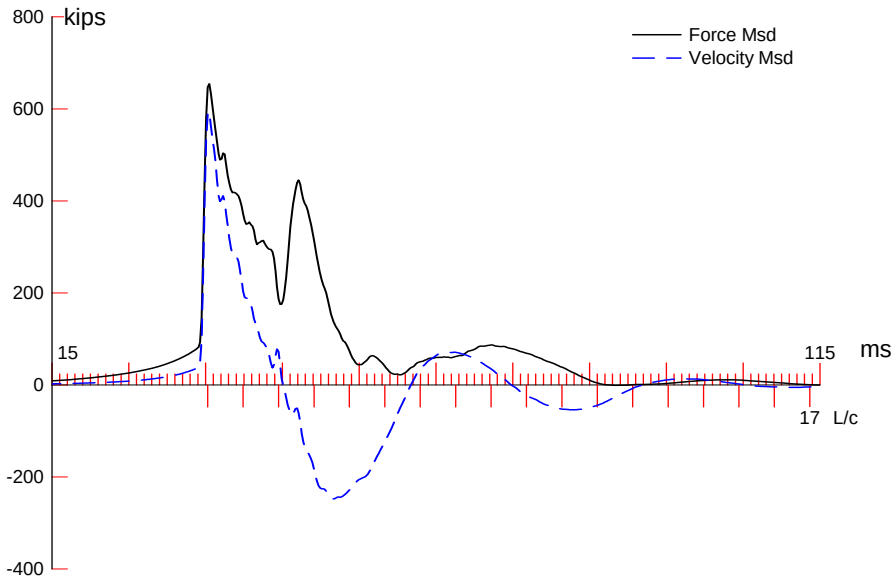
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	21.40	29992.2	492.000	4.699
77.50	21.40	29992.2	492.000	4.699

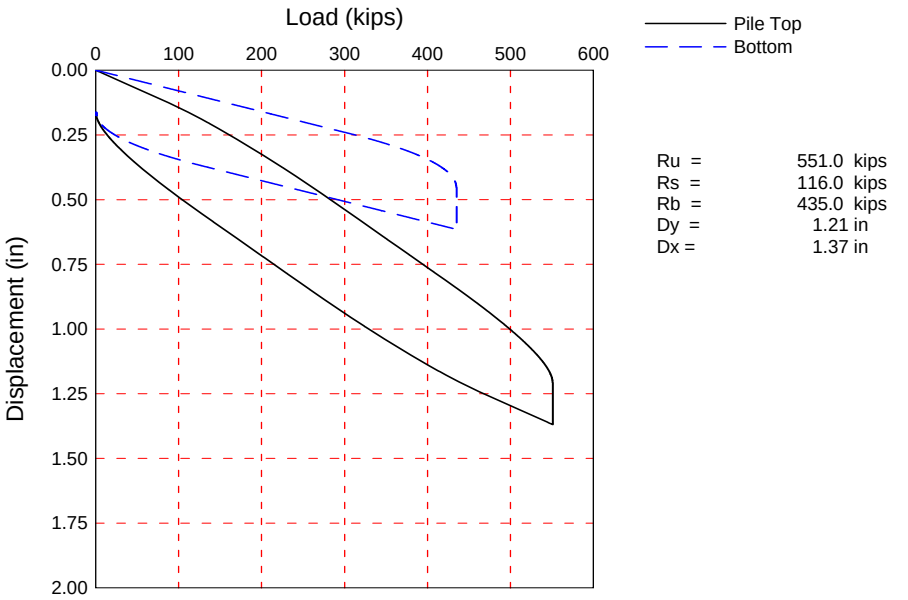
Toe Area 1.378 ft^2

Top Segment Length 3.37 ft, Top Impedance 38.20 kips/ft/s

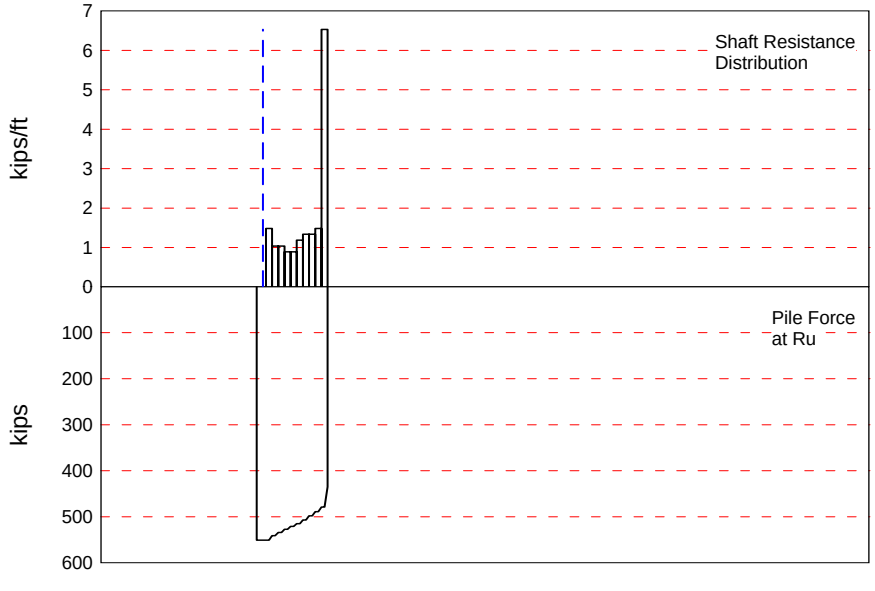
Pile Damping 1.0 %, Time Incr 0.200 ms, Wave Speed 16807.9 ft/s, 2L/c 9.2 ms







Ru	=	551.0 kips
Rs	=	116.0 kips
Rb	=	435.0 kips
Dy	=	1.21 in
Dx	=	1.37 in



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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 551.0; along Shaft 116.0; at Toe 435.0 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
				551.0				
1	16.8	8.2	10.0	541.0	10.0	1.23	0.26	0.245
2	23.6	14.9	7.0	534.0	17.0	1.04	0.22	0.245
3	30.3	21.6	7.0	527.0	24.0	1.04	0.22	0.245
4	37.1	28.4	6.0	521.0	30.0	0.89	0.19	0.245
5	43.8	35.1	6.0	515.0	36.0	0.89	0.19	0.245
6	50.5	41.8	8.0	507.0	44.0	1.19	0.25	0.245
7	57.3	48.6	9.0	498.0	53.0	1.34	0.28	0.245
8	64.0	55.3	9.0	489.0	62.0	1.34	0.28	0.245
9	70.8	62.1	10.0	479.0	72.0	1.48	0.32	0.245
10	77.5	68.8	44.0	435.0	116.0	6.53	1.39	0.245
Avg. Shaft			11.6			1.69	0.36	0.245
Toe			435.0				315.56	0.058

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.110	0.348
Case Damping Factor		0.744	0.661
Damping Type			Smith
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.024
Soil Plug Weight	(kips)		0.17

CAPWAP match quality = 2.27 (Wave Up Match) ; RSA = 0
Observed: final set = 0.163 in; blow count = 74 b/ft
Computed: final set = 0.123 in; blow count = 97 b/ft

max. Top Comp. Stress = 30.1 ksi (T= 35.9 ms, max= 1.043 x Top)
max. Comp. Stress = 31.3 ksi (Z= 16.8 ft, T= 36.7 ms)
max. Tens. Stress = -0.69 ksi (Z= 16.8 ft, T= 89.6 ms)
max. Energy (EMX) = 32.4 kip-ft; max. Measured Top Displ. (DMX)= 0.90 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	643.3	-8.4	30.1	-0.39	32.36	15.8	0.926
2	6.7	644.7	-9.2	30.1	-0.43	32.21	15.7	0.911
4	13.5	663.3	-13.0	31.0	-0.61	31.74	15.3	0.874
5	16.8	671.0	-14.8	31.3	-0.69	31.46	15.0	0.853
6	20.2	633.4	-6.2	29.6	-0.29	29.08	14.8	0.832
7	23.6	640.1	-7.9	29.9	-0.37	28.74	14.6	0.809
8	27.0	616.7	-2.5	28.8	-0.12	27.02	14.4	0.786
9	30.3	622.7	-3.9	29.1	-0.18	26.64	14.2	0.762
10	33.7	598.7	0.0	28.0	0.00	24.97	14.0	0.738
11	37.1	604.3	0.0	28.2	0.00	24.57	13.9	0.713
12	40.4	585.1	0.0	27.3	0.00	23.10	13.7	0.687
13	43.8	591.7	-0.4	27.6	-0.02	22.60	13.5	0.660
14	47.2	574.6	0.0	26.8	0.00	21.11	13.3	0.631
15	50.5	582.3	-0.9	27.2	-0.04	20.55	13.1	0.602
16	53.9	558.1	0.0	26.1	0.00	18.85	12.8	0.573
17	57.3	566.8	0.0	26.5	0.00	18.29	12.6	0.544
18	60.7	542.9	0.0	25.4	0.00	16.58	12.3	0.515
19	64.0	551.2	0.0	25.8	0.00	15.98	12.0	0.485
20	67.4	529.0	0.0	24.7	0.00	14.36	11.7	0.455
21	70.8	531.6	-0.0	24.8	-0.00	13.71	12.6	0.423
22	74.1	533.9	-0.0	24.9	-0.00	12.14	13.7	0.393
23	77.5	552.3	-0.0	25.8	-0.00	8.63	13.8	0.364
Absolute	16.8			31.3			(T =	36.7 ms)
	16.8				-0.69		(T =	89.6 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	700.0	641.9	583.7	525.6	467.4	409.3	351.1	293.0	234.8	176.7
RX	702.6	675.3	652.2	629.2	607.2	586.2	569.6	557.6	548.6	540.3
RU	700.0	641.9	583.7	525.6	467.4	409.3	351.1	293.0	234.8	176.7

RAU = 337.5 (kips); RA2 = 635.2 (kips)

Current CAPWAP Ru = 551.0 (kips); Corresponding J(RP)= 0.26; J(RX) = 0.77

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
16.01	35.48	611.3	670.1	670.1	0.897	0.160	0.163	32.5	735.0

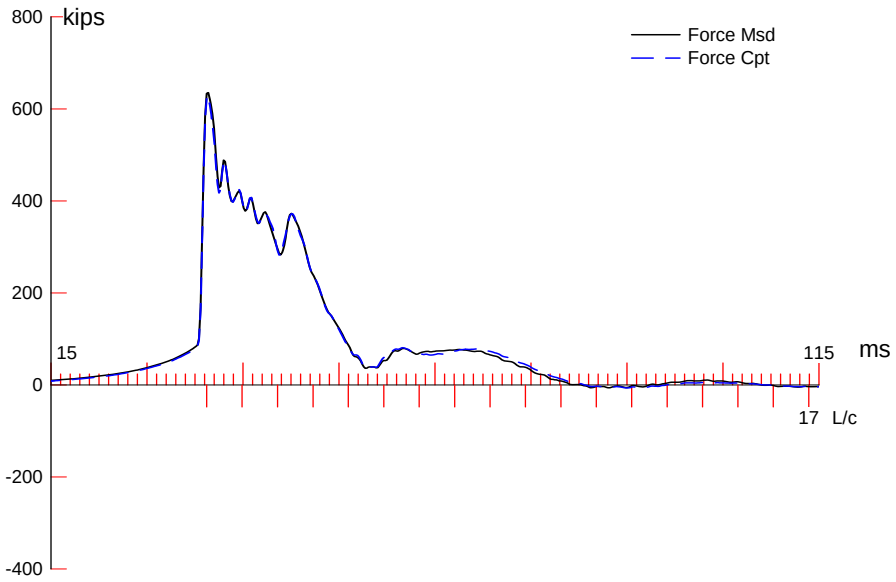
PILE PROFILE AND PILE MODEL

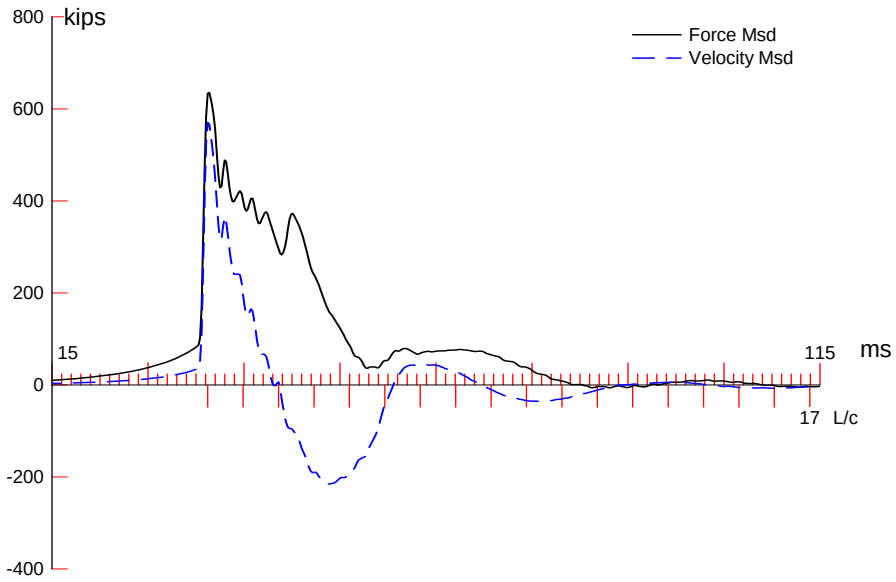
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	21.40	29992.2	492.000	4.699
77.50	21.40	29992.2	492.000	4.699

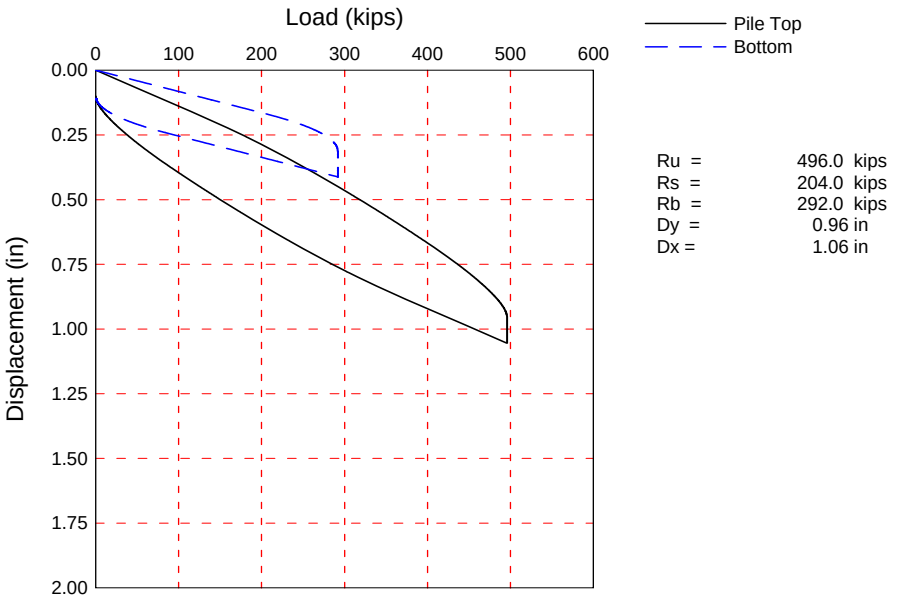
Toe Area 1.378 ft^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Slack in	Compression Eff.	Perim. ft	Soil Plug kips
1	3.37	38.20	0.00	0.000	0.000	-0.000	0.000	4.699	0.00
20	67.39	38.20	0.00	0.000	0.000	-0.000	0.000	4.699	0.01
21	70.76	38.20	0.00	0.000	0.000	-0.000	0.000	4.699	0.00
22	74.13	38.20	0.00	0.000	0.000	-0.000	0.000	4.699	0.02
23	77.50	38.20	0.00	0.000	0.000	-0.000	0.000	4.699	0.00

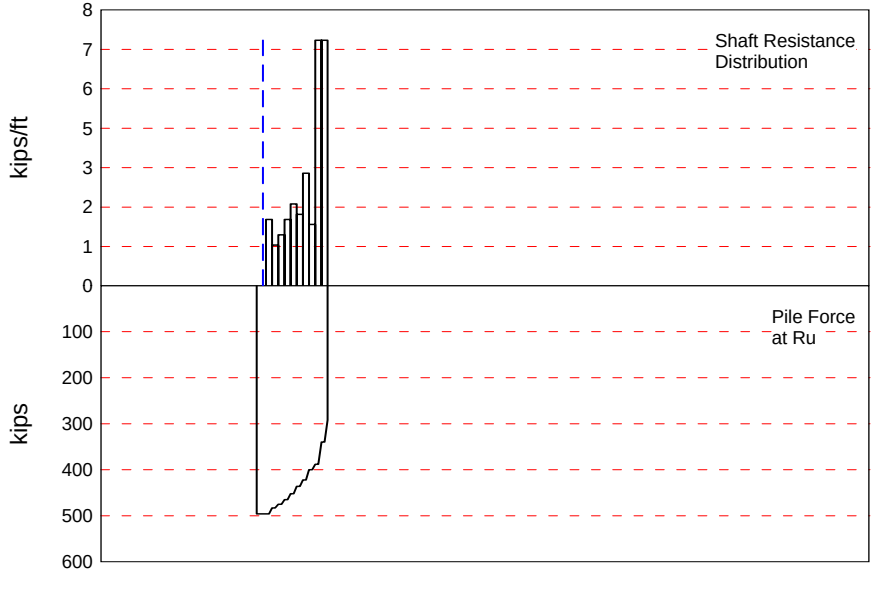
Pile Damping 1.0 %, Time Incr 0.200 ms, Wave Speed 16807.9 ft/s, 2L/c 9.2 ms







Ru	=	496.0 kips
Rs	=	204.0 kips
Rb	=	292.0 kips
Dy	=	0.96 in
Dx	=	1.06 in



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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 496.0; along Shaft 204.0; at Toe 292.0 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
				496.0				
1	16.8	8.2	13.0	483.0	13.0	1.59	0.34	0.230
2	23.6	14.9	8.0	475.0	21.0	1.19	0.25	0.230
3	30.3	21.7	10.0	465.0	31.0	1.48	0.32	0.230
4	37.1	28.4	13.0	452.0	44.0	1.93	0.41	0.230
5	43.8	35.1	16.0	436.0	60.0	2.37	0.51	0.230
6	50.5	41.9	14.0	422.0	74.0	2.08	0.44	0.230
7	57.3	48.6	22.0	400.0	96.0	3.26	0.69	0.230
8	64.0	55.4	12.0	388.0	108.0	1.78	0.38	0.230
9	70.8	62.1	48.0	340.0	156.0	7.12	1.52	0.230
10	77.5	68.8	48.0	292.0	204.0	7.12	1.52	0.230
Avg. Shaft			20.4			2.96	0.63	0.230
Toe			292.0				211.83	0.109

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.162	0.240
Case Damping Factor		1.228	0.835
Damping Type			Smith
Unloading Quake	(% of loading quake)	100	101
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	79	
Resistance Gap (included in Toe Quake)	(in)		0.005
Soil Plug Weight	(kips)		0.18

CAPWAP match quality = 1.28 (Wave Up Match) ; RSA = 0
Observed: final set = 0.100 in; blow count = 120 b/ft
Computed: final set = 0.124 in; blow count = 97 b/ft

max. Top Comp. Stress = 29.3 ksi (T= 35.7 ms, max= 1.052 x Top)
max. Comp. Stress = 30.9 ksi (Z= 16.8 ft, T= 36.7 ms)
max. Tens. Stress = -0.57 ksi (Z= 16.8 ft, T= 163.0 ms)
max. Energy (EMX) = 28.9 kip-ft; max. Measured Top Displ. (DMX)= 0.81 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	628.0	-12.0	29.3	-0.56	28.89	15.1	0.812
2	6.7	629.5	-12.0	29.4	-0.56	28.62	15.0	0.792
4	13.5	651.4	-12.3	30.4	-0.57	28.03	14.5	0.750
5	16.8	660.6	-12.3	30.9	-0.57	27.65	14.3	0.726
6	20.2	614.3	-2.3	28.7	-0.11	25.19	14.0	0.701
7	23.6	623.3	-2.2	29.1	-0.10	24.73	13.8	0.674
8	27.0	600.3	0.0	28.0	0.00	23.14	13.5	0.648
9	30.3	611.2	0.0	28.6	0.00	22.72	13.3	0.623
10	33.7	583.4	0.0	27.3	0.00	20.99	12.9	0.597
11	37.1	595.9	0.0	27.8	0.00	20.52	12.6	0.570
12	40.4	560.6	0.0	26.2	0.00	18.53	12.3	0.543
13	43.8	572.4	0.0	26.7	0.00	18.00	12.0	0.514
14	47.2	527.6	0.0	24.6	0.00	15.92	11.7	0.487
15	50.5	541.5	0.0	25.3	0.00	15.44	11.3	0.460
16	53.9	511.0	0.0	23.9	0.00	13.78	10.9	0.434
17	57.3	522.2	0.0	24.4	0.00	13.28	10.6	0.406
18	60.7	464.3	0.0	21.7	0.00	11.25	10.3	0.380
19	64.0	484.7	0.0	22.6	0.00	10.83	10.0	0.355
20	67.4	477.9	0.0	22.3	0.00	9.73	9.3	0.331
21	70.8	488.5	0.0	22.8	0.00	9.33	8.9	0.306
22	74.1	411.3	0.0	19.2	0.00	6.78	9.8	0.284
23	77.5	411.7	0.0	19.2	0.00	4.86	10.1	0.263
Absolute	16.8			30.9			(T =	36.7 ms)
	16.8				-0.57		(T =	163.0 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	757.7	710.6	663.4	616.2	569.1	521.9	474.7	427.6	380.4	333.2
RX	757.7	710.6	663.4	620.6	585.3	565.4	545.6	525.7	505.9	486.6
RU	777.8	732.6	687.4	642.3	597.1	552.0	506.8	461.7	416.5	371.3

RAU = 248.2 (kips); RA2 = 601.6 (kips)

Current CAPWAP Ru = 496.0 (kips); Corresponding J(RP)= 0.55; J(RX) = 0.85

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
15.25	35.48	582.6	646.7	646.7	0.805	0.101	0.100	29.3	775.5

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	21.40	29992.2	492.000	4.699
77.50	21.40	29992.2	492.000	4.699

Toe Area 1.378 ft^2

Top Segment Length 3.37 ft, Top Impedance 38.20 kips/ft/s

Pile Damping 1.0 %, Time Incr 0.200 ms, Wave Speed 16807.9 ft/s, 2L/c 9.2 ms

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Al Ziai
Company: Lunda Construction Co.	No. of Sheets: 50
E-mail: kweber@lundaconstruction.com	Date: December 1, 2014

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 2
Winnebago County, Wisconsin

On November 18, 2014, Pier 2 #1, Pier 2 #36, and Pier 2 #44 at the above structure were dynamically tested during initial driving and tested during restrike on November 19. 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 or ultimate capacity of 400 kips (200 tons). The reference grade at the bottom of the footing excavations was reported to be at elevation EL 731. The piles have a required minimum tip elevation of EL 671. The HP 14 x 73 H-piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0256) operated on fuel setting 4.

Pier 2 #1 was driven to a depth of 61.3 feet, which corresponds to a pile tip elevation of EL 609.7. The blow count over the final increment of driving was 5 blows per inch of penetration at an average hammer stroke of 8.8 feet. The blow count at the beginning of restrike was 5 blows for ⅜ inch of penetration at an average hammer stroke of 7.0 feet

Pier 2 #36 was driven to a depth of 61.0 feet, which corresponds to a pile tip elevation of EL 670. The blow count over the final increment of driving was 7 blows for ½ inch of penetration at an average hammer stroke of 7.6 feet. The blow count at the beginning of restrike was 5 blows for ½ inch of penetration at an average hammer stroke of 7.0 feet

Pier 2 #44 was driven to a depth of 59.7 feet, which corresponds to a pile tip elevation of EL 671.3. The blow count over the final increment of driving was 7 blows for ½ inch of penetration at an average hammer stroke of 9.2 feet. The blow count at the beginning of restrike was 10 blows for ⅜ inch of penetration at an average hammer stroke of 9.0 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 0234) in Pier 2 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	8	5
7.0	6	4
7.5	5	4
8.0	4	3
8.5	4	3
9.0	4	3
9.5	4	3

We recommend the above blow counts at the required stroke be maintained for **two 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 9.0 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 Pier 2 #44 had a pile tip elevation 0.3 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 673.

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:

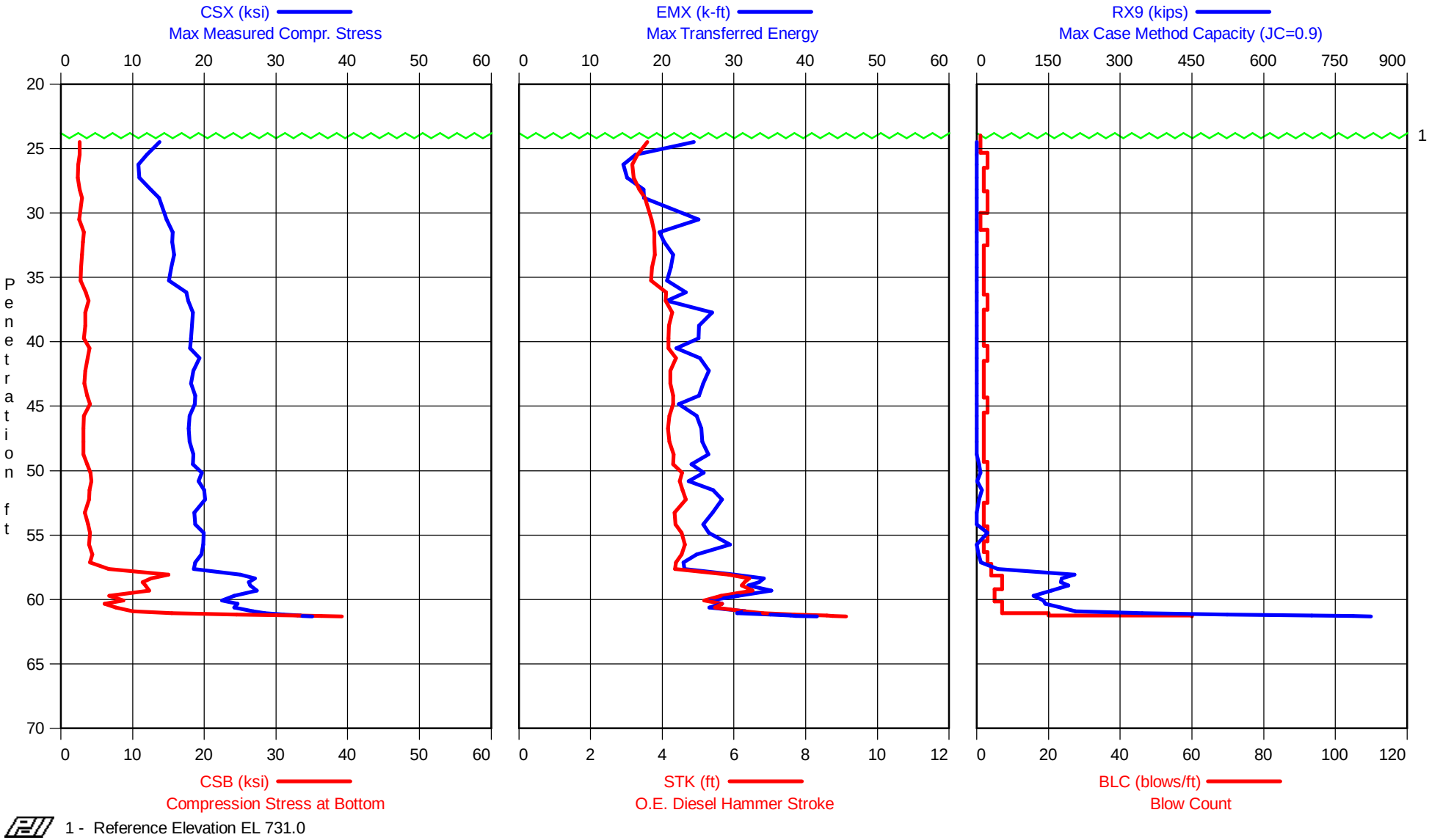
Dynamic Test Results - (pages 3 – 20)
CAPWAP Analysis Results - (pages 21 – 50)

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

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 18-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 2 #1
APE D30-42, HP 14 x 73



1 - Reference Elevation EL 731.0

USH 10 over Little Lake Butte des Morts - Pier 2 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-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: 1.20

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
2	23.00	1	AV1	13.4	2.7	24	3.5	61.7	0
			MAX	13.4	2.7	24	3.5	61.7	0
			MIN	13.4	2.7	24	3.5	61.7	0
2	24.00	1	AV1	14.1	2.6	24	3.7	60.5	0
			MAX	14.1	2.6	24	3.7	60.5	0
			MIN	14.1	2.6	24	3.7	60.5	0
3	25.00	1	AV1	12.5	2.6	17	3.4	62.7	0
			MAX	12.5	2.6	17	3.4	62.7	0
			MIN	12.5	2.6	17	3.4	62.7	0
6	26.00	3	AV2	11.4	2.6	15	3.2	64.2	0
			STD	0.1	0.0	0	0.0	0.1	0
			MAX	11.5	2.6	16	3.2	64.3	0
			MIN	11.3	2.6	15	3.2	64.0	0
8	27.00	2	AV2	10.5	2.3	14	3.1	64.8	0
			STD	0.1	0.0	0	0.0	0.2	0
			MAX	10.6	2.3	15	3.2	65.0	0
			MIN	10.3	2.2	14	3.1	64.7	0
10	28.00	2	AV2	11.7	2.5	16	3.3	63.7	0
			STD	0.4	0.0	1	0.0	0.3	0
			MAX	12.0	2.5	17	3.3	64.0	0
			MIN	11.3	2.5	16	3.2	63.3	0
13	29.00	3	AV3	13.4	2.9	17	3.5	61.9	0
			STD	0.6	0.2	0	0.1	0.7	0
			MAX	14.2	3.2	18	3.6	62.5	0
			MIN	13.0	2.7	17	3.4	60.9	0
14	30.00	1	AV1	14.6	2.6	25	3.7	60.3	0
			MAX	14.6	2.6	25	3.7	60.3	0
			MIN	14.6	2.6	25	3.7	60.3	0
15	31.00	1	AV1	14.9	2.5	25	3.7	60.0	0
			MAX	14.9	2.5	25	3.7	60.0	0
			MIN	14.9	2.5	25	3.7	60.0	0
18	32.00	3	AV3	15.7	3.3	19	3.8	59.4	0
			STD	0.2	0.2	1	0.0	0.2	0
			MAX	16.0	3.5	20	3.8	59.6	0
			MIN	15.5	3.0	19	3.8	59.1	0
20	33.00	2	AV2	15.8	2.7	22	3.8	59.3	0
			STD	0.8	0.1	1	0.1	0.8	0
			MAX	16.6	2.8	22	3.9	60.0	0
			MIN	15.0	2.6	21	3.7	58.5	0
22	34.00	2	AV2	15.1	3.0	21	3.7	60.3	0
			STD	0.2	0.1	0	0.0	0.2	0
			MAX	15.3	3.1	21	3.7	60.5	0
			MIN	15.0	2.9	21	3.7	60.2	0
24	35.00	2	AV2	15.4	2.8	21	3.7	60.1	0
			STD	0.2	0.0	0	0.0	0.2	0
			MAX	15.6	2.8	21	3.7	60.3	0
			MIN	15.2	2.7	20	3.7	59.9	0
26	36.00	2	AV2	16.0	2.9	23	3.9	58.9	0
			STD	1.1	0.3	2	0.2	1.3	0
			MAX	17.1	3.2	25	4.1	60.2	0
			MIN	14.9	2.7	21	3.7	57.6	0
29	37.00	3	AV3	17.8	3.9	21	4.1	57.3	0
			STD	0.2	0.1	0	0.0	0.2	0
			MAX	18.0	3.9	21	4.1	57.5	0
			MIN	17.5	3.8	20	4.1	57.1	0

USH 10 over Little Lake Butte des Morts - Pier 2 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
31	38.00	2	AV2	18.4	3.4	27	4.3	56.3	0
			STD	0.9	0.2	1	0.1	0.8	0
			MAX	19.3	3.6	28	4.4	57.0	0
			MIN	17.5	3.2	26	4.2	55.5	0
33	39.00	2	AV2	18.3	3.4	25	4.2	56.8	0
			STD	0.1	0.0	1	0.0	0.1	0
			MAX	18.3	3.4	26	4.2	56.9	0
			MIN	18.2	3.4	24	4.2	56.7	0
35	40.00	2	AV2	18.1	3.2	25	4.2	57.0	0
			STD	0.6	0.0	1	0.1	0.7	0
			MAX	18.8	3.3	26	4.3	57.7	0
			MIN	17.5	3.2	24	4.0	56.2	0
38	41.00	3	AV3	18.5	4.1	22	4.3	56.3	0
			STD	0.8	0.1	1	0.1	0.9	0
			MAX	19.6	4.2	24	4.5	57.3	0
			MIN	17.6	3.9	22	4.1	55.2	0
40	42.00	2	AV2	18.9	3.4	27	4.3	56.2	0
			STD	0.2	0.0	0	0.0	0.1	0
			MAX	19.0	3.4	27	4.3	56.3	0
			MIN	18.7	3.4	27	4.3	56.0	0
42	43.00	2	AV2	18.0	3.3	26	4.2	56.8	0
			STD	0.2	0.1	1	0.0	0.1	0
			MAX	18.2	3.4	26	4.2	56.9	0
			MIN	17.9	3.3	25	4.2	56.8	0
44	44.00	2	AV2	18.6	3.3	27	4.3	56.3	0
			STD	0.2	0.0	1	0.0	0.1	0
			MAX	18.8	3.3	28	4.3	56.4	0
			MIN	18.5	3.3	27	4.3	56.1	0
47	45.00	3	AV3	18.7	4.0	22	4.3	56.1	0
			STD	0.1	0.1	0	0.0	0.0	0
			MAX	18.8	4.1	23	4.3	56.1	0
			MIN	18.5	4.0	22	4.3	56.0	0
49	46.00	2	AV2	17.9	3.2	25	4.2	56.7	0
			STD	0.5	0.0	0	0.1	0.4	0
			MAX	18.4	3.3	25	4.3	57.1	0
			MIN	17.5	3.2	25	4.1	56.3	0
51	47.00	2	AV2	17.8	3.2	25	4.2	56.9	0
			STD	0.1	0.1	0	0.0	0.2	0
			MAX	17.9	3.3	26	4.2	57.1	0
			MIN	17.7	3.1	25	4.1	56.8	0
53	48.00	2	AV2	17.9	3.1	26	4.2	56.8	0
			STD	0.4	0.0	0	0.1	0.4	0
			MAX	18.4	3.1	26	4.3	57.1	0
			MIN	17.5	3.1	25	4.1	56.4	0
55	49.00	2	AV2	18.4	3.2	26	4.3	56.0	0
			STD	0.6	0.0	0	0.1	0.7	0
			MAX	19.0	3.2	27	4.4	56.7	0
			MIN	17.9	3.1	26	4.2	55.3	0
58	50.00	3	AV3	18.8	3.8	25	4.4	55.5	7
			STD	0.7	0.3	1	0.2	0.9	5
			MAX	19.7	4.1	26	4.6	56.6	11
			MIN	17.9	3.3	24	4.2	54.4	0
61	51.00	3	AV3	19.3	4.2	24	4.5	55.0	2
			STD	0.6	0.2	1	0.1	0.5	2
			MAX	19.9	4.5	26	4.6	55.7	4
			MIN	18.4	4.0	23	4.4	54.4	0
64	52.00	3	AV3	20.0	4.0	27	4.6	54.3	10
			STD	0.1	0.1	0	0.1	0.4	9
			MAX	20.1	4.1	28	4.7	54.8	21
			MIN	19.9	4.0	27	4.5	53.9	0

USH 10 over Little Lake Butte des Morts - Pier 2 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
66	53.00	2	AV2	19.6	3.6	28	4.5	54.8	0
			STD	0.5	0.2	0	0.1	0.5	0
			MAX	20.1	3.8	29	4.6	55.3	0
			MIN	19.2	3.4	28	4.4	54.2	0
68	54.00	2	AV2	18.3	3.4	27	4.3	56.0	0
			STD	0.3	0.1	1	0.1	0.4	0
			MAX	18.6	3.5	27	4.4	56.4	0
			MIN	18.1	3.3	26	4.3	55.6	0
71	55.00	3	AV3	19.5	4.0	26	4.5	55.1	15
			STD	0.8	0.0	1	0.2	1.0	12
			MAX	20.6	4.1	27	4.7	55.8	28
			MIN	18.9	4.0	24	4.4	53.7	0
73	56.00	2	AV2	19.9	3.9	29	4.6	54.2	0
			STD	0.1	0.1	0	0.0	0.0	0
			MAX	20.0	4.0	30	4.6	54.2	0
			MIN	19.8	3.8	29	4.6	54.2	0
76	57.00	3	AV3	19.4	4.2	25	4.5	55.0	2
			STD	0.3	0.3	0	0.1	0.4	3
			MAX	19.7	4.6	25	4.6	55.5	6
			MIN	19.0	3.9	24	4.4	54.6	0
80	58.00	4	AV4	19.6	7.4	23	4.6	54.6	75
			STD	1.8	3.3	2	0.4	2.0	76
			MAX	22.7	11.8	26	5.2	55.9	194
			MIN	18.4	4.1	21	4.3	51.2	0
87	59.00	7	AV7	26.7	12.8	33	6.3	46.7	187
			STD	0.6	2.3	2	0.2	0.6	18
			MAX	27.4	18.1	36	6.6	47.7	214
			MIN	25.8	10.8	30	6.1	45.8	169
92	60.00	5	AV5	25.0	9.4	32	5.9	48.7	139
			STD	2.1	2.7	3	0.6	2.5	21
			MAX	27.8	13.2	35	6.7	52.5	176
			MIN	21.8	5.3	26	5.0	45.6	113
99	61.00	7	AV7	24.9	8.0	29	5.8	49.0	169
			STD	1.3	1.7	2	0.4	1.5	29
			MAX	27.5	10.4	33	6.5	50.5	208
			MIN	23.2	5.1	26	5.4	46.2	133
104	61.25	20	AV5	30.5	22.4	34	7.5	43.2	480
			STD	2.1	6.6	4	0.7	2.0	127
			MAX	33.3	31.9	38	8.5	46.6	663
			MIN	27.2	13.4	28	6.4	40.6	307
108	61.32	60	AV4	34.0	36.5	39	8.8	39.8	784
			STD	0.6	1.9	2	0.2	0.4	34
			MAX	35.1	39.2	42	9.1	40.1	825
			MIN	33.5	34.2	37	8.7	39.2	738
			Average	20.0	6.9	26	4.8	54.5	85
			Std. Dev.	5.4	7.7	6	1.3	5.9	181
			Maximum	35.1	39.2	42	9.1	65.0	825
			Minimum	10.3	2.2	14	3.1	39.2	0

Total number of blows analyzed: 107

BL#	depth (ft)	Comments
2	24.00	Reference Elevation EL 731.0

Time Summary

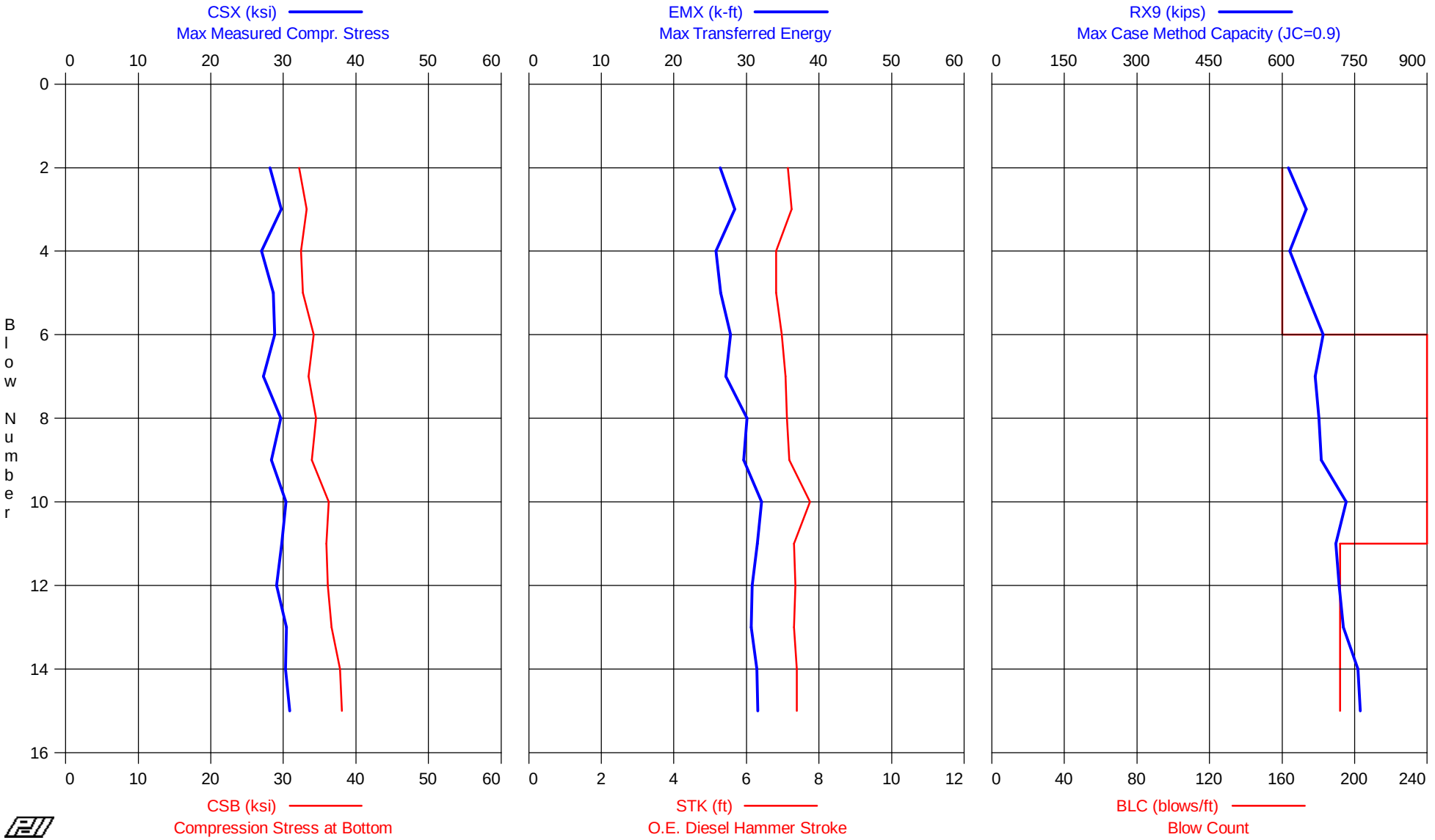
Drive 2 minutes 1 second 1:05:29 PM - 1:07:30 PM (11/18/2014) BN 1 - 109

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

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 19-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 2 #1 Restrike
APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 2 #1 Restrike
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-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: 1.20

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	61.36	160	AV4	28.4	32.6	27	7.0	44.5	632
			STD	1.0	0.4	1	0.2	0.6	18
			MAX	29.7	33.2	28	7.2	45.1	650
			MIN	27.0	32.2	26	6.8	43.8	613
10	61.39	240	AV5	28.9	34.5	29	7.2	43.9	689
			STD	1.1	1.0	2	0.3	0.8	23
			MAX	30.3	36.3	32	7.8	44.6	732
			MIN	27.3	33.5	27	7.0	42.4	668
14	61.41	192	AV4	29.9	36.6	31	7.3	43.5	728
			STD	0.5	0.7	0	0.0	0.1	17
			MAX	30.4	37.8	31	7.4	43.6	756
			MIN	29.1	35.9	31	7.3	43.4	711
15	61.41	192	AV1	30.9	38.1	32	7.4	43.4	761
			MAX	30.9	38.1	32	7.4	43.4	761
			MIN	30.9	38.1	32	7.4	43.4	761
			Average	29.2	34.8	29	7.2	43.9	689
			Std. Dev.	1.2	1.9	2	0.2	0.7	46
			Maximum	30.9	38.1	32	7.8	45.1	761
			Minimum	27.0	32.2	26	6.8	42.4	613

Total number of blows analyzed: 14

Time Summary

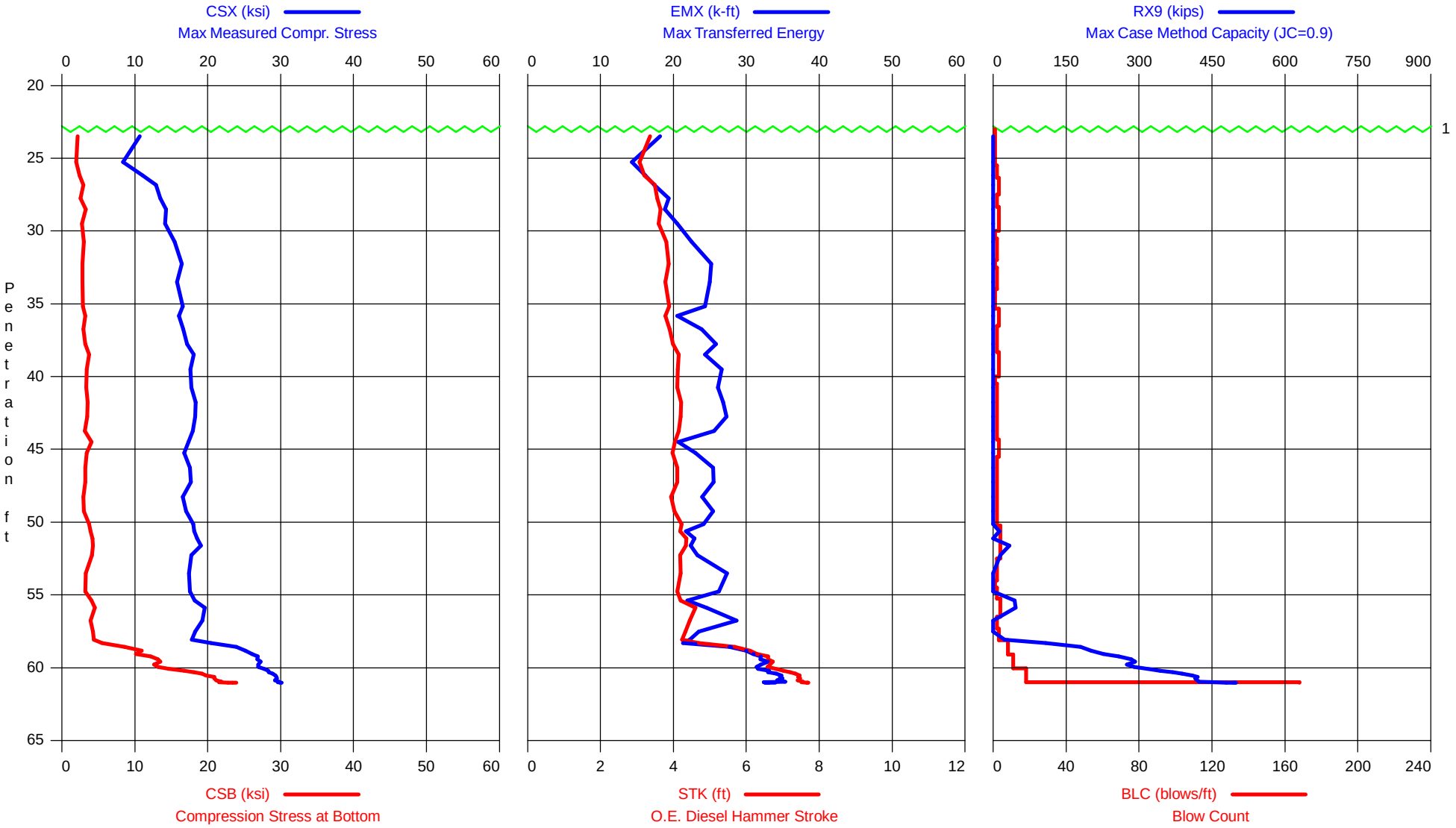
Drive 19 seconds 8:37:59 AM - 8:38:18 AM (11/19/2014) BN 1 - 15

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

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 18-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 2 #36
APE D30-42, HP 14 x 73



1 - Reference Elevation EL 731.0

USH 10 over Little Lake Butte des Morts - Pier 2 #36 APE D30-42, HP 14 x 73
OP: MR Test date: 18-Nov-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: 1.20

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
2	22.00	1	AV1	12.8	2.3	21	3.6	61.3	0
			MAX	12.8	2.3	21	3.6	61.3	0
			MIN	12.8	2.3	21	3.6	61.3	0
2	23.00	1	AV1	8.6	1.9	16	3.2	64.7	0
			MAX	8.6	1.9	16	3.2	64.7	0
			MIN	8.6	1.9	16	3.2	64.7	0
3	24.00	1	AV1	8.1	1.8	15	3.1	65.0	0
			MAX	8.1	1.8	15	3.1	65.0	0
			MIN	8.1	1.8	15	3.1	65.0	0
4	25.00	1	AV1	8.7	2.2	14	3.0	66.1	0
			MAX	8.7	2.2	14	3.0	66.1	0
			MIN	8.7	2.2	14	3.0	66.1	0
6	26.00	2	AV1	10.3	2.3	16	3.1	65.2	0
			MAX	10.3	2.3	16	3.1	65.2	0
			MIN	10.3	2.3	16	3.1	65.2	0
9	27.00	3	AV3	12.6	2.8	17	3.4	62.3	0
			STD	0.8	0.2	1	0.1	0.9	0
			MAX	13.6	3.0	19	3.6	63.4	0
			MIN	11.9	2.6	16	3.3	61.1	0
11	28.00	2	AV2	13.5	2.6	19	3.6	61.3	0
			STD	0.9	0.1	1	0.1	1.0	0
			MAX	14.4	2.7	20	3.7	62.3	0
			MIN	12.6	2.5	19	3.4	60.3	0
14	29.00	3	AV3	14.2	3.2	19	3.6	60.7	0
			STD	0.6	0.2	1	0.1	0.8	0
			MAX	15.0	3.4	20	3.8	61.6	0
			MIN	13.5	2.9	17	3.5	59.6	0
15	30.00	1	AV1	14.2	2.5	23	3.6	61.0	0
			MAX	14.2	2.5	23	3.6	61.0	0
			MIN	14.2	2.5	23	3.6	61.0	0
17	31.00	2	AV2	15.5	3.0	23	3.8	59.5	0
			STD	0.7	0.1	1	0.1	0.9	0
			MAX	16.2	3.1	23	3.9	60.4	0
			MIN	14.7	2.9	22	3.7	58.5	0
18	32.00	1	AV1	16.5	2.6	27	3.9	58.7	0
			MAX	16.5	2.6	27	3.9	58.7	0
			MIN	16.5	2.6	27	3.9	58.7	0
20	33.00	2	AV2	16.1	3.0	23	3.8	59.5	0
			STD	0.3	0.0	0	0.1	0.4	0
			MAX	16.3	3.1	24	3.8	59.9	0
			MIN	15.8	3.0	23	3.7	59.1	0
21	34.00	1	AV1	15.8	2.6	27	3.8	59.2	0
			MAX	15.8	2.6	27	3.8	59.2	0
			MIN	15.8	2.6	27	3.8	59.2	0
22	35.00	1	AV1	16.5	2.8	27	3.9	58.7	0
			MAX	16.5	2.8	27	3.9	58.7	0
			MIN	16.5	2.8	27	3.9	58.7	0
25	36.00	3	AV3	16.2	3.2	21	3.8	59.4	0
			STD	0.3	0.2	1	0.1	0.4	0
			MAX	16.6	3.5	22	3.9	60.0	0
			MIN	15.9	3.0	19	3.7	59.0	0
27	37.00	2	AV2	16.6	2.9	24	3.9	58.8	0
			STD	0.4	0.1	1	0.1	0.5	0
			MAX	17.0	3.0	25	4.0	59.2	0
			MIN	16.2	2.8	23	3.8	58.3	0

USH 10 over Little Lake Butte des Morts - Pier 2 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
29	38.00	2	AV2	17.1	3.2	26	4.0	58.1	0
			STD	0.3	0.1	0	0.0	0.3	0
			MAX	17.4	3.2	26	4.0	58.4	0
			MIN	16.8	3.1	26	3.9	57.8	0
32	39.00	3	AV3	17.8	3.6	23	4.1	57.3	0
			STD	0.5	0.2	2	0.1	0.3	0
			MAX	18.4	3.8	25	4.2	57.7	0
			MIN	17.2	3.3	21	4.0	56.9	0
33	40.00	1	AV1	18.1	3.5	32	4.2	56.8	0
			MAX	18.1	3.6	32	4.2	56.8	0
			MIN	18.1	3.6	32	4.2	56.8	0
35	41.00	2	AV2	17.7	3.4	26	4.1	57.3	0
			STD	0.2	0.2	0	0.0	0.2	0
			MAX	18.0	3.5	26	4.1	57.5	0
			MIN	17.5	3.2	26	4.1	57.2	0
37	42.00	2	AV2	18.4	3.5	27	4.2	56.7	0
			STD	0.1	0.1	0	0.0	0.0	0
			MAX	18.4	3.6	27	4.2	56.7	0
			MIN	18.3	3.5	27	4.2	56.6	0
39	43.00	2	AV2	18.3	3.5	27	4.2	56.8	0
			STD	0.2	0.3	0	0.0	0.3	0
			MAX	18.4	3.8	27	4.2	57.0	0
			MIN	18.1	3.1	27	4.2	56.5	0
41	44.00	2	AV2	18.0	3.2	26	4.1	57.0	0
			STD	0.6	0.2	0	0.1	0.5	0
			MAX	18.5	3.4	26	4.2	57.6	0
			MIN	17.4	3.0	25	4.1	56.5	0
44	45.00	3	AV3	17.2	3.9	21	4.0	57.9	0
			STD	0.3	0.5	0	0.0	0.3	0
			MAX	17.6	4.6	21	4.1	58.1	0
			MIN	16.8	3.6	20	4.0	57.5	0
46	46.00	2	AV2	17.3	3.2	26	4.1	57.6	0
			STD	0.5	0.1	0	0.1	0.6	0
			MAX	17.8	3.3	26	4.2	58.2	0
			MIN	16.8	3.2	25	4.0	57.0	0
48	47.00	2	AV2	17.7	3.2	25	4.1	57.3	0
			STD	0.4	0.1	0	0.1	0.4	0
			MAX	18.1	3.3	26	4.2	57.7	0
			MIN	17.3	3.1	25	4.0	56.8	0
50	48.00	2	AV2	17.1	3.0	25	4.0	57.8	0
			STD	0.1	0.1	0	0.0	0.1	0
			MAX	17.2	3.2	25	4.0	57.9	0
			MIN	17.1	2.9	25	4.0	57.7	0
52	49.00	2	AV2	16.3	2.9	24	3.9	58.7	0
			STD	0.3	0.0	1	0.1	0.6	0
			MAX	16.6	2.9	25	4.0	59.3	0
			MIN	16.1	2.9	23	3.8	58.0	0
54	50.00	2	AV2	17.5	3.3	26	4.1	57.3	0
			STD	0.0	0.2	0	0.0	0.2	0
			MAX	17.5	3.5	26	4.1	57.6	0
			MIN	17.5	3.2	25	4.1	57.1	0
58	51.00	4	AV4	18.2	4.0	22	4.2	56.5	6
			STD	0.3	0.2	1	0.1	0.4	11
			MAX	18.6	4.3	23	4.3	56.9	24
			MIN	17.9	3.7	21	4.2	56.1	0
62	52.00	4	AV4	18.9	4.3	22	4.3	55.9	24
			STD	0.4	0.2	1	0.1	0.6	18
			MAX	19.5	4.5	23	4.4	56.6	50
			MIN	18.4	4.1	20	4.2	55.3	0
64	53.00	2	AV2	17.5	3.4	26	4.2	56.6	0
			STD	0.4	0.2	0	0.1	0.5	0
			MAX	17.9	3.6	26	4.3	57.1	0
			MIN	17.1	3.2	26	4.1	56.1	0

USH 10 over Little Lake Butte des Morts - Pier 2 #36
OP: MR
APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
65	54.00	1	AV1	17.0	3.3	29	4.1	57.4	0
			MAX	17.0	3.3	29	4.1	57.4	0
			MIN	17.0	3.3	29	4.1	57.4	0
67	55.00	2	AV2	17.6	3.2	26	4.1	57.3	0
			STD	0.7	0.0	1	0.1	0.7	0
			MAX	18.2	3.3	27	4.2	58.0	0
			MIN	16.9	3.2	25	4.0	56.7	0
71	56.00	4	AV4	18.9	4.3	23	4.4	55.5	45
			STD	1.0	0.3	1	0.3	1.5	17
			MAX	20.5	4.6	25	4.8	56.8	63
			MIN	18.2	3.9	21	4.2	53.2	26
73	57.00	2	AV2	19.2	4.0	29	4.4	55.3	0
			STD	0.2	0.0	1	0.0	0.1	0
			MAX	19.4	4.0	29	4.5	55.4	0
			MIN	19.0	3.9	28	4.4	55.1	0
76	58.00	3	AV3	17.9	4.2	24	4.3	56.2	0
			STD	0.6	0.0	1	0.1	0.7	0
			MAX	18.7	4.3	26	4.5	56.8	0
			MIN	17.2	4.2	23	4.2	55.2	0
84	59.00	8	AV8	22.9	8.0	26	5.4	50.5	155
			STD	2.7	2.4	5	0.8	3.5	57
			MAX	26.0	11.7	32	6.3	56.2	220
			MIN	18.4	4.6	19	4.3	46.8	47
95	60.00	11	AV11	26.9	12.7	32	6.6	45.8	276
			STD	0.3	0.8	1	0.1	0.4	18
			MAX	27.5	13.6	33	6.8	46.9	300
			MIN	26.1	10.9	30	6.3	45.1	235
113	61.00	18	AV18	28.9	19.3	34	7.3	43.7	389
			STD	0.6	2.3	1	0.2	0.7	37
			MAX	29.8	22.1	36	7.6	45.2	425
			MIN	27.7	14.0	31	6.8	42.9	309
120	61.04	168	AV7	29.9	22.8	33	7.6	42.7	480
			STD	0.3	0.9	1	0.1	0.3	18
			MAX	30.2	23.9	34	7.8	43.4	500
			MIN	29.3	21.3	32	7.4	42.3	444
			Average	20.6	8.1	26	5.0	53.5	126
			Std. Dev.	5.9	7.0	6	1.5	6.8	173
			Maximum	30.2	23.9	36	7.8	66.1	500
			Minimum	8.1	1.8	14	3.0	42.3	0

Total number of blows analyzed: 119

BL#	depth (ft)	Comments
2	23.00	Reference Elevation EL 731.0

Time Summary

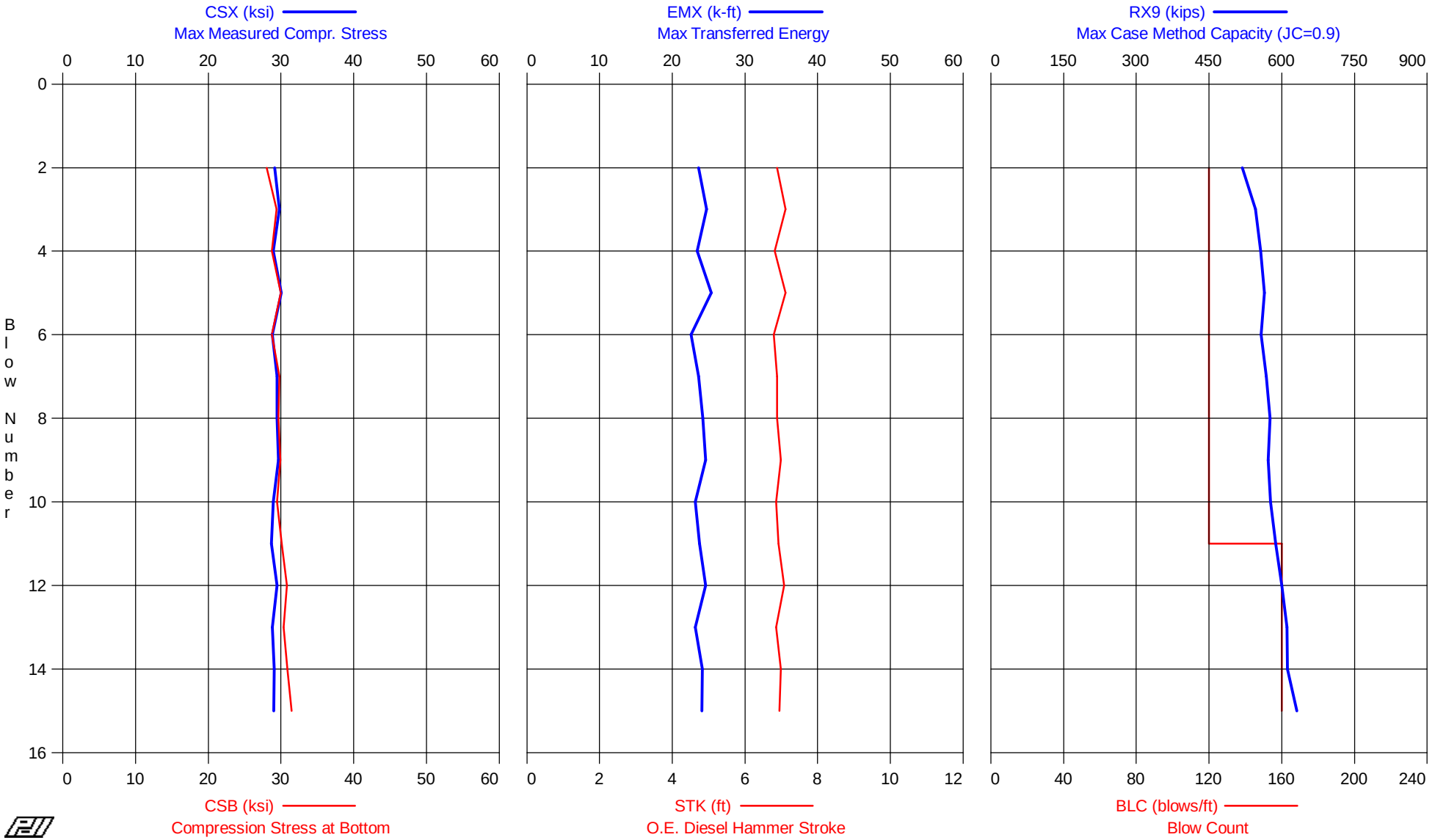
Drive 2 minutes 16 seconds 12:45:08 PM - 12:47:24 PM (11/18/2014) BN 1 - 120

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

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 19-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 2 #36 Restrike
APE D30-42, HP 14 x 73



Case Method & iCAP® Results PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 2 #36 Restrike APE D30-42, HP 14 x 73
OP: MR Test date: 19-Nov-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: 1.20

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
5	61.46	120	AV4	29.5	29.0	24	7.0	44.6	546
			STD	0.5	0.7	1	0.1	0.4	17
			MAX	30.1	30.0	25	7.1	45.1	564
			MIN	28.9	28.0	23	6.8	44.2	518
10	61.50	120	AV5	29.2	29.5	24	6.9	44.9	570
			STD	0.3	0.4	1	0.1	0.2	7
			MAX	29.7	29.9	25	7.0	45.2	577
			MIN	28.8	28.8	23	6.8	44.6	558
15	61.53	160	AV5	29.0	30.7	24	7.0	44.7	608
			STD	0.3	0.5	0	0.1	0.2	14
			MAX	29.5	31.5	25	7.1	45.0	631
			MIN	28.7	30.1	23	6.9	44.3	588
			Average	29.2	29.8	24	6.9	44.7	577
			Std. Dev.	0.4	0.9	1	0.1	0.3	29
			Maximum	30.1	31.5	25	7.1	45.2	631
			Minimum	28.7	28.0	23	6.8	44.2	518

Total number of blows analyzed: 14

Time Summary

Drive 18 seconds 8:26:18 AM - 8:26:36 AM (11/19/2014) BN 1 - 15

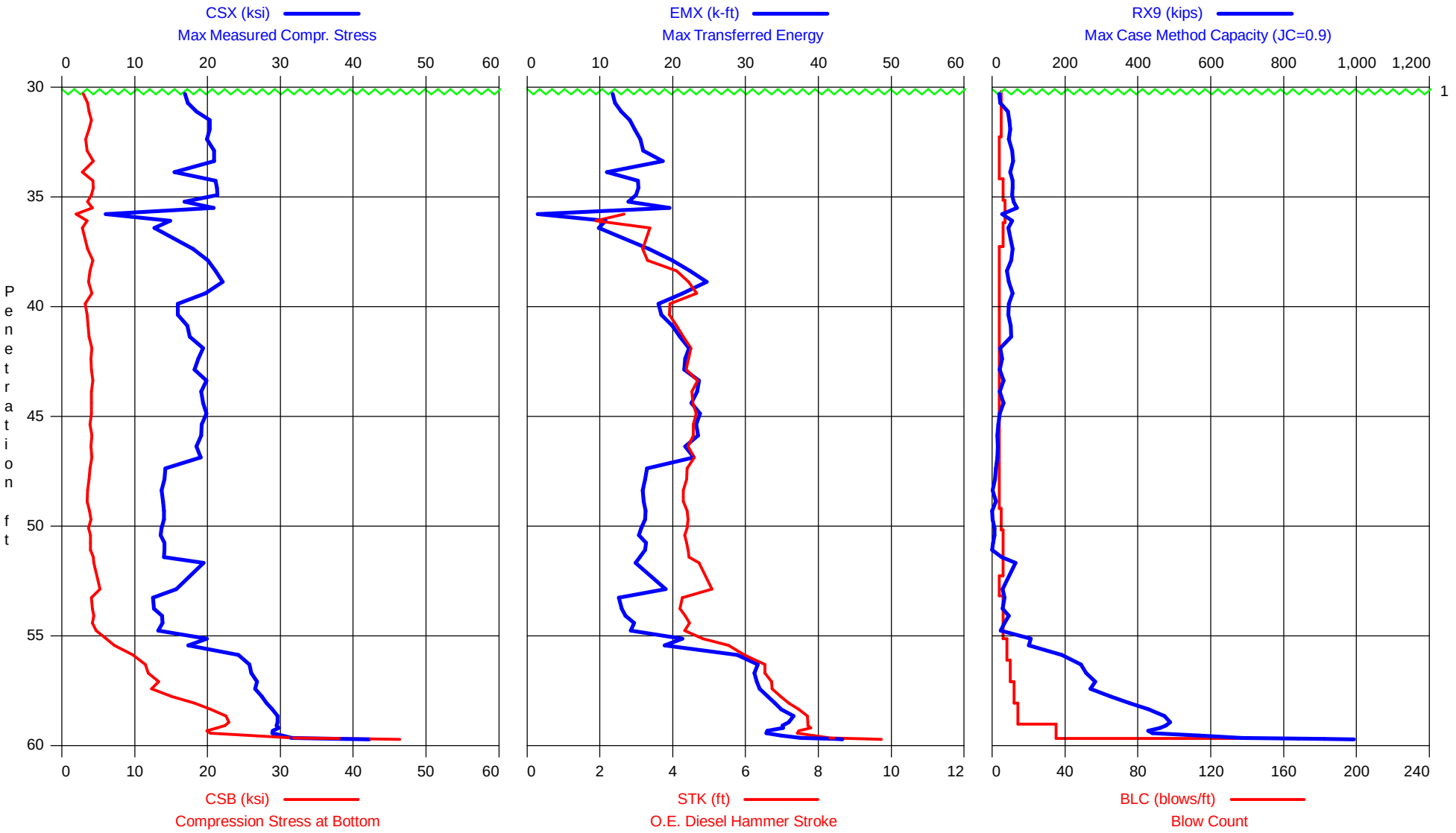
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 18-Nov-2014

USH 10 over LLBDM - Pier 2 #44

APE D30-42, HP 14 x 73



1 - Reference Elevation EL 731.0

USH 10 over LLBDM - Pier 2 #44 APE D30-42, HP 14 x 73
OP: MR Test date: 18-Nov-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: 1.20

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
5	31.00	5	AV5	17.4	3.4	**	12	**	24
			STD	0.7	0.4	**	0	**	15
			MAX	18.4	3.9	**	13	**	40
			MIN	16.3	3.0	**	12	**	3
10	32.00	5	AV5	20.0	3.9	**	14	**	47
			STD	0.7	0.2	**	1	**	4
			MAX	20.6	4.1	**	15	**	53
			MIN	18.6	3.7	**	13	**	40
14	33.00	4	AV4	20.4	3.4	**	16	**	50
			STD	0.5	0.3	**	0	**	5
			MAX	21.0	3.8	**	16	**	58
			MIN	19.8	3.1	**	15	**	45
18	34.00	4	AV4	18.2	3.6	3.7	15	60	53
			STD	5.0	0.9	0.0	6	0	12
			MAX	21.4	4.7	3.7	21	60	64
			MIN	9.5	2.3	3.7	5	60	33
24	35.00	6	AV6	21.3	4.2	**	15	**	55
			STD	0.2	0.3	**	0	**	3
			MAX	21.6	4.5	**	15	**	60
			MIN	21.1	3.6	**	15	**	52
31	36.00	7	AV7	15.7	3.4	2.6	13	71	55
			STD	7.3	1.2	0.4	9	5	20
			MAX	22.7	4.7	3.1	24	76	75
			MIN	2.7	1.4	2.2	0	65	17
37	37.00	6	AV3	10.8	2.6	2.6	7	72	41
			STD	8.6	1.2	0.7	9	9	21
			MAX	22.7	4.3	3.4	19	81	69
			MIN	2.7	1.4	1.9	0	63	20
41	38.00	4	AV4	19.0	3.9	3.2	18	64	55
			STD	4.4	0.6	0.1	11	1	15
			MAX	23.6	4.6	3.3	30	65	74
			MIN	13.2	3.0	3.2	6	63	39
45	39.00	4	AV4	21.6	3.8	4.3	24	56	43
			STD	2.2	0.5	0.2	11	1	6
			MAX	24.0	4.2	4.4	36	57	52
			MIN	18.6	3.1	4.1	11	55	36
49	40.00	4	AV4	17.8	3.7	4.3	20	56	51
			STD	2.2	0.5	0.4	2	2	15
			MAX	21.3	4.5	4.9	23	59	74
			MIN	15.9	3.2	3.9	18	53	36
53	41.00	4	AV4	16.6	3.5	4.0	19	58	47
			STD	1.0	0.2	0.2	2	1	10
			MAX	17.8	3.8	4.3	21	60	56
			MIN	15.1	3.4	3.8	17	56	32
57	42.00	4	AV4	18.5	3.9	4.4	22	56	37
			STD	0.9	0.2	0.1	1	1	15
			MAX	19.4	4.1	4.5	23	56	53
			MIN	17.6	3.6	4.3	21	55	21
61	43.00	4	AV4	18.5	4.0	4.4	22	56	24
			STD	0.5	0.1	0.1	0	1	4
			MAX	19.4	4.2	4.5	22	56	31
			MIN	17.9	3.8	4.3	21	55	19
65	44.00	4	AV4	19.5	4.1	4.6	23	54	26
			STD	0.7	0.1	0.1	1	1	6
			MAX	20.0	4.3	4.7	25	56	31
			MIN	18.3	4.0	4.4	22	54	17

USH 10 over LLBDM - Pier 2 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
69	45.00	4	AV4	19.6	4.1	4.6	23	54	26
			STD	0.9	0.1	0.1	1	1	11
			MAX	20.6	4.2	4.7	24	56	45
			MIN	18.2	4.0	4.4	22	54	17
73	46.00	4	AV4	19.2	4.0	4.6	23	55	15
			STD	0.4	0.2	0.1	1	1	6
			MAX	19.6	4.3	4.7	24	55	22
			MIN	18.6	3.8	4.4	23	54	7
77	47.00	4	AV4	18.8	4.0	4.5	22	55	14
			STD	0.5	0.1	0.1	1	1	4
			MAX	19.4	4.2	4.6	23	56	19
			MIN	18.0	4.0	4.4	21	54	9
81	48.00	4	AV4	14.2	3.8	4.4	16	56	9
			STD	4.6	0.4	0.1	5	1	9
			MAX	19.1	4.2	4.5	22	56	21
			MIN	9.4	3.3	4.3	11	55	0
85	49.00	4	AV4	13.8	3.5	4.3	16	56	5
			STD	4.6	0.5	0.1	5	1	9
			MAX	18.7	4.1	4.5	21	57	21
			MIN	9.0	2.8	4.1	11	55	0
90	50.00	5	AV5	14.7	3.9	4.4	17	56	3
			STD	4.1	0.3	0.0	5	0	5
			MAX	18.5	4.1	4.4	21	56	12
			MIN	9.6	3.4	4.3	11	55	0
96	51.00	6	AV6	13.9	3.8	4.4	16	56	3
			STD	4.3	0.3	0.1	5	0	5
			MAX	18.6	4.2	4.5	21	56	13
			MIN	9.5	3.3	4.3	11	55	0
102	52.00	6	AV4	14.3	4.2	4.5	14	55	29
			STD	4.4	0.2	0.1	3	1	28
			MAX	19.4	4.4	4.7	20	56	64
			MIN	9.9	3.8	4.4	11	54	0
106	53.00	4	AV2	15.7	5.3	5.1	19	52	29
			STD	6.0	0.2	0.3	8	1	28
			MAX	21.7	5.4	5.4	27	53	57
			MIN	9.8	5.1	4.8	11	51	1
112	54.00	6	AV5	13.7	4.3	4.3	14	56	39
			STD	3.6	0.3	0.2	3	1	29
			MAX	18.4	4.7	4.5	18	59	72
			MIN	9.4	3.9	3.9	10	55	0
118	55.00	6	AV6	13.5	4.3	4.4	14	56	34
			STD	4.0	0.3	0.1	4	1	30
			MAX	17.9	5.0	4.5	19	57	73
			MIN	9.1	4.0	4.2	9	55	0
126	56.00	8	AV5	21.0	8.4	5.7	24	49	144
			STD	4.7	1.4	0.4	6	1	49
			MAX	25.6	11.1	6.3	31	51	205
			MIN	11.9	6.7	5.3	13	47	58
136	57.00	10	AV5	26.0	11.9	6.5	31	46	253
			STD	0.4	0.5	0.1	0	0	11
			MAX	26.6	12.7	6.6	32	46	263
			MIN	25.6	11.0	6.4	31	46	232
148	58.00	12	AV6	27.1	14.4	6.9	33	45	309
			STD	0.4	2.0	0.1	1	0	38
			MAX	27.6	17.7	7.0	34	46	364
			MIN	26.4	12.3	6.7	32	44	269
162	59.00	14	AV7	29.2	21.5	7.6	36	43	453
			STD	0.4	1.6	0.2	1	0	37
			MAX	29.7	23.0	7.8	38	44	496
			MIN	28.6	18.7	7.3	34	42	389

USH 10 over LLBDM - Pier 2 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
185	59.67	35	AV11	29.6	22.7	7.7	35	43	488
			STD	0.8	3.1	0.3	2	1	66
			MAX	31.6	29.6	8.4	38	43	622
			MIN	28.8	19.3	7.4	32	41	417
192	59.71	168	AV4	37.7	41.3	9.2	41	39	891
			STD	4.0	4.6	0.6	3	1	92
			MAX	42.2	46.4	9.7	44	41	993
			MIN	31.6	34.0	8.3	37	38	747
			Average	20.0	8.0	5.2	21	53	132
			Std. Dev.	6.8	8.5	1.6	9	7	200
			Maximum	42.2	46.4	9.7	44	81	993
			Minimum	2.7	1.4	1.9	0	38	0

Total number of blows analyzed: 148

BL#	depth (ft)	Comments
1	30.20	Reference Elevation EL 731.0

Time Summary

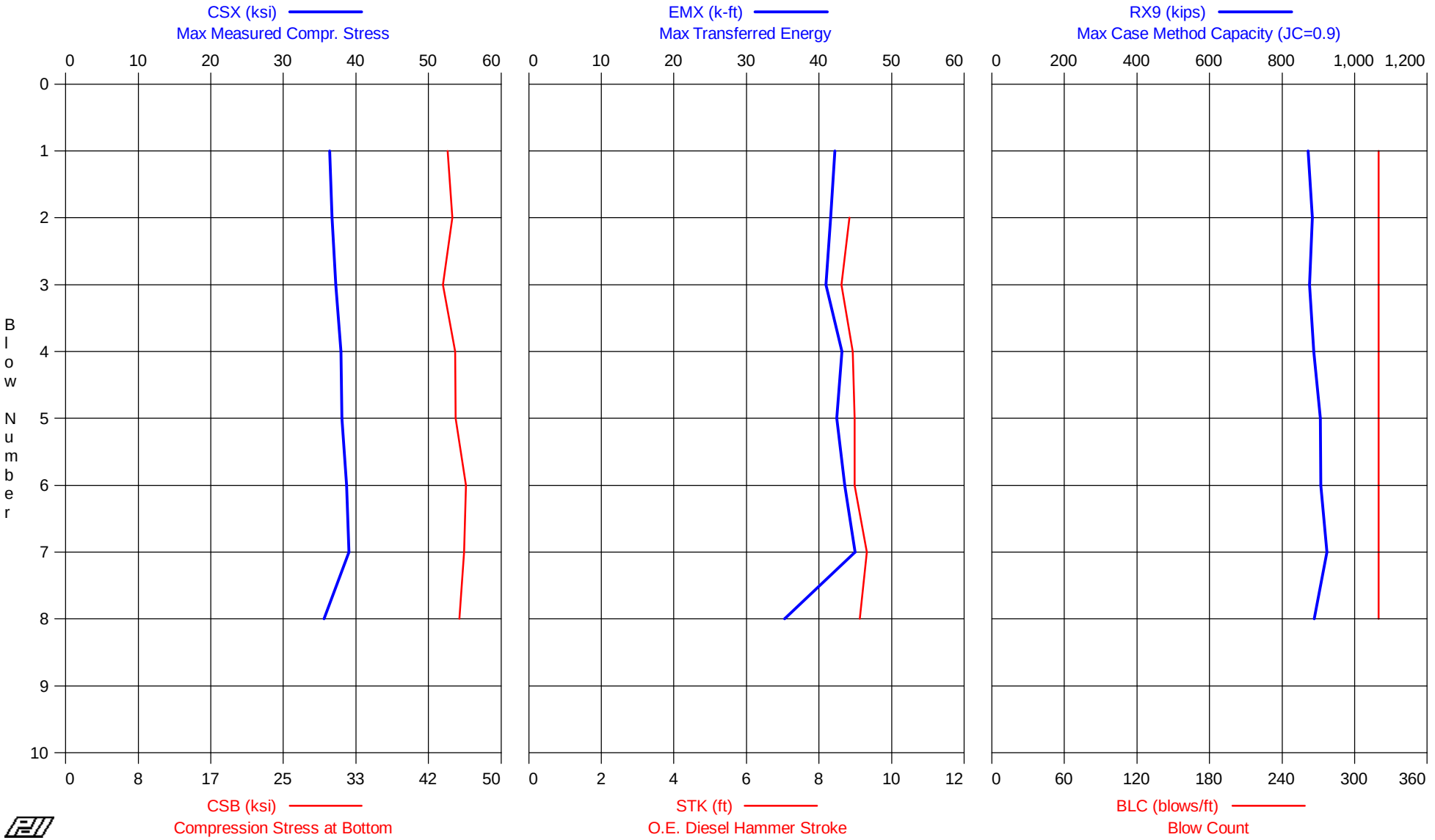
Drive 17 minutes 50 seconds 12:07:18 PM - 12:25:08 PM (11/18/2014) BN 1 - 192

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

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 19-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 2 #44 Restrike
APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 2 #44 Restrike
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-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: 1.20

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

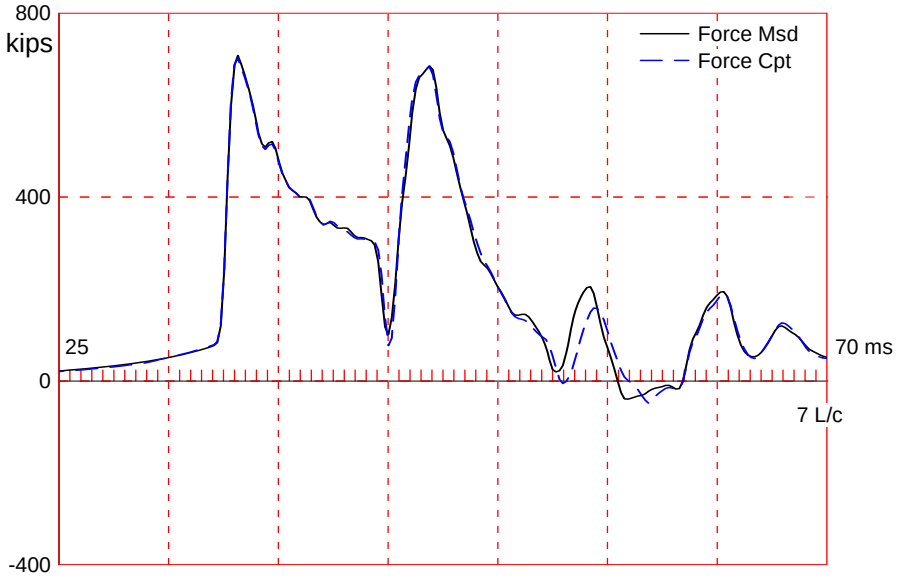
STK: O.E. Diesel Hammer Stroke
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

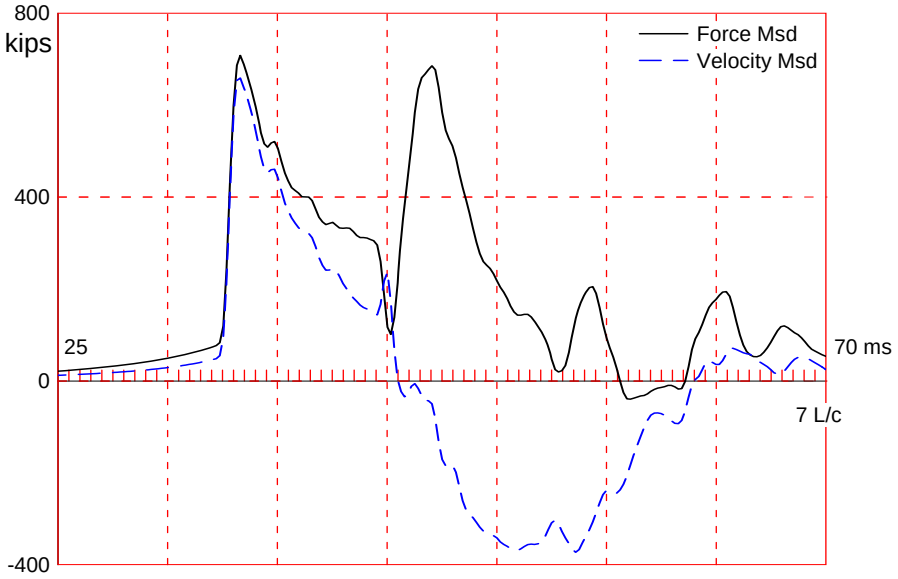
BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
8	59.69	320	AV8	37.4	44.8	42	9.0	39.5	893
			STD	1.1	0.8	3	0.2	0.4	16
			MAX	39.0	46.0	45	9.3	40.3	923
			MIN	35.6	43.3	35	8.6	38.8	872
			Average	37.4	44.8	42	9.0	39.5	893
			Std. Dev.	1.1	0.8	3	0.2	0.4	16
			Maximum	39.0	46.0	45	9.3	40.3	923
			Minimum	35.6	43.3	35	8.6	38.8	872

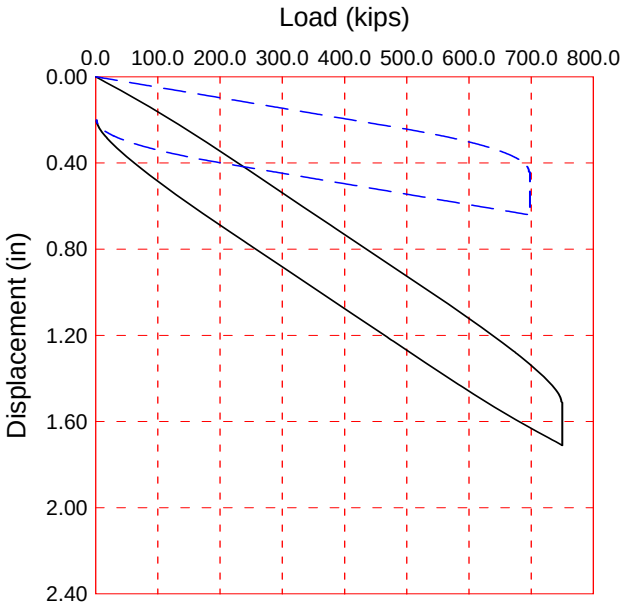
Total number of blows analyzed: 8

Time Summary

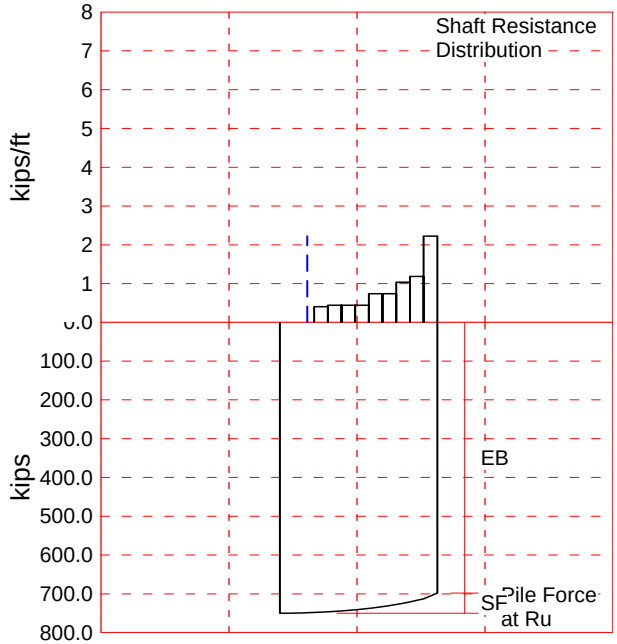
Drive 12 seconds 8:16:54 AM - 8:17:06 AM (11/19/2014) BN 1 - 10







RU =	750.0 kips
SF =	52.0 kips
EB =	698.0 kips
Dy =	1.51 in
Dx =	1.71 in
SET/Bl =	0.20 in



Length b. Sensors	77.5 ft
Embedment	61.3 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	3.84
Top Compr. Stress	32.9 ksi
Max Compr. Stress	38.0 ksi
Max Tension Stress	-6.47 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.34 in
Avg. Shaft Smith Dpg.	0.20 s/ft
Toe Smith Damping	0.07 s/ft

CAPWAP(R) 2014 Licensed to GRL Engineers, Inc.

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: 750.0; along Shaft 52.0; at Toe 698.0 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
				750.0			
1	23.6	7.4	3.0	747.0	3.0	0.41	0.09
2	30.3	14.1	3.0	744.0	6.0	0.45	0.09
3	37.1	20.8	3.0	741.0	9.0	0.45	0.09
4	43.8	27.6	3.0	738.0	12.0	0.45	0.09
5	50.5	34.3	5.0	733.0	17.0	0.74	0.16
6	57.3	41.1	5.0	728.0	22.0	0.74	0.16
7	64.0	47.8	7.0	721.0	29.0	1.04	0.22
8	70.8	54.5	8.0	713.0	37.0	1.19	0.25
9	77.5	61.3	15.0	698.0	52.0	2.23	0.47
Avg. Shaft			5.8			0.85	0.18
Toe			698.0				506.35

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.20	0.07
Quake	(in)	0.08	0.34
Case Damping Factor		0.27	1.28
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	30
Unloading Level	(% of Ru)	68	
Resistance Gap (included in Toe Quake) (in)			0.02

CAPWAP match quality = 3.84 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.04 in; Blow Count = 331 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.08; A4(K2524) CAL: 360; RF: 1.08

max. Top Comp. Stress = 32.9 ksi (T= 35.9 ms, max= 1.157 x Top)
max. Comp. Stress = 38.0 ksi (Z= 77.5 ft, T= 41.1 ms)
max. Tens. Stress = -6.47 ksi (Z= 43.8 ft, T= 57.1 ms)
max. Energy (EMX) = 40.8 kip-ft; max. Measured Top Displ. (DMX)= 1.15 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	703.6	-66.7	32.9	-3.12	40.8	17.4	1.15
2	6.7	704.4	-87.7	32.9	-4.10	40.6	17.4	1.13
4	13.5	706.2	-125.1	33.0	-5.84	39.7	17.3	1.08
5	16.8	708.3	-116.1	33.1	-5.42	39.1	17.2	1.05
6	20.2	712.0	-102.6	33.3	-4.79	38.5	17.1	1.02
7	23.6	715.0	-90.5	33.4	-4.23	37.9	17.0	0.99
8	27.0	705.7	-84.8	33.0	-3.96	36.6	16.9	0.96
9	30.3	708.7	-89.7	33.1	-4.19	35.8	16.8	0.92
10	33.7	699.6	-82.5	32.7	-3.86	34.4	16.7	0.89
11	37.1	702.7	-113.1	32.8	-5.28	33.5	16.6	0.86
12	40.4	693.7	-134.0	32.4	-6.26	32.0	16.5	0.82
13	43.8	697.7	-138.5	32.6	-6.47	31.1	16.4	0.78
14	47.2	690.7	-123.1	32.3	-5.75	29.6	16.2	0.74
15	50.5	695.3	-109.2	32.5	-5.10	28.4	16.1	0.70
16	53.9	683.1	-95.6	31.9	-4.47	26.3	15.9	0.66
17	57.3	696.7	-93.4	32.5	-4.36	25.1	15.8	0.62
18	60.7	704.3	-96.9	32.9	-4.53	23.0	15.6	0.57
19	64.0	717.9	-101.3	33.5	-4.73	21.7	15.8	0.53
20	67.4	752.3	-84.3	35.1	-3.94	19.4	17.4	0.48
21	70.8	777.7	-70.0	36.3	-3.27	18.0	18.5	0.44
22	74.1	782.8	-40.6	36.6	-1.90	15.7	19.2	0.39
23	77.5	813.8	-27.2	38.0	-1.27	15.0	16.6	0.36
Absolute	77.5			38.0			(T =	41.1 ms)
	43.8				-6.47		(T =	57.1 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	746.7	618.8	490.9	362.9	235.0					
RX	857.9	836.3	818.3	801.5	788.5	775.5	765.6	756.3	746.9	737.6
RU	746.7	618.8	490.9	362.9	235.0					

RAU = 592.2 (kips); RA2 = 840.5 (kips)

Current CAPWAP Ru = 750.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 1.53

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
17.6	35.68	672.5	713.9	717.4	1.15	0.20	0.20	41.1	728.0	2181

PILE PROFILE AND PILE MODEL

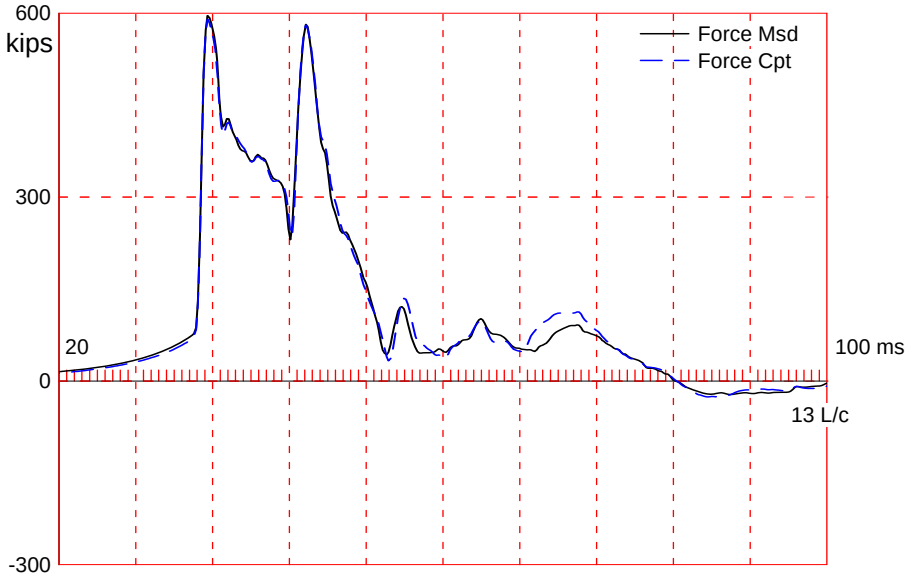
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

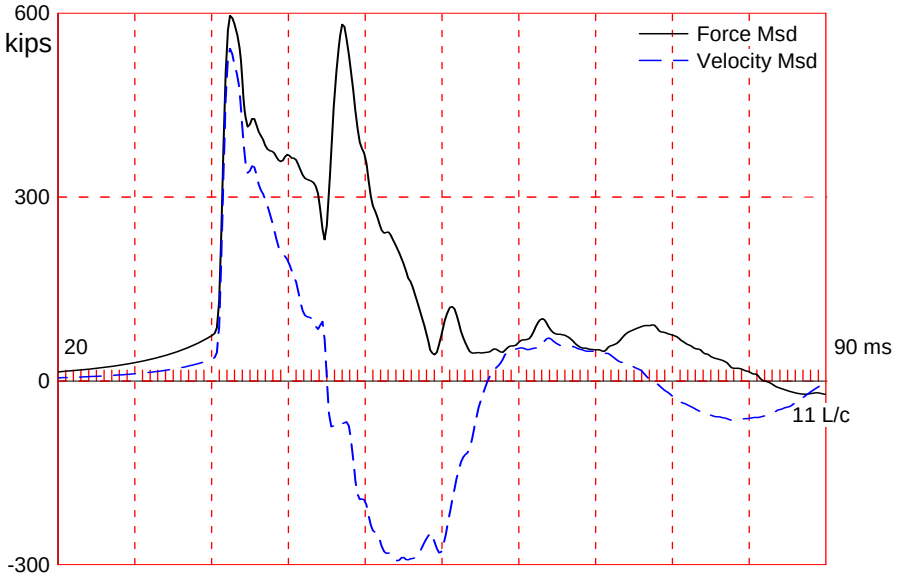
Toe Area 198.5 in^2

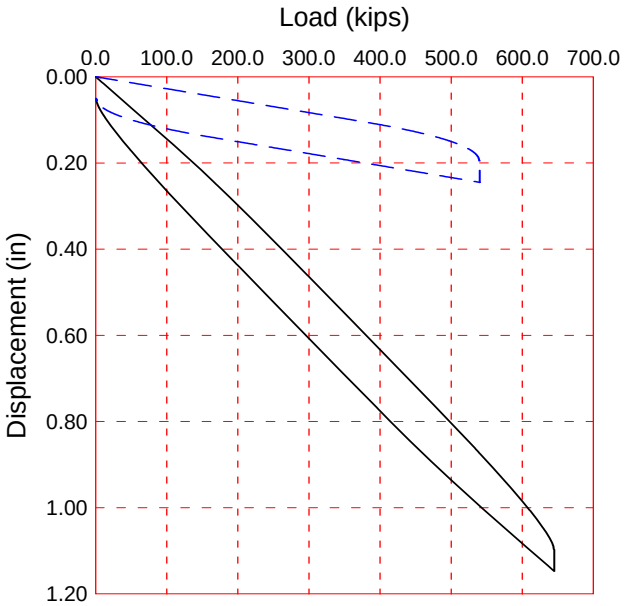
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

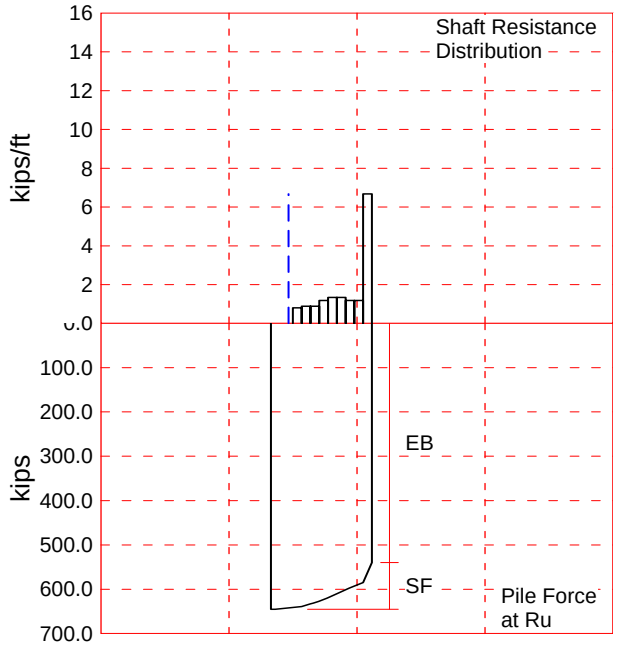
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	645.0 kips
SF =	105.0 kips
EB =	540.0 kips
Dy =	1.10 in
Dx =	1.15 in
SET/Bl =	0.05 in



Length b. Sensors	77.5 ft
Embedment	61.4 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	3.05
Top Compr. Stress	27.6 ksi
Max Compr. Stress	33.0 ksi
Max Tension Stress	-4.10 ksi
Avg. Shaft Quake	0.12 in
Toe Quake	0.15 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.08 s/ft

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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: 645.0; along Shaft 105.0; at Toe 540.0 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
				645.0			
1	23.6	7.5	6.0	639.0	6.0	0.80	0.17
2	30.3	14.2	6.0	633.0	12.0	0.89	0.19
3	37.1	20.9	6.0	627.0	18.0	0.89	0.19
4	43.8	27.7	8.0	619.0	26.0	1.19	0.25
5	50.5	34.4	9.0	610.0	35.0	1.34	0.28
6	57.3	41.2	9.0	601.0	44.0	1.34	0.28
7	64.0	47.9	8.0	593.0	52.0	1.19	0.25
8	70.8	54.6	8.0	585.0	60.0	1.19	0.25
9	77.5	61.4	45.0	540.0	105.0	6.68	1.42
Avg. Shaft			11.7			1.71	0.36
Toe			540.0				391.73

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.08
Quake	(in)	0.12	0.15
Case Damping Factor		0.82	1.13
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	51
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	35	
Resistance Gap (included in Toe Quake) (in)			0.02

CAPWAP match quality = 3.05 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.05 in; Blow Count = 240 b/ft
Computed: Final Set = 0.02 in; Blow Count = 620 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 = 27.6 ksi (T= 35.9 ms, max= 1.194 x Top)
max. Comp. Stress = 33.0 ksi (Z= 77.5 ft, T= 41.1 ms)
max. Tens. Stress = -4.10 ksi (Z= 50.5 ft, T= 57.5 ms)
max. Energy (EMX) = 29.2 kip-ft; max. Measured Top Displ. (DMX)= 0.89 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	591.2	-28.7	27.6	-1.34	29.2	14.3	0.89
2	6.7	592.2	-31.6	27.7	-1.48	28.9	14.3	0.87
4	13.5	594.4	-36.3	27.8	-1.70	28.0	14.2	0.82
5	16.8	598.7	-37.9	28.0	-1.77	27.6	14.1	0.80
6	20.2	606.7	-39.0	28.3	-1.82	27.1	13.9	0.77
7	23.6	613.2	-40.1	28.6	-1.88	26.5	13.7	0.74
8	27.0	590.5	-37.3	27.6	-1.74	24.7	13.5	0.71
9	30.3	597.1	-48.6	27.9	-2.27	24.0	13.3	0.68
10	33.7	575.5	-56.2	26.9	-2.63	22.2	13.1	0.64
11	37.1	584.3	-73.4	27.3	-3.43	21.5	12.9	0.61
12	40.4	587.9	-78.9	27.5	-3.69	19.7	12.6	0.58
13	43.8	590.2	-84.7	27.6	-3.96	19.0	12.3	0.54
14	47.2	584.2	-83.7	27.3	-3.91	17.0	12.1	0.51
15	50.5	599.5	-87.8	28.0	-4.10	16.2	11.8	0.47
16	53.9	601.9	-74.8	28.1	-3.49	14.2	11.5	0.43
17	57.3	612.1	-73.0	28.6	-3.41	13.3	11.3	0.40
18	60.7	613.7	-60.9	28.7	-2.84	11.4	11.0	0.36
19	64.0	627.3	-60.1	29.3	-2.81	10.4	10.8	0.32
20	67.4	628.5	-50.8	29.4	-2.37	8.7	10.9	0.28
21	70.8	619.3	-49.7	28.9	-2.32	7.8	11.3	0.24
22	74.1	663.6	-39.2	31.0	-1.83	6.4	10.8	0.20
23	77.5	705.7	-39.3	33.0	-1.84	4.9	8.5	0.17
Absolute	77.5			33.0			(T =	41.1 ms)
	50.5				-4.10		(T =	57.5 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	789.8	718.3	646.8	575.3	503.8					
RX	835.5	793.7	755.0	719.1	686.1	656.6	633.3	611.2	591.7	573.7
RU	792.7	721.9	651.0	580.1	509.2					

RAU = 504.2 (kips); RA2 = 692.3 (kips)

Current CAPWAP Ru = 645.0 (kips); Corresponding J(RP)= 0.41; J(RX) = 1.09

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
14.3	35.68	546.6	600.6	600.6	0.89	0.05	0.05	29.5	756.1	4154

PILE PROFILE AND PILE MODEL

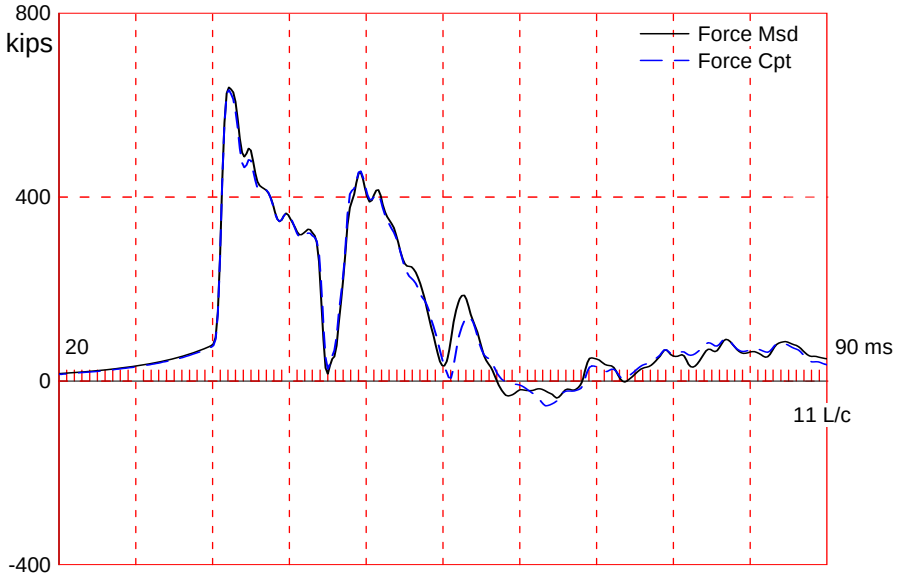
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

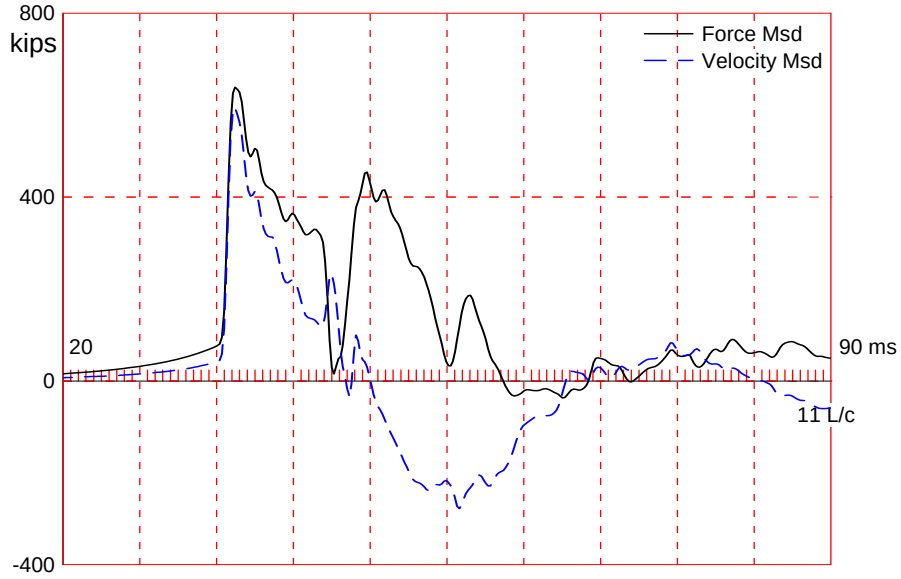
Toe Area 198.5 in^2

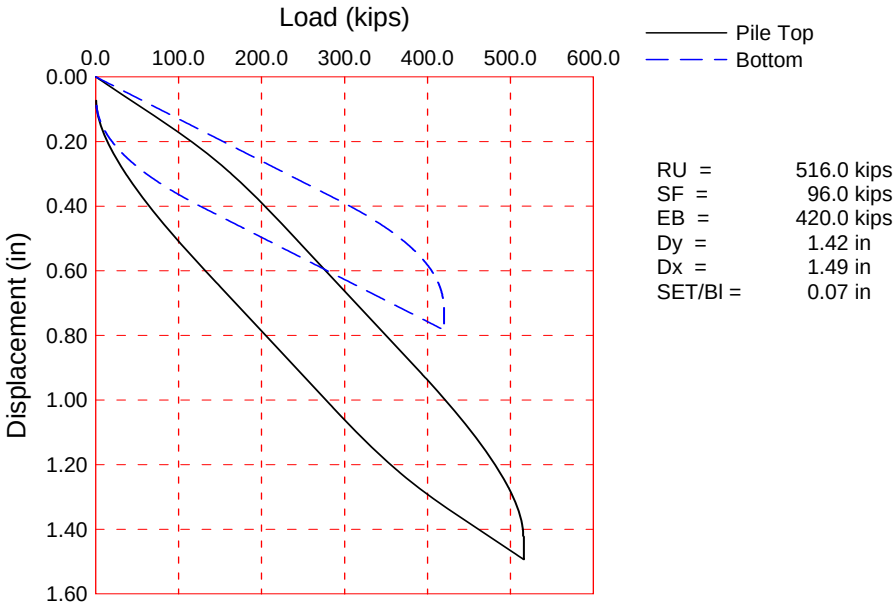
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

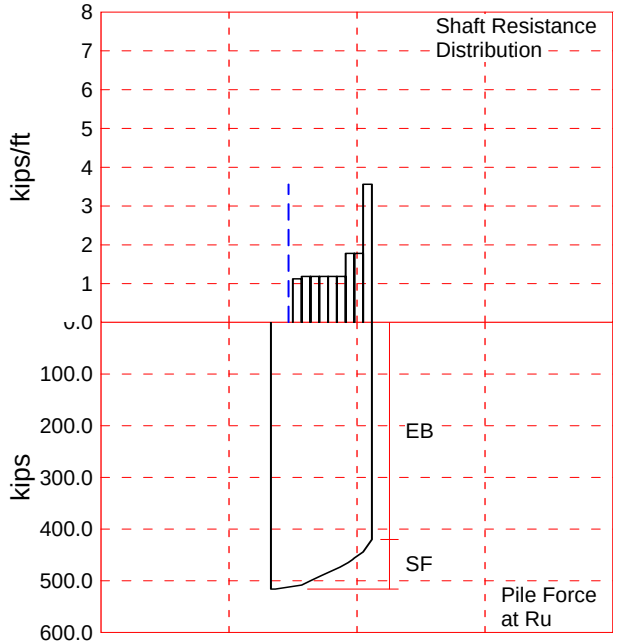
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	516.0 kips
SF =	96.0 kips
EB =	420.0 kips
Dy =	1.42 in
Dx =	1.49 in
SET/Bl =	0.07 in



Length b. Sensors	77.5 ft
Embedment	61.0 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	3.87
Top Compr. Stress	29.6 ksi
Max Compr. Stress	30.7 ksi
Max Tension Stress	-4.73 ksi
Avg. Shaft Quake	0.13 in
Toe Quake	0.55 in
Avg. Shaft Smith Dpg.	0.24 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: 516.0; along Shaft 96.0; at Toe 420.0 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
				516.0			
1	23.6	7.1	8.0	508.0	8.0	1.12	0.24
2	30.3	13.9	8.0	500.0	16.0	1.19	0.25
3	37.1	20.6	8.0	492.0	24.0	1.19	0.25
4	43.8	27.3	8.0	484.0	32.0	1.19	0.25
5	50.5	34.1	8.0	476.0	40.0	1.19	0.25
6	57.3	40.8	8.0	468.0	48.0	1.19	0.25
7	64.0	47.6	12.0	456.0	60.0	1.78	0.38
8	70.8	54.3	12.0	444.0	72.0	1.78	0.38
9	77.5	61.0	24.0	420.0	96.0	3.56	0.76
Avg. Shaft			10.7			1.57	0.33
Toe			420.0				304.68

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.24	0.03
Quake	(in)	0.13	0.55
Case Damping Factor		0.60	0.33
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	32	
Resistance Gap (included in Toe Quake)	(in)		0.11

CAPWAP match quality = 3.87 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.07 in; Blow Count = 168 b/ft
Computed: Final Set = 0.08 in; Blow Count = 152 b/ft

Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.09; A4(K2524) CAL: 360; RF: 1.09

max. Top Comp. Stress = 29.6 ksi (T= 35.9 ms, max= 1.037 x Top)
max. Comp. Stress = 30.7 ksi (Z= 23.6 ft, T= 37.1 ms)
max. Tens. Stress = -4.73 ksi (Z= 43.8 ft, T= 63.4 ms)
max. Energy (EMX) = 34.9 kip-ft; max. Measured Top Displ. (DMX)= 1.09 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	634.1	-55.3	29.6	-2.58	34.9	15.7	1.08
2	6.7	634.9	-62.5	29.7	-2.92	34.7	15.7	1.07
4	13.5	636.8	-70.4	29.8	-3.29	34.4	15.6	1.04
5	16.8	641.9	-70.8	30.0	-3.31	34.2	15.5	1.02
6	20.2	650.7	-73.2	30.4	-3.42	33.9	15.2	1.00
7	23.6	657.4	-82.8	30.7	-3.87	33.6	15.0	0.98
8	27.0	629.2	-85.7	29.4	-4.01	31.3	14.8	0.96
9	30.3	635.5	-95.2	29.7	-4.45	30.9	14.6	0.93
10	33.7	607.8	-92.7	28.4	-4.33	28.6	14.4	0.91
11	37.1	614.1	-93.2	28.7	-4.36	28.2	14.2	0.88
12	40.4	586.7	-94.5	27.4	-4.41	26.0	14.0	0.85
13	43.8	592.7	-101.2	27.7	-4.73	25.5	13.9	0.82
14	47.2	565.6	-99.0	26.4	-4.62	23.4	13.7	0.80
15	50.5	571.3	-100.1	26.7	-4.68	23.0	13.5	0.77
16	53.9	544.6	-92.4	25.4	-4.31	21.0	13.3	0.75
17	57.3	551.9	-91.0	25.8	-4.25	20.5	14.3	0.72
18	60.7	528.6	-81.2	24.7	-3.79	18.5	14.4	0.69
19	64.0	536.0	-75.6	25.0	-3.53	18.0	14.6	0.66
20	67.4	490.6	-64.3	22.9	-3.00	15.4	16.3	0.63
21	70.8	464.8	-63.7	21.7	-2.98	14.8	17.7	0.61
22	74.1	456.8	-51.7	21.3	-2.42	12.4	18.1	0.58
23	77.5	466.0	-50.1	21.8	-2.34	9.4	17.7	0.55
Absolute	23.6			30.7			(T =	37.1 ms)
	43.8				-4.73		(T =	63.4 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	526.0	454.0	382.0	310.1	238.1	166.1	94.1	22.1	0.0	0.0
RX	607.2	577.5	552.6	537.0	522.8	519.0	515.8	512.5	509.3	506.4
RU	526.0	454.0	382.0	310.1	238.1	166.1	94.1	22.1	0.0	0.0

RAU = 474.4 (kips); RA2 = 562.1 (kips)

Current CAPWAP Ru = 516.0 (kips); Corresponding J(RP)= 0.01; J(RX) = 0.59

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
15.8	35.68	602.8	643.0	643.0	1.09	0.07	0.07	35.6	739.3	955

PILE PROFILE AND PILE MODEL

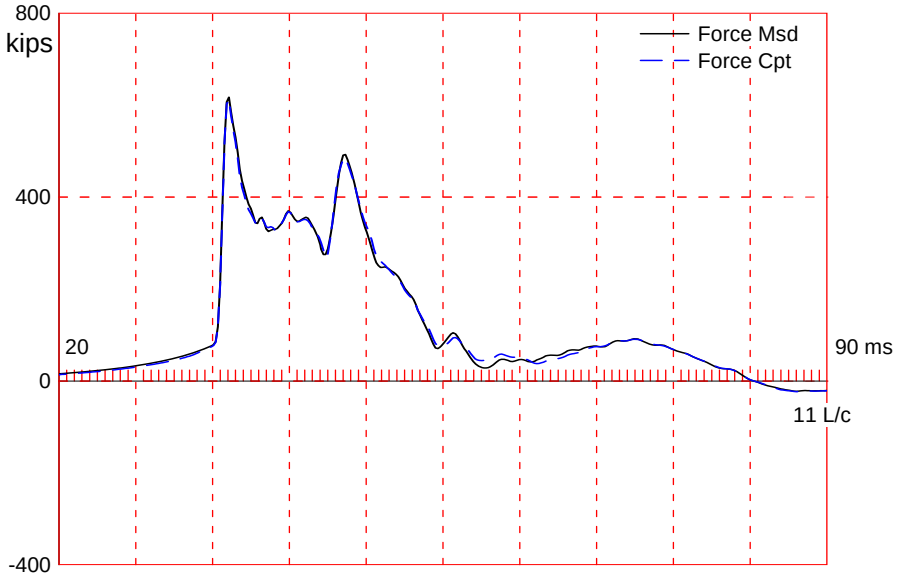
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

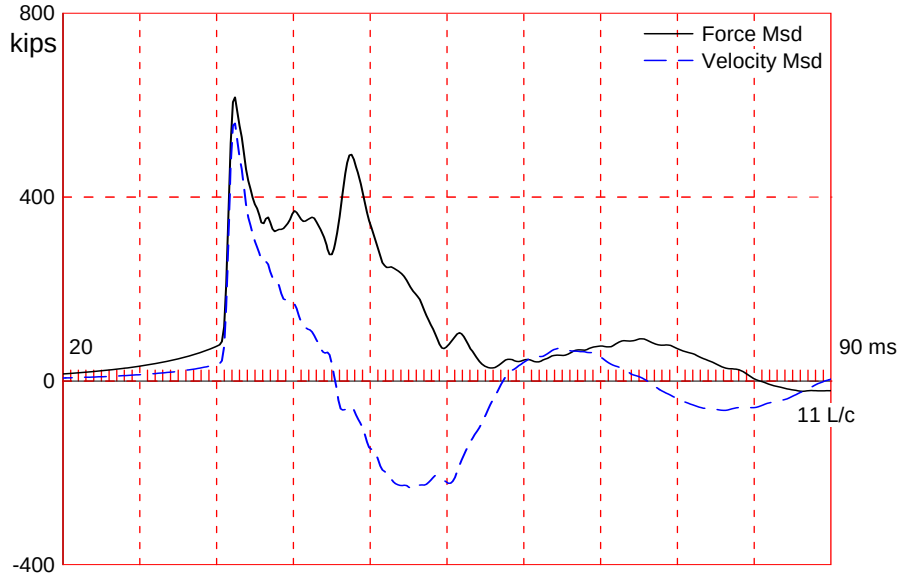
Toe Area 198.5 in^2

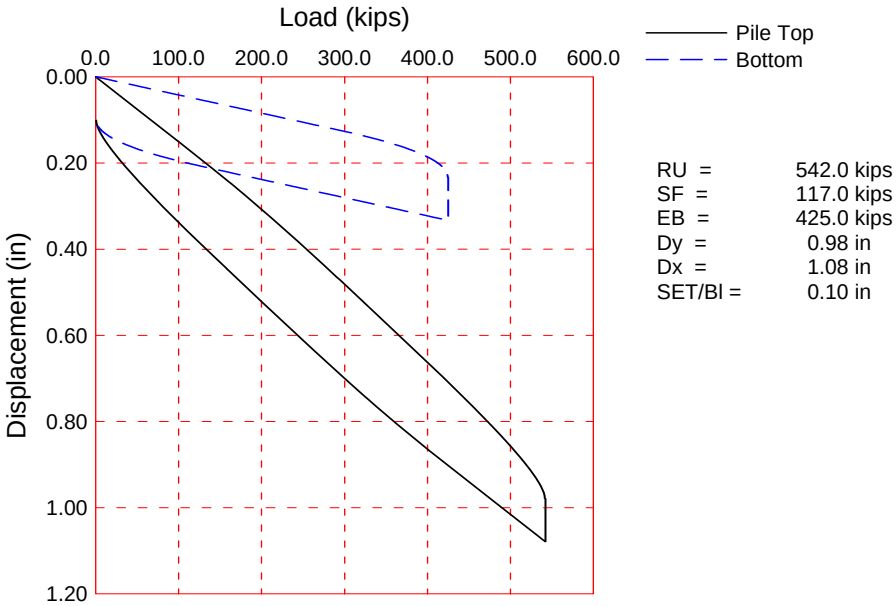
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

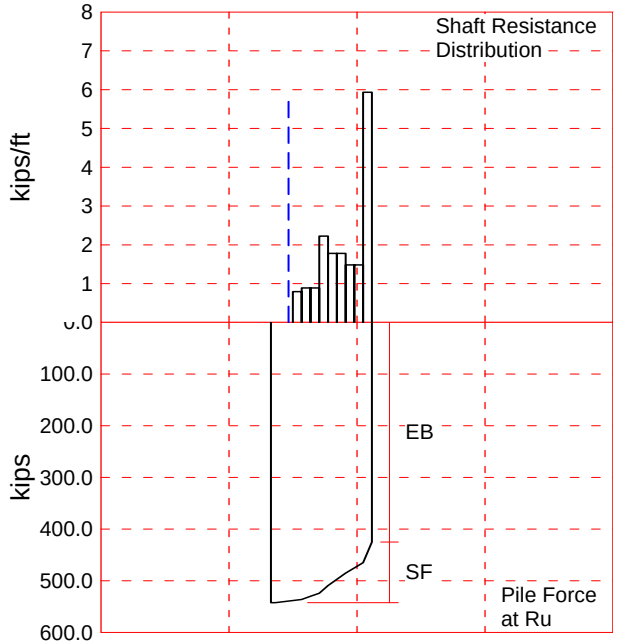
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	542.0 kips
SF =	117.0 kips
EB =	425.0 kips
Dy =	0.98 in
Dx =	1.08 in
SET/Bl =	0.10 in



Length b. Sensors	77.5 ft
Embedment	61.5 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	1.52
Top Compr. Stress	28.6 ksi
Max Compr. Stress	29.7 ksi
Max Tension Stress	-1.72 ksi
Avg. Shaft Quake	0.15 in
Toe Quake	0.18 in
Avg. Shaft Smith Dpg.	0.31 s/ft
Toe Smith Damping	0.13 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 542.0; along Shaft 117.0; at Toe 425.0 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
				542.0			
1	23.6	7.5	6.0	536.0	6.0	0.80	0.17
2	30.3	14.3	6.0	530.0	12.0	0.89	0.19
3	37.1	21.0	6.0	524.0	18.0	0.89	0.19
4	43.8	27.8	15.0	509.0	33.0	2.23	0.47
5	50.5	34.5	12.0	497.0	45.0	1.78	0.38
6	57.3	41.2	12.0	485.0	57.0	1.78	0.38
7	64.0	48.0	10.0	475.0	67.0	1.48	0.32
8	70.8	54.7	10.0	465.0	77.0	1.48	0.32
9	77.5	61.5	40.0	425.0	117.0	5.94	1.26
Avg. Shaft			13.0			1.90	0.41
Toe			425.0				308.31

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.31	0.13
Quake	(in)	0.15	0.18
Case Damping Factor		0.95	1.45
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	77	72
Resistance Gap (included in Toe Quake)	(in)		0.02
Soil Plug Weight	(kips)		0.078

CAPWAP match quality = 1.52 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.01 in; Blow Count = 1736 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 = 28.6 ksi (T= 35.9 ms, max= 1.038 x Top)
max. Comp. Stress = 29.7 ksi (Z= 23.6 ft, T= 37.1 ms)
max. Tens. Stress = -1.72 ksi (Z= 23.6 ft, T= 88.0 ms)
max. Energy (EMX) = 25.1 kip-ft; max. Measured Top Displ. (DMX)= 0.80 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	612.2	-25.4	28.6	-1.19	25.1	14.8	0.81
2	6.7	613.3	-27.7	28.7	-1.29	24.8	14.8	0.79
4	13.5	615.8	-31.9	28.8	-1.49	24.1	14.7	0.75
5	16.8	619.7	-33.8	29.0	-1.58	23.7	14.6	0.72
6	20.2	628.6	-35.5	29.4	-1.66	23.1	14.4	0.69
7	23.6	635.6	-36.9	29.7	-1.72	22.6	14.2	0.66
8	27.0	612.1	-31.9	28.6	-1.49	21.0	13.9	0.63
9	30.3	619.2	-33.3	28.9	-1.56	20.4	13.7	0.60
10	33.7	596.4	-27.9	27.9	-1.30	18.9	13.5	0.57
11	37.1	606.8	-28.9	28.3	-1.35	18.3	13.2	0.54
12	40.4	594.3	-23.4	27.8	-1.09	16.8	12.7	0.51
13	43.8	607.7	-24.6	28.4	-1.15	16.2	12.4	0.48
14	47.2	551.2	-10.7	25.8	-0.50	13.9	12.0	0.45
15	50.5	562.6	-11.8	26.3	-0.55	13.3	11.7	0.42
16	53.9	522.7	-3.9	24.4	-0.18	11.6	11.4	0.39
17	57.3	533.0	-5.9	24.9	-0.28	11.0	11.1	0.36
18	60.7	493.8	0.0	23.1	0.00	9.4	10.8	0.33
19	64.0	502.9	0.0	23.5	0.00	8.8	10.5	0.30
20	67.4	483.8	0.0	22.6	0.00	7.5	10.3	0.27
21	70.8	502.0	0.0	23.5	0.00	6.9	10.2	0.24
22	74.1	518.0	0.0	24.2	0.00	5.8	10.5	0.21
23	77.5	565.9	-0.4	26.4	-0.02	4.4	9.5	0.18
Absolute	23.6			29.7			(T =	37.1 ms)
	23.6				-1.72		(T =	88.0 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	745.6	652.6	559.6	466.5	373.5					
RX	754.4	682.8	631.5	596.7	573.4	550.8	528.6	511.4	496.4	482.6
RU	745.6	652.6	559.6	466.5	373.5					

RAU = 371.1 (kips); RA2 = 615.3 (kips)

Current CAPWAP Ru = 542.0 (kips); Corresponding J(RP)= 0.44; J(RX) = 1.08

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
15.2	35.68	579.3	631.5	631.5	0.80	0.10	0.10	25.4	674.5	2656

PILE PROFILE AND PILE MODEL

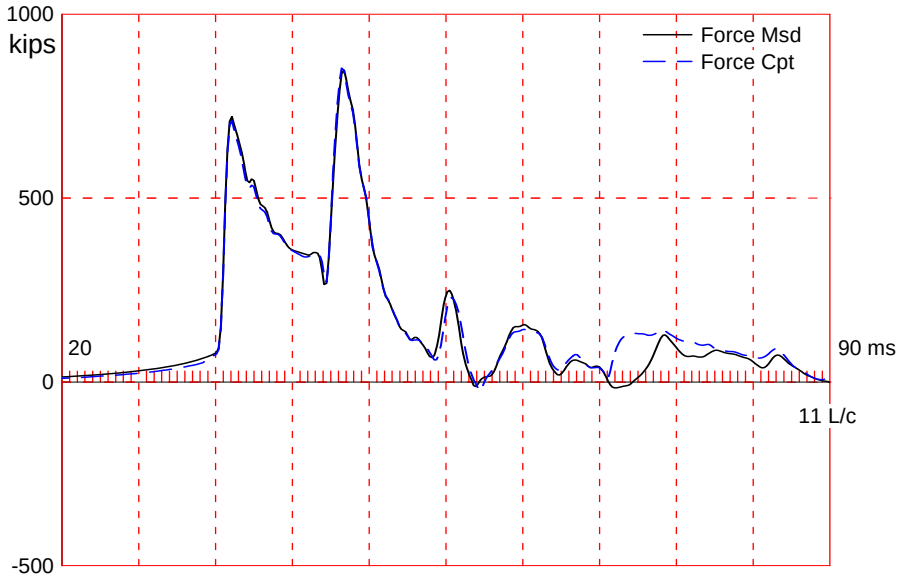
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

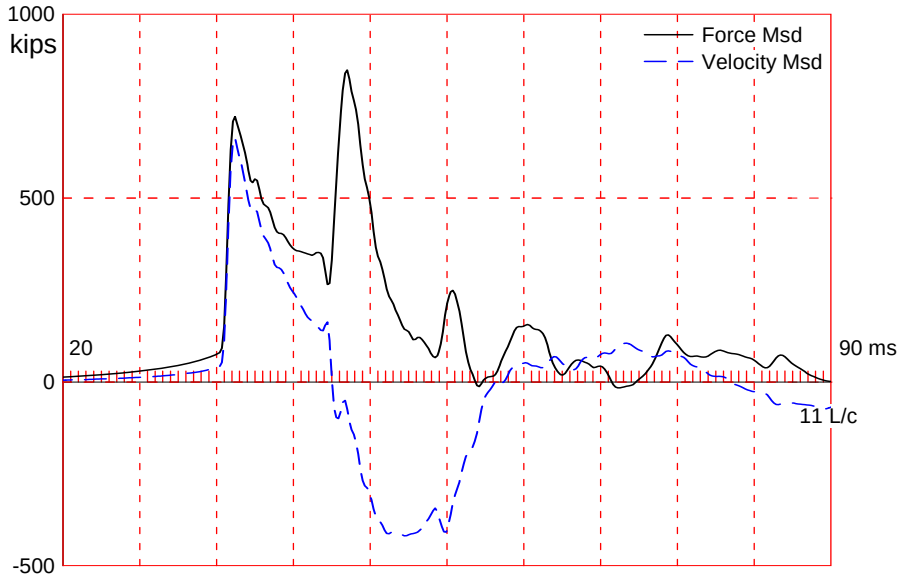
Toe Area 198.5 in^2

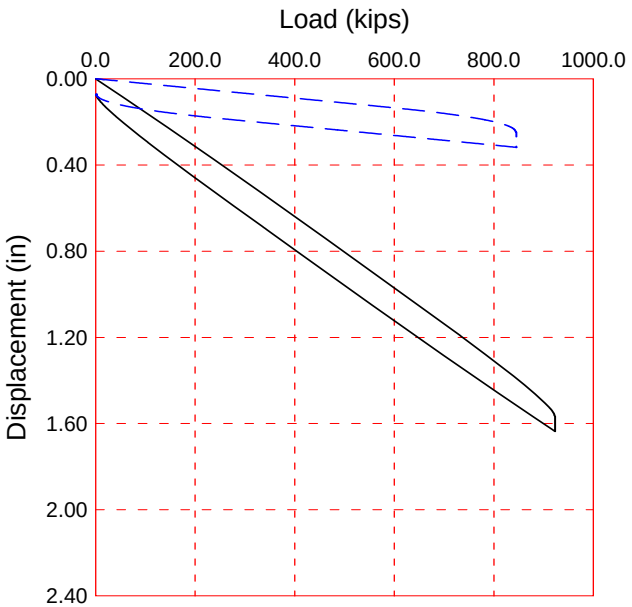
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

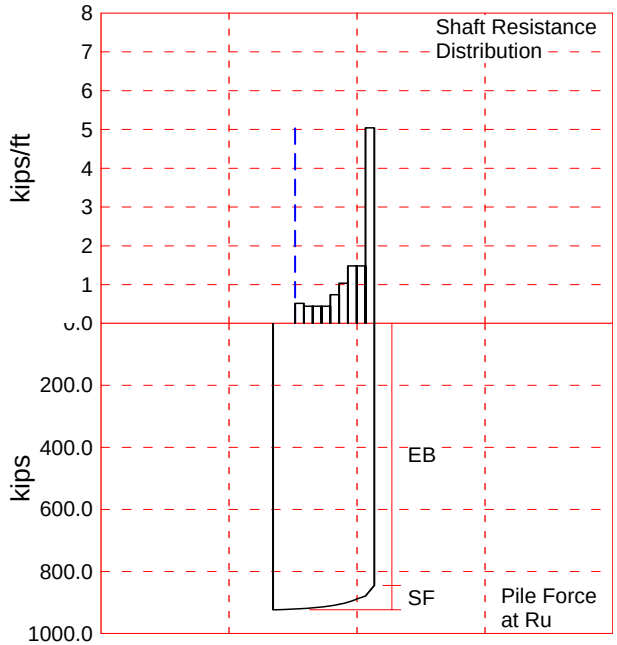
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	923.0 kips
SF =	78.0 kips
EB =	845.0 kips
Dy =	1.57 in
Dx =	1.64 in
SET/Bl =	0.07 in



Length b. Sensors	77.5 ft
Embedment	59.7 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	4.10
Top Compr. Stress	39.7 ksi
Max Compr. Stress	46.2 ksi
Max Tension Stress	-6.41 ksi
Avg. Shaft Quake	0.19 in
Toe Quake	0.19 in
Avg. Shaft Smith Dpg.	0.21 s/ft
Toe Smith Damping	0.11 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: 923.0; along Shaft 78.0; at Toe 845.0 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	Quake in
				923.0				
1	23.6	5.8	3.0	920.0	3.0	0.52	0.11	0.19
2	30.3	12.5	3.0	917.0	6.0	0.45	0.09	0.19
3	37.1	19.3	3.0	914.0	9.0	0.45	0.09	0.19
4	43.8	26.0	3.0	911.0	12.0	0.45	0.09	0.19
5	50.5	32.7	5.0	906.0	17.0	0.74	0.16	0.19
6	57.3	39.5	7.0	899.0	24.0	1.04	0.22	0.19
7	64.0	46.2	10.0	889.0	34.0	1.48	0.32	0.19
8	70.8	53.0	10.0	879.0	44.0	1.48	0.32	0.19
9	77.5	59.7	34.0	845.0	78.0	5.05	1.07	0.19
Avg. Shaft			8.7			1.31	0.28	0.19
Toe			845.0				612.99	0.19

Soil Model Parameters/Extensions	Shaft	Toe
Smith Damping Factor	0.21	0.11
Case Damping Factor	0.43	2.43
Damping Type	Viscous	Smith
Unloading Quake (% of loading quake)	40	30
Unloading Level (% of Ru)	40	
Resistance Gap (included in Toe Quake) (in)		0.03

CAPWAP match quality = 4.10 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.07 in; Blow Count = 168 b/ft
Computed: Final Set = 0.01 in; Blow Count = 1159 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
Not Active A3(K2253) CAL: 325; RF: 1.04; A4(K2524) CAL: 360; RF: 1.04

max. Top Comp. Stress = 39.7 ksi (T= 45.9 ms, max= 1.165 x Top)
max. Comp. Stress = 46.2 ksi (Z= 77.5 ft, T= 40.9 ms)
max. Tens. Stress = -6.41 ksi (Z= 33.7 ft, T= 56.3 ms)
max. Energy (EMX) = 43.1 kip-ft; max. Measured Top Displ. (DMX)= 1.11 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	849.4	-61.2	39.7	-2.86	43.1	17.6	1.15
2	6.7	839.2	-79.9	39.2	-3.73	42.6	17.6	1.12
4	13.5	819.6	-67.4	38.3	-3.15	41.3	17.5	1.06
5	16.8	802.6	-57.0	37.5	-2.66	40.6	17.4	1.03
6	20.2	785.7	-52.1	36.7	-2.43	39.9	17.3	0.99
7	23.6	763.2	-46.9	35.7	-2.19	39.2	17.2	0.96
8	27.0	744.0	-83.0	34.8	-3.88	37.6	17.1	0.92
9	30.3	730.5	-124.9	34.1	-5.83	36.7	17.0	0.89
10	33.7	739.6	-137.3	34.5	-6.41	35.1	16.9	0.85
11	37.1	750.2	-133.9	35.0	-6.26	34.1	16.7	0.81
12	40.4	762.4	-132.5	35.6	-6.19	32.3	16.6	0.77
13	43.8	784.2	-130.5	36.6	-6.10	31.0	16.5	0.72
14	47.2	799.6	-125.8	37.4	-5.88	29.1	16.3	0.68
15	50.5	806.3	-129.0	37.7	-6.03	27.7	16.1	0.63
16	53.9	830.7	-126.1	38.8	-5.89	25.2	15.9	0.58
17	57.3	859.2	-117.3	40.1	-5.48	23.4	15.6	0.53
18	60.7	866.7	-105.1	40.5	-4.91	20.6	15.3	0.48
19	64.0	902.9	-90.4	42.2	-4.22	18.6	15.0	0.42
20	67.4	917.4	-70.3	42.9	-3.29	15.4	14.8	0.36
21	70.8	919.8	-67.0	43.0	-3.13	13.2	15.6	0.30
22	74.1	951.3	-52.1	44.4	-2.44	10.5	14.9	0.25
23	77.5	989.4	-46.9	46.2	-2.19	9.0	10.4	0.20
Absolute	77.5			46.2			(T =	40.9 ms)
	33.7				-6.41		(T =	56.3 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	1008.3	928.5	848.7	768.9	689.1					
RX	1047.3	1011.7	988.2	968.2	949.6	935.3	922.6	911.6	900.5	889.4
RU	1015.1	936.7	858.3	779.9	701.4					

RAU = 725.5 (kips); RA2 = 1006.7 (kips)

Current CAPWAP Ru = 923.0 (kips); Corresponding J(RP)= 0.21; J(RX) = 1.19

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
17.7	35.89	675.8	731.4	857.4	1.11	0.07	0.07	43.5	882.0	5281

PILE PROFILE AND PILE MODEL

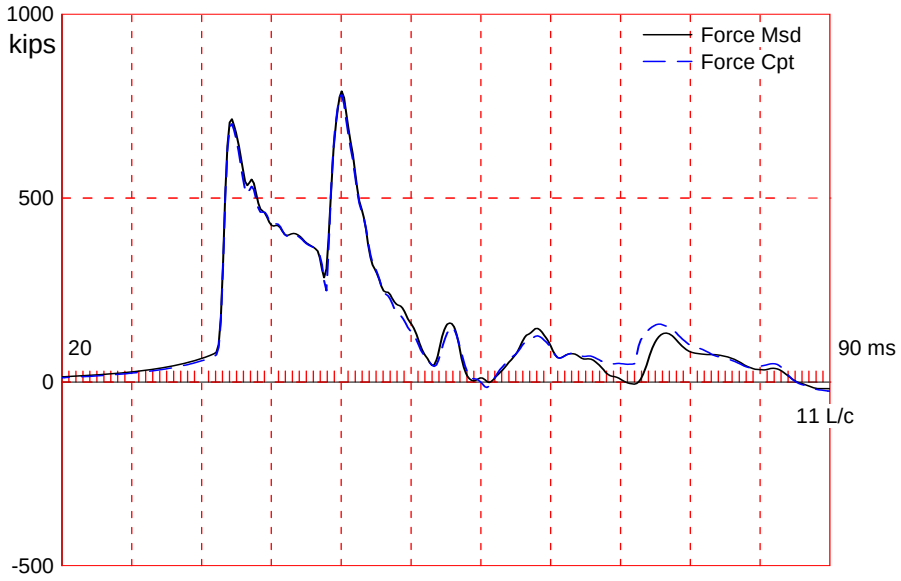
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

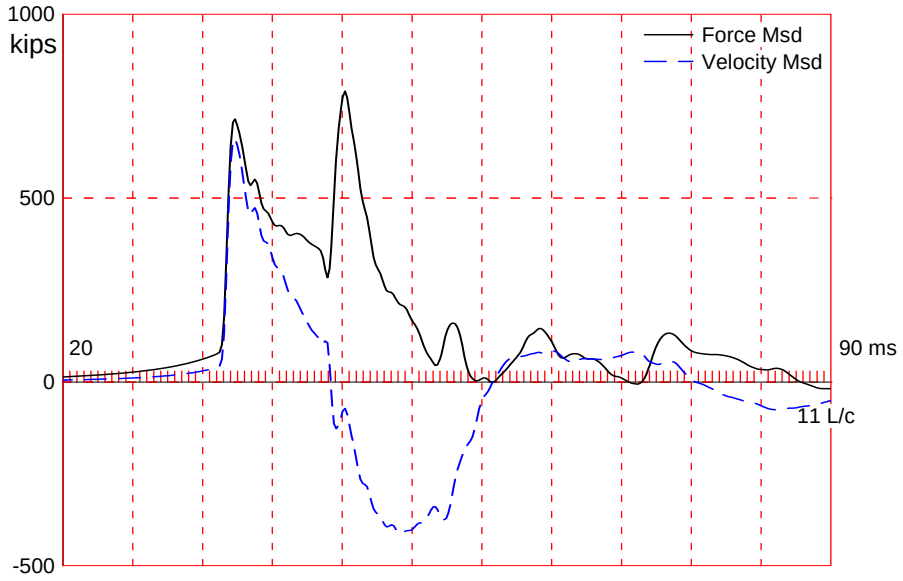
Toe Area 198.5 in^2

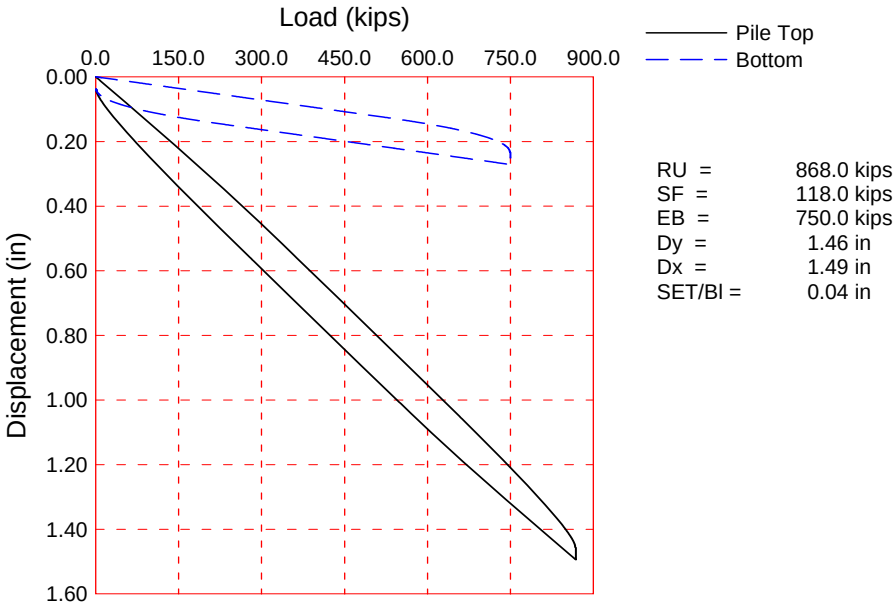
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

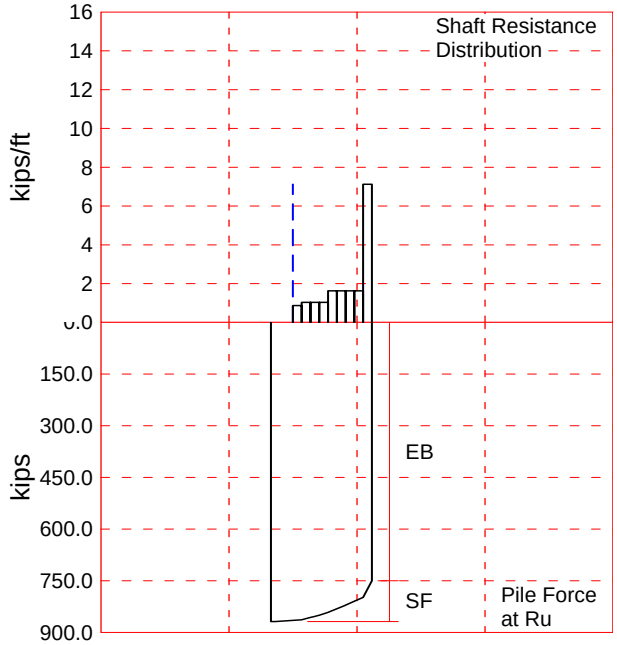
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	868.0 kips
SF =	118.0 kips
EB =	750.0 kips
Dy =	1.46 in
Dx =	1.49 in
SET/Bl =	0.04 in



Length b. Sensors	77.5 ft
Embedment	59.7 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	3.29
Top Compr. Stress	35.7 ksi
Max Compr. Stress	41.7 ksi
Max Tension Stress	-6.47 ksi
Avg. Shaft Quake	0.17 in
Toe Quake	0.18 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.15 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 868.0; along Shaft 118.0; at Toe 750.0 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
				868.0			
1	23.6	5.8	5.0	863.0	5.0	0.87	0.18
2	30.3	12.5	7.0	856.0	12.0	1.04	0.22
3	37.1	19.2	7.0	849.0	19.0	1.04	0.22
4	43.8	26.0	7.0	842.0	26.0	1.04	0.22
5	50.5	32.7	11.0	831.0	37.0	1.63	0.35
6	57.3	39.5	11.0	820.0	48.0	1.63	0.35
7	64.0	46.2	11.0	809.0	59.0	1.63	0.35
8	70.8	52.9	11.0	798.0	70.0	1.63	0.35
9	77.5	59.7	48.0	750.0	118.0	7.12	1.52
Avg. Shaft			13.1			1.98	0.42
Toe			750.0				544.08

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.15
Quake	(in)	0.17	0.18
Case Damping Factor		0.93	2.95
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	82	62
Unloading Level	(% of Ru)	28	
Resistance Gap (included in Toe Quake)	(in)		0.09
Soil Plug Weight	(kips)		0.007

CAPWAP match quality = 3.29 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.04 in; Blow Count = 320 b/ft
Computed: Final Set = 0.00 in; Blow Count = 3048 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.11; A4(K2524) CAL: 360; RF: 1.11

max. Top Comp. Stress = 35.7 ksi (T= 45.9 ms, max= 1.167 x Top)
max. Comp. Stress = 41.7 ksi (Z= 77.5 ft, T= 40.7 ms)
max. Tens. Stress = -6.47 ksi (Z= 37.1 ft, T= 56.7 ms)
max. Energy (EMX) = 42.3 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	3.4	764.5	-27.8	35.7	-1.30	42.3	17.6	1.10
2	6.7	757.0	-46.3	35.4	-2.16	41.8	17.6	1.07
4	13.5	737.1	-78.0	34.4	-3.65	40.6	17.5	1.01
5	16.8	724.1	-81.3	33.8	-3.80	39.9	17.4	0.98
6	20.2	718.2	-78.5	33.6	-3.67	39.2	17.2	0.94
7	23.6	726.4	-74.2	33.9	-3.47	38.3	17.0	0.91
8	27.0	706.1	-87.6	33.0	-4.09	35.9	16.7	0.87
9	30.3	718.4	-113.2	33.6	-5.29	34.9	16.5	0.83
10	33.7	729.1	-123.5	34.1	-5.77	32.1	16.2	0.79
11	37.1	734.0	-138.5	34.3	-6.47	31.0	16.0	0.75
12	40.4	734.7	-134.7	34.3	-6.29	28.2	15.7	0.71
13	43.8	756.5	-133.1	35.3	-6.22	27.0	15.4	0.67
14	47.2	762.8	-119.6	35.6	-5.59	24.4	15.0	0.63
15	50.5	765.4	-120.4	35.8	-5.63	23.0	14.7	0.58
16	53.9	782.7	-105.3	36.6	-4.92	19.6	14.4	0.53
17	57.3	794.8	-104.2	37.1	-4.87	18.2	14.1	0.49
18	60.7	802.8	-90.4	37.5	-4.22	15.0	13.8	0.44
19	64.0	833.9	-88.5	39.0	-4.14	13.2	13.5	0.39
20	67.4	827.6	-72.3	38.7	-3.38	10.3	14.0	0.34
21	70.8	819.2	-75.6	38.3	-3.53	8.6	14.7	0.28
22	74.1	859.8	-63.2	40.2	-2.95	6.0	14.5	0.23
23	77.5	892.4	-64.1	41.7	-3.00	3.9	10.3	0.18
Absolute	77.5			41.7			(T =	40.7 ms)
	37.1				-6.47		(T =	56.7 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	1025.3	952.5	879.8	807.0	734.3					
RX	1072.0	1019.3	971.6	928.7	894.1	865.3	842.3	822.1	805.0	788.6
RU	1025.4	952.6	879.9	807.2	734.4					

RAU = 624.3 (kips); RA2 = 918.2 (kips)

Current CAPWAP Ru = 868.0 (kips); Corresponding J(RP)= 0.43; J(RX) = 0.98

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
17.5	35.68	667.6	721.4	796.4	1.07	0.04	0.04	42.6	920.8	8333

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

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

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)

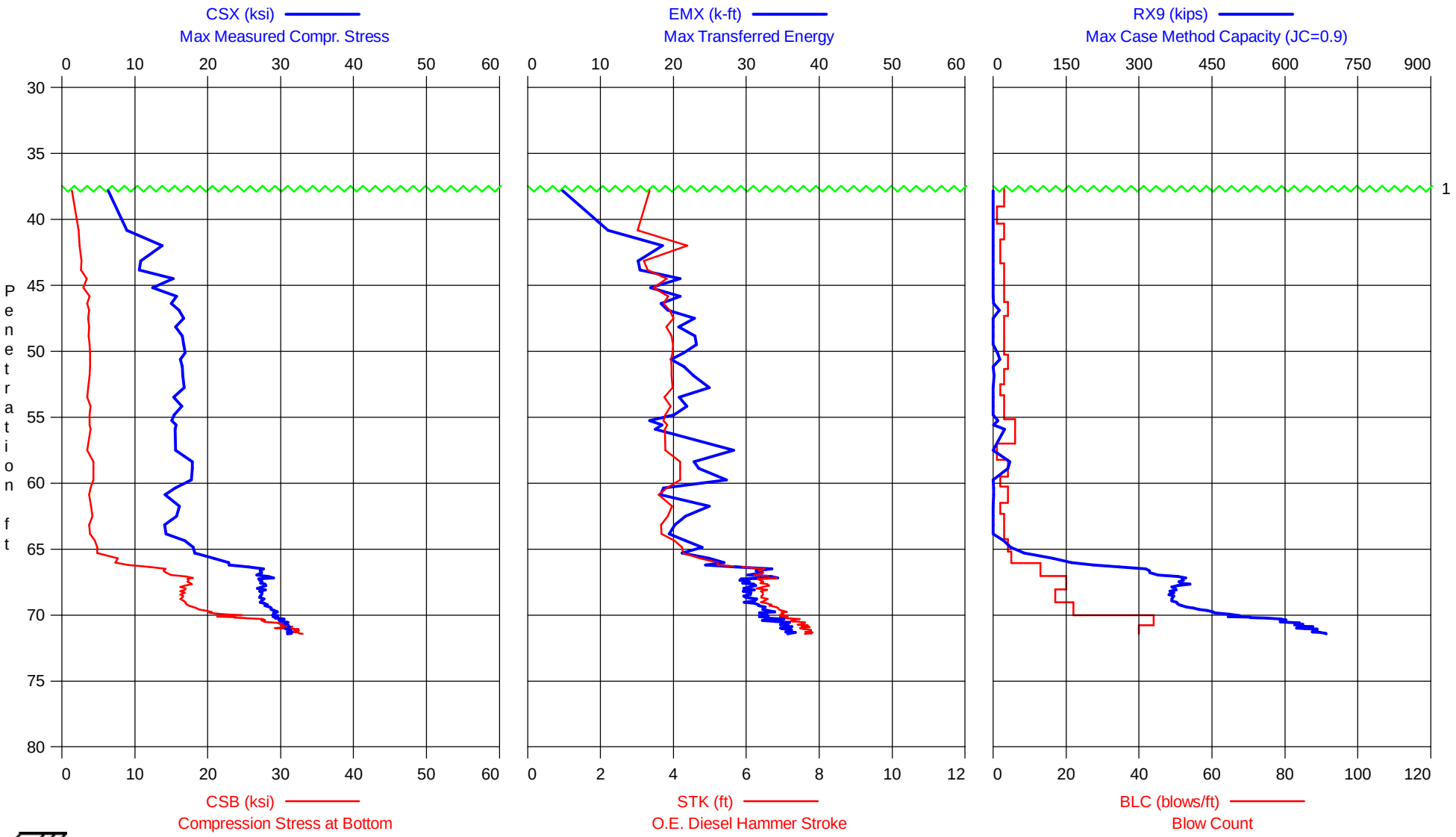
GRL Engineers, Inc. - Case Method & iCAP® Results

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

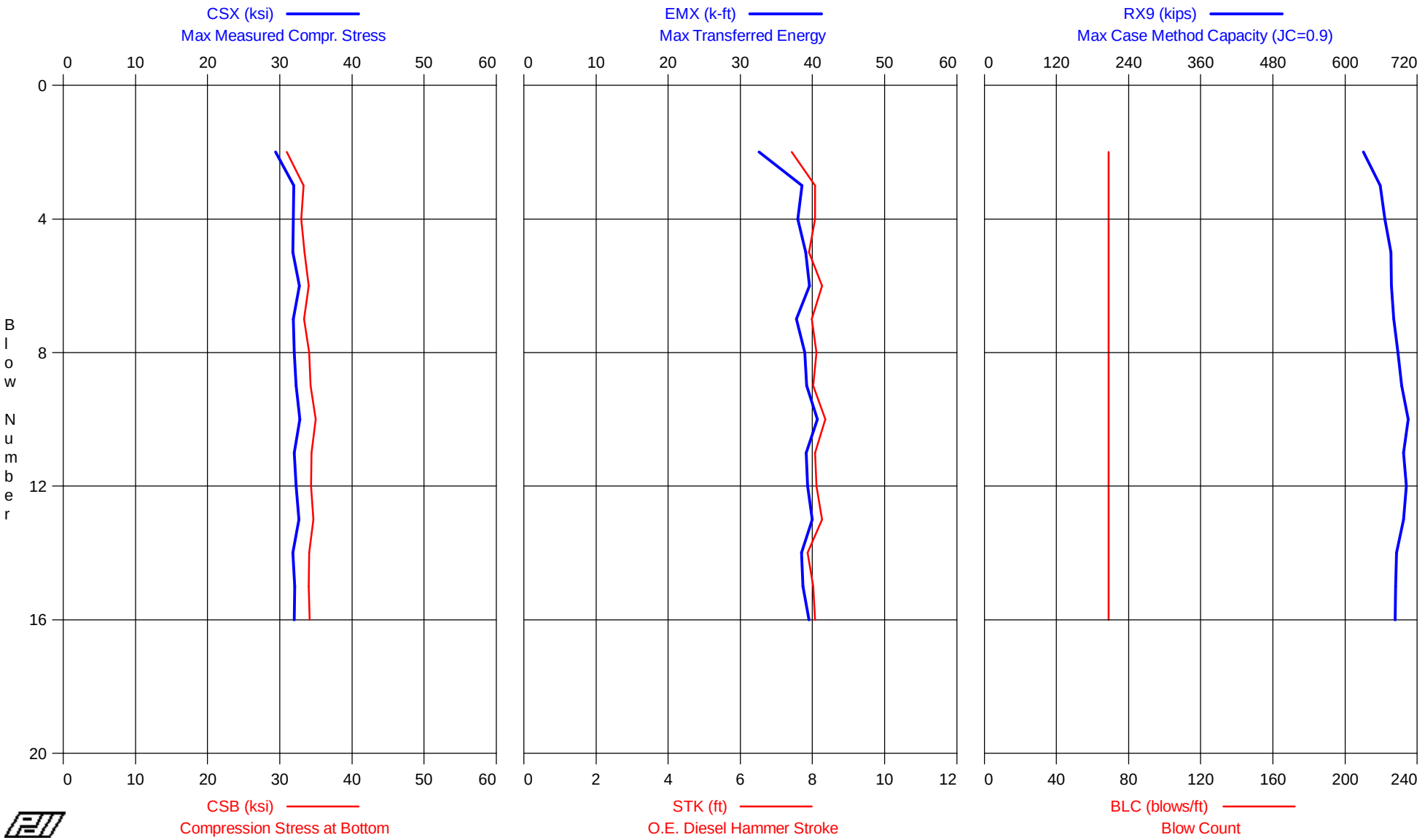
GRL Engineers, Inc. - Case Method & iCAP® Results

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

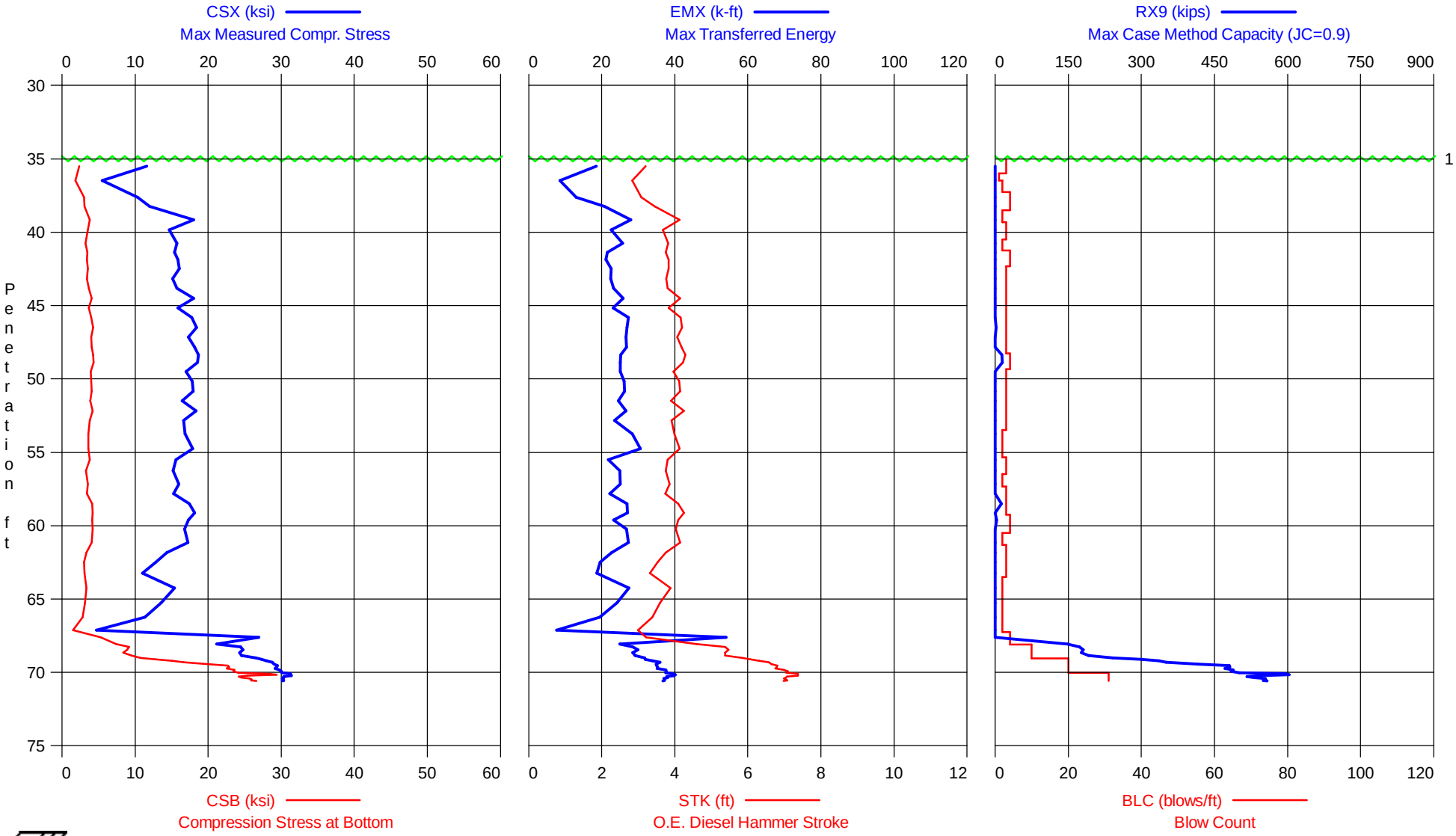
GRL Engineers, Inc. - Case Method & iCAP® Results

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
OP: AZ

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

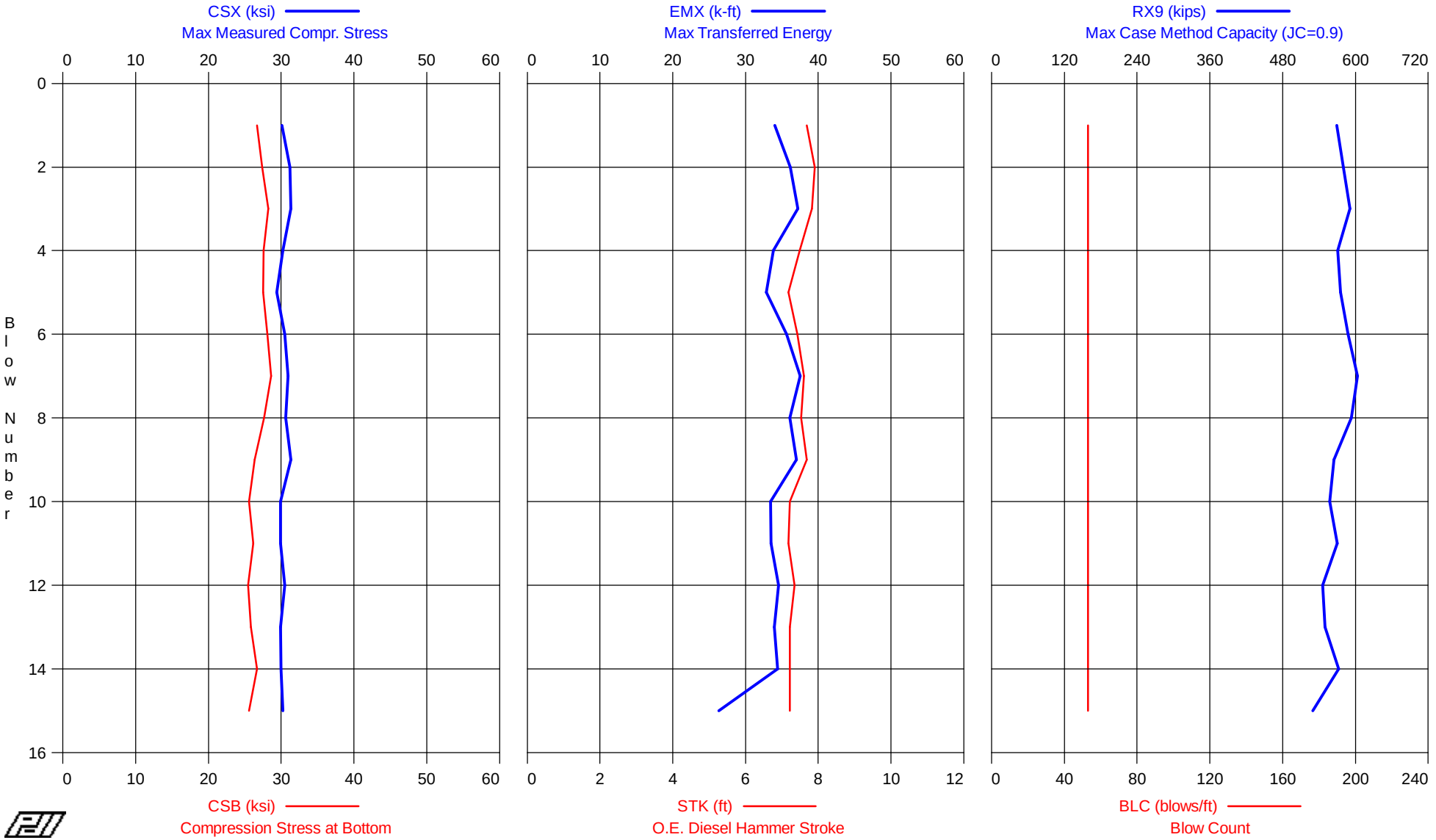
Drive 3 minutes 49 seconds 10:23:33 AM - 10:27:22 AM (12/9/2014) BN 1 - 146

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

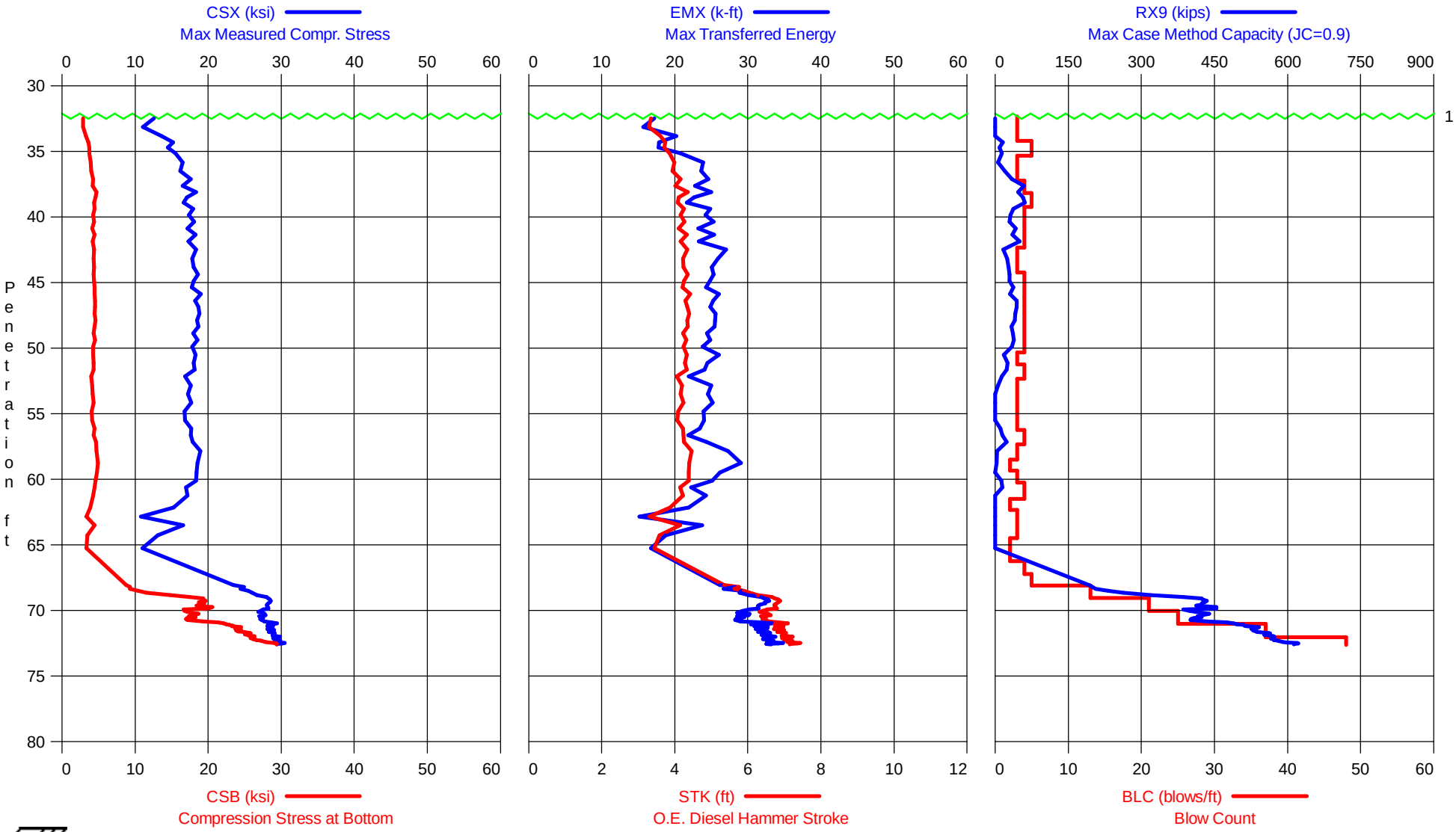
Drive 19 seconds 7:51:46 AM - 7:52:05 AM (12/10/2014) BN 1 - 15

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

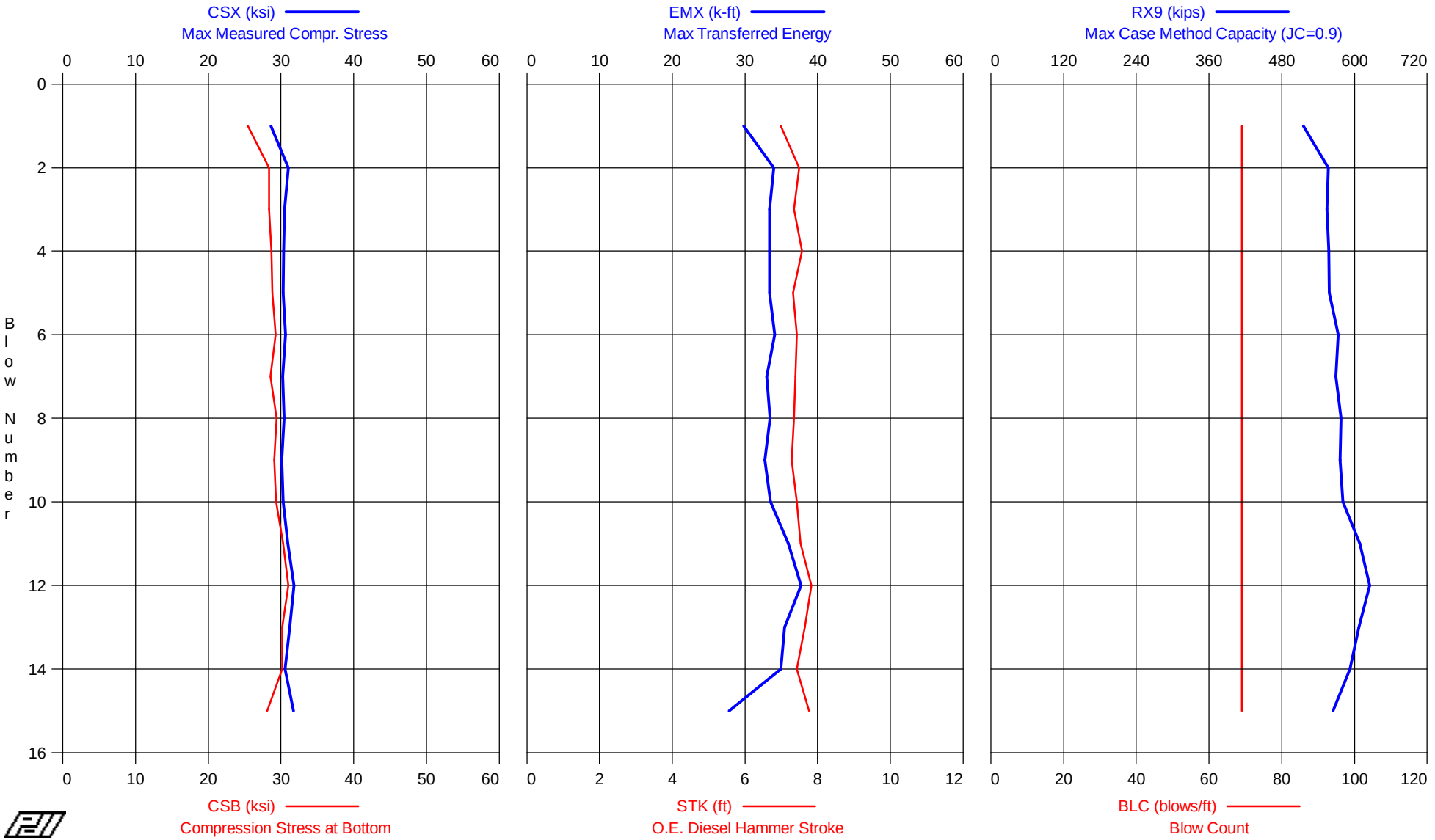
Drive	5 minutes 36 seconds	10:42:26 AM - 10:48:02 AM (12/9/2014) BN 1 - 256

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

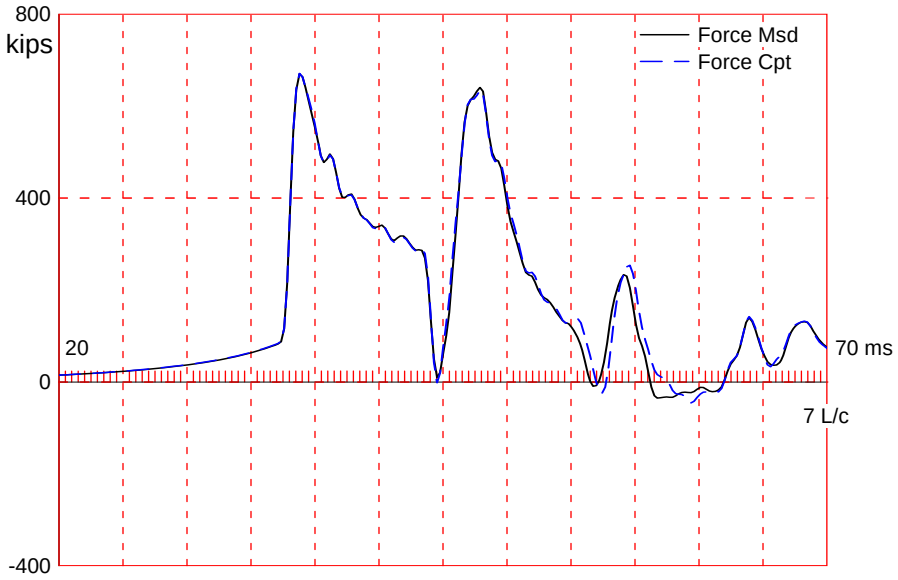
STK: O.E. Diesel Hammer Stroke
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

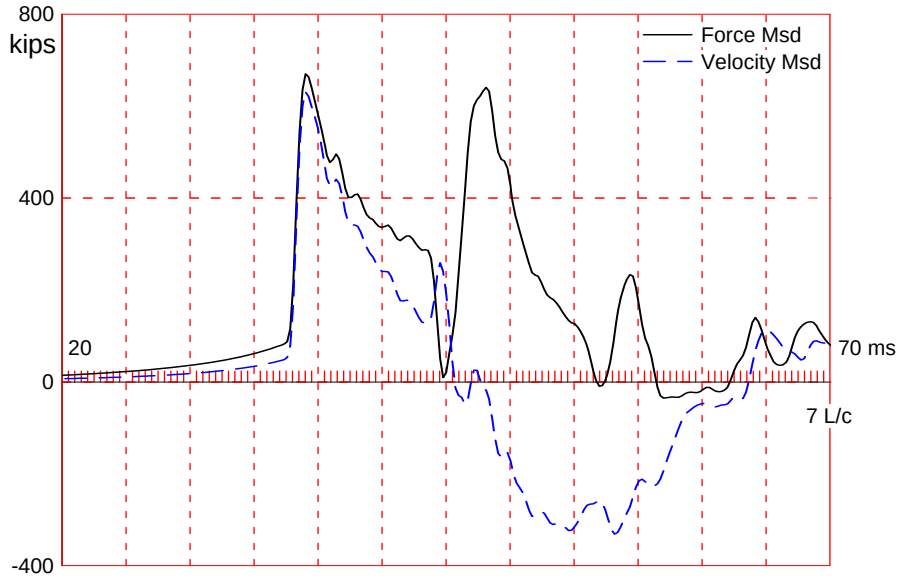
BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
5	72.70	69	AV5	30.1	27.9	33	7.3	43.5	549
			STD	0.8	1.2	1	0.2	0.6	16
			MAX	31.0	28.8	34	7.6	44.6	558
			MIN	28.6	25.5	30	7.0	42.9	516
10	72.78	69	AV5	30.3	29.1	33	7.4	43.4	575
			STD	0.2	0.3	0	0.1	0.2	4
			MAX	30.6	29.4	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

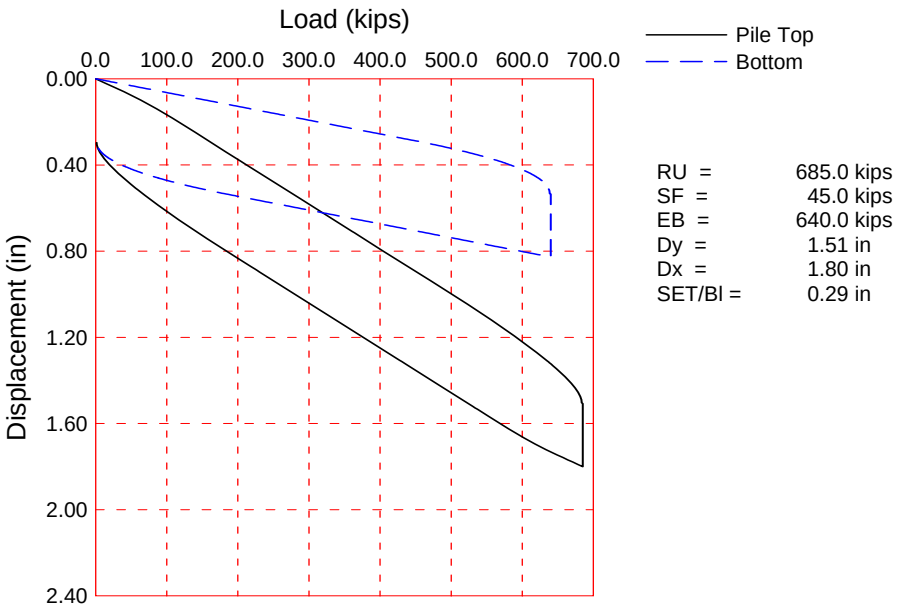
Total number of blows analyzed: 15

Time Summary

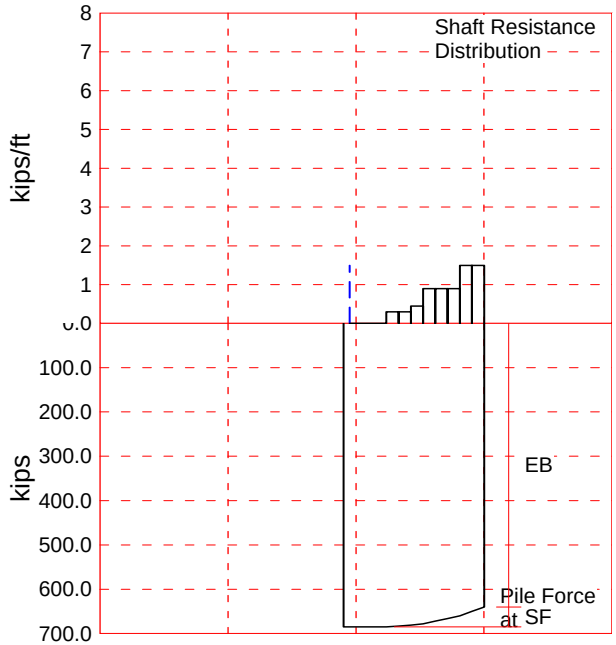
Drive 19 seconds 7:58:45 AM - 7:59:04 AM (12/10/2014) BN 1 - 15







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

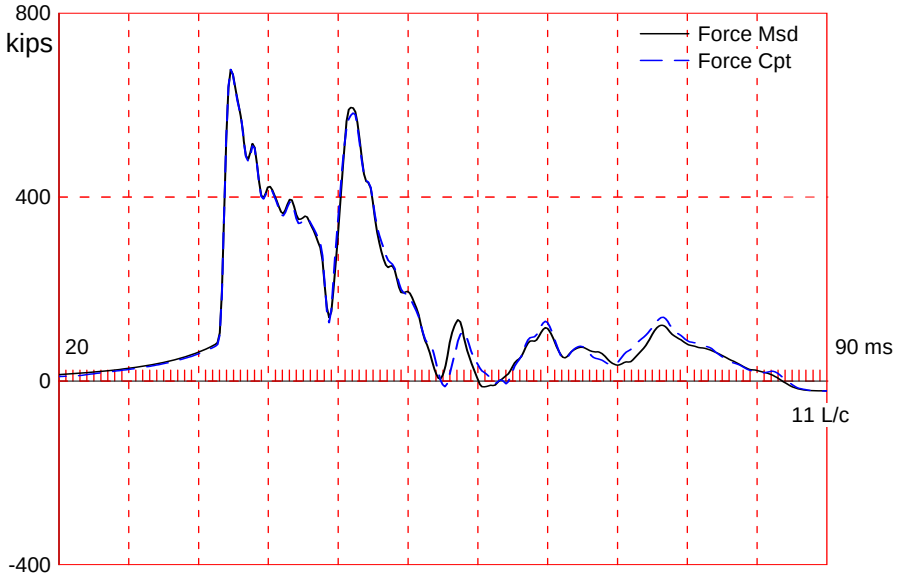
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.0	21.4	29992.2	492.000	4.70

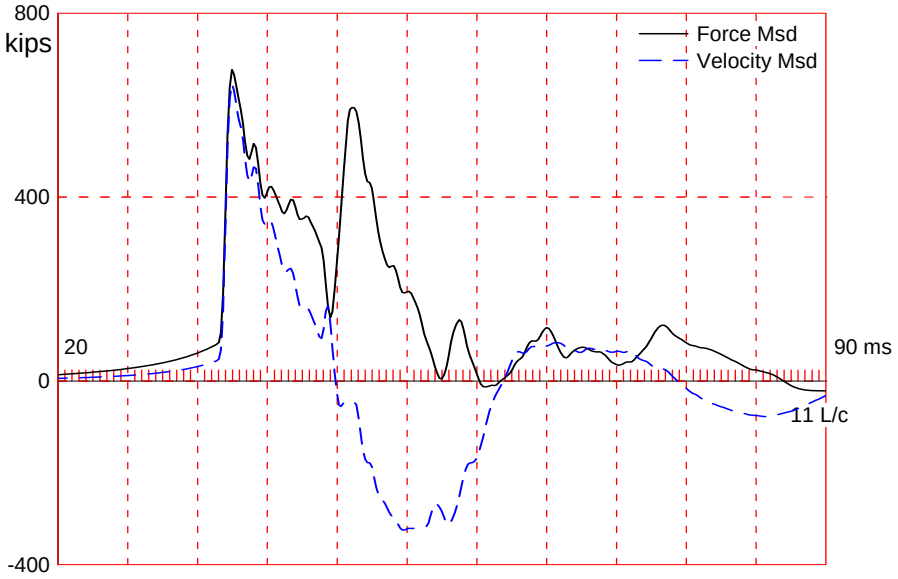
Toe Area 198.5 in^2

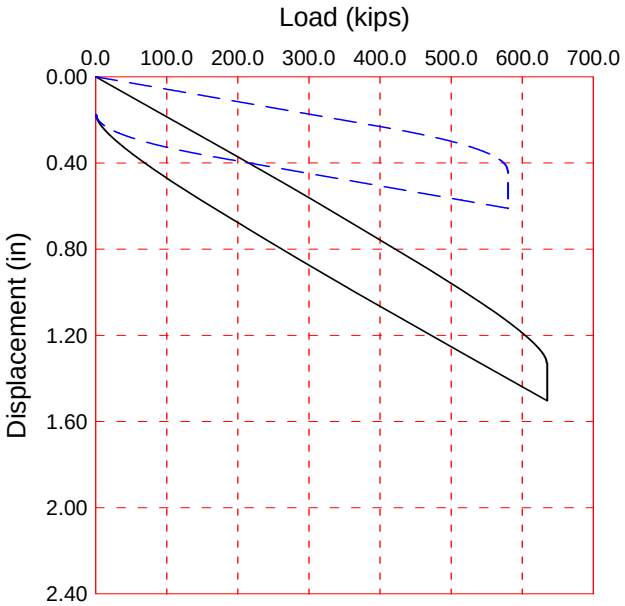
Top Segment Length 3.35 ft, Top Impedance 38 kips/ft/s

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

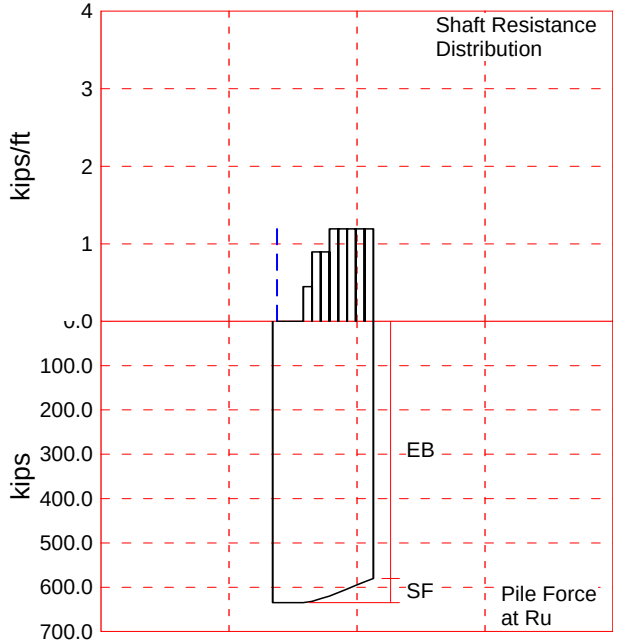
Total volume: 11.443 ft^3; Volume ratio considering added impedance: 1.000







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

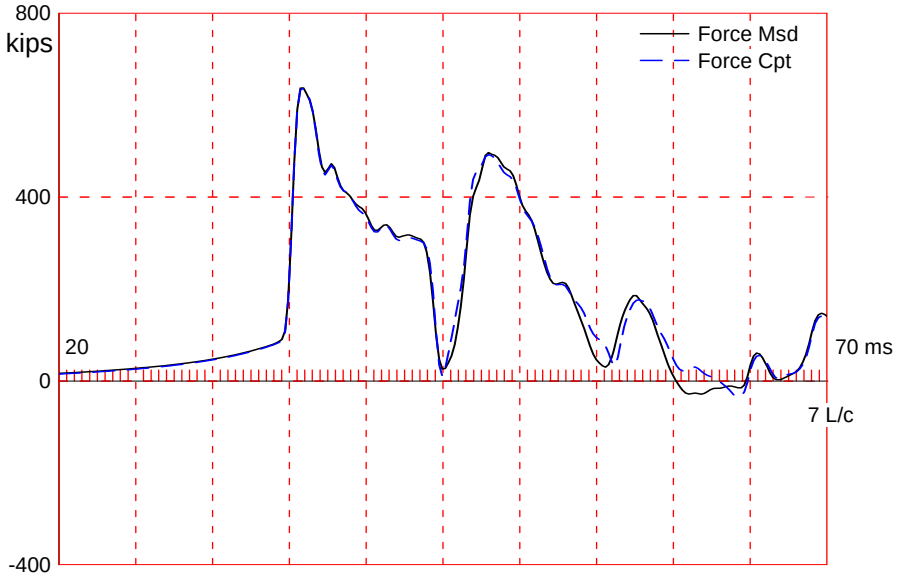
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.0	21.4	29992.2	492.000	4.70

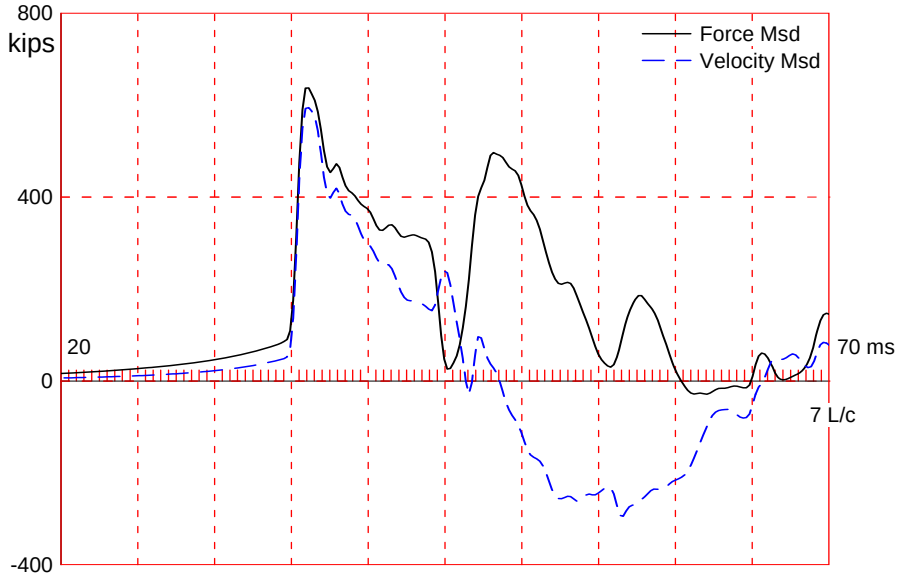
Toe Area 198.5 in^2

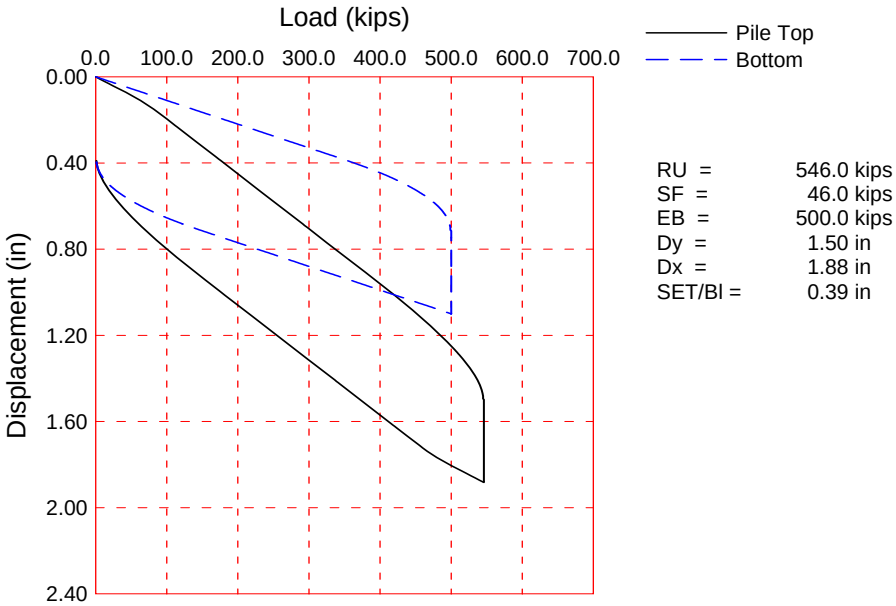
Top Segment Length 3.35 ft, Top Impedance 38 kips/ft/s

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

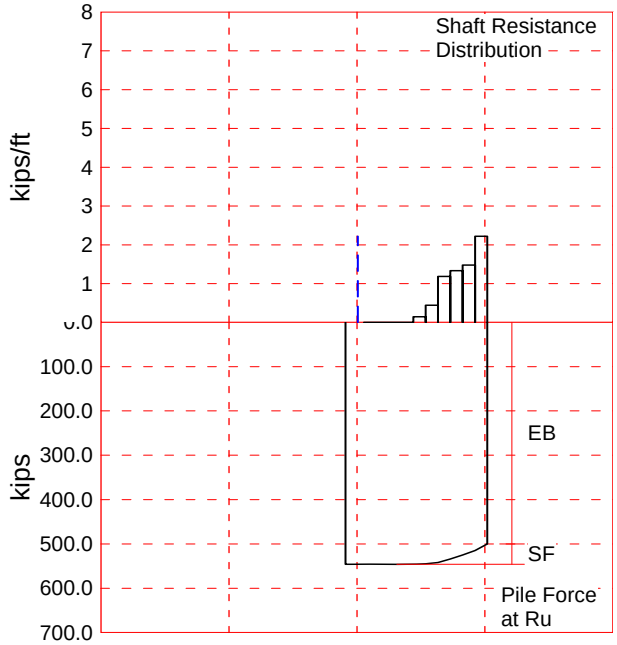
Total volume: 11.443 ft^3; Volume ratio considering added impedance: 1.000







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

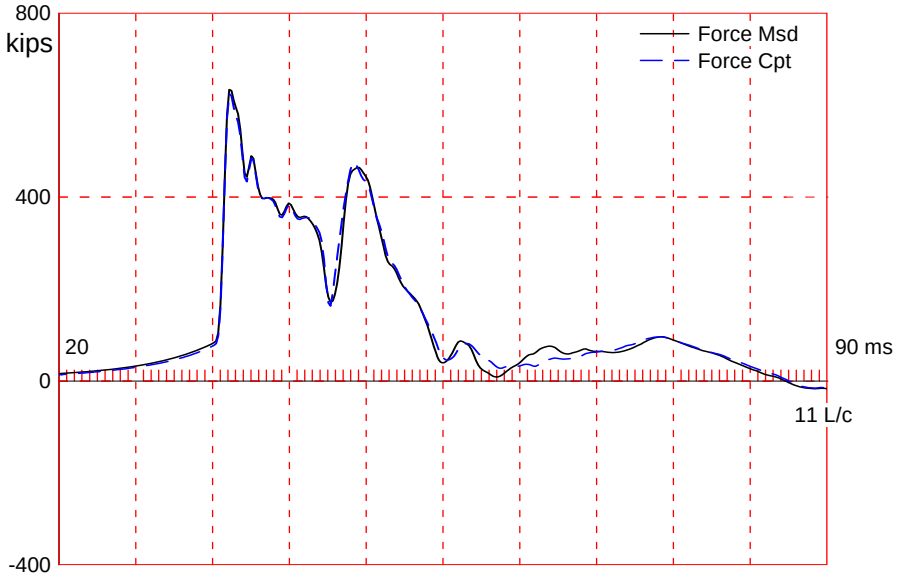
PILE PROFILE AND PILE MODEL

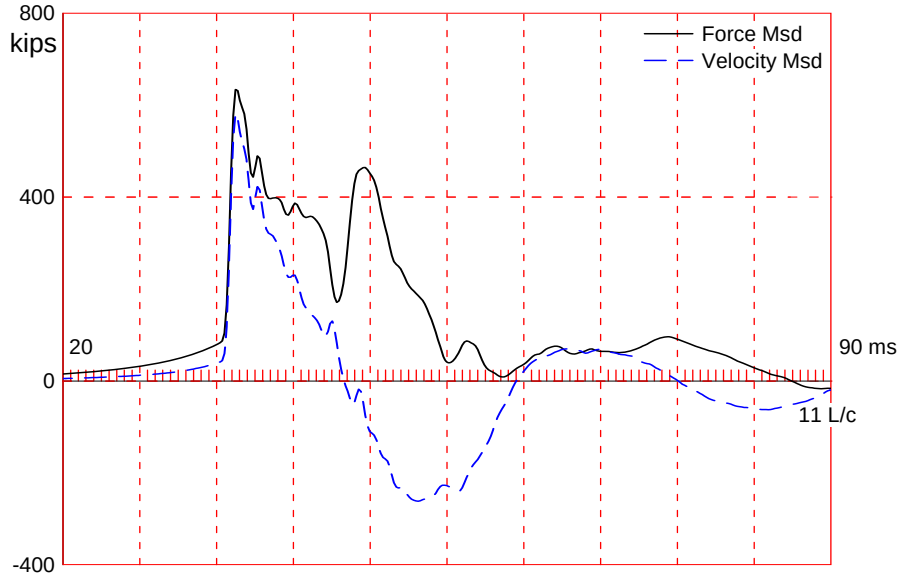
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.6	21.4	29992.2	492.000	4.70

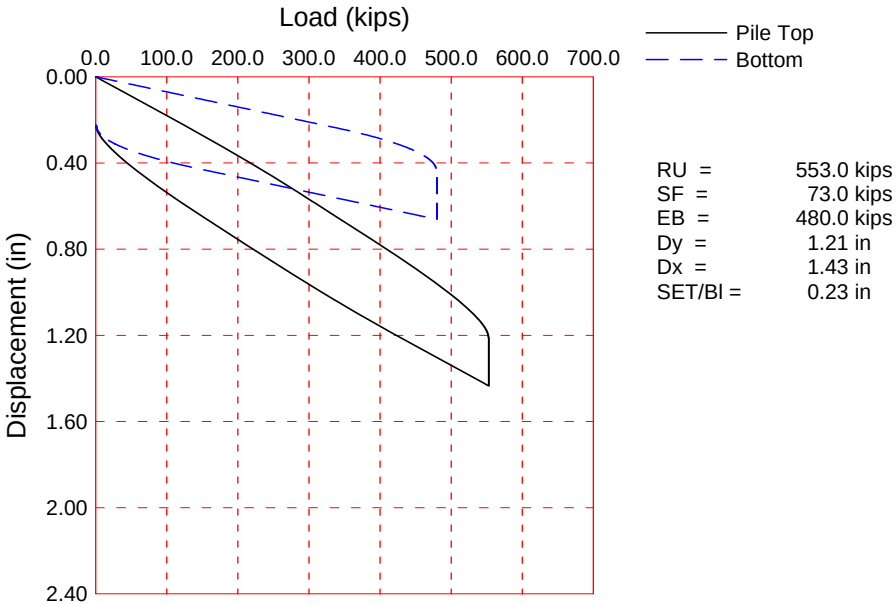
Toe Area 198.5 in^2

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

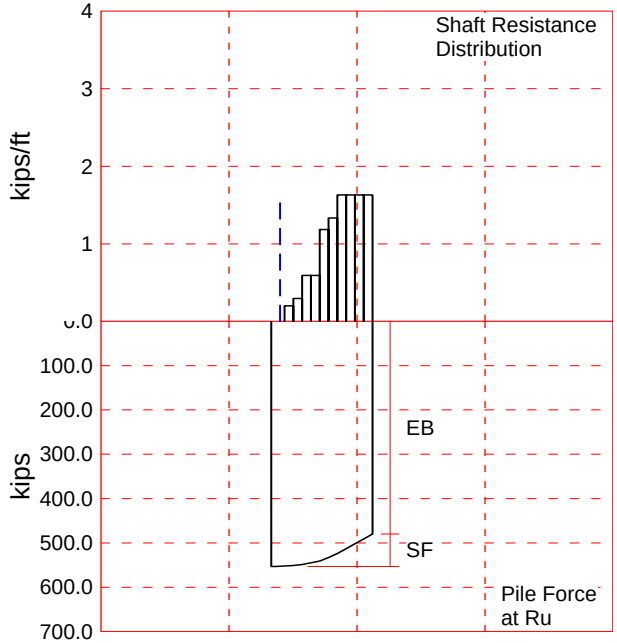
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 9.2 ms
Total volume: 11.529 ft^3; Volume ratio considering added impedance: 1.000







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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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

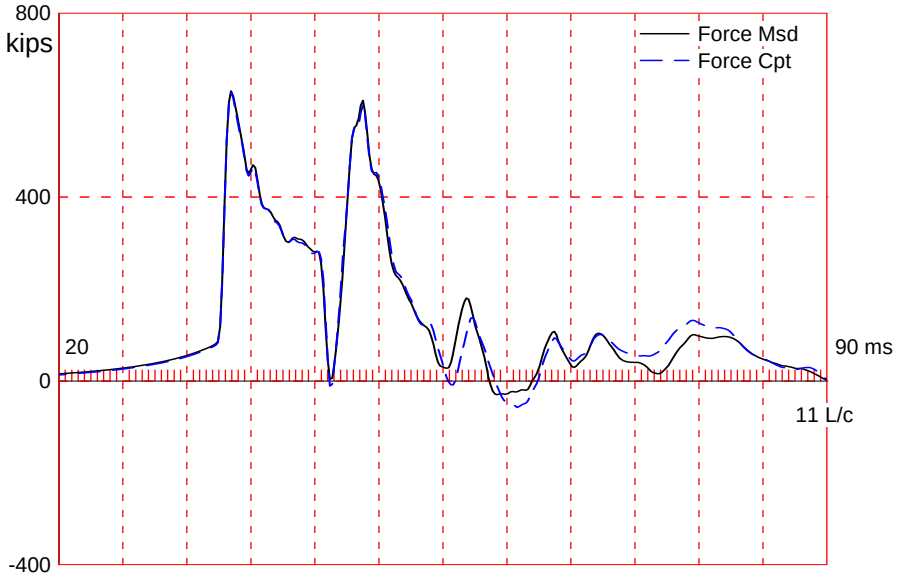
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.6	21.4	29992.2	492.000	4.70

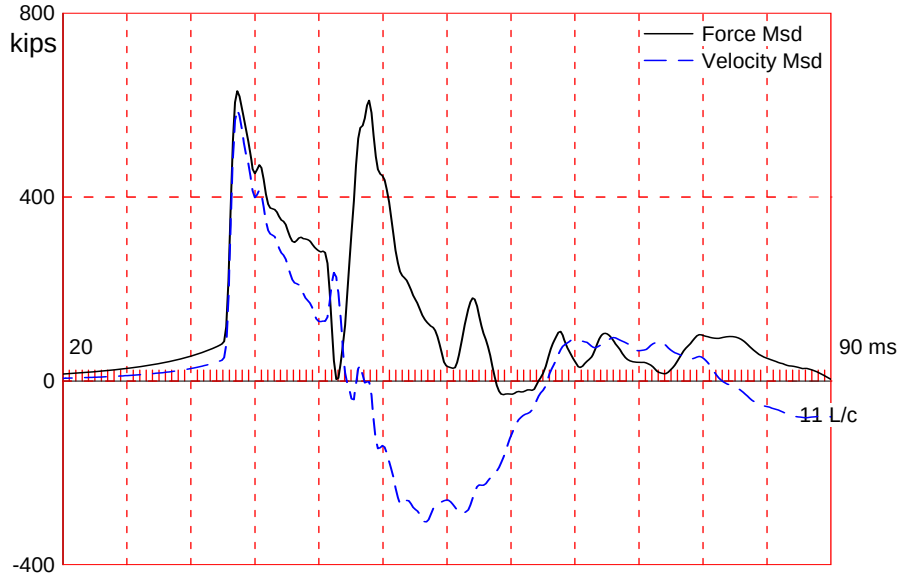
Toe Area 198.5 in^2

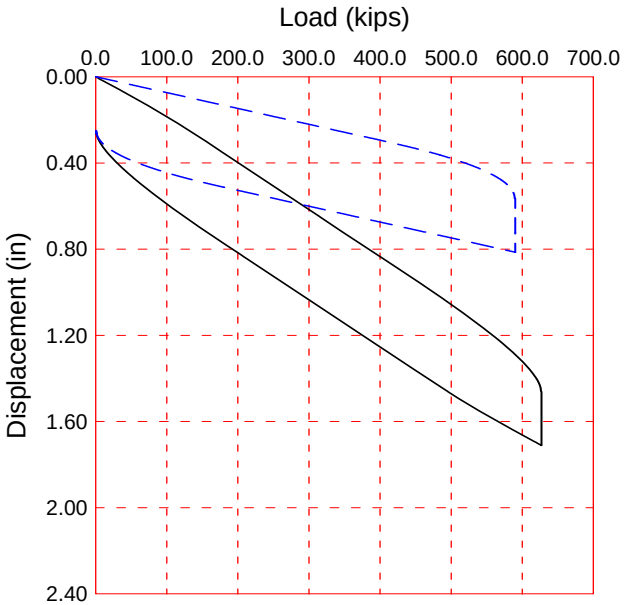
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

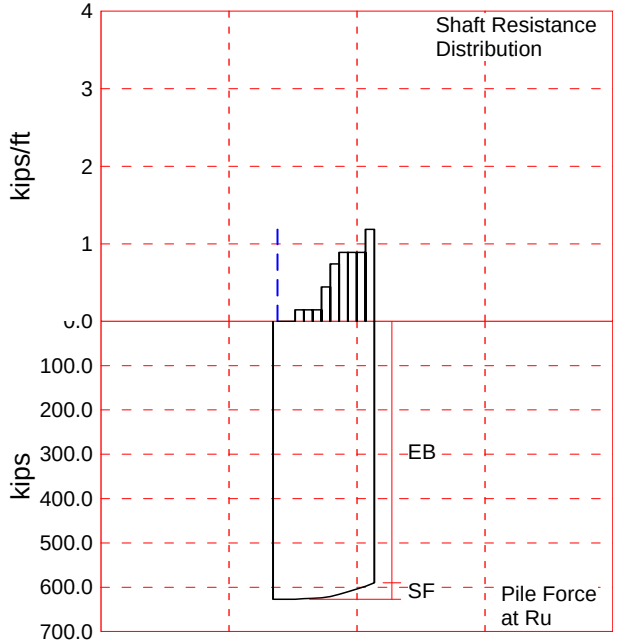
Total volume: 11.529 ft^3; Volume ratio considering added impedance: 1.000







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

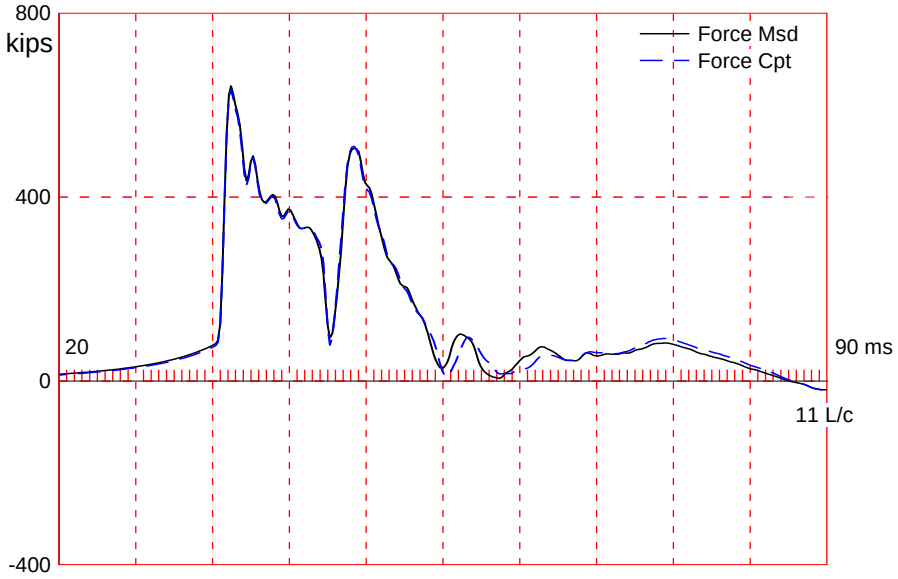
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

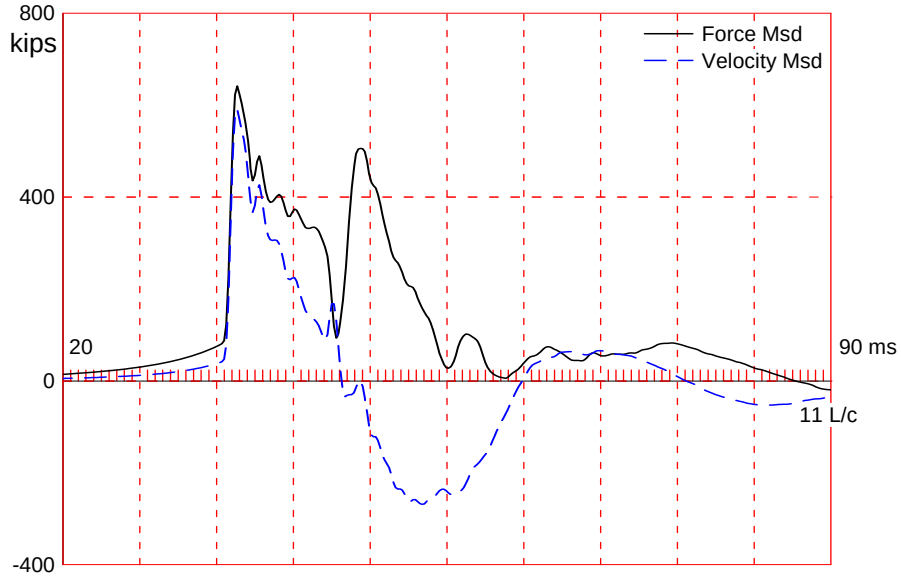
Toe Area 198.5 in^2

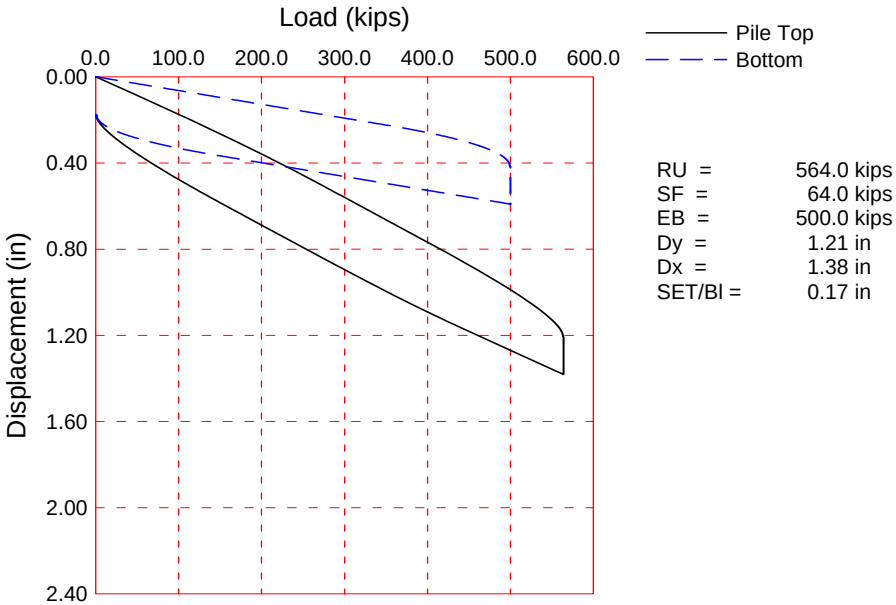
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

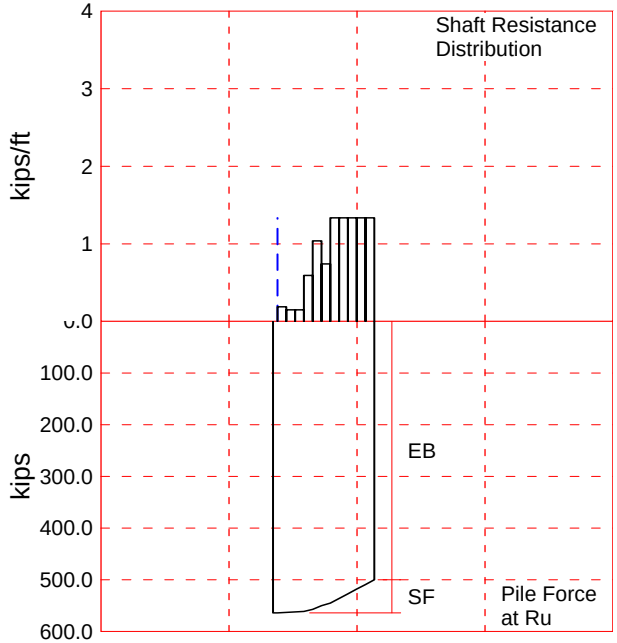
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







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 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: 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

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Travis Coleman
Company: Lunda Construction Co.	No. of Sheets: 47
E-mail: kweber@lundaconstruction.com	Date: February 26, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 4
Winnebago County, Wisconsin

On February 24, 2015, Pier 4 #1, Pier 4 #36, and Pier 4 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on February 25. 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 cofferdam reference grade was reported to be EL 741.1 for Pier 4 #1 and EL 741.2 for Pier 4 #36 and Pier 4 #44. It was reported to GRL that the mud line was at EL 718.1. 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) that was reported to be operated on fuel setting 4.

Pier 4 #1 was driven to a depth of 86.2 feet, which corresponds to a pile tip elevation of EL 654.9. The blow count over the final increment of driving was 10 blows for 1⅜ inches of penetration at an average hammer stroke of 6.9 feet. The blow count at the beginning of restrike was 10 blows for ⅝ inch of penetration at an average hammer stroke of 7.2 feet.

Pier 4 #36 was driven to a depth of 83.8 feet, which corresponds to a pile tip elevation of EL 657.4. The blow count over the final increment of driving was 10 blows for 2⅞ inches of penetration at an average hammer stroke of 6.2 feet. The blow count at the beginning of restrike was 10 blows for 1⅝ inch of penetration at an average hammer stroke of 6.8 feet.

Pier 4 #44 was driven to a depth of 87.9 feet, which corresponds to a pile tip elevation of EL 653.3. The blow count over the final increment of driving was 10 blows for 1⅜ inches of penetration at an average hammer stroke of 7.4 feet. The blow count at the beginning of restrike was 10 blows for ⅞ inch of penetration at an average hammer stroke of 7.8 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 4 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)
6.0	9	4
6.5	7	4
7.0	6	4
7.5	5	3
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.

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.

Travis Coleman, P.E.

Mark Rawlings

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

Attachments:

Dynamic Test Results - (pages 3 – 26)
CAPWAP Analysis Results - (pages 27 – 47)

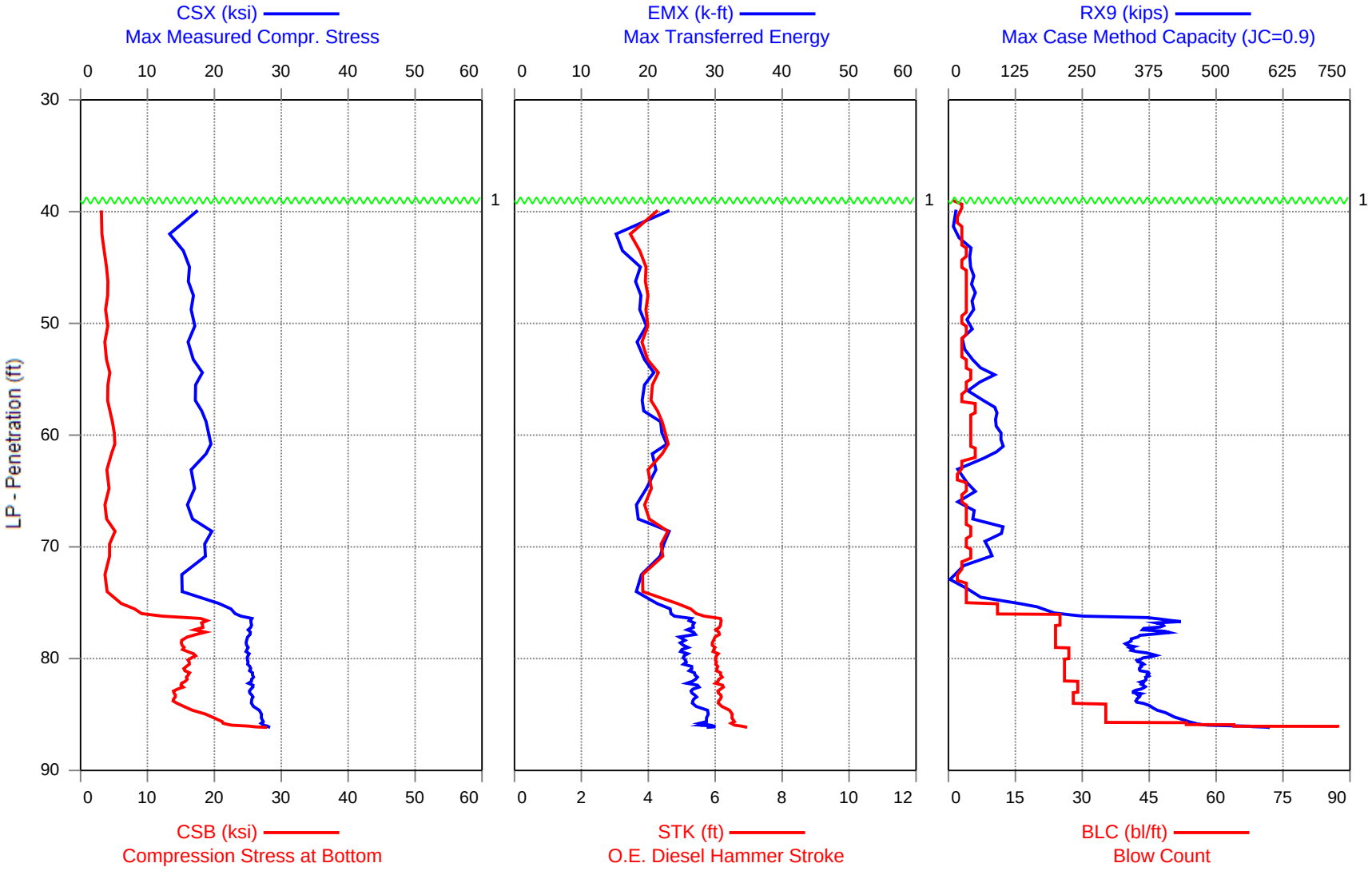
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 25-February-2015

Test started: 24-February-2015

USH 10 over Little Lake Butte des Morts - PIER 4 #1

APE D30-42, HP 14 x 73



1 - Reported reference at El. 741.1

2 - Mud line at El. 718.1

USH 10 over Little Lake Butte des Morts - PIER 4 #1 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.50 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
5	39.00	1	AV1	24.4	4.0	41	5.7	49.3	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	24.4	4.0	41	5.7	49.3	0
			MIN	24.4	4.0	41	5.7	49.3	0
6	39.33	3	AV1	18.0	3.5	20	4.2	57.0	29
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	18.0	3.5	20	4.2	57.0	29
			MIN	18.0	3.5	20	4.2	57.0	29
7	39.67	3	AV1	7.7	1.6	5	2.7	69.3	4
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	7.7	1.6	5	2.7	69.3	4
			MIN	7.7	1.6	5	2.7	69.3	4
9	40.50	2	AV1	22.0	3.7	32	5.2	51.5	10
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	22.0	3.7	32	5.2	51.5	10
			MIN	22.0	3.7	32	5.2	51.5	10
10	41.00	2	AV1	15.4	2.8	17	3.7	60.1	16
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	15.4	2.8	17	3.7	60.1	16
			MIN	15.4	2.8	17	3.7	60.1	16
13	42.00	3	AV3	12.3	3.0	14	3.3	63.6	5
			STD	1.0	0.2	2	0.1	1.2	1
			MAX	13.7	3.3	16	3.5	64.6	6
			MIN	11.6	2.8	13	3.2	61.9	3
16	43.00	3	AV3	14.3	3.4	16	3.6	60.7	30
			STD	0.8	0.1	1	0.1	1.1	4
			MAX	15.1	3.5	18	3.8	62.2	33
			MIN	13.3	3.2	15	3.4	59.7	23
20	44.00	4	AV4	15.9	3.6	17	3.8	59.4	44
			STD	1.6	0.2	1	0.2	1.7	4
			MAX	18.1	4.0	18	4.2	61.8	50
			MIN	13.6	3.4	14	3.5	56.9	40
23	45.00	3	AV3	15.7	3.7	19	3.8	59.6	38
			STD	0.6	0.1	1	0.1	0.5	5
			MAX	16.4	3.8	20	3.9	59.9	44
			MIN	15.0	3.7	17	3.7	58.9	32
27	46.00	4	AV4	16.9	4.1	19	4.0	57.9	48
			STD	0.8	0.1	1	0.2	1.2	2
			MAX	17.7	4.3	20	4.3	59.7	49
			MIN	15.7	4.0	18	3.8	56.3	44
31	47.00	4	AV4	16.1	4.2	18	3.9	58.4	45
			STD	0.8	0.3	1	0.0	0.3	4
			MAX	17.0	4.5	20	4.0	58.9	50
			MIN	14.9	3.6	16	3.9	58.0	40
35	48.00	4	AV4	16.9	4.0	19	4.0	58.2	47

USH 10 over Little Lake Butte des Morts - PIER 4 #1 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.9	0.3	1	0.1	0.8	4
			MAX	17.8	4.5	20	4.1	59.3	51
			MIN	15.8	3.7	17	3.8	57.3	43
39	49.00	4	AV4	16.9	3.8	19	4.0	58.1	47
			STD	0.3	0.1	1	0.1	0.6	2
			MAX	17.3	4.0	20	4.1	58.9	50
			MIN	16.5	3.6	18	3.9	57.2	45
42	50.00	3	AV3	16.8	3.8	20	3.9	58.5	35
			STD	1.2	0.3	2	0.2	1.3	2
			MAX	17.8	4.2	22	4.1	60.3	36
			MIN	15.2	3.4	18	3.7	57.3	31
46	51.00	4	AV4	16.6	4.0	18	3.9	58.7	43
			STD	0.3	0.2	1	0.1	0.4	3
			MAX	16.9	4.3	19	4.0	59.2	46
			MIN	16.1	3.7	18	3.8	58.2	40
49	52.00	3	AV3	16.1	3.7	19	3.8	59.3	24
			STD	0.4	0.1	0	0.1	0.8	10
			MAX	16.7	3.8	19	4.0	60.0	33
			MIN	15.8	3.5	18	3.7	58.2	9
52	53.00	3	AV3	16.7	3.7	20	3.9	58.4	33
			STD	0.7	0.2	2	0.1	1.0	6
			MAX	17.6	4.1	22	4.1	59.7	39
			MIN	15.9	3.5	18	3.8	57.4	24
56	54.00	4	AV4	16.7	4.0	18	3.9	58.4	51
			STD	0.6	0.1	1	0.1	0.6	3
			MAX	17.7	4.1	19	4.1	59.0	54
			MIN	16.1	3.8	18	3.9	57.5	47
61	55.00	5	AV5	18.8	4.6	21	4.4	55.5	81
			STD	0.5	0.3	1	0.1	0.8	6
			MAX	19.2	5.1	22	4.5	57.0	88
			MIN	18.0	4.1	20	4.2	54.9	73
65	56.00	4	AV4	16.7	3.8	19	4.0	57.9	47
			STD	0.9	0.3	2	0.2	1.2	6
			MAX	17.9	4.2	22	4.3	59.3	53
			MIN	15.9	3.5	17	3.8	56.3	37
68	57.00	3	AV3	16.0	3.9	19	3.8	59.1	46
			STD	0.5	0.1	1	0.1	0.4	16
			MAX	16.6	4.0	20	3.9	59.4	58
			MIN	15.5	3.9	17	3.8	58.5	24
74	58.00	6	AV6	18.5	4.3	20	4.3	55.8	88
			STD	0.8	0.1	1	0.2	1.0	4
			MAX	19.6	4.4	21	4.5	57.3	96
			MIN	17.3	4.0	18	4.1	54.7	86
79	59.00	5	AV5	18.4	4.7	21	4.3	55.8	87
			STD	0.6	0.2	1	0.1	0.7	3
			MAX	18.9	4.9	22	4.5	57.0	89
			MIN	17.4	4.5	19	4.2	55.1	82
84	60.00	5	AV5	19.2	5.0	22	4.5	54.8	96
			STD	0.3	0.2	0	0.1	0.4	4
			MAX	19.7	5.2	23	4.6	55.4	102
			MIN	18.7	4.7	21	4.4	54.3	93

USH 10 over Little Lake Butte des Morts - PIER 4 #1 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
89	61.00	5	AV5	19.5	5.2	23	4.6	54.4	101
			STD	0.7	0.2	1	0.1	0.7	4
			MAX	20.5	5.6	25	4.8	55.1	106
			MIN	18.7	5.1	22	4.5	53.3	96
95	62.00	6	AV6	18.8	4.6	21	4.4	55.4	87
			STD	0.5	0.3	1	0.1	0.6	9
			MAX	19.8	5.1	22	4.6	56.0	97
			MIN	18.1	4.2	20	4.3	54.2	70
98	63.00	3	AV3	16.9	4.1	21	4.1	57.4	32
			STD	0.5	0.2	1	0.1	0.6	11
			MAX	17.6	4.4	22	4.2	57.9	44
			MIN	16.6	3.9	21	4.0	56.5	17
100	64.00	2	AV2	15.9	3.7	21	3.8	59.2	0
			STD	0.6	0.1	1	0.1	0.9	0
			MAX	16.6	3.8	22	4.0	60.1	0
			MIN	15.3	3.6	20	3.7	58.3	0
104	65.00	4	AV4	16.9	4.3	19	4.1	57.7	54
			STD	1.8	0.4	3	0.4	2.5	3
			MAX	19.1	4.8	23	4.6	60.5	56
			MIN	15.1	3.7	16	3.7	54.4	49
107	66.00	3	AV3	16.9	4.0	20	4.0	57.8	20
			STD	0.7	0.3	1	0.1	0.7	16
			MAX	17.8	4.3	21	4.2	58.5	40
			MIN	16.3	3.7	20	3.9	56.8	0
111	67.00	4	AV4	16.1	3.7	18	3.9	58.7	44
			STD	0.8	0.2	1	0.2	1.1	7
			MAX	17.2	3.9	19	4.1	60.0	52
			MIN	15.0	3.5	16	3.7	57.3	33
115	68.00	4	AV4	16.6	3.9	18	4.0	58.0	57
			STD	0.7	0.3	1	0.2	1.1	21
			MAX	17.7	4.4	20	4.2	59.7	89
			MIN	15.9	3.7	17	3.8	56.7	33
120	69.00	5	AV5	19.6	5.2	23	4.6	54.5	103
			STD	0.6	0.3	1	0.1	0.7	6
			MAX	20.4	5.5	24	4.7	55.4	110
			MIN	18.7	4.6	22	4.4	53.6	93
124	70.00	4	AV4	18.6	4.3	22	4.4	55.6	67
			STD	0.2	0.2	0	0.1	0.5	4
			MAX	18.9	4.5	23	4.5	56.3	73
			MIN	18.3	4.1	22	4.3	55.1	63
129	71.00	5	AV5	18.7	4.4	22	4.4	55.3	82
			STD	0.5	0.2	0	0.1	0.5	3
			MAX	19.4	4.6	22	4.5	55.9	86
			MIN	18.1	4.1	21	4.3	54.7	77
132	72.00	3	AV3	16.5	3.8	20	4.0	57.8	29
			STD	1.5	0.2	2	0.3	1.7	16
			MAX	18.4	4.0	22	4.4	59.9	51
			MIN	14.7	3.6	18	3.7	55.7	15
134	73.00	2	AV2	15.4	3.7	20	3.9	58.9	0
			STD	0.4	0.1	0	0.1	0.4	0

USH 10 over Little Lake Butte des Morts - PIER 4 #1 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	15.8	3.7	21	3.9	59.3	0
			MIN	15.0	3.6	20	3.8	58.5	0
138	74.00	4	AV4	14.5	3.6	17	3.8	59.8	29
			STD	0.8	0.0	1	0.1	0.9	14
			MAX	15.7	3.6	18	3.9	60.7	43
			MIN	13.7	3.6	16	3.6	58.8	9
142	75.00	4	AV4	17.4	4.9	20	4.2	57.0	76
			STD	2.2	0.6	3	0.5	2.8	47
			MAX	21.2	5.4	25	5.0	59.0	122
			MIN	15.5	3.8	16	3.9	52.2	0
153	76.00	11	AV11	22.5	7.9	23	5.3	51.0	174
			STD	0.6	1.0	1	0.1	0.7	21
			MAX	23.3	8.9	24	5.5	52.0	200
			MIN	21.7	5.9	21	5.1	50.0	133
178	77.00	25	AV25	25.0	16.4	26	6.0	48.0	361
			STD	0.9	3.4	2	0.3	1.1	71
			MAX	26.2	20.3	28	6.3	50.3	450
			MIN	23.1	9.0	22	5.4	46.7	221
226	79.00	24	AV45	25.1	16.6	26	6.0	47.8	364
			STD	0.4	1.6	1	0.1	0.4	29
			MAX	26.0	21.3	28	6.2	48.5	418
			MIN	24.4	14.4	19	5.9	47.1	325
253	80.00	27	AV27	24.9	16.3	25	6.0	47.9	363
			STD	0.3	0.8	1	0.1	0.3	18
			MAX	25.4	17.9	27	6.1	48.5	393
			MIN	24.3	15.0	24	5.9	47.4	336
279	81.00	26	AV26	25.1	15.9	26	6.0	47.8	358
			STD	0.3	0.4	1	0.1	0.3	5
			MAX	26.0	16.5	27	6.2	48.5	370
			MIN	24.4	15.3	25	5.9	47.2	348
305	82.00	26	AV26	25.6	16.0	27	6.1	47.4	370
			STD	0.3	0.3	1	0.1	0.3	7
			MAX	26.2	16.8	28	6.3	48.0	385
			MIN	25.1	15.5	26	6.0	46.9	355
334	83.00	29	AV29	25.4	14.8	27	6.1	47.5	359
			STD	0.4	0.6	1	0.1	0.4	8
			MAX	26.2	15.7	29	6.4	48.6	372
			MIN	24.4	13.6	24	5.8	46.5	340
362	84.00	28	AV28	25.6	14.1	27	6.1	47.4	354
			STD	0.3	0.3	0	0.1	0.3	5
			MAX	26.1	14.7	28	6.3	48.1	367
			MIN	25.0	13.4	26	6.0	46.9	343
387	85.71	35	AV25	26.7	18.1	28	6.4	46.4	408
			STD	0.6	2.2	1	0.1	0.5	26
			MAX	27.4	21.3	29	6.6	47.5	456
			MIN	25.6	14.6	27	6.1	45.7	366
397	85.90	53	AV10	27.1	21.6	28	6.5	46.1	462
			STD	0.2	0.4	1	0.1	0.2	7
			MAX	27.5	22.4	29	6.6	46.5	479
			MIN	26.7	21.0	27	6.4	45.8	455

USH 10 over Little Lake Butte des Morts - PIER 4 #1 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
407	86.05	64	AV10	27.5	23.6	29	6.7	45.6	510
			STD	0.5	1.4	1	0.1	0.5	33
			MAX	28.4	26.2	31	7.0	46.2	564
			MIN	26.9	22.1	27	6.5	44.6	470
417	86.17	87	AV10	28.2	26.8	29	6.9	44.8	585
			STD	0.3	1.0	2	0.1	0.2	18
			MAX	28.8	28.0	30	7.0	45.2	608
			MIN	27.8	25.5	24	6.8	44.4	554
			Average	22.7	12.4	24	5.5	50.8	268
			Std. Dev.	4.2	6.6	4	1.0	5.0	163
			Maximum	28.8	28.0	41	7.0	69.3	608
			Minimum	7.7	1.6	5	2.7	44.4	0

Total number of blows analyzed: 409

BL# Sensors

1-417 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.07); A4: [K2524] 360.0 (1.07)

BL# Comments

5 Reported reference at El. 741.1

Time Summary

Drive 10 minutes 38 seconds 11:43 AM - 11:54 AM BN 1 - 417

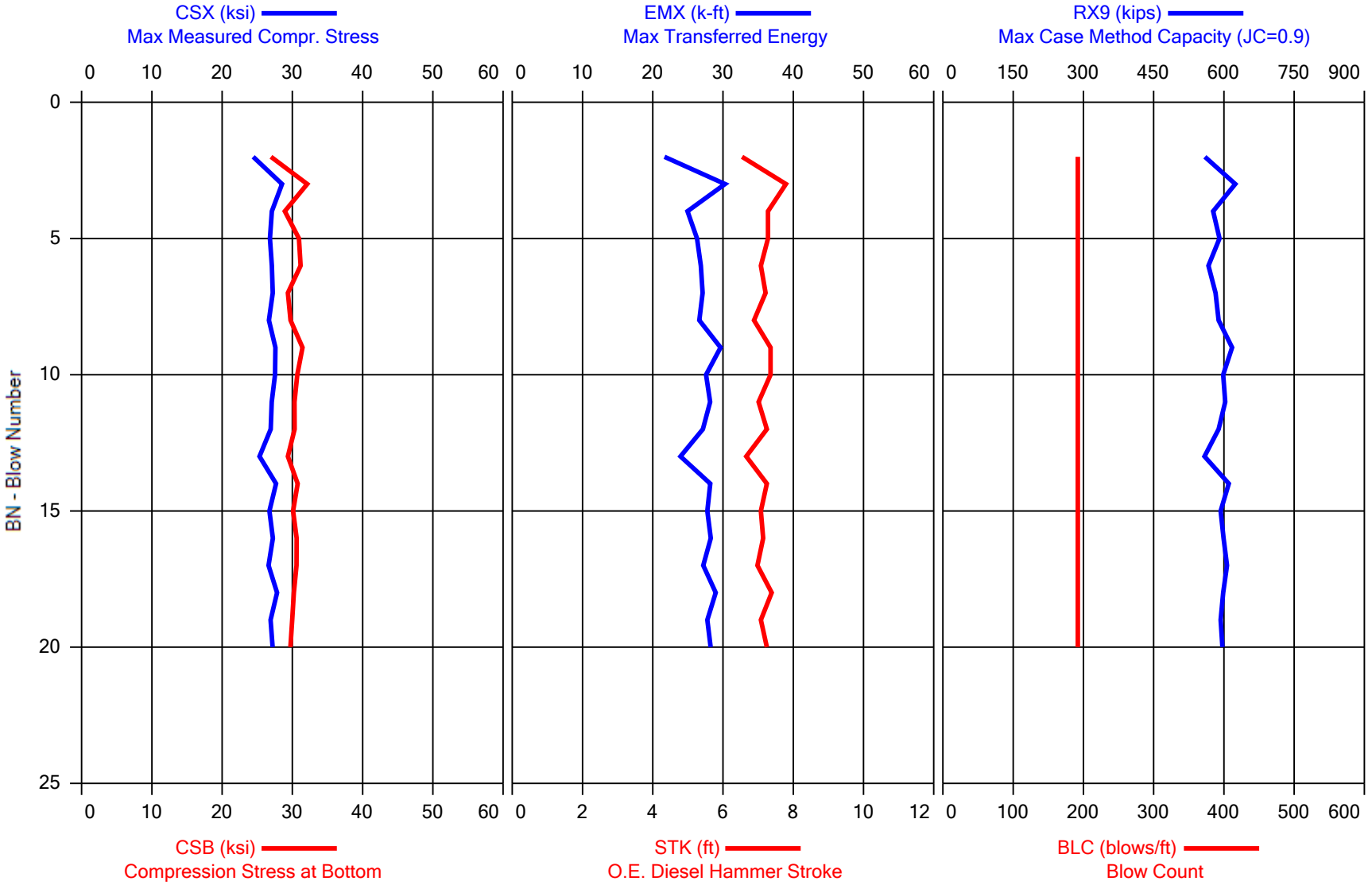
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 26-February-2015

Test started: 25-February-2015

USH 10 over Little Lake Butte des Morts - PIER 4 #1 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - PIER 4 #1 Restrike APE D30-42, HP 14 x 73
OP: TC Date: 25-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.50 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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
10	86.22	192	AV9	27.0	30.1	27	7.2	44.0	589
			STD	1.0	1.5	2	0.3	1.0	20
			MAX	28.5	32.1	30	7.8	46.0	624
			MIN	24.4	27.0	22	6.5	42.3	559
20	86.27	192	AV10	26.9	30.2	28	7.1	44.2	595
			STD	0.6	0.4	1	0.2	0.6	14
			MAX	27.8	30.8	29	7.4	45.6	610
			MIN	25.3	29.4	24	6.7	43.4	558
			Average	27.0	30.2	27	7.2	44.1	592
			Std. Dev.	0.9	1.1	2	0.3	0.8	17
			Maximum	28.5	32.1	30	7.8	46.0	624
			Minimum	24.4	27.0	22	6.5	42.3	558

Total number of blows analyzed: 19

BL# Sensors

1-20 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.09); A4: [K3550] 360.0 (1.09)

Time Summary

Drive 25 seconds 8:22 AM - 8:23 AM BN 1 - 20

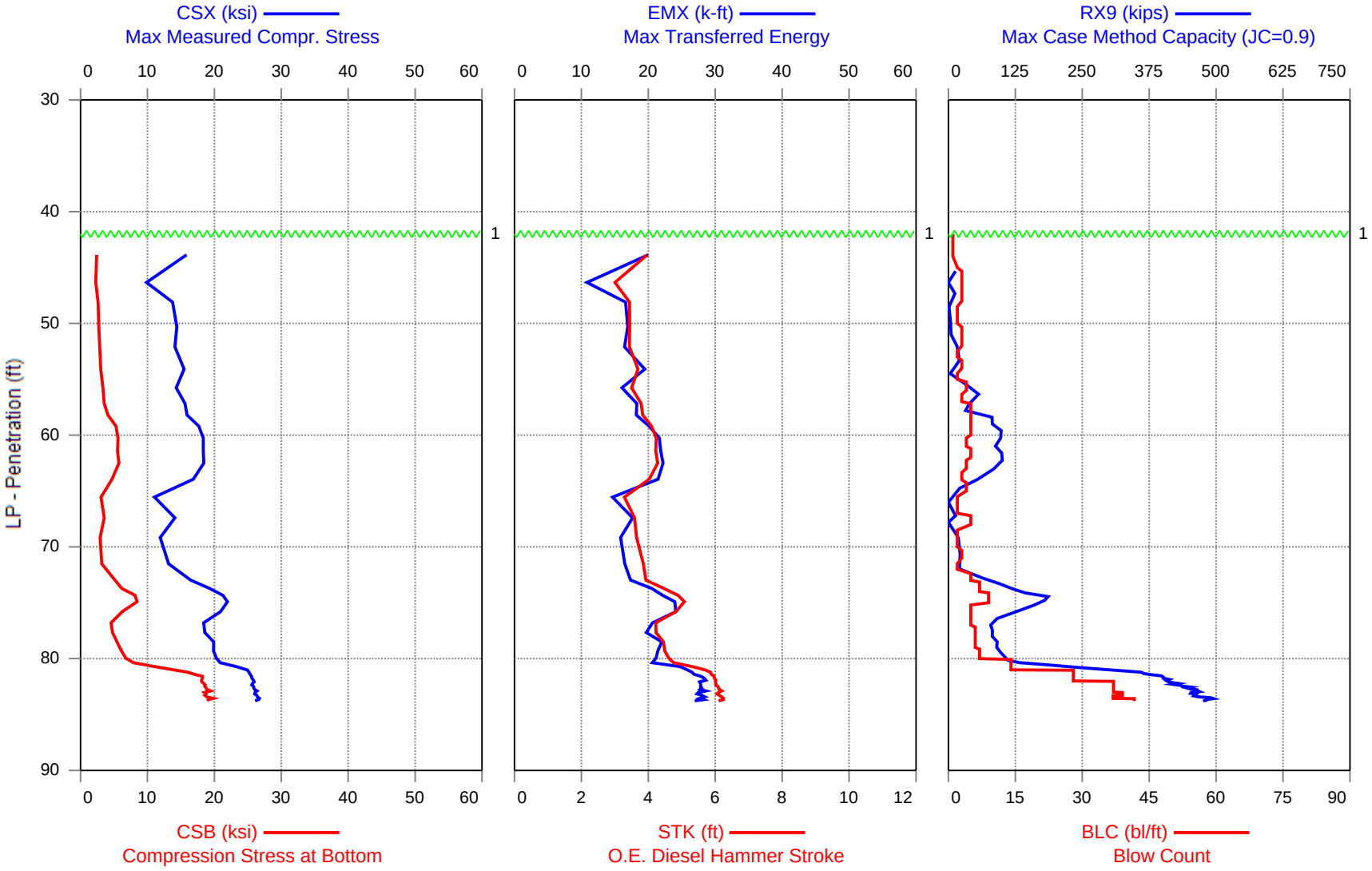
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 25-February-2015

Test started: 24-February-2015

USH 10 over Little Lake Butte des Morts - PIER 4 #36

APE D30-42, HP 14 x 73



1 - Reported reference at El. 741.2

2 - Mud line at El. 718.1

USH 10 over Little Lake Butte des Morts - PIER 4 #36 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.67 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
6	42.00	1	AV1	25.0	3.3	35	5.3	50.7	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	25.0	3.3	35	5.3	50.7	0
			MIN	25.0	3.3	35	5.3	50.7	0
7	43.00	1	AV1	12.9	2.2	17	3.0	66.1	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	12.9	2.2	17	3.0	66.1	0
			MIN	12.9	2.2	17	3.0	66.1	0
8	44.00	1	AV1	1.7	0.0	1	2.7	68.9	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	1.7	0.0	1	2.7	68.9	0
			MIN	1.7	0.0	1	2.7	68.9	0
10	45.00	2	AV1	26.0	3.9	32	5.6	49.6	40
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	26.0	3.9	32	5.6	49.6	40
			MIN	26.0	3.9	32	5.6	49.6	40
11	45.33	3	AV1	13.6	2.7	15	3.2	64.7	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.6	2.7	15	3.2	64.7	0
			MIN	13.6	2.7	15	3.2	64.7	0
12	45.67	3	AV1	9.5	2.1	9	2.9	66.9	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	9.5	2.1	9	2.9	66.9	0
			MIN	9.5	2.1	9	2.9	66.9	0
13	46.00	3	AV1	7.2	1.9	7	2.8	68.4	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	7.2	1.9	7	2.8	68.4	0
			MIN	7.2	1.9	7	2.8	68.4	0
16	47.00	3	AV3	10.9	2.5	13	3.1	65.4	0
			STD	2.4	0.5	3	0.2	2.3	1
			MAX	13.8	3.2	16	3.4	68.4	1
			MIN	7.8	1.9	8	2.8	62.8	0
19	48.00	3	AV3	13.4	2.7	15	3.4	62.8	13
			STD	1.5	0.2	2	0.2	1.7	7
			MAX	15.6	2.9	17	3.7	64.1	19
			MIN	12.4	2.4	13	3.2	60.4	4
21	49.00	2	AV2	14.3	2.6	19	3.5	61.6	0
			STD	0.1	0.0	1	0.0	0.1	0
			MAX	14.3	2.6	20	3.5	61.6	0
			MIN	14.2	2.6	18	3.5	61.5	0
23	50.00	2	AV2	15.8	2.7	20	3.6	60.7	0
			STD	0.6	0.1	1	0.1	1.0	0
			MAX	16.4	2.8	22	3.8	61.7	0
			MIN	15.2	2.5	19	3.5	59.7	0
26	51.00	3	AV3	13.4	2.8	15	3.3	63.3	7

USH 10 over Little Lake Butte des Morts - PIER 4 #36 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			STD	0.4	0.1	0	0.1	0.6	5
			MAX	13.9	3.0	15	3.4	64.1	12
			MIN	13.0	2.7	14	3.2	62.6	0
29	52.00	3	AV3	14.6	3.0	16	3.5	61.8	11
			STD	0.6	0.1	0	0.1	0.5	6
			MAX	15.4	3.0	16	3.6	62.3	19
			MIN	14.1	2.8	16	3.4	61.1	7
31	53.00	2	AV2	13.4	2.7	17	3.3	63.2	24
			STD	1.7	0.3	3	0.3	2.4	2
			MAX	15.1	3.0	21	3.6	65.6	25
			MIN	11.6	2.4	14	3.1	60.8	22
34	54.00	3	AV3	14.9	3.0	18	3.6	61.0	12
			STD	2.6	0.5	3	0.4	3.2	17
			MAX	18.2	3.6	21	4.1	65.0	36
			MIN	11.7	2.5	14	3.1	57.2	0
36	55.00	2	AV2	16.3	3.1	22	3.8	59.5	5
			STD	0.8	0.1	0	0.1	0.5	5
			MAX	17.1	3.1	22	3.9	60.0	10
			MIN	15.5	3.0	22	3.7	59.0	0
40	56.00	4	AV4	14.0	3.2	15	3.4	62.2	38
			STD	0.5	0.1	1	0.0	0.4	7
			MAX	14.7	3.3	16	3.5	62.7	48
			MIN	13.4	3.0	14	3.4	61.6	31
43	57.00	3	AV3	17.8	4.3	23	4.1	57.5	58
			STD	1.7	0.3	2	0.3	2.0	6
			MAX	19.7	4.7	25	4.4	60.1	66
			MIN	15.7	3.9	21	3.7	55.4	53
48	58.00	5	AV5	12.7	3.2	14	3.3	63.5	32
			STD	2.7	0.7	3	0.4	3.1	21
			MAX	16.6	4.1	17	3.9	67.4	60
			MIN	9.1	2.3	9	2.9	58.5	0
53	59.00	5	AV5	18.1	4.7	21	4.2	57.1	79
			STD	1.3	0.3	2	0.3	1.7	13
			MAX	19.8	5.1	23	4.6	59.0	94
			MIN	16.4	4.2	19	3.9	54.6	62
58	60.00	5	AV5	18.0	5.6	21	4.2	56.9	97
			STD	0.3	0.3	1	0.0	0.2	2
			MAX	18.5	5.9	21	4.2	57.1	101
			MIN	17.7	5.2	20	4.1	56.5	93
62	61.00	4	AV4	18.3	5.5	22	4.2	56.6	94
			STD	0.8	0.4	1	0.2	1.0	7
			MAX	19.2	6.1	24	4.4	58.1	105
			MIN	17.1	5.0	20	4.0	55.7	85
67	62.00	5	AV5	18.7	5.8	22	4.3	56.1	97
			STD	0.5	0.3	1	0.1	0.6	7
			MAX	19.1	6.1	23	4.4	57.4	106
			MIN	17.8	5.3	21	4.1	55.7	86
71	63.00	4	AV4	18.3	5.7	22	4.3	56.3	96
			STD	0.2	0.3	0	0.0	0.1	6
			MAX	18.5	6.1	23	4.3	56.4	100
			MIN	18.1	5.2	22	4.3	56.2	86

USH 10 over Little Lake Butte des Morts - PIER 4 #36 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
74	64.00	3	AV3	17.7	4.9	23	4.1	57.2	61
			STD	0.5	0.1	1	0.1	0.5	6
			MAX	18.2	5.0	24	4.2	57.8	69
			MIN	17.1	4.8	22	4.0	56.5	55
78	65.00	4	AV4	14.6	4.0	18	3.7	59.9	28
			STD	1.2	0.4	1	0.1	1.0	18
			MAX	16.3	4.6	20	3.9	61.2	48
			MIN	13.2	3.6	17	3.6	58.4	0
80	66.00	2	AV2	9.5	2.7	13	3.1	65.3	0
			STD	1.6	0.3	2	0.2	1.7	0
			MAX	11.1	3.0	15	3.3	67.0	0
			MIN	7.9	2.4	11	2.9	63.6	0
82	67.00	2	AV2	12.1	3.2	17	3.3	63.4	0
			STD	2.8	0.5	5	0.3	3.0	0
			MAX	14.9	3.7	22	3.7	66.4	0
			MIN	9.3	2.6	13	3.0	60.4	0
87	68.00	5	AV5	13.0	3.4	15	3.4	62.4	8
			STD	3.0	0.6	4	0.4	3.1	16
			MAX	17.2	4.4	20	3.9	66.8	40
			MIN	9.4	2.8	10	2.9	58.7	0
89	69.00	2	AV2	4.3	1.3	5	2.8	68.2	0
			STD	2.1	0.6	3	0.0	0.0	0
			MAX	6.4	1.9	9	2.8	68.2	0
			MIN	2.2	0.7	2	2.8	68.1	0
91	70.00	2	AV1	26.7	5.1	41	6.2	47.3	55
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	26.7	5.1	41	6.2	47.3	55
			MIN	26.7	5.1	41	6.2	47.3	55
94	71.00	3	AV3	14.3	3.8	17	3.6	61.2	22
			STD	0.7	0.1	1	0.1	0.9	17
			MAX	14.8	4.0	18	3.7	62.0	43
			MIN	13.3	3.6	16	3.5	59.9	0
96	72.00	2	AV2	6.3	1.6	8	3.1	65.7	0
			STD	3.8	1.0	5	0.3	2.5	0
			MAX	10.1	2.6	13	3.3	68.1	0
			MIN	2.5	0.6	3	2.8	63.2	0
101	73.00	5	AV4	17.5	4.6	20	4.2	57.6	64
			STD	4.8	0.7	7	1.0	5.8	10
			MAX	25.2	5.3	31	5.9	62.8	80
			MIN	13.4	3.9	14	3.4	48.3	54
108	74.00	7	AV7	19.1	6.2	20	4.4	55.4	111
			STD	1.2	0.9	2	0.3	1.4	19
			MAX	21.3	7.8	24	4.9	57.4	139
			MIN	17.6	4.9	18	4.1	52.8	82
117	75.00	9	AV9	21.6	8.3	23	5.0	52.4	173
			STD	0.8	1.0	1	0.2	0.9	19
			MAX	22.7	9.7	24	5.2	53.8	199
			MIN	20.1	6.2	21	4.7	51.1	132
122	76.00	5	AV5	21.4	6.9	25	4.9	52.7	138
			STD	0.6	1.2	1	0.1	0.7	18

USH 10 over Little Lake Butte des Morts - PIER 4 #36 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	22.0	8.4	26	5.0	54.1	159
			MIN	20.3	5.3	23	4.6	52.1	110
127	77.00	5	AV5	18.6	4.6	21	4.3	56.3	85
			STD	1.0	0.3	2	0.2	1.4	11
			MAX	19.8	5.2	22	4.6	58.2	105
			MIN	17.2	4.4	18	4.0	54.6	74
133	78.00	6	AV6	18.6	4.8	20	4.2	56.5	81
			STD	0.4	0.1	1	0.1	0.6	5
			MAX	19.3	5.0	21	4.4	57.3	89
			MIN	18.0	4.6	19	4.1	55.7	76
139	79.00	6	AV6	19.9	5.5	22	4.5	55.2	90
			STD	0.2	0.2	0	0.0	0.2	1
			MAX	20.1	5.9	23	4.5	55.6	92
			MIN	19.4	5.1	21	4.4	55.0	88
146	80.00	7	AV7	20.1	6.4	22	4.6	54.6	100
			STD	0.4	0.4	1	0.1	0.6	5
			MAX	20.6	6.9	23	4.7	55.6	106
			MIN	19.4	5.9	21	4.4	54.0	93
160	81.00	14	AV14	22.2	9.8	23	5.1	52.0	186
			STD	1.8	2.5	3	0.4	2.0	66
			MAX	25.1	14.0	27	5.7	54.6	297
			MIN	20.0	6.8	19	4.6	49.0	110
188	82.00	28	AV28	25.4	17.2	27	5.9	48.3	381
			STD	0.4	1.4	1	0.1	0.5	31
			MAX	26.3	18.9	30	6.1	49.3	417
			MIN	24.7	13.7	25	5.7	47.5	308
225	83.00	37	AV37	25.9	18.7	28	6.1	47.6	441
			STD	0.5	0.5	1	0.1	0.4	19
			MAX	27.4	20.2	30	6.4	48.3	472
			MIN	25.2	17.6	27	5.9	46.4	406
236	83.28	39	AV11	26.0	18.6	27	6.1	47.7	457
			STD	0.2	0.3	1	0.0	0.2	9
			MAX	26.4	19.0	28	6.1	48.0	469
			MIN	25.7	18.0	26	6.0	47.4	445
246	83.55	37	AV10	26.5	19.2	28	6.2	47.2	475
			STD	0.4	0.7	1	0.1	0.4	17
			MAX	27.2	20.5	29	6.4	47.9	506
			MIN	25.7	18.4	27	6.0	46.6	455
256	83.79	42	AV10	26.5	19.1	28	6.2	47.2	483
			STD	0.4	0.5	1	0.1	0.4	8
			MAX	27.3	20.2	30	6.5	47.9	496
			MIN	25.7	18.7	26	6.0	46.3	471
			Average	20.5	10.2	23	4.9	54.0	213
			Std. Dev.	5.6	6.8	6	1.1	6.3	184
			Maximum	27.4	20.5	41	6.5	68.9	506
			Minimum	1.7	0.0	1	2.7	46.3	0

Total number of blows analyzed: 248

BL# Sensors

1-256 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.08); A4: [K3550] 360.0 (1.08)

BL# Comments

6 Reported reference at El. 741.2

Time Summary

Drive 7 minutes 4 seconds 12:15 PM - 12:22 PM BN 1 - 256

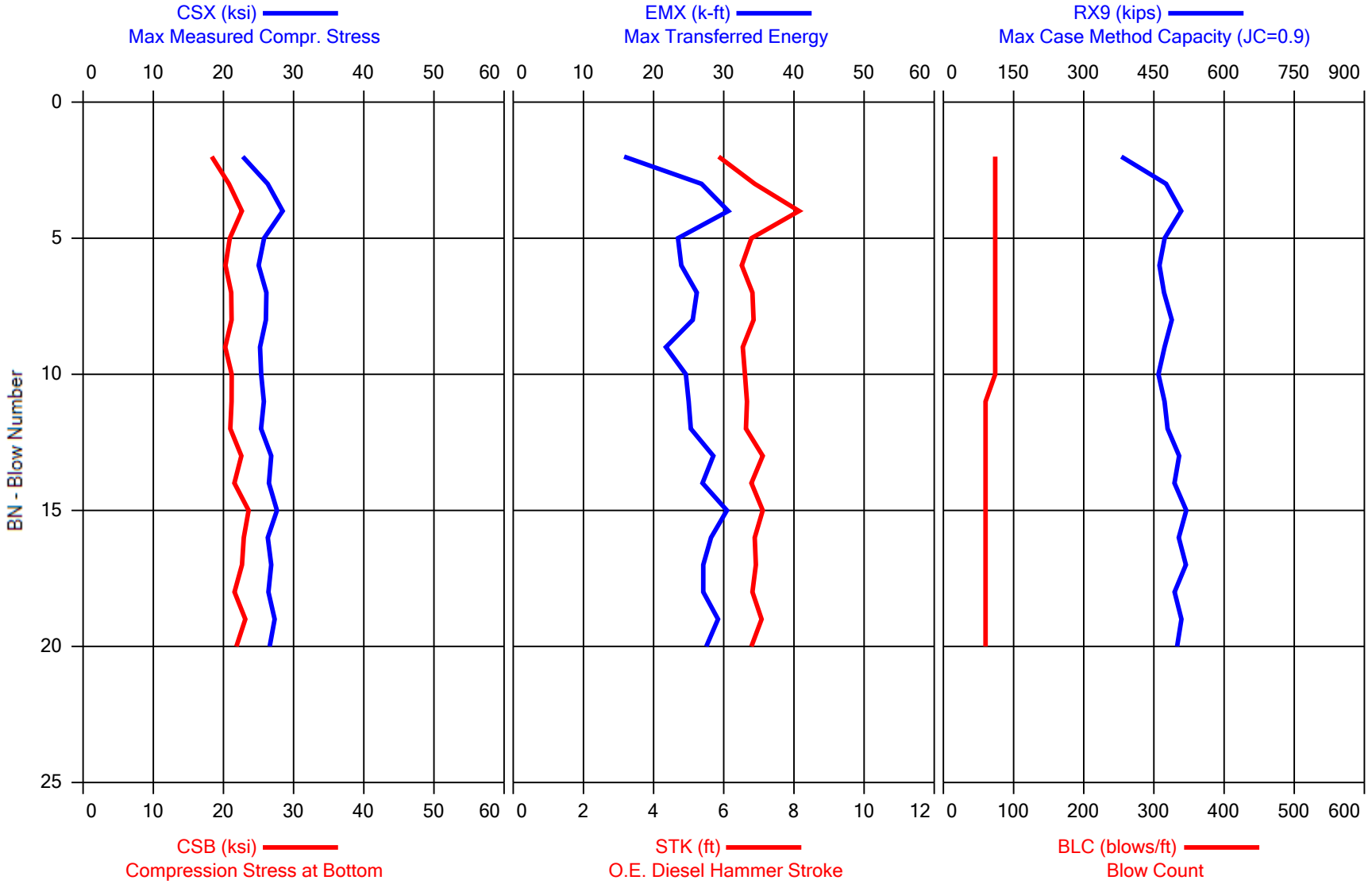
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 26-February-2015

Test started: 25-February-2015

USH 10 over Little Lake Butte des Morts - PIER 4 #36 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - PIER 4 #36 Restrike APE D30-42, HP 14 x 73
OP: TC Date: 25-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.67 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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
10	83.93	74	AV9	25.7	20.7	24	6.8	45.3	466
			STD	1.4	1.1	4	0.6	1.7	33
			MAX	28.4	22.6	31	8.1	48.5	508
			MIN	22.7	18.3	16	5.9	41.4	380
20	84.09	60	AV10	26.5	22.2	28	6.9	44.9	499
			STD	0.6	0.8	2	0.2	0.5	14
			MAX	27.6	23.6	30	7.1	45.7	519
			MIN	25.4	21.0	25	6.6	44.2	473
			Average	26.1	21.5	26	6.8	45.1	483
			Std. Dev.	1.2	1.2	3	0.4	1.3	30
			Maximum	28.4	23.6	31	8.1	48.5	519
			Minimum	22.7	18.3	16	5.9	41.4	380

Total number of blows analyzed: 19

BL# Sensors

1-20 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.09); A4: [K3550] 360.0 (1.09)

Time Summary

Drive 25 seconds 8:14 AM - 8:14 AM BN 1 - 20

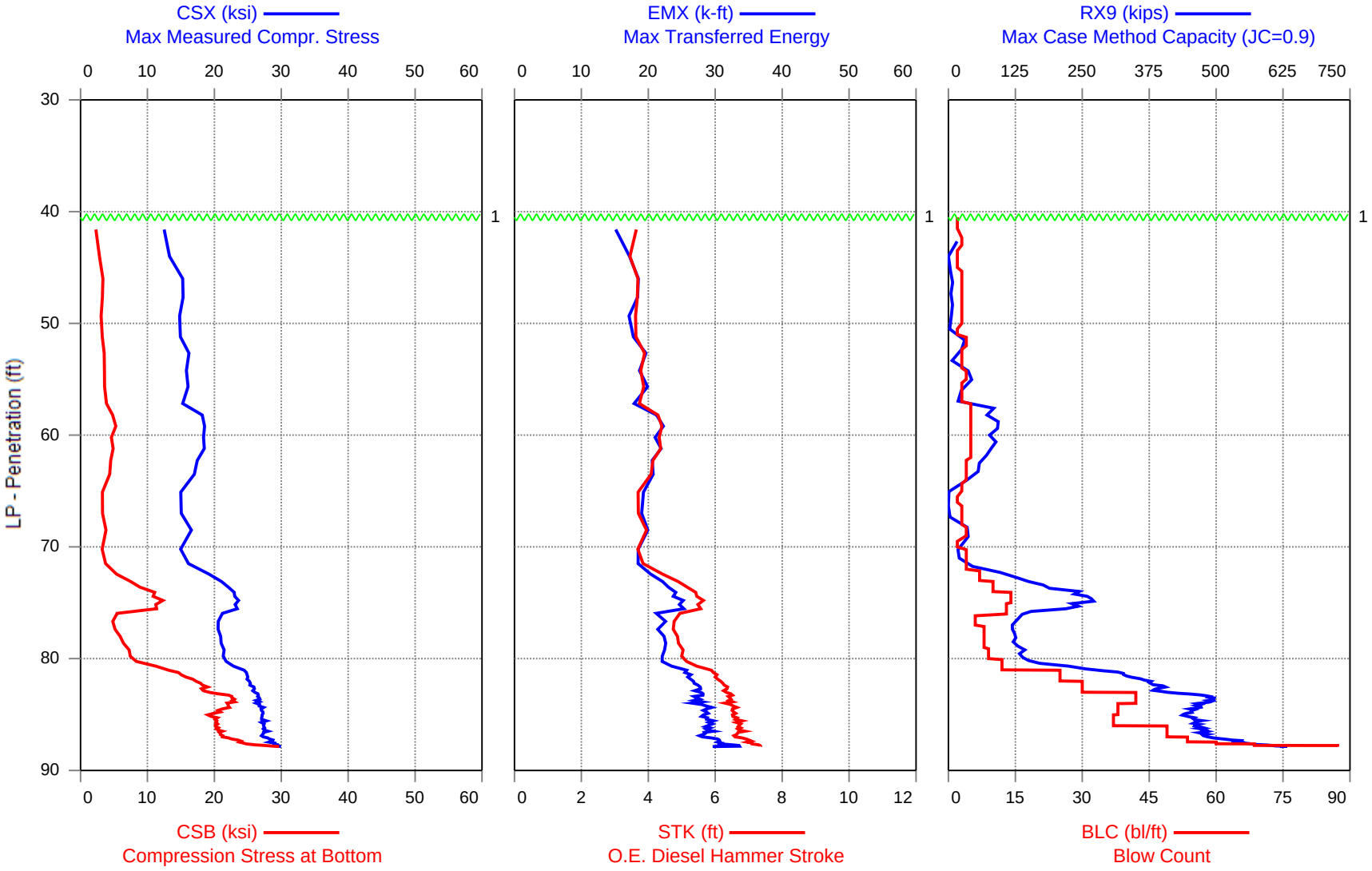
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 25-February-2015

Test started: 24-February-2015

USH 10 over Little Lake Butte des Morts - PIER 4 #44

APE D30-42, HP 14 x 73



1 - Reported reference at El. 741.2

2 - Mud line at El. 741.2

USH 10 over Little Lake Butte des Morts - PIER 4 #44 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.42 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
3	40.50	2	AV1	13.4	2.7	17	3.4	62.7	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.4	2.7	17	3.4	62.7	0
			MIN	13.4	2.7	17	3.4	62.7	0
4	41.00	2	AV1	8.6	2.0	11	3.0	66.5	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	8.6	2.0	11	3.0	66.5	0
			MIN	8.6	2.0	11	3.0	66.5	0
6	42.00	2	AV1	0.8	0.0	0	2.7	69.4	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	0.8	0.0	0	2.7	69.4	0
			MIN	0.8	0.0	0	2.7	69.4	0
9	43.00	3	AV3	17.0	3.2	20	4.1	58.5	16
			STD	5.8	0.5	8	1.1	6.8	23
			MAX	24.9	3.9	31	5.7	64.1	49
			MIN	11.3	2.8	13	3.2	49.0	0
11	44.00	2	AV2	11.5	2.5	15	3.2	64.2	0
			STD	1.0	0.0	2	0.1	1.0	0
			MAX	12.5	2.5	17	3.3	65.2	0
			MIN	10.4	2.4	13	3.1	63.1	0
13	45.00	2	AV2	16.2	3.2	22	3.8	59.5	0
			STD	0.3	0.0	1	0.0	0.2	0
			MAX	16.4	3.2	23	3.8	59.7	0
			MIN	15.9	3.1	21	3.8	59.2	0
16	46.00	3	AV3	14.9	3.3	18	3.6	60.6	6
			STD	0.5	0.0	1	0.1	0.7	2
			MAX	15.6	3.3	19	3.7	61.6	8
			MIN	14.2	3.2	17	3.5	59.8	4
19	47.00	3	AV3	15.7	3.4	19	3.7	59.9	8
			STD	0.3	0.2	0	0.1	0.4	4
			MAX	16.0	3.6	19	3.8	60.4	14
			MIN	15.3	3.3	19	3.7	59.4	4
22	48.00	3	AV3	15.3	3.3	18	3.7	60.4	4
			STD	0.7	0.1	1	0.1	0.7	3
			MAX	16.2	3.5	19	3.8	61.1	7
			MIN	14.7	3.1	17	3.6	59.5	0
25	49.00	3	AV3	15.5	3.1	18	3.7	60.2	7
			STD	0.9	0.3	2	0.2	1.2	8
			MAX	16.6	3.4	19	3.9	61.7	19
			MIN	14.4	2.7	16	3.5	58.8	0
28	50.00	3	AV3	14.4	3.1	17	3.6	61.3	7
			STD	2.0	0.4	3	0.3	2.3	5
			MAX	17.0	3.6	21	4.0	63.9	13
			MIN	12.3	2.7	13	3.2	58.3	0
30	51.00	2	AV2	14.5	2.7	18	3.5	61.6	0

USH 10 over Little Lake Butte des Morts - PIER 4 #44 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	1.4	0.2	2	0.2	1.9	0
			MAX	15.9	2.9	20	3.8	63.5	0
			MIN	13.0	2.5	16	3.3	59.7	0
34	52.00	4	AV4	15.9	3.8	19	3.8	59.3	36
			STD	1.3	0.4	2	0.2	1.6	20
			MAX	17.8	4.1	22	4.2	61.0	54
			MIN	14.4	3.1	16	3.6	56.8	1
37	53.00	3	AV3	16.1	3.5	19	3.9	59.1	7
			STD	1.7	0.4	2	0.3	2.1	10
			MAX	18.2	4.1	22	4.3	61.5	20
			MIN	14.1	3.0	17	3.5	56.3	0
40	54.00	3	AV3	14.4	3.1	17	3.5	61.4	10
			STD	0.4	0.0	1	0.1	0.8	6
			MAX	15.0	3.1	18	3.7	62.2	17
			MIN	14.1	3.1	16	3.4	60.3	4
44	55.00	4	AV4	16.6	3.7	19	3.9	58.7	50
			STD	0.8	0.3	1	0.1	0.8	4
			MAX	17.3	4.1	20	4.0	60.1	56
			MIN	15.2	3.3	18	3.7	57.9	46
47	56.00	3	AV3	16.7	3.8	21	4.0	58.3	33
			STD	0.8	0.3	2	0.1	0.9	2
			MAX	17.6	4.2	23	4.1	59.5	34
			MIN	15.6	3.6	19	3.8	57.4	30
50	57.00	3	AV3	14.0	3.0	17	3.5	61.5	3
			STD	0.9	0.2	0	0.1	0.9	4
			MAX	15.1	3.2	17	3.7	62.4	8
			MIN	13.1	2.9	16	3.4	60.2	0
55	58.00	5	AV5	17.4	4.6	20	4.1	57.4	78
			STD	1.9	0.6	3	0.4	2.7	15
			MAX	19.6	5.2	23	4.6	61.7	95
			MIN	14.6	3.6	16	3.5	54.3	54
60	59.00	5	AV5	18.1	5.0	21	4.3	56.2	83
			STD	0.5	0.3	1	0.1	0.7	13
			MAX	18.7	5.2	23	4.5	57.2	96
			MIN	17.3	4.4	20	4.1	55.1	62
65	60.00	5	AV5	18.5	5.1	22	4.4	55.7	88
			STD	0.7	0.4	1	0.1	0.8	9
			MAX	19.5	5.5	23	4.5	57.0	98
			MIN	17.4	4.4	21	4.2	54.7	73
70	61.00	5	AV5	18.5	4.7	22	4.4	55.7	83
			STD	0.3	0.2	1	0.1	0.5	9
			MAX	19.1	4.9	23	4.5	56.4	92
			MIN	18.2	4.4	20	4.3	54.8	66
75	62.00	5	AV5	18.1	4.7	21	4.3	56.3	74
			STD	0.4	0.2	1	0.1	0.6	8
			MAX	18.6	5.1	22	4.4	57.3	82
			MIN	17.4	4.4	20	4.1	55.6	61
79	63.00	4	AV4	17.6	4.6	21	4.2	57.0	58
			STD	0.6	0.2	1	0.1	0.8	4
			MAX	18.5	4.9	23	4.4	57.7	65
			MIN	17.0	4.2	20	4.0	55.7	53

USH 10 over Little Lake Butte des Morts - PIER 4 #44 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
83	64.00	4	AV4	16.6	4.3	20	4.0	58.0	51
			STD	1.1	0.3	2	0.2	1.4	4
			MAX	17.9	4.8	23	4.3	59.9	56
			MIN	15.1	4.0	18	3.7	56.1	48
86	65.00	3	AV3	14.6	3.3	18	3.7	60.5	3
			STD	0.3	0.1	0	0.1	0.5	3
			MAX	15.0	3.3	18	3.7	60.8	7
			MIN	14.2	3.2	18	3.6	59.8	0
88	66.00	2	AV2	15.5	3.3	21	3.7	59.9	0
			STD	0.5	0.1	0	0.1	0.5	0
			MAX	16.0	3.4	21	3.8	60.3	0
			MIN	15.0	3.2	21	3.7	59.4	0
91	67.00	3	AV3	14.7	3.2	18	3.6	60.7	1
			STD	0.3	0.1	0	0.0	0.3	1
			MAX	15.0	3.4	19	3.7	61.1	2
			MIN	14.3	3.1	18	3.6	60.3	0
94	68.00	3	AV3	15.3	3.4	20	3.8	59.7	2
			STD	0.7	0.1	1	0.1	0.7	3
			MAX	16.3	3.4	21	3.9	60.3	6
			MIN	14.6	3.2	19	3.7	58.7	0
98	69.00	4	AV4	17.1	3.9	20	4.0	58.1	54
			STD	1.6	0.3	2	0.3	2.3	5
			MAX	18.2	4.2	22	4.3	62.0	61
			MIN	14.4	3.4	17	3.5	56.2	49
100	70.00	2	AV2	15.2	3.1	21	3.8	59.8	0
			STD	0.2	0.1	0	0.0	0.2	0
			MAX	15.4	3.2	21	3.8	59.9	0
			MIN	15.0	3.0	20	3.7	59.6	0
104	71.00	4	AV4	15.2	3.4	17	3.7	60.2	22
			STD	1.4	0.1	1	0.2	1.8	11
			MAX	16.8	3.6	19	4.0	62.2	40
			MIN	13.7	3.3	16	3.4	58.1	14
108	72.00	4	AV4	16.1	3.8	19	3.8	59.2	40
			STD	0.6	0.2	1	0.1	1.0	9
			MAX	17.1	4.1	21	4.0	60.1	50
			MIN	15.6	3.4	17	3.7	57.7	26
115	73.00	7	AV7	19.6	5.8	21	4.5	54.9	115
			STD	1.7	1.1	2	0.4	2.1	19
			MAX	21.4	7.2	23	4.9	58.5	138
			MIN	16.5	4.2	17	3.9	52.7	78
125	74.00	10	AV10	22.0	9.0	23	5.1	51.6	189
			STD	0.6	1.2	1	0.2	0.7	30
			MAX	23.1	11.4	24	5.4	52.7	255
			MIN	21.0	6.7	22	4.9	50.3	146
139	75.00	14	AV14	23.2	11.5	24	5.5	49.9	256
			STD	0.4	0.7	1	0.1	0.5	18
			MAX	23.9	12.7	27	5.8	50.6	283
			MIN	22.8	10.1	23	5.4	48.9	222
152	76.00	13	AV13	22.7	9.5	24	5.4	50.6	199
			STD	1.1	2.8	2	0.3	1.4	42

USH 10 over Little Lake Butte des Morts - PIER 4 #44 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	24.0	12.9	26	5.7	53.1	258
			MIN	20.7	4.8	20	4.8	49.0	138
158	77.00	6	AV6	20.6	5.0	23	4.8	53.4	126
			STD	0.3	0.3	1	0.1	0.5	6
			MAX	21.0	5.6	23	4.9	54.0	135
			MIN	20.3	4.6	21	4.7	52.7	118
166	78.00	8	AV8	20.7	5.4	22	4.8	53.4	122
			STD	0.3	0.4	1	0.1	0.5	5
			MAX	21.3	5.9	23	4.9	53.9	129
			MIN	20.2	5.0	21	4.7	52.6	113
174	79.00	8	AV8	21.1	6.4	23	4.9	52.7	125
			STD	0.3	0.3	0	0.1	0.3	5
			MAX	21.4	7.0	23	5.0	53.5	136
			MIN	20.5	6.0	22	4.8	52.3	117
183	80.00	9	AV9	21.4	7.4	22	5.0	52.1	138
			STD	0.3	0.1	1	0.1	0.4	5
			MAX	22.2	7.7	23	5.2	52.6	144
			MIN	21.1	7.2	22	4.9	51.3	130
195	81.00	12	AV12	22.7	10.4	24	5.4	50.4	201
			STD	1.1	2.0	2	0.3	1.3	44
			MAX	25.2	13.5	28	6.0	52.1	265
			MIN	21.3	7.8	21	5.0	47.8	148
220	82.00	25	AV25	24.8	15.4	26	6.0	47.9	334
			STD	0.4	1.2	1	0.1	0.5	24
			MAX	25.5	17.4	27	6.2	49.5	377
			MIN	23.4	12.8	23	5.6	47.2	283
250	83.00	30	AV30	25.7	18.3	27	6.3	46.9	389
			STD	0.5	0.6	1	0.1	0.4	13
			MAX	26.6	19.7	29	6.5	47.8	422
			MIN	24.6	17.2	26	6.0	46.0	370
292	84.00	42	AV42	26.5	22.1	27	6.4	46.4	476
			STD	0.5	1.2	1	0.1	0.4	24
			MAX	27.6	23.5	29	6.7	47.2	515
			MIN	25.6	19.3	26	6.2	45.5	413
330	85.00	38	AV38	27.0	21.2	29	6.5	46.0	458
			STD	0.5	1.0	1	0.1	0.4	11
			MAX	27.9	22.9	30	6.8	47.4	479
			MIN	25.7	19.0	26	6.1	45.3	436
367	86.00	37	AV37	27.2	20.1	29	6.7	45.6	457
			STD	0.5	0.5	1	0.1	0.5	10
			MAX	28.3	20.9	31	7.0	46.7	476
			MIN	25.9	18.9	26	6.3	44.5	431
416	87.00	49	AV49	27.4	20.8	29	6.7	45.5	476
			STD	0.5	0.5	1	0.1	0.5	6
			MAX	28.6	22.1	31	7.1	46.6	491
			MIN	26.6	19.9	27	6.4	44.3	464
440	87.45	54	AV24	28.2	22.9	30	6.9	44.8	519
			STD	0.6	0.9	1	0.2	0.6	22
			MAX	29.6	24.4	32	7.2	46.0	553
			MIN	27.0	21.1	28	6.5	43.9	484

USH 10 over Little Lake Butte des Morts - PIER 4 #44 APE D30-42, HP 14 x 73
OP: TC Date: 24-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
450	87.62	60	AV10	28.9	24.3	31	7.1	44.3	553
			STD	0.3	0.4	1	0.1	0.2	8
			MAX	29.2	24.9	32	7.2	44.6	562
			MIN	28.3	23.5	30	7.0	43.8	538
460	87.76	69	AV10	29.2	25.8	32	7.2	43.9	581
			STD	0.5	0.8	1	0.2	0.5	13
			MAX	30.3	27.1	34	7.5	45.1	602
			MIN	28.2	24.2	30	6.8	43.0	556
470	87.88	87	AV10	29.7	28.9	33	7.4	43.5	619
			STD	0.5	0.8	3	0.2	0.4	14
			MAX	30.2	29.9	35	7.6	44.4	640
			MIN	28.6	27.4	25	7.0	42.9	598
			Average	23.6	14.8	25	5.7	49.9	314
			Std. Dev.	4.9	8.0	5	1.2	5.7	195
			Maximum	30.3	29.9	35	7.6	69.4	640
			Minimum	0.8	0.0	0	2.7	42.9	0

Total number of blows analyzed: 467

BL# Sensors

1-470 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.07); A4: [K3550] 360.0 (1.07)

BL# Comments

3 Reported reference at El. 741.2

Time Summary

Drive 10 minutes 0 second 12:40 PM - 12:50 PM BN 1 - 470

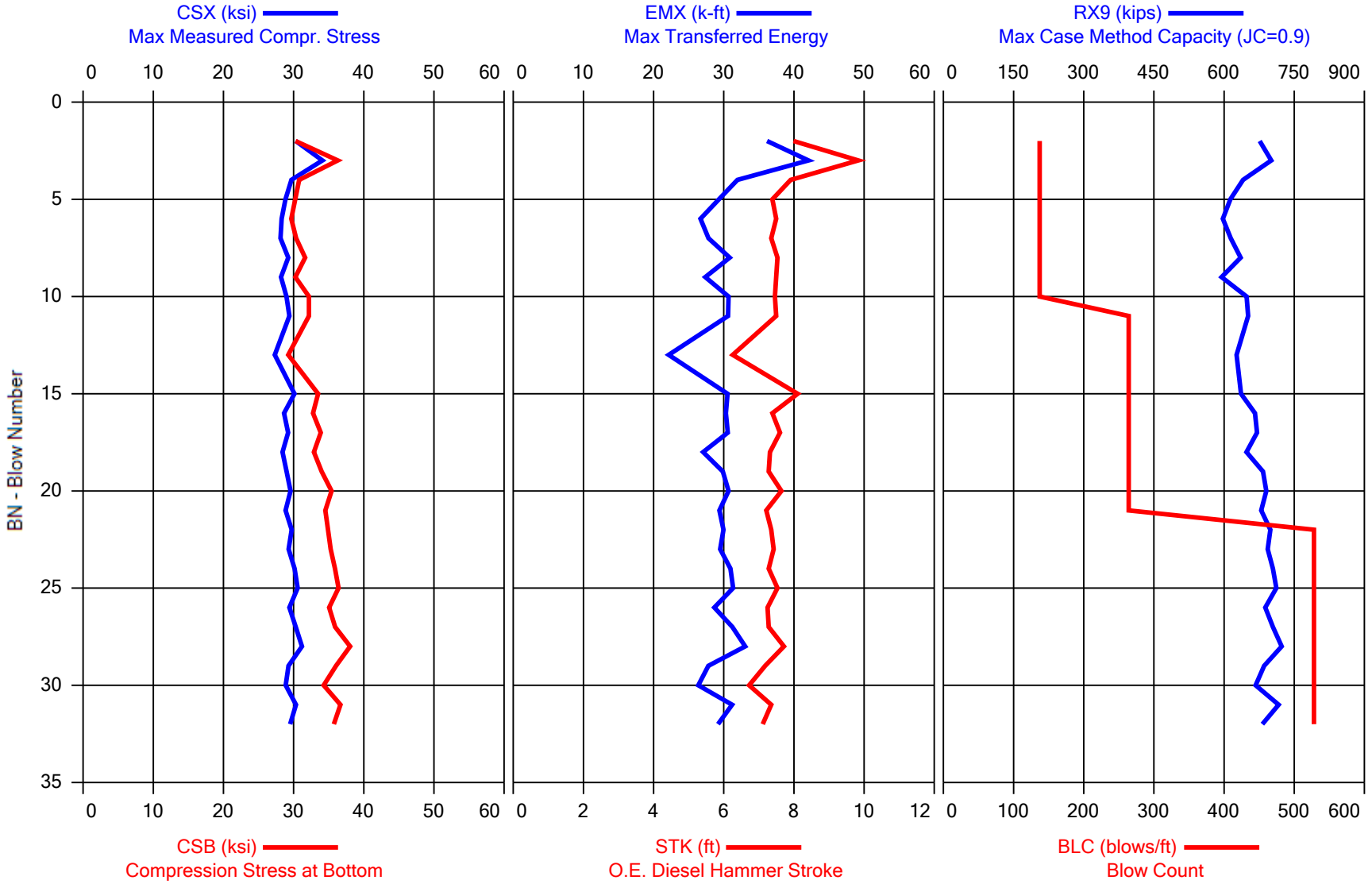
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 25-February-2015

Test started: 25-February-2015

USH 10 over Little Lake Butte des Morts - PIER 4 #44 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - PIER 4 #44 Restrike APE D30-42, HP 14 x 73
OP: TC Date: 25-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.42 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	87.95	137	AV9	29.5	31.3	31	7.8	42.3	636
			STD	1.8	1.9	5	0.7	1.7	34
			MAX	34.1	36.3	42	9.8	43.5	701
			MIN	28.1	29.7	27	7.4	37.8	595
21	87.99	264	AV9	28.9	33.2	29	7.4	43.5	661
			STD	0.8	1.7	3	0.5	1.4	21
			MAX	30.1	35.4	31	8.1	47.0	690
			MIN	27.3	29.2	22	6.3	41.5	627
32	88.01	528	AV11	29.9	35.8	30	7.3	43.7	698
			STD	0.7	1.0	2	0.2	0.7	16
			MAX	31.2	38.1	33	7.7	45.4	723
			MIN	28.9	34.3	26	6.7	42.5	667
			Average	29.5	33.6	30	7.5	43.2	667
			Std. Dev.	1.2	2.4	3	0.6	1.4	35
			Maximum	34.1	38.1	42	9.8	47.0	723
			Minimum	27.3	29.2	22	6.3	37.8	595

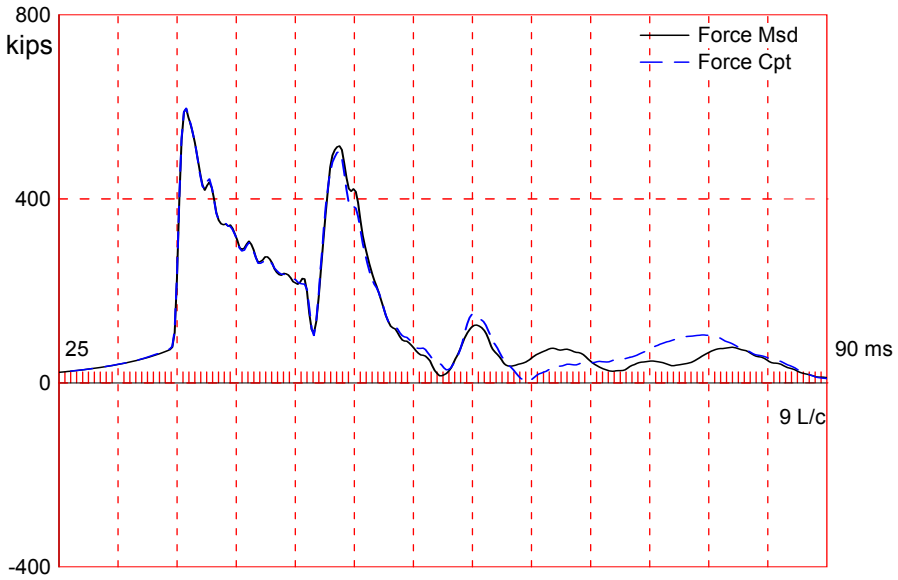
Total number of blows analyzed: 29

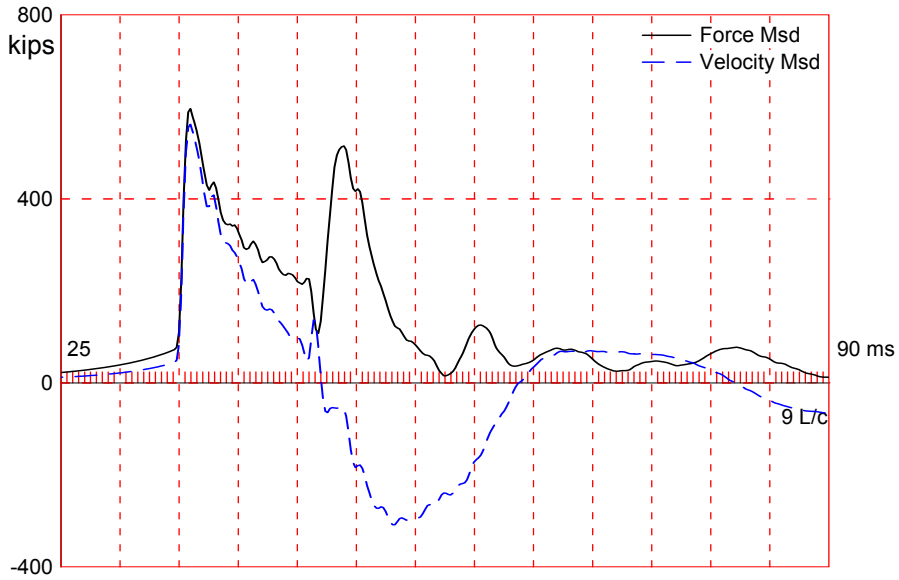
BL# Sensors

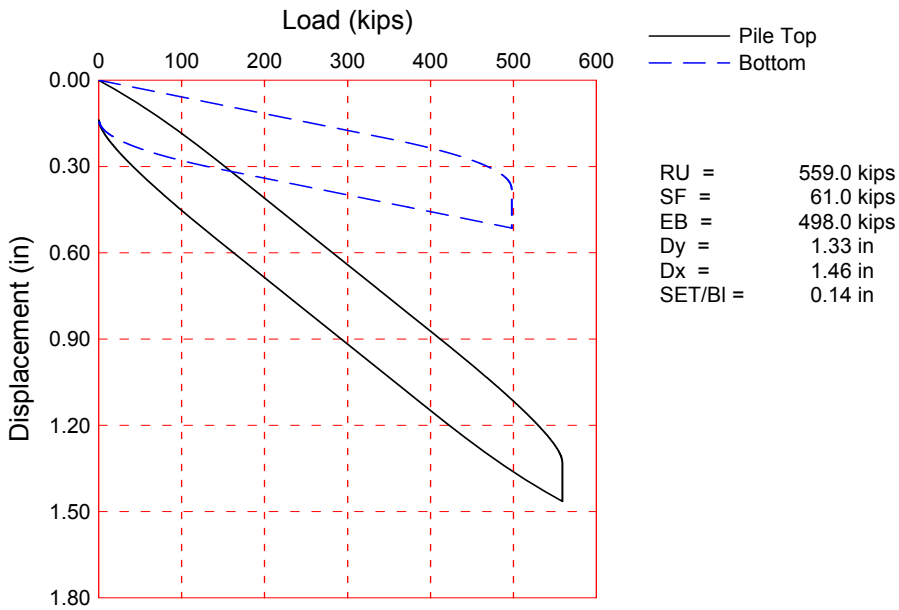
1-32 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.09); A4: [K3550] 360.0 (1.09)

Time Summary

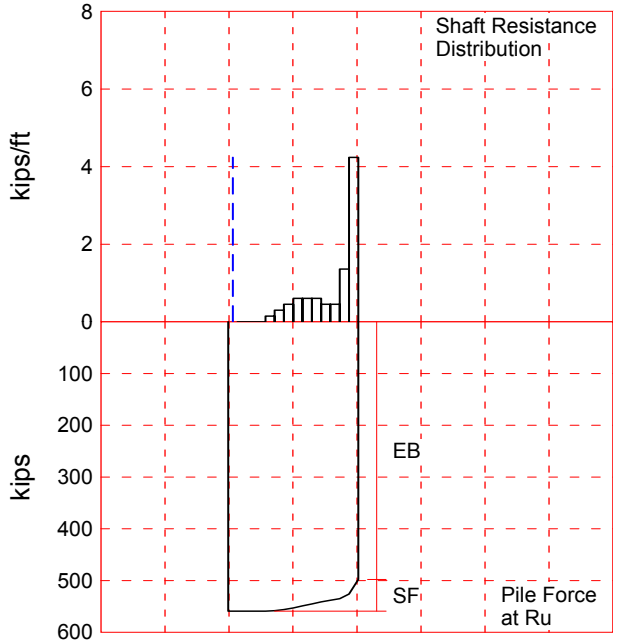
Drive 1 minute 19 seconds 8:03 AM - 8:05 AM BN 1 - 32







RU =	559.0 kips
SF =	61.0 kips
EB =	498.0 kips
Dy =	1.33 in
Dx =	1.46 in
SET/Bl =	0.14 in



Length b. Sensors	92.5 ft
Embedment	86.1 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	4.92
Top Compr. Stress	27.9 ksi
Max Compr. Stress	29.9 ksi
Max Tension Stress	-6.48 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.29 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.10 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

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: 559.0; along Shaft 61.0; at Toe 498.0 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
				559.0				
1	13.2	6.8	0.0	559.0	0.0	0.00	0.00	0.00
2	19.8	13.5	0.0	559.0	0.0	0.00	0.00	0.00
3	26.4	20.1	0.0	559.0	0.0	0.00	0.00	0.00
4	33.0	26.7	1.0	558.0	1.0	0.15	0.03	0.28
5	39.6	33.3	2.0	556.0	3.0	0.30	0.06	0.28
6	46.3	39.9	3.0	553.0	6.0	0.45	0.10	0.28
7	52.9	46.5	4.0	549.0	10.0	0.61	0.13	0.28
8	59.5	53.1	4.0	545.0	14.0	0.61	0.13	0.28
9	66.1	59.7	4.0	541.0	18.0	0.61	0.13	0.28
10	72.7	66.3	3.0	538.0	21.0	0.45	0.10	0.28
11	79.3	72.9	3.0	535.0	24.0	0.45	0.10	0.28
12	85.9	79.5	9.0	526.0	33.0	1.36	0.29	0.28
13	92.5	86.1	28.0	498.0	61.0	4.24	0.90	0.28
Avg. Shaft			4.7			0.71	0.15	0.28
Toe			498.0				361.27	0.10

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.04	0.29
Case Damping Factor		0.45	1.30
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	32	31
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	77	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)		0.038

CAPWAP match quality = 4.92 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.14 in; Blow Count = 87 b/ft
Computed: Final Set = 0.10 in; Blow Count = 122 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.07; A4(K2524) CAL: 360; RF: 1.07

max. Top Comp. Stress = 27.9 ksi (T= 36.2 ms, max= 1.072 x Top)
max. Comp. Stress = 29.9 ksi (Z= 92.5 ft, T= 42.3 ms)
max. Tens. Stress = -6.48 ksi (Z= 59.5 ft, T= 61.5 ms)
max. Energy (EMX) = 30.1 kip-ft; max. Measured Top Displ. (DMX)= 1.04 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	597.4	-34.9	27.9	-1.63	30.1	14.7	1.03
2	6.6	598.0	-36.1	27.9	-1.69	30.0	14.7	1.01
4	13.2	599.2	-37.9	28.0	-1.77	29.5	14.6	0.98
6	19.8	600.5	-41.5	28.1	-1.94	29.0	14.6	0.94
8	26.4	602.4	-44.8	28.1	-2.09	28.5	14.5	0.90
10	33.0	606.2	-48.1	28.3	-2.25	27.8	14.4	0.85
12	39.6	607.0	-71.2	28.4	-3.33	26.7	14.2	0.80
14	46.3	604.6	-100.9	28.2	-4.71	25.3	14.0	0.75
15	49.6	595.1	-110.6	27.8	-5.17	24.2	13.9	0.72
16	52.9	598.9	-125.4	28.0	-5.86	23.6	13.8	0.69
17	56.2	584.7	-132.9	27.3	-6.21	22.3	13.6	0.66
18	59.5	588.6	-138.8	27.5	-6.48	21.6	13.5	0.63
19	62.8	574.8	-134.7	26.9	-6.29	20.3	13.4	0.60
20	66.1	578.4	-135.3	27.0	-6.32	19.6	13.3	0.57
21	69.4	563.9	-131.5	26.3	-6.14	18.3	13.1	0.54
22	72.7	567.4	-132.1	26.5	-6.17	17.5	13.0	0.50
23	76.0	558.1	-128.1	26.1	-5.98	16.3	12.9	0.47
24	79.3	565.0	-128.6	26.4	-6.01	15.5	12.7	0.44
25	82.6	599.4	-126.1	28.0	-5.89	14.4	13.2	0.40
26	85.9	622.7	-126.3	29.1	-5.90	13.6	14.3	0.37
27	89.2	622.4	-115.6	29.1	-5.40	11.9	15.0	0.33
28	92.5	640.6	-115.8	29.9	-5.41	9.8	13.7	0.30
Absolute	92.5			29.9			(T =	42.3 ms)
	59.5				-6.48		(T =	61.5 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	623.8	514.0	404.1	294.2	184.3					
RX	711.8	683.1	654.4	626.8	606.7	602.4	598.2	594.0	589.7	585.5
RU	623.8	514.0	404.1	294.2	184.3					

RAU = 519.1 (kips); RA2 = 632.0 (kips)

Current CAPWAP Ru = 559.0 (kips); Corresponding J(RP)= 0.12; matches RX20 within 5%

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
14.9	35.97	568.9	604.3	604.3	1.04	0.14	0.14	30.3	619.0	1779

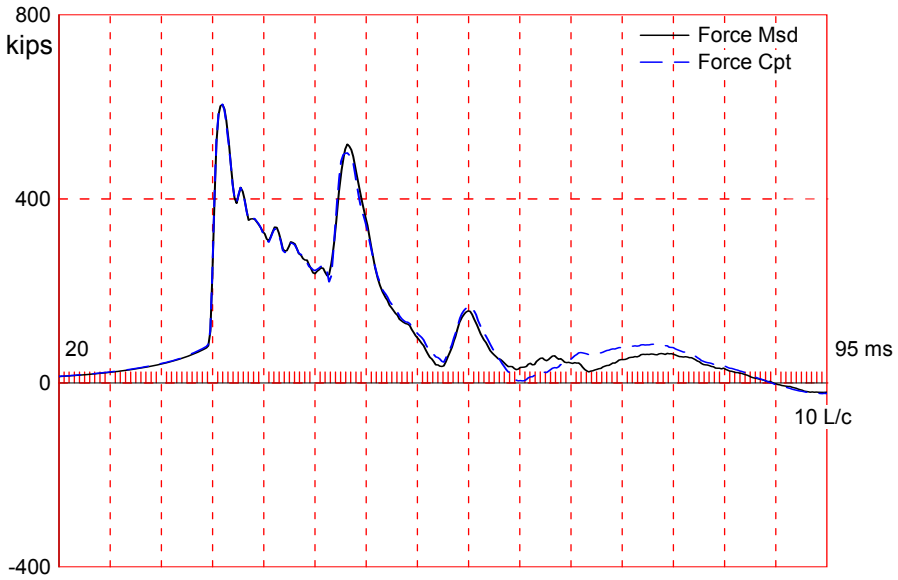
PILE PROFILE AND PILE MODEL

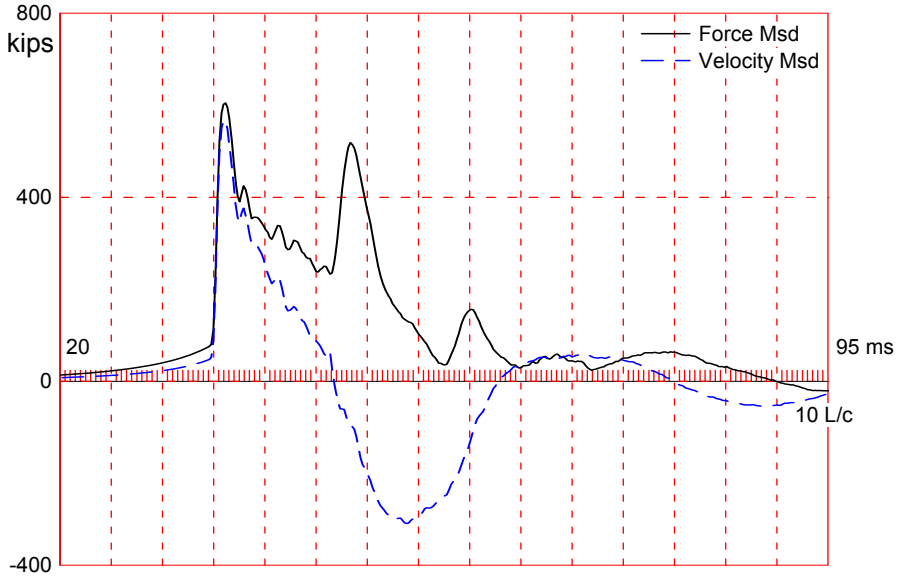
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.5	21.4	29992.2	492.000	4.70

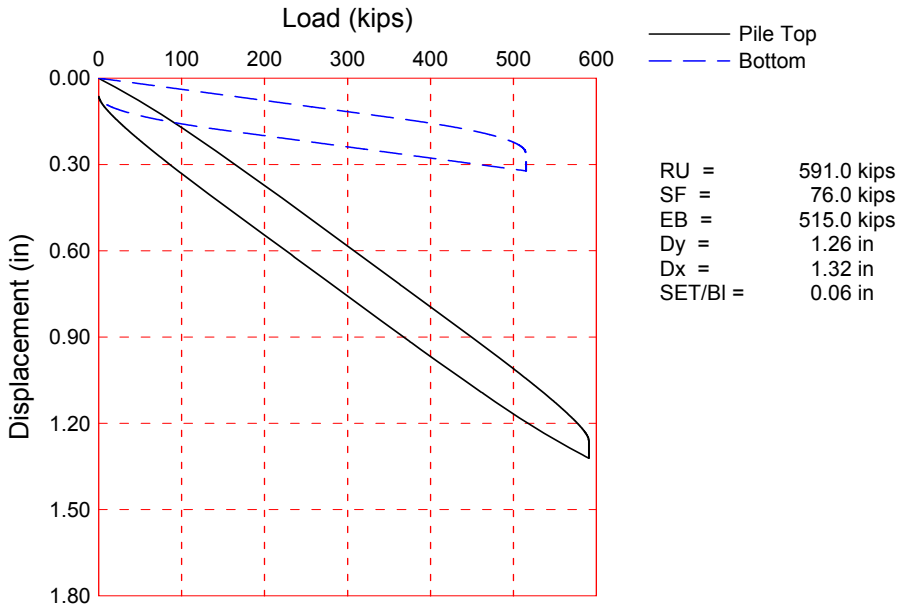
Toe Area 198.5 in^2

Top Segment Length 3.30 ft, Top Impedance 38 kips/ft/s

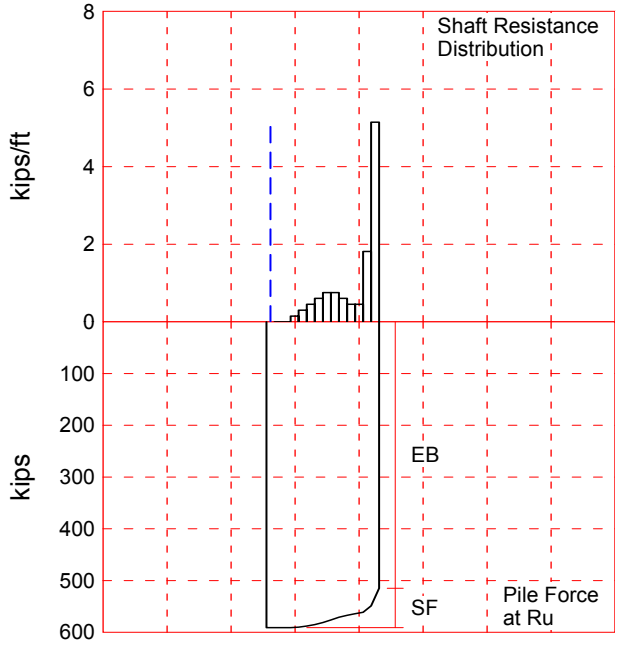
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.747 ft^3; Volume ratio considering added impedance: 1.000







RU =	591.0 kips
SF =	76.0 kips
EB =	515.0 kips
Dy =	1.26 in
Dx =	1.32 in
SET/Bl =	0.06 in



Length b. Sensors	92.5 ft
Embedment	86.2 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	3.83
Top Compr. Stress	28.3 ksi
Max Compr. Stress	32.5 ksi
Max Tension Stress	-5.82 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.20 in
Avg. Shaft Smith Dpg.	0.34 s/ft
Toe Smith Damping	0.13 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.

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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: 591.0; along Shaft 76.0; at Toe 515.0 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
				591.0				
1	13.2	6.9	0.0	591.0	0.0	0.00	0.00	0.00
2	19.8	13.5	0.0	591.0	0.0	0.00	0.00	0.00
3	26.4	20.1	1.0	590.0	1.0	0.15	0.03	0.34
4	33.0	26.7	2.0	588.0	3.0	0.30	0.06	0.34
5	39.6	33.3	3.0	585.0	6.0	0.45	0.10	0.34
6	46.3	39.9	4.0	581.0	10.0	0.61	0.13	0.34
7	52.9	46.5	5.0	576.0	15.0	0.76	0.16	0.34
8	59.5	53.1	5.0	571.0	20.0	0.76	0.16	0.34
9	66.1	59.8	4.0	567.0	24.0	0.61	0.13	0.34
10	72.7	66.4	3.0	564.0	27.0	0.45	0.10	0.34
11	79.3	73.0	3.0	561.0	30.0	0.45	0.10	0.34
12	85.9	79.6	12.0	549.0	42.0	1.82	0.39	0.34
13	92.5	86.2	34.0	515.0	76.0	5.15	1.10	0.34
Avg. Shaft			5.8			0.88	0.19	0.34
Toe			515.0				373.60	0.13

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.05	0.20
Case Damping Factor		0.68	1.75
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	41	51
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	44	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)		0.100

CAPWAP match quality = 3.83 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.06 in; Blow Count = 192 b/ft
Computed: Final Set = 0.02 in; Blow Count = 514 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.09; A4(K3550) CAL: 360; RF: 1.09

max. Top Comp. Stress = 28.3 ksi (T= 36.4 ms, max= 1.146 x Top)
max. Comp. Stress = 32.5 ksi (Z= 92.5 ft, T= 42.1 ms)
max. Tens. Stress = -5.82 ksi (Z= 79.3 ft, T= 62.5 ms)
max. Energy (EMX) = 30.3 kip-ft; max. Measured Top Displ. (DMX)= 1.01 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	606.4	-27.7	28.3	-1.29	30.3	14.8	0.99
2	6.6	607.2	-29.1	28.4	-1.36	30.0	14.8	0.97
4	13.2	609.0	-31.5	28.4	-1.47	29.5	14.7	0.93
6	19.8	612.2	-34.0	28.6	-1.59	29.0	14.6	0.89
8	26.4	617.9	-36.8	28.9	-1.72	28.3	14.5	0.85
10	33.0	619.8	-38.6	29.0	-1.81	27.1	14.3	0.80
12	39.6	618.2	-51.9	28.9	-2.42	25.5	14.0	0.74
14	46.3	613.0	-79.7	28.6	-3.72	23.8	13.7	0.68
15	49.6	596.4	-87.9	27.9	-4.11	22.3	13.5	0.65
16	52.9	603.5	-100.4	28.2	-4.69	21.6	13.3	0.62
17	56.2	581.6	-106.0	27.2	-4.95	20.0	13.2	0.59
18	59.5	587.7	-116.1	27.5	-5.43	19.3	13.0	0.56
19	62.8	565.6	-118.8	26.4	-5.55	17.7	12.9	0.52
20	66.1	570.7	-124.1	26.7	-5.80	17.0	12.7	0.49
21	69.4	567.6	-122.0	26.5	-5.70	15.6	12.6	0.46
22	72.7	577.9	-123.6	27.0	-5.78	14.7	12.5	0.42
23	76.0	575.8	-121.5	26.9	-5.68	13.5	12.3	0.38
24	79.3	606.5	-124.6	28.3	-5.82	12.6	12.0	0.35
25	82.6	622.4	-123.6	29.1	-5.77	11.4	11.7	0.31
26	85.9	627.5	-124.0	29.3	-5.79	10.5	11.9	0.28
27	89.2	638.2	-114.6	29.8	-5.35	8.7	11.9	0.24
28	92.5	695.2	-114.5	32.5	-5.35	6.9	10.4	0.21
Absolute	92.5			32.5			(T =	42.1 ms)
	79.3				-5.82		(T =	62.5 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	762.3	679.6	596.8	514.1	431.3					
RX	789.6	720.4	674.2	651.5	631.8	616.7	603.4	592.0	580.6	570.6
RU	767.8	686.1	604.5	522.8	441.2					

RAU = 444.6 (kips); RA2 = 654.4 (kips)

Current CAPWAP Ru = 591.0 (kips); Corresponding J(RP)= 0.41; J(RX) = 1.42

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
14.9	36.17	569.2	606.8	610.6	1.01	0.06	0.06	30.5	682.9	2711

PILE PROFILE AND PILE MODEL

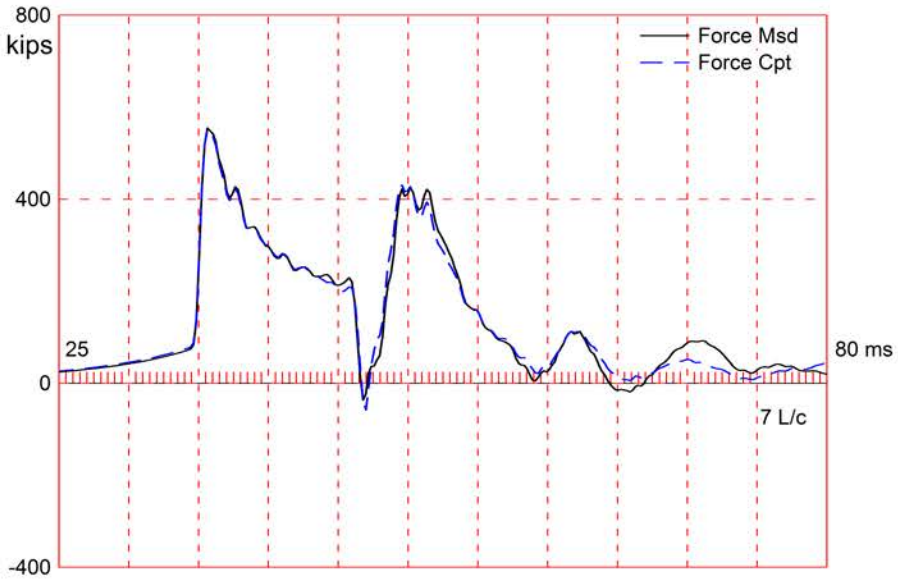
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.5	21.4	29992.2	492.000	4.70

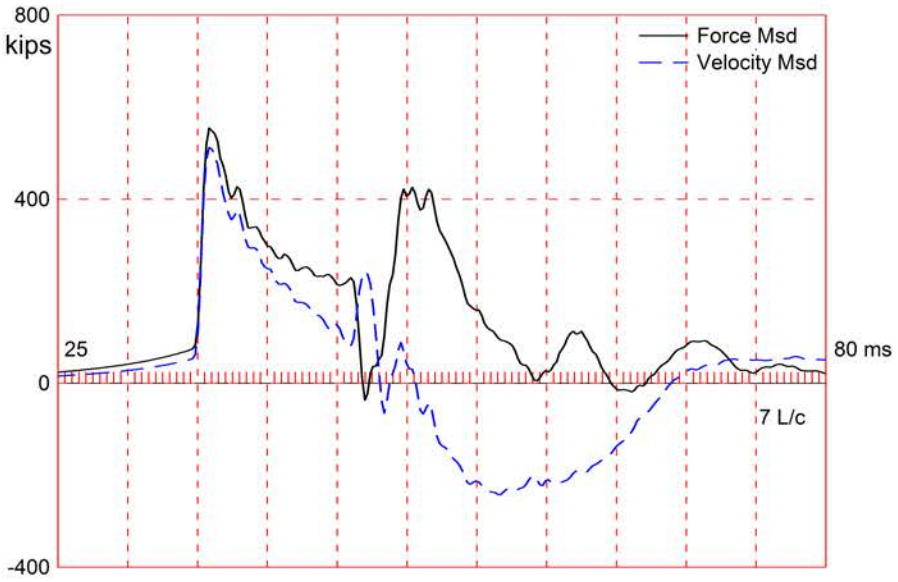
Toe Area 198.5 in^2

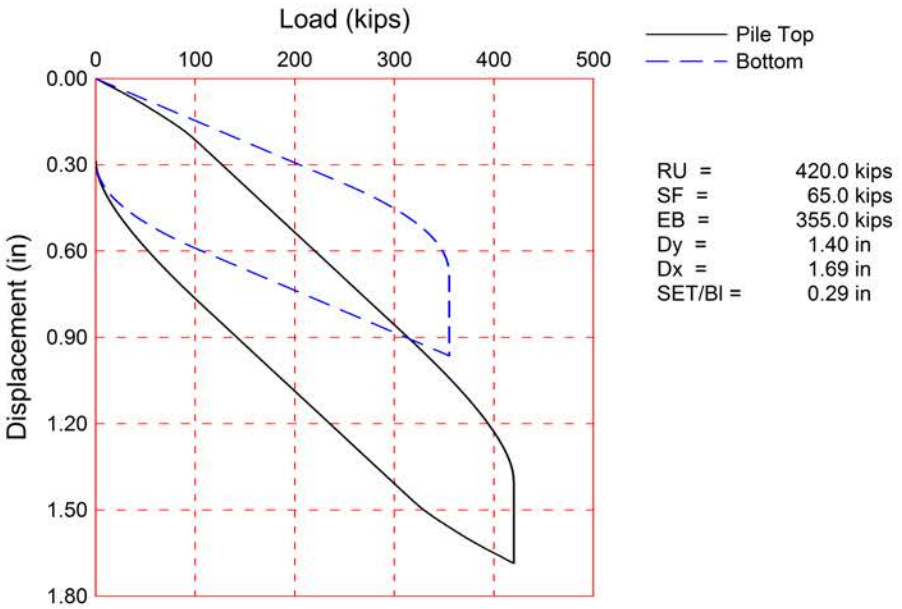
Top Segment Length 3.30 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.747 ft^3; Volume ratio considering added impedance: 1.000

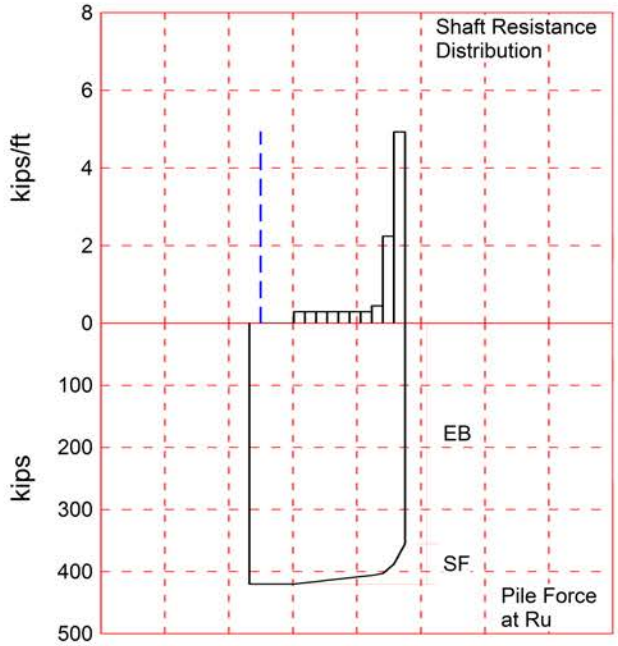
Match Quality Poor - Results May Be Unreliable!!!







RU =	420.0 kips
SF =	65.0 kips
EB =	355.0 kips
Dy =	1.40 in
Dx =	1.69 in
SET/Bl =	0.29 in



Length b. Sensors	93.7 ft
Embedment	83.7 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	6.37
Top Compr. Stress	25.7 ksi
Max Compr. Stress	26.0 ksi
Max Tension Stress	-4.37 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.52 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.11 s/ft

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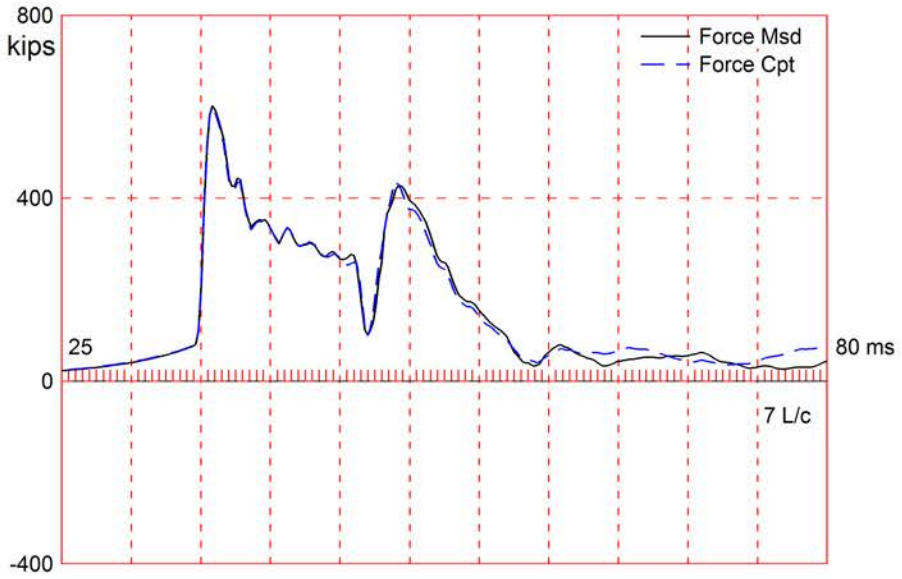
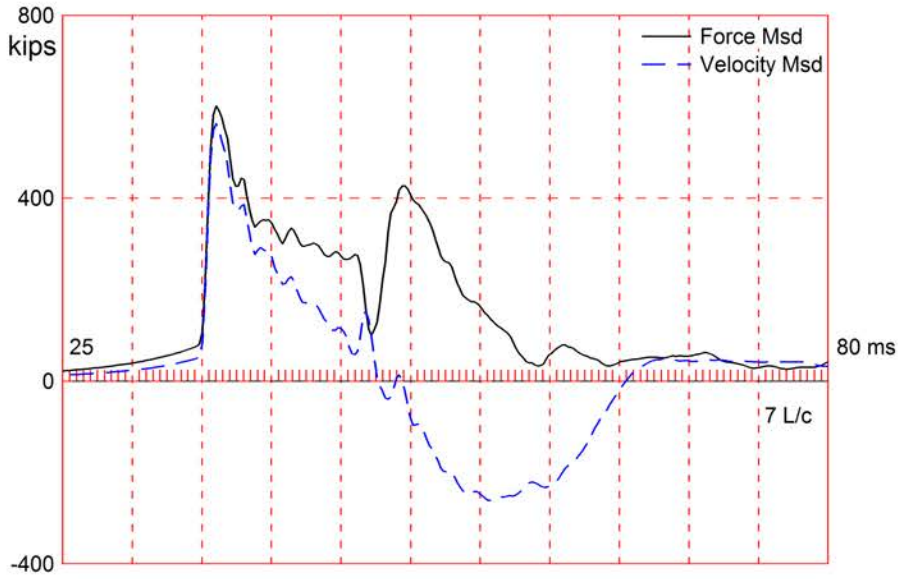
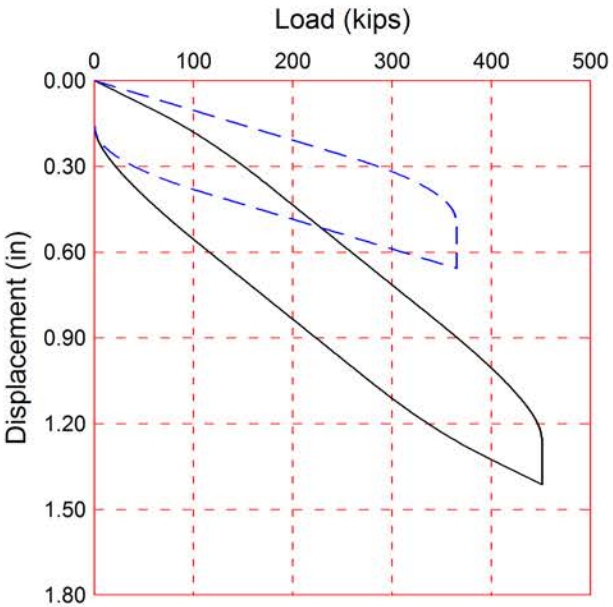
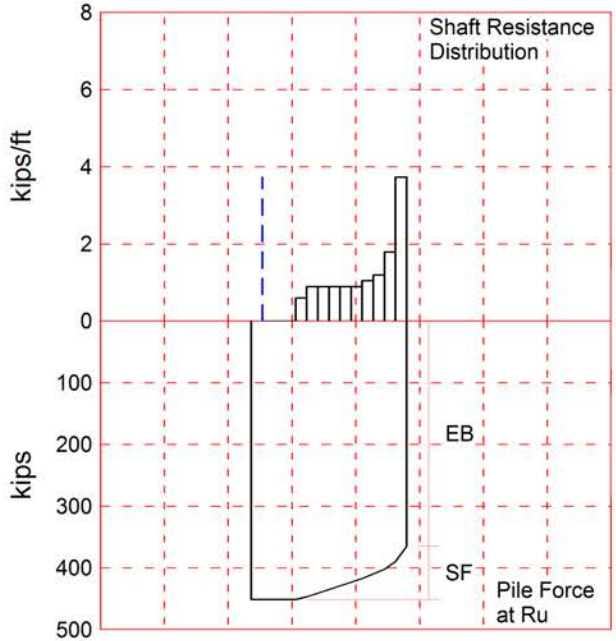






RU =	451.0 kips
SF =	86.0 kips
EB =	365.0 kips
Dy =	1.25 in
Dx =	1.41 in
SET/Bl =	0.16 in



Length b. Sensors	93.7 ft
Embedment	83.8 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	3.68
Top Compr. Stress	28.1 ksi
Max Compr. Stress	28.8 ksi
Max Tension Stress	-1.77 ksi
Avg. Shaft Quake	0.07 in
Toe Quake	0.38 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.14 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: 451.0; along Shaft 86.0; at Toe 365.0 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
				451.0				
1	13.4	3.6	0.0	451.0	0.0	0.00	0.00	0.00
2	20.1	10.2	0.0	451.0	0.0	0.00	0.00	0.00
3	26.8	16.9	0.0	451.0	0.0	0.00	0.00	0.00
4	33.5	23.6	4.0	447.0	4.0	0.60	0.13	0.28
5	40.1	30.3	6.0	441.0	10.0	0.90	0.19	0.28
6	46.8	37.0	6.0	435.0	16.0	0.90	0.19	0.28
7	53.5	43.7	6.0	429.0	22.0	0.90	0.19	0.28
8	60.2	50.4	6.0	423.0	28.0	0.90	0.19	0.28
9	66.9	57.1	6.0	417.0	34.0	0.90	0.19	0.28
10	73.6	63.8	7.0	410.0	41.0	1.05	0.22	0.28
11	80.3	70.5	8.0	402.0	49.0	1.20	0.25	0.28
12	87.0	77.2	12.0	390.0	61.0	1.79	0.38	0.28
13	93.7	83.8	25.0	365.0	86.0	3.74	0.80	0.28
Avg. Shaft			6.6			1.03	0.22	0.28
Toe			365.0				264.78	0.14

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.07	0.38
Case Damping Factor		0.63	1.34
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	93
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.07
Soil Plug Weight	(kips)		0.146

CAPWAP match quality = 3.68 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.16 in; Blow Count = 74 b/ft
Computed: Final Set = 0.13 in; Blow Count = 89 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.10; A4(K3550) CAL: 360; RF: 1.10

max. Top Comp. Stress = 28.1 ksi (T= 36.2 ms, max= 1.027 x Top)
max. Comp. Stress = 28.8 ksi (Z= 33.5 ft, T= 38.0 ms)
max. Tens. Stress = -1.77 ksi (Z= 33.5 ft, T= 99.5 ms)
max. Energy (EMX) = 31.2 kip-ft; max. Measured Top Displ. (DMX)= 1.06 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	600.9	-27.6	28.1	-1.29	31.2	14.8	1.06
2	6.7	601.6	-28.1	28.1	-1.31	31.1	14.8	1.04
4	13.4	603.0	-29.8	28.2	-1.39	30.6	14.7	1.00
6	20.1	604.5	-32.5	28.2	-1.52	29.9	14.6	0.96
8	26.8	607.8	-35.0	28.4	-1.63	29.3	14.5	0.92
10	33.5	617.4	-37.9	28.8	-1.77	28.5	14.2	0.87
12	40.1	609.6	-35.8	28.5	-1.67	26.8	13.9	0.82
14	46.8	592.1	-31.2	27.7	-1.46	24.6	13.6	0.76
15	50.2	569.9	-25.1	26.6	-1.17	22.9	13.4	0.74
16	53.5	574.7	-25.6	26.9	-1.20	22.5	13.3	0.71
17	56.9	552.9	-22.2	25.8	-1.04	20.9	13.1	0.68
18	60.2	557.6	-28.9	26.1	-1.35	20.4	12.9	0.66
19	63.6	536.0	-23.9	25.0	-1.12	18.9	12.8	0.63
20	66.9	540.9	-30.7	25.3	-1.43	18.4	12.6	0.60
21	70.3	520.5	-26.2	24.3	-1.22	17.0	12.4	0.58
22	73.6	525.8	-31.7	24.6	-1.48	16.5	12.3	0.55
23	76.9	502.0	-26.5	23.5	-1.24	15.0	12.1	0.52
24	80.3	509.4	-30.7	23.8	-1.44	14.6	11.9	0.50
25	83.6	483.4	-23.1	22.6	-1.08	13.1	12.6	0.47
26	87.0	482.5	-28.1	22.5	-1.31	12.6	13.7	0.44
27	90.3	486.6	-15.7	22.7	-0.73	10.9	14.6	0.42
28	93.7	501.0	-19.4	23.4	-0.91	8.7	14.1	0.39
Absolute	33.5			28.8			(T =	38.0 ms)
	33.5				-1.77		(T =	99.5 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	581.7	462.5	343.4	224.3	105.2					
RX	629.7	587.0	544.3	527.8	514.2	500.7	487.2	479.0	471.9	464.7
RU	581.7	462.5	343.4	224.3	105.2					

RAU = 408.9 (kips); RA2 = 548.8 (kips)

Current CAPWAP Ru = 451.0 (kips); Corresponding J(RP)= 0.22; matches RX20 within 5%

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
14.9	36.03	568.6	608.6	608.6	1.06	0.17	0.16	31.3	612.2	1177

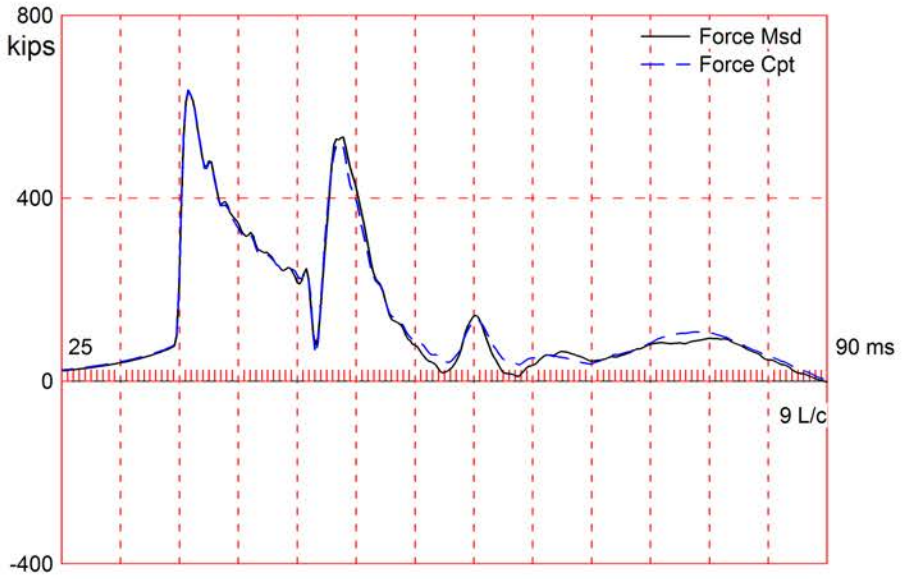
PILE PROFILE AND PILE MODEL

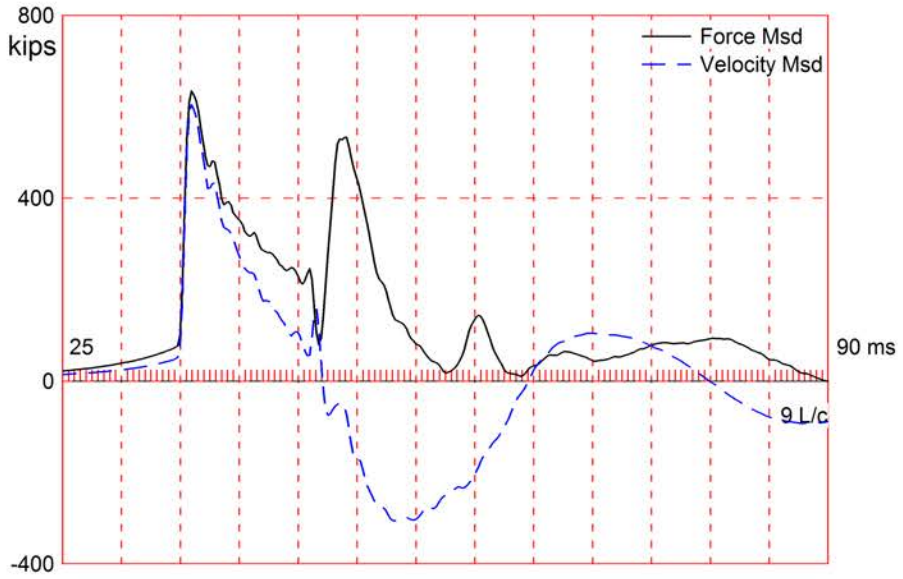
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
93.7	21.4	29992.2	492.000	4.70

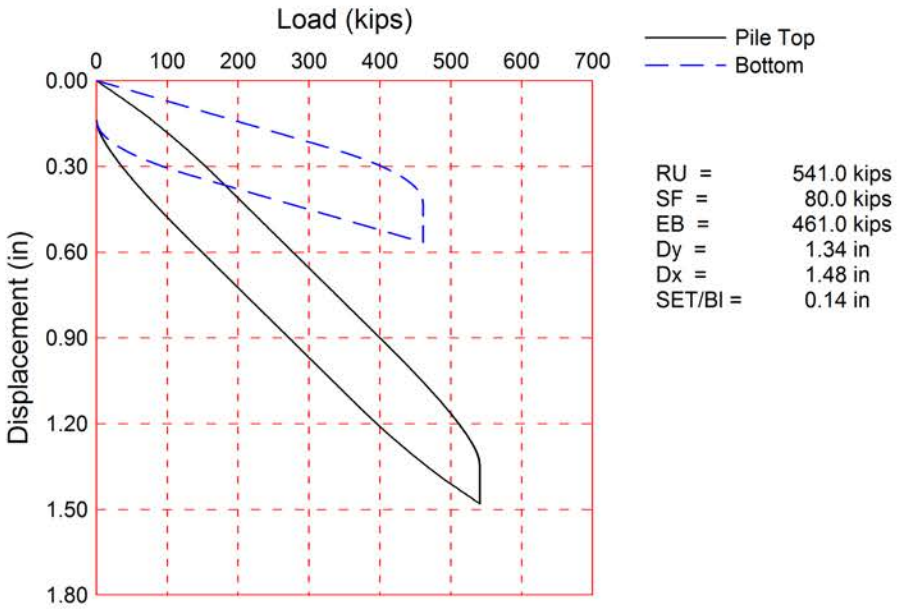
Toe Area 198.5 in^2

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

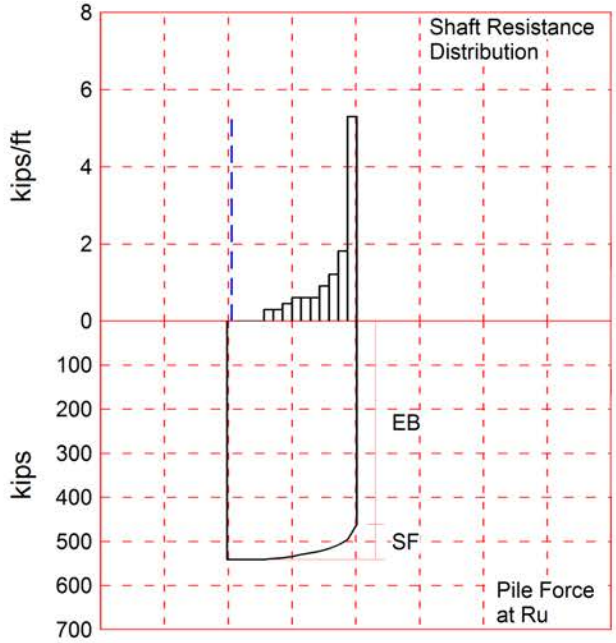
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 11.1 ms
Total volume: 13.920 ft^3; Volume ratio considering added impedance: 1.000







RU =	541.0 kips
SF =	80.0 kips
EB =	461.0 kips
Dy =	1.34 in
Dx =	1.48 in
SET/Bl =	0.14 in



Length b. Sensors	92.4 ft
Embedment	87.8 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	3.16
Top Compr. Stress	29.8 ksi
Max Compr. Stress	30.3 ksi
Max Tension Stress	-4.35 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.33 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.11 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 541.0; along Shaft 80.0; 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
				541.0				
1	13.2	8.6	0.0	541.0	0.0	0.00	0.00	0.00
2	19.8	15.2	0.0	541.0	0.0	0.00	0.00	0.00
3	26.4	21.8	0.0	541.0	0.0	0.00	0.00	0.00
4	33.0	28.4	2.0	539.0	2.0	0.30	0.06	0.28
5	39.6	35.0	2.0	537.0	4.0	0.30	0.06	0.28
6	46.2	41.6	3.0	534.0	7.0	0.45	0.10	0.28
7	52.8	48.2	4.0	530.0	11.0	0.61	0.13	0.28
8	59.4	54.8	4.0	526.0	15.0	0.61	0.13	0.28
9	66.0	61.4	4.0	522.0	19.0	0.61	0.13	0.28
10	72.6	68.0	6.0	516.0	25.0	0.91	0.19	0.28
11	79.2	74.6	8.0	508.0	33.0	1.21	0.26	0.28
12	85.8	81.2	12.0	496.0	45.0	1.82	0.39	0.28
13	92.4	87.8	35.0	461.0	80.0	5.30	1.13	0.28
Avg. Shaft			6.2			0.91	0.19	0.28
Toe			461.0				334.42	0.11

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.05	0.33
Case Damping Factor		0.59	1.33
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	104
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.07
Soil Plug Weight	(kips)		0.063

CAPWAP match quality = 3.16 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.14 in; Blow Count = 87 b/ft
Computed: Final Set = 0.10 in; Blow Count = 122 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.07; A4(K3550) CAL: 360; RF: 1.07

max. Top Comp. Stress = 29.8 ksi (T= 36.1 ms, max= 1.016 x Top)
max. Comp. Stress = 30.3 ksi (Z= 92.4 ft, T= 43.4 ms)
max. Tens. Stress = -4.35 ksi (Z= 79.2 ft, T= 62.8 ms)
max. Energy (EMX) = 34.4 kip-ft; max. Measured Top Displ. (DMX)= 1.11 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	637.5	-25.2	29.8	-1.18	34.4	15.8	1.10
2	6.6	638.0	-27.2	29.8	-1.27	34.3	15.7	1.09
4	13.2	638.9	-32.8	29.8	-1.53	33.8	15.7	1.05
6	19.8	639.9	-38.4	29.9	-1.80	33.3	15.6	1.01
8	26.4	641.7	-44.7	30.0	-2.09	32.7	15.6	0.97
10	33.0	646.8	-50.4	30.2	-2.35	32.0	15.4	0.92
12	39.6	641.6	-55.1	30.0	-2.57	30.6	15.2	0.87
14	46.2	638.4	-62.4	29.8	-2.91	29.1	15.0	0.82
15	49.5	628.0	-63.6	29.3	-2.97	27.8	14.9	0.79
16	52.8	631.6	-66.3	29.5	-3.10	27.2	14.7	0.76
17	56.1	616.1	-64.7	28.8	-3.02	25.7	14.6	0.73
18	59.4	619.6	-72.2	28.9	-3.37	25.0	14.5	0.70
19	62.7	604.4	-73.5	28.2	-3.43	23.4	14.3	0.66
20	66.0	608.9	-81.2	28.4	-3.79	22.7	14.2	0.63
21	69.3	595.4	-81.8	27.8	-3.82	21.2	14.0	0.60
22	72.6	602.7	-88.8	28.2	-4.15	20.4	13.9	0.56
23	75.9	581.3	-86.8	27.2	-4.06	18.6	13.6	0.53
24	79.2	595.6	-93.0	27.8	-4.35	17.8	13.6	0.49
25	82.5	605.0	-86.8	28.3	-4.05	15.8	15.2	0.46
26	85.8	634.6	-92.7	29.6	-4.33	15.1	16.5	0.43
27	89.1	632.2	-80.3	29.5	-3.75	12.9	16.9	0.40
28	92.4	647.8	-84.7	30.3	-3.96	9.8	15.7	0.36
Absolute	92.4			30.3			(T =	43.4 ms)
	79.2				-4.35		(T =	62.8 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	637.5	515.1	392.7	270.3	147.8					
RX	756.7	722.3	688.8	658.1	640.5	631.1	622.0	613.4	604.7	596.0
RU	637.5	515.1	392.7	270.3	147.8					

RAU = 406.6 (kips); RA2 = 674.1 (kips)

Current CAPWAP Ru = 541.0 (kips); Corresponding J(RP)= 0.16;

RMX requires higher damping; see PDA-W

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
16.0	35.94	609.3	640.2	640.2	1.11	0.14	0.14	34.6	663.8	1773

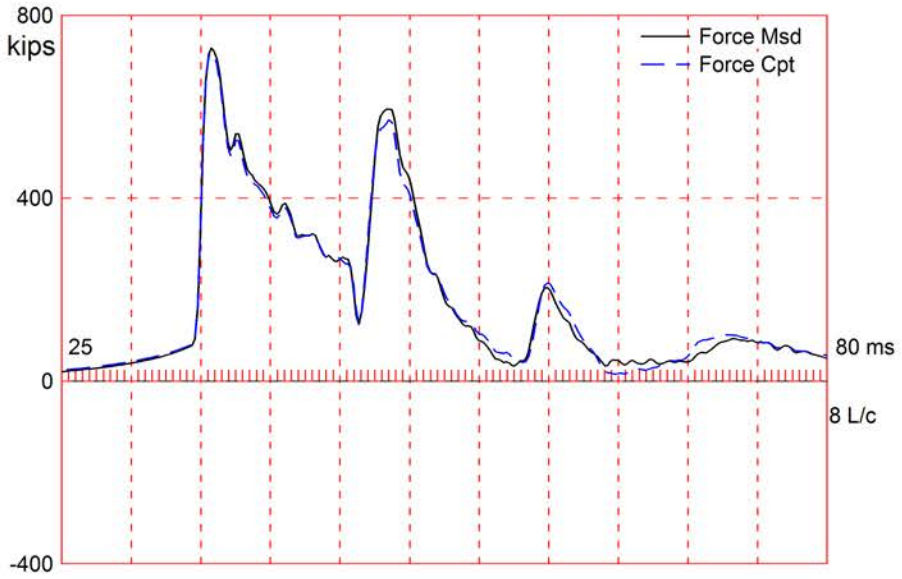
PILE PROFILE AND PILE MODEL

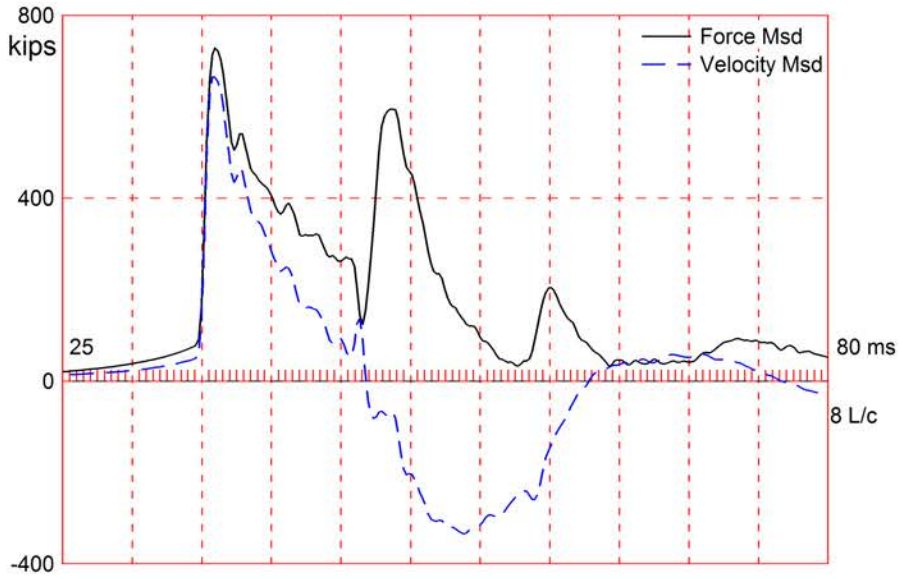
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.4	21.4	29992.2	492.000	4.70

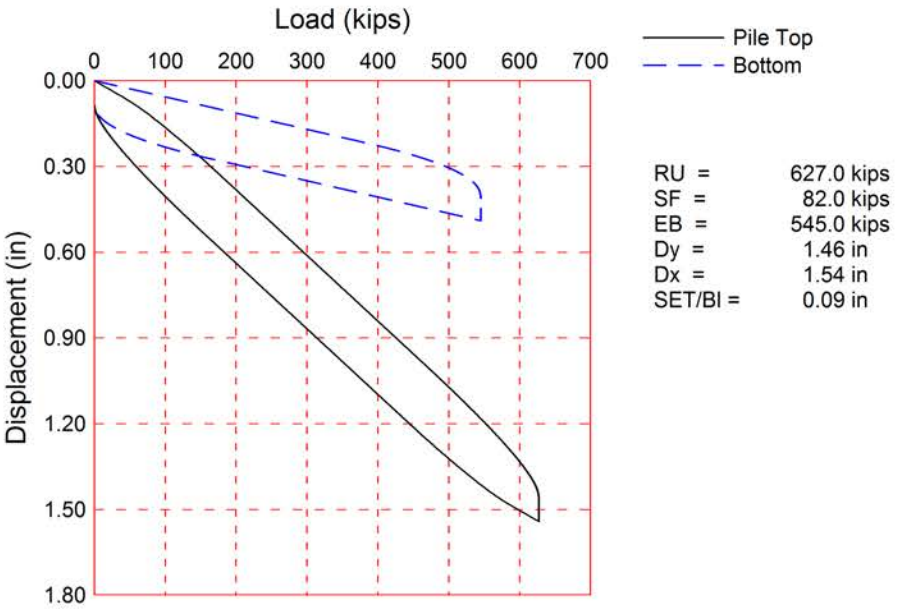
Toe Area 198.5 in^2

Top Segment Length 3.30 ft, Top Impedance 38 kips/ft/s

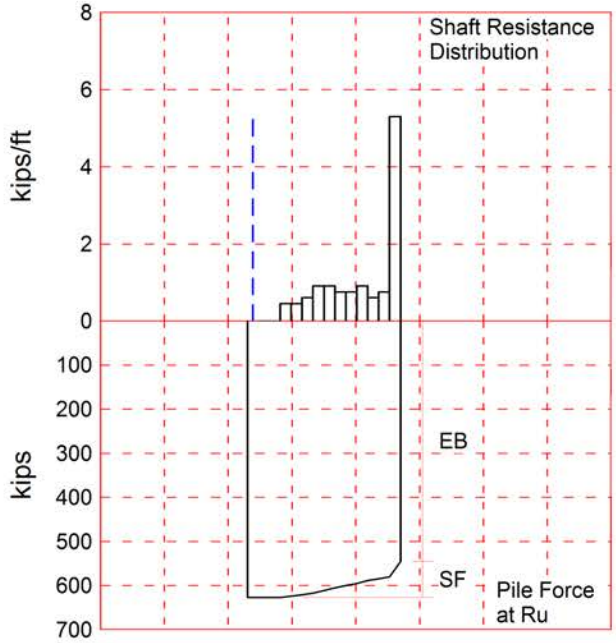
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.735 ft^3; Volume ratio considering added impedance: 1.000







RU =	627.0 kips
SF =	82.0 kips
EB =	545.0 kips
Dy =	1.46 in
Dx =	1.54 in
SET/Bl =	0.09 in



Length b. Sensors	92.4 ft
Embedment	87.9 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	33.5 ksi
Max Compr. Stress	36.2 ksi
Max Tension Stress	-5.80 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.31 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.11 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

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 82.0; at Toe 545.0 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
				627.0					
1	13.2	8.7	0.0	627.0	0.0	0.00	0.00	0.00	0.04
2	19.8	15.3	0.0	627.0	0.0	0.00	0.00	0.00	0.04
3	26.4	21.9	3.0	624.0	3.0	0.45	0.10	0.27	0.04
4	33.0	28.5	3.0	621.0	6.0	0.45	0.10	0.27	0.04
5	39.6	35.1	4.0	617.0	10.0	0.61	0.13	0.27	0.04
6	46.2	41.7	6.0	611.0	16.0	0.91	0.19	0.27	0.04
7	52.8	48.3	6.0	605.0	22.0	0.91	0.19	0.27	0.04
8	59.4	54.9	5.0	600.0	27.0	0.76	0.16	0.27	0.04
9	66.0	61.5	5.0	595.0	32.0	0.76	0.16	0.27	0.04
10	72.6	68.1	6.0	589.0	38.0	0.91	0.19	0.27	0.04
11	79.2	74.7	4.0	585.0	42.0	0.61	0.13	0.27	0.04
12	85.8	81.3	5.0	580.0	47.0	0.76	0.16	0.27	0.04
13	92.4	87.9	35.0	545.0	82.0	5.30	1.13	0.27	0.04
Avg. Shaft			6.3			0.93	0.20	0.27	0.04
Toe			545.0				395.36	0.11	0.31

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		0.58	1.57
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	68	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	14	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)		0.004

CAPWAP match quality = 2.86 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.09 in; Blow Count = 137 b/ft
Computed: Final Set = 0.06 in; Blow Count = 215 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.10; A4(K3550) CAL: 360; RF: 1.10

max. Top Comp. Stress = 33.5 ksi (T= 36.1 ms, max= 1.080 x Top)
max. Comp. Stress = 36.2 ksi (Z= 92.4 ft, T= 42.0 ms)
max. Tens. Stress = -5.80 ksi (Z= 72.6 ft, T= 60.9 ms)
max. Energy (EMX) = 42.6 kip-ft; max. Measured Top Displ. (DMX)= 1.16 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	717.6	-20.7	33.5	-0.97	42.6	17.7	1.15
2	6.6	718.5	-21.4	33.6	-1.00	42.4	17.6	1.13
4	13.2	720.3	-24.4	33.6	-1.14	41.8	17.6	1.09
6	19.8	724.3	-27.8	33.8	-1.30	41.1	17.5	1.05
8	26.4	732.6	-30.4	34.2	-1.42	40.4	17.2	1.01
10	33.0	724.5	-41.9	33.8	-1.96	38.6	17.0	0.95
12	39.6	719.5	-74.1	33.6	-3.46	36.6	16.7	0.89
14	46.2	711.7	-102.5	33.2	-4.79	34.4	16.3	0.84
15	49.5	687.1	-112.5	32.1	-5.26	32.1	16.1	0.80
16	52.8	692.8	-119.5	32.4	-5.58	31.3	15.9	0.77
17	56.1	667.6	-117.9	31.2	-5.51	29.0	15.8	0.73
18	59.4	673.1	-119.4	31.4	-5.58	28.2	15.6	0.70
19	62.7	653.7	-119.6	30.5	-5.59	26.3	15.4	0.66
20	66.0	659.9	-122.7	30.8	-5.73	25.4	15.3	0.63
21	69.3	641.7	-122.4	30.0	-5.72	23.5	15.1	0.59
22	72.6	647.1	-124.2	30.2	-5.80	22.6	14.9	0.55
23	75.9	629.6	-120.6	29.4	-5.63	20.5	14.8	0.51
24	79.2	659.1	-123.0	30.8	-5.75	19.5	14.6	0.48
25	82.5	688.4	-120.8	32.2	-5.64	17.9	16.0	0.44
26	85.8	705.5	-122.2	33.0	-5.71	16.9	16.9	0.40
27	89.1	708.0	-121.8	33.1	-5.69	15.3	16.6	0.36
28	92.4	775.1	-123.2	36.2	-5.76	12.4	14.5	0.32
Absolute	92.4			36.2			(T =	42.0 ms)
	72.6				-5.80		(T =	60.9 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	785.7	663.3	541.0	418.6	296.3					
RX	894.1	816.2	774.1	743.7	714.4	691.8	675.0	660.4	645.9	631.3
RU	785.7	663.3	541.0	418.6	296.3					

RAU = 478.8 (kips); RA2 = 775.9 (kips)

Current CAPWAP Ru = 627.0 (kips); Corresponding J(RP)= 0.26; J(RX) = 1.86

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
17.6	35.74	671.4	726.0	729.7	1.16	0.09	0.09	42.6	819.2	1817

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
92.4	21.4	29992.2	492.000	4.70

Toe Area 198.5 in^2

Top Segment Length 3.30 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 0.196 ms, 2L/c 11.0 ms
Total volume: 13.735 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Al Ziai
Company: Lunda Construction Co.	No. of Sheets: 55
E-mail: kweber@lundaconstruction.com	Date: December 19, 2014

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 5
Winnebago County, Wisconsin

On December 17, 2014, Pier 5 #1, Pier 5 #36, and Pier 5 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on December 18. 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 elevation for the piles was the top of the ring at EL 740.4. We understand the pier was excavated to two to three feet below the bottom of footing elevation of EL 720.5. The piles have a required minimum tip elevation of EL 663. 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 5 #1 was driven to a depth of 87.9 feet, which corresponds to a pile tip elevation of EL 652.5. The blow count over the final increment of driving was 10 blows for 1¾ inches of penetration at an average hammer stroke of 7.3 feet. The blow count at the beginning of restrike was 5 blows for ⅝ inch of penetration at an average hammer stroke of 7.9 feet.

Pier 5 #36 was driven to a depth of 86.7 feet, which corresponds to a pile tip elevation of EL 653.7. The blow count over the final increment of driving was 10 blows for ¾ inch of penetration at an average hammer stroke of 7.6 feet. The blow count at the beginning of restrike was 5 blows for ⅝ inch of penetration at an average hammer stroke of 7.5 feet

Pier 5 #44 was driven to a depth of 87.0 feet, which corresponds to a pile tip elevation of EL 653.4. The blow count over the final increment of driving was 43 blows per foot at an average hammer stroke of 7.2 feet. The blow count at the beginning of restrike was 5 blows for ⅝ 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 5 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	7	5
7.0	5	4
7.5	5	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.

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 – 25)
CAPWAP Analysis Results - (pages 26 – 55)

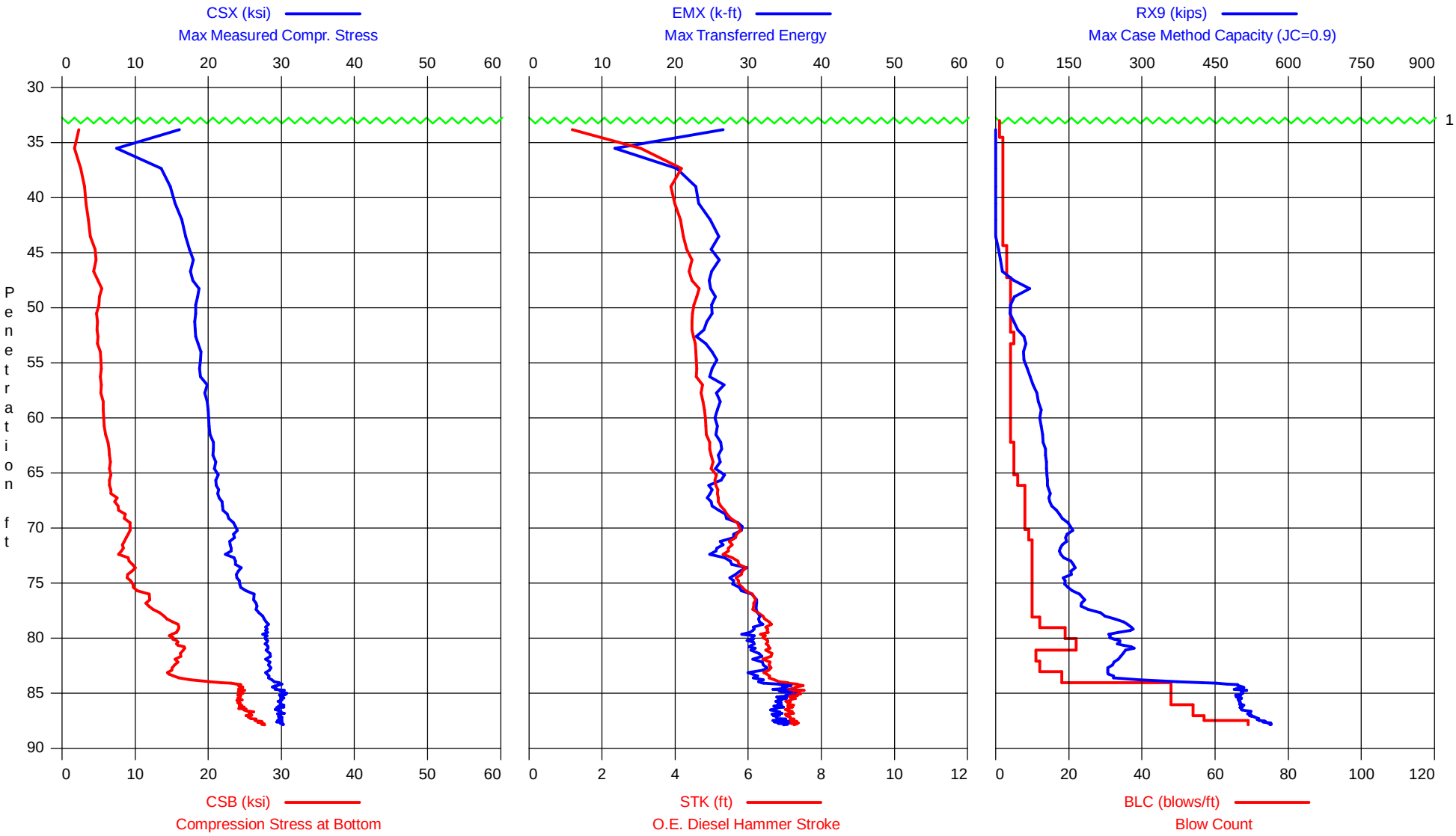
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 18-Dec-2014

Test date: 17-Dec-2014

USH 10 - B-70-403 - Pier 5 #1 - EOID

APE D30-42, HP 14 x 73



1 - Reported reference EL 740.39

USH 10 - B-70-403 - Pier 5 #1 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

AR: 21.40 in^2
LE: 88.90 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
1	33.00	1	AV1	16.0	1.8	**	21	**	0
			MAX	16.0	1.8	**	21	**	0
			MIN	16.0	1.8	**	21	**	0
2	34.00	1	AV1	18.8	2.8	**	39	**	0
			MAX	18.8	2.8	**	39	**	0
			MIN	18.8	2.8	**	39	**	0
4	35.00	2	AV2	11.7	2.2	3.4	17	63	0
			STD	1.6	0.2	0.2	2	1	0
			MAX	13.3	2.4	3.6	20	64	0
			MIN	10.1	2.0	3.2	15	61	0
6	36.00	2	AV2	6.2	1.6	3.0	10	67	0
			STD	0.4	0.0	0.0	0	0	0
			MAX	6.6	1.6	3.0	11	67	0
			MIN	5.8	1.5	3.0	10	67	0
8	37.00	2	AV1	2.6	0.8	2.9	2	67	0
			MAX	2.6	0.8	2.9	2	67	0
			MIN	2.6	0.8	2.9	2	67	0
10	38.00	2	AV2	19.0	3.4	4.8	29	54	0
			STD	3.9	0.5	1.0	8	5	0
			MAX	22.9	4.0	5.8	37	59	0
			MIN	15.1	2.9	3.8	21	49	0
12	39.00	2	AV2	13.9	2.9	3.8	21	60	0
			STD	0.7	0.1	0.1	2	1	0
			MAX	14.6	3.1	3.9	23	61	0
			MIN	13.2	2.8	3.6	20	59	0
14	40.00	2	AV2	16.2	3.3	4.1	25	57	0
			STD	0.3	0.1	0.0	1	0	0
			MAX	16.5	3.4	4.2	26	58	0
			MIN	15.9	3.2	4.1	23	57	0
16	41.00	2	AV2	15.2	3.3	3.9	23	58	0
			STD	0.4	0.0	0.1	1	1	0
			MAX	15.6	3.3	4.1	24	59	0
			MIN	14.8	3.3	3.8	22	58	0
18	42.00	2	AV2	16.2	3.5	4.1	24	57	0
			STD	1.1	0.2	0.2	2	1	0
			MAX	17.4	3.7	4.3	26	58	0
			MIN	15.1	3.3	3.9	23	56	0
20	43.00	2	AV2	16.7	3.8	4.2	26	57	0
			STD	0.0	0.0	0.0	0	0	0
			MAX	16.8	3.8	4.2	26	57	0
			MIN	16.7	3.8	4.2	26	57	0
22	44.00	2	AV2	17.0	3.9	4.2	26	57	0
			STD	0.0	0.1	0.0	1	0	0
			MAX	17.0	4.1	4.2	27	57	0
			MIN	17.0	3.8	4.2	26	57	0
25	45.00	3	AV3	17.4	4.5	4.3	25	56	5
			STD	0.3	0.2	0.1	0	0	4
			MAX	17.7	4.7	4.4	25	56	11
			MIN	17.0	4.3	4.3	25	56	0
28	46.00	3	AV3	18.0	4.6	4.5	26	55	10
			STD	0.1	0.1	0.0	0	0	3
			MAX	18.1	4.7	4.5	26	55	13
			MIN	17.9	4.5	4.5	26	55	7
31	47.00	3	AV3	17.6	4.3	4.4	25	56	14
			STD	0.4	0.1	0.1	0	1	9
			MAX	18.2	4.4	4.5	26	56	25
			MIN	17.1	4.2	4.3	25	55	5

USH 10 - B-70-403 - Pier 5 #1 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
35	48.00	4	AV4	18.3	5.0	4.5	25	55	45
			STD	0.8	0.2	0.2	1	1	15
			MAX	19.4	5.3	4.8	27	56	70
			MIN	17.3	4.8	4.4	23	53	29
39	49.00	4	AV4	18.6	5.4	4.6	25	54	56
			STD	0.4	0.2	0.1	1	1	14
			MAX	19.1	5.6	4.7	26	55	74
			MIN	18.0	5.0	4.5	23	54	41
43	50.00	4	AV4	18.3	4.9	4.5	25	55	29
			STD	0.5	0.2	0.1	1	1	4
			MAX	18.9	5.2	4.7	27	56	34
			MIN	17.4	4.8	4.3	24	54	24
47	51.00	4	AV4	18.2	4.8	4.5	25	55	31
			STD	0.5	0.2	0.1	1	1	3
			MAX	18.8	5.0	4.6	26	56	37
			MIN	17.4	4.5	4.3	24	55	28
51	52.00	4	AV4	18.2	4.7	4.5	25	55	37
			STD	0.7	0.2	0.1	1	1	5
			MAX	19.1	4.9	4.6	26	56	43
			MIN	17.3	4.5	4.3	23	54	31
56	53.00	5	AV5	18.4	4.9	4.5	23	55	61
			STD	0.4	0.2	0.1	1	0	5
			MAX	18.8	5.2	4.6	24	55	70
			MIN	17.8	4.7	4.5	22	54	53
60	54.00	4	AV4	18.3	5.0	4.5	24	55	57
			STD	0.7	0.3	0.2	1	1	6
			MAX	19.4	5.5	4.7	26	56	65
			MIN	17.6	4.8	4.3	23	54	50
64	55.00	4	AV4	19.4	5.4	4.6	26	54	58
			STD	0.9	0.3	0.1	1	1	4
			MAX	20.7	5.7	4.8	27	55	63
			MIN	18.3	4.9	4.4	24	53	51
68	56.00	4	AV4	18.8	5.4	4.6	25	55	65
			STD	0.5	0.3	0.1	1	1	4
			MAX	19.5	5.8	4.8	27	55	69
			MIN	18.2	4.9	4.5	24	53	59
72	57.00	4	AV4	19.6	5.2	4.7	26	54	74
			STD	0.8	0.3	0.1	2	1	4
			MAX	20.9	5.6	4.9	28	55	80
			MIN	18.8	4.9	4.6	24	53	69
76	58.00	4	AV4	19.5	5.3	4.7	26	54	83
			STD	0.2	0.0	0.0	0	0	3
			MAX	19.6	5.4	4.8	26	54	86
			MIN	19.3	5.3	4.6	25	54	79
80	59.00	4	AV4	19.8	5.6	4.8	26	54	89
			STD	0.1	0.1	0.0	1	0	4
			MAX	19.9	5.7	4.8	27	54	95
			MIN	19.6	5.5	4.7	25	53	85
84	60.00	4	AV4	20.1	5.6	4.8	26	53	91
			STD	0.3	0.1	0.0	0	0	1
			MAX	20.4	5.8	4.9	26	53	93
			MIN	19.7	5.5	4.8	25	53	90
88	61.00	4	AV4	20.1	5.8	4.8	26	53	93
			STD	0.2	0.1	0.0	0	0	1
			MAX	20.4	6.0	4.9	26	54	94
			MIN	19.8	5.6	4.8	25	53	90
92	62.00	4	AV4	20.5	6.1	4.9	26	53	96
			STD	0.5	0.2	0.1	1	0	2
			MAX	21.2	6.3	5.0	28	53	100
			MIN	19.9	5.9	4.8	25	52	94

USH 10 - B-70-403 - Pier 5 #1 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
97	63.00	5	AV5	20.6	6.3	4.9	26	53	100
			STD	0.5	0.3	0.1	1	0	3
			MAX	21.4	6.8	5.1	28	53	104
			MIN	19.8	6.0	4.8	25	52	94
102	64.00	5	AV5	20.7	6.6	5.0	26	52	102
			STD	0.4	0.2	0.1	1	0	2
			MAX	21.3	6.9	5.1	27	53	104
			MIN	20.2	6.4	4.9	25	52	99
107	65.00	5	AV5	21.1	6.5	5.0	26	52	104
			STD	0.3	0.2	0.1	1	0	3
			MAX	21.6	6.9	5.2	28	53	106
			MIN	20.7	6.2	5.0	25	52	99
113	66.00	6	AV6	21.1	6.5	5.1	26	52	105
			STD	0.2	0.2	0.0	0	0	2
			MAX	21.4	6.8	5.1	26	52	107
			MIN	20.8	6.2	5.1	26	52	102
121	67.00	8	AV8	21.3	6.7	5.2	25	52	109
			STD	0.3	0.2	0.1	1	0	2
			MAX	21.7	7.0	5.2	26	52	115
			MIN	20.7	6.3	5.1	24	51	107
129	68.00	8	AV8	21.7	7.4	5.2	25	51	110
			STD	0.3	0.3	0.1	0	0	3
			MAX	22.2	7.8	5.3	25	52	115
			MIN	21.1	6.8	5.1	24	51	106
137	69.00	8	AV8	22.3	8.2	5.4	26	51	127
			STD	0.6	0.5	0.1	1	0	5
			MAX	23.9	9.4	5.7	28	51	135
			MIN	21.9	7.4	5.3	26	49	117
145	70.00	8	AV8	23.5	9.1	5.7	29	49	148
			STD	0.5	0.4	0.1	1	1	8
			MAX	24.1	9.6	5.9	30	50	158
			MIN	22.7	8.4	5.5	26	49	136
154	71.00	9	AV9	23.7	9.0	5.7	28	49	149
			STD	0.4	0.3	0.1	1	0	7
			MAX	24.2	9.6	5.9	30	50	162
			MIN	23.1	8.6	5.5	26	48	140
164	72.00	10	AV10	23.1	8.4	5.5	26	50	138
			STD	0.6	0.3	0.1	1	1	6
			MAX	24.0	9.0	5.8	28	51	146
			MIN	22.5	7.8	5.3	25	49	131
174	73.00	10	AV10	23.0	8.4	5.5	26	50	138
			STD	0.8	0.8	0.2	2	1	9
			MAX	24.2	9.7	5.8	29	52	157
			MIN	21.9	7.4	5.2	24	49	129
184	74.00	10	AV10	24.1	9.7	5.8	29	49	159
			STD	0.3	0.4	0.1	1	0	6
			MAX	24.6	10.3	6.0	30	49	166
			MIN	23.6	9.2	5.7	27	48	148
194	75.00	10	AV10	23.9	9.1	5.7	28	49	144
			STD	0.4	0.2	0.1	1	0	8
			MAX	24.7	9.6	5.9	29	50	158
			MIN	23.3	8.8	5.5	26	48	134
204	76.00	10	AV10	25.1	10.3	5.9	29	48	154
			STD	0.7	0.7	0.1	1	1	10
			MAX	26.3	11.8	6.1	31	49	179
			MIN	23.8	9.5	5.6	27	48	142
214	77.00	10	AV8	26.4	11.8	6.2	31	47	178
			STD	0.4	0.4	0.1	1	0	5
			MAX	26.7	12.4	6.3	32	48	187
			MIN	25.5	11.3	6.1	30	47	170

USH 10 - B-70-403 - Pier 5 #1 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
224	78.00	10	AV10	26.9	12.9	6.3	31	47	202
			STD	0.6	0.7	0.2	1	1	18
			MAX	28.0	14.0	6.5	32	48	226
			MIN	25.8	11.8	5.9	30	46	176
236	79.00	12	AV12	27.8	15.2	6.5	31	46	259
			STD	0.4	0.8	0.1	1	0	16
			MAX	28.3	16.4	6.7	33	47	283
			MIN	27.1	13.8	6.3	29	46	227
255	80.00	19	AV19	27.9	15.4	6.5	30	46	253
			STD	0.5	0.5	0.1	1	1	21
			MAX	28.9	16.2	6.8	33	47	285
			MIN	27.0	14.0	6.1	28	45	225
277	81.00	22	AV22	28.0	16.0	6.5	31	46	261
			STD	0.4	0.6	0.1	1	0	14
			MAX	28.8	17.1	6.8	33	47	288
			MIN	27.3	15.0	6.3	27	45	239
288	82.00	11	AV11	28.2	16.1	6.5	31	46	258
			STD	0.5	0.5	0.1	1	0	6
			MAX	28.9	16.9	6.8	33	47	268
			MIN	27.4	15.2	6.3	29	45	249
300	83.00	12	AV12	28.4	15.3	6.6	32	46	236
			STD	0.6	0.5	0.2	1	1	7
			MAX	29.6	16.1	6.9	34	47	246
			MIN	27.3	14.3	6.3	30	45	223
318	84.00	18	AV18	28.4	16.3	6.6	31	46	268
			STD	0.5	2.1	0.2	1	1	53
			MAX	29.4	20.9	7.0	33	47	389
			MIN	27.3	14.3	6.3	30	45	218
366	85.00	48	AV48	29.6	24.2	7.3	35	44	492
			STD	0.7	0.8	0.2	2	1	24
			MAX	30.9	25.1	7.8	38	45	522
			MIN	28.4	21.6	7.0	31	42	418
414	86.00	48	AV48	30.0	24.3	7.2	35	44	500
			STD	0.5	0.4	0.2	1	0	5
			MAX	31.3	25.4	7.5	37	45	510
			MIN	28.8	23.3	6.9	33	43	488
468	87.00	54	AV54	29.8	25.1	7.1	34	44	512
			STD	0.6	0.7	0.1	1	0	10
			MAX	31.1	27.2	7.5	36	45	535
			MIN	28.6	23.9	6.9	32	43	491
493	87.44	57	AV21	29.8	25.9	7.1	34	44	532
			STD	0.5	0.6	0.2	1	0	9
			MAX	30.8	26.9	7.4	36	45	545
			MIN	28.9	24.6	6.9	32	44	514
503	87.58	69	AV10	29.8	26.7	7.2	34	44	547
			STD	0.5	0.6	0.1	1	0	7
			MAX	30.8	27.8	7.5	37	44	558
			MIN	28.9	25.6	7.1	33	43	539
513	87.73	69	AV10	29.9	27.1	7.3	35	44	556
			STD	0.6	0.5	0.2	1	0	8
			MAX	30.9	27.9	7.5	36	45	565
			MIN	28.8	26.3	6.9	33	43	542
523	87.88	69	AV10	30.1	27.5	7.3	35	44	563
			STD	0.4	0.4	0.1	1	0	4
			MAX	31.0	28.1	7.4	36	44	569
			MIN	29.6	26.9	7.1	34	43	557
			Average	25.8	15.7	6.2	30	48	290
			Std. Dev.	4.8	8.3	1.1	4	4	192
			Maximum	31.3	28.1	7.8	39	67	569
			Minimum	2.6	0.8	2.9	2	42	0

Total number of blows analyzed: 516

BL#	depth (ft)	Comments
1	33.00	Reported reference EL 740.39

Time Summary

Drive	12 minutes 25 seconds	3:17:02 PM - 3:29:27 PM (12/17/2014)	BN 1 - 523

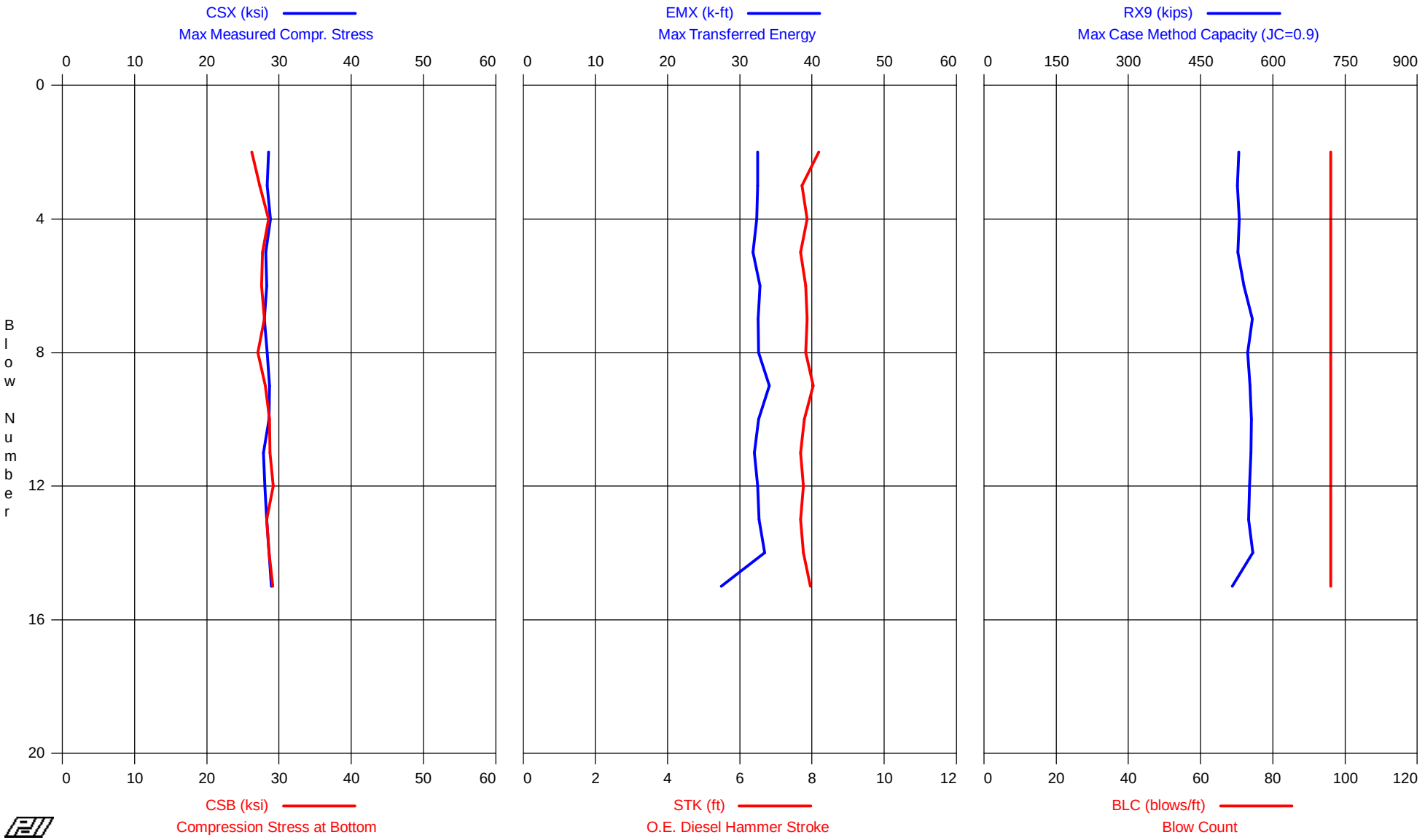
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 18-Dec-2014

Test date: 18-Dec-2014

USH 10 - B-70-403 - Pier 5 #1 - BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 5 #1 - BOR
OP: AZ

APE D30-42, HP 14 x 73
Test date: 18-Dec-2014

AR: 21.40 in^2
LE: 88.90 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
5	87.93	96	AV4	28.5	27.4	7.9	32	42	528
			STD	0.2	0.8	0.2	0	1	2
			MAX	28.8	28.6	8.2	32	43	530
			MIN	28.2	26.2	7.7	32	41	526
10	87.98	96	AV5	28.4	27.9	7.9	33	42	551
			STD	0.3	0.5	0.1	1	0	6
			MAX	28.7	28.7	8.0	34	42	557
			MIN	27.9	27.1	7.8	33	42	540
15	88.03	96	AV5	28.3	28.8	7.8	32	42	546
			STD	0.4	0.4	0.1	2	0	15
			MAX	28.9	29.2	7.9	33	43	558
			MIN	27.8	28.3	7.7	27	42	516
			Average	28.4	28.1	7.8	32	42	543
			Std. Dev.	0.3	0.8	0.1	1	0	14
			Maximum	28.9	29.2	8.2	34	43	558
			Minimum	27.8	26.2	7.7	27	41	516

Total number of blows analyzed: 14

Time Summary

Drive 20 seconds 7:54:37 AM - 7:54:57 AM (12/18/2014) BN 1 - 15

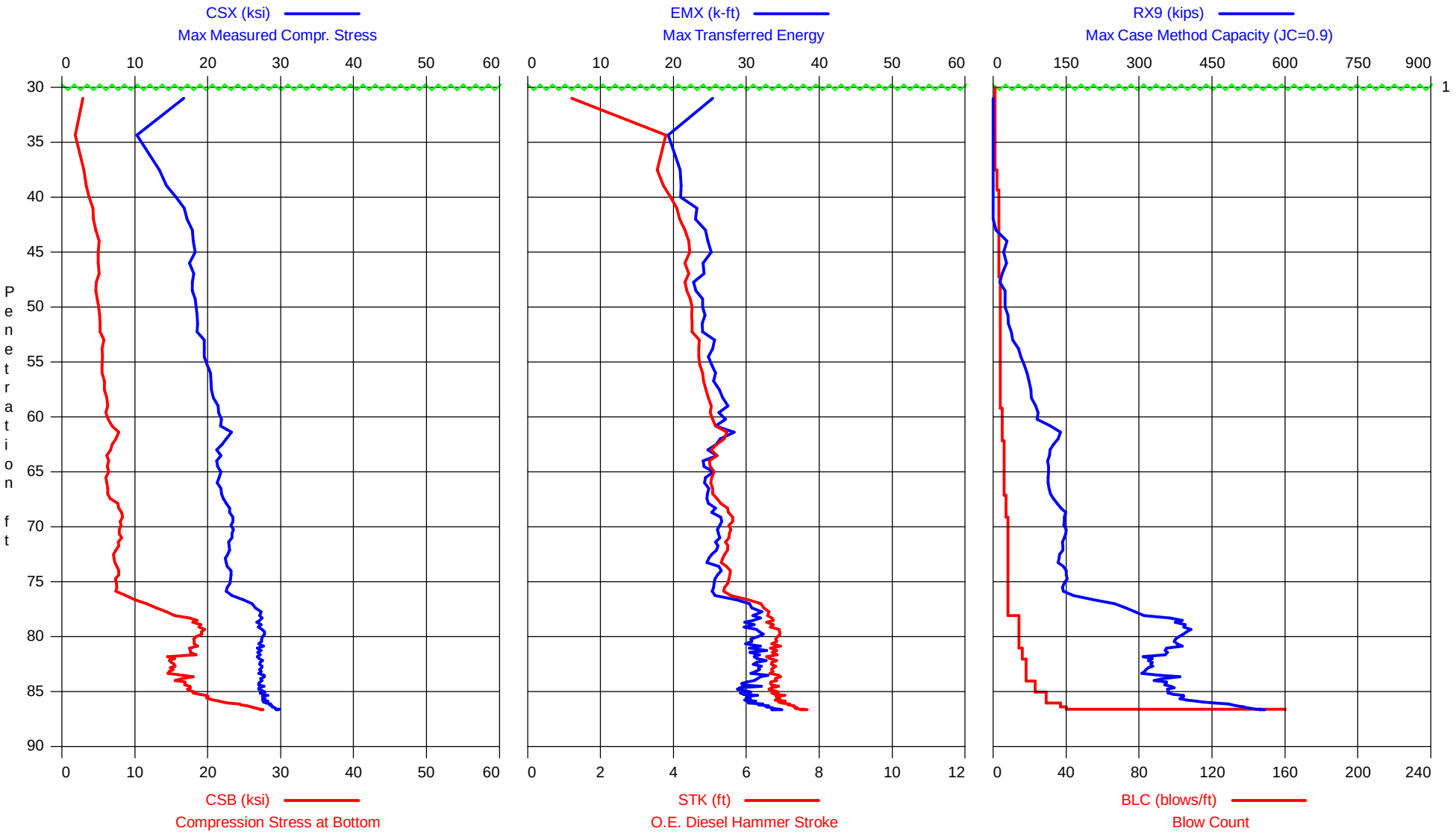
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 18-Dec-2014

Test date: 17-Dec-2014

USH 10 - B-70-403 - Pier 5 #36 - EOID

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 5 #36 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

AR: 21.40 in^2
LE: 88.70 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
1	30.00	1	AV1	17.4	2.7	**	17	**	0
			MAX	17.4	2.7	**	17	**	0
			MIN	17.4	2.7	**	17	**	0
2	31.00	1	AV1	19.2	3.5	**	37	**	0
			MAX	19.2	3.5	**	37	**	0
			MIN	19.2	3.5	**	37	**	0
3	32.00	1	AV1	13.6	2.5	3.6	21	61	0
			MAX	13.6	2.5	3.6	21	61	0
			MIN	13.6	2.5	3.6	21	61	0
4	33.00	1	AV1	7.9	1.6	3.0	13	66	0
			MAX	7.9	1.6	3.0	13	66	0
			MIN	7.9	1.6	3.0	13	66	0
5	34.00	1	AV1	0.8	0.0	2.6	0	70	0
			MAX	0.8	0.0	2.6	0	70	0
			MIN	0.8	0.0	2.6	0	70	0
7	36.00	1	AV1	22.3	4.0	5.7	44	49	0
			MAX	22.3	4.0	5.7	44	49	0
			MIN	22.3	4.0	5.7	44	49	0
8	37.00	1	AV1	16.0	3.2	3.8	29	59	0
			MAX	16.0	3.2	3.8	29	59	0
			MIN	16.0	3.2	3.8	29	59	0
10	38.00	2	AV2	12.1	2.9	3.4	17	63	0
			STD	1.0	0.1	0.1	1	1	0
			MAX	13.1	3.0	3.5	18	63	0
			MIN	11.1	2.8	3.3	16	62	0
12	39.00	2	AV2	13.8	3.2	3.7	21	61	0
			STD	1.2	0.0	0.2	1	1	0
			MAX	15.0	3.3	3.8	23	62	0
			MIN	12.5	3.2	3.5	20	59	0
15	40.00	3	AV3	15.4	3.6	3.9	21	59	0
			STD	0.3	0.2	0.1	1	0	0
			MAX	15.6	3.9	4.0	22	59	0
			MIN	15.0	3.4	3.8	20	58	0
18	41.00	3	AV3	16.6	4.1	4.1	22	58	0
			STD	0.6	0.2	0.1	1	1	0
			MAX	17.4	4.3	4.2	24	58	0
			MIN	15.9	3.9	3.9	21	57	0
21	42.00	3	AV3	17.2	4.4	4.2	23	57	0
			STD	0.1	0.0	0.0	0	0	0
			MAX	17.4	4.4	4.2	23	57	0
			MIN	17.1	4.3	4.1	23	57	0
24	43.00	3	AV3	17.4	4.5	4.2	23	57	3
			STD	0.5	0.2	0.1	1	1	4
			MAX	18.1	4.8	4.4	25	57	8
			MIN	16.8	4.3	4.1	22	56	0
27	44.00	3	AV3	17.9	5.1	4.4	25	56	19
			STD	0.1	0.2	0.1	1	0	10
			MAX	18.1	5.3	4.5	25	56	32
			MIN	17.7	4.9	4.3	24	55	9
30	45.00	3	AV3	18.5	5.1	4.5	26	55	24
			STD	0.5	0.0	0.1	0	0	10
			MAX	19.1	5.1	4.6	26	56	37
			MIN	18.0	5.1	4.4	25	54	13

USH 10 - B-70-403 - Pier 5 #36 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
33	46.00	3	AV3	17.6	5.0	4.3	23	56	30
			STD	0.2	0.1	0.0	0	0	1
			MAX	17.8	5.1	4.4	23	56	31
			MIN	17.4	4.8	4.3	23	56	30
36	47.00	3	AV3	18.3	5.2	4.5	25	55	19
			STD	0.9	0.3	0.1	1	1	3
			MAX	19.5	5.6	4.7	27	56	22
			MIN	17.6	4.9	4.4	24	54	15
40	48.00	4	AV4	17.7	4.6	4.3	23	56	15
			STD	0.5	0.1	0.1	1	0	4
			MAX	18.3	4.7	4.4	23	57	19
			MIN	16.9	4.6	4.2	22	55	8
44	49.00	4	AV4	18.0	4.6	4.4	23	56	25
			STD	0.2	0.2	0.0	0	0	5
			MAX	18.3	4.9	4.4	23	56	32
			MIN	17.7	4.5	4.3	22	55	19
48	50.00	4	AV4	18.6	5.1	4.5	24	55	24
			STD	0.4	0.2	0.1	0	0	2
			MAX	19.3	5.3	4.7	25	55	26
			MIN	18.3	4.8	4.5	24	54	21
52	51.00	4	AV4	18.3	5.1	4.5	24	55	28
			STD	0.6	0.2	0.1	1	1	5
			MAX	19.3	5.4	4.6	25	56	38
			MIN	17.6	4.8	4.3	23	54	24
56	52.00	4	AV4	18.8	5.3	4.6	24	55	31
			STD	0.5	0.2	0.1	1	1	2
			MAX	19.4	5.6	4.7	25	55	34
			MIN	18.2	4.9	4.4	23	54	29
60	53.00	4	AV4	18.8	5.4	4.6	25	55	40
			STD	0.8	0.4	0.2	1	1	4
			MAX	19.9	5.9	4.8	26	56	45
			MIN	17.6	5.0	4.4	23	53	34
64	54.00	4	AV4	19.5	5.5	4.7	25	54	50
			STD	0.4	0.1	0.1	1	1	6
			MAX	20.0	5.7	4.9	27	54	58
			MIN	18.9	5.4	4.6	25	53	43
68	55.00	4	AV4	19.7	5.6	4.7	25	54	59
			STD	0.4	0.1	0.1	1	0	7
			MAX	20.3	5.7	4.8	26	54	67
			MIN	19.2	5.4	4.6	25	54	51
72	56.00	4	AV4	20.1	5.5	4.8	25	54	66
			STD	0.5	0.2	0.1	1	1	4
			MAX	20.5	5.7	4.9	26	55	70
			MIN	19.3	5.2	4.6	24	53	59
76	57.00	4	AV4	20.4	5.7	4.8	26	53	72
			STD	0.1	0.2	0.0	0	0	2
			MAX	20.5	6.0	4.9	26	54	76
			MIN	20.2	5.6	4.8	25	53	70
80	58.00	4	AV4	20.5	5.8	4.9	26	53	77
			STD	0.2	0.0	0.0	0	0	3
			MAX	20.8	5.9	4.9	26	53	80
			MIN	20.4	5.8	4.9	26	53	73
84	59.00	4	AV4	21.1	6.2	5.0	27	52	83
			STD	0.3	0.1	0.0	1	0	6
			MAX	21.6	6.3	5.1	28	53	93
			MIN	20.9	6.2	5.0	26	52	78
89	60.00	5	AV5	21.5	6.2	5.0	27	52	90
			STD	0.1	0.2	0.0	0	0	4
			MAX	21.6	6.4	5.1	27	52	95
			MIN	21.5	5.9	5.0	26	52	83

USH 10 - B-70-403 - Pier 5 #36 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
94	61.00	5	AV5	21.8	6.6	5.1	26	52	109
			STD	0.2	0.5	0.1	1	0	15
			MAX	22.2	7.5	5.2	27	52	130
			MIN	21.5	6.2	5.1	25	51	87
99	62.00	5	AV5	23.0	7.7	5.5	28	50	137
			STD	0.4	0.2	0.1	1	0	3
			MAX	23.4	7.8	5.5	29	51	141
			MIN	22.3	7.3	5.3	26	50	132
105	63.00	6	AV6	21.8	6.9	5.2	26	51	123
			STD	0.6	0.2	0.1	1	1	6
			MAX	22.5	7.3	5.3	27	52	131
			MIN	21.1	6.7	5.0	24	51	114
111	64.00	6	AV6	21.6	6.3	5.1	25	52	114
			STD	0.5	0.2	0.1	1	1	2
			MAX	22.4	6.6	5.3	27	52	116
			MIN	20.9	5.9	5.0	24	51	110
117	65.00	6	AV6	21.4	6.4	5.0	25	52	114
			STD	0.4	0.2	0.1	1	0	3
			MAX	22.0	6.6	5.2	26	53	118
			MIN	20.8	6.2	4.9	24	51	110
123	66.00	6	AV6	21.6	6.1	5.1	24	52	113
			STD	0.3	0.1	0.1	1	0	2
			MAX	22.0	6.3	5.1	25	52	116
			MIN	21.2	5.9	5.0	24	52	110
129	67.00	6	AV6	21.9	6.3	5.1	25	52	116
			STD	0.6	0.3	0.1	1	1	2
			MAX	22.7	6.5	5.3	26	53	119
			MIN	20.9	5.9	4.9	24	51	113
136	68.00	7	AV7	22.2	7.0	5.2	24	51	127
			STD	0.6	0.8	0.2	1	1	6
			MAX	23.0	8.4	5.4	26	53	137
			MIN	21.1	6.1	4.9	23	50	120
143	69.00	7	AV7	23.1	8.1	5.5	26	50	145
			STD	0.4	0.5	0.1	1	1	5
			MAX	23.8	8.7	5.7	27	51	153
			MIN	22.5	7.3	5.3	24	49	137
151	70.00	8	AV8	23.4	8.1	5.6	26	50	146
			STD	0.5	0.4	0.1	1	1	3
			MAX	23.9	8.7	5.7	27	50	149
			MIN	22.7	7.3	5.4	25	49	143
159	71.00	8	AV8	23.4	8.0	5.5	26	50	149
			STD	0.4	0.4	0.1	1	0	3
			MAX	24.1	8.6	5.7	27	50	154
			MIN	22.9	7.4	5.4	25	49	145
167	72.00	8	AV8	23.0	7.8	5.5	26	50	143
			STD	0.3	0.3	0.1	0	0	2
			MAX	23.5	8.3	5.6	27	51	147
			MIN	22.4	7.4	5.4	25	50	140
175	73.00	8	AV8	22.7	7.2	5.4	25	50	138
			STD	0.2	0.3	0.1	1	0	4
			MAX	23.0	7.6	5.6	27	51	144
			MIN	22.3	6.6	5.3	25	50	132
183	74.00	8	AV8	22.7	7.5	5.4	26	50	141
			STD	0.3	0.4	0.1	1	0	7
			MAX	23.2	7.9	5.6	27	51	153
			MIN	22.4	6.8	5.3	24	50	131
191	75.00	8	AV8	23.2	7.6	5.6	26	50	151
			STD	0.3	0.3	0.1	1	0	2
			MAX	23.8	7.9	5.8	28	50	154
			MIN	22.9	7.0	5.5	25	49	148

USH 10 - B-70-403 - Pier 5 #36 - EOID
OP: AZ
APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
199	76.00	8	AV8	22.7	7.4	5.4	25	50	144
			STD	0.4	0.3	0.1	1	0	4
			MAX	23.2	7.9	5.6	27	51	150
			MIN	22.2	7.0	5.2	25	50	139
207	77.00	8	AV8	24.6	9.9	6.0	28	48	201
			STD	1.2	1.0	0.3	2	1	35
			MAX	26.2	11.5	6.4	31	50	249
			MIN	22.7	8.6	5.4	25	47	144
215	78.00	8	AV8	26.9	13.7	6.5	31	46	280
			STD	0.6	1.0	0.1	1	0	14
			MAX	27.5	14.9	6.7	32	47	299
			MIN	25.6	12.3	6.4	30	46	256
229	79.00	14	AV14	27.2	17.9	6.7	31	46	372
			STD	0.4	1.2	0.1	1	0	26
			MAX	27.9	19.9	6.9	33	46	405
			MIN	26.2	15.8	6.5	29	45	315
243	80.00	14	AV14	27.5	19.1	6.9	31	45	396
			STD	0.5	0.5	0.2	1	1	10
			MAX	28.3	19.9	7.1	34	46	413
			MIN	26.9	18.2	6.7	29	44	382
257	81.00	14	AV14	27.3	18.2	6.8	31	45	376
			STD	0.6	0.3	0.2	1	1	10
			MAX	28.6	18.9	7.2	34	46	397
			MIN	26.3	17.6	6.5	28	44	358
273	82.00	16	AV16	27.0	16.8	6.7	31	45	342
			STD	0.5	1.6	0.2	1	1	27
			MAX	27.9	18.9	7.0	34	46	379
			MIN	25.9	13.1	6.5	29	45	286
291	83.00	18	AV18	27.3	15.3	6.7	32	45	323
			STD	0.4	0.8	0.1	1	0	11
			MAX	28.1	16.9	7.0	34	46	345
			MIN	26.6	13.6	6.5	30	45	302
309	84.00	18	AV18	27.4	16.0	6.8	32	45	337
			STD	0.5	1.4	0.1	1	0	29
			MAX	28.2	18.7	7.0	34	46	390
			MIN	26.6	14.3	6.6	29	44	305
332	85.00	23	AV23	27.3	17.2	6.7	30	45	359
			STD	0.5	0.8	0.2	1	0	14
			MAX	28.6	18.9	7.2	34	46	393
			MIN	26.6	14.9	6.5	28	44	323
361	86.00	29	AV29	27.7	20.0	6.9	30	45	390
			STD	0.5	1.3	0.2	1	1	22
			MAX	28.7	22.3	7.2	32	47	439
			MIN	26.1	17.4	6.4	27	44	352
374	86.35	37	AV13	28.5	24.4	7.2	32	44	485
			STD	0.4	1.1	0.2	1	0	18
			MAX	29.4	25.8	7.4	34	45	509
			MIN	27.7	22.0	6.9	29	43	443
384	86.60	40	AV10	29.2	26.6	7.4	34	43	526
			STD	0.4	0.4	0.1	1	0	8
			MAX	29.9	27.3	7.6	36	44	536
			MIN	28.7	26.0	7.2	33	43	513
394	86.67	160	AV10	29.6	27.4	7.6	34	43	552
			STD	0.3	0.3	0.1	1	0	6
			MAX	30.0	27.8	7.8	35	44	560
			MIN	28.8	26.7	7.3	32	42	540
			Average	24.0	12.3	5.9	28	49	233
			Std. Dev.	4.1	6.9	1.1	4	5	160
			Maximum	30.0	27.8	7.8	44	70	560
			Minimum	0.8	0.0	2.6	0	42	0

Total number of blows analyzed: 393

BL#	depth (ft)	Comments
1	30.00	Reported reference EL 740.39

Time Summary

Drive	8 minutes 50 seconds	2:42:02 PM - 2:50:52 PM (12/17/2014)	BN 1 - 394

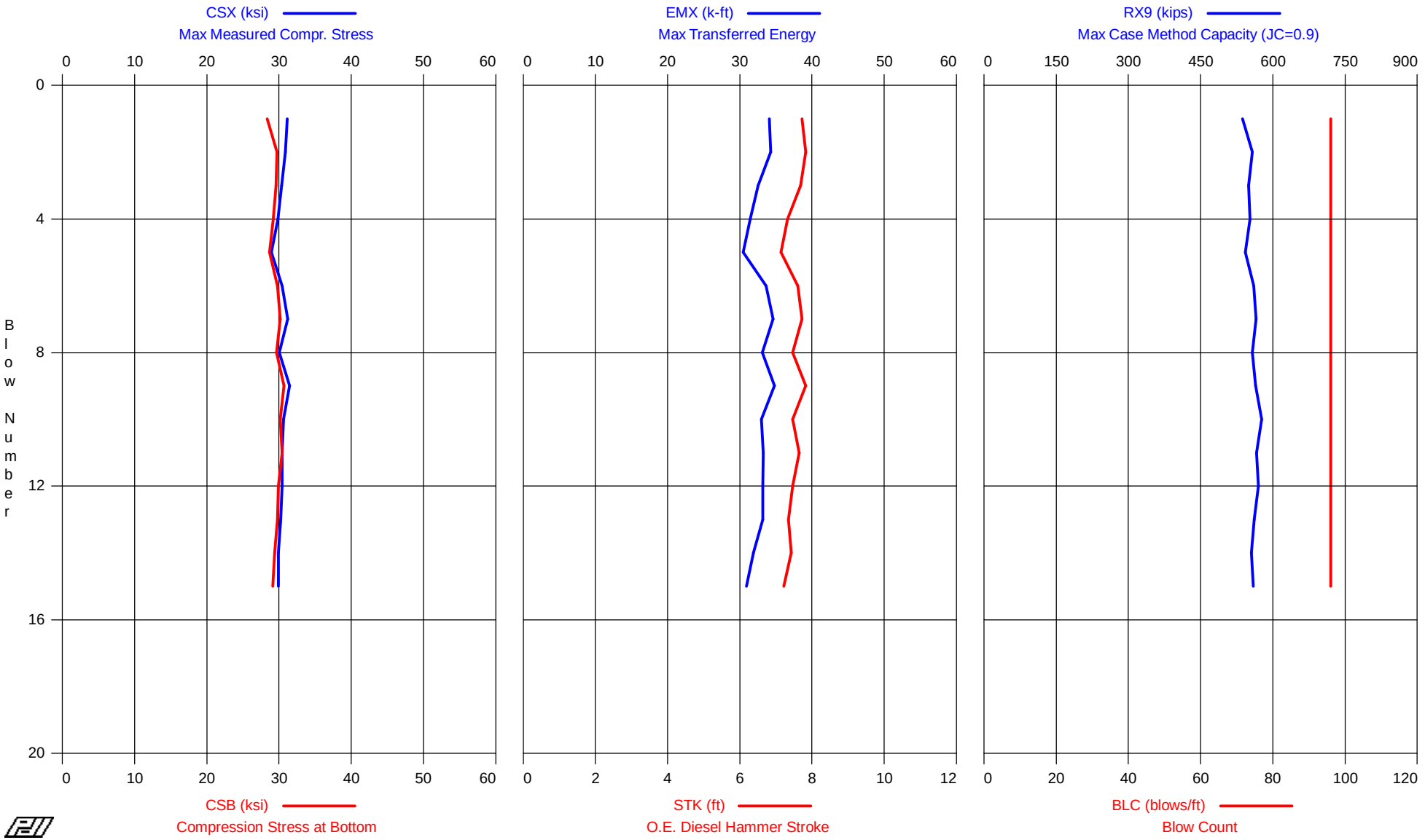
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 18-Dec-2014

Test date: 18-Dec-2014

USH 10 - B-70-403 - Pier 5 #36 - BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 5 #36 - BOR
OP: AZ

APE D30-42, HP 14 x 73
Test date: 18-Dec-2014

AR: 21.40 in^2
LE: 88.70 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
5	86.72	96	AV5	30.2	29.1	7.5	33	43	548
			STD	0.8	0.5	0.3	1	1	8
			MAX	31.1	29.7	7.8	34	44	558
			MIN	29.0	28.3	7.1	30	42	537
10	86.77	96	AV5	30.7	30.1	7.6	34	43	565
			STD	0.5	0.4	0.1	1	0	7
			MAX	31.4	30.7	7.8	35	43	577
			MIN	30.0	29.7	7.5	33	42	558
15	86.83	96	AV5	30.2	29.7	7.4	32	43	562
			STD	0.2	0.4	0.1	1	0	5
			MAX	30.4	30.4	7.6	33	44	570
			MIN	29.9	29.1	7.2	31	43	556
			Average	30.4	29.6	7.5	33	43	558
			Std. Dev.	0.6	0.6	0.2	1	1	10
			Maximum	31.4	30.7	7.8	35	44	577
			Minimum	29.0	28.3	7.1	30	42	537

Total number of blows analyzed: 15

Time Summary

Drive 20 seconds 8:04:24 AM - 8:04:44 AM (12/18/2014) BN 1 - 15

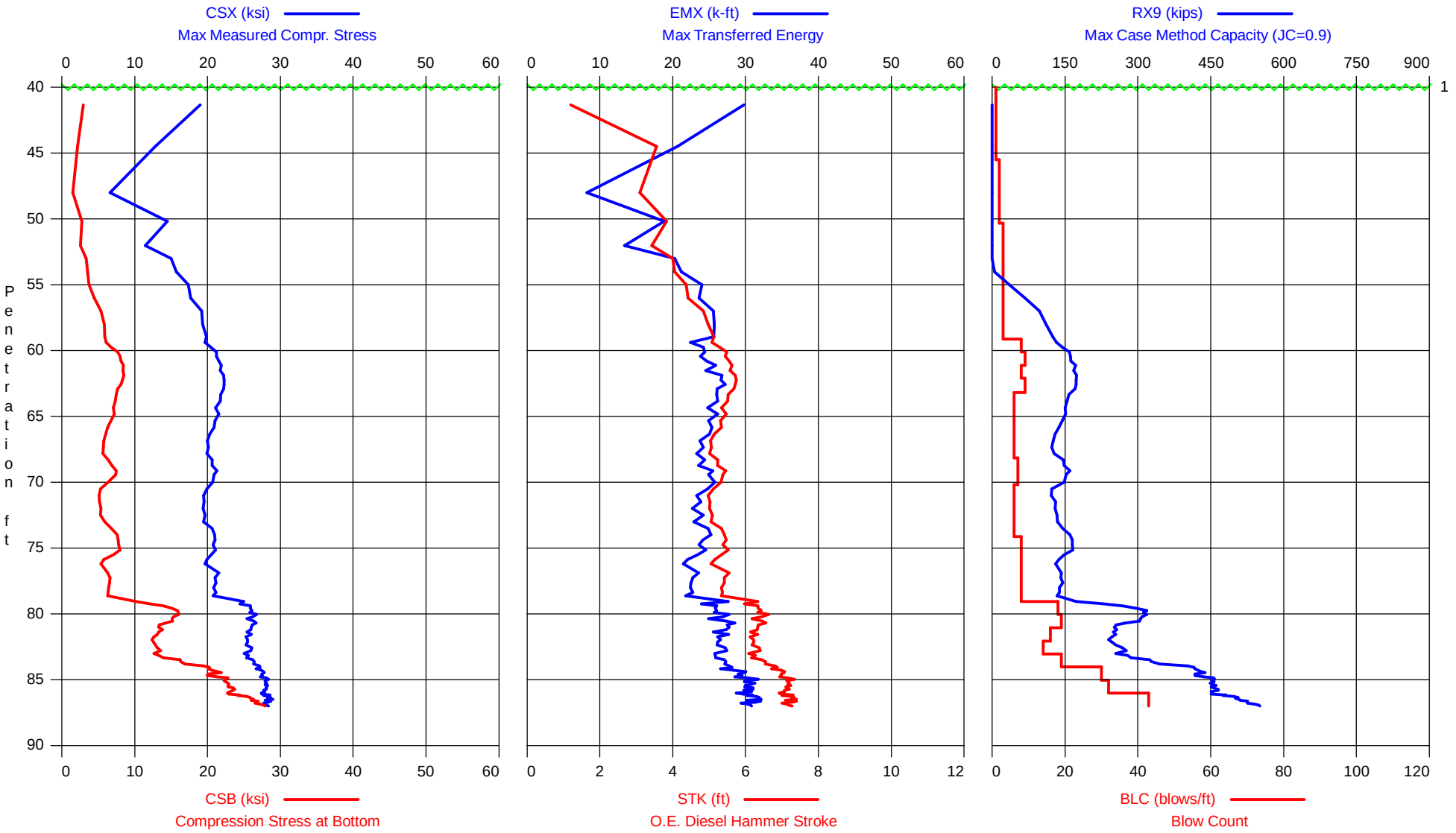
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 18-Dec-2014

Test date: 17-Dec-2014

USH 10 - B-70-403 - Pier 5 #44 - EOID

APE D30-42, HP 14 x 73



1 - Reported reference EL 740.39

USH 10 - B-70-403 - Pier 5 #44 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 17-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
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
1	40.00	1	AV1	21.2	3.3	**	23	**	0
			MAX	21.2	3.3	**	23	**	0
			MIN	21.2	3.3	**	23	**	0
2	41.00	1	AV1	21.4	3.3	**	41	**	0
			MAX	21.4	3.3	**	41	**	0
			MIN	21.4	3.3	**	41	**	0
4	43.00	1	AV1	14.4	2.3	3.6	26	61	0
			MAX	14.4	2.3	3.6	26	61	0
			MIN	14.4	2.3	3.6	26	61	0
5	44.00	1	AV1	13.7	2.1	3.6	23	61	0
			MAX	13.7	2.1	3.6	23	61	0
			MIN	13.7	2.1	3.6	23	61	0
6	45.00	1	AV1	12.0	2.2	3.5	18	62	0
			MAX	12.0	2.2	3.5	18	62	0
			MIN	12.0	2.2	3.5	18	62	0
12	48.00	2	AV2	9.7	2.2	3.2	12	64	0
			STD	2.6	0.4	0.2	4	2	0
			MAX	12.3	2.6	3.4	16	66	0
			MIN	7.1	1.8	3.0	9	62	0
14	49.00	2	AV1	0.4	0.0	2.8	0	68	0
			MAX	0.4	0.0	2.8	0	68	0
			MIN	0.4	0.0	2.8	0	68	0
16	50.00	2	AV1	18.2	3.0	4.4	25	56	0
			MAX	18.2	3.0	4.4	25	56	0
			MIN	18.2	3.0	4.4	25	56	0
19	51.00	3	AV1	10.7	2.5	3.3	12	64	0
			MAX	10.7	2.5	3.3	12	64	0
			MIN	10.7	2.5	3.3	12	64	0
22	52.00	3	AV2	13.0	2.7	3.5	15	61	0
			STD	2.3	0.3	0.3	3	2	0
			MAX	15.3	3.0	3.8	18	64	0
			MIN	10.7	2.4	3.3	12	59	0
25	53.00	3	AV3	12.1	2.9	3.6	16	61	0
			STD	3.3	0.4	0.4	5	3	0
			MAX	16.4	3.4	4.2	22	65	0
			MIN	8.5	2.3	3.2	10	57	0
28	54.00	3	AV3	15.6	3.5	4.0	21	58	2
			STD	1.1	0.2	0.2	1	1	2
			MAX	17.1	3.8	4.3	22	59	5
			MIN	14.4	3.2	3.8	19	56	0
31	55.00	3	AV3	17.2	3.7	4.3	24	56	22
			STD	0.4	0.2	0.1	1	0	9
			MAX	17.5	3.9	4.4	25	57	32
			MIN	16.6	3.5	4.2	23	56	10
34	56.00	3	AV3	17.7	4.2	4.4	23	55	58
			STD	0.3	0.3	0.1	1	0	7
			MAX	17.9	4.6	4.5	25	56	64
			MIN	17.3	3.9	4.4	22	55	48
37	57.00	3	AV3	18.4	5.0	4.6	25	54	86
			STD	0.7	0.1	0.1	1	1	9
			MAX	19.4	5.1	4.8	26	55	98
			MIN	17.9	4.8	4.5	23	53	75
40	58.00	3	AV3	19.6	5.8	5.0	26	52	109
			STD	0.5	0.0	0.1	1	1	3
			MAX	20.3	5.8	5.2	28	53	113
			MIN	19.2	5.7	4.9	25	52	107

USH 10 - B-70-403 - Pier 5 #44 - EOID
OP: AZ

APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
43	59.00	3	AV3	19.8	6.0	5.1	27	52	117
			STD	0.5	0.1	0.2	1	1	5
			MAX	20.5	6.1	5.3	29	53	122
			MIN	19.2	5.8	5.0	25	51	111
51	60.00	8	AV8	20.1	6.5	5.2	23	51	140
			STD	0.7	0.6	0.2	1	1	10
			MAX	21.6	7.5	5.6	26	52	159
			MIN	19.5	5.9	5.0	22	50	130
60	61.00	9	AV9	21.4	8.0	5.5	24	50	163
			STD	0.5	0.2	0.1	1	1	5
			MAX	22.4	8.3	5.8	26	51	170
			MIN	20.5	7.5	5.3	23	49	156
68	62.00	8	AV8	22.0	8.5	5.7	26	49	171
			STD	0.4	0.1	0.1	1	0	4
			MAX	23.0	8.7	5.9	28	50	178
			MIN	21.6	8.2	5.5	24	48	166
77	63.00	9	AV9	22.3	8.0	5.7	27	49	172
			STD	0.4	0.3	0.1	1	0	5
			MAX	23.0	8.4	6.0	28	50	178
			MIN	21.7	7.5	5.6	25	48	164
83	64.00	6	AV6	21.8	7.4	5.5	26	50	156
			STD	0.3	0.1	0.1	0	0	4
			MAX	22.3	7.6	5.7	26	50	161
			MIN	21.4	7.3	5.4	26	49	149
89	65.00	6	AV6	21.3	7.1	5.4	25	50	150
			STD	0.4	0.2	0.1	1	1	3
			MAX	21.9	7.4	5.6	28	51	155
			MIN	20.9	6.9	5.3	24	50	146
95	66.00	6	AV6	21.0	6.5	5.3	25	51	141
			STD	0.1	0.3	0.0	1	0	4
			MAX	21.2	7.0	5.4	26	51	148
			MIN	20.8	6.2	5.2	24	51	135
101	67.00	6	AV6	20.2	5.9	5.1	24	52	128
			STD	0.2	0.2	0.1	1	0	4
			MAX	20.5	6.1	5.2	25	52	133
			MIN	20.0	5.6	5.0	24	52	123
107	68.00	6	AV6	20.0	5.7	5.0	24	52	125
			STD	0.2	0.1	0.1	1	0	3
			MAX	20.5	5.8	5.2	25	53	130
			MIN	19.7	5.6	5.0	23	51	122
114	69.00	7	AV7	20.6	6.7	5.2	24	51	149
			STD	0.3	0.4	0.1	0	0	5
			MAX	21.0	7.3	5.3	25	52	158
			MIN	20.2	5.9	5.1	23	51	142
121	70.00	7	AV5	21.1	7.1	5.4	26	50	155
			STD	0.5	0.5	0.1	1	1	5
			MAX	21.7	7.5	5.6	27	51	161
			MIN	20.3	6.1	5.3	25	50	148
127	71.00	6	AV6	19.9	5.4	5.1	25	52	125
			STD	0.7	0.4	0.2	2	1	10
			MAX	20.8	6.2	5.3	27	53	144
			MIN	18.8	4.9	4.8	22	51	112
133	72.00	6	AV6	19.5	5.2	5.0	23	52	129
			STD	0.5	0.1	0.1	1	1	4
			MAX	20.1	5.5	5.2	25	53	134
			MIN	18.9	5.1	4.9	21	51	125
139	73.00	6	AV6	19.5	5.5	5.1	24	52	134
			STD	0.3	0.2	0.1	1	0	3
			MAX	20.0	5.9	5.2	25	52	137
			MIN	19.1	5.2	5.0	23	51	130

USH 10 - B-70-403 - Pier 5 #44 - EOID
OP: AZ
APE D30-42, HP 14 x 73
Test date: 17-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
145	74.00	6	AV6	20.5	6.9	5.3	25	51	146
			STD	0.6	0.5	0.2	1	1	9
			MAX	21.2	7.8	5.5	26	52	157
			MIN	19.5	6.2	5.1	23	50	132
153	75.00	8	AV8	20.9	7.8	5.4	24	50	166
			STD	0.3	0.1	0.1	1	0	2
			MAX	21.3	8.0	5.6	25	51	170
			MIN	20.4	7.6	5.3	23	50	162
161	76.00	8	AV8	20.5	6.8	5.3	23	51	148
			STD	0.7	0.9	0.2	1	1	12
			MAX	21.4	8.0	5.6	25	52	168
			MIN	19.8	5.4	5.1	22	50	136
169	77.00	8	AV5	20.8	5.9	5.4	23	51	137
			STD	1.1	0.5	0.3	1	1	6
			MAX	22.6	6.5	6.0	25	52	143
			MIN	19.4	5.4	5.0	21	48	130
177	78.00	8	AV8	21.0	6.6	5.4	22	50	142
			STD	0.3	0.1	0.1	1	0	5
			MAX	21.6	6.7	5.5	24	51	147
			MIN	20.5	6.3	5.2	22	50	136
185	79.00	8	AV6	21.7	6.8	5.5	24	50	137
			STD	1.3	1.0	0.4	3	1	5
			MAX	24.6	9.0	6.3	31	51	143
			MIN	20.8	6.2	5.3	22	47	131
203	80.00	18	AV18	25.6	14.2	6.3	26	47	276
			STD	0.8	1.9	0.3	2	1	45
			MAX	26.7	16.4	6.9	30	49	325
			MIN	23.7	10.4	5.7	23	45	176
222	81.00	19	AV19	26.2	14.6	6.4	27	46	289
			STD	0.4	1.0	0.1	1	1	25
			MAX	27.0	16.1	6.7	29	48	321
			MIN	25.3	12.5	6.1	25	46	247
238	82.00	16	AV16	25.6	13.1	6.2	27	47	249
			STD	0.6	0.5	0.2	1	1	6
			MAX	27.1	14.2	6.6	29	48	259
			MIN	24.4	12.3	5.9	24	46	239
252	83.00	14	AV14	25.6	12.9	6.3	27	47	260
			STD	0.6	0.5	0.2	1	1	14
			MAX	27.0	14.0	6.8	30	48	287
			MIN	24.9	11.9	6.0	25	45	243
271	84.00	19	AV19	26.1	15.9	6.4	27	46	324
			STD	0.7	2.2	0.3	1	1	46
			MAX	27.9	21.1	7.0	29	48	432
			MIN	24.9	12.9	6.0	25	44	261
301	85.00	30	AV30	27.5	21.1	7.0	29	45	431
			STD	0.7	1.2	0.2	2	1	20
			MAX	28.6	23.4	7.4	33	46	465
			MIN	26.1	17.9	6.5	25	43	380
333	86.00	32	AV32	28.0	23.0	7.1	30	44	456
			STD	0.6	0.5	0.2	1	1	7
			MAX	29.1	24.0	7.6	34	45	473
			MIN	27.1	21.7	6.9	28	43	442
376	87.00	43	AV43	28.2	25.9	7.2	31	44	509
			STD	0.7	1.5	0.2	1	1	29
			MAX	29.5	28.2	7.6	33	46	558
			MIN	26.7	22.4	6.7	28	43	444
			Average	23.7	13.2	6.0	26	48	264
			Std. Dev.	4.2	7.7	1.0	4	4	154
			Maximum	29.5	28.2	7.6	41	68	558
			Minimum	0.4	0.0	2.8	0	43	0

Total number of blows analyzed: 359

BL#	depth (ft)	Comments
1	40.00	Reported reference EL 740.39

BL#	depth (ft)	Comments
185	79.00	LE = 90.25

Time Summary

Drive	4 minutes 15 seconds	11:13:49 AM - 11:18:04 AM (12/17/2014) BN 1 - 164
Stop	16 minutes 41 seconds	11:18:04 AM - 11:34:45 AM
Drive	20 seconds	11:34:45 AM - 11:35:05 AM BN 165 - 182
Stop	1 hour 43 minutes 52 seconds	11:35:05 AM - 1:18:57 PM
Drive	4 minutes 13 seconds	1:18:57 PM - 1:23:10 PM BN 185 - 376

Total time [2:09:21] = (Driving [0:08:48] + Stop [2:00:33])

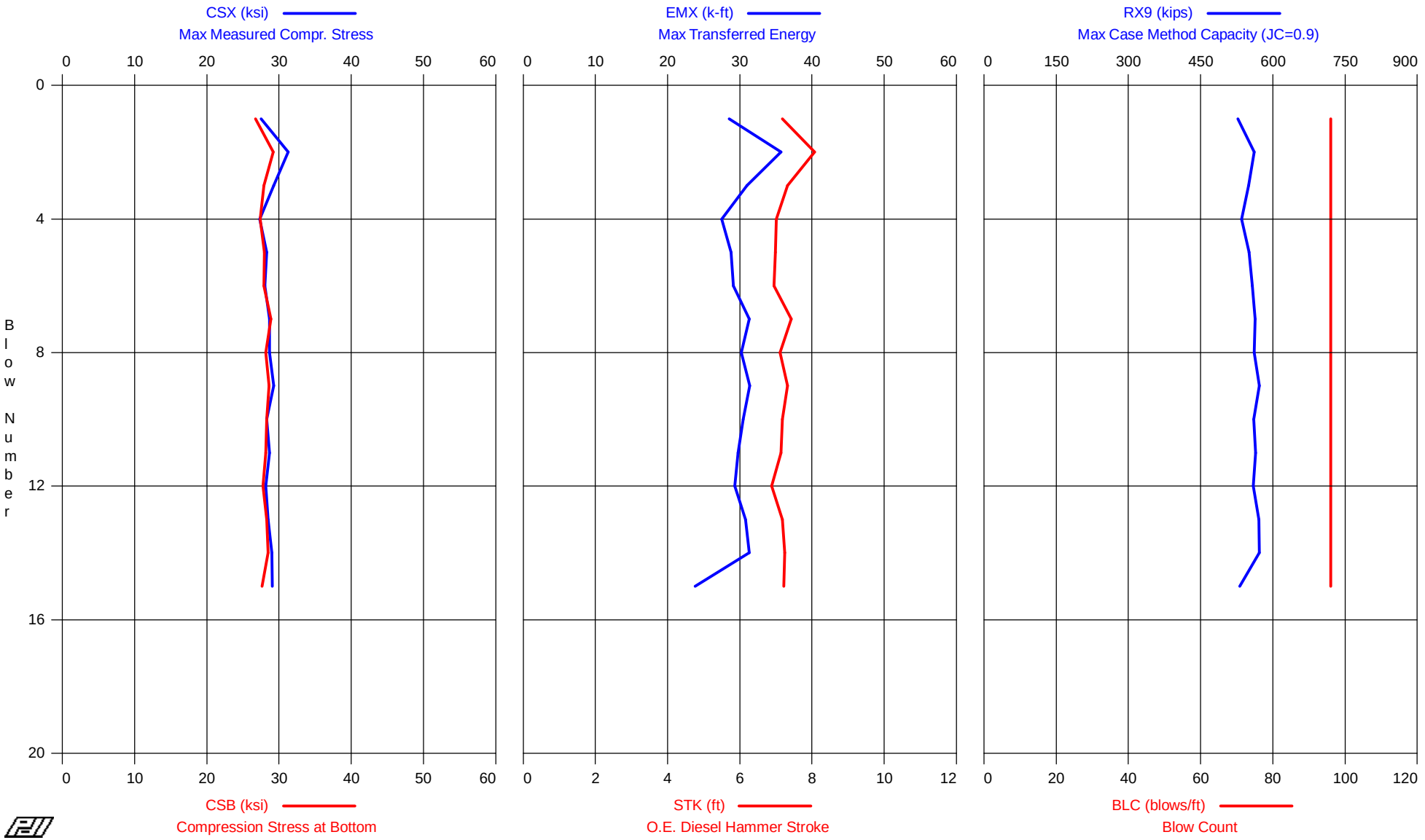
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 18-Dec-2014

Test date: 18-Dec-2014

USH 10 - B-70-403 - Pier 5 #44 - BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 5 #44 - BOR
OP: AZ

APE D30-42, HP 14 x 73
Test date: 18-Dec-2014

AR: 21.40 in^2
LE: 90.25 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

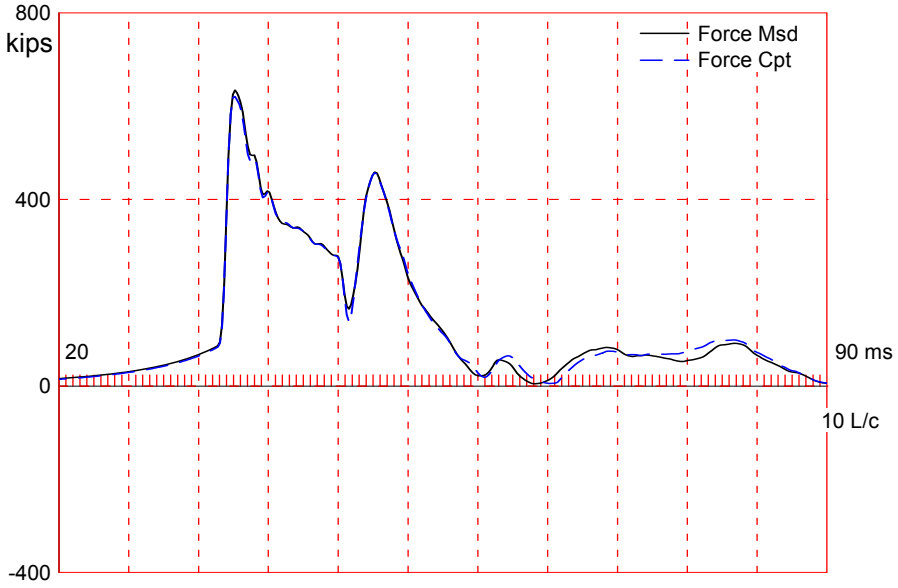
EMX: Max Transferred Energy
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

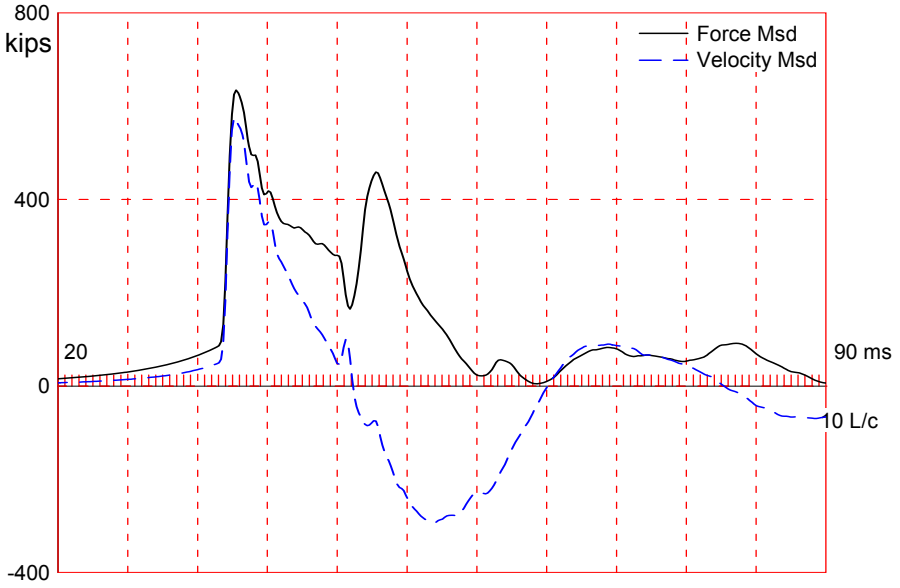
BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
5	87.05	96	AV5	28.7	27.8	7.3	30	44	545
			STD	1.4	0.8	0.4	3	1	12
			MAX	31.3	29.2	8.1	36	45	562
			MIN	27.3	26.7	7.0	27	42	527
10	87.10	96	AV5	28.6	28.4	7.2	30	44	563
			STD	0.4	0.3	0.2	1	0	5
			MAX	29.3	28.9	7.4	31	45	572
			MIN	28.1	27.9	6.9	29	43	557
15	87.16	96	AV5	28.7	28.1	7.1	29	44	560
			STD	0.3	0.3	0.1	3	0	15
			MAX	29.1	28.5	7.2	31	45	572
			MIN	28.2	27.6	6.9	24	44	532
			Average	28.7	28.1	7.2	30	44	556
			Std. Dev.	0.9	0.6	0.3	2	1	14
			Maximum	31.3	29.2	8.1	36	45	572
			Minimum	27.3	26.7	6.9	24	42	527

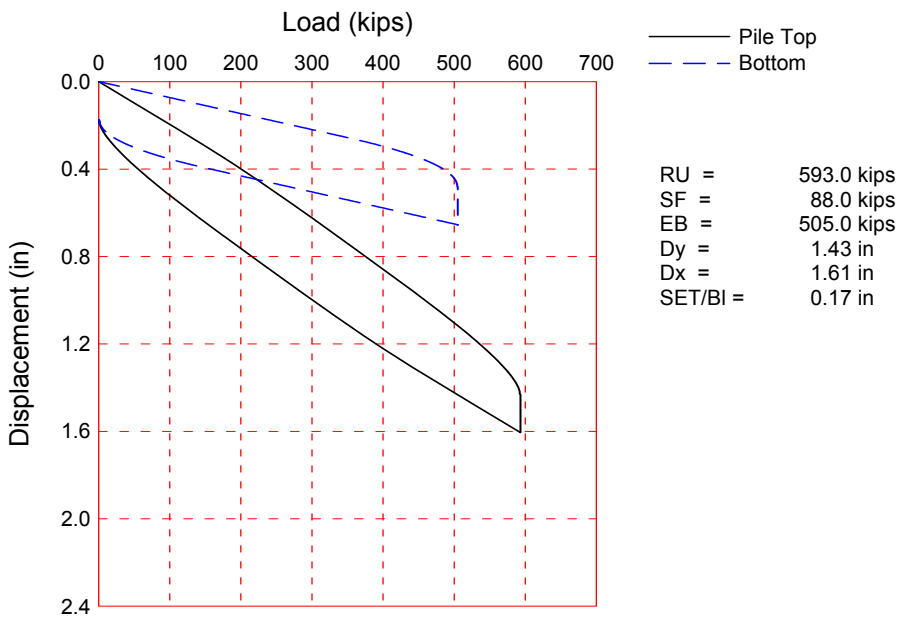
Total number of blows analyzed: 15

Time Summary

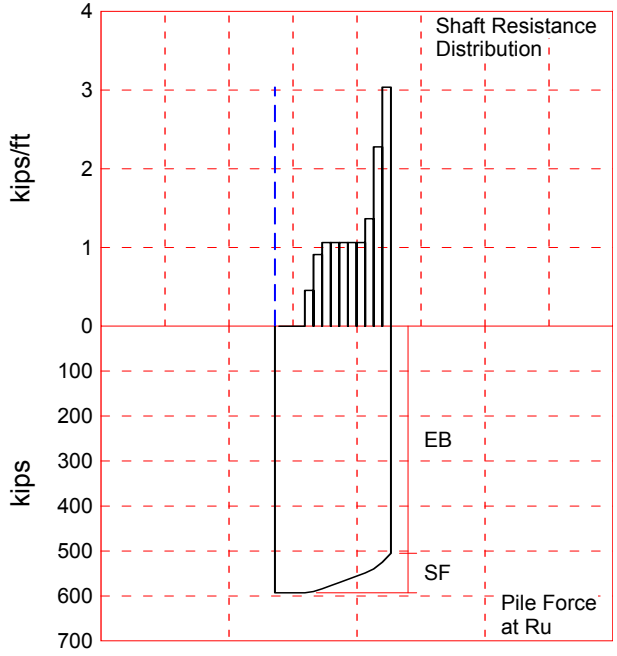
Drive 19 seconds 8:12:48 AM - 8:13:07 AM (12/18/2014) BN 1 - 15







RU =	593.0 kips
SF =	88.0 kips
EB =	505.0 kips
Dy =	1.43 in
Dx =	1.61 in
SET/Bl =	0.17 in



Length b. Sensors	88.9 ft
Embedment	87.9 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	2.09
Top Compr. Stress	29.0 ksi
Max Compr. Stress	29.9 ksi
Max Tension Stress	-5.06 ksi
Avg. Shaft Quake	0.20 in
Toe Quake	0.37 in
Avg. Shaft Smith Dpg.	0.23 s/ft
Toe Smith Damping	0.06 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

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: 593.0; along Shaft 88.0; at Toe 505.0 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
				593.0				
1	9.9	8.9	0.0	593.0	0.0	0.00	0.00	0.00
2	16.5	15.4	0.0	593.0	0.0	0.00	0.00	0.00
3	23.0	22.0	0.0	593.0	0.0	0.00	0.00	0.00
4	29.6	28.6	3.0	590.0	3.0	0.46	0.10	0.23
5	36.2	35.2	6.0	584.0	9.0	0.91	0.19	0.23
6	42.8	41.8	7.0	577.0	16.0	1.06	0.23	0.23
7	49.4	48.4	7.0	570.0	23.0	1.06	0.23	0.23
8	56.0	54.9	7.0	563.0	30.0	1.06	0.23	0.23
9	62.6	61.5	7.0	556.0	37.0	1.06	0.23	0.23
10	69.1	68.1	7.0	549.0	44.0	1.06	0.23	0.23
11	75.7	74.7	9.0	540.0	53.0	1.37	0.29	0.23
12	82.3	81.3	15.0	525.0	68.0	2.28	0.48	0.23
13	88.9	87.9	20.0	505.0	88.0	3.04	0.65	0.23
Avg. Shaft			6.8			1.00	0.21	0.23
Toe			505.0				366.34	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.20	0.37
Case Damping Factor		0.53	0.79
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	37
Unloading Level	(% of Ru)	33	
Soil Plug Weight	(kips)		0.082

CAPWAP match quality = 2.09 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.17 in; Blow Count = 69 b/ft
Computed: Final Set = 0.15 in; Blow Count = 78 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.14; A4(K2524) CAL: 360; RF: 1.14

max. Top Comp. Stress = 29.0 ksi (T= 36.4 ms, max= 1.030 x Top)
max. Comp. Stress = 29.9 ksi (Z= 36.2 ft, T= 38.4 ms)
max. Tens. Stress = -5.06 ksi (Z= 56.0 ft, T= 62.3 ms)
max. Energy (EMX) = 36.0 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	621.6	-25.2	29.0	-1.18	36.0	15.3	1.09
2	6.6	622.5	-26.9	29.1	-1.26	35.9	15.2	1.08
4	13.2	624.4	-32.1	29.2	-1.50	35.4	15.2	1.04
6	19.8	626.9	-49.0	29.3	-2.29	34.8	15.1	1.00
8	26.3	634.1	-59.4	29.6	-2.78	34.1	14.9	0.95
10	32.9	633.2	-64.2	29.6	-3.00	32.6	14.6	0.90
12	39.5	621.5	-72.5	29.0	-3.39	30.4	14.2	0.85
13	42.8	628.9	-84.6	29.4	-3.95	29.9	14.0	0.82
14	46.1	606.3	-89.6	28.3	-4.18	28.0	13.8	0.79
15	49.4	613.5	-99.9	28.7	-4.67	27.4	13.7	0.76
16	52.7	591.8	-103.6	27.6	-4.84	25.6	13.5	0.73
17	56.0	598.9	-108.3	28.0	-5.06	24.9	13.3	0.70
18	59.3	578.0	-104.2	27.0	-4.87	23.2	13.1	0.67
19	62.6	584.9	-104.4	27.3	-4.88	22.5	12.9	0.64
20	65.9	565.0	-98.8	26.4	-4.62	20.8	12.7	0.61
21	69.1	572.9	-98.3	26.8	-4.59	20.1	12.5	0.58
22	72.4	555.7	-92.4	26.0	-4.31	18.5	12.3	0.54
23	75.7	566.7	-92.7	26.5	-4.33	17.8	12.2	0.51
24	79.0	559.9	-85.9	26.2	-4.01	16.0	13.5	0.48
25	82.3	573.4	-86.1	26.8	-4.02	15.3	14.3	0.45
26	85.6	576.5	-74.5	26.9	-3.48	13.1	14.8	0.41
27	88.9	590.3	-74.4	27.6	-3.48	11.5	14.3	0.38
Absolute	36.2			29.9			(T =	38.4 ms)
	56.0				-5.06		(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	666.8	612.3	557.8	503.4	448.9	394.4	339.9	285.4	230.9	176.4
RX	728.4	706.6	685.9	665.6	645.3	624.9	604.6	590.8	580.5	570.1
RU	666.8	612.3	557.8	503.4	448.9	394.4	339.9	285.4	230.9	176.4

RAU = 444.5 (kips); RA2 = 615.2 (kips)

Current CAPWAP Ru = 593.0 (kips); Corresponding J(RP)= 0.14; 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
15.1	36.04	578.5	633.3	636.0	1.07	0.17	0.17	36.1	694.5	1365

PILE PROFILE AND PILE MODEL

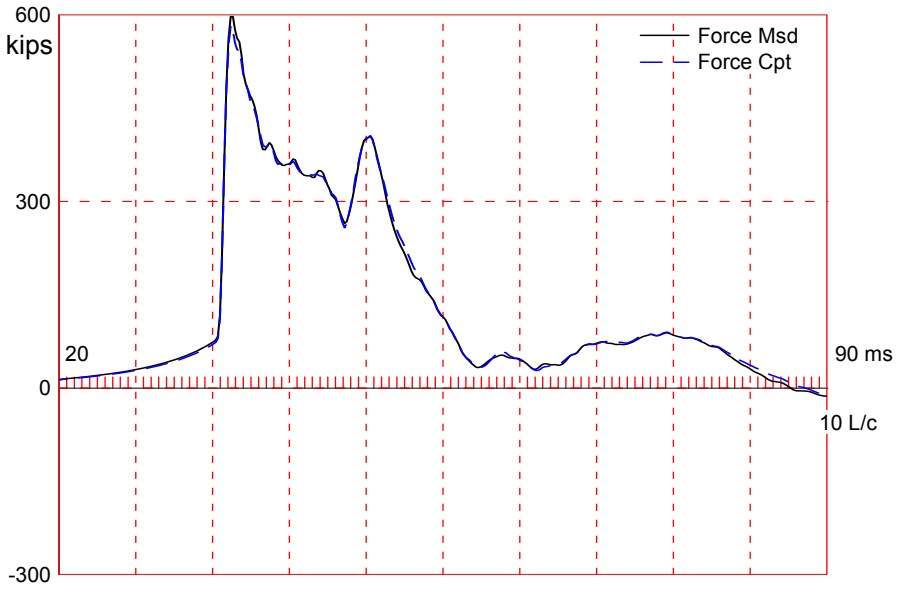
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
88.9	21.4	29992.2	492.000	4.70

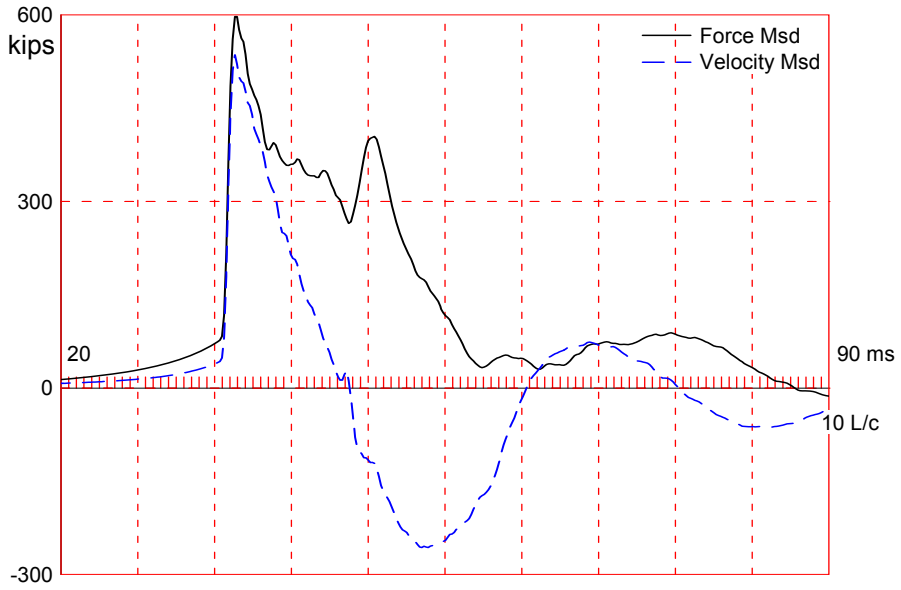
Toe Area 198.5 in^2

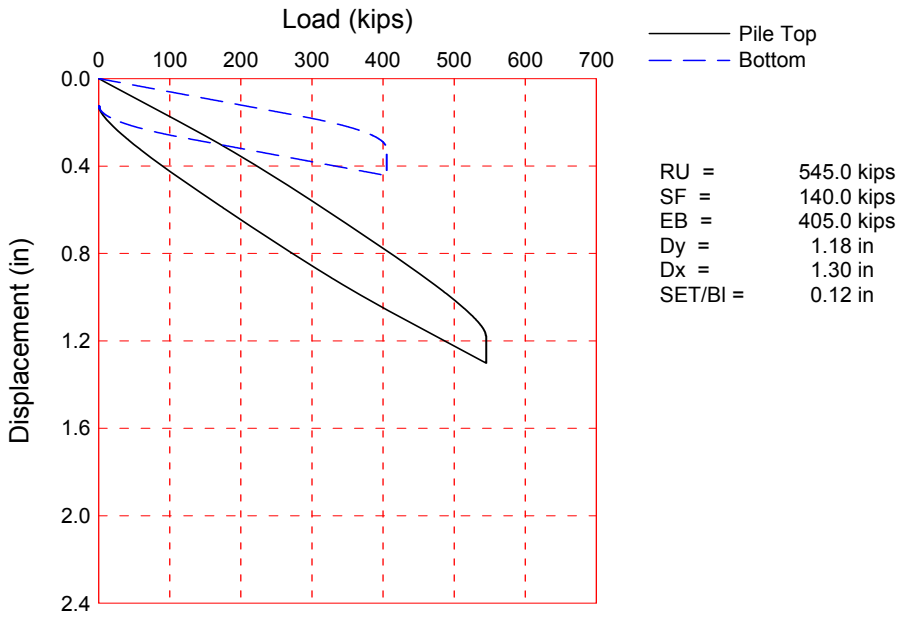
Top Segment Length 3.29 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 10.6 ms

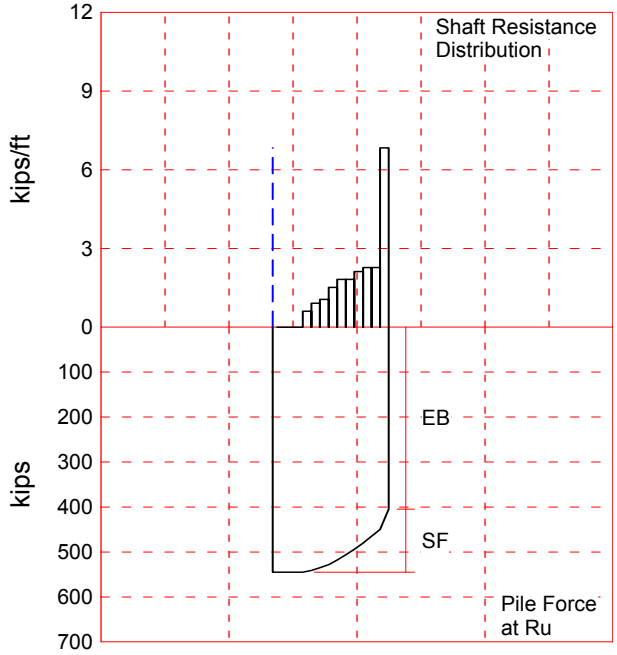
Total volume: 13.212 ft^3; Volume ratio considering added impedance: 1.000







RU =	545.0 kips
SF =	140.0 kips
EB =	405.0 kips
Dy =	1.18 in
Dx =	1.30 in
SET/Bl =	0.12 in



Length b. Sensors	88.9 ft
Embedment	87.9 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	1.18
Top Compr. Stress	27.2 ksi
Max Compr. Stress	28.1 ksi
Max Tension Stress	-3.18 ksi
Avg. Shaft Quake	0.16 in
Toe Quake	0.25 in
Avg. Shaft Smith Dpg.	0.33 s/ft
Toe Smith Damping	0.06 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 545.0; along Shaft 140.0; at Toe 405.0 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
				545.0				
1	9.9	8.9	0.0	545.0	0.0	0.00	0.00	0.00
2	16.5	15.5	0.0	545.0	0.0	0.00	0.00	0.00
3	23.0	22.1	0.0	545.0	0.0	0.00	0.00	0.00
4	29.6	28.7	4.0	541.0	4.0	0.61	0.13	0.33
5	36.2	35.3	6.0	535.0	10.0	0.91	0.19	0.33
6	42.8	41.8	7.0	528.0	17.0	1.06	0.23	0.33
7	49.4	48.4	10.0	518.0	27.0	1.52	0.32	0.33
8	56.0	55.0	12.0	506.0	39.0	1.82	0.39	0.33
9	62.6	61.6	12.0	494.0	51.0	1.82	0.39	0.33
10	69.1	68.2	14.0	480.0	65.0	2.13	0.45	0.33
11	75.7	74.8	15.0	465.0	80.0	2.28	0.48	0.33
12	82.3	81.4	15.0	450.0	95.0	2.28	0.48	0.33
13	88.9	87.9	45.0	405.0	140.0	6.83	1.45	0.33
Avg. Shaft			10.8			1.59	0.34	0.33
Toe			405.0				293.80	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.16	0.25
Case Damping Factor		1.22	0.64
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	32
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	23	
Resistance Gap (included in Toe Quake)	(in)		0.06
Soil Plug Weight	(kips)		0.029

CAPWAP match quality = 1.18 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.12 in; Blow Count = 103 b/ft

max. Top Comp. Stress = 27.2 ksi (T= 36.0 ms, max= 1.030 x Top)
max. Comp. Stress = 28.1 ksi (Z= 29.6 ft, T= 37.6 ms)
max. Tens. Stress = -3.18 ksi (Z= 49.4 ft, T= 61.3 ms)
max. Energy (EMX) = 32.4 kip-ft; max. Measured Top Displ. (DMX)= 0.98 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	583.2	-21.5	27.2	-1.00	32.4	14.4	0.98
2	6.6	583.6	-22.3	27.3	-1.04	32.1	14.4	0.97
4	13.2	584.8	-23.6	27.3	-1.10	31.6	14.3	0.93
6	19.8	586.2	-27.5	27.4	-1.29	30.9	14.2	0.88
8	26.3	594.6	-34.8	27.8	-1.63	30.0	14.0	0.83
10	32.9	586.2	-48.3	27.4	-2.26	28.1	13.6	0.78
12	39.5	571.2	-59.3	26.7	-2.77	25.7	13.1	0.72
13	42.8	582.6	-66.0	27.2	-3.08	25.2	12.9	0.69
14	46.1	557.3	-66.0	26.0	-3.08	23.3	12.5	0.66
15	49.4	570.3	-68.1	26.6	-3.18	22.7	12.2	0.63
16	52.7	532.6	-62.3	24.9	-2.91	20.3	11.9	0.60
17	56.0	545.5	-64.9	25.5	-3.03	19.7	11.6	0.57
18	59.3	505.9	-57.7	23.6	-2.70	17.2	11.2	0.54
19	62.6	513.4	-59.3	24.0	-2.77	16.6	10.9	0.51
20	65.9	497.8	-52.0	23.3	-2.43	14.4	10.6	0.48
21	69.1	508.7	-53.4	23.8	-2.50	13.8	10.2	0.44
22	72.4	503.2	-44.8	23.5	-2.09	11.6	9.9	0.41
23	75.7	513.5	-46.1	24.0	-2.15	11.0	9.6	0.39
24	79.0	499.5	-37.1	23.3	-1.73	9.2	9.5	0.36
25	82.3	507.0	-38.2	23.7	-1.78	8.6	9.9	0.33
26	85.6	497.6	-33.0	23.2	-1.54	7.1	10.2	0.30
27	88.9	507.4	-33.6	23.7	-1.57	4.9	9.2	0.27
Absolute	29.6			28.1			(T =	37.6 ms)
	49.4				-3.18		(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	720.3	677.8	635.2	592.7	550.1	507.6	465.0	422.5	379.9	337.4
RX	743.2	712.9	682.9	658.2	637.5	616.8	596.6	577.4	560.4	544.9
RU	725.1	683.0	640.9	598.8	556.7	514.7	472.6	430.5	388.4	346.3

RAU = 333.5 (kips); RA2 = 572.1 (kips)

Current CAPWAP Ru = 545.0 (kips); Corresponding J(RP)= 0.41; J(RX) = 0.90

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
14.1	35.85	540.0	605.8	605.8	0.98	0.13	0.12	32.6	706.7	2176

PILE PROFILE AND PILE MODEL

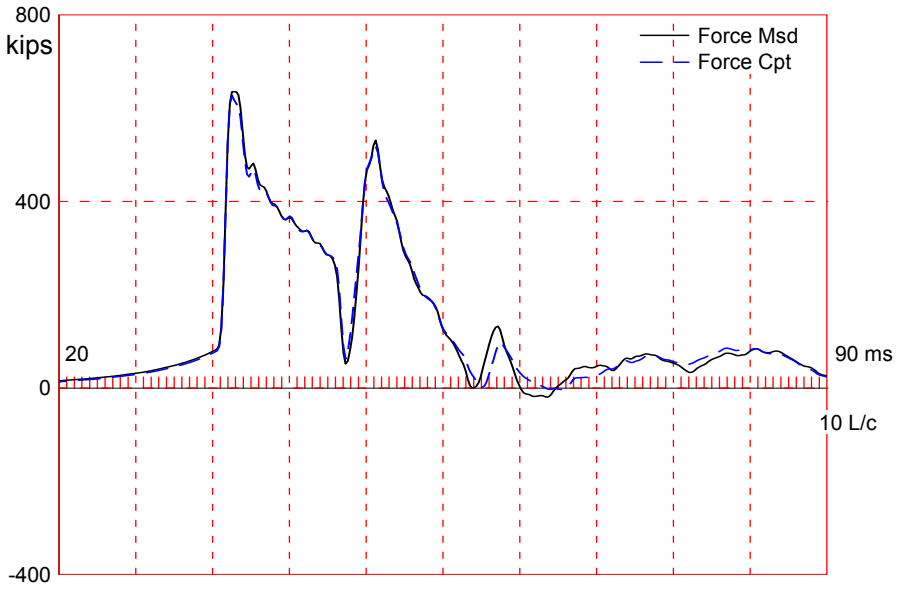
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
88.9	21.4	29992.2	492.000	4.70

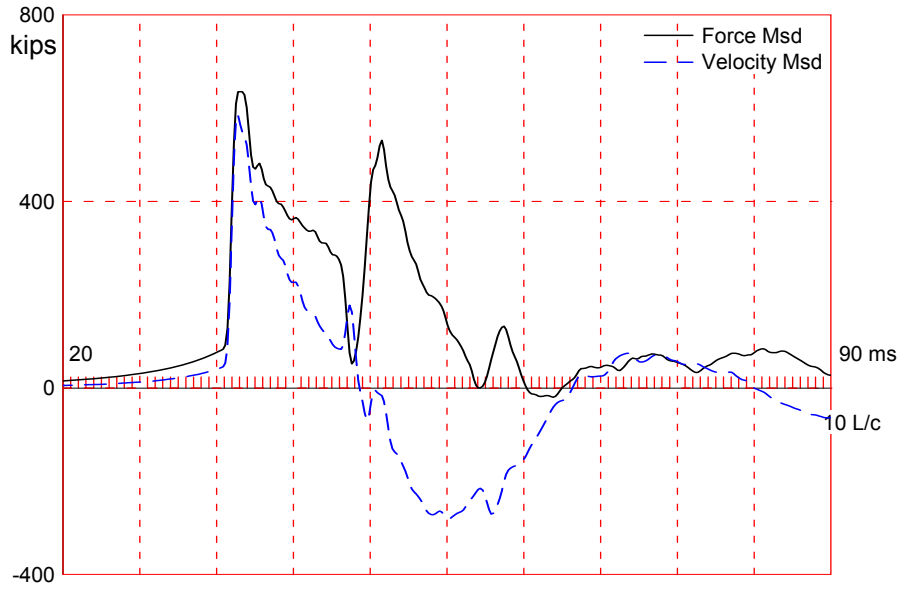
Toe Area 198.5 in^2

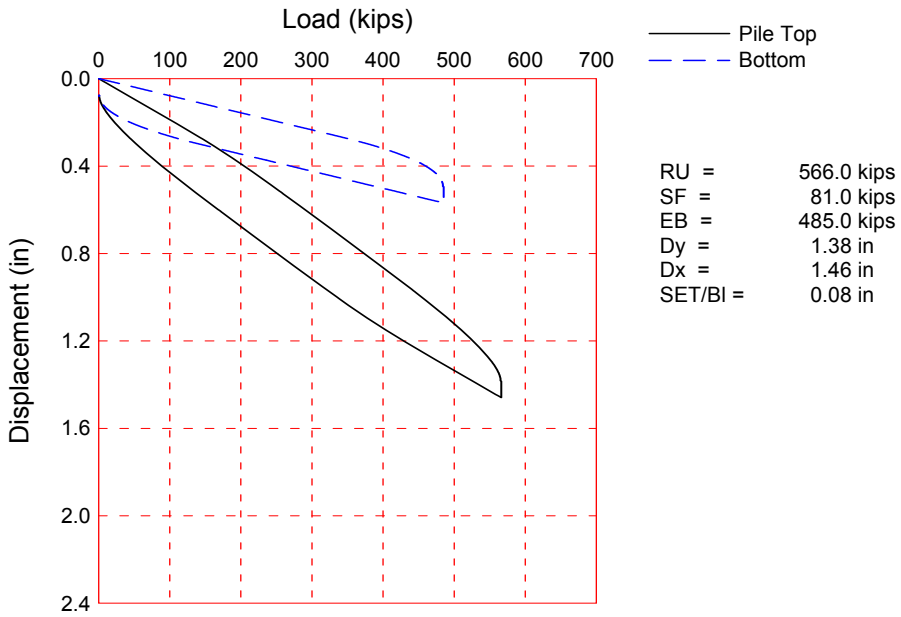
Top Segment Length 3.29 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 10.6 ms

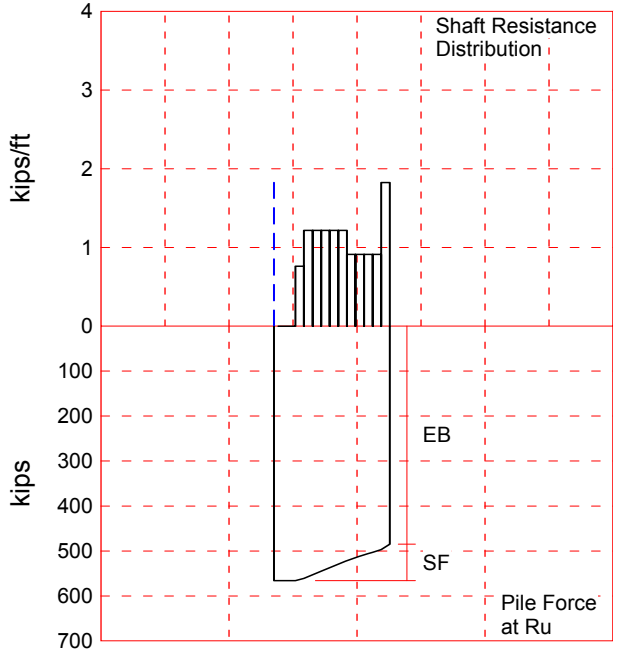
Total volume: 13.212 ft^3; Volume ratio considering added impedance: 1.000







RU =	566.0 kips
SF =	81.0 kips
EB =	485.0 kips
Dy =	1.38 in
Dx =	1.46 in
SET/Bl =	0.08 in



Length b. Sensors	88.7 ft
Embedment	86.7 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	3.26
Top Compr. Stress	29.4 ksi
Max Compr. Stress	30.1 ksi
Max Tension Stress	-3.73 ksi
Avg. Shaft Quake	0.20 in
Toe Quake	0.38 in
Avg. Shaft Smith Dpg.	0.20 s/ft
Toe Smith Damping	0.06 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: 566.0; along Shaft 81.0; at Toe 485.0 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
				566.0				
1	9.9	7.8	0.0	566.0	0.0	0.00	0.00	0.00
2	16.4	14.4	0.0	566.0	0.0	0.00	0.00	0.00
3	23.0	21.0	5.0	561.0	5.0	0.76	0.16	0.20
4	29.6	27.5	8.0	553.0	13.0	1.22	0.26	0.20
5	36.1	34.1	8.0	545.0	21.0	1.22	0.26	0.20
6	42.7	40.7	8.0	537.0	29.0	1.22	0.26	0.20
7	49.3	47.2	8.0	529.0	37.0	1.22	0.26	0.20
8	55.8	53.8	8.0	521.0	45.0	1.22	0.26	0.20
9	62.4	60.4	6.0	515.0	51.0	0.91	0.19	0.20
10	69.0	67.0	6.0	509.0	57.0	0.91	0.19	0.20
11	75.6	73.5	6.0	503.0	63.0	0.91	0.19	0.20
12	82.1	80.1	6.0	497.0	69.0	0.91	0.19	0.20
13	88.7	86.7	12.0	485.0	81.0	1.83	0.39	0.20
Avg. Shaft			6.2			0.93	0.20	0.20
Toe			485.0				351.84	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.20	0.38
Case Damping Factor		0.42	0.76
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	47
Unloading Level	(% of Ru)	34	

CAPWAP match quality = 3.26 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.11 in; Blow Count = 106 b/ft

Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.06; A4(K2524) CAL: 360; RF: 1.06

max. Top Comp. Stress = 29.4 ksi (T= 36.2 ms, max= 1.025 x Top)
max. Comp. Stress = 30.1 ksi (Z= 23.0 ft, T= 37.3 ms)
max. Tens. Stress = -3.73 ksi (Z= 69.0 ft, T= 62.9 ms)
max. Energy (EMX) = 35.3 kip-ft; max. Measured Top Displ. (DMX)= 1.06 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	628.7	-16.2	29.4	-0.76	35.3	15.5	1.08
2	6.6	629.4	-20.5	29.4	-0.96	35.2	15.5	1.07
4	13.1	631.2	-36.1	29.5	-1.68	34.8	15.4	1.03
6	19.7	638.9	-51.0	29.8	-2.38	34.2	15.2	0.99
8	26.3	632.0	-65.6	29.5	-3.07	32.5	14.8	0.95
10	32.9	615.2	-72.4	28.7	-3.38	30.1	14.4	0.90
12	39.4	599.1	-71.7	28.0	-3.35	27.8	14.1	0.84
13	42.7	605.3	-71.7	28.3	-3.35	27.2	13.9	0.82
14	46.0	583.7	-66.6	27.3	-3.11	25.4	13.7	0.79
15	49.3	589.9	-66.1	27.6	-3.09	24.8	13.5	0.76
16	52.6	568.9	-61.2	26.6	-2.86	23.1	13.3	0.73
17	55.8	574.3	-62.8	26.8	-2.93	22.5	13.2	0.70
18	59.1	552.6	-66.4	25.8	-3.10	20.8	13.0	0.68
19	62.4	557.2	-77.0	26.0	-3.60	20.2	12.9	0.65
20	65.7	542.5	-79.6	25.3	-3.72	18.7	12.8	0.62
21	69.0	547.1	-79.8	25.6	-3.73	18.1	12.9	0.58
22	72.3	533.0	-75.4	24.9	-3.52	16.7	12.7	0.55
23	75.6	537.6	-75.3	25.1	-3.52	16.1	13.7	0.52
24	78.8	521.7	-70.4	24.4	-3.29	14.8	15.7	0.49
25	82.1	538.8	-70.7	25.2	-3.30	14.1	16.3	0.46
26	85.4	547.7	-66.3	25.6	-3.10	12.9	16.8	0.43
27	88.7	562.4	-66.4	26.3	-3.10	12.1	16.0	0.40
Absolute	23.0			30.1			(T =	37.3 ms)
	69.0				-3.73		(T =	62.9 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	578.3	513.2	448.2	383.2	318.2	253.2	188.2	123.2	58.1	0.0
RX	691.3	671.3	651.9	636.2	622.4	610.2	597.9	585.7	573.5	562.3
RU	578.3	513.2	448.2	383.2	318.2	253.2	188.2	123.2	58.1	0.0

RAU = 460.5 (kips); RA2 = 637.7 (kips)

Current CAPWAP Ru = 566.0 (kips); Corresponding J(RP)= 0.02; J(RX) = 0.87

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	35.96	593.0	635.4	638.6	1.06	0.08	0.08	35.4	746.7	1276

PILE PROFILE AND PILE MODEL

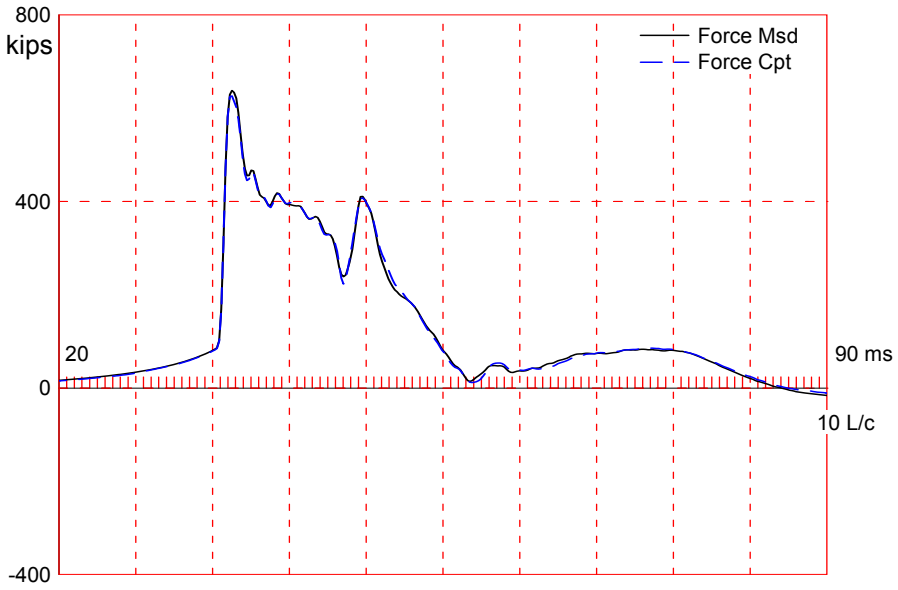
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
88.7	21.4	29992.2	492.000	4.70

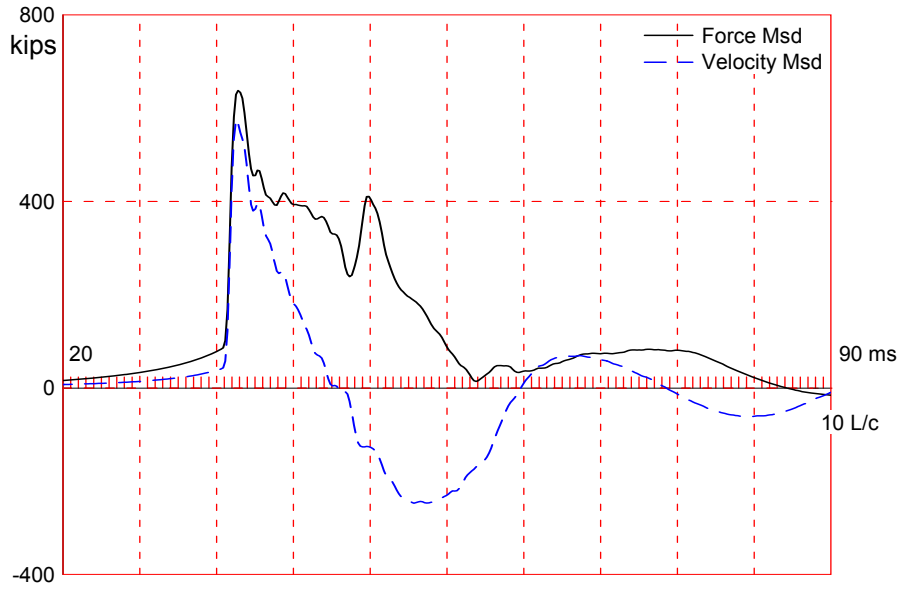
Toe Area 198.5 in^2

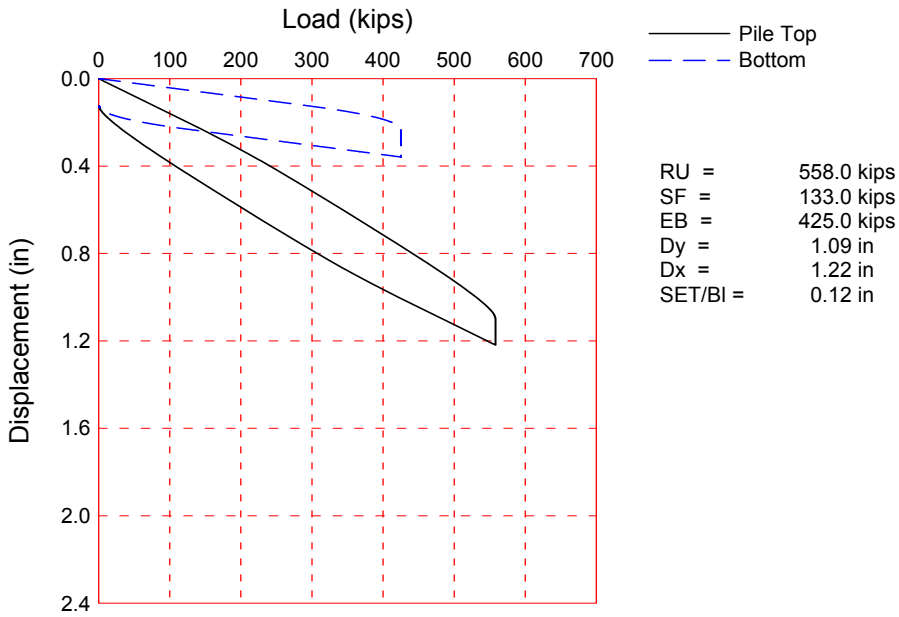
Top Segment Length 3.29 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.195 ms, 2L/c 10.6 ms

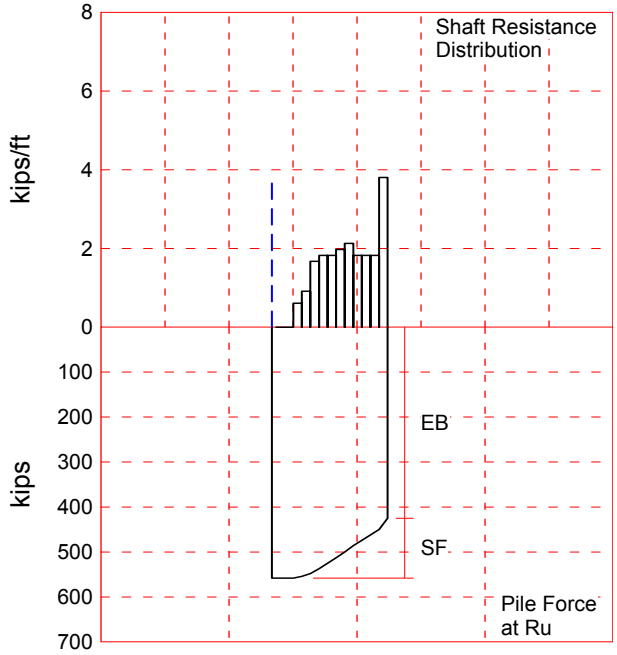
Total volume: 13.182 ft^3; Volume ratio considering added impedance: 1.000







RU =	558.0 kips
SF =	133.0 kips
EB =	425.0 kips
Dy =	1.09 in
Dx =	1.22 in
SET/Bl =	0.12 in



Length b. Sensors	88.7 ft
Embedment	86.7 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	1.35
Top Compr. Stress	29.3 ksi
Max Compr. Stress	30.4 ksi
Max Tension Stress	-2.60 ksi
Avg. Shaft Quake	0.17 in
Toe Quake	0.18 in
Avg. Shaft Smith Dpg.	0.33 s/ft
Toe Smith Damping	0.07 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.

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: 558.0; along Shaft 133.0; at Toe 425.0 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
				558.0				
1	9.9	7.9	0.0	558.0	0.0	0.00	0.00	0.00
2	16.4	14.4	0.0	558.0	0.0	0.00	0.00	0.00
3	23.0	21.0	4.0	554.0	4.0	0.61	0.13	0.33
4	29.6	27.6	6.0	548.0	10.0	0.91	0.19	0.33
5	36.1	34.1	11.0	537.0	21.0	1.67	0.36	0.33
6	42.7	40.7	12.0	525.0	33.0	1.83	0.39	0.33
7	49.3	47.3	12.0	513.0	45.0	1.83	0.39	0.33
8	55.8	53.9	13.0	500.0	58.0	1.98	0.42	0.33
9	62.4	60.4	14.0	486.0	72.0	2.13	0.45	0.33
10	69.0	67.0	12.0	474.0	84.0	1.83	0.39	0.33
11	75.6	73.6	12.0	462.0	96.0	1.83	0.39	0.33
12	82.1	80.1	12.0	450.0	108.0	1.83	0.39	0.33
13	88.7	86.7	25.0	425.0	133.0	3.80	0.81	0.33
Avg. Shaft			10.2			1.53	0.33	0.33
Toe			425.0				308.31	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.17	0.18
Case Damping Factor		1.15	0.78
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	39
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	33	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)		0.017

CAPWAP match quality = 1.35 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.10 in; Blow Count = 116 b/ft

Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(F590) CAL: 95.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.09; A4(K2253) CAL: 325; RF: 1.09

max. Top Comp. Stress = 29.3 ksi (T= 36.2 ms, max= 1.036 x Top)
max. Comp. Stress = 30.4 ksi (Z= 23.0 ft, T= 37.3 ms)
max. Tens. Stress = -2.60 ksi (Z= 55.8 ft, T= 61.4 ms)
max. Energy (EMX) = 31.3 kip-ft; max. Measured Top Displ. (DMX)= 0.89 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	627.3	-13.8	29.3	-0.64	31.3	15.1	0.90
2	6.6	628.5	-15.3	29.4	-0.72	31.1	15.1	0.88
4	13.1	631.2	-19.1	29.5	-0.89	30.6	15.0	0.84
6	19.7	642.5	-22.1	30.0	-1.03	30.0	14.7	0.80
8	26.3	636.0	-36.2	29.7	-1.69	28.3	14.3	0.75
10	32.9	628.7	-45.9	29.4	-2.14	26.2	13.7	0.70
12	39.4	598.7	-48.2	28.0	-2.25	23.2	12.9	0.64
13	42.7	611.9	-53.7	28.6	-2.51	22.6	12.6	0.61
14	46.0	566.0	-48.4	26.4	-2.26	20.1	12.2	0.58
15	49.3	579.0	-53.5	27.0	-2.50	19.5	11.9	0.55
16	52.6	536.9	-51.0	25.1	-2.38	17.2	11.5	0.52
17	55.8	550.0	-55.6	25.7	-2.60	16.6	11.1	0.49
18	59.1	507.2	-50.3	23.7	-2.35	14.4	10.8	0.46
19	62.4	518.8	-52.3	24.2	-2.45	13.8	10.4	0.43
20	65.7	498.6	-43.3	23.3	-2.02	11.8	10.1	0.40
21	69.0	499.5	-44.0	23.3	-2.06	11.1	9.8	0.37
22	72.3	485.6	-36.5	22.7	-1.70	9.5	9.5	0.34
23	75.6	491.3	-37.0	23.0	-1.73	8.9	9.2	0.31
24	78.8	488.1	-30.8	22.8	-1.44	7.5	9.8	0.29
25	82.1	505.5	-31.4	23.6	-1.47	7.0	10.4	0.26
26	85.4	496.6	-28.9	23.2	-1.35	5.8	10.6	0.23
27	88.7	503.7	-29.1	23.5	-1.36	4.8	9.5	0.20
Absolute	23.0			30.4			(T =	37.3 ms)
	55.8				-2.60		(T =	61.4 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	762.4	716.8	671.2	625.6	580.0	534.4	488.8	443.2	397.6	352.0
RX	790.5	754.3	718.7	684.8	653.3	627.2	606.1	587.3	570.4	554.3
RU	773.2	728.6	684.1	639.6	595.1	550.6	506.1	461.6	417.1	372.5

RAU = 255.7 (kips); RA2 = 565.9 (kips)

Current CAPWAP Ru = 558.0 (kips); Corresponding J(RP)= 0.45; J(RX) = 0.88

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
15.2	35.77	581.4	636.9	639.2	0.89	0.13	0.12	31.5	742.3	2500

PILE PROFILE AND PILE MODEL

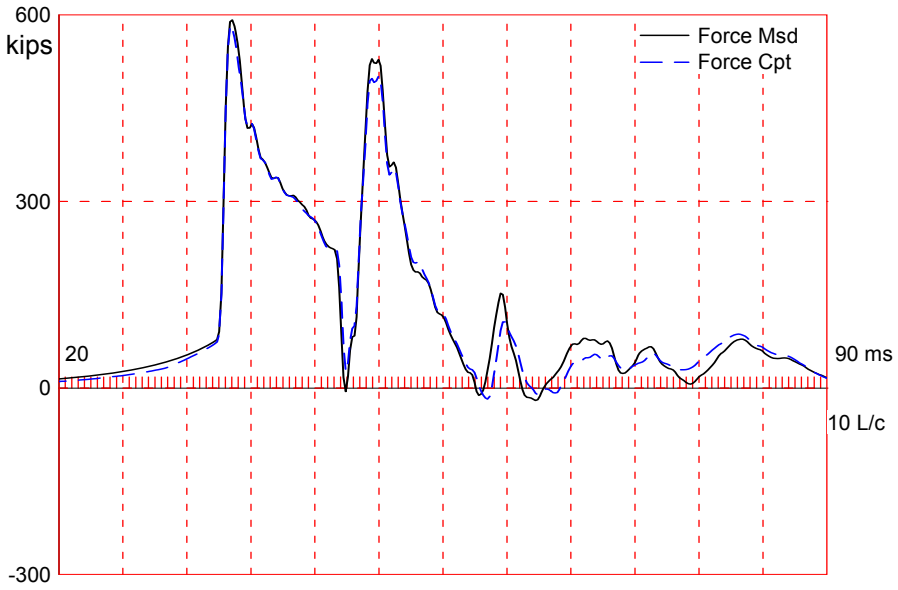
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
88.7	21.4	29992.2	492.000	4.70

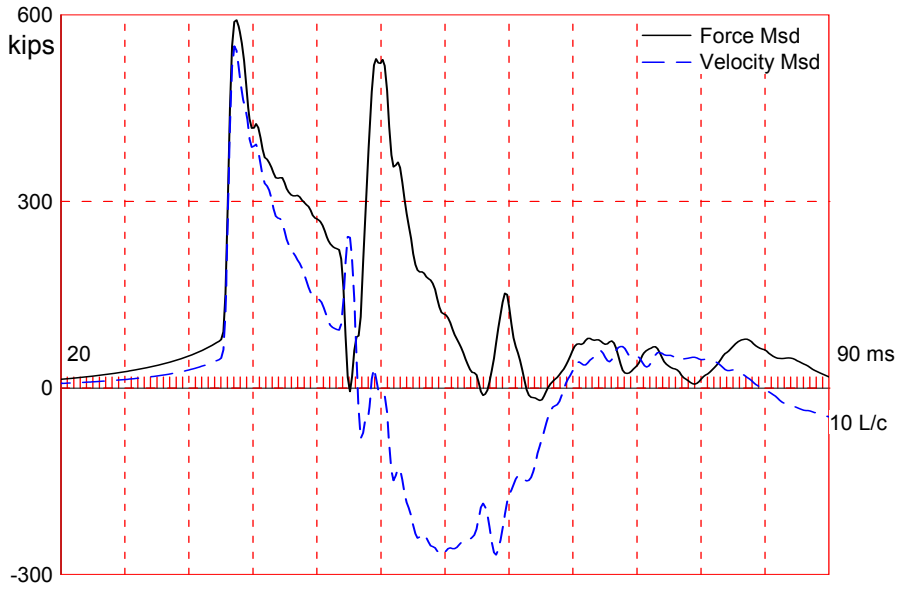
Toe Area 198.5 in^2

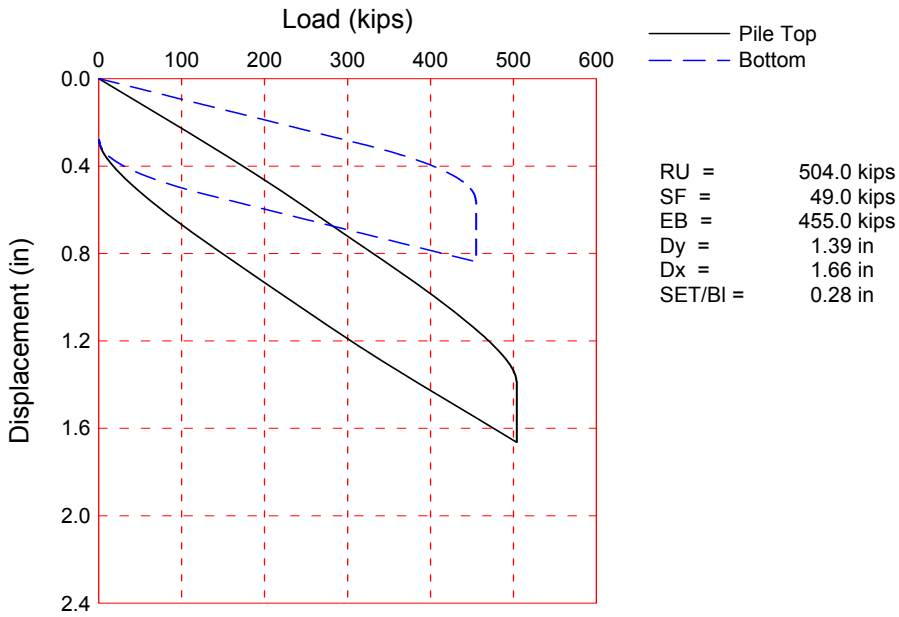
Top Segment Length 3.29 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.195 ms, 2L/c 10.6 ms

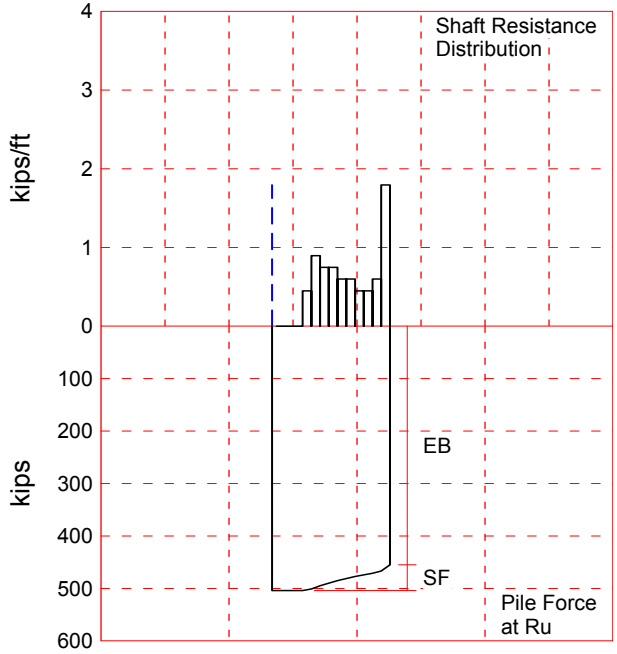
Total volume: 13.182 ft^3; Volume ratio considering added impedance: 1.000







RU =	504.0 kips
SF =	49.0 kips
EB =	455.0 kips
Dy =	1.39 in
Dx =	1.66 in
SET/Bl =	0.28 in



Length b. Sensors	90.3 ft
Embedment	87.0 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	4.41
Top Compr. Stress	27.2 ksi
Max Compr. Stress	27.8 ksi
Max Tension Stress	-4.96 ksi
Avg. Shaft Quake	0.25 in
Toe Quake	0.43 in
Avg. Shaft Smith Dpg.	0.21 s/ft
Toe Smith Damping	0.07 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: 504.0; along Shaft 49.0; at Toe 455.0 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
				504.0				
1	10.0	6.8	0.0	504.0	0.0	0.00	0.00	0.00
2	16.7	13.5	0.0	504.0	0.0	0.00	0.00	0.00
3	23.4	20.1	0.0	504.0	0.0	0.00	0.00	0.00
4	30.1	26.8	3.0	501.0	3.0	0.45	0.10	0.21
5	36.8	33.5	6.0	495.0	9.0	0.90	0.19	0.21
6	43.5	40.2	5.0	490.0	14.0	0.75	0.16	0.21
7	50.1	46.9	5.0	485.0	19.0	0.75	0.16	0.21
8	56.8	53.6	4.0	481.0	23.0	0.60	0.13	0.21
9	63.5	60.3	4.0	477.0	27.0	0.60	0.13	0.21
10	70.2	66.9	3.0	474.0	30.0	0.45	0.10	0.21
11	76.9	73.6	3.0	471.0	33.0	0.45	0.10	0.21
12	83.6	80.3	4.0	467.0	37.0	0.60	0.13	0.21
13	90.3	87.0	12.0	455.0	49.0	1.80	0.38	0.21
Avg. Shaft			3.8			0.56	0.12	0.21
Toe			455.0				330.07	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.25	0.43
Case Damping Factor		0.27	0.83
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	30
Unloading Level	(% of Ru)	57	
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)	0.020	

CAPWAP match quality = 4.41 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.28 in; Blow Count = 43 b/ft
Computed: Final Set = 0.32 in; Blow Count = 38 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(F590) CAL: 95.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.03; A4(K2253) CAL: 325; RF: 1.03

max. Top Comp. Stress = 27.2 ksi (T= 36.0 ms, max= 1.022 x Top)
max. Comp. Stress = 27.8 ksi (Z= 30.1 ft, T= 37.8 ms)
max. Tens. Stress = -4.96 ksi (Z= 56.8 ft, T= 62.8 ms)
max. Energy (EMX) = 30.7 kip-ft; max. Measured Top Displ. (DMX)= 1.09 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	583.2	-26.3	27.2	-1.23	30.7	14.5	1.11
2	6.7	583.6	-37.9	27.3	-1.77	30.6	14.5	1.10
4	13.4	584.3	-62.3	27.3	-2.91	30.2	14.5	1.07
6	20.1	585.7	-83.4	27.4	-3.89	29.7	14.4	1.03
8	26.7	591.5	-96.2	27.6	-4.49	29.2	14.2	0.99
10	33.4	590.0	-93.4	27.6	-4.37	27.9	14.0	0.94
12	40.1	576.7	-86.7	26.9	-4.05	25.9	13.7	0.89
13	43.5	581.1	-85.7	27.1	-4.01	25.5	13.6	0.87
14	46.8	567.2	-91.1	26.5	-4.26	24.2	13.5	0.84
15	50.1	571.1	-102.3	26.7	-4.78	23.7	13.4	0.82
16	53.5	557.9	-105.5	26.1	-4.93	22.3	13.2	0.79
17	56.8	566.5	-106.1	26.5	-4.96	21.8	13.0	0.76
18	60.2	557.8	-101.7	26.1	-4.75	20.7	12.9	0.73
19	63.5	555.8	-101.4	26.0	-4.74	20.1	12.9	0.70
20	66.9	542.3	-97.0	25.3	-4.53	18.9	12.9	0.67
21	70.2	545.7	-96.8	25.5	-4.52	18.3	13.1	0.64
22	73.5	538.6	-93.4	25.2	-4.37	17.3	13.2	0.61
23	76.9	542.0	-93.6	25.3	-4.37	16.7	14.0	0.58
24	80.2	531.8	-90.7	24.8	-4.24	15.8	15.3	0.55
25	83.6	525.6	-90.6	24.6	-4.23	15.5	16.4	0.53
26	86.9	542.4	-86.1	25.3	-4.02	15.0	17.2	0.50
27	90.3	558.5	-85.9	26.1	-4.01	14.7	16.1	0.48
Absolute	30.1			27.8			(T =	37.8 ms)
	56.8				-4.96		(T =	62.8 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	492.2	360.8	229.4	98.1	0.0					
RX	656.6	627.4	599.6	573.9	555.0	539.4	523.7	508.1	492.5	476.8
RU	492.2	360.8	229.4	98.1	0.0					

RAU = 424.9 (kips); RA2 = 562.5 (kips)

Current CAPWAP Ru = 504.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 1.45

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
14.5	35.80	553.7	595.3	595.3	1.09	0.28	0.28	30.6	536.3	1138

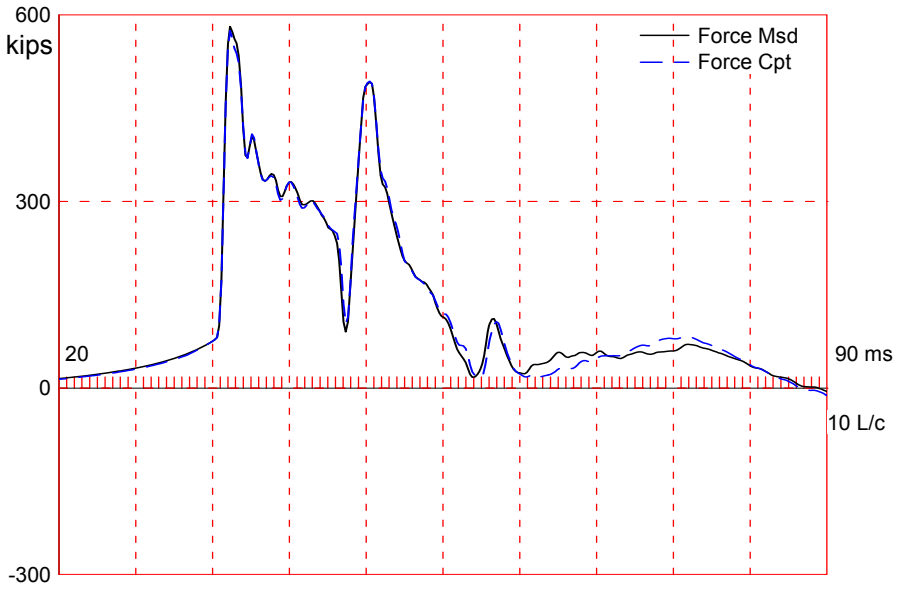
PILE PROFILE AND PILE MODEL

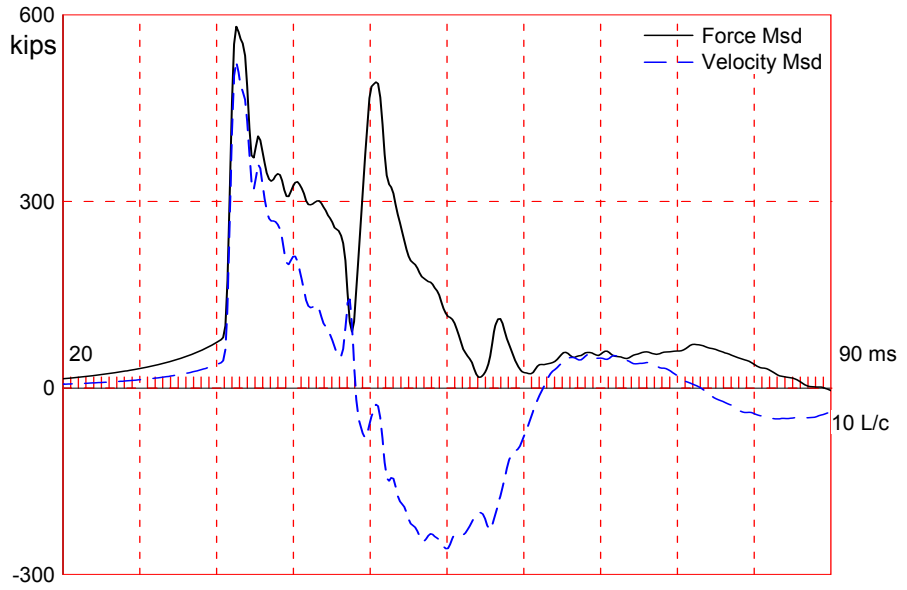
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
90.3	21.4	29992.2	492.000	4.70

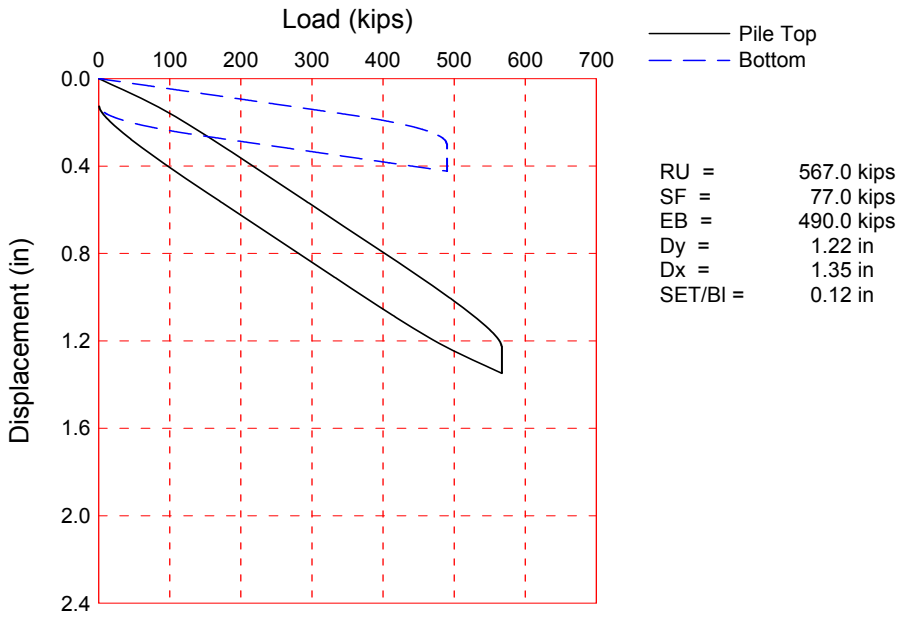
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
19	63.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
21	70.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
27	90.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

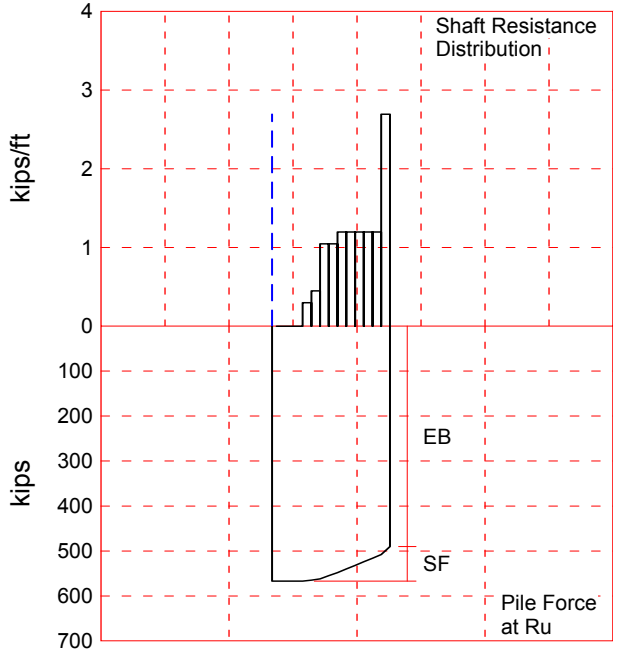
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 10.7 ms
Total volume: 13.412 ft^3; Volume ratio considering added impedance: 1.000







RU =	567.0 kips
SF =	77.0 kips
EB =	490.0 kips
Dy =	1.22 in
Dx =	1.35 in
SET/Bl =	0.12 in



Length b. Sensors	90.3 ft
Embedment	87.0 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	2.76
Top Compr. Stress	26.9 ksi
Max Compr. Stress	27.4 ksi
Max Tension Stress	-4.65 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.23 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.05 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 567.0; along Shaft 77.0; at Toe 490.0 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
				567.0				
1	10.0	6.8	0.0	567.0	0.0	0.00	0.00	0.00
2	16.7	13.5	0.0	567.0	0.0	0.00	0.00	0.00
3	23.4	20.2	0.0	567.0	0.0	0.00	0.00	0.00
4	30.1	26.9	2.0	565.0	2.0	0.30	0.06	0.30
5	36.8	33.6	3.0	562.0	5.0	0.45	0.10	0.30
6	43.5	40.2	7.0	555.0	12.0	1.05	0.22	0.30
7	50.1	46.9	7.0	548.0	19.0	1.05	0.22	0.30
8	56.8	53.6	8.0	540.0	27.0	1.20	0.25	0.30
9	63.5	60.3	8.0	532.0	35.0	1.20	0.25	0.30
10	70.2	67.0	8.0	524.0	43.0	1.20	0.25	0.30
11	76.9	73.7	8.0	516.0	51.0	1.20	0.25	0.30
12	83.6	80.4	8.0	508.0	59.0	1.20	0.25	0.30
13	90.3	87.0	18.0	490.0	77.0	2.69	0.57	0.30
Avg. Shaft			5.9			0.88	0.19	0.30
Toe			490.0				355.46	0.05

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.05	0.23
Case Damping Factor		0.60	0.64
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	34	30
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	39	
Resistance Gap (included in Toe Quake)	(in)		0.01

CAPWAP match quality = 2.76 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.09 in; Blow Count = 137 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 = 26.9 ksi (T= 36.0 ms, max= 1.019 x Top)
max. Comp. Stress = 27.4 ksi (Z= 30.1 ft, T= 37.6 ms)
max. Tens. Stress = -4.65 ksi (Z= 56.8 ft, T= 62.0 ms)
max. Energy (EMX) = 27.1 kip-ft; max. Measured Top Displ. (DMX)= 0.93 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	575.6	-21.8	26.9	-1.02	27.1	13.9	0.93
2	6.7	576.2	-22.4	26.9	-1.04	27.0	13.9	0.92
4	13.4	577.6	-24.3	27.0	-1.14	26.5	13.8	0.88
6	20.1	579.2	-39.1	27.1	-1.83	26.0	13.7	0.84
8	26.7	583.7	-46.8	27.3	-2.18	25.3	13.6	0.80
10	33.4	580.5	-65.4	27.1	-3.06	24.1	13.4	0.75
12	40.1	578.1	-82.9	27.0	-3.87	22.6	13.0	0.69
13	43.5	584.5	-93.3	27.3	-4.36	22.1	12.8	0.67
14	46.8	558.7	-92.8	26.1	-4.34	20.4	12.6	0.64
15	50.1	565.1	-96.8	26.4	-4.52	19.8	12.4	0.61
16	53.5	540.9	-95.4	25.3	-4.46	18.1	12.2	0.58
17	56.8	547.8	-99.5	25.6	-4.65	17.4	12.0	0.55
18	60.2	519.7	-92.0	24.3	-4.30	15.7	11.7	0.52
19	63.5	526.3	-92.6	24.6	-4.32	15.1	11.5	0.49
20	66.9	504.6	-85.3	23.6	-3.99	13.5	11.3	0.46
21	70.2	514.3	-84.4	24.0	-3.94	12.8	11.1	0.43
22	73.5	508.6	-76.3	23.8	-3.57	11.2	10.9	0.39
23	76.9	511.4	-76.4	23.9	-3.57	10.5	10.8	0.36
24	80.2	512.1	-68.9	23.9	-3.22	9.1	12.6	0.33
25	83.6	540.5	-68.5	25.2	-3.20	8.5	13.2	0.30
26	86.9	537.2	-61.2	25.1	-2.86	7.1	13.6	0.27
27	90.3	550.6	-60.9	25.7	-2.84	6.2	12.4	0.24
Absolute	30.1			27.4			(T =	37.6 ms)
	56.8				-4.65		(T =	62.0 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	581.2	528.0	474.8	421.5	368.3	315.1	261.8	208.6	155.4	102.2
RX	689.5	658.5	630.4	606.2	593.6	581.1	568.5	556.1	547.9	540.3
RU	581.2	528.0	474.8	421.5	368.3	315.1	261.8	208.6	155.4	102.2

RAU = 378.2 (kips); RA2 = 553.3 (kips)

Current CAPWAP Ru = 567.0 (kips); Corresponding J(RP)= 0.03; J(RX) = 0.61

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
13.9	35.80	529.4	584.2	584.2	0.93	0.13	0.12	27.2	618.4	2227

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
90.3	21.4	29992.2	492.000	4.70

Toe Area 198.5 in^2

Top Segment Length 3.34 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 10.7 ms

Total volume: 13.412 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Travis Coleman
Company: Lunda Construction Co.	No. of Sheets: 57
E-mail: kweber@lundaconstruction.com	Date: December 30, 2014

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 6
Winnebago County, Wisconsin

On December 24, 2014, Pier 6 #1, Pier 6 #36, and Pier 6 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on December 29. 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 elevations for the piles were the top of the template at EL 740.4 to EL 740.8. We understand the pier was excavated to approximately two to three feet below the bottom of footing elevation of EL 720.5. The piles have a required minimum tip elevation of EL 663. 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 6 #1 was driven to a depth of 87.0 feet, which corresponds to a pile tip elevation of EL 653.4. The blow count over the final increment of driving was 10 blows for 2 inches of penetration at an average hammer stroke of 7.7 feet. The blow count at the beginning of restrike was 5 blows for ½ inch of penetration at an average hammer stroke of 7.3 feet.

Pier 6 #36 was driven to a depth of 83.0 feet, which corresponds to a pile tip elevation of EL 657.8. The blow count over the final increment of driving was 10 blows for 3 ¾ inch of penetration at an average hammer stroke of 6.6 feet. The blow count at the beginning of restrike was 5 blows for 1 ⅛ inch of penetration at an average hammer stroke of 6.8 feet

Pier 6 #44 was driven to a depth of 88.0 feet, which corresponds to a pile tip elevation of EL 652.8. The blow count over the final increment of driving was 60 blows for one foot of penetration at an average hammer stroke of 7.3 feet. The blow count at the beginning of restrike was 5 blows for ⅝ inch of penetration at an average hammer stroke of 8.7 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 6 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	7	4
7.0	5	3
7.5	5	3
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 the plan minimum tip requirements. We anticipate the production piles will terminate at depths similar to those of the test piles.

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.

Travis Coleman, P.E.

Rory Flynn, E.I.

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

Attachments:

Dynamic Test Results - (pages 3 – 27)
CAPWAP Analysis Results - (pages 28 – 57)

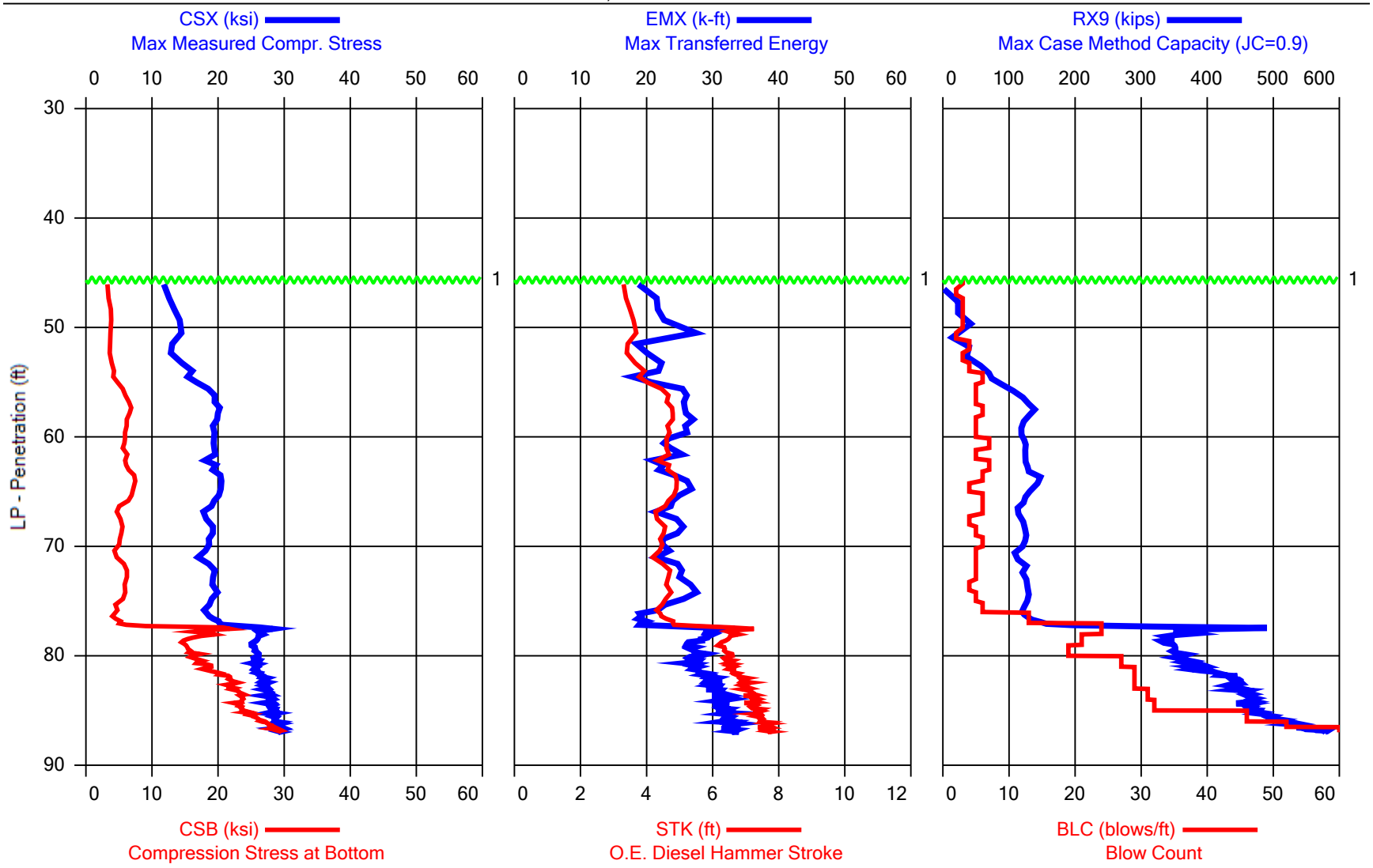
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 30-December-2014

Test started: 24-December-2014

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #1 - EOID

APE D30-42, HP 14 x 73



1 - Top of Template EL 740.38

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #1 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.67 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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
8	45.67	3	AV1	12.8	3.5	18	3.4	62.8	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	12.8	3.5	18	3.4	62.8	0
			MIN	12.8	3.5	18	3.4	62.8	0
9	46.00	3	AV1	11.8	3.2	18	3.3	63.2	5
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	11.8	3.2	18	3.3	63.2	5
			MIN	11.8	3.2	18	3.3	63.2	5
10	46.50	2	AV1	10.9	3.1	21	3.2	64.2	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	10.9	3.1	21	3.2	64.2	0
			MIN	10.9	3.1	21	3.2	64.2	0
11	47.00	2	AV1	12.8	3.5	24	3.4	62.4	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	12.8	3.5	24	3.4	62.4	0
			MIN	12.8	3.5	24	3.4	62.4	0
12	47.33	3	AV1	12.6	3.3	20	3.4	62.8	14
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	12.6	3.3	20	3.4	62.8	14
			MIN	12.6	3.3	20	3.4	62.8	14
13	47.67	3	AV1	12.4	3.5	21	3.3	63.0	26
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	12.4	3.5	21	3.3	63.0	26
			MIN	12.4	3.5	21	3.3	63.0	26
14	48.00	3	AV1	13.4	3.7	21	3.5	61.5	29
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.4	3.7	21	3.5	61.5	29
			MIN	13.4	3.7	21	3.5	61.5	29
15	48.33	3	AV1	13.9	3.8	22	3.5	61.4	26
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.9	3.8	22	3.5	61.4	26
			MIN	13.9	3.8	22	3.5	61.4	26
17	49.00	3	AV2	13.6	3.9	23	3.5	61.6	21
			STD	0.7	0.0	1	0.1	0.8	1
			MAX	14.3	3.9	23	3.6	62.4	22
			MIN	12.8	3.9	22	3.4	60.7	21
20	50.00	3	AV3	13.8	3.7	22	3.5	61.4	42
			STD	0.6	0.2	0	0.1	0.6	6

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #1 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	14.4	3.9	22	3.6	62.2	50
			MIN	13.0	3.5	22	3.4	60.8	36
22	51.00	2	AV2	15.2	3.8	30	3.8	59.4	0
			STD	0.1	0.0	0	0.0	0.1	0
			MAX	15.3	3.9	30	3.8	59.4	0
			MIN	15.1	3.8	30	3.8	59.3	0
26	52.00	4	AV4	13.3	3.7	19	3.5	62.1	40
			STD	0.9	0.2	1	0.1	1.3	4
			MAX	13.9	3.9	19	3.6	64.2	45
			MIN	11.8	3.4	17	3.2	61.1	36
29	53.00	3	AV3	13.1	3.5	22	3.4	62.3	36
			STD	1.4	0.2	2	0.2	1.6	9
			MAX	14.8	3.7	25	3.7	64.3	48
			MIN	11.4	3.3	19	3.2	60.4	29
33	54.00	4	AV4	15.2	4.1	22	3.8	59.6	59
			STD	0.8	0.2	1	0.1	1.0	6
			MAX	16.1	4.5	23	3.9	61.0	64
			MIN	14.1	4.0	21	3.6	58.4	49
39	55.00	6	AV6	15.9	4.3	18	3.9	59.1	75
			STD	0.5	0.2	1	0.1	0.6	6
			MAX	16.5	4.6	20	4.0	59.9	83
			MIN	15.2	4.1	18	3.7	58.2	68
44	56.00	5	AV5	18.5	5.5	25	4.4	55.2	101
			STD	0.7	0.2	1	0.2	1.0	11
			MAX	19.4	5.8	27	4.7	56.5	117
			MIN	17.6	5.2	24	4.2	54.0	87
49	57.00	5	AV5	19.5	6.3	26	4.6	54.2	123
			STD	0.2	0.3	1	0.1	0.3	3
			MAX	19.8	6.7	27	4.7	54.7	128
			MIN	19.2	6.0	25	4.5	53.7	120
55	58.00	6	AV6	20.1	6.7	26	4.8	53.4	136
			STD	0.4	0.3	1	0.1	0.5	3
			MAX	20.7	7.1	27	4.9	54.1	140
			MIN	19.4	6.3	25	4.6	52.8	131
60	59.00	5	AV5	19.7	6.2	27	4.7	53.6	122
			STD	0.3	0.2	1	0.1	0.4	4
			MAX	20.0	6.5	27	4.8	54.4	129
			MIN	19.2	6.0	26	4.6	53.2	117
65	60.00	5	AV5	19.3	5.9	26	4.7	54.1	119
			STD	0.4	0.1	1	0.1	0.6	1
			MAX	20.0	6.0	28	4.9	54.6	121
			MIN	18.9	5.8	25	4.6	53.0	117

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #1 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
72	61.00	7	AV7	19.4	5.8	23	4.6	54.4	124
			STD	0.4	0.1	0	0.1	0.4	3
			MAX	20.0	6.0	23	4.7	54.8	130
			MIN	18.9	5.6	22	4.5	53.7	122
77	62.00	5	AV5	19.4	6.1	25	4.6	54.2	125
			STD	0.5	0.3	2	0.1	0.7	2
			MAX	19.8	6.4	27	4.7	55.5	129
			MIN	18.4	5.4	21	4.4	53.7	121
84	63.00	7	AV7	19.1	6.1	22	4.5	54.7	127
			STD	1.1	0.2	1	0.2	1.3	6
			MAX	20.7	6.4	24	4.9	56.6	135
			MIN	17.3	5.8	20	4.2	52.6	115
90	64.00	6	AV6	20.2	7.3	24	4.9	53.0	142
			STD	0.9	0.4	2	0.1	0.7	13
			MAX	21.4	7.7	26	5.1	53.9	152
			MIN	18.6	6.6	20	4.7	51.9	116
94	65.00	4	AV4	20.4	7.2	27	4.9	52.8	136
			STD	0.3	0.2	0	0.1	0.4	5
			MAX	20.9	7.4	27	5.0	53.3	142
			MIN	20.0	7.0	27	4.8	52.2	129
100	66.00	6	AV6	19.8	6.7	24	4.7	53.6	126
			STD	0.6	0.3	1	0.1	0.7	5
			MAX	20.7	7.2	26	5.0	54.6	133
			MIN	18.9	6.2	22	4.6	52.5	120
106	67.00	6	AV6	18.4	4.9	23	4.4	55.4	114
			STD	0.7	0.3	1	0.2	1.0	3
			MAX	19.3	5.3	24	4.7	56.8	118
			MIN	17.3	4.6	21	4.2	54.0	110
110	68.00	4	AV4	18.3	5.5	25	4.3	55.9	119
			STD	0.6	0.7	1	0.1	0.8	4
			MAX	18.9	6.3	26	4.5	57.1	125
			MIN	17.3	4.6	23	4.1	55.0	113
115	69.00	5	AV5	19.3	5.3	25	4.6	54.6	127
			STD	0.8	0.2	2	0.2	0.9	4
			MAX	20.5	5.6	28	4.8	55.5	134
			MIN	18.6	5.0	23	4.4	53.2	123
121	70.00	6	AV6	18.6	5.1	22	4.4	55.2	122
			STD	0.5	0.4	1	0.1	0.5	3
			MAX	19.3	5.6	24	4.6	56.0	127
			MIN	18.0	4.6	21	4.3	54.6	117
126	71.00	5	AV5	17.6	4.5	23	4.3	56.1	112
			STD	0.8	0.2	1	0.1	0.9	5
			MAX	18.4	4.8	24	4.4	57.7	120

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #1 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MIN	16.2	4.3	20	4.0	55.3	106
131	72.00	5	AV5	18.5	5.5	24	4.5	55.1	122
			STD	0.9	0.7	1	0.2	1.1	6
			MAX	19.9	6.4	26	4.8	56.8	129
			MIN	16.9	4.5	22	4.2	53.5	112
136	73.00	5	AV5	19.3	6.2	25	4.7	54.0	122
			STD	0.3	0.3	0	0.0	0.2	5
			MAX	19.6	6.7	26	4.7	54.2	131
			MIN	18.9	6.0	25	4.6	53.7	115
140	74.00	4	AV4	19.3	5.8	27	4.6	54.2	128
			STD	0.8	0.2	1	0.1	0.7	2
			MAX	20.4	6.2	28	4.8	55.0	130
			MIN	18.4	5.6	25	4.5	53.3	125
145	75.00	5	AV5	19.4	5.8	26	4.7	54.1	129
			STD	0.5	0.3	1	0.1	0.5	2
			MAX	20.2	6.4	28	4.8	54.6	131
			MIN	18.9	5.5	25	4.6	53.5	124
151	76.00	6	AV6	18.3	4.6	22	4.4	55.6	122
			STD	0.6	0.2	1	0.1	0.7	5
			MAX	19.1	4.8	23	4.6	56.8	129
			MIN	17.3	4.4	21	4.2	54.6	115
164	77.00	13	AV13	19.1	4.6	19	4.6	54.5	133
			STD	0.8	0.6	1	0.2	1.0	10
			MAX	20.5	5.8	21	4.9	56.2	154
			MIN	17.8	3.9	18	4.3	52.8	120
188	78.00	24	AV24	25.1	15.0	27	6.2	47.6	331
			STD	2.7	6.3	5	0.8	3.3	107
			MAX	28.8	25.6	35	7.4	53.4	523
			MIN	20.3	4.3	18	4.8	43.3	149
209	79.00	21	AV21	25.8	15.9	28	6.4	46.4	342
			STD	0.6	1.6	2	0.2	0.7	12
			MAX	26.7	19.8	30	6.8	47.8	365
			MIN	24.5	14.2	25	6.0	45.3	319
228	80.00	19	AV19	25.7	15.8	27	6.4	46.5	354
			STD	0.4	0.8	1	0.2	0.6	11
			MAX	26.5	18.2	30	6.7	47.4	381
			MIN	25.0	14.8	25	6.1	45.4	340
255	81.00	27	AV27	25.7	17.3	27	6.5	46.2	371
			STD	0.5	1.2	1	0.2	0.6	16
			MAX	26.5	19.8	29	6.8	47.3	409
			MIN	24.8	15.6	25	6.2	45.3	345
284	82.00	29	AV29	26.1	19.7	28	6.7	45.6	408

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #1 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			STD	0.6	1.5	1	0.2	0.6	23
			MAX	27.3	22.2	31	7.1	46.8	454
			MIN	25.1	17.2	25	6.3	44.3	368
313	83.00	29	AV29	27.1	22.0	30	7.0	44.6	444
			STD	0.5	0.6	1	0.2	0.5	10
			MAX	28.1	23.5	32	7.3	46.1	461
			MIN	25.7	20.8	28	6.5	43.7	424
344	84.00	31	AV31	27.7	23.3	31	7.2	44.0	461
			STD	0.6	0.6	1	0.2	0.6	10
			MAX	28.9	24.5	34	7.5	45.5	485
			MIN	26.3	21.6	27	6.7	43.0	430
376	85.00	32	AV32	28.0	23.3	31	7.3	43.8	462
			STD	0.5	0.5	1	0.2	0.5	9
			MAX	28.9	24.1	33	7.6	45.2	476
			MIN	26.7	22.0	29	6.8	42.9	438
422	86.00	46	AV46	28.6	25.3	32	7.4	43.3	494
			STD	0.4	0.9	1	0.1	0.4	13
			MAX	29.4	27.0	34	7.7	44.4	516
			MIN	27.6	23.7	30	7.0	42.6	467
448	86.50	52	AV26	29.0	27.7	33	7.6	42.7	536
			STD	0.3	0.5	1	0.1	0.3	10
			MAX	29.9	28.7	35	7.9	43.3	551
			MIN	28.5	26.6	31	7.4	41.9	514
458	86.67	60	AV10	28.8	28.2	33	7.6	43.0	543
			STD	0.5	0.5	1	0.2	0.5	7
			MAX	29.5	29.0	35	7.8	43.7	551
			MIN	28.0	27.4	31	7.3	42.3	527
468	86.83	60	AV10	29.0	28.9	33	7.6	42.9	561
			STD	0.4	0.6	1	0.2	0.5	10
			MAX	29.9	30.1	35	7.9	43.5	577
			MIN	28.5	27.9	31	7.4	41.9	545
478	87.00	60	AV10	29.3	29.5	33	7.7	42.5	581
			STD	0.3	0.4	1	0.1	0.3	9
			MAX	29.7	30.3	35	7.9	42.8	599
			MIN	28.6	29.1	32	7.6	42.0	568
			Average	24.2	16.4	28	6.1	48.4	331
			Std. Dev.	4.7	8.8	4	1.3	5.7	172
			Maximum	29.9	30.3	35	7.9	64.3	599
			Minimum	10.9	3.1	17	3.2	41.9	0

Total number of blows analyzed: 471

BL# Sensors

1-478 F3: [F590] 95.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K2253] 325.0 (1.03); A4: [K2524] 360.0 (1.03)

BL#	Comments
8	Top of Template EL 740.38
476	W

Time Summary

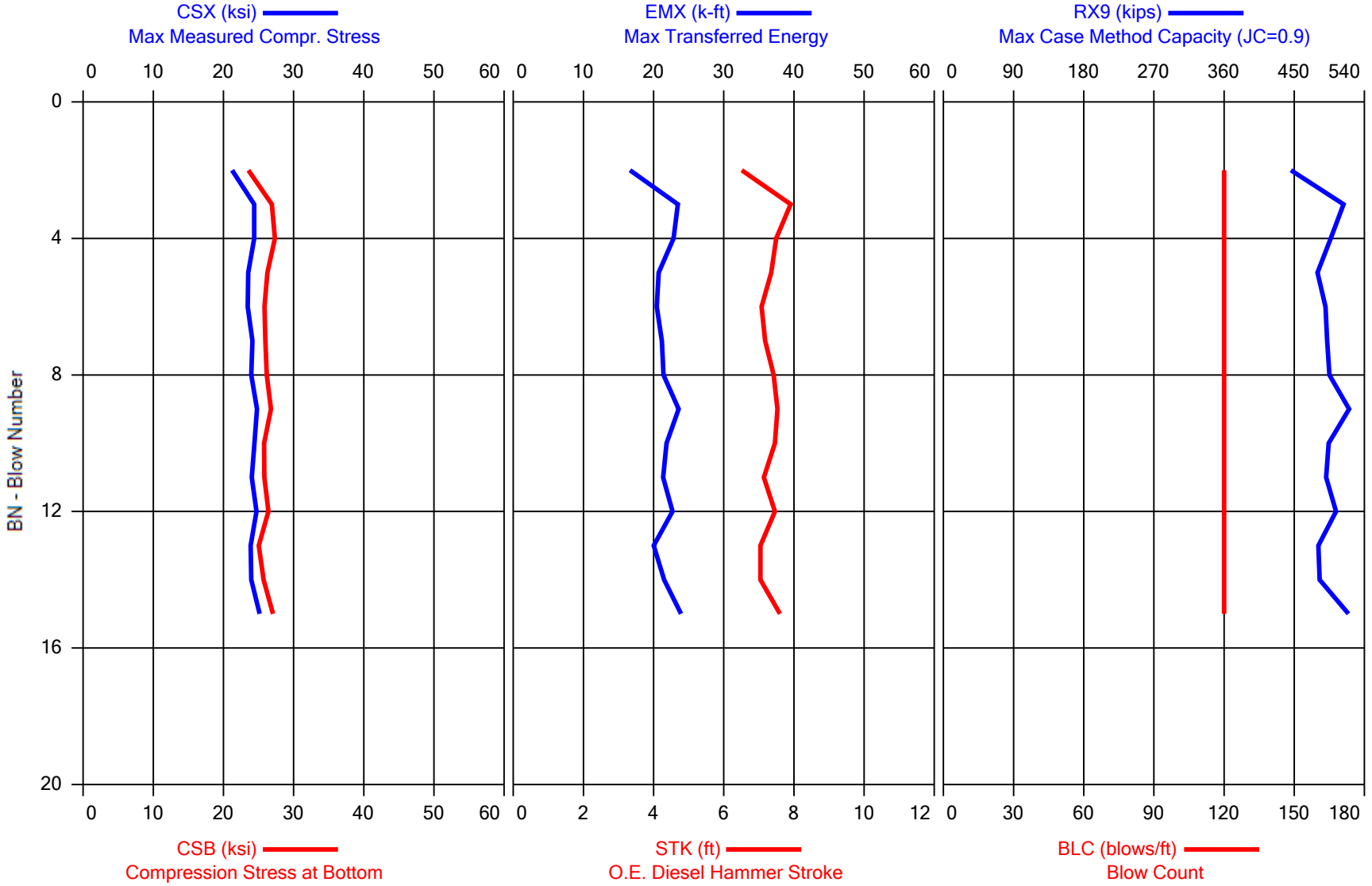
Drive 10 minutes 16 seconds 10:24 AM - 10:34 AM BN 1 - 478

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 29-December-2014 Test started: 29-December-2014

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #1 - BOR

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #1 - BOR APE D30-42, HP 14 x 73
OP: TC Date: 29-December-2014

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.67 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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
5	87.04	120	AV4	23.4	26.0	21	7.3	43.7	484
			MAX	24.4	27.3	23	7.9	46.1	513
			MIN	21.2	23.5	17	6.5	42.0	446
10	87.08	120	AV5	24.1	26.1	22	7.3	43.6	498
			MAX	24.8	26.8	24	7.5	44.3	520
			MIN	23.5	25.8	20	7.1	43.0	490
15	87.13	120	AV5	24.4	26.0	22	7.3	43.8	496
			MAX	25.2	27.1	24	7.6	44.4	520
			MIN	23.9	25.0	20	7.0	42.8	481
			Average	24.0	26.0	22	7.3	43.7	493
			Maximum	25.2	27.3	24	7.9	46.1	520
			Minimum	21.2	23.5	17	6.5	42.0	446

Total number of blows analyzed: 14

BL# Sensors

1-15 F3: [F590] 95.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K2253] 325.0 (1.00); A4: [K2524] 360.0 (1.00)

Time Summary

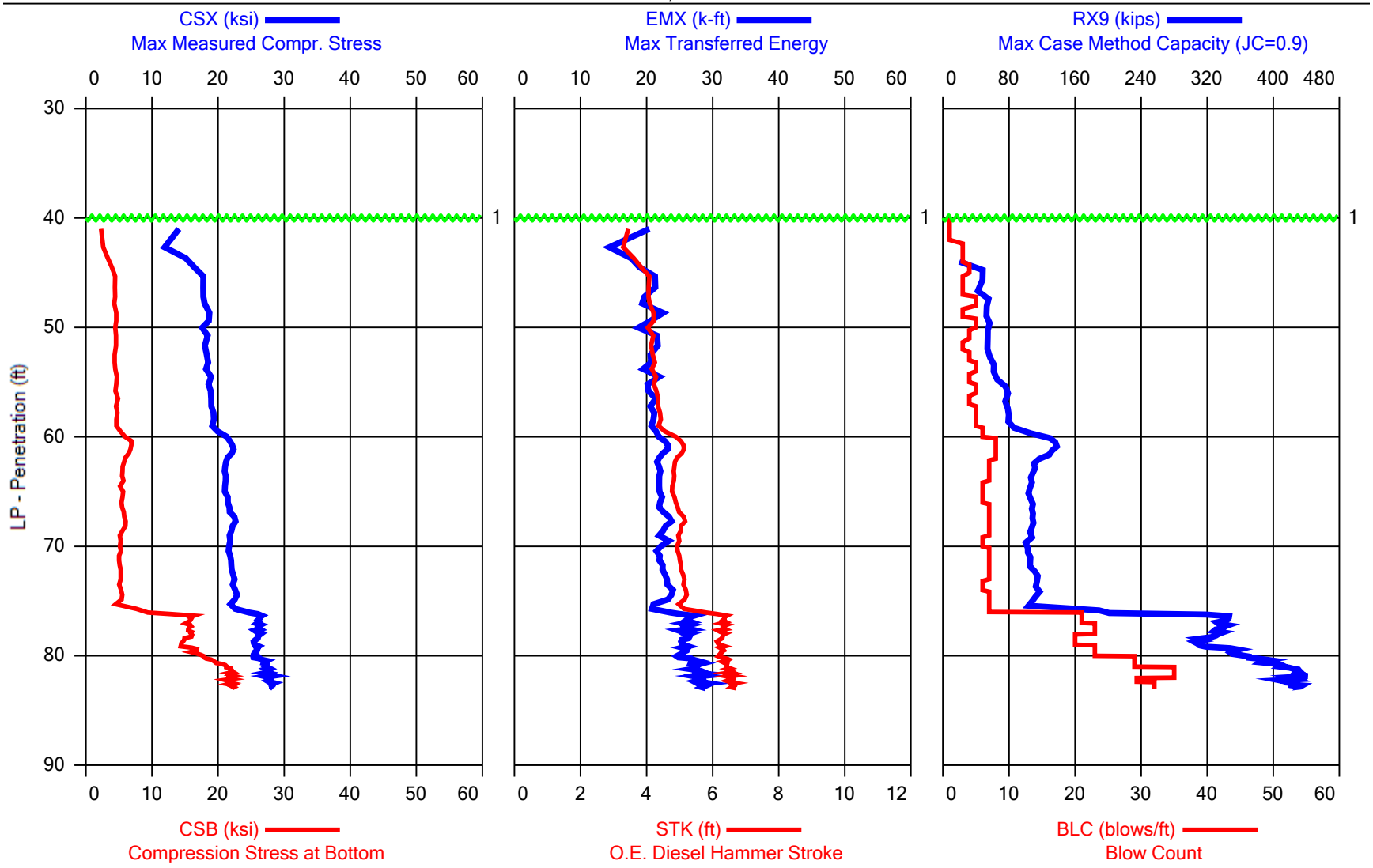
Drive 19 seconds 8:17 AM - 8:18 AM BN 1 - 15

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 29-December-2014 Test started: 24-December-2014

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #36 - EOID

APE D30-42, HP 14 x 73



1 - Top of Template EL740.78

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #36 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.67 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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
11	40.00	1	AV1	15.4	2.1	21	3.5	61.6	0
			MAX	15.4	2.1	21	3.5	61.6	0
			MIN	15.4	2.1	21	3.5	61.6	0
12	41.00	1	AV1	14.3	2.5	22	3.5	61.5	0
			MAX	14.3	2.5	22	3.5	61.5	0
			MIN	14.3	2.5	22	3.5	61.5	0
13	42.00	1	AV1	12.5	2.2	19	3.3	63.5	0
			MAX	12.5	2.2	19	3.3	63.5	0
			MIN	12.5	2.2	19	3.3	63.5	0
14	42.33	3	AV1	9.3	2.1	11	3.0	66.1	0
			MAX	9.3	2.1	11	3.0	66.1	0
			MIN	9.3	2.1	11	3.0	66.1	0
15	42.67	3	AV1	12.7	2.7	15	3.4	62.7	0
			MAX	12.7	2.7	15	3.4	62.7	0
			MIN	12.7	2.7	15	3.4	62.7	0
16	43.00	3	AV1	13.8	3.0	17	3.5	61.9	0
			MAX	13.8	3.0	17	3.5	61.9	0
			MIN	13.8	3.0	17	3.5	61.9	0
17	43.33	3	AV1	14.8	3.2	17	3.6	61.3	0
			MAX	14.8	3.2	17	3.6	61.3	0
			MIN	14.8	3.2	17	3.6	61.3	0
18	43.67	3	AV1	15.4	3.3	17	3.7	60.4	1
			MAX	15.4	3.3	17	3.7	60.4	1
			MIN	15.4	3.3	17	3.7	60.4	1
19	44.00	3	AV1	15.2	3.5	19	3.6	60.8	19
			MAX	15.2	3.5	19	3.6	60.8	19
			MIN	15.2	3.5	19	3.6	60.8	19
20	44.25	4	AV1	16.4	4.2	19	3.8	59.2	39
			MAX	16.4	4.2	19	3.8	59.2	39
			MIN	16.4	4.2	19	3.8	59.2	39
21	44.50	4	AV1	16.7	3.6	18	3.9	58.8	43
			MAX	16.7	3.6	18	3.9	58.8	43
			MIN	16.7	3.6	18	3.9	58.8	43
23	45.00	4	AV2	17.2	4.5	21	4.0	58.2	51
			MAX	18.2	5.1	22	4.2	59.5	51
			MIN	16.1	3.9	20	3.8	56.8	51

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #36 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
26	46.00	3	AV3	17.8	4.3	21	4.1	57.6	48
			MAX	18.3	4.7	21	4.1	58.0	50
			MIN	17.4	3.8	21	4.0	57.1	46
29	47.00	3	AV3	17.7	4.4	21	4.1	57.6	42
			MAX	18.2	4.7	22	4.1	58.0	45
			MIN	17.3	4.2	21	4.0	57.1	40
34	48.00	5	AV5	17.8	4.3	19	4.1	57.6	56
			MAX	18.2	4.3	20	4.1	58.5	57
			MIN	17.1	4.2	18	3.9	57.1	54
37	49.00	3	AV3	18.7	4.6	23	4.2	56.6	50
			MAX	18.8	5.1	23	4.2	56.8	52
			MIN	18.6	4.3	22	4.2	56.5	47
42	50.00	5	AV5	18.1	4.5	20	4.1	57.2	55
			MAX	18.9	4.8	21	4.3	58.4	57
			MIN	17.1	4.1	18	3.9	56.3	51
46	51.00	4	AV4	18.3	4.6	21	4.2	56.8	56
			MAX	18.7	4.9	22	4.2	57.2	58
			MIN	18.1	4.3	20	4.1	56.6	54
49	52.00	3	AV3	18.0	4.5	22	4.1	57.1	53
			MAX	18.8	4.6	23	4.2	57.5	55
			MIN	17.6	4.4	20	4.1	56.5	51
53	53.00	4	AV4	18.1	4.3	20	4.2	57.0	57
			MAX	18.6	4.4	22	4.3	57.6	64
			MIN	17.4	4.2	19	4.1	56.3	52
58	54.00	5	AV5	18.5	4.4	20	4.2	56.5	63
			MAX	19.0	4.5	22	4.3	57.9	65
			MIN	17.4	4.4	19	4.0	55.8	60
62	55.00	4	AV4	18.9	4.7	22	4.3	56.2	63
			MAX	19.0	5.1	22	4.3	56.4	72
			MIN	18.7	4.5	21	4.3	56.0	57
67	56.00	5	AV5	18.7	4.5	20	4.3	56.4	77
			MAX	19.2	4.6	20	4.3	56.8	79
			MIN	18.4	4.4	20	4.2	55.8	76
71	57.00	4	AV4	19.0	4.8	21	4.4	55.8	76
			MAX	19.3	5.2	22	4.4	56.0	79
			MIN	18.8	4.5	21	4.3	55.5	74
76	58.00	5	AV5	19.1	4.7	21	4.4	55.7	79
			MAX	19.6	5.0	21	4.5	56.4	83
			MIN	18.4	4.5	20	4.3	55.0	76

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #36 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
81	59.00	5	AV5	19.2	4.6	21	4.4	55.6	80
			MAX	19.7	4.8	21	4.5	56.2	83
			MIN	18.6	4.4	21	4.3	54.9	72
87	60.00	6	AV6	20.2	5.3	21	4.6	54.3	102
			MAX	21.1	5.9	22	4.9	55.4	121
			MIN	19.4	4.5	20	4.4	53.0	85
95	61.00	8	AV8	22.1	6.8	23	5.1	51.8	136
			MAX	23.0	7.1	24	5.3	52.4	141
			MIN	21.5	6.2	22	5.0	50.9	131
103	62.00	8	AV8	21.8	6.4	22	5.0	52.2	128
			MAX	23.0	6.8	24	5.2	53.0	134
			MIN	21.2	5.9	21	4.9	51.1	119
110	63.00	7	AV7	21.1	5.6	22	4.8	53.0	111
			MAX	21.7	6.1	23	5.0	53.3	114
			MIN	20.9	5.4	21	4.8	52.5	107
117	64.00	7	AV7	21.0	5.5	22	4.8	53.3	108
			MAX	22.0	5.9	23	5.1	54.3	114
			MIN	20.1	5.2	21	4.6	52.0	103
123	65.00	6	AV6	21.2	5.4	22	4.8	53.2	105
			MAX	22.1	5.9	24	5.0	54.3	109
			MIN	20.2	5.0	21	4.6	52.1	101
129	66.00	6	AV6	21.3	5.5	22	4.8	53.1	106
			MAX	21.9	5.8	24	5.0	53.9	111
			MIN	20.8	5.2	21	4.7	52.4	98
136	67.00	7	AV7	21.7	5.6	22	5.0	52.5	108
			MAX	22.3	5.8	23	5.1	53.4	113
			MIN	21.0	5.3	21	4.8	51.7	103
143	68.00	7	AV7	22.5	5.9	23	5.1	51.7	109
			MAX	22.8	6.2	24	5.2	52.2	112
			MIN	22.1	5.8	23	5.0	51.3	106
150	69.00	7	AV7	21.9	5.5	22	5.0	52.2	107
			MAX	22.6	6.0	24	5.2	53.1	112
			MIN	21.2	5.2	21	4.8	51.5	103
156	70.00	6	AV6	21.8	5.2	23	5.0	52.5	103
			MAX	22.6	5.5	24	5.2	53.0	114
			MIN	21.4	5.0	22	4.9	51.5	93
163	71.00	7	AV7	21.7	5.1	22	5.0	52.4	104
			MAX	22.6	5.5	23	5.2	53.2	108
			MIN	21.0	4.9	21	4.8	51.4	99
170	72.00	7	AV7	22.0	5.0	22	5.0	52.2	106

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #36 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	22.6	5.4	23	5.2	52.8	109
			MIN	21.6	4.8	21	4.9	51.4	102
177	73.00	7	AV7	22.3	5.3	23	5.1	51.8	113
			MAX	23.3	5.6	24	5.3	52.6	116
			MIN	21.4	4.9	21	4.9	50.7	110
183	74.00	6	AV6	22.5	5.2	24	5.2	51.4	114
			MAX	23.3	5.4	25	5.4	52.1	123
			MIN	21.9	5.0	23	5.0	50.5	105
190	75.00	7	AV7	22.6	5.4	23	5.2	51.5	113
			MAX	23.3	5.9	25	5.4	52.2	119
			MIN	21.9	5.0	22	5.0	50.6	107
197	76.00	7	AV7	22.6	6.7	22	5.2	51.5	141
			MAX	24.9	10.4	25	5.9	53.2	207
			MIN	21.3	4.3	19	4.8	48.4	98
218	77.00	21	AV21	26.1	14.7	26	6.3	46.9	319
			MAX	27.1	16.7	28	6.5	48.9	362
			MIN	24.6	8.5	23	5.8	46.0	163
241	78.00	23	AV23	26.1	15.7	26	6.3	46.8	337
			MAX	27.3	16.6	28	6.6	47.7	352
			MIN	25.2	14.8	24	6.1	45.8	326
261	79.00	20	AV20	25.8	15.1	26	6.2	47.1	316
			MAX	26.6	16.3	27	6.4	48.1	337
			MIN	24.6	14.3	24	6.0	46.4	300
284	80.00	23	AV23	25.7	16.2	26	6.3	47.0	345
			MAX	26.9	17.5	27	6.5	47.7	365
			MIN	24.8	14.3	24	6.1	46.2	307
313	81.00	29	AV29	26.7	19.5	27	6.4	46.6	391
			MAX	28.0	21.4	29	6.6	47.7	416
			MIN	24.9	17.7	24	6.1	45.7	362
348	82.00	35	AV35	27.7	21.9	28	6.5	46.0	428
			MAX	28.6	22.7	30	6.8	46.8	451
			MIN	26.8	20.9	26	6.3	45.3	407
359	82.38	29	AV11	27.8	21.6	28	6.5	46.0	420
			MAX	28.6	22.8	29	6.7	46.9	444
			MIN	27.2	20.0	26	6.3	45.6	402
369	82.69	32	AV10	28.1	21.8	28	6.6	45.8	423
			MAX	28.8	22.5	30	6.8	46.2	453
			MIN	27.7	20.8	27	6.5	45.1	407
379	83.00	32	AV10	28.2	22.2	29	6.6	45.7	428
			MAX	28.7	23.2	29	6.8	46.5	442

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #36 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MIN	27.5	21.3	28	6.4	45.3	409
			Average	23.5	11.7	24	5.5	50.5	231
			Maximum	28.8	23.2	30	6.8	66.1	453
			Minimum	9.3	2.1	11	3.0	45.1	0

Total number of blows analyzed: 369

BL# Sensors

1-379 F3: [F590] 95.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K2253] 325.0 (1.04); A4: [K2524] 360.0 (1.04)

BL# Comments

11 Top of Template EL740.78
376 CW

Time Summary

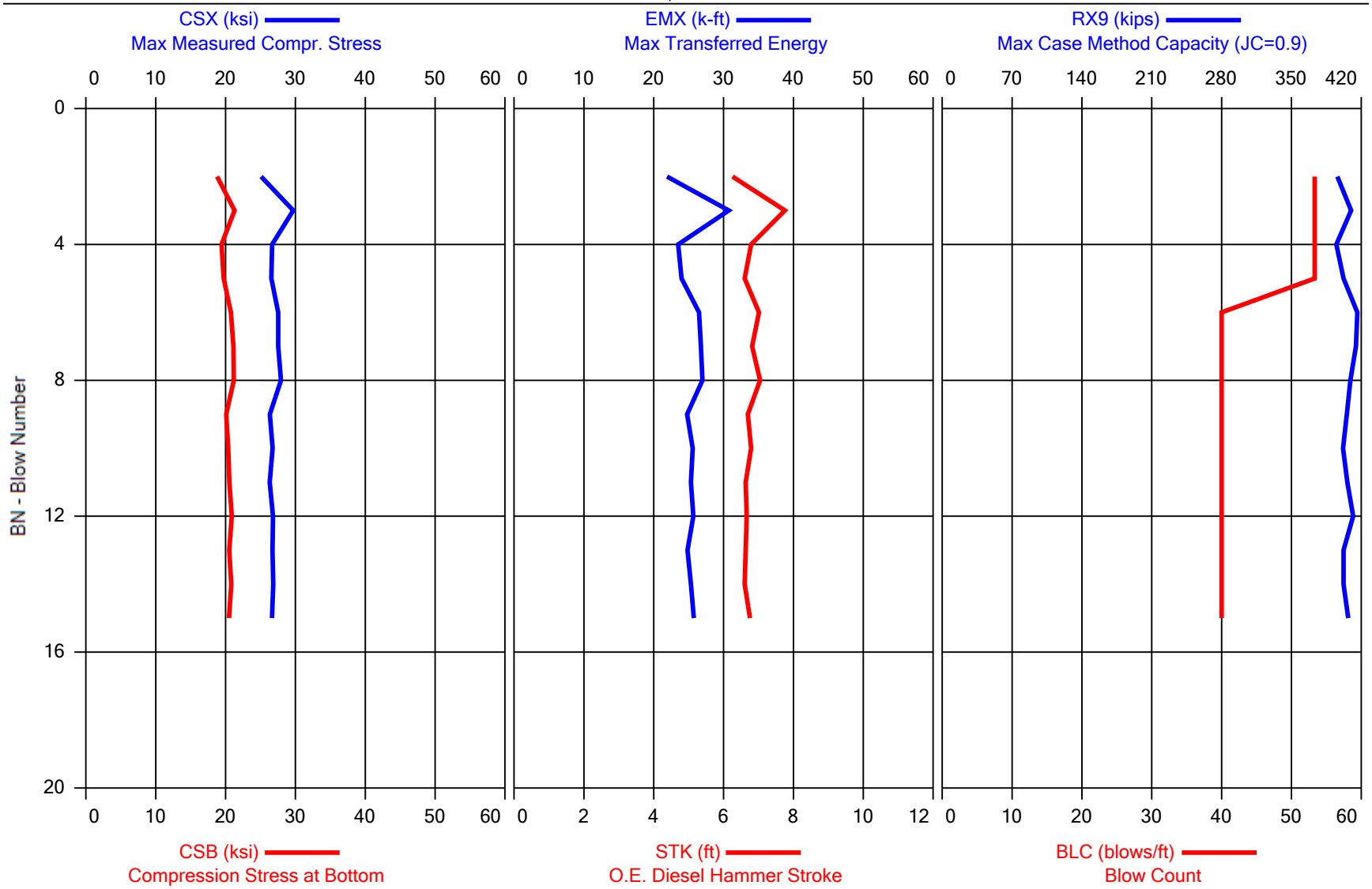
Drive 9 minutes 59 seconds 9:52 AM - 10:02 AM BN 1 - 379

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 29-December-2014 Test started: 29-December-2014

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #36 - BOR

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #36 - BOR APE D30-42, HP 14 x 73
OP: TC Date: 29-December-2014

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.67 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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
5	83.09	53	AV4	27.0	19.8	25	6.8	45.1	401
			MAX	29.7	21.3	31	7.8	47.0	410
			MIN	25.1	18.8	22	6.3	42.4	395
10	83.22	40	AV5	27.2	20.7	26	6.9	44.9	409
			MAX	27.9	21.2	27	7.0	45.5	416
			MIN	26.3	20.1	25	6.7	44.4	402
15	83.34	40	AV5	26.7	20.6	25	6.7	45.6	406
			MAX	26.8	20.9	26	6.8	45.8	412
			MIN	26.3	20.5	25	6.6	45.3	402
			Average	27.0	20.4	26	6.8	45.2	406
			Maximum	29.7	21.3	31	7.8	47.0	416
			Minimum	25.1	18.8	22	6.3	42.4	395

Total number of blows analyzed: 14

BL# Sensors

1-15 F3: [F607] 93.6 (1.00); F4: [F590] 95.0 (1.00); A3: [K2524] 360.0 (1.06); A4: [K2253] 325.0 (1.06)

BL# Comments

4 CW

Time Summary

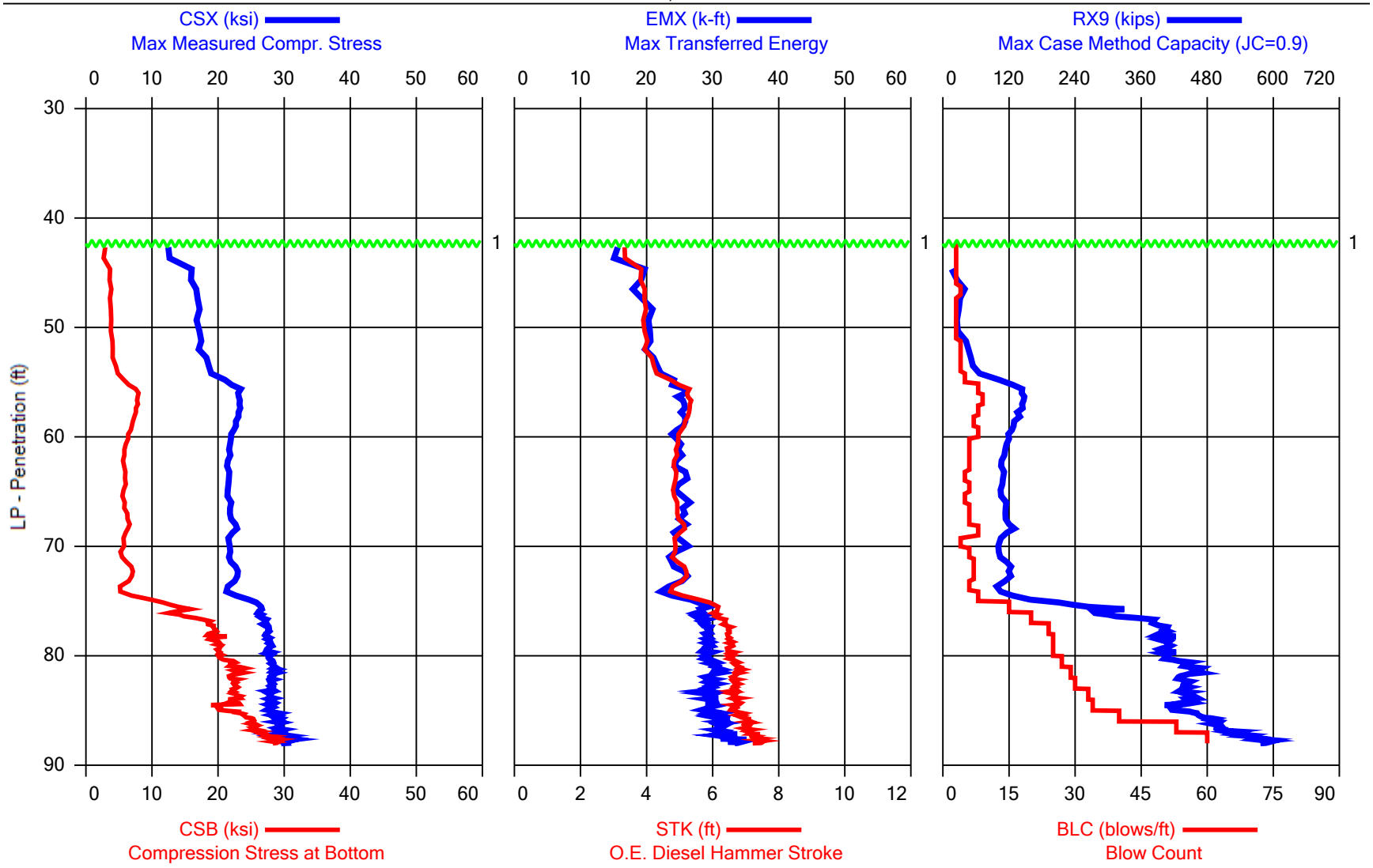
Drive 18 seconds 8:09 AM - 8:10 AM BN 1 - 15

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 29-December-2014 Test started: 24-December-2014

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #44 - EOID

APE D30-42, HP 14 x 73



1 - Top of Template EL 740.78

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #44 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.67 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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
4	42.33	3	AV1	11.3	2.8	15	3.1	64.9	0
			MAX	11.3	2.8	15	3.1	64.9	0
			MIN	11.3	2.8	15	3.1	64.9	0
5	42.67	3	AV1	13.0	3.0	17	3.4	62.6	0
			MAX	13.0	3.0	17	3.4	62.6	0
			MIN	13.0	3.0	17	3.4	62.6	0
6	43.00	3	AV1	13.0	2.9	15	3.5	61.9	0
			MAX	13.0	2.9	15	3.5	61.9	0
			MIN	13.0	2.9	15	3.5	61.9	0
9	44.00	3	AV3	12.7	2.7	15	3.3	63.0	0
			MAX	12.9	2.7	16	3.4	63.1	0
			MIN	12.3	2.6	15	3.3	62.9	0
12	45.00	3	AV3	16.0	3.6	20	3.8	59.1	16
			MAX	16.5	4.2	20	3.9	59.4	19
			MIN	15.5	3.4	19	3.8	58.9	12
15	46.00	3	AV3	15.9	3.6	19	3.8	59.3	26
			MAX	16.5	4.3	21	3.9	59.7	32
			MIN	15.4	3.1	18	3.8	58.7	23
19	47.00	4	AV4	16.9	3.8	18	4.0	58.4	38
			MAX	17.9	4.2	19	4.1	59.8	44
			MIN	15.5	3.5	18	3.7	57.4	34
22	48.00	3	AV3	16.3	3.5	19	3.8	59.1	29
			MAX	16.7	3.8	20	3.9	60.0	37
			MIN	15.6	3.4	19	3.7	58.6	22
25	49.00	3	AV3	17.3	3.9	21	4.0	58.2	31
			MAX	18.6	4.2	22	4.2	59.9	42
			MIN	15.8	3.7	19	3.7	56.8	17
28	50.00	3	AV3	17.3	3.7	21	4.0	58.2	23
			MAX	17.6	3.9	21	4.0	58.6	25
			MIN	17.0	3.6	21	3.9	57.7	20
31	51.00	3	AV3	17.1	3.9	21	4.0	58.3	30
			MAX	17.4	4.1	21	4.0	58.7	33
			MIN	16.5	3.6	20	3.9	57.9	27
35	52.00	4	AV4	17.4	4.0	20	4.0	58.2	46
			MAX	17.7	4.2	20	4.1	58.7	48
			MIN	16.9	3.9	19	3.9	57.6	44

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #44 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
39	53.00	4	AV4	17.8	4.1	21	4.1	57.4	50
			MAX	18.9	4.2	22	4.3	58.5	52
			MIN	16.7	3.9	20	3.9	56.3	46
43	54.00	4	AV4	18.4	4.5	22	4.2	56.8	54
			MAX	18.8	5.0	22	4.3	57.3	55
			MIN	17.9	4.2	21	4.1	56.4	52
48	55.00	5	AV5	20.4	5.4	23	4.6	54.4	91
			MAX	21.9	6.1	25	4.9	56.0	107
			MIN	19.0	4.6	21	4.3	52.8	62
56	56.00	8	AV8	22.8	7.2	25	5.2	51.5	138
			MAX	25.1	8.1	28	5.7	52.8	155
			MIN	21.8	6.3	24	4.9	49.3	119
65	57.00	9	AV9	23.1	7.8	25	5.3	50.9	146
			MAX	23.7	8.0	26	5.4	51.3	150
			MIN	22.8	7.5	24	5.2	50.3	142
73	58.00	8	AV8	23.3	7.6	26	5.3	50.8	140
			MAX	24.1	8.0	27	5.4	52.0	148
			MIN	22.0	7.2	23	5.1	50.2	131
80	59.00	7	AV7	22.8	7.1	26	5.2	51.4	133
			MAX	23.4	7.2	26	5.3	52.1	145
			MIN	22.0	6.7	25	5.0	50.9	127
88	60.00	8	AV8	22.3	6.6	24	5.0	52.1	123
			MAX	22.9	7.1	25	5.1	52.8	127
			MIN	21.6	6.2	23	4.9	51.6	118
94	61.00	6	AV6	21.8	6.1	25	4.9	52.7	117
			MAX	22.2	6.4	26	5.0	52.9	121
			MIN	21.5	5.8	24	4.9	52.1	115
100	62.00	6	AV6	21.6	5.7	25	4.9	52.9	111
			MAX	22.3	6.0	26	5.0	53.8	120
			MIN	20.8	5.3	23	4.7	52.1	104
106	63.00	6	AV6	21.5	5.8	25	4.9	53.0	108
			MAX	22.1	6.1	26	4.9	53.5	117
			MIN	21.0	5.5	24	4.8	52.6	102
111	64.00	5	AV5	21.7	6.0	26	4.9	52.8	109
			MAX	22.7	6.3	27	5.1	53.6	117
			MIN	20.8	5.8	25	4.7	51.7	98
117	65.00	6	AV6	21.5	5.9	25	4.8	53.2	106
			MAX	21.8	6.3	25	4.9	53.5	109
			MIN	21.3	5.5	24	4.8	52.8	101

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #44 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
122	66.00	5	AV5	21.7	5.7	26	4.9	52.8	109
			MAX	22.3	6.2	28	5.0	53.3	113
			MIN	21.2	5.5	25	4.8	52.1	98
128	67.00	6	AV6	21.8	5.9	26	4.9	52.7	115
			MAX	22.4	6.3	27	5.0	53.2	120
			MIN	21.6	5.6	25	4.8	52.1	109
134	68.00	6	AV6	22.0	6.4	25	5.0	52.3	115
			MAX	23.1	7.0	27	5.2	53.0	118
			MIN	21.2	5.9	24	4.9	51.5	111
142	69.00	8	AV8	22.6	6.2	25	5.1	51.9	122
			MAX	23.3	6.7	26	5.2	52.8	134
			MIN	21.8	5.7	23	4.9	51.1	114
146	70.00	4	AV4	21.6	5.8	26	4.9	52.9	101
			MAX	22.3	6.2	28	5.0	53.4	104
			MIN	21.1	5.6	25	4.8	52.2	98
152	71.00	6	AV6	21.6	5.3	24	4.8	53.3	102
			MAX	22.2	5.5	25	5.0	53.9	107
			MIN	21.2	5.0	23	4.7	52.5	99
159	72.00	7	AV7	22.3	6.4	24	5.0	52.2	118
			MAX	22.9	7.2	24	5.2	52.9	128
			MIN	21.6	5.6	23	4.9	51.3	105
166	73.00	7	AV7	23.0	7.0	26	5.2	51.2	121
			MAX	23.8	7.5	27	5.4	52.1	130
			MIN	22.3	6.3	25	5.0	50.5	111
172	74.00	6	AV6	21.6	5.5	24	4.8	53.1	103
			MAX	22.3	6.5	25	5.0	53.9	111
			MIN	21.0	5.0	23	4.7	52.1	96
180	75.00	8	AV8	23.1	7.6	24	5.2	51.4	133
			MAX	25.1	10.7	28	5.7	53.8	175
			MIN	21.1	5.3	21	4.7	49.1	101
195	76.00	15	AV15	26.3	13.6	28	6.1	47.6	262
			MAX	26.9	16.9	30	6.4	48.7	352
			MIN	25.1	11.3	26	5.8	46.6	198
215	77.00	20	AV20	26.7	16.0	28	6.2	47.2	339
			MAX	27.5	19.2	30	6.5	48.3	387
			MIN	25.6	11.2	26	5.9	46.2	248
239	78.00	24	AV24	27.5	19.2	29	6.5	46.3	400
			MAX	28.5	20.7	31	6.8	47.3	414
			MIN	26.2	17.8	28	6.2	45.3	384
264	79.00	25	AV25	27.6	19.5	29	6.5	46.1	402

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #44 - EOID APE D30-42, HP 14 x 73
OP: TC Date: 24-December-2014

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	28.3	21.8	31	6.8	46.9	428
			MIN	26.6	17.6	28	6.3	45.3	383
289	80.00	25	AV25	27.7	20.2	29	6.5	46.1	405
			MAX	28.7	21.0	30	6.8	46.9	449
			MIN	26.7	18.7	27	6.3	45.3	387
316	81.00	27	AV27	28.1	21.4	30	6.6	45.7	426
			MAX	29.1	23.9	32	7.0	46.4	469
			MIN	27.3	19.5	28	6.4	44.5	395
345	82.00	29	AV29	28.4	22.8	30	6.7	45.4	452
			MAX	29.4	25.4	32	7.1	46.1	492
			MIN	27.6	21.0	29	6.5	44.3	418
375	83.00	30	AV30	28.1	22.5	30	6.7	45.6	439
			MAX	29.1	24.2	31	6.8	46.7	481
			MIN	26.9	21.3	28	6.3	45.0	417
408	84.00	33	AV33	27.9	22.6	29	6.7	45.6	445
			MAX	29.0	24.1	31	6.9	46.2	474
			MIN	27.2	21.3	28	6.5	44.7	421
442	85.00	34	AV34	28.0	21.1	30	6.7	45.5	430
			MAX	29.3	24.0	32	7.1	46.4	456
			MIN	26.9	18.1	28	6.4	44.3	389
482	86.00	40	AV40	28.7	24.1	31	6.9	44.8	471
			MAX	30.3	25.8	33	7.2	45.9	500
			MIN	27.5	21.3	28	6.6	43.8	432
535	87.00	53	AV53	29.2	25.5	31	7.0	44.4	504
			MAX	30.0	26.6	33	7.3	45.6	534
			MIN	27.9	24.4	29	6.7	43.7	483
595	88.00	60	AV60	30.2	27.9	33	7.3	43.6	565
			MAX	31.5	29.5	37	7.8	44.6	599
			MIN	29.0	25.7	30	7.0	42.4	522
			Average	26.1	17.5	28	6.2	47.8	346
			Maximum	31.5	29.5	37	7.8	64.9	599
			Minimum	11.3	2.6	15	3.1	42.4	0

Total number of blows analyzed: 592

BL# Sensors

1-595 F3: [F607] 93.6 (1.00); F4: [F590] 95.0 (1.00); A3: [K2524] 360.0 (1.04); A4: [K2253] 325.0 (1.04)

BL# Comments

4 Top of Template EL 740.78
592 CW

Time Summary

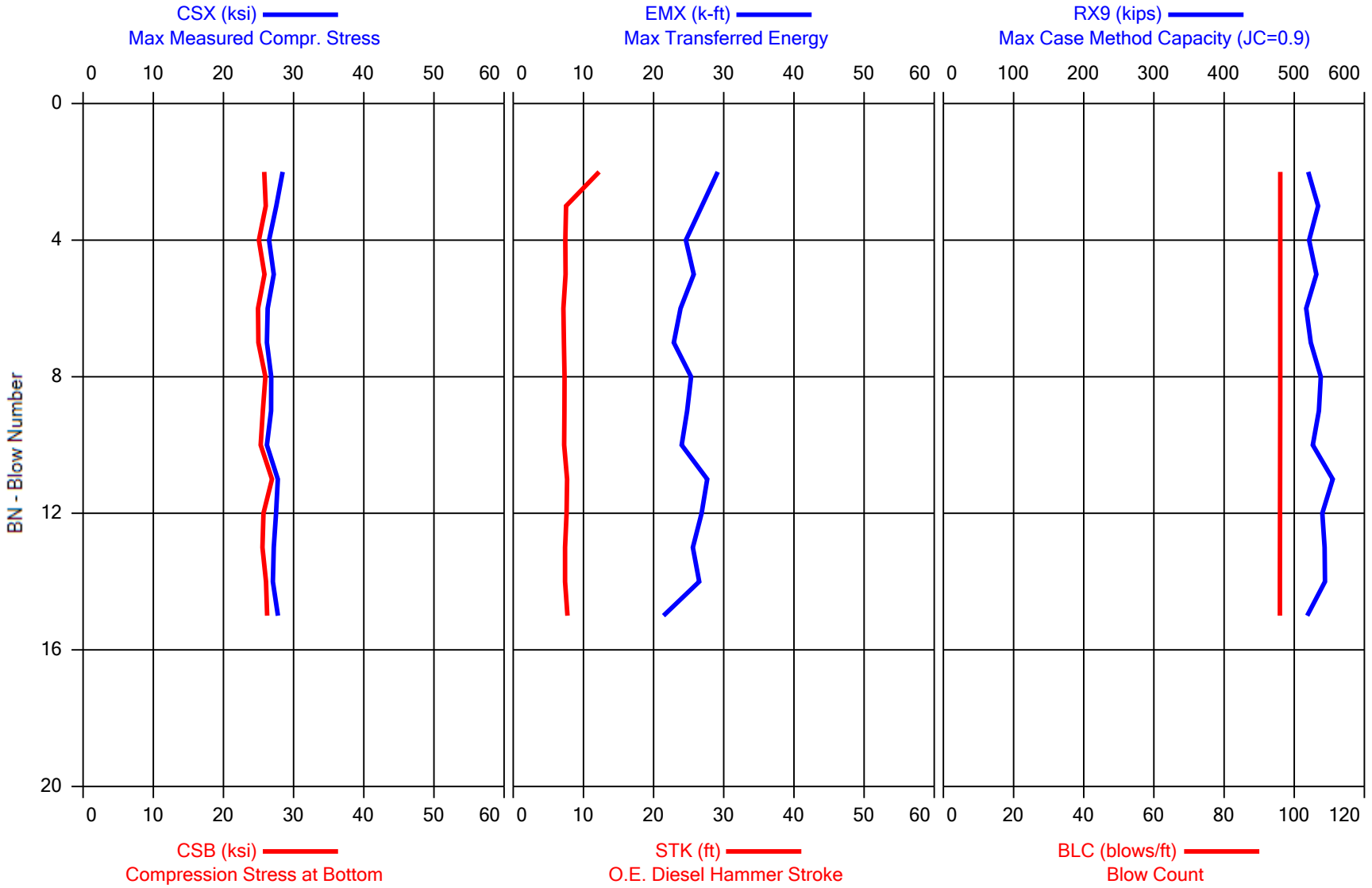
Drive 12 minutes 50 seconds 9:17 AM - 9:30 AM BN 1 - 595

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 29-December-2014 Test started: 29-December-2014

USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #44 - BOR

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - Pier 6 #44 - BOR APE D30-42, HP 14 x 73
OP: TC Date: 29-December-2014

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.67 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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
5	88.05	96	AV4	27.4	25.7	27	8.7	40.9	527
			MAX	28.4	26.0	29	12.2	43.3	534
			MIN	26.5	25.0	25	7.4	34.0	520
10	88.10	96	AV5	26.5	25.4	24	7.2	43.8	528
			MAX	26.8	26.0	25	7.3	44.1	538
			MIN	26.2	24.9	23	7.1	43.6	517
15	88.16	96	AV5	27.4	26.1	26	7.6	42.9	540
			MAX	27.8	26.9	28	7.7	43.4	555
			MIN	27.0	25.6	21	7.4	42.5	518
			Average	27.1	25.7	25	7.8	42.7	532
			Maximum	28.4	26.9	29	12.2	44.1	555
			Minimum	26.2	24.9	21	7.1	34.0	517

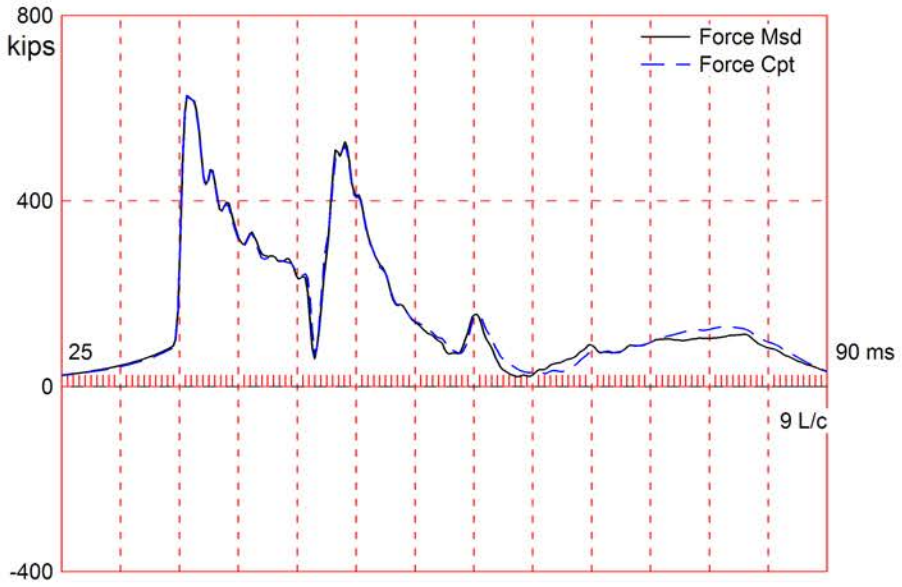
Total number of blows analyzed: 14

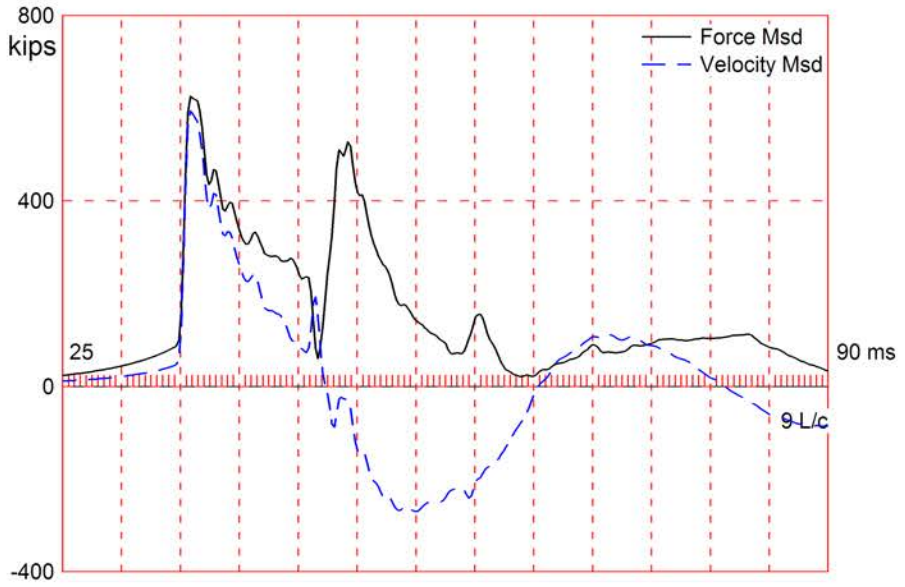
BL# Sensors

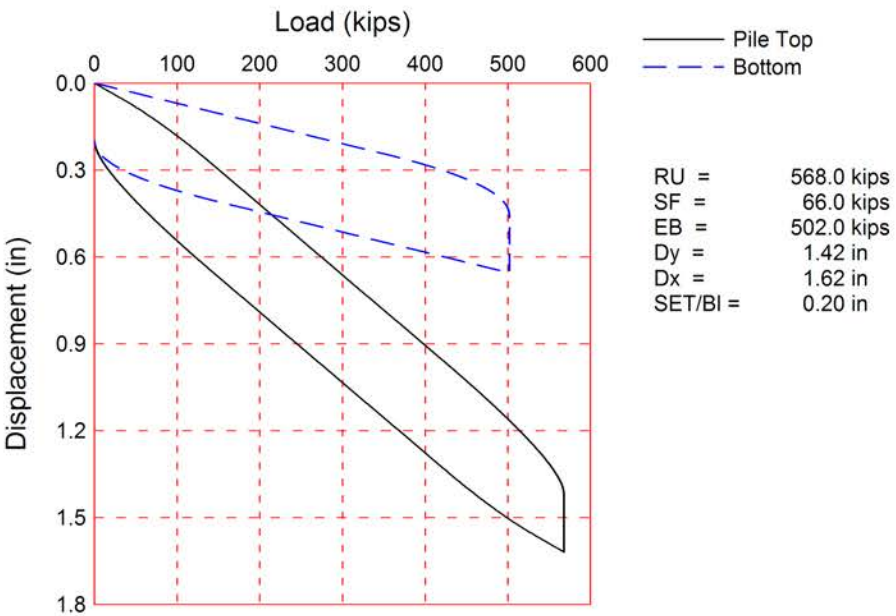
1-15 F3: [F590] 95.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K2253] 325.0 (1.00); A4: [K2524] 360.0 (1.00)

Time Summary

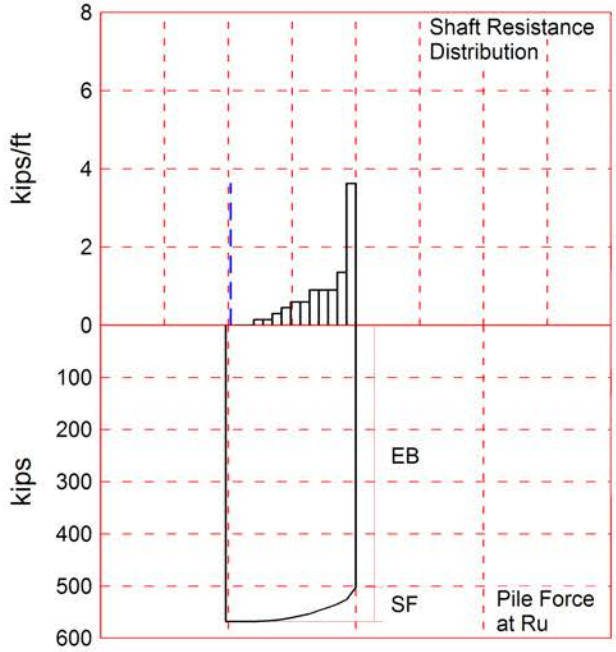
Drive 20 seconds 8:00 AM - 8:01 AM BN 1 - 15







RU =	568.0 kips
SF =	66.0 kips
EB =	502.0 kips
Dy =	1.42 in
Dx =	1.62 in
SET/Bl =	0.20 in



Length b. Sensors	92.7 ft
Embedment	86.7 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	2.77
Top Compr. Stress	29.4 ksi
Max Compr. Stress	30.3 ksi
Max Tension Stress	-3.87 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.35 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.09 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

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: 568.0; along Shaft 66.0; at Toe 502.0 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
				568.0				
1	13.2	7.2	0.0	568.0	0.0	0.00	0.00	0.00
2	19.9	13.8	0.0	568.0	0.0	0.00	0.00	0.00
3	26.5	20.5	1.0	567.0	1.0	0.15	0.03	0.25
4	33.1	27.1	1.0	566.0	2.0	0.15	0.03	0.25
5	39.7	33.7	2.0	564.0	4.0	0.30	0.06	0.25
6	46.3	40.3	3.0	561.0	7.0	0.45	0.10	0.25
7	53.0	46.9	4.0	557.0	11.0	0.60	0.13	0.25
8	59.6	53.6	4.0	553.0	15.0	0.60	0.13	0.25
9	66.2	60.2	6.0	547.0	21.0	0.91	0.19	0.25
10	72.8	66.8	6.0	541.0	27.0	0.91	0.19	0.25
11	79.4	73.4	6.0	535.0	33.0	0.91	0.19	0.25
12	86.1	80.0	9.0	526.0	42.0	1.36	0.29	0.25
13	92.7	86.7	24.0	502.0	66.0	3.63	0.77	0.25
Avg. Shaft			5.1			0.76	0.16	0.25
Toe			502.0				364.17	0.09

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.04	0.35
Case Damping Factor		0.43	1.18
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	59	42
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	64	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.020	

CAPWAP match quality	=	2.77	(Wave Up Match) ; RSA = 0	
Observed: Final Set	=	0.20 in;	Blow Count =	60 b/ft
Computed: Final Set	=	0.16 in;	Blow Count =	73 b/ft
max. Top Comp. Stress	=	29.4 ksi	(T= 36.0 ms, max= 1.030 x Top)	
max. Comp. Stress	=	30.3 ksi	(Z= 92.7 ft, T= 42.3 ms)	
max. Tens. Stress	=	-3.87 ksi	(Z= 72.8 ft, T= 63.6 ms)	
max. Energy (EMX)	=	34.4 kip-ft;	max. Measured Top Displ. (DMX)=	1.10 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	629.0	-12.8	29.4	-0.60	34.4	15.5	1.10
2	6.6	629.4	-14.2	29.4	-0.67	34.2	15.4	1.09
4	13.2	630.2	-17.4	29.4	-0.81	33.7	15.4	1.05
6	19.9	631.3	-32.4	29.5	-1.52	33.2	15.3	1.01
8	26.5	634.2	-46.8	29.6	-2.19	32.5	15.2	0.96
10	33.1	632.5	-58.7	29.5	-2.74	31.5	15.1	0.92
12	39.7	633.9	-69.0	29.6	-3.22	30.3	14.9	0.86
14	46.3	632.5	-74.0	29.5	-3.46	28.9	14.7	0.81
15	49.6	623.5	-72.1	29.1	-3.37	27.7	14.5	0.78
16	53.0	627.5	-71.4	29.3	-3.33	27.1	14.4	0.75
17	56.3	614.2	-68.3	28.7	-3.19	25.7	14.3	0.72
18	59.6	619.4	-68.4	28.9	-3.20	25.0	14.1	0.69
19	62.9	608.1	-72.0	28.4	-3.36	23.6	14.0	0.66
20	66.2	616.6	-78.7	28.8	-3.68	22.8	13.8	0.62
21	69.5	600.3	-79.3	28.0	-3.70	21.1	13.5	0.59
22	72.8	607.4	-82.9	28.4	-3.87	20.4	13.3	0.56
23	76.1	583.1	-78.5	27.2	-3.67	18.8	13.2	0.53
24	79.4	587.6	-78.7	27.5	-3.68	18.0	13.7	0.49
25	82.7	586.2	-73.8	27.4	-3.45	16.4	15.7	0.46
26	86.1	617.7	-73.9	28.9	-3.45	15.7	16.3	0.43
27	89.4	616.5	-66.0	28.8	-3.08	13.8	16.4	0.39
28	92.7	648.1	-66.2	30.3	-3.09	11.8	14.9	0.36
Absolute	92.7			30.3			(T =	42.3 ms)
	72.8				-3.87		(T =	63.6 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	620.7	499.0	377.4	255.8	134.1					
RX	734.2	676.2	641.8	612.8	588.0	566.2	548.0	534.7	521.5	508.3
RU	620.7	499.0	377.4	255.8	134.1					

RAU = 460.0 (kips); RA2 = 623.0 (kips)

Current CAPWAP Ru = 568.0 (kips); Corresponding J(RP)= 0.09; J(RX) = 0.98

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	35.84	598.4	630.5	630.5	1.10	0.20	0.20	34.5	636.8	1476

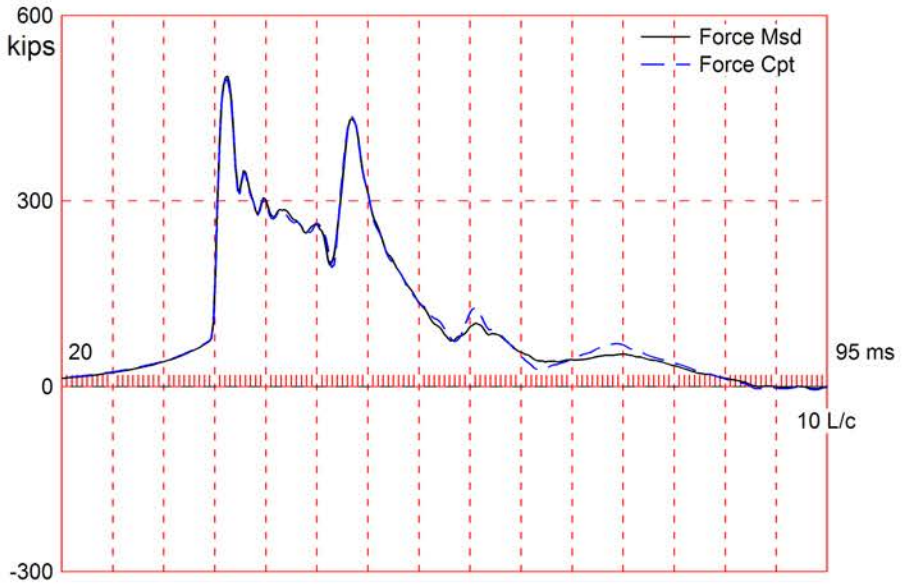
PILE PROFILE AND PILE MODEL

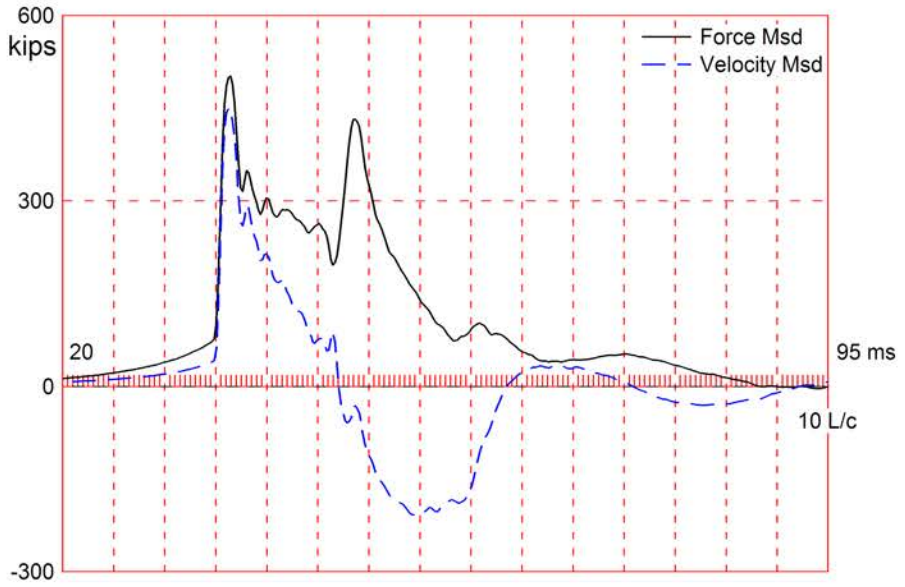
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

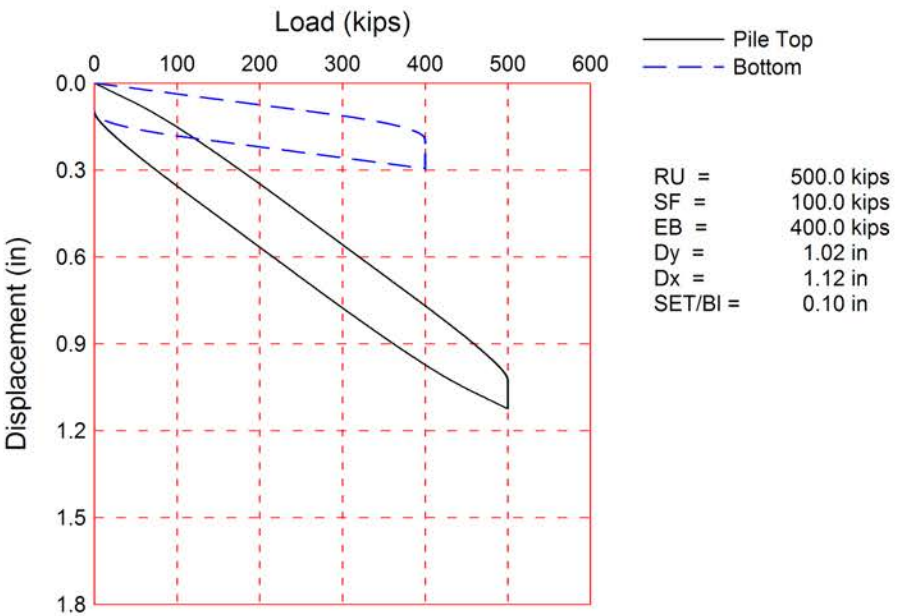
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	76.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
25	82.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

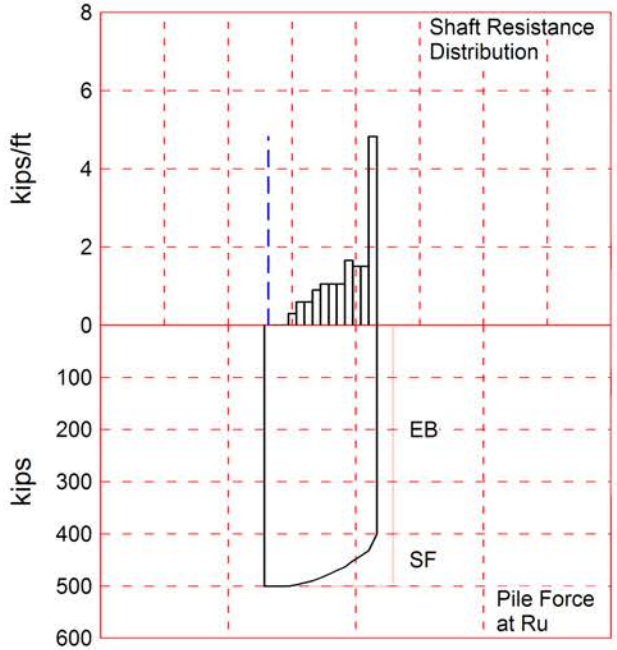
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.772 ft^3; Volume ratio considering added impedance: 1.000







RU =	500.0 kips
SF =	100.0 kips
EB =	400.0 kips
Dy =	1.02 in
Dx =	1.12 in
SET/Bl =	0.10 in



Length b. Sensors	92.7 ft
Embedment	87.0 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	2.12
Top Compr. Stress	23.2 ksi
Max Compr. Stress	23.9 ksi
Max Tension Stress	-2.55 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.15 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.10 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: 500.0; along Shaft 100.0; at Toe 400.0 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
				500.0				
1	13.2	7.6	0.0	500.0	0.0	0.00	0.00	0.00
2	19.9	14.2	0.0	500.0	0.0	0.00	0.00	0.00
3	26.5	20.8	2.0	498.0	2.0	0.30	0.06	0.28
4	33.1	27.4	4.0	494.0	6.0	0.60	0.13	0.28
5	39.7	34.0	4.0	490.0	10.0	0.60	0.13	0.28
6	46.3	40.7	6.0	484.0	16.0	0.91	0.19	0.28
7	53.0	47.3	7.0	477.0	23.0	1.06	0.23	0.28
8	59.6	53.9	7.0	470.0	30.0	1.06	0.23	0.28
9	66.2	60.5	7.0	463.0	37.0	1.06	0.23	0.28
10	72.8	67.1	11.0	452.0	48.0	1.66	0.35	0.28
11	79.4	73.8	10.0	442.0	58.0	1.51	0.32	0.28
12	86.1	80.4	10.0	432.0	68.0	1.51	0.32	0.28
13	92.7	87.0	32.0	400.0	100.0	4.83	1.03	0.28
Avg. Shaft			7.7			1.15	0.24	0.28
Toe			400.0				290.17	0.10

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.04	0.15
Case Damping Factor		0.73	1.05
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	55	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	15	
Resistance Gap (included in Toe Quake)	(in)		0.01

CAPWAP match quality = 2.12 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.06 in; Blow Count = 191 b/ft

max. Top Comp. Stress = 23.2 ksi (T= 36.6 ms, max= 1.032 x Top)
max. Comp. Stress = 23.9 ksi (Z= 92.7 ft, T= 42.3 ms)
max. Tens. Stress = -2.55 ksi (Z= 66.2 ft, T= 62.8 ms)
max. Energy (EMX) = 20.4 kip-ft; max. Measured Top Displ. (DMX)= 0.81 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	496.6	-16.3	23.2	-0.76	20.4	11.8	0.80
2	6.6	497.5	-16.4	23.2	-0.76	20.2	11.8	0.79
4	13.2	499.4	-16.6	23.3	-0.78	19.8	11.8	0.75
6	19.9	504.6	-16.7	23.6	-0.78	19.2	11.7	0.71
8	26.5	512.1	-16.8	23.9	-0.78	18.6	11.5	0.67
10	33.1	511.7	-16.6	23.9	-0.77	17.7	11.3	0.62
12	39.7	505.0	-19.2	23.6	-0.90	16.4	11.0	0.58
14	46.3	500.4	-31.4	23.4	-1.47	15.1	10.7	0.53
15	49.6	482.0	-35.7	22.5	-1.67	13.9	10.5	0.50
16	53.0	488.3	-42.6	22.8	-1.99	13.5	10.4	0.47
17	56.3	466.7	-45.7	21.8	-2.13	12.3	10.2	0.45
18	59.6	473.1	-51.3	22.1	-2.40	11.9	10.1	0.42
19	62.9	452.9	-52.8	21.2	-2.46	10.7	9.9	0.40
20	66.2	462.3	-54.5	21.6	-2.55	10.2	9.7	0.37
21	69.5	449.2	-52.7	21.0	-2.46	9.2	9.5	0.34
22	72.8	452.8	-53.7	21.2	-2.51	8.7	9.3	0.32
23	76.1	443.7	-50.3	20.7	-2.35	7.5	9.0	0.29
24	79.4	448.1	-50.6	20.9	-2.36	7.0	8.8	0.26
25	82.7	455.8	-47.1	21.3	-2.20	5.9	9.8	0.24
26	86.1	465.4	-47.5	21.7	-2.22	5.4	10.0	0.21
27	89.4	460.7	-44.1	21.5	-2.06	4.4	9.7	0.18
28	92.7	512.6	-44.4	23.9	-2.07	3.4	8.0	0.15
Absolute	92.7			23.9			(T =	42.3 ms)
	66.2				-2.55		(T =	62.8 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	627.2	594.6	561.9	529.2	496.5	463.8	431.1	398.4	365.8	333.1
RX	647.8	620.5	594.9	572.7	551.7	530.7	511.9	498.4	488.9	481.9
RU	629.0	596.5	564.0	531.5	499.0	466.5	434.0	401.5	369.0	336.5

RAU = 347.8 (kips); RA2 = 528.4 (kips)

Current CAPWAP Ru = 500.0 (kips); Corresponding J(RP)= 0.39; J(RX) = 0.69

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
11.8	36.23	450.5	503.5	503.5	0.81	0.10	0.10	20.6	540.1	2857

PILE PROFILE AND PILE MODEL

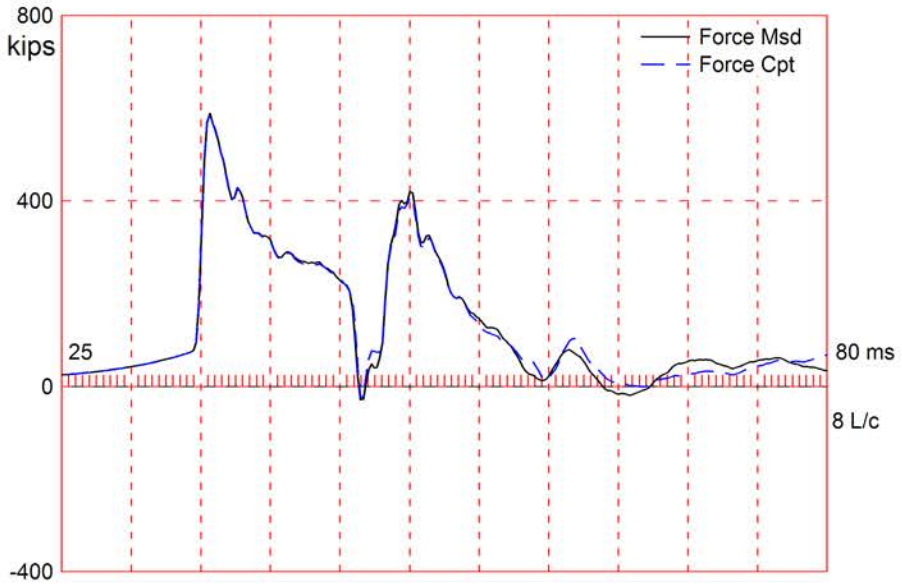
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

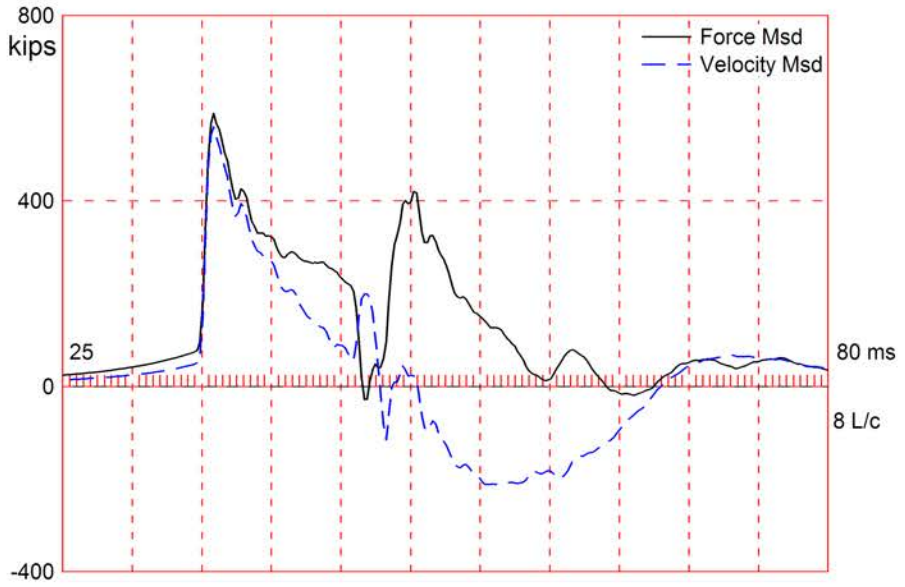
Toe Area 198.5 in^2

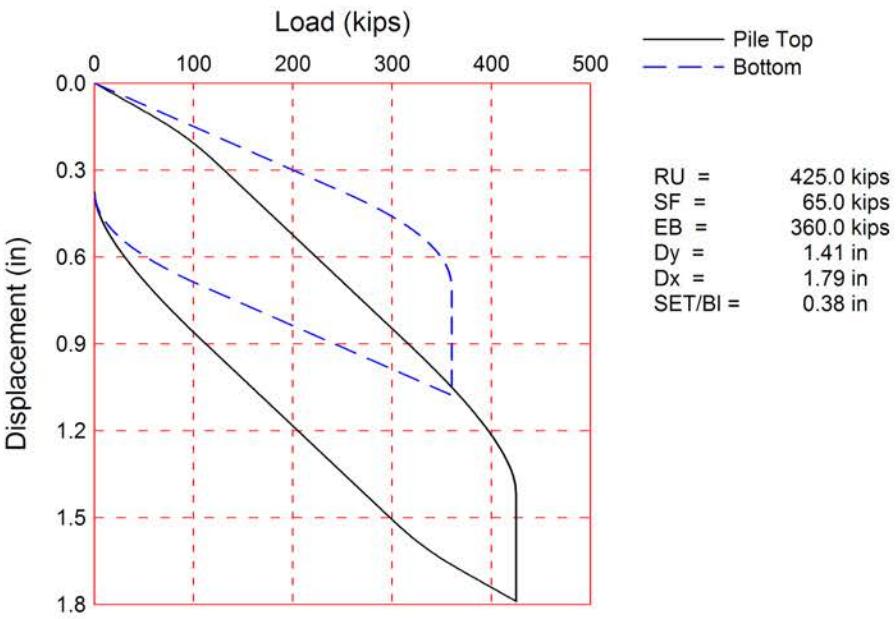
Top Segment Length 3.31 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms

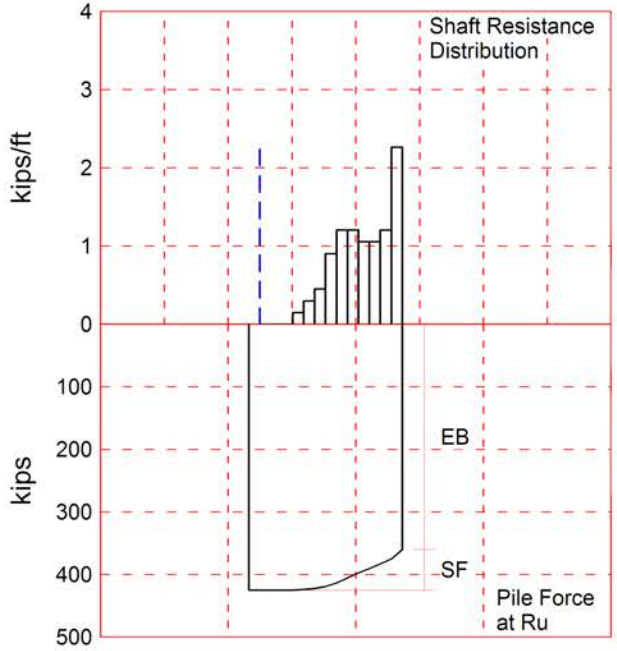
Total volume: 13.772 ft^3; Volume ratio considering added impedance: 1.000







RU =	425.0 kips
SF =	65.0 kips
EB =	360.0 kips
Dy =	1.41 in
Dx =	1.79 in
SET/Bl =	0.38 in



Length b. Sensors	92.7 ft
Embedment	82.9 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	4.44
Top Compr. Stress	27.6 ksi
Max Compr. Stress	27.9 ksi
Max Tension Stress	-3.92 ksi
Avg. Shaft Quake	0.07 in
Toe Quake	0.54 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.07 s/ft

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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: 425.0; along Shaft 65.0; at Toe 360.0 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
				425.0				
1	13.2	3.5	0.0	425.0	0.0	0.00	0.00	0.00
2	19.9	10.1	0.0	425.0	0.0	0.00	0.00	0.00
3	26.5	16.7	0.0	425.0	0.0	0.00	0.00	0.00
4	33.1	23.3	1.0	424.0	1.0	0.15	0.03	0.24
5	39.7	30.0	2.0	422.0	3.0	0.30	0.06	0.24
6	46.3	36.6	3.0	419.0	6.0	0.45	0.10	0.24
7	53.0	43.2	6.0	413.0	12.0	0.91	0.19	0.24
8	59.6	49.8	8.0	405.0	20.0	1.21	0.26	0.24
9	66.2	56.4	8.0	397.0	28.0	1.21	0.26	0.24
10	72.8	63.0	7.0	390.0	35.0	1.06	0.23	0.24
11	79.4	69.7	7.0	383.0	42.0	1.06	0.23	0.24
12	86.1	76.3	8.0	375.0	50.0	1.21	0.26	0.24
13	92.7	82.9	15.0	360.0	65.0	2.27	0.48	0.24
Avg. Shaft			5.0			0.78	0.17	0.24
Toe			360.0				261.16	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.07	0.54
Case Damping Factor		0.41	0.66
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	32	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	87	
Resistance Gap (included in Toe Quake)	(in)		0.04
Soil Plug Weight	(kips)	0.020	0.025

CAPWAP match quality	=	4.44	(Wave Up Match) ; RSA = 0	
Observed: Final Set	=	0.38 in;	Blow Count	= 32 b/ft
Computed: Final Set	=	0.34 in;	Blow Count	= 36 b/ft
max. Top Comp. Stress	=	27.6 ksi	(T= 36.0 ms, max= 1.012 x Top)	
max. Comp. Stress	=	27.9 ksi	(Z= 39.7 ft, T= 38.2 ms)	
max. Tens. Stress	=	-3.92 ksi	(Z= 46.3 ft, T= 67.1 ms)	
max. Energy (EMX)	=	29.3 kip-ft;	max. Measured Top Displ. (DMX)=	1.09 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	590.0	-11.8	27.6	-0.55	29.3	14.6	1.08
2	6.6	590.4	-16.8	27.6	-0.78	29.2	14.6	1.07
4	13.2	591.3	-30.6	27.6	-1.43	29.0	14.6	1.05
6	19.9	592.3	-42.6	27.7	-1.99	28.7	14.5	1.02
8	26.5	593.5	-53.8	27.7	-2.51	28.3	14.5	0.99
10	33.1	596.2	-66.3	27.9	-3.10	27.8	14.4	0.95
12	39.7	597.2	-76.2	27.9	-3.56	27.1	14.2	0.91
14	46.3	596.2	-83.9	27.9	-3.92	26.0	14.0	0.87
15	49.6	589.7	-81.9	27.5	-3.83	25.1	13.8	0.85
16	53.0	594.6	-81.2	27.8	-3.79	24.8	13.6	0.82
17	56.3	577.1	-75.1	27.0	-3.51	23.2	13.4	0.80
18	59.6	582.5	-75.3	27.2	-3.52	22.9	13.3	0.78
19	62.9	556.9	-67.3	26.0	-3.14	21.0	13.0	0.75
20	66.2	562.2	-68.7	26.3	-3.21	20.7	12.9	0.73
21	69.5	543.0	-62.1	25.4	-2.90	18.9	12.8	0.71
22	72.8	548.3	-63.2	25.6	-2.95	18.5	13.8	0.68
23	76.1	518.5	-57.6	24.2	-2.69	17.0	13.6	0.66
24	79.4	520.9	-63.8	24.3	-2.98	16.6	14.1	0.64
25	82.7	499.4	-58.5	23.3	-2.73	15.1	15.7	0.61
26	86.1	468.2	-60.4	21.9	-2.82	14.7	16.8	0.59
27	89.4	422.4	-51.4	19.7	-2.40	13.1	17.7	0.57
28	92.7	434.2	-50.5	20.3	-2.36	11.3	17.5	0.54
Absolute	39.7			27.9			(T =	38.2 ms)
	46.3				-3.92		(T =	67.1 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	465.0	394.1	323.2	252.3	181.3	110.4	39.5	0.0	0.0	0.0
RX	571.7	548.2	524.7	501.1	477.6	460.1	449.3	439.0	428.8	418.6
RU	465.0	394.1	323.2	252.3	181.3	110.4	39.5	0.0	0.0	0.0

RAU = 355.1 (kips); RA2 = 462.8 (kips)

Current CAPWAP Ru = 425.0 (kips); Corresponding J(RP)= 0.06; 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
14.9	35.84	569.3	604.9	604.9	1.09	0.39	0.38	29.5	484.8	720

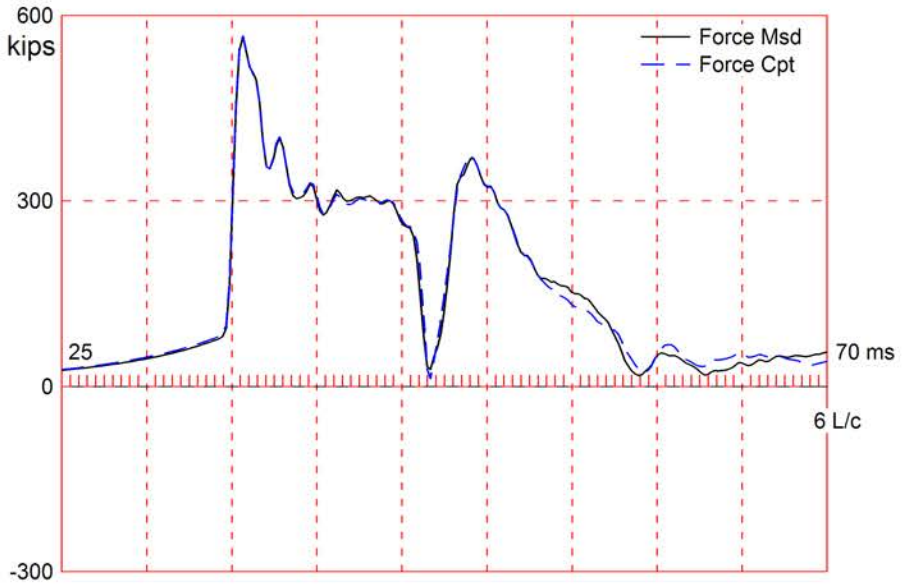
PILE PROFILE AND PILE MODEL

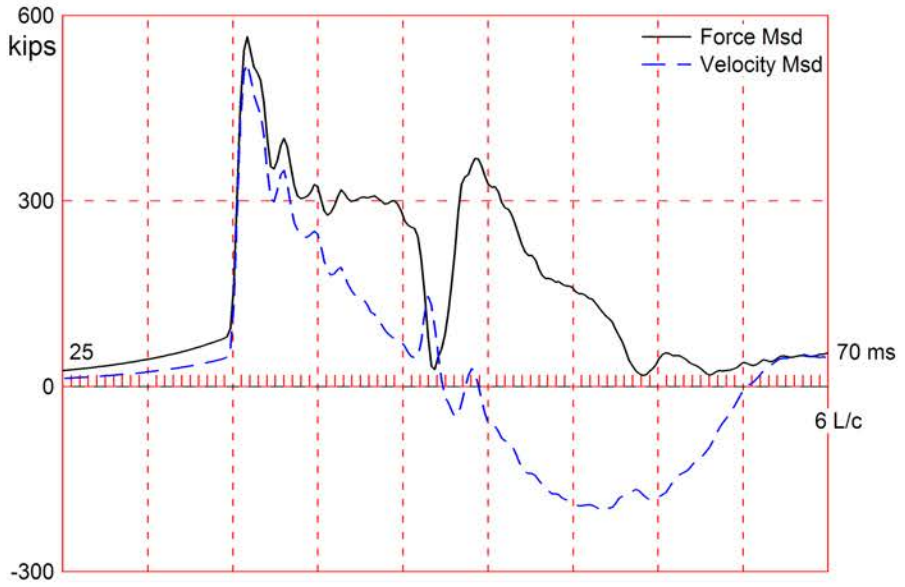
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

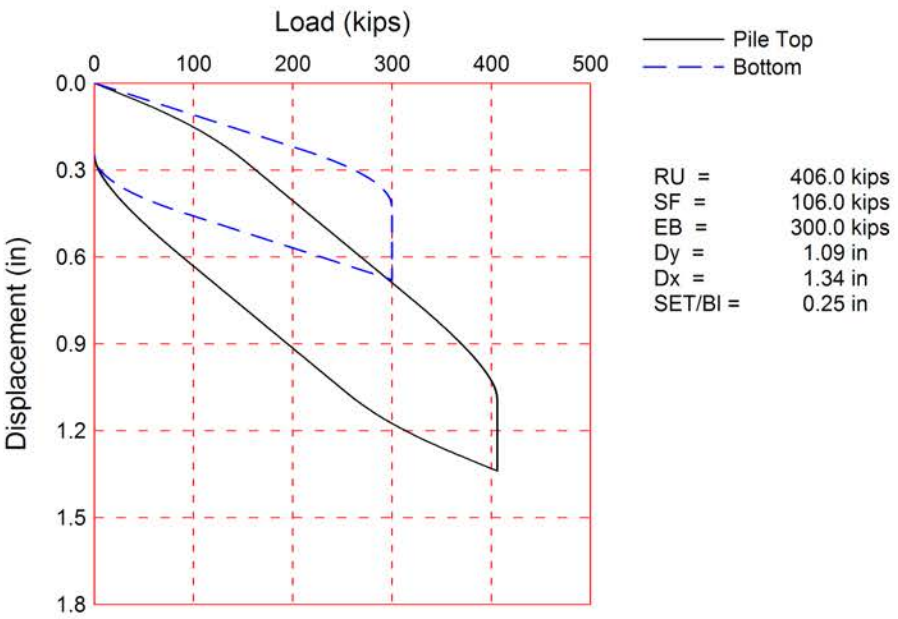
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	76.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	79.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

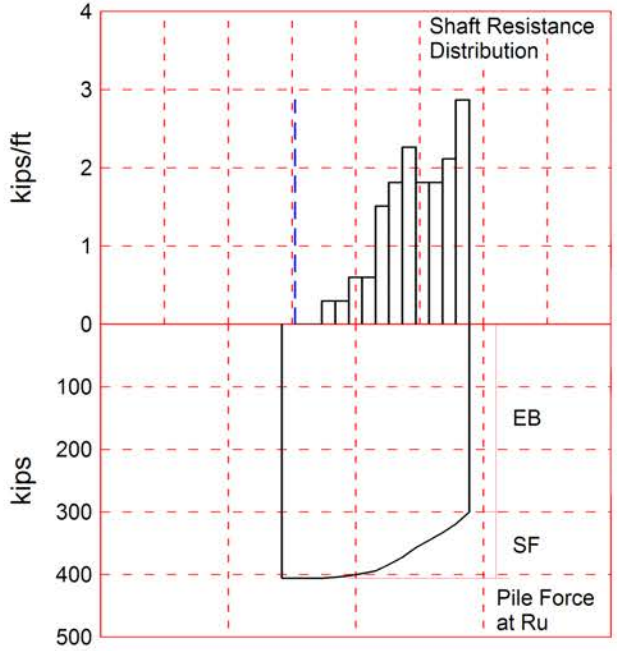
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.772 ft^3; Volume ratio considering added impedance: 1.000







RU =	406.0 kips
SF =	106.0 kips
EB =	300.0 kips
Dy =	1.09 in
Dx =	1.34 in
SET/Bl =	0.25 in



Length b. Sensors	92.7 ft
Embedment	83.1 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	3.19
Top Compr. Stress	26.5 ksi
Max Compr. Stress	27.0 ksi
Max Tension Stress	-2.66 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.33 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.08 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: 406.0; along Shaft 106.0; at Toe 300.0 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
				406.0					
1	13.2	3.7	0.0	406.0	0.0	0.00	0.00	0.00	0.04
2	19.9	10.3	0.0	406.0	0.0	0.00	0.00	0.00	0.04
3	26.5	16.9	2.0	404.0	2.0	0.30	0.06	0.27	0.04
4	33.1	23.5	2.0	402.0	4.0	0.30	0.06	0.27	0.04
5	39.7	30.1	4.0	398.0	8.0	0.60	0.13	0.27	0.04
6	46.3	36.7	4.0	394.0	12.0	0.60	0.13	0.27	0.04
7	53.0	43.4	10.0	384.0	22.0	1.51	0.32	0.27	0.04
8	59.6	50.0	12.0	372.0	34.0	1.81	0.39	0.27	0.04
9	66.2	56.6	15.0	357.0	49.0	2.27	0.48	0.27	0.04
10	72.8	63.2	12.0	345.0	61.0	1.81	0.39	0.27	0.04
11	79.4	69.8	12.0	333.0	73.0	1.81	0.39	0.27	0.04
12	86.1	76.5	14.0	319.0	87.0	2.12	0.45	0.27	0.04
13	92.7	83.1	19.0	300.0	106.0	2.87	0.61	0.27	0.04
Avg. Shaft			8.2			1.28	0.27	0.27	0.04
Toe			300.0				217.63	0.08	0.33

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		0.75	0.63
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	25	
Resistance Gap (included in Toe Quake)	(in)		0.07
Soil Plug Weight	(kips)	0.040	

CAPWAP match quality = 3.19 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.25 in; Blow Count = 48 b/ft
Computed: Final Set = 0.21 in; Blow Count = 57 b/ft
Transducer F1(F607) CAL: 93.6; RF: 1.00; F2(F590) CAL: 95.0; RF: 1.00
A1(K2524) CAL: 360; RF: 1.06; A2(K2253) CAL: 325; RF: 1.06

max. Top Comp. Stress = 26.5 ksi (T= 36.0 ms, max= 1.017 x Top)
max. Comp. Stress = 27.0 ksi (Z= 26.5 ft, T= 37.4 ms)
max. Tens. Stress = -2.66 ksi (Z= 79.4 ft, T= 64.4 ms)
max. Energy (EMX) = 25.0 kip-ft; max. Measured Top Displ. (DMX)= 0.93 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	567.6	-17.5	26.5	-0.82	25.0	13.6	0.91
2	6.6	568.3	-18.6	26.5	-0.87	25.0	13.6	0.90
4	13.2	569.9	-20.8	26.6	-0.97	24.8	13.5	0.87
6	19.9	572.2	-22.6	26.7	-1.06	24.3	13.4	0.84
8	26.5	577.4	-24.2	27.0	-1.13	23.8	13.3	0.80
10	33.1	574.0	-33.0	26.8	-1.54	22.8	13.1	0.76
12	39.7	573.3	-40.3	26.8	-1.88	21.8	12.9	0.71
14	46.3	565.3	-47.3	26.4	-2.21	20.5	12.6	0.67
15	49.6	557.8	-49.7	26.1	-2.32	19.5	12.3	0.64
16	53.0	565.3	-53.4	26.4	-2.49	19.1	12.1	0.62
17	56.3	534.5	-50.8	25.0	-2.38	17.3	11.8	0.59
18	59.6	542.9	-51.2	25.4	-2.39	16.9	11.5	0.57
19	62.9	507.2	-48.8	23.7	-2.28	15.0	11.2	0.55
20	66.2	518.7	-52.4	24.2	-2.45	14.6	10.9	0.53
21	69.5	476.6	-47.4	22.3	-2.21	12.5	10.7	0.50
22	72.8	484.1	-53.2	22.6	-2.49	12.2	11.7	0.48
23	76.1	442.5	-51.7	20.7	-2.42	10.5	11.1	0.46
24	79.4	444.0	-57.0	20.7	-2.66	10.2	11.4	0.44
25	82.7	409.5	-52.0	19.1	-2.43	8.6	13.7	0.42
26	86.1	388.3	-51.5	18.1	-2.41	8.4	14.6	0.40
27	89.4	362.7	-42.5	16.9	-1.99	6.7	15.5	0.38
28	92.7	372.0	-42.0	17.4	-1.96	5.3	14.8	0.36
Absolute	26.5			27.0			(T =	37.4 ms)
	79.4				-2.66		(T =	64.4 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	505.3	446.1	386.9	327.6	268.4	209.2	150.0	90.7	31.5	0.0
RX	540.5	520.0	499.5	478.9	458.4	437.9	424.0	414.7	405.7	397.6
RU	505.3	446.1	386.9	327.6	268.4	209.2	150.0	90.7	31.5	0.0

RAU = 332.8 (kips); RA2 = 449.3 (kips)

Current CAPWAP Ru = 406.0 (kips); Corresponding J(RP)= 0.17; J(RX) = 0.80

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
13.8	35.84	528.8	568.7	570.7	0.93	0.27	0.25	25.2	514.4	1154

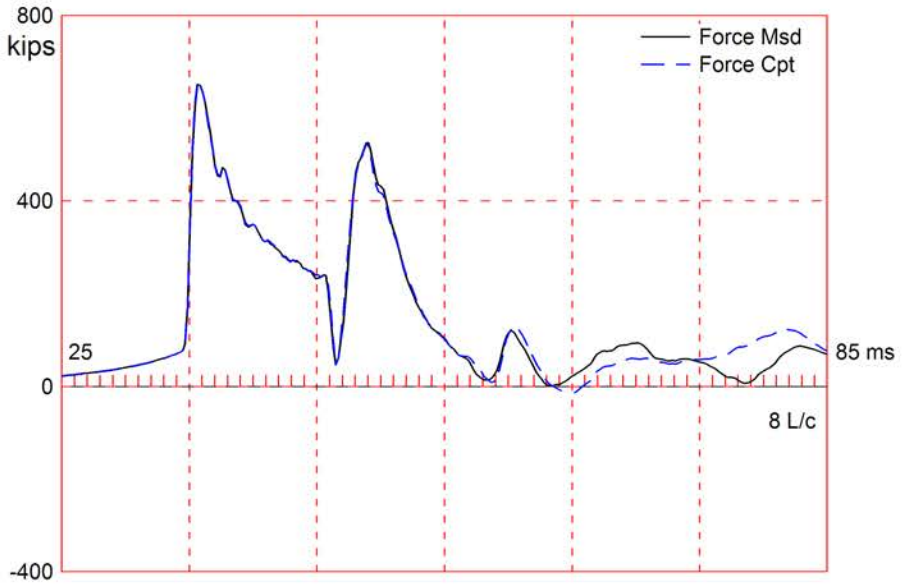
PILE PROFILE AND PILE MODEL

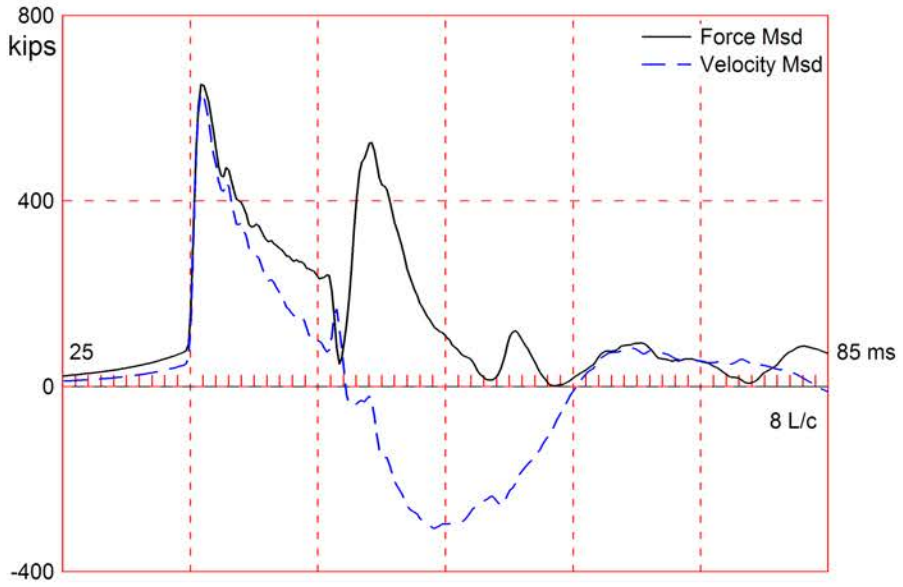
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

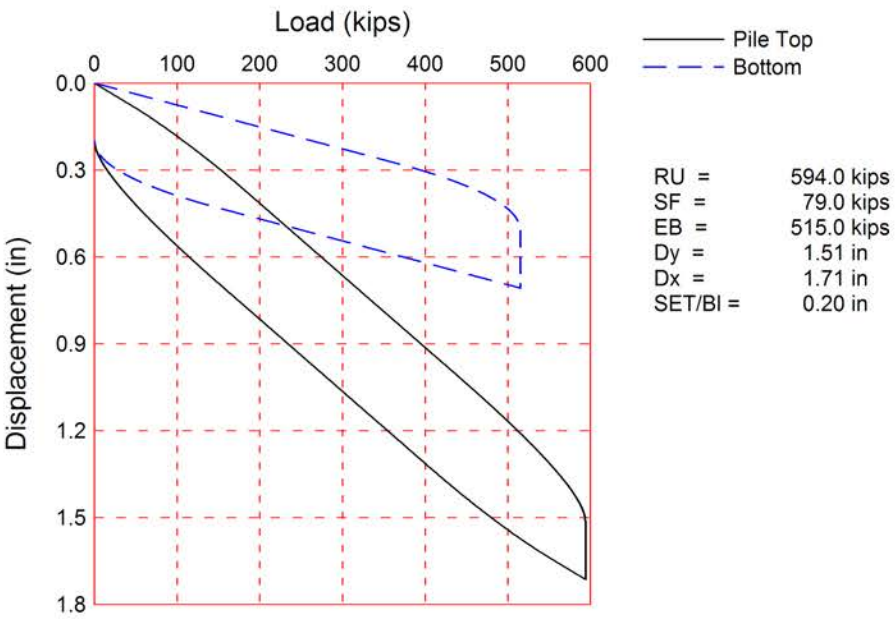
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
22	72.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
23	76.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	79.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
25	82.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

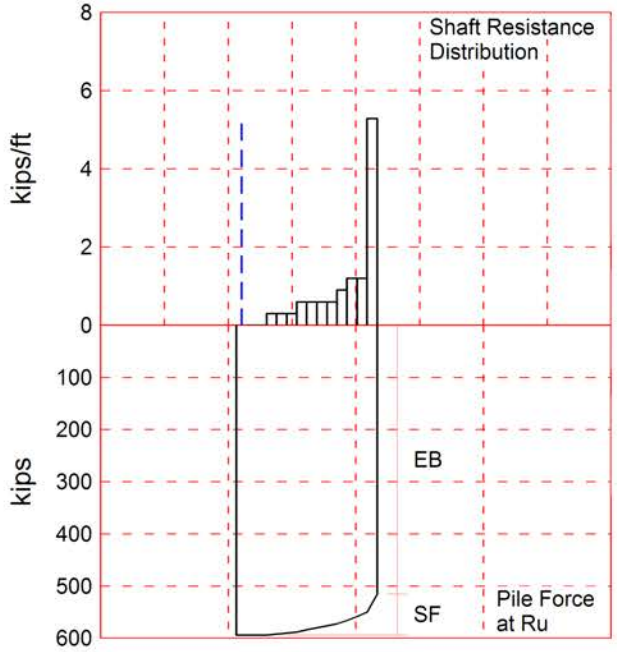
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.772 ft^3; Volume ratio considering added impedance: 1.000







RU =	594.0 kips
SF =	79.0 kips
EB =	515.0 kips
Dy =	1.51 in
Dx =	1.71 in
SET/Bl =	0.20 in



Length b. Sensors	92.7 ft
Embedment	88.0 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	4.59
Top Compr. Stress	30.8 ksi
Max Compr. Stress	31.1 ksi
Max Tension Stress	-6.14 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.39 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.07 s/ft

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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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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: 594.0; along Shaft 79.0; at Toe 515.0 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
				594.0				
1	13.2	8.5	0.0	594.0	0.0	0.00	0.00	0.00
2	19.9	15.1	0.0	594.0	0.0	0.00	0.00	0.00
3	26.5	21.8	2.0	592.0	2.0	0.30	0.06	0.28
4	33.1	28.4	2.0	590.0	4.0	0.30	0.06	0.28
5	39.7	35.0	2.0	588.0	6.0	0.30	0.06	0.28
6	46.3	41.6	4.0	584.0	10.0	0.60	0.13	0.28
7	53.0	48.2	4.0	580.0	14.0	0.60	0.13	0.28
8	59.6	54.9	4.0	576.0	18.0	0.60	0.13	0.28
9	66.2	61.5	4.0	572.0	22.0	0.60	0.13	0.28
10	72.8	68.1	6.0	566.0	28.0	0.91	0.19	0.28
11	79.4	74.7	8.0	558.0	36.0	1.21	0.26	0.28
12	86.1	81.3	8.0	550.0	44.0	1.21	0.26	0.28
13	92.7	88.0	35.0	515.0	79.0	5.29	1.13	0.28
Avg. Shaft			6.1			0.90	0.19	0.28
Toe			515.0				373.60	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.06	0.39
Case Damping Factor		0.58	0.94
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	70	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	47	
Resistance Gap (included in Toe Quake)	(in)		0.06
Soil Plug Weight	(kips)	0.010	0.019

CAPWAP match quality = 4.59 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.16 in; Blow Count = 75 b/ft
Transducer F1(F607) CAL: 93.6; RF: 1.00; F2(F590) CAL: 95.0; RF: 1.00
A1(K2524) CAL: 360; RF: 1.04; A2(K2253) CAL: 325; RF: 1.04

max. Top Comp. Stress = 30.8 ksi (T= 36.0 ms, max= 1.011 x Top)
max. Comp. Stress = 31.1 ksi (Z= 26.5 ft, T= 37.6 ms)
max. Tens. Stress = -6.14 ksi (Z= 53.0 ft, T= 62.4 ms)
max. Energy (EMX) = 36.3 kip-ft; max. Measured Top Displ. (DMX)= 1.14 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	658.4	-33.1	30.8	-1.55	36.3	16.4	1.13
2	6.6	658.6	-38.2	30.8	-1.79	36.2	16.4	1.12
4	13.2	659.0	-61.3	30.8	-2.86	35.7	16.3	1.08
6	19.9	660.2	-80.7	30.8	-3.77	35.2	16.2	1.04
8	26.5	665.8	-84.0	31.1	-3.93	34.5	16.0	1.00
10	33.1	660.5	-83.8	30.9	-3.92	33.2	15.9	0.95
12	39.7	656.9	-84.1	30.7	-3.93	31.8	15.7	0.90
14	46.3	655.6	-113.1	30.6	-5.28	30.3	15.4	0.85
15	49.6	639.2	-122.4	29.9	-5.72	28.7	15.3	0.82
16	53.0	643.7	-131.4	30.1	-6.14	28.1	15.1	0.79
17	56.3	627.6	-129.7	29.3	-6.06	26.6	15.0	0.76
18	59.6	632.0	-130.6	29.5	-6.10	25.9	14.9	0.73
19	62.9	616.0	-127.4	28.8	-5.95	24.4	14.8	0.70
20	66.2	622.9	-127.9	29.1	-5.98	23.7	14.6	0.67
21	69.5	613.5	-124.3	28.7	-5.81	22.2	14.3	0.63
22	72.8	617.5	-124.5	28.8	-5.81	21.4	14.2	0.60
23	76.1	592.2	-118.4	27.7	-5.53	19.5	14.1	0.56
24	79.4	599.5	-119.1	28.0	-5.56	18.7	14.1	0.53
25	82.7	578.6	-111.3	27.0	-5.20	16.6	15.6	0.50
26	86.1	610.1	-111.5	28.5	-5.21	15.8	16.9	0.46
27	89.4	615.1	-103.5	28.7	-4.84	13.9	17.3	0.43
28	92.7	629.6	-103.7	29.4	-4.84	10.3	15.7	0.39
Absolute	26.5			31.1			(T =	37.6 ms)
	53.0				-6.14		(T =	62.4 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	645.2	513.3	381.5	249.6	117.7					
RX	732.8	693.7	654.5	620.8	603.3	586.6	571.9	558.8	551.6	545.3
RU	645.2	513.3	381.5	249.6	117.7					

RAU = 438.5 (kips); RA2 = 619.1 (kips)

Current CAPWAP Ru = 594.0 (kips); Corresponding J(RP)= 0.08; J(RX) = 0.91

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
16.8	35.84	641.8	662.7	662.7	1.14	0.21	0.20	36.4	651.9	1561

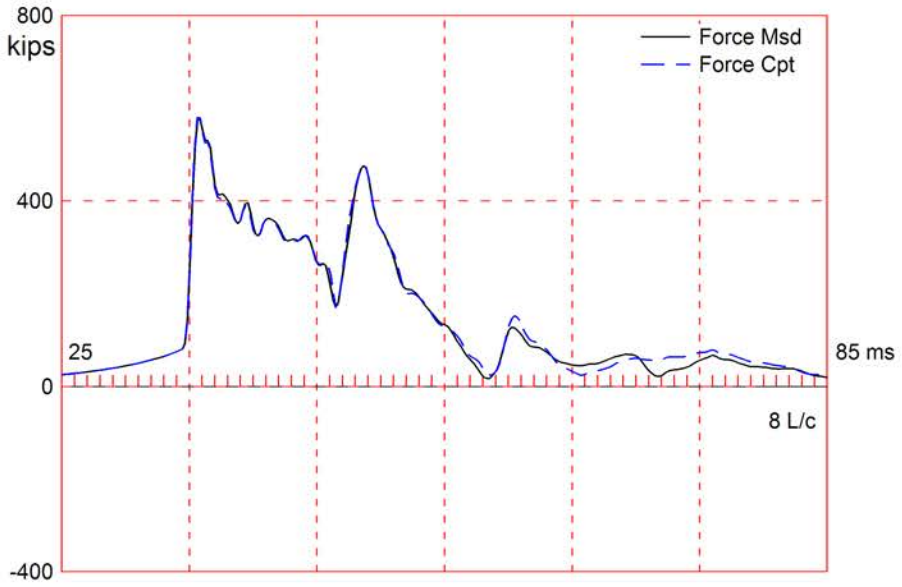
PILE PROFILE AND PILE MODEL

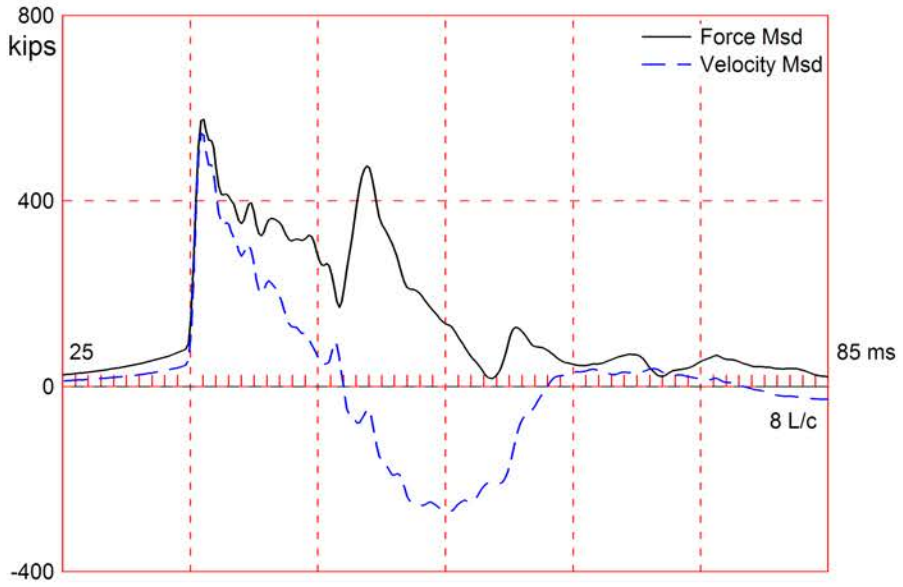
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

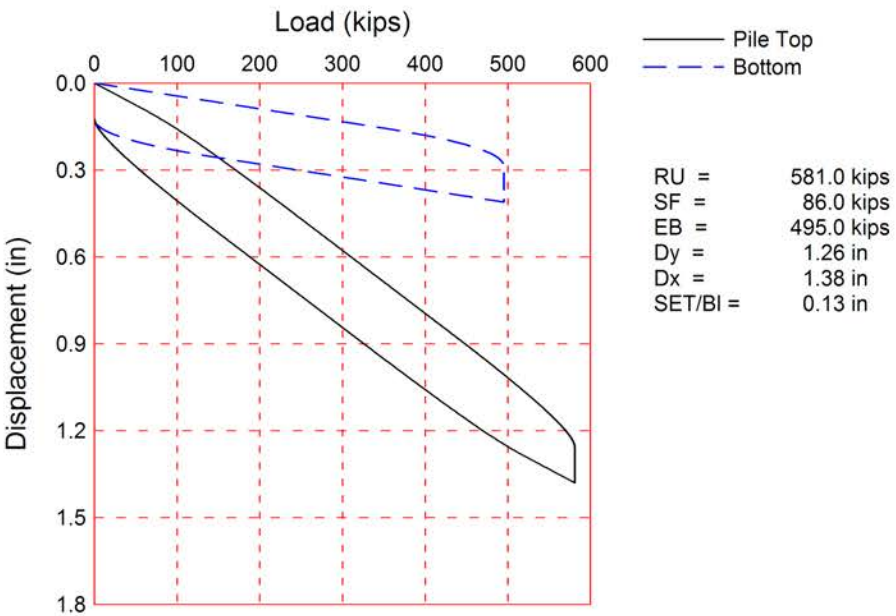
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	76.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
24	79.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

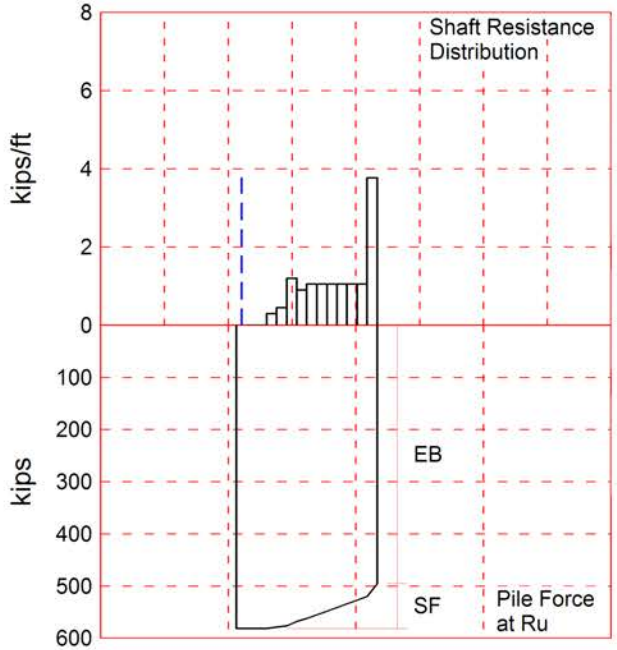
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.772 ft^3; Volume ratio considering added impedance: 1.000







RU =	581.0 kips
SF =	86.0 kips
EB =	495.0 kips
Dy =	1.26 in
Dx =	1.38 in
SET/Bl =	0.13 in



Length b. Sensors	92.7 ft
Embedment	88.0 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	2.82
Top Compr. Stress	27.1 ksi
Max Compr. Stress	27.8 ksi
Max Tension Stress	-4.44 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.22 in
Avg. Shaft Smith Dpg.	0.35 s/ft
Toe Smith Damping	0.08 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

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: 581.0; along Shaft 86.0; at Toe 495.0 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
				581.0				
1	13.2	8.6	0.0	581.0	0.0	0.00	0.00	0.00
2	19.9	15.2	0.0	581.0	0.0	0.00	0.00	0.00
3	26.5	21.8	2.0	579.0	2.0	0.30	0.06	0.35
4	33.1	28.4	3.0	576.0	5.0	0.45	0.10	0.35
5	39.7	35.0	8.0	568.0	13.0	1.21	0.26	0.35
6	46.3	41.7	6.0	562.0	19.0	0.91	0.19	0.35
7	53.0	48.3	7.0	555.0	26.0	1.06	0.23	0.35
8	59.6	54.9	7.0	548.0	33.0	1.06	0.23	0.35
9	66.2	61.5	7.0	541.0	40.0	1.06	0.23	0.35
10	72.8	68.1	7.0	534.0	47.0	1.06	0.23	0.35
11	79.4	74.8	7.0	527.0	54.0	1.06	0.23	0.35
12	86.1	81.4	7.0	520.0	61.0	1.06	0.23	0.35
13	92.7	88.0	25.0	495.0	86.0	3.78	0.80	0.35
Avg. Shaft			6.6			0.98	0.21	0.35
Toe			495.0				359.09	0.08

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.06	0.22
Case Damping Factor		0.79	1.04
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	25	
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)	0.040	0.019

CAPWAP match quality = 2.82 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.13 in; Blow Count = 96 b/ft
Computed: Final Set = 0.09 in; Blow Count = 138 b/ft

max. Top Comp. Stress = 27.1 ksi (T= 36.0 ms, max= 1.024 x Top)
max. Comp. Stress = 27.8 ksi (Z= 39.7 ft, T= 38.4 ms)
max. Tens. Stress = -4.44 ksi (Z= 59.6 ft, T= 62.4 ms)
max. Energy (EMX) = 29.6 kip-ft; max. Measured Top Displ. (DMX)= 0.97 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	580.5	-17.8	27.1	-0.83	29.6	14.1	0.97
2	6.6	581.2	-17.9	27.2	-0.83	29.4	14.1	0.95
4	13.2	583.2	-18.0	27.2	-0.84	28.9	14.0	0.91
6	19.9	586.7	-18.1	27.4	-0.85	28.4	13.9	0.87
8	26.5	593.8	-23.7	27.7	-1.11	27.6	13.7	0.83
10	33.1	594.1	-49.2	27.8	-2.30	26.1	13.4	0.77
12	39.7	594.1	-71.6	27.8	-3.34	24.5	13.0	0.72
14	46.3	564.5	-79.4	26.4	-3.71	21.8	12.6	0.66
15	49.6	540.9	-81.1	25.3	-3.79	20.0	12.3	0.63
16	53.0	549.9	-88.5	25.7	-4.13	19.4	12.1	0.60
17	56.3	523.5	-90.5	24.5	-4.23	17.5	11.8	0.57
18	59.6	531.7	-95.0	24.8	-4.44	16.8	11.6	0.54
19	62.9	519.4	-91.0	24.3	-4.25	15.1	11.4	0.51
20	66.2	521.8	-91.8	24.4	-4.29	14.6	11.1	0.48
21	69.5	521.7	-87.2	24.4	-4.08	13.0	10.7	0.45
22	72.8	539.9	-88.1	25.2	-4.12	12.3	10.6	0.41
23	76.1	539.8	-84.0	25.2	-3.92	10.8	10.5	0.38
24	79.4	544.4	-84.7	25.4	-3.96	10.1	10.4	0.35
25	82.7	539.9	-79.7	25.2	-3.72	8.7	10.9	0.32
26	86.1	540.1	-80.1	25.2	-3.74	8.0	11.6	0.28
27	89.4	534.4	-75.1	25.0	-3.51	6.7	12.0	0.25
28	92.7	569.2	-75.2	26.6	-3.51	5.4	10.5	0.22
Absolute	39.7			27.8			(T =	38.4 ms)
	59.6				-4.44		(T =	62.4 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	652.9	604.0	555.0	506.1	457.2	408.3	359.4	310.5	261.6	212.7
RX	703.9	674.5	645.0	617.7	600.1	588.2	576.6	565.0	553.4	541.8
RU	652.9	604.0	555.0	506.1	457.2	408.3	359.4	310.5	261.6	212.7

RAU = 364.0 (kips); RA2 = 582.0 (kips)

Current CAPWAP Ru = 581.0 (kips); Corresponding J(RP)= 0.15; J(RX) = 0.56

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
14.6	35.84	556.3	585.6	585.6	0.97	0.13	0.13	29.8	650.9	2605

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
92.7	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.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
22	72.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
23	76.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	79.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
25	82.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.7	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 0.197 ms, 2L/c 11.0 ms
Total volume: 13.772 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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TRANSMITTAL

To: Mr. Kevin Weber	From: Rory Flynn
Company: Lunda Construction Co.	No. of Sheets: 54
E-mail: kweber@lundaconstruction.com	Date: January 29, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 7
Winnebago County, Wisconsin

On January 27, 2015, Pier 7 #1, Pier 7 #36, and Pier 7 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on January 28. 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 664. 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 elevations for the piles were the top of the template at EL 740.5 to EL 740.6. We understand the pier was excavated to an elevation of EL 718.3 to EL 719.3.

Pier 7 #1 was driven to a depth of 90.5 feet, which corresponds to a pile tip elevation of EL 650.1. The blow count over the final increment of driving was 28 blows for 6 inches of penetration at an average hammer stroke of 7.4 feet. The blow count at the beginning of restrike was 5 blows for $^3/_8$ inch of penetration at an average hammer stroke of 7.1 feet.

Pier 7 #36 was driven to a depth of 81.8 feet, which corresponds to a pile tip elevation of EL 658.6. The blow count over the final increment of driving was 42 blows for 10 inches of penetration at an average hammer stroke of 6.6 feet. The blow count at the beginning of restrike was 5 blows for ½ inch of penetration at an average hammer stroke of 7.4 feet

Pier 7 #44 was driven to a depth of 89.8 feet, which corresponds to a pile tip elevation of EL 650.6. The blow count over the final increment of driving was 58 blows for 10 inches of penetration at an average hammer stroke of 6.8 feet. The blow count at the beginning of restrike was 5 blows for $^3/_8$ inch of penetration at an average hammer stroke of 6.9 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 7 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)
6.0	8	5
6.5	6	4
7.0	5	3
7.5	4	3
8.0	4	3
8.5	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 or greater, after satisfying the plan minimum tip requirements. We anticipate the production piles will terminate at depths similar to those of the test piles.

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.

Rory Flynn, E.I.

Travis Coleman, P.E.

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

Attachments:

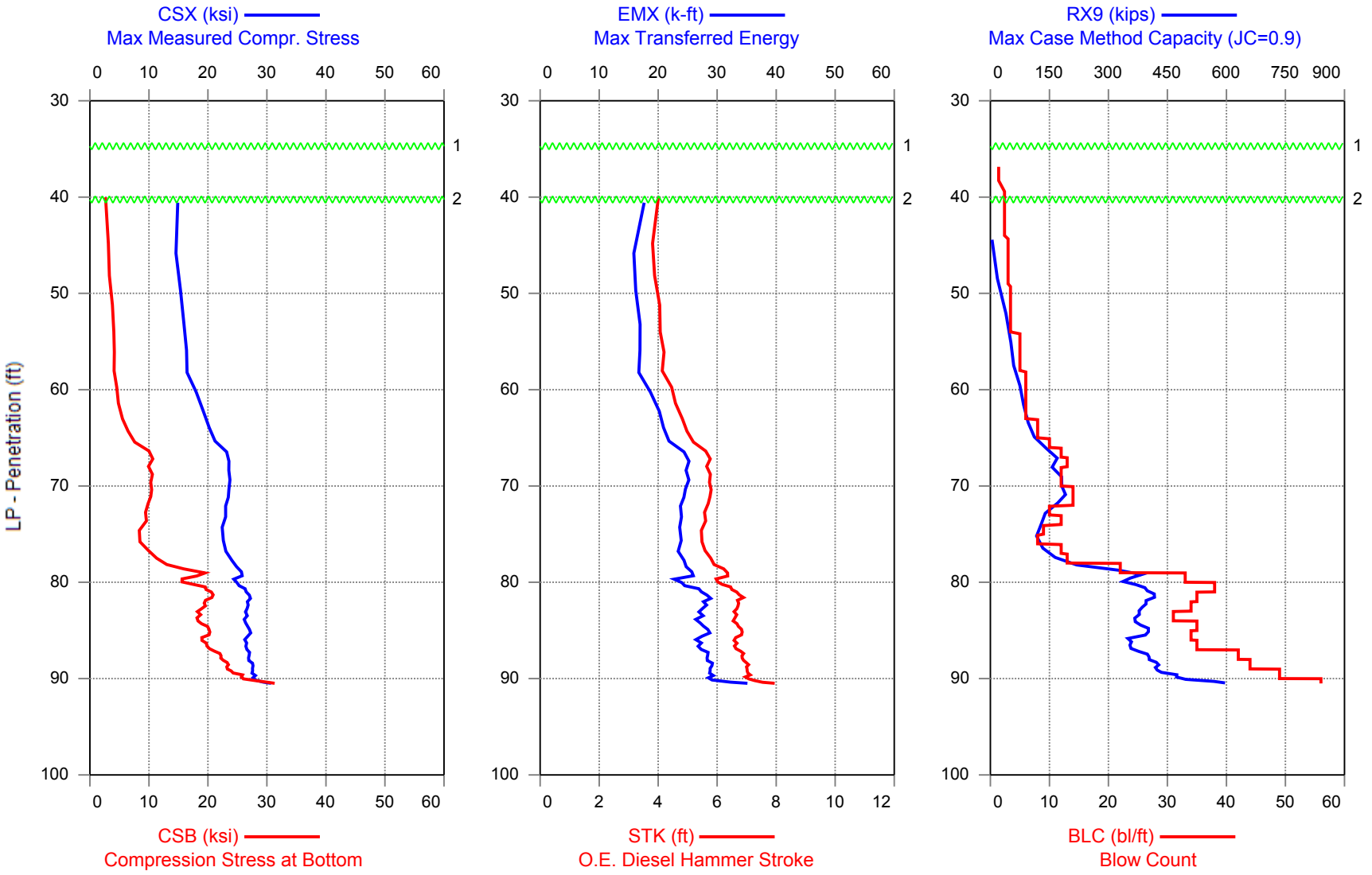
Dynamic Test Results - (pages 3 – 24)
CAPWAP Analysis Results - (pages 25 – 54)

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 28-January-2015

Test started: 27-January-2015

USH 10 - B-70-403 - PIER 7 #1 EOID
APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.56

2 - Bottom of Excavation EL 718.31

USH 10 - B-70-403 - PIER 7 #1 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
7	39.00	1	AV3	13.6	2.0	17	3.7	60.8	0
			MAX	21.5	3.1	29	4.9	67.6	0
			MIN	5.9	0.9	6	2.9	52.9	0
19	44.00	2	AV10	15.1	2.9	18	3.9	59.1	1
			MAX	25.2	4.5	36	5.9	64.9	14
			MIN	8.4	1.9	8	3.1	48.4	0
34	49.00	3	AV15	14.8	3.3	16	3.9	58.8	9
			MAX	17.1	3.8	20	4.3	62.0	25
			MIN	11.5	2.7	11	3.5	56.3	0
51	54.00	3	AV17	15.7	3.9	17	4.0	57.8	37
			MAX	17.0	4.3	19	4.3	60.3	55
			MIN	13.5	3.2	13	3.7	56.1	23
56	55.00	5	AV5	15.8	4.0	16	4.1	57.6	47
			MAX	16.7	4.1	17	4.2	59.3	55
			MIN	14.1	3.9	13	3.8	56.8	39
61	56.00	5	AV5	16.5	4.1	17	4.2	56.8	58
			MAX	17.5	4.4	19	4.3	57.9	62
			MIN	15.5	3.9	16	4.0	55.8	53
66	57.00	5	AV5	16.7	4.1	17	4.2	56.7	58
			MAX	17.5	4.3	19	4.3	57.4	63
			MIN	15.9	4.1	16	4.1	55.9	53
71	58.00	5	AV5	16.3	4.1	17	4.2	57.0	61
			MAX	18.2	4.2	20	4.5	58.0	65
			MIN	15.4	4.0	15	4.0	55.0	52
77	59.00	6	AV6	16.2	4.2	16	4.2	57.0	64
			MAX	17.3	4.3	19	4.3	57.8	76
			MIN	15.4	4.0	15	4.0	55.8	51
83	60.00	6	AV6	18.1	4.6	19	4.5	54.9	77
			MAX	19.1	4.9	20	4.7	56.3	79
			MIN	17.0	4.4	17	4.3	53.7	75
89	61.00	6	AV6	17.8	4.6	18	4.5	55.2	78
			MAX	19.3	4.9	21	4.8	56.9	85
			MIN	16.3	4.3	16	4.2	53.5	73
95	62.00	6	AV6	18.7	4.8	19	4.6	54.5	83
			MAX	19.3	5.2	21	4.7	55.1	88
			MIN	18.2	4.4	18	4.5	53.8	81
101	63.00	6	AV6	19.8	5.4	21	4.8	53.2	92
			MAX	20.0	5.7	22	4.9	53.5	95

USH 10 - B-70-403 - PIER 7 #1 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MIN	19.5	5.1	21	4.8	53.0	89
109	64.00	8	AV8	19.8	5.8	20	4.9	53.0	97
			MAX	20.4	6.1	21	5.0	54.2	101
			MIN	19.0	5.4	19	4.6	52.4	92
117	65.00	8	AV8	20.6	6.7	21	5.0	52.2	106
			MAX	21.6	7.0	23	5.2	53.3	115
			MIN	19.6	6.1	19	4.8	51.2	100
127	66.00	10	AV10	21.4	7.7	22	5.2	51.3	120
			MAX	22.2	8.3	23	5.4	52.0	125
			MIN	20.8	6.9	20	5.1	50.6	111
139	67.00	12	AV12	23.4	10.4	25	5.7	49.2	164
			MAX	24.7	11.2	27	6.1	51.2	183
			MIN	21.5	8.3	22	5.2	47.5	128
152	68.00	13	AV13	23.5	10.2	25	5.7	49.2	159
			MAX	24.3	10.9	27	6.0	49.9	176
			MIN	22.8	9.5	24	5.5	48.1	140
164	69.00	12	AV12	23.7	10.5	25	5.7	48.9	173
			MAX	24.3	10.8	26	5.9	50.1	184
			MIN	22.4	10.1	22	5.5	48.3	152
176	70.00	12	AV12	23.6	10.3	25	5.8	48.9	178
			MAX	24.2	10.7	27	5.9	49.9	187
			MIN	22.6	10.1	23	5.5	48.2	167
190	71.00	14	AV14	23.6	10.5	25	5.8	48.8	190
			MAX	24.2	10.7	26	5.9	49.5	198
			MIN	23.0	10.2	24	5.6	48.2	184
204	72.00	14	AV14	23.3	10.0	24	5.7	49.0	179
			MAX	23.9	10.4	25	5.9	49.8	190
			MIN	22.5	9.6	22	5.5	48.5	162
214	73.00	10	AV10	22.8	9.5	24	5.6	49.6	140
			MAX	23.5	9.8	25	5.7	50.4	159
			MIN	22.1	9.1	23	5.4	49.0	131
226	74.00	12	AV12	22.9	9.6	24	5.6	49.5	140
			MAX	23.5	10.4	25	5.8	50.6	156
			MIN	21.9	8.7	22	5.4	48.9	128
235	75.00	9	AV9	22.4	8.3	24	5.5	50.1	115
			MAX	22.7	8.8	25	5.5	50.5	122
			MIN	21.9	8.0	23	5.4	49.8	111
243	76.00	8	AV8	22.5	8.4	24	5.5	50.2	118
			MAX	22.9	8.7	25	5.6	50.8	120
			MIN	21.9	8.2	23	5.3	49.7	115

USH 10 - B-70-403 - PIER 7 #1 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
255	77.00	12	AV12	23.0	9.6	23	5.6	49.7	135
			MAX	24.0	10.8	25	5.8	50.7	156
			MIN	22.1	8.6	22	5.3	48.7	122
268	78.00	13	AV13	23.8	11.4	24	5.8	48.9	171
			MAX	24.6	12.9	26	6.0	49.9	201
			MIN	22.9	10.3	23	5.5	48.0	145
290	79.00	22	AV22	25.3	15.5	25	6.2	47.3	280
			MAX	26.9	20.3	28	6.6	48.6	400
			MIN	23.8	12.7	23	5.8	45.7	192
323	80.00	33	AV33	24.9	17.1	24	6.1	47.5	361
			MAX	27.0	20.3	28	6.6	49.6	401
			MIN	22.9	14.7	20	5.6	45.7	323
361	81.00	38	AV38	25.8	18.8	26	6.4	46.6	383
			MAX	27.2	20.7	28	6.8	49.2	412
			MIN	23.3	15.1	21	5.7	45.3	332
396	82.00	35	AV35	27.0	20.4	28	6.8	45.3	411
			MAX	28.0	21.5	30	7.0	46.4	425
			MIN	25.8	19.1	26	6.4	44.4	389
430	83.00	34	AV34	26.7	19.2	28	6.7	45.5	388
			MAX	27.4	20.5	29	6.9	46.2	402
			MIN	25.9	18.0	26	6.5	44.7	364
461	84.00	31	AV31	26.4	18.3	27	6.6	45.9	371
			MAX	27.2	19.2	29	6.8	46.7	387
			MIN	25.6	17.5	25	6.3	45.0	352
496	85.00	35	AV35	26.7	19.5	28	6.7	45.4	387
			MAX	27.9	20.7	30	7.1	46.1	412
			MIN	25.9	18.1	26	6.5	44.3	367
530	86.00	34	AV34	26.8	19.7	28	6.7	45.4	381
			MAX	27.8	20.8	30	7.0	46.7	408
			MIN	25.5	18.0	25	6.3	44.5	337
565	87.00	35	AV35	26.5	19.8	27	6.6	45.7	357
			MAX	27.2	20.5	29	6.8	47.3	368
			MIN	24.8	18.5	24	6.2	45.0	346
607	88.00	42	AV42	26.9	21.9	28	6.8	45.0	393
			MAX	27.9	22.5	30	7.1	45.8	405
			MIN	26.1	20.6	27	6.6	44.3	358
651	89.00	44	AV44	27.4	23.2	29	7.0	44.6	421
			MAX	28.7	24.0	31	7.3	45.2	433
			MIN	26.7	22.2	28	6.8	43.6	397

USH 10 - B-70-403 - PIER 7 #1 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
700	90.00	49	AV49	27.7	24.9	29	7.0	44.4	453
			MAX	29.1	27.1	32	7.5	46.6	511
			MIN	25.4	23.2	25	6.4	43.1	419
728	90.50	56	AV28	28.8	28.6	31	7.4	43.5	550
			MAX	31.0	31.4	35	7.9	45.3	613
			MIN	26.6	25.4	26	6.8	41.9	484
			Average	24.5	16.0	25	6.1	48.0	295
			Maximum	31.0	31.4	36	7.9	67.6	613
			Minimum	5.9	0.9	6	2.9	41.9	0

Total number of blows analyzed: 722

BL# Sensors

1-728 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.07); A4: [K3550] 360.0 (1.07)

BL# Comments

1 Reported Reference EL 740.56
10 Bottom of Excavation EL 718.31

Time Summary

Drive 16 minutes 38 seconds 1:28 PM - 1:45 PM BN 1 - 728

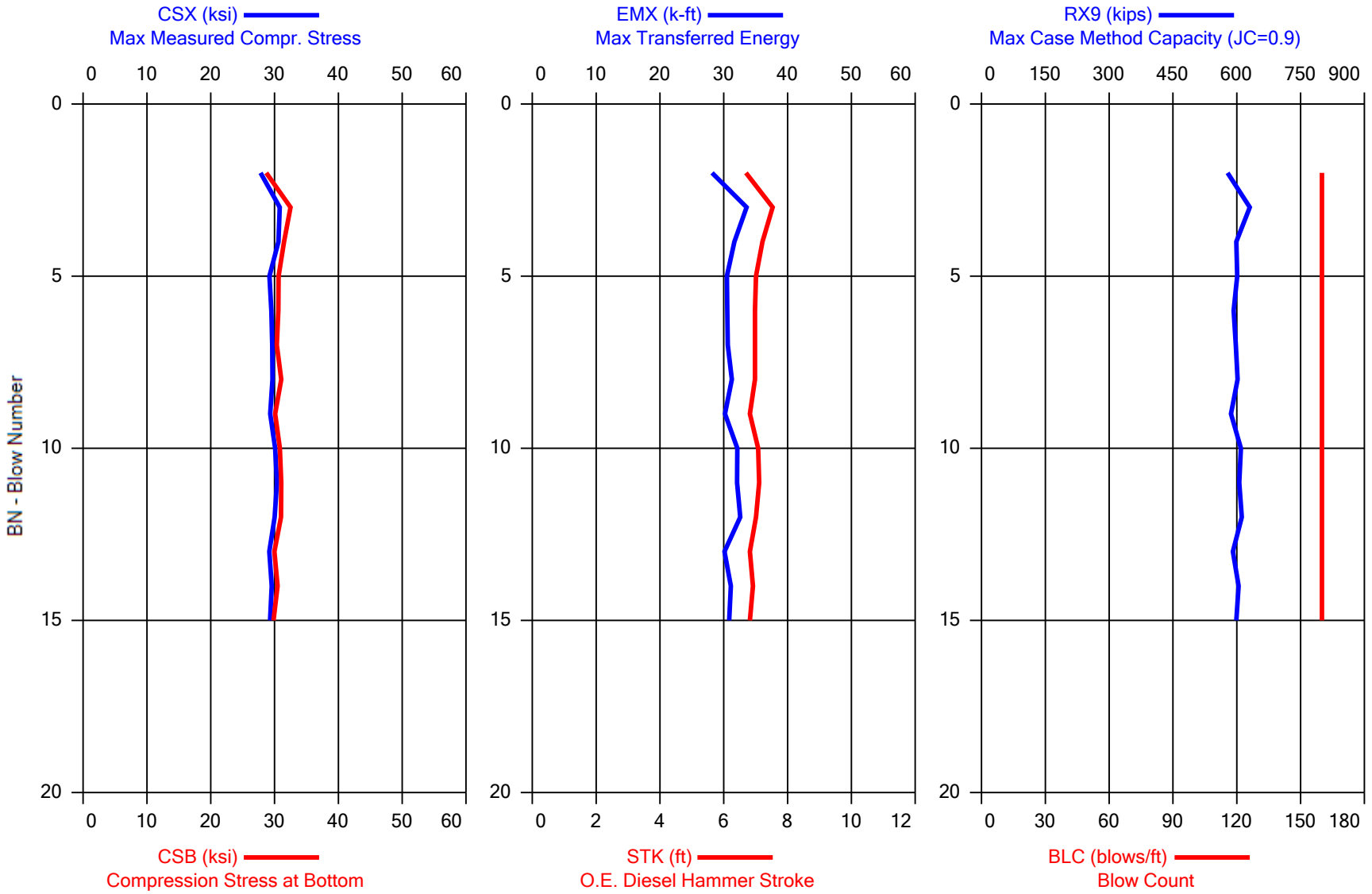
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 29-January-2015

Test started: 28-January-2015

USH 10 - B-70-403 - PIER 7 #1 BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - PIER 7 #1 BOR APE D30-42, HP 14 x 73
OP: RF Date: 28-January-2015

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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
5	90.53	160	AV4	29.6	30.8	31	7.1	44.2	602
			MAX	30.8	32.5	34	7.5	45.5	631
			MIN	27.8	28.7	28	6.7	43.0	578
10	90.56	160	AV5	29.6	30.6	31	7.0	44.6	598
			MAX	30.1	31.0	32	7.1	45.1	610
			MIN	29.3	30.1	30	6.8	44.3	586
15	90.59	160	AV5	29.7	30.5	31	6.9	44.7	602
			MAX	30.4	31.0	33	7.1	45.1	612
			MIN	29.2	29.8	30	6.8	44.2	591
			Average	29.6	30.6	31	7.0	44.6	601
			Maximum	30.8	32.5	34	7.5	45.5	631
			Minimum	27.8	28.7	28	6.7	43.0	578

Total number of blows analyzed: 14

BL# Sensors

1-15 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.09); A4: [K3550] 360.0 (1.09)

Time Summary

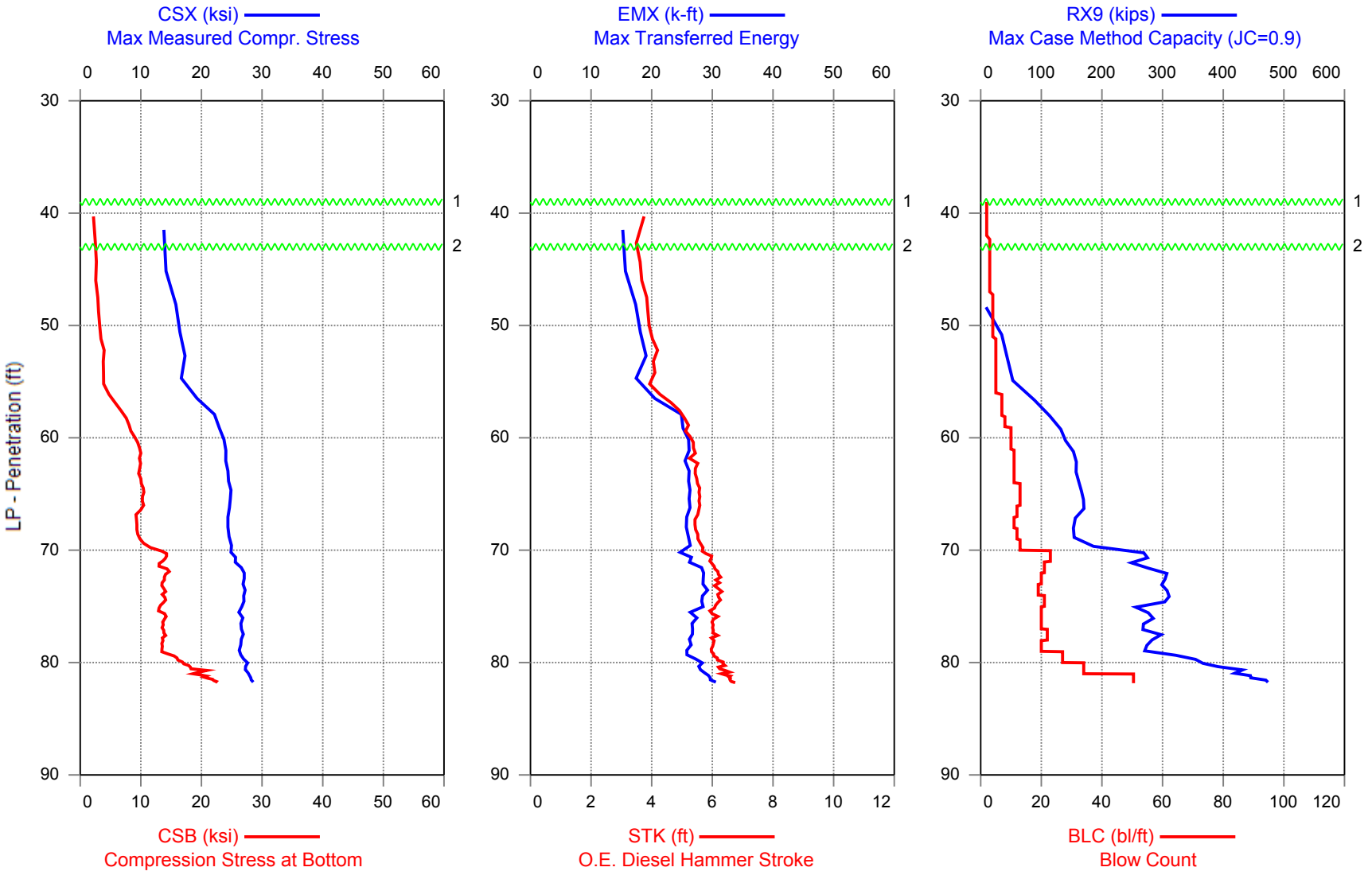
Drive 18 seconds 8:01 AM - 8:02 AM BN 1 - 15

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 27-January-2015

Test started: 27-January-2015

USH 10 - B-70-403 - PIER 7 #36 EOID
APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.47

2 - Bottom of Excavation EL 719.31

USH 10 - B-70-403 - PIER 7 #36 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
3	39.00	2	AV1	14.4	2.4	15	3.5	61.6	0
			MAX	14.4	2.4	15	3.5	61.6	0
			MIN	14.4	2.4	15	3.5	61.6	0
4	39.50	2	AV1	8.6	1.3	7	3.1	65.4	0
			MAX	8.6	1.3	7	3.1	65.4	0
			MIN	8.6	1.3	7	3.1	65.4	0
6	40.50	2	AV1	25.0	2.2	33	5.4	50.4	0
			MAX	25.0	2.2	33	5.4	50.4	0
			MIN	25.0	2.2	33	5.4	50.4	0
7	41.00	2	AV1	14.9	2.9	18	3.5	61.4	0
			MAX	14.9	2.9	18	3.5	61.4	0
			MIN	14.9	2.9	18	3.5	61.4	0
9	42.00	2	AV2	10.6	2.0	11	3.2	64.3	0
			MAX	11.1	2.1	11	3.2	64.4	0
			MIN	10.1	1.9	11	3.2	64.1	0
12	43.00	3	AV3	13.4	2.9	15	3.6	61.3	0
			MAX	16.3	3.1	18	3.9	63.8	0
			MIN	10.4	2.7	12	3.3	58.5	0
15	44.00	3	AV3	12.9	2.3	13	3.5	62.1	0
			MAX	13.9	2.6	14	3.5	62.8	0
			MIN	12.1	2.0	12	3.4	61.5	0
18	45.00	3	AV3	15.0	2.8	17	3.7	59.8	0
			MAX	16.6	2.9	18	3.9	61.2	0
			MIN	13.6	2.6	15	3.6	58.4	0
21	46.00	3	AV3	13.9	2.6	16	3.6	60.8	0
			MAX	14.3	2.8	17	3.7	61.4	0
			MIN	13.2	2.4	15	3.5	60.2	0
24	47.00	3	AV3	15.2	2.8	17	3.8	59.5	0
			MAX	15.5	3.3	18	3.9	60.3	0
			MIN	14.7	2.5	17	3.7	59.0	0
28	48.00	4	AV4	15.7	2.8	17	3.8	59.2	5
			MAX	16.1	3.0	18	3.9	60.4	13
			MIN	14.6	2.7	16	3.7	58.8	0
32	49.00	4	AV4	16.0	3.0	18	3.9	58.8	8
			MAX	16.2	3.1	18	3.9	59.4	13
			MIN	15.6	3.0	17	3.8	58.4	5
36	50.00	4	AV4	16.1	3.1	18	3.9	58.7	21
			MAX	16.6	3.3	18	3.9	59.2	29

USH 10 - B-70-403 - PIER 7 #36 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MIN	15.6	3.0	16	3.8	58.4	15
40	51.00	4	AV4	16.4	3.3	18	4.0	58.2	29
			MAX	17.0	3.5	20	4.1	59.0	46
			MIN	15.7	3.0	16	3.9	57.5	19
45	52.00	5	AV5	17.0	3.7	19	4.1	57.5	48
			MAX	17.8	4.2	20	4.2	58.3	57
			MIN	16.2	3.5	17	4.0	56.6	37
50	53.00	5	AV5	17.2	3.8	19	4.1	57.3	40
			MAX	18.0	4.0	21	4.3	58.1	54
			MIN	16.5	3.7	18	4.0	56.3	29
55	54.00	5	AV5	17.1	3.9	18	4.1	57.4	46
			MAX	17.4	4.1	19	4.1	57.7	52
			MIN	16.9	3.8	18	4.0	57.1	37
60	55.00	5	AV5	16.8	3.7	18	4.0	57.8	49
			MAX	17.6	3.9	19	4.2	58.8	58
			MIN	15.9	3.6	16	3.9	57.0	42
65	56.00	5	AV5	16.9	4.2	18	4.1	57.7	63
			MAX	18.1	4.5	20	4.2	59.2	73
			MIN	15.5	3.7	15	3.8	56.5	51
72	57.00	7	AV7	19.4	5.4	20	4.5	55.1	88
			MAX	20.7	5.9	23	4.7	56.1	96
			MIN	18.3	4.8	19	4.3	53.9	77
79	58.00	7	AV7	21.7	6.7	25	4.9	52.7	104
			MAX	22.4	7.5	26	5.1	53.4	108
			MIN	21.0	6.1	23	4.8	51.9	97
87	59.00	8	AV8	22.9	7.8	26	5.1	51.6	124
			MAX	23.3	8.1	27	5.2	52.2	132
			MIN	22.3	7.5	24	5.0	51.1	117
97	60.00	10	AV10	23.1	8.6	25	5.2	51.3	135
			MAX	24.0	9.1	27	5.4	52.1	138
			MIN	22.3	8.2	23	5.0	50.6	130
107	61.00	10	AV10	23.8	9.5	26	5.3	50.7	143
			MAX	24.6	9.8	27	5.5	51.6	151
			MIN	23.0	9.1	24	5.1	50.0	136
118	62.00	11	AV11	23.9	9.9	25	5.4	50.6	155
			MAX	24.6	10.2	28	5.5	51.5	160
			MIN	23.1	9.4	23	5.2	49.9	149
129	63.00	11	AV11	24.4	9.9	27	5.5	50.1	158
			MAX	24.9	10.3	28	5.6	50.7	169
			MIN	23.9	9.5	25	5.3	49.6	152

USH 10 - B-70-403 - PIER 7 #36 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
140	64.00	11	AV11	24.5	9.9	26	5.5	50.1	158
			MAX	24.9	10.3	28	5.6	50.6	165
			MIN	23.9	9.2	24	5.4	49.5	149
153	65.00	13	AV13	24.8	10.4	26	5.6	49.7	167
			MAX	25.6	11.0	28	5.7	50.4	171
			MIN	23.9	9.9	25	5.4	49.0	161
166	66.00	13	AV13	24.7	10.3	26	5.6	49.6	171
			MAX	25.4	10.8	27	5.7	50.2	182
			MIN	24.2	9.9	25	5.4	49.2	161
178	67.00	12	AV12	24.6	9.7	26	5.5	49.8	166
			MAX	25.3	11.0	28	5.7	50.7	177
			MIN	23.7	8.7	25	5.3	49.1	155
189	68.00	11	AV11	24.3	9.3	26	5.4	50.3	153
			MAX	24.5	9.7	26	5.5	51.2	159
			MIN	23.4	8.9	24	5.2	50.0	147
201	69.00	12	AV12	24.5	9.5	26	5.5	50.0	154
			MAX	25.3	10.1	27	5.7	50.5	158
			MIN	23.8	9.2	25	5.4	49.1	148
214	70.00	13	AV13	24.9	11.0	26	5.6	49.4	179
			MAX	26.2	12.8	28	5.9	49.9	236
			MIN	24.3	10.0	25	5.5	48.4	153
237	71.00	23	AV23	25.3	14.0	26	5.9	48.5	271
			MAX	26.2	14.5	28	6.1	50.8	284
			MIN	23.1	13.4	21	5.3	47.7	251
258	72.00	21	AV21	26.4	13.7	28	6.1	47.7	271
			MAX	27.3	15.3	29	6.2	48.8	309
			MIN	25.0	12.5	25	5.8	47.1	228
278	73.00	20	AV20	27.1	13.8	29	6.2	47.2	304
			MAX	27.8	14.5	31	6.4	47.9	311
			MIN	26.2	13.3	27	6.0	46.5	294
297	74.00	19	AV19	27.0	13.8	29	6.2	47.2	304
			MAX	27.9	14.3	31	6.5	47.9	316
			MIN	26.3	13.2	27	6.0	46.3	295
318	75.00	21	AV21	26.9	13.7	28	6.2	47.3	301
			MAX	27.7	14.8	30	6.4	48.1	318
			MIN	26.1	12.8	27	6.0	46.5	264
338	76.00	20	AV20	26.5	13.5	27	6.0	47.8	270
			MAX	27.7	14.4	29	6.3	48.5	303
			MIN	25.7	12.4	25	5.9	46.8	236

USH 10 - B-70-403 - PIER 7 #36 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
358	77.00	20	AV20	26.5	13.7	27	6.0	47.9	269
			MAX	27.3	14.2	29	6.2	49.1	284
			MIN	25.4	13.2	24	5.7	47.1	253
380	78.00	22	AV22	26.7	13.8	26	6.0	47.8	288
			MAX	27.4	14.4	28	6.3	48.7	312
			MIN	25.7	13.3	24	5.8	47.0	267
400	79.00	20	AV20	26.5	13.5	27	6.0	47.9	272
			MAX	27.5	14.0	29	6.3	48.5	278
			MIN	25.7	13.1	25	5.9	46.9	262
427	80.00	27	AV27	26.8	15.5	27	6.1	47.5	332
			MAX	27.7	17.0	29	6.4	48.4	367
			MIN	25.8	13.4	25	5.9	46.5	272
461	81.00	34	AV34	27.4	18.6	28	6.4	46.6	404
			MAX	28.4	22.8	31	6.7	48.2	476
			MIN	25.7	16.7	25	5.9	45.6	362
503	81.83	50	AV42	28.2	21.2	30	6.6	45.9	455
			MAX	29.2	23.1	32	6.8	47.6	486
			MIN	26.2	18.9	26	6.1	45.0	416
			Average	24.6	12.2	26	5.7	49.7	237
			Maximum	29.2	23.1	33	6.8	65.4	486
			Minimum	8.6	1.3	7	3.1	45.0	0

Total number of blows analyzed: 500

BL# Sensors

1-503 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.09); A4: [K3550] 360.0 (1.09)

BL# Comments

3 Reported Reference EL 740.47
12 Bottom of Excavation EL 719.31

Time Summary

Drive 10 minutes 45 seconds 1:01 PM - 1:12 PM BN 1 - 503

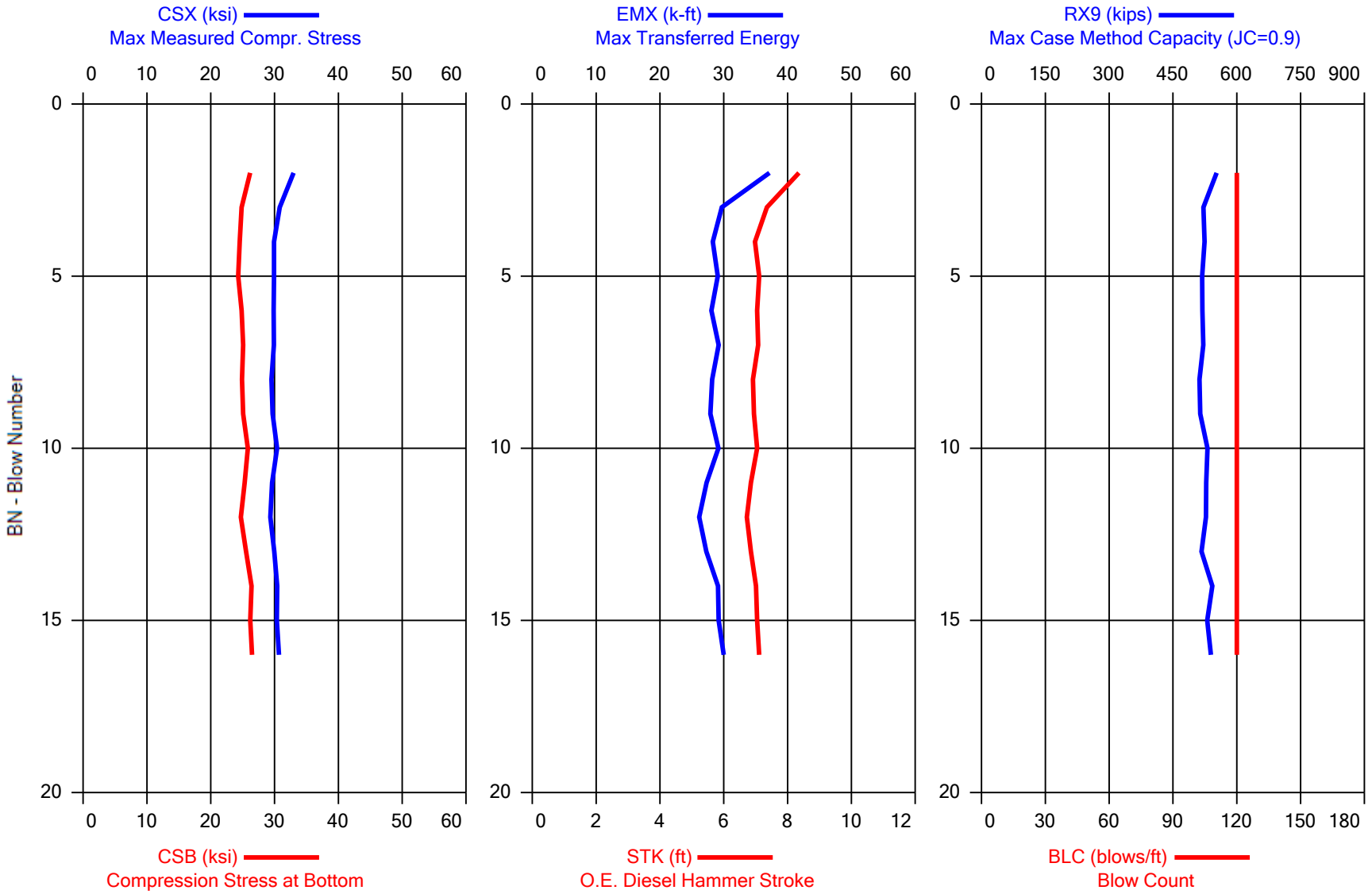
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 29-January-2015

Test started: 28-January-2015

USH 10 - B-70-403 - PIER 7 #36 BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - PIER 7 #36 BOR APE D30-42, HP 14 x 73
OP: RF Date: 28-January-2015

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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
5	81.87	120	AV4	30.9	25.0	31	7.4	43.3	529
			MAX	33.0	26.2	37	8.4	44.6	553
			MIN	29.9	24.3	28	7.0	40.9	519
10	81.91	120	AV5	29.9	25.1	28	7.0	44.5	520
			MAX	30.4	25.8	29	7.1	44.8	531
			MIN	29.5	24.8	28	6.9	44.3	512
16	81.96	120	AV6	30.1	25.8	28	6.9	44.8	531
			MAX	30.7	26.5	30	7.1	45.4	542
			MIN	29.3	24.7	26	6.7	44.2	517
			Average	30.2	25.3	29	7.1	44.3	527
			Maximum	33.0	26.5	37	8.4	45.4	553
			Minimum	29.3	24.3	26	6.7	40.9	512

Total number of blows analyzed: 15

BL# Sensors

1-16 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.09); A4: [K3550] 360.0 (1.09)

Time Summary

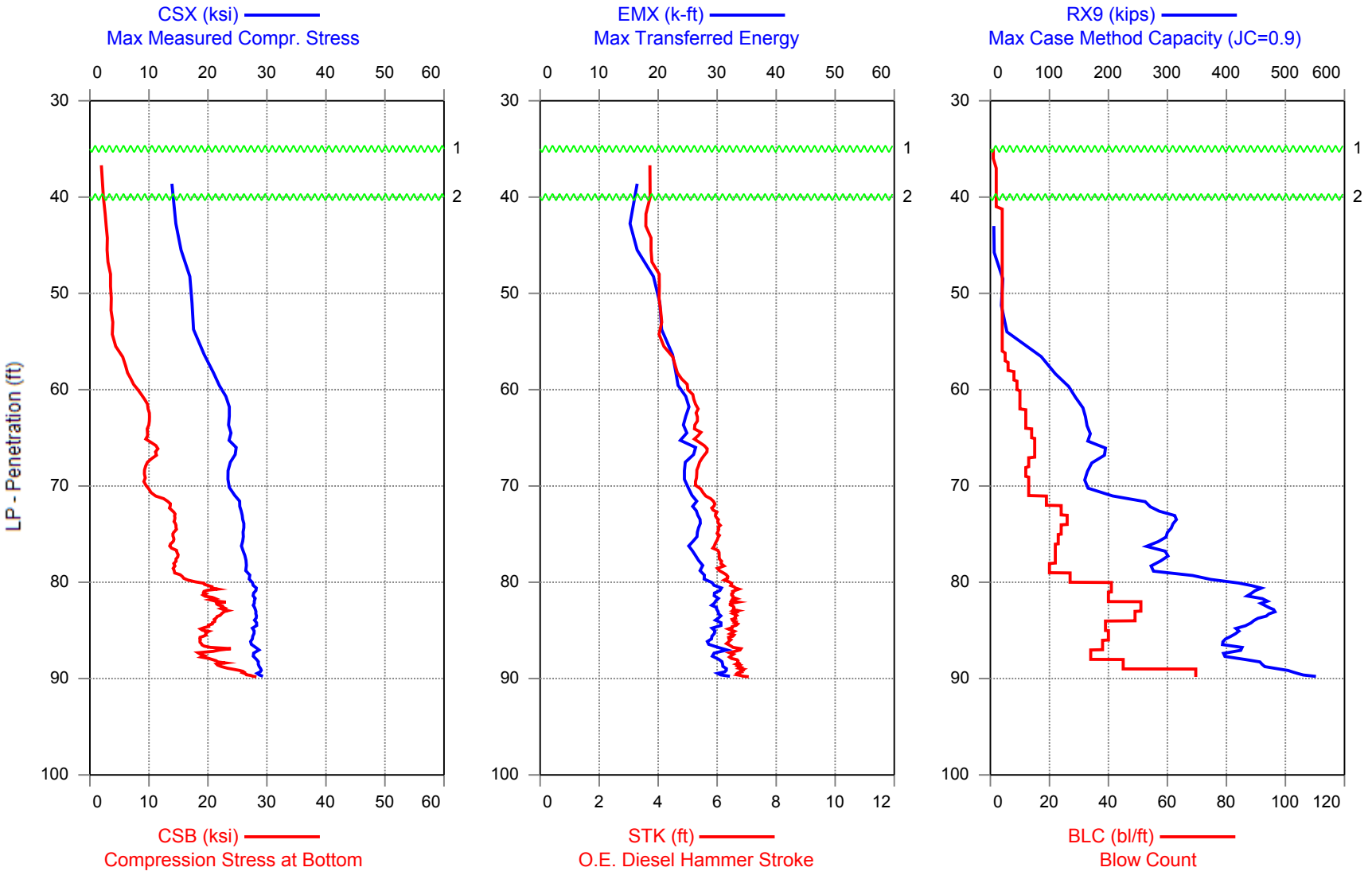
Drive 20 seconds 7:51 AM - 7:51 AM BN 1 - 16

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 29-January-2015

Test started: 27-January-2015

USH 10 - B-70-403 - PIER 7 #44 EOID
APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.47

2 - Bottom of Excavation EL 719.31

USH 10 - B-70-403 - PIER 7 #44 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
3	35.00	1	AV1	9.2	1.2	10	3.0	66.5	0
			MAX	9.2	1.2	10	3.0	66.5	0
			MIN	9.2	1.2	10	3.0	66.5	0
4	36.00	1	AV1	5.7	0.9	7	2.7	69.6	0
			MAX	5.7	0.9	7	2.7	69.6	0
			MIN	5.7	0.9	7	2.7	69.6	0
6	37.00	2	AV1	26.0	2.9	34	5.9	48.4	0
			MAX	26.0	2.9	34	5.9	48.4	0
			MIN	26.0	2.9	34	5.9	48.4	0
7	37.50	2	AV1	16.1	2.6	21	3.7	60.4	0
			MAX	16.1	2.6	21	3.7	60.4	0
			MIN	16.1	2.6	21	3.7	60.4	0
8	38.00	2	AV1	13.3	2.1	12	3.4	62.7	0
			MAX	13.3	2.1	12	3.4	62.7	0
			MIN	13.3	2.1	12	3.4	62.7	0
10	39.00	2	AV1	26.1	2.9	38	5.8	48.6	0
			MAX	26.1	2.9	38	5.8	48.6	0
			MIN	26.1	2.9	38	5.8	48.6	0
11	39.50	2	AV1	13.8	2.3	16	3.3	63.1	0
			MAX	13.8	2.3	16	3.3	63.1	0
			MIN	13.8	2.3	16	3.3	63.1	0
12	40.00	2	AV1	14.2	2.4	15	3.6	61.2	0
			MAX	14.2	2.4	15	3.6	61.2	0
			MIN	14.2	2.4	15	3.6	61.2	0
14	41.00	2	AV2	8.8	2.0	8	3.0	66.8	0
			MAX	9.7	2.0	9	3.0	67.6	0
			MIN	8.0	1.9	8	2.9	65.9	0
18	42.00	4	AV4	14.9	2.7	16	3.7	60.2	9
			MAX	19.4	3.2	21	4.4	64.2	23
			MIN	10.8	2.1	11	3.2	55.6	0
22	43.00	4	AV4	12.9	2.7	13	3.4	62.4	2
			MAX	16.9	3.0	18	4.0	66.2	7
			MIN	9.4	2.2	8	3.0	58.2	0
26	44.00	4	AV4	14.9	2.8	16	3.7	60.4	5
			MAX	17.3	3.3	18	4.0	63.3	10
			MIN	12.0	2.4	11	3.3	57.9	0
30	45.00	4	AV4	15.8	3.0	17	3.8	59.5	3
			MAX	16.8	3.1	19	3.9	60.7	6

USH 10 - B-70-403 - PIER 7 #44 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MIN	15.0	2.7	16	3.6	58.4	0
34	46.00	4	AV4	15.2	2.9	16	3.7	60.1	11
			MAX	16.0	3.0	17	3.8	61.7	16
			MIN	13.8	2.7	14	3.5	59.2	7
38	47.00	4	AV4	15.6	3.1	17	3.8	59.7	5
			MAX	16.6	3.6	19	3.9	60.7	7
			MIN	14.5	2.8	15	3.6	58.6	1
42	48.00	4	AV4	16.5	3.2	18	3.9	58.5	19
			MAX	17.3	3.3	20	4.1	59.6	23
			MIN	15.3	3.0	16	3.8	57.5	14
46	49.00	4	AV4	17.4	3.6	20	4.1	57.6	20
			MAX	18.4	3.9	21	4.2	58.6	28
			MIN	16.5	3.2	18	3.9	56.5	14
50	50.00	4	AV4	17.2	3.6	20	4.0	57.8	24
			MAX	18.1	3.7	21	4.2	58.4	26
			MIN	16.7	3.5	18	3.9	56.9	22
54	51.00	4	AV4	17.2	3.6	20	4.1	57.7	17
			MAX	18.4	3.9	22	4.3	58.7	24
			MIN	16.4	3.3	19	3.9	56.3	10
58	52.00	4	AV4	17.1	3.5	20	4.1	57.7	18
			MAX	17.9	3.6	21	4.2	58.4	24
			MIN	16.5	3.3	19	3.9	56.9	10
62	53.00	4	AV4	18.3	4.0	22	4.2	56.6	28
			MAX	19.0	4.2	24	4.4	57.7	38
			MIN	17.4	3.9	19	4.0	55.7	17
66	54.00	4	AV4	16.7	3.7	19	4.0	58.4	32
			MAX	17.5	3.8	20	4.1	59.3	38
			MIN	15.7	3.6	18	3.8	57.5	25
70	55.00	4	AV4	17.8	3.9	21	4.1	57.4	21
			MAX	18.3	4.1	22	4.2	58.1	41
			MIN	17.1	3.7	20	4.0	56.8	7
74	56.00	4	AV4	18.3	4.5	22	4.2	56.7	50
			MAX	18.9	5.2	22	4.3	57.2	72
			MIN	17.9	4.0	21	4.1	55.9	28
79	57.00	5	AV5	19.9	5.6	23	4.5	54.9	95
			MAX	20.3	6.0	24	4.6	55.8	100
			MIN	19.3	5.2	22	4.3	54.4	90
85	58.00	6	AV6	20.6	6.1	23	4.6	54.2	104
			MAX	21.8	6.5	25	4.9	55.0	113
			MIN	19.8	5.7	22	4.5	52.9	99

USH 10 - B-70-403 - PIER 7 #44 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
93	59.00	8	AV8	21.0	6.6	22	4.7	53.8	111
			MAX	22.3	7.0	24	5.0	55.1	119
			MIN	19.7	6.0	20	4.5	52.3	100
102	60.00	9	AV9	22.0	7.6	24	4.9	52.6	130
			MAX	23.1	8.3	25	5.2	53.9	141
			MIN	20.8	7.2	21	4.7	51.4	118
112	61.00	10	AV10	23.0	8.7	25	5.2	51.5	144
			MAX	23.8	9.4	26	5.3	52.3	153
			MIN	22.3	8.1	23	5.0	50.7	132
122	62.00	10	AV10	23.4	9.8	25	5.3	51.0	152
			MAX	23.9	10.4	26	5.4	51.6	164
			MIN	23.0	9.3	23	5.1	50.5	145
134	63.00	12	AV12	23.7	10.0	25	5.3	50.7	161
			MAX	24.4	10.4	26	5.5	51.0	166
			MIN	23.3	9.5	24	5.3	50.0	157
146	64.00	12	AV12	23.5	10.0	24	5.3	50.9	163
			MAX	24.2	10.6	26	5.4	51.7	174
			MIN	22.8	9.7	22	5.1	50.3	154
160	65.00	14	AV14	23.7	9.7	24	5.3	50.7	168
			MAX	24.5	10.2	27	5.5	51.5	176
			MIN	22.7	9.2	22	5.2	49.9	155
175	66.00	15	AV15	24.0	10.5	25	5.4	50.3	174
			MAX	25.0	11.6	27	5.6	51.7	194
			MIN	22.6	9.1	23	5.1	49.4	157
190	67.00	15	AV15	24.8	11.2	26	5.6	49.4	197
			MAX	25.4	11.6	28	5.8	49.9	203
			MIN	24.4	10.4	25	5.5	48.8	191
203	68.00	13	AV13	23.8	9.9	25	5.4	50.4	173
			MAX	24.2	11.1	26	5.5	50.8	187
			MIN	23.3	9.0	23	5.3	49.9	163
215	69.00	12	AV12	23.4	9.3	25	5.3	50.8	165
			MAX	23.9	9.8	25	5.4	51.1	173
			MIN	23.1	8.9	24	5.2	50.4	153
228	70.00	13	AV13	23.3	9.3	24	5.3	51.0	158
			MAX	23.6	9.6	25	5.3	51.3	166
			MIN	22.9	8.8	23	5.2	50.8	150
241	71.00	13	AV13	24.0	10.2	26	5.5	50.1	175
			MAX	24.7	11.1	27	5.7	51.0	193
			MIN	23.2	9.4	24	5.3	49.2	159

USH 10 - B-70-403 - PIER 7 #44 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
260	72.00	19	AV19	25.3	12.9	26	5.8	48.6	252
			MAX	26.0	14.0	28	6.0	49.7	279
			MIN	24.3	11.1	25	5.6	47.9	212
284	73.00	24	AV24	25.5	13.9	26	5.9	48.3	284
			MAX	26.5	14.7	28	6.1	49.2	314
			MIN	24.5	13.2	24	5.7	47.6	266
310	74.00	26	AV26	25.9	14.4	27	6.0	47.9	314
			MAX	26.6	14.9	29	6.2	48.4	320
			MIN	25.5	14.0	26	5.9	47.2	307
334	75.00	24	AV24	26.0	14.4	27	6.0	47.8	304
			MAX	26.5	15.1	28	6.2	48.1	309
			MIN	25.5	13.8	26	6.0	47.3	295
357	76.00	23	AV23	25.9	14.1	26	6.0	47.9	292
			MAX	26.4	14.8	28	6.1	48.6	306
			MIN	25.4	13.6	24	5.8	47.5	274
379	77.00	22	AV22	25.8	14.1	26	6.0	48.1	280
			MAX	26.7	15.1	27	6.2	48.8	309
			MIN	25.3	13.3	24	5.8	47.3	255
401	78.00	22	AV22	26.4	14.7	27	6.1	47.6	295
			MAX	27.0	15.4	29	6.3	48.0	311
			MIN	25.9	14.2	25	6.0	47.0	281
421	79.00	20	AV20	26.5	14.3	27	6.1	47.5	274
			MAX	27.5	15.1	30	6.3	48.2	302
			MIN	25.7	13.9	25	5.9	46.7	256
448	80.00	27	AV27	27.1	16.0	28	6.3	46.8	357
			MAX	27.9	18.2	30	6.5	47.3	405
			MIN	26.5	14.2	27	6.2	46.2	272
489	81.00	41	AV41	27.9	20.1	30	6.6	45.9	445
			MAX	29.0	22.7	32	6.9	46.7	481
			MIN	27.2	18.5	28	6.3	44.9	410
529	82.00	40	AV40	27.8	20.2	30	6.5	46.0	448
			MAX	28.8	22.9	32	6.8	47.0	491
			MIN	26.7	18.9	28	6.3	45.1	429
580	83.00	51	AV51	27.9	22.4	30	6.6	45.9	472
			MAX	28.7	24.1	31	6.8	46.7	503
			MIN	27.2	20.8	28	6.3	45.3	448
629	84.00	49	AV49	28.1	21.8	30	6.6	45.9	464
			MAX	28.7	23.2	31	6.7	46.8	485
			MIN	27.1	20.7	28	6.3	45.4	443
668	85.00	39	AV39	28.0	20.0	30	6.6	46.0	430

USH 10 - B-70-403 - PIER 7 #44 EOID APE D30-42, HP 14 x 73
OP: RF Date: 27-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	28.7	21.5	32	6.8	47.0	449
			MIN	27.0	18.6	28	6.3	45.3	401
708	86.00	40	AV40	27.7	19.3	29	6.5	46.2	410
			MAX	28.7	20.2	31	6.7	47.3	428
			MIN	26.5	18.3	28	6.2	45.4	393
746	87.00	38	AV38	27.7	19.9	29	6.5	46.2	408
			MAX	29.1	24.9	32	6.9	47.7	472
			MIN	26.0	18.3	26	6.1	44.9	382
780	88.00	34	AV34	27.9	19.7	30	6.5	46.1	404
			MAX	28.9	22.0	33	6.8	47.3	431
			MIN	26.7	18.0	27	6.2	45.2	376
825	89.00	45	AV45	28.6	22.1	31	6.7	45.4	460
			MAX	29.3	24.1	32	6.9	46.3	491
			MIN	27.6	20.3	29	6.5	44.8	426
883	89.83	70	AV58	28.9	26.2	31	6.8	45.2	521
			MAX	30.2	28.4	34	7.1	46.3	563
			MIN	27.5	24.3	29	6.5	44.1	493
			Average	25.7	16.0	27	6.0	48.4	325
			Maximum	30.2	28.4	38	7.1	69.6	563
			Minimum	5.7	0.9	7	2.7	44.1	0

Total number of blows analyzed: 879

BL# Sensors

1-883 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.09); A4: [K3550] 360.0 (1.09)

BL# Comments

3 Reported Reference EL 740.47
12 Bottom of Excavation EL 719.31

Time Summary

Drive 19 minutes 7 seconds 12:28 PM - 12:47 PM BN 1 - 883

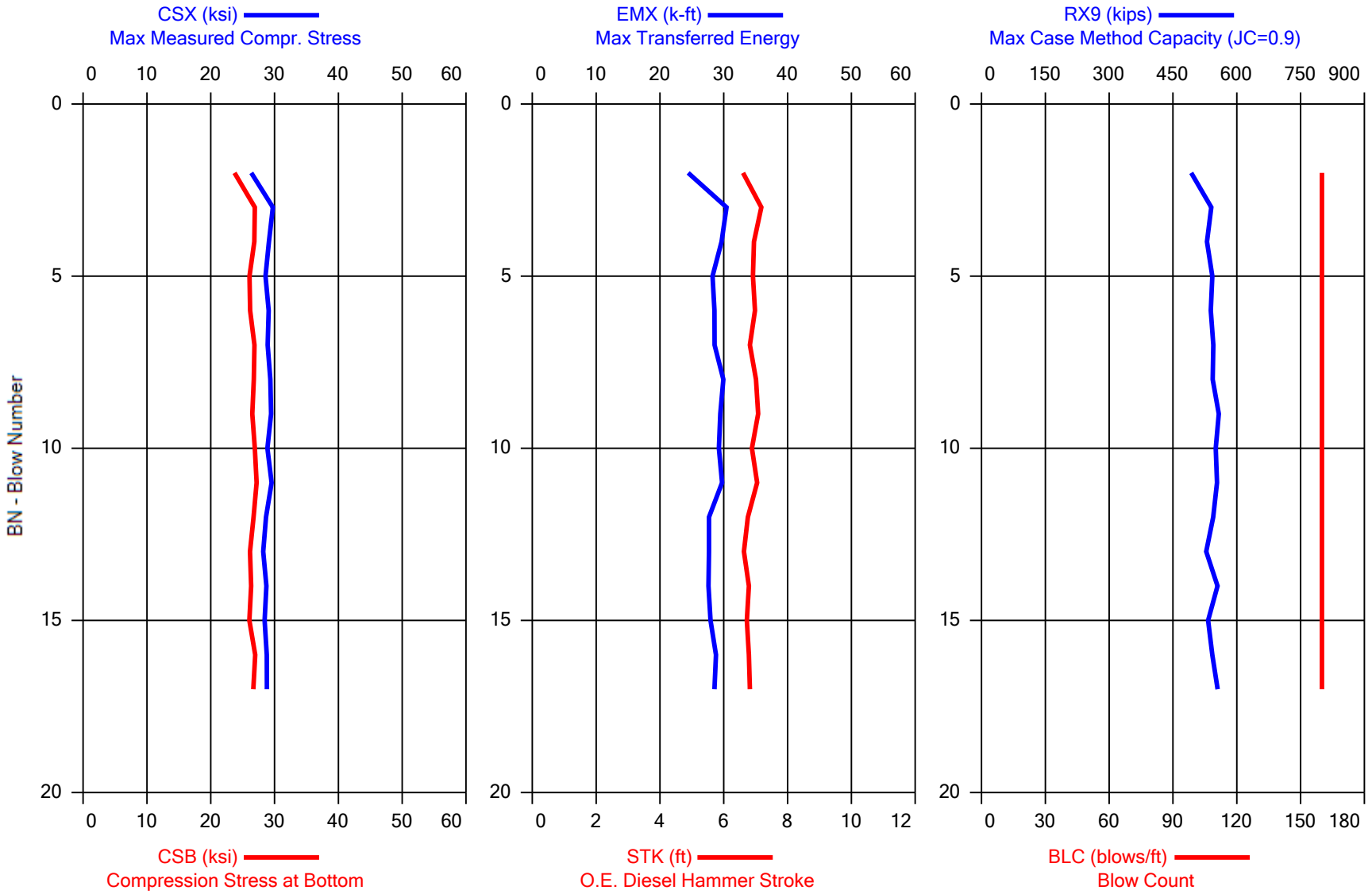
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 29-January-2015

Test started: 28-January-2015

USH 10 - B-70-403 - PIER 7 #44 BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - PIER 7 #44 BOR APE D30-42, HP 14 x 73
OP: RF Date: 28-January-2015

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
5	89.86	160	AV4	28.4	25.9	28	6.9	44.8	526
			MAX	29.7	26.9	30	7.2	45.8	543
			MIN	26.3	23.7	24	6.6	44.0	493
10	89.90	160	AV5	29.1	26.6	29	7.0	44.7	547
			MAX	29.4	26.9	30	7.1	45.1	558
			MIN	28.9	26.2	29	6.8	44.3	539
17	89.94	160	AV7	28.7	26.6	28	6.8	45.2	544
			MAX	29.5	27.2	30	7.0	45.7	555
			MIN	28.2	26.1	28	6.6	44.4	528
			Average	28.8	26.4	29	6.9	44.9	541
			Maximum	29.7	27.2	30	7.2	45.8	558
			Minimum	26.3	23.7	24	6.6	44.0	493

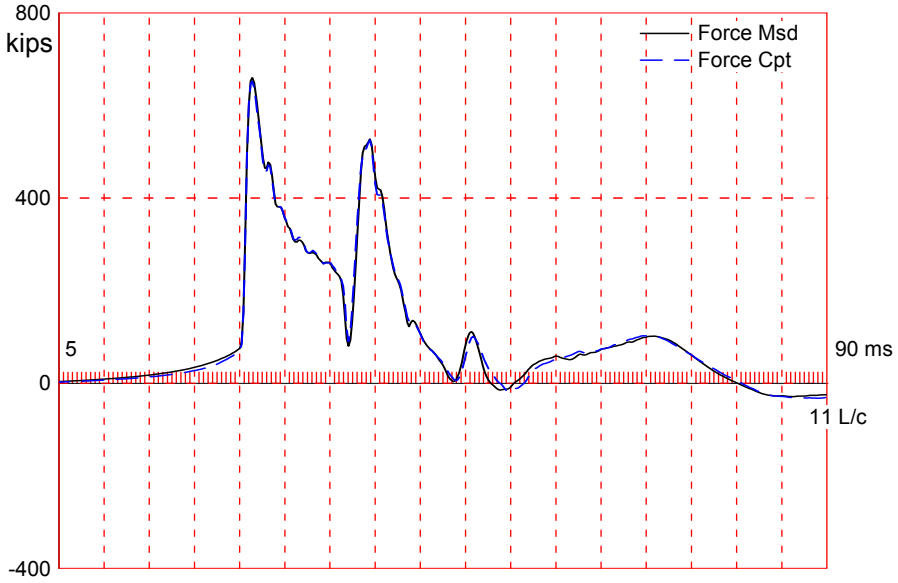
Total number of blows analyzed: 16

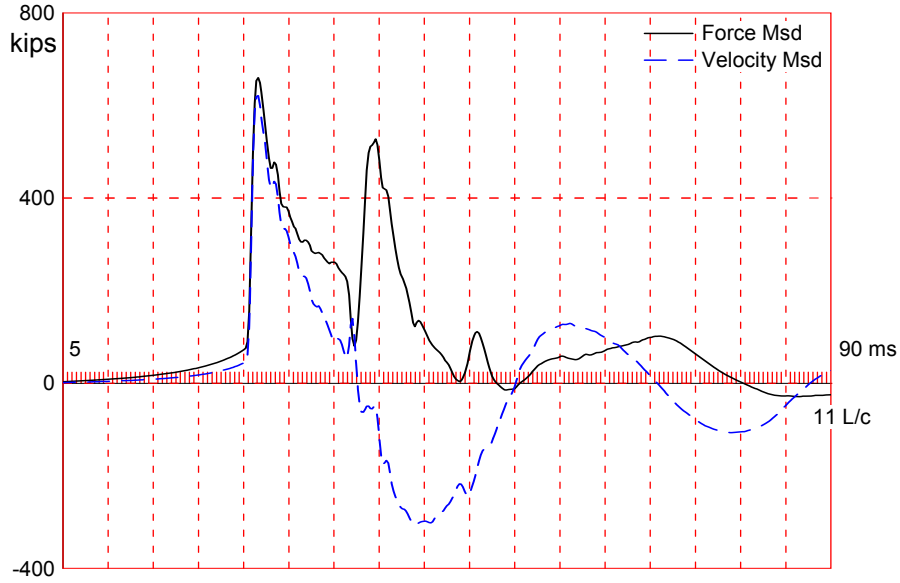
BL# Sensors

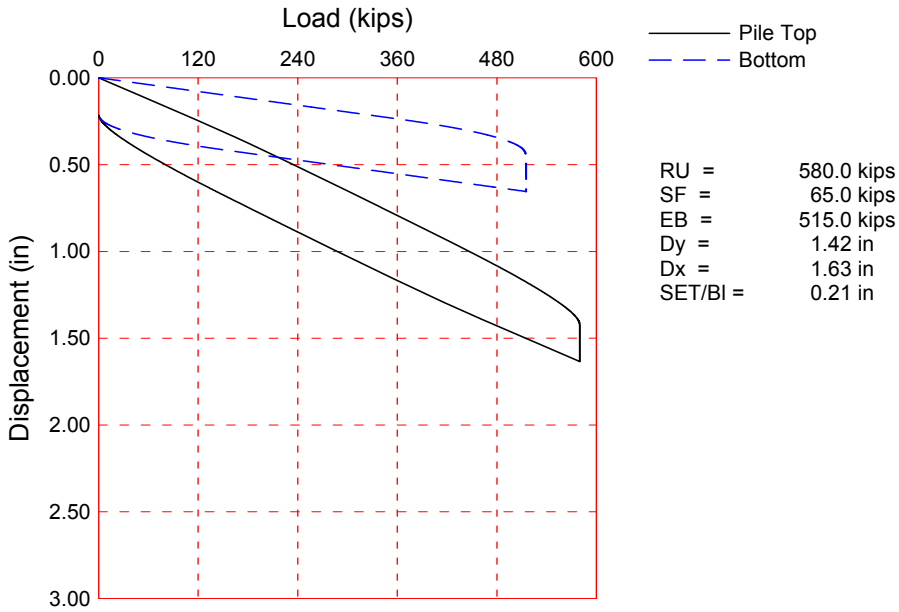
1-17 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.09); A4: [K3550] 360.0 (1.09)

Time Summary

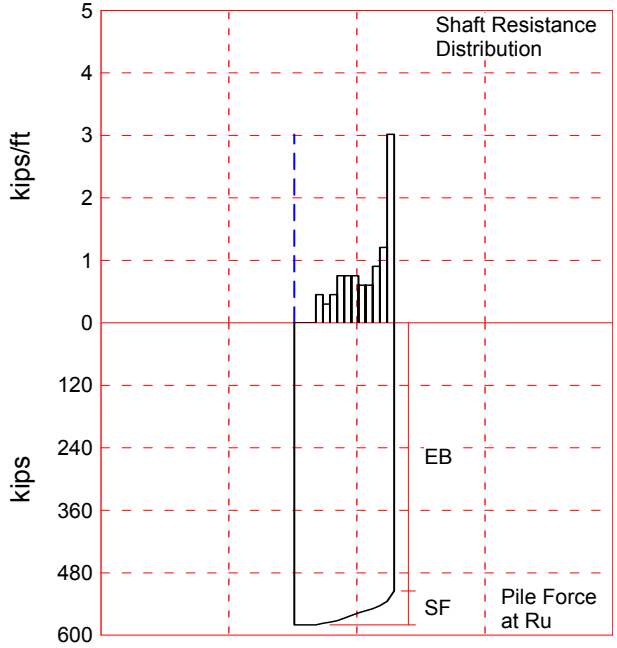
Drive 21 seconds 7:41 AM - 7:41 AM BN 1 - 17







RU =	580.0 kips
SF =	65.0 kips
EB =	515.0 kips
Dy =	1.42 in
Dx =	1.63 in
SET/BI =	0.21 in



Length b. Sensors	92.8 ft
Embedment	90.5 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	2.11
Top Compr. Stress	30.5 ksi
Max Compr. Stress	31.9 ksi
Max Tension Stress	-5.72 ksi
Avg. Shaft Quake	0.19 in
Toe Quake	0.34 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.11 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: 580.0; along Shaft 65.0; at Toe 515.0 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
				580.0				
1	6.6	4.4	0.0	580.0	0.0	0.00	0.00	0.00
2	13.3	11.0	0.0	580.0	0.0	0.00	0.00	0.00
3	19.9	17.6	0.0	580.0	0.0	0.00	0.00	0.00
4	26.5	24.3	3.0	577.0	3.0	0.45	0.10	0.25
5	33.1	30.9	2.0	575.0	5.0	0.30	0.06	0.25
6	39.8	37.5	3.0	572.0	8.0	0.45	0.10	0.25
7	46.4	44.1	5.0	567.0	13.0	0.75	0.16	0.25
8	53.0	50.8	5.0	562.0	18.0	0.75	0.16	0.25
9	59.6	57.4	5.0	557.0	23.0	0.75	0.16	0.25
10	66.3	64.0	4.0	553.0	27.0	0.60	0.13	0.25
11	72.9	70.6	4.0	549.0	31.0	0.60	0.13	0.25
12	79.5	77.3	6.0	543.0	37.0	0.91	0.19	0.25
13	86.1	83.9	8.0	535.0	45.0	1.21	0.26	0.25
14	92.8	90.5	20.0	515.0	65.0	3.02	0.64	0.25
Avg. Shaft			4.6			0.72	0.15	0.25
Toe			515.0				373.60	0.11

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.19	0.34
Case Damping Factor		0.43	1.48
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	56	34
Unloading Level	(% of Ru)	91	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.020	

CAPWAP match quality = 2.11 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.21 in; Blow Count = 56 b/ft
Computed: Final Set = 0.25 in; Blow Count = 48 b/ft

max. Top Comp. Stress = 30.5 ksi (T= 26.8 ms, max= 1.046 x Top)
max. Comp. Stress = 31.9 ksi (Z= 92.8 ft, T= 32.7 ms)
max. Tens. Stress = -5.72 ksi (Z= 53.0 ft, T= 52.8 ms)
max. Energy (EMX) = 35.3 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	3.3	653.0	-35.1	30.5	-1.64	35.3	16.4	1.09
2	6.6	653.7	-42.3	30.5	-1.98	35.1	16.4	1.08
4	13.3	655.3	-58.3	30.6	-2.72	34.7	16.4	1.05
6	19.9	659.3	-74.8	30.8	-3.49	34.2	16.3	1.01
8	26.5	666.5	-88.5	31.1	-4.13	33.5	16.1	0.96
10	33.1	658.1	-90.9	30.7	-4.24	32.0	15.9	0.91
12	39.8	657.7	-91.1	30.7	-4.26	30.7	15.6	0.86
14	46.4	655.1	-109.1	30.6	-5.10	29.0	15.3	0.81
15	49.7	637.2	-113.4	29.8	-5.30	27.4	15.1	0.78
16	53.0	643.0	-122.5	30.0	-5.72	26.8	15.0	0.75
17	56.3	625.7	-119.6	29.2	-5.59	25.2	14.8	0.72
18	59.6	630.9	-122.3	29.5	-5.71	24.6	14.7	0.69
19	62.9	613.2	-118.1	28.6	-5.52	23.0	14.5	0.66
20	66.3	620.2	-118.6	29.0	-5.54	22.3	14.4	0.62
21	69.6	616.6	-114.7	28.8	-5.36	20.9	14.0	0.59
22	72.9	617.6	-116.4	28.9	-5.44	20.1	13.9	0.56
23	76.2	600.9	-111.7	28.1	-5.22	18.7	13.9	0.52
24	79.5	608.4	-112.4	28.4	-5.25	17.9	13.7	0.49
25	82.8	627.6	-105.9	29.3	-4.95	16.3	14.8	0.45
26	86.1	650.7	-106.7	30.4	-4.99	15.5	16.2	0.42
27	89.4	649.1	-97.7	30.3	-4.57	13.8	16.1	0.38
28	92.8	683.0	-98.7	31.9	-4.61	13.0	14.3	0.35
Absolute	92.8			31.9			(T =	32.7 ms)
	53.0				-5.72		(T =	52.8 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	713.3	659.2	605.1	551.0	497.0	442.9	388.8	334.7	280.6	226.5
RX	762.0	732.6	709.4	694.0	678.5	663.0	647.5	633.6	621.0	611.6
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RAU = 415.4 (kips); RA2 = 614.0 (kips)

Current CAPWAP Ru = 580.0 (kips); Corresponding J(RP)= 0.49; matches RX20 within 5%

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
16.3	26.61	621.3	659.9	659.9	1.08	0.21	0.21	35.4	656.4	1580

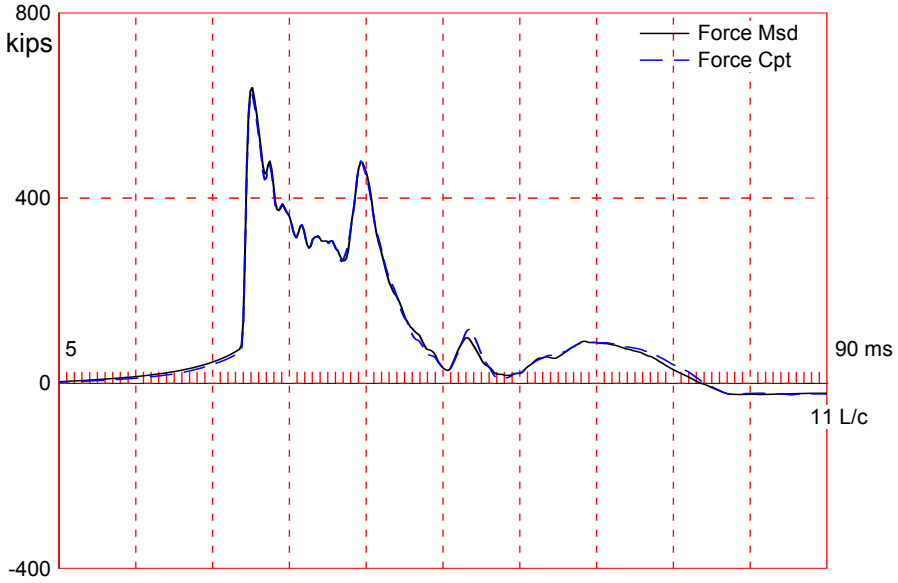
PILE PROFILE AND PILE MODEL

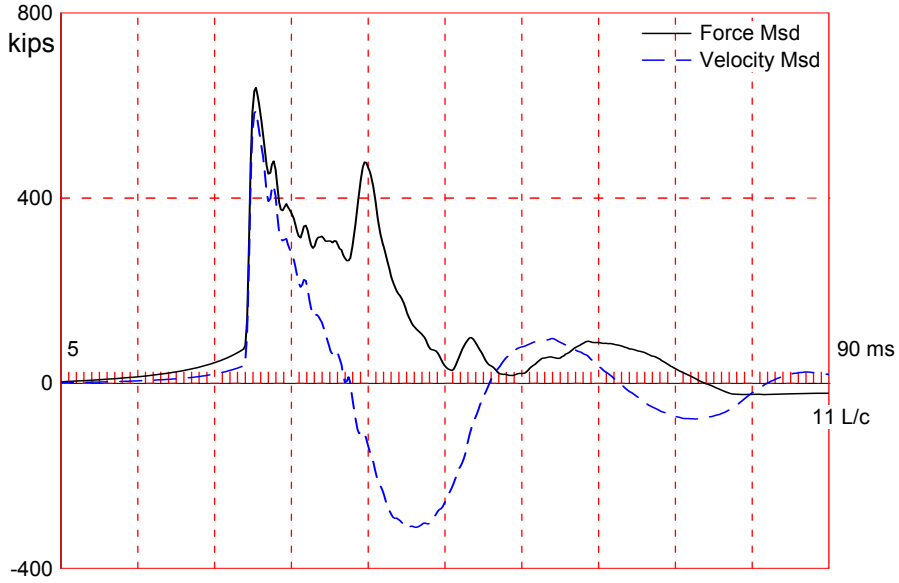
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.8	21.4	29992.2	492.000	4.70

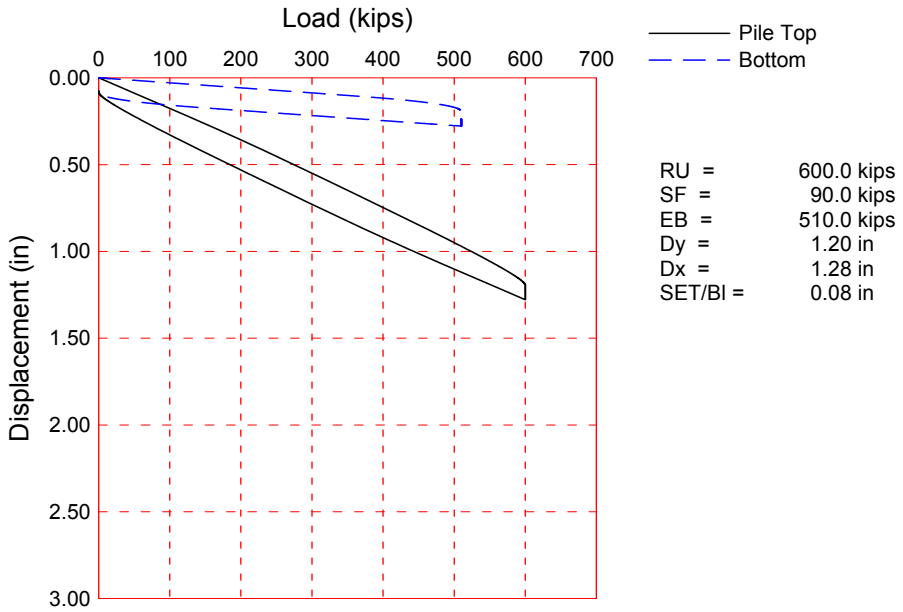
Toe Area 198.5 in²

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	76.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	79.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

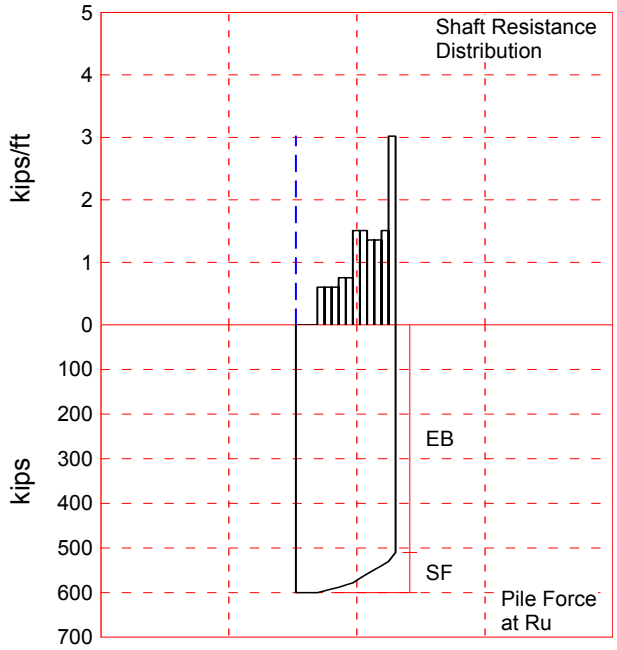
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.784 ft^3; Volume ratio considering added impedance: 1.000







RU =	600.0 kips
SF =	90.0 kips
EB =	510.0 kips
Dy =	1.20 in
Dx =	1.28 in
SET/Bl =	0.08 in



Length b. Sensors	92.7 ft
Embedment	90.5 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	1.51
Top Compr. Stress	29.3 ksi
Max Compr. Stress	30.4 ksi
Max Tension Stress	-5.35 ksi
Avg. Shaft Quake	0.18 in
Toe Quake	0.15 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.08 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 600.0; along Shaft 90.0; at Toe 510.0 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
				600.0					
1	6.6	4.5	0.0	600.0	0.0	0.00	0.00	0.00	0.19
2	13.2	11.1	0.0	600.0	0.0	0.00	0.00	0.00	0.19
3	19.9	17.7	0.0	600.0	0.0	0.00	0.00	0.00	0.19
4	26.5	24.3	4.0	596.0	4.0	0.60	0.13	0.28	0.19
5	33.1	30.9	4.0	592.0	8.0	0.60	0.13	0.28	0.19
6	39.7	37.6	4.0	588.0	12.0	0.60	0.13	0.28	0.19
7	46.3	44.2	5.0	583.0	17.0	0.76	0.16	0.28	0.19
8	53.0	50.8	5.0	578.0	22.0	0.76	0.16	0.28	0.19
9	59.6	57.4	10.0	568.0	32.0	1.51	0.32	0.28	0.19
10	66.2	64.0	10.0	558.0	42.0	1.51	0.32	0.28	0.19
11	72.8	70.7	9.0	549.0	51.0	1.36	0.29	0.28	0.19
12	79.4	77.3	9.0	540.0	60.0	1.36	0.29	0.28	0.19
13	86.1	83.9	10.0	530.0	70.0	1.51	0.32	0.28	0.19
14	92.7	90.5	20.0	510.0	90.0	3.02	0.64	0.28	0.16
Avg. Shaft			6.4			0.99	0.21	0.28	0.18
Toe			510.0				369.97	0.08	0.15

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		0.66	1.07
Damping Type		Viscous	Viscous
Unloading Quake	(% of loading quake)	46	30
Unloading Level	(% of Ru)	51	
Resistance Gap (included in Toe Quake)	(in)		0.00
Soil Plug Weight	(kips)	0.020	

CAPWAP match quality = 1.51 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.09 in; Blow Count = 137 b/ft
Transducer F3(F607) CAL: 93.6; RF: 0.98; F4(D815) CAL: 93.0; RF: 0.98
A3(K2524) CAL: 360; RF: 1.09; A4(K3550) CAL: 360; RF: 1.09

max. Top Comp. Stress = 29.3 ksi (T= 26.8 ms, max= 1.037 x Top)
max. Comp. Stress = 30.4 ksi (Z= 92.7 ft, T= 32.7 ms)
max. Tens. Stress = -5.35 ksi (Z= 59.6 ft, T= 51.0 ms)
max. Energy (EMX) = 32.9 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	3.3	627.6	-26.1	29.3	-1.22	32.9	15.7	0.98
2	6.6	628.4	-28.8	29.4	-1.35	32.6	15.6	0.97
4	13.2	630.1	-34.2	29.4	-1.60	32.1	15.6	0.92
6	19.9	635.0	-39.4	29.7	-1.84	31.3	15.5	0.88
8	26.5	645.9	-43.9	30.2	-2.05	30.6	15.2	0.83
10	33.1	636.0	-62.4	29.7	-2.92	28.7	14.9	0.78
12	39.7	627.3	-89.8	29.3	-4.20	26.8	14.6	0.72
14	46.3	620.5	-107.7	29.0	-5.03	25.0	14.2	0.66
15	49.6	603.4	-109.7	28.2	-5.12	23.4	14.0	0.63
16	53.0	612.3	-114.0	28.6	-5.33	22.7	13.8	0.60
17	56.3	601.0	-112.1	28.1	-5.24	21.3	13.5	0.57
18	59.6	611.3	-114.5	28.6	-5.35	20.6	13.2	0.54
19	62.9	578.8	-105.9	27.0	-4.95	18.5	12.9	0.50
20	66.2	589.7	-107.4	27.6	-5.02	17.7	12.6	0.47
21	69.5	576.0	-98.9	26.9	-4.62	15.7	12.1	0.43
22	72.8	586.2	-100.2	27.4	-4.68	14.8	12.0	0.40
23	76.1	577.7	-92.5	27.0	-4.32	13.1	11.9	0.36
24	79.4	613.8	-94.2	28.7	-4.40	12.2	11.6	0.33
25	82.7	629.2	-86.5	29.4	-4.04	10.8	11.3	0.29
26	86.1	639.8	-87.3	29.9	-4.08	10.0	10.8	0.26
27	89.4	622.8	-79.0	29.1	-3.69	8.8	10.0	0.22
28	92.7	650.6	-80.1	30.4	-3.74	8.0	8.4	0.19
Absolute	92.7			30.4			(T =	32.7 ms)
	59.6				-5.35		(T =	51.0 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	817.5	733.8	650.0	566.3	482.6					
RX	830.0	764.4	706.2	663.5	632.8	606.1	581.4	557.4	534.0	510.6
RU	816.6	732.7	648.8	564.8	480.9					

RAU = 373.6 (kips); RA2 = 606.1 (kips)

Current CAPWAP Ru = 600.0 (kips); Corresponding J(RP)= 0.52; J(RX) = 1.05

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	26.78	593.5	642.7	642.7	0.96	0.07	0.08	33.1	764.8	3495

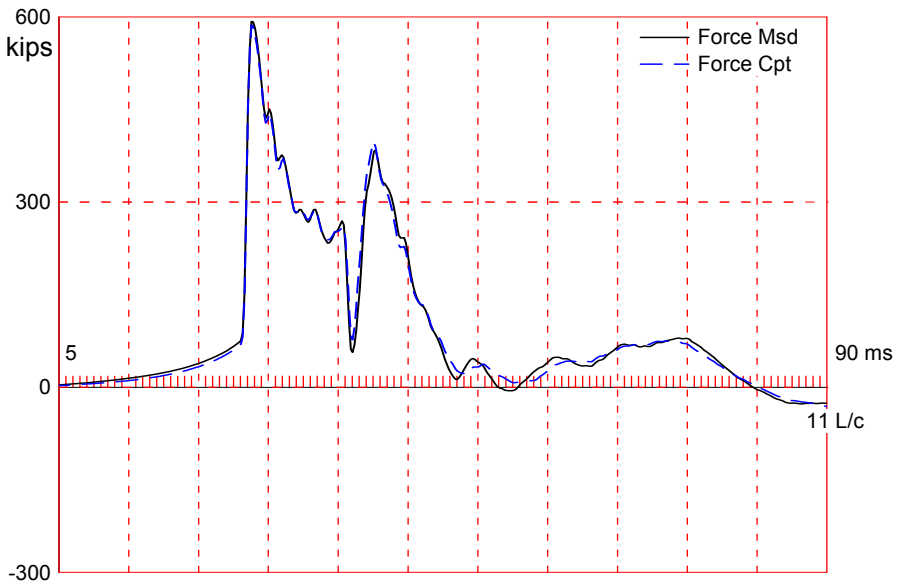
PILE PROFILE AND PILE MODEL

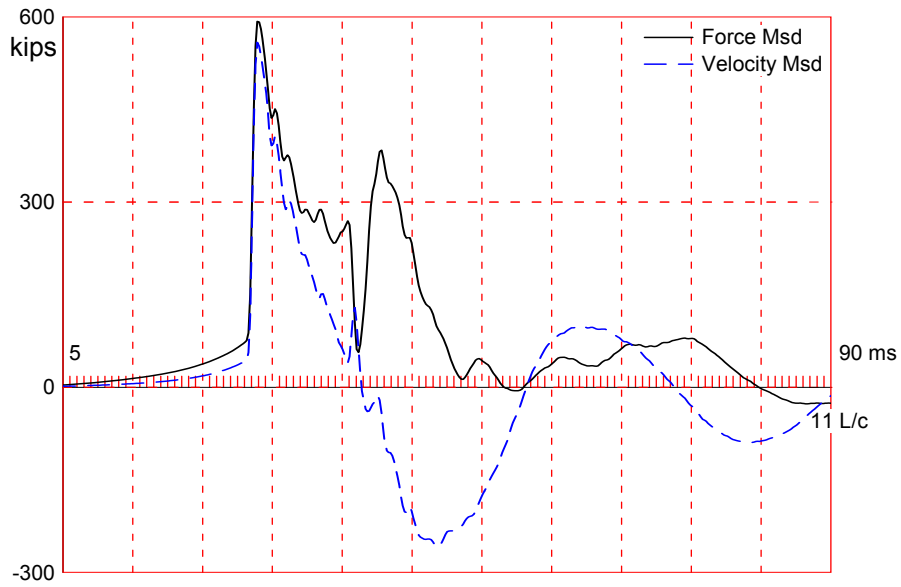
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

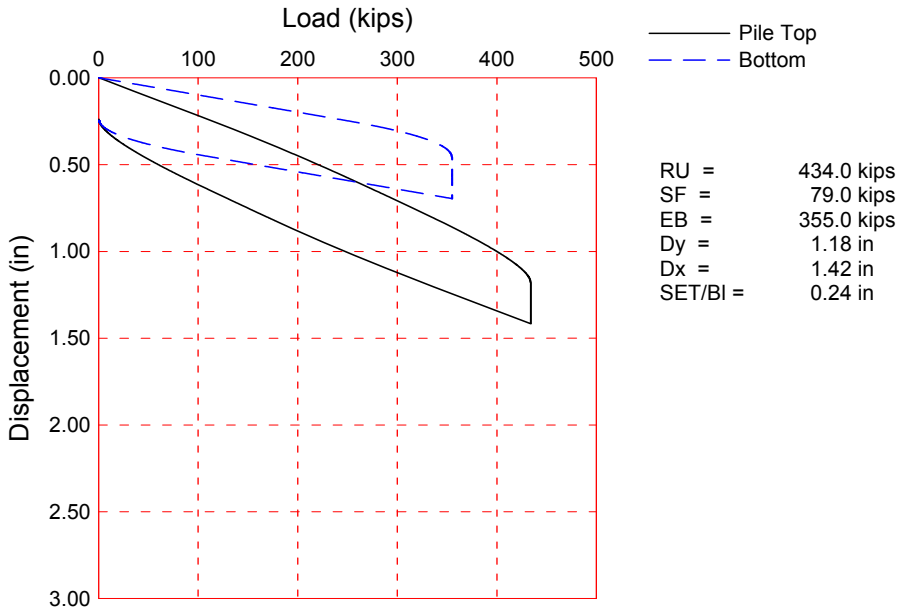
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	76.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	79.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

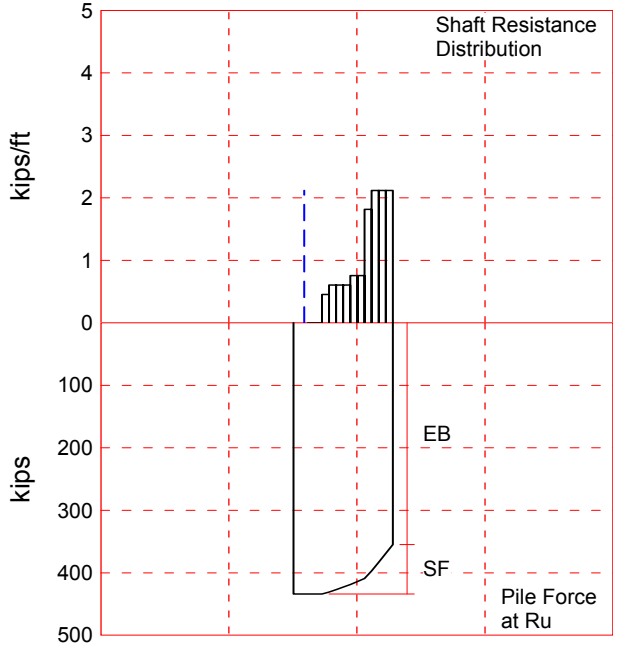
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.772 ft^3; Volume ratio considering added impedance: 1.000







RU =	434.0 kips
SF =	79.0 kips
EB =	355.0 kips
Dy =	1.18 in
Dx =	1.42 in
SET/BI =	0.24 in



Length b. Sensors	92.4 ft
Embedment	81.8 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	2.97
Top Compr. Stress	27.5 ksi
Max Compr. Stress	28.3 ksi
Max Tension Stress	-4.52 ksi
Avg. Shaft Quake	0.19 in
Toe Quake	0.35 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.10 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: 434.0; along Shaft 79.0; at Toe 355.0 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
				434.0				
1	19.8	9.2	0.0	434.0	0.0	0.00	0.00	0.00
2	26.4	15.8	0.0	434.0	0.0	0.00	0.00	0.00
3	33.0	22.4	3.0	431.0	3.0	0.45	0.10	0.25
4	39.6	29.0	4.0	427.0	7.0	0.61	0.13	0.25
5	46.2	35.6	4.0	423.0	11.0	0.61	0.13	0.25
6	52.8	42.2	4.0	419.0	15.0	0.61	0.13	0.25
7	59.4	48.8	5.0	414.0	20.0	0.76	0.16	0.25
8	66.0	55.4	5.0	409.0	25.0	0.76	0.16	0.25
9	72.6	62.0	12.0	397.0	37.0	1.82	0.39	0.25
10	79.2	68.6	14.0	383.0	51.0	2.12	0.45	0.25
11	85.8	75.2	14.0	369.0	65.0	2.12	0.45	0.25
12	92.4	81.8	14.0	355.0	79.0	2.12	0.45	0.25
Avg. Shaft			6.6			0.97	0.21	0.25
Toe			355.0				257.53	0.10

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.19	0.35
Case Damping Factor		0.52	0.93
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	89	39
Soil Plug Weight	(kips)	0.060	0.065

CAPWAP match quality = 2.97 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.24 in; Blow Count = 50 b/ft
Computed: Final Set = 0.28 in; Blow Count = 43 b/ft

max. Top Comp. Stress = 27.5 ksi (T= 26.7 ms, max= 1.030 x Top)
max. Comp. Stress = 28.3 ksi (Z= 29.7 ft, T= 28.3 ms)
max. Tens. Stress = -4.52 ksi (Z= 72.6 ft, T= 53.6 ms)
max. Energy (EMX) = 30.5 kip-ft; max. Measured Top Displ. (DMX)= 1.00 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	587.6	-36.8	27.5	-1.72	30.5	14.8	1.02
2	6.6	587.9	-39.1	27.5	-1.83	30.4	14.7	1.01
4	13.2	588.6	-43.2	27.5	-2.02	30.1	14.7	0.98
6	19.8	589.5	-47.3	27.5	-2.21	29.6	14.6	0.94
8	26.4	604.1	-60.9	28.2	-2.84	29.0	14.3	0.90
10	33.0	599.7	-74.9	28.0	-3.50	28.5	14.3	0.86
12	39.6	596.4	-80.5	27.9	-3.76	27.2	14.0	0.82
14	46.2	588.0	-80.1	27.5	-3.74	25.6	13.8	0.77
15	49.5	577.3	-76.8	27.0	-3.59	24.4	13.6	0.74
16	52.8	592.4	-78.8	27.7	-3.68	23.9	13.3	0.72
17	56.1	585.3	-76.9	27.3	-3.59	22.8	12.9	0.69
18	59.4	580.2	-83.6	27.1	-3.91	22.4	13.1	0.67
19	62.7	559.1	-85.6	26.1	-4.00	21.1	13.1	0.64
20	66.0	567.2	-91.5	26.5	-4.27	20.7	12.9	0.61
21	69.3	558.8	-90.8	26.1	-4.24	19.5	12.6	0.59
22	72.6	569.2	-96.8	26.6	-4.52	19.0	12.3	0.56
23	75.9	536.5	-84.1	25.1	-3.93	17.1	12.0	0.54
24	79.2	546.9	-85.6	25.6	-4.00	16.6	11.7	0.51
25	82.5	508.3	-73.2	23.7	-3.42	14.6	13.0	0.49
26	85.8	493.6	-73.7	23.1	-3.44	14.3	14.0	0.47
27	89.1	485.0	-64.6	22.7	-3.02	12.5	14.7	0.44
28	92.4	498.4	-65.0	23.3	-3.04	11.4	14.4	0.42
Absolute	29.7			28.3			(T =	28.3 ms)
	72.6				-4.52		(T =	53.6 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	555.7	434.9	314.0	193.2	72.4					
RX	609.3	557.9	511.2	489.2	468.0	455.9	451.7	447.4	443.3	439.3
RU	555.7	434.9	314.0	193.2	72.4					

RAU = 378.2 (kips); RA2 = 498.4 (kips)

Current CAPWAP Ru = 434.0 (kips); Corresponding J(RP)= 0.20; matches RX20 within 5%

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
14.8	26.51	564.1	595.9	599.2	1.00	0.24	0.24	30.6	591.2	1009

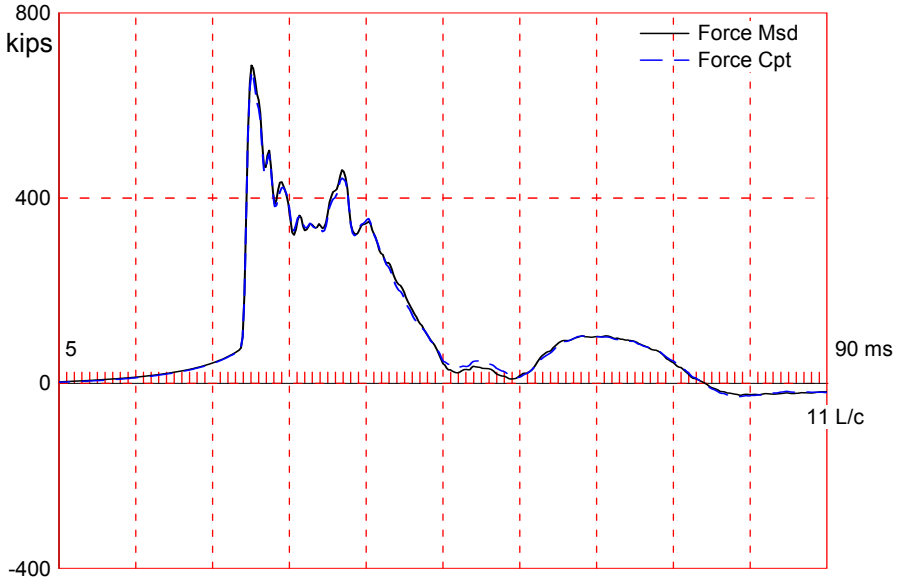
PILE PROFILE AND PILE MODEL

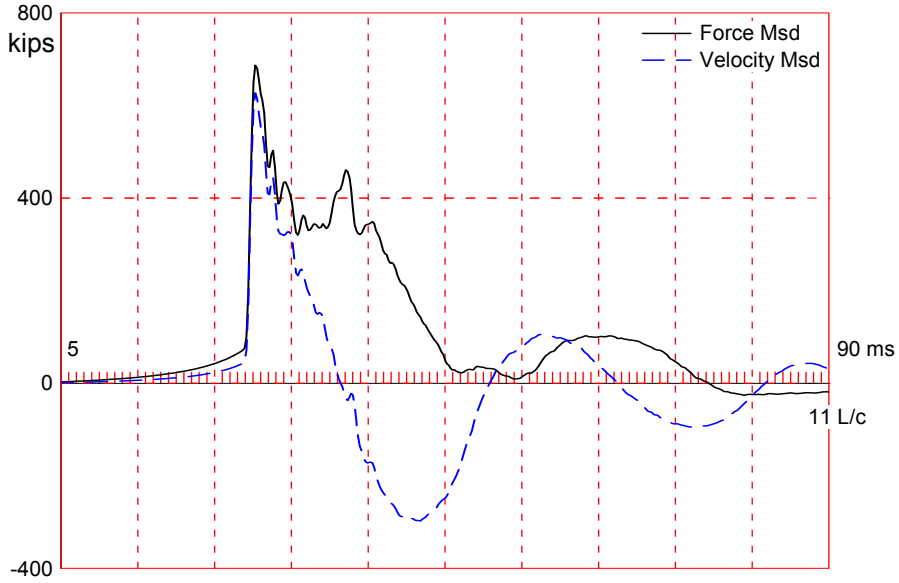
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.4	21.4	29992.2	492.000	4.70

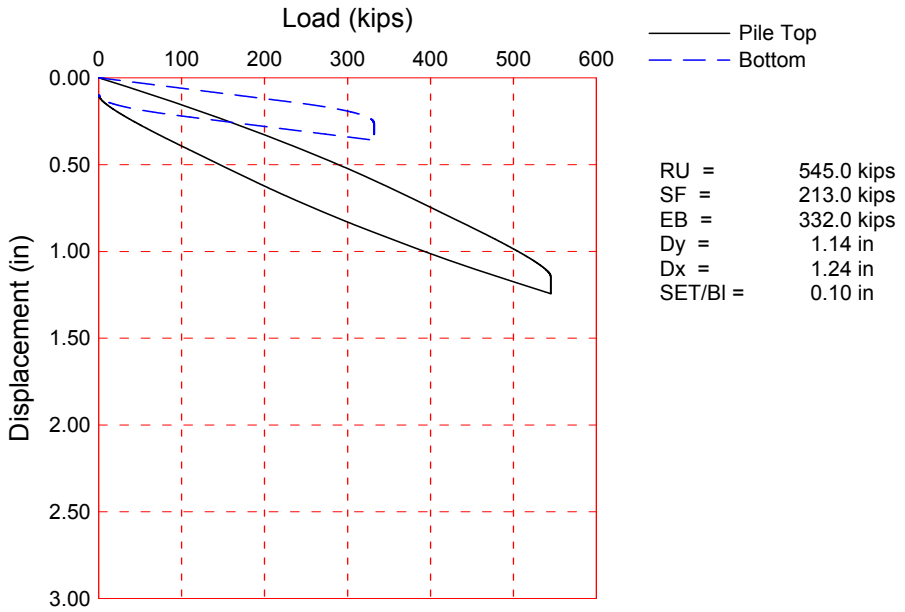
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
10	33.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
11	36.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
18	59.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
20	66.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

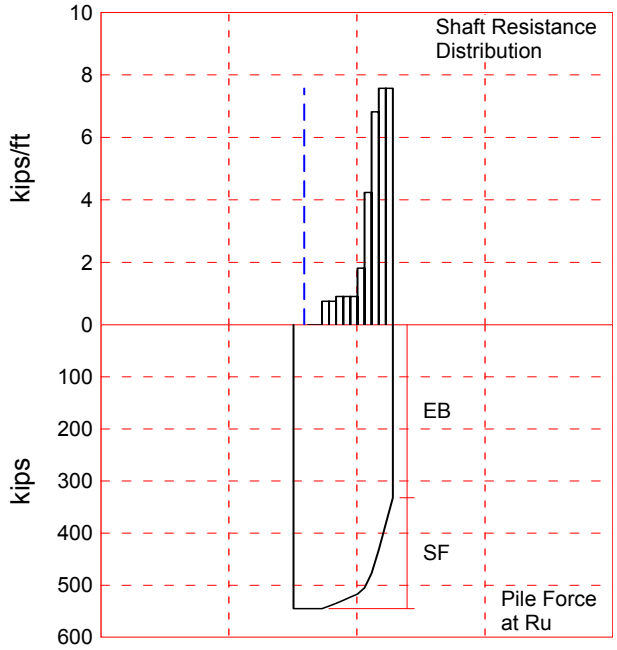
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.735 ft^3; Volume ratio considering added impedance: 1.000







RU =	545.0 kips
SF =	213.0 kips
EB =	332.0 kips
Dy =	1.14 in
Dx =	1.24 in
SET/Bl =	0.10 in



Length b. Sensors	92.4 ft
Embedment	81.8 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	1.43
Top Compr. Stress	31.5 ksi
Max Compr. Stress	32.8 ksi
Max Tension Stress	-5.33 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.20 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.10 s/ft

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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: 545.0; along Shaft 213.0; at Toe 332.0 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
				545.0				
1	19.8	9.2	0.0	545.0	0.0	0.00	0.00	0.00
2	26.4	15.8	0.0	545.0	0.0	0.00	0.00	0.00
3	33.0	22.4	5.0	540.0	5.0	0.76	0.16	0.30
4	39.6	29.0	5.0	535.0	10.0	0.76	0.16	0.30
5	46.2	35.6	6.0	529.0	16.0	0.91	0.19	0.30
6	52.8	42.2	6.0	523.0	22.0	0.91	0.19	0.30
7	59.4	48.8	6.0	517.0	28.0	0.91	0.19	0.30
8	66.0	55.4	12.0	505.0	40.0	1.82	0.39	0.30
9	72.6	62.0	28.0	477.0	68.0	4.24	0.90	0.30
10	79.2	68.6	45.0	432.0	113.0	6.82	1.45	0.30
11	85.8	75.2	50.0	382.0	163.0	7.57	1.61	0.30
12	92.4	81.8	50.0	332.0	213.0	7.57	1.61	0.30
Avg. Shaft			17.8			2.60	0.55	0.30
Toe			332.0				240.84	0.10

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.08	0.20
Case Damping Factor		1.67	0.87
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	30
Unloading Level	(% of Ru)	31	
Soil Plug Weight	(kips)	0.135	0.051

CAPWAP match quality = 1.43 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.11 in; Blow Count = 106 b/ft

max. Top Comp. Stress = 31.5 ksi (T= 26.7 ms, max= 1.040 x Top)
max. Comp. Stress = 32.8 ksi (Z= 29.7 ft, T= 28.3 ms)
max. Tens. Stress = -5.33 ksi (Z= 66.0 ft, T= 52.2 ms)
max. Energy (EMX) = 35.9 kip-ft; max. Measured Top Displ. (DMX)= 1.00 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	674.1	-32.3	31.5	-1.51	35.9	16.8	1.00
2	6.6	674.8	-35.7	31.5	-1.67	35.4	16.7	0.97
4	13.2	676.3	-42.4	31.6	-1.98	34.4	16.6	0.92
6	19.8	678.1	-48.3	31.7	-2.26	33.4	16.6	0.87
8	26.4	692.6	-54.1	32.4	-2.53	32.4	16.2	0.81
10	33.0	697.1	-65.9	32.6	-3.08	31.4	16.0	0.76
12	39.6	682.0	-78.0	31.9	-3.64	29.0	15.6	0.70
14	46.2	670.8	-89.6	31.3	-4.19	26.7	15.1	0.64
15	49.5	650.2	-91.3	30.4	-4.26	25.0	14.8	0.61
16	52.8	665.8	-98.3	31.1	-4.59	24.3	14.4	0.57
17	56.1	638.3	-100.6	29.8	-4.70	22.6	14.1	0.54
18	59.4	642.8	-106.4	30.0	-4.97	22.0	14.1	0.51
19	62.7	630.5	-108.7	29.5	-5.08	20.4	13.7	0.48
20	66.0	652.9	-114.0	30.5	-5.33	19.7	13.2	0.45
21	69.3	625.7	-109.2	29.2	-5.10	17.6	12.4	0.41
22	72.6	657.9	-111.1	30.7	-5.19	16.9	11.6	0.38
23	75.9	590.3	-95.5	27.6	-4.46	13.8	10.6	0.35
24	79.2	620.1	-97.0	29.0	-4.53	13.3	9.5	0.32
25	82.5	492.6	-72.5	23.0	-3.39	9.8	8.5	0.30
26	85.8	497.5	-73.6	23.2	-3.44	9.4	8.4	0.27
27	89.1	439.6	-47.7	20.5	-2.23	6.5	9.0	0.25
28	92.4	446.2	-48.8	20.8	-2.28	4.4	8.7	0.22
Absolute	29.7			32.8			(T =	28.3 ms)
	66.0				-5.33		(T =	52.2 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	853.1	759.4	665.7	572.0	478.4					
RX	857.2	768.5	682.4	614.2	566.8	538.0	521.0	510.5	506.1	502.0
RU	853.5	759.9	666.3	572.7	479.1					

RAU = 222.5 (kips); RA2 = 639.4 (kips)

Current CAPWAP Ru = 545.0 (kips); Corresponding J(RP)= 0.66; J(RX) = 0.92

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
16.5	26.51	631.1	690.3	690.3	1.00	0.10	0.10	36.2	791.2	1660

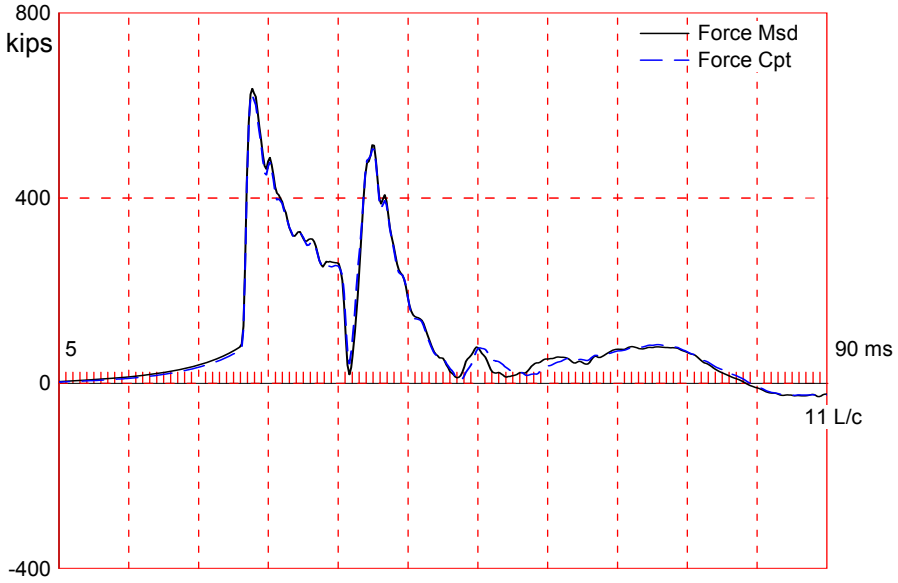
PILE PROFILE AND PILE MODEL

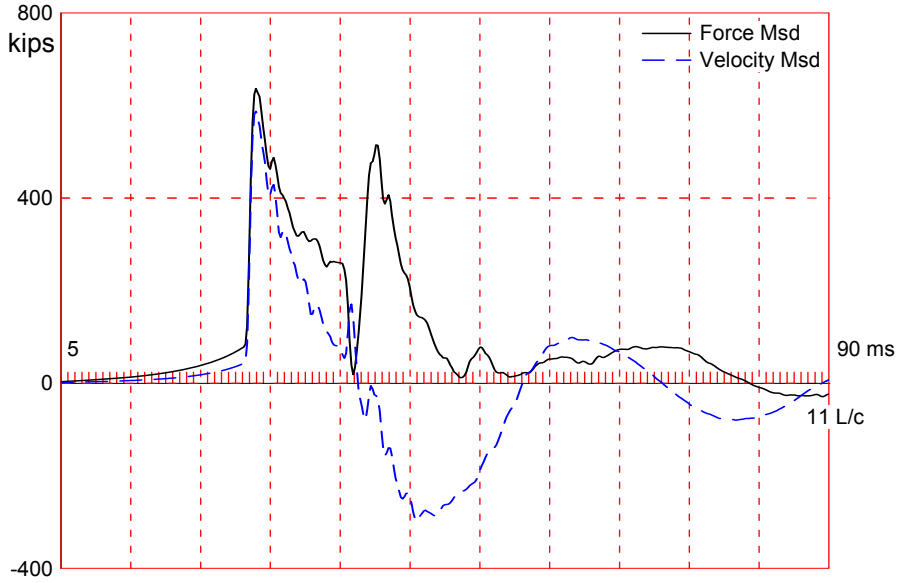
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.4	21.4	29992.2	492.000	4.70

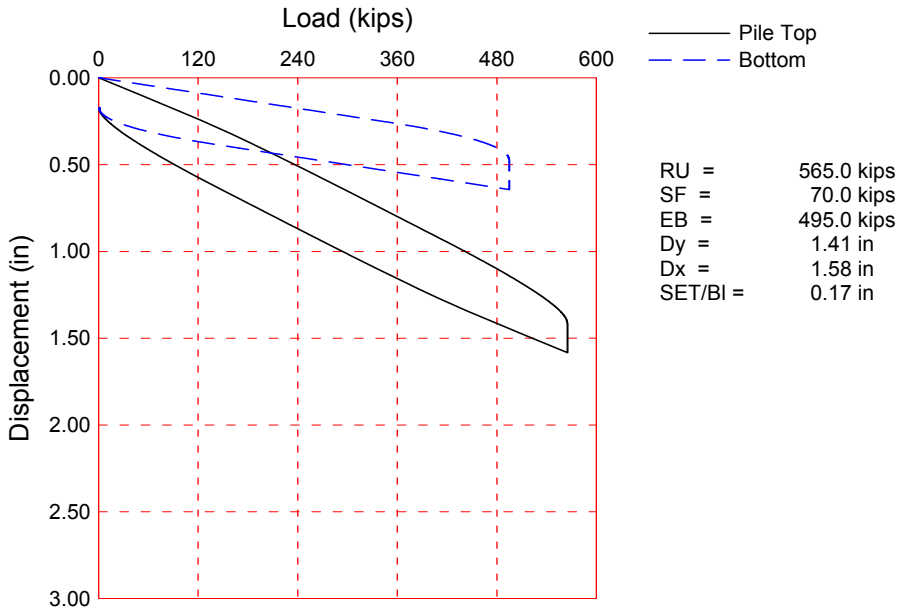
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
10	33.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
11	36.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
18	59.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
19	62.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
26	85.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
27	89.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.025
28	92.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.050

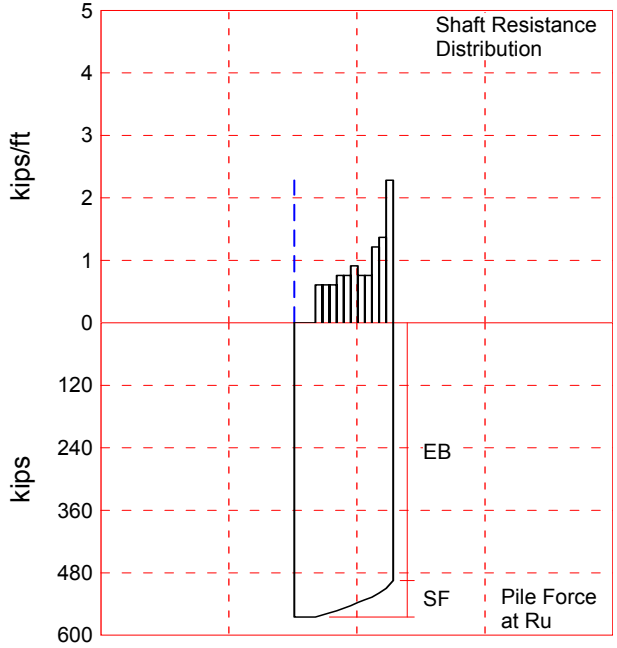
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.735 ft^3; Volume ratio considering added impedance: 1.000







RU =	565.0 kips
SF =	70.0 kips
EB =	495.0 kips
Dy =	1.41 in
Dx =	1.58 in
SET/BI =	0.17 in



Length b. Sensors	92.0 ft
Embedment	89.8 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	2.60
Top Compr. Stress	29.2 ksi
Max Compr. Stress	30.1 ksi
Max Tension Stress	-4.73 ksi
Avg. Shaft Quake	0.16 in
Toe Quake	0.36 in
Avg. Shaft Smith Dpg.	0.23 s/ft
Toe Smith Damping	0.07 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: 565.0; along Shaft 70.0; at Toe 495.0 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
				565.0				
1	6.6	4.4	0.0	565.0	0.0	0.00	0.00	0.00
2	13.1	11.0	0.0	565.0	0.0	0.00	0.00	0.00
3	19.7	17.5	0.0	565.0	0.0	0.00	0.00	0.00
4	26.3	24.1	4.0	561.0	4.0	0.61	0.13	0.23
5	32.9	30.7	4.0	557.0	8.0	0.61	0.13	0.23
6	39.4	37.3	4.0	553.0	12.0	0.61	0.13	0.23
7	46.0	43.8	5.0	548.0	17.0	0.76	0.16	0.23
8	52.6	50.4	5.0	543.0	22.0	0.76	0.16	0.23
9	59.1	57.0	6.0	537.0	28.0	0.91	0.19	0.23
10	65.7	63.5	5.0	532.0	33.0	0.76	0.16	0.23
11	72.3	70.1	5.0	527.0	38.0	0.76	0.16	0.23
12	78.9	76.7	8.0	519.0	46.0	1.22	0.26	0.23
13	85.4	83.3	9.0	510.0	55.0	1.37	0.29	0.23
14	92.0	89.8	15.0	495.0	70.0	2.28	0.49	0.23
Avg. Shaft			5.0			0.78	0.17	0.23
Toe			495.0				359.09	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.16	0.36
Case Damping Factor		0.42	0.91
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	51	51
Unloading Level	(% of Ru)	75	
Soil Plug Weight	(kips)	0.040	

CAPWAP match quality = 2.60 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.17 in; Blow Count = 70 b/ft
Computed: Final Set = 0.19 in; Blow Count = 62 b/ft

max. Top Comp. Stress = 29.2 ksi (T= 26.8 ms, max= 1.030 x Top)
max. Comp. Stress = 30.1 ksi (Z= 23.0 ft, T= 28.0 ms)
max. Tens. Stress = -4.73 ksi (Z= 72.3 ft, T= 53.8 ms)
max. Energy (EMX) = 34.1 kip-ft; max. Measured Top Displ. (DMX)= 1.05 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	626.0	-29.5	29.2	-1.38	34.1	15.7	1.07
2	6.6	626.7	-31.2	29.3	-1.46	34.1	15.6	1.06
4	13.1	628.3	-36.1	29.4	-1.69	33.7	15.6	1.03
6	19.7	643.8	-40.6	30.1	-1.90	33.2	15.2	0.99
8	26.3	640.5	-50.0	29.9	-2.33	32.6	15.2	0.95
10	32.9	631.3	-63.6	29.5	-2.97	31.0	15.0	0.90
12	39.4	622.9	-75.9	29.1	-3.54	29.4	14.7	0.86
14	46.0	617.1	-75.8	28.8	-3.54	27.6	14.4	0.81
15	49.3	610.7	-71.3	28.5	-3.33	26.1	14.0	0.78
16	52.6	613.4	-71.2	28.7	-3.33	25.7	13.9	0.75
17	55.9	591.5	-72.3	27.6	-3.38	24.2	13.9	0.72
18	59.1	595.8	-82.6	27.8	-3.86	23.6	13.8	0.69
19	62.4	576.9	-84.3	27.0	-3.94	22.0	13.6	0.66
20	65.7	581.6	-94.0	27.2	-4.39	21.4	13.5	0.63
21	69.0	567.3	-96.6	26.5	-4.51	20.0	13.4	0.60
22	72.3	572.9	-101.2	26.8	-4.73	19.4	13.2	0.57
23	75.6	561.7	-95.8	26.2	-4.48	18.0	13.0	0.54
24	78.9	568.8	-95.9	26.6	-4.48	17.3	13.8	0.51
25	82.1	550.3	-86.9	25.7	-4.06	15.6	15.2	0.48
26	85.4	586.6	-86.9	27.4	-4.06	14.9	16.5	0.44
27	88.7	587.9	-76.8	27.5	-3.59	13.2	16.9	0.41
28	92.0	603.0	-76.8	28.2	-3.59	12.1	15.6	0.38
Absolute	23.0			30.1			(T =	28.0 ms)
	72.3				-4.73		(T =	53.8 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	583.7	522.7	461.8	400.8	339.8	278.8	217.8	156.9	95.9	34.9
RX	704.3	684.1	663.8	646.3	629.2	613.9	600.7	587.6	574.4	561.3
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RAU = 426.9 (kips); RA2 = 634.9 (kips)

Current CAPWAP Ru = 565.0 (kips); Corresponding J(RP)= 0.06; J(RX) = 1.74

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
15.4	26.59	587.6	636.4	636.4	1.05	0.17	0.17	34.0	670.1	1364

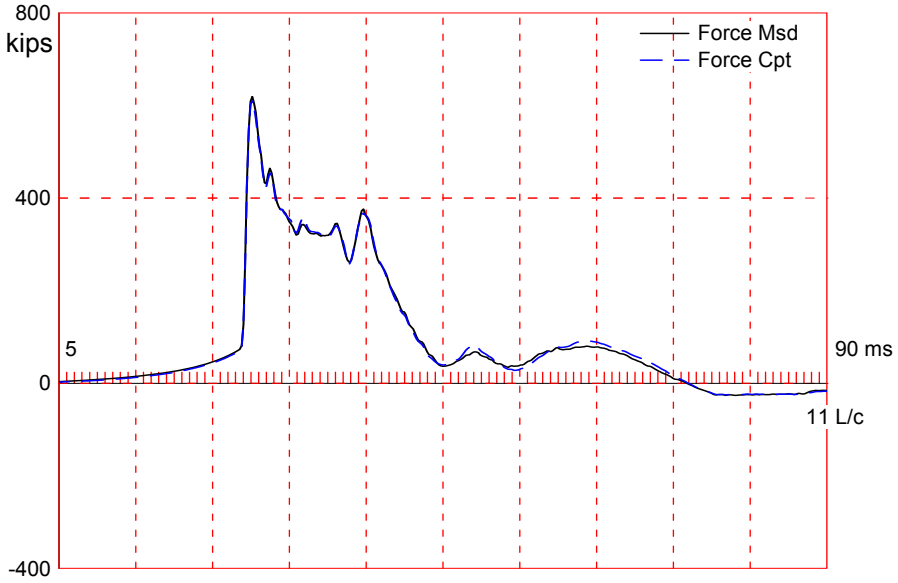
PILE PROFILE AND PILE MODEL

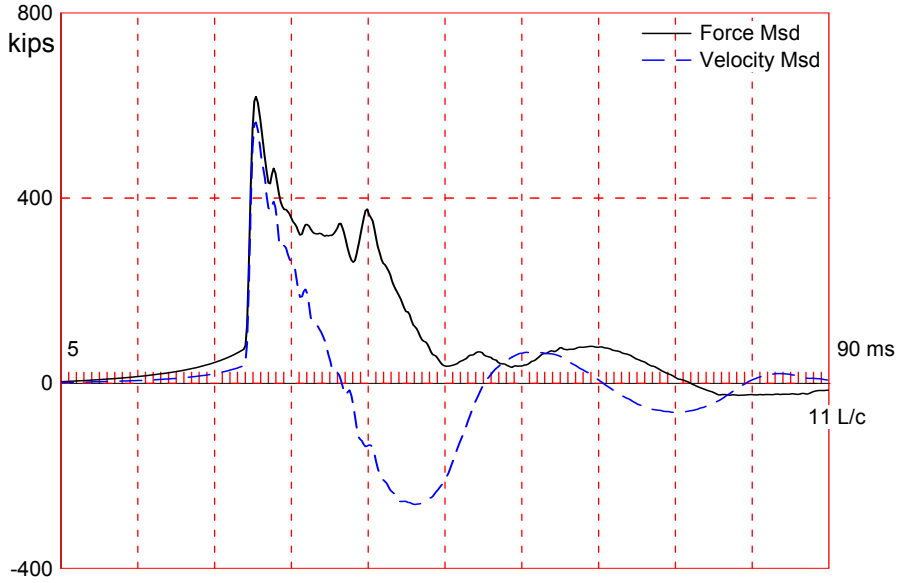
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.0	21.4	29992.2	492.000	4.70

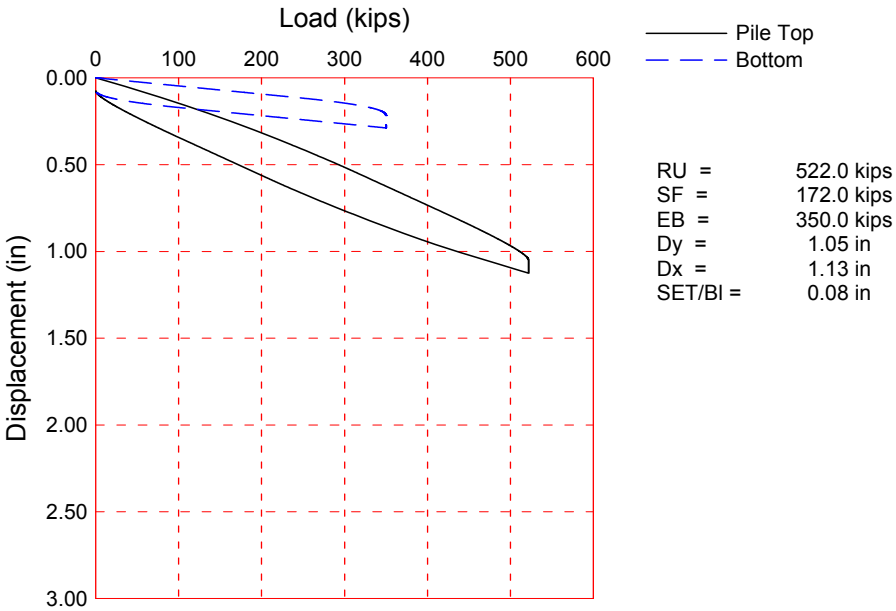
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
8	26.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
9	29.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
17	55.9	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
18	59.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

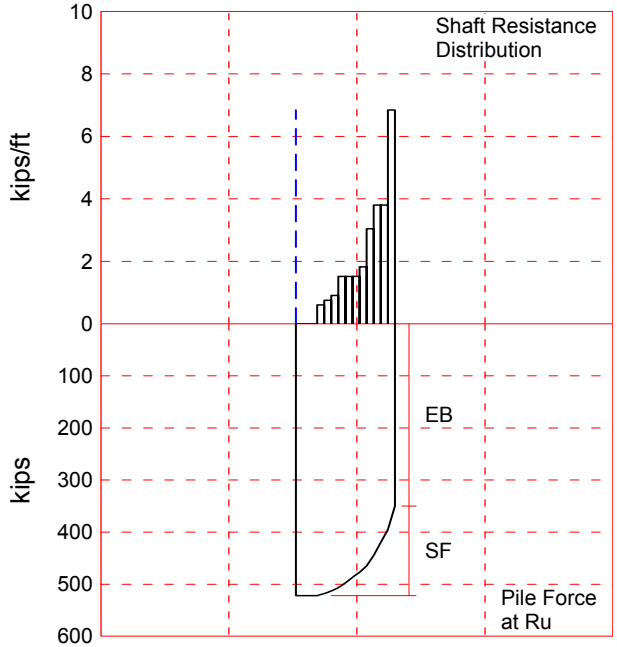
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.195 ms, 2L/c 10.9 ms
Total volume: 13.672 ft^3; Volume ratio considering added impedance: 1.000







RU =	522.0 kips
SF =	172.0 kips
EB =	350.0 kips
Dy =	1.05 in
Dx =	1.13 in
SET/Bl =	0.08 in



Length b. Sensors	92.0 ft
Embedment	89.9 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	1.56
Top Compr. Stress	28.5 ksi
Max Compr. Stress	29.6 ksi
Max Tension Stress	-3.84 ksi
Avg. Shaft Quake	0.07 in
Toe Quake	0.16 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.08 s/ft

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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: 522.0; along Shaft 172.0; at Toe 350.0 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
				522.0					
1	6.6	4.4	0.0	522.0	0.0	0.00	0.00	0.00	0.08
2	13.1	11.0	0.0	522.0	0.0	0.00	0.00	0.00	0.08
3	19.7	17.6	0.0	522.0	0.0	0.00	0.00	0.00	0.08
4	26.3	24.1	4.0	518.0	4.0	0.61	0.13	0.30	0.08
5	32.9	30.7	5.0	513.0	9.0	0.76	0.16	0.30	0.08
6	39.4	37.3	6.0	507.0	15.0	0.91	0.19	0.30	0.08
7	46.0	43.9	10.0	497.0	25.0	1.52	0.32	0.30	0.08
8	52.6	50.4	10.0	487.0	35.0	1.52	0.32	0.30	0.08
9	59.1	57.0	10.0	477.0	45.0	1.52	0.32	0.30	0.08
10	65.7	63.6	12.0	465.0	57.0	1.83	0.39	0.30	0.08
11	72.3	70.1	20.0	445.0	77.0	3.04	0.65	0.30	0.08
12	78.9	76.7	25.0	420.0	102.0	3.80	0.81	0.30	0.08
13	85.4	83.3	25.0	395.0	127.0	3.80	0.81	0.30	0.07
14	92.0	89.9	45.0	350.0	172.0	6.85	1.46	0.30	0.05
Avg. Shaft			12.3			1.91	0.41	0.30	0.07
Toe			350.0				253.90	0.08	0.16

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		1.35	0.77
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	96	30
Reloading Level	(% of Ru)	-100	100
Unloading Level	(% of Ru)	25	
Resistance Gap (included in Toe Quake)	(in)		0.00
Soil Plug Weight	(kips)	0.040	0.005

CAPWAP match quality = 1.56 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.08 in; Blow Count = 151 b/ft
Transducer F3(F607) CAL: 93.6; RF: 0.98; F4(D815) CAL: 93.0; RF: 0.98
A3(K2524) CAL: 360; RF: 1.09; A4(K3550) CAL: 360; RF: 1.09

max. Top Comp. Stress = 28.5 ksi (T= 26.8 ms, max= 1.036 x Top)
max. Comp. Stress = 29.6 ksi (Z= 23.0 ft, T= 28.0 ms)
max. Tens. Stress = -3.84 ksi (Z= 65.7 ft, T= 51.6 ms)
max. Energy (EMX) = 29.5 kip-ft; max. Measured Top Displ. (DMX)= 0.88 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	611.0	-27.4	28.5	-1.28	29.5	15.0	0.88
2	6.6	612.0	-29.9	28.6	-1.40	29.2	15.0	0.86
4	13.1	614.3	-34.7	28.7	-1.62	28.7	14.9	0.82
6	19.7	630.7	-39.5	29.5	-1.84	28.0	14.4	0.78
8	26.3	630.4	-43.5	29.5	-2.03	27.3	14.4	0.73
10	32.9	623.0	-45.8	29.1	-2.14	25.7	14.1	0.68
12	39.4	614.0	-47.6	28.7	-2.22	23.8	13.6	0.63
14	46.0	607.4	-59.2	28.4	-2.77	21.8	13.0	0.58
15	49.3	579.1	-59.4	27.1	-2.77	19.8	12.4	0.55
16	52.6	586.2	-67.8	27.4	-3.17	19.2	12.2	0.52
17	55.9	544.9	-67.8	25.5	-3.17	17.3	12.1	0.49
18	59.1	555.6	-75.3	26.0	-3.52	16.7	11.8	0.46
19	62.4	524.4	-76.1	24.5	-3.56	15.0	11.5	0.43
20	65.7	541.8	-82.1	25.3	-3.84	14.5	11.1	0.40
21	69.0	510.0	-79.4	23.8	-3.71	12.8	10.6	0.38
22	72.3	530.3	-81.1	24.8	-3.79	12.2	10.1	0.35
23	75.6	473.3	-71.8	22.1	-3.36	10.1	9.5	0.32
24	78.9	493.5	-73.4	23.1	-3.43	9.6	9.0	0.29
25	82.1	465.5	-62.1	21.7	-2.90	7.6	8.5	0.26
26	85.4	482.2	-62.6	22.5	-2.92	7.1	9.3	0.24
27	88.7	453.7	-50.1	21.2	-2.34	5.5	9.5	0.21
28	92.0	462.4	-50.2	21.6	-2.35	3.9	8.3	0.19
Absolute	23.0			29.6			(T =	28.0 ms)
	65.7				-3.84		(T =	51.6 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	765.4	728.4	691.3	654.3	617.3	580.3	543.3	506.3	469.3	432.3
RX	765.4	728.4	693.8	660.9	627.9	604.7	585.1	568.3	551.5	534.6
RU	798.8	727.7	656.7	585.6	514.6	443.5	372.5	301.5	230.4	159.4

RAU = 198.2 (kips); RA2 = 557.5 (kips)

Current CAPWAP Ru = 522.0 (kips); Corresponding J(RP)= 1.32; J(RX) = 1.96

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
14.8	26.78	547.4	606.5	619.3	0.88	0.08	0.08	29.8	745.0	2146

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
92.0	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.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
8	26.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
9	29.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
17	55.9	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
18	59.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.0	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 0.195 ms, 2L/c 10.9 ms
Total volume: 13.672 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Travis Coleman
Company: Lunda Construction Co.	No. of Sheets: 53
E-mail: kweber@lundaconstruction.com	Date: February 5, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 8
Winnebago County, Wisconsin

On February 3, 2014, Pier 8 #1, Pier 8 #36, and Pier 8 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on February 4. 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 elevation for the piles was the top of the ring at EL 740.7. We understand the pier was excavated to approximately EL 718. The piles have a required minimum tip elevation of EL 664.0. 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 8 #1 was driven to a depth of 83.5 feet, which corresponds to a pile tip elevation of EL 657.3. The blow count over the final increment of driving was 10 blows for 1⅞ inches of penetration at an average hammer stroke of 7.7 feet. The blow count at the beginning of restrike was 5 blows for ⅝ inch of penetration at an average hammer stroke of 7.5 feet.

Pier 8 #36 was driven to a depth of 81.3 feet, which corresponds to a pile tip elevation of EL 659.5. The blow count over the final increment of driving was 10 blows for 2 inches of penetration at an average hammer stroke of 7.0 feet. The blow count at the beginning of restrike was 5 blows for ⅝ inches of penetration at an average hammer stroke of 6.8 feet

Pier 8 #44 was driven to a depth of 83.0 feet, which corresponds to a pile tip elevation of EL 657.8. The blow count over the final increment of driving was 10 blows for 1⅛ inches of penetration at an average hammer stroke of 7.7 feet. The blow count at the beginning of restrike was 5 blows per ¼ inch of penetration at an average hammer stroke of 7.2 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 8 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)
6.0	16	8
6.5	12	6
7.0	9	6
7.5	8	5
8.0	7	4
8.5	6	4

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 or greater, after satisfying the plan minimum tip requirements. We anticipate the production piles will terminate at depths similar to those of the test piles.

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.

Travis Coleman, P.E.

Rory Flynn, E.I.

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

Attachments:

Dynamic Test Results - (pages 3 – 26)
CAPWAP Analysis Results - (pages 27 – 53)

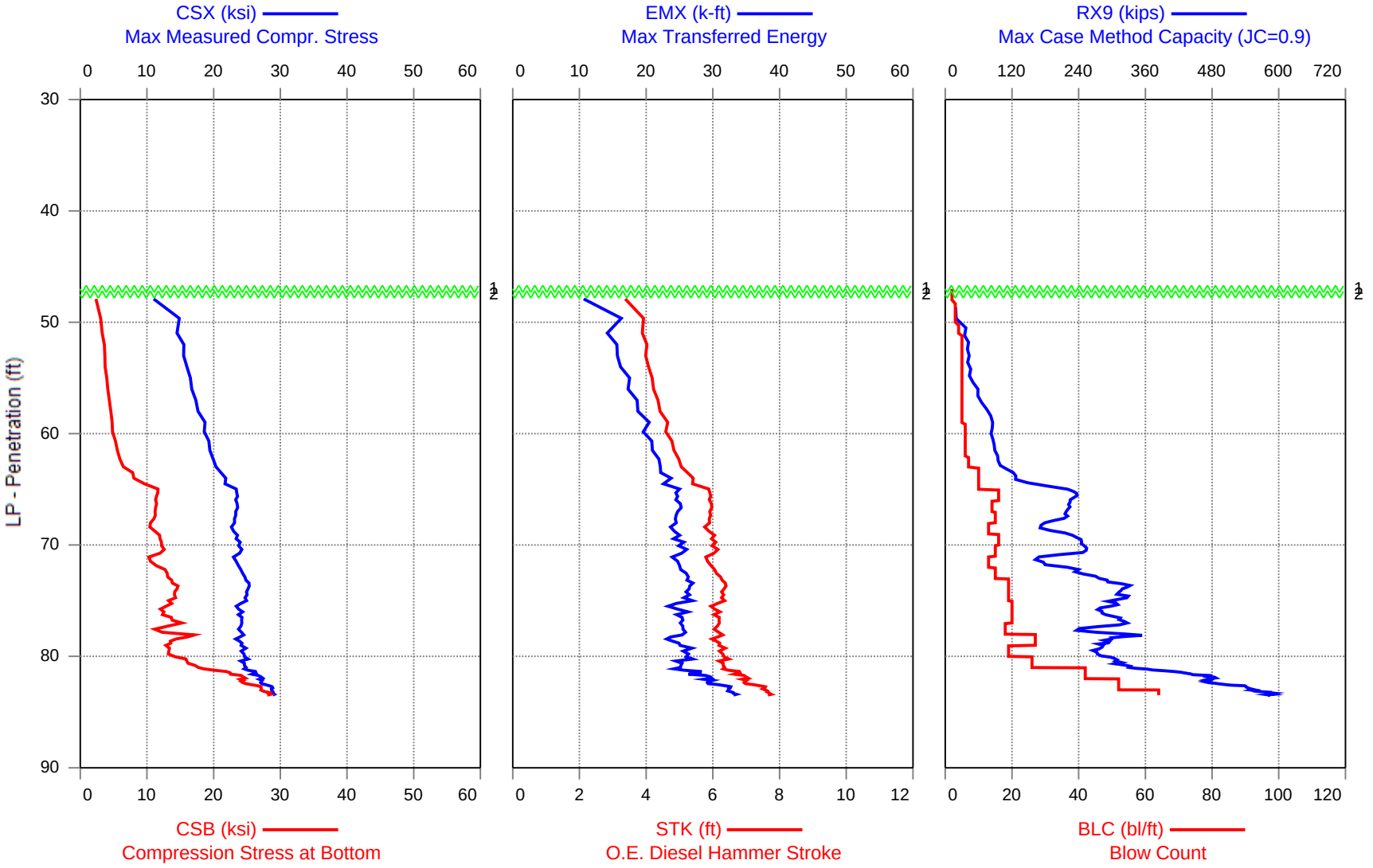
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 03-February-2015

Test started: 03-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #1

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.8

2 - Mud Line at EL 718.2

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #1 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 94.16 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
22	47.00	2	AV1	10.0	2.3	9	3.2	64.0	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	10.0	2.3	9	3.2	64.0	0
			MIN	10.0	2.3	9	3.2	64.0	0
23	47.50	2	AV1	9.0	1.9	8	3.1	65.1	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	9.0	1.9	8	3.1	65.1	0
			MIN	9.0	1.9	8	3.1	65.1	0
24	48.00	2	AV1	11.3	2.3	11	3.4	62.7	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	11.3	2.3	11	3.4	62.7	0
			MIN	11.3	2.3	11	3.4	62.7	0
25	48.33	3	AV1	13.5	2.8	14	3.7	60.4	22
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.5	2.8	14	3.7	60.4	22
			MIN	13.5	2.8	14	3.7	60.4	22
26	48.67	3	AV1	11.2	2.5	11	3.5	62.0	9
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	11.2	2.5	11	3.5	62.0	9
			MIN	11.2	2.5	11	3.5	62.0	9
27	49.00	3	AV1	13.2	2.5	14	3.8	59.2	25
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.2	2.5	14	3.8	59.2	25
			MIN	13.2	2.5	14	3.8	59.2	25
28	49.33	3	AV1	14.4	3.1	17	3.9	58.6	13
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	14.4	3.1	17	3.9	58.6	13
			MIN	14.4	3.1	17	3.9	58.6	13
29	49.67	3	AV1	15.7	3.2	18	4.0	58.2	12
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	15.7	3.2	18	4.0	58.2	12
			MIN	15.7	3.2	18	4.0	58.2	12
30	50.00	3	AV1	15.2	3.1	17	3.9	58.8	34
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	15.2	3.1	17	3.9	58.8	34
			MIN	15.2	3.1	17	3.9	58.8	34
31	50.25	4	AV1	15.7	3.5	17	4.0	58.1	39
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	15.7	3.5	17	4.0	58.1	39
			MIN	15.7	3.5	17	4.0	58.1	39
32	50.50	4	AV1	15.4	3.4	16	3.9	58.4	38
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	15.4	3.4	16	3.9	58.4	38
			MIN	15.4	3.4	16	3.9	58.4	38
33	50.75	4	AV1	14.9	3.3	15	4.0	57.9	34

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #1 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	14.9	3.3	15	4.0	57.9	34
			MIN	14.9	3.3	15	4.0	57.9	34
34	51.00	4	AV1	14.7	3.3	14	4.0	58.2	37
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	14.7	3.3	14	4.0	58.2	37
			MIN	14.7	3.3	14	4.0	58.2	37
35	51.20	5	AV1	13.6	3.2	12	3.7	60.1	34
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.6	3.2	12	3.7	60.1	34
			MIN	13.6	3.2	12	3.7	60.1	34
36	51.40	5	AV1	13.9	3.2	13	3.8	59.6	34
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.9	3.2	13	3.8	59.6	34
			MIN	13.9	3.2	13	3.8	59.6	34
39	52.00	5	AV3	15.8	3.7	16	4.1	57.5	42
			STD	0.7	0.2	1	0.2	1.2	3
			MAX	16.6	3.9	17	4.3	59.1	45
			MIN	14.8	3.4	15	3.8	56.3	38
44	53.00	5	AV5	15.5	3.7	16	4.0	58.2	42
			STD	0.6	0.2	1	0.1	0.8	4
			MAX	16.3	3.9	17	4.1	59.3	49
			MIN	14.7	3.3	14	3.8	57.2	38
49	54.00	5	AV5	15.7	3.7	16	4.0	57.9	40
			STD	0.5	0.1	1	0.1	0.5	2
			MAX	16.3	3.8	16	4.1	58.9	41
			MIN	14.9	3.6	15	3.9	57.3	38
54	55.00	5	AV5	16.2	3.9	17	4.1	57.2	45
			STD	0.4	0.1	1	0.1	0.4	4
			MAX	16.7	4.0	18	4.2	57.8	52
			MIN	15.6	3.8	16	4.0	56.6	41
59	56.00	5	AV5	16.8	4.1	18	4.2	56.5	54
			STD	0.6	0.1	1	0.1	0.6	5
			MAX	17.7	4.3	18	4.4	57.6	63
			MIN	15.9	4.0	16	4.1	55.6	48
64	57.00	5	AV5	17.0	4.2	18	4.3	56.2	59
			STD	0.4	0.1	1	0.1	0.5	5
			MAX	17.6	4.4	19	4.4	56.8	66
			MIN	16.5	4.1	17	4.2	55.3	52
69	58.00	5	AV5	17.5	4.5	18	4.4	55.6	72
			STD	0.5	0.1	1	0.1	0.6	5
			MAX	18.2	4.7	19	4.5	56.4	82
			MIN	16.8	4.4	17	4.3	54.9	68
74	59.00	5	AV5	18.2	4.7	20	4.5	54.7	83
			STD	0.4	0.2	1	0.1	0.5	2
			MAX	18.7	4.9	20	4.6	55.4	85
			MIN	17.9	4.4	19	4.4	54.1	78
80	60.00	6	AV6	18.7	4.8	20	4.6	54.2	84
			STD	0.5	0.2	1	0.1	0.6	2
			MAX	19.4	5.2	21	4.8	55.1	87
			MIN	18.0	4.6	19	4.5	53.5	82

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #1 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
86	61.00	6	AV6	19.2	5.2	21	4.7	53.6	86
			STD	0.4	0.1	1	0.1	0.5	3
			MAX	19.8	5.4	22	4.9	54.3	90
			MIN	18.6	4.9	19	4.6	52.9	83
92	62.00	6	AV6	19.4	5.6	21	4.8	53.2	90
			STD	0.5	0.2	1	0.1	0.6	3
			MAX	20.1	5.9	23	5.0	54.1	93
			MIN	18.5	5.3	19	4.6	52.1	85
99	63.00	7	AV7	20.2	6.2	22	5.0	52.1	97
			STD	0.3	0.2	1	0.1	0.3	4
			MAX	20.6	6.5	23	5.1	52.7	102
			MIN	19.6	5.9	21	4.9	51.7	89
109	64.00	10	AV10	21.2	7.7	23	5.3	51.0	121
			STD	0.7	0.8	1	0.2	0.9	8
			MAX	22.4	8.8	25	5.6	52.4	130
			MIN	20.2	6.5	21	5.0	49.6	103
119	65.00	10	AV10	22.2	9.8	23	5.5	49.9	168
			STD	1.0	1.5	2	0.3	1.2	34
			MAX	23.7	11.8	26	6.0	51.6	226
			MIN	20.7	7.8	20	5.1	48.0	124
135	66.00	16	AV16	23.4	11.5	25	5.9	48.3	231
			STD	0.3	0.2	1	0.1	0.3	6
			MAX	24.3	11.9	26	6.1	49.1	240
			MIN	22.7	10.9	23	5.7	47.7	223
149	67.00	14	AV14	23.5	11.4	25	6.0	48.1	222
			STD	0.2	0.2	1	0.1	0.2	4
			MAX	23.9	11.6	26	6.1	48.6	229
			MIN	23.1	11.1	24	5.8	47.7	213
164	68.00	15	AV15	23.2	11.0	24	5.9	48.3	207
			STD	0.5	0.3	1	0.1	0.5	16
			MAX	24.2	11.4	26	6.1	49.2	222
			MIN	22.4	10.3	23	5.7	47.4	176
177	69.00	13	AV13	23.0	10.8	24	5.9	48.5	187
			STD	0.5	0.5	1	0.1	0.6	18
			MAX	23.8	11.7	25	6.1	49.4	218
			MIN	22.0	10.3	23	5.6	47.6	166
193	70.00	16	AV16	23.7	12.1	25	6.0	47.9	241
			STD	0.4	0.2	1	0.1	0.4	7
			MAX	24.5	12.5	27	6.2	49.0	253
			MIN	22.6	11.7	23	5.7	47.1	226
208	71.00	15	AV15	23.9	12.1	25	6.0	47.8	237
			STD	0.5	0.7	1	0.1	0.5	26
			MAX	24.7	12.8	27	6.3	48.9	261
			MIN	22.7	10.5	24	5.8	46.9	173
221	72.00	13	AV13	23.4	10.7	25	5.9	48.5	178
			STD	0.6	0.7	1	0.2	0.7	19
			MAX	24.2	12.1	26	6.1	49.7	228
			MIN	22.2	9.9	23	5.6	47.6	158
236	73.00	15	AV15	24.4	12.9	26	6.1	47.5	250
			STD	0.4	0.4	1	0.1	0.4	18

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #1 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	25.2	14.0	28	6.4	48.0	282
			MIN	23.9	12.3	24	6.0	46.6	220
255	74.00	19	AV19	25.1	14.2	26	6.3	46.7	311
			STD	0.3	0.6	1	0.1	0.3	19
			MAX	25.5	14.9	27	6.5	47.4	340
			MIN	24.4	12.9	25	6.1	46.3	283
274	75.00	19	AV19	24.9	14.1	26	6.3	46.8	316
			STD	0.4	0.5	1	0.1	0.5	10
			MAX	26.1	14.8	29	6.7	47.7	331
			MIN	24.2	13.1	25	6.1	45.6	293
294	76.00	20	AV20	23.9	12.8	25	6.1	47.6	292
			STD	0.6	0.7	2	0.2	0.6	15
			MAX	25.0	14.4	28	6.4	48.5	320
			MIN	22.8	11.5	22	5.9	46.5	268
314	77.00	20	AV20	24.1	13.5	25	6.1	47.4	306
			STD	0.5	1.2	1	0.1	0.5	17
			MAX	25.2	15.9	27	6.5	48.4	329
			MIN	23.1	11.5	23	5.9	46.2	275
332	78.00	18	AV18	24.1	12.6	26	6.1	47.4	275
			STD	0.5	1.4	1	0.1	0.5	32
			MAX	24.6	15.3	28	6.3	48.3	325
			MIN	23.2	11.0	24	5.9	46.8	227
359	79.00	27	AV27	23.9	14.6	24	6.1	47.5	303
			STD	0.7	1.8	1	0.2	0.7	26
			MAX	25.6	18.2	28	6.6	48.9	358
			MIN	22.6	11.7	21	5.8	45.9	271
378	80.00	19	AV19	24.5	13.3	26	6.3	46.9	276
			STD	0.5	0.2	1	0.1	0.5	6
			MAX	25.2	13.9	28	6.5	48.2	284
			MIN	23.2	12.9	24	5.9	46.2	259
404	81.00	26	AV26	24.6	16.2	26	6.3	46.8	313
			STD	0.9	0.9	2	0.2	0.9	11
			MAX	26.0	18.2	28	6.7	48.9	337
			MIN	22.5	14.3	22	5.8	45.5	293
446	82.00	42	AV42	26.1	22.1	28	6.7	45.4	427
			STD	1.1	2.3	2	0.3	1.0	47
			MAX	27.8	25.2	31	7.4	48.1	492
			MIN	23.3	17.5	22	6.0	43.5	341
498	83.00	52	AV52	27.8	25.6	31	7.2	43.9	508
			STD	0.9	1.4	2	0.3	0.9	34
			MAX	29.8	28.0	35	7.9	45.7	564
			MIN	26.0	23.3	27	6.6	42.1	458
520	83.34	64	AV22	28.9	27.8	33	7.6	42.7	572
			STD	0.4	0.7	1	0.2	0.4	15
			MAX	29.3	28.9	34	7.9	43.7	598
			MIN	27.7	26.4	30	7.3	42.1	544
530	83.50	64	AV9	28.9	28.3	33	7.7	42.6	586
			STD	0.4	0.4	1	0.1	0.4	7
			MAX	29.5	28.8	34	7.9	43.1	598
			MIN	28.3	27.7	32	7.5	41.9	577
			Average	23.7	14.5	25	6.1	48.1	287

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #1 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			Std. Dev.	3.6	7.0	4	0.9	4.1	149
			Maximum	29.8	28.9	35	7.9	65.1	598
			Minimum	9.0	1.9	8	3.1	41.9	0

Total number of blows analyzed: 508

BL# Sensors

1-530 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

BL# Comments

22 Reported Reference EL 740.8
23 Mud Line at EL 718.2

Time Summary

Drive 12 minutes 14 seconds 12:31 PM - 12:43 PM BN 1 - 530

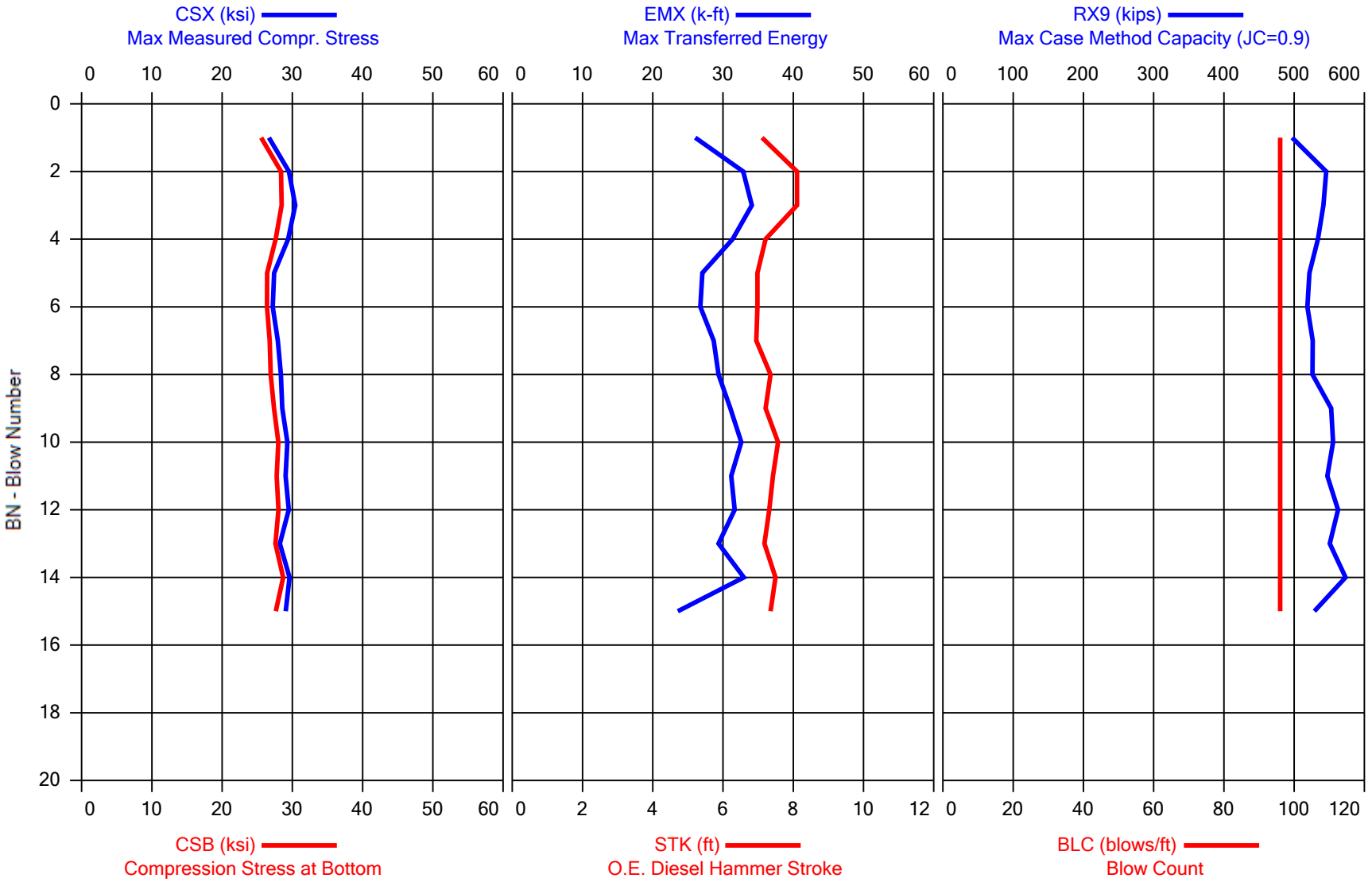
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 04-February-2015

Test started: 04-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #1 BOR

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #1 BOR APE D30-42, HP 14 x 73
OP: AM Date: 04-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 94.17 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
5	83.55	96	AV5	28.7	27.3	30	7.5	43.1	528
			STD	1.4	1.1	3	0.5	1.4	17
			MAX	30.4	28.5	34	8.1	44.6	546
			MIN	26.7	25.6	26	7.0	41.5	497
10	83.60	96	AV5	28.3	27.1	30	7.2	43.9	536
			STD	0.7	0.6	2	0.2	0.7	15
			MAX	29.3	28.0	33	7.6	44.7	555
			MIN	27.2	26.4	27	6.9	42.9	519
15	83.66	96	AV5	29.1	27.9	30	7.4	43.5	552
			STD	0.5	0.4	3	0.1	0.3	15
			MAX	29.6	28.7	33	7.5	44.0	573
			MIN	28.2	27.6	24	7.2	43.1	529
			Average	28.7	27.4	30	7.4	43.5	539
			Std. Dev.	1.0	0.8	3	0.3	0.9	19
			Maximum	30.4	28.7	34	8.1	44.7	573
			Minimum	26.7	25.6	24	6.9	41.5	497

Total number of blows analyzed: 15

BL# Sensors

1-15 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

Time Summary

Drive 19 seconds 7:59 AM - 7:59 AM BN 1 - 15

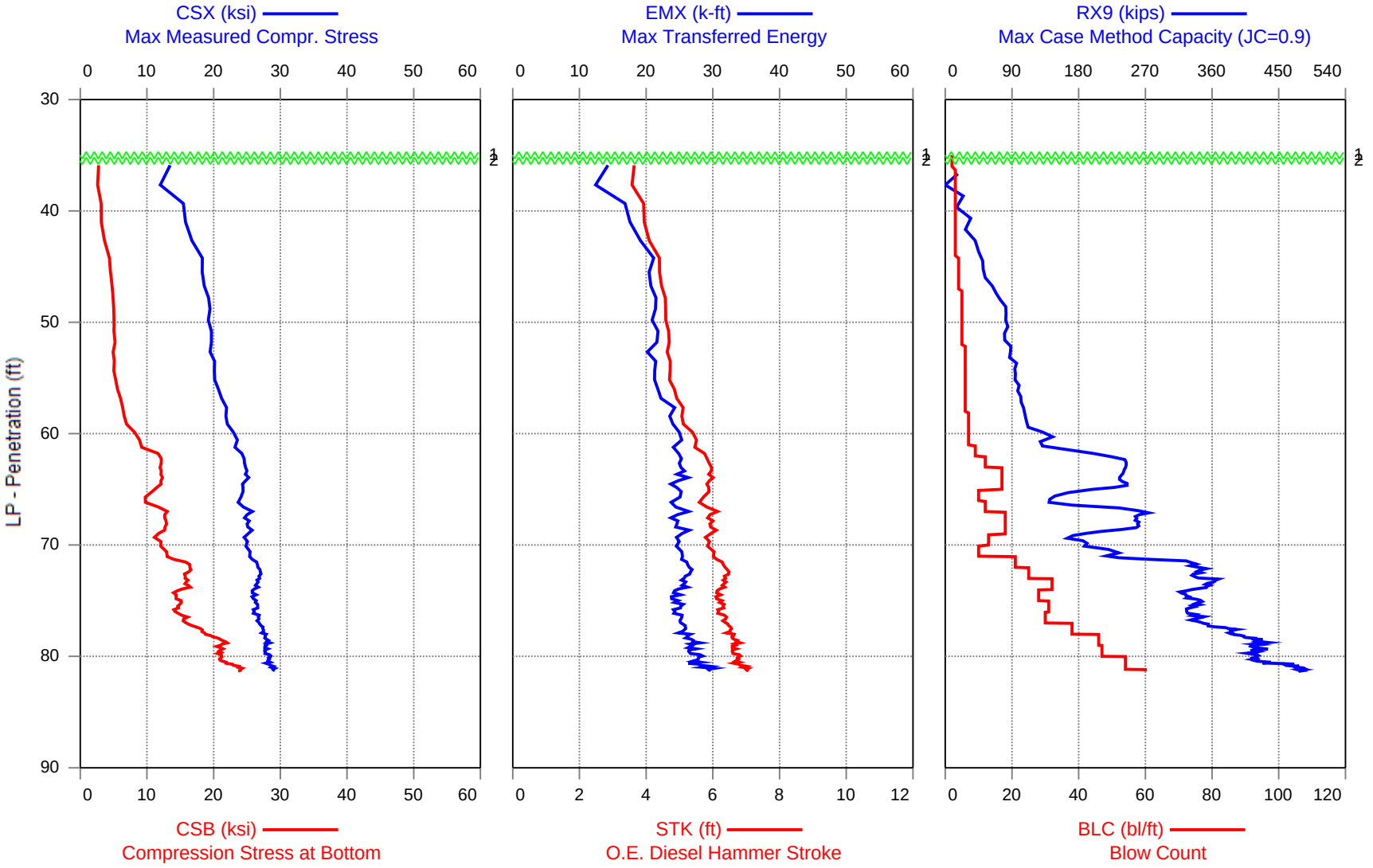
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 04-February-2015

Test started: 03-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #36

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.9

2 - Mud Line at EL 717.5

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #36 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 94.75 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
8	35.00	2	AV1	13.7	2.5	15	3.5	62.0	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.7	2.5	15	3.5	62.0	0
			MIN	13.7	2.5	15	3.5	62.0	0
9	35.50	2	AV1	11.1	2.3	11	3.4	62.8	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	11.1	2.3	11	3.4	62.8	0
			MIN	11.1	2.3	11	3.4	62.8	0
10	36.00	2	AV1	11.2	2.3	12	3.4	62.6	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	11.2	2.3	12	3.4	62.6	0
			MIN	11.2	2.3	12	3.4	62.6	0
11	36.33	3	AV1	15.0	3.3	17	3.9	58.5	22
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	15.0	3.3	17	3.9	58.5	22
			MIN	15.0	3.3	17	3.9	58.5	22
12	36.67	3	AV1	16.4	3.4	17	4.0	57.7	4
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	16.4	3.4	17	4.0	57.7	4
			MIN	16.4	3.4	17	4.0	57.7	4
13	37.00	3	AV1	13.3	2.8	12	3.6	60.8	25
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.3	2.8	12	3.6	60.8	25
			MIN	13.3	2.8	12	3.6	60.8	25
16	38.00	3	AV3	9.4	2.1	10	3.3	63.8	0
			STD	2.7	0.5	4	0.3	2.4	0
			MAX	13.2	2.9	16	3.7	65.8	0
			MIN	7.1	1.6	7	3.0	60.4	0
19	39.00	3	AV3	16.3	3.4	18	4.1	57.7	24
			STD	1.7	0.4	3	0.3	2.0	16
			MAX	18.4	3.8	21	4.5	60.0	40
			MIN	14.2	2.8	14	3.7	55.2	3
22	40.00	3	AV3	15.6	3.1	17	4.0	58.4	15
			STD	1.9	0.4	2	0.3	1.8	4
			MAX	17.2	3.5	19	4.2	60.9	19
			MIN	13.0	2.7	14	3.6	57.0	10
25	41.00	3	AV3	15.3	3.1	17	3.9	58.9	34
			STD	0.3	0.1	1	0.1	0.4	1
			MAX	15.6	3.2	18	3.9	59.5	35
			MIN	14.8	3.1	16	3.8	58.6	34
28	42.00	3	AV3	16.5	3.3	19	4.1	57.6	27
			STD	0.3	0.1	0	0.1	0.4	15
			MAX	16.8	3.4	19	4.1	58.1	42
			MIN	16.2	3.1	18	4.0	57.2	7
31	43.00	3	AV3	16.4	3.5	18	4.0	57.8	40

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #36 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.2	0.1	1	0.0	0.2	1
			MAX	16.7	3.7	19	4.1	58.0	41
			MIN	16.1	3.4	18	4.0	57.6	40
34	44.00	3	AV3	18.4	4.3	22	4.4	55.5	45
			STD	0.5	0.1	1	0.1	0.5	2
			MAX	18.9	4.4	24	4.5	56.0	47
			MIN	17.8	4.2	21	4.3	54.8	43
38	45.00	4	AV4	18.1	4.4	21	4.4	55.7	51
			STD	0.7	0.2	1	0.1	0.8	3
			MAX	18.9	4.8	22	4.5	57.0	54
			MIN	16.9	4.2	18	4.2	54.9	46
42	46.00	4	AV4	18.3	4.6	20	4.4	55.5	53
			STD	0.7	0.1	1	0.1	0.7	4
			MAX	19.1	4.7	22	4.5	56.4	60
			MIN	17.6	4.4	18	4.3	54.7	51
46	47.00	4	AV4	18.4	4.7	21	4.4	55.3	61
			STD	0.7	0.1	1	0.1	0.8	8
			MAX	19.0	4.9	22	4.5	56.7	69
			MIN	17.2	4.6	18	4.2	54.7	51
51	48.00	5	AV5	19.1	4.8	21	4.6	54.6	70
			STD	0.3	0.1	0	0.1	0.3	3
			MAX	19.5	5.0	22	4.6	55.1	74
			MIN	18.6	4.7	21	4.5	54.2	65
56	49.00	5	AV5	19.6	5.1	22	4.6	54.3	80
			STD	0.5	0.1	1	0.1	0.6	3
			MAX	20.0	5.3	23	4.7	55.3	85
			MIN	18.7	4.9	20	4.4	53.6	76
61	50.00	5	AV5	19.3	5.1	21	4.6	54.4	83
			STD	0.1	0.2	0	0.0	0.1	4
			MAX	19.4	5.4	22	4.6	54.6	88
			MIN	19.2	4.9	21	4.6	54.2	78
66	51.00	5	AV5	19.6	5.0	22	4.7	54.1	81
			STD	0.4	0.2	1	0.1	0.4	5
			MAX	20.0	5.5	23	4.8	54.7	89
			MIN	19.0	4.8	20	4.5	53.4	76
71	52.00	5	AV5	19.6	5.2	22	4.7	54.0	82
			STD	0.3	0.2	1	0.1	0.4	4
			MAX	20.1	5.5	23	4.8	54.3	87
			MIN	19.3	5.0	21	4.6	53.3	77
77	53.00	6	AV6	19.5	5.0	20	4.6	54.1	88
			STD	0.4	0.1	1	0.1	0.5	3
			MAX	20.1	5.2	22	4.8	55.0	91
			MIN	18.8	4.8	19	4.5	53.4	83
83	54.00	6	AV6	20.2	5.1	21	4.7	53.7	94
			STD	0.5	0.2	1	0.1	0.4	5
			MAX	20.6	5.5	22	4.8	54.2	99
			MIN	19.4	4.9	20	4.6	53.3	85
89	55.00	6	AV6	20.1	5.2	21	4.7	53.8	94
			STD	0.2	0.3	0	0.1	0.3	2
			MAX	20.5	5.8	22	4.8	54.1	95
			MIN	19.9	4.9	21	4.6	53.3	91

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #36 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
95	56.00	6	AV6	20.5	5.4	22	4.8	53.4	98
			STD	0.5	0.2	1	0.1	0.5	2
			MAX	21.2	5.8	22	4.9	54.2	100
			MIN	19.9	5.0	21	4.6	52.8	93
101	57.00	6	AV6	21.0	5.9	22	4.9	52.9	100
			STD	0.4	0.3	1	0.1	0.5	3
			MAX	21.5	6.3	23	5.0	53.8	105
			MIN	20.3	5.3	21	4.7	52.5	94
107	58.00	6	AV6	21.8	6.3	24	5.1	51.9	106
			STD	0.5	0.1	1	0.1	0.4	5
			MAX	22.5	6.5	25	5.2	52.6	110
			MIN	21.1	6.2	22	4.9	51.4	98
114	59.00	7	AV7	21.9	6.7	24	5.1	51.9	108
			STD	0.3	0.2	1	0.1	0.3	2
			MAX	22.3	7.2	25	5.2	52.3	112
			MIN	21.2	6.4	23	5.0	51.4	104
121	60.00	7	AV7	22.4	7.5	25	5.2	51.1	120
			STD	0.5	0.7	1	0.1	0.6	10
			MAX	23.4	8.9	26	5.5	52.1	136
			MIN	21.6	6.8	22	5.0	50.1	109
128	61.00	7	AV7	23.5	8.9	25	5.5	49.9	135
			STD	0.3	0.4	0	0.1	0.3	10
			MAX	24.0	9.5	26	5.6	50.3	150
			MIN	23.1	8.3	25	5.4	49.4	123
137	62.00	9	AV9	23.8	10.7	24	5.6	49.5	176
			STD	0.7	1.3	1	0.2	0.9	30
			MAX	24.8	12.0	26	5.9	51.4	221
			MIN	22.3	8.0	23	5.2	48.5	128
149	63.00	12	AV12	24.6	12.1	25	5.9	48.4	241
			STD	0.5	0.2	1	0.1	0.4	7
			MAX	25.5	12.4	27	6.0	49.5	248
			MIN	23.8	11.9	24	5.6	47.8	220
166	64.00	17	AV17	25.0	12.1	25	5.9	48.2	239
			STD	0.3	0.1	1	0.1	0.3	5
			MAX	25.7	12.3	27	6.1	48.8	247
			MIN	24.5	11.8	24	5.8	47.6	228
183	65.00	17	AV17	24.6	11.9	25	5.9	48.4	235
			STD	0.5	0.4	1	0.1	0.4	13
			MAX	25.7	12.5	27	6.1	48.8	249
			MIN	23.9	11.1	23	5.8	47.4	202
193	66.00	10	AV10	24.1	10.1	25	5.7	49.0	155
			STD	0.5	0.6	1	0.1	0.6	15
			MAX	24.7	10.9	27	6.0	50.2	181
			MIN	23.1	9.4	23	5.4	48.1	138
205	67.00	12	AV12	24.6	11.4	25	5.8	48.6	201
			STD	0.9	1.3	1	0.2	0.9	49
			MAX	26.0	13.2	27	6.2	49.7	267
			MIN	23.4	9.4	23	5.6	47.3	137
223	68.00	18	AV18	25.1	12.8	25	5.9	48.2	261
			STD	0.6	0.2	1	0.1	0.6	7

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #36 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	26.0	13.2	26	6.2	49.0	276
			MIN	24.2	12.3	22	5.7	47.2	250
241	69.00	18	AV18	25.3	12.5	25	6.0	48.0	236
			STD	0.4	0.4	1	0.1	0.4	28
			MAX	26.2	13.2	28	6.2	48.7	267
			MIN	24.7	11.5	24	5.8	47.1	187
254	70.00	13	AV13	24.8	11.6	25	5.8	48.6	179
			STD	0.5	0.5	1	0.1	0.6	12
			MAX	25.5	12.6	26	6.0	49.5	201
			MIN	24.0	10.8	23	5.6	47.9	161
264	71.00	10	AV10	25.3	12.7	25	6.0	47.9	217
			STD	0.3	0.4	1	0.1	0.3	18
			MAX	25.8	13.2	26	6.1	48.4	240
			MIN	24.9	12.0	24	5.9	47.4	183
285	72.00	21	AV21	26.2	15.2	26	6.2	47.1	305
			STD	0.5	1.3	1	0.1	0.5	42
			MAX	27.0	17.0	27	6.4	48.0	345
			MIN	25.3	12.8	24	6.0	46.5	219
310	73.00	25	AV25	26.9	16.0	26	6.4	46.4	341
			STD	0.4	0.6	1	0.1	0.4	6
			MAX	27.6	16.8	28	6.7	47.4	355
			MIN	26.0	14.7	25	6.1	45.6	329
342	74.00	32	AV32	26.5	16.0	26	6.3	46.8	355
			STD	0.3	0.5	1	0.1	0.4	10
			MAX	27.3	17.0	27	6.5	47.4	378
			MIN	25.8	15.1	24	6.1	46.0	333
370	75.00	28	AV28	26.0	14.5	24	6.2	47.3	328
			STD	0.5	0.5	1	0.1	0.5	9
			MAX	27.0	15.8	26	6.4	48.5	346
			MIN	25.1	13.4	22	5.9	46.5	315
401	76.00	31	AV31	26.3	14.6	25	6.2	47.1	334
			STD	0.6	0.5	1	0.2	0.6	8
			MAX	27.4	15.8	27	6.5	48.3	350
			MIN	25.3	13.7	23	5.9	46.1	317
431	77.00	30	AV30	26.6	15.4	25	6.3	46.8	338
			STD	0.6	0.6	1	0.2	0.6	8
			MAX	27.6	16.7	27	6.7	48.2	354
			MIN	24.9	14.3	22	5.9	45.5	322
469	78.00	38	AV38	27.3	17.6	26	6.5	46.2	374
			STD	0.5	1.0	1	0.1	0.5	15
			MAX	28.2	19.4	27	6.7	47.6	402
			MIN	26.3	15.7	23	6.1	45.4	348
515	79.00	46	AV46	28.0	20.8	27	6.7	45.6	415
			STD	0.5	0.9	1	0.2	0.5	13
			MAX	29.3	22.6	30	7.0	46.7	442
			MIN	27.0	18.8	25	6.3	44.4	382
562	80.00	47	AV47	27.9	21.0	27	6.6	45.7	418
			STD	0.6	0.4	1	0.2	0.6	8
			MAX	29.0	22.0	29	7.0	46.9	442
			MIN	26.7	19.9	24	6.3	44.5	403

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #36 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
625	81.17	54	AV63	28.5	22.3	28	6.8	45.1	446
			STD	0.6	1.3	1	0.2	0.6	27
			MAX	29.6	24.7	31	7.2	46.4	493
			MIN	27.1	20.0	25	6.4	44.0	405
635	81.33	60	AV10	28.8	23.8	29	7.0	44.6	480
			STD	0.3	0.3	1	0.1	0.3	7
			MAX	29.6	24.2	31	7.1	44.9	494
			MIN	28.3	23.0	28	6.9	44.1	471
			Average	25.2	14.4	25	6.0	48.3	288
			Std. Dev.	3.5	5.8	3	0.8	3.6	130
			Maximum	29.6	24.7	31	7.2	65.8	494
			Minimum	7.1	1.6	7	3.0	44.0	0

Total number of blows analyzed: 628

BL# Sensors

1-635 F3: [D815] 93.0 (0.97); F4: [F607] 93.6 (0.97); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

BL# Comments

8 Reported Reference EL 740.9
9 Mud Line at EL 717.5

Time Summary

Drive 14 minutes 13 seconds 11:59 AM - 12:13 PM BN 1 - 635

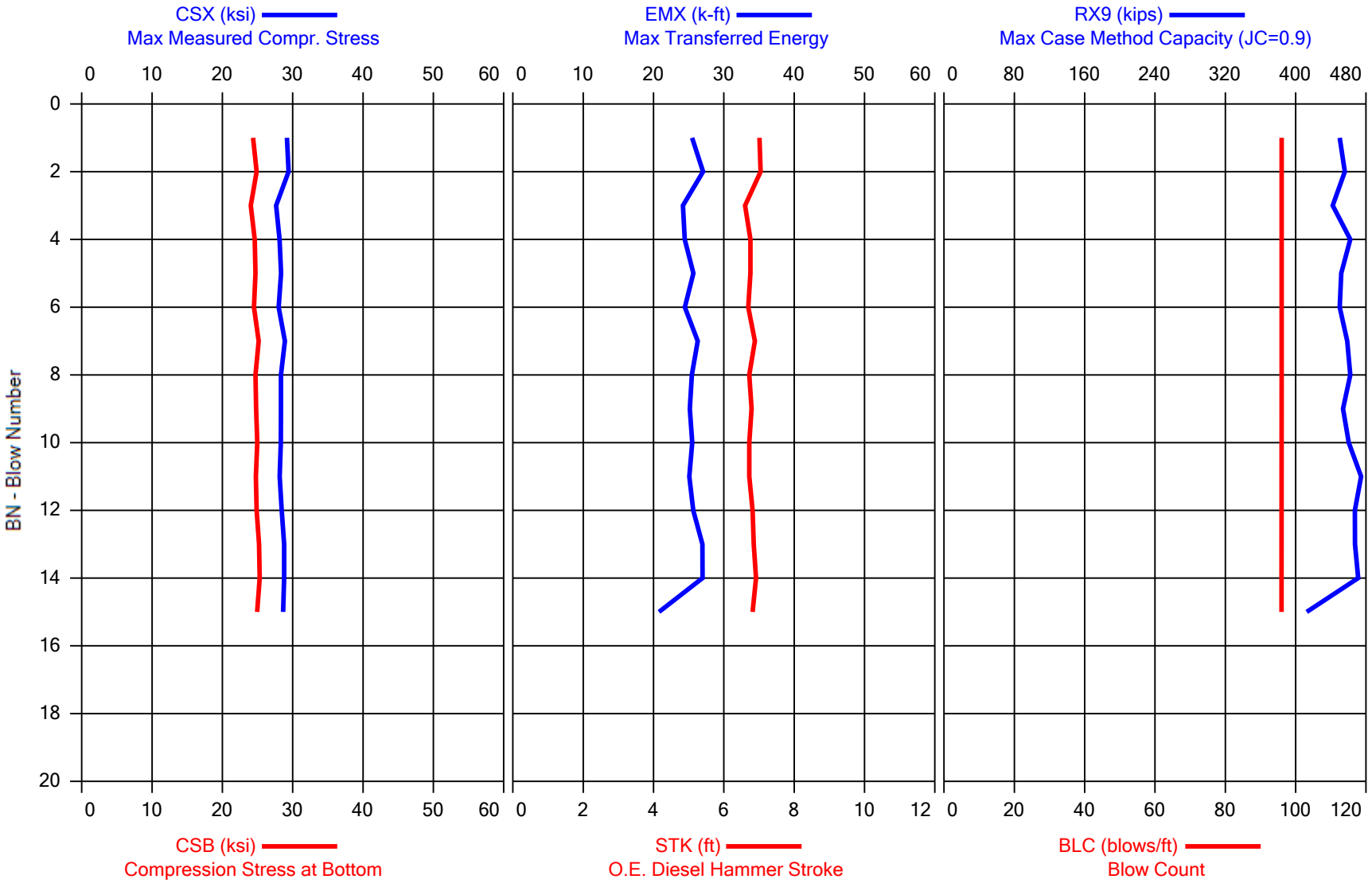
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 04-February-2015

Test started: 04-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #36 BOR

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #36 BOR APE D30-42, HP 14 x 73
OP: AM Date: 04-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 94.75 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
5	81.39	96	AV5	28.5	24.5	25	6.8	45.1	452
			STD	0.7	0.3	1	0.2	0.5	7
			MAX	29.4	24.9	27	7.0	45.8	462
			MIN	27.6	24.0	24	6.6	44.4	442
10	81.44	96	AV5	28.4	24.8	25	6.8	45.3	457
			STD	0.3	0.2	1	0.1	0.2	4
			MAX	28.9	25.2	26	6.9	45.5	462
			MIN	28.0	24.5	24	6.7	44.9	450
15	81.49	96	AV5	28.6	25.0	25	6.8	45.1	459
			STD	0.2	0.2	2	0.1	0.2	23
			MAX	28.8	25.3	27	6.9	45.4	474
			MIN	28.2	24.8	21	6.7	44.8	413
			Average	28.5	24.8	25	6.8	45.1	456
			Std. Dev.	0.4	0.3	1	0.1	0.4	14
			Maximum	29.4	25.3	27	7.0	45.8	474
			Minimum	27.6	24.0	21	6.6	44.4	413

Total number of blows analyzed: 15

BL# Sensors

1-15 F3: [F607] 93.6 (0.97); F4: [D815] 93.0 (0.97); A3: [K2524] 360.0 (1.10); A4: [K3550] 360.0 (1.10)

Time Summary

Drive 18 seconds 7:48 AM - 7:49 AM BN 1 - 15

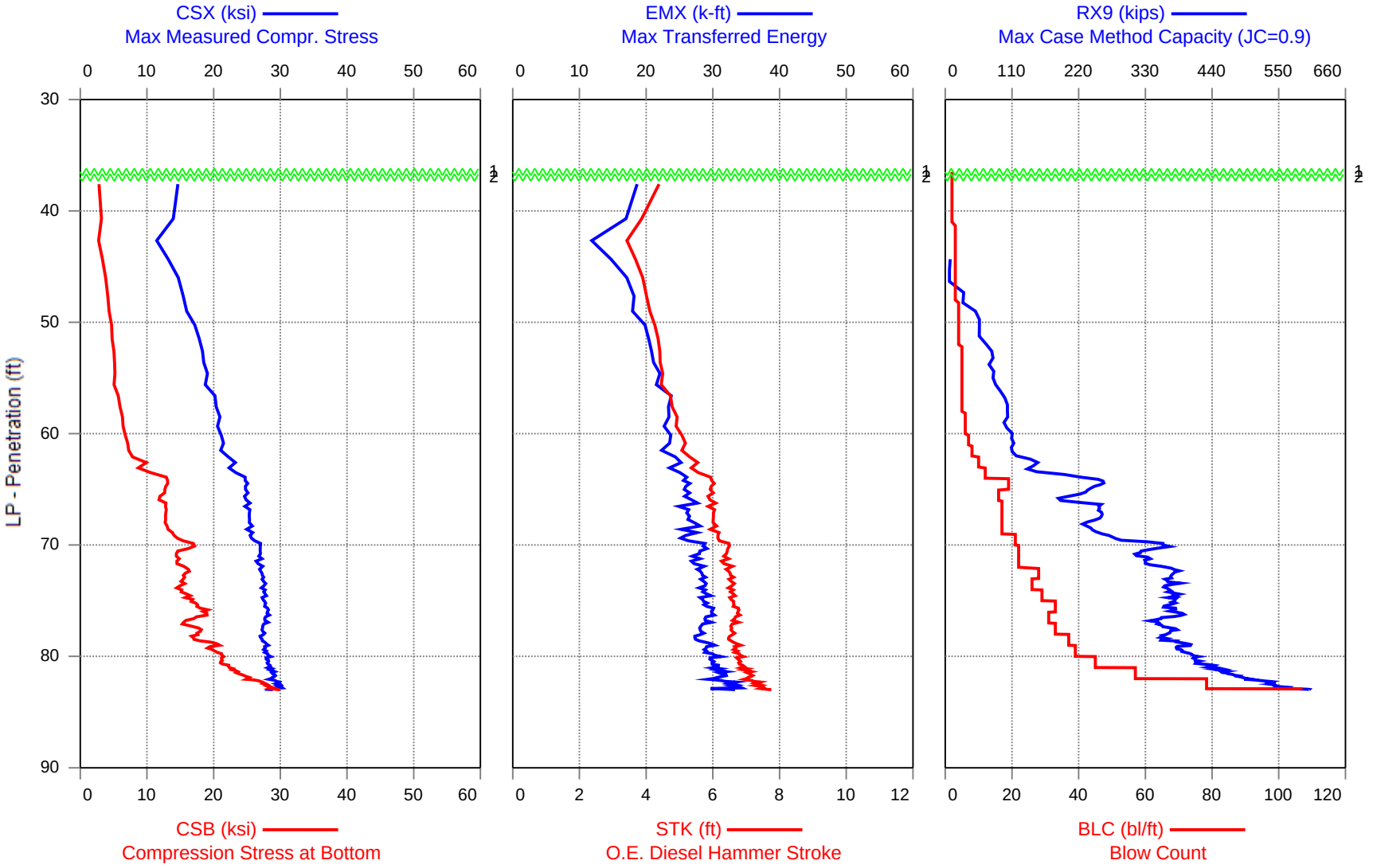
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 03-February-2015

Test started: 03-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #44

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.8

2 - Mud Line at EL 717.5

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #44 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.50 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
6	36.50	2	AV1	21.9	4.0	33	5.8	48.9	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	21.9	4.0	33	5.8	48.9	0
			MIN	21.9	4.0	33	5.8	48.9	0
7	37.00	2	AV1	17.1	3.7	21	4.3	55.8	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	17.1	3.7	21	4.3	55.8	0
			MIN	17.1	3.7	21	4.3	55.8	0
8	37.50	2	AV1	9.4	1.8	9	3.1	64.8	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	9.4	1.8	9	3.1	64.8	0
			MIN	9.4	1.8	9	3.1	64.8	0
9	38.00	2	AV1	1.7	0.2	0	2.8	67.8	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	1.7	0.2	0	2.8	67.8	0
			MIN	1.7	0.2	0	2.8	67.8	0
11	39.00	2	AV1	23.2	4.4	30	5.8	48.6	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	23.2	4.4	30	5.8	48.6	0
			MIN	23.2	4.4	30	5.8	48.6	0
12	39.50	2	AV1	16.3	4.1	22	4.1	57.4	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	16.3	4.1	22	4.1	57.4	0
			MIN	16.3	4.1	22	4.1	57.4	0
13	40.00	2	AV1	5.9	1.3	5	2.8	68.2	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	5.9	1.3	5	2.8	68.2	0
			MIN	5.9	1.3	5	2.8	68.2	0
15	41.00	2	AV1	17.8	3.7	25	4.6	54.5	0
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	17.8	3.7	25	4.6	54.5	0
			MIN	17.8	3.7	25	4.6	54.5	0
18	42.00	3	AV3	13.5	3.1	14	3.7	60.1	0
			STD	2.7	0.5	3	0.4	3.1	0
			MAX	17.2	3.8	19	4.3	63.0	0
			MIN	10.8	2.5	10	3.3	55.9	0
21	43.00	3	AV3	11.7	2.8	12	3.4	62.2	0
			STD	0.6	0.1	1	0.1	0.8	0
			MAX	12.4	2.9	13	3.6	63.1	0
			MIN	10.8	2.7	12	3.3	61.2	0
24	44.00	3	AV3	12.5	3.2	13	3.6	61.3	3
			STD	1.1	0.3	2	0.2	1.3	5
			MAX	14.0	3.5	16	3.8	62.4	10
			MIN	11.5	2.9	12	3.4	59.4	0
27	45.00	3	AV3	13.3	3.4	15	3.7	60.1	5

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #44 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.9	0.2	2	0.1	1.0	6
			MAX	14.3	3.7	18	3.9	61.4	14
			MIN	12.2	3.1	13	3.5	59.0	0
30	46.00	3	AV3	14.5	3.7	16	3.9	59.1	10
			STD	1.7	0.3	3	0.3	2.0	8
			MAX	16.2	4.0	20	4.1	61.8	21
			MIN	12.1	3.3	13	3.5	57.1	0
33	47.00	3	AV3	15.3	4.0	19	4.0	58.0	13
			STD	1.1	0.2	1	0.2	1.3	11
			MAX	16.2	4.2	20	4.2	59.8	26
			MIN	13.9	3.8	17	3.7	57.0	0
36	48.00	3	AV3	15.1	4.1	17	3.9	58.4	31
			STD	0.3	0.1	1	0.1	0.5	3
			MAX	15.6	4.3	19	4.0	58.9	35
			MIN	14.9	4.0	17	3.9	57.8	28
40	49.00	4	AV4	16.0	4.3	19	4.1	57.1	40
			STD	0.3	0.1	1	0.1	0.3	11
			MAX	16.5	4.4	20	4.2	57.5	51
			MIN	15.8	4.3	18	4.1	56.6	24
44	50.00	4	AV4	16.2	4.4	18	4.1	57.3	55
			STD	0.6	0.1	1	0.1	0.7	3
			MAX	17.3	4.6	19	4.3	57.8	59
			MIN	15.7	4.2	17	4.0	56.2	50
48	51.00	4	AV4	17.6	4.8	20	4.3	55.9	56
			STD	0.8	0.2	2	0.2	0.9	5
			MAX	18.3	5.0	23	4.5	57.5	62
			MIN	16.3	4.5	18	4.1	55.0	49
52	52.00	4	AV4	17.9	4.8	20	4.4	55.8	61
			STD	0.3	0.1	0	0.1	0.3	6
			MAX	18.1	5.0	21	4.4	56.2	71
			MIN	17.5	4.8	20	4.3	55.3	56
57	53.00	5	AV5	18.3	5.1	21	4.4	55.5	75
			STD	0.3	0.1	1	0.1	0.5	2
			MAX	18.8	5.1	22	4.5	56.1	78
			MIN	17.9	5.0	20	4.3	54.8	72
62	54.00	5	AV5	18.5	5.1	21	4.4	55.4	76
			STD	0.8	0.1	1	0.2	1.0	7
			MAX	19.5	5.3	23	4.6	56.8	82
			MIN	17.3	5.0	20	4.2	54.3	66
67	55.00	5	AV5	19.1	5.2	22	4.5	54.9	82
			STD	0.5	0.2	1	0.1	0.6	4
			MAX	19.7	5.4	23	4.6	55.9	86
			MIN	18.3	5.0	21	4.3	54.2	75
72	56.00	5	AV5	18.8	5.1	22	4.5	55.2	81
			STD	0.6	0.1	1	0.1	0.7	8
			MAX	19.3	5.2	22	4.6	56.4	88
			MIN	17.6	4.9	20	4.3	54.6	66
77	57.00	5	AV5	20.2	5.7	24	4.7	53.7	96
			STD	0.3	0.1	1	0.1	0.4	3
			MAX	20.7	5.8	25	4.8	54.1	99
			MIN	19.8	5.5	23	4.6	53.1	92

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #44 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
82	58.00	5	AV5	20.4	6.0	23	4.8	53.4	103
			STD	0.2	0.2	1	0.1	0.4	1
			MAX	20.7	6.3	24	4.9	54.0	104
			MIN	20.0	5.7	23	4.7	53.0	101
88	59.00	6	AV6	20.9	6.3	23	4.9	52.7	100
			STD	0.4	0.1	1	0.1	0.5	3
			MAX	21.6	6.5	25	5.1	53.1	105
			MIN	20.4	6.2	22	4.8	51.7	95
94	60.00	6	AV6	20.7	6.5	23	4.9	52.5	104
			STD	0.4	0.2	1	0.1	0.5	5
			MAX	21.4	6.8	26	5.1	53.2	113
			MIN	20.1	6.3	22	4.8	51.7	97
101	61.00	7	AV7	21.4	7.0	24	5.1	51.6	111
			STD	0.6	0.2	1	0.1	0.7	3
			MAX	22.2	7.2	26	5.4	52.6	117
			MIN	20.4	6.7	22	4.9	50.6	105
109	62.00	8	AV8	21.2	7.3	22	5.1	51.8	110
			STD	0.4	0.1	1	0.1	0.4	2
			MAX	21.9	7.6	24	5.2	52.4	113
			MIN	20.7	7.0	21	5.0	51.2	106
119	63.00	10	AV10	22.9	9.2	25	5.5	50.1	144
			STD	0.7	0.8	1	0.1	0.6	8
			MAX	23.7	10.2	27	5.6	50.9	155
			MIN	21.9	7.5	23	5.3	49.4	128
131	64.00	12	AV12	23.5	10.8	25	5.6	49.4	177
			STD	1.1	1.8	2	0.3	1.2	37
			MAX	25.1	13.0	27	6.0	51.2	233
			MIN	21.8	8.3	23	5.2	47.8	131
150	65.00	19	AV19	24.8	13.0	26	6.0	48.1	252
			STD	0.3	0.2	1	0.1	0.3	8
			MAX	25.4	13.3	28	6.1	48.6	265
			MIN	24.4	12.5	25	5.8	47.5	236
166	66.00	16	AV16	24.9	12.2	26	5.9	48.2	211
			STD	0.3	0.4	1	0.1	0.3	19
			MAX	25.5	13.0	29	6.1	48.9	235
			MIN	24.3	11.6	25	5.8	47.5	182
183	67.00	17	AV17	25.2	12.8	26	6.0	48.0	245
			STD	0.5	0.3	1	0.1	0.6	19
			MAX	25.7	13.2	28	6.2	49.7	262
			MIN	23.6	12.1	23	5.6	47.1	196
200	68.00	17	AV17	25.3	12.8	26	6.0	47.9	251
			STD	0.3	0.1	1	0.1	0.3	9
			MAX	25.8	13.0	28	6.1	48.5	261
			MIN	24.9	12.6	25	5.9	47.4	232
217	69.00	17	AV17	25.5	13.3	27	6.1	47.7	240
			STD	0.6	0.4	2	0.1	0.5	10
			MAX	26.5	14.2	29	6.3	48.6	260
			MIN	24.6	12.6	24	5.8	46.7	221
238	70.00	21	AV21	26.1	15.3	27	6.3	47.0	304
			STD	0.7	1.1	2	0.2	0.6	35

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #44 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	27.7	17.5	30	6.7	47.8	362
			MIN	25.2	13.9	24	6.0	45.6	264
260	71.00	22	AV22	27.0	15.4	28	6.4	46.4	335
			STD	0.3	1.3	1	0.1	0.3	24
			MAX	27.5	18.6	29	6.6	47.0	387
			MIN	26.5	13.9	26	6.3	45.9	303
282	72.00	22	AV22	26.9	14.8	28	6.4	46.5	339
			STD	0.5	0.7	1	0.2	0.6	16
			MAX	27.9	17.1	30	6.8	47.2	388
			MIN	26.1	13.6	26	6.2	45.2	312
310	73.00	28	AV26	27.2	15.9	28	6.5	46.1	375
			STD	0.3	0.5	1	0.1	0.4	7
			MAX	27.8	16.9	29	6.7	46.9	387
			MIN	26.4	14.8	27	6.3	45.4	364
336	74.00	26	AV26	27.5	15.1	29	6.5	46.0	368
			STD	0.3	0.6	1	0.1	0.3	9
			MAX	28.2	16.2	30	6.8	46.7	393
			MIN	26.8	13.9	27	6.3	45.3	357
365	75.00	29	AV29	27.6	15.9	29	6.6	45.9	377
			STD	0.4	0.8	1	0.1	0.3	6
			MAX	28.5	17.6	31	6.8	46.8	387
			MIN	26.6	14.3	27	6.3	45.1	364
398	76.00	33	AV33	27.9	17.8	29	6.7	45.5	373
			STD	0.3	1.0	1	0.1	0.3	8
			MAX	28.4	20.0	31	6.8	46.2	387
			MIN	27.2	16.0	27	6.5	45.0	358
429	77.00	31	AV31	27.9	17.3	29	6.7	45.5	367
			STD	0.3	1.5	1	0.1	0.3	20
			MAX	28.7	19.8	31	6.9	46.1	397
			MIN	27.3	14.9	28	6.5	44.8	331
462	78.00	33	AV31	27.4	17.3	28	6.6	45.9	367
			STD	0.4	1.1	1	0.1	0.4	10
			MAX	28.2	19.1	30	6.8	46.6	384
			MIN	26.5	14.6	27	6.4	45.1	344
499	79.00	37	AV37	27.4	18.3	28	6.6	45.9	373
			STD	0.5	1.6	1	0.1	0.5	19
			MAX	28.6	21.3	31	6.9	46.5	408
			MIN	26.6	16.0	26	6.4	44.7	349
538	80.00	39	AV39	27.9	20.3	29	6.7	45.4	394
			STD	0.4	0.9	1	0.1	0.4	12
			MAX	29.0	22.0	32	7.0	46.5	420
			MIN	26.7	18.8	28	6.4	44.4	374
583	81.00	45	AV45	28.2	21.5	30	6.8	45.1	421
			STD	0.4	0.6	1	0.1	0.4	13
			MAX	29.2	23.3	32	7.1	45.8	448
			MIN	27.3	20.2	29	6.6	44.2	407
640	82.00	57	AV57	28.8	23.9	31	7.1	44.4	468
			STD	0.4	0.9	1	0.1	0.4	16
			MAX	30.3	25.8	34	7.5	45.2	501
			MIN	27.9	22.0	29	6.8	43.2	440

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #44 APE D30-42, HP 14 x 73
OP: AM Date: 03-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
711	82.91	78	AV69	29.5	27.4	32	7.3	43.6	536
			STD	0.8	1.1	2	0.2	0.6	19
			MAX	30.9	29.3	36	7.7	45.0	568
			MIN	25.8	24.5	26	6.8	42.6	492
721	83.00	107	AV10	28.2	29.5	32	7.7	42.7	595
			STD	1.0	0.7	1	0.1	0.3	12
			MAX	29.4	30.4	34	7.8	43.1	612
			MIN	26.3	28.2	29	7.5	42.3	568
			Average	26.0	16.6	28	6.3	47.2	332
			Std. Dev.	3.9	6.7	4	0.9	4.0	143
			Maximum	30.9	30.4	36	7.8	68.2	612
			Minimum	1.7	0.2	0	2.8	42.3	0

Total number of blows analyzed: 708

BL# Sensors

1-721 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.07); A4: [K3550] 360.0 (1.07)

BL# Comments

6 Reported Reference EL 740.8
7 Mud Line at EL 717.5

Time Summary

Drive 18 minutes 12 seconds 11:23 AM - 11:41 AM BN 1 - 721

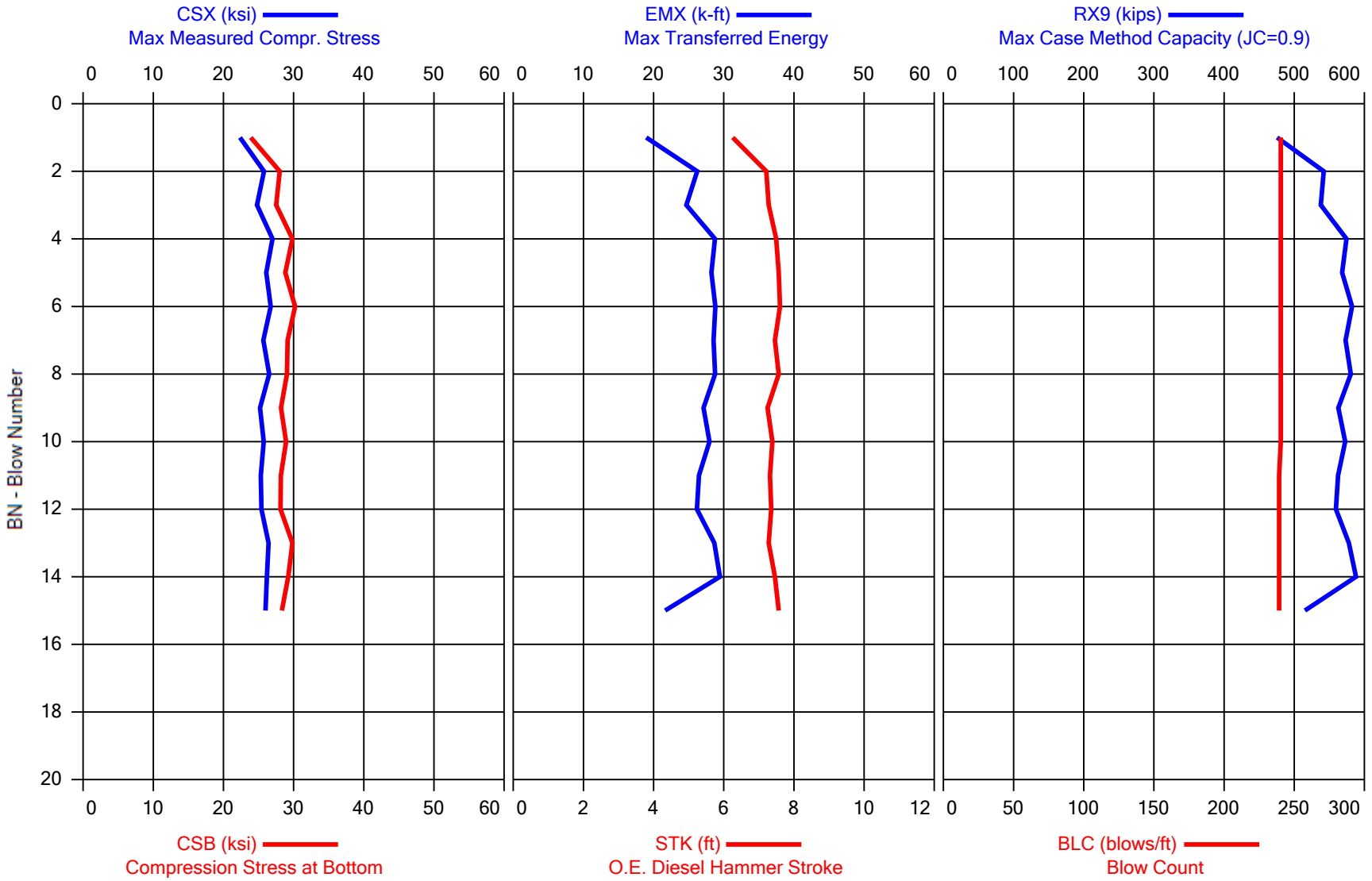
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 04-February-2015

Test started: 04-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #44 BOR

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 8 #44 BOR APE D30-42, HP 14 x 73
OP: AM Date: 04-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.50 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
5	83.02	240	AV5	25.2	27.6	25	7.2	44.1	540
			STD	1.6	2.0	4	0.5	1.5	35
			MAX	27.0	29.8	29	7.6	47.0	574
			MIN	22.4	23.9	19	6.3	42.9	475
10	83.04	240	AV5	26.0	29.1	28	7.5	43.2	574
			STD	0.6	0.6	1	0.1	0.4	7
			MAX	26.7	30.2	29	7.6	43.8	582
			MIN	25.2	28.2	27	7.2	42.8	563
15	83.06	239	AV5	25.9	28.7	26	7.4	43.4	561
			STD	0.4	0.7	3	0.1	0.3	25
			MAX	26.4	29.8	29	7.6	43.7	588
			MIN	25.3	28.1	22	7.3	42.9	515
			Average	25.7	28.5	27	7.3	43.6	558
			Std. Dev.	1.1	1.4	3	0.3	1.0	29
			Maximum	27.0	30.2	29	7.6	47.0	588
			Minimum	22.4	23.9	19	6.3	42.8	475

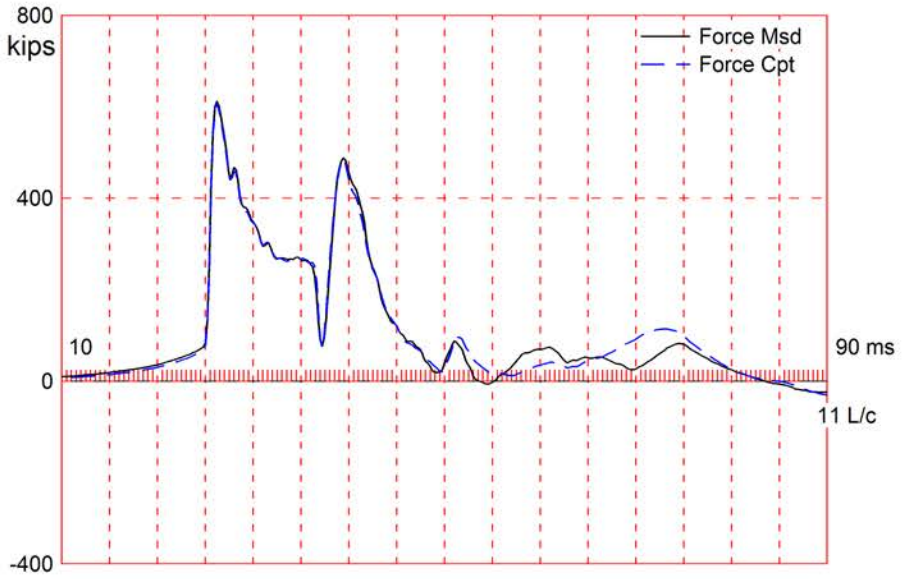
Total number of blows analyzed: 15

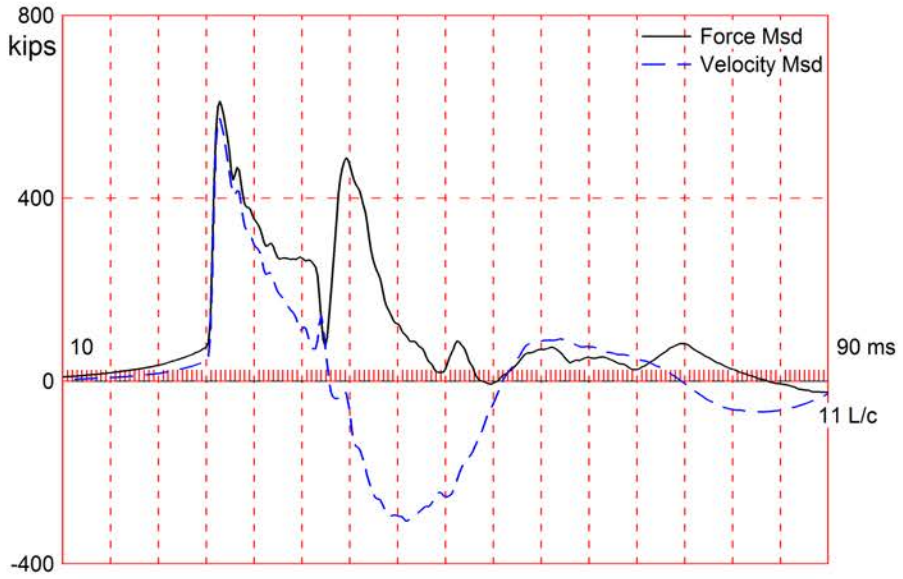
BL# Sensors

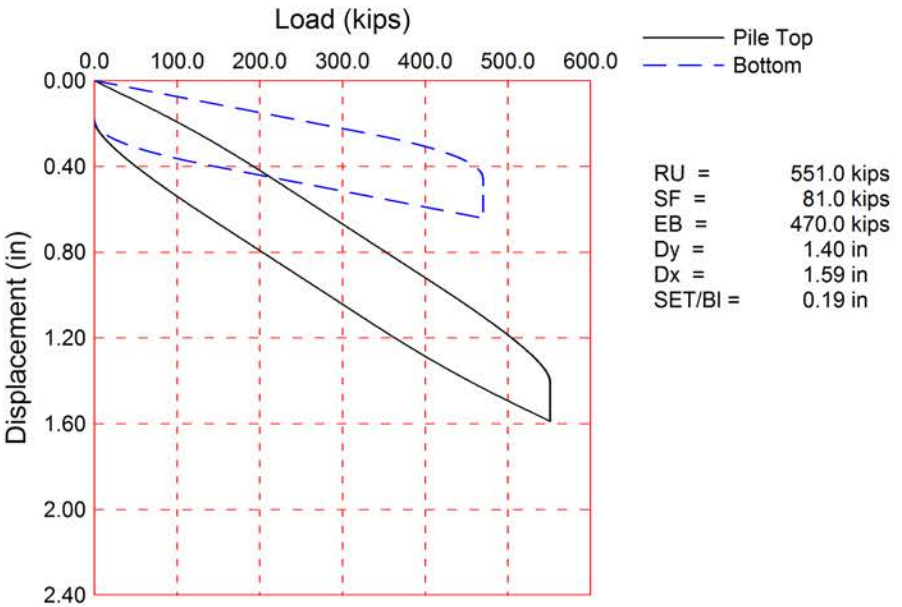
1-15 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.10); A4: [K3550] 360.0 (1.10)

Time Summary

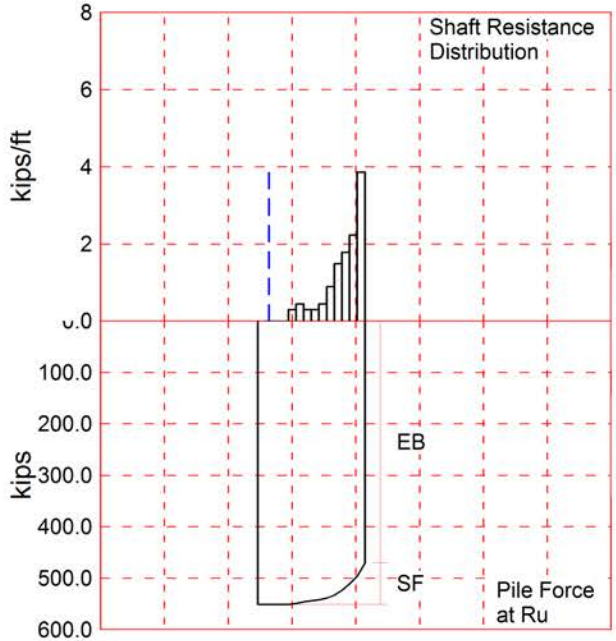
Drive 19 seconds 7:39 AM - 7:39 AM BN 1 - 15







RU =	551.0 kips
SF =	81.0 kips
EB =	470.0 kips
Dy =	1.40 in
Dx =	1.59 in
SET/Bl =	0.19 in



Length b. Sensors	94.2 ft
Embedment	83.5 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	4.96
Top Compr. Stress	28.3 ksi
Max Compr. Stress	28.9 ksi
Max Tension Stress	-6.43 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.35 in
Avg. Shaft Smith Dpg.	0.23 s/ft
Toe Smith Damping	0.07 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: 551.0; along Shaft 81.0; at Toe 470.0 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
				551.0				
1	13.5	2.8	0.0	551.0	0.0	0.00	0.00	0.00
2	20.2	9.5	0.0	551.0	0.0	0.00	0.00	0.00
3	26.9	16.2	0.0	551.0	0.0	0.00	0.00	0.00
4	33.6	22.9	2.0	549.0	2.0	0.30	0.06	0.23
5	40.4	29.7	3.0	546.0	5.0	0.45	0.09	0.23
6	47.1	36.4	2.0	544.0	7.0	0.30	0.06	0.23
7	53.8	43.1	2.0	542.0	9.0	0.30	0.06	0.23
8	60.5	49.8	3.0	539.0	12.0	0.45	0.09	0.23
9	67.3	56.6	6.0	533.0	18.0	0.89	0.19	0.23
10	74.0	63.3	10.0	523.0	28.0	1.49	0.32	0.23
11	80.7	70.0	12.0	511.0	40.0	1.78	0.38	0.23
12	87.4	76.7	15.0	496.0	55.0	2.23	0.47	0.23
13	94.2	83.5	26.0	470.0	81.0	3.87	0.82	0.23
Avg. Shaft			6.2			0.97	0.21	0.23
Toe			470.0				340.95	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.08	0.35
Case Damping Factor		0.49	0.86
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	60	51
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)		0.017

CAPWAP match quality = 4.96 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.19 in; Blow Count = 64 b/ft
Computed: Final Set = 0.15 in; Blow Count = 82 b/ft

max. Top Comp. Stress = 28.3 ksi (T= 26.6 ms, max= 1.021 x Top)
max. Comp. Stress = 28.9 ksi (Z= 33.6 ft, T= 28.4 ms)
max. Tens. Stress = -6.43 ksi (Z= 67.3 ft, T= 54.0 ms)
max. Energy (EMX) = 33.4 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	606.4	-36.3	28.3	-1.70	33.4	15.2	1.10
2	6.7	607.2	-37.2	28.4	-1.74	33.3	15.2	1.09
4	13.5	608.7	-40.9	28.4	-1.91	32.8	15.1	1.05
6	20.2	610.5	-54.9	28.5	-2.56	32.3	15.0	1.01
8	26.9	613.4	-72.9	28.7	-3.41	31.5	15.0	0.96
10	33.6	619.0	-92.0	28.9	-4.30	30.7	14.8	0.92
12	40.4	616.5	-104.6	28.8	-4.89	29.4	14.6	0.86
14	47.1	608.6	-105.0	28.4	-4.91	27.8	14.5	0.81
15	50.4	602.8	-102.5	28.2	-4.79	26.9	14.4	0.78
16	53.8	605.9	-104.7	28.3	-4.89	26.4	14.3	0.75
17	57.2	601.6	-112.6	28.1	-5.26	25.4	14.2	0.72
18	60.5	606.3	-123.0	28.3	-5.75	24.8	14.0	0.69
19	63.9	600.8	-128.6	28.1	-6.01	23.6	13.9	0.66
20	67.3	607.7	-137.7	28.4	-6.43	23.0	13.7	0.63
21	70.6	593.6	-135.7	27.7	-6.34	21.4	13.4	0.60
22	74.0	601.8	-137.3	28.1	-6.42	20.7	13.2	0.57
23	77.3	573.9	-124.0	26.8	-5.79	18.6	12.8	0.53
24	80.7	584.3	-124.2	27.3	-5.80	17.9	12.6	0.50
25	84.1	548.9	-108.0	25.6	-5.05	15.7	13.9	0.47
26	87.4	575.8	-108.1	26.9	-5.05	15.0	15.1	0.43
27	90.8	570.8	-88.3	26.7	-4.12	12.8	15.7	0.40
28	94.2	585.8	-88.4	27.4	-4.13	10.8	14.6	0.37
Absolute	33.6			28.9			(T =	28.4 ms)
	67.3				-6.43		(T =	54.0 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	595.3	535.6	475.9	416.2	356.5	296.8	237.0	177.3	117.6	57.9
RX	702.1	682.8	663.7	644.5	625.3	608.9	602.1	595.4	588.7	582.0
RU	595.3	535.6	475.9	416.2	356.5	296.8	237.0	177.3	117.6	57.9

RAU = 420.9 (kips); RA2 = 616.4 (kips)

Current CAPWAP Ru = 551.0 (kips); Corresponding J(RP)= 0.07;

RMX requires higher damping; see PDA-W

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
15.2	26.61	581.9	610.4	616.0	1.08	0.19	0.19	33.5	636.0	1382

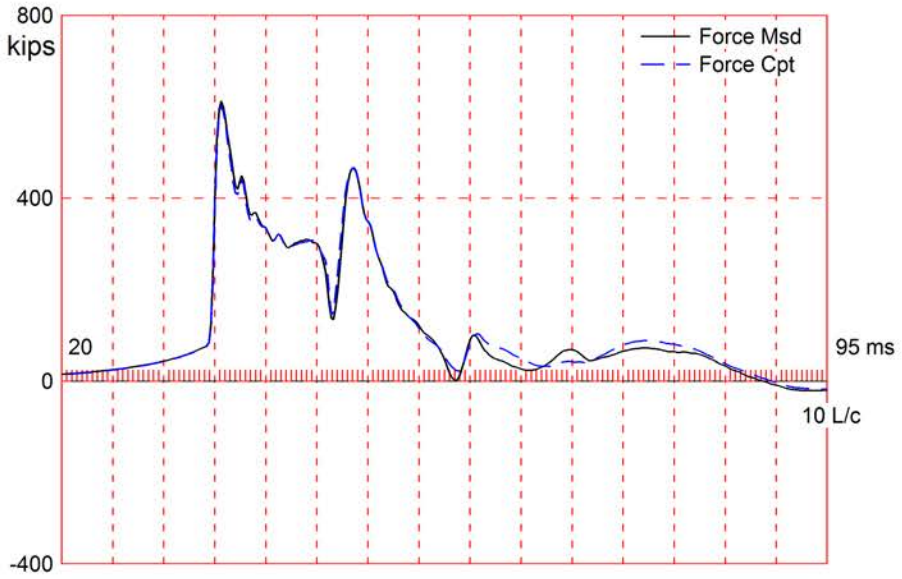
PILE PROFILE AND PILE MODEL

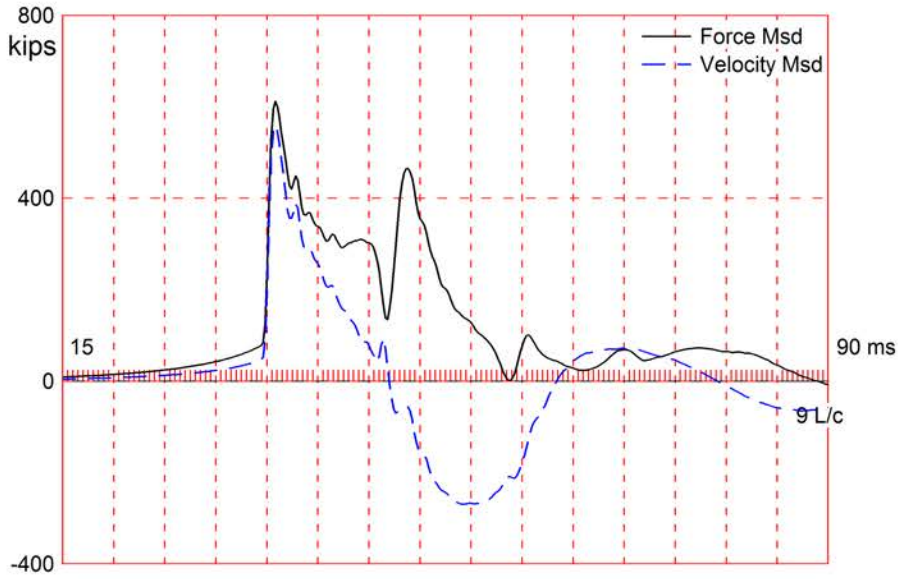
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
94.2	21.4	29992.2	492.000	4.70

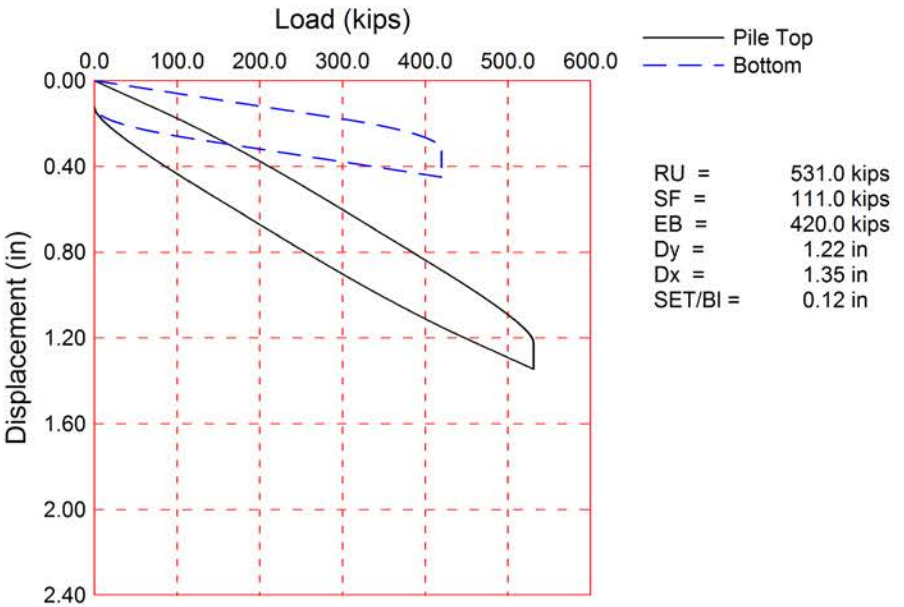
Toe Area 198.5 in^2

Top Segment Length 3.36 ft, Top Impedance 38 kips/ft/s

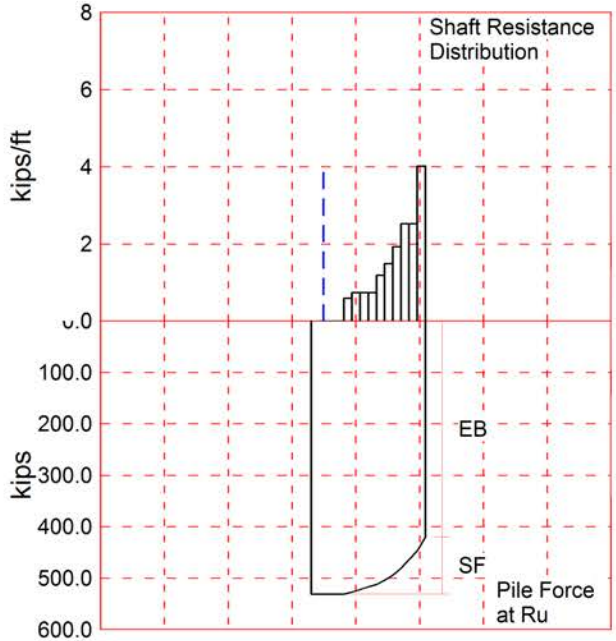
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 11.2 ms
Total volume: 13.993 ft^3; Volume ratio considering added impedance: 1.000







RU =	531.0 kips
SF =	111.0 kips
EB =	420.0 kips
Dy =	1.22 in
Dx =	1.35 in
SET/Bl =	0.12 in



Length b. Sensors	94.2 ft
Embedment	83.5 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	3.25
Top Compr. Stress	28.2 ksi
Max Compr. Stress	29.0 ksi
Max Tension Stress	-3.64 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.25 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.10 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 531.0; along Shaft 111.0; at Toe 420.0 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
				531.0					
1	13.5	2.8	0.0	531.0	0.0	0.00	0.00	0.00	0.10
2	20.2	9.6	0.0	531.0	0.0	0.00	0.00	0.00	0.10
3	26.9	16.3	0.0	531.0	0.0	0.00	0.00	0.00	0.10
4	33.6	23.0	4.0	527.0	4.0	0.59	0.13	0.30	0.10
5	40.4	29.7	5.0	522.0	9.0	0.74	0.16	0.30	0.10
6	47.1	36.5	5.0	517.0	14.0	0.74	0.16	0.30	0.10
7	53.8	43.2	5.0	512.0	19.0	0.74	0.16	0.30	0.10
8	60.5	49.9	8.0	504.0	27.0	1.19	0.25	0.30	0.10
9	67.3	56.6	10.0	494.0	37.0	1.49	0.32	0.30	0.10
10	74.0	63.4	13.0	481.0	50.0	1.93	0.41	0.30	0.10
11	80.7	70.1	17.0	464.0	67.0	2.53	0.54	0.30	0.10
12	87.4	76.8	17.0	447.0	84.0	2.53	0.54	0.30	0.10
13	94.2	83.5	27.0	420.0	111.0	4.01	0.85	0.30	0.09
Avg. Shaft			8.5			1.33	0.28	0.30	0.10
Toe			420.0				304.68	0.10	0.25

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		0.87	1.10
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	84	106
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.07
Soil Plug Weight	(kips)	0.040	

CAPWAP match quality = 3.25 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.11 in; Blow Count = 105 b/ft

max. Top Comp. Stress = 28.2 ksi (T= 36.0 ms, max= 1.030 x Top)
max. Comp. Stress = 29.0 ksi (Z= 33.6 ft, T= 37.8 ms)
max. Tens. Stress = -3.64 ksi (Z= 67.3 ft, T= 63.2 ms)
max. Energy (EMX) = 30.7 kip-ft; max. Measured Top Displ. (DMX)= 1.00 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	602.7	-25.4	28.2	-1.19	30.7	14.9	1.01
2	6.7	603.4	-24.9	28.2	-1.16	30.6	14.8	1.00
4	13.5	604.9	-27.9	28.3	-1.30	30.1	14.8	0.96
6	20.2	606.6	-32.5	28.3	-1.52	29.4	14.7	0.91
8	26.9	610.7	-37.2	28.5	-1.74	28.6	14.6	0.86
10	33.6	621.0	-47.3	29.0	-2.21	27.7	14.3	0.81
12	40.4	611.5	-57.5	28.6	-2.69	25.8	14.0	0.76
14	47.1	597.1	-65.5	27.9	-3.06	23.8	13.7	0.70
15	50.4	578.3	-64.8	27.0	-3.02	22.3	13.5	0.67
16	53.8	584.5	-72.7	27.3	-3.40	21.7	13.3	0.64
17	57.2	569.3	-71.2	26.6	-3.32	20.2	13.0	0.61
18	60.5	577.1	-77.9	27.0	-3.64	19.6	12.8	0.58
19	63.9	551.0	-71.8	25.7	-3.35	17.7	12.5	0.55
20	67.3	568.2	-78.0	26.5	-3.64	17.1	12.1	0.52
21	70.6	539.0	-69.0	25.2	-3.22	15.1	11.6	0.49
22	74.0	546.9	-74.5	25.5	-3.48	14.4	11.4	0.45
23	77.4	510.7	-62.0	23.9	-2.90	12.3	11.1	0.42
24	80.7	524.0	-67.8	24.5	-3.17	11.6	10.9	0.39
25	84.1	526.8	-51.0	24.6	-2.38	9.4	12.0	0.36
26	87.4	542.6	-55.7	25.3	-2.60	8.8	13.0	0.33
27	90.8	525.4	-39.4	24.5	-1.84	7.0	13.1	0.30
28	94.2	534.1	-43.6	25.0	-2.03	5.6	11.0	0.27
Absolute	33.6			29.0			(T =	37.8 ms)
	67.3				-3.64		(T =	63.2 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	660.3	608.2	556.1	504.0	451.9	399.7	347.6	295.5	243.4	191.3
RX	706.3	670.2	653.8	637.4	621.0	604.6	588.9	573.3	558.4	544.1
RU	660.3	608.2	556.1	504.0	451.9	399.7	347.6	295.5	243.4	191.3

RAU = 340.9 (kips); RA2 = 582.2 (kips)

Current CAPWAP Ru = 531.0 (kips); Corresponding J(RP)= 0.25; matches RX9 within 5%

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
14.7	35.82	562.8	618.7	618.7	1.00	0.16	0.12	30.9	657.6	2333

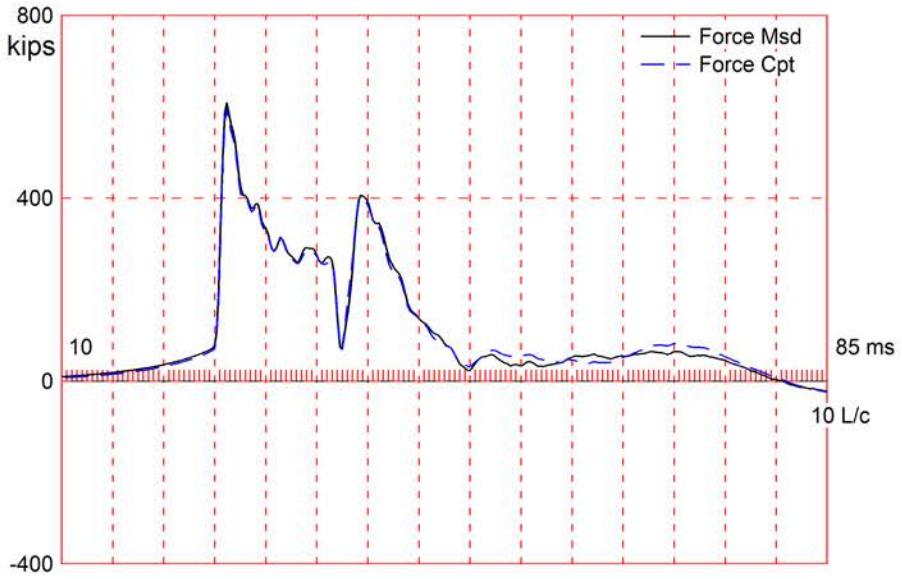
PILE PROFILE AND PILE MODEL

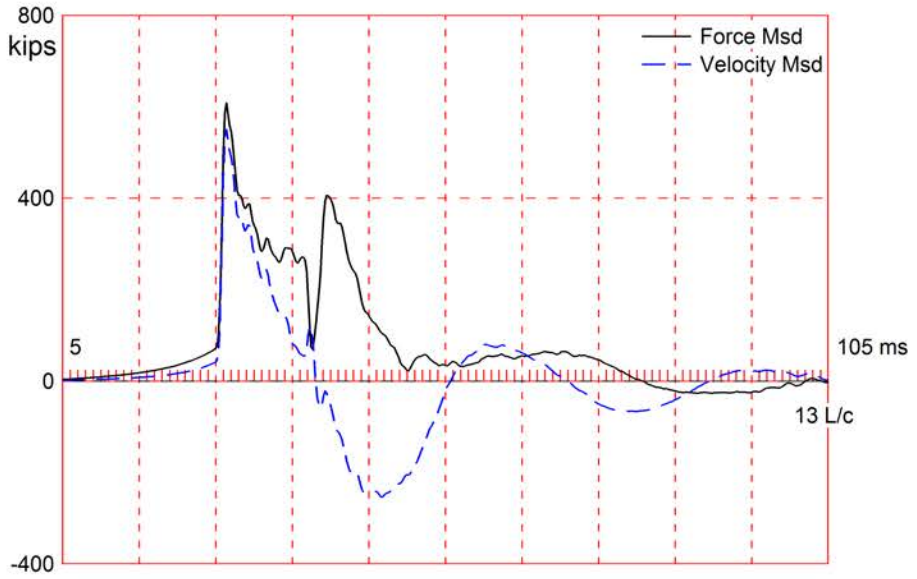
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
94.2	21.4	29992.2	492.000	4.70

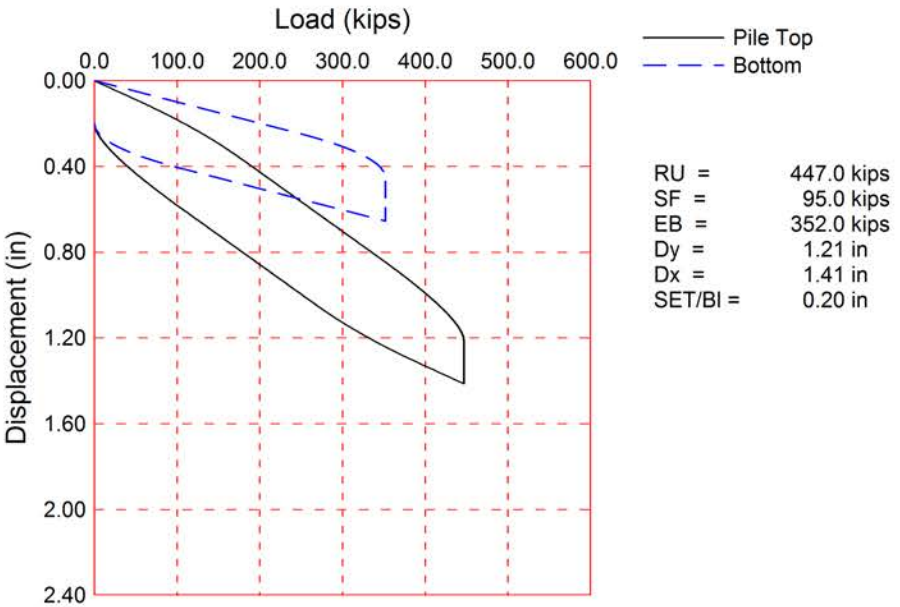
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	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
22	74.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
23	77.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	80.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
25	84.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	94.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

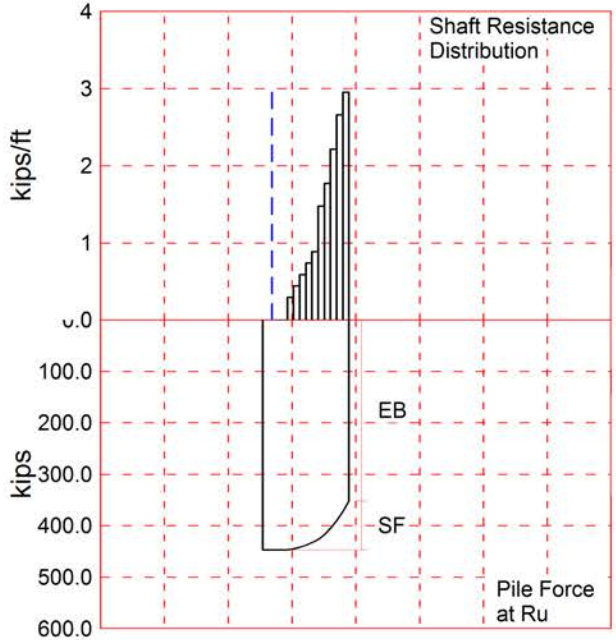
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 11.2 ms
Total volume: 13.994 ft^3; Volume ratio considering added impedance: 1.000







RU =	447.0 kips
SF =	95.0 kips
EB =	352.0 kips
Dy =	1.21 in
Dx =	1.41 in
SET/Bl =	0.20 in



Length b. Sensors	94.8 ft
Embedment	81.3 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	2.70
Top Compr. Stress	27.7 ksi
Max Compr. Stress	28.2 ksi
Max Tension Stress	-3.04 ksi
Avg. Shaft Quake	0.07 in
Toe Quake	0.35 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.12 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: 447.0; along Shaft 95.0; at Toe 352.0 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
				447.0				
1	20.3	6.9	0.0	447.0	0.0	0.00	0.00	0.00
2	27.1	13.6	0.0	447.0	0.0	0.00	0.00	0.00
3	33.8	20.4	2.0	445.0	2.0	0.30	0.06	0.25
4	40.6	27.2	3.0	442.0	5.0	0.44	0.09	0.25
5	47.4	33.9	4.0	438.0	9.0	0.59	0.13	0.25
6	54.1	40.7	5.0	433.0	14.0	0.74	0.16	0.25
7	60.9	47.5	6.0	427.0	20.0	0.89	0.19	0.25
8	67.7	54.2	10.0	417.0	30.0	1.48	0.31	0.25
9	74.4	61.0	12.0	405.0	42.0	1.77	0.38	0.25
10	81.2	67.8	15.0	390.0	57.0	2.22	0.47	0.25
11	88.0	74.5	18.0	372.0	75.0	2.66	0.57	0.25
12	94.8	81.3	20.0	352.0	95.0	2.96	0.63	0.25
Avg. Shaft			7.9			1.17	0.25	0.25
Toe			352.0				255.35	0.12

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.07	0.35
Case Damping Factor		0.62	1.11
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	75
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.06
Soil Plug Weight	(kips)	0.055	0.056

CAPWAP match quality = 2.70 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.21 in; Blow Count = 56 b/ft

max. Top Comp. Stress = 27.7 ksi (T= 26.6 ms, max= 1.018 x Top)
max. Comp. Stress = 28.2 ksi (Z= 33.8 ft, T= 28.4 ms)
max. Tens. Stress = -3.04 ksi (Z= 67.7 ft, T= 54.4 ms)
max. Energy (EMX) = 29.9 kip-ft; max. Measured Top Displ. (DMX)= 1.00 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	592.9	-33.4	27.7	-1.56	29.9	14.8	1.03
2	6.8	593.5	-34.9	27.7	-1.63	29.8	14.8	1.02
4	13.5	594.8	-38.8	27.8	-1.81	29.4	14.7	0.98
6	20.3	596.2	-42.6	27.9	-1.99	28.8	14.7	0.94
8	27.1	598.4	-46.0	28.0	-2.15	28.2	14.6	0.90
10	33.8	603.7	-49.4	28.2	-2.31	27.6	14.4	0.86
12	40.6	601.4	-50.6	28.1	-2.36	26.3	14.2	0.81
14	47.4	596.2	-50.2	27.9	-2.34	24.8	14.0	0.75
15	50.8	583.6	-50.3	27.3	-2.35	23.6	13.8	0.73
16	54.1	588.3	-57.1	27.5	-2.67	23.2	13.7	0.70
17	57.5	572.6	-55.6	26.7	-2.60	21.9	13.5	0.67
18	60.9	578.5	-62.4	27.0	-2.92	21.4	13.3	0.65
19	64.3	563.1	-59.7	26.3	-2.79	20.0	13.0	0.62
20	67.7	577.4	-65.1	27.0	-3.04	19.5	12.6	0.59
21	71.1	555.4	-55.8	25.9	-2.61	17.6	12.1	0.57
22	74.4	561.0	-60.4	26.2	-2.82	17.1	12.0	0.54
23	77.8	516.2	-48.7	24.1	-2.27	15.1	11.9	0.51
24	81.2	519.8	-54.2	24.3	-2.53	14.6	11.7	0.48
25	84.6	473.7	-39.5	22.1	-1.85	12.5	13.2	0.46
26	88.0	482.1	-43.5	22.5	-2.03	12.0	14.1	0.43
27	91.4	463.3	-25.5	21.6	-1.19	9.8	15.0	0.41
28	94.8	471.8	-29.4	22.0	-1.37	8.3	14.2	0.39
Absolute	33.8			28.2			(T =	28.4 ms)
	67.7				-3.04		(T =	54.4 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	574.4	514.2	453.9	393.6	333.3	273.1	212.8	152.5	92.2	32.0
RX	627.3	589.1	572.8	556.6	541.4	527.6	513.7	499.8	486.4	476.2
RU	574.4	514.2	453.9	393.6	333.3	273.1	212.8	152.5	92.2	32.0

RAU = 358.5 (kips); RA2 = 511.0 (kips)

Current CAPWAP Ru = 447.0 (kips); Corresponding J(RP)= 0.21;

RMX requires higher damping; see PDA-W

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
14.6	26.37	558.7	618.4	618.4	1.00	0.20	0.20	29.9	599.0	1214

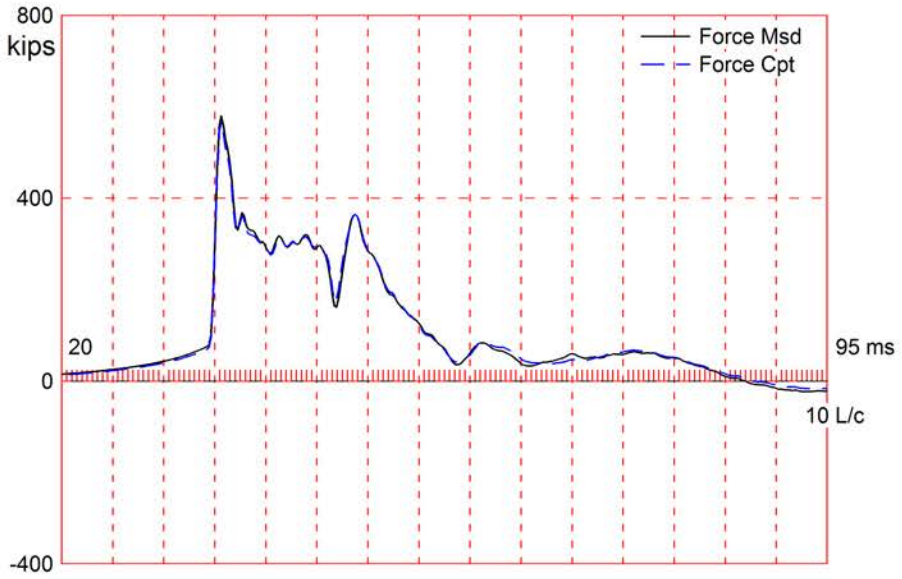
PILE PROFILE AND PILE MODEL

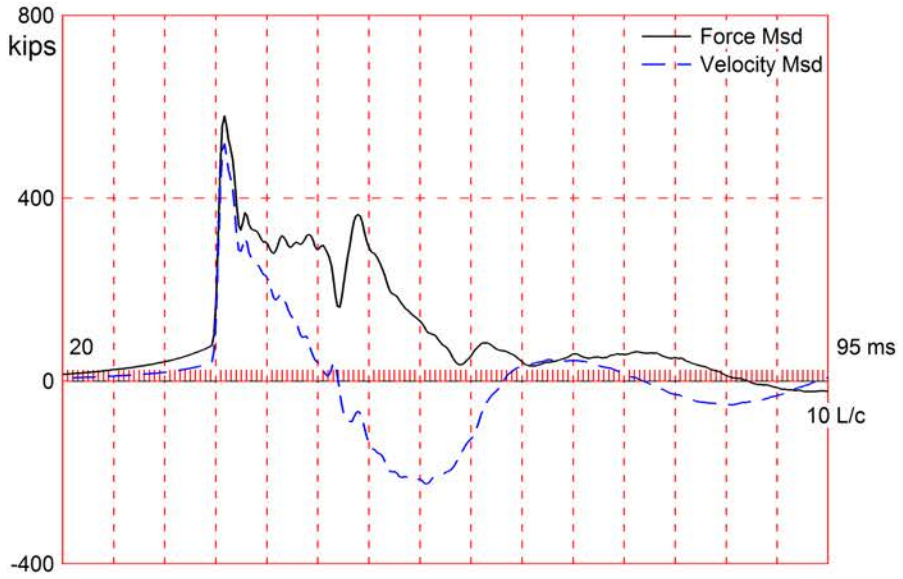
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
94.8	21.4	29992.2	492.000	4.70

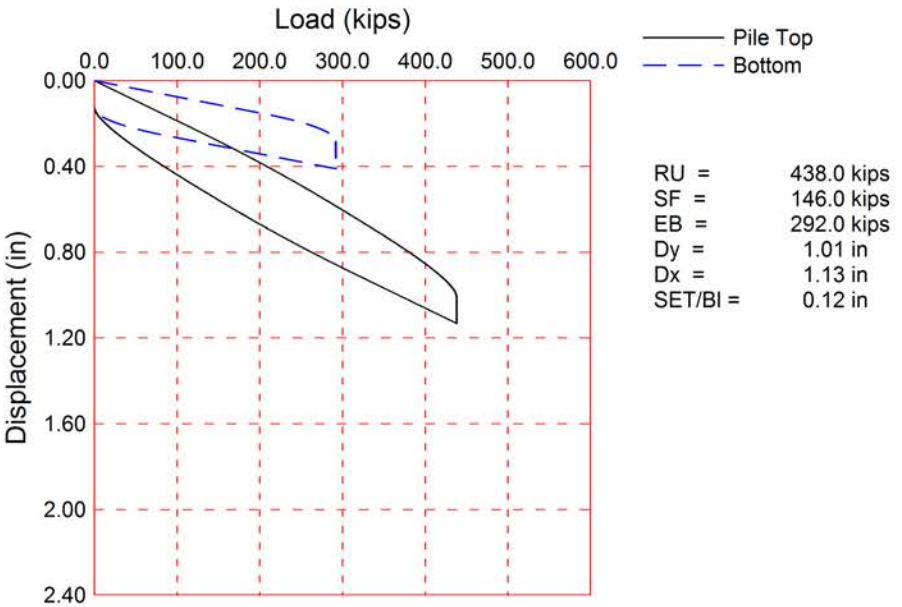
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	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
22	74.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
23	77.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.025
24	81.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
25	84.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	94.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

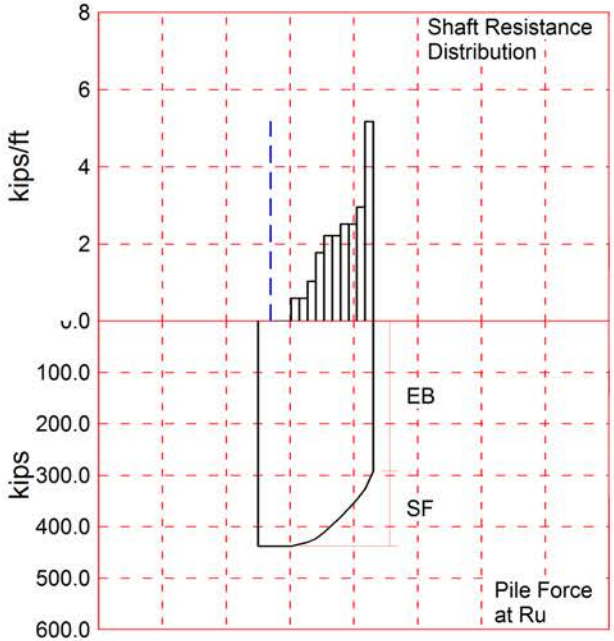
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 11.3 ms
Total volume: 14.081 ft^3; Volume ratio considering added impedance: 1.000







RU =	438.0 kips
SF =	146.0 kips
EB =	292.0 kips
Dy =	1.01 in
Dx =	1.13 in
SET/Bl =	0.12 in



Length b. Sensors	94.8 ft
Embedment	81.4 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	1.80
Top Compr. Stress	26.5 ksi
Max Compr. Stress	27.3 ksi
Max Tension Stress	-1.48 ksi
Avg. Shaft Quake	0.17 in
Toe Quake	0.22 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.12 s/ft

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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.

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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: 438.0; along Shaft 146.0; at Toe 292.0 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
				438.0				
1	20.3	6.9	0.0	438.0	0.0	0.00	0.00	0.00
2	27.1	13.7	0.0	438.0	0.0	0.00	0.00	0.00
3	33.8	20.5	4.0	434.0	4.0	0.59	0.13	0.26
4	40.6	27.2	4.0	430.0	8.0	0.59	0.13	0.26
5	47.4	34.0	7.0	423.0	15.0	1.03	0.22	0.26
6	54.1	40.8	12.0	411.0	27.0	1.77	0.38	0.26
7	60.9	47.5	15.0	396.0	42.0	2.22	0.47	0.26
8	67.7	54.3	15.0	381.0	57.0	2.22	0.47	0.26
9	74.4	61.1	17.0	364.0	74.0	2.51	0.53	0.26
10	81.2	67.8	17.0	347.0	91.0	2.51	0.53	0.26
11	88.0	74.6	20.0	327.0	111.0	2.96	0.63	0.26
12	94.8	81.4	35.0	292.0	146.0	5.17	1.10	0.26
Avg. Shaft			12.2			1.79	0.38	0.26
Toe			292.0				211.83	0.12

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.17	0.22
Case Damping Factor		0.99	0.92
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	64	102
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.02
Soil Plug Weight	(kips)	0.030	

CAPWAP match quality = 1.80 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.13 in; Blow Count = 95 b/ft

max. Top Comp. Stress = 26.5 ksi (T= 36.0 ms, max= 1.030 x Top)
max. Comp. Stress = 27.3 ksi (Z= 33.8 ft, T= 37.9 ms)
max. Tens. Stress = -1.48 ksi (Z= 54.1 ft, T= 62.0 ms)
max. Energy (EMX) = 24.0 kip-ft; max. Measured Top Displ. (DMX)= 0.85 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	566.4	-18.0	26.5	-0.84	24.0	14.0	0.87
2	6.8	567.4	-19.9	26.5	-0.93	23.8	13.9	0.86
4	13.5	569.2	-23.2	26.6	-1.08	23.4	13.8	0.82
6	20.3	571.1	-26.0	26.7	-1.21	22.8	13.8	0.78
8	27.1	574.4	-28.5	26.8	-1.33	22.2	13.7	0.74
10	33.8	583.6	-31.0	27.3	-1.45	21.4	13.4	0.69
12	40.6	576.0	-29.4	26.9	-1.37	19.9	13.1	0.64
14	47.4	574.3	-31.5	26.8	-1.47	18.5	12.7	0.58
15	50.8	557.1	-26.5	26.0	-1.24	17.2	12.4	0.56
16	54.1	567.7	-31.8	26.5	-1.48	16.8	12.1	0.53
17	57.5	534.4	-19.3	25.0	-0.90	15.1	11.7	0.50
18	60.9	545.8	-24.3	25.5	-1.14	14.6	11.4	0.48
19	64.3	503.6	-8.1	23.5	-0.38	12.8	11.0	0.45
20	67.7	515.3	-12.6	24.1	-0.59	12.4	10.7	0.43
21	71.1	482.5	0.0	22.5	0.00	10.8	10.2	0.40
22	74.4	496.9	-1.8	23.2	-0.09	10.4	9.8	0.38
23	77.8	449.5	0.0	21.0	0.00	8.9	9.6	0.35
24	81.2	457.1	-0.0	21.4	-0.00	8.5	9.4	0.33
25	84.6	419.6	-0.0	19.6	-0.00	7.2	9.1	0.31
26	88.0	407.4	-0.0	19.0	-0.00	6.9	9.9	0.29
27	91.4	374.5	-0.0	17.5	-0.00	5.7	10.8	0.27
28	94.8	410.4	-0.0	19.2	-0.00	4.4	9.9	0.24
Absolute	33.8			27.3			(T =	37.9 ms)
	54.1				-1.48		(T =	62.0 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	642.0	594.5	546.9	499.4	451.9	404.4	356.9	309.4	261.9	214.3
RX	651.2	610.8	579.4	549.8	524.3	499.6	483.9	470.8	457.7	444.6
RU	642.0	594.5	546.9	499.4	451.9	404.4	356.9	309.4	261.9	214.3

RAU = 262.4 (kips); RA2 = 498.0 (kips)

Current CAPWAP Ru = 438.0 (kips); Corresponding J(RP)= 0.43; matches RX9 within 5%

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
13.9	35.84	530.8	586.3	591.5	0.85	0.12	0.12	24.1	593.9	1460

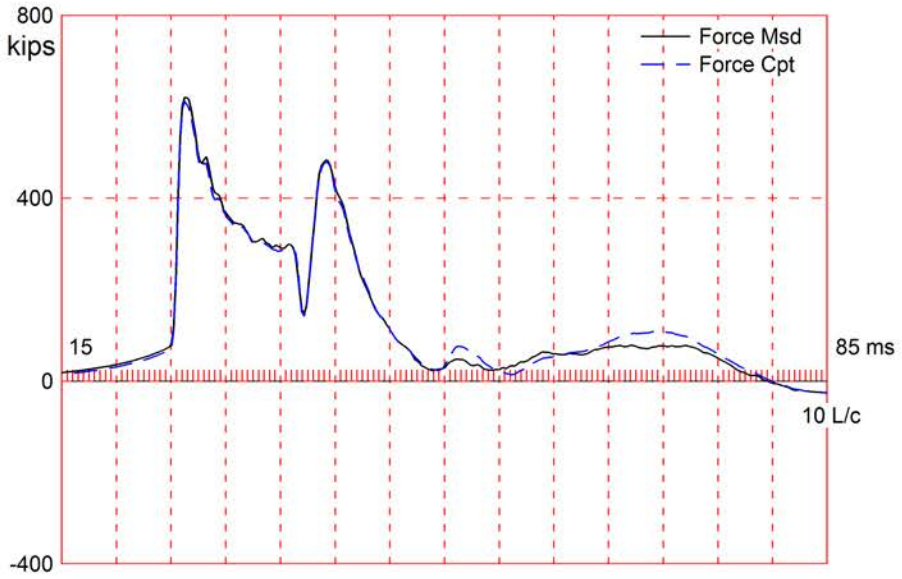
PILE PROFILE AND PILE MODEL

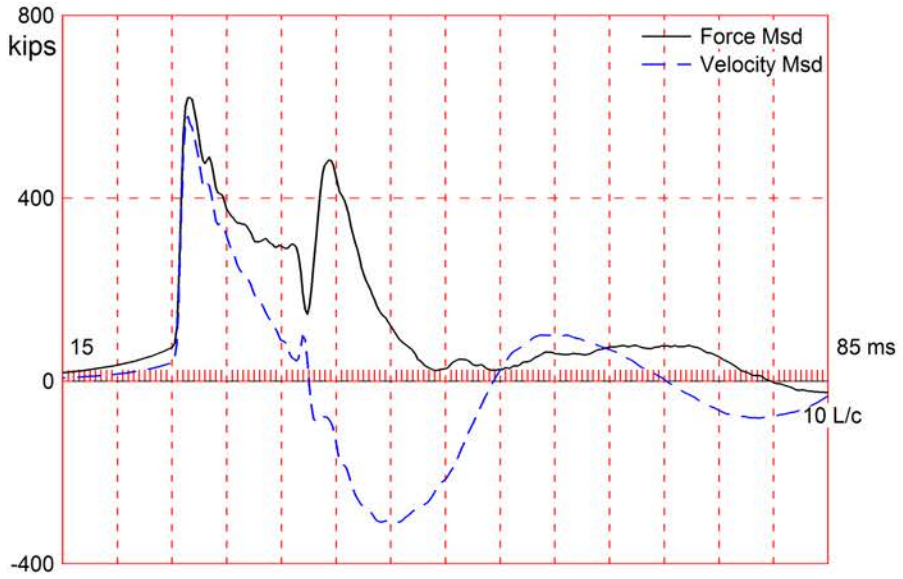
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
94.8	21.4	29992.2	492.000	4.70

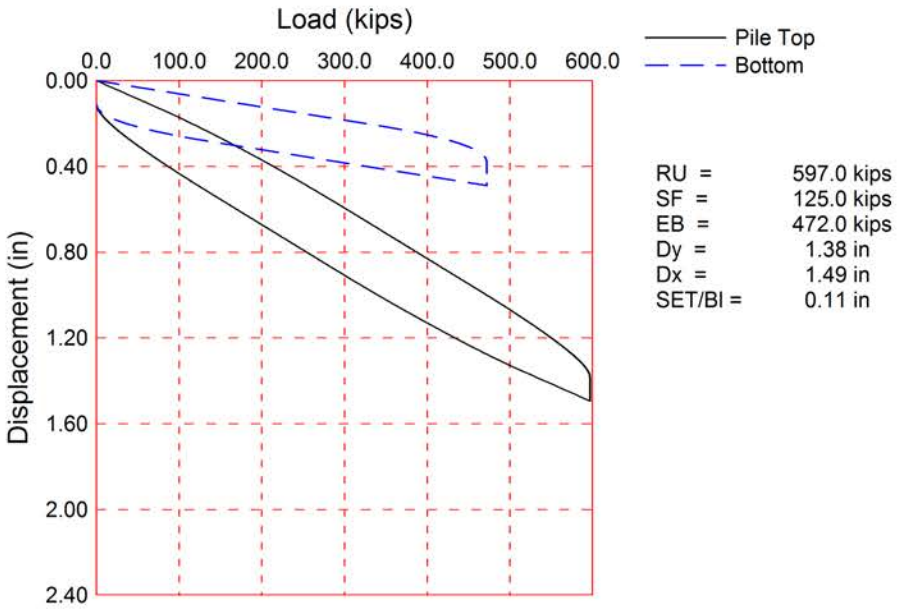
Toe Area 198.5 in^2

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
23	77.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	81.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
25	84.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	94.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

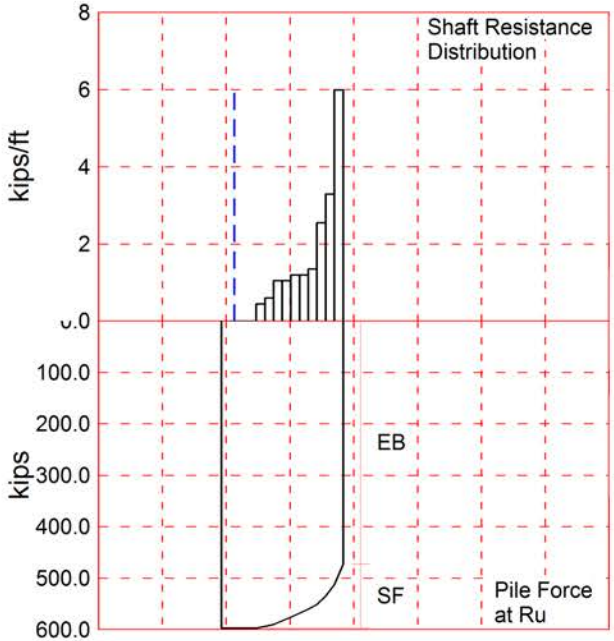
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 11.3 ms
Total volume: 14.081 ft^3; Volume ratio considering added impedance: 1.000







RU =	597.0 kips
SF =	125.0 kips
EB =	472.0 kips
Dy =	1.38 in
Dx =	1.49 in
SET/Bl =	0.11 in



Length b. Sensors	93.5 ft
Embedment	83.0 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	3.01
Top Compr. Stress	28.6 ksi
Max Compr. Stress	29.3 ksi
Max Tension Stress	-5.81 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.29 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.06 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: 597.0; along Shaft 125.0; at Toe 472.0 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
				597.0				
1	13.4	2.8	0.0	597.0	0.0	0.00	0.00	0.00
2	20.0	9.5	0.0	597.0	0.0	0.00	0.00	0.00
3	26.7	16.2	0.0	597.0	0.0	0.00	0.00	0.00
4	33.4	22.9	3.0	594.0	3.0	0.45	0.10	0.25
5	40.1	29.5	4.0	590.0	7.0	0.60	0.13	0.25
6	46.8	36.2	7.0	583.0	14.0	1.05	0.22	0.25
7	53.4	42.9	7.0	576.0	21.0	1.05	0.22	0.25
8	60.1	49.6	8.0	568.0	29.0	1.20	0.25	0.25
9	66.8	56.3	8.0	560.0	37.0	1.20	0.25	0.25
10	73.5	62.9	9.0	551.0	46.0	1.35	0.29	0.25
11	80.1	69.6	17.0	534.0	63.0	2.55	0.54	0.25
12	86.8	76.3	22.0	512.0	85.0	3.29	0.70	0.25
13	93.5	83.0	40.0	472.0	125.0	5.99	1.27	0.25
Avg. Shaft			9.6			1.51	0.32	0.25
Toe			472.0				342.40	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.09	0.29
Case Damping Factor		0.82	0.74
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	47
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	42	
Resistance Gap (included in Toe Quake)	(in)		0.06

CAPWAP match quality = 3.01 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.11 in; Blow Count = 107 b/ft
Computed: Final Set = 0.11 in; Blow Count = 114 b/ft

max. Top Comp. Stress = 28.6 ksi (T= 26.6 ms, max= 1.024 x Top)
max. Comp. Stress = 29.3 ksi (Z= 33.4 ft, T= 28.4 ms)
max. Tens. Stress = -5.81 ksi (Z= 66.8 ft, T= 52.4 ms)
max. Energy (EMX) = 35.5 kip-ft; max. Measured Top Displ. (DMX)= 1.04 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	613.1	-33.1	28.6	-1.55	35.5	15.3	1.08
2	6.7	613.8	-35.2	28.7	-1.64	35.3	15.3	1.07
4	13.4	615.2	-40.4	28.7	-1.89	34.8	15.3	1.03
6	20.0	616.8	-45.4	28.8	-2.12	34.1	15.2	0.98
8	26.7	620.1	-51.2	29.0	-2.39	33.4	15.1	0.94
10	33.4	627.8	-66.0	29.3	-3.08	32.5	14.9	0.88
12	40.1	624.0	-88.2	29.1	-4.12	30.8	14.6	0.83
14	46.8	619.4	-108.4	28.9	-5.06	28.8	14.2	0.77
15	50.1	595.9	-112.6	27.8	-5.26	26.9	14.0	0.74
16	53.4	602.7	-118.9	28.2	-5.55	26.2	13.8	0.71
17	56.8	579.9	-117.0	27.1	-5.47	24.3	13.5	0.68
18	60.1	587.3	-123.4	27.4	-5.77	23.6	13.4	0.65
19	63.4	561.0	-121.6	26.2	-5.68	21.5	13.1	0.61
20	66.8	568.8	-124.4	26.6	-5.81	20.8	13.0	0.58
21	70.1	544.5	-118.8	25.4	-5.55	18.9	12.7	0.55
22	73.5	559.0	-120.3	26.1	-5.62	18.1	12.4	0.51
23	76.8	558.3	-114.3	26.1	-5.34	16.2	12.0	0.48
24	80.1	573.9	-114.8	26.8	-5.36	15.4	12.2	0.44
25	83.5	563.4	-100.9	26.3	-4.71	12.8	13.4	0.41
26	86.8	588.8	-101.0	27.5	-4.72	12.0	14.1	0.38
27	90.2	570.1	-82.9	26.6	-3.87	9.4	14.3	0.34
28	93.5	584.6	-82.9	27.3	-3.87	6.9	12.6	0.31
Absolute	33.4			29.3			(T =	28.4 ms)
	66.8				-5.81		(T =	52.4 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	701.0	650.6	600.1	549.7	499.2	448.8	398.3	347.9	297.4	247.0
RX	776.4	746.8	720.4	697.5	679.9	662.6	645.2	627.9	610.6	598.0
RU	701.0	650.6	600.1	549.7	499.2	448.8	398.3	347.9	297.4	247.0

RAU = 387.4 (kips); RA2 = 620.3 (kips)

Current CAPWAP Ru = 597.0 (kips); Corresponding J(RP)= 0.21; matches RX9 within 5%

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
15.3	26.42	584.4	621.2	622.1	1.04	0.11	0.11	35.5	736.2	2052

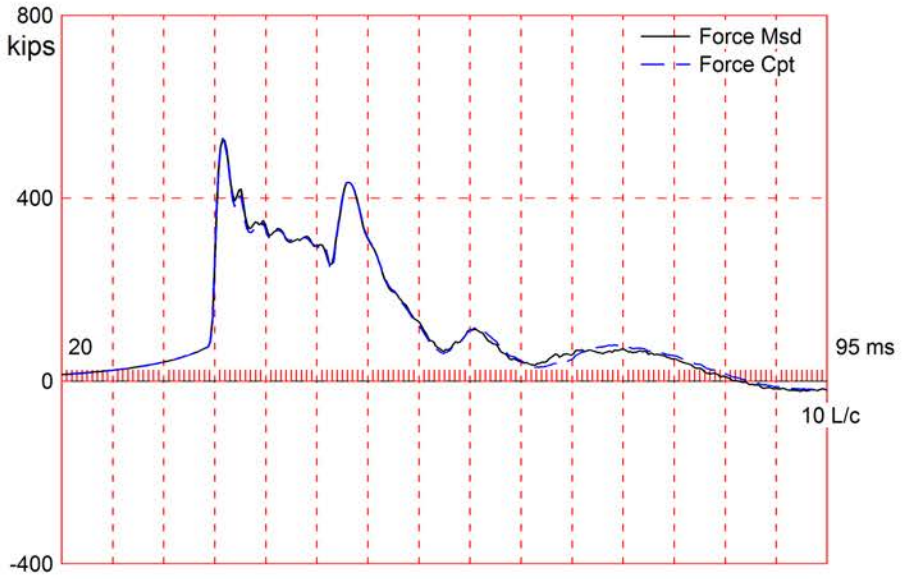
PILE PROFILE AND PILE MODEL

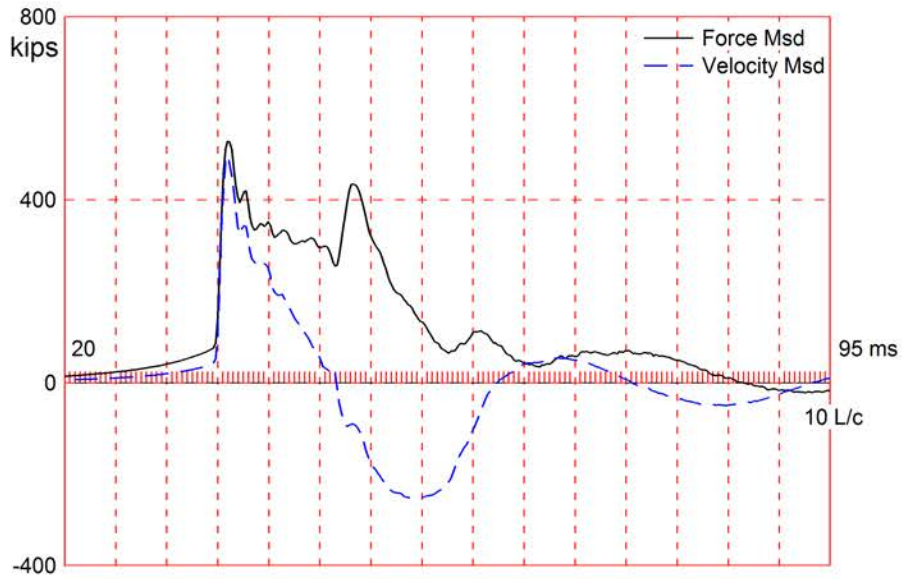
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
93.5	21.4	29992.2	492.000	4.70

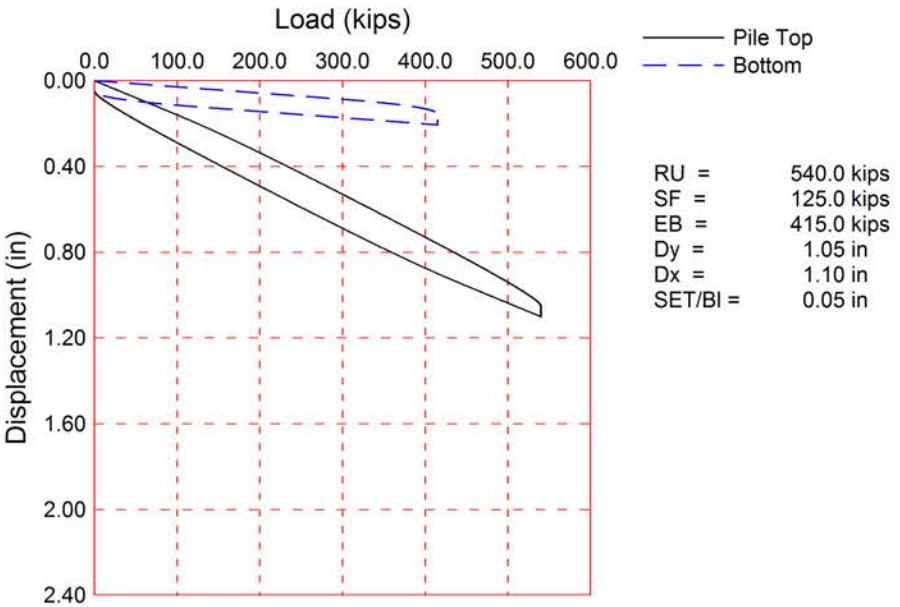
Toe Area 198.5 in^2

Top Segment Length 3.34 ft, Top Impedance 38 kips/ft/s

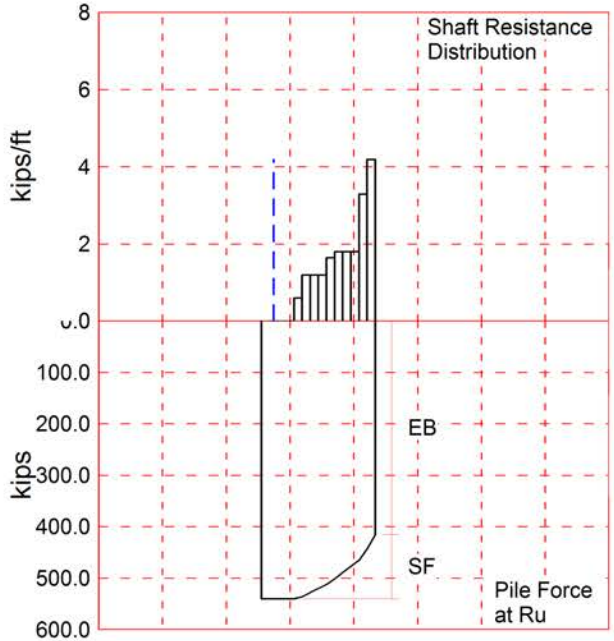
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 11.1 ms
Total volume: 13.895 ft^3; Volume ratio considering added impedance: 1.000







RU =	540.0 kips
SF =	125.0 kips
EB =	415.0 kips
Dy =	1.05 in
Dx =	1.10 in
SET/Bl =	0.05 in



Length b. Sensors	93.5 ft
Embedment	83.0 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	2.12
Top Compr. Stress	24.9 ksi
Max Compr. Stress	25.9 ksi
Max Tension Stress	-1.52 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.12 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.10 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 540.0; along Shaft 125.0; at Toe 415.0 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
				540.0					
1	13.4	2.9	0.0	540.0	0.0	0.00	0.00	0.00	0.10
2	20.0	9.5	0.0	540.0	0.0	0.00	0.00	0.00	0.10
3	26.7	16.2	0.0	540.0	0.0	0.00	0.00	0.00	0.10
4	33.4	22.9	4.0	536.0	4.0	0.60	0.13	0.29	0.10
5	40.1	29.6	8.0	528.0	12.0	1.20	0.25	0.29	0.10
6	46.8	36.3	8.0	520.0	20.0	1.20	0.25	0.29	0.10
7	53.4	42.9	8.0	512.0	28.0	1.20	0.25	0.29	0.10
8	60.1	49.6	11.0	501.0	39.0	1.65	0.35	0.29	0.10
9	66.8	56.3	12.0	489.0	51.0	1.80	0.38	0.29	0.10
10	73.5	63.0	12.0	477.0	63.0	1.80	0.38	0.29	0.10
11	80.1	69.7	12.0	465.0	75.0	1.80	0.38	0.29	0.10
12	86.8	76.3	22.0	443.0	97.0	3.29	0.70	0.29	0.10
13	93.5	83.0	28.0	415.0	125.0	4.19	0.89	0.29	0.06
Avg. Shaft			9.6			1.51	0.32	0.29	0.09
Toe			415.0				301.06	0.10	0.12

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		0.95	1.09
Damping Type		Viscous	Sm+Visc
Reloading Level	(% of Ru)	100	100

CAPWAP match quality = 2.12 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.05 in; Blow Count = 240 b/ft
Computed: Final Set = 0.04 in; Blow Count = 270 b/ft

max. Top Comp. Stress = 24.9 ksi (T= 36.2 ms, max= 1.040 x Top)
max. Comp. Stress = 25.9 ksi (Z= 33.4 ft, T= 37.9 ms)
max. Tens. Stress = -1.52 ksi (Z= 33.4 ft, T= 93.4 ms)
max. Energy (EMX) = 24.6 kip-ft; max. Measured Top Displ. (DMX)= 0.86 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	532.1	-21.0	24.9	-0.98	24.6	12.9	0.86
2	6.7	532.9	-22.2	24.9	-1.04	24.4	12.8	0.85
4	13.4	534.8	-24.6	25.0	-1.15	23.8	12.8	0.80
6	20.0	536.9	-27.5	25.1	-1.28	23.2	12.7	0.76
8	26.7	541.7	-30.2	25.3	-1.41	22.4	12.6	0.71
10	33.4	553.5	-32.5	25.9	-1.52	21.5	12.2	0.66
12	40.1	551.6	-31.0	25.8	-1.45	19.9	11.8	0.61
14	46.8	532.6	-25.7	24.9	-1.20	17.7	11.3	0.55
15	50.1	506.8	-19.5	23.7	-0.91	16.1	11.1	0.52
16	53.4	516.1	-25.8	24.1	-1.21	15.5	10.9	0.49
17	56.8	494.0	-20.5	23.1	-0.96	14.0	10.6	0.46
18	60.1	504.9	-27.9	23.6	-1.30	13.5	10.3	0.43
19	63.4	487.7	-18.4	22.8	-0.86	11.8	10.0	0.40
20	66.8	504.4	-25.2	23.6	-1.18	11.2	9.7	0.37
21	70.1	499.7	-15.2	23.3	-0.71	9.6	9.5	0.34
22	73.5	501.4	-21.4	23.4	-1.00	9.0	9.2	0.31
23	76.8	488.4	-11.8	22.8	-0.55	7.6	8.9	0.28
24	80.1	487.0	-17.7	22.7	-0.83	7.0	8.5	0.25
25	83.5	492.7	-9.0	23.0	-0.42	5.9	8.4	0.22
26	86.8	510.1	-14.2	23.8	-0.66	5.3	9.0	0.19
27	90.2	488.9	-2.2	22.8	-0.10	4.0	8.8	0.16
28	93.5	495.1	-6.3	23.1	-0.29	3.3	7.2	0.13
Absolute	33.4			25.9			(T =	37.9 ms)
	33.4				-1.52		(T =	93.4 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	692.0	658.4	624.7	591.1	557.4	523.8	490.2	456.5	422.9	389.2
RX	716.1	687.3	658.6	635.7	613.8	591.9	574.5	563.0	551.5	539.9
RU	705.5	673.2	640.9	608.6	576.3	544.0	511.7	479.4	447.1	414.8

RAU = 289.3 (kips); RA2 = 576.1 (kips)

Current CAPWAP Ru = 540.0 (kips); Corresponding J(RP)= 0.45; J(RX) = 0.90

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
13.1	36.16	499.3	529.1	530.3	0.86	0.05	0.05	24.8	650.5	3458

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
93.5	21.4	29992.2	492.000	4.70

Toe Area 198.5 in^2

Top Segment Length 3.34 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 11.1 ms
Total volume: 13.895 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Al Ziai
Company: Lunda Construction Co.	No. of Sheets: 61
E-mail: kweber@lundaconstruction.com	Date: January 15, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 9
Winnebago County, Wisconsin

On January 14, 2014, Pier 9 #1, Pier 9 #36, and Pier 9 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on January 15. 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 elevation for the piles was the top of the ring at EL 740.7. We understand the pier was excavated to elevation of EL 716.6. The piles have a required minimum tip elevation of EL 658.5. 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 9 #1 was driven to a depth of 88.9 feet, which corresponds to a pile tip elevation of EL 651.8. The blow count over the final increment of driving was 10 blows for 2¾ inches of penetration at an average hammer stroke of 7.8 feet. The blow count at the beginning of restrike was 5 blows for ¾ inch of penetration at an average hammer stroke of 7.7 feet.

Pier 9 #36 was driven to a depth of 90.0 feet, which corresponds to a pile tip elevation of EL 650.7. The blow count over the final increment of driving was 10 blows for 2¾ inches of penetration at an average hammer stroke of 7.1 feet. The blow count at the beginning of restrike was 5 blows for 1⅛ inches of penetration at an average hammer stroke of 8.0 feet

Pier 9 #44 was driven to a depth of 93.7 feet, which corresponds to a pile tip elevation of EL 647.0. The blow count over the final increment of driving was 10 blows for 2¾ inches of penetration at an average hammer stroke of 7.2 feet. The blow count at the beginning of restrike was 5 blows per inch of penetration at an average hammer stroke of 7.6 feet

We recommend the production piles at Pier 9 of Structure B-70-403 driven with the APE D30-42 hammer PD0256 obtain the minimum recommended blow count, noted below, based on the field observed hammer stroke. We recommend maintaining the minimum blow count for **one full foot** of driving at the recommended average hammer stroke. Additionally, all production piles should achieve the minimum pile tip elevation of EL 658.5 for uplift, as indicated on the plans.

Field Observed Hammer Stroke (feet)	Exterior Piles (480 kips) Recommended Minimum Blow Count (blows per foot)	Interior Piles (400 kips) Recommended Minimum Blow Count (blows per foot
6.0	82	56
6.5	61	45
7.0	50	38
7.5	50	38
8.0	50	38

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.

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 – 35)
CAPWAP Analysis Results - (pages 36 – 61)

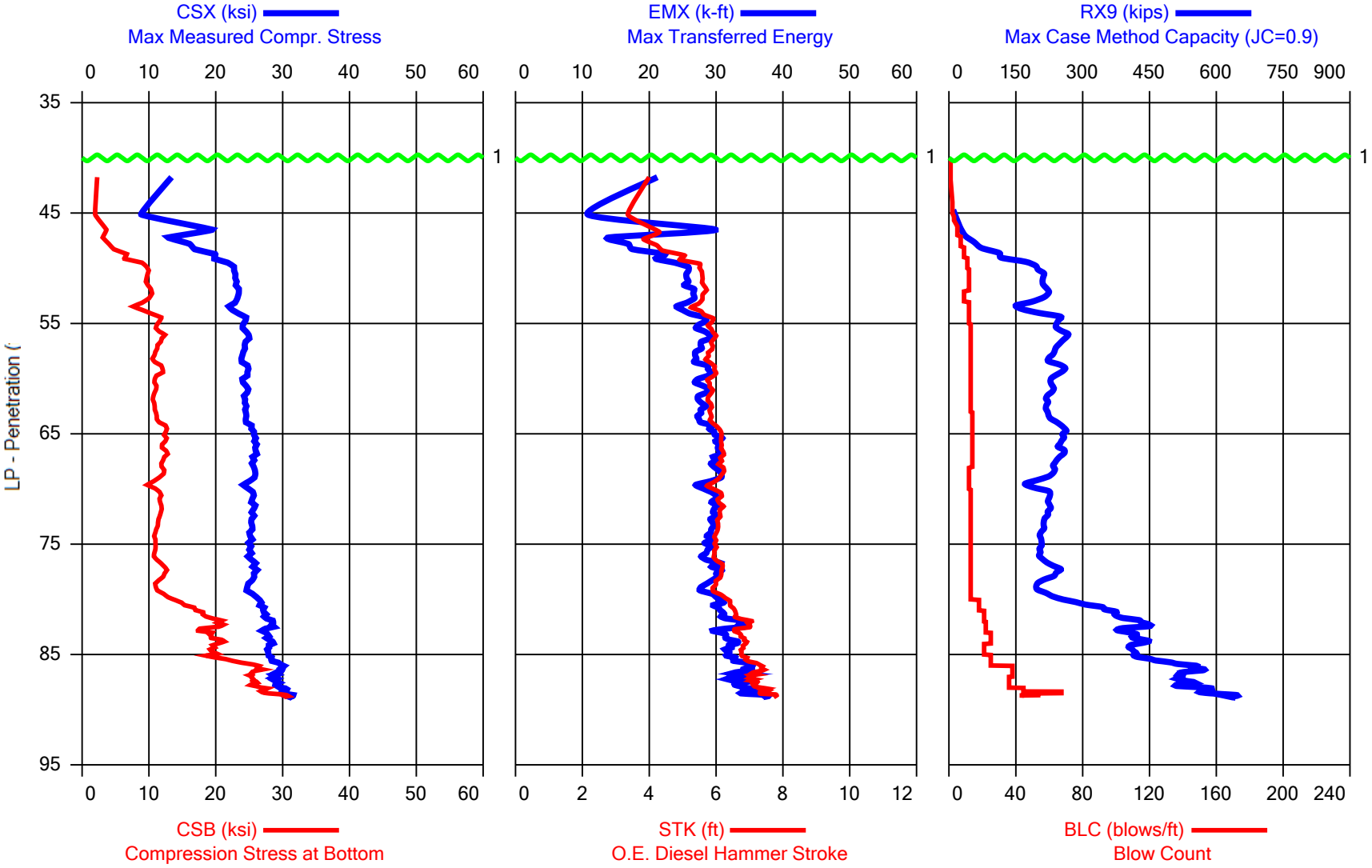
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 15-January-2015

Test started: 14-January-2015

USH 10 - B-70-403 - Pier 9 #1 - EOID

APE D30-42, HP 14 x 73



1 - Reported reference EL 740.7

USH 10 - B-70-403 - Pier 9 #1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.75 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.10 []

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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
3	40.00	1	AV1	13.4	2.3	3.6	23	60.8	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	13.4	2.3	3.6	23	60.8	0
			MIN	13.4	2.3	3.6	23	60.8	0
4	41.00	1	AV1	9.9	1.7	3.3	17	63.4	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	9.9	1.7	3.3	17	63.4	0
			MIN	9.9	1.7	3.3	17	63.4	0
5	42.00	1	AV1	5.0	1.1	3.0	11	66.2	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	5.0	1.1	3.0	11	66.2	0
			MIN	5.0	1.1	3.0	11	66.2	0
8	44.00	2	AV1	25.3	3.9	6.1	34	47.7	37
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	25.3	3.9	6.1	34	47.7	37
			MIN	25.3	3.9	6.1	34	47.7	37
9	44.50	2	AV1	13.9	2.8	3.6	18	61.2	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	13.9	2.8	3.6	18	61.2	0
			MIN	13.9	2.8	3.6	18	61.2	0
10	45.00	2	AV1	10.3	2.1	3.4	13	62.8	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	10.3	2.1	3.4	13	62.8	0
			MIN	10.3	2.1	3.4	13	62.8	0
11	45.33	3	AV1	8.7	2.3	3.3	11	63.8	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	8.7	2.3	3.3	11	63.8	0
			MIN	8.7	2.3	3.3	11	63.8	0

USH 10 - B-70-403 - Pier 9 #1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
12	45.67	3	AV1	2.5	0.6	3.2	1	64.0	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	2.5	0.6	3.2	1	64.0	0
			MIN	2.5	0.6	3.2	1	64.0	0
14	46.20	5	AV1	24.1	4.0	**	44	**	18
			STD	0.0	0.0	**	0	**	0
			MAX	24.1	4.0	**	44	**	18
			MIN	24.1	4.0	**	44	**	18
18	47.00	5	AV4	16.8	3.4	4.3	22	57.1	37
			STD	5.3	0.8	1.1	13	5.8	7
			MAX	26.0	4.7	6.2	45	60.6	48
			MIN	13.5	2.8	3.6	14	47.1	31
25	48.00	7	AV7	14.6	3.6	4.0	16	58.3	53
			STD	2.4	0.5	0.4	3	2.5	11
			MAX	16.8	4.3	4.4	18	62.7	69
			MIN	10.3	2.6	3.4	10	55.7	35
34	49.00	9	AV9	18.6	5.8	4.7	20	54.0	100
			STD	1.7	1.0	0.4	3	1.9	20
			MAX	20.6	7.4	5.2	23	56.7	125
			MIN	16.4	4.1	4.2	17	51.3	71
45	50.00	11	AV11	21.6	8.5	5.3	24	50.9	173
			STD	1.3	1.4	0.3	2	1.5	28
			MAX	23.5	9.9	5.7	27	53.3	198
			MIN	19.6	5.9	4.8	20	49.1	112
57	51.00	12	AV12	22.9	9.8	5.6	26	49.7	210
			STD	0.5	0.2	0.1	1	0.4	6
			MAX	23.9	10.3	5.7	28	50.1	219
			MIN	21.9	9.5	5.5	24	49.1	197
69	52.00	12	AV12	23.2	9.9	5.6	26	49.4	214
			STD	0.5	0.3	0.1	1	0.5	6
			MAX	24.2	10.5	5.9	28	50.3	222
			MIN	22.6	9.3	5.4	25	48.5	201
78	53.00	9	AV9	23.3	10.1	5.6	27	49.4	214

USH 10 - B-70-403 - Pier 9 #1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
			STD	0.5	0.4	0.1	1	0.5	11
			MAX	24.6	10.8	5.9	28	50.0	228
			MIN	22.8	9.4	5.5	25	48.5	193
90	54.00	12	AV12	22.5	8.6	5.4	25	50.3	165
			STD	0.8	0.8	0.2	1	0.8	15
			MAX	23.8	9.9	5.7	27	51.6	189
			MIN	21.2	7.4	5.1	23	49.0	142
102	55.00	12	AV12	24.2	11.4	5.8	28	48.7	242
			STD	0.6	0.7	0.2	1	0.7	14
			MAX	25.2	12.5	6.1	30	50.0	261
			MIN	23.1	9.8	5.5	25	47.7	205
115	56.00	13	AV13	24.4	11.4	5.9	28	48.5	250
			STD	0.7	0.5	0.2	1	0.7	12
			MAX	25.2	12.4	6.1	30	49.6	269
			MIN	23.2	10.8	5.6	26	47.7	235
128	57.00	13	AV13	24.6	11.8	5.9	28	48.2	256
			STD	0.5	0.5	0.1	1	0.5	9
			MAX	25.5	12.8	6.1	29	49.2	270
			MIN	23.5	11.2	5.7	26	47.4	237
141	58.00	13	AV13	24.2	11.0	5.8	27	48.7	237
			STD	0.4	0.2	0.1	1	0.3	4
			MAX	24.9	11.5	5.9	29	49.2	243
			MIN	23.6	10.7	5.7	26	48.2	229
154	59.00	13	AV13	24.2	11.1	5.8	28	48.6	235
			STD	0.6	0.7	0.2	1	0.6	16
			MAX	25.4	12.5	6.1	30	49.5	260
			MIN	23.3	10.4	5.6	26	47.5	214
167	60.00	13	AV13	24.7	11.6	5.9	29	48.2	247
			STD	0.6	0.6	0.2	1	0.6	12
			MAX	25.4	12.5	6.1	30	49.3	267
			MIN	23.6	10.8	5.7	26	47.4	227
180	61.00	13	AV13	24.4	11.0	5.8	28	48.6	230
			STD	0.6	0.2	0.1	1	0.5	6

USH 10 - B-70-403 - Pier 9 #1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	25.7	11.3	6.1	30	49.6	245
			MIN	23.6	10.6	5.6	25	47.6	219
193	62.00	13	AV13	24.5	10.7	5.8	28	48.7	224
			STD	0.3	0.2	0.1	1	0.3	6
			MAX	25.3	11.1	6.0	31	49.2	234
			MIN	24.0	10.4	5.7	26	47.9	214
206	63.00	13	AV13	24.4	10.8	5.8	28	48.6	220
			STD	0.4	0.1	0.1	1	0.4	5
			MAX	25.1	11.1	6.0	29	49.4	228
			MIN	23.5	10.7	5.6	27	48.0	214
220	64.00	14	AV14	24.6	11.2	5.8	28	48.5	229
			STD	0.5	0.2	0.1	1	0.5	9
			MAX	25.3	11.4	6.0	29	49.6	249
			MIN	23.7	10.8	5.6	25	47.8	217
234	65.00	14	AV14	25.4	12.5	6.1	29	47.7	257
			STD	0.6	0.4	0.1	1	0.5	8
			MAX	26.1	13.4	6.2	31	48.7	270
			MIN	24.1	11.9	5.8	27	47.2	238
248	66.00	14	AV14	25.9	12.4	6.2	30	47.3	254
			STD	0.5	0.3	0.1	1	0.4	4
			MAX	26.8	12.9	6.3	32	48.2	262
			MIN	25.2	11.9	5.9	28	46.7	244
262	67.00	14	AV14	26.0	12.4	6.2	31	47.2	254
			STD	0.3	0.5	0.1	0	0.3	8
			MAX	26.7	13.5	6.4	31	47.6	269
			MIN	25.5	11.6	6.1	30	46.5	240
276	68.00	14	AV14	25.5	12.0	6.1	30	47.5	240
			STD	0.4	0.3	0.1	1	0.4	6
			MAX	26.0	12.8	6.3	31	48.2	249
			MIN	24.9	11.6	5.9	27	47.0	228
288	69.00	12	AV12	26.0	12.1	6.2	31	47.1	232
			STD	0.5	0.3	0.1	1	0.5	8
			MAX	26.9	12.6	6.5	33	47.9	244

USH 10 - B-70-403 - Pier 9 #1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	25.2	11.3	6.0	29	46.1	216
300	70.00	12	AV12	24.6	10.5	5.9	28	48.5	186
			STD	0.7	0.6	0.2	1	0.7	14
			MAX	25.8	11.3	6.2	30	49.3	210
			MIN	23.9	9.6	5.7	27	47.2	165
313	71.00	13	AV13	25.5	11.6	6.1	30	47.5	225
			STD	0.5	0.2	0.1	1	0.5	4
			MAX	26.6	11.9	6.4	31	48.4	232
			MIN	24.7	11.3	5.9	27	46.6	217
326	72.00	13	AV13	25.6	11.8	6.1	30	47.4	226
			STD	0.4	0.1	0.1	1	0.4	4
			MAX	26.4	12.0	6.3	32	48.0	232
			MIN	25.1	11.5	6.0	29	46.7	219
339	73.00	13	AV13	25.4	11.6	6.1	30	47.6	217
			STD	0.4	0.2	0.1	1	0.4	5
			MAX	26.2	12.0	6.3	31	48.3	225
			MIN	24.7	11.2	5.9	28	46.8	210
352	74.00	13	AV13	25.4	11.2	6.1	30	47.7	212
			STD	0.4	0.2	0.1	1	0.3	4
			MAX	26.4	11.4	6.3	31	48.1	219
			MIN	24.8	10.8	6.0	29	47.0	203
365	75.00	13	AV13	25.2	10.9	6.0	29	48.1	206
			STD	0.6	0.1	0.1	1	0.5	5
			MAX	25.8	11.2	6.1	30	49.4	214
			MIN	23.4	10.7	5.6	26	47.5	197
378	76.00	13	AV13	25.2	10.9	6.0	29	48.0	205
			STD	0.6	0.2	0.1	1	0.5	3
			MAX	26.0	11.4	6.2	30	48.9	210
			MIN	24.1	10.7	5.8	27	47.2	198
391	77.00	13	AV13	25.4	11.4	6.1	29	47.7	216
			STD	0.6	0.5	0.2	1	0.6	12
			MAX	26.7	12.4	6.4	32	48.9	238
			MIN	24.5	10.7	5.8	27	46.6	197

USH 10 - B-70-403 - Pier 9 #1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
404	78.00	13	AV13	25.9	12.4	6.2	30	47.3	242
			STD	0.6	0.2	0.1	1	0.5	9
			MAX	27.2	13.0	6.5	33	48.5	261
			MIN	24.6	12.0	5.9	27	46.2	228
417	79.00	13	AV13	25.0	11.2	6.0	29	48.0	203
			STD	0.5	0.3	0.1	1	0.5	8
			MAX	26.1	11.8	6.2	31	49.4	219
			MIN	23.8	10.8	5.6	26	47.3	194
430	80.00	13	AV13	25.5	12.2	6.1	29	47.6	223
			STD	0.7	0.9	0.2	1	0.6	18
			MAX	26.5	13.9	6.4	31	48.7	253
			MIN	24.2	11.1	5.8	27	46.6	196
448	81.00	18	AV18	26.9	15.6	6.5	30	46.3	315
			STD	0.5	1.1	0.1	1	0.4	32
			MAX	27.9	17.0	6.7	32	47.2	358
			MIN	25.9	13.6	6.2	28	45.5	260
469	82.00	21	AV21	27.6	19.0	6.7	32	45.6	391
			STD	0.6	1.2	0.2	1	0.5	25
			MAX	28.8	21.3	7.0	35	46.4	445
			MIN	26.5	17.6	6.4	29	44.4	366
491	83.00	22	AV22	27.9	19.3	6.8	32	45.1	414
			STD	0.8	1.6	0.3	2	0.8	31
			MAX	29.5	21.6	7.3	37	46.5	462
			MIN	26.5	17.1	6.4	29	43.6	372
516	84.00	25	AV25	28.1	20.1	6.8	32	45.1	428
			STD	0.6	0.9	0.2	1	0.5	14
			MAX	29.2	21.8	7.1	34	46.2	455
			MIN	26.8	18.5	6.5	30	44.2	400
537	85.00	21	AV21	27.9	19.7	6.8	32	45.3	412
			STD	0.3	0.5	0.1	1	0.3	10
			MAX	28.3	21.2	6.9	33	45.8	433
			MIN	27.4	19.0	6.6	30	44.9	397

USH 10 - B-70-403 - Pier 9 #1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
562	86.00	25	AV25	28.7	22.2	7.0	33	44.5	468
			STD	0.8	2.5	0.2	2	0.6	42
			MAX	30.6	26.5	7.5	37	45.5	551
			MIN	27.5	18.1	6.7	31	43.2	405
600	87.00	38	AV38	29.4	25.9	7.3	34	43.8	541
			STD	0.7	0.8	0.2	1	0.6	22
			MAX	31.1	27.5	7.7	37	45.6	585
			MIN	27.4	24.2	6.7	30	42.5	500
636	88.00	36	AV36	29.0	25.7	7.1	33	44.2	528
			STD	0.4	0.6	0.1	1	0.3	18
			MAX	29.8	27.1	7.4	35	44.8	567
			MIN	28.2	24.5	6.9	31	43.5	498
652	88.35	45	AV16	30.5	27.3	7.5	36	43.0	581
			STD	0.5	0.4	0.1	1	0.4	11
			MAX	31.5	28.0	7.9	39	43.7	602
			MIN	29.6	26.4	7.3	34	42.1	567
662	88.50	67	AV10	29.8	27.0	7.3	34	43.6	566
			STD	0.3	0.7	0.1	1	0.3	7
			MAX	30.5	28.7	7.5	35	44.0	578
			MIN	29.4	25.9	7.2	33	43.0	556
672	88.69	53	AV10	30.7	29.5	7.6	36	42.9	622
			STD	0.9	1.4	0.2	2	0.7	24
			MAX	32.1	32.5	8.0	39	43.9	661
			MIN	29.4	27.1	7.2	34	41.8	582
682	88.92	44	AV10	31.4	30.4	7.8	37	42.3	640
			STD	0.4	0.6	0.1	1	0.4	9
			MAX	32.0	31.7	8.0	39	42.8	655
			MIN	30.7	29.6	7.6	36	41.7	625
			Average	25.8	15.3	6.3	30	47.2	313
			Std. Dev.	3.3	6.7	0.8	4	3.2	146
			Maximum	32.1	32.5	8.0	45	66.2	661
			Minimum	2.5	0.6	3.0	1	41.7	0

Total number of blows analyzed: 677

BL#	Sensors
1-682	F3: [H880] 93.7 (1.00); F4: [F607] 93.6 (1.00); A3: [K2253] 325.0 (1.13); A4: [K2524] 360.0 (1.13)

BL#	Comments
3	Reported reference EL 740.7

Time Summary

Drive	15 minutes 16 seconds	1:49 PM - 2:05 PM BN 1 - 682

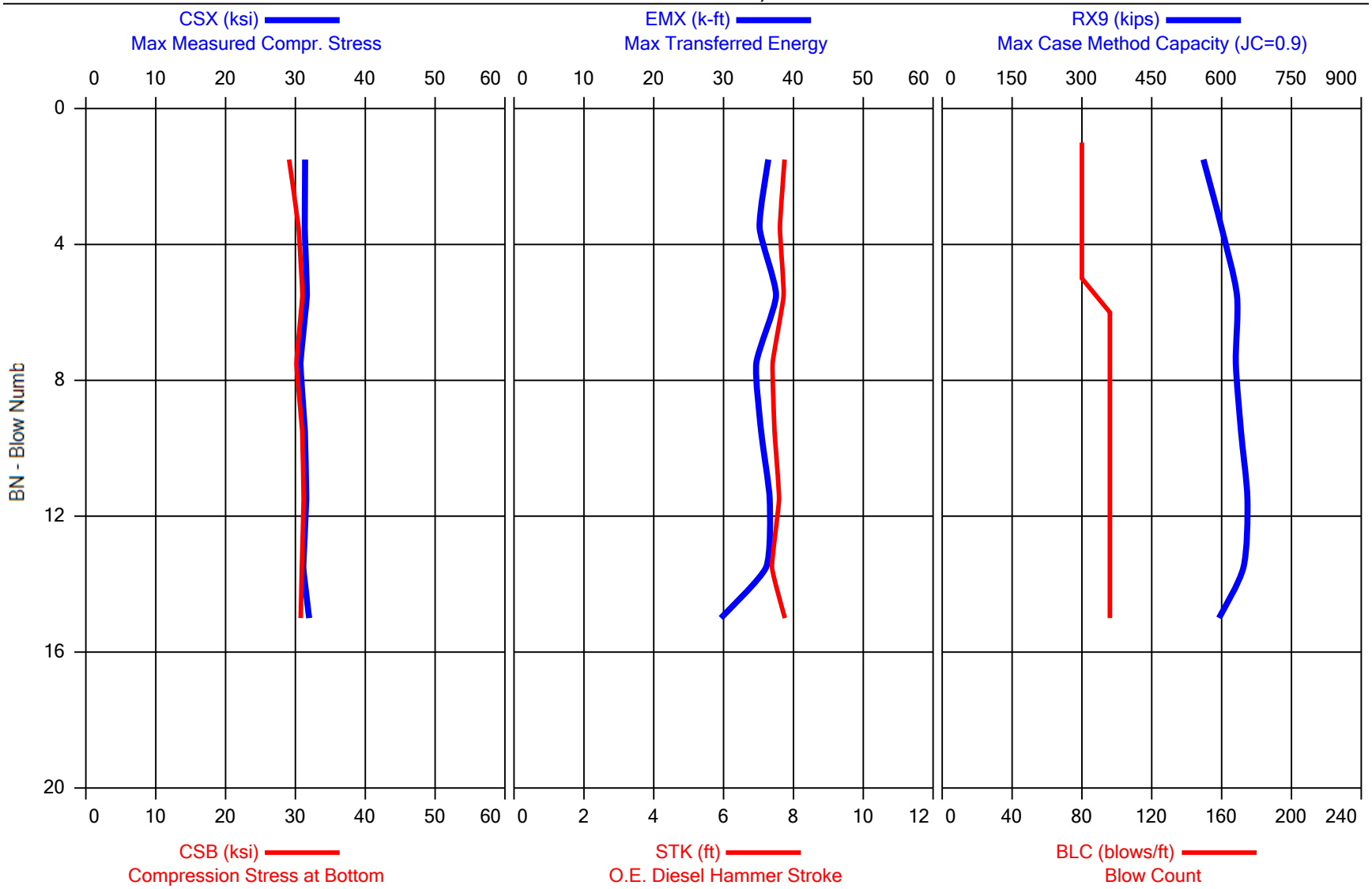
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 15-January-2015

Test started: 15-January-2015

USH 10 - B-70-403 - Pier 9 #1 - BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 9 #1 - BOR APE D30-42, HP 14 x 73
OP: AZ Date: 15-January-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.75 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.35 []

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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
5	89	80	AV4	31.4	30.4	7.7	36	42.6	602
			STD	0.9	0.3	0.3	2	0.8	13
			MAX	32.3	30.7	8.1	39	43.6	620
			MIN	30.3	29.9	7.3	33	41.6	588
10	89	96	AV5	31.3	30.7	7.5	36	43.0	638
			STD	0.7	0.6	0.2	2	0.5	7
			MAX	32.5	31.5	7.9	39	43.5	646
			MIN	30.5	30.1	7.4	34	42.0	630
15	89	96	AV5	31.5	31.0	7.5	35	43.0	640
			STD	0.4	0.3	0.2	3	0.5	23
			MAX	32.0	31.5	7.8	37	43.6	658
			MIN	30.9	30.8	7.3	30	42.4	594
			Average	31.4	30.7	7.6	36	42.9	628
			Std. Dev.	0.7	0.5	0.2	2	0.6	23
			Maximum	32.5	31.5	8.1	39	43.6	658
			Minimum	30.3	29.9	7.3	30	41.6	588

Total number of blows analyzed: 14

BL# Sensors

1-15 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.12); A4: [K2524] 360.0 (1.12)

Time Summary

Drive 19 seconds 8:16 AM - 8:16 AM BN 1 - 15

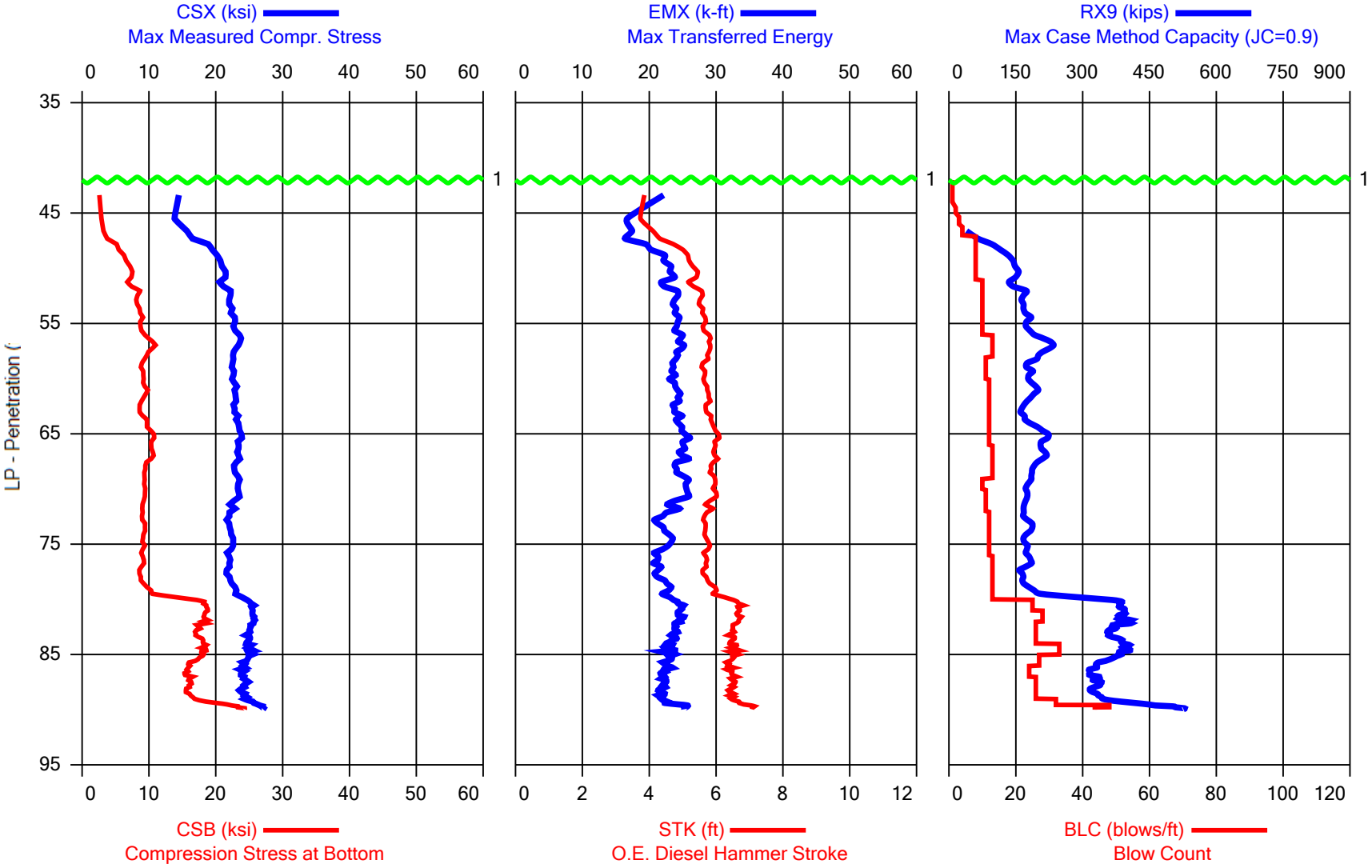
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 15-January-2015

Test started: 14-January-2015

USH 10 - B-70-403 - Pier 9 #36 - EOID

APE D30-42, HP 14 x 73



1 - Reported reference EL 740.7

USH 10 - B-70-403 - Pier 9 #36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.66 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.10 []

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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
3	42.00	1	AV1	15.1	2.5	4.0	24	58.2	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	15.1	2.5	4.0	24	58.2	0
			MIN	15.1	2.5	4.0	24	58.2	0
4	43.00	1	AV1	15.2	2.3	3.9	23	58.4	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	15.2	2.3	3.9	23	58.4	0
			MIN	15.2	2.3	3.9	23	58.4	0
5	44.00	1	AV1	13.7	2.6	3.7	23	60.1	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	13.7	2.6	3.7	23	60.1	0
			MIN	13.7	2.6	3.7	23	60.1	0
6	44.50	2	AV1	14.0	2.8	3.8	18	59.5	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	14.0	2.8	3.8	18	59.5	0
			MIN	14.0	2.8	3.8	18	59.5	0
7	45.00	2	AV1	14.1	2.6	3.7	17	59.8	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	14.1	2.6	3.7	17	59.8	0
			MIN	14.1	2.6	3.7	17	59.8	0
8	45.33	3	AV1	12.1	2.9	3.6	15	61.1	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	12.1	2.9	3.6	15	61.1	0
			MIN	12.1	2.9	3.6	15	61.1	0
10	46.00	3	AV2	14.5	3.0	3.8	17	59.4	0
			STD	0.0	0.3	0.0	0	0.1	0
			MAX	14.6	3.3	3.8	17	59.4	0
			MIN	14.5	2.7	3.8	17	59.3	0

USH 10 - B-70-403 - Pier 9 #36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
14	47.00	4	AV4	15.7	3.2	4.1	17	57.3	39
			STD	0.3	0.1	0.1	0	0.4	7
			MAX	16.1	3.3	4.2	18	57.9	48
			MIN	15.3	3.1	4.0	17	56.9	29
22	48.00	8	AV8	17.7	4.5	4.5	18	54.9	80
			STD	1.3	0.8	0.2	2	1.3	18
			MAX	19.4	5.5	4.8	20	57.2	99
			MIN	15.7	3.3	4.1	15	53.2	53
30	49.00	8	AV8	19.8	5.9	5.1	21	51.9	124
			STD	0.5	0.5	0.2	1	0.7	12
			MAX	20.7	6.4	5.3	23	53.1	136
			MIN	19.1	5.1	4.8	19	50.9	101
38	50.00	8	AV8	20.8	6.9	5.2	23	51.1	146
			STD	0.4	0.3	0.1	1	0.4	5
			MAX	21.3	7.4	5.4	24	51.8	153
			MIN	20.1	6.4	5.1	21	50.5	136
46	51.00	8	AV8	21.5	7.4	5.4	23	50.3	153
			STD	0.8	0.3	0.2	2	0.8	4
			MAX	22.7	7.7	5.7	26	51.8	158
			MIN	20.3	6.9	5.1	20	49.1	147
56	52.00	10	AV10	21.1	7.4	5.3	22	50.9	145
			STD	0.7	0.7	0.1	1	0.6	14
			MAX	22.6	8.7	5.6	24	51.8	171
			MIN	20.1	6.5	5.1	21	49.5	131
66	53.00	10	AV10	22.2	8.3	5.6	24	49.6	168
			STD	0.7	0.3	0.2	1	0.8	7
			MAX	23.3	8.8	5.9	26	50.6	182
			MIN	21.1	8.0	5.4	22	48.4	157
76	54.00	10	AV10	22.3	8.5	5.6	24	49.7	168
			STD	0.5	0.3	0.1	1	0.5	4
			MAX	22.9	9.1	5.8	26	50.4	176
			MIN	21.6	8.1	5.4	23	48.6	162
86	55.00	10	AV10	22.7	8.8	5.6	24	49.4	177
			STD	0.5	0.3	0.1	1	0.5	7

USH 10 - B-70-403 - Pier 9 #36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
			MAX	23.4	9.2	5.8	25	50.5	190
			MIN	21.5	8.5	5.4	22	48.7	167
96	56.00	10	AV10	22.9	8.9	5.7	24	49.3	179
			STD	0.5	0.2	0.1	1	0.5	7
			MAX	23.7	9.5	5.9	25	50.2	187
			MIN	22.1	8.6	5.4	23	48.4	162
109	57.00	13	AV13	23.6	10.3	5.8	25	48.7	220
			STD	0.3	0.6	0.1	1	0.3	14
			MAX	24.1	11.2	6.0	26	49.1	242
			MIN	23.1	9.3	5.7	24	48.0	197
122	58.00	13	AV13	22.8	10.1	5.8	24	48.8	213
			STD	0.3	0.5	0.1	1	0.4	12
			MAX	23.7	11.0	6.0	27	49.5	236
			MIN	22.3	9.5	5.6	23	47.9	197
133	59.00	11	AV11	22.5	9.0	5.7	24	49.3	183
			STD	0.3	0.3	0.1	1	0.5	12
			MAX	23.2	9.5	6.0	25	49.9	207
			MIN	22.2	8.6	5.5	23	48.1	169
144	60.00	11	AV11	22.6	9.2	5.6	24	49.3	182
			STD	0.4	0.1	0.1	1	0.4	5
			MAX	23.1	9.4	5.8	25	50.2	193
			MIN	22.0	8.9	5.4	22	48.7	176
156	61.00	12	AV12	22.8	9.3	5.7	24	49.2	189
			STD	0.5	0.2	0.1	1	0.4	8
			MAX	23.8	9.7	5.9	25	50.1	203
			MIN	22.1	9.0	5.5	23	48.4	177
168	62.00	12	AV12	23.0	9.4	5.8	25	48.7	188
			STD	0.4	0.4	0.1	1	0.5	9
			MAX	23.7	10.2	6.0	26	49.5	204
			MIN	22.4	8.8	5.6	23	48.0	172
180	63.00	12	AV12	22.8	8.6	5.7	24	49.1	166
			STD	0.5	0.2	0.1	1	0.5	5
			MAX	23.6	8.9	5.9	25	49.9	174
			MIN	22.0	8.2	5.5	23	48.2	157

USH 10 - B-70-403 - Pier 9 #36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
192	64.00	12	AV12	23.1	9.3	5.8	24	48.7	169
			STD	0.4	0.4	0.1	1	0.6	5
			MAX	23.9	10.1	6.1	26	49.5	178
			MIN	22.4	8.8	5.6	23	47.4	161
204	65.00	12	AV12	23.6	10.1	6.0	25	48.0	205
			STD	0.3	0.4	0.1	0	0.4	11
			MAX	24.1	10.8	6.2	26	48.5	224
			MIN	23.0	9.6	5.9	24	47.3	183
216	66.00	12	AV12	23.7	10.6	6.0	26	47.8	215
			STD	0.5	0.2	0.1	1	0.5	8
			MAX	24.6	10.8	6.2	28	48.8	225
			MIN	22.8	10.2	5.8	24	47.3	204
229	67.00	13	AV13	23.4	10.5	6.0	25	48.1	213
			STD	0.2	0.2	0.1	1	0.3	7
			MAX	23.7	10.8	6.1	26	48.5	222
			MIN	23.0	10.0	5.9	24	47.5	200
242	68.00	13	AV13	23.1	9.9	5.9	25	48.2	201
			STD	0.4	0.5	0.1	1	0.4	9
			MAX	23.8	10.7	6.1	26	48.9	216
			MIN	22.5	9.1	5.8	23	47.4	187
255	69.00	13	AV13	23.0	9.4	5.9	24	48.4	187
			STD	0.4	0.1	0.1	1	0.5	4
			MAX	23.6	9.5	6.1	26	49.5	194
			MIN	22.3	9.2	5.6	23	47.6	180
265	70.00	10	AV10	23.4	9.3	6.0	26	48.1	176
			STD	0.4	0.1	0.1	1	0.5	5
			MAX	24.5	9.6	6.2	27	48.7	182
			MIN	22.9	9.2	5.8	25	47.1	169
276	71.00	11	AV11	23.4	9.4	6.0	26	48.0	175
			STD	0.3	0.2	0.1	1	0.3	3
			MAX	24.2	9.7	6.2	27	48.5	180
			MIN	23.0	9.1	5.9	24	47.3	170
287	72.00	11	AV11	22.5	9.0	5.8	23	48.8	169

USH 10 - B-70-403 - Pier 9 #36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
			STD	0.5	0.1	0.1	1	0.5	2
			MAX	23.4	9.1	6.1	26	49.6	173
			MIN	21.7	8.8	5.6	22	47.6	165
299	73.00	12	AV12	21.9	9.0	5.7	22	49.3	172
			STD	0.3	0.2	0.1	1	0.3	7
			MAX	22.3	9.5	5.8	23	49.7	185
			MIN	21.5	8.7	5.6	20	48.6	163
311	74.00	12	AV12	22.1	9.4	5.7	22	49.2	185
			STD	0.2	0.1	0.0	1	0.1	4
			MAX	22.4	9.6	5.7	23	49.4	188
			MIN	21.7	9.3	5.6	21	49.0	176
323	75.00	12	AV12	22.5	9.1	5.7	23	49.0	169
			STD	0.4	0.2	0.1	1	0.5	3
			MAX	23.1	9.4	6.0	24	49.8	175
			MIN	21.9	8.8	5.5	22	48.1	164
335	76.00	12	AV12	22.2	9.1	5.7	22	49.0	175
			STD	0.5	0.3	0.1	1	0.4	3
			MAX	22.9	9.7	5.9	24	49.6	181
			MIN	21.5	8.7	5.6	20	48.3	171
348	77.00	13	AV13	22.0	9.2	5.7	21	49.1	183
			STD	0.2	0.2	0.1	1	0.2	4
			MAX	22.4	9.5	5.8	22	49.4	188
			MIN	21.7	8.8	5.6	20	48.7	174
361	78.00	13	AV13	21.8	8.6	5.6	21	49.3	163
			STD	0.4	0.2	0.1	1	0.4	5
			MAX	22.8	9.0	5.9	23	49.9	169
			MIN	21.2	8.4	5.5	20	48.4	152
374	79.00	13	AV13	22.4	9.2	5.8	23	48.6	170
			STD	0.6	0.4	0.2	1	0.7	8
			MAX	23.6	9.9	6.2	25	49.3	187
			MIN	21.6	8.6	5.7	21	47.3	161
387	80.00	13	AV13	23.4	11.9	6.1	23	47.6	237
			STD	0.6	2.1	0.2	1	0.7	53
			MAX	24.4	16.0	6.4	24	48.6	340

USH 10 - B-70-403 - Pier 9 #36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	22.7	10.0	5.8	21	46.4	187
412	81.00	25	AV25	25.3	18.4	6.7	25	45.5	385
			STD	0.4	0.5	0.1	1	0.3	8
			MAX	26.1	19.5	6.9	26	46.5	402
			MIN	24.3	17.0	6.4	23	44.8	366
440	82.00	28	AV28	25.6	18.4	6.7	25	45.6	390
			STD	0.3	0.4	0.1	1	0.3	11
			MAX	26.4	19.0	6.9	27	46.2	415
			MIN	25.1	17.4	6.5	23	44.9	370
466	83.00	26	AV26	25.3	17.5	6.5	24	46.0	374
			STD	0.4	0.7	0.1	1	0.4	18
			MAX	26.1	18.9	6.8	26	46.6	415
			MIN	24.8	16.7	6.4	23	45.3	350
492	84.00	26	AV26	24.8	17.6	6.5	23	46.3	375
			STD	0.4	0.5	0.1	1	0.4	14
			MAX	25.6	18.5	6.7	25	47.3	399
			MIN	23.9	16.5	6.2	22	45.5	346
525	85.00	33	AV33	25.1	18.2	6.6	23	46.0	394
			STD	0.5	0.4	0.2	1	0.6	10
			MAX	26.1	19.1	6.9	25	46.8	413
			MIN	24.3	17.5	6.3	22	44.9	377
552	86.00	27	AV27	24.6	16.9	6.4	23	46.4	354
			STD	0.4	0.8	0.1	1	0.3	19
			MAX	25.2	18.3	6.6	25	47.2	384
			MIN	23.6	15.5	6.2	21	45.7	327
576	87.00	24	AV24	24.0	15.8	6.5	22	46.3	321
			STD	0.6	0.4	0.2	1	0.6	9
			MAX	25.3	17.1	6.8	24	47.5	344
			MIN	23.1	15.0	6.1	21	45.2	307
602	88.00	26	AV26	24.4	16.2	6.5	22	46.1	333
			STD	0.6	0.3	0.2	1	0.5	9
			MAX	25.6	16.7	6.8	24	47.0	350
			MIN	23.6	15.4	6.3	20	45.1	318

USH 10 - B-70-403 - Pier 9 #36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
628	89.00	26	AV26	24.1	16.0	6.5	22	46.3	329
			STD	0.5	0.5	0.1	1	0.5	11
			MAX	25.1	16.9	6.8	24	47.1	348
			MIN	23.0	15.2	6.2	20	45.2	311
646	89.56	32	AV18	25.4	19.2	6.7	23	45.7	397
			STD	0.9	1.8	0.2	1	0.7	36
			MAX	27.1	22.0	7.0	26	46.9	454
			MIN	23.7	16.5	6.3	21	44.4	348
656	89.77	48	AV10	27.0	22.9	7.1	26	44.2	487
			STD	0.4	0.5	0.1	1	0.3	23
			MAX	27.7	23.7	7.2	27	44.7	523
			MIN	26.5	22.2	6.9	25	43.8	454
666	90.00	44	AV10	27.0	24.1	7.1	25	44.4	524
			STD	0.5	0.5	0.2	1	0.5	8
			MAX	28.0	24.9	7.4	27	45.1	536
			MIN	25.9	23.3	6.8	24	43.4	512
			Average	23.4	12.7	6.0	23	47.9	259
			Std. Dev.	2.0	4.8	0.6	2	2.4	108
			Maximum	28.0	24.9	7.4	28	61.1	536
			Minimum	12.1	2.3	3.6	15	43.4	0

Total number of blows analyzed: 664

BL# Sensors

1-666 F3: [H880] 93.7 (1.00); F4: [F607] 93.6 (1.00); A3: [K2253] 325.0 (1.00); A4: [K2524] 360.0 (1.00)

BL# Comments

3 Reported reference EL 740.7

Time Summary

Drive 14 minutes 11 seconds 1:15 PM - 1:29 PM BN 1 - 666

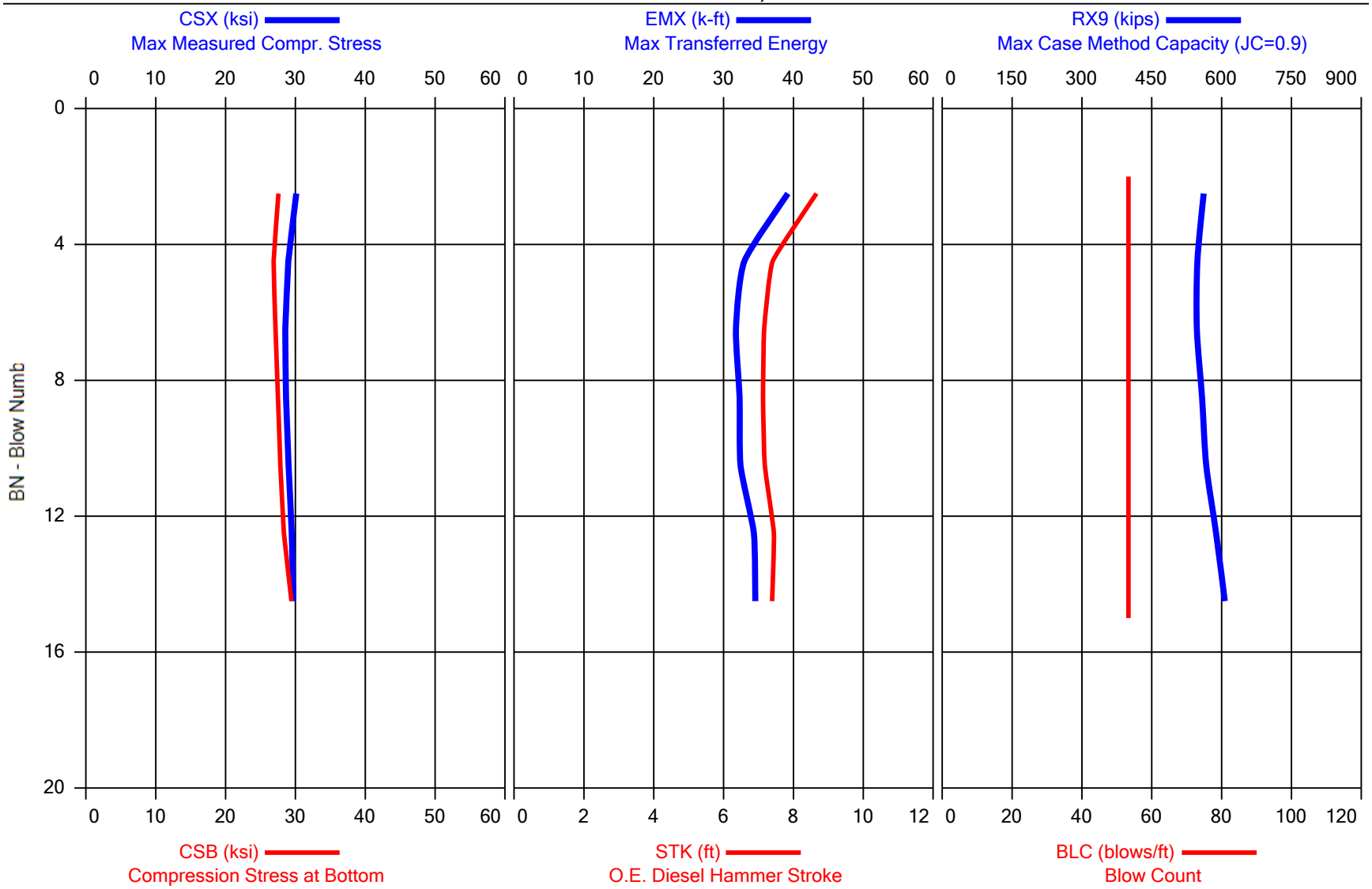
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 15-January-2015

Test started: 15-January-2015

USH 10 - B-70-403 - Pier 9 #36 - BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 9 #36 - BOR APE D30-42, HP 14 x 73
OP: AZ Date: 15-January-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.66 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.10 []

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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
5	90.09	53	AV4	29.5	27.2	8.0	36	41.8	555
			STD	1.3	0.4	0.6	4	1.6	12
			MAX	31.5	27.6	8.7	41	43.5	575
			MIN	28.0	26.6	7.4	32	40.0	546
10	90.19	53	AV5	28.7	27.5	7.2	32	44.1	555
			STD	0.3	0.4	0.0	1	0.1	11
			MAX	29.1	28.0	7.2	33	44.2	567
			MIN	28.3	26.8	7.1	31	43.9	536
15	90.28	53	AV5	29.4	28.6	7.4	34	43.5	592
			STD	0.4	0.7	0.2	1	0.5	14
			MAX	30.2	29.6	7.6	35	44.1	608
			MIN	28.9	27.6	7.1	32	42.9	570
			Average	29.2	27.8	7.5	34	43.2	568
			Std. Dev.	0.9	0.8	0.5	3	1.3	22
			Maximum	31.5	29.6	8.7	41	44.2	608
			Minimum	28.0	26.6	7.1	31	40.0	536

Total number of blows analyzed: 14

BL# Sensors

1-15 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.11); A4: [K3550] 360.0 (1.11)

Time Summary

Drive 19 seconds 8:04 AM - 8:05 AM BN 1 - 15

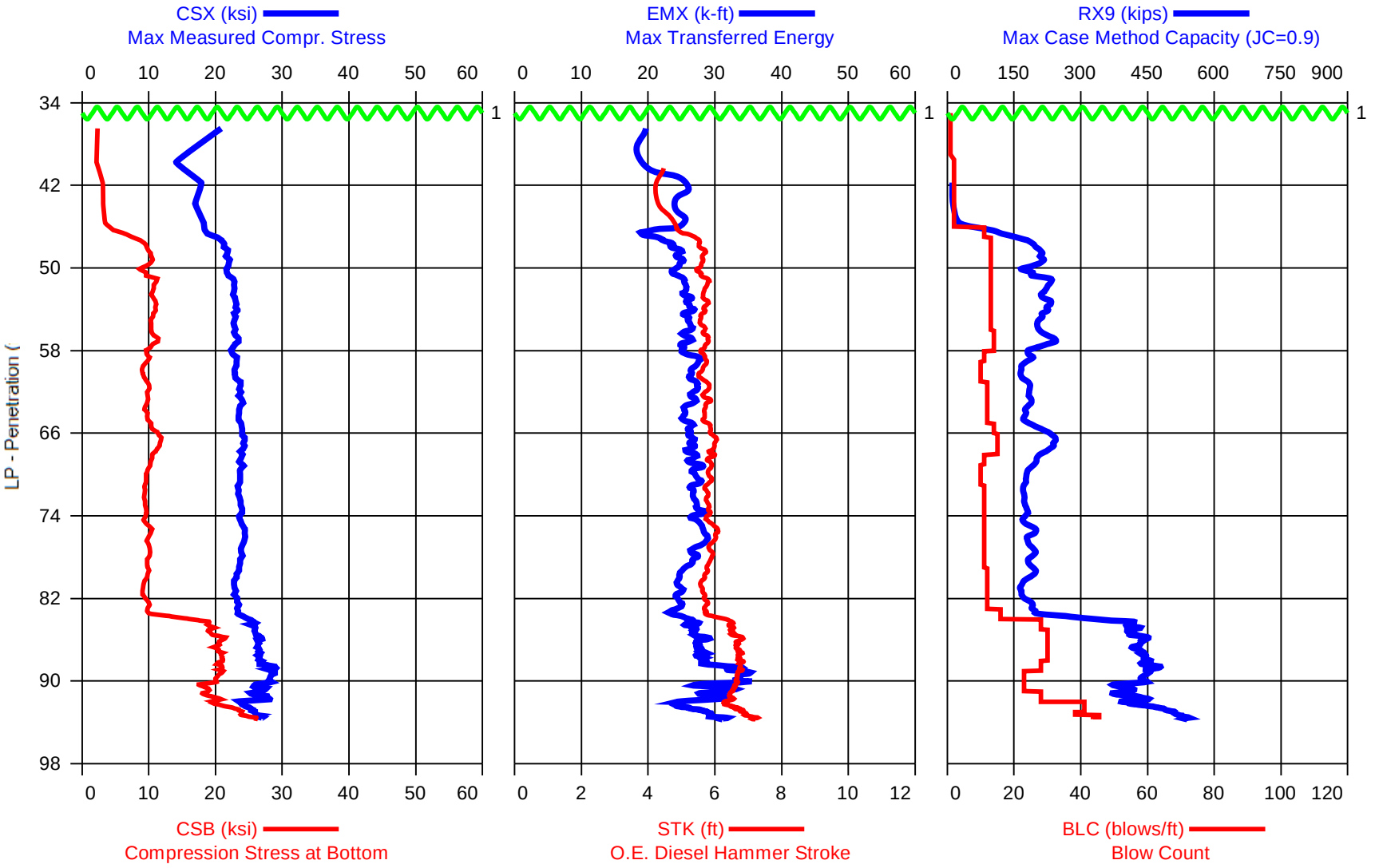
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 14-January-2015

Test started: 14-January-2015

USH 10 - B-70-403 - Pier 9 #44 - EOID

APE D30-42, HP 14 x 73



1 - Reported reference EL 740.7

USH 10 - B-70-403 - Pier 9 #44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.00 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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
1	35.00	1	AV1	18.9	1.9	**	16	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	18.9	1.9	**	16	**	0
			MIN	18.9	1.9	**	16	**	0
2	36.00	1	AV1	21.1	2.2	**	19	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	21.1	2.2	**	19	**	0
			MIN	21.1	2.2	**	19	**	0
3	37.00	1	AV1	21.7	2.4	**	22	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	21.7	2.4	**	22	**	0
			MIN	21.7	2.4	**	22	**	0
4	38.00	1	AV1	21.7	2.6	**	22	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	21.7	2.6	**	22	**	0
			MIN	21.7	2.6	**	22	**	0
5	39.00	1	AV1	22.4	2.6	**	31	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	22.4	2.6	**	31	**	0
			MIN	22.4	2.6	**	31	**	0
7	40.00	2	AV2	14.5	2.3	4.3	20	56.2	0
			STD	1.3	0.1	0.3	4	1.9	0
			MAX	15.8	2.3	4.6	24	58.0	0
			MIN	13.3	2.2	4.0	16	54.3	0
9	41.00	2	AV2	13.6	2.6	3.1	20	65.6	24
			STD	8.6	1.0	0.0	15	0.0	24
			MAX	22.2	3.6	3.1	36	65.6	47
			MIN	4.9	1.5	3.1	5	65.6	0

USH 10 - B-70-403 - Pier 9 #44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
11	42.00	2	AV2	20.8	3.4	5.5	30	50.2	0
			STD	2.8	0.3	0.7	6	2.9	0
			MAX	23.5	3.7	6.2	36	53.1	0
			MIN	18.0	3.1	4.8	24	47.2	0
13	43.00	2	AV2	14.9	2.7	3.3	17	63.4	19
			STD	7.1	0.8	0.0	10	0.0	19
			MAX	22.0	3.5	3.3	27	63.4	38
			MIN	7.8	2.0	3.3	7	63.4	0
15	44.00	2	AV2	14.5	2.9	4.4	23	55.6	0
			STD	1.6	0.2	0.2	3	1.3	0
			MAX	16.0	3.1	4.6	26	56.8	0
			MIN	12.9	2.7	4.2	20	54.3	0
17	45.00	2	AV2	13.4	2.7	4.0	16	58.7	7
			STD	3.5	0.6	0.6	7	3.9	6
			MAX	16.9	3.2	4.5	23	62.6	13
			MIN	10.0	2.1	3.4	9	54.8	0
19	46.00	2	AV2	23.9	4.2	6.7	39	45.5	26
			STD	1.3	0.3	0.0	0	0.0	26
			MAX	25.2	4.5	6.7	40	45.5	52
			MIN	22.6	3.9	6.7	39	45.5	0
30	47.00	11	AV11	18.4	5.6	5.0	19	52.8	113
			STD	5.0	1.5	0.9	8	4.9	34
			MAX	25.4	7.4	6.7	32	64.8	159
			MIN	5.8	2.2	3.1	3	45.6	38
43	48.00	13	AV13	21.2	9.1	5.5	23	49.8	185
			STD	0.4	0.6	0.1	1	0.6	13
			MAX	21.9	9.9	5.8	25	51.0	198
			MIN	20.2	8.2	5.3	21	48.6	160
56	49.00	13	AV13	21.7	10.1	5.7	24	49.3	210
			STD	0.4	0.3	0.1	1	0.3	5
			MAX	22.5	10.5	5.8	26	50.0	216
			MIN	21.1	9.5	5.5	23	48.9	201
69	50.00	13	AV13	22.0	10.1	5.6	25	49.5	203

USH 10 - B-70-403 - Pier 9 #44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			STD	0.3	0.5	0.1	1	0.3	14
			MAX	22.8	10.7	5.7	26	50.0	218
			MIN	21.6	9.2	5.5	23	49.0	172
82	51.00	13	AV13	21.8	9.5	5.6	24	49.7	190
			STD	0.5	1.0	0.1	1	0.5	21
			MAX	22.8	11.7	5.8	27	50.6	231
			MIN	21.2	8.2	5.4	23	48.8	161
95	52.00	13	AV13	22.8	10.9	5.8	26	48.8	229
			STD	0.3	0.3	0.1	1	0.3	6
			MAX	23.3	11.6	6.0	27	49.3	239
			MIN	22.4	10.5	5.7	25	48.0	221
108	53.00	13	AV13	22.7	10.5	5.7	26	49.3	215
			STD	0.3	0.2	0.1	1	0.3	5
			MAX	23.2	11.0	5.8	28	49.9	224
			MIN	22.3	10.2	5.5	25	48.9	206
121	54.00	13	AV13	23.1	11.0	5.7	26	49.0	229
			STD	0.4	0.2	0.1	1	0.5	6
			MAX	23.7	11.3	6.1	27	49.5	239
			MIN	22.4	10.4	5.6	24	47.7	220
134	55.00	13	AV13	23.0	10.7	5.6	26	49.4	215
			STD	0.3	0.2	0.1	1	0.3	7
			MAX	23.6	11.1	5.8	27	49.9	227
			MIN	22.5	10.2	5.5	24	48.7	205
147	56.00	13	AV13	22.8	10.3	5.6	26	49.4	203
			STD	0.3	0.1	0.1	1	0.5	3
			MAX	23.5	10.5	5.9	28	50.1	209
			MIN	22.3	10.1	5.5	25	48.5	197
161	57.00	14	AV14	23.1	10.9	5.7	26	49.0	226
			STD	0.5	0.5	0.1	1	0.5	14
			MAX	24.3	11.6	6.1	29	49.6	249
			MIN	22.6	10.2	5.6	24	47.6	205
175	58.00	14	AV14	22.8	10.4	5.7	25	49.1	214
			STD	0.5	0.6	0.1	1	0.5	21

USH 10 - B-70-403 - Pier 9 #44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	23.6	11.4	5.9	26	50.1	245
			MIN	21.8	9.3	5.5	24	48.3	180
186	59.00	11	AV11	22.9	9.8	5.7	27	49.2	185
			STD	0.3	0.3	0.1	1	0.3	8
			MAX	23.4	10.2	5.9	28	49.8	195
			MIN	22.4	9.5	5.5	25	48.5	172
196	60.00	10	AV10	23.0	9.2	5.7	27	49.3	168
			STD	0.3	0.3	0.1	1	0.5	5
			MAX	23.6	9.7	5.8	28	49.9	175
			MIN	22.5	8.8	5.5	26	48.6	161
206	61.00	10	AV10	23.1	9.3	5.6	27	49.4	169
			STD	0.6	0.3	0.2	1	0.8	6
			MAX	24.4	10.0	6.1	29	50.4	180
			MIN	22.4	9.0	5.4	25	47.7	158
218	62.00	12	AV12	23.6	10.0	5.8	27	48.9	185
			STD	0.5	0.2	0.1	1	0.5	3
			MAX	24.4	10.2	6.0	29	49.6	191
			MIN	23.1	9.7	5.6	26	47.9	181
230	63.00	12	AV12	23.8	9.8	5.8	27	48.9	187
			STD	0.5	0.1	0.2	1	0.6	5
			MAX	24.6	10.0	6.0	28	49.7	196
			MIN	23.1	9.6	5.6	26	47.9	179
242	64.00	12	AV12	23.7	9.5	5.7	26	49.1	179
			STD	0.5	0.2	0.1	1	0.5	5
			MAX	24.4	9.8	5.9	27	49.7	188
			MIN	23.0	9.1	5.6	23	48.2	172
254	65.00	12	AV12	23.5	9.9	5.7	26	49.2	174
			STD	0.2	0.2	0.1	1	0.2	5
			MAX	23.8	10.2	5.8	27	49.5	181
			MIN	23.1	9.6	5.6	25	48.7	164
268	66.00	14	AV14	24.0	10.7	5.9	26	48.5	209
			STD	0.4	0.4	0.1	1	0.4	14
			MAX	24.9	11.4	6.1	28	49.0	233

USH 10 - B-70-403 - Pier 9 #44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	23.6	10.2	5.7	25	47.7	188
283	67.00	15	AV15	24.2	11.7	6.0	26	48.0	240
			STD	0.3	0.2	0.1	1	0.3	5
			MAX	25.1	12.0	6.2	28	48.7	246
			MIN	23.7	11.4	5.8	25	47.2	229
298	68.00	15	AV15	24.1	11.2	5.9	26	48.2	229
			STD	0.4	0.4	0.1	1	0.4	9
			MAX	24.7	11.7	6.1	28	48.8	243
			MIN	23.5	10.4	5.8	25	47.6	212
309	69.00	11	AV11	23.8	10.4	5.9	27	48.5	200
			STD	0.6	0.2	0.2	2	0.7	4
			MAX	24.9	10.6	6.2	30	49.3	205
			MIN	23.1	10.0	5.7	25	47.2	190
319	70.00	10	AV10	23.8	9.9	5.9	27	48.5	184
			STD	0.6	0.2	0.1	1	0.6	6
			MAX	25.0	10.3	6.2	30	49.3	196
			MIN	23.0	9.6	5.7	25	47.3	178
329	71.00	10	AV10	23.7	9.5	5.8	27	48.6	176
			STD	0.5	0.1	0.1	1	0.5	2
			MAX	24.7	9.8	6.1	30	49.1	179
			MIN	23.1	9.4	5.7	26	47.4	170
340	72.00	11	AV11	23.3	9.4	5.7	27	49.0	171
			STD	0.3	0.1	0.1	1	0.2	2
			MAX	23.8	9.6	5.9	28	49.3	175
			MIN	22.9	9.2	5.7	26	48.5	169
351	73.00	11	AV11	23.6	9.3	5.8	27	48.9	173
			STD	0.4	0.1	0.1	1	0.4	2
			MAX	24.5	9.5	6.0	28	49.5	175
			MIN	23.1	9.2	5.6	25	48.0	169
362	74.00	11	AV11	24.0	9.6	5.9	28	48.5	180
			STD	0.4	0.1	0.1	1	0.4	4
			MAX	24.4	10.0	6.0	30	49.2	185
			MIN	23.4	9.4	5.7	26	47.9	174

USH 10 - B-70-403 - Pier 9 #44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
373	75.00	11	AV11	23.8	9.5	5.8	27	48.6	174
			STD	0.6	0.4	0.2	1	0.6	5
			MAX	24.7	10.2	6.1	30	49.3	182
			MIN	23.1	9.1	5.7	26	47.6	166
384	76.00	11	AV9	24.4	10.3	6.1	29	47.7	196
			STD	0.5	0.3	0.1	1	0.4	10
			MAX	25.3	10.9	6.3	30	48.3	212
			MIN	23.7	9.9	5.9	27	47.0	178
395	77.00	11	AV11	24.1	9.8	5.9	28	48.2	182
			STD	0.4	0.2	0.1	1	0.5	3
			MAX	24.9	10.2	6.2	30	48.9	188
			MIN	23.4	9.5	5.8	26	47.3	178
406	78.00	11	AV11	23.9	10.2	5.9	27	48.3	195
			STD	0.5	0.2	0.1	1	0.5	4
			MAX	25.1	10.4	6.2	30	49.3	203
			MIN	23.1	9.8	5.7	25	47.2	187
417	79.00	11	AV11	23.6	9.7	5.8	26	48.7	184
			STD	0.3	0.2	0.1	1	0.3	4
			MAX	24.1	10.0	5.9	28	49.2	193
			MIN	23.2	9.4	5.7	26	48.3	179
429	80.00	12	AV12	23.3	9.9	5.7	25	48.9	194
			STD	0.3	0.2	0.1	0	0.3	5
			MAX	23.9	10.2	5.9	26	49.3	200
			MIN	23.0	9.6	5.7	24	48.4	184
441	81.00	12	AV12	22.8	9.3	5.6	24	49.6	170
			STD	0.4	0.2	0.1	1	0.5	6
			MAX	23.7	9.8	5.8	26	50.4	182
			MIN	22.1	9.0	5.4	23	48.7	164
453	82.00	12	AV12	23.0	9.1	5.7	25	49.3	168
			STD	0.5	0.2	0.1	1	0.6	5
			MAX	24.1	9.5	5.9	27	50.2	179
			MIN	22.2	8.8	5.4	22	48.2	161

USH 10 - B-70-403 - Pier 9 #44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
465	83.00	12	AV12	23.4	9.9	5.7	25	49.0	188
			STD	0.5	0.2	0.1	1	0.5	5
			MAX	24.1	10.3	5.9	26	49.8	199
			MIN	22.5	9.6	5.5	23	48.2	176
481	84.00	16	AV16	23.8	11.7	5.9	24	48.5	237
			STD	0.7	2.4	0.2	1	0.9	48
			MAX	25.3	16.0	6.4	27	49.5	325
			MIN	22.9	9.6	5.6	23	46.4	194
509	85.00	28	AV28	25.7	18.9	6.5	27	46.2	406
			STD	0.4	0.9	0.1	1	0.4	25
			MAX	26.4	20.6	6.8	29	47.3	443
			MIN	24.5	16.0	6.2	25	45.2	336
539	86.00	30	AV30	26.3	19.9	6.6	27	45.7	424
			STD	0.6	1.1	0.2	1	0.6	22
			MAX	27.7	22.2	7.0	30	46.7	467
			MIN	25.3	17.4	6.3	25	44.4	373
569	87.00	30	AV30	26.4	20.4	6.7	28	45.6	430
			STD	0.3	0.5	0.1	1	0.3	9
			MAX	27.2	21.2	6.9	30	46.0	442
			MIN	25.9	19.3	6.5	26	44.7	409
599	88.00	30	AV30	26.5	20.8	6.7	28	45.4	442
			STD	0.4	0.4	0.1	1	0.4	9
			MAX	27.5	21.6	7.0	31	46.1	458
			MIN	25.7	20.0	6.5	26	44.5	425
627	89.00	28	AV28	27.8	20.8	6.8	31	45.2	456
			STD	1.2	0.6	0.1	3	0.4	24
			MAX	29.8	22.0	7.0	36	46.0	507
			MIN	26.1	19.2	6.5	27	44.4	398
650	90.00	23	AV23	28.4	20.4	6.7	34	45.6	443
			STD	0.5	0.5	0.1	1	0.4	11
			MAX	29.5	21.2	6.9	36	46.1	463
			MIN	27.3	19.5	6.5	32	44.7	424
673	91.00	23	AV21	27.0	18.8	6.6	31	45.8	408

USH 10 - B-70-403 - Pier 9 #44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 14-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			STD	1.2	0.9	0.1	3	0.5	27
			MAX	28.9	20.5	6.8	35	46.5	459
			MIN	24.8	17.2	6.4	24	45.0	362
701	92.00	28	AV26	26.4	19.3	6.5	29	46.3	410
			STD	1.6	1.1	0.1	3	0.4	32
			MAX	28.7	21.4	6.6	33	47.3	469
			MIN	22.8	17.7	6.2	23	45.7	369
742	93.00	41	AV41	24.7	21.8	6.6	26	46.0	459
			STD	0.8	1.6	0.2	2	0.8	37
			MAX	26.2	24.3	7.0	30	47.6	520
			MIN	23.3	19.4	6.1	24	44.4	396
752	93.26	38	AV10	26.0	23.9	6.9	29	44.9	512
			STD	0.4	0.3	0.1	1	0.4	9
			MAX	26.5	24.2	7.0	31	45.6	525
			MIN	25.4	23.4	6.7	28	44.4	500
762	93.48	46	AV10	26.4	24.6	7.0	29	44.5	527
			STD	0.5	0.6	0.2	1	0.5	11
			MAX	27.3	25.7	7.4	32	45.2	548
			MIN	25.7	23.6	6.8	28	43.5	510
772	93.71	44	AV10	26.8	26.1	7.2	31	43.9	538
			STD	0.4	0.4	0.1	1	0.3	7
			MAX	27.7	26.8	7.4	33	44.5	550
			MIN	26.2	25.5	7.0	30	43.4	522
			Average	24.2	13.9	6.1	27	47.8	283
			Std. Dev.	2.5	5.6	0.6	3	2.3	131
			Maximum	29.8	26.8	7.4	40	65.6	550
			Minimum	4.9	1.5	3.1	3	43.4	0

Total number of blows analyzed: 766

BL#	Sensors
1-693	F3: [F607] 93.6 (1.00); F4: [F590] 95.0 (1.00); A3: [K2524] 360.0 (1.10); A4: [K2253] 325.0 (1.10)
694-694	F3: [F607] 93.6 (1.00); F4: [H880] 93.7 (1.00); A3: [K2524] 360.0 (1.10); A4: [K2253] 325.0 (1.10)
695-696	F3: [F607] 93.6 (1.00); F4: [F590] 95.0 (1.00); A3: [K2524] 360.0 (1.10);

	A4: [K2253] 325.0 (1.10)
697-772	F3: [F607] 93.6 (1.00); F4: [H880] 93.7 (1.00); A3: [K2524] 360.0 (1.10); A4: [K2253] 325.0 (1.10)

BL#	Comments
1	Reported reference EL 740.7

Time Summary

Drive	21 minutes 10 seconds	12:07 PM - 12:28 PM (1/14/2015) BN 1 - 696
Stop	21 minutes 6 seconds	12:28 PM - 12:49 PM
Drive	1 minute 39 seconds	12:49 PM - 12:51 PM BN 697 - 772

Total time [00:43:56] = (Driving [00:22:49] + Stop [00:21:06])

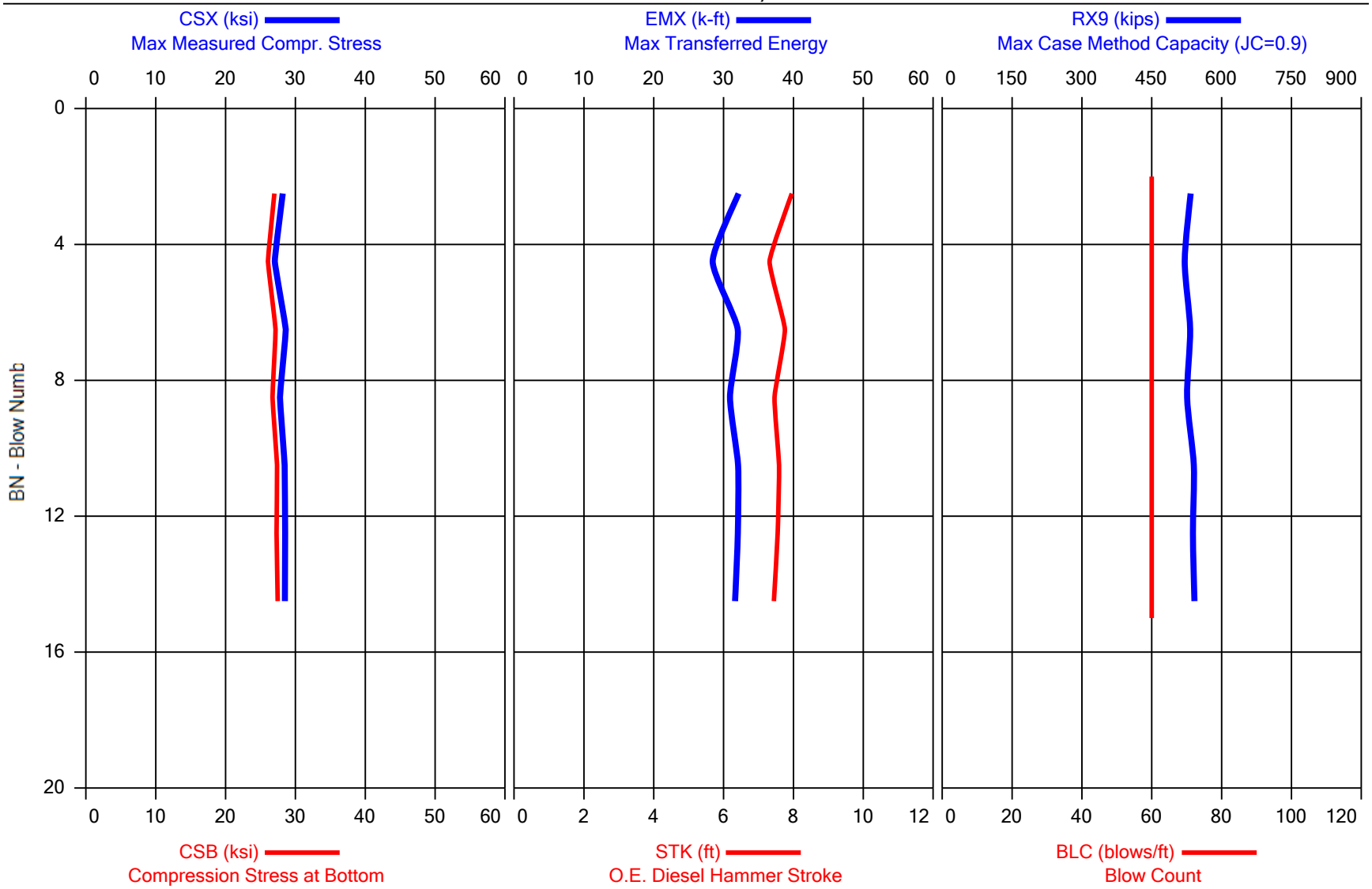
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 15-January-2015

Test started: 15-January-2015

USH 10 - B-70-403 - Pier 9 #44 - BOR

APE D30-42, HP 14 x 73



USH 10 - B-70-403 - Pier 9 #44 - BOR APE D30-42, HP 14 x 73
OP: AZ Date: 15-January-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.35 []

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#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
5	94.01	60	AV4	27.6	26.5	7.6	30	42.8	527
			STD	1.0	0.6	0.5	3	1.3	15
			MAX	29.2	27.5	8.5	35	43.9	540
			MIN	26.4	25.8	7.2	28	40.6	502
10	94.10	60	AV5	28.1	26.9	7.6	31	42.9	529
			STD	0.6	0.3	0.2	1	0.5	7
			MAX	29.1	27.2	7.8	32	43.5	538
			MIN	27.3	26.3	7.4	30	42.2	518
15	94.18	60	AV5	28.7	27.5	7.5	32	43.0	542
			STD	0.3	0.3	0.1	1	0.3	6
			MAX	29.3	28.1	7.8	34	43.3	551
			MIN	28.4	27.1	7.4	31	42.4	533
			Average	28.2	27.0	7.6	31	42.9	533
			Std. Dev.	0.8	0.6	0.3	2	0.8	12
			Maximum	29.3	28.1	8.5	35	43.9	551
			Minimum	26.4	25.8	7.2	28	40.6	502

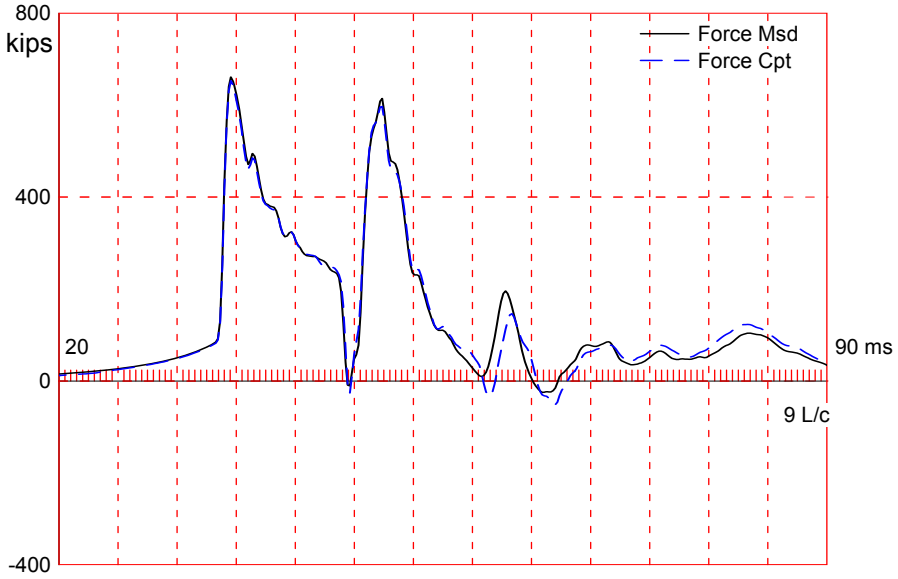
Total number of blows analyzed: 14

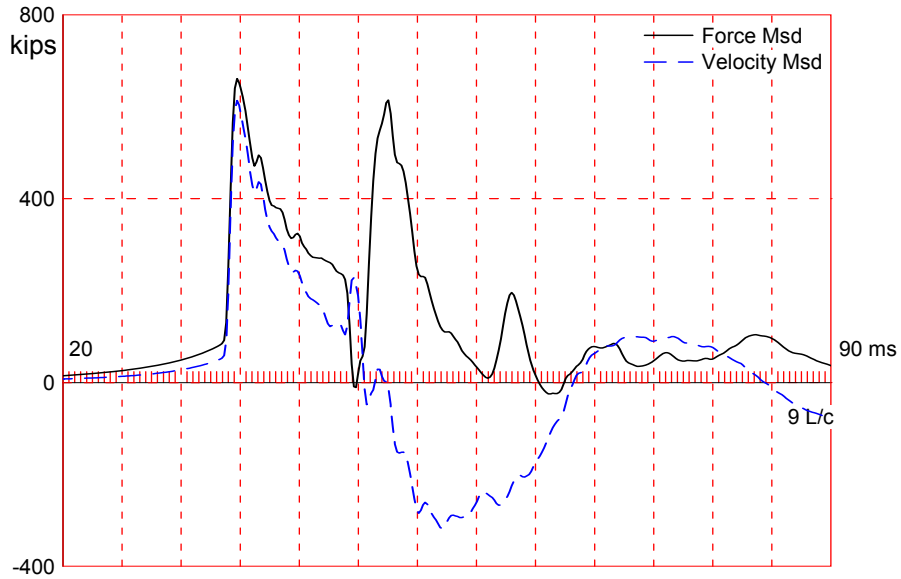
BL# Sensors

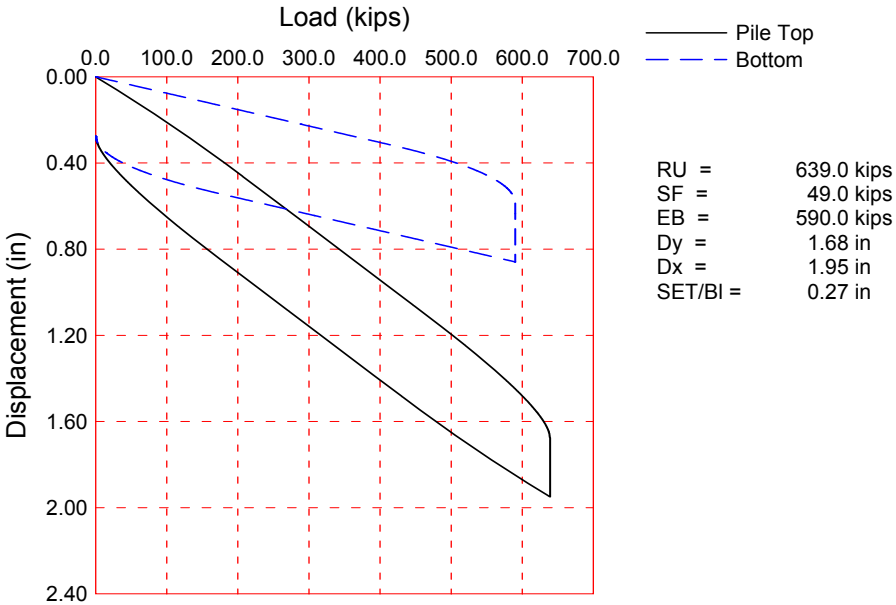
1-15 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.09); A4: [K2524] 360.0 (1.09)

Time Summary

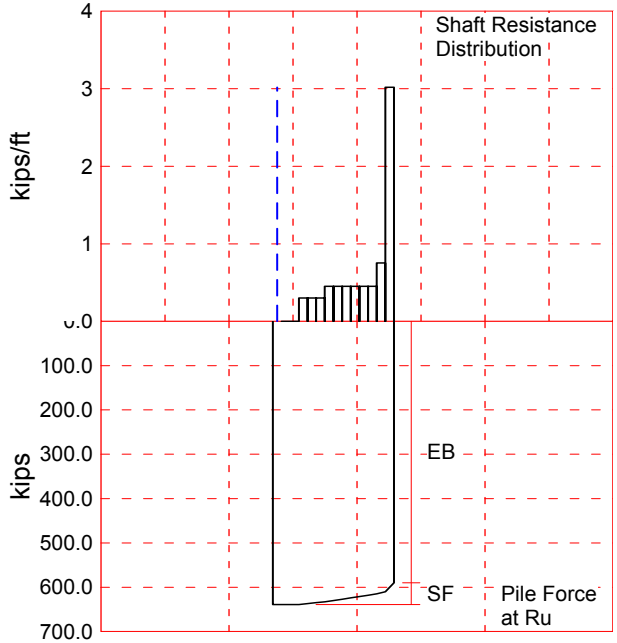
Drive 19 seconds 8:28 AM - 8:28 AM BN 1 - 15







RU =	639.0 kips
SF =	49.0 kips
EB =	590.0 kips
Dy =	1.68 in
Dx =	1.95 in
SET/Bl =	0.27 in



Length b. Sensors	92.8 ft
Embedment	88.9 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	4.37
Top Compr. Stress	30.5 ksi
Max Compr. Stress	31.8 ksi
Max Tension Stress	-5.22 ksi
Avg. Shaft Quake	0.12 in
Toe Quake	0.45 in
Avg. Shaft Smith Dpg.	0.21 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: 639.0; along Shaft 49.0; 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
				639.0				
1	13.3	9.4	0.0	639.0	0.0	0.00	0.00	0.00
2	19.9	16.0	0.0	639.0	0.0	0.00	0.00	0.00
3	26.5	22.7	2.0	637.0	2.0	0.30	0.06	0.21
4	33.1	29.3	2.0	635.0	4.0	0.30	0.06	0.21
5	39.8	35.9	2.0	633.0	6.0	0.30	0.06	0.21
6	46.4	42.5	3.0	630.0	9.0	0.45	0.10	0.21
7	53.0	49.2	3.0	627.0	12.0	0.45	0.10	0.21
8	59.6	55.8	3.0	624.0	15.0	0.45	0.10	0.21
9	66.3	62.4	3.0	621.0	18.0	0.45	0.10	0.21
10	72.9	69.0	3.0	618.0	21.0	0.45	0.10	0.21
11	79.5	75.7	3.0	615.0	24.0	0.45	0.10	0.21
12	86.1	82.3	5.0	610.0	29.0	0.75	0.16	0.21
13	92.8	88.9	20.0	590.0	49.0	3.02	0.64	0.21
Avg. Shaft			3.8			0.55	0.12	0.21
Toe			590.0				428.01	0.03

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.12	0.45
Case Damping Factor		0.27	0.46
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	30
Reloading Level	(% of Ru)	-99	0
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)		0.000

CAPWAP match quality = 4.37 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.27 in; Blow Count = 44 b/ft
Computed: Final Set = 0.31 in; Blow Count = 38 b/ft
Transducer F3(H880) CAL: 93.7; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.13; A4(K2524) CAL: 360; RF: 1.13

max. Top Comp. Stress = 30.5 ksi (T= 36.1 ms, max= 1.040 x Top)
max. Comp. Stress = 31.8 ksi (Z= 92.8 ft, T= 43.6 ms)
max. Tens. Stress = -5.22 ksi (Z= 59.6 ft, T= 62.5 ms)
max. Energy (EMX) = 37.6 kip-ft; max. Measured Top Displ. (DMX)= 1.22 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	653.8	-62.5	30.5	-2.92	37.6	16.3	1.23
2	6.6	654.3	-69.7	30.6	-3.25	37.5	16.2	1.22
4	13.3	655.5	-89.0	30.6	-4.16	37.2	16.2	1.19
6	19.9	657.6	-95.1	30.7	-4.44	36.7	16.1	1.15
8	26.5	662.0	-96.5	30.9	-4.51	36.0	16.0	1.11
10	33.1	657.8	-89.6	30.7	-4.18	34.7	15.8	1.06
12	39.8	654.2	-84.3	30.6	-3.94	33.3	15.7	1.01
14	46.4	651.7	-88.5	30.4	-4.14	31.8	15.5	0.95
15	49.7	642.5	-101.6	30.0	-4.74	30.6	15.4	0.92
16	53.0	645.3	-111.2	30.1	-5.19	30.0	15.3	0.90
17	56.3	636.3	-110.8	29.7	-5.18	28.7	15.2	0.86
18	59.6	639.1	-111.8	29.9	-5.22	28.1	15.1	0.83
19	62.9	630.2	-108.8	29.4	-5.08	26.7	15.0	0.80
20	66.3	633.2	-107.4	29.6	-5.02	26.0	14.9	0.77
21	69.6	624.5	-100.6	29.2	-4.70	24.7	15.0	0.73
22	72.9	627.6	-99.8	29.3	-4.66	23.9	15.6	0.70
23	76.2	619.1	-96.4	28.9	-4.50	22.5	15.2	0.67
24	79.5	623.5	-97.5	29.1	-4.56	21.6	16.5	0.63
25	82.8	614.0	-91.6	28.7	-4.28	20.2	18.2	0.59
26	86.1	646.4	-89.9	30.2	-4.20	19.2	19.4	0.55
27	89.4	664.4	-80.9	31.0	-3.78	18.1	19.9	0.53
28	92.8	680.1	-79.7	31.8	-3.72	16.6	18.9	0.50
Absolute	92.8			31.8			(T =	43.6 ms)
	59.6				-5.22		(T =	62.5 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	552.3	479.6	406.9	334.2	261.5	188.8	116.1	43.4	0.0	0.0
RX	734.0	714.5	696.5	680.5	667.8	660.0	654.2	649.0	643.9	638.8
RU	552.3	479.6	406.9	334.2	261.5	188.8	116.1	43.4	0.0	0.0

RAU = 561.6 (kips); RA2 = 685.0 (kips)

Current CAPWAP Ru = 639.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 0.90

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
16.1	35.87	616.5	662.7	665.2	1.22	0.28	0.27	37.8	607.1	1341

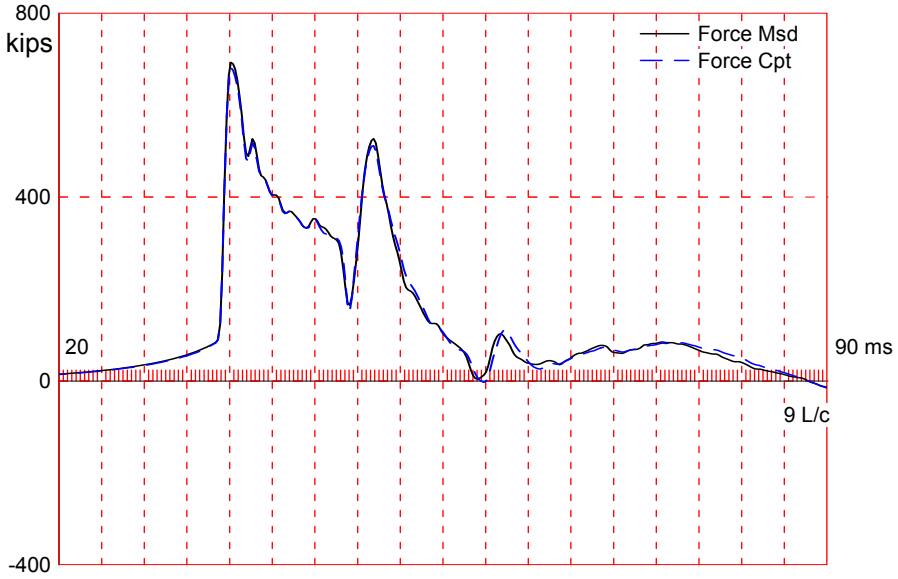
PILE PROFILE AND PILE MODEL

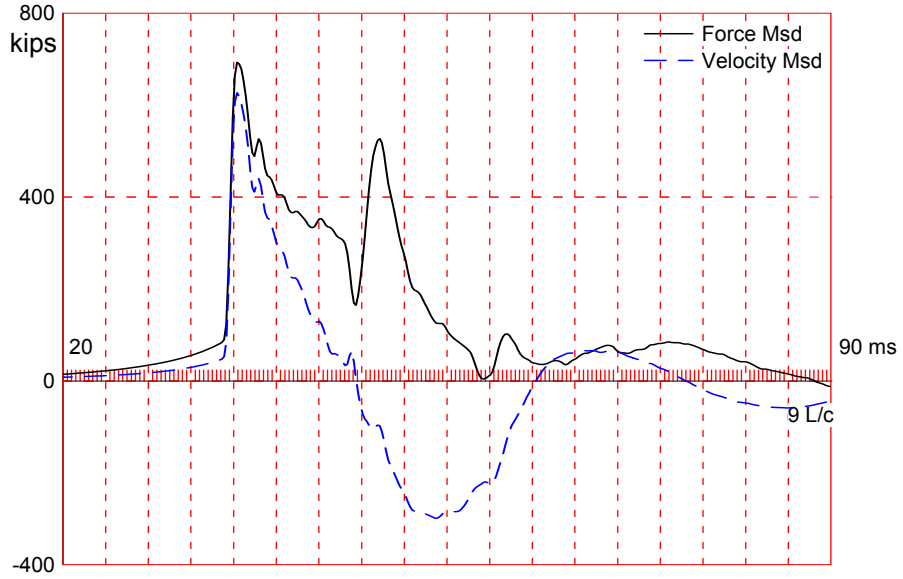
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.8	21.4	29992.2	492.000	4.70

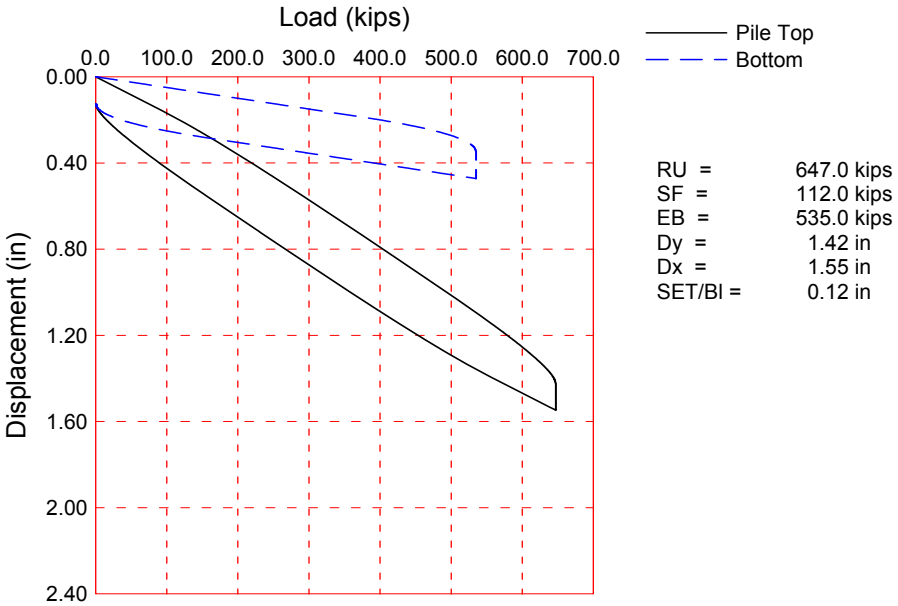
Toe Area 198.5 in^2

Top Segment Length 3.31 ft, Top Impedance 38 kips/ft/s

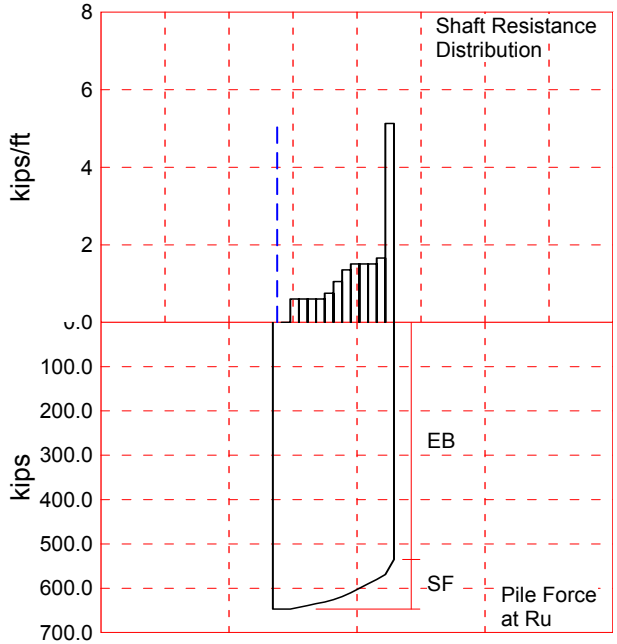
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.784 ft^3; Volume ratio considering added impedance: 1.000







RU =	647.0 kips
SF =	112.0 kips
EB =	535.0 kips
Dy =	1.42 in
Dx =	1.55 in
SET/Bl =	0.12 in



Length b. Sensors	92.8 ft
Embedment	89.0 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	1.97
Top Compr. Stress	31.9 ksi
Max Compr. Stress	32.6 ksi
Max Tension Stress	-4.86 ksi
Avg. Shaft Quake	0.13 in
Toe Quake	0.27 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.04 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 647.0; along Shaft 112.0; at Toe 535.0 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
				647.0				
1	13.3	9.5	0.0	647.0	0.0	0.00	0.00	0.00
2	19.9	16.1	4.0	643.0	4.0	0.60	0.13	0.29
3	26.5	22.7	4.0	639.0	8.0	0.60	0.13	0.29
4	33.1	29.4	4.0	635.0	12.0	0.60	0.13	0.29
5	39.8	36.0	4.0	631.0	16.0	0.60	0.13	0.29
6	46.4	42.6	5.0	626.0	21.0	0.75	0.16	0.29
7	53.0	49.2	7.0	619.0	28.0	1.06	0.22	0.29
8	59.6	55.9	9.0	610.0	37.0	1.36	0.29	0.29
9	66.3	62.5	10.0	600.0	47.0	1.51	0.32	0.29
10	72.9	69.1	10.0	590.0	57.0	1.51	0.32	0.29
11	79.5	75.7	10.0	580.0	67.0	1.51	0.32	0.29
12	86.1	82.4	11.0	569.0	78.0	1.66	0.35	0.29
13	92.8	89.0	34.0	535.0	112.0	5.13	1.09	0.29
Avg. Shaft			8.6			1.26	0.27	0.29
Toe			535.0				388.11	0.04

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.13	0.27
Case Damping Factor		0.85	0.56
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	20	
Resistance Gap (included in Toe Quake)	(in)		0.02

CAPWAP match quality = 1.97 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.09 in; Blow Count = 132 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.12; A4(K2524) CAL: 360; RF: 1.12

max. Top Comp. Stress = 31.9 ksi (T= 36.1 ms, max= 1.023 x Top)
max. Comp. Stress = 32.6 ksi (Z= 19.9 ft, T= 37.1 ms)
max. Tens. Stress = -4.86 ksi (Z= 46.4 ft, T= 61.7 ms)
max. Energy (EMX) = 38.9 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	682.3	-27.1	31.9	-1.26	38.9	16.7	1.08
2	6.6	683.2	-28.7	31.9	-1.34	38.7	16.7	1.06
4	13.3	687.1	-30.9	32.1	-1.44	38.2	16.5	1.03
6	19.9	698.0	-32.6	32.6	-1.52	37.5	16.2	0.98
8	26.5	685.9	-41.7	32.0	-1.95	35.6	15.9	0.93
10	33.1	674.6	-73.3	31.5	-3.43	33.6	15.6	0.88
12	39.8	665.2	-97.4	31.1	-4.55	31.5	15.3	0.82
14	46.4	659.2	-104.0	30.8	-4.86	29.5	14.9	0.77
15	49.7	642.2	-100.2	30.0	-4.68	27.8	14.6	0.74
16	53.0	652.3	-101.1	30.5	-4.72	27.1	14.4	0.70
17	56.3	627.6	-96.7	29.3	-4.52	25.0	14.1	0.67
18	59.6	638.6	-97.6	29.8	-4.56	24.3	13.8	0.64
19	62.9	605.8	-90.8	28.3	-4.24	22.0	13.5	0.60
20	66.3	616.9	-91.5	28.8	-4.28	21.2	13.2	0.57
21	69.6	580.5	-84.3	27.1	-3.94	18.8	12.8	0.53
22	72.9	591.6	-85.6	27.6	-4.00	17.9	12.6	0.50
23	76.2	574.5	-79.2	26.8	-3.70	15.7	12.3	0.46
24	79.5	591.7	-80.5	27.6	-3.76	14.9	12.0	0.43
25	82.8	592.4	-73.3	27.7	-3.42	12.9	13.1	0.39
26	86.1	624.7	-73.9	29.2	-3.45	12.0	14.1	0.36
27	89.4	619.9	-66.9	29.0	-3.13	10.1	14.4	0.32
28	92.8	626.2	-67.0	29.3	-3.13	7.9	13.0	0.28
Absolute	19.9			32.6			(T =	37.1 ms)
	46.4				-4.86		(T =	61.7 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	766.9	711.0	655.0	599.1	543.1	487.2	431.2	375.3	319.3	263.4
RX	809.0	782.9	765.5	748.1	730.7	713.3	695.9	678.5	661.2	644.7
RU	768.4	712.6	656.8	601.0	545.2	489.4	433.6	377.8	322.0	266.2

RAU = 350.2 (kips); RA2 = 671.8 (kips)

Current CAPWAP Ru = 647.0 (kips); Corresponding J(RP)= 0.21; J(RX) = 0.89

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
16.5	35.87	630.3	696.1	696.1	1.07	0.13	0.12	39.0	782.3	2140

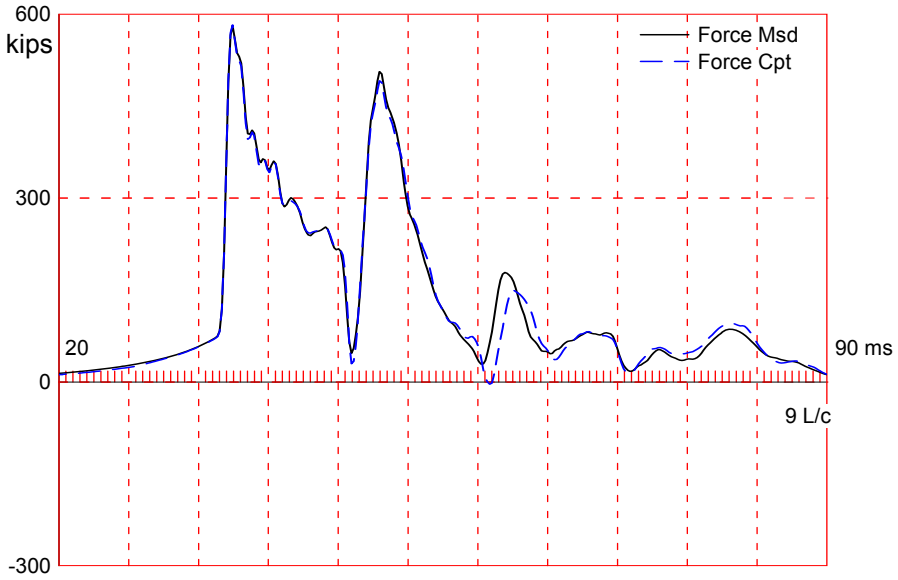
PILE PROFILE AND PILE MODEL

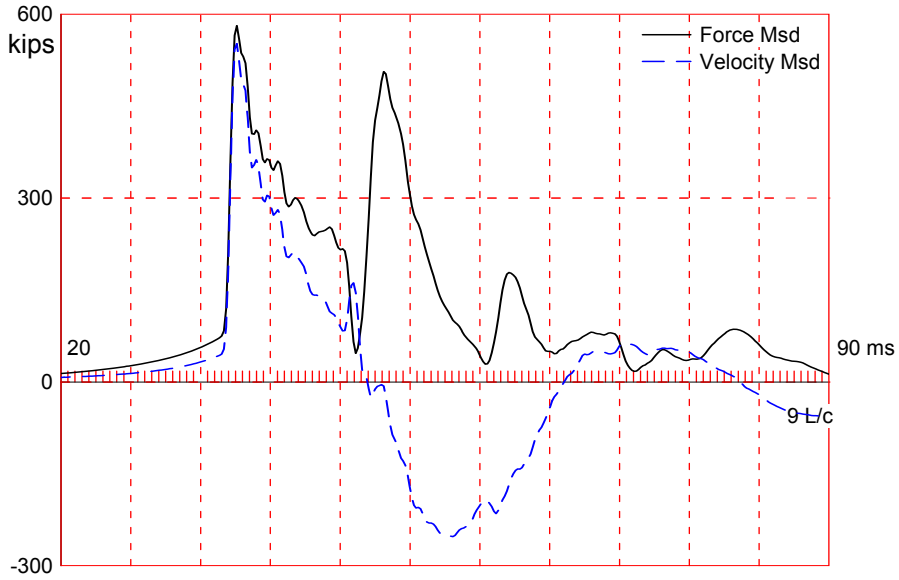
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.8	21.4	29992.2	492.000	4.70

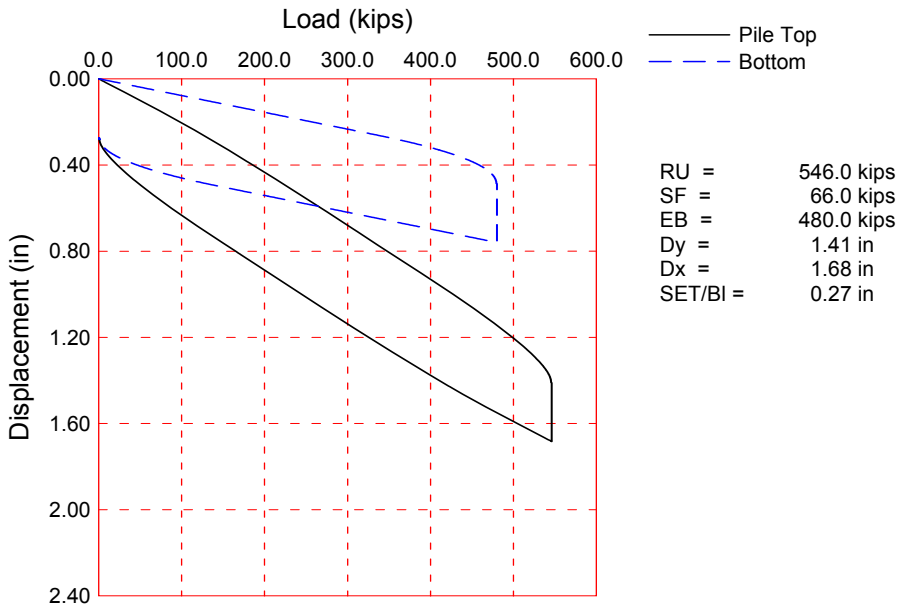
Toe Area 198.5 in^2

Top Segment Length 3.31 ft, Top Impedance 38 kips/ft/s

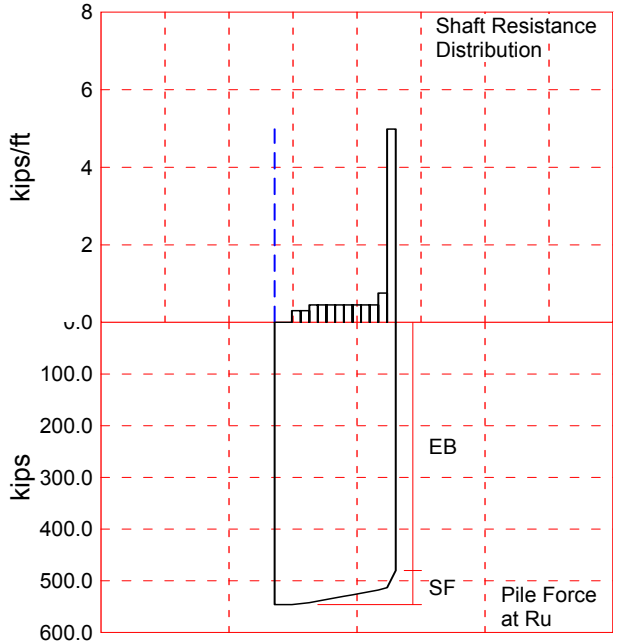
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.784 ft^3; Volume ratio considering added impedance: 1.000







RU =	546.0 kips
SF =	66.0 kips
EB =	480.0 kips
Dy =	1.41 in
Dx =	1.68 in
SET/Bl =	0.27 in



Length b. Sensors	92.7 ft
Embedment	90.0 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	3.40
Top Compr. Stress	27.2 ksi
Max Compr. Stress	27.6 ksi
Max Tension Stress	-2.31 ksi
Avg. Shaft Quake	0.13 in
Toe Quake	0.37 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: 546.0; along Shaft 66.0; 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	Smith Damping Factor s/ft
				546.0				
1	6.6	4.0	0.0	546.0	0.0	0.00	0.00	0.00
2	13.2	10.6	0.0	546.0	0.0	0.00	0.00	0.00
3	19.9	17.2	2.0	544.0	2.0	0.30	0.06	0.25
4	26.5	23.8	2.0	542.0	4.0	0.30	0.06	0.25
5	33.1	30.4	3.0	539.0	7.0	0.45	0.10	0.25
6	39.7	37.1	3.0	536.0	10.0	0.45	0.10	0.25
7	46.3	43.7	3.0	533.0	13.0	0.45	0.10	0.25
8	52.9	50.3	3.0	530.0	16.0	0.45	0.10	0.25
9	59.6	56.9	3.0	527.0	19.0	0.45	0.10	0.25
10	66.2	63.5	3.0	524.0	22.0	0.45	0.10	0.25
11	72.8	70.1	3.0	521.0	25.0	0.45	0.10	0.25
12	79.4	76.8	3.0	518.0	28.0	0.45	0.10	0.25
13	86.0	83.4	5.0	513.0	33.0	0.76	0.16	0.25
14	92.7	90.0	33.0	480.0	66.0	4.99	1.06	0.25
Avg. Shaft			4.7			0.73	0.16	0.25
Toe			480.0				348.21	0.03

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.13	0.37
Case Damping Factor		0.43	0.38
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	85	30
Unloading Level	(% of Ru)	63	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.040	

CAPWAP match quality = 3.40 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.27 in; Blow Count = 44 b/ft
Computed: Final Set = 0.23 in; Blow Count = 52 b/ft
Transducer F3(H880) CAL: 93.7; 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 = 27.2 ksi (T= 36.2 ms, max= 1.013 x Top)
max. Comp. Stress = 27.6 ksi (Z= 19.9 ft, T= 37.2 ms)
max. Tens. Stress = -2.31 ksi (Z= 52.9 ft, T= 62.4 ms)
max. Energy (EMX) = 28.3 kip-ft; max. Measured Top Displ. (DMX)= 1.03 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	583.2	-30.1	27.2	-1.41	28.3	14.4	1.04
2	6.6	583.8	-32.8	27.3	-1.53	28.2	14.4	1.03
4	13.2	585.9	-37.7	27.4	-1.76	27.9	14.3	1.00
6	19.9	590.6	-40.9	27.6	-1.91	27.5	14.2	0.96
8	26.5	587.5	-39.6	27.4	-1.85	26.5	14.0	0.92
10	33.1	589.1	-36.9	27.5	-1.72	25.4	13.7	0.88
12	39.7	581.7	-33.9	27.2	-1.58	24.1	13.5	0.84
14	46.3	570.6	-33.0	26.7	-1.54	22.8	13.4	0.79
15	49.6	560.9	-42.1	26.2	-1.97	21.9	13.3	0.77
16	52.9	564.0	-49.4	26.3	-2.31	21.4	13.3	0.74
17	56.3	554.6	-48.6	25.9	-2.27	20.4	13.1	0.71
18	59.6	557.7	-46.4	26.1	-2.17	19.9	13.1	0.69
19	62.9	548.4	-40.8	25.6	-1.90	18.9	12.9	0.66
20	66.2	552.6	-40.8	25.8	-1.90	18.3	12.8	0.63
21	69.5	549.9	-39.4	25.7	-1.84	17.3	12.5	0.60
22	72.8	554.4	-38.5	25.9	-1.80	16.8	12.4	0.57
23	76.1	537.7	-35.1	25.1	-1.64	15.8	12.5	0.54
24	79.4	540.2	-37.6	25.2	-1.75	15.2	12.6	0.51
25	82.7	531.7	-38.2	24.8	-1.79	14.1	14.6	0.48
26	86.0	535.8	-39.5	25.0	-1.85	13.5	15.1	0.45
27	89.4	535.4	-34.6	25.0	-1.62	12.2	16.0	0.42
28	92.7	546.4	-36.6	25.5	-1.71	9.4	15.3	0.40
Absolute	19.9			27.6			(T =	37.2 ms)
	52.9				-2.31		(T =	62.4 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	535.1	473.9	412.6	351.4	290.2	229.0	167.7	106.5	45.3	0.0
RX	617.4	601.6	588.7	581.5	574.2	567.0	559.7	552.5	545.2	538.7
RU	535.1	473.9	412.6	351.4	290.2	229.0	167.7	106.5	45.3	0.0

RAU = 434.0 (kips); RA2 = 582.8 (kips)

Current CAPWAP Ru = 546.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 0.79

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
14.7	36.03	559.7	587.7	587.7	1.03	0.27	0.27	28.4	522.5	1333

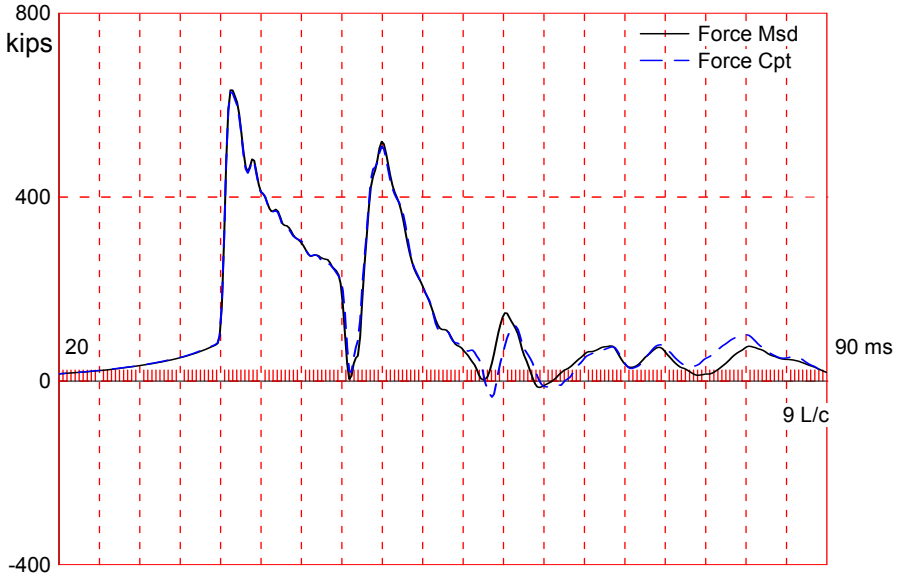
PILE PROFILE AND PILE MODEL

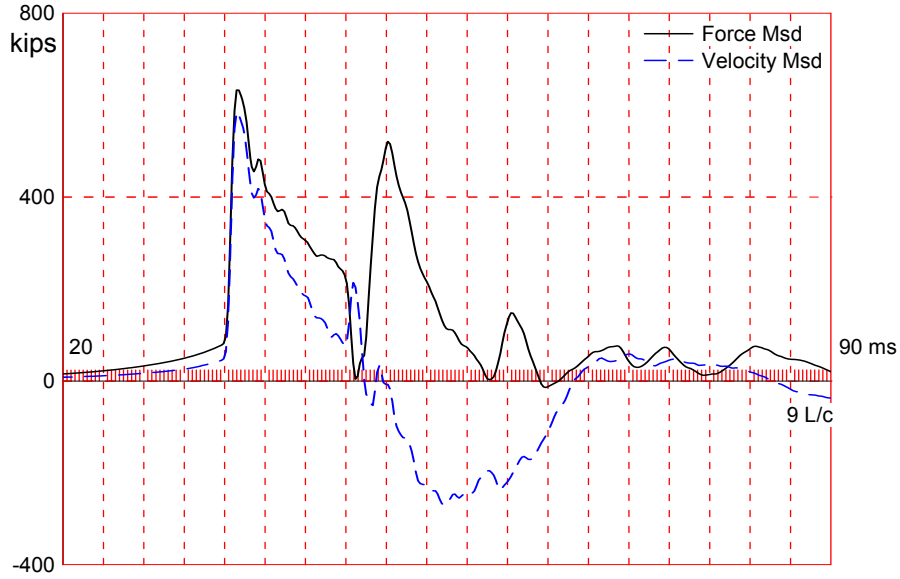
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

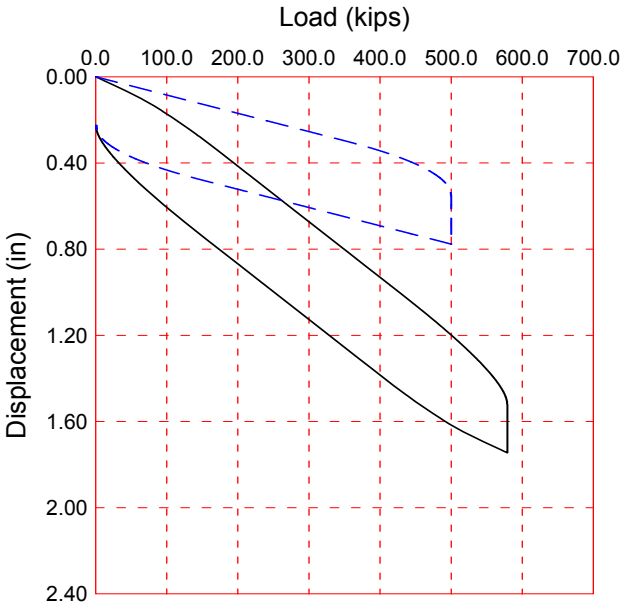
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
11	36.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
12	39.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
13	43.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
14	46.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	76.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	79.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

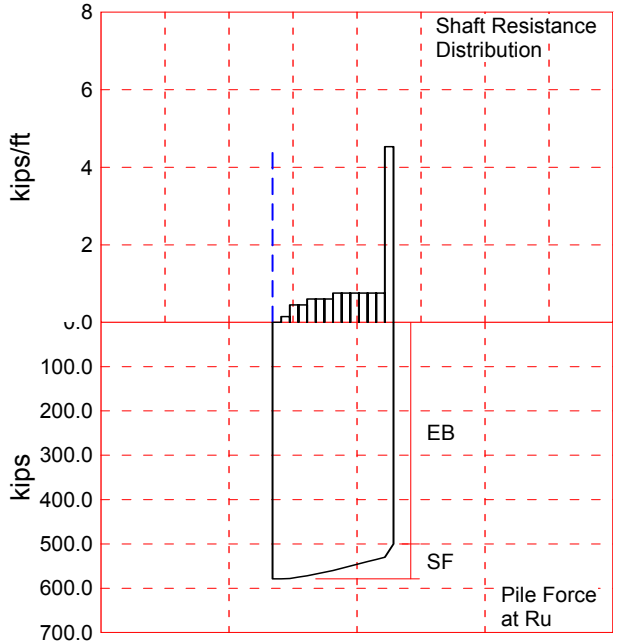
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.770 ft^3; Volume ratio considering added impedance: 1.000







RU =	579.0 kips
SF =	79.0 kips
EB =	500.0 kips
Dy =	1.52 in
Dx =	1.75 in
SET/Bl =	0.23 in



Length b. Sensors	92.7 ft
Embedment	90.1 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	3.85
Top Compr. Stress	29.4 ksi
Max Compr. Stress	29.7 ksi
Max Tension Stress	-3.71 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.42 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.03 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 579.0; along Shaft 79.0; 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
				579.0				
1	6.6	4.0	0.0	579.0	0.0	0.00	0.00	0.00
2	13.2	10.7	1.0	578.0	1.0	0.15	0.03	0.27
3	19.9	17.3	3.0	575.0	4.0	0.45	0.10	0.27
4	26.5	23.9	3.0	572.0	7.0	0.45	0.10	0.27
5	33.1	30.5	4.0	568.0	11.0	0.60	0.13	0.27
6	39.7	37.1	4.0	564.0	15.0	0.60	0.13	0.27
7	46.3	43.7	4.0	560.0	19.0	0.60	0.13	0.27
8	52.9	50.4	5.0	555.0	24.0	0.76	0.16	0.27
9	59.6	57.0	5.0	550.0	29.0	0.76	0.16	0.27
10	66.2	63.6	5.0	545.0	34.0	0.76	0.16	0.27
11	72.8	70.2	5.0	540.0	39.0	0.76	0.16	0.27
12	79.4	76.8	5.0	535.0	44.0	0.76	0.16	0.27
13	86.0	83.5	5.0	530.0	49.0	0.76	0.16	0.27
14	92.7	90.1	30.0	500.0	79.0	4.53	0.96	0.27
Avg. Shaft			5.6			0.88	0.19	0.27
Toe			500.0				362.72	0.03

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.06	0.42
Case Damping Factor		0.56	0.39
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	32
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	46	
Resistance Gap (included in Toe Quake)	(in)		0.06

CAPWAP match quality = 3.85 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.19 in; Blow Count = 63 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.11; A4(K3550) CAL: 360; RF: 1.11

max. Top Comp. Stress = 29.4 ksi (T= 36.0 ms, max= 1.009 x Top)
max. Comp. Stress = 29.7 ksi (Z= 19.9 ft, T= 37.2 ms)
max. Tens. Stress = -3.71 ksi (Z= 59.6 ft, T= 63.0 ms)
max. Energy (EMX) = 34.1 kip-ft; max. Measured Top Displ. (DMX)= 1.11 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	629.5	-37.0	29.4	-1.73	34.1	15.4	1.10
2	6.6	630.0	-39.2	29.4	-1.83	34.1	15.4	1.09
4	13.2	633.3	-58.6	29.6	-2.74	33.8	15.2	1.06
6	19.9	635.3	-74.8	29.7	-3.49	33.0	15.0	1.02
8	26.5	627.8	-77.2	29.3	-3.61	31.6	14.8	0.98
10	33.1	621.6	-66.7	29.0	-3.12	30.2	14.6	0.94
12	39.7	610.4	-57.7	28.5	-2.69	28.5	14.3	0.89
14	46.3	599.9	-58.3	28.0	-2.72	26.7	14.1	0.84
15	49.6	586.2	-62.2	27.4	-2.91	25.4	13.9	0.82
16	52.9	590.5	-76.8	27.6	-3.59	24.9	13.8	0.79
17	56.3	572.1	-76.3	26.7	-3.57	23.3	13.7	0.76
18	59.6	576.1	-79.5	26.9	-3.71	22.8	13.6	0.74
19	62.9	557.6	-74.5	26.1	-3.48	21.3	13.4	0.71
20	66.2	561.4	-72.2	26.2	-3.37	20.7	13.3	0.68
21	69.5	543.0	-64.4	25.4	-3.01	19.2	13.2	0.65
22	72.8	546.6	-65.2	25.5	-3.05	18.6	14.0	0.62
23	76.1	528.3	-61.6	24.7	-2.88	17.0	13.7	0.59
24	79.4	531.6	-59.9	24.8	-2.80	16.4	14.1	0.56
25	82.7	522.8	-52.4	24.4	-2.45	14.9	16.0	0.53
26	86.0	534.5	-46.7	25.0	-2.18	14.1	17.2	0.49
27	89.4	551.0	-35.9	25.7	-1.68	12.6	17.7	0.46
28	92.7	566.9	-34.0	26.5	-1.59	9.3	16.8	0.44
Absolute	19.9			29.7			(T =	37.2 ms)
	59.6				-3.71		(T =	63.0 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	539.2	470.2	401.2	332.2	263.2	194.2	125.2	56.2	0.0	0.0
RX	666.2	643.4	623.0	607.6	597.1	586.7	576.6	567.5	559.6	553.4
RU	539.2	470.2	401.2	332.2	263.2	194.2	125.2	56.2	0.0	0.0

RAU = 366.9 (kips); RA2 = 616.8 (kips)

Current CAPWAP Ru = 579.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 0.58

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
15.4	35.83	588.8	640.3	640.3	1.11	0.23	0.23	34.2	613.8	1389

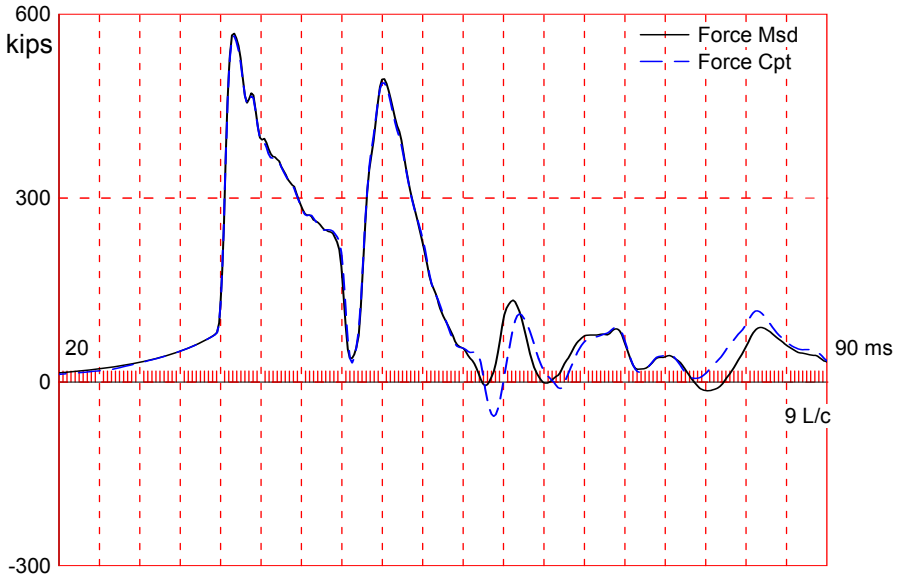
PILE PROFILE AND PILE MODEL

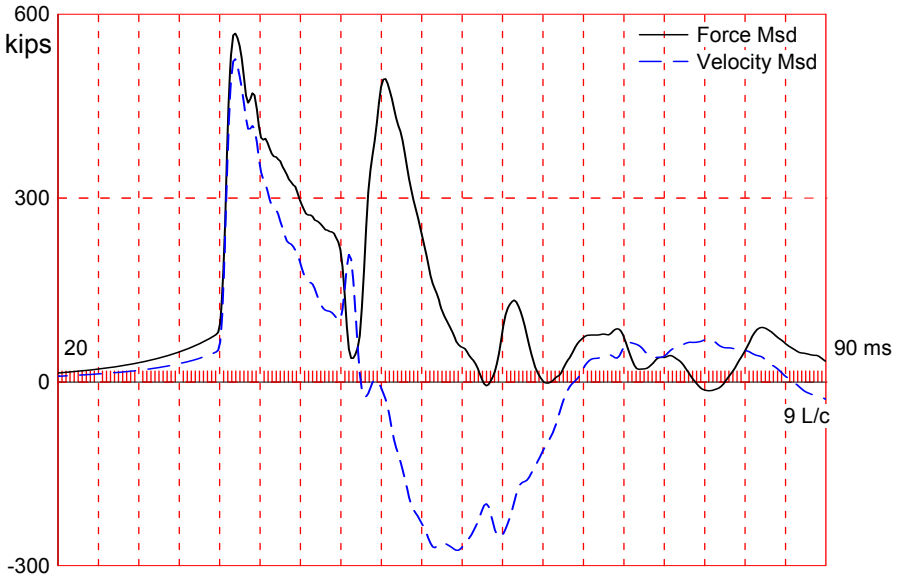
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

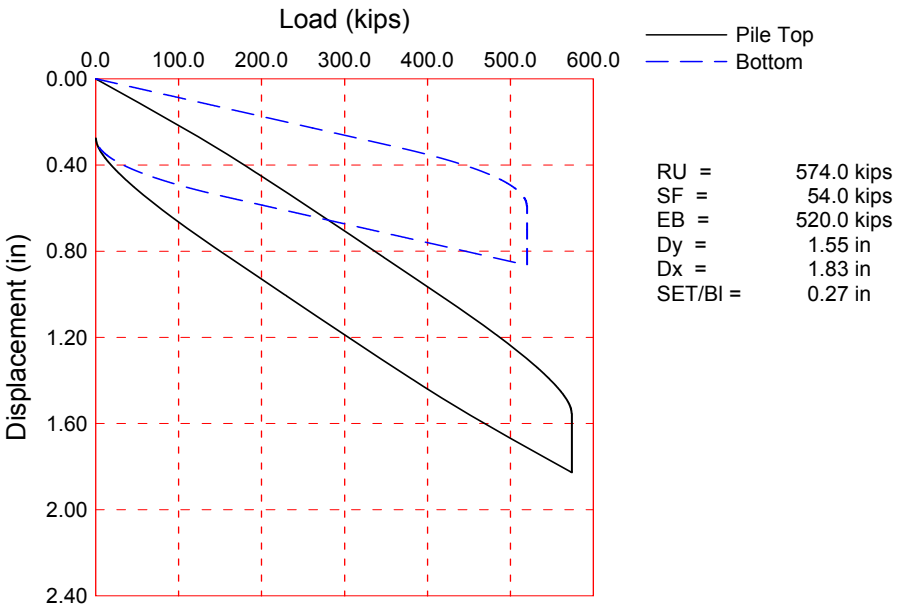
Toe Area 198.5 in^2

Top Segment Length 3.31 ft, Top Impedance 38 kips/ft/s

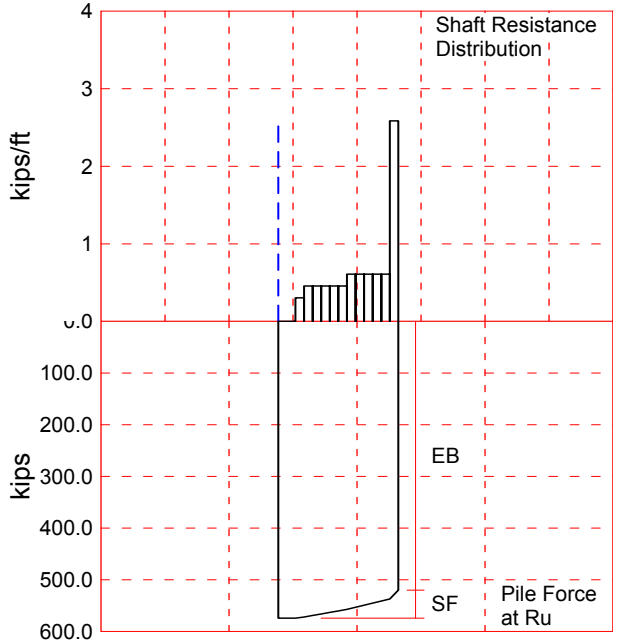
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.770 ft^3; Volume ratio considering added impedance: 1.000







RU =	574.0 kips
SF =	54.0 kips
EB =	520.0 kips
Dy =	1.55 in
Dx =	1.83 in
SET/BI =	0.27 in



Length b. Sensors	92.0 ft
Embedment	92.0 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	4.18
Top Compr. Stress	26.4 ksi
Max Compr. Stress	26.9 ksi
Max Tension Stress	-4.57 ksi
Avg. Shaft Quake	0.18 in
Toe Quake	0.45 in
Avg. Shaft Smith Dpg.	0.24 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: 574.0; along Shaft 54.0; 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
				574.0				
1	6.6	6.6	0.0	574.0	0.0	0.00	0.00	0.00
2	13.1	13.1	0.0	574.0	0.0	0.00	0.00	0.00
3	19.7	19.7	2.0	572.0	2.0	0.30	0.06	0.24
4	26.3	26.3	3.0	569.0	5.0	0.46	0.10	0.24
5	32.9	32.9	3.0	566.0	8.0	0.46	0.10	0.24
6	39.4	39.4	3.0	563.0	11.0	0.46	0.10	0.24
7	46.0	46.0	3.0	560.0	14.0	0.46	0.10	0.24
8	52.6	52.6	3.0	557.0	17.0	0.46	0.10	0.24
9	59.1	59.1	4.0	553.0	21.0	0.61	0.13	0.24
10	65.7	65.7	4.0	549.0	25.0	0.61	0.13	0.24
11	72.3	72.3	4.0	545.0	29.0	0.61	0.13	0.24
12	78.9	78.9	4.0	541.0	33.0	0.61	0.13	0.24
13	85.4	85.4	4.0	537.0	37.0	0.61	0.13	0.24
14	92.0	92.0	17.0	520.0	54.0	2.59	0.55	0.24
Avg. Shaft			3.9			0.59	0.12	0.24
Toe			520.0				377.22	0.03

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.18	0.45
Case Damping Factor		0.34	0.41
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	30	30
Unloading Level	(% of Ru)	94	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.040	

CAPWAP match quality = 4.18 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.27 in; Blow Count = 44 b/ft
Computed: Final Set = 0.31 in; Blow Count = 39 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(H880) CAL: 93.7; RF: 1.00
A3(K2524) CAL: 360; RF: 1.10; A4(K2253) CAL: 325; RF: 1.10

max. Top Comp. Stress = 26.4 ksi (T= 36.4 ms, max= 1.017 x Top)
max. Comp. Stress = 26.9 ksi (Z= 19.7 ft, T= 37.3 ms)
max. Tens. Stress = -4.57 ksi (Z= 52.6 ft, T= 62.9 ms)
max. Energy (EMX) = 31.8 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	565.4	-53.6	26.4	-2.51	31.8	13.9	1.13
2	6.6	566.1	-47.9	26.4	-2.24	31.8	13.9	1.12
4	13.1	569.4	-58.2	26.6	-2.72	31.5	13.8	1.09
6	19.7	575.0	-63.4	26.9	-2.96	31.0	13.6	1.06
8	26.3	573.0	-55.4	26.8	-2.59	30.0	13.4	1.02
10	32.9	573.4	-38.9	26.8	-1.82	28.7	13.1	0.97
12	39.4	569.0	-36.4	26.6	-1.70	27.3	12.9	0.93
14	46.0	556.8	-77.4	26.0	-3.62	25.9	12.9	0.88
15	49.3	545.6	-90.9	25.5	-4.24	24.9	12.8	0.85
16	52.6	549.3	-97.7	25.7	-4.57	24.4	12.7	0.83
17	55.9	541.0	-88.5	25.3	-4.13	23.4	12.6	0.80
18	59.1	545.3	-83.2	25.5	-3.89	22.9	12.5	0.78
19	62.4	533.2	-77.3	24.9	-3.61	21.6	12.4	0.75
20	65.7	537.5	-77.1	25.1	-3.60	21.0	12.3	0.72
21	69.0	525.6	-71.9	24.6	-3.36	19.7	12.4	0.69
22	72.3	529.9	-72.2	24.8	-3.37	19.0	13.4	0.66
23	75.6	518.4	-65.1	24.2	-3.04	17.7	13.8	0.62
24	78.9	524.3	-65.8	24.5	-3.08	17.1	13.9	0.59
25	82.1	530.6	-55.4	24.8	-2.59	15.8	15.2	0.56
26	85.4	541.6	-49.0	25.3	-2.29	15.0	15.9	0.53
27	88.7	547.4	-35.2	25.6	-1.64	13.8	16.3	0.50
28	92.0	567.3	-29.5	26.5	-1.38	12.3	15.4	0.48
Absolute	19.7			26.9			(T =	37.3 ms)
	52.6				-4.57		(T =	62.9 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	497.0	436.4	375.8	315.2	254.6	194.0	133.5	72.9	12.3	0.0
RX	634.2	611.8	601.8	591.8	581.8	571.9	563.3	557.5	551.9	546.4
RU	497.0	436.4	375.8	315.2	254.6	194.0	133.5	72.9	12.3	0.0

RAU = 471.3 (kips); RA2 = 602.9 (kips)

Current CAPWAP Ru = 574.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 0.48

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
13.9	36.36	530.6	572.2	572.2	1.13	0.28	0.27	31.9	546.1	1182

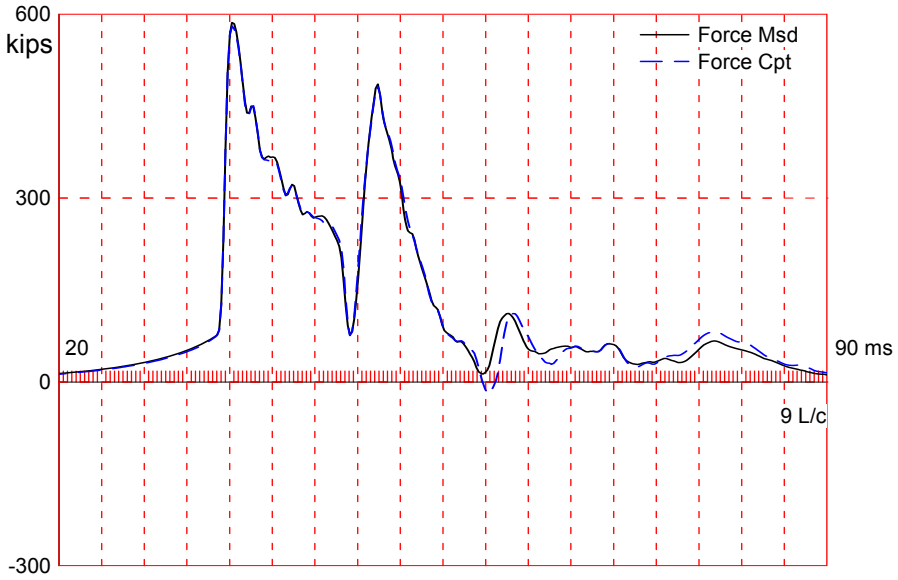
PILE PROFILE AND PILE MODEL

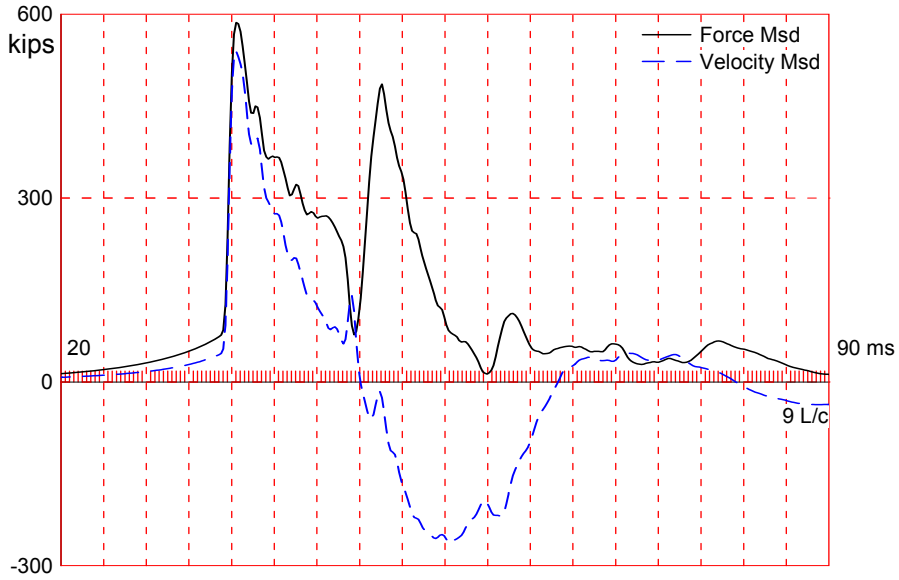
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.0	21.4	29992.2	492.000	4.70

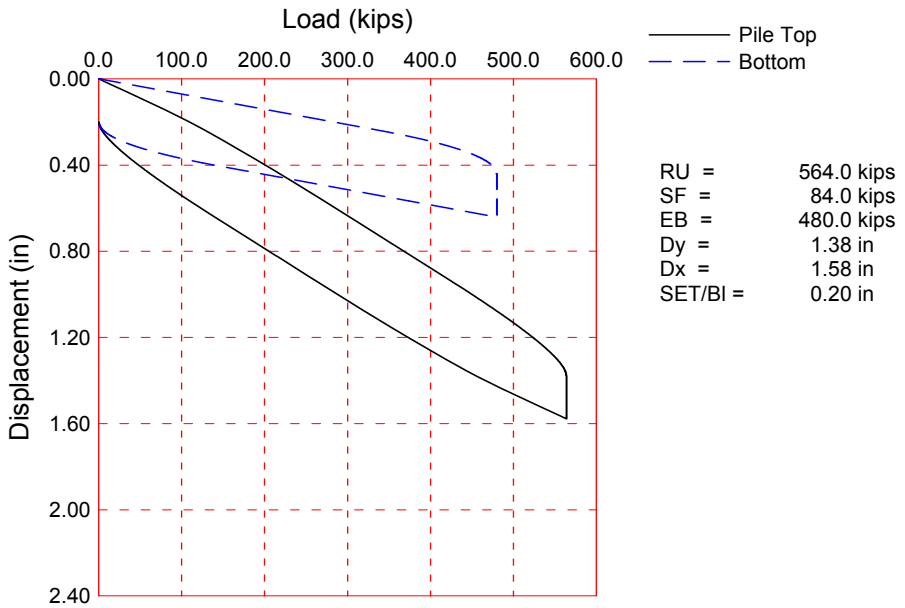
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
12	39.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
16	52.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

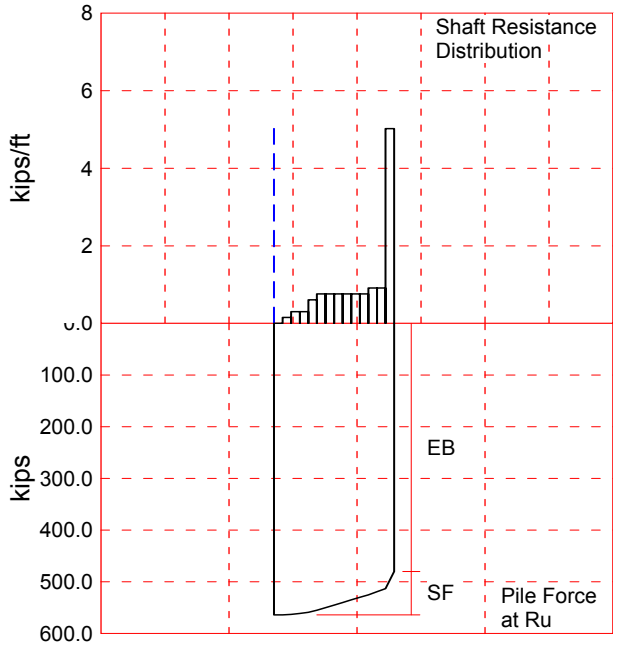
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.195 ms, 2L/c 10.9 ms
Total volume: 13.672 ft^3; Volume ratio considering added impedance: 1.000







RU =	564.0 kips
SF =	84.0 kips
EB =	480.0 kips
Dy =	1.38 in
Dx =	1.58 in
SET/Bl =	0.20 in



Length b. Sensors	92.0 ft
Embedment	92.0 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	2.50
Top Compr. Stress	27.2 ksi
Max Compr. Stress	27.4 ksi
Max Tension Stress	-3.37 ksi
Avg. Shaft Quake	0.11 in
Toe Quake	0.34 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.03 s/ft

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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: 564.0; along Shaft 84.0; 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	Smith Damping Factor s/ft
				564.0				
1	6.6	6.6	0.0	564.0	0.0	0.00	0.00	0.00
2	13.1	13.1	1.0	563.0	1.0	0.15	0.03	0.26
3	19.7	19.7	2.0	561.0	3.0	0.30	0.06	0.26
4	26.3	26.3	2.0	559.0	5.0	0.30	0.06	0.26
5	32.9	32.9	4.0	555.0	9.0	0.61	0.13	0.26
6	39.4	39.4	5.0	550.0	14.0	0.76	0.16	0.26
7	46.0	46.0	5.0	545.0	19.0	0.76	0.16	0.26
8	52.6	52.6	5.0	540.0	24.0	0.76	0.16	0.26
9	59.1	59.1	5.0	535.0	29.0	0.76	0.16	0.26
10	65.7	65.7	5.0	530.0	34.0	0.76	0.16	0.26
11	72.3	72.3	5.0	525.0	39.0	0.76	0.16	0.26
12	78.9	78.9	6.0	519.0	45.0	0.91	0.19	0.26
13	85.4	85.4	6.0	513.0	51.0	0.91	0.19	0.26
14	92.0	92.0	33.0	480.0	84.0	5.02	1.07	0.26
Avg. Shaft			6.0			0.91	0.19	0.26
Toe			480.0				348.21	0.03

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.11	0.34
Case Damping Factor		0.57	0.38
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	34
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	46	
Resistance Gap (included in Toe Quake)	(in)		0.02

CAPWAP match quality = 2.50 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.17 in; Blow Count = 69 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.09; A4(K2524) CAL: 360; RF: 1.09

max. Top Comp. Stress = 27.2 ksi (T= 36.2 ms, max= 1.010 x Top)
max. Comp. Stress = 27.4 ksi (Z= 19.7 ft, T= 37.1 ms)
max. Tens. Stress = -3.37 ksi (Z= 52.6 ft, T= 62.4 ms)
max. Energy (EMX) = 29.9 kip-ft; max. Measured Top Displ. (DMX)= 1.01 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	581.9	-22.2	27.2	-1.04	29.9	14.2	1.01
2	6.6	583.2	-23.0	27.2	-1.08	29.8	14.2	1.00
4	13.1	587.1	-24.1	27.4	-1.13	29.5	14.1	0.97
6	19.7	587.6	-24.3	27.4	-1.14	28.8	13.9	0.93
8	26.3	584.4	-24.1	27.3	-1.12	27.8	13.7	0.89
10	32.9	584.2	-25.0	27.3	-1.17	26.7	13.5	0.85
12	39.4	576.3	-48.3	26.9	-2.26	25.2	13.2	0.80
14	46.0	564.7	-68.5	26.4	-3.20	23.5	12.9	0.76
15	49.3	548.3	-71.1	25.6	-3.32	22.2	12.8	0.73
16	52.6	553.5	-72.2	25.9	-3.37	21.7	12.6	0.71
17	55.9	537.5	-65.0	25.1	-3.04	20.4	12.5	0.68
18	59.1	542.6	-60.0	25.3	-2.80	19.9	12.4	0.65
19	62.4	527.2	-53.1	24.6	-2.48	18.5	12.2	0.63
20	65.7	532.2	-54.5	24.9	-2.55	18.0	12.1	0.60
21	69.0	517.1	-51.7	24.2	-2.41	16.8	11.9	0.57
22	72.3	522.9	-56.4	24.4	-2.64	16.2	11.8	0.54
23	75.6	508.9	-52.5	23.8	-2.45	14.9	11.6	0.51
24	78.9	520.5	-52.9	24.3	-2.47	14.2	12.1	0.48
25	82.1	523.2	-47.7	24.4	-2.23	12.8	13.6	0.45
26	85.4	531.9	-47.2	24.8	-2.21	12.2	14.6	0.41
27	88.7	542.1	-39.0	25.3	-1.82	10.8	14.8	0.38
28	92.0	557.6	-36.0	26.0	-1.68	8.2	13.9	0.35
Absolute	19.7			27.4			(T =	37.1 ms)
	52.6				-3.37		(T =	62.4 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	550.2	492.7	435.2	377.7	320.2	262.7	205.2	147.7	90.2	32.6
RX	660.2	641.9	623.6	605.4	587.1	570.7	557.9	546.0	537.2	530.6
RU	550.2	492.7	435.2	377.7	320.2	262.7	205.2	147.7	90.2	32.6

RAU = 427.7 (kips); RA2 = 590.1 (kips)

Current CAPWAP Ru = 564.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 0.55

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
14.2	35.97	542.3	582.9	592.6	1.01	0.20	0.20	30.0	595.3	1500

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
92.0	21.4	29992.2	492.000	4.70

Toe Area 198.5 in^2

Top Segment Length 3.29 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 0.195 ms, 2L/c 10.9 ms
Total volume: 13.672 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Travis Coleman
Company: Lunda Construction Co.	No. of Sheets: 60
E-mail: kweber@lundaconstruction.com	Date: January 23, 2015

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

On January 21, 2014, Pier 10 #1, Pier 10 #36, and Pier 10 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on January 22. 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 elevation for the piles was the top of the ring at EL 740.8. We understand the pier was excavated to elevation of EL 717.6. The piles have a required minimum tip elevation of EL 658.5. 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 10 #1 was driven to a depth of 92.8 feet, which corresponds to a pile tip elevation of EL 648.0. The blow count over the final increment of driving was 10 blows for 2 inches of penetration at an average hammer stroke of 7.8 feet. The blow count at the beginning of restrike was 5 blows for ⅝ inch of penetration at an average hammer stroke of 7.4 feet. The dynamic test results indicated the pile did not meet the required driving resistance and driving resumed until the pile met the required driving resistance. The pile was driven to a final penetration depth of 93.5 feet, with a final blow count of 10 blows over ¾ inches at an average hammer stroke of 7.0 feet.

Pier 10 #36 was driven to a depth of 87.6 feet, which corresponds to a pile tip elevation of EL 653.2. The blow count over the final increment of driving was 10 blows for 1¾ inches of penetration at an average hammer stroke of 7.5 feet. The blow count at the beginning of restrike was 5 blows for ⅝ inch of penetration at an average hammer stroke of 7.3 feet.

Pier 10 #44 was driven to a depth of 86.7 feet, which corresponds to a pile tip elevation of EL 654.1. The blow count over the final increment of driving was 10 blows for 1½ inches of penetration at an average hammer stroke of 7.3 feet. The blow count at the beginning of restrike was 5 blows for ½ inch of penetration at an average hammer stroke of 7.3 feet

We recommend the production piles at Pier 10 of Structure B-70-403 driven with the APE D30-42 hammer PD0256 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. Additionally, all production piles should achieve the minimum pile tip elevation of EL 658.5 for uplift, as indicated on the plans.

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	12	7
7.0	9	6
7.5	7	5
8.0	6	4
8.5	6	4

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.

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.

Travis Coleman, P.E.

Al Ziai

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

Attachments:

Dynamic Test Results - (pages 3 – 30)
CAPWAP Analysis Results - (pages 31 – 60)

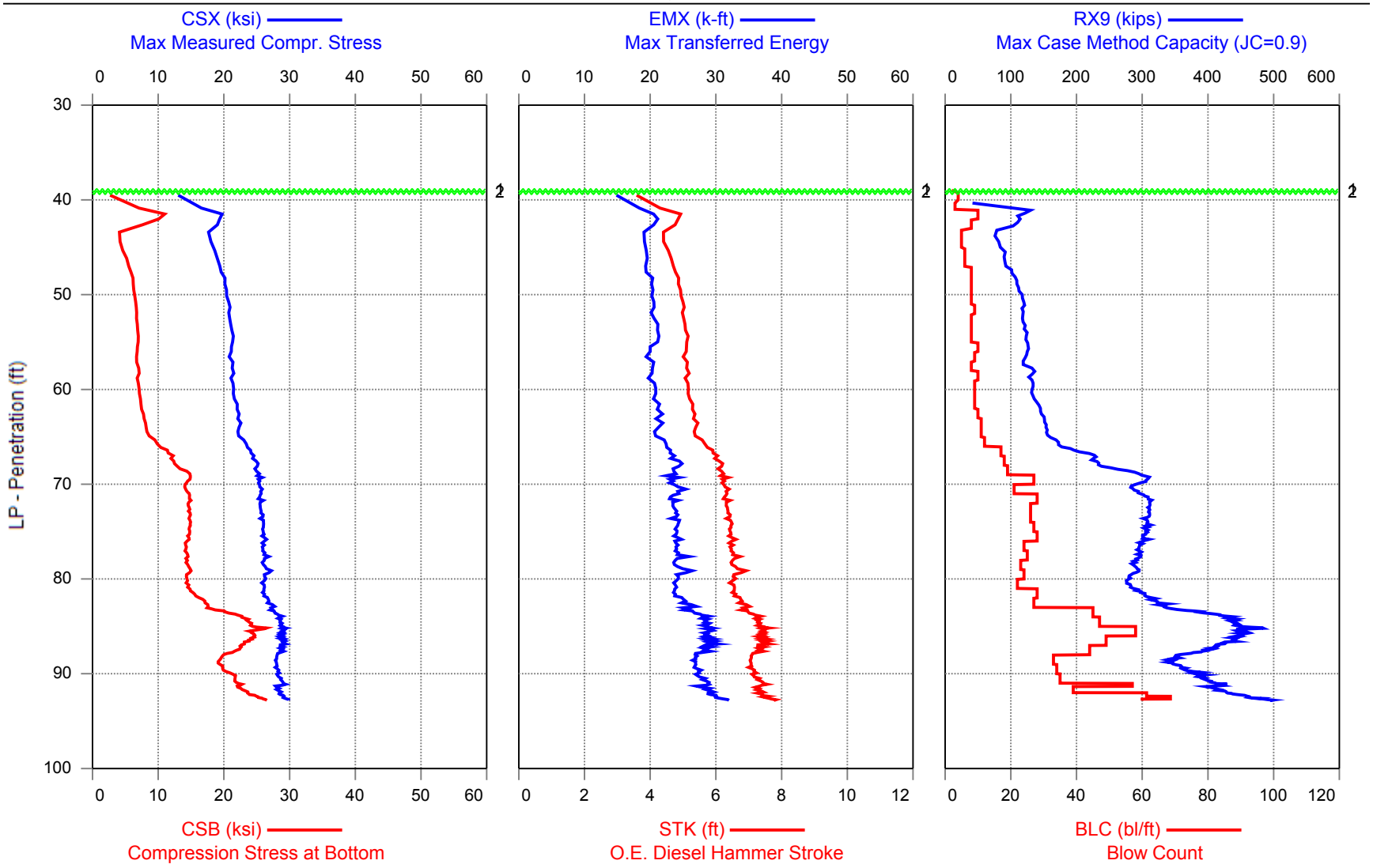
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 22-January-2015

Test started: 21-January-2015

B-70-403 - USH 10 over Little Lake Butte des Morts - Pier 10 #1 - EOID

APE D30-42, HP 14 x 73



1 - Depth reference at EL 740.8

2 - Mud line at EL 717.56

B-70-403 - USH 10 over Little Lake Butte des Morts - Pier 10 #1 - EOID APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

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 ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
4	39.00	2	AV1	13.3	2.3	16	3.6	60.9	0
			MAX	13.3	2.3	16	3.6	60.9	0
			MIN	13.3	2.3	16	3.6	60.9	0
5	39.25	4	AV1	13.3	2.9	14	3.7	60.5	0
			MAX	13.3	2.9	14	3.7	60.5	0
			MIN	13.3	2.9	14	3.7	60.5	0
8	40.00	4	AV3	12.9	2.7	15	3.6	61.3	6
			MAX	13.3	2.8	16	3.6	61.7	17
			MIN	12.4	2.5	13	3.5	61.0	0
11	41.00	3	AV3	14.1	5.9	16	3.8	59.8	77
			MAX	17.2	8.3	17	4.3	63.1	124
			MIN	11.2	2.6	13	3.3	56.1	10
21	42.00	10	AV10	19.9	10.4	21	5.0	52.4	120
			MAX	20.8	12.5	24	5.2	53.6	139
			MIN	18.7	8.7	19	4.7	51.4	107
29	43.00	8	AV8	18.8	7.8	20	4.7	53.7	105
			MAX	19.7	10.0	21	4.9	54.6	112
			MIN	18.0	5.0	18	4.6	52.9	90
34	44.00	5	AV5	17.6	4.0	19	4.4	55.7	75
			MAX	17.8	4.2	20	4.5	56.5	79
			MIN	17.1	3.6	18	4.2	55.2	71
39	45.00	5	AV5	18.2	4.3	19	4.5	55.2	82
			MAX	18.7	4.7	20	4.6	55.8	88
			MIN	17.9	4.0	18	4.3	54.5	76
45	46.00	6	AV6	18.7	4.7	19	4.6	54.6	89
			MAX	18.9	5.1	20	4.6	55.1	92
			MIN	18.1	4.4	18	4.5	54.2	85
51	47.00	6	AV6	19.1	5.3	19	4.7	54.0	91
			MAX	19.5	5.6	20	4.7	54.6	95
			MIN	18.7	5.2	19	4.6	53.6	87
59	48.00	8	AV8	19.7	5.8	19	4.8	53.4	101
			MAX	20.1	6.2	20	4.9	54.0	106
			MIN	19.3	5.5	19	4.7	53.0	98
67	49.00	8	AV8	20.2	6.2	20	4.9	53.0	109
			MAX	20.4	6.3	21	4.9	53.1	112
			MIN	20.0	6.1	20	4.8	52.7	105
75	50.00	8	AV8	20.3	6.3	20	4.9	52.7	114
			MAX	20.6	6.5	21	5.0	53.0	119

B-70-403 - USH 10 over Little Lake Butte des Morts - Pier 10 #1 - EOID APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MIN	20.0	6.1	19	4.9	52.5	108
83	51.00	8	AV8	20.7	6.5	21	5.0	52.3	118
			MAX	21.1	6.7	21	5.1	53.0	124
			MIN	20.1	6.4	20	4.9	51.7	115
92	52.00	9	AV9	20.8	6.7	20	5.0	52.3	119
			MAX	21.7	6.9	22	5.2	53.0	129
			MIN	20.1	6.6	19	4.9	51.1	112
100	53.00	8	AV8	20.8	6.7	21	5.0	52.2	118
			MAX	21.2	7.0	22	5.1	52.9	120
			MIN	20.0	6.6	20	4.9	51.7	115
108	54.00	8	AV8	21.2	6.9	21	5.1	51.9	122
			MAX	21.8	7.0	22	5.2	52.7	127
			MIN	20.5	6.7	20	4.9	51.4	119
116	55.00	8	AV8	21.4	7.0	21	5.1	51.6	123
			MAX	21.8	7.1	22	5.2	51.9	128
			MIN	21.1	6.9	21	5.1	51.1	118
126	56.00	10	AV10	21.1	6.9	20	5.1	51.8	127
			MAX	21.5	7.0	22	5.2	52.3	128
			MIN	20.7	6.7	19	5.0	51.3	125
135	57.00	9	AV9	21.1	6.7	20	5.1	51.9	123
			MAX	21.7	6.8	21	5.2	52.8	126
			MIN	20.5	6.6	19	4.9	51.2	117
143	58.00	8	AV8	21.2	6.9	20	5.1	51.8	126
			MAX	21.6	7.2	22	5.2	52.5	140
			MIN	20.5	6.6	19	5.0	51.3	114
153	59.00	10	AV10	21.3	7.0	20	5.1	51.7	131
			MAX	21.9	7.4	21	5.3	52.4	136
			MIN	20.6	6.6	19	5.0	50.8	125
162	60.00	9	AV9	21.4	7.0	21	5.1	51.6	134
			MAX	21.6	7.2	21	5.3	51.9	139
			MIN	21.0	6.8	20	5.1	51.0	129
171	61.00	9	AV9	21.5	7.2	21	5.2	51.5	133
			MAX	22.2	7.3	22	5.4	52.4	137
			MIN	20.7	7.0	20	5.0	50.6	126
180	62.00	9	AV9	22.0	7.4	21	5.3	50.9	141
			MAX	22.6	7.6	23	5.5	51.3	148
			MIN	21.6	7.3	20	5.2	50.1	135
190	63.00	10	AV10	22.2	7.7	22	5.3	50.7	147
			MAX	22.9	8.0	23	5.5	51.4	156
			MIN	21.5	7.4	20	5.2	49.8	144

B-70-403 - USH 10 over Little Lake Butte des Morts - Pier 10 #1 - EOID APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
201	64.00	11	AV11	22.3	8.0	21	5.4	50.5	153
			MAX	23.1	8.3	23	5.6	51.3	156
			MIN	21.6	7.6	20	5.2	49.5	147
212	65.00	11	AV11	22.2	8.4	21	5.4	50.5	155
			MAX	22.9	8.9	23	5.6	51.1	161
			MIN	21.7	8.0	20	5.2	49.7	153
224	66.00	12	AV12	23.1	9.6	22	5.6	49.6	170
			MAX	24.0	10.0	24	5.8	50.8	175
			MIN	22.1	8.8	20	5.3	48.7	161
241	67.00	17	AV17	24.1	11.4	23	5.9	48.3	204
			MAX	25.2	12.3	25	6.3	49.4	230
			MIN	23.1	10.0	22	5.6	47.0	179
259	68.00	18	AV18	24.8	12.3	24	6.1	47.7	230
			MAX	25.3	12.7	25	6.3	48.6	236
			MIN	23.9	11.6	22	5.8	47.0	221
278	69.00	19	AV19	25.1	13.9	24	6.2	47.3	270
			MAX	25.9	15.4	27	6.4	48.2	297
			MIN	24.3	12.4	23	5.9	46.5	235
305	70.00	27	AV27	25.4	14.7	23	6.2	47.1	304
			MAX	26.2	15.2	25	6.5	48.2	313
			MIN	24.4	13.9	21	5.9	46.2	293
326	71.00	21	AV21	25.7	14.3	25	6.3	46.7	288
			MAX	26.6	15.0	27	6.6	47.4	299
			MIN	24.9	13.6	23	6.1	45.7	282
354	72.00	28	AV28	25.5	14.8	23	6.3	46.9	308
			MAX	26.7	15.1	26	6.6	47.6	317
			MIN	24.9	14.3	22	6.1	45.7	296
380	73.00	26	AV26	25.5	14.7	24	6.3	46.7	310
			MAX	26.6	15.2	26	6.7	47.5	319
			MIN	24.7	14.1	22	6.1	45.6	304
406	74.00	26	AV26	25.9	14.8	24	6.4	46.4	309
			MAX	26.4	15.3	25	6.6	47.2	316
			MIN	25.1	14.5	22	6.2	45.9	299
433	75.00	27	AV27	26.0	14.8	24	6.5	46.3	307
			MAX	26.6	15.2	25	6.6	46.9	315
			MIN	25.3	14.5	23	6.3	45.7	300
461	76.00	28	AV28	26.1	14.7	24	6.5	46.2	304
			MAX	27.3	15.2	26	6.8	46.8	313
			MIN	25.5	14.3	23	6.3	45.0	297

B-70-403 - USH 10 over Little Lake Butte des Morts - Pier 10 #1 - EOID APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
485	77.00	24	AV24	25.9	14.2	24	6.4	46.3	296
			MAX	26.5	14.5	25	6.7	47.1	303
			MIN	25.3	13.9	23	6.2	45.6	290
510	78.00	25	AV25	26.3	14.4	24	6.6	45.9	295
			MAX	27.2	14.9	27	6.9	47.0	303
			MIN	25.3	13.8	23	6.3	44.8	286
533	79.00	23	AV23	26.2	14.5	24	6.5	46.0	289
			MAX	27.0	15.1	26	6.9	47.2	295
			MIN	24.6	13.8	22	6.2	44.9	278
557	80.00	24	AV24	26.6	14.6	25	6.7	45.6	286
			MAX	28.0	15.3	28	7.3	46.5	297
			MIN	25.7	13.7	23	6.4	43.7	274
579	81.00	22	AV22	26.0	14.5	24	6.5	46.1	280
			MAX	26.7	15.0	25	6.8	46.8	288
			MIN	25.3	14.0	23	6.3	45.2	273
607	82.00	28	AV28	26.1	15.4	24	6.6	45.9	301
			MAX	26.9	16.3	26	6.9	46.6	320
			MIN	25.4	14.6	22	6.4	44.9	289
634	83.00	27	AV27	27.1	17.2	26	6.8	45.0	326
			MAX	28.6	18.2	29	7.3	46.2	343
			MIN	25.9	16.4	24	6.5	43.6	310
679	84.00	45	AV45	27.8	20.3	27	7.0	44.5	387
			MAX	29.7	23.4	30	7.6	45.9	440
			MIN	26.4	16.9	23	6.6	42.7	332
726	85.00	47	AV47	28.6	23.7	28	7.3	43.7	439
			MAX	29.5	24.7	30	7.6	44.6	454
			MIN	27.6	22.6	27	7.0	42.9	426
784	86.00	58	AV58	28.9	24.9	29	7.4	43.2	457
			MAX	29.8	27.2	31	7.7	43.8	494
			MIN	28.2	23.7	27	7.2	42.5	434
833	87.00	49	AV49	28.9	23.7	29	7.4	43.3	433
			MAX	30.7	25.0	32	8.0	44.1	452
			MIN	27.9	22.4	27	7.1	41.7	410
877	88.00	44	AV44	28.6	21.7	28	7.3	43.7	394
			MAX	29.8	23.0	31	7.6	44.8	420
			MIN	27.6	19.6	26	6.9	42.7	357
910	89.00	33	AV33	28.0	19.4	27	7.1	44.3	347
			MAX	29.0	20.0	28	7.4	45.2	358
			MIN	27.0	18.6	25	6.8	43.4	336
944	90.00	34	AV34	28.2	20.1	27	7.1	44.2	367

B-70-403 - USH 10 over Little Lake Butte des Morts - Pier 10 #1 - EOID APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	30.0	21.7	30	7.7	45.1	393
			MIN	27.3	19.3	25	6.8	42.5	351
979	91.00	35	AV35	28.6	21.7	28	7.3	43.7	396
			MAX	30.0	22.3	30	7.8	45.0	417
			MIN	27.3	21.0	26	6.8	42.3	382
998	91.33	57	AV19	28.8	22.4	28	7.4	43.3	417
			MAX	30.2	23.2	31	7.9	44.4	432
			MIN	25.0	20.1	23	7.0	42.1	378
1024	92.00	39	AV26	28.3	22.9	29	7.3	43.6	416
			MAX	29.3	24.0	31	7.6	45.3	434
			MIN	26.6	21.6	26	6.8	42.7	392
1047	92.38	61	AV23	28.7	24.1	29	7.4	43.4	445
			MAX	29.7	25.2	31	7.7	44.4	465
			MIN	27.8	23.0	27	7.0	42.5	424
1057	92.52	69	AV10	29.0	25.2	30	7.5	43.1	463
			MAX	29.7	25.7	31	7.7	43.8	470
			MIN	28.4	24.8	29	7.2	42.6	456
1067	92.67	69	AV10	29.4	25.8	31	7.6	42.7	476
			MAX	30.1	26.5	32	7.9	44.0	486
			MIN	28.0	24.8	28	7.2	41.9	459
1077	92.83	60	AV10	29.9	26.4	32	7.8	42.3	493
			MAX	30.6	26.8	33	8.0	42.7	504
			MIN	29.3	26.0	31	7.6	41.8	483
			Average	25.9	16.3	25	6.5	46.5	308
			Maximum	30.7	27.2	33	8.0	63.1	504
			Minimum	11.2	2.3	13	3.3	41.7	0

Total number of blows analyzed: 1074

BL# Sensors

1-1077 F3: [F607] 93.6 (0.94); F4: [D815] 93.0 (0.94); A3: [K2524] 360.0 (1.04); A4: [K3550] 360.0 (1.04)

BL# Comments

4 Depth reference at EL 740.8
5 Mud line at EL 717.56

Time Summary

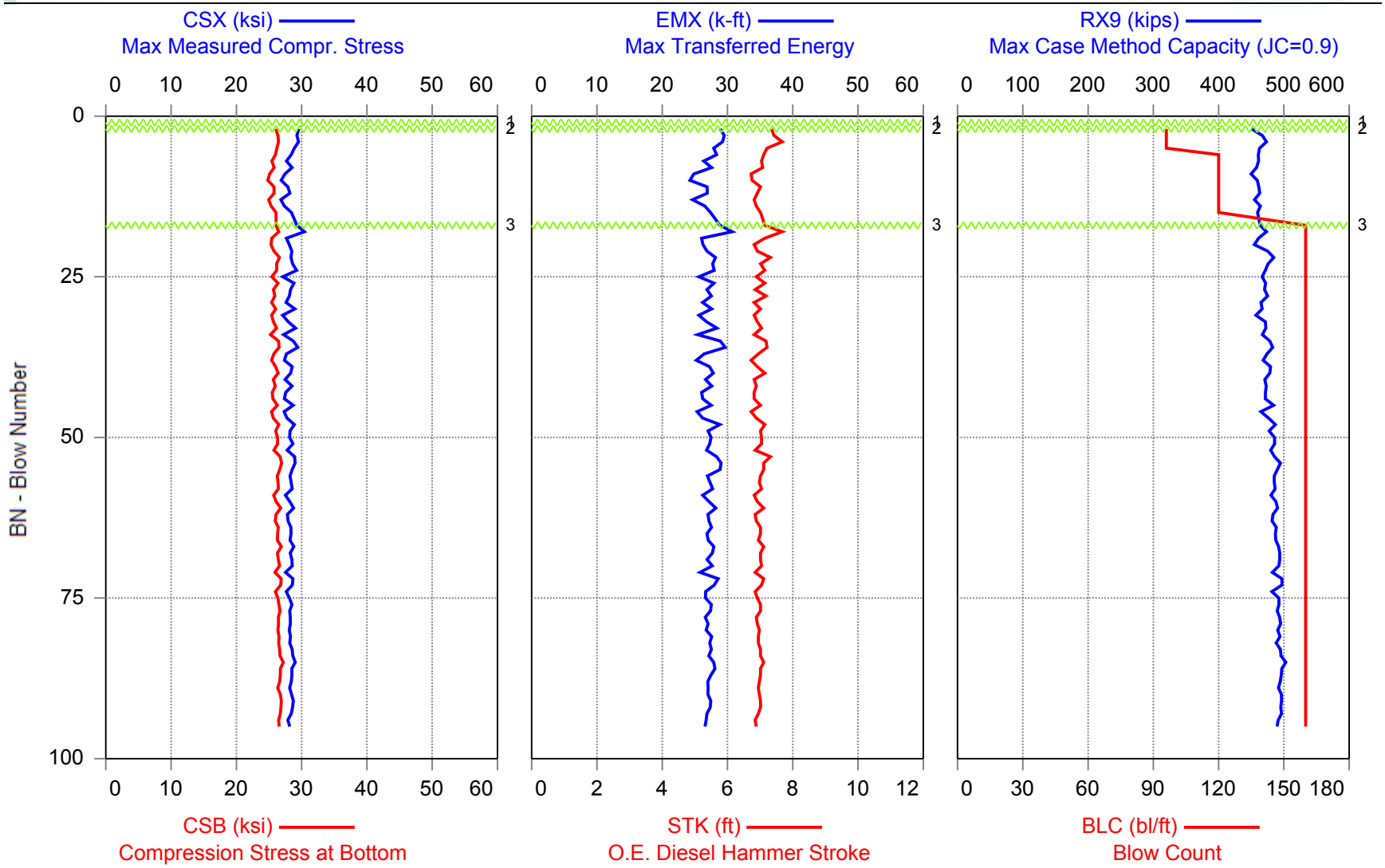
Drive 31 minutes 36 seconds 9:03 AM - 9:35 AM BN 1 - 1077

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 22-January-2015

Test started: 22-January-2015

USH 10 - B-70-403 - Pier 10 #1 Redrive



1 - Depth reference EL 740.8

2 - Mud line EL 717.6

3 - Start of Redrive

USH 10 - B-70-403 - Pier 10 #1 Redrive APE D30-42, HP 14 x 73
OP: RF Date: 22-January-2015

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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
5	92.92	96	AV4	29.3	26.3	29	7.4	43.3	463
			MAX	29.6	26.5	30	7.7	43.9	473
			MIN	28.9	26.0	28	7.2	42.6	451
10	92.96	120	AV5	27.8	25.4	26	6.9	44.7	458
			MAX	28.5	26.0	28	7.1	45.4	461
			MIN	26.9	24.8	24	6.7	44.2	450
15	93.00	120	AV5	27.7	25.6	26	6.9	44.8	461
			MAX	28.4	26.1	27	7.0	45.1	464
			MIN	26.8	25.0	25	6.8	44.5	455
25	93.03	160	AV9	28.6	25.9	28	7.1	44.2	470
			MAX	30.4	26.6	31	7.7	45.1	484
			MIN	27.1	25.3	26	6.8	42.6	455
35	93.09	160	AV10	28.2	25.8	27	7.0	44.6	470
			MAX	29.1	26.5	29	7.2	45.1	478
			MIN	27.1	25.2	25	6.8	44.0	457
45	93.15	160	AV10	28.1	25.9	27	6.9	44.8	475
			MAX	29.4	26.5	30	7.2	45.4	484
			MIN	27.4	25.4	25	6.7	43.9	468
55	93.22	160	AV10	28.3	26.2	28	7.0	44.5	483
			MAX	29.0	26.9	29	7.3	45.4	495
			MIN	27.3	25.4	25	6.7	43.6	465
65	93.28	160	AV10	28.2	26.2	27	7.0	44.7	486
			MAX	28.8	26.8	28	7.1	45.1	490
			MIN	27.5	25.7	26	6.8	44.2	480
75	93.34	160	AV10	28.3	26.4	27	7.0	44.6	491
			MAX	28.8	26.9	29	7.1	45.0	497
			MIN	27.5	25.9	26	6.8	44.2	482
85	93.40	160	AV10	28.4	26.6	27	7.0	44.6	494
			MAX	29.0	27.2	28	7.1	44.9	503
			MIN	28.1	26.4	27	6.9	44.2	488
95	93.47	160	AV10	28.4	26.7	27	7.0	44.7	494
			MAX	28.7	26.9	28	7.0	45.0	497
			MIN	27.9	26.3	27	6.8	44.5	490
			Average	28.3	26.2	27	7.0	44.5	480
			Maximum	30.4	27.2	31	7.7	45.4	503
			Minimum	26.8	24.8	24	6.7	42.6	450

Total number of blows analyzed: 93

BL#	Sensors
1-95	F3: [F607] 93.6 (0.96); F4: [D815] 93.0 (0.96); A3: [K2524] 360.0 (1.04); A4: [K3550] 360.0 (1.04)

BL#	Comments
1	Depth reference EL 740.8
2	Mud line EL 717.6
17	Start of Redrive

Time Summary

Drive	18 seconds	8:01 AM - 8:01 AM (1/22/2015) BN 1 - 15
Stop	13 minutes 7 seconds	8:01 AM - 8:14 AM
Drive	1 minute 46 seconds	8:14 AM - 8:16 AM BN 16 - 95

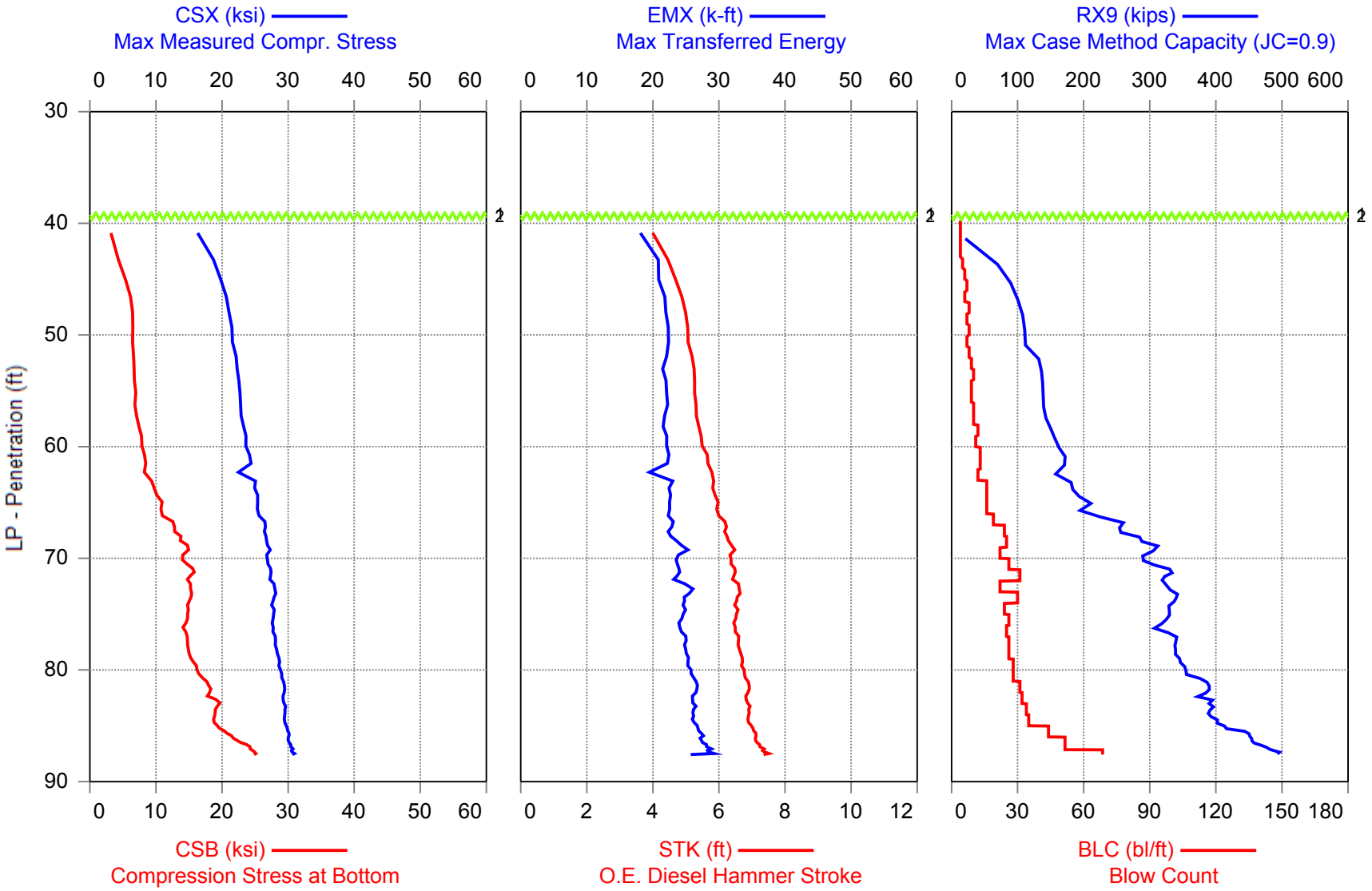
Total time [00:15:12] = (Driving [00:02:05] + Stop [00:13:07])

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 22-January-2015

Test started: 21-January-2015

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



1 - Depth reference EL 740.8

2 - Mud line EL 717.6

USH 10 - B-70-403 - Pier 10 #36 - EOID APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
4	40.00	4	AV2	14.6	2.7	15	3.6	60.6	0
			MAX	15.6	3.0	16	3.7	60.9	0
			MIN	13.5	2.4	14	3.6	60.3	0
8	41.00	4	AV4	15.7	3.1	17	3.9	58.6	9
			MAX	18.5	3.7	20	4.4	60.8	31
			MIN	13.6	2.4	14	3.6	55.3	0
12	42.00	4	AV4	17.8	3.6	21	4.2	56.5	25
			MAX	18.6	4.0	21	4.4	57.9	46
			MIN	16.6	3.1	19	4.0	55.6	11
16	43.00	4	AV4	18.2	3.8	21	4.4	55.8	42
			MAX	18.5	3.9	22	4.4	56.3	54
			MIN	17.7	3.7	20	4.3	55.4	36
21	44.00	5	AV5	19.0	4.6	21	4.5	54.9	72
			MAX	19.3	5.1	23	4.6	55.6	81
			MIN	18.4	4.2	20	4.4	54.1	66
27	45.00	6	AV6	19.5	5.1	21	4.6	54.2	83
			MAX	19.9	5.4	22	4.7	54.6	87
			MIN	19.0	4.9	20	4.6	53.7	79
34	46.00	7	AV7	20.2	5.7	21	4.8	53.5	92
			MAX	20.7	6.0	22	4.9	54.2	95
			MIN	19.7	5.4	20	4.6	53.0	87
40	47.00	6	AV6	20.7	6.2	22	4.9	52.9	98
			MAX	21.2	6.4	23	5.0	53.3	102
			MIN	20.1	6.0	22	4.8	52.2	94
48	48.00	8	AV8	21.0	6.4	22	5.0	52.4	107
			MAX	21.5	6.8	23	5.1	52.8	111
			MIN	20.5	6.1	21	4.9	52.0	101
55	49.00	7	AV7	21.3	6.5	22	5.0	52.2	106
			MAX	21.9	6.7	24	5.2	52.7	109
			MIN	20.7	6.3	22	4.9	51.4	104
63	50.00	8	AV8	21.4	6.5	22	5.0	52.1	111
			MAX	21.9	6.8	23	5.1	52.6	116
			MIN	20.9	6.2	21	4.9	51.7	104
70	51.00	7	AV7	21.6	6.4	22	5.1	51.9	111
			MAX	21.9	6.6	23	5.1	52.2	115
			MIN	21.4	6.3	22	5.0	51.6	106
78	52.00	8	AV8	22.0	6.6	22	5.2	51.5	120
			MAX	22.2	6.8	23	5.2	51.9	132

USH 10 - B-70-403 - Pier 10 #36 - EOID APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MIN	21.6	6.5	22	5.1	51.2	112
87	53.00	9	AV9	22.2	6.7	22	5.2	51.2	135
			MAX	22.5	7.0	23	5.3	51.6	140
			MIN	21.8	6.6	21	5.1	50.9	132
97	54.00	10	AV10	22.4	6.7	22	5.3	51.0	138
			MAX	22.9	7.1	22	5.4	51.6	144
			MIN	22.0	6.2	21	5.1	50.6	133
106	55.00	9	AV9	22.6	6.8	22	5.2	51.1	137
			MAX	22.9	7.1	23	5.4	51.4	143
			MIN	22.3	6.4	21	5.2	50.6	134
115	56.00	9	AV9	22.8	6.9	22	5.3	50.9	138
			MAX	23.2	7.5	23	5.4	51.3	142
			MIN	22.4	6.4	21	5.2	50.6	134
125	57.00	10	AV10	22.8	6.9	22	5.3	50.8	139
			MAX	23.3	7.3	23	5.4	51.1	142
			MIN	22.6	6.4	21	5.2	50.3	138
135	58.00	10	AV10	23.1	7.2	22	5.3	50.6	144
			MAX	24.0	7.8	23	5.5	51.0	153
			MIN	22.7	6.7	21	5.3	49.8	136
147	59.00	12	AV12	23.4	7.6	22	5.4	50.3	152
			MAX	24.0	8.1	23	5.6	51.0	159
			MIN	22.6	7.1	20	5.3	49.7	144
158	60.00	11	AV11	23.6	7.9	22	5.5	50.1	157
			MAX	24.0	8.2	23	5.5	50.4	163
			MIN	23.3	7.5	21	5.4	49.8	150
171	61.00	13	AV13	24.0	8.1	22	5.6	49.5	169
			MAX	24.5	8.6	23	5.7	50.4	175
			MIN	23.3	7.8	21	5.4	49.1	161
184	62.00	13	AV13	24.4	8.5	22	5.7	49.2	171
			MAX	25.3	8.9	23	5.8	49.9	175
			MIN	23.8	7.9	21	5.5	48.6	167
196	63.00	12	AV12	23.0	8.5	21	5.8	48.7	161
			MAX	25.8	9.5	25	6.0	49.2	181
			MIN	12.9	5.3	6	5.7	47.9	82
212	64.00	16	AV16	24.9	9.6	22	5.8	48.7	182
			MAX	25.4	10.1	24	6.0	49.1	189
			MIN	24.6	9.2	21	5.7	48.0	177
228	65.00	16	AV16	25.3	10.5	23	5.9	48.3	197
			MAX	25.9	11.1	25	6.0	48.9	214
			MIN	25.0	9.8	22	5.8	47.8	185

USH 10 - B-70-403 - Pier 10 #36 - EOID APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
244	66.00	16	AV16	25.4	10.7	23	5.9	48.2	200
			MAX	25.8	11.3	23	6.1	48.8	212
			MIN	24.7	10.4	22	5.8	47.7	190
263	67.00	19	AV19	26.1	12.0	23	6.1	47.5	241
			MAX	26.9	13.6	24	6.3	48.5	271
			MIN	25.0	10.3	21	5.9	46.8	195
287	68.00	24	AV24	26.5	12.9	23	6.2	47.2	258
			MAX	27.6	13.8	24	6.5	47.8	280
			MIN	25.9	11.9	21	6.0	46.2	242
312	69.00	25	AV25	26.8	14.2	24	6.3	46.8	295
			MAX	27.3	15.5	25	6.5	47.2	318
			MIN	26.3	13.3	22	6.2	46.1	274
334	70.00	22	AV22	27.0	14.5	25	6.4	46.5	299
			MAX	27.7	15.6	26	6.6	47.1	319
			MIN	26.3	13.5	23	6.2	45.8	278
360	71.00	26	AV26	27.0	14.7	24	6.4	46.5	305
			MAX	28.0	16.0	25	6.6	47.3	331
			MIN	26.4	13.7	22	6.2	45.7	275
391	72.00	31	AV31	27.3	15.3	24	6.5	46.3	326
			MAX	28.0	16.0	25	6.7	46.8	338
			MIN	27.0	14.6	22	6.3	45.6	311
413	73.00	22	AV22	27.9	15.2	25	6.6	45.9	327
			MAX	28.7	15.5	27	6.8	46.6	335
			MIN	27.0	14.6	23	6.4	45.3	320
443	74.00	30	AV30	27.9	15.2	25	6.6	45.9	340
			MAX	28.8	15.8	27	6.8	46.6	348
			MIN	27.2	14.8	24	6.4	45.1	331
467	75.00	24	AV24	27.8	14.8	25	6.5	46.0	329
			MAX	28.5	15.2	26	6.8	46.7	334
			MIN	27.1	14.5	23	6.3	45.3	323
493	76.00	26	AV26	27.7	14.7	24	6.5	46.2	324
			MAX	28.2	15.1	25	6.7	47.0	335
			MIN	27.0	14.1	23	6.3	45.5	314
518	77.00	25	AV25	27.8	14.4	24	6.5	46.1	321
			MAX	28.4	15.1	26	6.8	46.6	345
			MIN	27.3	13.6	23	6.4	45.3	302
544	78.00	26	AV26	28.1	14.8	25	6.6	45.8	339
			MAX	28.7	15.1	27	6.8	46.6	345
			MIN	27.3	14.4	24	6.4	45.2	334

USH 10 - B-70-403 - Pier 10 #36 - EOID APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
570	79.00	26	AV26	28.4	15.0	25	6.7	45.6	340
			MAX	29.7	15.6	27	7.1	46.1	349
			MIN	27.9	14.6	24	6.5	44.3	334
598	80.00	28	AV28	28.7	15.9	25	6.7	45.4	350
			MAX	29.5	16.6	27	6.9	46.1	359
			MIN	28.0	15.3	24	6.5	44.7	340
626	81.00	28	AV28	29.0	16.8	26	6.8	45.2	365
			MAX	29.8	17.8	27	7.0	45.9	390
			MIN	28.4	15.9	25	6.6	44.4	351
657	82.00	31	AV31	29.4	18.1	27	6.9	44.8	389
			MAX	30.0	18.7	28	7.1	45.4	398
			MIN	28.8	17.6	25	6.7	44.2	383
689	83.00	32	AV32	29.3	18.6	26	6.8	45.1	384
			MAX	30.0	21.7	27	7.1	45.8	411
			MIN	28.6	17.4	25	6.6	44.3	363
723	84.00	34	AV34	29.6	19.1	26	6.9	44.8	392
			MAX	30.2	19.8	28	7.1	45.4	407
			MIN	29.0	18.5	25	6.7	44.2	381
758	85.00	35	AV35	29.5	18.8	26	6.9	44.8	400
			MAX	30.0	20.4	28	7.1	45.5	414
			MIN	28.8	18.2	25	6.7	44.3	377
802	86.00	44	AV44	30.0	20.4	27	7.1	44.3	437
			MAX	30.7	21.8	29	7.3	44.9	462
			MIN	29.3	19.3	26	6.9	43.7	407
861	87.15	51	AV59	30.3	23.1	28	7.2	43.9	464
			MAX	31.4	24.8	30	7.5	44.9	488
			MIN	29.2	21.3	26	6.9	43.0	444
874	87.29	69	AV13	30.5	24.6	28	7.3	43.6	487
			MAX	30.9	25.0	29	7.5	44.2	496
			MIN	29.9	23.7	27	7.1	43.2	476
884	87.44	69	AV10	30.7	24.9	29	7.4	43.4	496
			MAX	31.2	25.2	29	7.6	43.8	503
			MIN	30.1	24.6	28	7.2	42.8	489
894	87.58	69	AV10	30.9	25.1	29	7.5	43.2	493
			MAX	31.3	25.4	30	7.6	43.7	506
			MIN	30.4	24.8	23	7.3	42.7	428
			Average	27.0	14.6	25	6.3	46.9	303
			Maximum	31.4	25.4	30	7.6	60.9	506
			Minimum	12.9	2.4	6	3.6	42.7	0

Total number of blows analyzed: 892

BL#	Sensors
1-894	F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.00); A4: [K3550] 360.0 (1.00)

BL#	Comments
1	Depth reference EL 740.8
2	Mud line EL 717.6

Time Summary

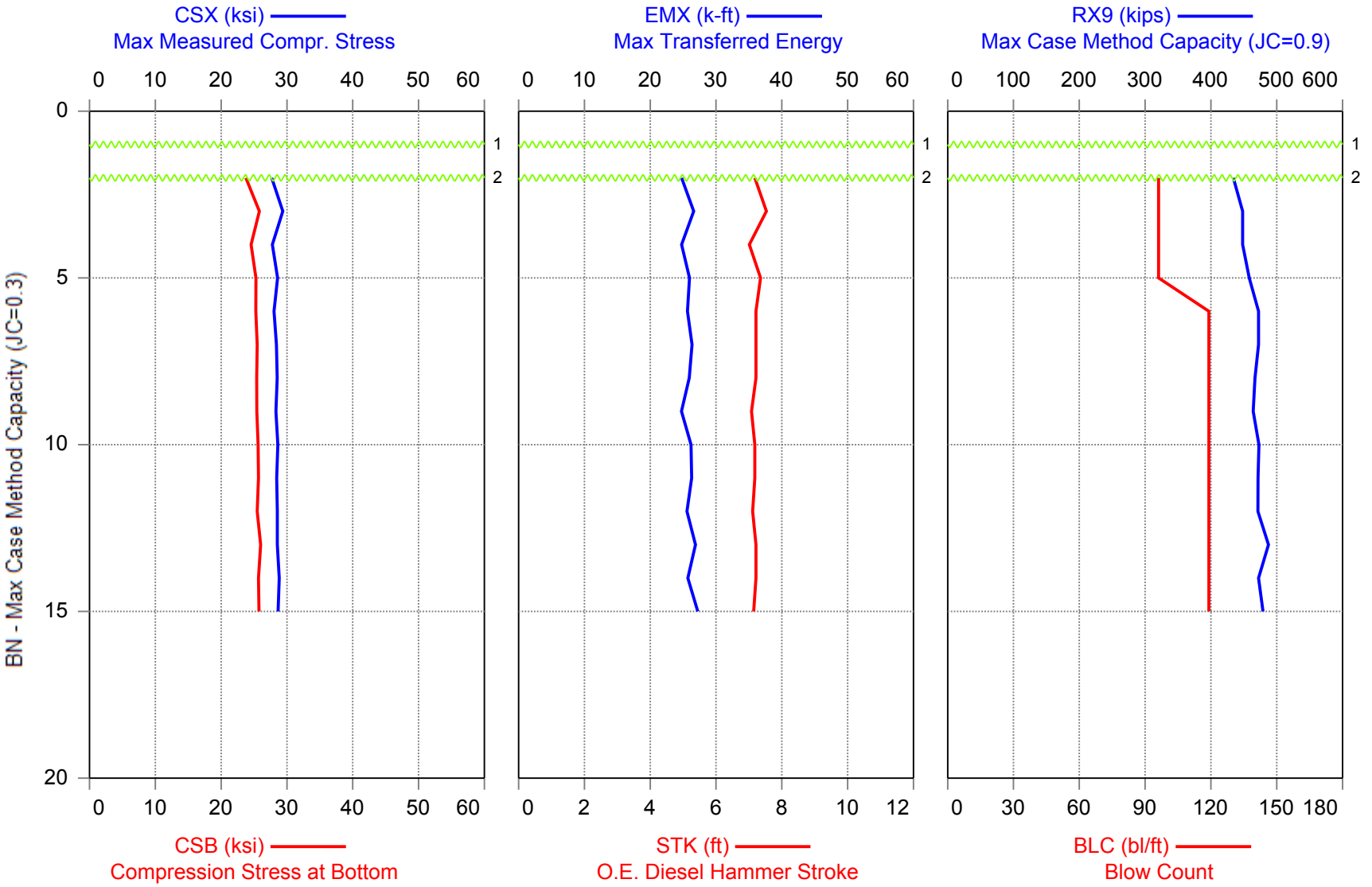
Drive	19 minutes 23 seconds	8:25 AM - 8:44 AM BN 1 - 894

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 22-January-2015

Test started: 22-January-2015

USH 10 - B-70-403 - Pier 10 #36 BOR



1 - Depth reference EL 740.8

2 - Mud line EL 717.6

USH 10 - B-70-403 - Pier 10 #36 BOR APE D30-42, HP 14 x 73
OP: RF Date: 22-January-2015

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 ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
5	87.64	96	AV4	28.4	24.9	26	7.3	43.8	447
			MAX	29.4	25.8	27	7.5	44.5	458
			MIN	27.7	23.8	25	7.0	43.0	434
10	87.68	119	AV5	28.4	25.4	26	7.2	44.0	470
			MAX	28.6	25.6	26	7.2	44.3	473
			MIN	28.0	25.3	25	7.1	43.9	464
15	87.72	119	AV5	28.6	25.7	26	7.2	44.0	476
			MAX	28.8	26.0	27	7.2	44.2	487
			MIN	28.4	25.5	26	7.1	43.9	471
			Average	28.4	25.4	26	7.2	43.9	466
			Maximum	29.4	26.0	27	7.5	44.5	487
			Minimum	27.7	23.8	25	7.0	43.0	434

Total number of blows analyzed: 14

BL# Sensors

1-15 F3: [F607] 93.6 (0.96); F4: [D815] 93.0 (0.96); A3: [K2524] 360.0 (1.04); A4: [K3550] 360.0 (1.04)

BL# Comments

1 Depth reference EL 740.8
2 Mud line EL 717.6

Time Summary

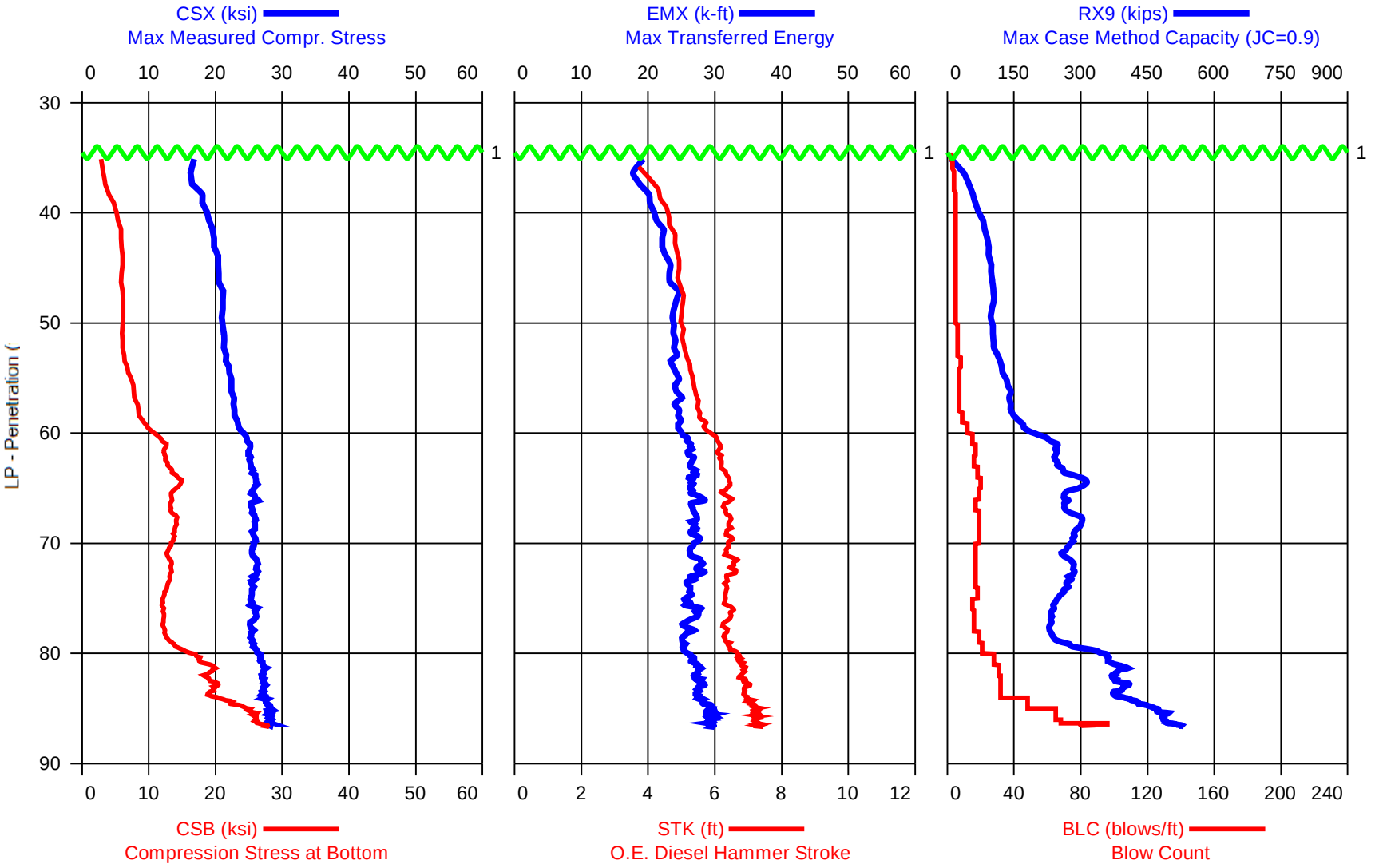
Drive 19 seconds 7:48 AM - 7:48 AM BN 1 - 15

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 22-January-2015 Test started: 21-January-2015

US 10 over LLBDM B-70-403 - Pier 10 #44

APE D30-42, HP 14 x 73



1 - Reported reference EL 740.8

US 10 over LLBDM B-70-403 - Pier 10 #44 APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 91.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.20 []

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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
2	35.00	2	AV2	22.6	3.2	**	25	**	19
			STD	0.5	0.0	**	4	**	4
			MAX	23.1	3.2	**	29	**	23
			MIN	22.1	3.1	**	21	**	15
5	36.00	3	AV3	12.9	2.7	3.6	16	61.4	6
			STD	2.8	0.3	0.5	3	3.6	8
			MAX	16.7	3.0	4.2	20	65.1	18
			MIN	9.9	2.4	3.1	12	56.5	0
9	37.00	4	AV4	16.1	3.2	4.0	18	58.0	44
			STD	0.3	0.2	0.1	1	0.5	5
			MAX	16.4	3.4	4.1	19	58.4	49
			MIN	15.6	2.9	3.9	16	57.2	38
13	38.00	4	AV4	16.9	3.6	4.2	19	56.6	50
			STD	0.5	0.2	0.1	1	0.7	3
			MAX	17.8	3.9	4.4	22	57.4	54
			MIN	16.6	3.5	4.1	18	55.4	47
18	39.00	5	AV5	17.8	4.2	4.4	20	55.6	59
			STD	0.4	0.2	0.1	1	0.5	4
			MAX	18.4	4.6	4.5	20	56.4	65
			MIN	17.2	3.9	4.3	18	54.8	55
23	40.00	5	AV5	18.6	5.0	4.6	21	54.5	67
			STD	0.2	0.1	0.1	1	0.4	5
			MAX	19.0	5.1	4.7	22	54.9	72
			MIN	18.3	5.0	4.5	20	53.8	59
28	41.00	5	AV5	19.0	5.4	4.6	21	54.3	79
			STD	0.3	0.0	0.1	1	0.5	3
			MAX	19.4	5.4	4.7	22	54.8	82
			MIN	18.7	5.3	4.5	20	53.6	74

US 10 over LLBDM B-70-403 - Pier 10 #44 APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
33	42.00	5	AV5	19.7	5.9	4.8	22	53.5	84
			STD	0.6	0.1	0.1	1	0.6	4
			MAX	20.4	6.0	4.9	24	54.6	90
			MIN	18.8	5.7	4.6	21	52.9	80
38	43.00	5	AV5	19.6	5.8	4.8	22	53.4	92
			STD	0.3	0.1	0.1	0	0.3	4
			MAX	20.0	5.9	4.9	22	53.8	98
			MIN	19.2	5.7	4.7	21	52.8	87
43	44.00	5	AV5	20.1	6.0	4.9	22	53.0	92
			STD	0.2	0.1	0.0	1	0.2	4
			MAX	20.5	6.2	4.9	23	53.2	100
			MIN	19.8	5.9	4.8	22	52.7	87
48	45.00	5	AV5	20.5	6.1	4.9	23	52.7	98
			STD	0.3	0.1	0.1	0	0.4	2
			MAX	20.9	6.2	5.0	24	53.1	101
			MIN	20.0	5.9	4.8	23	52.2	96
53	46.00	5	AV5	20.3	5.9	4.9	23	52.8	98
			STD	0.4	0.2	0.1	1	0.4	4
			MAX	20.9	6.1	5.0	24	53.3	105
			MIN	19.6	5.6	4.8	21	52.2	95
58	47.00	5	AV5	20.8	5.9	5.0	24	52.4	102
			STD	0.2	0.1	0.1	0	0.3	3
			MAX	21.2	6.1	5.0	24	52.9	105
			MIN	20.5	5.7	4.9	23	52.1	98
63	48.00	5	AV5	21.2	6.1	5.1	25	51.9	107
			STD	0.2	0.0	0.0	0	0.2	3
			MAX	21.6	6.2	5.1	26	52.1	111
			MIN	21.1	6.1	5.0	24	51.6	102
68	49.00	5	AV5	21.0	6.1	5.0	24	52.2	100
			STD	0.1	0.1	0.0	0	0.1	2
			MAX	21.2	6.3	5.0	25	52.5	103
			MIN	20.8	6.1	5.0	23	52.1	99
73	50.00	5	AV5	20.9	6.1	5.0	24	52.3	97

US 10 over LLBDM B-70-403 - Pier 10 #44 APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
			STD	0.3	0.2	0.1	0	0.3	2
			MAX	21.4	6.3	5.1	24	52.8	100
			MIN	20.5	5.8	4.9	23	52.0	94
79	51.00	6	AV6	21.2	6.0	5.0	24	52.1	103
			STD	0.3	0.1	0.0	1	0.2	2
			MAX	21.6	6.1	5.1	25	52.3	106
			MIN	20.8	5.9	5.0	23	51.8	100
85	52.00	6	AV6	21.2	6.1	5.0	24	52.0	103
			STD	0.4	0.1	0.1	1	0.4	3
			MAX	21.9	6.2	5.2	25	52.8	108
			MIN	20.5	5.9	4.9	23	51.4	101
91	53.00	6	AV6	21.4	6.2	5.1	24	51.8	109
			STD	0.2	0.1	0.0	1	0.2	4
			MAX	21.7	6.3	5.2	25	52.0	115
			MIN	21.1	5.8	5.1	23	51.5	103
99	54.00	8	AV8	21.8	6.5	5.2	24	51.2	120
			STD	0.3	0.2	0.1	0	0.3	3
			MAX	22.2	6.8	5.3	24	52.0	125
			MIN	21.1	6.2	5.1	23	50.8	115
106	55.00	7	AV7	22.2	7.0	5.3	24	50.8	125
			STD	0.3	0.1	0.1	1	0.3	4
			MAX	22.8	7.3	5.4	26	51.2	133
			MIN	21.8	6.9	5.2	24	50.2	121
113	56.00	7	AV7	22.3	7.7	5.4	24	50.6	136
			STD	0.2	0.3	0.0	0	0.2	4
			MAX	22.7	8.1	5.4	25	50.8	141
			MIN	22.1	7.4	5.3	24	50.2	128
120	57.00	7	AV7	22.6	7.8	5.5	25	50.1	141
			STD	0.3	0.2	0.1	1	0.2	4
			MAX	23.2	8.0	5.6	26	50.4	146
			MIN	22.3	7.6	5.4	24	49.7	136
127	58.00	7	AV7	22.7	8.3	5.5	24	50.0	142
			STD	0.2	0.1	0.1	1	0.2	3

US 10 over LLBDM B-70-403 - Pier 10 #44 APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	23.1	8.5	5.6	25	50.4	146
			MIN	22.4	8.1	5.4	23	49.7	138
136	59.00	9	AV9	23.0	8.7	5.6	25	49.6	154
			STD	0.3	0.3	0.1	1	0.4	8
			MAX	23.7	9.3	5.8	26	50.1	165
			MIN	22.6	8.4	5.5	24	48.8	140
148	60.00	12	AV12	23.6	10.0	5.7	25	49.0	177
			STD	0.3	0.4	0.1	1	0.4	8
			MAX	24.2	10.7	5.9	25	49.6	193
			MIN	23.2	9.5	5.6	24	48.4	167
163	61.00	15	AV15	24.7	11.8	6.1	26	47.7	226
			STD	0.4	0.5	0.1	1	0.4	16
			MAX	25.5	12.7	6.3	27	48.3	258
			MIN	24.1	11.0	5.9	25	46.8	201
180	62.00	17	AV17	25.0	12.4	6.1	26	47.5	245
			STD	0.3	0.2	0.1	1	0.3	4
			MAX	25.7	12.7	6.3	28	48.2	252
			MIN	24.5	12.1	5.9	24	46.8	240
196	63.00	16	AV16	25.2	12.6	6.2	27	47.3	245
			STD	0.3	0.2	0.1	1	0.3	7
			MAX	25.9	13.0	6.4	27	47.7	257
			MIN	24.6	12.1	6.1	26	46.5	232
214	64.00	18	AV18	25.7	13.6	6.3	27	46.8	270
			STD	0.4	0.4	0.1	1	0.4	14
			MAX	26.4	14.4	6.5	29	47.8	299
			MIN	24.8	12.9	6.0	25	46.1	251
234	65.00	20	AV20	26.0	14.7	6.4	26	46.4	308
			STD	0.3	0.2	0.1	1	0.3	6
			MAX	26.8	15.1	6.6	28	46.9	317
			MIN	25.6	14.2	6.3	26	45.7	290
253	66.00	19	AV19	25.7	13.5	6.3	27	46.7	268
			STD	0.3	0.2	0.1	1	0.5	9
			MAX	26.3	14.0	6.6	29	47.6	292

US 10 over LLBDM B-70-403 - Pier 10 #44 APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	24.9	13.2	6.1	26	45.7	256
270	67.00	17	AV17	25.6	13.3	6.3	27	46.7	264
			STD	0.5	0.2	0.1	1	0.5	4
			MAX	26.7	13.7	6.6	29	47.6	275
			MIN	24.7	12.9	6.1	26	45.7	258
289	68.00	19	AV19	25.8	13.9	6.4	27	46.5	292
			STD	0.3	0.4	0.1	0	0.3	13
			MAX	26.4	14.4	6.6	28	47.0	313
			MIN	25.1	13.3	6.3	26	45.8	271
308	69.00	19	AV19	25.8	14.0	6.4	27	46.4	295
			STD	0.3	0.2	0.1	1	0.3	7
			MAX	26.3	14.3	6.5	28	47.1	305
			MIN	24.9	13.5	6.2	25	46.0	285
327	70.00	19	AV19	25.8	13.7	6.4	27	46.4	283
			STD	0.4	0.2	0.1	1	0.4	4
			MAX	26.5	14.1	6.7	29	47.0	292
			MIN	25.1	13.2	6.3	26	45.6	277
344	71.00	17	AV17	25.5	13.0	6.4	26	46.6	266
			STD	0.2	0.3	0.1	1	0.2	7
			MAX	25.9	13.4	6.5	27	46.9	276
			MIN	25.2	12.3	6.3	26	46.2	249
361	72.00	17	AV17	26.0	13.2	6.5	28	46.1	274
			STD	0.5	0.3	0.2	1	0.5	11
			MAX	26.9	13.5	6.8	29	47.1	292
			MIN	25.0	12.5	6.2	25	45.3	254
378	73.00	17	AV17	26.1	13.3	6.5	28	46.1	283
			STD	0.5	0.2	0.2	1	0.5	9
			MAX	26.9	13.6	6.8	29	46.9	301
			MIN	25.3	12.9	6.3	26	45.2	271
395	74.00	17	AV17	25.6	13.0	6.3	26	46.7	272
			STD	0.3	0.2	0.1	1	0.3	7
			MAX	26.5	13.3	6.6	28	47.4	291
			MIN	25.0	12.7	6.1	25	45.8	264

US 10 over LLBDM B-70-403 - Pier 10 #44 APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
413	75.00	18	AV18	25.4	12.4	6.3	26	46.7	258
			STD	0.3	0.2	0.1	1	0.3	7
			MAX	26.1	12.7	6.5	27	47.2	273
			MIN	24.8	12.0	6.2	25	46.2	245
428	76.00	15	AV15	25.6	12.1	6.4	26	46.6	241
			STD	0.6	0.2	0.2	1	0.6	7
			MAX	26.7	12.4	6.7	29	47.5	255
			MIN	24.7	11.7	6.1	24	45.4	230
444	77.00	16	AV16	26.0	12.2	6.5	27	46.3	234
			STD	0.2	0.1	0.1	1	0.3	4
			MAX	26.3	12.5	6.6	28	46.8	242
			MIN	25.5	12.0	6.3	26	45.7	226
460	78.00	16	AV16	25.3	12.2	6.3	26	46.8	231
			STD	0.4	0.2	0.1	1	0.4	6
			MAX	26.0	12.5	6.5	27	47.4	241
			MIN	24.8	12.0	6.1	25	46.0	221
479	79.00	19	AV19	25.4	12.7	6.3	25	46.8	241
			STD	0.4	0.3	0.1	1	0.3	8
			MAX	25.9	13.5	6.5	27	47.4	261
			MIN	24.7	12.2	6.1	24	46.3	230
500	80.00	21	AV21	25.9	14.7	6.5	25	46.2	307
			STD	0.4	0.9	0.1	1	0.4	30
			MAX	26.7	16.5	6.7	27	46.8	346
			MIN	25.4	13.5	6.3	24	45.4	262
528	81.00	28	AV28	26.8	17.6	6.8	27	45.3	364
			STD	0.3	0.6	0.1	1	0.3	6
			MAX	27.5	19.0	6.9	28	45.8	380
			MIN	26.2	16.6	6.6	26	44.7	354
559	82.00	31	AV31	27.2	19.3	6.8	28	45.0	387
			STD	0.3	0.6	0.1	1	0.3	11
			MAX	28.2	20.4	7.1	29	45.6	414
			MIN	26.6	18.0	6.7	26	44.1	364

US 10 over LLBDM B-70-403 - Pier 10 #44 APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
591	83.00	32	AV32	27.2	19.5	6.9	28	44.9	387
			STD	0.4	0.8	0.1	1	0.4	15
			MAX	27.7	20.8	7.1	29	45.8	417
			MIN	26.4	17.8	6.6	26	44.1	366
623	84.00	32	AV32	27.2	19.4	6.9	27	44.9	384
			STD	0.3	0.5	0.1	0	0.3	10
			MAX	27.7	20.2	7.1	28	45.7	399
			MIN	26.3	18.6	6.6	26	44.3	369
671	85.00	48	AV48	27.7	22.6	7.1	29	44.2	434
			STD	0.4	1.3	0.1	1	0.4	20
			MAX	28.7	24.9	7.4	30	45.2	470
			MIN	26.7	20.3	6.8	27	43.3	401
736	86.00	65	AV65	28.1	25.7	7.2	29	43.8	482
			STD	0.3	0.5	0.1	1	0.3	8
			MAX	28.7	26.6	7.5	31	44.6	506
			MIN	27.2	24.6	7.0	28	43.2	463
758	86.32	68	AV22	28.2	26.0	7.2	29	43.8	491
			STD	0.3	0.2	0.1	1	0.2	4
			MAX	28.9	26.5	7.4	31	44.3	499
			MIN	27.7	25.6	7.1	28	43.3	485
768	86.43	96	AV10	28.5	26.8	7.3	30	43.7	508
			STD	0.4	0.3	0.1	1	0.3	6
			MAX	28.9	27.1	7.4	31	44.2	514
			MIN	27.9	26.1	7.1	28	43.3	497
778	86.54	87	AV10	28.3	27.4	7.3	29	43.8	520
			STD	0.2	0.3	0.1	1	0.2	5
			MAX	28.6	27.9	7.4	30	44.2	529
			MIN	27.9	26.8	7.1	29	43.5	513
788	86.67	80	AV10	28.6	27.9	7.3	30	43.6	532
			STD	0.4	0.4	0.1	1	0.4	5
			MAX	29.2	28.4	7.5	31	44.3	539
			MIN	27.8	27.4	7.1	28	43.0	522
			Average	25.5	15.3	6.4	27	46.8	299
			Std. Dev.	2.6	6.4	0.8	2	3.0	126

US 10 over LLBDM B-70-403 - Pier 10 #44 APE D30-42, HP 14 x 73
OP: MR Date: 21-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
			Maximum	29.2	28.4	7.5	31	65.1	539
			Minimum	9.9	2.4	3.1	12	43.0	0

Total number of blows analyzed: 788

BL# Sensors

1-788 F3: [F607] 93.6 (0.94); F4: [D815] 93.0 (0.94); A3: [K2524] 360.0 (1.06); A4: [K3550] 360.0 (1.06)

BL# Comments

1 Reported reference EL 740.8

Time Summary

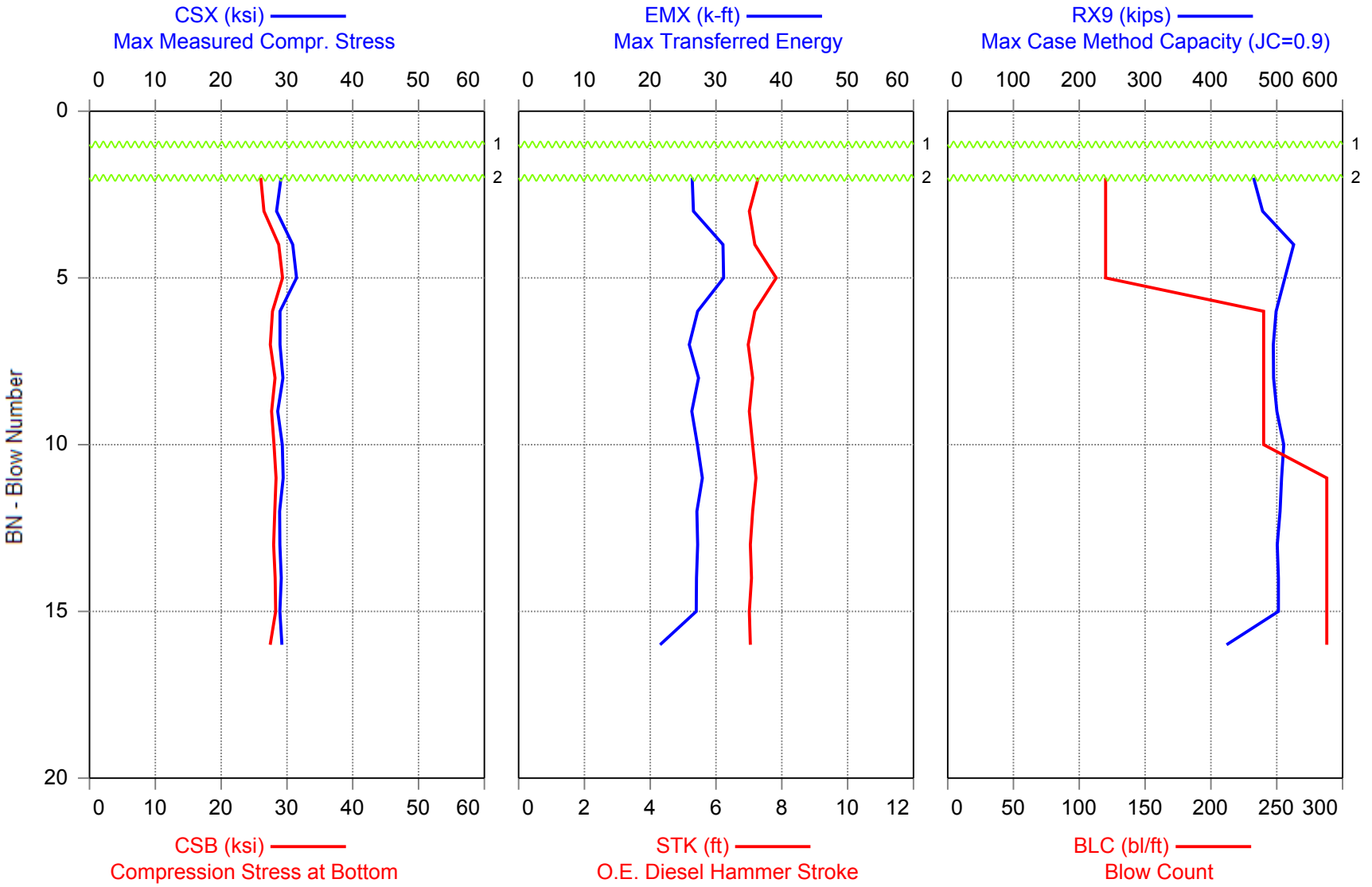
Drive 17 minutes 8 seconds 7:47 AM - 8:04 AM BN 1 - 788

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 23-January-2015

Test started: 22-January-2015

USH 10 - B-70-403 - Pier 10 #44 BOR



1 - Depth reference EL 740.8

2 - Mud line EL 717.6

USH 10 - B-70-403 - Pier 10 #44 BOR APE D30-42, HP 14 x 73
OP: RF Date: 22-January-2015

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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
5	86.70	120	AV4	30.0	27.7	29	7.3	43.6	495
			MAX	31.5	29.3	31	7.8	44.5	526
			MIN	28.4	26.0	26	7.0	42.2	465
10	86.72	240	AV5	29.0	27.8	27	7.1	44.3	500
			MAX	29.4	28.2	27	7.2	44.6	511
			MIN	28.6	27.5	26	7.0	44.0	495
16	86.74	288	AV6	29.1	28.1	26	7.1	44.3	490
			MAX	29.4	28.3	28	7.2	44.5	507
			MIN	28.9	27.4	21	7.0	43.9	424
			Average	29.3	27.9	27	7.1	44.1	495
			Maximum	31.5	29.3	31	7.8	44.6	526
			Minimum	28.4	26.0	21	7.0	42.2	424

Total number of blows analyzed: 15

BL# Sensors

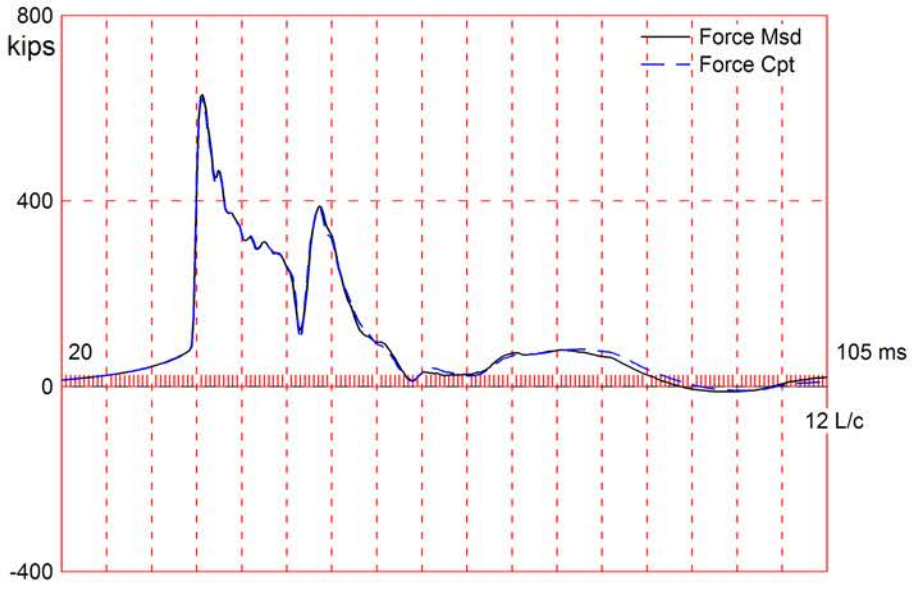
1-3 F3: [F607] 93.6 (0.95); F4: [D815] 93.0 (0.95); A3: [K2524] 360.0 (1.05); A4: [K3550] 360.0 (1.05)
4-4 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.10); A4: [K3550] 360.0 (1.10)
5-16 F3: [F607] 93.6 (0.95); F4: [D815] 93.0 (0.95); A3: [K2524] 360.0 (1.05); A4: [K3550] 360.0 (1.05)

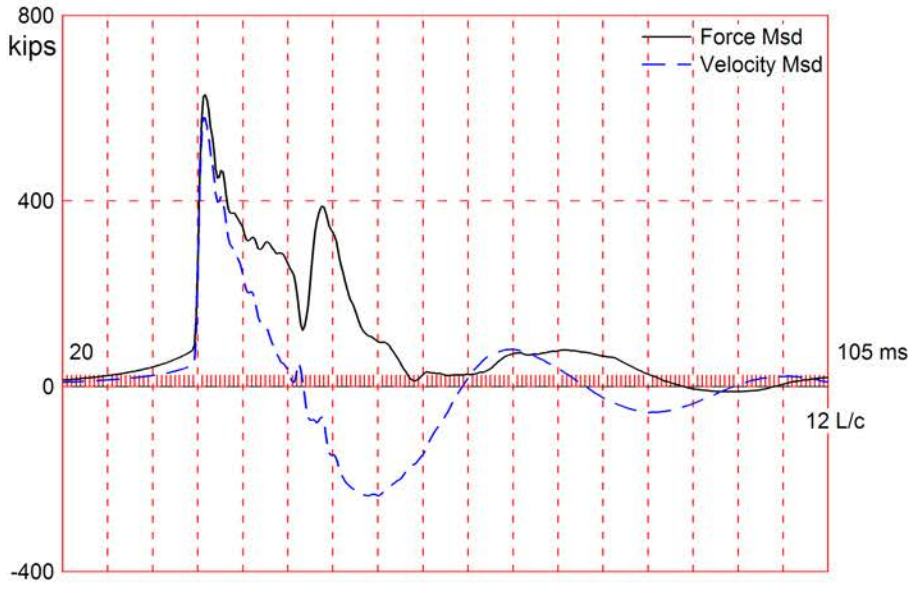
BL# Comments

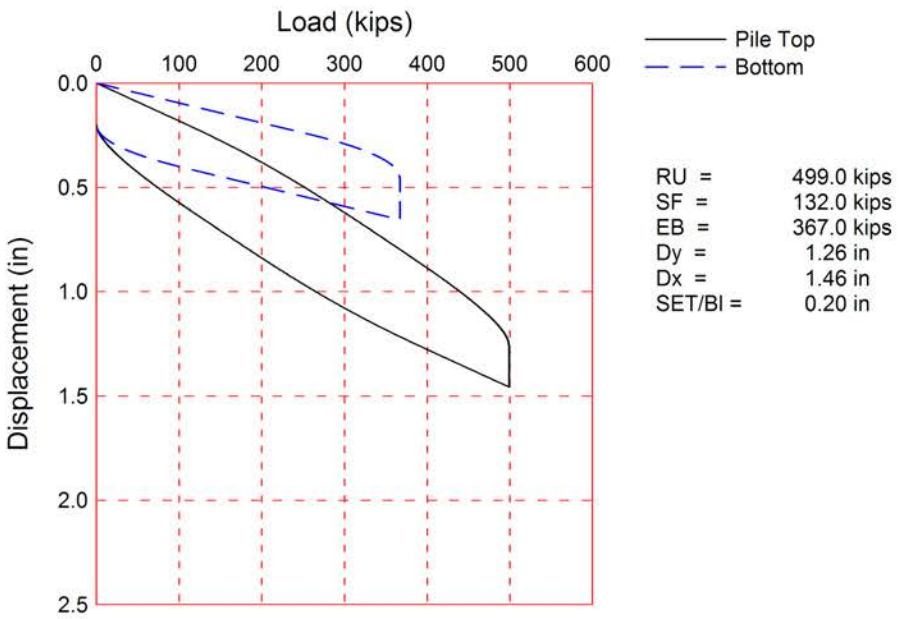
1 Depth reference EL 740.8
2 Mud line EL 717.6
4 CW

Time Summary

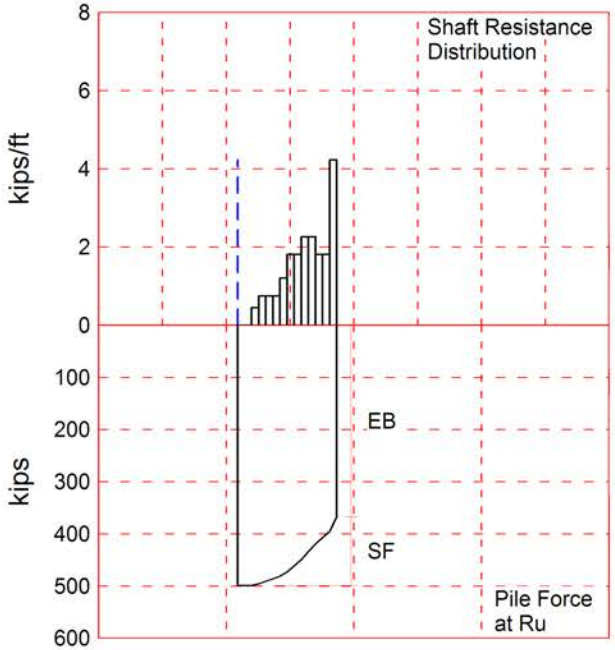
Drive 20 seconds 7:35 AM - 7:36 AM BN 1 - 16







RU =	499.0 kips
SF =	132.0 kips
EB =	367.0 kips
Dy =	1.26 in
Dx =	1.46 in
SET/BI =	0.20 in



Length b. Sensors	92.6 ft
Embedment	92.6 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	2.04
Top Compr. Stress	29.0 ksi
Max Compr. Stress	29.6 ksi
Max Tension Stress	-3.33 ksi
Avg. Shaft Quake	0.17 in
Toe Quake	0.35 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.10 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: 499.0; along Shaft 132.0; at Toe 367.0 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
				499.0				
1	6.6	6.6	0.0	499.0	0.0	0.00	0.00	0.00
2	13.2	13.2	0.0	499.0	0.0	0.00	0.00	0.00
3	19.8	19.8	3.0	496.0	3.0	0.45	0.10	0.24
4	26.5	26.5	5.0	491.0	8.0	0.76	0.16	0.24
5	33.1	33.1	5.0	486.0	13.0	0.76	0.16	0.24
6	39.7	39.7	5.0	481.0	18.0	0.76	0.16	0.24
7	46.3	46.3	8.0	473.0	26.0	1.21	0.26	0.24
8	52.9	52.9	12.0	461.0	38.0	1.81	0.39	0.24
9	59.5	59.5	12.0	449.0	50.0	1.81	0.39	0.24
10	66.1	66.1	15.0	434.0	65.0	2.27	0.48	0.24
11	72.7	72.7	15.0	419.0	80.0	2.27	0.48	0.24
12	79.4	79.4	12.0	407.0	92.0	1.81	0.39	0.24
13	86.0	86.0	12.0	395.0	104.0	1.81	0.39	0.24
14	92.6	92.6	28.0	367.0	132.0	4.23	0.90	0.24
Avg. Shaft			9.4			1.43	0.30	0.24
Toe			367.0				266.23	0.10

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.17	0.35
Case Damping Factor		0.83	0.96
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	97	45
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	20	
Resistance Gap (included in Toe Quake)	(in)		0.08
Soil Plug Weight	(kips)		0.112

CAPWAP match quality = 2.04 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.16 in; Blow Count = 74 b/ft

max. Top Comp. Stress = 29.0 ksi (T= 36.0 ms, max= 1.021 x Top)
max. Comp. Stress = 29.6 ksi (Z= 19.8 ft, T= 37.0 ms)
max. Tens. Stress = -3.33 ksi (Z= 59.5 ft, T= 63.0 ms)
max. Energy (EMX) = 31.2 kip-ft; max. Measured Top Displ. (DMX)= 0.97 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	620.9	-10.5	29.0	-0.49	31.2	15.4	0.97
2	6.6	621.7	-12.1	29.0	-0.56	31.1	15.3	0.96
4	13.2	625.3	-14.9	29.2	-0.69	30.8	15.2	0.93
6	19.8	633.8	-18.0	29.6	-0.84	30.4	15.0	0.89
8	26.5	630.7	-26.6	29.5	-1.24	29.2	14.7	0.85
10	33.1	618.8	-34.8	28.9	-1.63	27.6	14.5	0.81
12	39.7	608.6	-46.9	28.4	-2.19	26.0	14.1	0.77
14	46.3	604.1	-58.9	28.2	-2.75	24.3	13.7	0.72
15	49.6	581.4	-60.8	27.2	-2.84	22.6	13.4	0.69
16	52.9	591.2	-67.3	27.6	-3.15	22.2	13.1	0.67
17	56.2	552.7	-66.5	25.8	-3.11	20.0	12.8	0.64
18	59.5	563.2	-71.2	26.3	-3.33	19.6	12.5	0.62
19	62.8	528.4	-68.3	24.7	-3.19	17.5	12.2	0.59
20	66.1	538.9	-69.7	25.2	-3.25	17.1	11.9	0.56
21	69.4	494.3	-63.1	23.1	-2.95	14.8	11.6	0.54
22	72.7	502.8	-63.9	23.5	-2.98	14.4	11.4	0.51
23	76.0	457.6	-57.3	21.4	-2.68	12.3	11.2	0.49
24	79.4	464.7	-58.3	21.7	-2.72	11.9	11.0	0.46
25	82.7	429.7	-52.8	20.1	-2.47	10.3	11.7	0.43
26	86.0	453.3	-53.3	21.2	-2.49	9.9	12.8	0.41
27	89.3	456.9	-48.2	21.3	-2.25	8.5	13.5	0.38
28	92.6	467.8	-48.6	21.9	-2.27	6.7	13.3	0.36
Absolute	19.8			29.6			(T =	37.0 ms)
	59.5				-3.33		(T =	63.0 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	658.4	603.1	547.8	492.4	437.1	381.8	326.5	271.1	215.8	160.5
RX	685.4	644.9	623.5	602.0	580.6	559.2	537.7	519.4	508.2	498.5
RU	670.2	615.3	560.4	505.5	450.6	395.6	340.7	285.8	230.9	176.0

RAU = 317.9 (kips); RA2 = 553.2 (kips)

Current CAPWAP Ru = 499.0 (kips); Corresponding J(RP)= 0.29; J(RX) = 0.90

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
15.3	35.61	581.6	630.1	633.6	0.97	0.20	0.20	31.3	641.9	1359

PILE PROFILE AND PILE MODEL

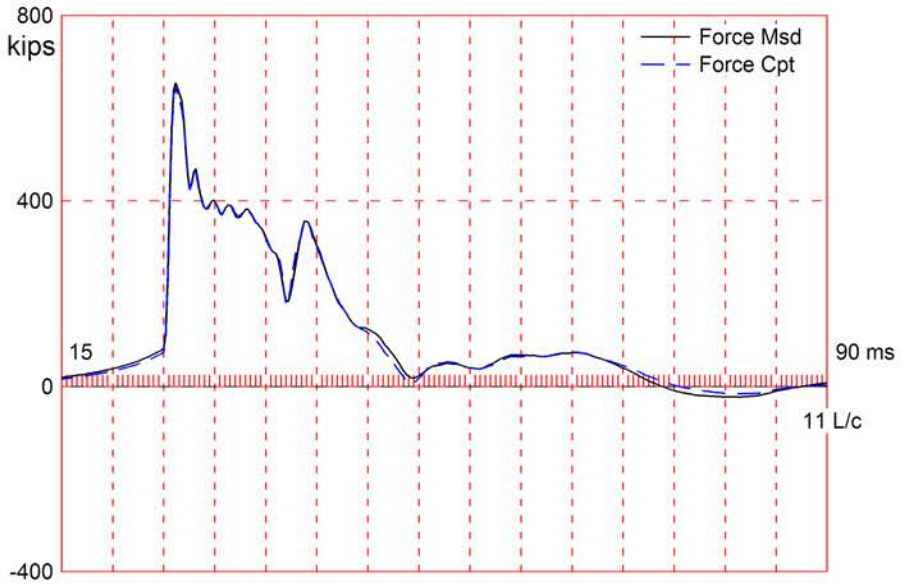
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.6	21.4	29992.2	492.000	4.70

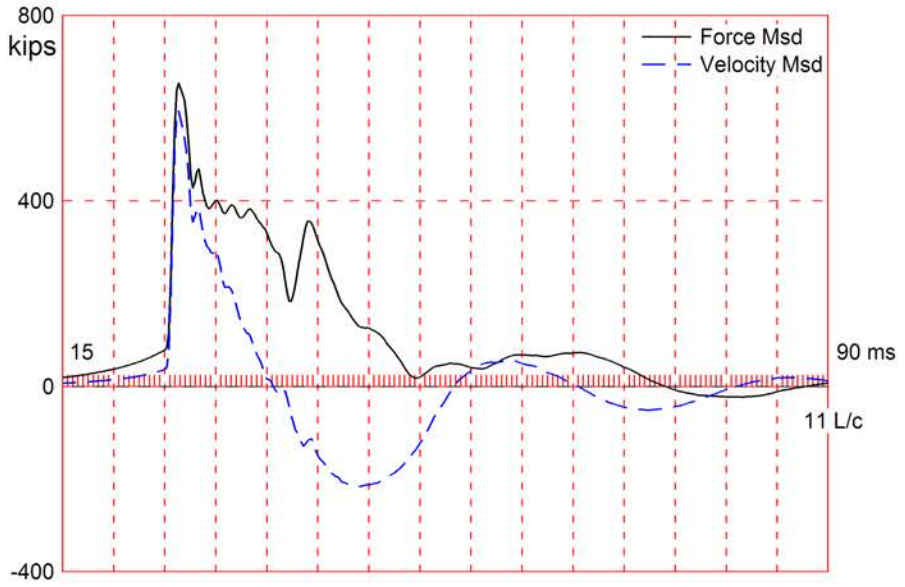
Toe Area 198.5 in^2

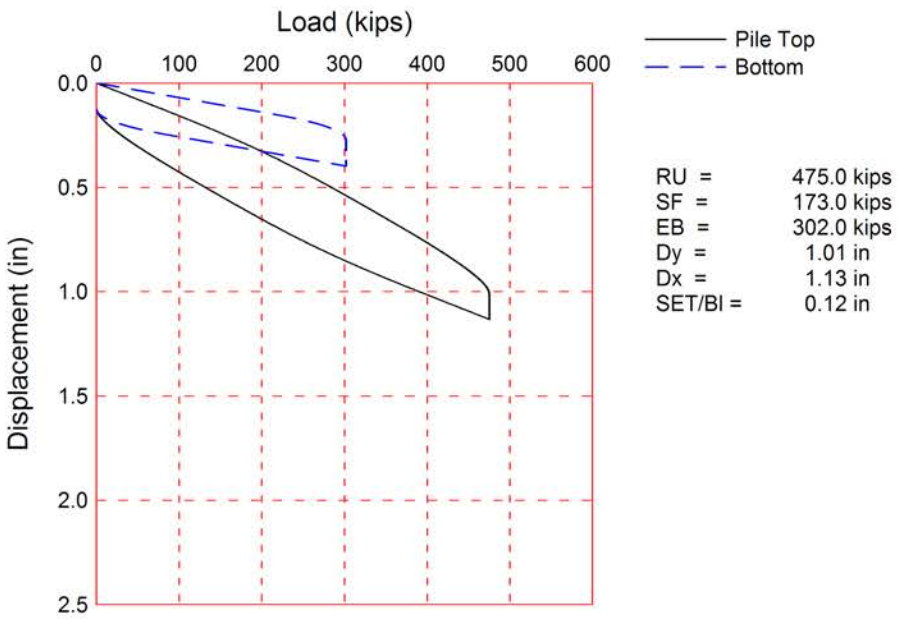
Top Segment Length 3.31 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms

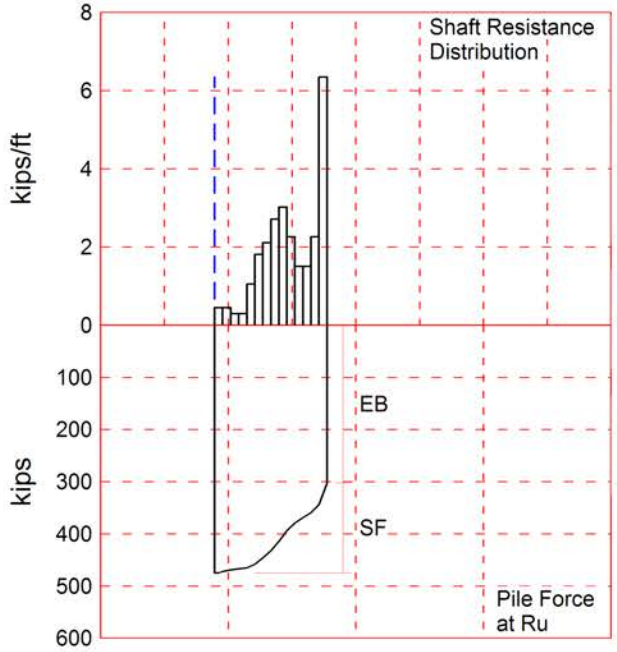
Total volume: 13.758 ft^3; Volume ratio considering added impedance: 1.000







RU =	475.0 kips
SF =	173.0 kips
EB =	302.0 kips
Dy =	1.01 in
Dx =	1.13 in
SET/Bl =	0.12 in



Length b. Sensors	92.6 ft
Embedment	92.6 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	1.63
Top Compr. Stress	30.3 ksi
Max Compr. Stress	30.4 ksi
Max Tension Stress	-2.00 ksi
Avg. Shaft Quake	0.16 in
Toe Quake	0.21 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.11 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 475.0; along Shaft 173.0; at Toe 302.0 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
				475.0			
1	6.6	6.6	3.0	472.0	3.0	0.45	0.10
2	13.2	13.2	3.0	469.0	6.0	0.45	0.10
3	19.8	19.8	2.0	467.0	8.0	0.30	0.06
4	26.5	26.5	2.0	465.0	10.0	0.30	0.06
5	33.1	33.1	7.0	458.0	17.0	1.06	0.23
6	39.7	39.7	12.0	446.0	29.0	1.81	0.39
7	46.3	46.3	14.0	432.0	43.0	2.12	0.45
8	52.9	52.9	18.0	414.0	61.0	2.72	0.58
9	59.5	59.5	20.0	394.0	81.0	3.02	0.64
10	66.1	66.1	15.0	379.0	96.0	2.27	0.48
11	72.7	72.7	10.0	369.0	106.0	1.51	0.32
12	79.4	79.4	10.0	359.0	116.0	1.51	0.32
13	86.0	86.0	15.0	344.0	131.0	2.27	0.48
14	92.6	92.6	42.0	302.0	173.0	6.35	1.35
Avg. Shaft			12.4			1.87	0.40
Toe			302.0				219.08

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.25	0.11
Quake	(in)	0.16	0.21
Case Damping Factor		1.13	0.87
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	35
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	24	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.030	0.064

CAPWAP match quality = 1.63 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.13 in; Blow Count = 89 b/ft

max. Top Comp. Stress = 30.3 ksi (T= 26.6 ms, max= 1.006 x Top)
max. Comp. Stress = 30.4 ksi (Z= 6.6 ft, T= 26.8 ms)
max. Tens. Stress = -2.00 ksi (Z= 52.9 ft, T= 52.7 ms)
max. Energy (EMX) = 31.5 kip-ft; max. Measured Top Displ. (DMX)= 0.88 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	648.0	-17.1	30.3	-0.80	31.5	15.7	0.89
2	6.6	651.7	-18.2	30.4	-0.85	31.3	15.6	0.87
4	13.2	644.7	-20.1	30.1	-0.94	30.3	15.4	0.84
6	19.8	636.4	-22.0	29.7	-1.03	29.2	15.2	0.81
8	26.5	635.3	-23.9	29.7	-1.12	28.2	15.0	0.76
10	33.1	643.7	-28.7	30.1	-1.34	27.1	14.5	0.71
12	39.7	636.9	-37.2	29.8	-1.74	25.0	13.8	0.66
14	46.3	613.1	-41.2	28.6	-1.92	22.2	13.1	0.61
15	49.6	573.6	-38.4	26.8	-1.79	19.9	12.6	0.58
16	52.9	588.0	-42.8	27.5	-2.00	19.4	12.2	0.55
17	56.2	537.8	-37.4	25.1	-1.75	16.9	11.8	0.53
18	59.5	550.5	-39.9	25.7	-1.87	16.4	11.4	0.50
19	62.8	493.1	-31.4	23.0	-1.47	14.0	11.1	0.47
20	66.1	502.8	-32.2	23.5	-1.50	13.5	10.8	0.45
21	69.4	468.1	-26.1	21.9	-1.22	11.8	10.4	0.42
22	72.7	477.3	-26.9	22.3	-1.26	11.4	10.2	0.40
23	76.0	447.5	-23.0	20.9	-1.08	10.3	10.1	0.38
24	79.4	451.8	-24.1	21.1	-1.12	9.9	10.0	0.35
25	82.7	432.7	-21.2	20.2	-0.99	8.9	9.8	0.33
26	86.0	440.6	-21.9	20.6	-1.02	8.6	10.6	0.31
27	89.3	435.3	-20.8	20.3	-0.97	7.4	11.2	0.29
28	92.6	461.4	-21.3	21.6	-0.99	5.7	10.7	0.27
Absolute	6.6			30.4			(T =	26.8 ms)
	52.9				-2.00		(T =	52.7 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	746.6	695.5	644.4	593.3	542.1	491.0	439.9	388.8	337.7	286.5
RX	750.4	708.6	666.8	626.6	586.7	567.1	547.7	528.4	510.1	493.0
RU	754.8	704.5	654.2	603.9	553.6	503.3	453.0	402.7	352.4	302.1

RAU = 292.2 (kips); RA2 = 535.2 (kips)

Current CAPWAP Ru = 475.0 (kips); Corresponding J(RP)= 0.53; matches RX9 within 5%

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	26.36	599.6	658.2	658.2	0.88	0.13	0.12	31.8	761.8	1510

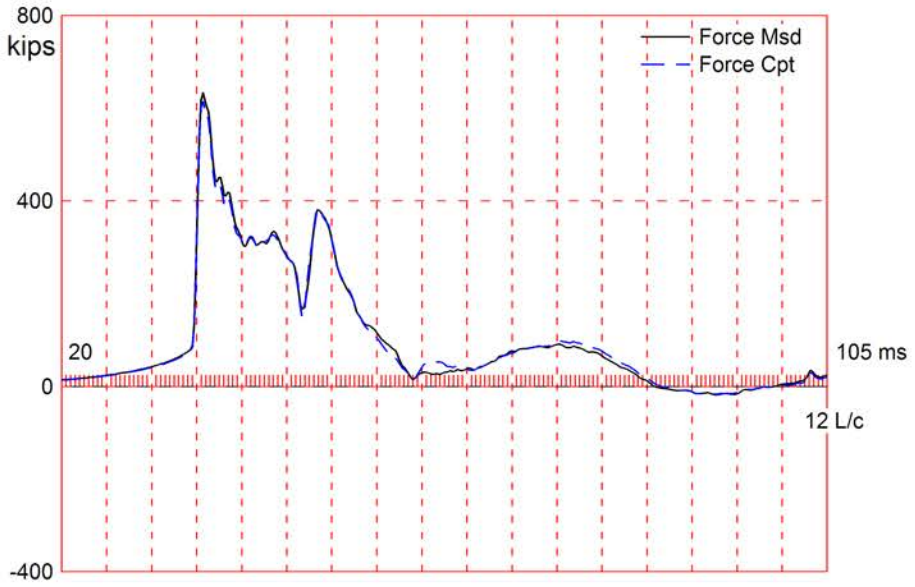
PILE PROFILE AND PILE MODEL

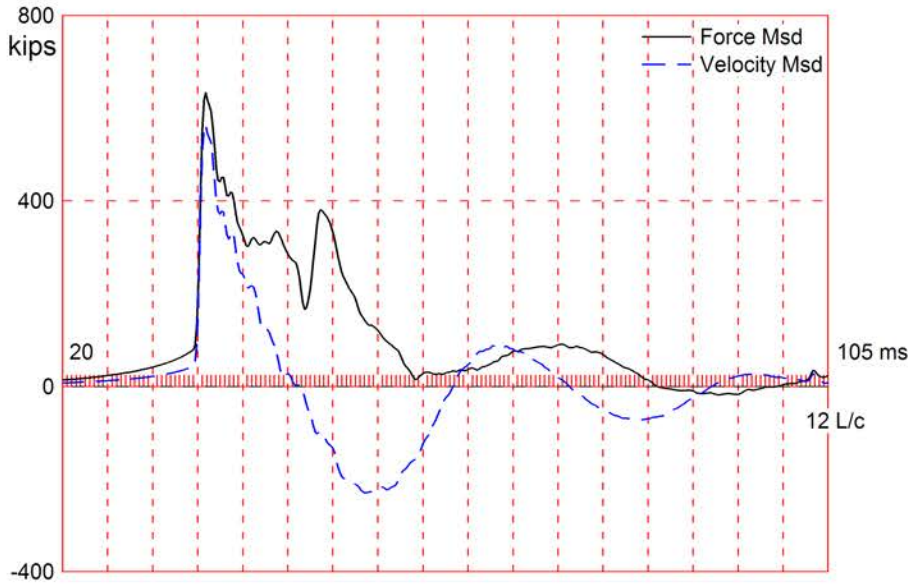
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.6	21.4	29992.2	492.000	4.70

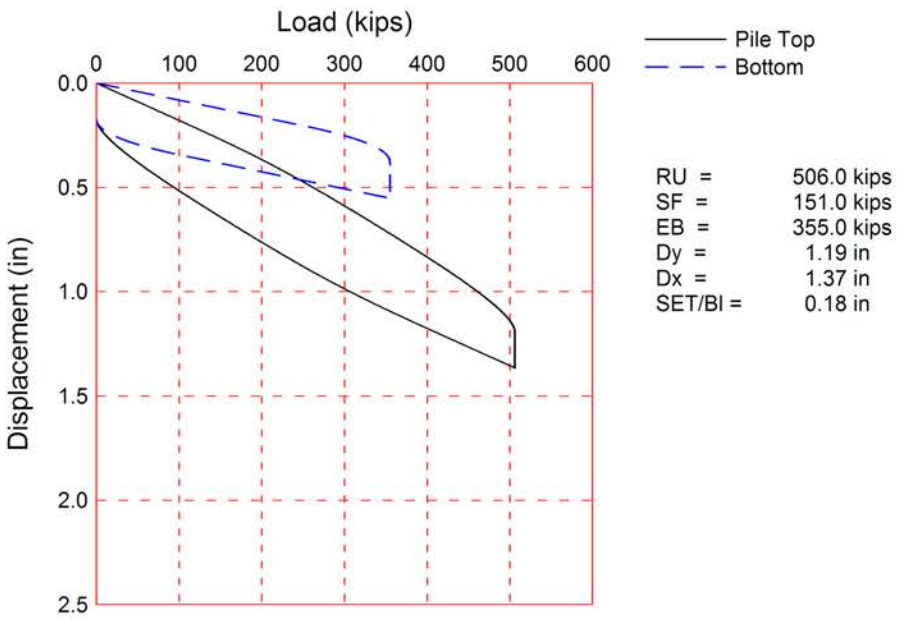
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	76.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	79.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
25	82.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

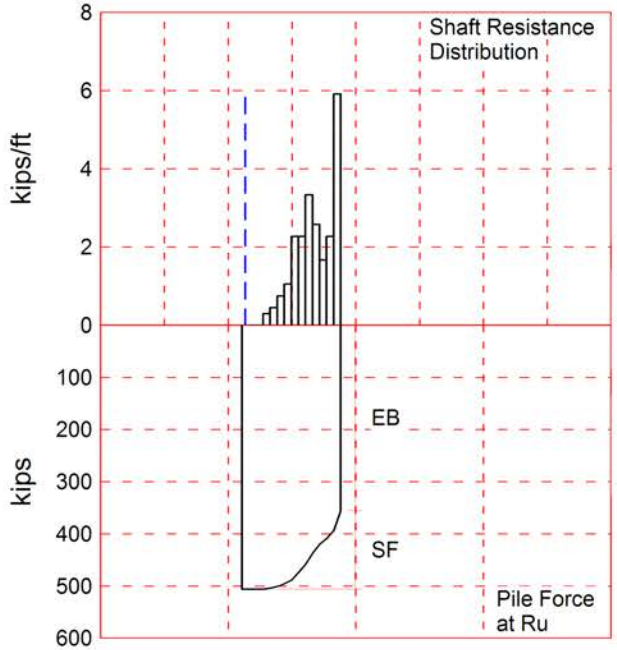
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.0 ms
Total volume: 13.758 ft^3, Volume ratio considering added impedance: 1.000







RU =	506.0 kips
SF =	151.0 kips
EB =	355.0 kips
Dy =	1.19 in
Dx =	1.37 in
SET/Bl =	0.18 in



Length b. Sensors	92.3 ft
Embedment	87.5 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	2.02
Top Compr. Stress	28.7 ksi
Max Compr. Stress	29.2 ksi
Max Tension Stress	-3.51 ksi
Avg. Shaft Quake	0.16 in
Toe Quake	0.29 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.09 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: 506.0; along Shaft 151.0; at Toe 355.0 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
				506.0				
1	13.2	8.5	0.0	506.0	0.0	0.00	0.00	0.00
2	19.8	15.0	0.0	506.0	0.0	0.00	0.00	0.00
3	26.4	21.6	2.0	504.0	2.0	0.30	0.06	0.24
4	32.9	28.2	3.0	501.0	5.0	0.46	0.10	0.24
5	39.5	34.8	5.0	496.0	10.0	0.76	0.16	0.24
6	46.1	41.4	7.0	489.0	17.0	1.06	0.23	0.24
7	52.7	48.0	15.0	474.0	32.0	2.28	0.48	0.24
8	59.3	54.6	15.0	459.0	47.0	2.28	0.48	0.24
9	65.9	61.2	22.0	437.0	69.0	3.34	0.71	0.24
10	72.5	67.8	17.0	420.0	86.0	2.58	0.55	0.24
11	79.1	74.3	11.0	409.0	97.0	1.67	0.36	0.24
12	85.7	80.9	15.0	394.0	112.0	2.28	0.48	0.24
13	92.3	87.5	39.0	355.0	151.0	5.92	1.26	0.24
Avg. Shaft			11.6			1.73	0.37	0.24
Toe			355.0				257.53	0.09

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.16	0.29
Case Damping Factor		0.95	0.84
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	52	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	18	
Resistance Gap (included in Toe Quake)	(in)		0.07
Soil Plug Weight	(kips)	0.040	0.233

CAPWAP match quality = 2.02 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.18 in; Blow Count = 69 b/ft
Computed: Final Set = 0.17 in; Blow Count = 70 b/ft

max. Top Comp. Stress = 28.7 ksi (T= 36.1 ms, max= 1.017 x Top)
max. Comp. Stress = 29.2 ksi (Z= 26.4 ft, T= 37.4 ms)
max. Tens. Stress = -3.51 ksi (Z= 59.3 ft, T= 62.7 ms)
max. Energy (EMX) = 30.3 kip-ft; max. Measured Top Displ. (DMX)= 0.93 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	615.0	-18.5	28.7	-0.86	30.3	15.2	0.95
2	6.6	615.7	-20.3	28.8	-0.95	30.2	15.2	0.94
4	13.2	617.1	-25.0	28.8	-1.17	29.8	15.2	0.90
6	19.8	619.8	-29.3	29.0	-1.37	29.4	15.1	0.87
8	26.4	625.7	-32.0	29.2	-1.50	28.9	14.9	0.83
10	32.9	624.8	-40.0	29.2	-1.87	27.8	14.7	0.78
12	39.5	623.1	-54.9	29.1	-2.57	26.4	14.3	0.73
14	46.1	618.5	-65.5	28.9	-3.06	24.7	13.9	0.68
15	49.4	602.7	-68.2	28.2	-3.18	23.2	13.5	0.66
16	52.7	615.0	-74.7	28.7	-3.49	22.7	13.2	0.63
17	56.0	567.3	-72.3	26.5	-3.38	20.3	12.8	0.61
18	59.3	581.0	-75.1	27.1	-3.51	19.7	12.4	0.58
19	62.6	540.9	-69.7	25.3	-3.26	17.4	12.0	0.55
20	65.9	557.9	-70.5	26.1	-3.29	16.9	11.6	0.52
21	69.2	499.2	-60.6	23.3	-2.83	14.1	11.0	0.50
22	72.5	509.3	-62.0	23.8	-2.90	13.6	10.7	0.47
23	75.8	450.5	-54.7	21.0	-2.55	11.6	10.7	0.44
24	79.1	460.0	-56.0	21.5	-2.62	11.1	10.6	0.42
25	82.4	465.1	-53.4	21.7	-2.50	9.7	10.4	0.39
26	85.7	467.2	-53.3	21.8	-2.49	9.3	11.2	0.37
27	89.0	456.1	-48.6	21.3	-2.27	7.9	11.6	0.34
28	92.3	468.6	-48.9	21.9	-2.28	5.8	11.9	0.32
Absolute	26.4			29.2			(T =	37.4 ms)
	59.3				-3.51		(T =	62.7 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	697.0	645.9	594.8	543.7	492.6	441.5	390.5	339.4	288.3	237.2
RX	697.0	654.6	623.3	605.5	587.7	569.9	552.1	534.3	516.5	498.7
RU	698.7	647.8	596.9	546.0	495.1	444.2	393.3	342.4	291.5	240.6

RAU = 321.1 (kips); RA2 = 539.8 (kips)

Current CAPWAP Ru = 506.0 (kips); Corresponding J(RP)= 0.37; J(RX) = 0.86

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
14.9	35.87	569.3	638.5	638.5	0.93	0.18	0.18	30.3	660.5	1614

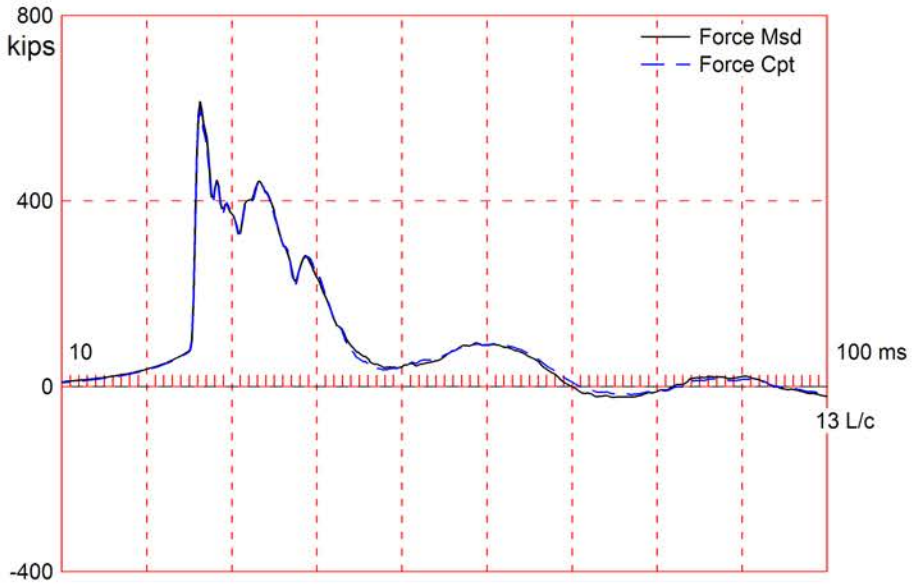
PILE PROFILE AND PILE MODEL

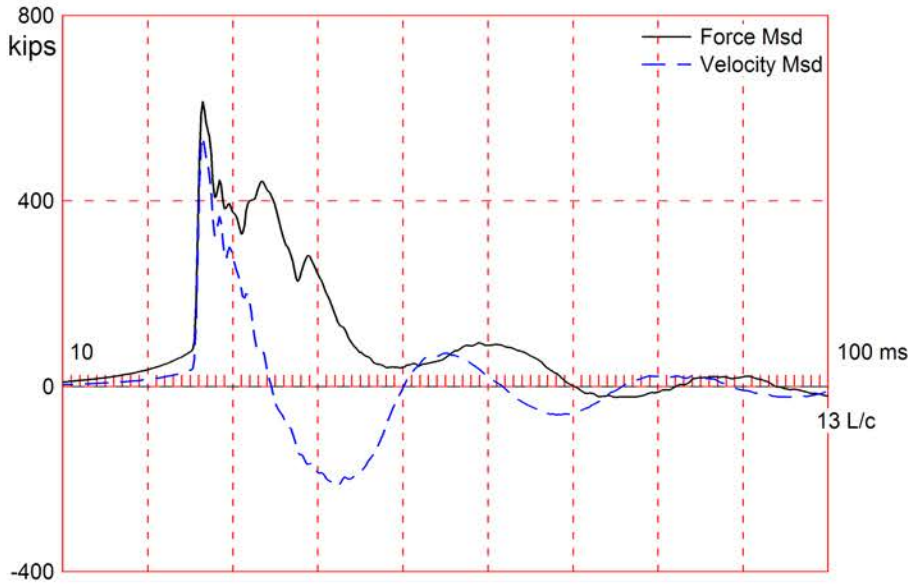
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.3	21.4	29992.2	492.000	4.70

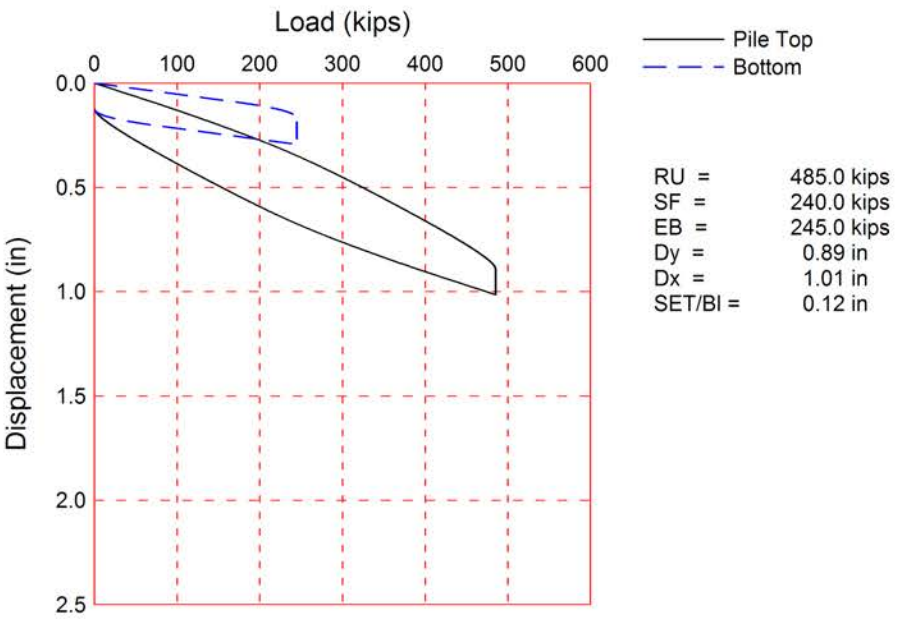
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	75.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.030
24	79.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
25	82.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

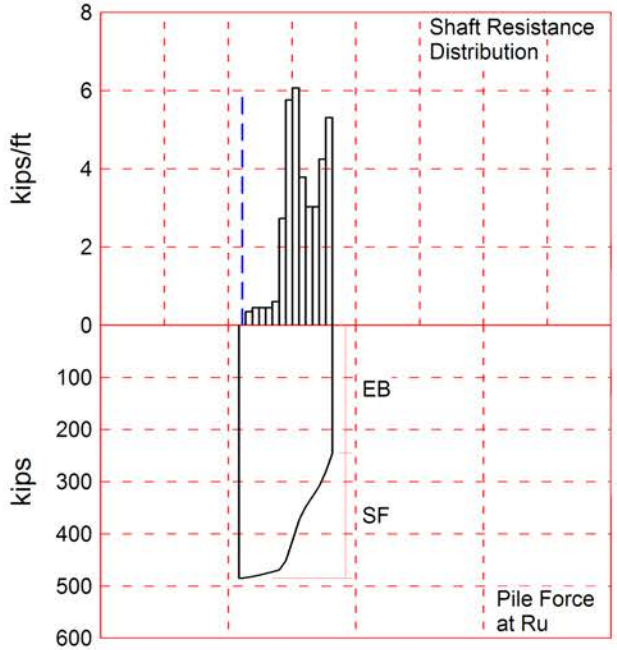
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.709 ft^3, Volume ratio considering added impedance: 1.000







RU =	485.0 kips
SF =	240.0 kips
EB =	245.0 kips
Dy =	0.89 in
Dx =	1.01 in
SET/Bl =	0.12 in



Length b. Sensors	92.3 ft
Embedment	87.6 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	1.73
Top Compr. Stress	28.0 ksi
Max Compr. Stress	28.8 ksi
Max Tension Stress	-1.31 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.13 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.09 s/ft

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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.

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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: 485.0; along Shaft 240.0; at Toe 245.0 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
				485.0			
1	13.2	8.6	3.0	482.0	3.0	0.35	0.07
2	19.8	15.1	3.0	479.0	6.0	0.46	0.10
3	26.4	21.7	3.0	476.0	9.0	0.46	0.10
4	32.9	28.3	3.0	473.0	12.0	0.46	0.10
5	39.5	34.9	4.0	469.0	16.0	0.61	0.13
6	46.1	41.5	18.0	451.0	34.0	2.73	0.58
7	52.7	48.1	38.0	413.0	72.0	5.77	1.23
8	59.3	54.7	40.0	373.0	112.0	6.07	1.29
9	65.9	61.3	25.0	348.0	137.0	3.79	0.81
10	72.5	67.9	20.0	328.0	157.0	3.04	0.65
11	79.1	74.4	20.0	308.0	177.0	3.04	0.65
12	85.7	81.0	28.0	280.0	205.0	4.25	0.90
13	92.3	87.6	35.0	245.0	240.0	5.31	1.13
Avg. Shaft			18.5			2.74	0.58
Toe			245.0				177.73

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.09
Quake	(in)	0.09	0.13
Case Damping Factor		1.88	0.58
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	109
Reloading Level	(% of Ru)	100	100
Soil Plug Weight	(kips)	0.170	0.094

CAPWAP match quality = 1.73 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.13 in; Blow Count = 93 b/ft

Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.08; A4(K3550) CAL: 360; RF: 1.08

max. Top Comp. Stress = 28.0 ksi (T= 26.7 ms, max= 1.030 x Top)
max. Comp. Stress = 28.8 ksi (Z= 46.1 ft, T= 29.4 ms)
max. Tens. Stress = -1.31 ksi (Z= 32.9 ft, T= 75.1 ms)
max. Energy (EMX) = 26.5 kip-ft; max. Measured Top Displ. (DMX)= 0.79 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	598.5	-19.6	28.0	-0.92	26.5	14.5	0.79
2	6.6	600.7	-21.1	28.1	-0.99	26.1	14.4	0.76
4	13.2	609.0	-25.3	28.5	-1.18	25.3	14.2	0.71
6	19.8	601.8	-26.3	28.1	-1.23	23.9	13.9	0.66
8	26.4	595.1	-27.5	27.8	-1.29	22.7	13.7	0.62
10	32.9	589.2	-28.1	27.5	-1.31	21.4	13.4	0.57
12	39.5	589.9	-27.8	27.6	-1.30	20.0	12.9	0.52
14	46.1	616.3	-25.6	28.8	-1.20	18.5	11.8	0.46
15	49.4	573.6	-8.3	26.8	-0.39	16.2	10.8	0.44
16	52.7	601.1	-9.1	28.1	-0.42	15.7	10.1	0.41
17	56.0	490.2	0.0	22.9	0.00	12.3	9.2	0.38
18	59.3	512.0	0.0	23.9	0.00	11.9	8.6	0.36
19	62.6	409.3	0.0	19.1	0.00	9.0	8.0	0.33
20	65.9	427.2	0.0	20.0	0.00	8.6	7.4	0.31
21	69.2	370.4	0.0	17.3	0.00	7.0	6.9	0.29
22	72.5	379.9	-0.0	17.7	-0.00	6.7	6.7	0.27
23	75.8	350.4	-0.0	16.4	-0.00	5.5	6.5	0.25
24	79.1	350.8	-0.0	16.4	-0.00	5.2	6.5	0.23
25	82.4	328.8	-0.0	15.4	-0.00	4.3	6.2	0.21
26	85.7	332.5	-0.0	15.5	-0.00	4.0	6.4	0.19
27	89.0	309.7	-0.0	14.5	-0.00	3.0	7.0	0.17
28	92.3	310.6	-0.0	14.5	-0.00	2.2	7.0	0.16
Absolute	46.1			28.8			(T =	29.4 ms)
	32.9				-1.31		(T =	75.1 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	760.3	720.4	680.5	640.6	600.6	560.7	520.8	480.9	440.9	401.0
RX	760.3	720.4	680.5	640.6	600.6	560.7	526.0	501.8	482.4	466.5
RU	779.3	741.3	703.2	665.2	627.2	589.1	551.1	513.1	475.1	437.0

RAU = 101.5 (kips); RA2 = 505.6 (kips)

Current CAPWAP Ru = 485.0 (kips); Corresponding J(RP)= 0.69; J(RX) = 0.79

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
14.2	26.46	542.8	616.8	619.4	0.79	0.12	0.12	26.9	707.9	1885

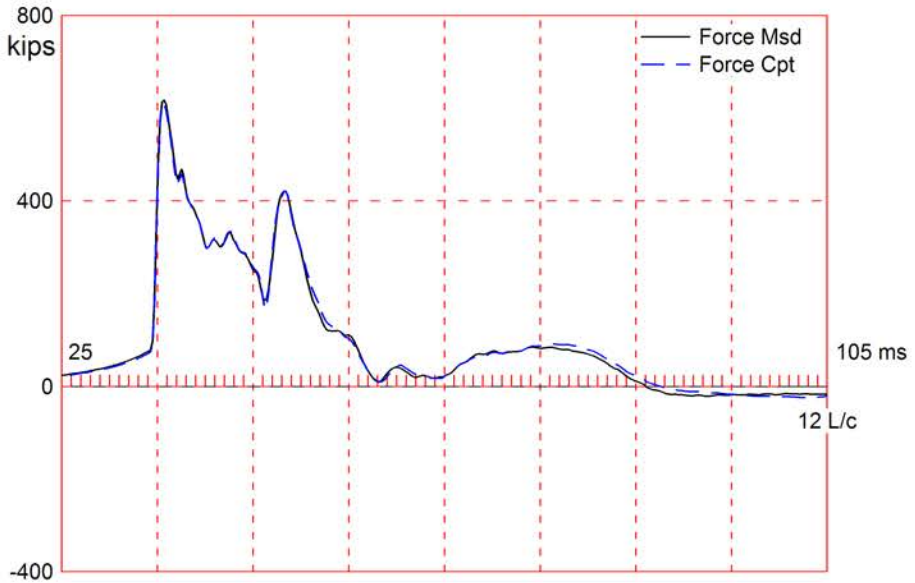
PILE PROFILE AND PILE MODEL

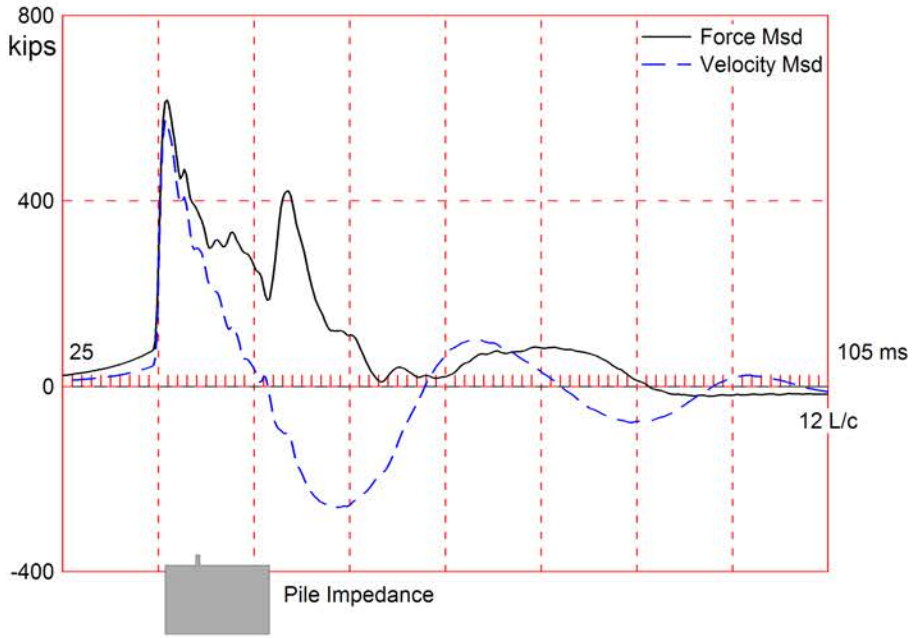
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.3	21.4	29992.2	492.000	4.70

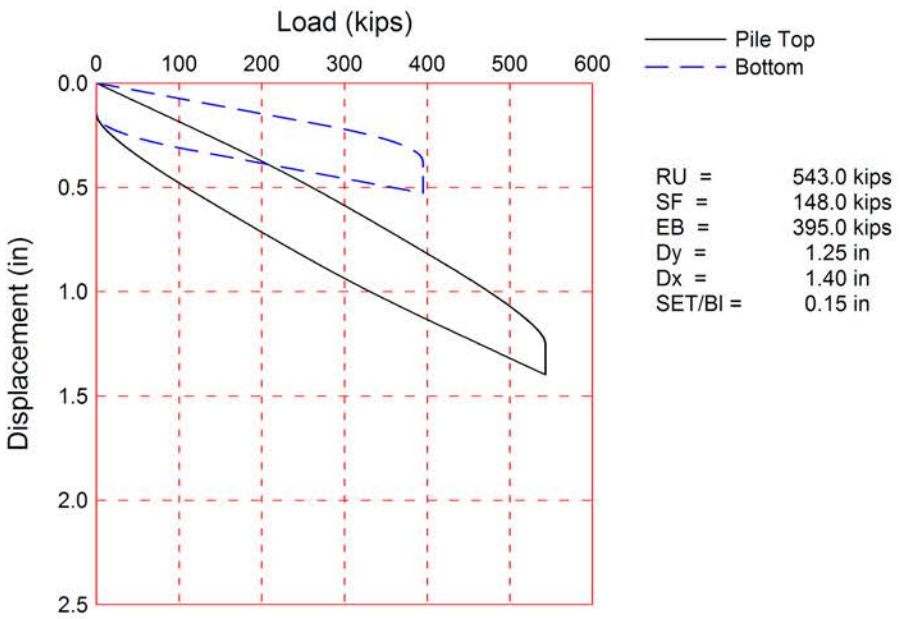
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
21	69.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
22	72.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.050
25	82.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	92.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

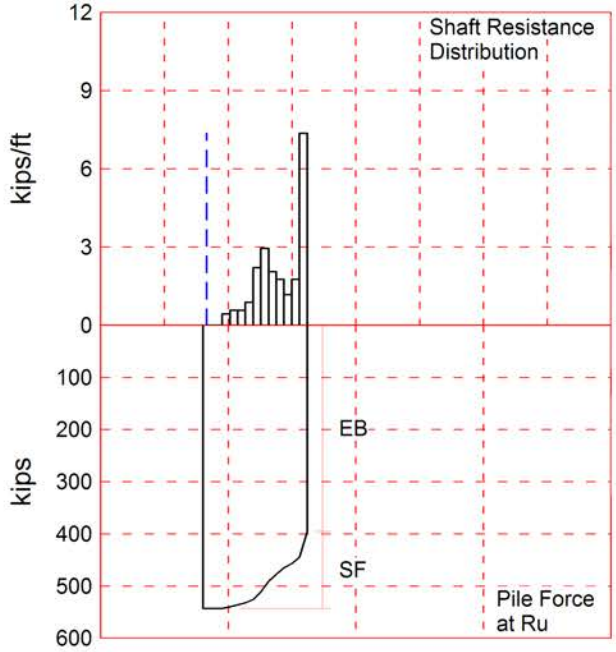
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.709 ft^3, Volume ratio considering added impedance: 1.000







RU =	543.0 kips
SF =	148.0 kips
EB =	395.0 kips
Dy =	1.25 in
Dx =	1.40 in
SET/Bl =	0.15 in



Length b. Sensors	91.5 ft
Embedment	86.7 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	1.96
Top Compr. Stress	28.5 ksi
Max Compr. Stress	30.0 ksi
Max Tension Stress	-4.38 ksi
Avg. Shaft Quake	0.21 in
Toe Quake	0.29 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.10 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: 543.0; along Shaft 148.0; at Toe 395.0 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
				543.0				
1	10.2	5.3	0.0	543.0	0.0	0.00	0.00	0.00
2	16.9	12.1	0.0	543.0	0.0	0.00	0.00	0.00
3	23.7	18.9	3.0	540.0	3.0	0.44	0.09	0.24
4	30.5	25.7	4.0	536.0	7.0	0.59	0.13	0.24
5	37.3	32.4	4.0	532.0	11.0	0.59	0.13	0.24
6	44.1	39.2	6.0	526.0	17.0	0.89	0.19	0.24
7	50.8	46.0	15.0	511.0	32.0	2.21	0.47	0.24
8	57.6	52.8	20.0	491.0	52.0	2.95	0.63	0.24
9	64.4	59.5	14.0	477.0	66.0	2.07	0.44	0.24
10	71.2	66.3	12.0	465.0	78.0	1.77	0.38	0.24
11	77.9	73.1	8.0	457.0	86.0	1.18	0.25	0.24
12	84.7	79.9	12.0	445.0	98.0	1.77	0.38	0.24
13	91.5	86.7	50.0	395.0	148.0	7.38	1.57	0.24
Avg. Shaft			11.4			1.71	0.36	0.24
Toe			395.0				286.55	0.10

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.21	0.29
Case Damping Factor		0.93	1.03
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	53
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	58	
Resistance Gap (included in Toe Quake)	(in)		0.08
Soil Plug Weight	(kips)	0.030	0.098

CAPWAP match quality = 1.96 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.13 in; Blow Count = 93 b/ft

max. Top Comp. Stress = 28.5 ksi (T= 36.1 ms, max= 1.050 x Top)
max. Comp. Stress = 30.0 ksi (Z= 23.7 ft, T= 37.3 ms)
max. Tens. Stress = -4.38 ksi (Z= 50.8 ft, T= 61.7 ms)
max. Energy (EMX) = 31.2 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	610.6	-23.0	28.5	-1.07	31.2	15.2	0.97
2	6.8	611.4	-21.9	28.6	-1.02	31.0	15.2	0.96
4	13.6	613.2	-25.2	28.6	-1.18	30.7	15.1	0.92
6	20.3	634.8	-30.0	29.7	-1.40	30.2	14.7	0.88
8	27.1	618.8	-41.7	28.9	-1.95	29.0	14.6	0.84
10	33.9	606.3	-60.9	28.3	-2.85	27.4	14.5	0.79
12	40.7	601.2	-77.1	28.1	-3.60	25.7	14.1	0.74
13	44.1	612.6	-85.6	28.6	-4.00	25.3	13.9	0.71
14	47.4	600.5	-87.0	28.1	-4.07	23.8	13.5	0.69
15	50.8	615.9	-93.7	28.8	-4.38	23.3	13.2	0.66
16	54.2	571.9	-85.2	26.7	-3.98	20.6	12.7	0.63
17	57.6	584.3	-87.6	27.3	-4.09	20.0	12.4	0.60
18	61.0	520.1	-71.0	24.3	-3.32	17.0	12.1	0.57
19	64.4	529.5	-71.6	24.7	-3.34	16.5	11.8	0.54
20	67.8	487.6	-60.4	22.8	-2.82	14.4	11.6	0.51
21	71.2	494.2	-62.4	23.1	-2.92	13.8	11.4	0.48
22	74.6	480.3	-53.2	22.4	-2.49	12.0	11.3	0.45
23	77.9	490.2	-54.9	22.9	-2.57	11.4	11.1	0.42
24	81.3	497.6	-51.0	23.2	-2.38	10.2	10.8	0.39
25	84.7	520.3	-51.8	24.3	-2.42	9.6	11.6	0.36
26	88.1	520.9	-48.6	24.3	-2.27	8.2	12.2	0.34
27	91.5	532.4	-49.2	24.9	-2.30	5.8	11.4	0.31
Absolute	23.7			30.0			(T =	37.3 ms)
	50.8				-4.38		(T =	61.7 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	710.2	660.6	610.9	561.3	511.6	462.0	412.3	362.7	313.0	263.4
RX	735.3	701.2	672.5	651.5	633.3	615.2	597.0	578.8	560.6	542.5
RU	713.2	663.8	614.5	565.1	515.8	466.4	417.0	367.7	318.3	269.0

RAU = 370.1 (kips); RA2 = 605.3 (kips)

Current CAPWAP Ru = 543.0 (kips); Corresponding J(RP)= 0.34; J(RX) = 0.90

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
15.3	35.89	582.6	624.1	624.1	0.96	0.15	0.15	31.4	677.2	1881

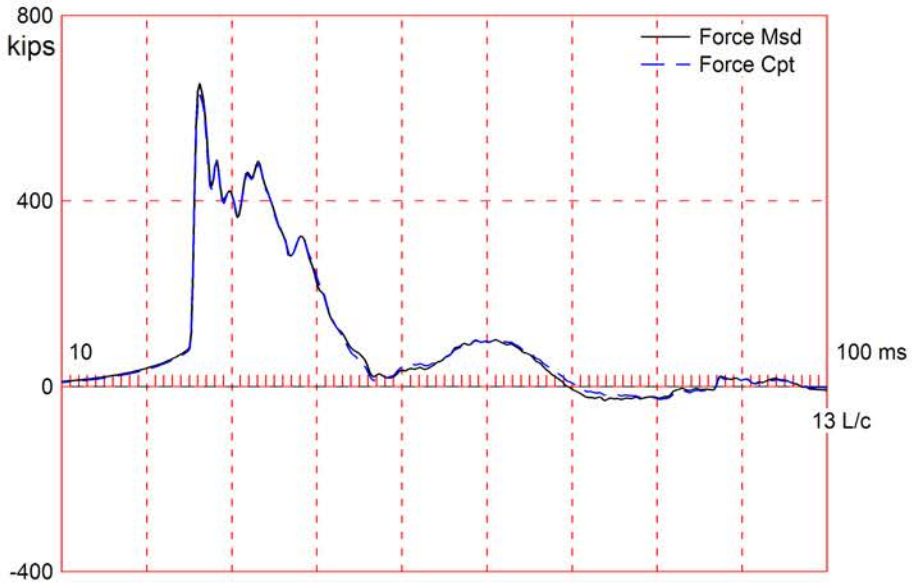
PILE PROFILE AND PILE MODEL

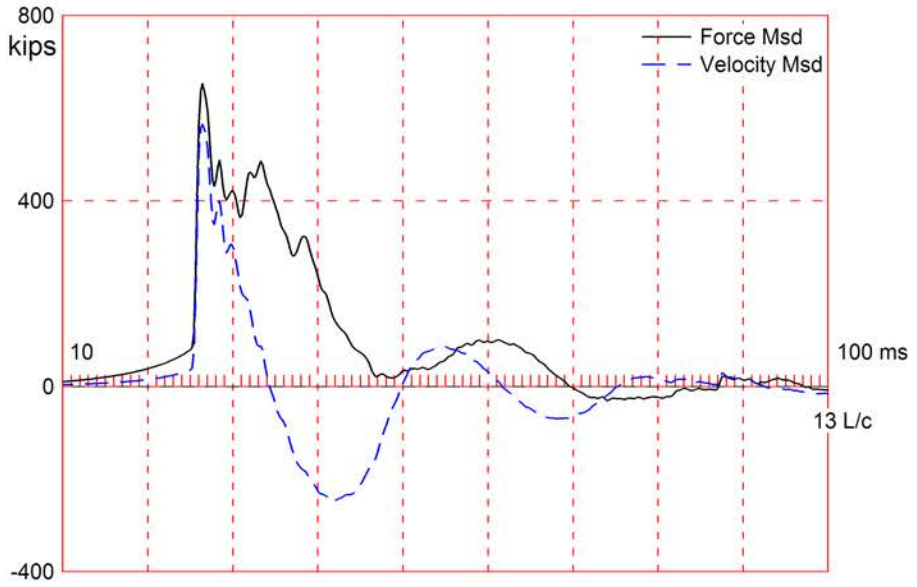
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
91.5	21.4	29992.2	492.000	4.70

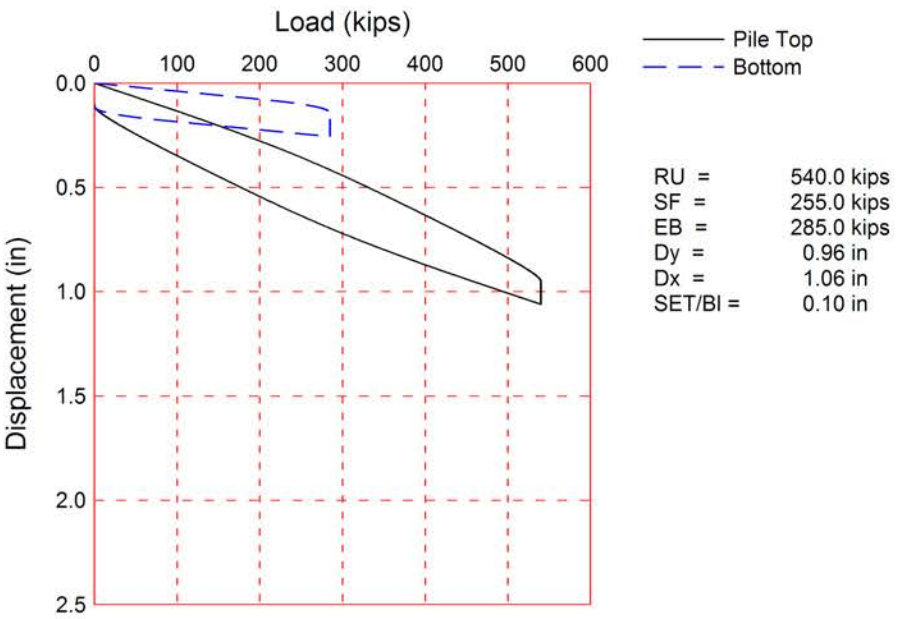
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	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
9	30.5	44.00	15.19	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
10	33.9	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
26	88.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
27	91.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020

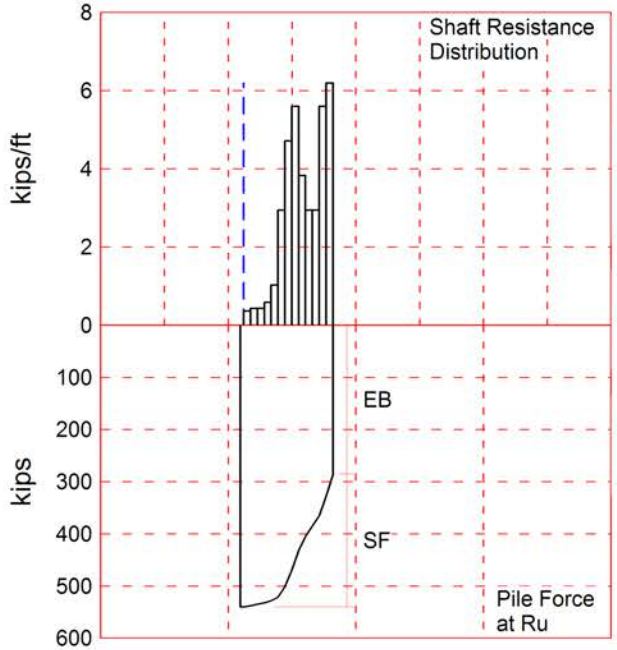
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.202 ms, 2L/c 10.9 ms
Total volume: 13.674 ft^3; Volume ratio considering added impedance: 1.006







RU =	540.0 kips
SF =	255.0 kips
EB =	285.0 kips
Dy =	0.96 in
Dx =	1.06 in
SET/Bl =	0.10 in



Length b. Sensors	91.5 ft
Embedment	86.7 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	1.73
Top Compr. Stress	29.6 ksi
Max Compr. Stress	30.6 ksi
Max Tension Stress	-2.49 ksi
Avg. Shaft Quake	0.12 in
Toe Quake	0.11 in
Avg. Shaft Smith Dpg.	0.31 s/ft
Toe Smith Damping	0.15 s/ft

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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: 540.0; along Shaft 255.0; at Toe 285.0 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
				540.0			
1	10.2	5.4	2.0	538.0	2.0	0.37	0.08
2	16.9	12.1	3.0	535.0	5.0	0.44	0.09
3	23.7	18.9	3.0	532.0	8.0	0.44	0.09
4	30.5	25.7	4.0	528.0	12.0	0.59	0.13
5	37.3	32.5	7.0	521.0	19.0	1.03	0.22
6	44.1	39.2	20.0	501.0	39.0	2.95	0.63
7	50.8	46.0	32.0	469.0	71.0	4.72	1.00
8	57.6	52.8	38.0	431.0	109.0	5.61	1.19
9	64.4	59.6	26.0	405.0	135.0	3.84	0.82
10	71.2	66.4	20.0	385.0	155.0	2.95	0.63
11	77.9	73.1	20.0	365.0	175.0	2.95	0.63
12	84.7	79.9	38.0	327.0	213.0	5.61	1.19
13	91.5	86.7	42.0	285.0	255.0	6.20	1.32
Avg. Shaft			19.6			2.94	0.63
Toe			285.0				206.75

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.31	0.15
Quake	(in)	0.12	0.11
Case Damping Factor		2.07	1.12
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	62	
Soil Plug Weight	(kips)	0.070	0.020

CAPWAP match quality = 1.73 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 119 b/ft
Computed: Final Set = 0.10 in; Blow Count = 116 b/ft

max. Top Comp. Stress = 29.6 ksi (T= 26.6 ms, max= 1.036 x Top)
max. Comp. Stress = 30.6 ksi (Z= 44.1 ft, T= 29.4 ms)
max. Tens. Stress = -2.49 ksi (Z= 44.1 ft, T= 49.4 ms)
max. Energy (EMX) = 30.6 kip-ft; max. Measured Top Displ. (DMX)= 0.83 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	633.4	-26.9	29.6	-1.26	30.6	15.3	0.84
2	6.8	637.4	-26.0	29.8	-1.21	30.2	15.2	0.81
4	13.6	635.2	-30.3	29.7	-1.42	28.8	15.0	0.76
6	20.3	628.1	-33.5	29.3	-1.57	27.2	14.7	0.70
8	27.1	623.4	-38.4	29.1	-1.79	25.7	14.4	0.65
10	33.9	619.6	-44.5	28.9	-2.08	23.9	13.9	0.59
12	40.7	625.4	-48.0	29.2	-2.24	21.6	12.8	0.53
13	44.1	656.0	-53.4	30.6	-2.49	20.9	12.2	0.49
14	47.4	596.2	-38.5	27.9	-1.80	18.0	11.4	0.46
15	50.8	627.0	-43.8	29.3	-2.04	17.3	10.6	0.43
16	54.2	527.1	-20.1	24.6	-0.94	13.9	9.8	0.40
17	57.6	548.7	-24.5	25.6	-1.15	13.3	9.2	0.37
18	61.0	449.5	0.0	21.0	0.00	10.1	8.6	0.34
19	64.4	459.3	-2.0	21.5	-0.09	9.6	8.1	0.32
20	67.8	428.6	0.0	20.0	0.00	7.7	7.6	0.29
21	71.2	430.5	0.0	20.1	0.00	7.2	7.3	0.27
22	74.6	409.1	-0.0	19.1	-0.00	5.9	7.1	0.24
23	77.9	407.9	-0.0	19.1	-0.00	5.5	6.9	0.22
24	81.3	386.8	-0.0	18.1	-0.00	4.5	6.3	0.19
25	84.7	394.7	-0.0	18.4	-0.00	4.1	6.5	0.17
26	88.1	354.1	-0.0	16.5	-0.00	2.9	6.7	0.15
27	91.5	360.3	-0.0	16.8	-0.00	2.2	5.9	0.13
Absolute	44.1			30.6			(T =	29.4 ms)
	44.1				-2.49		(T =	49.4 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	833.0	793.1	753.1	713.2	673.2	633.3	593.3	553.4	513.4	473.5
RX	833.0	793.1	754.7	719.8	685.0	650.1	615.2	580.4	551.9	527.4
RU	848.0	809.5	771.1	732.6	694.1	655.7	617.2	578.8	540.3	501.9

RAU = 0.0 (kips); RA2 = 572.8 (kips)

Current CAPWAP Ru = 540.0 (kips); Corresponding J(RP)= 0.73; J(RX) = 0.85

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
15.0	26.61	571.5	661.0	661.0	0.83	0.10	0.10	31.1	799.8	2591

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
91.5	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.	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
21	71.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
22	74.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.030
23	77.9	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
24	81.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
27	91.5	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 0.202 ms, 2L/c 10.9 ms
Total volume: 13.598 ft^3, Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Mark Rawlings
Company: Lunda Construction Co.	No. of Sheets: 2
E-mail: kweber@lundaconstruction.com	Date: February 12, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 11
Winnebago County, Wisconsin

On February 10, 2015, Pier 11 #1, Pier 11 #16, Pier 11 #23, and Pier 11 #56 at the above structure were dynamically tested during initial driving. Project plans indicated the exterior row piles have a required driving resistance or ultimate capacity of 400 kips (200 tons) and the interior row piles have a required driving resistance or ultimate capacity of 350 kips (175 tons). The reference grade at the cofferdam template was reported to be at elevation El. 740.3 for Pier 11 #56 and El. 741.1 for the other three test piles. The mud line was reported to be at El. 717.6. The piles have a required minimum tip elevation of El. 658.5. The 95.9 to 96.7 foot long HP 14 x 73 H-piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0256) operated on fuel setting 4.

Pier 11 #1 was driven to a depth of 88.0 feet, which corresponds to a pile tip elevation of El. 653.1. The reported pile set over the final ten blows of driving was 2.75 inches. The average hammer stroke over this increment was 7.4 feet. Pier 11 #16 was driven to a depth of 83.0 feet, which corresponds to a pile tip elevation of El. 658.1. The reported pile set over the final ten blows was 3.0 inches. The average hammer stroke over this increment was 6.8 feet. Pier 11 #23 was driven to a depth of 82.0 feet, which corresponds to a pile tip elevation of El. 659.1. The reported pile set over the final ten blows was 2.75 inches. The average hammer stroke over this increment was 7.1 feet. Pier 11 #56 was driven to a depth of 83.6 feet, which corresponds to a pile tip elevation of El. 656.8. The reported pile set over the final ten blows was 2.25 inches. The average hammer stroke over this increment was 7.6 feet.

Restrike testing was performed on these four piles on February 11. Pier 11 #1 was driven approximately 2.9 inches during the restrike testing. The reported pile set was ⅝ inch for five blows at the beginning of the restrike. Data acquisition issues prevented the collection of all of the restrike data. The average hammer stroke for the collected blows was 6.9 feet. Pier 11 #16 was driven approximately 3.4 inches during the restrike test. The reported pile set was 1.13 inches for five blows at the beginning of restrike. The average hammer stroke was 6.8 feet. Pier 11 #23 was driven approximately 2.3 inches during the restrike. The reported pile set was ¾ inch for five blows at the beginning of restrike. The average hammer stroke was 6.9 feet. Pier 11 #56 was driven

approximately 1.5 inches during the restrike. The reported pile set was ½ inch for five blows at the beginning of restrike. The average hammer stroke was 7.5 feet. Analysis of the restrike data indicated that this pile was damaged near the toe. After reviewing the initial driving data for Pier 11 #56, it has been concluded that damage likely occurred early in the driving sequence as the pile penetrated through boulders and cobbles between the approximate elevations of El. 685 and El. 670. **GRL recommends that a replacement pile be driven for Pier 11 #56.**

For the 400 and 350 kip piles driven with APE D30-42 hammer (PD 0256) in Pier 11 of the USH 10 bridge over Little Lake Butte des Morts we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Exterior Piles (400 kips) Recommended Minimum Blow Count (blows per inch)	Interior Piles (350 kips) Recommended Minimum Blow Count (blows per inch)
6.5	4	3
7.0	4	3
7.5	3	3
8.0	3	2
8.5	3	2
9.0	3	2

We recommend the above blow counts at the required stroke be maintained for **three consecutive inches** of driving. Driving should be halted if a blow count of 10 blows per inch at a 8 foot stroke or higher is achieved prior to attaining the requisite blows in the foot. We anticipate the production piles will terminate at depths similar to those of the test pile. Based on the elevation provided for the pile depth reference, Pier 11 #23 did not achieve the minimum tip requirement with a tip elevation approximately 0.6 feet above the required El. 658.5. Additional piles may meet the driving criteria above the minimum tip requirement. We recommend the design engineer be consulted on the adequacy of these piles in meeting uplift loading requirement.

Please call if you have any questions on these recommendations.

GRL Engineers, Inc.

Mark A. Rawlings

Mark Rawlings

Travis Coleman, P.E.

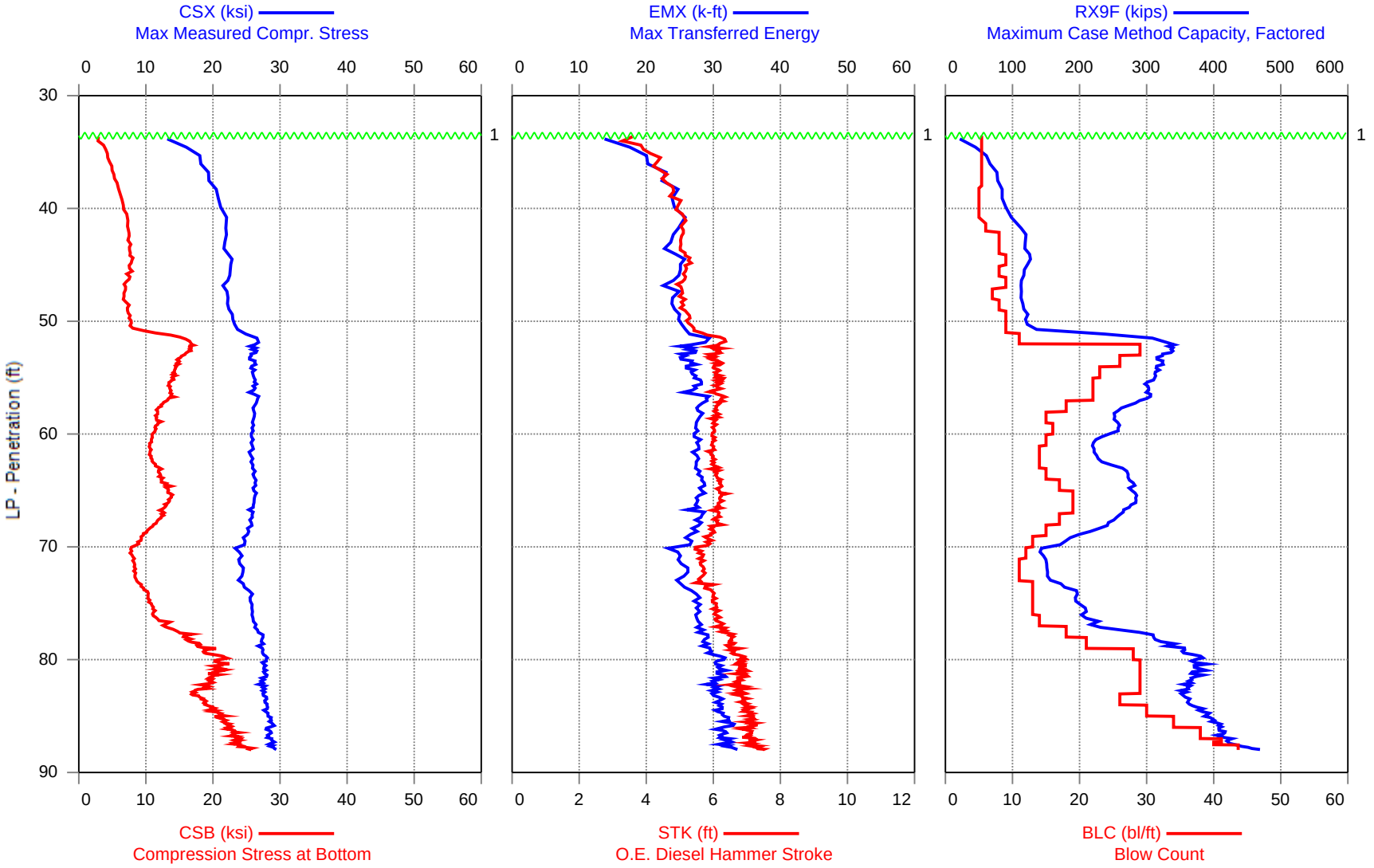
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-February-2015

Test started: 10-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #1

APE D30-42, HP 14 x 73



1 - Reported reference at El. 741.1

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #1 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.50 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
RX9F: Maximum Case Method Capacity, Factored

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
27	38.00	5	AV25	17.5	4.5	20	4.2	57.1	59
			STD	2.4	0.9	3	0.4	2.9	21
			MAX	20.2	5.9	25	4.8	64.6	87
			MIN	10.8	2.7	11	3.2	53.5	11
32	39.00	5	AV5	20.4	6.1	24	4.8	53.4	84
			STD	0.3	0.2	1	0.1	0.4	5
			MAX	20.9	6.3	25	4.9	54.1	92
			MIN	20.0	5.9	22	4.6	52.9	76
37	40.00	5	AV5	21.3	6.6	24	5.0	52.5	87
			STD	0.4	0.2	1	0.1	0.5	3
			MAX	21.8	6.7	26	5.1	53.2	91
			MIN	20.8	6.3	23	4.8	51.9	85
42	41.00	5	AV4	21.9	7.1	26	5.1	51.8	94
			STD	0.5	0.3	1	0.1	0.5	2
			MAX	22.7	7.4	27	5.3	52.5	96
			MIN	21.3	6.7	25	5.0	51.0	91
48	42.00	6	AV5	21.9	7.3	25	5.1	51.9	112
			STD	0.3	0.2	1	0.1	0.3	5
			MAX	22.4	7.6	25	5.2	52.3	119
			MIN	21.6	7.0	24	5.0	51.4	107
56	43.00	8	AV6	21.9	7.4	24	5.1	52.0	119
			STD	0.3	0.2	1	0.1	0.2	2
			MAX	22.3	7.8	25	5.1	52.4	122
			MIN	21.4	7.2	23	5.0	51.7	114
64	44.00	8	AV8	21.8	7.6	23	5.1	52.0	121
			STD	0.4	0.3	1	0.1	0.4	3
			MAX	22.4	8.1	25	5.2	52.6	125
			MIN	21.2	7.0	22	4.9	51.3	118
73	45.00	9	AV9	22.7	7.8	25	5.3	51.1	126
			STD	0.3	0.4	1	0.1	0.3	4
			MAX	23.2	8.6	26	5.4	51.5	136
			MIN	22.3	7.4	24	5.2	50.6	123
81	46.00	8	AV8	22.5	7.6	25	5.2	51.5	117
			STD	0.3	0.4	1	0.1	0.3	1
			MAX	22.9	8.2	26	5.2	52.1	119
			MIN	22.0	6.6	24	5.0	51.2	115
90	47.00	9	AV9	21.9	7.1	24	5.1	52.0	114
			STD	0.5	0.4	1	0.1	0.5	2
			MAX	22.7	7.9	26	5.2	53.1	119
			MIN	20.9	6.7	21	4.8	51.4	111
97	48.00	7	AV7	22.0	6.8	24	5.0	52.0	113
			STD	0.4	0.3	1	0.1	0.3	2
			MAX	22.5	7.4	26	5.1	52.8	116
			MIN	21.3	6.4	23	4.9	51.7	112
105	49.00	8	AV8	22.3	7.2	24	5.1	51.8	115

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #1 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.7	0.3	1	0.1	0.7	3
			MAX	23.3	7.6	26	5.3	52.8	119
			MIN	21.5	6.8	22	4.9	50.7	111
114	50.00	9	AV9	22.9	7.5	25	5.2	51.1	121
			STD	0.5	0.3	1	0.1	0.5	3
			MAX	23.9	8.0	27	5.5	51.6	128
			MIN	22.5	7.2	24	5.1	50.1	117
123	51.00	9	AV9	23.5	8.6	26	5.4	50.5	135
			STD	0.4	1.1	1	0.1	0.4	23
			MAX	24.1	11.0	27	5.5	51.2	188
			MIN	22.9	7.6	25	5.2	50.0	116
134	52.00	11	AV11	26.3	15.3	28	6.2	47.4	301
			STD	0.8	1.5	1	0.2	0.8	33
			MAX	27.5	16.9	31	6.5	49.1	335
			MIN	24.7	11.9	26	5.7	46.3	230
163	53.00	29	AV29	26.1	16.4	26	6.1	47.6	335
			STD	0.6	0.4	1	0.1	0.5	7
			MAX	27.5	17.2	28	6.5	48.8	345
			MIN	24.8	15.3	24	5.8	46.3	316
189	54.00	26	AV26	25.9	14.9	26	6.1	47.7	320
			STD	0.5	0.3	1	0.1	0.5	5
			MAX	26.7	15.6	28	6.3	48.6	328
			MIN	25.1	14.4	24	5.8	47.0	312
212	55.00	23	AV23	25.9	14.2	27	6.1	47.6	314
			STD	0.3	0.2	1	0.1	0.3	3
			MAX	26.7	14.5	29	6.3	48.1	321
			MIN	25.5	13.9	25	6.0	46.9	308
234	56.00	22	AV22	26.3	13.7	28	6.2	47.3	304
			STD	0.3	0.3	1	0.1	0.3	6
			MAX	26.7	14.2	30	6.3	48.0	319
			MIN	25.5	13.2	26	6.0	46.7	295
256	57.00	22	AV22	26.2	13.7	28	6.1	47.4	302
			STD	0.6	0.3	2	0.1	0.6	5
			MAX	27.0	14.5	30	6.4	49.0	310
			MIN	24.5	13.1	24	5.7	46.5	288
274	58.00	18	AV18	26.2	12.2	28	6.1	47.5	271
			STD	0.4	0.5	1	0.1	0.3	12
			MAX	27.1	13.1	30	6.4	48.0	292
			MIN	25.7	11.5	27	6.0	46.5	251
289	59.00	15	AV15	26.1	11.7	28	6.1	47.7	253
			STD	0.5	0.3	1	0.1	0.4	3
			MAX	27.0	12.7	29	6.3	48.6	258
			MIN	25.5	11.3	27	5.8	46.9	248
305	60.00	16	AV16	25.9	11.4	27	6.0	47.9	256
			STD	0.3	0.3	1	0.1	0.4	5
			MAX	26.4	12.0	28	6.1	48.7	262
			MIN	25.1	10.9	25	5.8	47.4	242
320	61.00	15	AV15	25.8	10.8	28	6.0	48.0	226
			STD	0.3	0.2	1	0.1	0.2	7
			MAX	26.3	11.2	29	6.1	48.5	242
			MIN	25.3	10.5	26	5.9	47.5	216

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #1 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9F kips
334	62.00	14	AV14	25.7	10.6	28	6.0	48.1	222
			STD	0.4	0.2	1	0.1	0.4	3
			MAX	26.3	11.1	29	6.1	49.1	229
			MIN	24.6	10.4	26	5.7	47.5	216
348	63.00	14	AV14	25.9	11.2	28	6.0	47.9	240
			STD	0.4	0.4	1	0.1	0.4	14
			MAX	26.8	12.0	29	6.3	48.6	268
			MIN	25.4	10.7	26	5.8	46.9	222
363	64.00	15	AV15	26.1	12.1	28	6.1	47.6	271
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	27.0	12.6	29	6.3	48.4	277
			MIN	25.2	11.5	26	5.9	46.8	261
380	65.00	17	AV17	26.2	13.0	28	6.2	47.2	278
			STD	0.3	0.5	1	0.1	0.3	5
			MAX	26.9	14.0	30	6.4	47.8	286
			MIN	25.7	12.1	27	6.0	46.6	265
399	66.00	19	AV19	26.3	13.6	28	6.2	47.1	283
			STD	0.3	0.3	1	0.1	0.3	4
			MAX	27.1	14.2	30	6.4	47.7	293
			MIN	25.7	13.1	27	6.1	46.4	278
418	67.00	19	AV19	25.9	12.8	27	6.1	47.5	273
			STD	0.5	0.4	1	0.1	0.4	8
			MAX	26.7	13.6	29	6.3	48.5	290
			MIN	24.7	12.1	25	5.9	46.9	262
435	68.00	17	AV17	25.8	12.0	28	6.1	47.5	252
			STD	0.5	0.5	1	0.1	0.4	7
			MAX	27.0	12.8	30	6.3	48.3	262
			MIN	24.9	11.3	26	5.9	46.7	237
450	69.00	15	AV15	25.3	10.3	27	6.0	48.0	220
			STD	0.5	0.5	1	0.1	0.5	16
			MAX	26.2	11.1	29	6.2	48.9	248
			MIN	24.2	9.6	25	5.8	47.2	192
463	70.00	13	AV13	24.6	9.0	26	5.8	48.7	176
			STD	0.5	0.4	1	0.1	0.5	11
			MAX	25.7	9.5	29	6.1	50.0	190
			MIN	23.5	8.2	23	5.5	47.7	149
475	71.00	12	AV12	23.8	7.9	24	5.6	49.6	143
			STD	0.5	0.2	1	0.1	0.5	3
			MAX	24.6	8.3	26	5.8	50.2	148
			MIN	23.2	7.5	23	5.4	48.8	139
486	72.00	11	AV11	24.2	8.3	26	5.7	49.3	151
			STD	0.5	0.2	1	0.1	0.4	3
			MAX	25.0	8.5	27	5.9	49.8	155
			MIN	23.2	7.9	24	5.5	48.5	146
497	73.00	11	AV11	24.2	8.4	26	5.7	49.3	153
			STD	0.5	0.2	1	0.1	0.3	3
			MAX	25.3	8.8	27	5.8	49.8	159
			MIN	23.5	8.1	24	5.5	48.6	149
510	74.00	13	AV13	24.8	9.5	26	5.8	48.8	180
			STD	1.0	0.5	2	0.2	1.0	12

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #1 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	26.1	10.4	28	6.1	51.4	199
			MIN	22.5	8.6	22	5.2	47.7	161
523	75.00	13	AV13	25.6	10.4	27	6.0	47.9	195
			STD	0.4	0.2	1	0.1	0.4	4
			MAX	26.5	10.7	29	6.2	48.7	202
			MIN	25.0	10.2	26	5.8	47.3	189
536	76.00	13	AV13	25.8	11.1	28	6.1	47.6	206
			STD	0.4	0.2	1	0.1	0.4	5
			MAX	26.5	11.4	29	6.3	48.3	214
			MIN	25.1	10.8	26	5.9	47.0	199
550	77.00	14	AV14	26.2	12.2	28	6.2	47.3	216
			STD	0.6	0.9	1	0.1	0.5	15
			MAX	27.4	14.1	30	6.4	48.4	250
			MIN	24.8	11.1	25	5.9	46.5	196
568	78.00	18	AV18	26.9	14.8	28	6.4	46.6	276
			STD	0.6	1.2	1	0.2	0.6	31
			MAX	28.0	16.9	30	6.7	47.7	319
			MIN	25.6	12.8	26	6.1	45.6	226
589	79.00	21	AV21	27.2	17.3	29	6.5	46.1	329
			STD	0.5	1.0	1	0.1	0.5	15
			MAX	28.3	19.9	30	6.8	47.0	366
			MIN	26.3	15.7	27	6.3	45.3	307
617	80.00	28	AV28	27.7	20.2	30	6.7	45.4	368
			STD	0.5	1.3	1	0.2	0.5	13
			MAX	28.7	22.2	33	7.0	46.4	389
			MIN	26.6	18.4	28	6.4	44.4	350
646	81.00	29	AV29	27.7	20.9	31	6.8	45.0	377
			STD	0.4	0.7	1	0.1	0.4	11
			MAX	28.7	22.9	33	7.1	45.7	402
			MIN	27.0	19.7	30	6.6	44.2	360
675	82.00	29	AV29	27.6	19.9	31	6.8	45.1	369
			STD	0.5	0.5	1	0.1	0.5	8
			MAX	28.7	21.2	33	7.1	45.9	388
			MIN	26.6	19.1	29	6.6	44.3	359
704	83.00	29	AV29	27.5	18.3	30	6.8	45.2	359
			STD	0.5	1.0	1	0.1	0.4	9
			MAX	28.4	20.2	32	7.0	46.5	380
			MIN	26.1	16.8	28	6.4	44.4	345
730	84.00	26	AV26	27.8	18.3	31	6.9	44.9	360
			STD	0.4	0.7	1	0.1	0.3	6
			MAX	28.6	19.1	32	7.1	45.6	368
			MIN	27.2	16.7	29	6.7	44.3	348
760	85.00	30	AV30	28.0	20.3	31	7.0	44.4	382
			STD	0.4	0.8	1	0.1	0.3	9
			MAX	28.7	22.1	32	7.2	44.9	400
			MIN	27.4	19.1	30	6.9	43.8	363
794	86.00	34	AV34	28.7	21.8	32	7.2	44.0	402
			STD	0.4	0.7	1	0.1	0.3	8
			MAX	29.3	23.2	33	7.3	44.8	418
			MIN	28.0	20.0	31	6.9	43.6	383

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #1 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
832	87.00	38	AV38	28.3	23.1	31	7.0	44.4	412
			STD	0.4	0.6	1	0.1	0.4	8
			MAX	29.0	24.9	33	7.3	45.2	433
			MIN	27.7	21.6	29	6.8	43.7	398
844	87.29	41	AV12	28.9	23.8	32	7.2	44.0	421
			STD	0.3	0.4	1	0.1	0.4	4
			MAX	29.6	24.8	33	7.4	44.4	429
			MIN	28.4	23.2	31	7.0	43.4	416
854	87.54	40	AV10	28.7	23.5	32	7.1	44.3	425
			STD	0.4	0.5	1	0.1	0.3	7
			MAX	29.5	24.6	34	7.3	44.8	434
			MIN	28.1	22.9	30	6.9	43.6	415
864	87.77	44	AV10	28.8	24.1	32	7.2	43.9	441
			STD	0.4	0.6	1	0.1	0.3	7
			MAX	29.6	24.9	34	7.4	44.4	456
			MIN	28.2	23.0	31	7.0	43.3	430
874	88.00	44	AV10	29.2	25.6	33	7.4	43.4	461
			STD	0.3	0.4	1	0.1	0.3	8
			MAX	29.8	26.1	34	7.6	43.9	475
			MIN	28.8	24.8	32	7.2	42.9	452
			Average	26.0	14.6	28	6.2	47.4	281
			Std. Dev.	2.4	5.4	3	0.7	2.8	101
			Maximum	29.8	26.1	34	7.6	64.6	475
			Minimum	10.8	2.7	11	3.2	42.9	11

Total number of blows analyzed: 868

BL# Sensors

1-874 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.10); A4: [K3550] 360.0 (1.10)

BL# Comments

3 Reported reference at El. 741.1

Time Summary

Drive 18 minutes 44 seconds 2:17 PM - 2:36 PM BN 1 - 874

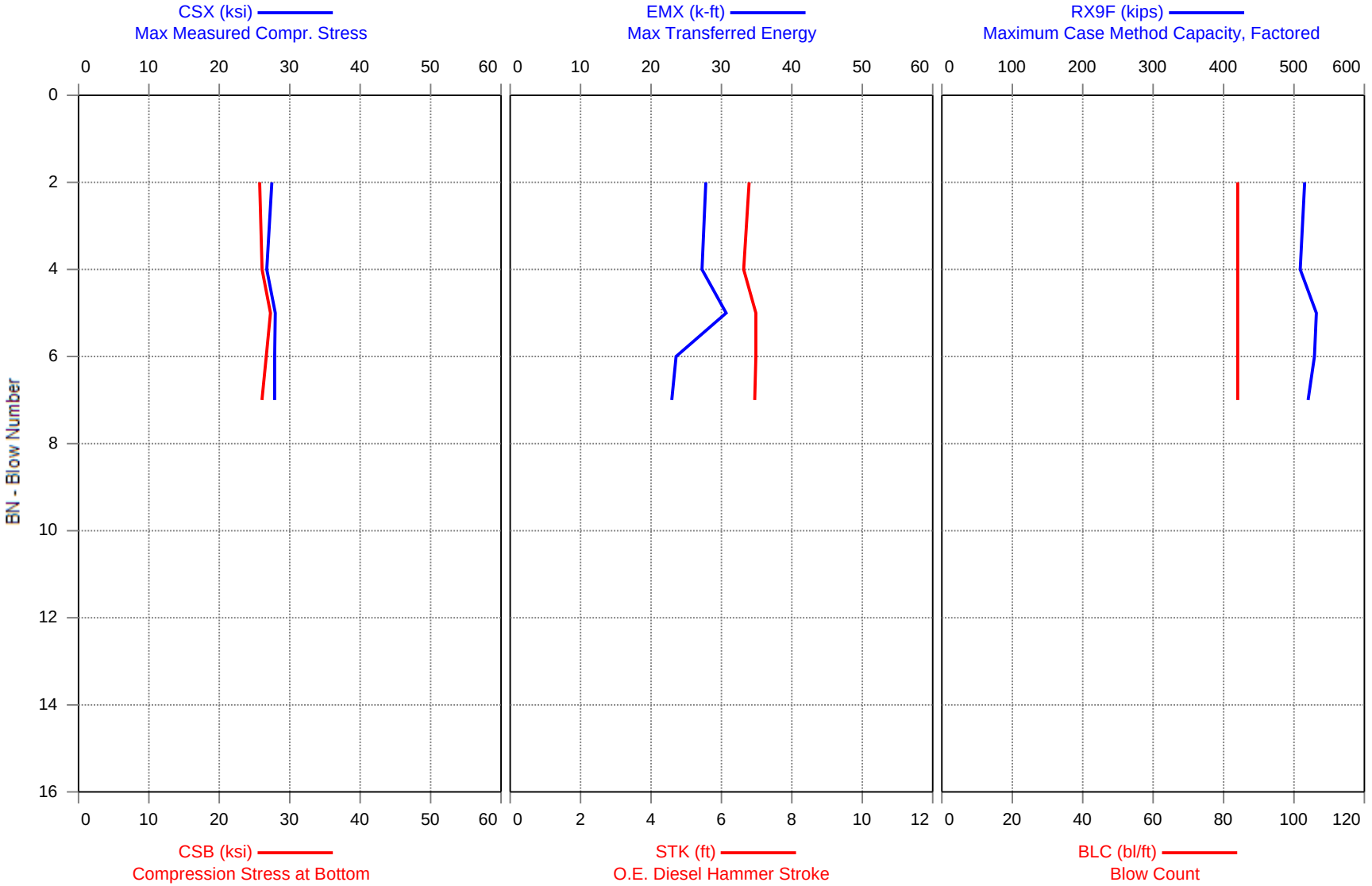
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-February-2015

Test started: 11-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #1 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #1 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 11-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.30 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
RX9F: Maximum Case Method Capacity, Factored

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
7	88.08	84	AV5	27.6	26.4	26	6.9	45.0	521
			STD	0.5	0.5	3	0.1	0.4	9
			MAX	28.0	27.3	31	7.0	45.7	532
			MIN	26.7	25.7	23	6.6	44.6	509
			Average	27.6	26.4	26	6.9	45.0	521
			Std. Dev.	0.5	0.5	3	0.1	0.4	9
			Maximum	28.0	27.3	31	7.0	45.7	532
			Minimum	26.7	25.7	23	6.6	44.6	509

Total number of blows analyzed: 5

BL# Sensors

1-7 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: off; A4: [K3550] 360.0 (1.10)

Time Summary

Drive 2 minutes 38 seconds 8:54 AM - 8:57 AM BN 1 - 7

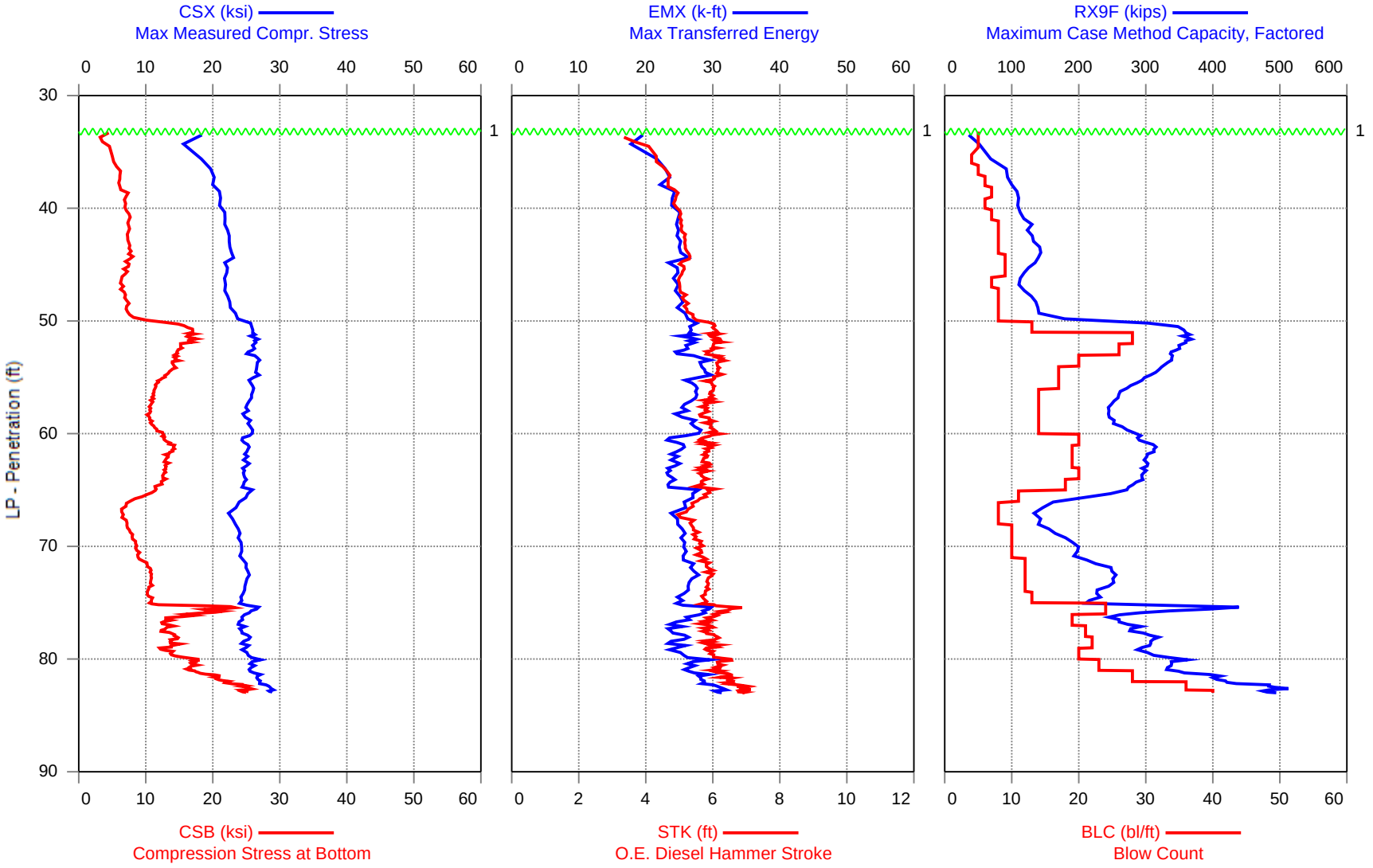
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-February-2015

Test started: 10-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #16

APE D30-42, HP 14 x 73



1 - Reported Reference El. 741.1

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #16 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.50 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
RX9F: Maximum Case Method Capacity, Factored

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
5	34.00	5	AV5	17.1	3.8	18	3.4	63.0	36
			STD	6.2	0.6	8	0.1	0.7	14
			MAX	24.7	4.5	33	3.4	63.8	57
			MIN	10.6	2.8	11	3.3	62.2	15
10	35.00	5	AV3	16.9	4.3	19	4.0	57.7	56
			STD	0.4	0.5	1	0.1	0.5	5
			MAX	17.3	4.9	20	4.1	58.2	60
			MIN	16.3	3.7	18	4.0	57.1	48
14	36.00	4	AV4	18.3	5.1	22	4.3	56.1	69
			STD	0.8	0.3	1	0.2	1.0	7
			MAX	19.3	5.4	23	4.5	57.2	73
			MIN	17.3	4.6	20	4.1	54.9	57
19	37.00	5	AV5	19.7	6.0	23	4.6	54.5	92
			STD	0.5	0.4	1	0.1	0.5	4
			MAX	20.2	6.4	24	4.7	55.5	99
			MIN	18.8	5.4	22	4.4	54.0	87
25	38.00	6	AV6	20.2	6.1	23	4.7	53.8	96
			STD	0.4	0.3	1	0.1	0.5	4
			MAX	20.9	6.6	24	4.9	54.3	102
			MIN	19.7	5.7	22	4.6	52.9	92
32	39.00	7	AV7	20.9	6.8	24	4.9	52.9	109
			STD	0.5	0.5	1	0.1	0.5	4
			MAX	21.4	7.4	25	5.0	54.1	115
			MIN	20.0	6.1	21	4.6	52.4	102
38	40.00	6	AV6	21.1	6.9	24	4.9	52.9	108
			STD	0.6	0.1	1	0.1	0.6	4
			MAX	21.7	7.1	26	5.0	54.0	116
			MIN	20.0	6.7	22	4.7	52.2	105
45	41.00	7	AV7	21.8	7.4	25	5.0	52.1	115
			STD	0.2	0.3	0	0.0	0.2	4
			MAX	22.1	7.7	25	5.1	52.5	122
			MIN	21.4	6.8	24	5.0	51.9	111
53	42.00	8	AV8	22.0	7.5	25	5.1	52.0	126
			STD	0.3	0.2	1	0.0	0.2	7
			MAX	22.5	7.8	26	5.1	52.2	141
			MIN	21.6	7.2	24	5.0	51.6	116
61	43.00	8	AV8	22.5	7.3	25	5.2	51.5	129
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	23.2	7.7	26	5.3	52.2	137
			MIN	21.9	6.9	23	5.0	50.8	120
69	44.00	8	AV8	22.6	7.6	25	5.2	51.4	143
			STD	0.3	0.2	1	0.0	0.2	5
			MAX	23.1	8.0	26	5.3	51.7	149
			MIN	22.0	7.2	24	5.1	50.9	134
78	45.00	9	AV9	22.5	7.5	25	5.2	51.3	137

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #16 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.7	0.4	1	0.1	0.7	3
			MAX	23.3	8.3	27	5.3	52.4	143
			MIN	21.3	6.9	23	5.0	50.7	132
87	46.00	9	AV9	22.1	7.0	25	5.1	51.7	121
			STD	0.3	0.4	0	0.0	0.2	5
			MAX	22.5	7.5	25	5.2	52.2	132
			MIN	21.5	6.4	24	5.0	51.4	116
94	47.00	7	AV7	21.8	6.4	25	5.0	52.3	111
			STD	0.1	0.3	0	0.0	0.2	2
			MAX	22.0	7.1	25	5.1	52.4	114
			MIN	21.7	6.1	24	5.0	52.0	106
102	48.00	8	AV8	22.0	6.7	25	5.1	51.9	124
			STD	0.3	0.3	1	0.1	0.4	7
			MAX	22.5	7.1	26	5.2	52.5	135
			MIN	21.6	6.2	24	5.0	51.2	115
110	49.00	8	AV8	22.6	7.2	25	5.2	51.3	137
			STD	0.3	0.2	1	0.1	0.3	5
			MAX	23.1	7.6	26	5.3	51.7	146
			MIN	22.1	7.0	24	5.1	50.9	127
118	50.00	8	AV8	23.6	8.3	26	5.4	50.4	160
			STD	0.5	1.2	1	0.1	0.5	30
			MAX	24.3	10.9	28	5.6	51.3	222
			MIN	22.7	7.1	24	5.2	49.6	137
131	51.00	13	AV13	25.8	15.7	27	6.0	47.8	338
			STD	0.3	1.5	1	0.1	0.4	28
			MAX	26.3	17.7	28	6.2	48.9	361
			MIN	25.0	12.1	26	5.8	47.3	261
159	52.00	28	AV28	26.2	16.6	27	6.1	47.6	361
			STD	0.5	0.5	1	0.1	0.5	6
			MAX	27.4	17.9	29	6.4	48.8	372
			MIN	24.8	15.4	24	5.8	46.5	347
185	53.00	26	AV20	25.6	14.9	25	5.9	48.2	343
			STD	0.6	0.3	1	0.1	0.5	7
			MAX	27.3	15.6	28	6.3	49.0	357
			MIN	24.6	14.2	24	5.7	46.8	333
205	54.00	20	AV16	26.7	14.3	28	6.2	47.2	337
			STD	0.3	0.4	1	0.1	0.4	5
			MAX	27.4	15.0	31	6.4	47.9	344
			MIN	26.2	13.4	26	6.0	46.5	324
222	55.00	17	AV17	26.5	13.6	29	6.2	47.3	314
			STD	0.5	0.8	1	0.1	0.4	9
			MAX	27.5	15.2	30	6.3	48.6	325
			MIN	25.1	12.5	26	5.8	46.7	292
239	56.00	17	AV17	25.8	11.8	27	6.0	48.0	285
			STD	0.4	0.4	1	0.1	0.4	10
			MAX	26.5	12.5	28	6.1	48.9	300
			MIN	25.0	11.2	25	5.8	47.6	270
253	57.00	14	AV14	25.8	11.1	27	6.0	48.1	260
			STD	0.6	0.2	1	0.1	0.5	5
			MAX	26.7	11.3	29	6.2	49.1	269
			MIN	24.8	10.8	25	5.7	47.3	253

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #16 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9F kips
267	58.00	14	AV14	25.2	10.8	26	5.8	48.7	247
			STD	0.4	0.2	1	0.1	0.5	4
			MAX	26.1	11.2	28	6.1	49.6	255
			MIN	24.5	10.4	24	5.6	47.6	240
281	59.00	14	AV14	25.0	10.6	26	5.8	48.8	248
			STD	0.7	0.3	2	0.2	0.7	5
			MAX	26.5	11.2	28	6.2	49.7	257
			MIN	24.1	10.0	23	5.6	47.2	239
295	60.00	14	AV14	25.8	11.6	28	6.0	48.0	268
			STD	0.7	0.6	2	0.2	0.7	11
			MAX	27.0	12.7	31	6.4	49.1	288
			MIN	24.7	10.8	24	5.7	46.6	248
315	61.00	20	AV20	24.8	13.0	25	5.8	48.8	294
			STD	0.6	0.4	1	0.2	0.6	7
			MAX	25.9	13.8	28	6.1	49.6	312
			MIN	24.0	12.3	22	5.6	47.7	284
334	62.00	19	AV19	25.2	13.8	25	5.9	48.5	311
			STD	0.6	0.5	1	0.1	0.5	7
			MAX	26.9	14.8	28	6.3	49.2	329
			MIN	24.5	12.8	23	5.7	46.9	299
353	63.00	19	AV15	25.0	13.1	24	5.8	48.7	300
			STD	0.6	0.4	1	0.2	0.6	5
			MAX	26.4	13.8	27	6.2	49.7	310
			MIN	23.9	12.4	23	5.6	47.3	291
373	64.00	20	AV20	24.7	12.8	24	5.7	49.2	296
			STD	0.4	0.2	1	0.1	0.5	4
			MAX	25.7	13.4	25	6.0	49.8	306
			MIN	24.1	12.4	23	5.5	48.1	290
391	65.00	18	AV18	24.9	12.0	24	5.7	49.1	281
			STD	0.7	0.6	2	0.2	0.7	9
			MAX	26.6	13.1	29	6.1	50.8	300
			MIN	23.3	11.2	21	5.3	47.4	267
402	66.00	11	AV11	25.0	9.6	27	5.7	49.0	221
			STD	0.7	1.3	1	0.2	0.8	32
			MAX	26.0	11.7	29	6.0	50.4	267
			MIN	23.9	7.5	24	5.4	47.8	170
410	67.00	8	AV8	23.3	6.7	26	5.3	50.8	144
			STD	0.5	0.4	1	0.1	0.6	7
			MAX	24.3	7.2	28	5.6	51.5	156
			MIN	22.6	6.3	25	5.2	49.7	133
418	68.00	8	AV8	22.7	6.9	24	5.2	51.4	139
			STD	0.9	0.4	2	0.2	1.0	6
			MAX	24.3	7.5	27	5.5	52.7	147
			MIN	21.4	6.2	22	4.9	49.8	131
428	69.00	10	AV10	23.9	7.6	26	5.4	50.2	157
			STD	0.5	0.3	1	0.1	0.5	9
			MAX	24.6	8.2	27	5.6	51.4	169
			MIN	22.7	7.1	24	5.2	49.4	137
438	70.00	10	AV10	24.1	8.3	26	5.6	49.6	188
			STD	0.4	0.3	1	0.1	0.5	8

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #16 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	24.8	8.7	27	5.8	50.6	202
			MIN	23.3	7.9	24	5.4	48.9	172
448	71.00	10	AV10	24.2	8.8	26	5.6	49.5	196
			STD	0.5	0.3	1	0.1	0.6	5
			MAX	25.2	9.3	28	5.9	50.2	204
			MIN	23.4	8.4	24	5.4	48.5	186
460	72.00	12	AV12	24.8	10.0	26	5.8	48.7	228
			STD	0.5	0.6	1	0.1	0.5	16
			MAX	25.7	10.9	28	6.0	49.4	258
			MIN	24.0	8.7	25	5.6	47.8	208
472	73.00	12	AV12	25.3	10.8	27	5.9	48.3	252
			STD	0.5	0.2	1	0.1	0.5	5
			MAX	26.3	11.0	29	6.2	48.9	259
			MIN	24.6	10.5	26	5.8	47.3	246
484	74.00	12	AV12	24.8	10.6	26	5.8	48.6	241
			STD	0.4	0.3	1	0.1	0.4	12
			MAX	25.5	11.2	28	6.0	49.4	261
			MIN	24.1	10.2	25	5.6	47.9	224
497	75.00	13	AV13	24.3	10.6	25	5.8	48.9	223
			STD	0.5	0.3	1	0.1	0.5	12
			MAX	25.3	11.1	28	6.0	49.7	236
			MIN	23.4	10.1	24	5.6	48.0	196
521	76.00	24	AV24	25.6	18.4	28	6.3	47.0	336
			STD	1.1	4.2	2	0.3	1.2	76
			MAX	28.0	23.6	32	7.0	49.4	451
			MIN	23.6	10.3	24	5.6	44.6	202
540	77.00	19	AV19	24.2	13.8	26	5.9	48.4	260
			STD	0.8	1.7	2	0.2	0.9	15
			MAX	26.1	18.4	29	6.4	49.6	301
			MIN	23.0	11.9	22	5.6	46.6	240
561	78.00	21	AV21	24.6	13.4	24	5.9	48.4	291
			STD	0.7	0.8	1	0.2	0.7	14
			MAX	25.6	14.5	27	6.1	49.9	316
			MIN	23.2	12.1	22	5.5	47.4	269
583	79.00	22	AV22	25.1	14.1	25	6.0	47.9	308
			STD	0.8	0.7	2	0.2	0.8	10
			MAX	26.8	15.4	29	6.5	49.1	326
			MIN	24.1	12.5	23	5.7	46.2	284
603	80.00	20	AV18	25.2	14.2	25	6.0	48.0	311
			STD	0.9	1.6	2	0.2	0.9	23
			MAX	27.0	17.4	29	6.6	49.4	363
			MIN	23.7	11.6	22	5.6	45.9	276
626	81.00	23	AV23	26.0	16.9	27	6.2	47.1	339
			STD	0.7	0.6	1	0.2	0.6	11
			MAX	27.5	18.3	31	6.6	48.3	375
			MIN	24.7	16.0	25	5.9	45.7	324
654	82.00	28	AV28	26.6	19.9	28	6.4	46.5	391
			STD	0.8	1.6	1	0.2	0.7	27
			MAX	28.0	22.6	31	6.8	47.9	427
			MIN	25.0	17.3	25	6.0	45.3	339

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #16 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
681	82.75	36	AV27	28.1	24.2	30	6.8	45.3	473
			STD	1.0	1.4	2	0.2	0.8	32
			MAX	30.1	26.2	34	7.2	47.0	517
			MIN	26.2	21.1	27	6.3	43.9	409
691	83.00	40	AV10	28.5	24.6	31	6.8	45.1	479
			STD	0.4	0.6	1	0.1	0.3	11
			MAX	29.1	25.2	32	7.0	45.6	499
			MIN	27.8	23.8	29	6.7	44.4	462
			Average	24.8	12.8	26	5.8	48.8	270
			Std. Dev.	2.1	4.7	2	0.5	2.3	99
			Maximum	30.1	26.2	34	7.2	63.8	517
			Minimum	10.6	2.8	11	3.3	43.9	15

Total number of blows analyzed: 673

BL# Sensors

1-691 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.10); A4: [K3550] 360.0 (1.10)

BL# Comments

1 Reported Reference El. 741.1

Time Summary

Drive 14 minutes 29 seconds 1:26 PM - 1:41 PM BN 1 - 691

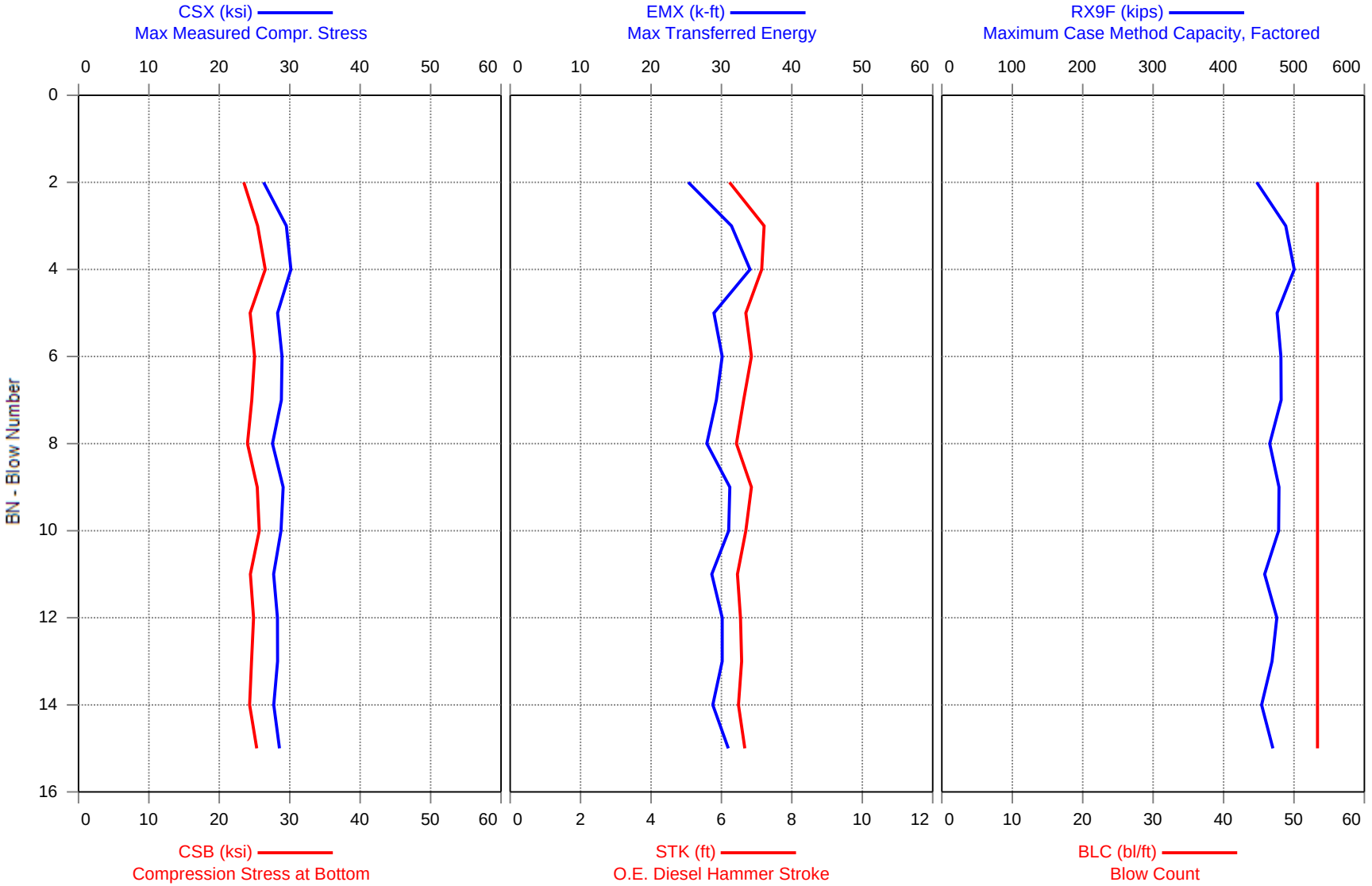
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-February-2015

Test started: 11-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #16 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #16 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 11-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.50 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
RX9F: Maximum Case Method Capacity, Factored

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
5	83.09	53	AV4	28.6	25.0	30	6.8	45.2	478
			STD	1.5	1.1	3	0.4	1.3	20
			MAX	30.2	26.5	34	7.2	47.1	500
			MIN	26.3	23.5	25	6.2	43.9	447
10	83.19	53	AV5	28.6	24.9	30	6.7	45.5	477
			STD	0.5	0.6	1	0.2	0.5	6
			MAX	29.1	25.7	31	6.8	46.4	482
			MIN	27.5	24.0	28	6.4	45.0	466
15	83.28	53	AV5	28.1	24.7	30	6.5	46.0	465
			STD	0.3	0.4	1	0.1	0.2	8
			MAX	28.5	25.3	31	6.7	46.3	476
			MIN	27.7	24.3	29	6.5	45.6	454
			Average	28.4	24.9	30	6.7	45.6	473
			Std. Dev.	0.9	0.7	2	0.3	0.8	13
			Maximum	30.2	26.5	34	7.2	47.1	500
			Minimum	26.3	23.5	25	6.2	43.9	447

Total number of blows analyzed: 14

BL# Sensors

1-15 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

Time Summary

Drive 18 seconds 8:42 AM - 8:43 AM BN 1 - 15

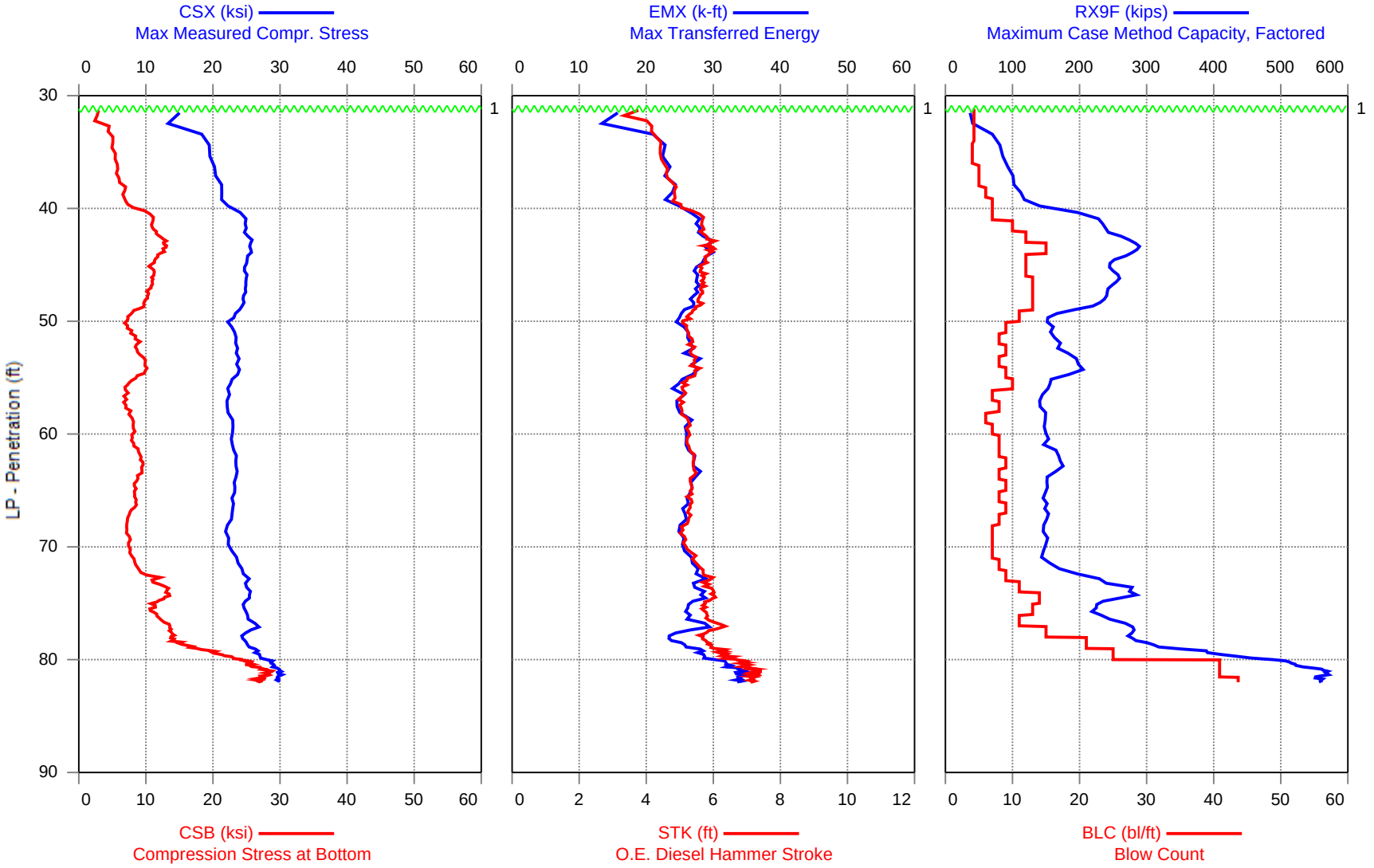
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-February-2015

Test started: 10-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #23

APE D30-42, HP 14 x 73



1 - Reported Reference El. 741.1

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #23 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.67 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
RX9F: Maximum Case Method Capacity, Factored

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
17	34.00	4	AV13	15.8	3.8	17	4.0	58.3	52
			STD	4.0	1.1	6	0.4	2.9	22
			MAX	20.0	5.6	23	4.4	63.4	90
			MIN	7.0	2.2	5	3.3	55.3	19
21	35.00	4	AV4	19.5	5.2	23	4.4	55.4	80
			STD	0.2	0.3	1	0.0	0.2	4
			MAX	19.7	5.8	24	4.5	55.5	85
			MIN	19.3	4.9	22	4.4	55.1	76
25	36.00	4	AV4	19.7	5.3	23	4.5	55.2	86
			STD	0.1	0.1	0	0.0	0.2	3
			MAX	19.8	5.5	23	4.5	55.3	91
			MIN	19.5	5.2	22	4.4	54.9	82
30	37.00	5	AV5	20.4	5.8	23	4.6	54.3	96
			STD	0.6	0.4	1	0.1	0.8	3
			MAX	21.0	6.3	25	4.8	55.4	99
			MIN	19.6	5.3	21	4.4	53.4	91
35	38.00	5	AV5	20.9	6.1	23	4.7	53.6	103
			STD	0.6	0.2	1	0.1	0.7	2
			MAX	21.5	6.4	24	4.9	54.8	107
			MIN	19.9	5.9	22	4.5	52.9	101
41	39.00	6	AV6	21.5	6.9	24	4.9	52.9	110
			STD	0.5	0.4	1	0.1	0.5	6
			MAX	22.4	7.6	26	5.0	53.4	117
			MIN	21.0	6.5	23	4.8	52.1	100
48	40.00	7	AV7	21.7	7.3	24	4.9	52.7	132
			STD	0.8	0.6	1	0.2	0.9	12
			MAX	23.0	8.6	25	5.2	53.9	148
			MIN	20.6	6.5	22	4.7	51.4	116
55	41.00	7	AV7	24.5	10.6	27	5.6	49.7	210
			STD	0.6	0.6	1	0.1	0.6	21
			MAX	25.3	11.3	29	5.7	50.9	231
			MIN	23.3	9.4	26	5.3	49.0	170
65	42.00	10	AV10	24.9	11.0	28	5.7	49.2	236
			STD	0.2	0.2	1	0.1	0.3	4
			MAX	25.2	11.4	29	5.8	49.8	243
			MIN	24.6	10.8	26	5.5	48.9	231
77	43.00	12	AV12	25.3	12.3	29	5.8	48.7	263
			STD	0.5	0.6	1	0.1	0.5	14
			MAX	26.4	13.3	31	6.1	49.5	285
			MIN	24.5	11.4	27	5.6	47.6	240
92	44.00	15	AV15	25.6	12.7	29	5.9	48.3	284
			STD	0.5	0.4	1	0.1	0.5	6
			MAX	26.6	13.7	31	6.1	49.2	296
			MIN	24.8	12.1	28	5.7	47.4	272
104	45.00	12	AV12	25.1	11.4	29	5.8	48.8	255

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #23 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.3	0.4	1	0.1	0.3	11
			MAX	25.5	12.0	30	5.9	49.4	276
			MIN	24.4	10.8	27	5.6	48.5	240
116	46.00	12	AV12	24.8	11.0	27	5.7	49.3	251
			STD	0.4	0.3	1	0.1	0.3	7
			MAX	25.5	11.3	29	5.8	49.9	265
			MIN	24.3	10.4	26	5.5	48.6	240
129	47.00	13	AV13	24.9	10.9	28	5.7	49.2	254
			STD	0.3	0.1	1	0.1	0.3	6
			MAX	25.5	11.3	29	5.8	49.6	262
			MIN	24.5	10.7	26	5.6	48.7	240
142	48.00	13	AV13	24.7	10.3	27	5.6	49.4	240
			STD	0.2	0.2	1	0.1	0.2	3
			MAX	25.0	10.8	28	5.7	50.0	246
			MIN	24.3	10.1	26	5.5	49.1	236
155	49.00	13	AV13	24.4	9.5	27	5.5	49.8	221
			STD	0.6	0.5	1	0.1	0.6	14
			MAX	25.2	10.0	29	5.8	50.9	238
			MIN	23.5	8.2	25	5.3	48.8	196
166	50.00	11	AV11	23.1	7.6	25	5.3	51.0	159
			STD	0.5	0.4	1	0.1	0.5	10
			MAX	23.8	8.2	26	5.4	52.2	175
			MIN	22.0	7.1	23	5.0	50.3	146
175	51.00	9	AV9	22.8	7.3	26	5.2	51.4	158
			STD	0.6	0.4	1	0.1	0.5	5
			MAX	23.5	8.1	27	5.3	52.0	167
			MIN	22.0	6.8	24	5.1	50.7	150
183	52.00	8	AV8	23.4	8.6	26	5.3	50.8	165
			STD	0.3	0.3	1	0.1	0.4	8
			MAX	23.8	9.3	27	5.4	51.4	178
			MIN	22.9	8.2	25	5.2	50.3	153
192	53.00	9	AV9	23.6	8.7	26	5.4	50.6	174
			STD	0.3	0.3	1	0.1	0.4	9
			MAX	24.3	9.2	29	5.6	51.0	192
			MIN	23.3	8.3	25	5.3	49.6	164
200	54.00	8	AV8	23.7	9.8	27	5.4	50.3	197
			STD	0.4	0.1	1	0.1	0.3	5
			MAX	24.3	10.0	29	5.5	50.8	204
			MIN	23.1	9.5	26	5.3	49.8	188
209	55.00	9	AV9	23.8	9.6	27	5.5	50.1	190
			STD	0.4	0.6	1	0.1	0.5	18
			MAX	24.4	10.3	29	5.7	50.8	209
			MIN	23.2	8.5	26	5.3	49.2	153
219	56.00	10	AV10	22.5	7.4	24	5.1	51.7	156
			STD	0.4	0.5	1	0.1	0.4	5
			MAX	23.1	8.3	26	5.3	52.3	166
			MIN	21.9	6.9	23	5.0	50.9	148
226	57.00	7	AV7	22.3	7.1	25	5.1	51.9	146
			STD	0.4	0.3	1	0.1	0.4	6
			MAX	22.7	7.4	27	5.2	52.5	158
			MIN	21.8	6.5	24	5.0	51.4	138

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #23 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9F kips
234	58.00	8	AV8	22.3	7.1	25	5.1	52.0	142
			STD	0.2	0.4	0	0.0	0.2	6
			MAX	22.6	7.9	25	5.1	52.3	151
			MIN	22.0	6.6	24	5.0	51.6	135
240	59.00	6	AV6	22.7	7.9	26	5.2	51.4	149
			STD	0.4	0.3	1	0.1	0.5	3
			MAX	23.1	8.2	27	5.3	52.2	153
			MIN	22.0	7.5	25	5.0	50.9	144
247	60.00	7	AV7	23.0	8.2	26	5.3	50.9	148
			STD	0.3	0.1	1	0.1	0.4	6
			MAX	23.5	8.4	27	5.4	51.6	156
			MIN	22.6	8.0	25	5.1	50.3	141
255	61.00	8	AV8	22.8	8.0	26	5.2	51.2	150
			STD	0.3	0.2	0	0.1	0.3	4
			MAX	23.2	8.3	27	5.3	51.7	158
			MIN	22.4	7.6	25	5.1	50.8	144
263	62.00	8	AV8	23.2	8.9	27	5.3	50.7	164
			STD	0.3	0.3	1	0.1	0.3	7
			MAX	23.6	9.2	28	5.5	51.1	170
			MIN	22.7	8.2	26	5.2	50.1	147
272	63.00	9	AV9	23.4	9.4	27	5.4	50.4	173
			STD	0.2	0.2	0	0.0	0.2	3
			MAX	23.7	9.7	28	5.5	50.6	177
			MIN	23.1	9.0	26	5.4	50.1	168
280	64.00	8	AV8	23.5	9.1	28	5.4	50.4	158
			STD	0.4	0.4	1	0.1	0.4	7
			MAX	24.0	9.8	29	5.5	51.3	168
			MIN	22.7	8.6	26	5.2	49.8	147
289	65.00	9	AV9	23.3	8.4	27	5.4	50.6	152
			STD	0.4	0.2	1	0.1	0.4	3
			MAX	23.9	8.8	28	5.5	51.2	158
			MIN	22.6	8.0	26	5.2	49.9	148
297	66.00	8	AV8	22.9	8.4	26	5.3	50.9	147
			STD	0.4	0.2	1	0.1	0.4	3
			MAX	23.5	8.6	27	5.4	51.4	152
			MIN	22.2	8.1	25	5.2	50.4	141
306	67.00	9	AV9	22.9	8.1	26	5.3	50.9	151
			STD	0.3	0.4	1	0.1	0.3	4
			MAX	23.6	8.8	27	5.4	51.3	161
			MIN	22.6	7.6	25	5.2	50.2	146
314	68.00	8	AV8	22.8	7.3	26	5.3	51.0	152
			STD	0.2	0.2	0	0.0	0.2	3
			MAX	23.2	7.6	26	5.4	51.3	157
			MIN	22.3	7.0	25	5.2	50.6	148
321	69.00	7	AV7	21.9	7.2	25	5.1	51.9	146
			STD	0.3	0.2	1	0.1	0.3	8
			MAX	22.4	7.6	26	5.2	52.4	161
			MIN	21.5	6.9	23	5.0	51.3	133
328	70.00	7	AV7	22.3	7.5	25	5.1	51.6	150
			STD	0.2	0.2	1	0.1	0.2	5

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #23 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	22.6	8.0	27	5.2	51.9	156
			MIN	22.0	7.4	25	5.1	51.2	143
335	71.00	7	AV7	23.2	7.8	26	5.4	50.6	144
			STD	0.5	0.3	1	0.1	0.5	5
			MAX	23.8	8.6	28	5.5	51.5	153
			MIN	22.3	7.4	25	5.2	50.0	138
343	72.00	8	AV8	23.8	8.5	27	5.5	49.9	159
			STD	0.4	0.3	1	0.1	0.4	9
			MAX	24.3	8.8	28	5.7	50.6	172
			MIN	23.1	7.9	25	5.4	49.2	147
352	73.00	9	AV9	24.9	10.5	28	5.8	48.7	209
			STD	0.6	1.1	1	0.2	0.6	24
			MAX	26.2	12.2	30	6.1	49.5	251
			MIN	24.1	9.2	26	5.6	47.4	176
363	74.00	11	AV11	25.1	12.5	28	5.9	48.5	263
			STD	0.6	0.9	1	0.2	0.7	21
			MAX	26.0	13.6	30	6.1	49.8	291
			MIN	24.0	11.0	25	5.5	47.6	225
377	75.00	14	AV14	25.2	12.6	28	5.9	48.3	258
			STD	0.5	0.9	1	0.1	0.6	24
			MAX	26.1	13.7	30	6.2	49.2	287
			MIN	24.3	10.6	26	5.7	47.3	212
390	76.00	13	AV13	24.8	11.1	26	5.7	48.9	225
			STD	0.3	0.4	1	0.1	0.3	10
			MAX	25.2	11.8	27	5.8	49.5	247
			MIN	24.2	10.3	25	5.6	48.6	209
401	77.00	11	AV11	25.7	12.6	27	6.0	48.1	254
			STD	0.7	0.7	2	0.2	0.7	16
			MAX	26.7	13.7	31	6.3	48.9	280
			MIN	24.9	11.5	25	5.8	47.0	232
416	78.00	15	AV15	25.3	13.8	26	5.9	48.4	278
			STD	1.0	0.3	2	0.3	1.0	5
			MAX	27.5	14.4	30	6.5	49.9	286
			MIN	23.9	13.3	22	5.5	46.3	269
437	79.00	21	AV21	25.0	15.3	25	5.8	48.6	300
			STD	0.7	1.3	1	0.2	0.6	17
			MAX	26.1	17.7	27	6.1	50.0	337
			MIN	23.7	13.3	22	5.5	47.6	271
462	80.00	25	AV25	26.9	21.1	29	6.3	46.7	414
			STD	0.8	1.8	1	0.2	0.7	36
			MAX	28.2	24.3	31	6.7	48.3	480
			MIN	25.3	17.6	25	5.9	45.4	345
525	81.54	41	AV61	29.4	26.9	33	7.1	44.3	544
			STD	0.7	1.4	1	0.2	0.6	25
			MAX	30.6	29.1	36	7.5	45.7	578
			MIN	27.8	23.8	30	6.6	43.1	502
535	81.77	44	AV10	29.6	27.3	34	7.1	44.1	556
			STD	0.3	0.4	1	0.1	0.2	8
			MAX	30.1	28.0	35	7.3	44.5	567
			MIN	29.2	26.7	32	7.0	43.7	543

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #23 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
545	82.00	44	AV10	29.7	26.9	34	7.1	44.1	559
			STD	0.2	0.3	1	0.1	0.2	7
			MAX	30.1	27.6	35	7.3	44.5	569
			MIN	29.2	26.4	33	7.0	43.7	549
			Average	24.6	12.8	27	5.7	49.3	259
			Std. Dev.	2.9	6.9	3	0.7	3.0	142
			Maximum	30.6	29.1	36	7.5	63.4	578
			Minimum	7.0	2.2	5	3.3	43.1	19

Total number of blows analyzed: 539

BL# Sensors

1-545 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

BL# Comments

5 Reported Reference El. 741.1

Time Summary

Drive 11 minutes 37 seconds 12:58 PM - 1:09 PM BN 1 - 545

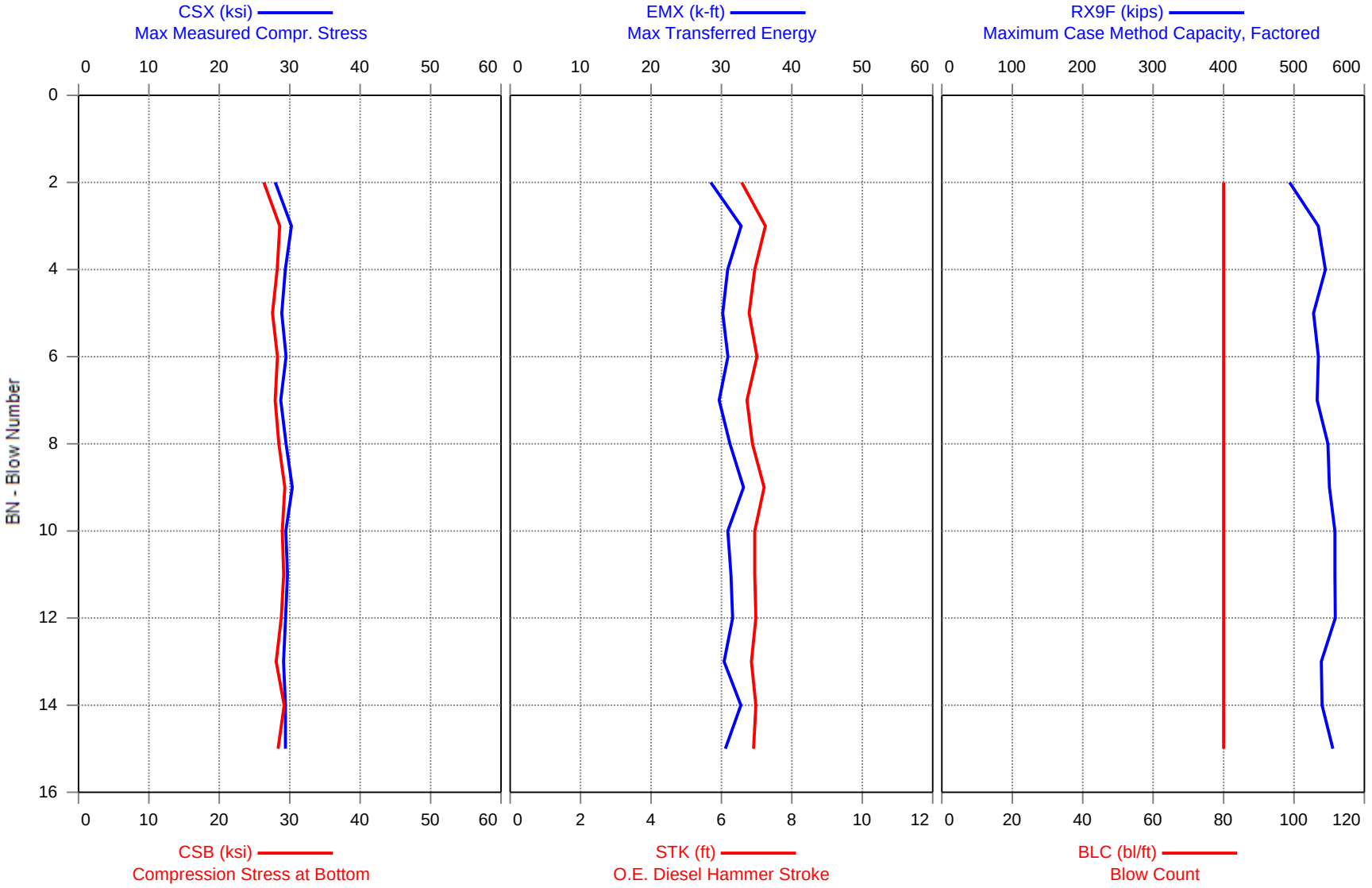
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-February-2015

Test started: 11-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #23 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #23 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 11-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.67 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
RX9F: Maximum Case Method Capacity, Factored

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9F
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
5	82.06	80	AV4	29.1	27.7	31	6.9	44.9	525
			STD	0.8	0.9	2	0.2	0.8	19
			MAX	30.2	28.6	33	7.2	45.9	544
			MIN	27.9	26.3	28	6.6	43.8	494
10	82.13	80	AV5	29.5	28.6	31	7.0	44.7	545
			STD	0.5	0.5	1	0.2	0.5	10
			MAX	30.4	29.3	33	7.2	45.4	558
			MIN	28.7	27.9	30	6.7	43.9	533
15	82.19	80	AV5	29.4	28.7	31	6.9	44.7	550
			STD	0.2	0.4	1	0.0	0.1	9
			MAX	29.7	29.2	33	7.0	45.0	559
			MIN	29.1	28.1	30	6.8	44.6	539
			Average	29.4	28.4	31	6.9	44.8	541
			Std. Dev.	0.6	0.7	1	0.2	0.5	16
			Maximum	30.4	29.3	33	7.2	45.9	559
			Minimum	27.9	26.3	28	6.6	43.8	494

Total number of blows analyzed: 14

BL# Sensors

1-15 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

Time Summary

Drive 18 seconds 8:31 AM - 8:31 AM BN 1 - 15

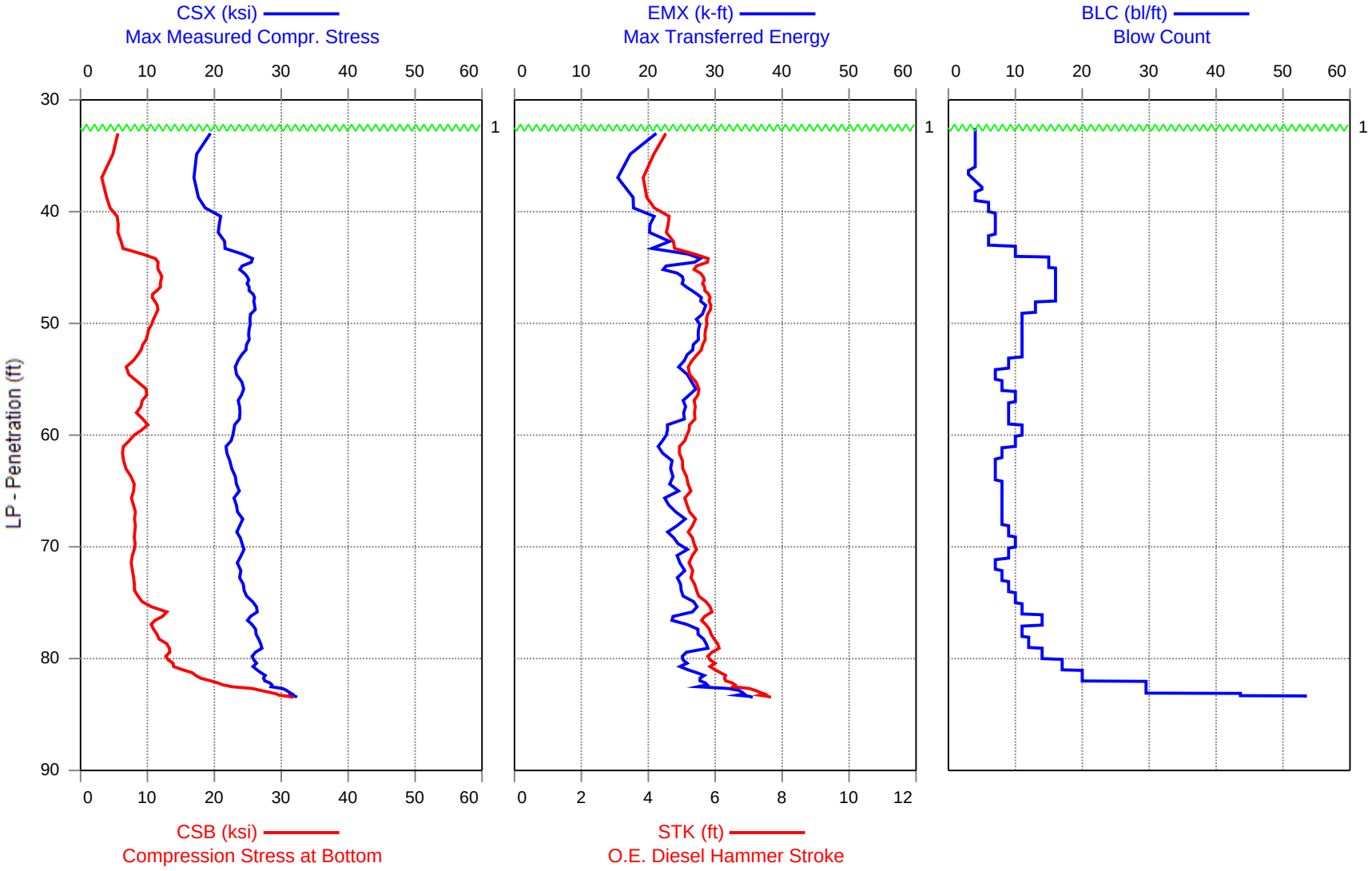
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 11-February-2015

Test started: 10-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #56

APE D30-42, HP 14 x 73



1 - Reported reference at El. 740.3

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #56 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.92 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

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm
6	32.50	4	AV1	15.4	4.5	17	3.7	59.9
			STD	0.0	0.0	0	0.0	0.0
			MAX	15.4	4.5	17	3.7	59.9
			MIN	15.4	4.5	17	3.7	59.9
8	33.00	4	AV2	24.1	6.3	31	5.4	50.3
			STD	0.6	0.2	4	0.2	0.8
			MAX	24.6	6.5	35	5.6	51.0
			MIN	23.5	6.1	27	5.3	49.5
12	34.00	4	AV4	18.2	5.5	18	4.3	56.4
			STD	2.2	0.2	5	0.4	2.4
			MAX	22.0	5.7	26	5.0	58.5
			MIN	16.3	5.2	12	3.9	52.3
13	35.25	4	AV1	19.0	4.9	18	4.3	55.8
			STD	0.0	0.0	0	0.0	0.0
			MAX	19.0	4.9	18	4.3	55.8
			MIN	19.0	4.9	18	4.3	55.8
16	36.00	4	AV3	16.8	4.1	16	4.1	57.7
			STD	3.6	0.3	5	0.6	3.7
			MAX	22.0	4.4	24	5.0	60.3
			MIN	14.2	3.6	11	3.7	52.4
19	37.00	3	AV2	16.5	2.9	15	3.8	59.5
			STD	2.7	0.4	4	0.4	3.2
			MAX	19.2	3.3	19	4.3	62.6
			MIN	13.8	2.4	11	3.4	56.3
24	38.00	5	AV2	14.9	2.9	12	3.3	63.4
			STD	1.9	0.3	2	0.1	1.0
			MAX	16.8	3.2	14	3.4	64.4
			MIN	13.0	2.6	10	3.2	62.4
28	39.00	4	AV4	17.9	3.9	19	4.0	58.2
			STD	2.4	0.6	3	0.4	2.9
			MAX	19.7	4.3	21	4.3	63.1
			MIN	13.8	2.8	13	3.3	56.1
34	40.00	6	AV6	18.3	4.3	17	4.1	57.4
			STD	1.7	0.3	3	0.3	2.0
			MAX	19.8	4.8	20	4.4	60.5
			MIN	15.6	4.0	14	3.7	55.6
41	41.00	7	AV7	21.0	5.6	21	4.6	54.2
			STD	1.5	0.3	3	0.3	1.7
			MAX	23.4	5.9	25	5.2	56.7
			MIN	18.9	5.1	17	4.2	51.5
48	42.00	7	AV7	20.4	5.6	20	4.5	54.8
			STD	0.5	0.1	1	0.1	0.5
			MAX	21.0	5.8	21	4.6	55.5
			MIN	19.9	5.4	19	4.4	54.2
54	43.00	6	AV6	21.5	6.0	23	4.7	53.6

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #56 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm
			STD	0.8	0.2	1	0.2	0.8
			MAX	22.4	6.3	24	4.9	55.4
			MIN	19.8	5.7	21	4.4	52.9
64	44.00	10	AV10	22.9	7.8	23	5.1	52.0
			STD	1.9	1.7	4	0.4	2.1
			MAX	25.4	10.8	28	5.7	55.7
			MIN	19.5	6.0	17	4.4	49.2
79	45.00	15	AV15	25.1	11.4	26	5.7	49.3
			STD	1.0	0.3	3	0.2	1.0
			MAX	26.3	11.9	29	5.9	51.3
			MIN	23.1	10.9	20	5.2	48.2
95	46.00	16	AV16	24.4	11.9	24	5.5	49.9
			STD	0.6	0.3	2	0.1	0.6
			MAX	25.6	12.4	26	5.8	51.0
			MIN	23.2	11.4	21	5.3	48.9
111	47.00	16	AV16	25.1	11.9	26	5.7	49.3
			STD	0.4	0.3	1	0.1	0.3
			MAX	25.7	12.6	27	5.8	50.0
			MIN	24.4	11.2	23	5.5	48.8
127	48.00	16	AV16	25.9	10.9	28	5.8	48.6
			STD	0.5	0.3	1	0.1	0.4
			MAX	26.7	11.7	29	6.0	49.3
			MIN	25.2	10.4	26	5.7	47.8
140	49.00	13	AV13	25.9	11.4	28	5.8	48.6
			STD	0.5	0.3	1	0.1	0.4
			MAX	26.9	12.0	31	6.1	49.4
			MIN	24.8	10.9	26	5.6	47.7
151	50.00	11	AV11	25.4	11.0	28	5.8	48.9
			STD	0.3	0.3	1	0.1	0.3
			MAX	25.9	11.4	29	5.9	49.4
			MIN	24.9	10.5	26	5.6	48.4
162	51.00	11	AV11	25.2	10.2	27	5.7	49.1
			STD	0.5	0.2	1	0.1	0.4
			MAX	25.9	10.5	29	5.9	49.7
			MIN	24.5	9.8	26	5.6	48.5
173	52.00	11	AV11	25.0	9.7	27	5.7	49.3
			STD	0.3	0.3	1	0.1	0.3
			MAX	25.4	10.1	28	5.8	49.8
			MIN	24.7	9.3	26	5.5	48.9
184	53.00	11	AV11	24.5	8.8	26	5.5	49.8
			STD	0.5	0.3	1	0.1	0.5
			MAX	25.2	9.2	28	5.7	50.7
			MIN	23.7	8.3	25	5.3	49.2
193	54.00	9	AV9	23.4	7.4	25	5.3	51.0
			STD	0.3	0.6	1	0.1	0.4
			MAX	24.1	8.3	26	5.5	51.7
			MIN	22.8	6.5	24	5.1	50.1
200	55.00	7	AV7	23.4	7.3	26	5.2	51.1
			STD	0.6	0.4	1	0.1	0.5
			MAX	24.2	7.9	27	5.4	51.7
			MIN	22.7	6.8	25	5.1	50.3

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #56
OP: TC
APE D30-42, HP 14 x 73
Date: 10-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm
208	56.00	8	AV8	24.3	9.3	27	5.5	50.0
			STD	0.3	0.7	1	0.1	0.4
			MAX	24.8	10.1	28	5.6	50.7
			MIN	23.7	8.0	25	5.3	49.4
218	57.00	10	AV10	23.8	9.6	26	5.4	50.3
			STD	0.5	0.4	1	0.1	0.5
			MAX	24.8	10.1	27	5.6	51.1
			MIN	23.1	9.0	24	5.2	49.4
227	58.00	9	AV9	23.8	8.8	25	5.4	50.4
			STD	0.5	0.4	1	0.1	0.5
			MAX	24.5	9.6	27	5.5	51.3
			MIN	23.1	8.1	23	5.2	49.8
236	59.00	9	AV9	23.6	9.3	25	5.4	50.6
			STD	0.6	0.9	1	0.1	0.6
			MAX	24.6	10.4	28	5.6	51.4
			MIN	22.6	8.3	23	5.2	49.6
247	60.00	11	AV11	22.8	9.0	23	5.2	51.4
			STD	0.2	0.9	1	0.1	0.3
			MAX	23.1	10.2	24	5.3	51.9
			MIN	22.4	7.7	21	5.1	51.0
257	61.00	10	AV10	22.4	7.2	22	5.1	52.0
			STD	1.0	0.7	2	0.2	1.0
			MAX	24.2	8.3	25	5.4	53.4
			MIN	21.1	6.2	20	4.8	50.2
265	62.00	8	AV8	21.8	6.3	22	4.9	52.6
			STD	0.4	0.2	1	0.1	0.4
			MAX	22.4	6.5	23	5.1	53.4
			MIN	21.2	6.0	21	4.8	52.0
272	63.00	7	AV7	22.6	6.6	24	5.1	52.0
			STD	0.5	0.2	1	0.1	0.4
			MAX	23.5	6.8	26	5.2	52.6
			MIN	21.8	6.1	23	4.9	51.2
279	64.00	7	AV7	22.9	7.4	23	5.1	51.8
			STD	0.6	0.4	1	0.1	0.7
			MAX	24.2	8.0	25	5.4	52.4
			MIN	22.4	7.0	22	5.0	50.5
287	65.00	8	AV8	23.4	8.0	23	5.2	51.3
			STD	0.4	0.2	1	0.1	0.3
			MAX	23.9	8.2	24	5.3	51.8
			MIN	22.8	7.8	22	5.1	50.9
295	66.00	8	AV8	23.2	7.8	23	5.1	51.6
			STD	0.6	0.3	2	0.1	0.6
			MAX	24.2	8.2	26	5.4	52.5
			MIN	22.3	7.5	21	5.0	50.6
303	67.00	8	AV8	23.4	8.1	24	5.2	51.3
			STD	0.2	0.3	1	0.1	0.3
			MAX	23.8	8.5	24	5.3	51.7
			MIN	22.9	7.6	22	5.1	50.9
311	68.00	8	AV8	24.2	8.2	25	5.4	50.4
			STD	0.5	0.3	1	0.1	0.5

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #56
OP: TC
APE D30-42, HP 14 x 73
Date: 10-February-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm
			MAX	25.0	8.4	28	5.6	51.2
			MIN	23.4	7.6	24	5.2	49.7
320	69.00	9	AV9	23.5	8.1	23	5.2	51.2
			STD	0.4	0.1	1	0.1	0.3
			MAX	24.0	8.3	24	5.3	51.6
			MIN	23.0	7.8	22	5.1	50.7
330	70.00	10	AV10	24.1	8.1	24	5.4	50.6
			STD	0.3	0.1	1	0.1	0.3
			MAX	24.7	8.4	26	5.5	50.9
			MIN	23.7	8.0	23	5.3	49.9
339	71.00	9	AV9	24.2	7.8	25	5.4	50.6
			STD	0.5	0.2	1	0.1	0.6
			MAX	25.1	8.1	27	5.6	51.7
			MIN	23.2	7.5	23	5.1	49.7
346	72.00	7	AV7	23.6	7.6	25	5.2	51.1
			STD	0.4	0.1	1	0.1	0.4
			MAX	24.3	7.8	26	5.4	51.9
			MIN	22.9	7.4	23	5.1	50.5
354	73.00	8	AV8	23.8	7.9	25	5.3	50.9
			STD	0.4	0.2	1	0.1	0.4
			MAX	24.3	8.3	26	5.4	51.4
			MIN	23.3	7.6	24	5.2	50.4
363	74.00	9	AV9	24.4	8.1	25	5.4	50.3
			STD	0.6	0.2	1	0.1	0.6
			MAX	25.3	8.4	26	5.6	51.3
			MIN	23.5	7.9	24	5.2	49.4
373	75.00	10	AV10	25.1	8.7	26	5.6	49.7
			STD	0.7	0.4	1	0.2	0.8
			MAX	26.2	9.3	27	5.8	51.1
			MIN	23.8	7.9	23	5.2	48.7
384	76.00	11	AV11	26.3	11.5	27	5.9	48.5
			STD	0.6	1.4	2	0.1	0.6
			MAX	27.3	13.3	30	6.1	49.2
			MIN	25.6	9.4	24	5.7	47.5
398	77.00	14	AV14	25.3	11.4	24	5.7	49.3
			STD	0.5	0.8	1	0.1	0.5
			MAX	26.4	13.1	27	5.9	50.1
			MIN	24.6	10.2	23	5.5	48.3
409	78.00	11	AV11	26.2	11.1	27	5.8	48.6
			STD	0.3	0.6	1	0.1	0.3
			MAX	26.7	12.2	28	6.0	49.1
			MIN	25.6	10.1	26	5.7	48.0
421	79.00	12	AV12	26.8	12.5	29	6.0	47.8
			STD	0.5	0.7	1	0.1	0.5
			MAX	27.5	13.3	30	6.2	48.7
			MIN	25.9	11.1	27	5.8	47.2
435	80.00	14	AV14	26.2	13.1	26	5.9	48.3
			STD	0.7	0.4	2	0.2	0.6
			MAX	27.5	13.8	29	6.2	49.5
			MIN	25.0	12.2	24	5.6	47.1

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #56 APE D30-42, HP 14 x 73
OP: TC Date: 10-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm
452	81.00	17	AV17	26.1	13.9	25	5.9	48.3
			STD	0.4	0.7	1	0.1	0.4
			MAX	26.9	15.1	27	6.1	48.9
			MIN	25.5	12.6	24	5.8	47.6
472	82.00	20	AV20	27.2	17.4	28	6.2	47.1
			STD	0.5	1.1	1	0.1	0.5
			MAX	28.1	19.8	30	6.5	48.0
			MIN	26.2	15.5	26	6.0	46.3
504	83.08	30	AV32	29.5	23.9	31	6.8	45.1
			STD	1.3	3.1	3	0.4	1.2
			MAX	31.7	28.9	35	7.5	46.9
			MIN	27.5	19.3	26	6.3	43.1
514	83.31	44	AV10	31.5	29.5	34	7.4	43.4
			STD	0.3	0.4	1	0.1	0.3
			MAX	32.0	30.4	35	7.5	44.0
			MIN	30.9	28.9	32	7.2	43.0
524	83.50	53	AV10	32.2	31.4	35	7.6	42.8
			STD	0.4	0.6	1	0.1	0.3
			MAX	32.9	32.3	37	7.8	43.3
			MIN	31.8	30.4	34	7.4	42.2
			Average	24.8	11.3	26	5.6	49.8
			Std. Dev.	2.9	5.9	4	0.7	3.1
			Maximum	32.9	32.3	37	7.8	64.4
			Minimum	13.0	2.4	10	3.2	42.2

Total number of blows analyzed: 515

BL# Sensors

1-524 F3: [F607] 93.6 (0.96); F4: [D815] 93.0 (0.96); A3: [K2524] 360.0 (1.10); A4: [K3550] 360.0 (1.10)

BL# Comments

6 Reported reference at El. 740.3

Time Summary

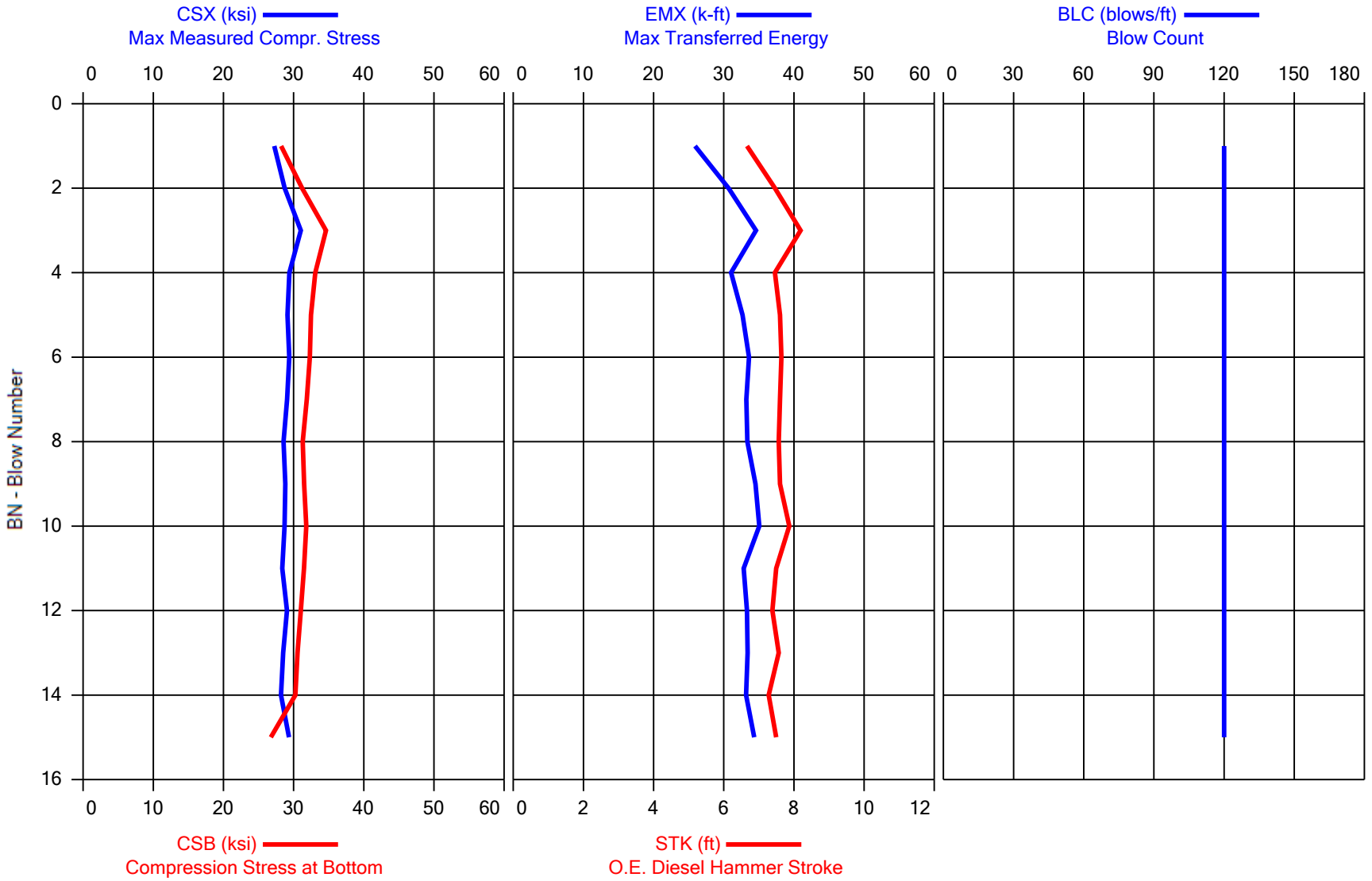
Drive 11 minutes 5 seconds 12:30 PM - 12:41 PM BN 1 - 524

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-February-2015 Test started: 11-February-2015

USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #56 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - B-70-403 - PIER 11 #56 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 11-February-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.92 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

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM
	ft	blows/ft		ksi	ksi	k-ft	ft	bpm
5	83.54	120	AV5	29.1	31.9	31	7.5	43.2
			STD	1.2	2.1	3	0.5	1.4
			MAX	31.0	34.6	35	8.2	45.6
			MIN	27.2	28.2	26	6.7	41.3
10	83.58	120	AV5	28.9	31.8	34	7.7	42.7
			STD	0.3	0.3	1	0.1	0.3
			MAX	29.4	32.3	35	7.9	42.9
			MIN	28.6	31.3	33	7.6	42.1
15	83.63	120	AV5	28.7	30.0	33	7.4	43.2
			STD	0.4	1.7	1	0.1	0.3
			MAX	29.3	31.5	34	7.6	43.7
			MIN	28.2	26.8	33	7.3	42.9
			Average	28.9	31.2	33	7.5	43.0
			Std. Dev.	0.8	1.8	2	0.3	0.9
			Maximum	31.0	34.6	35	8.2	45.6
			Minimum	27.2	26.8	26	6.7	41.3

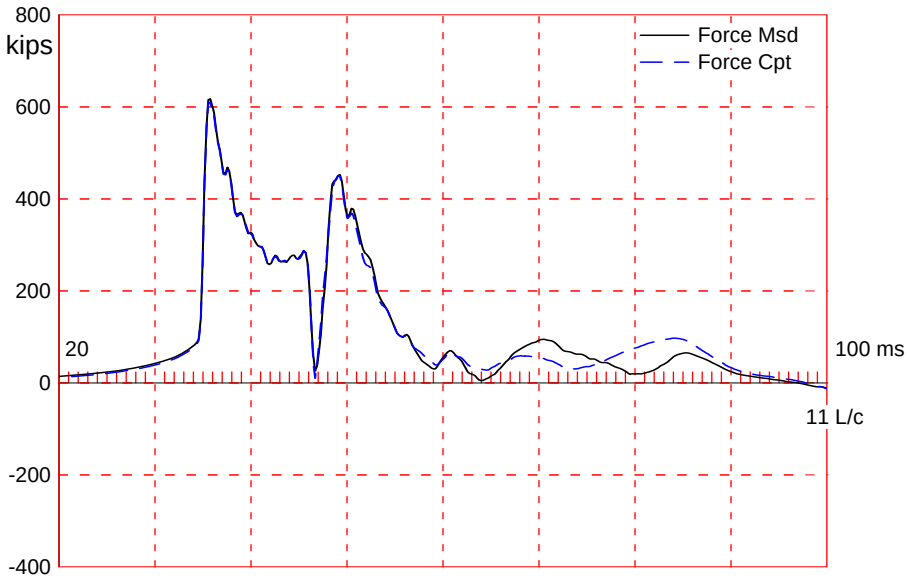
Total number of blows analyzed: 15

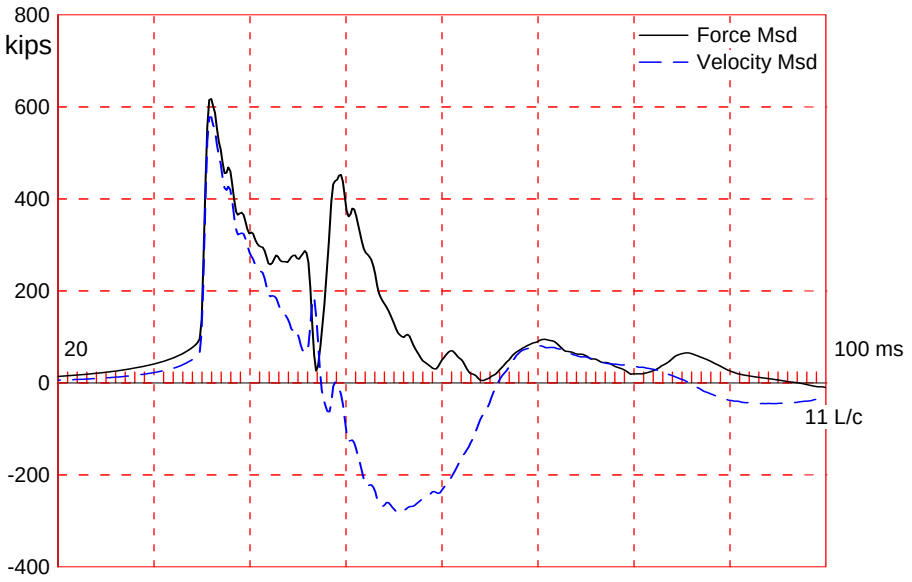
BL# Sensors

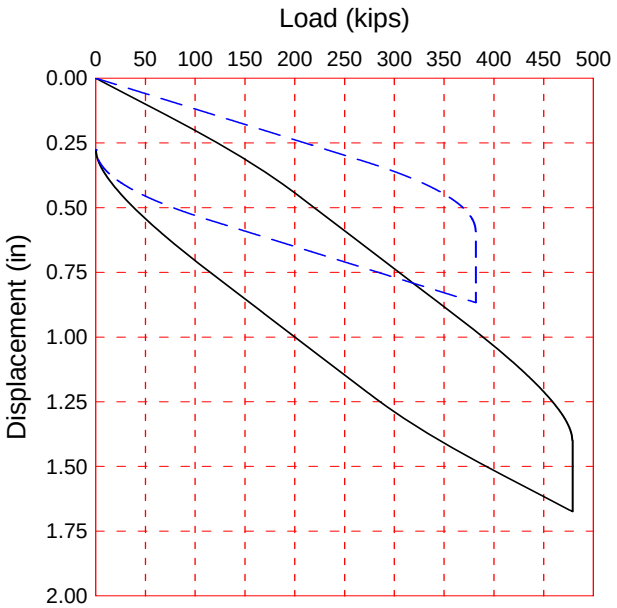
1-15 F3: [F607] 93.6 (0.96); F4: [D815] 93.0 (0.96); A3: [K2524] 360.0 (1.10); A4: [K3550] 360.0 (1.10)

Time Summary

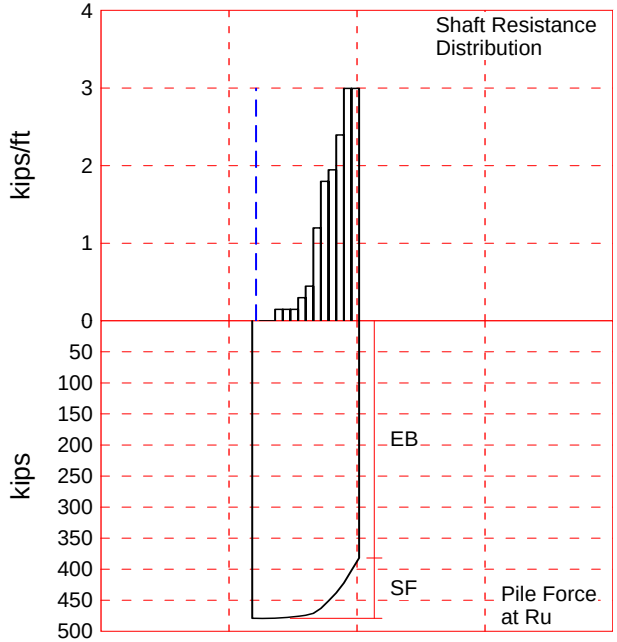
Drive 19 seconds 8:19 AM - 8:19 AM BN 1 - 15







RU =	479.0 kips
SF =	97.0 kips
EB =	382.0 kips
Dy =	1.40 in
Dx =	1.67 in
SET/Bl =	0.27 in



Length b. Sensors	93.5 ft
Embedment	88.0 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	4.98
Top Compr. Stress	28.5 ksi
Max Compr. Stress	28.9 ksi
Max Tension Stress	-3.85 ksi
Avg. Shaft Quake	0.11 in
Toe Quake	0.46 in
Avg. Shaft Smith Dpg.	0.20 s/ft
Toe Smith Damping	0.11 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 479.0; along Shaft 97.0; at Toe 382.0 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
				479.0				
1	13.4	7.8	0.0	479.0	0.0	0.00	0.00	0.00
2	20.0	14.5	0.0	479.0	0.0	0.00	0.00	0.00
3	26.7	21.2	1.0	478.0	1.0	0.15	0.03	0.20
4	33.4	27.8	1.0	477.0	2.0	0.15	0.03	0.20
5	40.1	34.5	1.0	476.0	3.0	0.15	0.03	0.20
6	46.8	41.2	2.0	474.0	5.0	0.30	0.06	0.20
7	53.4	47.9	3.0	471.0	8.0	0.45	0.10	0.20
8	60.1	54.6	8.0	463.0	16.0	1.20	0.25	0.20
9	66.8	61.2	12.0	451.0	28.0	1.80	0.38	0.20
10	73.5	67.9	13.0	438.0	41.0	1.95	0.41	0.20
11	80.1	74.6	16.0	422.0	57.0	2.40	0.51	0.20
12	86.8	81.3	20.0	402.0	77.0	2.99	0.64	0.20
13	93.5	88.0	20.0	382.0	97.0	2.99	0.64	0.20
Avg. Shaft			7.5			1.10	0.23	0.20
Toe			382.0				277.12	0.11

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.11	0.46
Case Damping Factor		0.51	1.15
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	90	82
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.11
Soil Plug Weight	(kips)	0.054	

CAPWAP match quality = 4.98 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.27 in; Blow Count = 44 b/ft
Computed: Final Set = 0.24 in; Blow Count = 51 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.10; A4(K3550) CAL: 360; RF: 1.10

max. Top Comp. Stress = 28.5 ksi (T= 36.2 ms, max= 1.015 x Top)
max. Comp. Stress = 28.9 ksi (Z= 60.1 ft, T= 39.5 ms)
max. Tens. Stress = -3.85 ksi (Z= 66.8 ft, T= 63.6 ms)
max. Energy (EMX) = 33.9 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	3.3	610.4	-25.4	28.5	-1.19	33.9	15.3	1.15
2	6.7	611.0	-26.1	28.5	-1.22	33.8	15.3	1.14
4	13.4	612.3	-27.7	28.6	-1.29	33.4	15.3	1.11
6	20.0	614.1	-29.5	28.7	-1.38	32.8	15.2	1.06
8	26.7	617.0	-35.4	28.8	-1.65	32.1	15.1	1.02
10	33.4	616.0	-48.7	28.8	-2.27	31.1	15.1	0.97
12	40.1	615.6	-58.9	28.8	-2.75	30.0	14.9	0.92
14	46.8	616.8	-68.1	28.8	-3.18	28.9	14.8	0.87
15	50.1	612.4	-69.9	28.6	-3.27	28.1	14.7	0.84
16	53.4	617.0	-73.9	28.8	-3.45	27.5	14.6	0.81
17	56.8	612.7	-74.4	28.6	-3.48	26.5	14.4	0.78
18	60.1	619.4	-80.9	28.9	-3.78	26.0	14.2	0.76
19	63.4	598.7	-76.2	28.0	-3.56	24.1	13.9	0.73
20	66.8	605.8	-82.3	28.3	-3.85	23.5	13.7	0.70
21	70.1	571.0	-70.7	26.7	-3.30	21.2	13.5	0.67
22	73.5	578.3	-76.8	27.0	-3.59	20.6	14.1	0.64
23	76.8	548.5	-64.2	25.6	-3.00	18.2	14.1	0.61
24	80.1	570.1	-69.2	26.6	-3.23	17.7	14.9	0.59
25	83.5	521.3	-53.1	24.4	-2.48	15.2	16.1	0.56
26	86.8	507.4	-57.4	23.7	-2.68	14.7	17.4	0.53
27	90.2	501.0	-37.8	23.4	-1.76	11.9	18.0	0.51
28	93.5	519.0	-42.0	24.2	-1.96	10.2	16.6	0.48
Absolute	60.1			28.9			(T =	39.5 ms)
	66.8				-3.85		(T =	63.6 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	546.6	413.0	279.3	145.7	12.1					
RX	669.8	623.5	577.1	537.1	522.2	508.2	503.4	500.4	497.4	494.4
RU	546.6	413.0	279.3	145.7	12.1					

RAU = 471.7 (kips); RA2 = 554.4 (kips)

Current CAPWAP Ru = 479.0 (kips); Corresponding J(RP)= 0.10; matches RX20 within 5%

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
15.4	35.96	588.1	626.6	627.7	1.13	0.33	0.27	34.0	581.5	1109

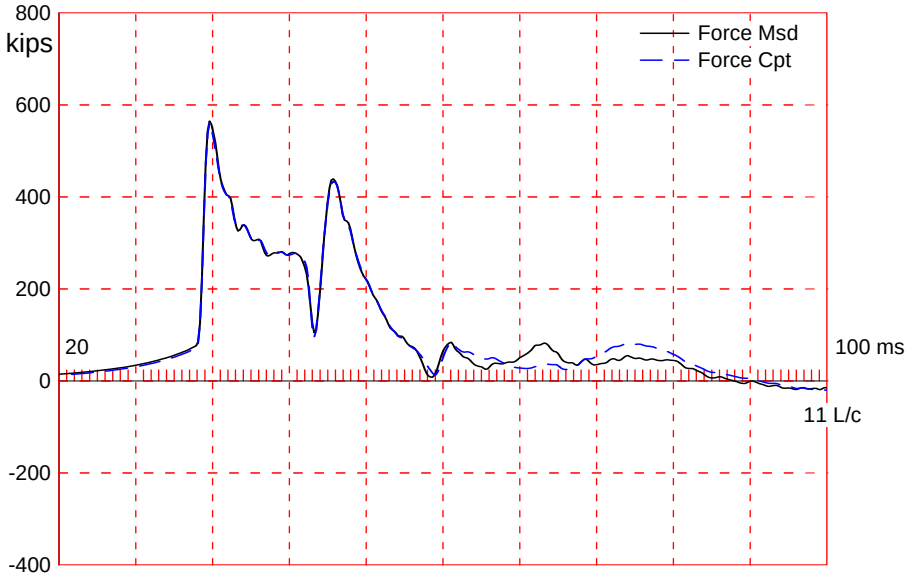
PILE PROFILE AND PILE MODEL

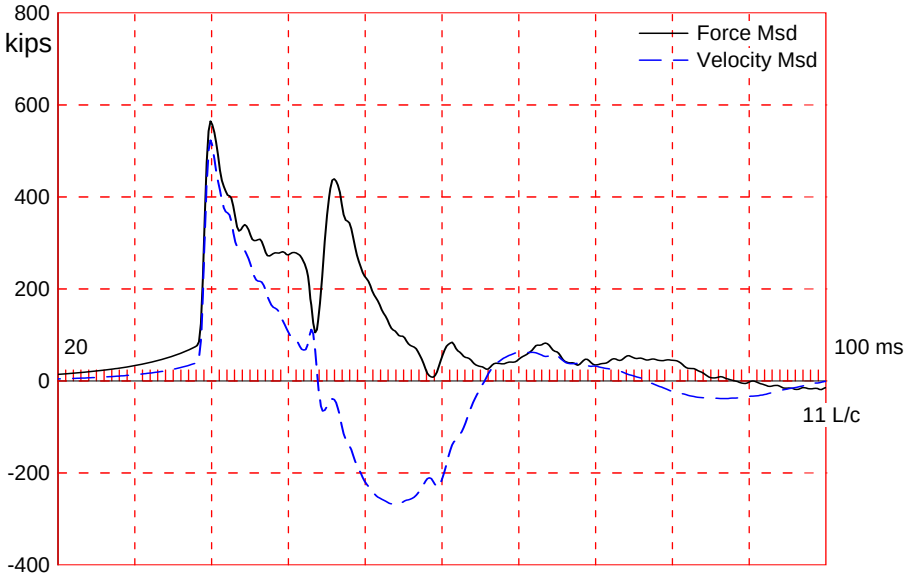
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
93.5	21.4	29992.2	492.000	4.70

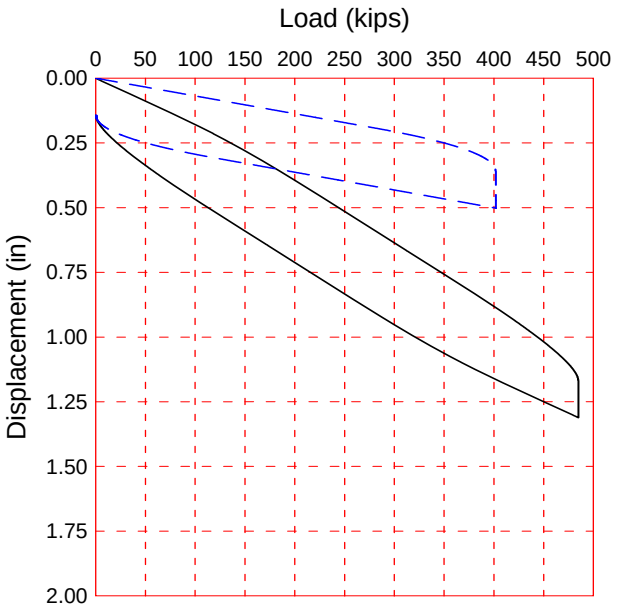
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
26	86.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.054
27	90.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	93.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

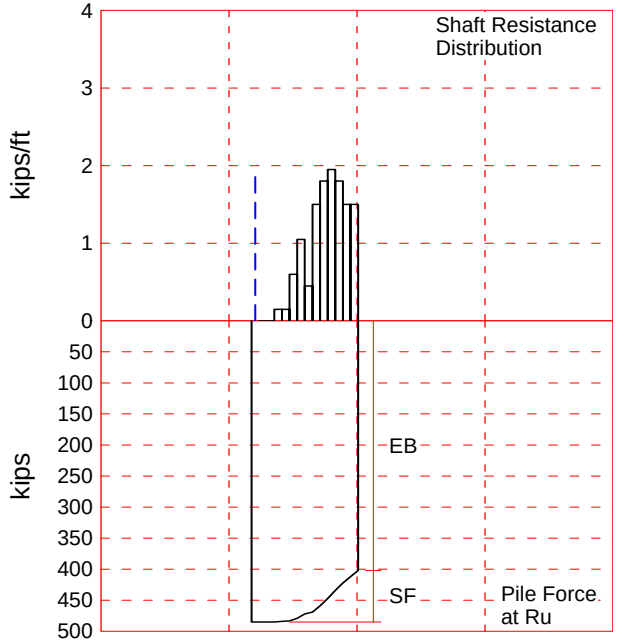
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 11.1 ms
Total volume: 13.895 ft^3; Volume ratio considering added impedance: 1.000







RU =	485.0 kips
SF =	83.0 kips
EB =	402.0 kips
Dy =	1.17 in
Dx =	1.31 in
SET/Bl =	0.14 in



Length b. Sensors	93.3 ft
Embedment	88.0 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	3.84
Top Compr. Stress	26.2 ksi
Max Compr. Stress	26.8 ksi
Max Tension Stress	-4.25 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.28 in
Avg. Shaft Smith Dpg.	0.20 s/ft
Toe Smith Damping	0.10 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 485.0; along Shaft 83.0; at Toe 402.0 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
				485.0				
1	13.3	8.1	0.0	485.0	0.0	0.00	0.00	0.00
2	20.0	14.7	0.0	485.0	0.0	0.00	0.00	0.00
3	26.7	21.4	1.0	484.0	1.0	0.15	0.03	0.20
4	33.3	28.1	1.0	483.0	2.0	0.15	0.03	0.20
5	40.0	34.7	4.0	479.0	6.0	0.60	0.13	0.20
6	46.7	41.4	7.0	472.0	13.0	1.05	0.22	0.20
7	53.3	48.1	3.0	469.0	16.0	0.45	0.10	0.20
8	60.0	54.7	10.0	459.0	26.0	1.50	0.32	0.20
9	66.6	61.4	12.0	447.0	38.0	1.80	0.38	0.20
10	73.3	68.1	13.0	434.0	51.0	1.95	0.42	0.20
11	80.0	74.7	12.0	422.0	63.0	1.80	0.38	0.20
12	86.6	81.4	10.0	412.0	73.0	1.50	0.32	0.20
13	93.3	88.0	10.0	402.0	83.0	1.50	0.32	0.20
Avg. Shaft			6.4			0.94	0.20	0.20
Toe			402.0				291.62	0.10

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.09	0.28
Case Damping Factor		0.44	1.05
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	73
Reloading Level	(% of Ru)	100	100
Soil Plug Weight	(kips)		0.008

CAPWAP match quality = 3.84 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.14 in; Blow Count = 84 b/ft
Computed: Final Set = 0.10 in; Blow Count = 116 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
Not Active A3(K2524) CAL: 360; RF: 1.00; A4(K3550) CAL: 360; RF: 1.10

max. Top Comp. Stress = 26.2 ksi (T= 36.1 ms, max= 1.021 x Top)
max. Comp. Stress = 26.8 ksi (Z= 40.0 ft, T= 38.3 ms)
max. Tens. Stress = -4.25 ksi (Z= 60.0 ft, T= 63.0 ms)
max. Energy (EMX) = 27.7 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	3.3	561.2	-22.7	26.2	-1.06	27.7	13.8	0.98
2	6.7	561.8	-23.7	26.2	-1.11	27.6	13.8	0.97
4	13.3	563.2	-25.3	26.3	-1.18	27.2	13.7	0.93
6	20.0	565.1	-26.5	26.4	-1.24	26.6	13.6	0.89
8	26.7	568.1	-28.7	26.5	-1.34	25.9	13.5	0.84
10	33.3	568.6	-46.7	26.6	-2.18	25.0	13.4	0.80
12	40.0	573.1	-63.4	26.8	-2.96	24.0	13.1	0.75
14	46.7	568.4	-74.2	26.6	-3.47	22.5	12.9	0.69
15	50.0	546.8	-71.4	25.5	-3.34	21.0	12.8	0.67
16	53.3	551.7	-79.7	25.8	-3.72	20.5	12.6	0.64
17	56.6	549.2	-83.1	25.7	-3.88	19.7	12.4	0.61
18	60.0	557.3	-90.9	26.0	-4.25	19.1	12.2	0.59
19	63.3	533.2	-83.6	24.9	-3.90	17.4	11.9	0.56
20	66.6	541.6	-90.4	25.3	-4.22	16.9	11.7	0.53
21	70.0	512.1	-80.2	23.9	-3.75	15.1	11.4	0.50
22	73.3	520.2	-86.3	24.3	-4.03	14.5	11.2	0.47
23	76.6	487.5	-74.6	22.8	-3.48	12.8	11.0	0.44
24	80.0	494.5	-79.6	23.1	-3.72	12.3	11.1	0.42
25	83.3	469.0	-69.4	21.9	-3.24	10.8	12.2	0.39
26	86.6	486.0	-73.8	22.7	-3.45	10.4	13.3	0.36
27	90.0	485.8	-61.9	22.7	-2.89	9.2	13.7	0.34
28	93.3	496.8	-62.0	23.2	-2.89	8.8	12.5	0.31
Absolute	40.0			26.8			(T =	38.3 ms)
	60.0				-4.25		(T =	63.0 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	594.7	494.6	394.5	294.4	194.3					
RX	645.5	597.8	567.7	537.9	511.4	487.6	470.7	456.9	443.0	429.2
RU	594.7	494.6	394.5	294.4	194.3					

RAU = 376.6 (kips); RA2 = 526.3 (kips)

Current CAPWAP Ru = 485.0 (kips); Corresponding J(RP)= 0.22; J(RX) = 1.03

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
13.8	35.88	526.8	568.3	568.3	0.96	0.19	0.14	27.8	604.2	1456

PILE PROFILE AND PILE MODEL

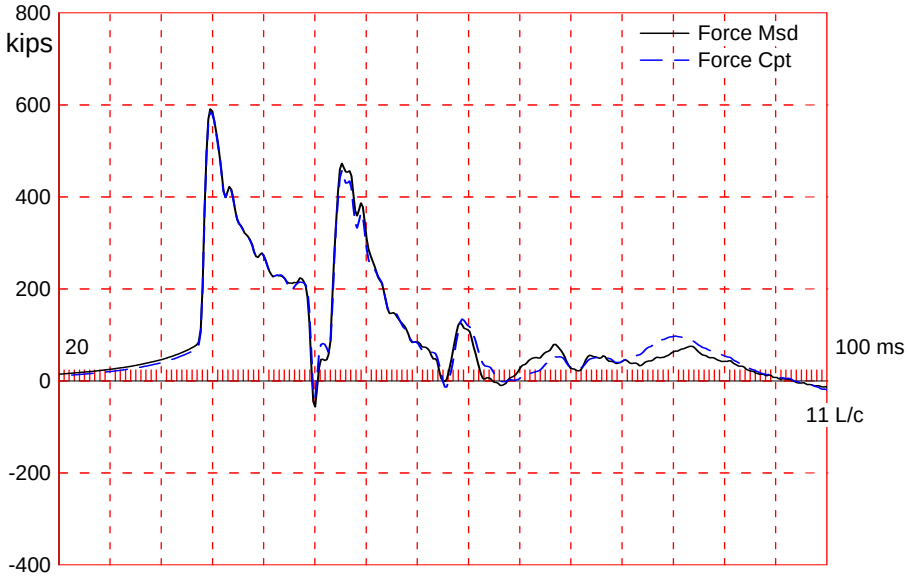
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
93.3	21.4	29992.2	492.000	4.70

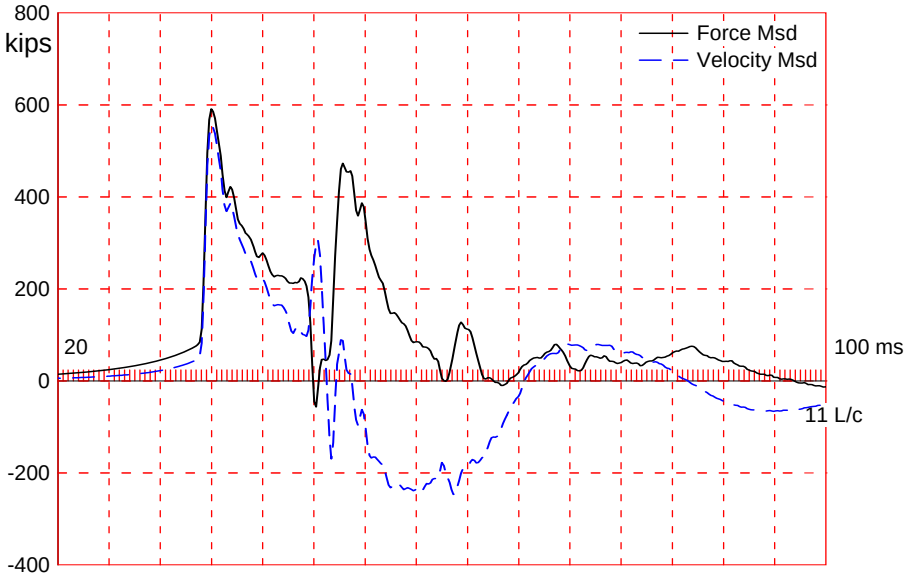
Toe Area 198.5 in^2

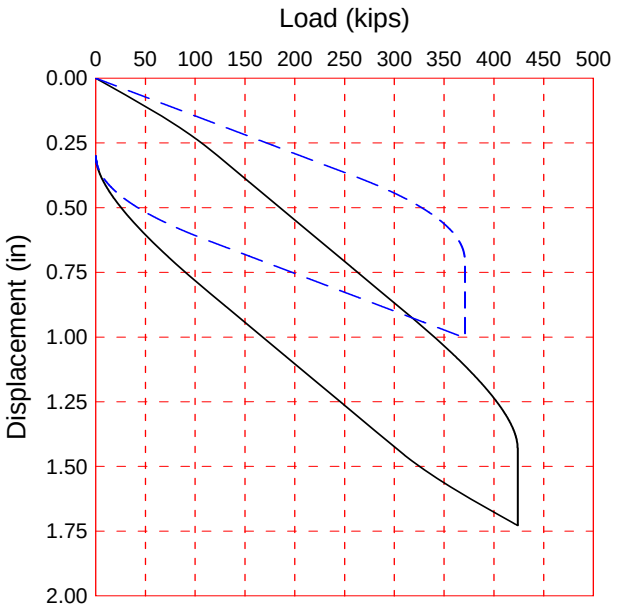
Top Segment Length 3.33 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.198 ms, 2L/c 11.1 ms

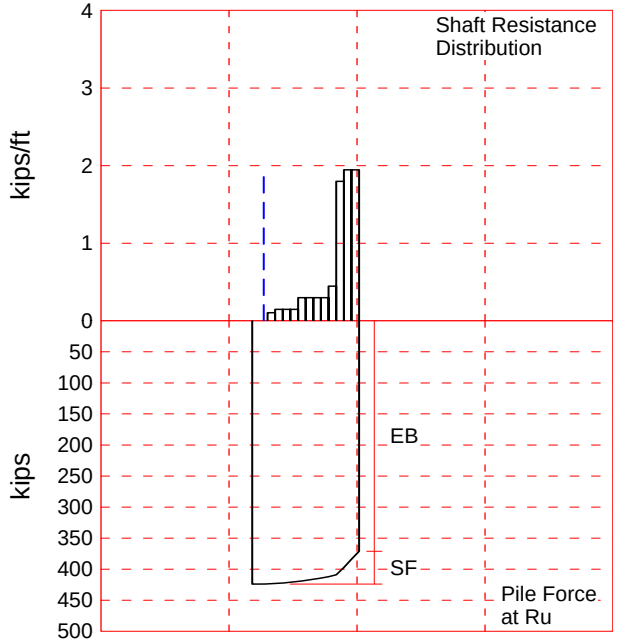
Total volume: 13.865 ft^3; Volume ratio considering added impedance: 1.000







RU =	424.0 kips
SF =	53.0 kips
EB =	371.0 kips
Dy =	1.43 in
Dx =	1.73 in
SET/Bl =	0.30 in



Length b. Sensors	93.5 ft
Embedment	82.9 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	4.38
Top Compr. Stress	27.3 ksi
Max Compr. Stress	27.5 ksi
Max Tension Stress	-5.05 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.54 in
Avg. Shaft Smith Dpg.	0.16 s/ft
Toe Smith Damping	0.07 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 424.0; along Shaft 53.0; at Toe 371.0 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
				424.0			
1	20.0	9.4	1.0	423.0	1.0	0.11	0.02
2	26.7	16.1	1.0	422.0	2.0	0.15	0.03
3	33.4	22.8	1.0	421.0	3.0	0.15	0.03
4	40.1	29.5	1.0	420.0	4.0	0.15	0.03
5	46.8	36.2	2.0	418.0	6.0	0.30	0.06
6	53.4	42.8	2.0	416.0	8.0	0.30	0.06
7	60.1	49.5	2.0	414.0	10.0	0.30	0.06
8	66.8	56.2	2.0	412.0	12.0	0.30	0.06
9	73.5	62.9	3.0	409.0	15.0	0.45	0.10
10	80.1	69.5	12.0	397.0	27.0	1.80	0.38
11	86.8	76.2	13.0	384.0	40.0	1.95	0.41
12	93.5	82.9	13.0	371.0	53.0	1.95	0.41
Avg. Shaft			4.4			0.64	0.14
Toe			371.0				269.14

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.16	0.07
Quake	(in)	0.08	0.54
Case Damping Factor		0.22	0.70
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	63	35
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	93	
Resistance Gap (included in Toe Quake)	(in)		0.03

CAPWAP match quality = 4.38 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.30 in; Blow Count = 40 b/ft
Computed: Final Set = 0.27 in; Blow Count = 44 b/ft
Transducer F3(F607) CAL: 93.6; RF: 0.98; F4(D815) CAL: 93.0; RF: 0.98
A3(K2524) CAL: 360; RF: 1.11; A4(K3550) CAL: 360; RF: 1.11

max. Top Comp. Stress = 27.3 ksi (T= 36.2 ms, max= 1.007 x Top)
max. Comp. Stress = 27.5 ksi (Z= 20.0 ft, T= 37.2 ms)
max. Tens. Stress = -5.05 ksi (Z= 73.5 ft, T= 65.0 ms)
max. Energy (EMX) = 30.1 kip-ft; max. Measured Top Displ. (DMX)= 1.14 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	585.1	-37.5	27.3	-1.75	30.1	14.7	1.16
2	6.7	585.7	-39.1	27.4	-1.83	29.7	14.6	1.14
4	13.4	587.0	-42.5	27.4	-1.99	29.1	14.6	1.11
6	20.0	589.1	-61.6	27.5	-2.88	28.7	14.5	1.08
8	26.7	587.8	-76.7	27.5	-3.59	28.1	14.4	1.04
10	33.4	586.5	-82.7	27.4	-3.87	27.4	14.3	1.00
12	40.1	585.4	-93.5	27.3	-4.37	26.6	14.3	0.96
14	46.8	585.4	-96.2	27.4	-4.50	25.9	14.1	0.92
15	50.1	580.8	-93.4	27.1	-4.36	25.2	14.1	0.90
16	53.4	582.8	-93.2	27.2	-4.35	24.8	14.0	0.88
17	56.8	578.2	-90.0	27.0	-4.21	24.1	14.0	0.85
18	60.1	580.2	-87.9	27.1	-4.11	23.7	13.9	0.83
19	63.4	575.7	-91.6	26.9	-4.28	23.0	13.9	0.80
20	66.8	578.2	-99.4	27.0	-4.64	22.7	13.8	0.78
21	70.1	574.7	-104.2	26.8	-4.87	21.9	13.9	0.76
22	73.5	580.9	-108.1	27.1	-5.05	21.5	14.6	0.73
23	76.8	577.8	-105.4	27.0	-4.93	20.7	14.5	0.71
24	80.1	584.3	-105.4	27.3	-4.92	20.3	15.5	0.68
25	83.5	546.5	-90.3	25.5	-4.22	18.2	17.2	0.66
26	86.8	502.1	-90.1	23.5	-4.21	18.0	18.5	0.63
27	90.2	465.5	-73.5	21.7	-3.43	16.0	19.1	0.61
28	93.5	481.0	-71.9	22.5	-3.36	15.0	18.3	0.58
Absolute	20.0			27.5			(T =	37.2 ms)
	73.5				-5.05		(T =	65.0 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	414.0	266.4	118.8	0.0	0.0					
RX	577.2	535.2	501.8	489.3	476.7	464.1	451.5	443.5	439.3	435.7
RU	414.0	266.4	118.8	0.0	0.0					

RAU = 395.0 (kips); RA2 = 501.9 (kips)

Current CAPWAP Ru = 424.0 (kips); Corresponding J(RP)= 0.00; matches RX20 within 5%

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
14.6	35.96	557.7	594.3	594.3	1.14	0.31	0.30	30.0	502.1	720

PILE PROFILE AND PILE MODEL

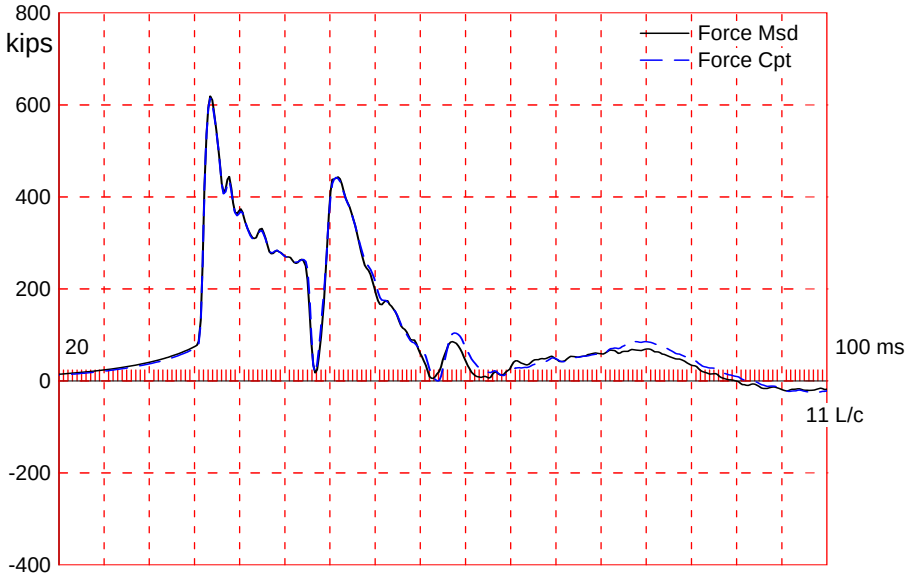
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
93.5	21.4	29992.2	492.000	4.70

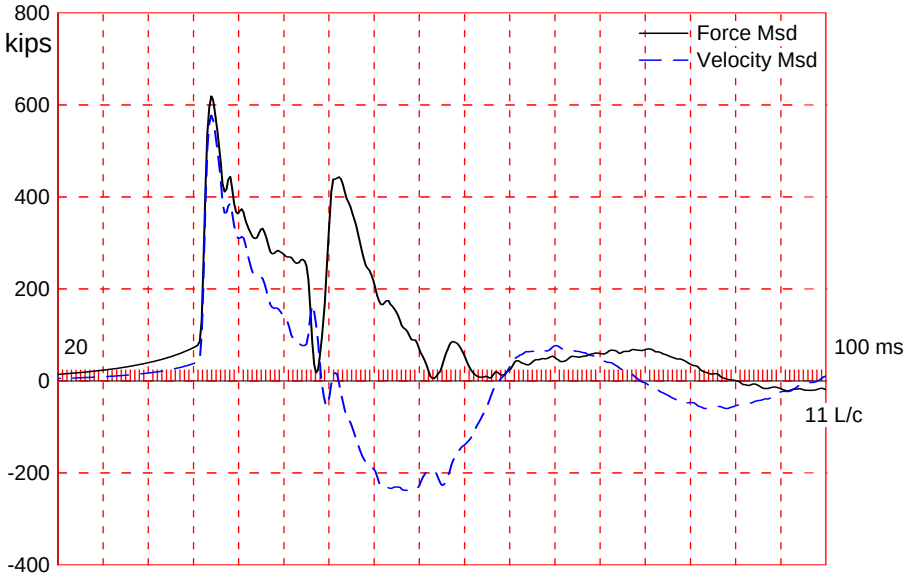
Toe Area 198.5 in^2

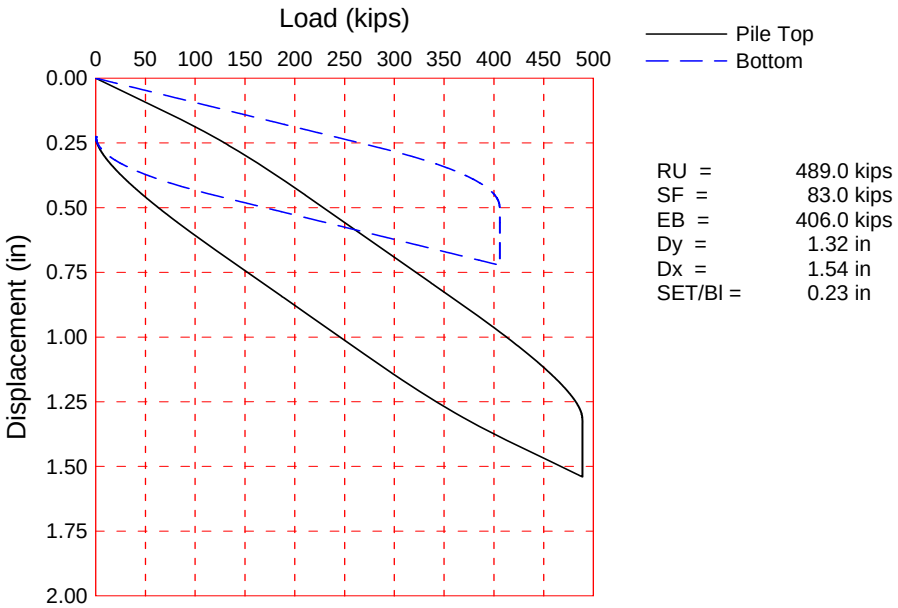
Top Segment Length 3.34 ft, Top Impedance 38 kips/ft/s

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 11.1 ms

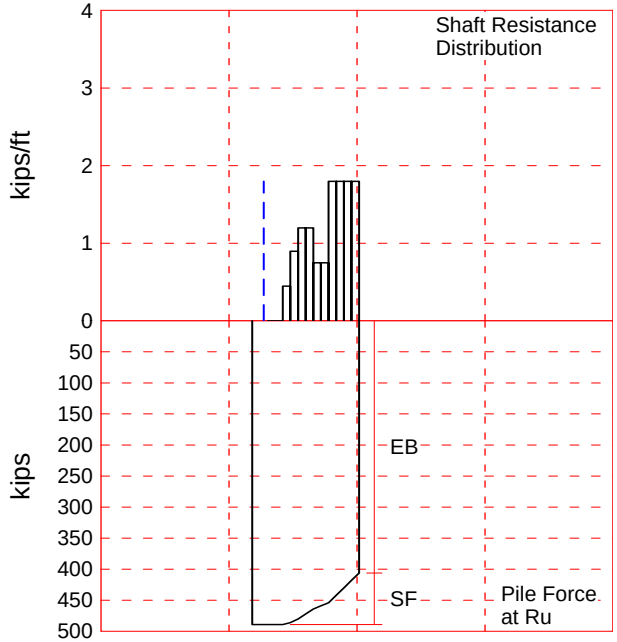
Total volume: 13.895 ft^3; Volume ratio considering added impedance: 1.000







RU =	489.0 kips
SF =	83.0 kips
EB =	406.0 kips
Dy =	1.32 in
Dx =	1.54 in
SET/Bl =	0.23 in



Length b. Sensors	93.5 ft
Embedment	83.1 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	28.7 ksi
Max Compr. Stress	29.3 ksi
Max Tension Stress	-4.52 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.38 in
Avg. Shaft Smith Dpg.	0.18 s/ft
Toe Smith Damping	0.07 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 489.0; along Shaft 83.0; at Toe 406.0 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
				489.0				
1	20.0	9.6	0.0	489.0	0.0	0.00	0.00	0.00
2	26.7	16.3	0.0	489.0	0.0	0.00	0.00	0.00
3	33.4	22.9	3.0	486.0	3.0	0.45	0.10	0.18
4	40.1	29.6	6.0	480.0	9.0	0.90	0.19	0.18
5	46.8	36.3	8.0	472.0	17.0	1.20	0.25	0.18
6	53.4	43.0	8.0	464.0	25.0	1.20	0.25	0.18
7	60.1	49.7	5.0	459.0	30.0	0.75	0.16	0.18
8	66.8	56.3	5.0	454.0	35.0	0.75	0.16	0.18
9	73.5	63.0	12.0	442.0	47.0	1.80	0.38	0.18
10	80.1	69.7	12.0	430.0	59.0	1.80	0.38	0.18
11	86.8	76.4	12.0	418.0	71.0	1.80	0.38	0.18
12	93.5	83.1	12.0	406.0	83.0	1.80	0.38	0.18
Avg. Shaft			6.9			1.00	0.21	0.18
Toe			406.0				294.53	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.10	0.38
Case Damping Factor		0.39	0.79
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	43	

CAPWAP match quality = 2.69 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.19 in; Blow Count = 65 b/ft
Transducer F3(D815) CAL: 93.0; RF: 0.99; F4(F607) CAL: 93.6; RF: 0.99
A3(K3550) CAL: 360; RF: 1.11; A4(K2524) CAL: 360; RF: 1.11

max. Top Comp. Stress = 28.7 ksi (T= 36.2 ms, max= 1.022 x Top)
max. Comp. Stress = 29.3 ksi (Z= 33.4 ft, T= 37.9 ms)
max. Tens. Stress = -4.52 ksi (Z= 66.8 ft, T= 63.8 ms)
max. Energy (EMX) = 31.3 kip-ft; max. Measured Top Displ. (DMX)= 1.04 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	614.9	-28.4	28.7	-1.33	31.3	15.2	1.06
2	6.7	615.5	-30.1	28.8	-1.40	31.2	15.2	1.05
4	13.4	616.8	-31.8	28.8	-1.48	30.9	15.1	1.02
6	20.0	618.3	-37.7	28.9	-1.76	30.4	15.1	0.98
8	26.7	621.2	-49.8	29.0	-2.32	29.7	15.0	0.93
10	33.4	628.2	-63.1	29.3	-2.95	29.1	14.8	0.89
12	40.1	627.6	-68.1	29.3	-3.18	27.7	14.5	0.84
14	46.8	618.1	-74.1	28.9	-3.46	25.9	14.1	0.79
15	50.1	596.6	-75.5	27.9	-3.53	24.2	13.9	0.76
16	53.4	600.9	-83.4	28.1	-3.89	23.7	13.8	0.74
17	56.8	577.6	-83.1	27.0	-3.88	22.1	13.7	0.71
18	60.1	581.3	-90.0	27.2	-4.21	21.7	13.6	0.69
19	63.4	568.6	-94.1	26.6	-4.39	20.5	13.4	0.66
20	66.8	576.6	-96.8	26.9	-4.52	20.0	13.3	0.63
21	70.1	568.7	-93.2	26.6	-4.36	18.8	13.0	0.60
22	73.5	577.1	-93.7	27.0	-4.38	18.3	12.8	0.58
23	76.8	546.6	-84.7	25.5	-3.96	16.4	12.5	0.55
24	80.1	554.8	-85.3	25.9	-3.99	15.9	13.1	0.52
25	83.5	518.7	-76.1	24.2	-3.56	14.2	14.9	0.49
26	86.8	487.4	-75.9	22.8	-3.55	13.7	16.4	0.47
27	90.2	487.1	-66.6	22.8	-3.11	12.0	17.0	0.44
28	93.5	498.1	-66.2	23.3	-3.09	11.3	15.7	0.42
Absolute	33.4			29.3			(T =	37.9 ms)
	66.8				-4.52		(T =	63.8 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	572.6	509.3	446.0	382.7	319.4	256.1	192.8	129.5	66.2	2.9
RX	629.7	608.5	588.3	568.1	547.9	529.7	515.2	504.7	495.0	485.2
RU	572.6	509.3	446.0	382.7	319.4	256.1	192.8	129.5	66.2	2.9

RAU = 379.1 (kips); RA2 = 530.6 (kips)

Current CAPWAP Ru = 489.0 (kips); Corresponding J(RP)= 0.13; J(RX) = 0.86

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
15.2	35.96	580.2	625.4	625.4	1.04	0.23	0.23	31.4	594.3	1060

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
93.5	21.4	29992.2	492.000	4.70

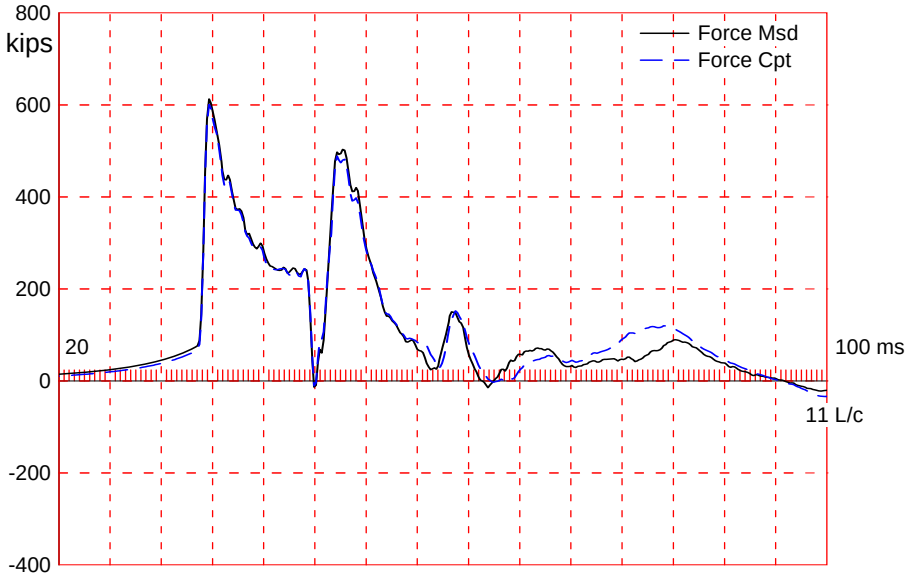
Toe Area 198.5 in^2

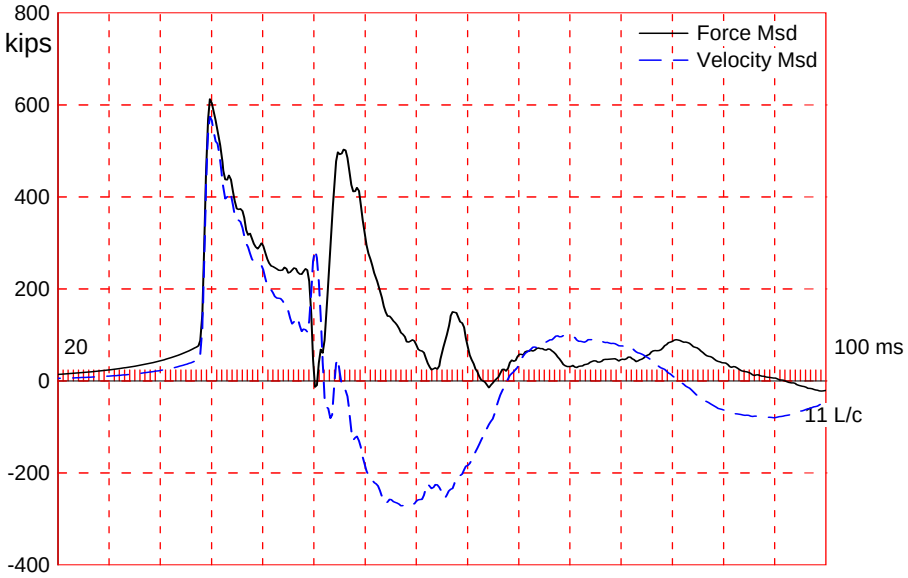
Top Segment Length 3.34 ft, Top Impedance 38 kips/ft/s

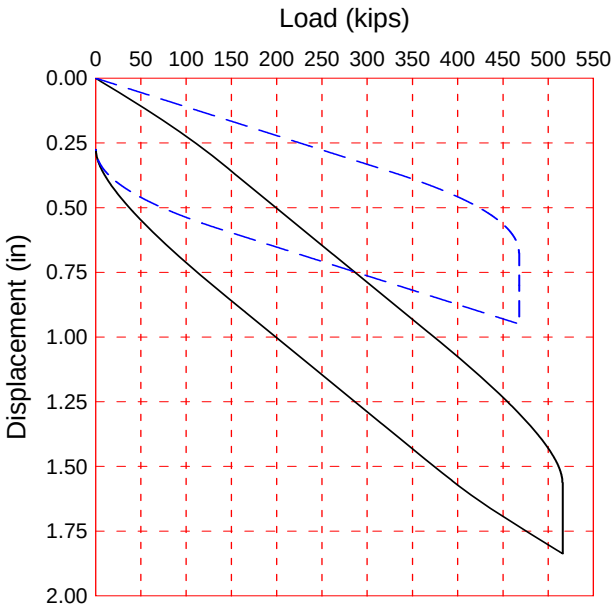
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 11.1 ms

Total volume: 13.895 ft^3; Volume ratio considering added impedance: 1.000

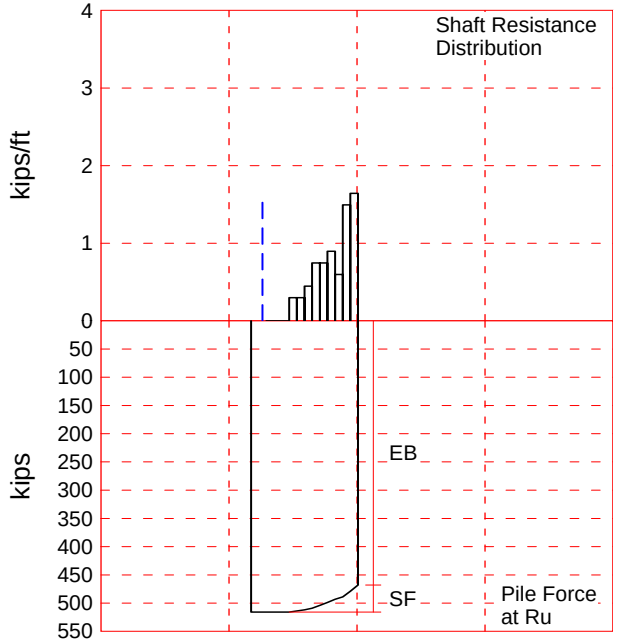
Match Quality Poor - Results May Be Unreliable!!!







RU =	516.0 kips
SF =	48.0 kips
EB =	468.0 kips
Dy =	1.56 in
Dx =	1.84 in
SET/Bl =	0.27 in



Length b. Sensors	93.7 ft
Embedment	82.0 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	5.16
Top Compr. Stress	28.1 ksi
Max Compr. Stress	28.2 ksi
Max Tension Stress	-5.19 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.52 in
Avg. Shaft Smith Dpg.	0.18 s/ft
Toe Smith Damping	0.07 s/ft

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Match Quality Poor - Results May Be Unreliable!!!

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 516.0; along Shaft 48.0; at Toe 468.0 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
				516.0				
1	20.1	8.4	0.0	516.0	0.0	0.00	0.00	0.00
2	26.8	15.1	0.0	516.0	0.0	0.00	0.00	0.00
3	33.5	21.8	0.0	516.0	0.0	0.00	0.00	0.00
4	40.1	28.5	2.0	514.0	2.0	0.30	0.06	0.18
5	46.8	35.2	2.0	512.0	4.0	0.30	0.06	0.18
6	53.5	41.9	3.0	509.0	7.0	0.45	0.10	0.18
7	60.2	48.5	5.0	504.0	12.0	0.75	0.16	0.18
8	66.9	55.2	5.0	499.0	17.0	0.75	0.16	0.18
9	73.6	61.9	6.0	493.0	23.0	0.90	0.19	0.18
10	80.3	68.6	4.0	489.0	27.0	0.60	0.13	0.18
11	87.0	75.3	10.0	479.0	37.0	1.49	0.32	0.18
12	93.7	82.0	11.0	468.0	48.0	1.64	0.35	0.18
Avg. Shaft			4.0			0.59	0.12	0.18
Toe			468.0				339.50	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.09	0.52
Case Damping Factor		0.22	0.92
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	30
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.07
Soil Plug Weight	(kips)	0.025	

CAPWAP match quality = 5.16 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.27 in; Blow Count = 44 b/ft
Computed: Final Set = 0.24 in; Blow Count = 51 b/ft

Transducer F3(D815) CAL: 93.0; RF: 0.98; F4(F607) CAL: 93.6; RF: 0.98
A3(K3550) CAL: 360; RF: 1.12; A4(K2524) CAL: 360; RF: 1.12

max. Top Comp. Stress = 28.1 ksi (T= 36.0 ms, max= 1.003 x Top)
max. Comp. Stress = 28.2 ksi (Z= 40.1 ft, T= 38.2 ms)
max. Tens. Stress = -5.19 ksi (Z= 66.9 ft, T= 63.7 ms)
max. Energy (EMX) = 33.0 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	3.3	600.9	-41.4	28.1	-1.93	33.0	15.3	1.22
2	6.7	600.8	-43.4	28.1	-2.03	32.9	15.3	1.21
4	13.4	600.7	-60.1	28.1	-2.81	32.5	15.3	1.17
6	20.1	600.6	-80.8	28.1	-3.77	31.9	15.2	1.13
8	26.8	600.4	-89.6	28.1	-4.19	31.3	15.2	1.09
10	33.5	600.6	-91.4	28.1	-4.27	30.5	15.1	1.04
12	40.1	602.6	-90.9	28.2	-4.25	29.8	15.0	0.99
14	46.8	597.2	-88.5	27.9	-4.13	28.5	14.9	0.94
15	50.2	592.3	-85.4	27.7	-3.99	27.6	14.9	0.92
16	53.5	597.5	-90.9	27.9	-4.25	27.2	14.7	0.89
17	56.9	592.6	-98.0	27.7	-4.58	26.1	14.6	0.86
18	60.2	597.3	-108.0	27.9	-5.04	25.6	14.4	0.84
19	63.6	585.0	-110.2	27.3	-5.15	24.2	14.3	0.81
20	66.9	589.6	-111.2	27.5	-5.19	23.7	14.1	0.78
21	70.3	577.7	-107.1	27.0	-5.00	22.3	14.1	0.75
22	73.6	581.1	-107.7	27.1	-5.03	21.6	15.2	0.72
23	76.9	566.1	-99.7	26.4	-4.66	20.1	15.2	0.69
24	80.3	580.5	-99.4	27.1	-4.65	19.5	15.9	0.66
25	83.6	567.2	-94.5	26.5	-4.42	18.3	17.6	0.63
26	87.0	541.4	-94.6	25.3	-4.42	17.6	18.5	0.60
27	90.3	553.6	-81.2	25.9	-3.79	15.7	19.4	0.57
28	93.7	572.2	-81.1	26.7	-3.79	14.8	18.3	0.54
Absolute	40.1			28.2			(T =	38.2 ms)
	66.9				-5.19		(T =	63.7 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	458.4	311.2	164.0	16.8	0.0					
RX	650.3	608.5	583.2	563.3	551.4	547.4	544.6	541.8	539.0	537.1
RU	458.4	311.2	164.0	16.8	0.0					

RAU = 436.5 (kips); RA2 = 568.8 (kips)

Current CAPWAP Ru = 516.0 (kips); Corresponding J(RP)= 0.00; matches RX20 within 5%

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
15.1	35.83	577.7	616.8	618.1	1.18	0.35	0.27	33.0	545.7	1033

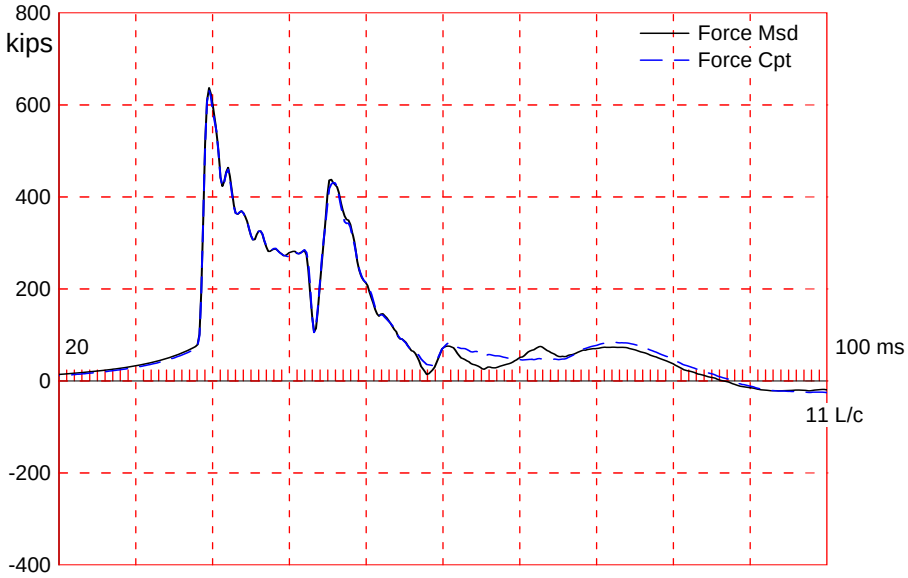
PILE PROFILE AND PILE MODEL

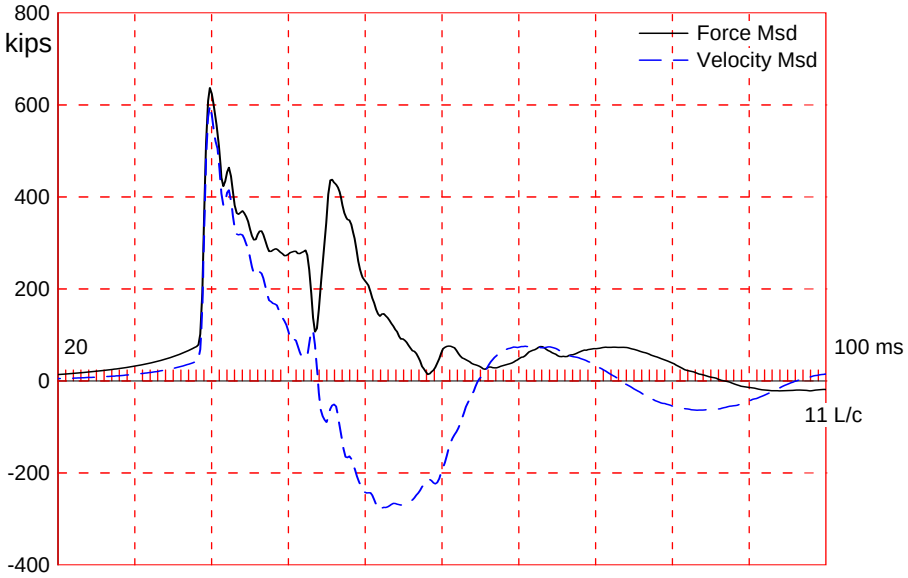
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
93.7	21.4	29992.2	492.000	4.70

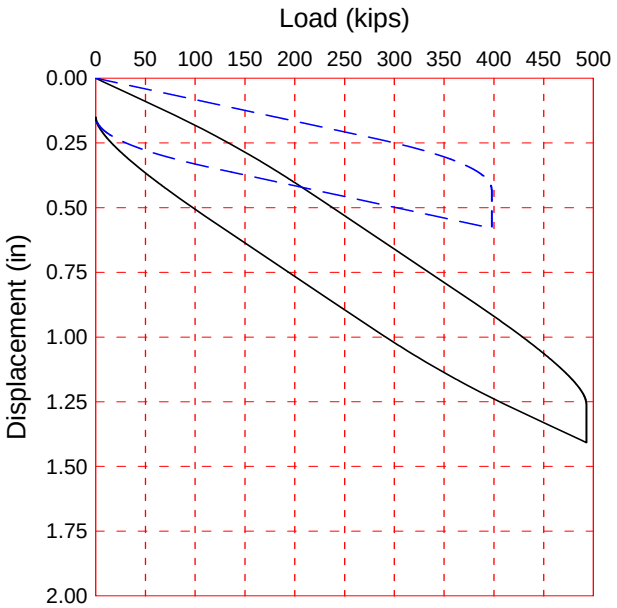
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
26	87.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.025
27	90.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	93.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

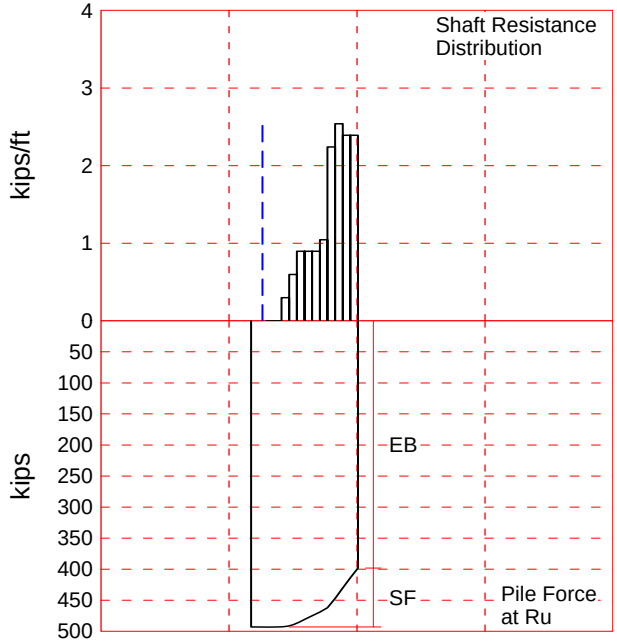
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 11.1 ms
Total volume: 13.920 ft^3; Volume ratio considering added impedance: 1.000







RU =	493.0 kips
SF =	95.0 kips
EB =	398.0 kips
Dy =	1.26 in
Dx =	1.41 in
SET/Bl =	0.15 in



Length b. Sensors	93.7 ft
Embedment	82.0 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	2.45
Top Compr. Stress	29.6 ksi
Max Compr. Stress	30.1 ksi
Max Tension Stress	-3.42 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.33 in
Avg. Shaft Smith Dpg.	0.21 s/ft
Toe Smith Damping	0.14 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 493.0; along Shaft 95.0; at Toe 398.0 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
				493.0				
1	20.1	8.4	0.0	493.0	0.0	0.00	0.00	0.00
2	26.8	15.1	0.0	493.0	0.0	0.00	0.00	0.00
3	33.5	21.8	2.0	491.0	2.0	0.30	0.06	0.21
4	40.1	28.5	4.0	487.0	6.0	0.60	0.13	0.21
5	46.8	35.2	6.0	481.0	12.0	0.90	0.19	0.21
6	53.5	41.9	6.0	475.0	18.0	0.90	0.19	0.21
7	60.2	48.6	6.0	469.0	24.0	0.90	0.19	0.21
8	66.9	55.3	7.0	462.0	31.0	1.05	0.22	0.21
9	73.6	62.0	15.0	447.0	46.0	2.24	0.48	0.21
10	80.3	68.7	17.0	430.0	63.0	2.54	0.54	0.21
11	87.0	75.3	16.0	414.0	79.0	2.39	0.51	0.21
12	93.7	82.0	16.0	398.0	95.0	2.39	0.51	0.21
Avg. Shaft			7.9			1.16	0.25	0.21
Toe			398.0				288.72	0.14

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.09	0.33
Case Damping Factor		0.52	1.41
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	89
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.02
Soil Plug Weight	(kips)	0.010	0.018

CAPWAP match quality = 2.45 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.11 in; Blow Count = 105 b/ft
Transducer F3(D815) CAL: 93.0; RF: 0.99; F4(F607) CAL: 93.6; RF: 0.99
A3(K3550) CAL: 360; RF: 1.11; A4(K2524) CAL: 360; RF: 1.11

max. Top Comp. Stress = 29.6 ksi (T= 36.0 ms, max= 1.017 x Top)
max. Comp. Stress = 30.1 ksi (Z= 33.5 ft, T= 37.8 ms)
max. Tens. Stress = -3.42 ksi (Z= 73.6 ft, T= 63.7 ms)
max. Energy (EMX) = 32.5 kip-ft; max. Measured Top Displ. (DMX)= 1.04 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	634.3	-27.7	29.6	-1.29	32.5	15.7	1.05
2	6.7	635.0	-27.6	29.7	-1.29	32.4	15.7	1.04
4	13.4	636.3	-30.8	29.7	-1.44	31.9	15.6	1.00
6	20.1	637.7	-34.8	29.8	-1.62	31.3	15.6	0.96
8	26.8	640.0	-38.3	29.9	-1.79	30.6	15.5	0.91
10	33.5	645.3	-41.6	30.1	-1.94	29.8	15.3	0.86
12	40.1	645.3	-54.1	30.1	-2.53	28.5	15.1	0.81
14	46.8	639.6	-64.0	29.9	-2.99	26.8	14.7	0.76
15	50.2	621.5	-60.7	29.0	-2.84	25.3	14.5	0.73
16	53.5	626.1	-67.0	29.2	-3.13	24.8	14.4	0.70
17	56.9	608.4	-63.7	28.4	-2.98	23.3	14.2	0.67
18	60.2	613.3	-70.0	28.7	-3.27	22.7	14.1	0.64
19	63.6	596.8	-67.6	27.9	-3.16	21.3	13.9	0.61
20	66.9	604.0	-72.9	28.2	-3.40	20.7	13.7	0.58
21	70.3	590.2	-68.0	27.6	-3.17	19.2	13.3	0.55
22	73.6	601.4	-73.1	28.1	-3.42	18.6	13.0	0.52
23	76.9	562.9	-57.1	26.3	-2.67	16.3	12.6	0.49
24	80.3	576.6	-61.8	26.9	-2.89	15.7	12.2	0.46
25	83.6	527.3	-44.2	24.6	-2.06	13.6	13.4	0.43
26	87.0	533.1	-48.5	24.9	-2.26	13.1	14.5	0.41
27	90.3	522.4	-32.5	24.4	-1.52	11.2	15.2	0.38
28	93.7	541.3	-36.2	25.3	-1.69	10.3	13.9	0.35
Absolute	33.5			30.1			(T =	37.8 ms)
	73.6				-3.42		(T =	63.7 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	647.4	528.0	408.6	289.3	169.9					
RX	716.7	647.8	600.3	562.0	541.3	526.1	510.8	495.6	480.4	465.1
RU	647.4	528.0	408.6	289.3	169.9					

RAU = 374.2 (kips); RA2 = 545.0 (kips)

Current CAPWAP Ru = 493.0 (kips); Corresponding J(RP)= 0.26; J(RX) = 1.43

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
15.8	35.83	603.6	640.6	640.6	1.04	0.15	0.15	32.7	661.6	1262

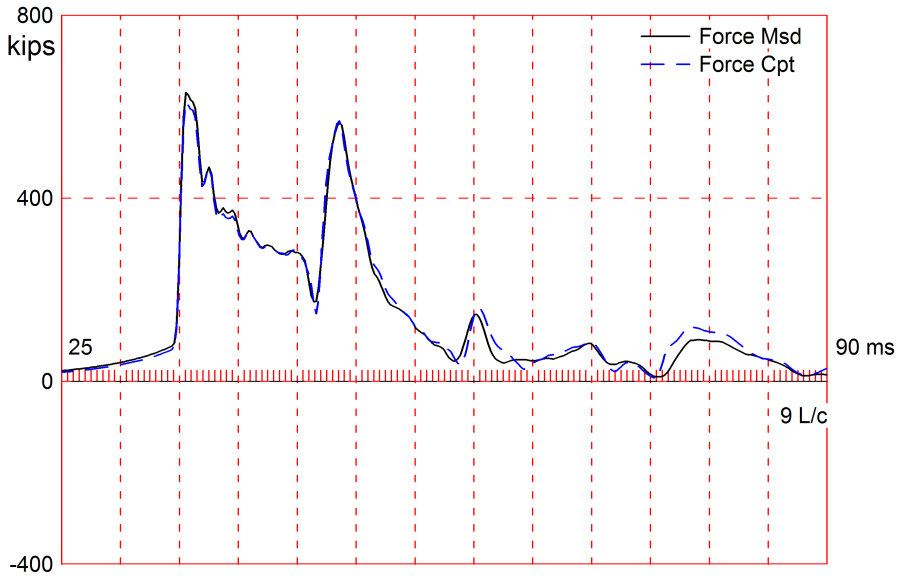
PILE PROFILE AND PILE MODEL

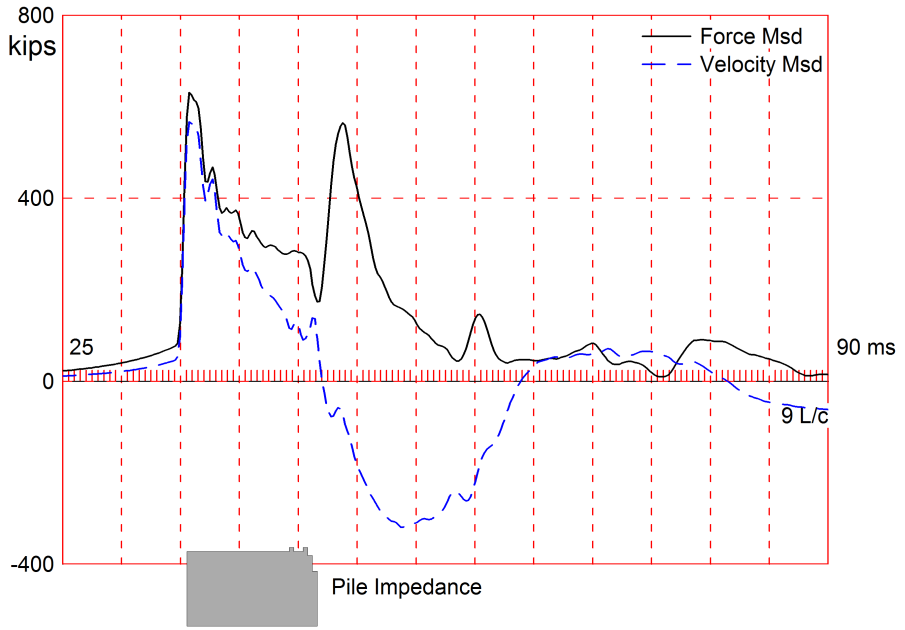
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
93.7	21.4	29992.2	492.000	4.70

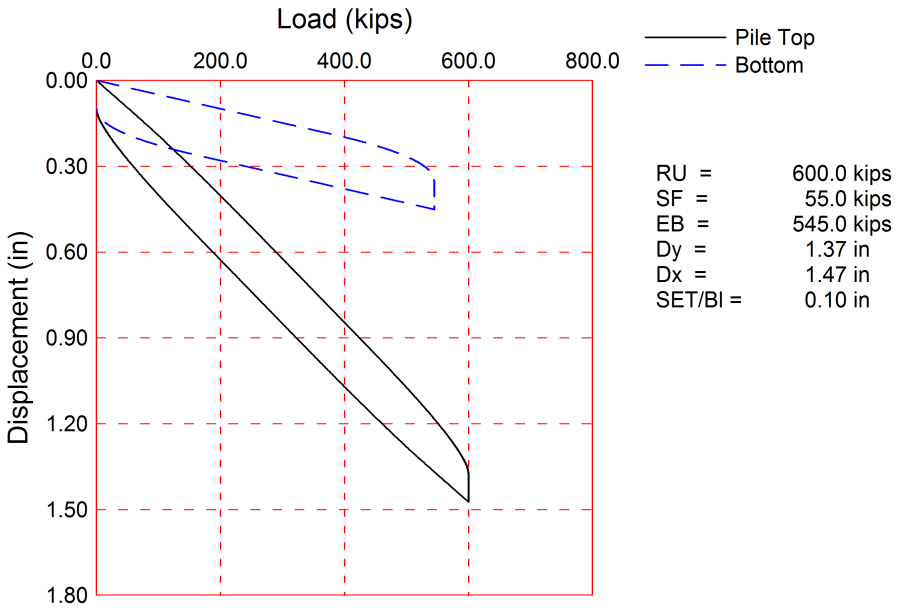
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
26	87.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
27	90.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	93.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

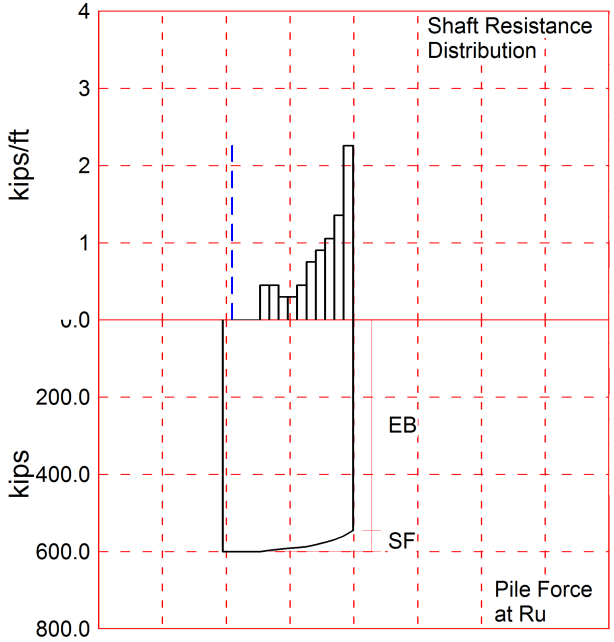
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 11.1 ms
Total volume: 13.920 ft^3; Volume ratio considering added impedance: 1.000







RU =	600.0 kips
SF =	55.0 kips
EB =	545.0 kips
Dy =	1.37 in
Dx =	1.47 in
SET/Bl =	0.10 in



Length b. Sensors	92.9 ft
Embedment	83.6 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	3.90
Top Compr. Stress	28.4 ksi
Max Compr. Stress	32.3 ksi
Max Tension Stress	-4.60 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.27 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.10 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 600.0; along Shaft 55.0; at Toe 545.0 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
				600.0					
1	13.3	3.9	0.0	600.0	0.0	0.00	0.00	0.00	0.10
2	19.9	10.6	0.0	600.0	0.0	0.00	0.00	0.00	0.10
3	26.5	17.2	0.0	600.0	0.0	0.00	0.00	0.00	0.10
4	33.2	23.8	3.0	597.0	3.0	0.45	0.10	0.30	0.10
5	39.8	30.5	3.0	594.0	6.0	0.45	0.10	0.30	0.10
6	46.5	37.1	2.0	592.0	8.0	0.30	0.06	0.30	0.10
7	53.1	43.7	2.0	590.0	10.0	0.30	0.06	0.30	0.10
8	59.7	50.4	3.0	587.0	13.0	0.45	0.10	0.30	0.10
9	66.4	57.0	5.0	582.0	18.0	0.75	0.16	0.30	0.10
10	73.0	63.6	6.0	576.0	24.0	0.90	0.19	0.30	0.10
11	79.6	70.3	7.0	569.0	31.0	1.05	0.22	0.30	0.10
12	86.3	76.9	9.0	560.0	40.0	1.36	0.29	0.30	0.10
13	92.9	83.6	15.0	545.0	55.0	2.26	0.48	0.30	0.10
Avg. Shaft			4.2			0.66	0.14	0.30	0.10
Toe			545.0				395.36	0.10	0.27

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		0.43	1.43
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	94	44
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	93	
Resistance Gap (included in Toe Quake)	(in)		0.05
Soil Plug Weight	(kips)		0.142

CAPWAP match quality = 3.90 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.05 in; Blow Count = 252 b/ft
Transducer F3(F607) CAL: 93.6; RF: 0.97; F4(D815) CAL: 93.0; RF: 0.97
A3(K2524) CAL: 360; RF: 1.13; A4(K3550) CAL: 360; RF: 1.10

max. Top Comp. Stress = 28.4 ksi (T= 35.9 ms, max= 1.137 x Top)
max. Comp. Stress = 32.3 ksi (Z= 92.9 ft, T= 42.1 ms)
max. Tens. Stress = -4.60 ksi (Z= 46.5 ft, T= 61.8 ms)
max. Energy (EMX) = 34.4 kip-ft; max. Measured Top Displ. (DMX)= 1.10 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	608.3	-27.1	28.4	-1.27	34.4	15.4	1.14
2	6.6	608.3	-29.0	28.4	-1.35	34.2	15.4	1.12
4	13.3	608.3	-32.7	28.4	-1.53	33.6	15.4	1.08
6	19.9	608.3	-39.2	28.4	-1.83	32.8	15.3	1.03
8	26.5	609.8	-40.6	28.5	-1.90	31.9	15.2	0.98
10	33.2	616.8	-44.5	28.8	-2.08	31.0	15.0	0.93
12	39.8	613.6	-80.5	28.7	-3.76	29.1	14.7	0.87
14	46.5	606.8	-98.5	28.3	-4.60	27.1	14.4	0.81
15	49.8	600.6	-95.3	28.1	-4.45	26.0	14.3	0.78
16	53.1	604.6	-92.0	28.2	-4.30	25.3	14.2	0.75
17	56.4	599.5	-86.1	28.0	-4.02	24.0	14.0	0.71
18	59.7	604.5	-89.7	28.2	-4.19	23.3	13.9	0.68
19	63.1	598.5	-88.3	28.0	-4.12	21.9	13.7	0.64
20	66.4	607.6	-87.8	28.4	-4.10	21.0	13.5	0.61
21	69.7	603.9	-77.5	28.2	-3.62	19.3	13.1	0.57
22	73.0	626.4	-73.1	29.3	-3.41	18.3	13.1	0.53
23	76.3	636.2	-61.7	29.7	-2.88	16.4	12.8	0.50
24	79.6	633.0	-59.9	29.6	-2.80	15.5	12.7	0.46
25	83.0	665.0	-45.0	31.1	-2.10	13.7	13.3	0.42
26	86.3	673.8	-45.4	31.5	-2.12	12.8	13.8	0.39
27	89.6	680.6	-30.3	31.8	-1.41	10.9	14.1	0.35
28	92.9	691.8	-28.4	32.3	-1.33	9.6	13.4	0.30
Absolute	92.9			32.3			(T =	42.1 ms)
	46.5				-4.60		(T =	61.8 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	673.2	565.3	457.4	349.5	241.6					
RX	800.7	756.1	730.9	705.7	680.5	655.4	635.4	617.5	599.6	587.3
RU	673.2	565.3	457.4	349.5	241.6					

RAU = 460.7 (kips); RA2 = 679.3 (kips)

Current CAPWAP Ru = 600.0 (kips); Corresponding J(RP)= 0.14; J(RX) = 1.60

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
15.0	35.74	571.2	641.5	641.5	1.10	0.10	0.10	34.5	688.9	2477

Possible Pile Damage at 0.9 L Below Gages?

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
92.9	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
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9
23	76.3	40.20	5.24	0.00	0.000	-0.00	0.000	4.70	16807.9
24	79.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9
26	86.3	40.20	5.24	0.00	0.000	-0.00	0.000	4.70	16807.9
27	89.6	36.20	-5.24	0.00	0.000	-0.00	0.000	4.70	16807.9
28	92.9	28.20	-26.18	0.00	0.000	-0.00	0.000	4.70	16807.9

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 11.1 ms
Total volume: 13.705 ft^3; Volume ratio considering added impedance: 0.993

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Travis Coleman
Company: Lunda Construction Co.	No. of Sheets: 64
E-mail: kweber@lundaconstruction.com	Date: April 23, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 12
Winnebago County, Wisconsin

On April 21, 2015, Pier 12 #1, Pier 12 #16, Pier 12 #23, and Pier 12 #56 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on April 22. Project plans indicated the exterior row piles have a required driving resistance, or ultimate capacity, of 400 kips (200 tons) and the interior row piles have a required driving resistance of 350 kips (175 tons). The reference elevation for the piles was the top of the ring at EL 740.3 to EL 739.4. We understand the pier was excavated to an elevation of EL 717.2. The piles have a required minimum tip elevation of EL 658.8. 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 12 #1 was driven to a depth of 88.4 feet, which corresponds to a pile tip elevation of EL 651.8. The blow count over the final increment of driving was 10 blows for 2 ½ inches of penetration at an average hammer stroke of 8.6 feet. The blow count at the beginning of restrike was 10 blows for 1 ½ inches of penetration at an average hammer stroke of 8.8 feet.

Pier 12 #16 was driven to a depth of 88.0 feet, which corresponds to a pile tip elevation of EL 652.3. The blow count over the final increment of driving was 10 blows for 4 inches of penetration at an average hammer stroke of 7.7 feet. The blow count at the beginning of restrike was 10 blows for 3 inches of penetration at an average hammer stroke of 8.2 feet.

Pier 12 #23 was driven to a depth of 88.0 feet, which corresponds to a pile tip elevation of EL 652.3. The blow count over the final increment of driving was 10 blows for 2 ½ inches of penetration at an average hammer stroke of 8.9 feet. The blow count at the beginning of restrike was 10 blows for 1 ½ inches of penetration at an average hammer stroke of 8.5 feet.

Pier 12 #56 was driven to a depth of 81.6 feet, which corresponds to a pile tip elevation of EL 657.8. The blow count over the final increment of driving was 10 blows for 3 inches of penetration at an average hammer stroke of 9.0 feet. The blow count at the beginning of restrike was 10 blows for 2 ½ inches of penetration at an average hammer stroke of 8.3 feet.

We recommend the production piles at Pier 12 of Structure B-70-403, driven with the APE D30-42 hammer PD0256, obtain the minimum recommended blow count, noted below, based on the field observed hammer stroke. We recommend maintaining the minimum blow count for **two consecutive inches** of driving at the recommended average hammer stroke. Additionally, all production piles should achieve the minimum pile tip elevation of EL 658.8 for uplift, as indicated on the plans.

Field Observed Hammer Stroke (feet)	Exterior Piles (400 kips) Recommended Minimum Blow Count (blows per inch)	Interior Piles (350 kips) Recommended Minimum Blow Count (blows per inch)
6.5	4	3
7.0	4	3
7.5	4	3
8.0	3	3
8.5	3	3
9.0	3	3

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.

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.

Travis Coleman, P.E.

Rory Flynn, E.I.

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

Attachments:

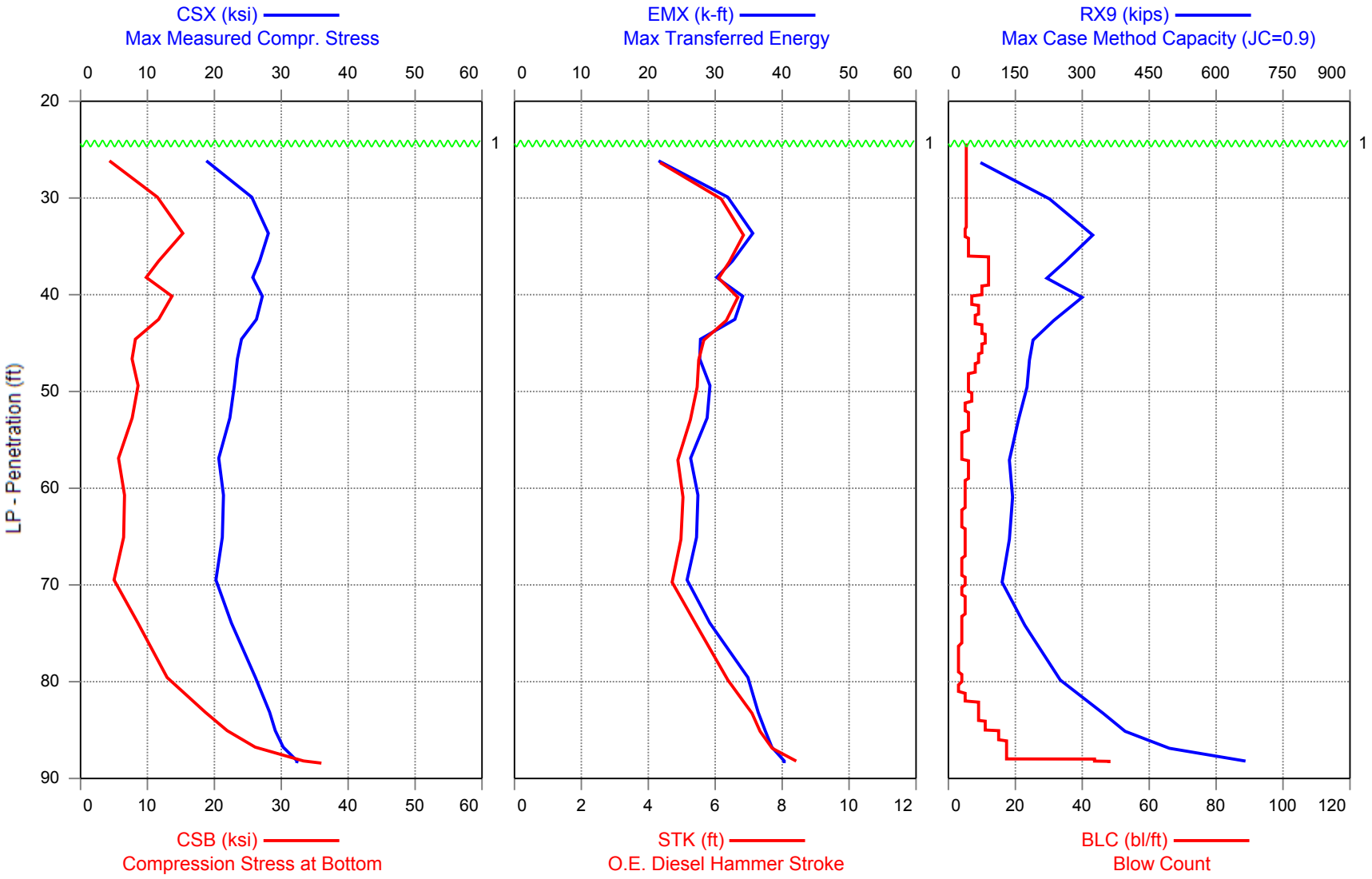
Dynamic Test Results - (pages 3 – 36)
CAPWAP Analysis Results - (pages 37 – 64)

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 21-April-2015

Test started: 21-April-2015

USH 10 over LLBDM - PIER 12 #1
APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.25

USH 10 over LLBDM - PIER 12 #1 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.66 ft EM: 30,000 ksi
WS: 16,807.9 f/s 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#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
48	33.00	5	AV47	23.1	9.1	5.5	28	51.1	169
			MAX	28.8	17.3	7.0	37	68.4	334
			MIN	10.9	2.1	2.8	10	44.4	0
53	34.00	5	AV5	28.1	15.8	6.9	36	44.8	330
			MAX	28.8	16.6	7.1	38	45.3	332
			MIN	27.6	14.9	6.8	35	44.1	326
59	35.00	6	AV6	27.9	14.6	6.8	36	45.2	322
			MAX	28.9	15.3	7.1	38	46.0	333
			MIN	26.7	13.7	6.5	33	44.3	311
65	36.00	6	AV6	27.7	14.0	6.7	35	45.6	298
			MAX	29.1	14.8	7.1	38	46.4	319
			MIN	26.8	13.0	6.4	32	44.2	281
77	37.00	12	AV12	26.7	11.3	6.4	32	46.4	259
			MAX	27.6	12.7	6.7	35	47.0	293
			MIN	26.0	10.0	6.3	31	45.4	237
89	38.00	12	AV12	26.4	11.0	6.3	32	46.8	253
			MAX	27.2	11.4	6.5	33	47.5	265
			MIN	25.6	10.2	6.1	30	46.1	238
101	39.00	12	AV12	25.3	9.1	6.0	29	47.9	201
			MAX	26.6	10.9	6.4	31	48.5	231
			MIN	24.8	8.3	5.9	28	46.6	178
111	40.00	10	AV10	26.6	12.5	6.4	33	46.4	272
			MAX	28.1	14.9	6.9	35	48.3	326
			MIN	25.0	9.3	5.9	31	44.8	211
118	41.00	7	AV7	27.7	15.1	6.9	35	44.9	324
			MAX	28.2	15.6	7.1	37	45.8	336
			MIN	26.8	14.3	6.6	34	44.3	306
127	42.00	9	AV9	26.9	13.7	6.6	34	45.9	287
			MAX	28.1	14.5	6.9	37	46.7	313
			MIN	25.8	12.8	6.3	32	44.7	258
135	43.00	8	AV8	26.5	11.8	6.4	34	46.5	238
			MAX	27.0	13.0	6.5	36	47.7	254
			MIN	25.6	10.7	6.1	32	46.0	224
145	44.00	10	AV10	25.4	9.3	6.0	31	47.8	201
			MAX	26.7	10.5	6.4	33	50.0	227
			MIN	23.3	8.4	5.5	27	46.4	180

USH 10 over LLBDM - PIER 12 #1 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
156	45.00	11	AV11	23.9	8.0	5.6	27	49.4	189
			MAX	24.4	8.9	5.8	28	49.8	200
			MIN	23.4	7.2	5.5	26	48.9	178
166	46.00	10	AV10	23.8	8.2	5.6	27	49.5	190
			MAX	24.3	8.6	5.7	28	49.7	203
			MIN	23.4	7.7	5.6	26	49.0	179
175	47.00	9	AV9	23.6	7.7	5.5	28	49.8	186
			MAX	24.6	8.2	5.8	30	51.0	194
			MIN	22.5	7.2	5.3	25	48.8	178
183	48.00	8	AV8	22.9	7.8	5.4	27	50.4	177
			MAX	23.7	8.4	5.6	29	51.8	190
			MIN	21.8	7.3	5.1	25	49.4	168
189	49.00	6	AV6	22.8	8.8	5.4	29	50.4	174
			MAX	23.3	9.0	5.5	30	50.9	196
			MIN	22.2	8.3	5.3	28	49.8	161
195	50.00	6	AV6	23.1	8.5	5.5	30	50.2	175
			MAX	24.2	8.8	5.7	32	51.0	185
			MIN	22.2	8.2	5.3	27	49.1	169
202	51.00	7	AV7	23.2	8.6	5.5	29	50.0	178
			MAX	24.1	9.4	5.8	30	50.8	186
			MIN	22.4	8.0	5.3	27	48.9	170
207	52.00	5	AV5	23.0	8.7	5.4	30	50.2	172
			MAX	23.7	9.2	5.6	32	51.2	196
			MIN	22.0	8.3	5.2	28	49.7	157
213	53.00	6	AV6	22.6	8.3	5.4	29	50.6	162
			MAX	23.2	8.8	5.5	30	51.0	169
			MIN	22.2	7.3	5.3	28	49.8	152
219	54.00	6	AV6	21.7	6.7	5.1	28	51.6	153
			MAX	22.4	7.4	5.4	29	52.9	162
			MIN	20.7	6.2	4.9	26	50.6	147
223	55.00	4	AV4	20.8	6.2	4.9	28	52.7	128
			MAX	21.8	6.6	5.1	29	53.6	136
			MIN	20.0	5.6	4.7	26	51.7	116
227	56.00	4	AV4	20.6	5.9	4.9	28	53.0	126
			MAX	21.3	6.0	5.0	29	53.3	129
			MIN	20.3	5.8	4.8	27	52.2	121
231	57.00	4	AV4	20.2	5.4	4.8	28	53.5	122
			MAX	20.6	5.5	4.9	29	54.4	128
			MIN	19.3	5.3	4.6	25	53.0	119

USH 10 over LLBDM - PIER 12 #1 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
237	58.00	6	AV6	20.6	5.2	4.8	25	53.1	143
			MAX	21.6	6.2	5.1	26	53.8	152
			MIN	19.9	4.7	4.7	23	51.8	136
243	59.00	6	AV6	21.4	6.4	5.1	26	52.0	153
			MAX	21.9	6.9	5.1	28	52.6	158
			MIN	20.9	5.9	4.9	25	51.7	148
248	60.00	5	AV5	21.2	6.6	5.0	27	52.4	142
			MAX	21.8	6.9	5.1	28	53.4	146
			MIN	20.3	6.3	4.8	25	51.8	138
253	61.00	5	AV5	21.2	6.7	5.0	27	52.5	140
			MAX	21.6	7.0	5.1	28	53.1	147
			MIN	20.8	6.5	4.8	26	51.9	136
258	62.00	5	AV5	21.8	6.3	5.1	28	51.6	145
			MAX	22.4	6.6	5.3	30	52.2	150
			MIN	21.3	5.9	5.0	27	50.9	138
262	63.00	4	AV4	21.6	6.7	5.1	29	52.0	146
			MAX	22.0	7.2	5.1	30	52.1	155
			MIN	21.4	6.2	5.0	28	51.7	141
266	64.00	4	AV4	21.7	7.1	5.1	29	51.9	139
			MAX	22.2	7.4	5.2	29	52.2	144
			MIN	21.4	6.8	5.0	28	51.5	134
271	65.00	5	AV5	21.1	6.6	5.0	27	52.5	138
			MAX	21.5	7.4	5.1	28	53.7	145
			MIN	20.1	5.7	4.7	25	51.9	132
276	66.00	5	AV5	21.3	6.4	5.0	27	52.1	140
			MAX	21.7	7.0	5.1	28	53.0	147
			MIN	20.5	5.9	4.9	26	51.6	125
281	67.00	5	AV5	20.6	5.7	4.9	26	53.0	131
			MAX	21.3	6.3	5.0	27	53.6	144
			MIN	20.1	5.4	4.7	24	52.2	121
285	68.00	4	AV4	21.1	6.0	5.0	29	52.5	127
			MAX	21.4	6.4	5.1	30	53.1	136
			MIN	20.6	5.7	4.8	27	52.0	120
289	69.00	4	AV4	20.6	5.5	4.8	28	53.2	116
			MAX	21.1	5.7	4.9	28	53.6	121
			MIN	20.2	5.1	4.7	27	52.7	109
294	70.00	5	AV5	20.1	4.6	4.7	24	53.9	124
			MAX	21.3	4.9	4.9	26	55.7	139
			MIN	18.3	4.1	4.4	23	52.7	113
298	71.00	4	AV4	20.1	4.6	4.7	26	54.0	116

USH 10 over LLBDM - PIER 12 #1 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
			MAX	20.6	5.3	4.8	27	54.5	122
			MIN	19.7	4.3	4.6	25	53.4	111
303	72.00	5	AV5	19.7	5.8	4.6	24	54.4	127
			MAX	21.6	8.8	5.1	28	55.9	147
			MIN	18.6	3.9	4.3	21	51.8	112
308	73.00	5	AV5	22.1	7.9	5.2	29	51.1	141
			MAX	22.7	8.8	5.4	30	52.3	149
			MIN	21.0	6.2	5.0	27	50.6	129
312	74.00	4	AV4	21.4	6.2	5.0	28	52.2	120
			MAX	22.0	6.5	5.1	29	53.1	135
			MIN	20.8	5.7	4.8	28	51.6	107
316	75.00	4	AV4	22.6	8.2	5.4	29	50.7	160
			MAX	23.6	9.6	5.6	31	52.7	189
			MIN	21.0	6.4	4.9	27	49.4	131
320	76.00	4	AV4	24.4	11.3	5.9	31	48.5	223
			MAX	25.4	13.5	6.2	33	49.3	259
			MIN	23.8	9.5	5.7	29	47.3	187
323	77.00	3	AV3	26.2	13.7	6.4	35	46.5	276
			MAX	26.9	14.3	6.6	37	47.4	292
			MIN	25.2	13.0	6.1	33	45.8	266
326	78.00	3	AV3	26.3	13.8	6.4	35	46.5	264
			MAX	26.8	14.1	6.5	37	46.9	272
			MIN	25.9	13.5	6.3	34	46.0	257
329	79.00	3	AV3	26.3	12.7	6.4	36	46.4	244
			MAX	26.9	13.4	6.5	39	47.0	264
			MIN	25.5	11.7	6.3	34	46.0	218
333	80.00	4	AV4	25.1	10.0	6.0	33	48.0	192
			MAX	26.5	10.7	6.4	35	49.2	212
			MIN	23.9	9.4	5.7	31	46.6	179
336	81.00	3	AV3	24.9	10.3	5.9	33	48.2	200
			MAX	26.2	11.6	6.3	36	49.1	231
			MIN	24.2	9.2	5.7	32	46.7	175
341	82.00	5	AV5	27.3	16.1	6.7	35	45.4	304
			MAX	28.5	17.9	7.1	37	47.0	339
			MIN	25.8	13.2	6.3	33	44.2	262
350	83.00	9	AV9	27.8	17.3	6.9	36	44.8	325
			MAX	28.4	18.2	7.1	37	45.4	342
			MIN	27.1	16.4	6.7	34	44.2	310
359	84.00	9	AV9	28.5	19.4	7.1	37	44.2	353
			MAX	29.6	21.5	7.5	39	45.7	402

USH 10 over LLBDM - PIER 12 #1 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	26.9	16.5	6.6	34	43.1	312
370	85.00	11	AV11	29.3	22.0	7.4	38	43.3	399
			MAX	29.7	23.3	7.6	39	43.6	424
			MIN	28.9	21.1	7.3	37	42.9	378
385	86.00	15	AV15	29.1	21.9	7.3	37	43.6	394
			MAX	29.7	22.8	7.6	39	44.8	417
			MIN	27.7	20.9	6.9	35	42.9	374
402	87.98	17	AV17	30.6	27.2	7.7	39	42.4	512
			MAX	34.0	31.5	8.1	41	43.5	599
			MIN	29.0	24.5	7.4	37	41.6	435
412	88.21	44	AV10	31.7	32.1	8.2	39	41.3	627
			MAX	32.7	33.4	8.6	41	41.9	666
			MIN	30.6	30.6	7.9	37	40.4	582
422	88.42	48	AV10	33.2	35.1	8.6	41	40.3	705
			MAX	34.7	37.2	9.1	45	40.9	729
			MIN	32.0	33.8	8.4	33	39.3	680
			Average	24.9	12.2	6.0	31	48.3	247
			Maximum	34.7	37.2	9.1	45	68.4	729
			Minimum	10.9	2.1	2.8	10	39.3	0

Total number of blows analyzed: 421

BL# Sensors

1-422 F3: [D815] 93.0 (0.97); F4: [F607] 93.6 (0.97); A3: [K3550] 360.0 (1.04); A4: [K2524] 360.0 (1.04)

BL# Comments

2 Reported Reference EL 740.25

Time Summary

Drive 9 minutes 3 seconds 9:14 AM - 9:23 AM BN 1 - 422

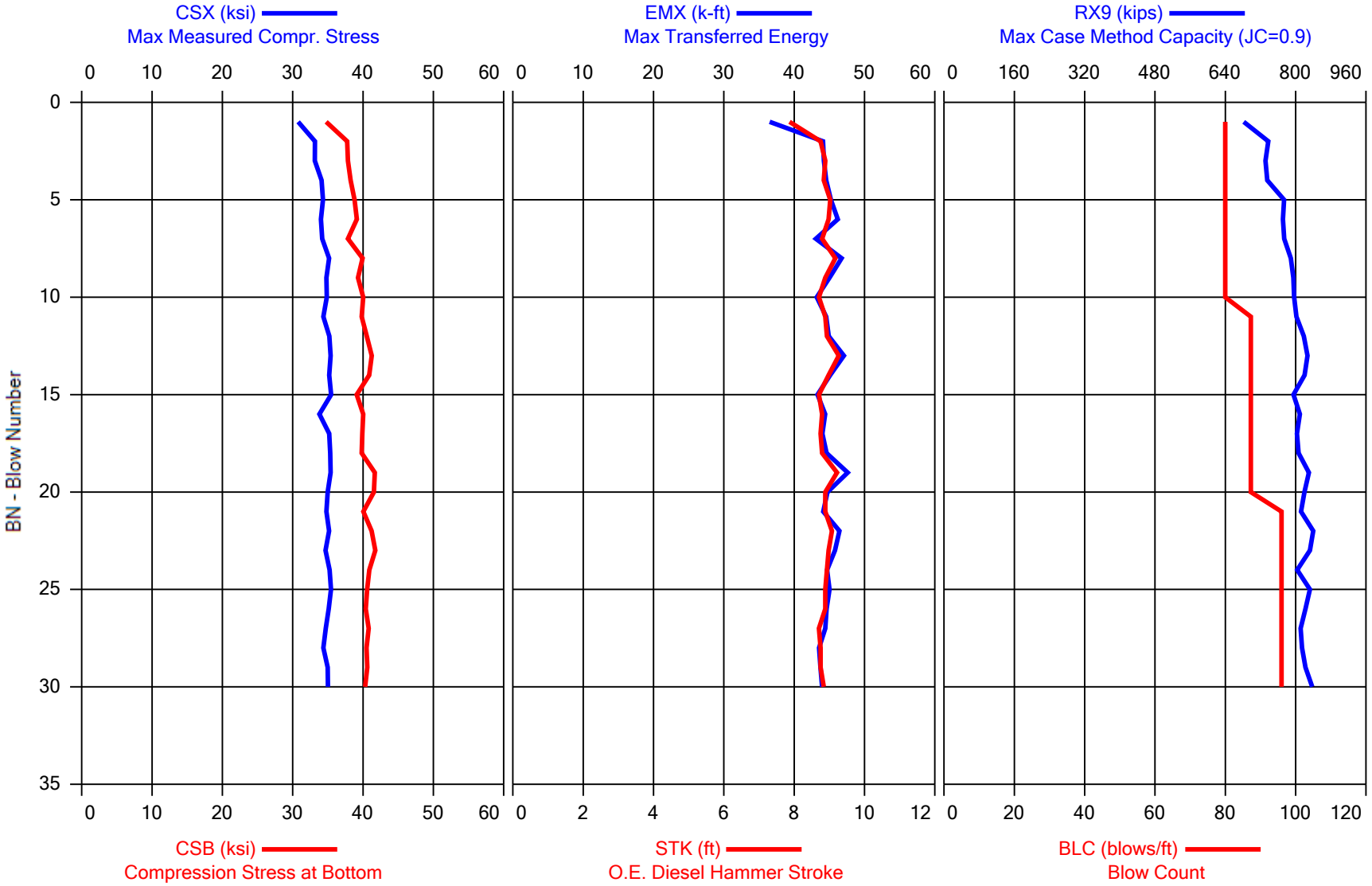
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 22-April-2015

Test started: 22-April-2015

USH 10 over Little Lake Butte des Morts - Pier 12 #1 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 12 #1 Restrike APE D30-42, HP 14 x 73
OP: TC Date: 22-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.66 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	88.54	80	AV10	33.8	38.4	44	8.8	39.9	759
			STD	1.2	1.4	3	0.3	0.8	35
			MAX	35.2	40.0	47	9.2	42.1	797
			MIN	30.8	34.8	37	7.9	39.1	682
20	88.66	87	AV10	35.0	40.5	45	8.9	39.6	813
			STD	0.5	0.8	1	0.2	0.4	11
			MAX	35.5	41.7	48	9.3	40.1	830
			MIN	33.8	39.1	43	8.7	38.9	795
30	88.76	96	AV10	34.9	40.7	45	8.9	39.7	823
			STD	0.3	0.5	1	0.1	0.2	12
			MAX	35.4	41.7	46	9.1	40.1	840
			MIN	34.4	40.0	44	8.7	39.3	803
			Average	34.6	39.8	45	8.9	39.8	798
			Std. Dev.	0.9	1.4	2	0.2	0.5	36
			Maximum	35.5	41.7	48	9.3	42.1	840
			Minimum	30.8	34.8	37	7.9	38.9	682

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.05); A4: [K3550] 360.0 (1.05)

Time Summary

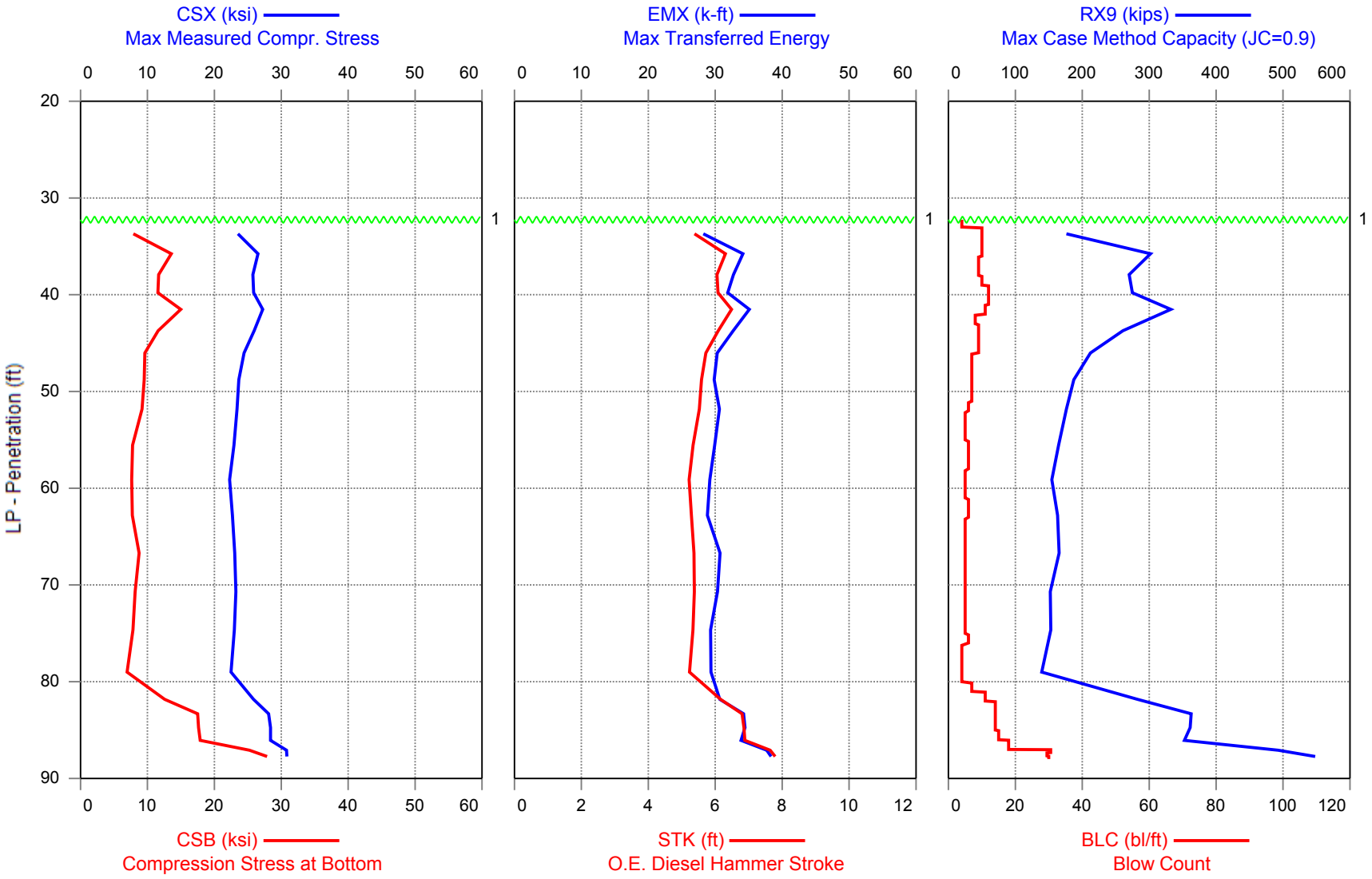
Drive 43 seconds 6:26 AM - 6:27 AM BN 1 - 30

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 21-April-2015

Test started: 21-April-2015

USH 10 over LLBDM - PIER 12 #16
APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.25

USH 10 over LLBDM - PIER 12 #16 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s 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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
3	32.25	4	AV1	24.9	3.5	4.9	35	53.0	33
			MAX	24.9	3.5	4.9	35	53.0	33
			MIN	24.9	3.5	4.9	35	53.0	33
4	32.50	4	AV1	17.5	3.0	3.6	13	61.3	42
			MAX	17.5	3.0	3.6	13	61.3	42
			MIN	17.5	3.0	3.6	13	61.3	42
6	33.00	4	AV1	22.3	6.8	4.9	32	52.8	105
			MAX	22.3	6.8	4.9	32	52.8	105
			MIN	22.3	6.8	4.9	32	52.8	105
7	33.10	10	AV1	20.8	4.3	4.8	23	53.4	125
			MAX	20.8	4.3	4.8	23	53.4	125
			MIN	20.8	4.3	4.8	23	53.4	125
8	33.20	10	AV1	20.6	4.4	4.8	23	53.1	113
			MAX	20.6	4.4	4.8	23	53.1	113
			MIN	20.6	4.4	4.8	23	53.1	113
9	33.30	10	AV1	21.3	4.3	5.0	24	52.5	102
			MAX	21.3	4.3	5.0	24	52.5	102
			MIN	21.3	4.3	5.0	24	52.5	102
10	33.40	10	AV1	22.4	4.4	5.0	25	52.4	100
			MAX	22.4	4.4	5.0	25	52.4	100
			MIN	22.4	4.4	5.0	25	52.4	100
11	33.50	10	AV1	21.4	4.1	4.7	22	53.7	105
			MAX	21.4	4.1	4.7	22	53.7	105
			MIN	21.4	4.1	4.7	22	53.7	105
16	34.00	10	AV5	22.7	6.8	5.2	26	51.4	160
			MAX	23.4	10.9	5.4	27	52.4	240
			MIN	22.1	4.5	5.0	25	50.4	109
26	35.00	10	AV10	26.4	13.0	6.3	34	46.9	291
			MAX	27.1	13.9	6.4	35	48.2	309
			MIN	25.5	11.3	5.9	31	46.4	257
36	36.00	10	AV10	26.7	13.8	6.4	34	46.7	308
			MAX	28.0	14.4	6.7	37	48.5	323
			MIN	24.9	13.1	5.9	31	45.4	293
45	37.00	9	AV9	26.3	12.9	6.2	34	47.1	288
			MAX	27.0	13.9	6.4	35	48.1	299
			MIN	25.4	12.1	6.0	32	46.6	274

USH 10 over LLBDM - PIER 12 #16 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
54	38.00	9	AV9	25.7	11.2	6.0	33	47.9	262
			MAX	26.4	12.3	6.2	35	48.7	284
			MIN	24.9	10.5	5.8	31	47.2	250
64	39.00	10	AV10	25.8	11.9	6.1	32	47.7	275
			MAX	26.6	12.5	6.3	33	48.8	289
			MIN	24.6	11.2	5.8	30	46.9	260
76	40.00	12	AV12	25.3	10.3	5.9	31	48.3	249
			MAX	26.3	11.4	6.2	32	49.4	271
			MIN	24.3	9.3	5.6	29	47.1	233
88	41.00	12	AV12	27.2	14.4	6.5	34	46.3	333
			MAX	28.1	15.5	6.7	36	47.3	354
			MIN	26.3	12.2	6.2	33	45.5	285
99	42.00	11	AV11	27.4	15.1	6.5	35	46.1	337
			MAX	28.1	15.8	6.8	37	46.9	347
			MIN	26.5	14.5	6.3	34	45.3	318
107	43.00	8	AV8	26.4	14.0	6.3	34	47.0	293
			MAX	27.4	14.8	6.5	36	47.7	307
			MIN	25.7	13.0	6.1	33	46.1	277
116	44.00	9	AV9	26.1	11.7	6.1	33	47.5	263
			MAX	27.3	12.4	6.5	35	48.7	275
			MIN	25.0	11.0	5.8	31	46.2	247
125	45.00	9	AV9	25.3	10.3	5.9	31	48.2	237
			MAX	26.9	11.0	6.3	34	49.3	254
			MIN	24.3	9.7	5.7	30	46.9	220
134	46.00	9	AV9	24.3	9.2	5.7	29	49.3	213
			MAX	25.2	9.7	5.9	31	50.4	220
			MIN	23.3	8.9	5.4	28	48.3	201
141	47.00	7	AV7	24.3	9.8	5.7	31	49.1	207
			MAX	25.1	10.4	5.9	33	49.9	215
			MIN	23.6	9.4	5.5	29	48.2	196
148	48.00	7	AV7	24.8	10.1	5.8	32	48.6	201
			MAX	25.5	10.6	6.0	33	49.0	225
			MIN	24.4	9.5	5.7	31	48.1	187
155	49.00	7	AV7	23.2	9.3	5.5	29	50.2	180
			MAX	24.0	9.7	5.7	31	50.9	186
			MIN	22.4	8.5	5.3	28	49.2	170
162	50.00	7	AV7	23.3	9.5	5.5	30	49.8	189
			MAX	24.1	9.7	5.7	30	50.8	198
			MIN	22.5	9.1	5.3	28	49.0	175

USH 10 over LLBDM - PIER 12 #16 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
169	51.00	7	AV7	23.5	9.5	5.6	30	49.6	188
			MAX	24.1	10.0	5.7	31	50.3	200
			MIN	22.9	9.0	5.4	29	49.0	176
175	52.00	6	AV6	23.7	9.5	5.6	31	49.4	183
			MAX	24.4	10.4	5.8	32	50.2	202
			MIN	23.2	8.9	5.4	29	48.9	170
180	53.00	5	AV5	23.3	8.7	5.5	31	50.2	167
			MAX	24.0	9.1	5.6	33	51.0	170
			MIN	22.6	8.5	5.3	29	49.4	165
185	54.00	5	AV5	22.8	8.9	5.4	30	50.6	160
			MAX	23.4	9.4	5.5	32	51.3	163
			MIN	22.3	8.6	5.2	29	50.0	153
190	55.00	5	AV5	22.9	7.6	5.3	31	50.7	162
			MAX	23.4	8.8	5.5	32	52.6	175
			MIN	21.3	6.3	4.9	28	50.1	146
196	56.00	6	AV6	22.6	6.8	5.2	28	51.3	158
			MAX	23.8	7.8	5.5	30	53.1	174
			MIN	21.0	5.9	4.8	25	50.1	145
202	57.00	6	AV6	23.3	8.4	5.4	30	50.3	173
			MAX	24.5	8.7	5.7	32	51.4	180
			MIN	22.4	7.7	5.2	28	49.1	163
208	58.00	6	AV6	22.9	7.7	5.4	29	50.6	169
			MAX	24.1	8.2	5.7	31	52.3	181
			MIN	21.3	6.9	5.0	27	49.2	155
213	59.00	5	AV5	22.4	7.7	5.2	30	51.2	152
			MAX	23.2	8.4	5.4	31	51.9	169
			MIN	21.7	7.2	5.1	28	50.2	145
218	60.00	5	AV5	22.1	7.3	5.2	29	51.5	145
			MAX	22.7	7.6	5.3	30	52.0	148
			MIN	21.7	7.0	5.1	28	50.7	143
223	61.00	5	AV5	21.8	7.9	5.1	29	51.6	152
			MAX	22.4	8.1	5.3	30	52.1	155
			MIN	21.4	7.6	5.0	28	50.9	148
229	62.00	6	AV6	22.1	6.5	5.1	27	51.6	150
			MAX	22.6	7.7	5.2	28	52.2	161
			MIN	21.6	5.7	5.0	27	51.1	140
235	63.00	6	AV6	22.7	7.8	5.3	28	50.9	165
			MAX	23.7	8.2	5.6	31	52.0	173
			MIN	21.7	7.0	5.1	26	49.7	154
240	64.00	5	AV5	23.1	8.7	5.4	31	50.4	173

USH 10 over LLBDM - PIER 12 #16 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
			MAX	24.0	9.0	5.6	32	50.9	181
			MIN	22.4	8.3	5.3	29	49.5	168
245	65.00	5	AV5	23.2	8.6	5.4	31	50.4	170
			MAX	23.8	8.8	5.6	33	50.6	175
			MIN	23.0	8.4	5.4	30	49.7	166
250	66.00	5	AV5	23.1	9.0	5.4	31	50.5	166
			MAX	23.7	10.5	5.5	32	50.8	184
			MIN	22.8	7.9	5.3	29	49.8	152
255	67.00	5	AV5	22.9	9.0	5.3	30	50.7	163
			MAX	23.4	9.5	5.4	31	51.1	171
			MIN	22.6	8.4	5.2	29	50.4	156
260	68.00	5	AV5	23.0	8.4	5.4	31	50.6	165
			MAX	23.4	8.8	5.4	31	51.2	168
			MIN	22.4	7.6	5.2	30	50.2	162
265	69.00	5	AV5	23.3	8.8	5.4	32	50.3	161
			MAX	24.3	9.7	5.7	33	50.9	165
			MIN	22.9	8.2	5.3	30	49.3	157
270	70.00	5	AV5	23.1	7.7	5.4	30	50.6	149
			MAX	23.4	8.1	5.4	30	50.9	155
			MIN	22.8	7.3	5.3	28	50.2	144
275	71.00	5	AV5	22.6	7.7	5.2	29	51.2	152
			MAX	23.3	8.3	5.4	31	52.2	162
			MIN	21.7	7.4	5.0	27	50.5	140
280	72.00	5	AV5	23.8	8.7	5.5	32	49.9	154
			MAX	24.1	9.4	5.6	33	50.5	163
			MIN	23.2	8.0	5.4	31	49.5	142
285	73.00	5	AV5	23.1	7.9	5.4	30	50.6	152
			MAX	23.7	8.8	5.5	31	51.5	158
			MIN	22.4	7.1	5.2	29	50.1	147
290	74.00	5	AV5	22.6	7.5	5.2	29	51.2	142
			MAX	23.2	7.7	5.4	30	52.0	149
			MIN	22.1	7.3	5.1	28	50.6	135
295	75.00	5	AV5	22.7	7.6	5.3	29	51.1	142
			MAX	23.2	7.9	5.3	29	51.3	148
			MIN	22.4	7.3	5.2	29	50.8	135
301	76.00	6	AV6	23.4	7.9	5.4	29	50.3	167
			MAX	24.2	8.8	5.6	31	51.7	188
			MIN	22.1	6.5	5.1	27	49.4	150
305	77.00	4	AV4	23.4	9.8	5.5	32	50.0	164
			MAX	23.8	10.2	5.6	33	50.5	177

USH 10 over LLBDM - PIER 12 #16 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	23.1	9.2	5.4	31	49.5	152
309	78.00	4	AV4	23.2	8.4	5.4	32	50.2	151
			MAX	23.8	9.4	5.6	33	50.9	157
			MIN	22.6	7.1	5.3	31	49.5	144
313	79.00	4	AV4	22.7	7.7	5.3	31	51.1	141
			MAX	23.4	8.9	5.4	33	51.6	151
			MIN	22.2	7.1	5.1	30	50.3	128
317	80.00	4	AV4	22.3	6.9	5.2	31	51.4	128
			MAX	23.3	7.1	5.4	33	52.2	143
			MIN	21.7	6.5	5.0	29	50.5	109
324	81.00	7	AV7	21.6	4.5	5.0	24	52.3	130
			MAX	22.3	5.1	5.2	26	53.5	149
			MIN	20.7	4.1	4.8	23	51.5	119
335	82.00	11	AV11	25.1	10.7	5.9	30	48.3	255
			MAX	27.2	14.9	6.5	34	52.5	314
			MIN	21.5	5.0	5.0	22	46.0	151
349	83.00	14	AV14	27.7	16.6	6.7	34	45.5	346
			MAX	28.3	18.7	6.8	35	47.0	387
			MIN	26.1	14.8	6.3	31	45.0	322
363	84.00	14	AV14	28.1	17.7	6.8	34	45.2	366
			MAX	29.3	19.9	7.1	36	46.9	432
			MIN	26.6	14.3	6.3	31	44.1	329
377	85.00	14	AV14	28.5	18.4	6.9	35	44.9	375
			MAX	29.2	20.0	7.1	36	46.1	410
			MIN	27.3	16.1	6.5	32	44.1	341
392	86.00	15	AV15	28.0	16.1	6.7	33	45.3	326
			MAX	28.9	17.9	6.9	34	46.2	348
			MIN	27.2	15.1	6.5	32	44.7	314
410	87.00	18	AV18	29.3	20.7	7.2	35	44.0	400
			MAX	31.3	24.5	7.8	40	45.2	463
			MIN	27.9	16.2	6.8	33	42.3	333
420	87.33	31	AV10	31.2	26.3	7.7	38	42.4	526
			MAX	33.0	28.1	8.0	40	43.0	606
			MIN	30.3	24.3	7.5	36	41.7	466
430	87.67	29	AV10	30.6	26.4	7.8	38	42.2	518
			MAX	32.8	29.3	8.4	42	43.0	567
			MIN	26.0	24.1	7.5	29	40.8	487
440	88.00	30	AV10	31.1	29.1	7.7	39	42.4	567
			MAX	31.9	31.6	7.9	40	43.4	616
			MIN	30.0	27.6	7.4	37	41.9	531

USH 10 over LLBDM - PIER 12 #16 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			Average	25.3	12.3	6.0	32	48.2	256
			Maximum	33.0	31.6	8.4	42	61.3	616
			Minimum	17.5	3.0	3.6	13	40.8	33

Total number of blows analyzed: 437

BL# Sensors

1-440 F3: [D815] 93.0 (0.97); F4: [F607] 93.6 (0.97); A3: [K3550] 360.0 (1.05); A4: [K2524] 360.0 (1.05)

BL# Comments

3 Reported Reference EL 740.25

Time Summary

Drive 13 minutes 30 seconds 9:38 AM - 9:52 AM BN 1 - 440

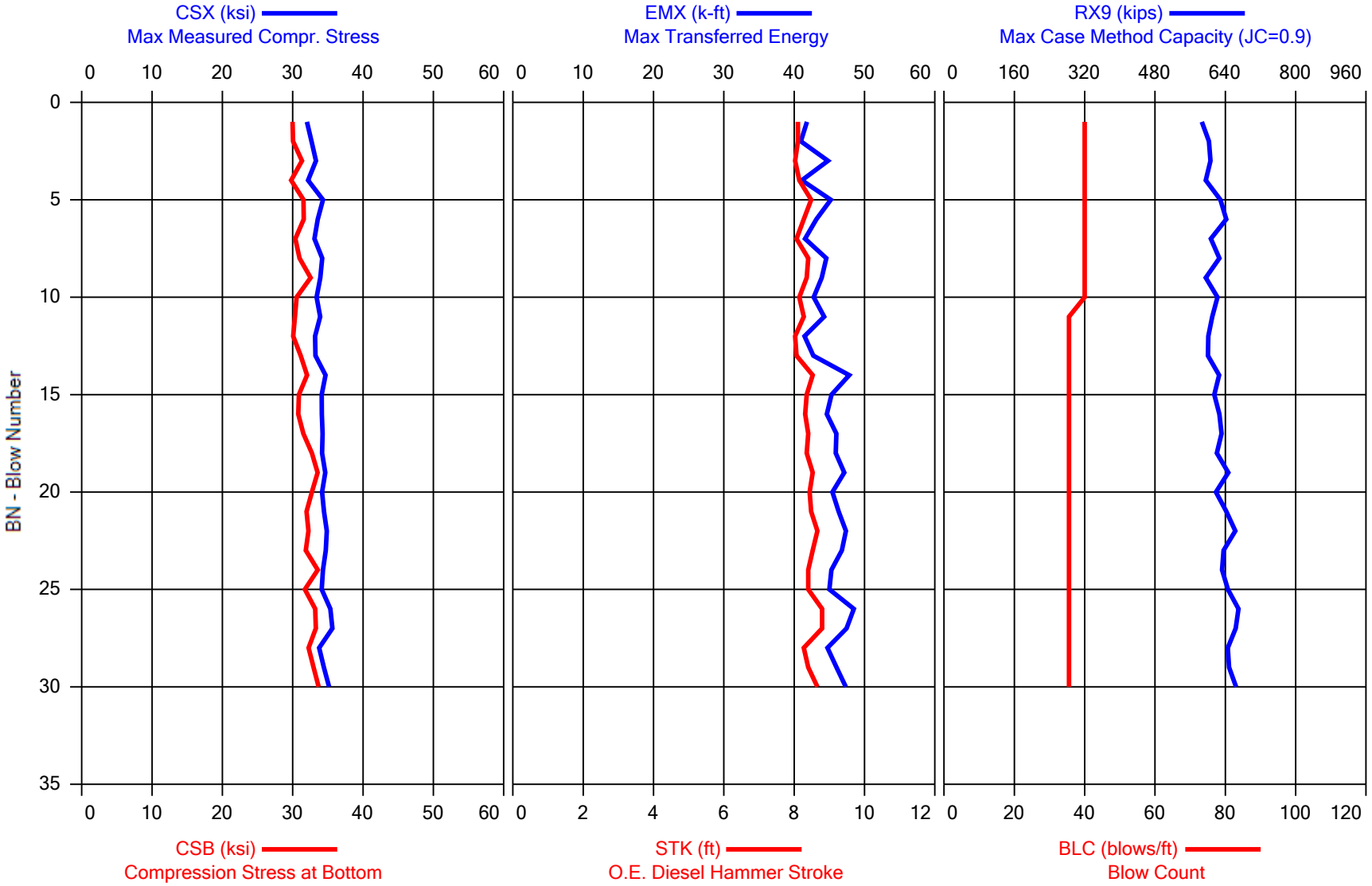
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 22-April-2015

Test started: 22-April-2015

USH 10 over Little Lake Butte des Morts - Pier 12 #16 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 12 #16 Restrike APE D30-42, HP 14 x 73
OP: TC Date: 22-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.50 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	88.25	40	AV10	33.3	30.9	43	8.2	41.3	611
			STD	0.7	0.8	2	0.1	0.4	17
			MAX	34.3	32.5	45	8.5	41.7	642
			MIN	32.0	29.8	41	8.0	40.6	586
20	88.53	36	AV10	34.0	31.6	45	8.3	41.0	620
			STD	0.5	1.1	2	0.2	0.4	13
			MAX	34.7	33.5	48	8.5	41.7	647
			MIN	33.2	30.1	41	8.0	40.5	600
30	88.81	36	AV10	34.7	32.7	46	8.5	40.5	651
			STD	0.6	0.7	1	0.2	0.4	12
			MAX	35.6	33.7	48	8.8	41.1	670
			MIN	33.8	31.7	45	8.3	39.9	632
			Average	34.0	31.7	45	8.4	40.9	627
			Std. Dev.	0.8	1.2	2	0.2	0.5	22
			Maximum	35.6	33.7	48	8.8	41.7	670
			Minimum	32.0	29.8	41	8.0	39.9	586

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

Time Summary

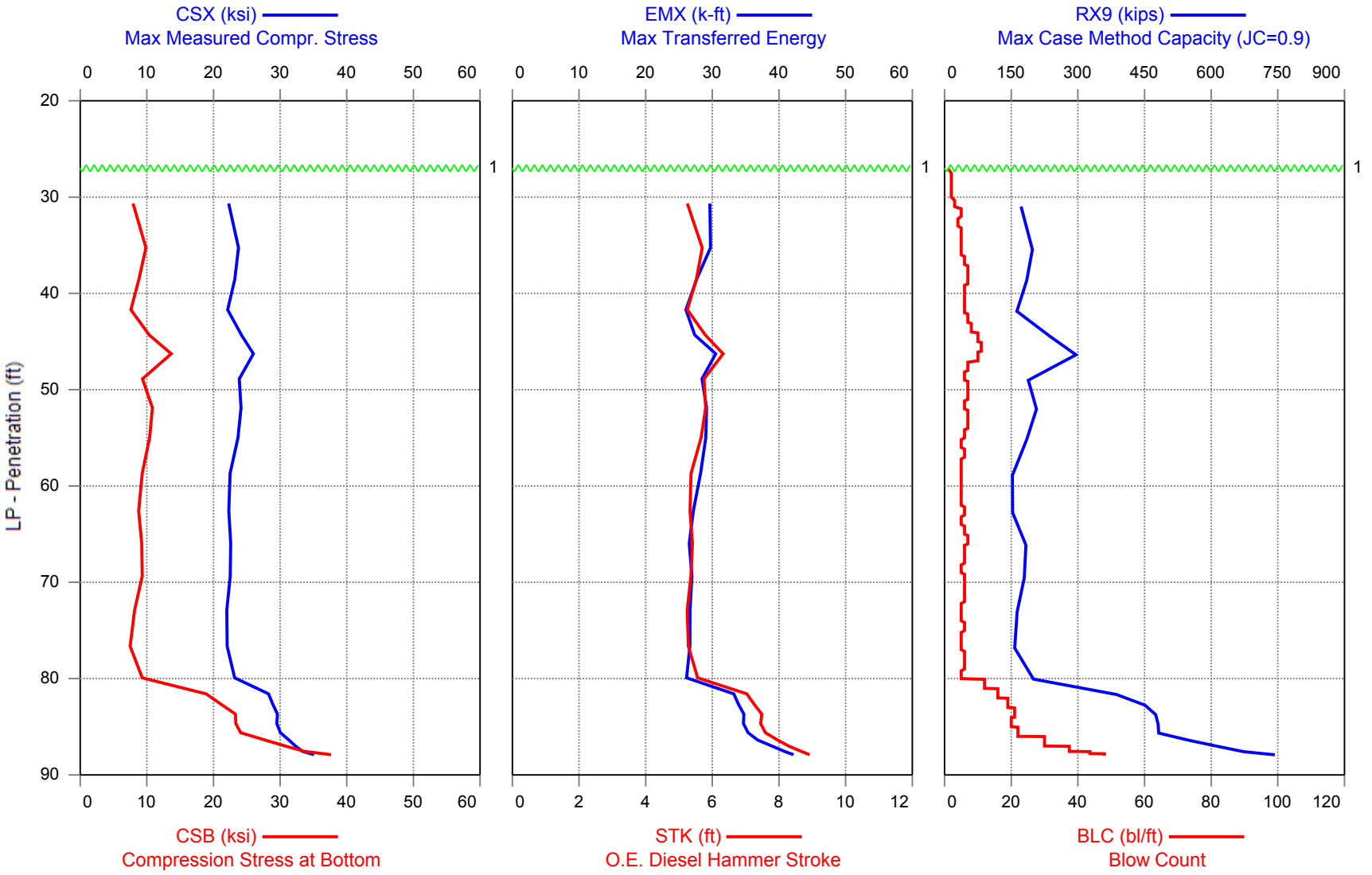
Drive 42 seconds 6:32 AM - 6:33 AM BN 1 - 30

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 21-April-2015

Test started: 21-April-2015

USH 10 over LLBDM - PIER 12 #23
APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.25

USH 10 over LLBDM - PIER 12 #23 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s 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#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
3	27.00	1	AV1	19.8	2.0	4.2	29	56.9	0
			MAX	19.8	2.0	4.2	29	56.9	0
			MIN	19.8	2.0	4.2	29	56.9	0
4	27.50	2	AV1	15.9	5.4	3.5	20	61.5	102
			MAX	15.9	5.4	3.5	20	61.5	102
			MIN	15.9	5.4	3.5	20	61.5	102
5	28.00	2	AV1	19.2	7.4	4.5	27	54.8	161
			MAX	19.2	7.4	4.5	27	54.8	161
			MIN	19.2	7.4	4.5	27	54.8	161
7	29.00	2	AV2	22.6	8.6	5.4	32	50.6	172
			MAX	22.6	8.7	5.4	32	50.7	182
			MIN	22.6	8.6	5.3	31	50.5	162
9	30.00	2	AV2	24.0	9.0	5.7	34	49.1	181
			MAX	24.3	9.1	5.8	35	49.4	185
			MIN	23.6	8.9	5.6	33	48.8	177
12	31.00	3	AV3	23.7	9.1	5.6	32	49.4	187
			MAX	24.0	9.2	5.7	33	49.5	198
			MIN	23.5	9.0	5.6	30	49.1	181
17	32.00	5	AV5	22.8	7.8	5.4	30	50.3	165
			MAX	24.3	8.7	5.9	33	51.7	182
			MIN	21.4	7.2	5.1	27	48.4	150
21	33.00	4	AV4	22.3	8.3	5.3	28	51.0	175
			MAX	22.7	9.0	5.4	30	51.2	204
			MIN	22.0	7.8	5.2	27	50.3	162
26	34.00	5	AV5	23.5	9.7	5.6	30	49.5	196
			MAX	23.9	10.3	5.7	30	49.8	200
			MIN	23.3	9.4	5.5	29	49.1	191
31	35.00	5	AV5	23.7	9.8	5.7	30	49.2	197
			MAX	24.0	10.1	5.8	31	49.7	207
			MIN	23.4	9.4	5.6	29	48.7	188
36	36.00	5	AV5	23.9	10.2	5.8	30	48.9	208
			MAX	24.8	10.5	5.9	31	49.3	213
			MIN	23.1	10.0	5.7	28	48.2	202
42	37.00	6	AV6	23.8	9.7	5.7	29	49.1	193
			MAX	24.7	10.2	6.0	32	49.7	205
			MIN	23.0	8.6	5.6	27	48.1	180

USH 10 over LLBDM - PIER 12 #23 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
49	38.00	7	AV7	22.6	7.8	5.3	26	50.7	177
			MAX	23.4	8.4	5.5	28	52.6	184
			MIN	20.8	7.1	4.9	23	49.8	166
56	39.00	7	AV7	23.5	9.7	5.6	28	49.5	198
			MAX	24.3	10.3	5.8	30	50.3	204
			MIN	22.8	8.9	5.4	27	48.6	190
62	40.00	6	AV6	23.6	9.0	5.6	29	49.5	181
			MAX	24.2	10.1	5.9	31	50.2	192
			MIN	23.0	8.4	5.4	27	48.5	174
68	41.00	6	AV6	22.6	8.0	5.4	27	50.5	167
			MAX	23.1	8.6	5.4	28	51.2	176
			MIN	22.1	7.2	5.2	26	50.2	149
74	42.00	6	AV6	21.7	7.1	5.1	26	51.6	155
			MAX	22.2	7.2	5.2	27	52.4	160
			MIN	21.1	6.9	5.0	25	51.1	148
81	43.00	7	AV7	22.0	7.6	5.2	25	51.2	164
			MAX	22.3	8.0	5.3	26	51.7	169
			MIN	21.6	7.2	5.1	24	50.8	158
89	44.00	8	AV8	22.5	7.8	5.4	25	50.6	168
			MAX	23.1	8.2	5.5	26	51.3	178
			MIN	21.8	7.4	5.2	24	49.9	161
99	45.00	10	AV10	24.8	11.2	5.9	28	48.3	247
			MAX	26.3	14.0	6.4	31	50.4	300
			MIN	23.0	7.7	5.4	24	46.5	176
110	46.00	11	AV11	26.3	14.4	6.4	31	46.5	323
			MAX	27.1	15.6	6.6	32	47.1	348
			MIN	25.8	13.2	6.2	30	45.7	297
120	47.00	10	AV10	25.9	13.2	6.3	30	46.9	290
			MAX	26.3	14.4	6.5	31	47.6	303
			MIN	25.0	12.2	6.1	29	46.3	269
127	48.00	7	AV7	25.0	11.3	6.1	30	47.6	226
			MAX	25.7	12.1	6.3	32	48.5	247
			MIN	24.1	10.2	5.9	29	46.8	199
133	49.00	6	AV6	24.2	9.3	5.8	30	48.6	179
			MAX	24.8	10.0	6.1	31	49.5	193
			MIN	23.3	7.8	5.6	27	47.7	161
140	50.00	7	AV7	22.8	8.1	5.5	26	50.2	178
			MAX	23.5	9.1	5.6	27	51.3	191
			MIN	21.6	7.2	5.2	25	49.4	169

USH 10 over LLBDM - PIER 12 #23 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
147	51.00	7	AV7	24.3	10.3	5.8	29	48.6	203
			MAX	24.7	11.5	5.9	31	49.2	226
			MIN	23.8	9.4	5.7	28	48.2	191
153	52.00	6	AV6	24.0	10.8	5.8	29	48.8	196
			MAX	24.6	11.4	5.9	31	49.4	216
			MIN	23.5	10.2	5.6	28	48.3	186
160	53.00	7	AV7	24.1	11.0	5.8	29	48.7	215
			MAX	24.4	11.8	5.9	30	49.2	223
			MIN	23.6	10.6	5.7	28	48.5	207
167	54.00	7	AV7	23.9	10.8	5.7	28	49.0	206
			MAX	24.3	11.4	5.9	29	49.4	214
			MIN	23.7	10.3	5.6	28	48.5	199
173	55.00	6	AV6	23.7	10.0	5.7	29	49.2	183
			MAX	24.7	10.8	5.9	31	49.8	197
			MIN	23.1	8.8	5.5	27	48.3	163
178	56.00	5	AV5	23.6	10.4	5.6	30	49.4	179
			MAX	24.1	10.9	5.7	31	49.7	183
			MIN	22.9	9.8	5.6	28	49.0	174
184	57.00	6	AV6	23.3	10.2	5.6	29	49.7	176
			MAX	23.7	11.7	5.7	30	50.1	211
			MIN	22.9	8.9	5.5	28	49.2	158
189	58.00	5	AV5	22.1	9.3	5.3	28	51.0	150
			MAX	22.4	9.6	5.4	28	51.3	159
			MIN	21.8	8.6	5.2	27	50.6	140
194	59.00	5	AV5	22.7	9.6	5.4	29	50.4	159
			MAX	23.7	10.6	5.7	31	51.0	168
			MIN	22.0	9.1	5.3	27	49.2	143
199	60.00	5	AV5	22.5	9.2	5.4	28	50.5	149
			MAX	23.0	9.6	5.5	29	50.9	153
			MIN	22.3	8.9	5.3	28	49.9	145
204	61.00	5	AV5	22.4	9.0	5.3	28	50.7	151
			MAX	23.1	9.6	5.5	29	51.2	155
			MIN	22.0	8.6	5.2	26	50.1	146
209	62.00	5	AV5	22.3	8.6	5.3	28	50.8	148
			MAX	23.1	9.3	5.4	29	51.9	150
			MIN	21.1	8.3	5.1	26	50.2	143
215	63.00	6	AV6	22.0	8.1	5.2	26	51.1	151
			MAX	22.5	8.6	5.4	27	53.0	164
			MIN	20.2	7.3	4.9	23	50.4	142
220	64.00	5	AV5	22.3	9.4	5.4	27	50.6	159

USH 10 over LLBDM - PIER 12 #23 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	23.6	10.8	5.7	30	52.1	183
			MIN	20.9	8.3	5.0	24	49.0	142
226	65.00	6	AV6	22.3	8.7	5.4	27	50.6	155
			MAX	23.1	9.6	5.6	28	51.6	166
			MIN	21.4	7.8	5.1	25	49.6	147
233	66.00	7	AV7	21.5	7.7	5.1	24	51.7	157
			MAX	23.4	10.6	5.7	27	52.8	201
			MIN	20.7	5.5	4.9	22	49.3	119
239	67.00	6	AV6	23.6	10.9	5.7	29	49.2	211
			MAX	23.9	11.7	5.8	30	49.7	247
			MIN	23.1	10.2	5.6	28	48.8	186
245	68.00	6	AV6	23.3	10.3	5.5	28	49.9	211
			MAX	23.9	11.2	5.7	29	51.0	226
			MIN	22.0	9.2	5.3	26	49.2	199
250	69.00	5	AV5	22.3	10.0	5.3	27	50.7	187
			MAX	23.2	10.8	5.6	29	51.3	227
			MIN	21.5	9.2	5.2	26	49.7	162
256	70.00	6	AV6	22.7	9.2	5.4	27	50.3	177
			MAX	24.0	10.5	5.7	29	51.4	206
			MIN	21.8	8.2	5.2	25	49.1	154
262	71.00	6	AV6	22.3	8.6	5.3	27	50.9	170
			MAX	23.5	10.3	5.6	28	52.3	228
			MIN	21.0	7.5	5.0	24	49.7	147
268	72.00	6	AV6	22.5	9.7	5.3	27	50.6	200
			MAX	23.4	10.7	5.6	29	51.1	251
			MIN	22.0	8.6	5.2	27	49.5	154
273	73.00	5	AV5	22.1	8.2	5.3	27	50.9	145
			MAX	22.6	8.6	5.3	28	51.4	153
			MIN	21.4	7.2	5.2	26	50.7	138
278	74.00	5	AV5	21.2	7.5	5.1	26	51.9	153
			MAX	21.9	8.6	5.2	26	52.8	174
			MIN	20.4	6.5	4.9	25	51.3	135
284	75.00	6	AV6	22.3	7.0	5.3	26	50.8	148
			MAX	23.1	7.5	5.5	28	51.9	158
			MIN	21.3	6.2	5.1	25	49.8	137
289	76.00	5	AV5	21.7	7.8	5.2	26	51.3	152
			MAX	22.8	8.6	5.4	28	52.3	176
			MIN	20.9	6.8	5.0	25	50.3	129
294	77.00	5	AV5	22.1	7.4	5.3	27	50.9	145
			MAX	22.4	7.9	5.4	28	51.3	167

USH 10 over LLBDM - PIER 12 #23 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	21.8	6.8	5.2	26	50.6	127
300	78.00	6	AV6	21.9	7.0	5.3	26	51.0	163
			MAX	22.2	9.1	5.3	26	51.6	208
			MIN	21.5	5.8	5.1	25	50.7	145
306	79.00	6	AV6	22.9	9.1	5.5	28	49.9	187
			MAX	24.2	10.0	5.9	30	50.9	211
			MIN	22.3	7.9	5.3	26	48.5	161
311	80.00	5	AV5	22.7	10.0	5.3	28	50.7	196
			MAX	25.2	11.1	5.5	29	51.6	242
			MIN	21.7	8.5	5.1	26	50.0	136
323	81.00	12	AV12	23.5	9.1	5.7	25	49.4	203
			MAX	26.1	11.2	6.3	29	52.5	236
			MIN	20.3	5.1	5.0	20	46.7	141
339	82.00	16	AV16	28.4	19.2	7.1	33	44.4	383
			MAX	31.0	24.1	7.8	38	48.0	463
			MIN	24.6	13.7	6.0	26	42.3	308
358	83.00	19	AV19	28.9	20.7	7.3	34	43.8	433
			MAX	30.0	24.2	7.6	37	44.8	551
			MIN	27.9	17.7	6.9	31	42.7	353
379	84.00	21	AV21	29.6	23.2	7.5	35	43.1	478
			MAX	30.7	24.5	7.9	37	43.9	533
			MIN	28.6	21.4	7.2	33	42.1	425
399	85.00	20	AV20	29.3	23.1	7.4	34	43.4	469
			MAX	30.1	24.5	7.7	37	44.6	531
			MIN	27.9	21.7	7.0	32	42.6	429
421	86.00	22	AV22	30.0	24.0	7.6	35	42.8	478
			MAX	31.3	25.3	8.0	38	43.7	568
			MIN	29.0	22.3	7.3	33	41.8	430
451	87.00	30	AV30	31.5	28.5	8.0	37	41.7	568
			MAX	32.7	31.9	8.5	40	43.4	704
			MIN	29.2	25.2	7.4	33	40.6	496
472	87.56	37	AV21	32.6	32.0	8.4	39	40.8	635
			MAX	33.6	34.3	8.8	42	41.8	678
			MIN	31.6	29.1	8.0	37	39.9	574
482	87.79	44	AV10	34.0	34.7	8.9	42	39.8	688
			MAX	34.8	36.7	9.1	44	40.4	710
			MIN	33.0	33.6	8.6	40	39.2	658
492	88.00	48	AV10	35.1	37.7	8.9	42	39.6	742
			MAX	37.7	40.2	9.1	44	40.3	775
			MIN	33.1	35.9	8.6	40	39.2	711

USH 10 over LLBDM - PIER 12 #23 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			Average	25.8	15.2	6.3	31	47.3	305
			Maximum	37.7	40.2	9.1	44	61.5	775
			Minimum	15.9	2.0	3.5	20	39.2	0

Total number of blows analyzed: 490

BL# Sensors

1-492 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.00); A4: [K3550] 360.0 (1.00)

BL# Comments

3 Reported Reference EL 740.25

Time Summary

Drive 10 minutes 48 seconds 10:08 AM - 10:18 AM BN 1 - 492

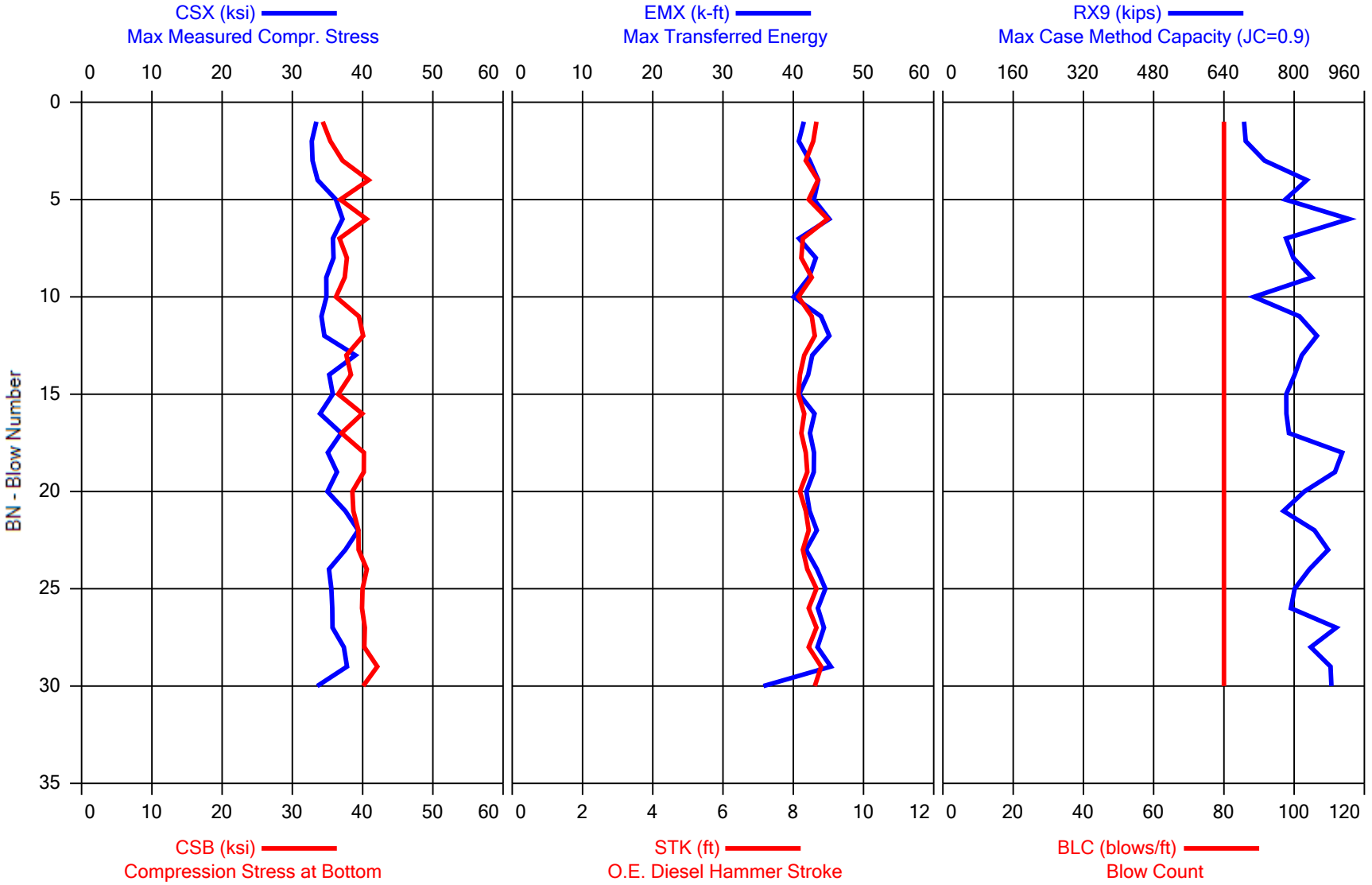
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 22-April-2015

Test started: 22-April-2015

USH 10 over Little Lake Butte des Morts - Pier 12 #23 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 12 #23 Restrike APE D30-42, HP 14 x 73
OP: TC Date: 22-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.50 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	88.13	80	AV10	34.7	37.3	42	8.5	40.6	777
			STD	1.4	1.9	1	0.2	0.5	72
			MAX	37.2	40.9	45	9.0	41.4	925
			MIN	32.8	34.3	40	8.1	39.5	686
20	88.25	80	AV10	35.6	38.8	43	8.3	41.0	826
			STD	1.4	1.3	1	0.1	0.3	43
			MAX	39.0	40.2	45	8.6	41.4	910
			MIN	33.9	36.5	41	8.1	40.3	782
30	88.38	80	AV10	36.5	40.1	43	8.5	40.6	843
			STD	1.6	0.8	3	0.2	0.4	40
			MAX	39.4	42.1	45	8.8	41.1	896
			MIN	33.5	38.7	36	8.3	39.9	776
			Average	35.6	38.7	43	8.4	40.7	815
			Std. Dev.	1.7	1.8	2	0.2	0.5	60
			Maximum	39.4	42.1	45	9.0	41.4	925
			Minimum	32.8	34.3	36	8.1	39.5	686

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.05); A4: [K3550] 360.0 (1.05)

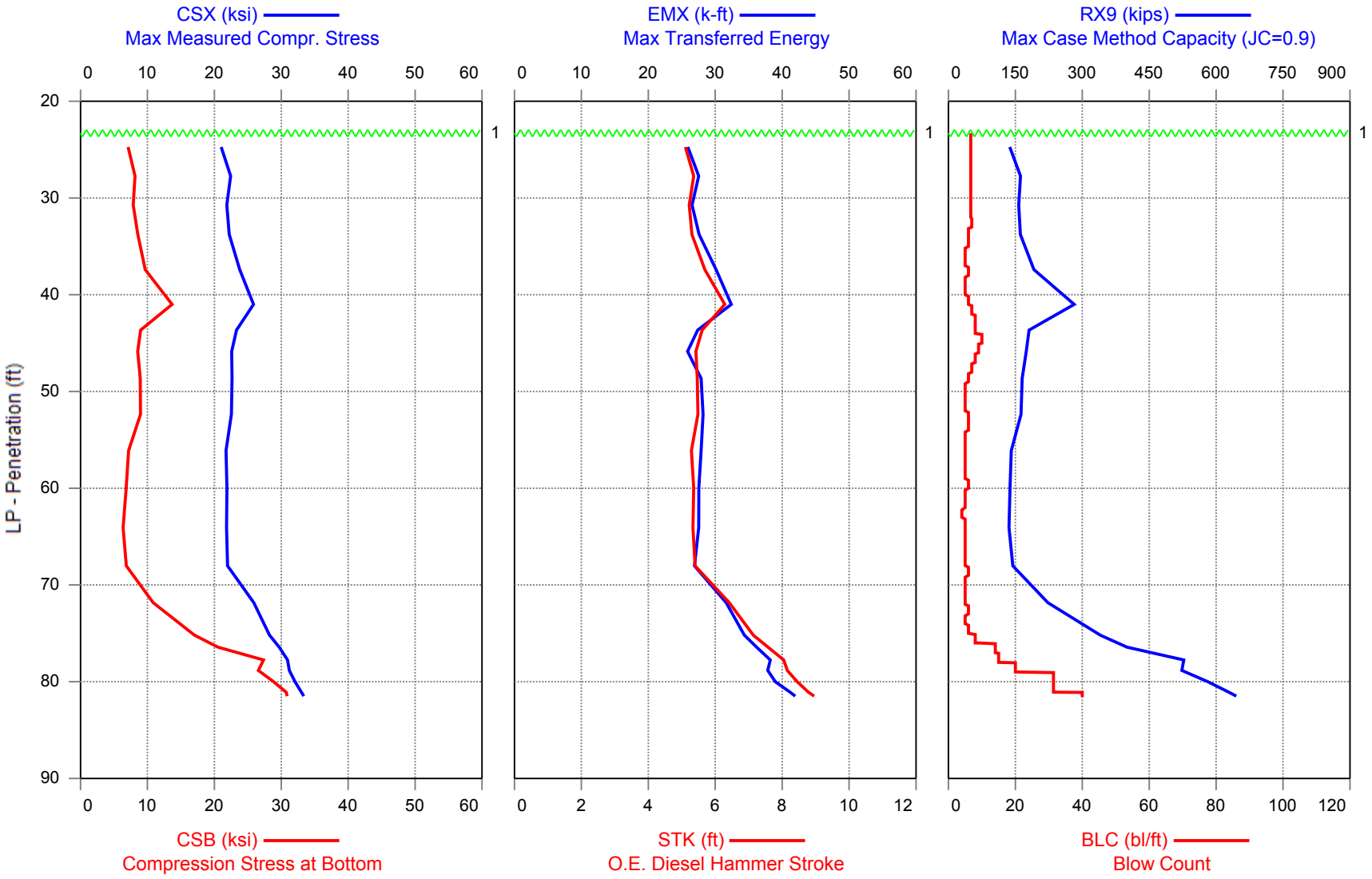
Time Summary

Drive 42 seconds 6:39 AM - 6:40 AM BN 1 - 30

Printed: 21-April-2015

Test started: 21-April-2015

USH 10 over LLBDM - PIER 12 #56
APE D30-42, HP 14 x 73



1 - Reported Reference EL 739.42

USH 10 over LLBDM - PIER 12 #56 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.58 ft EM: 30,000 ksi
WS: 16,807.9 f/s 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#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
3	23.30	7	AV1	21.1	4.2	4.9	28	52.6	55
			MAX	21.1	4.2	4.9	28	52.6	55
			MIN	21.1	4.2	4.9	28	52.6	55
61	32.00	7	AV58	21.8	7.7	5.2	27	51.3	154
			MAX	24.6	10.6	6.1	32	59.3	225
			MIN	15.9	2.7	3.8	17	47.7	31
68	33.00	7	AV7	21.9	8.7	5.3	26	51.0	167
			MAX	22.6	9.5	5.4	27	51.7	191
			MIN	21.5	7.8	5.1	25	50.4	154
74	34.00	6	AV6	22.2	8.3	5.3	28	50.9	154
			MAX	22.5	9.5	5.4	28	51.3	162
			MIN	21.8	7.1	5.2	27	50.5	143
80	35.00	6	AV6	22.3	8.4	5.3	28	50.9	160
			MAX	22.9	9.9	5.4	29	52.2	177
			MIN	21.1	7.2	5.0	25	50.4	149
85	36.00	5	AV5	22.9	9.2	5.5	30	50.0	172
			MAX	23.7	10.6	5.7	32	50.8	193
			MIN	22.1	8.5	5.3	28	49.2	154
90	37.00	5	AV5	22.5	7.7	5.3	29	50.6	148
			MAX	22.9	8.4	5.4	31	51.1	156
			MIN	22.1	7.3	5.2	28	50.2	143
96	38.00	6	AV6	23.6	9.1	5.6	30	49.5	177
			MAX	24.0	10.4	5.7	32	50.1	201
			MIN	23.1	7.4	5.5	29	49.1	162
101	39.00	5	AV5	25.3	12.2	6.1	32	47.6	246
			MAX	26.1	12.7	6.3	33	48.0	274
			MIN	24.8	11.3	6.0	30	46.7	217
106	40.00	5	AV5	26.0	14.6	6.3	32	46.7	302
			MAX	26.3	16.0	6.5	33	47.2	318
			MIN	25.7	13.6	6.2	32	46.3	284
112	41.00	6	AV6	26.3	14.3	6.4	33	46.5	302
			MAX	26.7	15.9	6.5	34	47.1	317
			MIN	25.6	13.5	6.2	32	46.0	291
119	42.00	7	AV7	25.8	13.2	6.3	33	46.9	269
			MAX	26.5	15.0	6.4	34	47.4	292
			MIN	25.3	12.2	6.1	31	46.4	252

USH 10 over LLBDM - PIER 12 #56 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
127	43.00	8	AV8	25.0	11.5	6.0	31	47.8	226
			MAX	25.8	12.9	6.3	32	48.8	244
			MIN	24.1	10.1	5.8	28	47.0	202
135	44.00	8	AV8	23.5	9.3	5.6	28	49.4	179
			MAX	24.8	11.8	6.0	30	50.6	214
			MIN	22.5	6.8	5.4	26	48.1	155
145	45.00	10	AV10	21.9	7.2	5.3	24	51.0	157
			MAX	22.6	8.0	5.4	25	52.0	171
			MIN	21.1	6.2	5.1	23	50.2	151
154	46.00	9	AV9	22.7	8.6	5.4	26	50.2	182
			MAX	23.2	10.0	5.6	27	51.1	210
			MIN	21.9	7.1	5.2	25	49.7	164
162	47.00	8	AV8	22.7	8.9	5.5	27	50.2	171
			MAX	24.4	9.3	5.9	29	50.9	186
			MIN	22.0	7.6	5.3	26	48.5	165
169	48.00	7	AV7	22.8	9.0	5.5	27	50.0	172
			MAX	23.8	9.5	5.7	28	50.5	197
			MIN	22.3	8.8	5.4	27	49.2	164
175	49.00	6	AV6	22.2	8.3	5.4	27	50.6	160
			MAX	23.5	9.9	5.6	29	51.5	181
			MIN	21.3	7.5	5.2	25	49.4	148
180	50.00	5	AV5	22.8	9.2	5.5	29	49.9	163
			MAX	23.3	9.8	5.6	30	50.9	169
			MIN	22.0	8.1	5.3	27	49.4	151
185	51.00	5	AV5	23.1	9.6	5.6	30	49.4	169
			MAX	23.8	9.9	5.8	31	49.8	173
			MIN	22.7	9.4	5.5	29	48.8	164
190	52.00	5	AV5	22.8	9.2	5.5	28	49.8	164
			MAX	23.3	9.4	5.7	29	50.1	166
			MIN	22.4	9.1	5.5	28	49.2	162
196	53.00	6	AV6	22.4	9.0	5.4	28	50.3	161
			MAX	22.9	9.9	5.6	29	51.3	173
			MIN	21.3	8.5	5.2	26	49.6	151
202	54.00	6	AV6	22.2	8.4	5.4	27	50.5	158
			MAX	23.9	9.0	5.8	31	52.1	164
			MIN	20.5	8.0	5.0	25	48.7	148
207	55.00	5	AV5	23.2	9.0	5.6	30	49.4	166
			MAX	24.0	9.8	5.8	32	49.9	176
			MIN	22.7	8.4	5.5	28	48.7	157

USH 10 over LLBDM - PIER 12 #56 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
212	56.00	5	AV5	22.2	7.5	5.4	29	50.5	142
			MAX	23.3	8.2	5.7	31	51.9	157
			MIN	20.9	7.0	5.1	27	49.3	133
217	57.00	5	AV5	20.9	6.4	5.1	26	51.8	135
			MAX	21.9	6.8	5.3	28	52.7	138
			MIN	20.1	6.1	4.9	25	50.8	130
222	58.00	5	AV5	20.7	5.7	5.0	26	52.1	121
			MAX	21.0	6.7	5.1	27	52.4	134
			MIN	20.2	5.0	5.0	26	51.7	112
227	59.00	5	AV5	22.0	7.3	5.4	28	50.5	138
			MAX	23.8	8.0	5.8	31	52.8	146
			MIN	20.0	5.7	4.9	25	48.7	120
233	60.00	6	AV6	22.0	7.4	5.4	27	50.5	140
			MAX	22.9	8.1	5.5	28	51.0	146
			MIN	21.4	6.8	5.3	25	49.9	133
238	61.00	5	AV5	22.0	6.5	5.4	28	50.5	135
			MAX	22.9	6.8	5.6	29	51.1	144
			MIN	21.3	6.1	5.2	27	49.6	126
243	62.00	5	AV5	21.6	6.1	5.3	28	51.0	140
			MAX	22.3	7.0	5.4	29	51.8	153
			MIN	20.8	5.6	5.1	25	50.4	132
247	63.00	4	AV4	22.7	7.5	5.5	30	49.8	141
			MAX	23.2	7.7	5.7	31	50.4	148
			MIN	22.2	7.3	5.4	29	49.1	135
252	64.00	5	AV5	22.0	7.0	5.4	28	50.5	138
			MAX	22.6	7.5	5.5	29	50.9	144
			MIN	21.5	6.7	5.3	27	50.0	135
257	65.00	5	AV5	21.5	5.7	5.3	27	51.0	133
			MAX	22.3	6.2	5.4	28	51.7	146
			MIN	20.7	5.0	5.1	26	50.2	125
262	66.00	5	AV5	21.2	5.4	5.2	26	51.4	131
			MAX	21.7	5.8	5.2	27	51.8	134
			MIN	20.9	4.8	5.1	25	51.1	129
267	67.00	5	AV5	21.4	6.6	5.3	27	51.0	135
			MAX	21.7	6.9	5.4	28	51.3	143
			MIN	21.0	6.3	5.2	25	50.5	127
272	68.00	5	AV5	22.1	7.2	5.4	28	50.3	142
			MAX	22.8	7.7	5.6	30	51.0	147
			MIN	21.3	6.8	5.3	27	49.4	139
278	69.00	6	AV6	21.6	6.3	5.3	25	50.9	149

USH 10 over LLBDM - PIER 12 #56 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	21.9	7.0	5.4	26	51.6	155
			MIN	21.0	6.0	5.1	24	50.5	146
283	70.00	5	AV5	23.5	7.6	5.8	29	48.9	156
			MAX	24.8	8.2	6.1	31	50.4	170
			MIN	22.0	7.0	5.4	27	47.4	140
288	71.00	5	AV5	24.8	8.3	6.1	31	47.5	172
			MAX	25.7	8.4	6.3	33	49.1	187
			MIN	23.4	8.2	5.7	28	46.7	166
293	72.00	5	AV5	25.5	9.3	6.3	31	46.9	201
			MAX	26.2	9.4	6.5	32	47.4	213
			MIN	24.9	9.1	6.1	30	46.2	193
299	73.00	6	AV6	26.6	12.3	6.6	32	45.9	251
			MAX	27.1	13.7	6.7	33	46.8	275
			MIN	25.8	10.7	6.3	30	45.4	226
304	74.00	5	AV5	28.0	17.0	7.1	34	44.2	330
			MAX	29.0	20.5	7.5	36	45.3	399
			MIN	26.9	14.2	6.8	32	43.2	277
310	75.00	6	AV6	28.6	17.7	7.3	36	43.8	353
			MAX	29.6	19.3	7.6	38	44.2	387
			MIN	28.0	16.7	7.1	34	42.8	333
318	76.00	8	AV8	27.7	15.6	6.9	33	44.7	318
			MAX	28.2	16.7	7.1	34	45.7	336
			MIN	26.8	14.9	6.6	31	44.3	305
319	76.00	9	AV1	28.7	17.5	7.2	35	43.8	343
			MAX	28.7	17.5	7.2	35	43.8	343
			MIN	28.7	17.5	7.2	35	43.8	343
341	77.00	14	AV22	29.4	20.1	7.5	36	43.1	391
			MAX	31.2	25.0	8.1	39	44.5	471
			MIN	27.9	17.8	7.0	32	41.4	349
356	78.00	15	AV15	30.9	26.5	8.0	38	41.7	510
			MAX	31.8	28.3	8.3	40	42.7	538
			MIN	30.0	23.9	7.6	36	41.0	471
376	79.00	20	AV20	31.1	27.1	8.1	38	41.5	530
			MAX	31.9	30.1	8.4	39	42.0	593
			MIN	30.3	24.6	7.9	37	40.9	501
410	81.08	31	AV34	32.1	28.9	8.5	39	40.6	583
			MAX	33.8	31.9	9.1	43	41.7	645
			MIN	30.6	25.8	8.0	36	39.3	527
420	81.33	40	AV10	33.0	30.8	8.8	41	40.0	634
			MAX	33.6	31.8	9.0	42	40.7	642

USH 10 over LLBDM - PIER 12 #56 APE D30-42, HP 14 x 73
OP: RF Date: 21-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	32.0	29.7	8.4	39	39.5	627
430	81.58	40	AV10	33.4	30.9	9.0	42	39.6	645
			MAX	34.2	31.8	9.2	44	39.9	655
			MIN	32.8	30.3	8.8	41	39.0	632
			Average	25.2	13.6	6.3	31	47.5	272
			Maximum	34.2	31.9	9.2	44	59.3	655
			Minimum	15.9	2.7	3.8	17	39.0	31

Total number of blows analyzed: 428

BL# Sensors

1-430 F3: [F607] 93.6 (0.98); F4: [D815] 93.0 (0.98); A3: [K2524] 360.0 (1.02); A4: [K3550] 360.0 (1.02)

BL# Comments

3 Reported Reference EL 739.42

Time Summary

Drive 11 minutes 5 seconds 10:34 AM - 10:46 AM BN 1 - 430

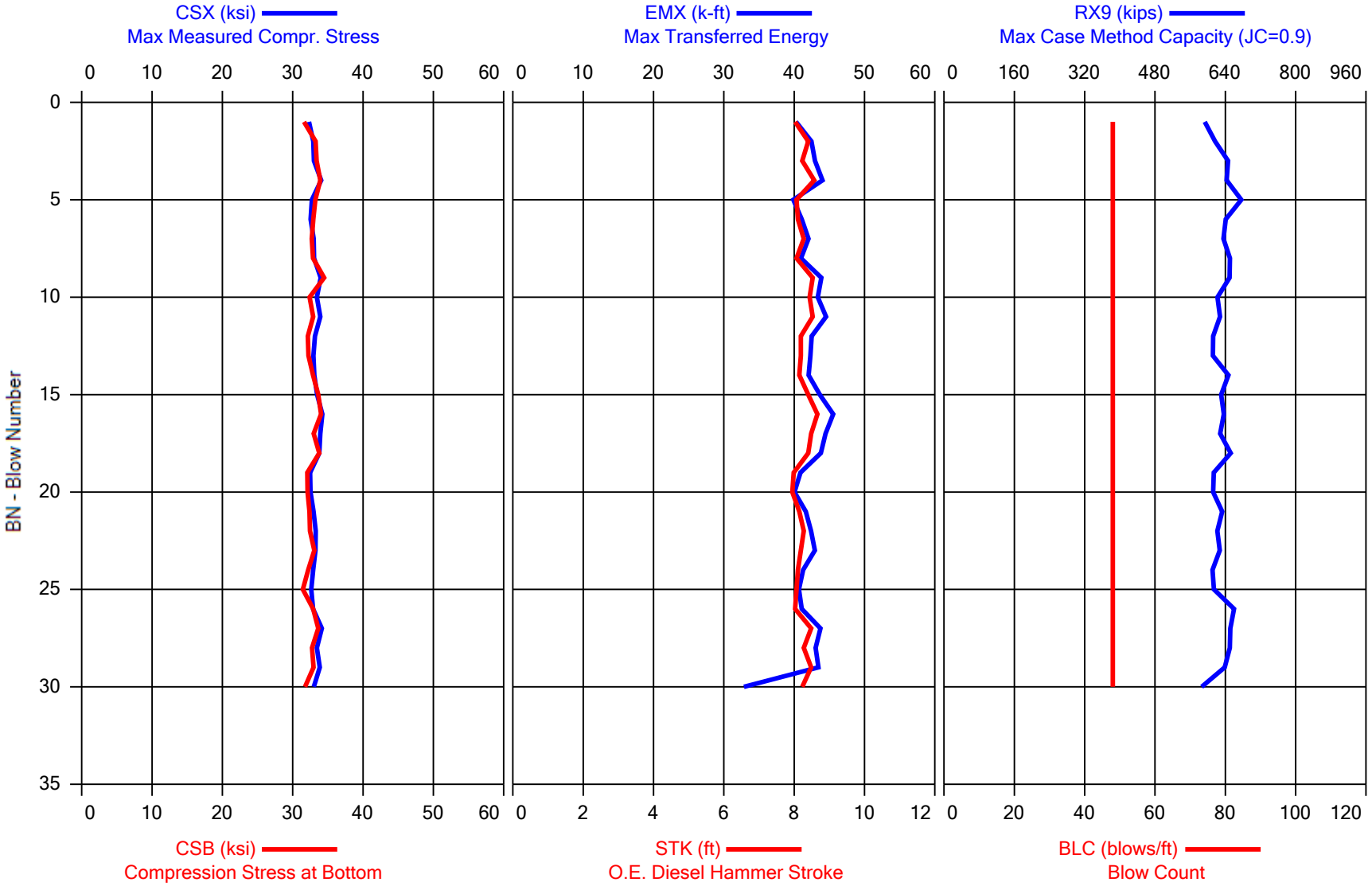
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 22-April-2015

Test started: 22-April-2015

USH 10 over Little Lake Butte des Morts - Pier 12 #56 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 12 #56 Restrike APE D30-42, HP 14 x 73
OP: TC Date: 22-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 92.58 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	81.79	48	AV10	33.1	33.1	42	8.3	41.1	637
			STD	0.5	0.8	1	0.2	0.5	21
			MAX	34.1	34.5	44	8.6	41.7	676
			MIN	32.3	31.6	40	8.0	40.4	593
20	82.00	48	AV10	33.3	32.9	43	8.3	41.1	627
			STD	0.6	0.7	2	0.2	0.5	14
			MAX	34.2	34.0	46	8.7	41.9	652
			MIN	32.5	32.1	40	7.9	40.2	612
30	82.21	48	AV10	33.2	32.6	41	8.2	41.2	629
			STD	0.4	0.6	3	0.1	0.4	21
			MAX	34.1	33.6	44	8.5	41.7	660
			MIN	32.6	31.4	33	8.0	40.6	586
			Average	33.2	32.8	42	8.3	41.1	631
			Std. Dev.	0.5	0.7	2	0.2	0.5	20
			Maximum	34.2	34.5	46	8.7	41.9	676
			Minimum	32.3	31.4	33	7.9	40.2	586

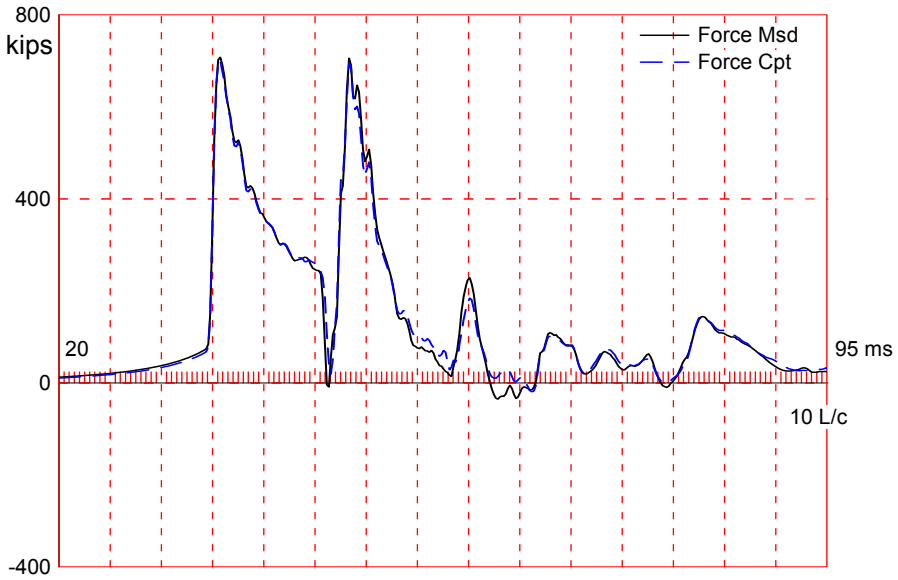
Total number of blows analyzed: 30

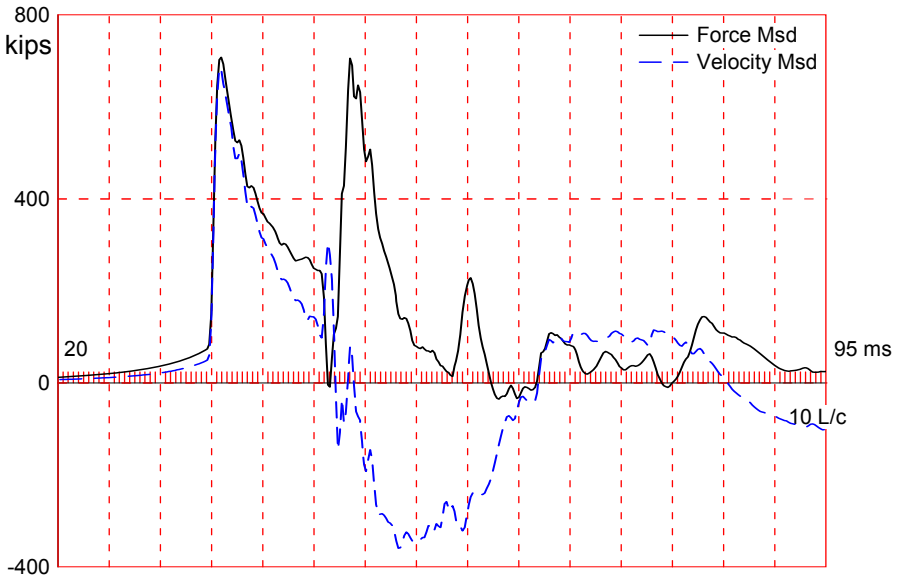
BL# Sensors

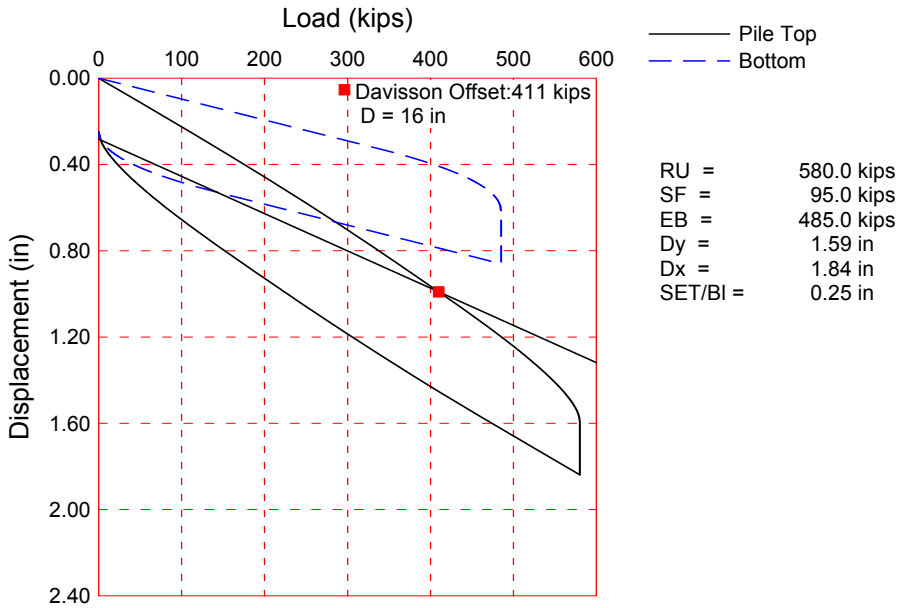
1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.05); A4: [K3550] 360.0 (1.05)

Time Summary

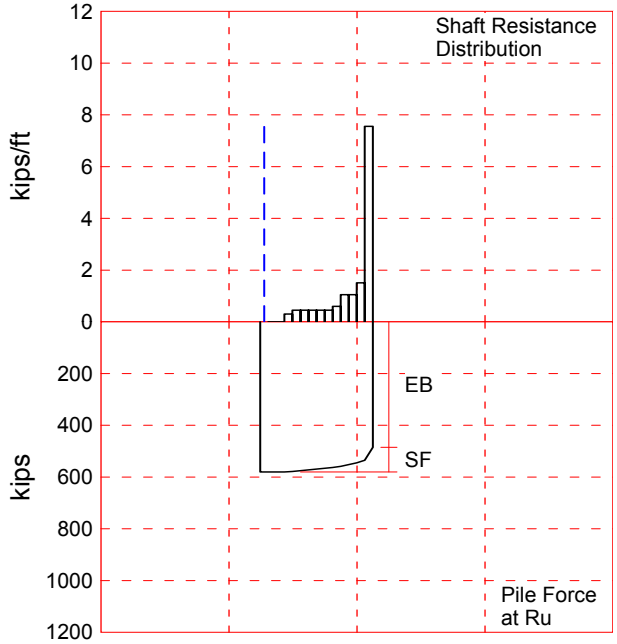
Drive 42 seconds 6:49 AM - 6:50 AM BN 1 - 30







RU =	580.0 kips
SF =	95.0 kips
EB =	485.0 kips
Dy =	1.59 in
Dx =	1.84 in
SET/BI =	0.25 in



Length b. Sensors	92.7 ft
Embedment	88.3 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.	16847 ft/s
Match Quality	3.89
Top Compr. Stress	33.1 ksi
Max Compr. Stress	33.8 ksi
Max Tension Stress	-5.63 ksi
Avg. Shaft Quake	0.25 in
Toe Quake	0.47 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.14 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

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: 580.0; along Shaft 95.0; at Toe 485.0 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
				580.0				
1	13.2	8.9	0.0	580.0	0.0	0.00	0.00	0.00
2	19.9	15.5	0.0	580.0	0.0	0.00	0.00	0.00
3	26.5	22.1	2.0	578.0	2.0	0.30	0.06	0.27
4	33.1	28.8	3.0	575.0	5.0	0.45	0.10	0.27
5	39.7	35.4	3.0	572.0	8.0	0.45	0.10	0.27
6	46.3	42.0	3.0	569.0	11.0	0.45	0.10	0.27
7	52.9	48.6	3.0	566.0	14.0	0.45	0.10	0.27
8	59.6	55.2	3.0	563.0	17.0	0.45	0.10	0.27
9	66.2	61.9	4.0	559.0	21.0	0.60	0.13	0.27
10	72.8	68.5	7.0	552.0	28.0	1.06	0.23	0.27
11	79.4	75.1	7.0	545.0	35.0	1.06	0.23	0.27
12	86.0	81.7	10.0	535.0	45.0	1.51	0.32	0.27
13	92.7	88.3	50.0	485.0	95.0	7.55	1.61	0.27
Avg. Shaft			7.3			1.08	0.23	0.27
Toe			485.0				351.84	0.14

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.25	0.47
Case Damping Factor		0.67	1.78
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	90
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.22

CAPWAP match quality = 3.89 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.25 in; Blow Count = 48 b/ft
Computed: Final Set = 0.22 in; Blow Count = 55 b/ft
Transducer F3(D815) CAL: 93.0; RF: 0.96; F4(F607) CAL: 93.6; RF: 0.96
A3(K3550) CAL: 360; RF: 1.03; A4(K2524) CAL: 360; RF: 1.03

max. Top Comp. Stress = 33.1 ksi (T= 48.7 ms, max= 1.021 x Top)
max. Comp. Stress = 33.8 ksi (Z= 92.7 ft, T= 42.4 ms)
max. Tens. Stress = -5.63 ksi (Z= 72.8 ft, T= 67.0 ms)
max. Energy (EMX) = 43.8 kip-ft; max. Measured Top Displ. (DMX)= 1.31 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	708.3	-34.6	33.1	-1.62	43.8	18.0	1.31
2	6.6	705.6	-34.0	33.0	-1.59	43.6	18.0	1.30
4	13.2	703.2	-38.0	32.9	-1.78	43.0	18.0	1.26
6	19.9	705.7	-57.5	33.0	-2.68	42.3	17.9	1.21
8	26.5	712.1	-75.4	33.3	-3.52	41.5	17.7	1.16
10	33.1	708.5	-90.3	33.1	-4.22	39.8	17.5	1.11
12	39.7	699.2	-93.7	32.7	-4.38	37.8	17.3	1.05
14	46.3	689.9	-90.4	32.2	-4.22	35.6	17.1	0.99
15	49.6	677.2	-84.3	31.6	-3.94	34.1	17.0	0.96
16	52.9	680.7	-90.7	31.8	-4.24	33.4	16.9	0.93
17	56.3	668.1	-87.1	31.2	-4.07	31.8	16.8	0.90
18	59.6	672.1	-85.5	31.4	-3.99	30.9	16.7	0.86
19	62.9	660.8	-84.3	30.9	-3.94	29.3	16.6	0.82
20	66.2	666.9	-99.5	31.2	-4.65	28.4	16.4	0.79
21	69.5	653.6	-110.2	30.5	-5.15	26.4	16.2	0.75
22	72.8	660.5	-120.5	30.9	-5.63	25.5	16.0	0.71
23	76.1	638.9	-114.5	29.8	-5.35	22.9	16.7	0.67
24	79.4	655.7	-110.0	30.6	-5.14	21.9	16.8	0.64
25	82.7	672.7	-91.2	31.4	-4.26	19.6	18.3	0.60
26	86.0	706.2	-79.2	33.0	-3.70	18.7	19.6	0.56
27	89.4	703.6	-61.0	32.9	-2.85	16.2	20.8	0.53
28	92.7	723.4	-59.1	33.8	-2.76	9.8	21.0	0.49
Absolute	92.7			33.8			(T =	42.4 ms)
	72.8				-5.63		(T =	67.0 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	634.8	479.7	324.5	169.3	14.2					
RX	838.5	795.8	776.6	757.3	738.0	723.2	708.5	695.2	684.2	675.7
RU	634.8	479.7	324.5	169.3	14.2					

RAU = 540.2 (kips); RA2 = 752.6 (kips)

Current CAPWAP Ru = 580.0 (kips); Corresponding J(RP)= 0.07;

RMX requires higher damping; see PDA-W

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
18.3	35.75	697.6	713.1	742.3	1.31	0.25	0.25	43.9	673.0	1940

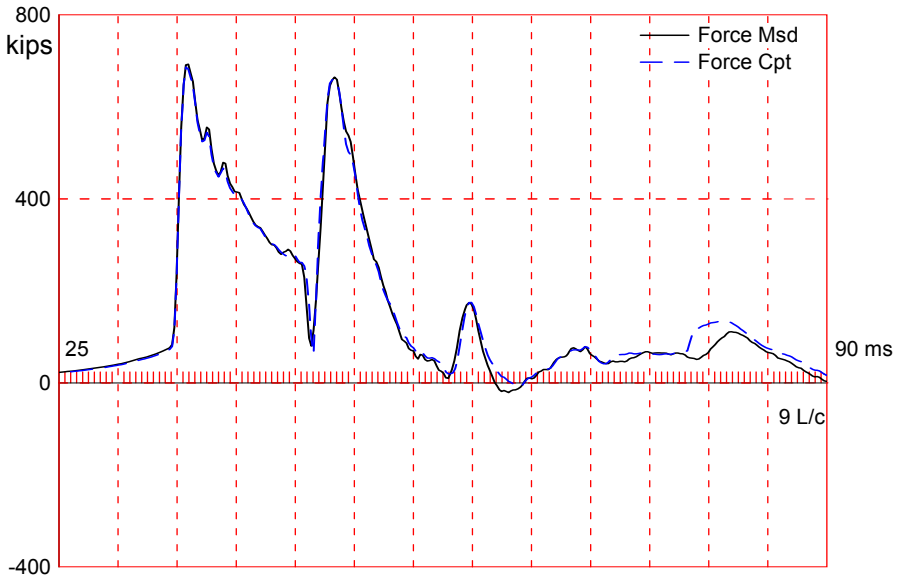
PILE PROFILE AND PILE MODEL

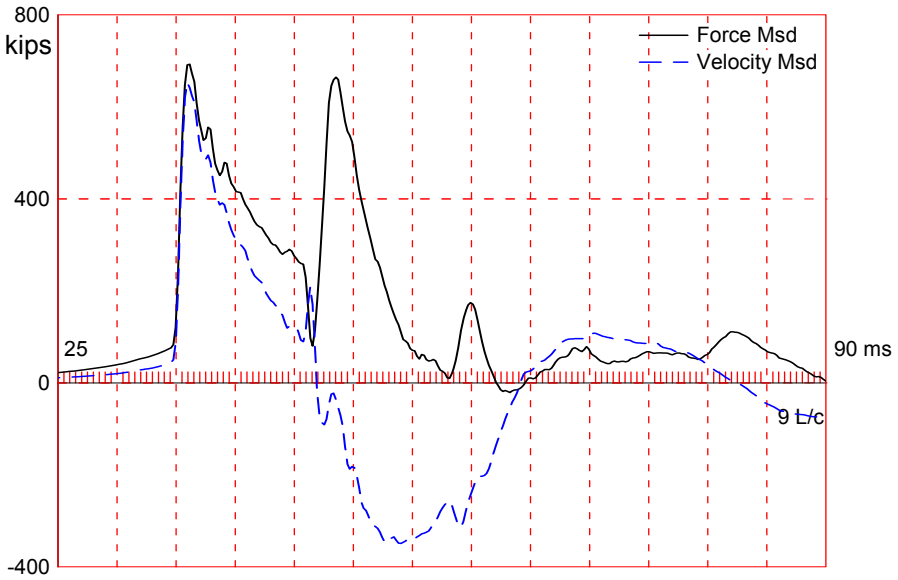
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

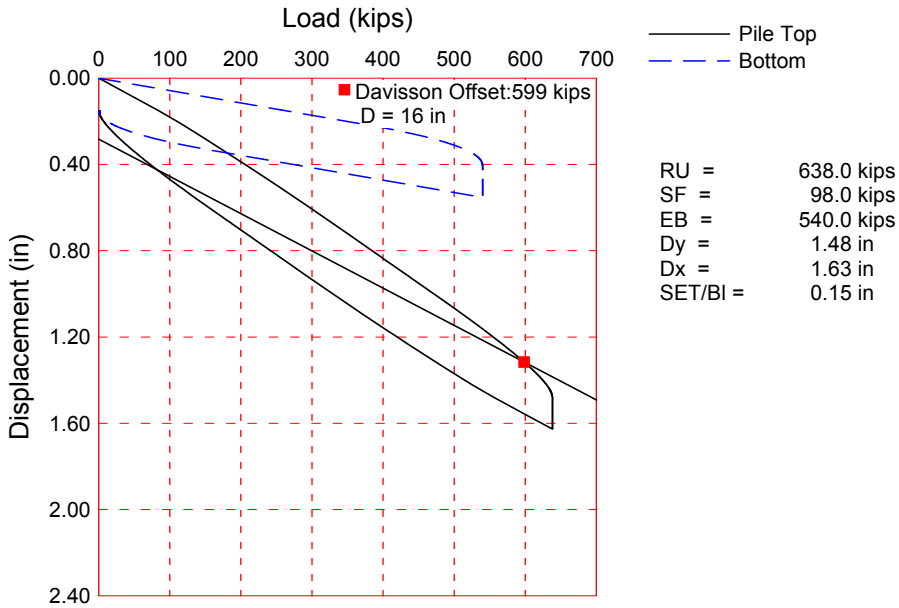
Toe Area 198.5 in^2

Top Segment Length 3.31 ft, Top Impedance 38 kips/ft/s

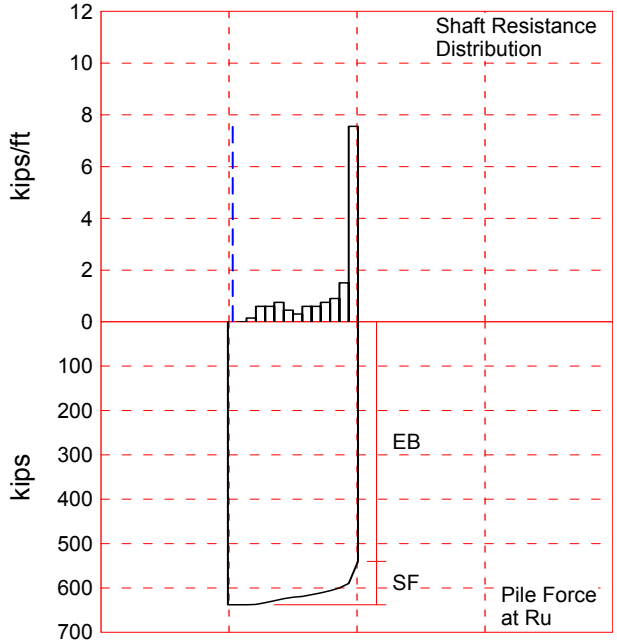
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16847.3 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.770 ft^3; Volume ratio considering added impedance: 1.000







RU =	638.0 kips
SF =	98.0 kips
EB =	540.0 kips
Dy =	1.48 in
Dx =	1.63 in
SET/Bl =	0.15 in



Length b. Sensors	92.7 ft
Embedment	88.5 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.	16847 ft/s
Match Quality	3.82
Top Compr. Stress	32.1 ksi
Max Compr. Stress	37.6 ksi
Max Tension Stress	-5.06 ksi
Avg. Shaft Quake	0.11 in
Toe Quake	0.31 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.18 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: 638.0; along Shaft 98.0; at Toe 540.0 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
				638.0				
1	13.2	9.0	0.0	638.0	0.0	0.00	0.00	0.00
2	19.9	15.6	1.0	637.0	1.0	0.15	0.03	0.29
3	26.5	22.3	4.0	633.0	5.0	0.60	0.13	0.29
4	33.1	28.9	4.0	629.0	9.0	0.60	0.13	0.29
5	39.7	35.5	5.0	624.0	14.0	0.76	0.16	0.29
6	46.3	42.1	3.0	621.0	17.0	0.45	0.10	0.29
7	52.9	48.7	2.0	619.0	19.0	0.30	0.06	0.29
8	59.6	55.4	4.0	615.0	23.0	0.60	0.13	0.29
9	66.2	62.0	4.0	611.0	27.0	0.60	0.13	0.29
10	72.8	68.6	5.0	606.0	32.0	0.76	0.16	0.29
11	79.4	75.2	6.0	600.0	38.0	0.91	0.19	0.29
12	86.0	81.8	10.0	590.0	48.0	1.51	0.32	0.29
13	92.7	88.5	50.0	540.0	98.0	7.55	1.61	0.29
Avg. Shaft			7.5			1.11	0.24	0.29
Toe			540.0				391.73	0.18

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.11	0.31
Case Damping Factor		0.74	2.54
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	79	41
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	75	
Resistance Gap (included in Toe Quake)	(in)		0.12

CAPWAP match quality = 3.82 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.11 in; Blow Count = 109 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.05; A4(K3550) CAL: 360; RF: 1.05

max. Top Comp. Stress = 32.1 ksi (T= 36.1 ms, max= 1.171 x Top)
max. Comp. Stress = 37.6 ksi (Z= 92.7 ft, T= 42.0 ms)
max. Tens. Stress = -5.06 ksi (Z= 46.3 ft, T= 61.5 ms)
max. Energy (EMX) = 43.6 kip-ft; max. Measured Top Displ. (DMX)= 1.23 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	687.0	-29.4	32.1	-1.37	43.6	17.2	1.23
2	6.6	687.4	-38.2	32.1	-1.79	43.4	17.2	1.21
4	13.2	688.7	-64.8	32.2	-3.03	42.8	17.1	1.17
6	19.9	693.7	-79.2	32.4	-3.70	42.0	16.9	1.12
8	26.5	698.4	-83.9	32.6	-3.92	40.7	16.6	1.07
10	33.1	686.8	-75.4	32.1	-3.52	38.4	16.3	1.02
12	39.7	674.2	-77.1	31.5	-3.60	35.9	16.0	0.96
14	46.3	653.0	-108.3	30.5	-5.06	33.0	15.8	0.89
15	49.6	639.2	-108.1	29.9	-5.05	31.4	15.7	0.86
16	52.9	643.8	-106.8	30.1	-4.99	30.5	15.6	0.82
17	56.3	637.7	-101.4	29.8	-4.74	29.0	15.4	0.78
18	59.6	652.6	-103.5	30.5	-4.83	28.0	15.3	0.75
19	62.9	662.6	-97.7	31.0	-4.57	25.9	15.2	0.70
20	66.2	669.4	-101.5	31.3	-4.74	24.7	15.0	0.66
21	69.5	688.9	-100.8	32.2	-4.71	22.7	14.9	0.62
22	72.8	713.3	-101.2	33.3	-4.73	21.5	14.7	0.58
23	76.1	714.7	-94.3	33.4	-4.40	19.3	14.5	0.54
24	79.4	728.5	-95.9	34.0	-4.48	18.0	14.6	0.49
25	82.7	760.9	-87.2	35.5	-4.07	15.8	16.3	0.45
26	86.0	771.6	-88.1	36.0	-4.11	14.7	17.5	0.41
27	89.4	764.3	-75.8	35.7	-3.54	12.4	17.7	0.37
28	92.7	804.3	-74.3	37.6	-3.47	8.5	16.3	0.33
Absolute	92.7			37.6			(T =	42.0 ms)
	46.3				-5.06		(T =	61.5 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	754.1	636.0	517.8	399.6	281.5					
RX	896.8	854.7	820.9	787.0	753.2	729.2	718.9	708.6	698.3	688.1
RU	754.1	636.0	517.8	399.6	281.5					

RAU = 360.4 (kips); RA2 = 785.8 (kips)

Current CAPWAP Ru = 638.0 (kips); Corresponding J(RP)= 0.20;

RMX requires higher damping; see PDA-W

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	35.95	658.2	686.7	706.0	1.23	0.15	0.15	43.8	762.0	2842

PILE PROFILE AND PILE MODEL

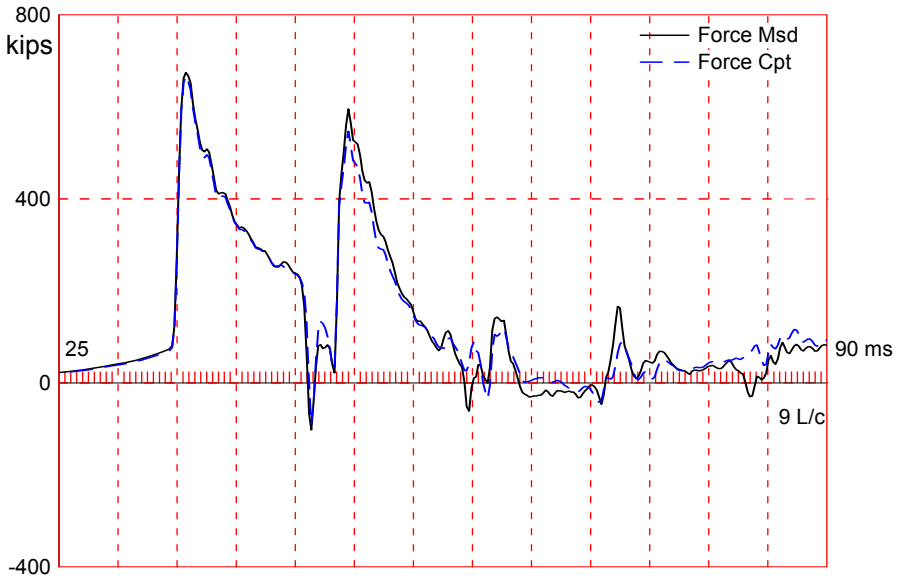
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.7	21.4	29992.2	492.000	4.70

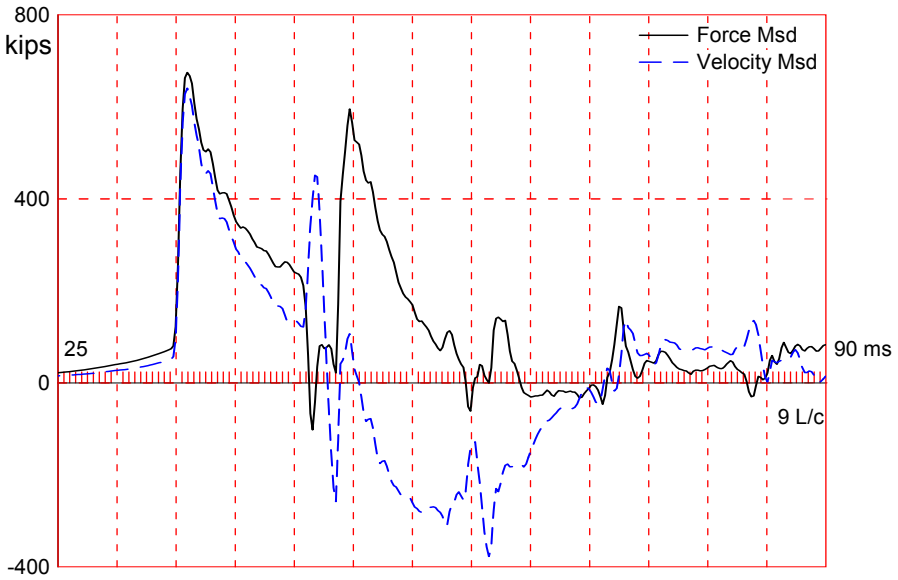
Toe Area 198.5 in^2

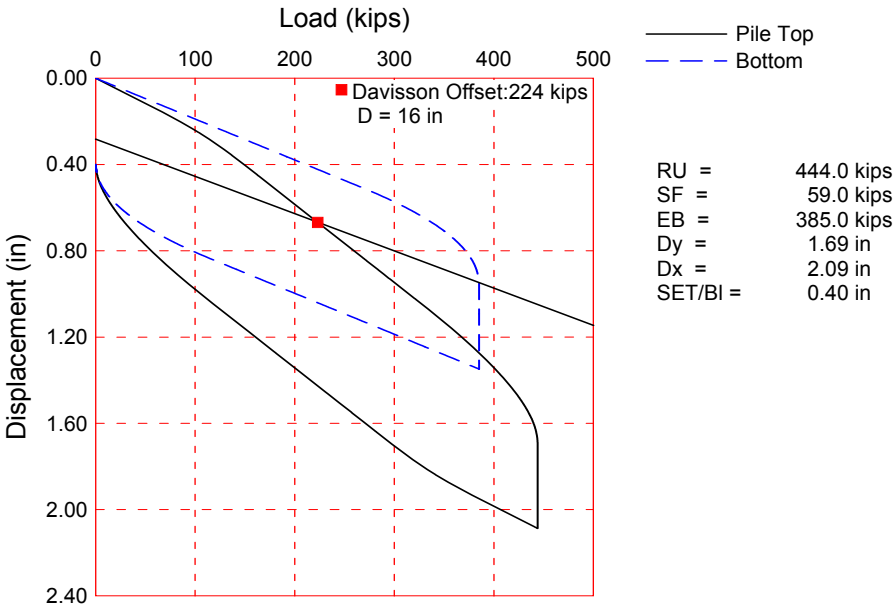
Top Segment Length 3.31 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16847.3 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.770 ft^3; Volume ratio considering added impedance: 1.000

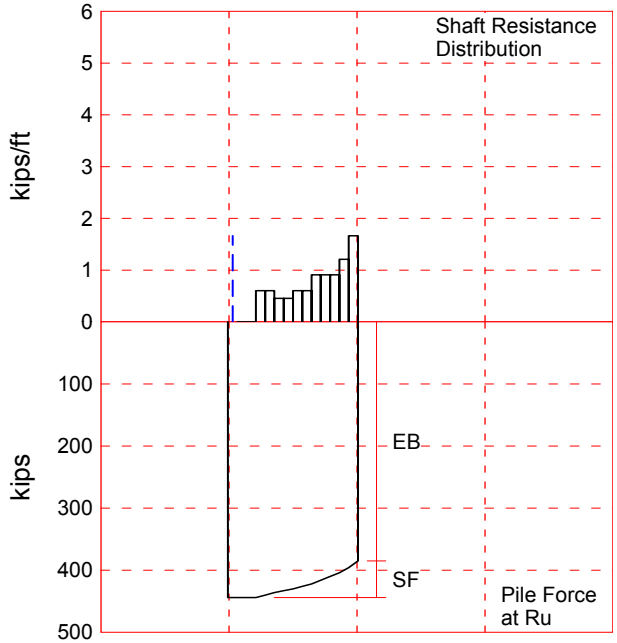
Match Quality Poor - Results May Be Unreliable!!!







RU =	444.0 kips
SF =	59.0 kips
EB =	385.0 kips
Dy =	1.69 in
Dx =	2.09 in
SET/BI =	0.40 in



Length b. Sensors	92.5 ft
Embedment	87.9 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.	16818 ft/s
Match Quality	6.12
Top Compr. Stress	31.2 ksi
Max Compr. Stress	31.7 ksi
Max Tension Stress	-6.29 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.73 in
Avg. Shaft Smith Dpg.	0.22 s/ft
Toe Smith Damping	0.11 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.

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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.

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Match Quality Poor - Results May Be Unreliable!!!

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 444.0; along Shaft 59.0; at Toe 385.0 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
				444.0				
1	13.2	8.6	0.0	444.0	0.0	0.00	0.00	0.00
2	19.8	15.2	0.0	444.0	0.0	0.00	0.00	0.00
3	26.4	21.8	4.0	440.0	4.0	0.61	0.13	0.22
4	33.0	28.4	4.0	436.0	8.0	0.61	0.13	0.22
5	39.6	35.0	3.0	433.0	11.0	0.45	0.10	0.22
6	46.3	41.7	3.0	430.0	14.0	0.45	0.10	0.22
7	52.9	48.3	4.0	426.0	18.0	0.61	0.13	0.22
8	59.5	54.9	4.0	422.0	22.0	0.61	0.13	0.22
9	66.1	61.5	6.0	416.0	28.0	0.91	0.19	0.22
10	72.7	68.1	6.0	410.0	34.0	0.91	0.19	0.22
11	79.3	74.7	6.0	404.0	40.0	0.91	0.19	0.22
12	85.9	81.3	8.0	396.0	48.0	1.21	0.26	0.22
13	92.5	87.9	11.0	385.0	59.0	1.66	0.35	0.22
Avg. Shaft			4.5			0.67	0.14	0.22
Toe			385.0				279.29	0.11

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.14	0.73
Case Damping Factor		0.34	1.11
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	68
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.19

CAPWAP match quality = 6.12 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.40 in; Blow Count = 30 b/ft
Computed: Final Set = 0.36 in; Blow Count = 33 b/ft

Transducer F3(D815) CAL: 93.0; RF: 0.97; F4(F607) CAL: 93.6; RF: 0.97
A3(K3550) CAL: 360; RF: 1.05; A4(K2524) CAL: 360; RF: 1.05

max. Top Comp. Stress = 31.2 ksi (T= 36.1 ms, max= 1.016 x Top)
max. Comp. Stress = 31.7 ksi (Z= 26.4 ft, T= 37.5 ms)
max. Tens. Stress = -6.29 ksi (Z= 79.3 ft, T= 66.2 ms)
max. Energy (EMX) = 41.2 kip-ft; max. Measured Top Displ. (DMX)= 1.37 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	667.1	-113.5	31.2	-5.30	41.2	17.0	1.37
2	6.6	667.4	-90.1	31.2	-4.21	40.7	17.0	1.35
4	13.2	668.0	-65.1	31.2	-3.04	39.7	16.9	1.32
6	19.8	670.6	-67.7	31.3	-3.16	38.8	16.8	1.27
8	26.4	677.7	-86.3	31.7	-4.03	37.8	16.6	1.23
10	33.0	665.4	-95.5	31.1	-4.46	35.9	16.5	1.18
12	39.6	651.8	-103.2	30.5	-4.82	34.0	16.3	1.14
14	46.3	643.8	-113.5	30.1	-5.30	32.3	16.1	1.09
15	49.6	634.1	-114.7	29.6	-5.36	31.1	16.0	1.07
16	52.9	636.8	-122.8	29.7	-5.74	30.7	15.9	1.04
17	56.2	622.3	-121.9	29.1	-5.69	29.2	15.8	1.02
18	59.5	625.4	-129.6	29.2	-6.05	28.8	16.6	0.99
19	62.8	612.6	-128.2	28.6	-5.99	27.3	17.1	0.97
20	66.1	615.7	-134.1	28.8	-6.26	26.9	17.2	0.94
21	69.4	593.8	-128.0	27.7	-5.98	24.9	18.3	0.92
22	72.7	596.7	-134.5	27.9	-6.28	24.5	19.7	0.89
23	76.0	574.7	-128.8	26.8	-6.02	22.6	19.8	0.87
24	79.3	577.8	-134.6	27.0	-6.29	22.3	20.5	0.84
25	82.6	554.6	-126.2	25.9	-5.90	20.5	22.0	0.81
26	85.9	509.6	-131.5	23.8	-6.14	20.2	23.6	0.79
27	89.2	500.3	-124.5	23.4	-5.82	18.0	24.3	0.76
28	92.5	525.0	-133.4	24.5	-6.23	16.5	23.2	0.74
Absolute	26.4			31.7			(T =	37.5 ms)
	79.3				-6.29		(T =	66.2 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	439.2	260.7	82.3	0.0	0.0					
RX	658.7	611.3	585.2	562.0	544.5	529.9	518.4	507.0	495.5	489.2
RU	439.2	260.7	82.3	0.0	0.0					

RAU = 440.7 (kips); RA2 = 587.1 (kips)

Current CAPWAP Ru = 444.0 (kips); Corresponding J(RP)= 0.00;

RMX requires higher damping; see PDA-W

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	35.95	648.6	682.8	682.8	1.37	0.40	0.40	40.7	551.3	713

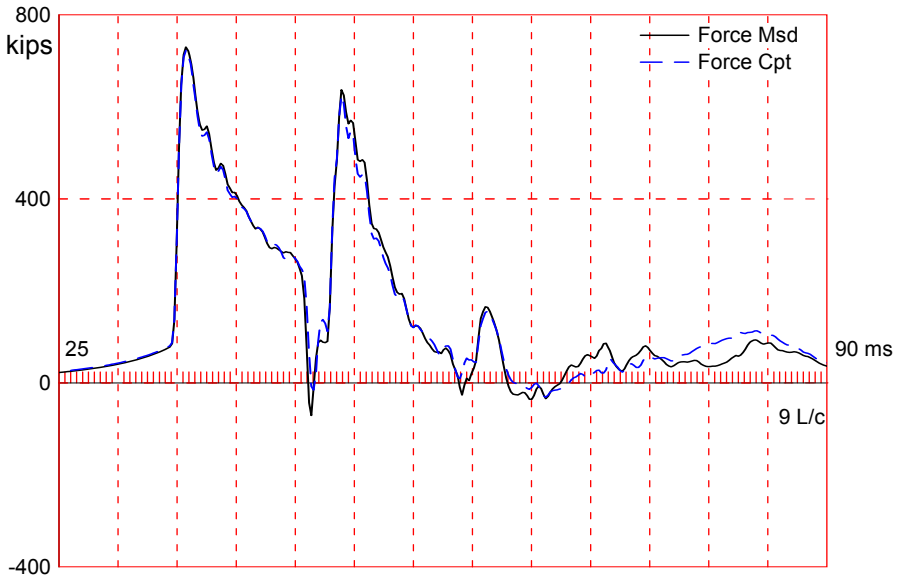
PILE PROFILE AND PILE MODEL

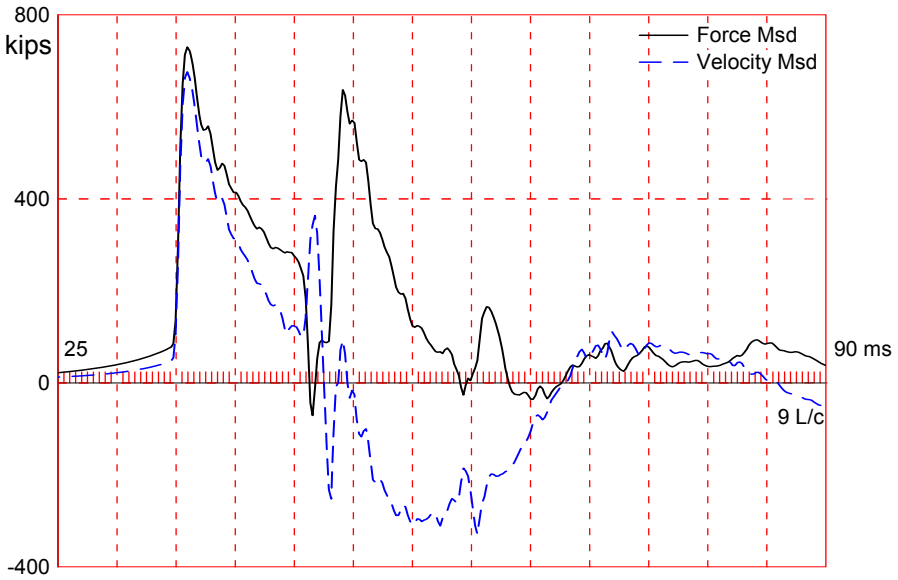
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.5	21.4	29992.2	492.000	4.70

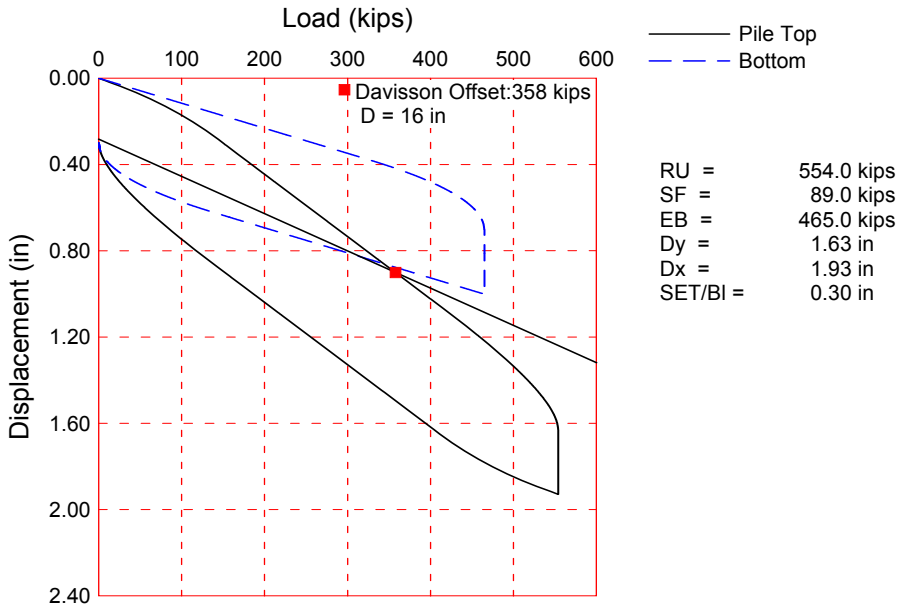
Toe Area 198.5 in^2

Top Segment Length 3.30 ft, Top Impedance 38 kips/ft/s

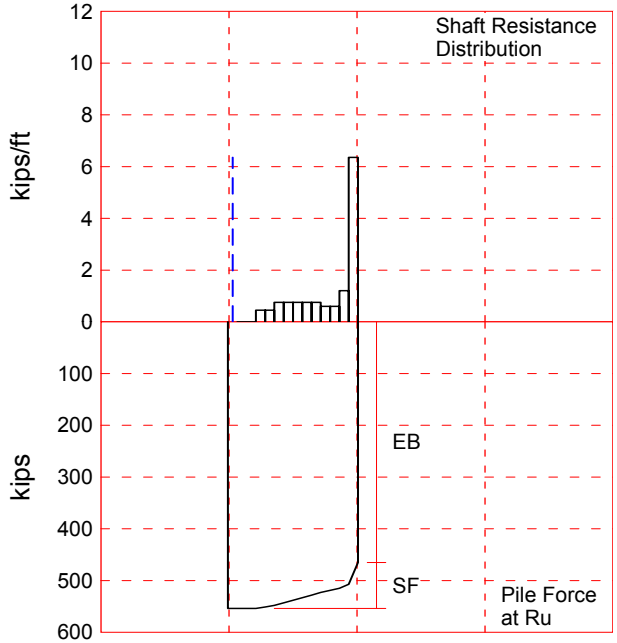
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16818.2 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.747 ft^3; Volume ratio considering added impedance: 1.000







RU =	554.0 kips
SF =	89.0 kips
EB =	465.0 kips
Dy =	1.63 in
Dx =	1.93 in
SET/BI =	0.30 in



Length b. Sensors	92.5 ft
Embedment	88.1 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.	16818 ft/s
Match Quality	4.85
Top Compr. Stress	33.8 ksi
Max Compr. Stress	34.3 ksi
Max Tension Stress	-6.89 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.54 in
Avg. Shaft Smith Dpg.	0.22 s/ft
Toe Smith Damping	0.11 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: 554.0; along Shaft 89.0; at Toe 465.0 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
				554.0				
1	13.2	8.8	0.0	554.0	0.0	0.00	0.00	0.00
2	19.8	15.4	0.0	554.0	0.0	0.00	0.00	0.00
3	26.4	22.1	3.0	551.0	3.0	0.45	0.10	0.22
4	33.0	28.7	3.0	548.0	6.0	0.45	0.10	0.22
5	39.6	35.3	5.0	543.0	11.0	0.76	0.16	0.22
6	46.3	41.9	5.0	538.0	16.0	0.76	0.16	0.22
7	52.9	48.5	5.0	533.0	21.0	0.76	0.16	0.22
8	59.5	55.1	5.0	528.0	26.0	0.76	0.16	0.22
9	66.1	61.7	5.0	523.0	31.0	0.76	0.16	0.22
10	72.7	68.3	4.0	519.0	35.0	0.61	0.13	0.22
11	79.3	74.9	4.0	515.0	39.0	0.61	0.13	0.22
12	85.9	81.5	8.0	507.0	47.0	1.21	0.26	0.22
13	92.5	88.1	42.0	465.0	89.0	6.36	1.35	0.22
Avg. Shaft			6.8			1.01	0.21	0.22
Toe			465.0				337.33	0.11

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.04	0.54
Case Damping Factor		0.51	1.34
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	53
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	65	
Resistance Gap (included in Toe Quake)	(in)		0.15

CAPWAP match quality = 4.85 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.30 in; Blow Count = 40 b/ft
Computed: Final Set = 0.26 in; Blow Count = 46 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.10; A4(K2524) CAL: 360; RF: 1.10

max. Top Comp. Stress = 33.8 ksi (T= 36.1 ms, max= 1.016 x Top)
max. Comp. Stress = 34.3 ksi (Z= 26.4 ft, T= 37.5 ms)
max. Tens. Stress = -6.89 ksi (Z= 79.3 ft, T= 65.2 ms)
max. Energy (EMX) = 45.3 kip-ft; max. Measured Top Displ. (DMX)= 1.33 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	723.5	-57.6	33.8	-2.69	45.3	17.9	1.30
2	6.6	724.0	-49.4	33.8	-2.31	45.0	17.8	1.28
4	13.2	725.2	-65.9	33.9	-3.08	44.5	17.8	1.24
6	19.8	728.1	-79.9	34.0	-3.73	43.9	17.7	1.20
8	26.4	734.7	-91.5	34.3	-4.28	43.1	17.5	1.15
10	33.0	727.8	-104.2	34.0	-4.87	41.4	17.3	1.10
12	39.6	723.3	-118.3	33.8	-5.53	39.5	17.0	1.05
14	46.3	709.4	-122.9	33.1	-5.74	37.1	16.7	1.00
15	49.6	691.3	-123.7	32.3	-5.78	35.1	16.6	0.97
16	52.9	695.5	-130.4	32.5	-6.09	34.5	16.5	0.94
17	56.2	677.6	-126.6	31.7	-5.91	32.6	16.3	0.91
18	59.5	681.7	-124.8	31.8	-5.83	31.9	16.2	0.87
19	62.8	664.0	-124.3	31.0	-5.81	30.0	16.3	0.84
20	66.1	667.6	-134.3	31.2	-6.27	29.3	17.0	0.81
21	69.4	649.2	-133.9	30.3	-6.26	27.4	16.9	0.78
22	72.7	652.4	-138.8	30.5	-6.48	26.6	18.1	0.75
23	76.0	638.7	-140.5	29.8	-6.57	25.0	19.1	0.71
24	79.3	643.4	-147.5	30.1	-6.89	24.2	19.1	0.68
25	82.6	630.6	-142.4	29.5	-6.65	22.6	20.3	0.65
26	85.9	622.5	-140.9	29.1	-6.58	21.9	22.2	0.61
27	89.2	635.5	-137.4	29.7	-6.42	19.6	23.4	0.58
28	92.5	659.6	-140.8	30.8	-6.58	13.2	22.9	0.55
Absolute	26.4			34.3			(T =	37.5 ms)
	79.3				-6.89		(T =	65.2 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	550.8	377.0	203.3	29.6	0.0					
RX	772.8	717.2	679.6	652.7	631.0	610.8	590.5	572.1	557.5	543.0
RU	550.8	377.0	203.3	29.6	0.0					

RAU = 486.2 (kips); RA2 = 685.3 (kips)

Current CAPWAP Ru = 554.0 (kips); Corresponding J(RP)= 0.00; J(RX) = 1.65

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	35.95	685.3	734.1	734.1	1.33	0.30	0.30	45.4	669.2	1192

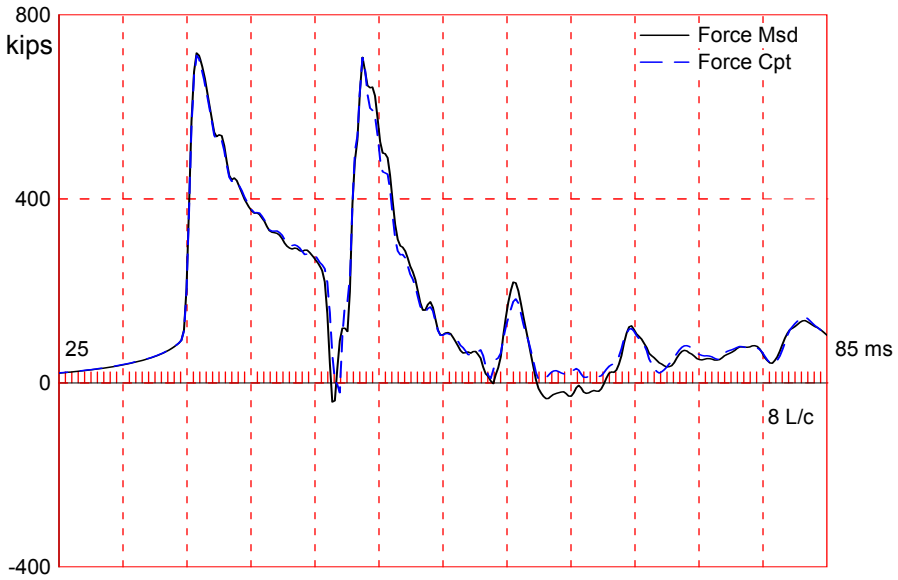
PILE PROFILE AND PILE MODEL

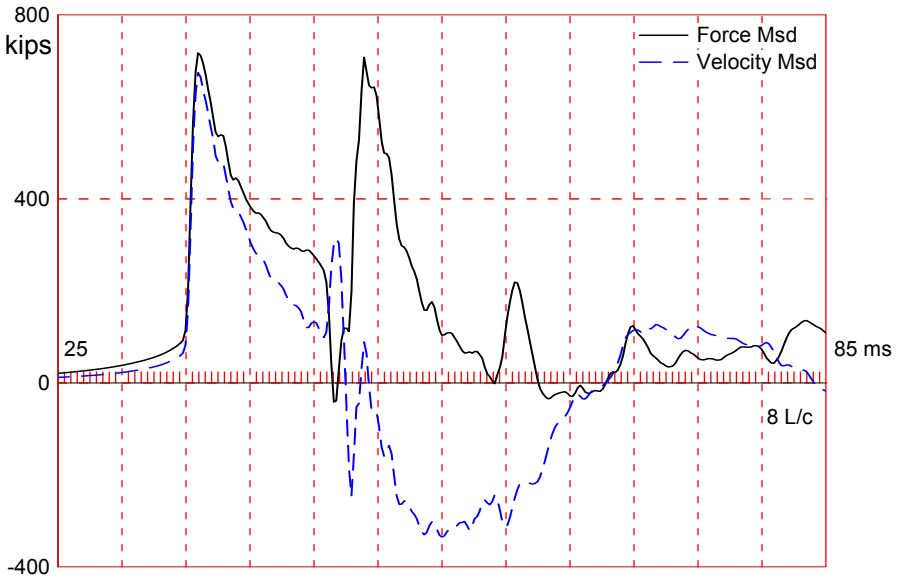
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.5	21.4	29992.2	492.000	4.70

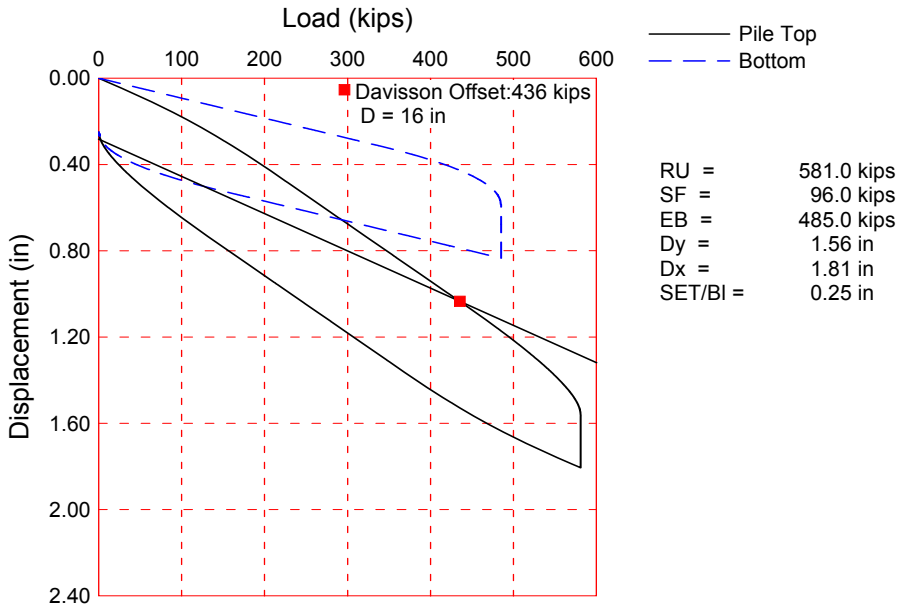
Toe Area 198.5 in^2

Top Segment Length 3.30 ft, Top Impedance 38 kips/ft/s

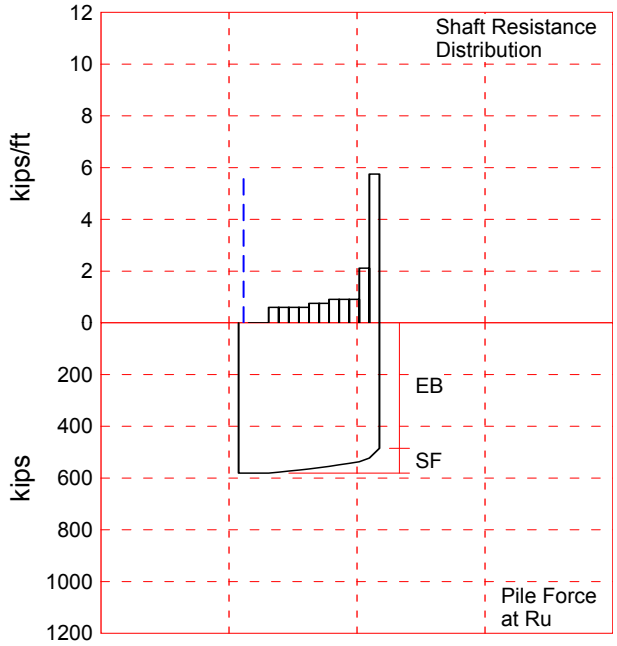
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16818.2 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.747 ft^3; Volume ratio considering added impedance: 1.000







RU =	581.0 kips
SF =	96.0 kips
EB =	485.0 kips
Dy =	1.56 in
Dx =	1.81 in
SET/Bl =	0.25 in



Length b. Sensors	92.5 ft
Embedment	87.9 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.	16818 ft/s
Match Quality	4.30
Top Compr. Stress	33.3 ksi
Max Compr. Stress	33.8 ksi
Max Tension Stress	-5.87 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.45 in
Avg. Shaft Smith Dpg.	0.23 s/ft
Toe Smith Damping	0.15 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 581.0; along Shaft 96.0; at Toe 485.0 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
				581.0				
1	13.2	8.6	0.0	581.0	0.0	0.00	0.00	0.00
2	19.8	15.2	0.0	581.0	0.0	0.00	0.00	0.00
3	26.4	21.8	4.0	577.0	4.0	0.61	0.13	0.23
4	33.0	28.5	4.0	573.0	8.0	0.61	0.13	0.23
5	39.6	35.1	4.0	569.0	12.0	0.61	0.13	0.23
6	46.3	41.7	4.0	565.0	16.0	0.61	0.13	0.23
7	52.9	48.3	5.0	560.0	21.0	0.76	0.16	0.23
8	59.5	54.9	5.0	555.0	26.0	0.76	0.16	0.23
9	66.1	61.5	6.0	549.0	32.0	0.91	0.19	0.23
10	72.7	68.1	6.0	543.0	38.0	0.91	0.19	0.23
11	79.3	74.7	6.0	537.0	44.0	0.91	0.19	0.23
12	85.9	81.3	14.0	523.0	58.0	2.12	0.45	0.23
13	92.5	87.9	38.0	485.0	96.0	5.75	1.22	0.23
Avg. Shaft			7.4			1.09	0.23	0.23
Toe			485.0				351.84	0.15

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.08	0.45
Case Damping Factor		0.58	1.90
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	91	152
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	98	
Resistance Gap (included in Toe Quake)	(in)		0.22

CAPWAP match quality = 4.30 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.25 in; Blow Count = 48 b/ft
Computed: Final Set = 0.22 in; Blow Count = 55 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.00; A4(K3550) CAL: 360; RF: 1.00

max. Top Comp. Stress = 33.3 ksi (T= 36.1 ms, max= 1.016 x Top)
max. Comp. Stress = 33.8 ksi (Z= 26.4 ft, T= 37.5 ms)
max. Tens. Stress = -5.87 ksi (Z= 79.3 ft, T= 67.4 ms)
max. Energy (EMX) = 43.3 kip-ft; max. Measured Top Displ. (DMX)= 1.30 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	712.6	-43.0	33.3	-2.01	43.3	17.8	1.28
2	6.6	713.0	-32.3	33.3	-1.51	43.1	17.7	1.26
4	13.2	713.9	-35.9	33.4	-1.68	42.6	17.7	1.22
6	19.8	716.0	-49.7	33.5	-2.32	41.9	17.6	1.18
8	26.4	724.2	-63.0	33.8	-2.94	41.0	17.3	1.13
10	33.0	712.4	-65.1	33.3	-3.04	38.9	17.0	1.08
12	39.6	701.3	-72.0	32.8	-3.37	36.7	16.8	1.02
14	46.3	691.5	-80.4	32.3	-3.76	34.4	16.5	0.96
15	49.6	677.9	-77.4	31.7	-3.61	32.7	16.3	0.93
16	52.9	682.7	-77.5	31.9	-3.62	32.0	16.2	0.90
17	56.2	664.6	-82.1	31.0	-3.84	30.0	16.1	0.87
18	59.5	670.0	-89.2	31.3	-4.17	29.2	15.9	0.83
19	62.8	652.7	-89.4	30.5	-4.17	27.2	15.7	0.80
20	66.1	658.0	-95.8	30.7	-4.47	26.3	15.6	0.76
21	69.4	636.1	-108.1	29.7	-5.05	24.1	15.8	0.72
22	72.7	640.7	-123.2	29.9	-5.76	23.2	16.9	0.69
23	76.0	618.9	-125.5	28.9	-5.86	21.0	18.1	0.65
24	79.3	632.9	-125.8	29.6	-5.87	20.0	18.3	0.61
25	82.6	645.0	-107.1	30.1	-5.01	17.9	19.4	0.57
26	85.9	684.1	-90.4	32.0	-4.22	17.0	20.9	0.54
27	89.2	681.4	-59.5	31.8	-2.78	13.9	22.1	0.50
28	92.5	702.2	-52.3	32.8	-2.44	8.8	22.7	0.47
Absolute	26.4			33.8			(T =	37.5 ms)
	79.3				-5.87		(T =	67.4 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	578.6	412.9	247.1	81.4	0.0					
RX	847.6	792.9	746.4	730.8	719.7	708.7	697.7	686.7	675.7	664.7
RU	578.6	412.9	247.1	81.4	0.0					

RAU = 478.7 (kips); RA2 = 765.0 (kips)

Current CAPWAP Ru = 581.0 (kips); Corresponding J(RP)= 0.00;

RMX requires higher damping; see PDA-W

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	35.95	683.3	724.0	724.0	1.30	0.25	0.25	43.6	673.3	2109

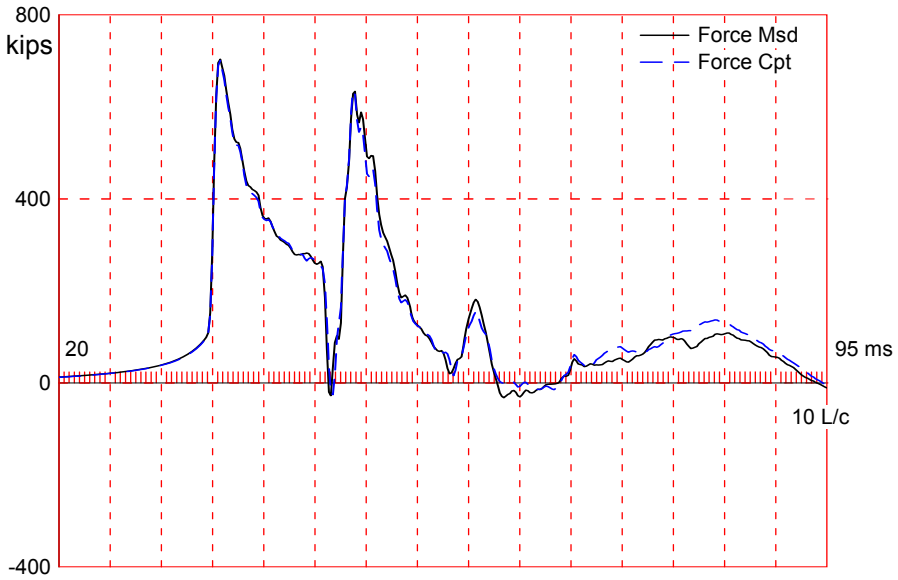
PILE PROFILE AND PILE MODEL

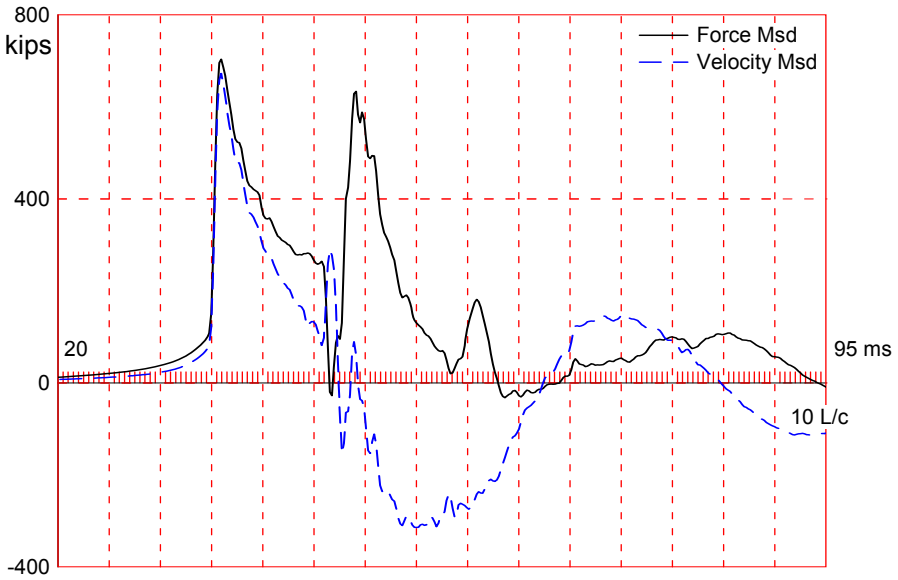
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.5	21.4	29992.2	492.000	4.70

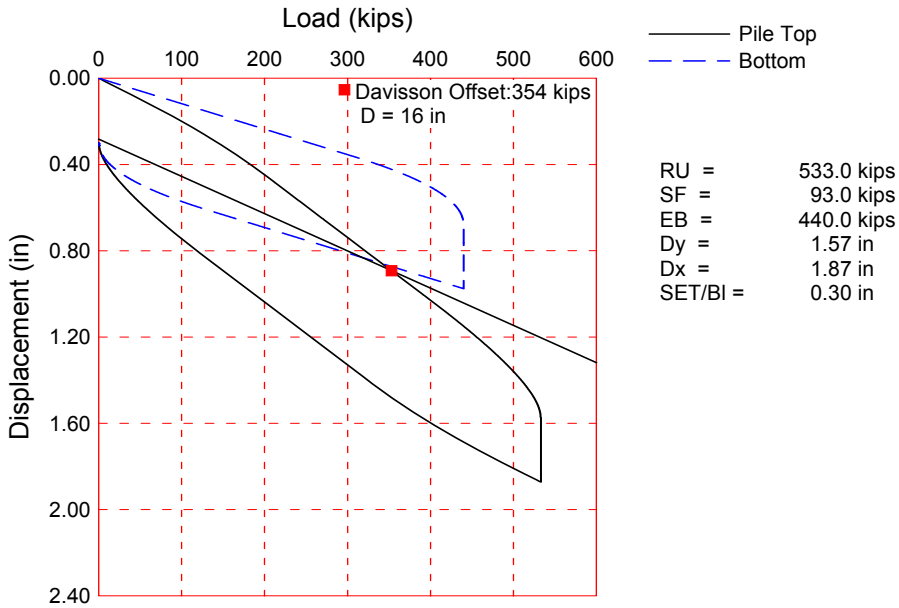
Toe Area 198.5 in^2

Top Segment Length 3.30 ft, Top Impedance 38 kips/ft/s

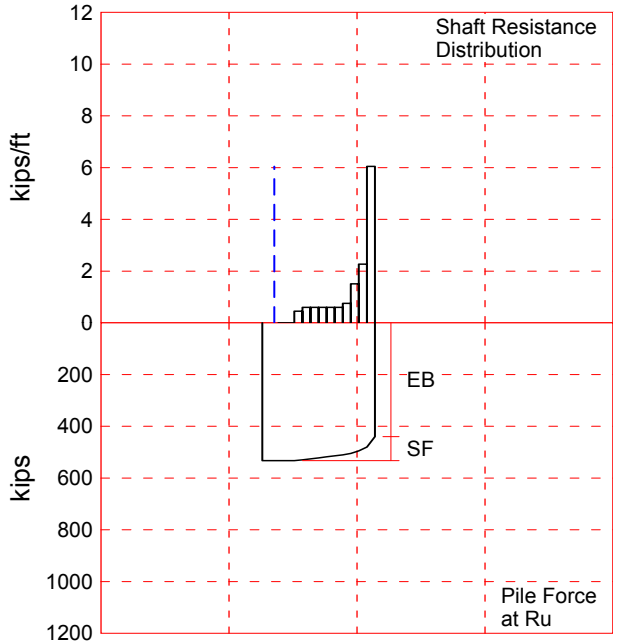
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16818.2 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.747 ft^3; Volume ratio considering added impedance: 1.000







RU =	533.0 kips
SF =	93.0 kips
EB =	440.0 kips
Dy =	1.57 in
Dx =	1.87 in
SET/BI =	0.30 in



Length b. Sensors	92.6 ft
Embedment	81.5 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.	16833 ft/s
Match Quality	4.19
Top Compr. Stress	32.8 ksi
Max Compr. Stress	33.4 ksi
Max Tension Stress	-6.16 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.52 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.14 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: 533.0; along Shaft 93.0; at Toe 440.0 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
				533.0				
1	19.8	8.7	0.0	533.0	0.0	0.00	0.00	0.00
2	26.5	15.4	0.0	533.0	0.0	0.00	0.00	0.00
3	33.1	22.0	3.0	530.0	3.0	0.45	0.10	0.24
4	39.7	28.6	4.0	526.0	7.0	0.60	0.13	0.24
5	46.3	35.2	4.0	522.0	11.0	0.60	0.13	0.24
6	52.9	41.8	4.0	518.0	15.0	0.60	0.13	0.24
7	59.5	48.4	4.0	514.0	19.0	0.60	0.13	0.24
8	66.1	55.0	4.0	510.0	23.0	0.60	0.13	0.24
9	72.7	61.6	5.0	505.0	28.0	0.76	0.16	0.24
10	79.4	68.3	10.0	495.0	38.0	1.51	0.32	0.24
11	86.0	74.9	15.0	480.0	53.0	2.27	0.48	0.24
12	92.6	81.5	40.0	440.0	93.0	6.05	1.29	0.24
Avg. Shaft			7.8			1.14	0.24	0.24
Toe			440.0				319.19	0.14

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.10	0.52
Case Damping Factor		0.58	1.61
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	92	76
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.24

CAPWAP match quality = 4.19 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.30 in; Blow Count = 40 b/ft
Computed: Final Set = 0.26 in; Blow Count = 46 b/ft
Transducer F3(F607) CAL: 93.6; RF: 0.98; F4(D815) CAL: 93.0; RF: 0.98
A3(K2524) CAL: 360; RF: 1.02; A4(K3550) CAL: 360; RF: 1.02

max. Top Comp. Stress = 32.8 ksi (T= 36.1 ms, max= 1.020 x Top)
max. Comp. Stress = 33.4 ksi (Z= 33.1 ft, T= 37.9 ms)
max. Tens. Stress = -6.16 ksi (Z= 72.7 ft, T= 67.6 ms)
max. Energy (EMX) = 42.6 kip-ft; max. Measured Top Displ. (DMX)= 1.30 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	701.4	-39.5	32.8	-1.85	42.6	17.7	1.31
2	6.6	702.0	-42.1	32.8	-1.97	42.4	17.6	1.29
4	13.2	703.3	-48.8	32.9	-2.28	41.9	17.6	1.25
6	19.8	704.9	-71.0	32.9	-3.32	41.3	17.5	1.21
8	26.5	708.1	-87.4	33.1	-4.08	40.4	17.4	1.16
10	33.1	715.8	-109.6	33.4	-5.12	39.5	17.2	1.11
12	39.7	709.2	-117.3	33.1	-5.48	37.6	17.0	1.05
14	46.3	697.6	-126.6	32.6	-5.91	35.3	16.7	1.00
15	49.6	682.5	-121.7	31.9	-5.68	33.6	16.6	0.97
16	52.9	686.2	-116.2	32.1	-5.43	33.0	16.5	0.94
17	56.2	671.1	-106.5	31.4	-4.98	31.3	16.3	0.90
18	59.5	674.5	-111.0	31.5	-5.19	30.6	16.2	0.87
19	62.8	659.4	-112.0	30.8	-5.23	28.9	16.1	0.84
20	66.1	663.0	-120.8	31.0	-5.64	28.1	16.0	0.81
21	69.4	648.8	-125.8	30.3	-5.88	26.4	15.9	0.77
22	72.7	654.1	-131.9	30.6	-6.16	25.6	16.4	0.74
23	76.0	639.7	-123.4	29.9	-5.76	23.7	17.4	0.70
24	79.4	646.9	-114.0	30.2	-5.33	22.9	17.8	0.67
25	82.7	610.6	-97.2	28.5	-4.54	20.1	19.0	0.64
26	86.0	628.8	-100.8	29.4	-4.71	19.4	20.4	0.60
27	89.3	625.6	-73.6	29.2	-3.44	15.9	21.7	0.57
28	92.6	647.6	-64.3	30.3	-3.00	9.8	22.3	0.54
Absolute	33.1			33.4			(T =	37.9 ms)
	72.7				-6.16		(T =	67.6 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	572.4	408.3	244.1	79.9	0.0					
RX	777.8	714.8	680.1	668.9	657.7	646.5	635.3	624.1	612.9	601.7
RU	572.4	408.3	244.1	79.9	0.0					

RAU = 488.4 (kips); RA2 = 703.9 (kips)

Current CAPWAP Ru = 533.0 (kips); Corresponding J(RP)= 0.05;

RMX requires higher damping; see PDA-W

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
17.8	35.95	680.6	712.7	712.7	1.30	0.30	0.30	42.8	642.0	1571

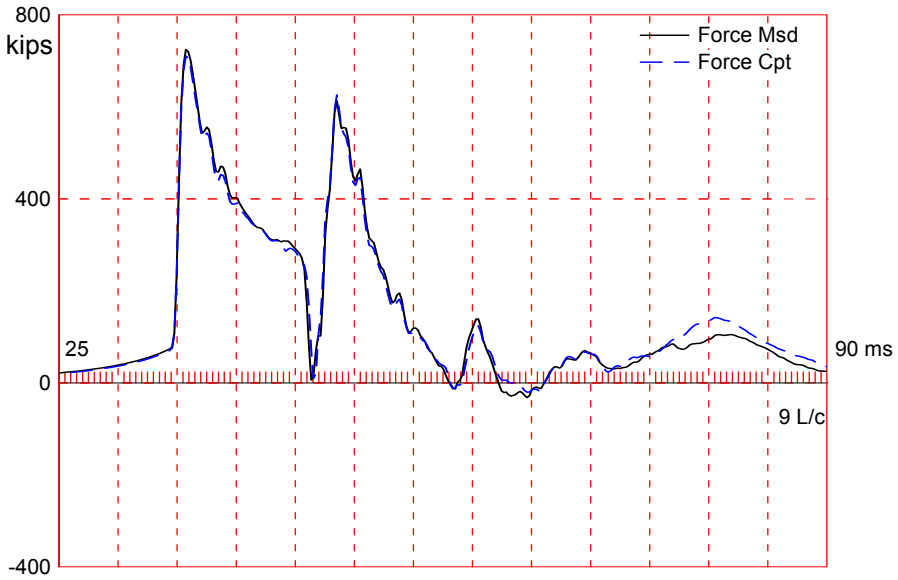
PILE PROFILE AND PILE MODEL

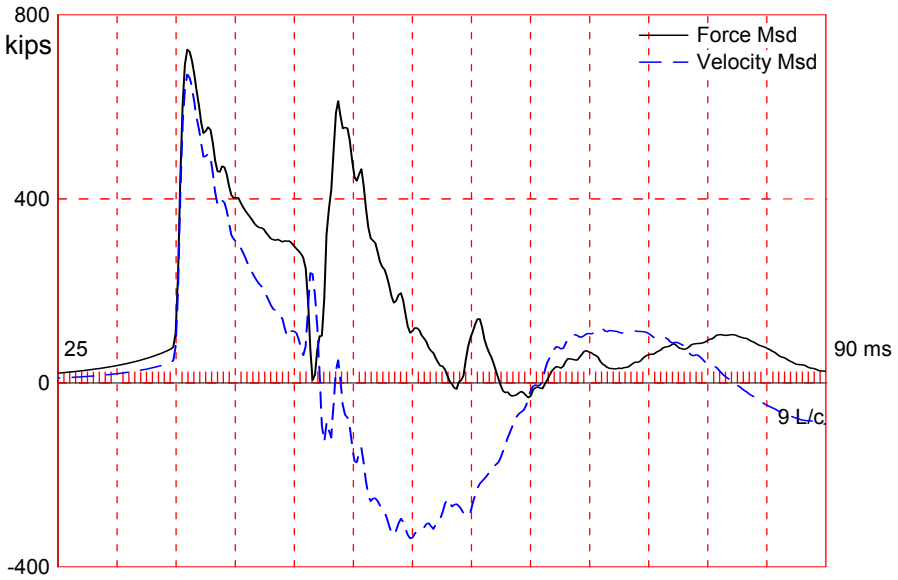
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
92.6	21.4	29992.2	492.000	4.70

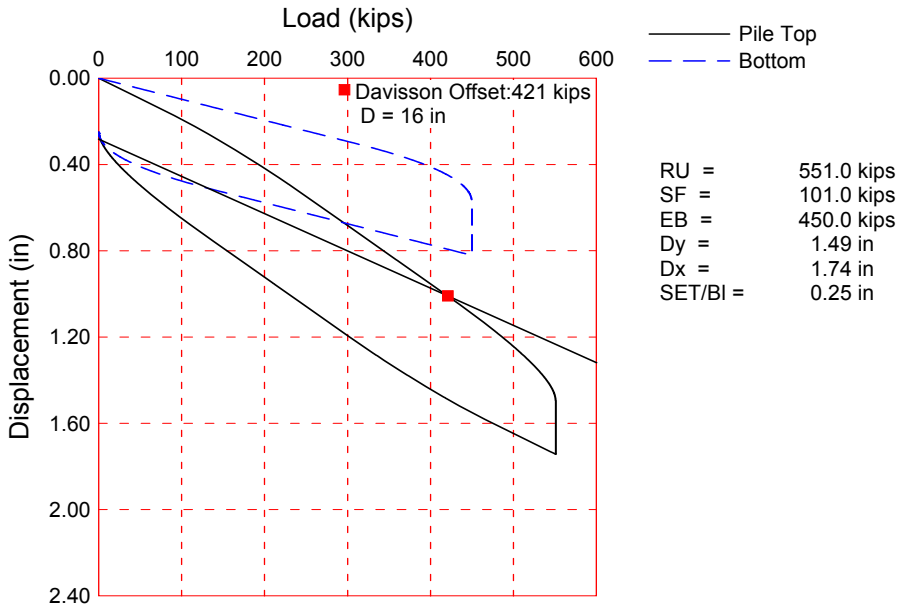
Toe Area 198.5 in^2

Top Segment Length 3.31 ft, Top Impedance 38 kips/ft/s

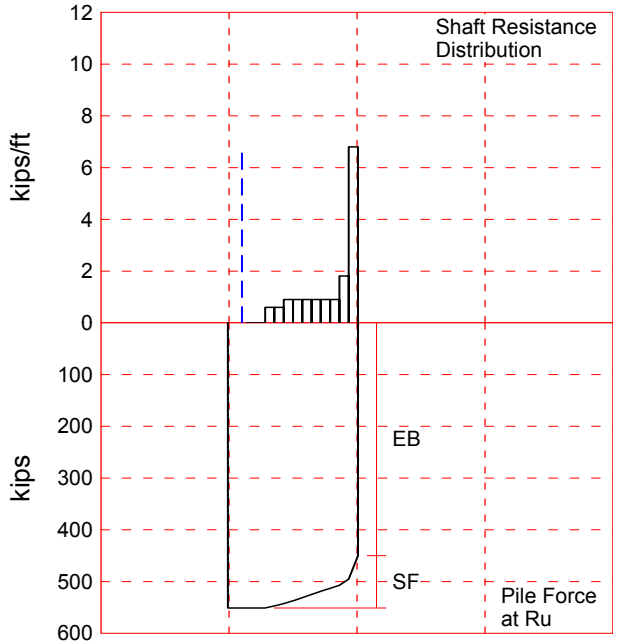
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16832.7 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.758 ft^3; Volume ratio considering added impedance: 1.000







RU =	551.0 kips
SF =	101.0 kips
EB =	450.0 kips
Dy =	1.49 in
Dx =	1.74 in
SET/Bl =	0.25 in



Length b. Sensors	92.6 ft
Embedment	81.7 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.	16833 ft/s
Match Quality	3.78
Top Compr. Stress	33.2 ksi
Max Compr. Stress	33.9 ksi
Max Tension Stress	-5.67 ksi
Avg. Shaft Quake	0.11 in
Toe Quake	0.44 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.17 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 551.0; along Shaft 101.0; at Toe 450.0 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
				551.0				
1	19.8	8.9	0.0	551.0	0.0	0.00	0.00	0.00
2	26.5	15.5	0.0	551.0	0.0	0.00	0.00	0.00
3	33.1	22.2	4.0	547.0	4.0	0.60	0.13	0.26
4	39.7	28.8	4.0	543.0	8.0	0.60	0.13	0.26
5	46.3	35.4	6.0	537.0	14.0	0.91	0.19	0.26
6	52.9	42.0	6.0	531.0	20.0	0.91	0.19	0.26
7	59.5	48.6	6.0	525.0	26.0	0.91	0.19	0.26
8	66.1	55.2	6.0	519.0	32.0	0.91	0.19	0.26
9	72.7	61.8	6.0	513.0	38.0	0.91	0.19	0.26
10	79.4	68.4	6.0	507.0	44.0	0.91	0.19	0.26
11	86.0	75.1	12.0	495.0	56.0	1.81	0.39	0.26
12	92.6	81.7	45.0	450.0	101.0	6.80	1.45	0.26
Avg. Shaft			8.4			1.24	0.26	0.26
Toe			450.0				326.45	0.17

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.11	0.44
Case Damping Factor		0.69	2.00
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	40
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.16

CAPWAP match quality = 3.78 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.25 in; Blow Count = 48 b/ft
Computed: Final Set = 0.21 in; Blow Count = 56 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.06; A4(K3550) CAL: 360; RF: 1.06

max. Top Comp. Stress = 33.2 ksi (T= 36.1 ms, max= 1.021 x Top)
max. Comp. Stress = 33.9 ksi (Z= 33.1 ft, T= 38.1 ms)
max. Tens. Stress = -5.67 ksi (Z= 59.5 ft, T= 62.9 ms)
max. Energy (EMX) = 44.9 kip-ft; max. Measured Top Displ. (DMX)= 1.24 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	711.1	-36.2	33.2	-1.69	44.9	17.9	1.26
2	6.6	711.4	-44.5	33.2	-2.08	44.7	17.9	1.25
4	13.2	712.2	-60.5	33.3	-2.82	44.2	17.8	1.21
6	19.8	713.2	-82.2	33.3	-3.84	43.5	17.8	1.16
8	26.5	716.3	-92.1	33.5	-4.30	42.6	17.7	1.11
10	33.1	726.2	-105.1	33.9	-4.91	41.6	17.4	1.06
12	39.7	716.7	-100.1	33.5	-4.68	39.2	17.1	1.00
14	46.3	709.2	-108.4	33.1	-5.06	36.7	16.7	0.94
15	49.6	684.2	-113.6	32.0	-5.31	34.3	16.4	0.91
16	52.9	691.2	-115.7	32.3	-5.41	33.6	16.3	0.87
17	56.2	666.7	-114.0	31.1	-5.32	31.3	16.1	0.84
18	59.5	673.5	-121.3	31.5	-5.67	30.5	15.9	0.81
19	62.8	649.4	-112.8	30.3	-5.27	28.2	15.7	0.77
20	66.1	655.8	-115.6	30.6	-5.40	27.3	15.5	0.74
21	69.4	632.0	-105.2	29.5	-4.91	25.1	15.3	0.70
22	72.7	638.2	-105.7	29.8	-4.94	24.2	15.7	0.66
23	76.0	622.4	-95.0	29.1	-4.44	22.1	16.5	0.63
24	79.4	641.1	-100.0	30.0	-4.67	21.2	16.5	0.59
25	82.7	648.6	-91.3	30.3	-4.26	19.3	17.9	0.56
26	86.0	684.1	-93.8	32.0	-4.38	18.5	19.4	0.52
27	89.3	678.2	-72.1	31.7	-3.37	15.9	20.4	0.49
28	92.6	698.3	-73.6	32.6	-3.44	10.4	19.5	0.46
Absolute	33.1			33.9			(T =	38.1 ms)
	59.5				-5.67		(T =	62.9 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	656.3	506.9	357.6	208.2	58.9					
RX	828.6	767.8	717.3	680.0	654.9	631.2	608.2	586.7	573.0	561.5
RU	656.3	506.9	357.6	208.2	58.9					

RAU = 493.8 (kips); RA2 = 672.0 (kips)

Current CAPWAP Ru = 551.0 (kips); Corresponding J(RP)= 0.14; J(RX) = 1.98

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
17.7	35.95	675.7	727.4	728.8	1.24	0.25	0.25	44.8	721.5	1607

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
92.6	21.4	29992.2	492.000	4.70

Toe Area 198.5 in^2

Top Segment Length 3.31 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16832.7 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 11.0 ms
Total volume: 13.758 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Travis Coleman
Company: Lunda Construction Co.	No. of Sheets: 46
E-mail: kweber@lundaconstruction.com	Date: March 24, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 13
Winnebago County, Wisconsin

On March 20, 2015, Pier 13 #1, Pier 13 #36, and Pier 13 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on March 23. 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 elevation for the piles was the top of the ring at EL 740.2 to EL 740.4. We understand the pier was excavated to elevation of EL 717.2. The piles have a required minimum tip elevation of EL 670.5. 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 13 #1 was driven to a depth of 78.6 feet, which corresponds to a pile tip elevation of EL 661.8. The blow count over the final increment of driving was 10 blows for 4 inches of penetration at an average hammer stroke of 7.4 feet. The blow count at the beginning of restrike was 10 blows for 2.¾ inch of penetration at an average hammer stroke of 6.7 feet.

Pier 13 #36 was driven to a depth of 82.1 feet, which corresponds to a pile tip elevation of EL 658.1. The blow count over the final increment of driving was 10 blows for 1½ inches of penetration at an average hammer stroke of 7.7 feet. The blow count at the beginning of restrike was 10 blows for ¾ inch of penetration at an average hammer stroke of 6.7 feet.

Pier 13 #44 was driven to a depth of 83.3 feet, which corresponds to a pile tip elevation of EL 657.0. The blow count over the final increment of driving was 10 blows for 1¼ inches of penetration at an average hammer stroke of 7.0 feet. The blow count at the beginning of restrike was 10 blows for ¾ inch of penetration at an average hammer stroke of 6.6 feet

We recommend the production piles at Pier 13 of Structure B-70-403 driven with the APE D30-42 hammer PD0256 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. Additionally, all production piles should achieve the minimum pile tip elevation of EL 670.5 for uplift, as indicated on the plans.

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	5	3
7.0	5	3
7.5	4	3
8.0	4	3
8.5	4	3

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.

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.

The dynamic test records for Pier 13 #36 indicated damage began to occur at the pile toe at approximately 76 feet of penetration. The restrike record required impedance reductions over the lower portion of the shaft, with a maximum impedance reduction of 24 percent at the pile toe. GRL recommends that only the shaft resistance above the damage be considered as the pile capacity, which is 130 kips. We recommend this analysis be reviewed by the structural engineer of record.

Please call if you have any questions on these recommendations.

GRL Engineers, Inc.

Travis Coleman, P.E.

Al Ziai

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

Attachments:

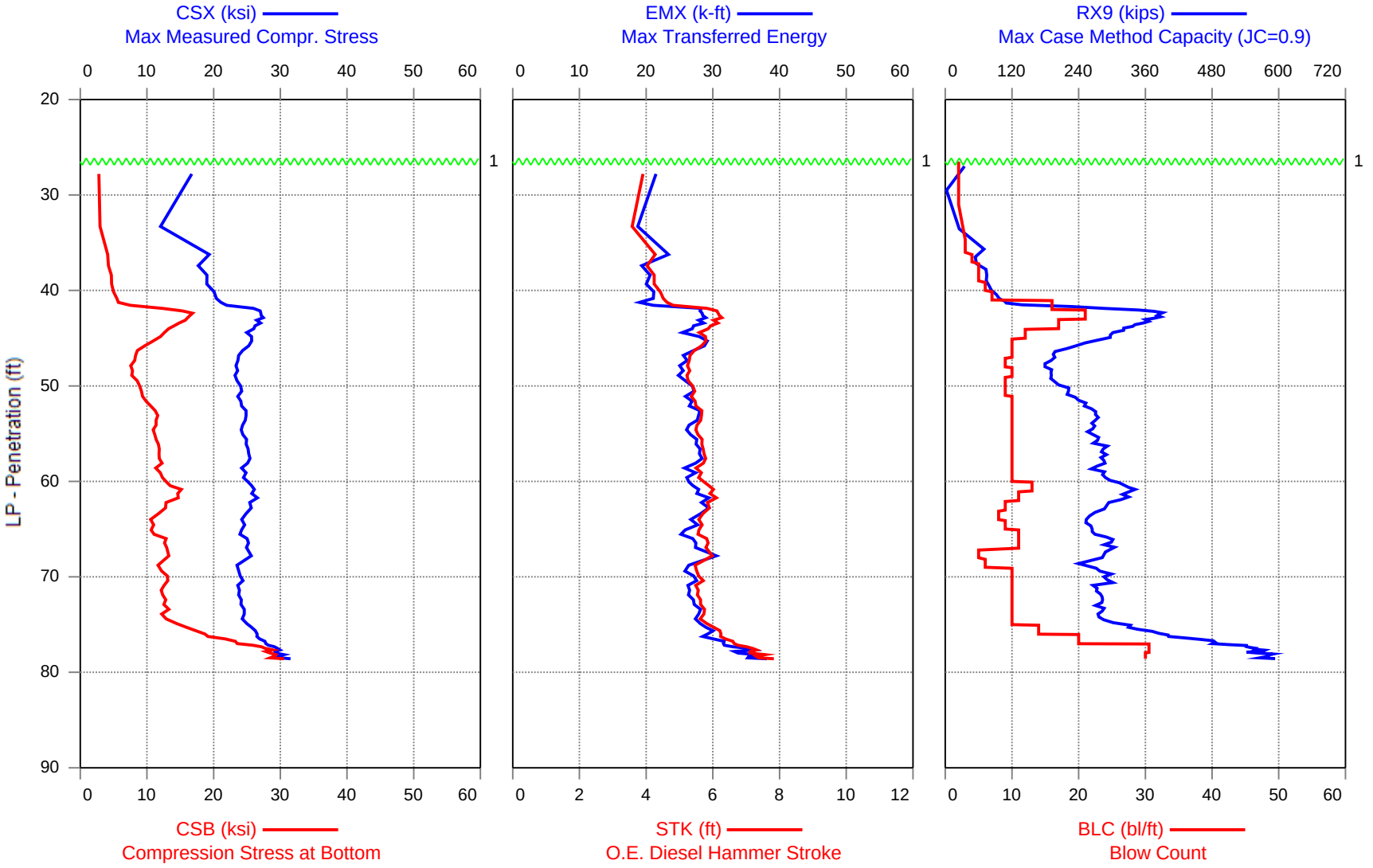
Dynamic Test Results - (pages 4 – 27)
CAPWAP Analysis Results - (pages 28 – 46)

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 20-March-2015

Test started: 20-March-2015

USH 10 over Little Lake Butte des Morts - PIER 13 #1
APE D30-42, HP 14 x 73



1 - Reported Reference at El. 740.35

USH 10 over Little Lake Butte des Morts - PIER 13 #1 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 71.83 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
14	32.00	2	AV7	14.9	2.6	19	3.6	61.1	16
			STD	4.4	0.5	5	0.6	4.3	18
			MAX	22.9	3.4	28	4.8	68.1	47
			MIN	6.8	2.0	10	2.8	53.5	0
20	34.67	3	AV1	4.9	3.0	12	3.2	64.5	26
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	4.9	3.0	12	3.2	64.5	26
			MIN	4.9	3.0	12	3.2	64.5	26
21	35.00	3	AV1	13.3	3.4	23	4.0	58.3	50
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	13.3	3.4	23	4.0	58.3	50
			MIN	13.3	3.4	23	4.0	58.3	50
22	35.33	3	AV1	21.7	4.0	31	4.8	53.2	67
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	21.7	4.0	31	4.8	53.2	67
			MIN	21.7	4.0	31	4.8	53.2	67
24	36.00	3	AV2	22.1	4.1	29	4.7	53.6	71
			STD	0.1	0.1	2	0.0	0.0	4
			MAX	22.1	4.2	30	4.7	53.6	75
			MIN	22.0	4.1	27	4.7	53.6	67
28	37.00	4	AV4	17.1	4.1	19	3.9	58.8	52
			STD	1.2	0.2	2	0.2	1.1	4
			MAX	19.0	4.4	22	4.2	60.1	58
			MIN	15.8	3.8	18	3.7	57.0	46
33	38.00	5	AV5	18.4	4.4	20	4.1	57.1	68
			STD	1.1	0.3	2	0.2	1.3	7
			MAX	19.7	4.7	22	4.4	59.0	76
			MIN	16.6	4.1	18	3.9	55.6	55
38	39.00	5	AV5	19.0	4.7	21	4.2	56.5	74
			STD	0.4	0.1	0	0.1	0.6	1
			MAX	19.7	4.8	21	4.4	57.1	76
			MIN	18.5	4.5	20	4.1	55.5	73
44	40.00	6	AV6	19.4	4.8	20	4.3	56.1	79
			STD	0.8	0.1	1	0.1	0.8	5
			MAX	20.7	5.0	22	4.5	57.3	85
			MIN	18.5	4.6	19	4.1	54.7	74
51	41.00	7	AV7	20.0	5.3	21	4.4	55.3	93
			STD	1.0	0.3	1	0.2	1.1	4
			MAX	21.6	5.6	23	4.7	56.9	98
			MIN	18.6	4.8	19	4.2	53.7	86
67	42.00	16	AV16	22.9	8.3	23	5.1	52.2	183
			STD	2.3	3.0	4	0.6	2.6	80
			MAX	27.0	13.8	30	6.1	55.6	329
			MIN	19.9	5.6	17	4.4	47.5	103
88	43.00	21	AV21	27.1	16.2	28	6.2	47.3	379

USH 10 over Little Lake Butte des Morts - PIER 13 #1 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			STD	0.7	0.7	1	0.2	0.7	12
			MAX	28.1	17.2	31	6.5	48.4	400
			MIN	25.9	14.4	26	5.9	46.3	347
105	44.00	17	AV17	26.5	14.5	28	6.0	47.9	346
			STD	0.7	0.9	1	0.2	0.6	17
			MAX	27.6	16.0	30	6.3	49.2	378
			MIN	24.9	13.1	25	5.7	46.9	319
117	45.00	12	AV12	25.5	12.5	27	5.7	49.0	304
			STD	0.7	0.5	2	0.2	0.7	13
			MAX	26.6	13.5	30	6.0	50.2	340
			MIN	24.2	11.5	24	5.4	47.8	290
127	46.00	10	AV10	25.5	10.3	29	5.7	49.0	251
			STD	0.7	0.7	1	0.2	0.7	19
			MAX	26.2	11.4	31	5.9	50.2	278
			MIN	24.4	9.3	27	5.4	48.3	223
137	47.00	10	AV10	24.0	8.4	26	5.4	50.5	200
			STD	1.0	0.3	2	0.2	1.0	9
			MAX	26.1	9.0	30	5.9	51.9	216
			MIN	22.7	8.0	24	5.1	48.3	190
146	48.00	9	AV9	23.7	7.9	26	5.3	50.8	185
			STD	0.5	0.3	1	0.1	0.4	6
			MAX	24.2	8.3	27	5.4	51.4	193
			MIN	23.0	7.5	24	5.2	50.4	176
156	49.00	10	AV10	23.3	7.7	25	5.2	51.1	189
			STD	0.9	0.3	1	0.2	0.8	8
			MAX	25.0	8.4	27	5.6	52.5	207
			MIN	22.0	7.4	23	5.0	49.7	172
165	50.00	9	AV9	23.5	8.6	26	5.3	51.1	197
			STD	0.6	0.3	1	0.1	0.6	9
			MAX	24.6	8.9	28	5.5	51.9	213
			MIN	22.6	8.1	24	5.1	50.0	177
174	51.00	9	AV9	24.1	9.1	27	5.4	50.2	221
			STD	0.7	0.2	1	0.1	0.6	7
			MAX	24.8	9.4	28	5.6	51.3	229
			MIN	22.8	8.8	25	5.2	49.6	209
184	52.00	10	AV10	23.9	9.8	26	5.4	50.3	242
			STD	0.5	0.3	1	0.1	0.5	9
			MAX	24.6	10.3	27	5.6	51.4	263
			MIN	22.9	9.3	24	5.2	49.6	231
194	53.00	10	AV10	24.7	11.2	28	5.6	49.4	266
			STD	0.4	0.4	1	0.1	0.4	7
			MAX	25.4	11.9	29	5.8	50.2	274
			MIN	24.0	10.4	27	5.4	48.7	251
204	54.00	10	AV10	24.7	11.4	28	5.6	49.4	269
			STD	0.5	0.2	1	0.1	0.5	7
			MAX	25.7	11.7	29	5.9	50.1	281
			MIN	24.1	10.9	25	5.5	48.5	261
214	55.00	10	AV10	24.3	11.1	26	5.5	49.9	264
			STD	0.5	0.4	1	0.1	0.5	8
			MAX	25.0	11.7	28	5.7	50.7	280
			MIN	23.4	10.5	25	5.3	49.3	251

USH 10 over Little Lake Butte des Morts - PIER 13 #1 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
224	56.00	10	AV10	24.6	11.4	27	5.6	49.5	271
			STD	0.4	0.2	1	0.1	0.4	7
			MAX	25.4	11.7	29	5.8	50.0	283
			MIN	24.0	11.0	26	5.5	48.8	260
234	57.00	10	AV10	25.1	11.9	28	5.7	49.2	284
			STD	0.5	0.3	1	0.1	0.5	9
			MAX	26.2	12.3	30	6.0	49.8	303
			MIN	24.4	11.4	27	5.5	48.1	273
244	58.00	10	AV10	25.4	12.0	28	5.8	48.8	285
			STD	0.6	0.5	1	0.1	0.6	7
			MAX	26.6	13.0	30	6.0	49.7	298
			MIN	24.4	11.1	26	5.6	47.8	275
254	59.00	10	AV10	24.7	11.7	27	5.6	49.5	276
			STD	0.9	0.6	2	0.2	0.9	11
			MAX	26.1	13.1	30	6.0	51.0	292
			MIN	23.4	10.9	24	5.3	48.1	255
264	60.00	10	AV10	24.7	12.3	27	5.6	49.4	289
			STD	0.4	0.3	1	0.1	0.5	7
			MAX	25.4	12.7	28	5.8	50.1	300
			MIN	24.2	11.7	25	5.5	48.7	275
277	61.00	13	AV13	25.7	14.1	27	5.9	48.3	328
			STD	0.6	1.0	1	0.2	0.6	14
			MAX	26.7	16.2	29	6.2	49.5	351
			MIN	24.6	13.0	25	5.6	47.3	309
288	62.00	11	AV11	26.1	14.5	28	6.0	48.0	322
			STD	0.9	0.9	2	0.3	0.9	14
			MAX	27.7	15.8	32	6.4	49.2	341
			MIN	24.7	13.0	26	5.7	46.4	297
297	63.00	9	AV9	25.6	12.8	29	5.9	48.4	290
			STD	0.8	0.3	1	0.2	0.8	7
			MAX	26.4	13.4	31	6.1	49.8	300
			MIN	24.2	12.3	27	5.5	47.7	277
305	64.00	8	AV8	24.7	11.3	28	5.7	49.3	261
			STD	0.6	0.7	1	0.1	0.6	9
			MAX	26.0	12.4	30	6.0	50.0	283
			MIN	23.9	9.9	27	5.5	48.1	252
314	65.00	9	AV9	24.3	10.8	27	5.6	49.5	258
			STD	0.7	0.4	1	0.2	0.6	9
			MAX	25.8	11.6	29	6.0	50.4	273
			MIN	23.4	10.4	25	5.4	48.1	242
325	66.00	11	AV11	24.3	11.4	26	5.6	49.4	276
			STD	0.6	0.9	1	0.1	0.6	13
			MAX	25.6	12.8	27	5.9	50.2	299
			MIN	23.4	10.2	25	5.4	48.3	261
336	67.00	11	AV11	25.2	12.9	27	5.9	48.5	298
			STD	0.5	0.6	1	0.1	0.5	10
			MAX	26.0	13.8	29	6.1	49.4	315
			MIN	24.2	11.8	26	5.6	47.7	280
341	68.00	5	AV5	25.4	13.2	30	5.9	48.3	286
			STD	0.7	0.4	1	0.2	0.8	7

USH 10 over Little Lake Butte des Morts - PIER 13 #1 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	26.1	13.7	32	6.1	49.8	296
			MIN	23.9	12.8	28	5.5	47.7	276
347	69.00	6	AV5	23.8	12.0	27	5.6	49.8	254
			STD	1.4	1.1	2	0.3	1.4	24
			MAX	25.2	13.0	30	5.9	52.3	281
			MIN	21.5	10.5	24	5.0	48.4	216
357	70.00	10	AV10	23.9	12.4	26	5.5	49.8	284
			STD	0.5	0.7	1	0.1	0.5	17
			MAX	24.9	13.2	28	5.8	50.6	311
			MIN	23.1	11.1	24	5.4	48.9	260
367	71.00	10	AV10	23.9	12.9	27	5.6	49.6	287
			STD	1.0	0.5	2	0.2	1.1	19
			MAX	25.6	13.5	29	6.0	52.5	309
			MIN	21.3	11.9	23	5.0	48.1	244
377	72.00	10	AV10	23.9	12.3	27	5.6	49.7	275
			STD	0.5	0.5	1	0.1	0.4	8
			MAX	24.6	13.0	28	5.7	50.5	286
			MIN	23.2	11.7	25	5.4	49.1	265
387	73.00	10	AV10	24.1	12.7	27	5.6	49.5	280
			STD	0.6	0.3	1	0.1	0.6	10
			MAX	24.8	13.4	28	5.8	50.6	293
			MIN	22.9	12.3	26	5.4	48.7	265
397	74.00	10	AV10	24.6	12.8	28	5.7	48.9	280
			STD	0.4	0.7	1	0.1	0.4	8
			MAX	25.3	13.7	30	5.9	49.4	293
			MIN	24.1	11.6	27	5.6	48.3	264
407	75.00	10	AV10	24.5	13.4	28	5.7	49.2	290
			STD	0.6	0.9	1	0.2	0.6	12
			MAX	25.3	14.9	30	5.9	50.5	307
			MIN	23.4	12.0	26	5.4	48.2	272
421	76.00	14	AV14	26.1	16.9	30	6.2	47.4	357
			STD	0.9	1.3	2	0.2	0.9	24
			MAX	28.1	19.1	35	6.7	48.4	397
			MIN	25.2	15.2	27	5.9	45.6	322
441	77.00	20	AV20	27.1	21.4	30	6.4	46.4	447
			STD	0.8	2.0	2	0.2	0.8	35
			MAX	28.5	24.1	33	6.8	47.8	490
			MIN	25.7	17.9	27	6.0	45.0	389
469	77.92	31	AV28	29.1	27.3	34	7.0	44.4	547
			STD	1.1	1.6	3	0.3	1.0	25
			MAX	30.7	30.0	38	7.7	46.8	596
			MIN	26.6	23.4	29	6.3	42.6	486
479	78.25	30	AV10	29.8	28.9	35	7.3	43.7	575
			STD	0.9	0.9	2	0.3	0.9	13
			MAX	31.2	30.9	38	7.8	44.9	594
			MIN	28.4	27.5	32	6.9	42.4	558
489	78.58	30	AV10	30.1	29.0	36	7.4	43.4	580
			STD	0.9	0.8	1	0.3	0.8	16
			MAX	31.5	30.6	38	7.8	45.0	605
			MIN	28.2	27.9	33	6.8	42.2	550
			Average	24.8	13.4	27	5.7	49.3	296

USH 10 over Little Lake Butte des Morts - PIER 13 #1 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			Std. Dev.	3.0	6.1	4	0.7	3.3	123
			Maximum	31.5	30.9	38	7.8	68.1	605
			Minimum	4.9	2.0	10	2.8	42.2	0

Total number of blows analyzed: 476

BL# Sensors

1-489 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

BL# Comments

3 Reported Reference at El. 740.35
4 Mudline at El. 717.23
336 Stopped to move gages up to pile head
344 LE = 93.83 ft; WC = 16,755.4 f/s

Time Summary

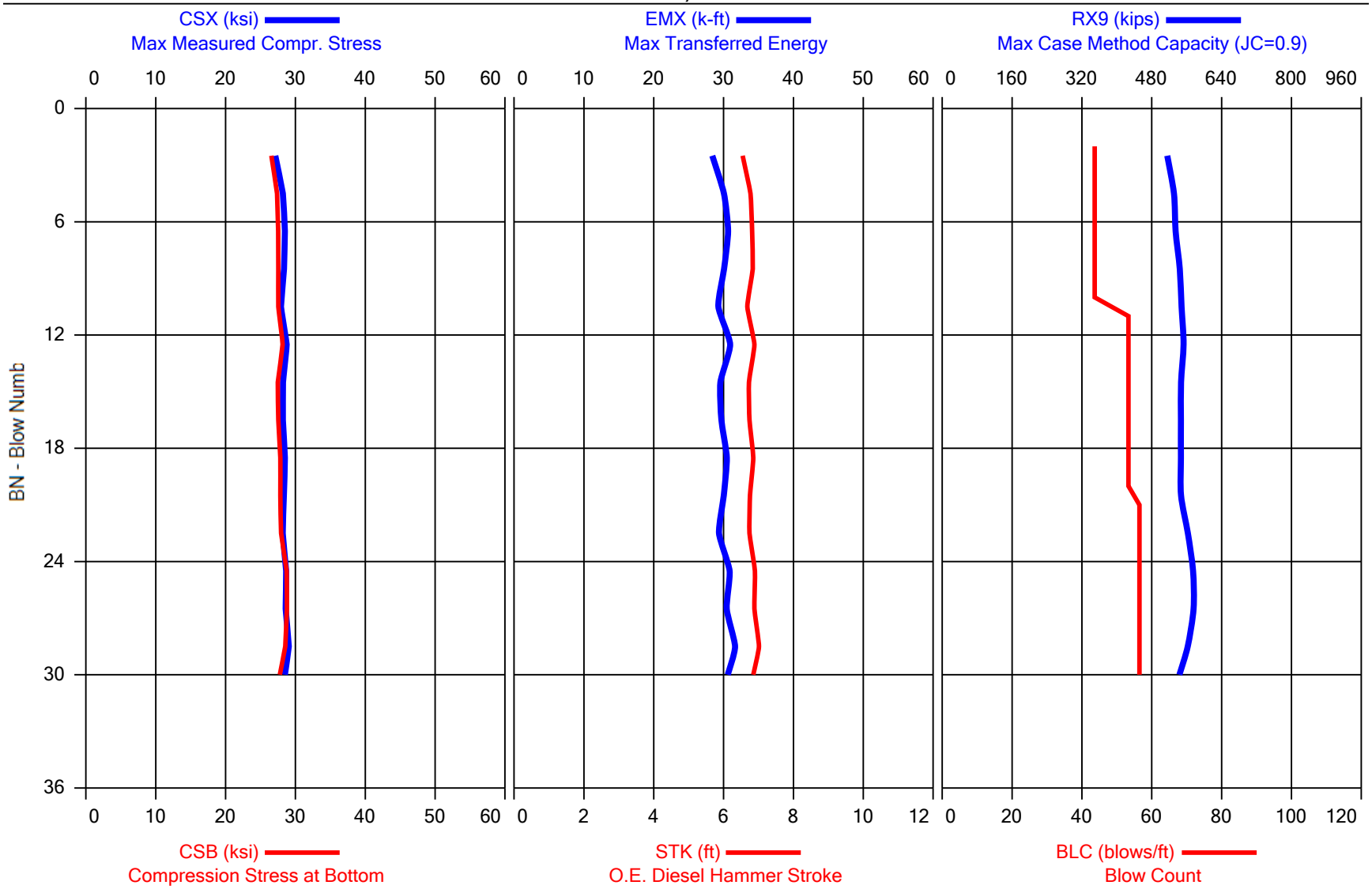
Drive 20 minutes 17 seconds 8:02 AM - 8:22 AM BN 1 - 489

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 23-March-2015 Test started: 23-March-2015

USH10 OVER LLBDM - PIER 13 #1 - BOR

APE D30-42, HP 14 x 73



USH10 OVER LLBDM - PIER 13 #1 - BOR APE D30-42, HP 14 x 73
OP: AZ Date: 23-March-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 84.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	78.81	44	AV9	28.1	27.3	6.7	30	45.4	534
			STD	0.6	0.5	0.1	1	0.4	15
			MAX	28.5	27.8	6.8	31	46.5	556
			MIN	26.5	26.0	6.4	28	45.0	500
20	79.00	53	AV10	28.4	27.7	6.8	30	45.2	547
			STD	0.3	0.3	0.1	1	0.3	4
			MAX	29.0	28.3	6.9	31	45.6	555
			MIN	27.7	27.4	6.7	29	44.7	540
30	79.17	56	AV10	28.6	28.4	6.9	31	45.0	564
			STD	0.4	0.5	0.1	1	0.4	12
			MAX	29.5	29.2	7.2	33	45.6	579
			MIN	27.9	27.4	6.7	28	44.0	543
			Average	28.3	27.8	6.8	30	45.2	549
			Std. Dev.	0.5	0.6	0.1	1	0.4	17
			Maximum	29.5	29.2	7.2	33	46.5	579
			Minimum	26.5	26.0	6.4	28	44.0	500

Total number of blows analyzed: 29

BL# Sensors

1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.09); A4: [K3550] 360.0 (1.09)

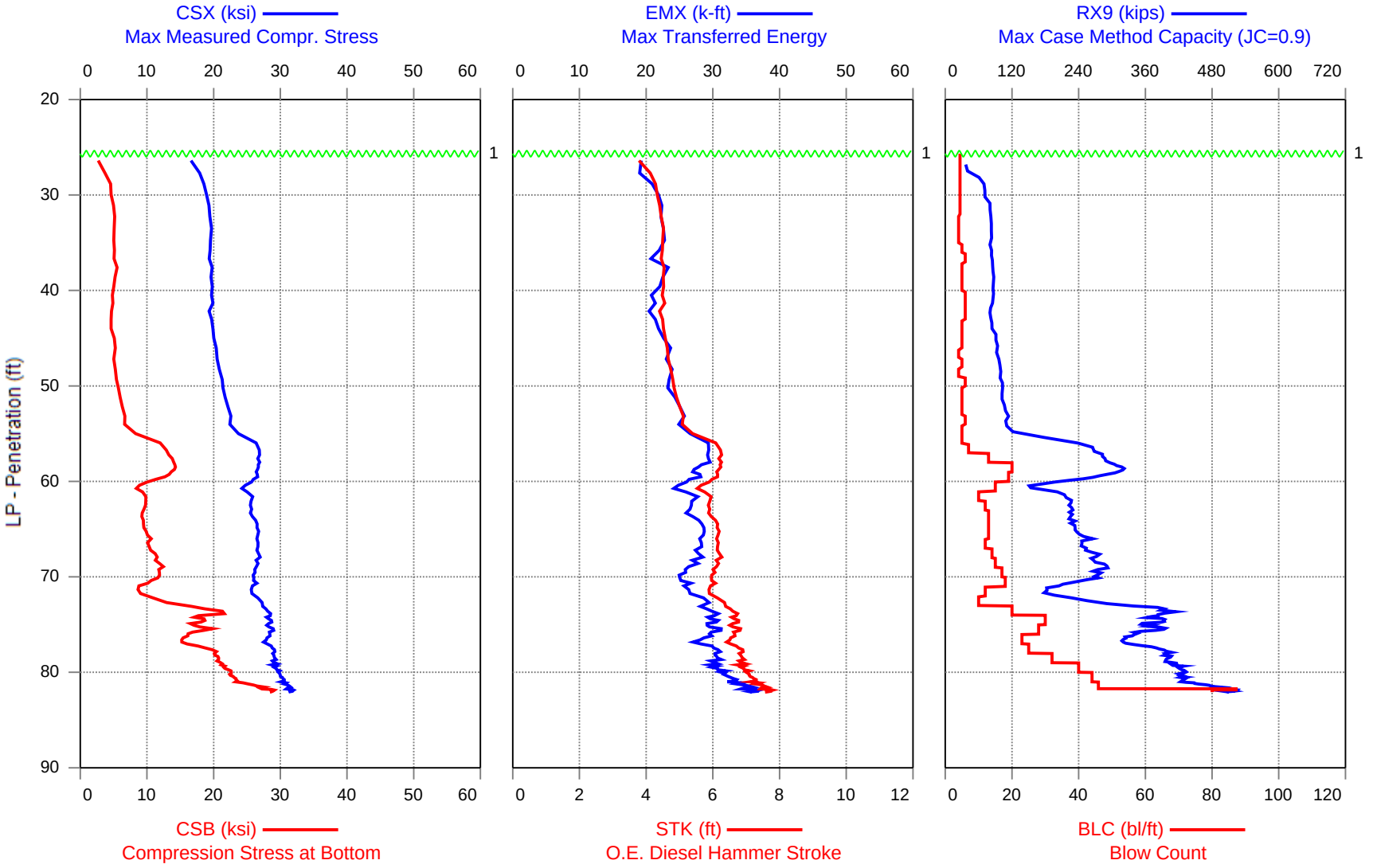
Time Summary

Drive 38 seconds 6:54 AM - 6:54 AM BN 1 - 30

Printed: 20-March-2015

Test started: 20-March-2015

USH 10 over Little Lake Butte des Morts - PIER 13 #36
APE D30-42, HP 14 x 73



1 - Reported reference at El. 740.23

USH 10 over Little Lake Butte des Morts - PIER 13 #36 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.67 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
31	32.00	4	AV27	18.4	4.2	21	4.2	56.9	60
			STD	2.4	0.9	3	0.5	3.1	24
			MAX	25.8	5.7	32	5.6	64.7	84
			MIN	12.4	1.9	12	3.2	49.5	0
35	33.00	4	AV4	19.5	5.1	22	4.5	55.0	83
			STD	0.5	0.2	1	0.1	0.5	3
			MAX	20.1	5.5	24	4.6	55.8	87
			MIN	18.7	5.0	21	4.3	54.4	78
39	34.00	4	AV4	19.6	5.0	22	4.5	54.9	84
			STD	0.4	0.4	2	0.1	0.4	4
			MAX	20.2	5.7	26	4.6	55.3	88
			MIN	19.1	4.5	20	4.4	54.3	78
43	35.00	4	AV4	19.4	5.1	23	4.5	55.2	81
			STD	0.4	0.1	1	0.1	0.4	4
			MAX	20.0	5.3	24	4.6	55.7	84
			MIN	18.8	5.0	21	4.4	54.6	75
48	36.00	5	AV5	19.5	5.1	22	4.5	54.9	83
			STD	0.4	0.3	1	0.1	0.5	1
			MAX	20.2	5.6	23	4.7	55.5	84
			MIN	19.0	4.7	21	4.4	54.0	81
54	37.00	6	AV6	19.5	5.1	21	4.5	55.1	84
			STD	0.4	0.2	1	0.1	0.5	2
			MAX	20.1	5.3	22	4.6	55.8	86
			MIN	18.8	4.8	20	4.3	54.4	82
59	38.00	5	AV5	19.8	5.5	23	4.5	54.7	85
			STD	0.4	0.1	1	0.1	0.4	1
			MAX	20.3	5.7	24	4.6	55.3	87
			MIN	19.2	5.3	22	4.4	54.1	84
64	39.00	5	AV5	19.6	5.2	23	4.5	54.9	87
			STD	0.3	0.1	1	0.1	0.4	1
			MAX	19.8	5.5	23	4.6	55.5	89
			MIN	19.1	5.1	22	4.4	54.4	86
69	40.00	5	AV5	19.8	5.0	22	4.5	54.8	86
			STD	0.8	0.2	2	0.2	0.9	3
			MAX	21.3	5.3	24	4.8	55.6	90
			MIN	19.0	4.6	20	4.4	53.3	81
75	41.00	6	AV6	19.7	5.0	21	4.5	54.9	86
			STD	0.4	0.5	1	0.1	0.5	2
			MAX	20.2	5.7	21	4.6	55.8	90
			MIN	19.1	4.3	20	4.3	54.5	84
81	42.00	6	AV6	19.6	4.6	21	4.5	55.1	83
			STD	0.8	0.3	1	0.2	1.0	2
			MAX	20.9	5.2	22	4.8	56.1	86
			MIN	18.8	4.3	19	4.3	53.4	80
87	43.00	6	AV6	19.6	4.7	21	4.5	55.1	81

USH 10 over Little Lake Butte des Morts - PIER 13 #36 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.2	0.2	0	0.1	0.3	1
			MAX	19.9	5.0	22	4.5	55.7	83
			MIN	19.3	4.5	20	4.4	54.8	80
92	44.00	5	AV5	19.7	4.6	22	4.5	55.0	84
			STD	0.6	0.2	1	0.1	0.7	2
			MAX	20.6	4.8	23	4.6	56.1	86
			MIN	18.8	4.3	21	4.3	54.2	82
97	45.00	5	AV5	20.0	5.0	22	4.6	54.5	90
			STD	0.9	0.3	2	0.2	1.1	4
			MAX	21.1	5.3	25	4.8	56.1	95
			MIN	18.7	4.7	20	4.3	53.1	84
102	46.00	5	AV5	20.0	5.1	22	4.5	54.7	93
			STD	0.2	0.1	0	0.0	0.2	2
			MAX	20.3	5.2	22	4.6	54.9	95
			MIN	19.6	4.9	22	4.5	54.5	89
106	47.00	4	AV4	20.7	5.3	25	4.7	53.9	93
			STD	0.5	0.3	1	0.1	0.6	2
			MAX	21.2	5.8	26	4.8	54.8	97
			MIN	19.9	5.0	23	4.5	53.3	92
111	48.00	5	AV5	20.7	5.0	23	4.7	53.7	98
			STD	0.4	0.2	1	0.1	0.5	3
			MAX	21.5	5.3	24	4.9	54.3	104
			MIN	20.2	4.7	21	4.6	52.9	94
115	49.00	4	AV4	20.9	5.4	24	4.7	53.6	99
			STD	0.7	0.1	1	0.2	0.8	2
			MAX	21.8	5.5	26	5.0	54.7	102
			MIN	19.9	5.3	23	4.5	52.4	96
121	50.00	6	AV6	21.3	5.5	23	4.8	53.2	102
			STD	0.3	0.1	1	0.1	0.3	5
			MAX	21.6	5.6	24	4.9	53.8	108
			MIN	20.7	5.4	22	4.7	52.9	92
126	51.00	5	AV5	21.5	5.8	24	4.9	53.0	103
			STD	0.2	0.3	1	0.1	0.3	3
			MAX	21.7	6.2	25	4.9	53.3	107
			MIN	21.2	5.4	23	4.8	52.6	98
131	52.00	5	AV5	21.9	6.1	25	5.0	52.4	103
			STD	0.1	0.0	0	0.0	0.1	3
			MAX	22.1	6.2	25	5.0	52.7	106
			MIN	21.8	6.0	24	4.9	52.3	98
136	53.00	5	AV5	22.3	6.5	25	5.0	52.1	109
			STD	0.1	0.2	1	0.0	0.1	4
			MAX	22.4	6.7	26	5.1	52.2	114
			MIN	22.2	6.3	25	5.0	52.0	102
142	54.00	6	AV6	22.6	6.7	26	5.1	51.7	111
			STD	0.3	0.2	1	0.1	0.3	3
			MAX	23.2	7.1	28	5.3	52.0	116
			MIN	22.3	6.5	23	5.1	51.0	106
147	55.00	5	AV5	22.6	7.1	25	5.1	51.7	117
			STD	0.2	0.4	0	0.0	0.2	9
			MAX	22.8	7.8	26	5.2	51.9	132
			MIN	22.3	6.7	24	5.1	51.4	107

USH 10 over Little Lake Butte des Morts - PIER 13 #36 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
152	56.00	5	AV5	25.9	11.0	29	5.9	48.2	200
			STD	0.8	1.1	1	0.2	0.9	32
			MAX	27.1	12.3	30	6.3	49.5	241
			MIN	24.6	9.1	28	5.6	46.9	152
159	57.00	7	AV7	26.7	12.8	29	6.2	47.2	264
			STD	0.3	0.4	1	0.1	0.3	10
			MAX	27.1	13.5	32	6.3	47.7	282
			MIN	26.2	12.4	28	6.1	46.8	249
172	58.00	13	AV13	26.8	13.6	29	6.2	47.1	286
			STD	0.3	0.4	1	0.1	0.3	5
			MAX	27.3	14.1	31	6.4	47.6	293
			MIN	26.2	12.9	28	6.1	46.6	277
192	59.00	20	AV20	26.6	14.1	28	6.2	47.2	313
			STD	0.5	0.3	1	0.1	0.5	8
			MAX	27.4	14.5	30	6.4	48.1	329
			MIN	25.8	13.6	25	6.0	46.5	296
211	60.00	19	AV19	26.3	12.4	27	6.1	47.6	265
			STD	0.5	1.1	1	0.1	0.5	30
			MAX	27.2	13.9	29	6.3	48.4	310
			MIN	25.5	10.2	26	5.9	46.8	211
226	61.00	15	AV15	24.8	8.9	25	5.7	49.3	170
			STD	0.6	0.6	1	0.1	0.6	18
			MAX	25.7	10.0	27	5.9	50.1	206
			MIN	24.0	8.2	24	5.5	48.3	145
236	62.00	10	AV10	25.5	9.8	27	5.9	48.4	215
			STD	0.5	0.2	1	0.1	0.5	11
			MAX	26.2	10.4	28	6.1	49.5	234
			MIN	24.4	9.5	26	5.6	47.7	191
248	63.00	12	AV12	25.6	9.7	27	5.9	48.3	226
			STD	0.4	0.2	1	0.1	0.4	4
			MAX	26.3	9.9	28	6.1	48.9	232
			MIN	25.1	9.3	26	5.8	47.7	218
261	64.00	13	AV13	25.8	9.3	27	5.9	48.2	226
			STD	0.4	0.3	1	0.1	0.4	7
			MAX	26.6	9.8	28	6.1	49.0	241
			MIN	25.0	8.8	25	5.7	47.4	215
274	65.00	13	AV13	26.5	9.5	28	6.1	47.5	231
			STD	0.3	0.2	1	0.1	0.4	7
			MAX	27.0	9.8	29	6.3	48.1	240
			MIN	25.8	9.2	27	6.0	47.0	222
287	66.00	13	AV13	26.6	10.1	29	6.2	47.4	244
			STD	0.3	0.3	1	0.1	0.3	11
			MAX	27.0	10.7	29	6.3	48.0	268
			MIN	26.0	9.6	27	6.0	47.0	227
299	67.00	12	AV12	26.6	10.3	28	6.1	47.4	249
			STD	0.4	0.3	1	0.1	0.4	10
			MAX	27.3	11.1	29	6.3	47.9	276
			MIN	26.0	9.9	27	6.0	46.8	231
313	68.00	14	AV14	26.7	11.1	28	6.2	47.2	266
			STD	0.5	0.6	1	0.1	0.5	11

USH 10 over Little Lake Butte des Morts - PIER 13 #36 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	27.7	11.9	30	6.5	48.0	291
			MIN	26.1	10.2	26	6.0	46.2	249
328	69.00	15	AV15	26.5	11.8	27	6.1	47.5	277
			STD	0.4	0.6	1	0.1	0.4	12
			MAX	27.0	12.7	28	6.3	48.3	294
			MIN	25.7	10.7	24	5.9	46.9	260
345	70.00	17	AV17	26.1	11.9	26	6.0	47.9	276
			STD	0.5	0.3	1	0.1	0.5	12
			MAX	27.1	12.7	28	6.3	48.6	300
			MIN	25.3	11.3	23	5.8	46.9	256
363	71.00	18	AV18	26.1	10.3	26	6.0	48.0	236
			STD	0.4	1.0	1	0.1	0.3	26
			MAX	26.9	12.3	27	6.2	48.5	278
			MIN	25.5	8.8	24	5.9	47.2	197
375	72.00	12	AV12	25.7	8.9	26	5.9	48.4	185
			STD	0.4	0.4	1	0.1	0.5	9
			MAX	26.5	9.8	28	6.1	49.0	197
			MIN	25.0	8.5	25	5.7	47.6	171
385	73.00	10	AV10	27.1	12.4	29	6.3	46.9	263
			STD	0.6	1.2	1	0.2	0.6	31
			MAX	27.9	14.2	31	6.5	48.0	310
			MIN	26.0	10.3	26	6.0	46.0	214
405	74.00	20	AV20	28.0	19.8	30	6.6	45.9	389
			STD	0.7	2.5	1	0.2	0.6	19
			MAX	29.1	25.6	32	6.9	47.0	424
			MIN	27.0	15.2	27	6.3	44.8	337
435	75.00	30	AV30	28.3	17.7	30	6.7	45.6	378
			STD	0.5	0.9	1	0.2	0.5	17
			MAX	29.3	19.7	32	7.0	46.8	413
			MIN	27.2	16.2	27	6.3	44.6	344
463	76.00	28	AV28	28.5	17.8	30	6.7	45.5	369
			STD	0.4	1.4	1	0.1	0.5	21
			MAX	29.2	21.7	32	6.9	46.6	403
			MIN	27.5	15.9	28	6.4	44.8	336
486	77.00	23	AV23	28.0	15.5	28	6.5	46.0	325
			STD	0.6	0.4	1	0.2	0.6	7
			MAX	28.9	16.6	31	6.8	47.1	342
			MIN	26.7	14.9	26	6.2	45.1	316
511	78.00	25	AV25	28.8	18.9	30	6.8	45.2	379
			STD	0.5	1.4	1	0.2	0.5	22
			MAX	29.9	21.0	33	7.1	46.5	418
			MIN	27.6	16.2	28	6.4	44.1	332
543	79.00	32	AV32	29.0	20.5	30	6.8	45.0	400
			STD	0.4	0.4	1	0.1	0.4	7
			MAX	29.8	21.3	32	7.1	46.0	413
			MIN	28.1	19.5	28	6.5	44.3	386
583	80.00	40	AV40	29.4	21.8	31	6.9	44.8	422
			STD	0.6	0.6	1	0.2	0.5	9
			MAX	30.5	23.1	33	7.3	46.1	438
			MIN	27.9	20.8	28	6.5	43.7	405

USH 10 over Little Lake Butte des Morts - PIER 13 #36 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
627	81.00	44	AV44	30.2	23.0	32	7.2	44.1	427
			STD	0.4	0.5	1	0.1	0.4	5
			MAX	31.3	24.0	35	7.5	44.9	439
			MIN	29.4	22.0	31	6.9	43.1	417
660	81.72	46	AV33	31.0	26.0	35	7.4	43.3	470
			STD	0.6	1.3	1	0.2	0.6	21
			MAX	32.1	28.0	37	7.9	44.6	505
			MIN	29.6	23.3	31	7.0	42.1	426
670	81.83	87	AV10	31.4	28.1	36	7.6	42.8	509
			STD	0.5	0.7	1	0.2	0.4	12
			MAX	32.2	29.3	37	7.8	43.5	522
			MIN	30.5	27.1	33	7.4	42.3	487
680	81.96	80	AV10	32.0	29.1	37	7.8	42.3	523
			STD	0.2	0.3	1	0.1	0.2	6
			MAX	32.5	29.4	38	7.9	42.7	529
			MIN	31.6	28.4	36	7.6	41.9	513
690	82.08	80	AV10	31.5	28.6	36	7.7	42.7	512
			STD	0.7	0.5	2	0.2	0.6	9
			MAX	32.4	29.3	38	7.9	43.7	523
			MIN	30.1	27.8	33	7.3	41.9	492
			Average	26.4	14.4	28	6.2	47.8	287
			Std. Dev.	3.7	7.1	4	1.0	4.0	133
			Maximum	32.5	29.4	38	7.9	64.7	529
			Minimum	12.4	1.9	12	3.2	41.9	0

Total number of blows analyzed: 686

BL# Sensors

1-690 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

BL# Comments

3 Reported reference at El. 740.23
4 Mudline at El. 717.23

Time Summary

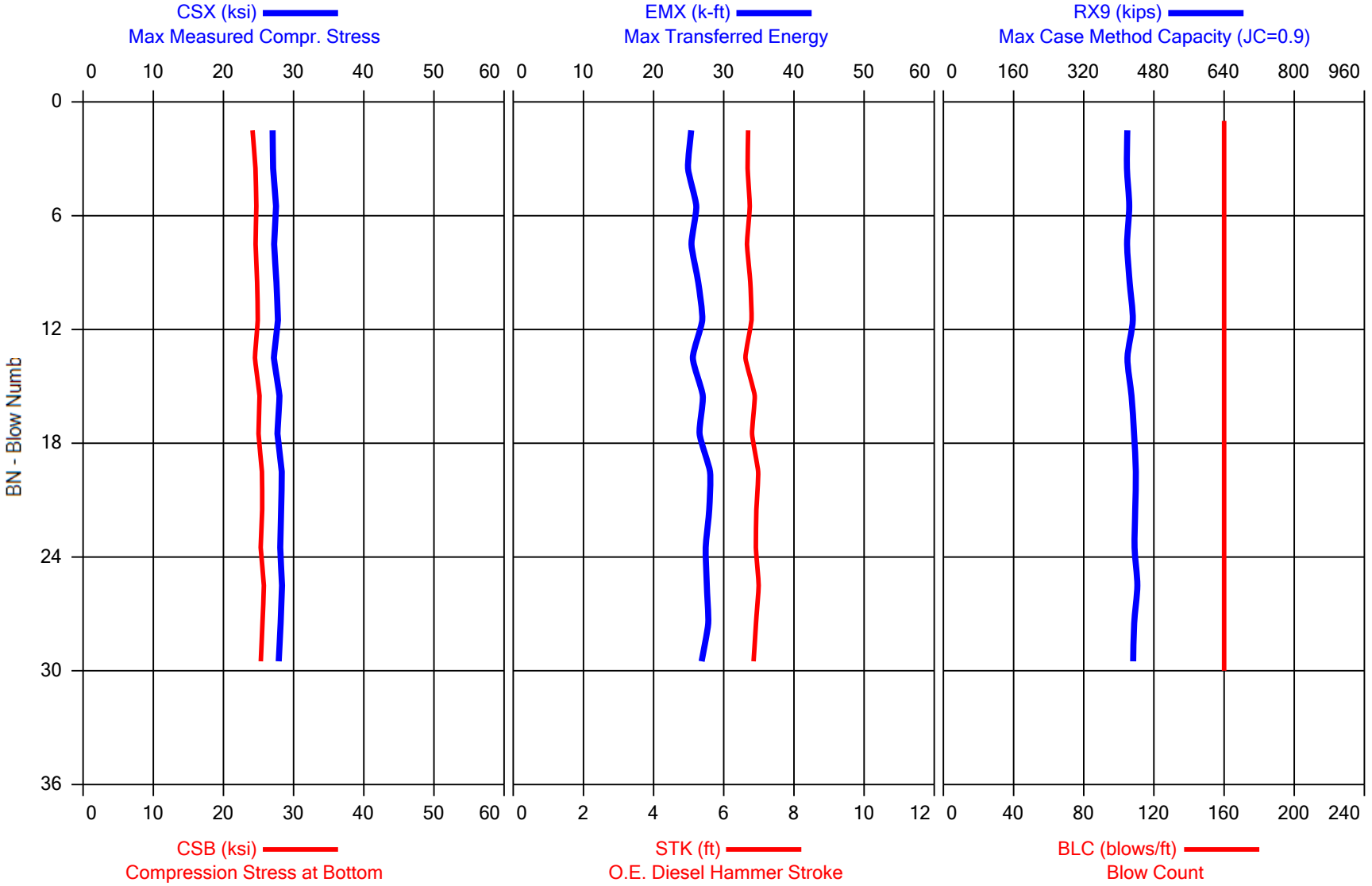
Drive 15 minutes 38 seconds 7:32 AM - 7:47 AM BN 1 - 690

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 23-March-2015 Test started: 23-March-2015

USH10 OVER LLBDM - PIER 13 #36 - BOR

APE D30-42, HP 14 x 73



USH10 OVER LLBDM - PIER 13 #36 - BOR APE D30-42, HP 14 x 73
OP: AZ Date: 23-March-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 87.00 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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
10	82	160	AV10	27.3	24.6	6.7	26	45.5	421
			STD	0.4	0.3	0.1	1	0.3	5
			MAX	27.8	25.0	6.8	27	46.0	428
			MIN	26.6	23.7	6.5	25	45.0	410
20	82	160	AV10	27.8	25.0	6.8	27	45.1	431
			STD	0.5	0.5	0.2	1	0.6	8
			MAX	28.8	25.9	7.1	29	45.9	443
			MIN	27.1	24.4	6.6	25	44.1	417
30	82	160	AV10	28.1	25.5	6.9	28	44.8	437
			STD	0.4	0.3	0.1	1	0.4	4
			MAX	28.7	26.0	7.1	29	45.4	445
			MIN	27.6	25.1	6.7	26	44.2	429
			Average	27.7	25.0	6.8	27	45.1	429
			Std. Dev.	0.6	0.5	0.2	1	0.5	9
			Maximum	28.8	26.0	7.1	29	46.0	445
			Minimum	26.6	23.7	6.5	25	44.1	410

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.09); A4: [K2524] 360.0 (1.09)

Time Summary

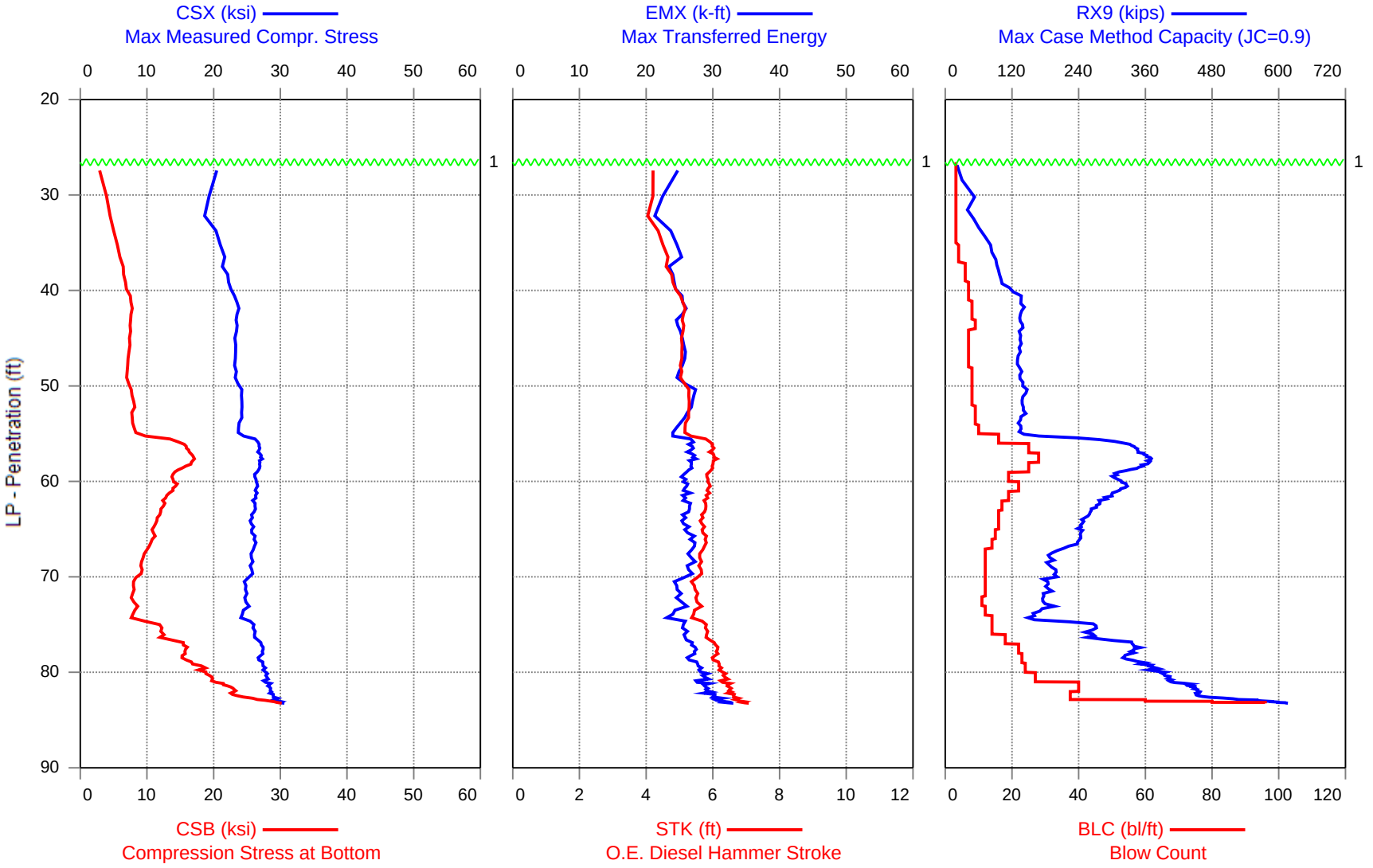
Drive 38 seconds 7:04 AM - 7:05 AM BN 1 - 30

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 20-March-2015

Test started: 20-March-2015

USH 10 over Little Lake Butte des Morts - PIER 13 #44
APE D30-42, HP 14 x 73



1 - Reported reference at El. 740.23

USH 10 over Little Lake Butte des Morts - PIER 13 #44 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 93.92 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
32	35.00	3	AV22	19.8	4.2	23	4.2	57.1	48
			STD	3.8	1.0	7	0.7	4.6	20
			MAX	29.7	5.5	43	6.5	67.9	79
			MIN	12.0	2.1	10	2.8	46.2	7
36	36.00	4	AV4	21.2	5.6	25	4.5	54.7	83
			STD	0.4	0.1	0	0.1	0.5	2
			MAX	21.9	5.7	25	4.7	55.2	87
			MIN	20.8	5.5	24	4.5	54.0	81
40	37.00	4	AV4	21.8	6.0	25	4.7	54.0	89
			STD	0.6	0.1	1	0.1	0.6	3
			MAX	22.3	6.2	27	4.8	54.8	94
			MIN	20.9	5.8	24	4.5	53.2	84
46	38.00	6	AV6	21.5	6.5	24	4.6	54.1	94
			STD	0.8	0.2	1	0.2	0.9	5
			MAX	22.6	6.7	25	4.9	55.8	100
			MIN	20.1	6.2	22	4.3	52.9	85
52	39.00	6	AV6	21.8	6.5	23	4.7	53.8	99
			STD	0.6	0.2	1	0.1	0.5	2
			MAX	22.4	6.8	25	4.8	54.7	102
			MIN	20.7	6.3	22	4.5	53.1	95
59	40.00	7	AV7	22.6	6.9	25	4.9	52.8	110
			STD	0.4	0.1	1	0.1	0.4	7
			MAX	23.3	7.2	26	5.0	53.3	117
			MIN	22.1	6.7	23	4.8	52.1	100
66	41.00	7	AV7	23.1	7.5	25	5.0	52.2	133
			STD	0.4	0.2	1	0.1	0.4	6
			MAX	23.8	7.8	27	5.2	52.8	145
			MIN	22.6	7.1	24	4.9	51.5	125
74	42.00	8	AV8	23.7	7.7	26	5.1	51.6	139
			STD	0.2	0.2	0	0.1	0.3	3
			MAX	24.1	7.9	27	5.2	52.0	144
			MIN	23.4	7.4	25	5.1	51.2	135
82	43.00	8	AV8	23.5	7.7	25	5.1	51.7	136
			STD	0.3	0.2	1	0.1	0.4	3
			MAX	23.9	7.9	26	5.2	52.3	139
			MIN	23.0	7.5	24	5.0	51.3	128
91	44.00	9	AV9	23.5	7.5	25	5.1	51.7	138
			STD	0.4	0.1	1	0.1	0.4	3
			MAX	24.1	7.6	26	5.2	52.4	141
			MIN	22.9	7.3	23	5.0	51.1	130
98	45.00	7	AV7	23.3	7.5	25	5.1	51.9	134
			STD	0.2	0.1	0	0.1	0.2	4
			MAX	23.6	7.7	26	5.2	52.2	140
			MIN	22.9	7.3	25	5.0	51.5	129
105	46.00	7	AV7	23.3	7.4	26	5.1	51.9	136

USH 10 over Little Lake Butte des Morts - PIER 13 #44 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.5	0.2	1	0.1	0.5	3
			MAX	23.9	7.7	27	5.2	52.9	142
			MIN	22.4	7.2	24	4.9	51.2	134
112	47.00	7	AV7	23.2	7.3	26	5.1	52.0	133
			STD	0.3	0.1	0	0.1	0.2	3
			MAX	23.7	7.5	27	5.1	52.3	138
			MIN	22.8	7.2	25	5.0	51.6	128
119	48.00	7	AV7	23.3	7.1	26	5.1	51.9	130
			STD	0.4	0.2	1	0.1	0.4	4
			MAX	23.8	7.3	27	5.2	52.7	134
			MIN	22.5	6.8	24	4.9	51.4	124
127	49.00	8	AV8	23.3	7.0	25	5.0	52.1	136
			STD	0.3	0.1	0	0.1	0.4	3
			MAX	23.6	7.2	25	5.1	52.7	143
			MIN	22.6	6.9	24	4.9	51.7	133
135	50.00	8	AV8	23.5	7.1	25	5.1	51.8	138
			STD	0.2	0.2	1	0.1	0.4	3
			MAX	23.9	7.4	26	5.2	52.3	142
			MIN	23.2	6.8	24	5.0	51.2	134
143	51.00	8	AV8	24.3	7.7	27	5.3	50.9	145
			STD	0.3	0.2	1	0.1	0.3	4
			MAX	24.7	7.9	28	5.4	51.4	154
			MIN	23.8	7.4	27	5.2	50.5	140
151	52.00	8	AV8	24.2	7.9	27	5.3	50.9	139
			STD	0.2	0.2	0	0.1	0.3	3
			MAX	24.4	8.3	28	5.3	51.5	142
			MIN	23.6	7.6	26	5.2	50.7	133
160	53.00	9	AV9	24.2	7.9	26	5.3	50.9	142
			STD	0.3	0.2	1	0.1	0.4	4
			MAX	24.6	8.3	28	5.4	51.7	151
			MIN	23.4	7.6	25	5.1	50.5	137
169	54.00	9	AV9	24.0	7.8	25	5.2	51.2	134
			STD	0.5	0.2	1	0.1	0.5	5
			MAX	24.6	8.2	26	5.3	52.2	144
			MIN	23.0	7.6	24	5.0	50.7	127
179	55.00	10	AV10	23.8	8.2	25	5.2	51.4	135
			STD	0.5	0.3	1	0.1	0.6	2
			MAX	24.6	8.7	26	5.4	52.5	138
			MIN	22.8	7.8	22	5.0	50.3	131
195	56.00	16	AV16	25.6	12.4	26	5.6	49.4	243
			STD	1.1	2.4	2	0.3	1.3	63
			MAX	27.3	15.1	28	6.0	51.9	319
			MIN	23.4	8.4	23	5.1	47.8	144
220	57.00	25	AV25	26.8	16.0	27	6.0	48.0	341
			STD	0.3	0.5	1	0.1	0.3	6
			MAX	27.3	17.0	27	6.1	48.6	352
			MIN	26.3	15.1	25	5.8	47.5	330
248	58.00	28	AV28	27.1	16.9	27	6.0	47.8	365
			STD	0.4	0.3	1	0.1	0.4	6
			MAX	27.8	17.5	29	6.3	48.7	379
			MIN	26.1	16.1	25	5.8	46.9	353

USH 10 over Little Lake Butte des Morts - PIER 13 #44
OP: AM
APE D30-42, HP 14 x 73
Date: 20-March-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
273	59.00	25	AV25	26.8	15.5	27	6.0	48.1	345
			STD	0.3	0.9	0	0.1	0.3	16
			MAX	27.6	17.0	28	6.1	48.5	369
			MIN	26.3	14.1	26	5.9	47.4	312
292	60.00	19	AV19	26.3	13.9	26	5.8	48.6	308
			STD	0.4	0.2	1	0.1	0.4	6
			MAX	26.8	14.3	27	6.0	49.6	320
			MIN	25.3	13.5	24	5.6	48.0	295
314	61.00	22	AV22	26.4	14.1	26	5.9	48.4	321
			STD	0.3	0.4	1	0.1	0.3	6
			MAX	27.0	15.0	27	6.0	48.9	331
			MIN	25.8	13.3	24	5.8	47.9	308
333	62.00	19	AV19	26.3	12.9	26	5.8	48.6	295
			STD	0.5	0.5	1	0.1	0.4	10
			MAX	27.0	13.9	29	6.0	49.5	310
			MIN	25.4	12.1	24	5.6	47.9	275
350	63.00	17	AV17	26.3	12.4	27	5.8	48.7	273
			STD	0.3	0.3	1	0.1	0.3	6
			MAX	26.9	13.1	28	5.9	49.2	281
			MIN	25.6	11.9	26	5.7	48.3	258
366	64.00	16	AV16	25.8	11.9	26	5.7	49.1	256
			STD	0.4	0.4	1	0.1	0.4	6
			MAX	26.6	12.8	27	5.9	49.7	265
			MIN	25.1	11.2	25	5.6	48.4	245
382	65.00	16	AV16	25.6	11.1	26	5.7	49.3	245
			STD	0.5	0.3	1	0.1	0.4	4
			MAX	26.7	11.5	28	5.9	50.0	251
			MIN	24.8	10.5	24	5.5	48.2	234
397	66.00	15	AV15	26.0	11.0	27	5.7	48.9	244
			STD	0.5	0.2	1	0.1	0.4	4
			MAX	27.1	11.4	28	6.0	49.5	252
			MIN	25.3	10.5	25	5.6	47.9	235
411	67.00	14	AV14	26.2	10.5	27	5.8	48.8	232
			STD	0.3	0.3	1	0.1	0.4	11
			MAX	26.6	11.1	28	5.9	49.4	245
			MIN	25.7	9.9	26	5.6	48.2	213
423	68.00	12	AV12	25.7	9.7	27	5.6	49.4	194
			STD	0.4	0.3	1	0.1	0.4	10
			MAX	26.5	10.4	28	5.8	50.1	212
			MIN	25.1	9.1	25	5.5	48.6	177
435	69.00	12	AV12	25.7	9.1	27	5.6	49.4	188
			STD	0.4	0.1	1	0.1	0.3	7
			MAX	26.2	9.3	28	5.8	50.3	202
			MIN	24.8	8.9	25	5.4	48.9	176
447	70.00	12	AV12	25.8	9.1	27	5.7	49.3	198
			STD	0.2	0.3	0	0.0	0.2	6
			MAX	26.1	9.7	27	5.7	49.7	207
			MIN	25.5	8.6	26	5.6	49.0	187
459	71.00	12	AV12	24.8	8.0	24	5.4	50.4	185
			STD	0.7	0.2	1	0.2	0.7	9

USH 10 over Little Lake Butte des Morts - PIER 13 #44 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			MAX	25.8	8.5	26	5.6	51.5	206
			MIN	23.6	7.6	22	5.2	49.4	171
471	72.00	12	AV12	24.8	8.0	25	5.5	50.0	182
			STD	0.4	0.3	1	0.1	0.4	11
			MAX	25.6	8.5	26	5.7	50.5	200
			MIN	24.3	7.4	23	5.4	49.2	161
482	73.00	11	AV11	24.8	8.0	25	5.5	49.9	178
			STD	0.4	0.4	1	0.1	0.4	8
			MAX	25.5	8.8	26	5.7	50.6	189
			MIN	24.1	7.4	24	5.4	49.2	169
494	74.00	12	AV12	24.7	8.2	25	5.5	49.9	172
			STD	0.8	0.4	2	0.2	0.9	16
			MAX	26.2	9.0	27	5.9	51.3	201
			MIN	23.4	7.7	22	5.2	48.4	155
508	75.00	14	AV14	25.0	9.3	25	5.6	49.6	194
			STD	1.0	1.7	2	0.2	1.0	47
			MAX	26.4	11.8	27	5.9	51.7	277
			MIN	23.1	7.5	21	5.1	48.3	146
522	76.00	14	AV14	26.0	12.2	26	5.8	48.8	265
			STD	0.6	0.3	1	0.1	0.6	9
			MAX	27.1	13.0	28	6.1	50.0	277
			MIN	24.7	11.8	23	5.5	47.6	240
540	77.00	18	AV18	26.6	13.5	26	5.9	48.3	292
			STD	0.5	1.4	1	0.1	0.5	31
			MAX	27.3	16.2	29	6.1	49.6	341
			MIN	25.2	11.7	24	5.6	47.6	254
562	78.00	22	AV22	27.3	15.8	27	6.1	47.5	340
			STD	0.5	0.4	1	0.1	0.4	9
			MAX	28.2	16.8	28	6.3	48.2	372
			MIN	26.4	15.0	26	5.9	46.8	327
585	79.00	23	AV23	27.0	15.7	27	6.1	47.7	332
			STD	0.4	0.6	1	0.1	0.4	14
			MAX	28.0	17.0	29	6.3	48.3	366
			MIN	26.4	14.9	25	5.9	46.7	313
609	80.00	24	AV24	27.5	18.0	28	6.2	47.2	372
			STD	0.4	0.9	1	0.1	0.4	13
			MAX	28.2	19.8	29	6.4	48.1	395
			MIN	26.6	16.4	26	6.0	46.5	342
636	81.00	27	AV27	27.9	19.5	29	6.3	46.7	400
			STD	0.5	0.6	1	0.1	0.4	8
			MAX	28.6	20.5	31	6.6	47.8	423
			MIN	26.9	18.5	26	6.0	45.8	386
676	82.00	40	AV40	28.4	22.2	29	6.5	46.3	442
			STD	0.5	1.0	1	0.1	0.5	15
			MAX	29.5	23.7	31	6.8	47.0	463
			MIN	27.5	19.8	27	6.3	45.3	406
708	82.85	37	AV32	28.9	24.0	30	6.6	45.8	471
			STD	0.6	1.3	1	0.2	0.5	25
			MAX	30.2	26.2	32	6.9	46.5	526
			MIN	28.1	22.3	28	6.4	44.8	441

USH 10 over Little Lake Butte des Morts - PIER 13 #44 APE D30-42, HP 14 x 73
OP: AM Date: 20-March-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
718	83.02	60	AV10	29.5	27.8	31	6.8	45.3	561
			STD	0.4	0.5	1	0.1	0.4	11
			MAX	30.3	28.7	32	6.9	45.8	578
			MIN	28.8	26.8	30	6.6	44.7	538
728	83.15	80	AV10	30.0	29.1	32	6.9	44.8	591
			STD	0.3	0.4	1	0.1	0.3	8
			MAX	30.7	29.8	33	7.1	45.2	603
			MIN	29.5	28.4	31	6.8	44.1	578
738	83.25	96	AV10	30.2	29.9	32	7.0	44.6	611
			STD	0.4	0.4	1	0.1	0.3	10
			MAX	30.8	30.6	34	7.1	45.1	634
			MIN	29.8	29.4	31	6.8	44.1	598
			Average	25.9	13.5	27	5.8	49.1	277
			Std. Dev.	2.3	6.0	2	0.6	2.7	128
			Maximum	30.8	30.6	43	7.1	67.9	634
			Minimum	12.0	2.1	10	2.8	44.1	7

Total number of blows analyzed: 728

BL# Sensors

1-738 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.10); A4: [K3550] 360.0 (1.10)

BL# Comments

5 Reported reference at El. 740.23
6 Mudline at El. 717.23

Time Summary

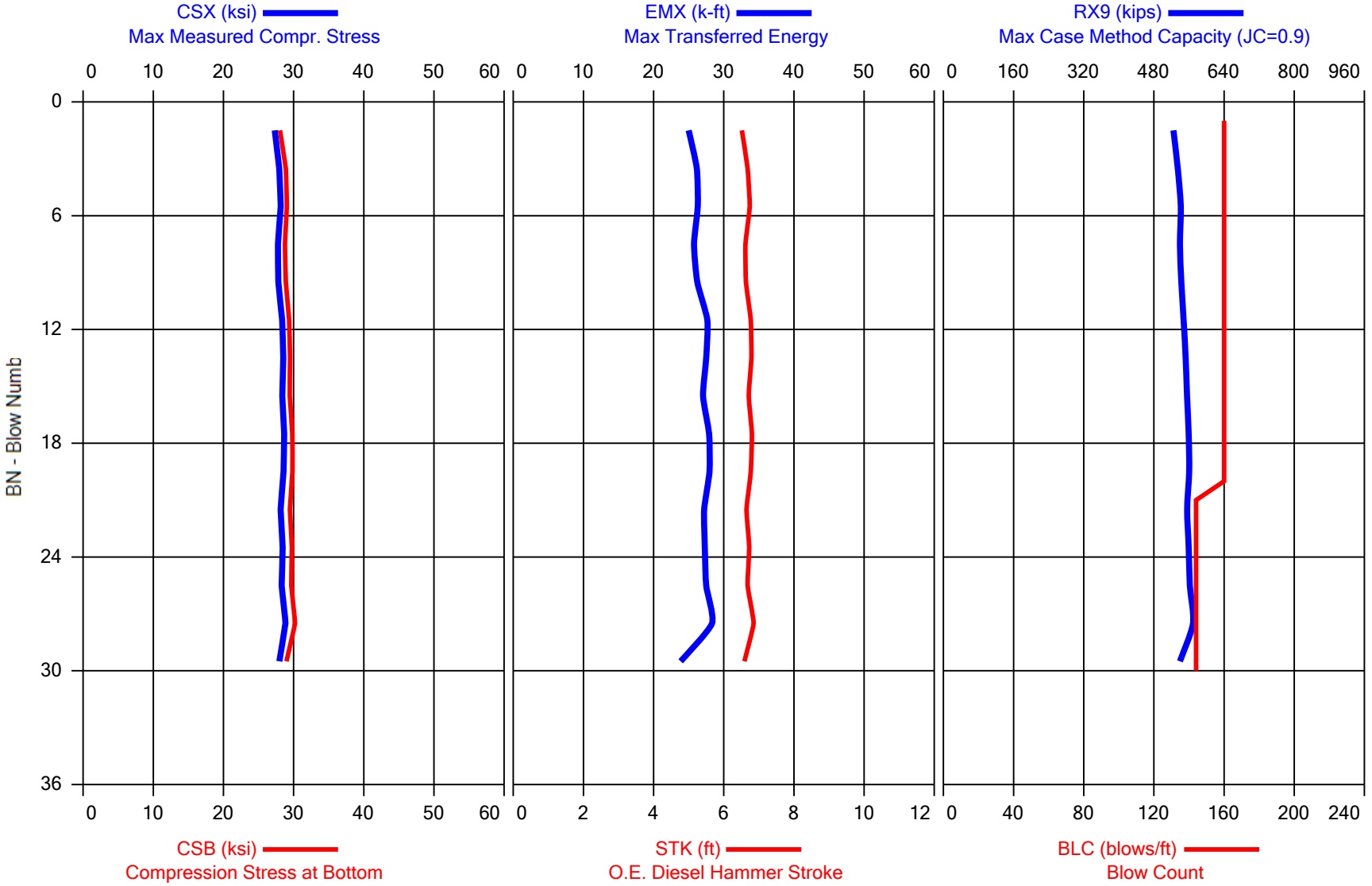
Drive 16 minutes 9 seconds 7:01 AM - 7:17 AM BN 1 - 738

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 23-March-2015 Test started: 23-March-2015

USH10 OVER LLBDM - PIER 13 #44 - BOR

APE D30-42, HP 14 x 73



USH10 OVER LLBDM - PIER 13 #44 - BOR APE D30-42, HP 14 x 73
OP: AZ Date: 23-March-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 88.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	83	160	AV10	27.8	28.7	6.6	26	45.7	536
			STD	0.4	0.5	0.1	1	0.4	9
			MAX	28.3	29.3	6.8	27	46.6	546
			MIN	27.0	27.5	6.4	24	45.1	516
20	83	160	AV10	28.5	29.6	6.8	28	45.3	555
			STD	0.2	0.3	0.1	1	0.2	5
			MAX	28.9	30.0	6.8	29	45.8	563
			MIN	28.1	29.1	6.6	26	45.0	547
29	83	144	AV9	28.4	29.7	6.7	27	45.5	561
			STD	0.4	0.3	0.1	1	0.4	6
			MAX	29.0	30.2	6.9	29	46.0	569
			MIN	27.9	29.3	6.5	27	44.9	552
30	83	144	AV1	28.1	28.6	6.6	21	45.7	519
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	28.1	28.6	6.6	21	45.7	519
			MIN	28.1	28.6	6.6	21	45.7	519
			Average	28.2	29.3	6.7	27	45.5	549
			Std. Dev.	0.4	0.6	0.1	1	0.4	14
			Maximum	29.0	30.2	6.9	29	46.6	569
			Minimum	27.0	27.5	6.4	21	44.9	516

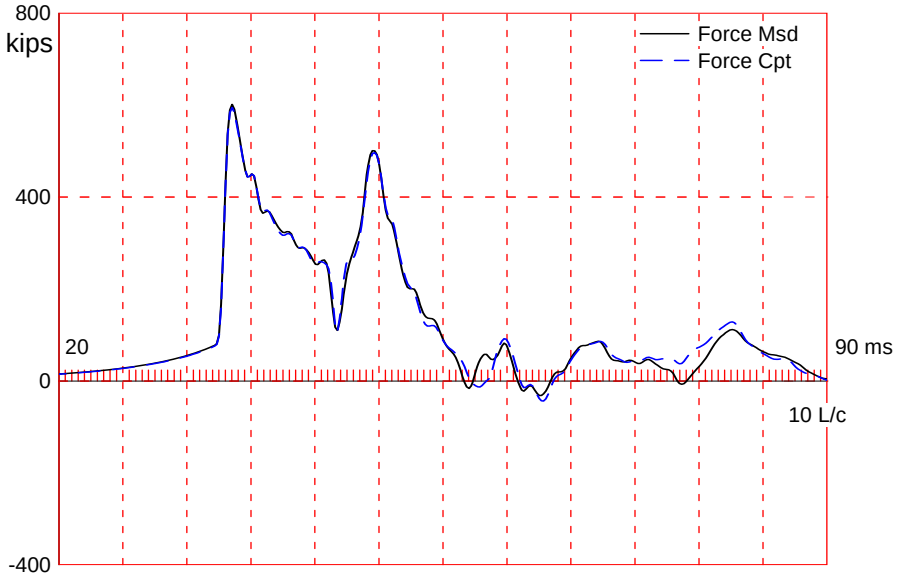
Total number of blows analyzed: 30

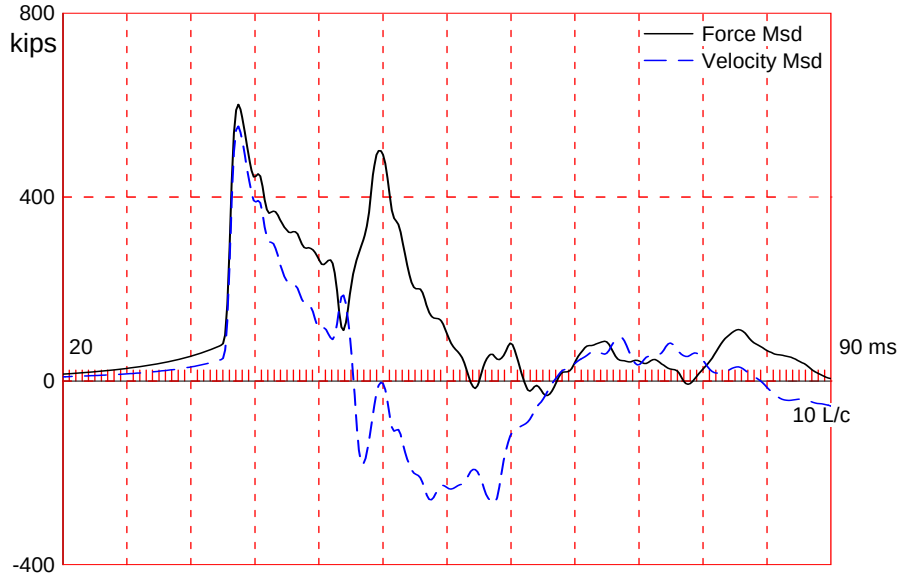
BL# Sensors

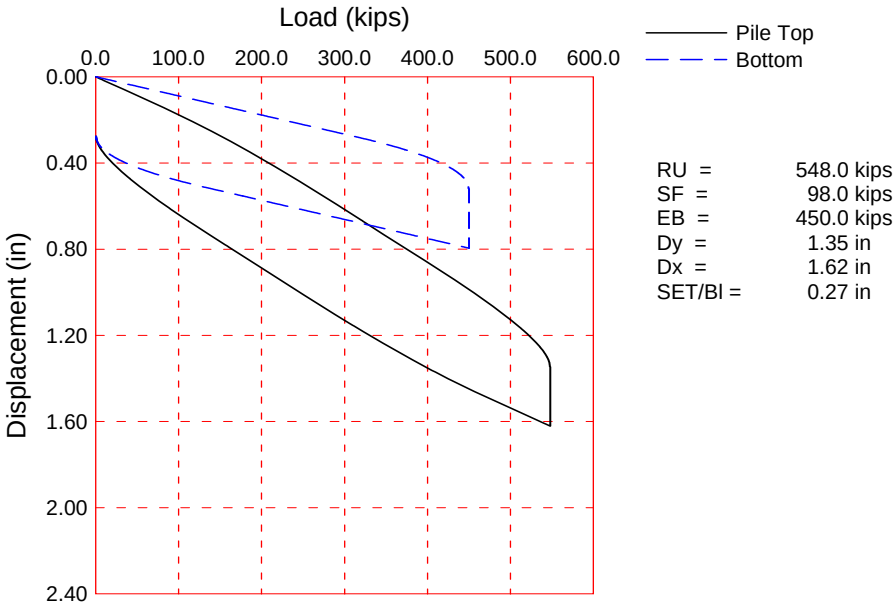
1-30 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.08); A4: [K2524] 360.0 (1.08)

Time Summary

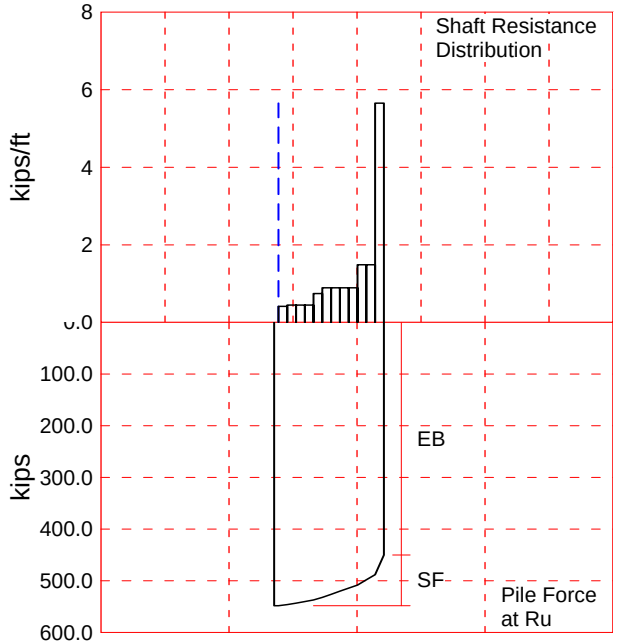
Drive 38 seconds 7:11 AM - 7:12 AM BN 1 - 30







RU =	548.0 kips
SF =	98.0 kips
EB =	450.0 kips
Dy =	1.35 in
Dx =	1.62 in
SET/Bl =	0.27 in



Length b. Sensors	84.0 ft
Embedment	78.7 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	3.63
Top Compr. Stress	27.9 ksi
Max Compr. Stress	28.1 ksi
Max Tension Stress	-5.42 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.40 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.07 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 548.0; along Shaft 98.0; at Toe 450.0 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
				548.0			
1	10.1	4.8	2.0	546.0	2.0	0.42	0.09
2	16.8	11.5	3.0	543.0	5.0	0.45	0.10
3	23.5	18.2	3.0	540.0	8.0	0.45	0.10
4	30.2	25.0	3.0	537.0	11.0	0.45	0.10
5	37.0	31.7	5.0	532.0	16.0	0.74	0.16
6	43.7	38.4	6.0	526.0	22.0	0.89	0.19
7	50.4	45.1	6.0	520.0	28.0	0.89	0.19
8	57.1	51.8	6.0	514.0	34.0	0.89	0.19
9	63.8	58.6	6.0	508.0	40.0	0.89	0.19
10	70.6	65.3	10.0	498.0	50.0	1.49	0.32
11	77.3	72.0	10.0	488.0	60.0	1.49	0.32
12	84.0	78.7	38.0	450.0	98.0	5.65	1.20
Avg. Shaft			8.2			1.24	0.26
Toe			450.0				326.45

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.24	0.07
Quake	(in)	0.14	0.40
Case Damping Factor		0.62	0.82
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	30	30
Unloading Level	(% of Ru)	43	
Resistance Gap (included in Toe Quake)	(in)		0.11

CAPWAP match quality = 3.63 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.27 in; Blow Count = 44 b/ft
Computed: Final Set = 0.27 in; Blow Count = 45 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.10; A4(K3550) CAL: 360; RF: 1.10

max. Top Comp. Stress = 27.9 ksi (T= 36.2 ms, max= 1.009 x Top)
max. Comp. Stress = 28.1 ksi (Z= 10.1 ft, T= 36.6 ms)
max. Tens. Stress = -5.42 ksi (Z= 43.7 ft, T= 62.0 ms)
max. Energy (EMX) = 30.5 kip-ft; max. Measured Top Displ. (DMX)= 1.04 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	596.7	-53.9	27.9	-2.52	30.5	14.6	1.03
2	6.7	599.2	-58.2	28.0	-2.72	30.3	14.6	1.01
4	13.4	596.2	-68.1	27.9	-3.18	29.3	14.4	0.97
6	20.2	589.0	-74.5	27.5	-3.48	28.0	14.2	0.93
8	26.9	582.0	-61.6	27.2	-2.88	26.7	14.1	0.89
9	30.2	585.9	-68.5	27.4	-3.20	26.4	13.9	0.86
10	33.6	577.9	-78.6	27.0	-3.67	25.4	13.8	0.84
11	37.0	582.5	-99.8	27.2	-4.66	24.9	13.7	0.81
12	40.3	566.8	-111.8	26.5	-5.22	23.5	13.5	0.79
13	43.7	571.4	-115.9	26.7	-5.42	23.0	13.4	0.76
14	47.0	551.7	-105.7	25.8	-4.94	21.5	13.2	0.73
15	50.4	556.3	-103.4	26.0	-4.83	21.0	13.1	0.70
16	53.8	536.7	-97.4	25.1	-4.55	19.4	13.0	0.67
17	57.1	541.1	-99.9	25.3	-4.67	18.8	12.9	0.64
18	60.5	521.7	-92.2	24.4	-4.31	17.3	12.7	0.61
19	63.8	527.7	-86.8	24.7	-4.05	16.8	12.5	0.58
20	67.2	511.4	-75.5	23.9	-3.53	15.3	12.3	0.55
21	70.6	517.8	-72.0	24.2	-3.36	14.7	13.1	0.52
22	73.9	504.1	-59.9	23.5	-2.80	12.9	14.4	0.49
23	77.3	530.8	-55.9	24.8	-2.61	12.2	15.5	0.46
24	80.6	533.6	-43.6	24.9	-2.04	10.5	15.6	0.43
25	84.0	548.8	-41.1	25.6	-1.92	7.9	14.0	0.41
Absolute	10.1			28.1			(T =	36.6 ms)
	43.7				-5.42		(T =	62.0 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	575.6	517.3	459.0	400.7	342.4	284.1	225.7	167.4	109.1	50.8
RX	675.5	654.7	637.4	620.8	604.3	587.8	572.6	558.6	545.3	533.1
RU	575.6	517.3	459.0	400.7	342.4	284.1	225.7	167.4	109.1	50.8

RAU = 412.7 (kips); RA2 = 567.4 (kips)

Current CAPWAP Ru = 548.0 (kips); Corresponding J(RP)= 0.05; J(RX) = 0.78

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
14.6	35.98	556.8	602.0	603.7	1.04	0.26	0.27	30.8	560.2	1552

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
84.0	21.4	29992.2	492.000	4.70

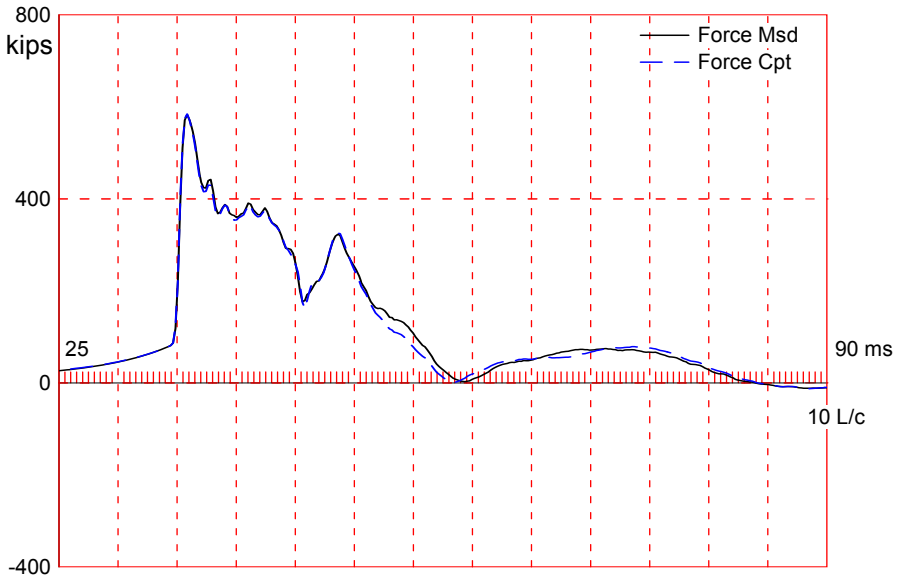
Toe Area 198.5 in^2

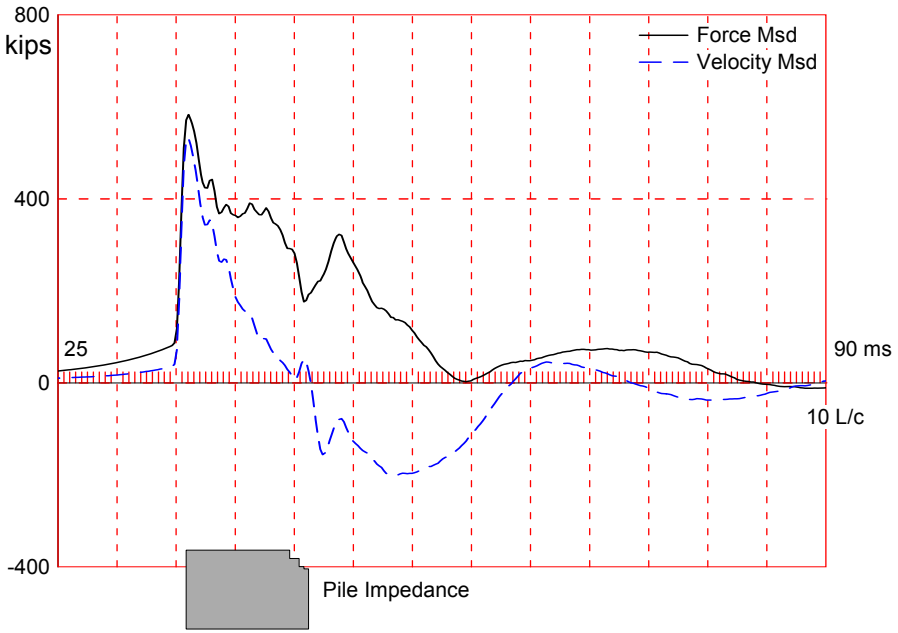
Top Segment Length 3.36 ft, Top Impedance 38 kips/ft/s

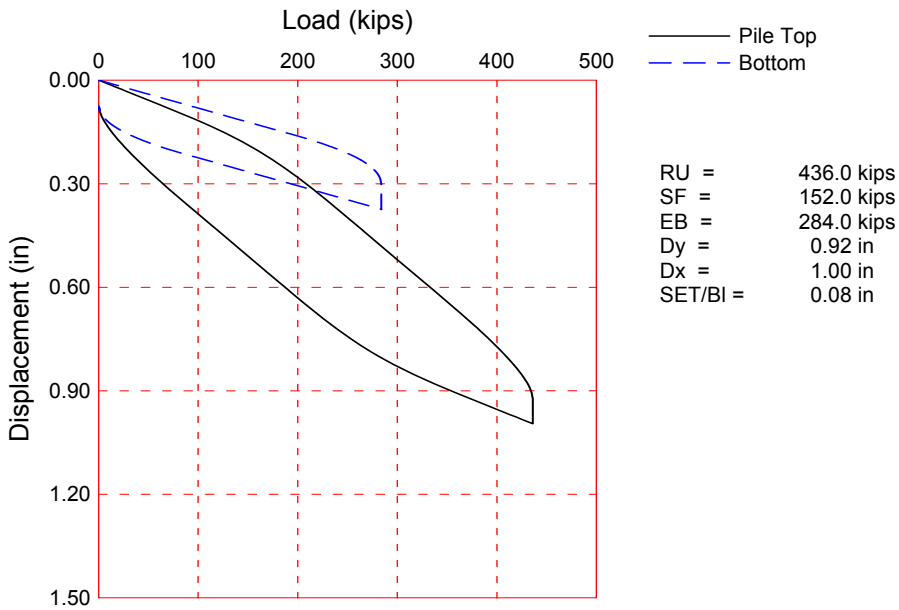
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 10.0 ms
Total volume: 12.483 ft^3; Volume ratio considering added impedance: 1.000

DYNAMIC RESISTANCE TABLE

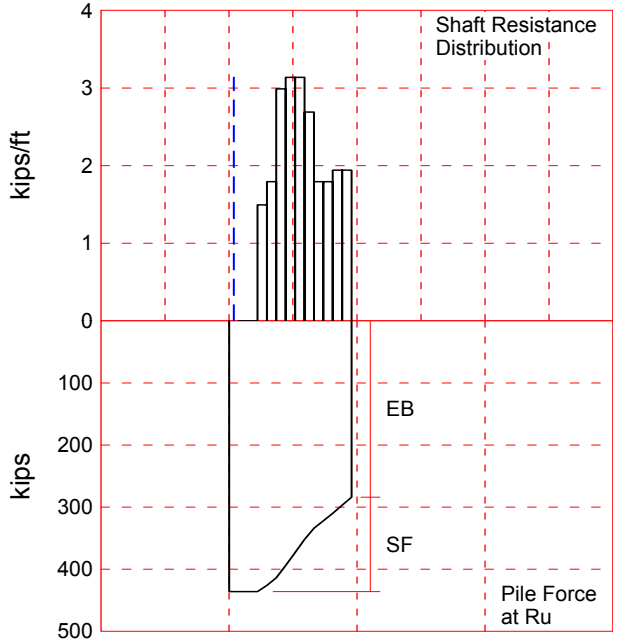
Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Damping Rd at Max. Rt kips	Max Rt (Ru+Rd) kips	Total Unit Rt W. Resp. to Depth kips/ft	Area ksf
1	10.1	4.8	2.0	6.9	8.9	1.86	0.40
2	16.8	11.5	3.0	10.3	13.3	1.98	0.42
3	23.5	18.2	3.0	10.2	13.2	1.96	0.42
4	30.2	25.0	3.0	10.0	13.0	1.94	0.41
5	37.0	31.7	5.0	16.3	21.3	3.17	0.68
6	43.7	38.4	6.0	19.2	25.2	3.75	0.80
7	50.4	45.1	6.0	18.8	24.8	3.69	0.78
8	57.1	51.8	6.0	18.4	24.4	3.63	0.77
9	63.8	58.6	6.0	18.0	24.0	3.56	0.76
10	70.6	65.3	10.0	31.1	41.1	6.12	1.30
11	77.3	72.0	10.0	36.9	46.9	6.98	1.49
12	84.0	78.7	38.0	127.5	165.5	24.63	5.24
Avg. Shaft			8.2	27.0	35.1	5.36	1.14
Toe			450.0	34.3	484.3		351.36
Total					905.9		







RU =	436.0 kips
SF =	152.0 kips
EB =	284.0 kips
Dy =	0.92 in
Dx =	1.00 in
SET/BI =	0.08 in



Length b. Sensors	87.0 ft
Embedment	82.1 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.	16800 ft/s
Match Quality	2.29
Top Compr. Stress	27.4 ksi
Max Compr. Stress	28.8 ksi
Max Tension Stress	-1.75 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.23 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.13 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: 436.0; along Shaft 152.0; at Toe 284.0 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
				436.0				
1	13.4	8.5	0.0	436.0	0.0	0.00	0.00	0.00
2	20.1	15.2	0.0	436.0	0.0	0.00	0.00	0.00
3	26.8	21.8	10.0	426.0	10.0	1.49	0.32	0.25
4	33.5	28.5	12.0	414.0	22.0	1.79	0.38	0.25
5	40.2	35.2	20.0	394.0	42.0	2.99	0.64	0.25
6	46.8	41.9	21.0	373.0	63.0	3.14	0.67	0.25
7	53.5	48.6	21.0	352.0	84.0	3.14	0.67	0.25
8	60.2	55.3	18.0	334.0	102.0	2.69	0.57	0.25
9	66.9	62.0	12.0	322.0	114.0	1.79	0.38	0.25
10	73.6	68.7	12.0	310.0	126.0	1.79	0.38	0.25
11	80.3	75.4	13.0	297.0	139.0	1.94	0.41	0.25
12	87.0	82.1	13.0	284.0	152.0	1.94	0.41	0.25
Avg. Shaft			12.7			1.85	0.39	0.25
Toe			284.0				206.02	0.13

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.06	0.23
Case Damping Factor		0.99	0.97
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	90	50
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	7	
Resistance Gap (included in Toe Quake)	(in)		0.03

CAPWAP match quality = 2.29 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.11 in; Blow Count = 105 b/ft
Transducer F1(D815) CAL: 93.0; RF: 1.00; F2(F607) CAL: 93.6; RF: 1.00
A1(K3550) CAL: 360; RF: 1.10; A2(K2524) CAL: 360; RF: 1.10

max. Top Comp. Stress = 27.4 ksi (T= 36.3 ms, max= 1.052 x Top)
max. Comp. Stress = 28.8 ksi (Z= 26.8 ft, T= 37.6 ms)
max. Tens. Stress = -1.75 ksi (Z= 73.6 ft, T= 63.9 ms)
max. Energy (EMX) = 25.5 kip-ft; max. Measured Top Displ. (DMX)= 0.79 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	585.7	-13.8	27.4	-0.64	25.5	13.9	0.79
2	6.7	587.0	-14.7	27.4	-0.68	25.4	13.8	0.77
4	13.4	589.9	-15.6	27.6	-0.73	25.0	13.7	0.74
6	20.1	597.1	-17.2	27.9	-0.80	24.5	13.5	0.70
8	26.8	616.2	-27.7	28.8	-1.29	23.9	13.0	0.66
10	33.5	597.5	-32.5	27.9	-1.52	21.7	12.4	0.61
11	36.8	568.1	-30.4	26.5	-1.42	19.8	11.9	0.59
12	40.2	580.3	-34.9	27.1	-1.63	19.4	11.6	0.56
13	43.5	523.1	-28.1	24.4	-1.31	16.7	11.0	0.54
14	46.8	534.9	-32.2	25.0	-1.50	16.3	10.7	0.52
15	50.2	476.4	-26.0	22.3	-1.22	13.7	10.3	0.49
16	53.5	487.4	-30.3	22.8	-1.41	13.4	10.0	0.47
17	56.9	429.4	-25.4	20.1	-1.19	11.1	9.6	0.45
18	60.2	438.0	-29.6	20.5	-1.38	10.7	9.4	0.42
19	63.6	387.5	-27.9	18.1	-1.30	8.9	9.1	0.40
20	66.9	390.5	-32.2	18.2	-1.50	8.6	9.0	0.38
21	70.3	350.4	-33.2	16.4	-1.55	7.4	9.1	0.36
22	73.6	350.2	-37.5	16.4	-1.75	7.1	9.5	0.34
23	77.0	340.5	-35.2	15.9	-1.65	6.0	10.9	0.32
24	80.3	352.2	-35.8	16.5	-1.67	5.7	11.7	0.30
25	83.7	340.6	-32.6	15.9	-1.52	4.6	12.1	0.27
26	87.0	349.8	-32.6	16.3	-1.52	4.1	10.6	0.25
Absolute	26.8			28.8			(T =	37.6 ms)
	73.6				-1.75		(T =	63.9 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	658.0	611.5	564.9	518.3	471.8	425.2	378.6	332.1	285.5	239.0
RX	677.6	642.1	608.6	575.2	541.8	514.9	489.3	469.4	449.5	429.6
RU	658.0	611.5	564.9	518.3	471.8	425.2	378.6	332.1	285.5	239.0

RAU = 295.1 (kips); RA2 = 504.6 (kips)

Current CAPWAP Ru = 436.0 (kips); Corresponding J(RP)= 0.48; J(RX) = 0.87

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
14.1	36.05	536.8	586.8	586.8	0.79	0.08	0.08	25.6	707.9	1420

Possible Pile Damage at 1.0 L Below Gages?

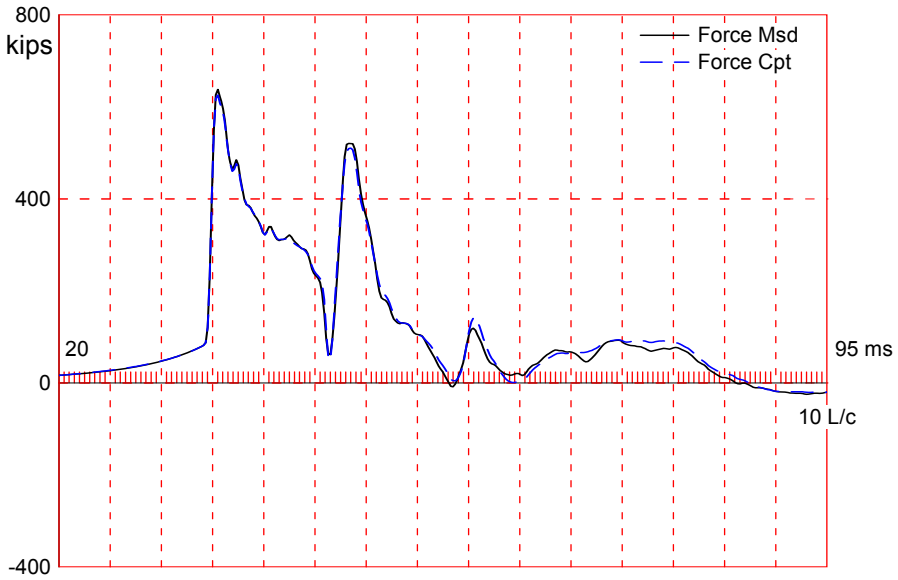
PILE PROFILE AND PILE MODEL

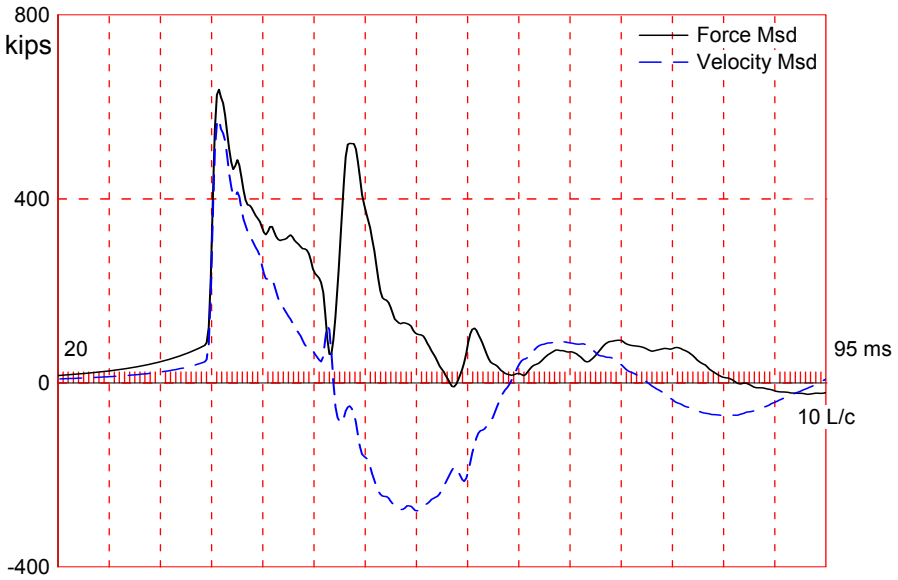
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
87.0	21.4	29992.2	492.000	4.70

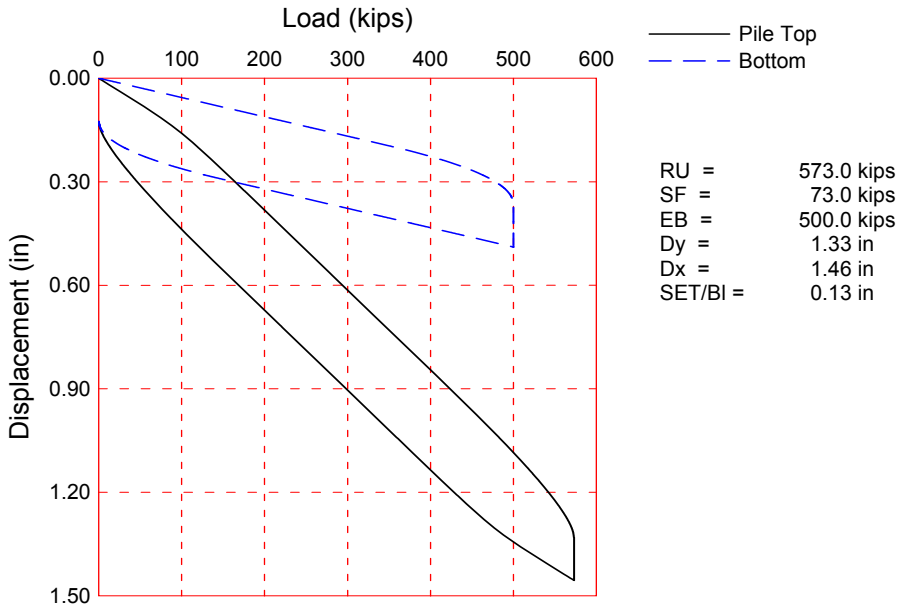
Toe Area 198.5 in^2

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
1	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16800.0
23	77.0	34.20	-10.47	0.00	0.000	-0.00	0.000	4.70	16800.0
25	83.7	30.20	-20.94	0.00	0.000	-0.00	0.000	4.70	16800.0
26	87.0	29.20	-23.56	0.00	0.000	-0.00	0.000	4.70	16800.0

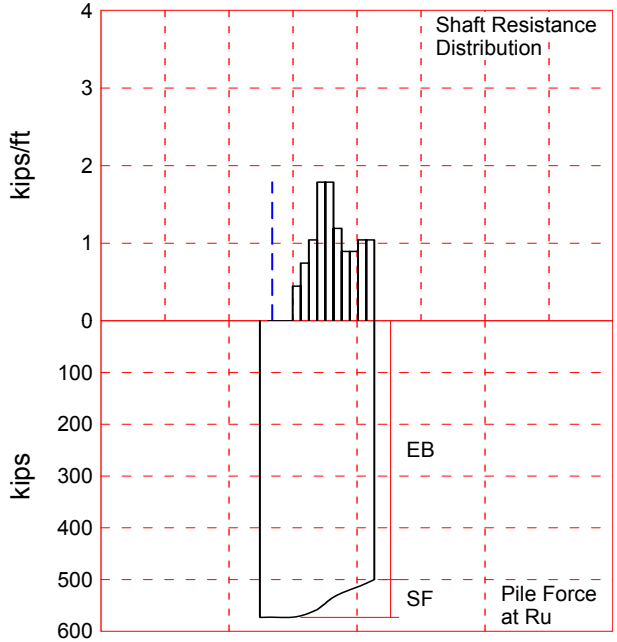
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16800.0 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 10.4 ms
Total volume: 12.604 ft^3; Volume ratio considering added impedance: 0.975







RU =	573.0 kips
SF =	73.0 kips
EB =	500.0 kips
Dy =	1.33 in
Dx =	1.46 in
SET/Bl =	0.13 in



Length b. Sensors	93.9 ft
Embedment	83.2 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	2.59
Top Compr. Stress	29.3 ksi
Max Compr. Stress	30.1 ksi
Max Tension Stress	-5.25 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.28 in
Avg. Shaft Smith Dpg.	0.22 s/ft
Toe Smith Damping	0.09 s/ft

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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: 573.0; along Shaft 73.0; 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
				573.0				
1	13.4	2.7	0.0	573.0	0.0	0.00	0.00	0.00
2	20.1	9.4	0.0	573.0	0.0	0.00	0.00	0.00
3	26.8	16.1	0.0	573.0	0.0	0.00	0.00	0.00
4	33.5	22.8	3.0	570.0	3.0	0.45	0.10	0.22
5	40.3	29.5	5.0	565.0	8.0	0.75	0.16	0.22
6	47.0	36.2	7.0	558.0	15.0	1.04	0.22	0.22
7	53.7	43.0	12.0	546.0	27.0	1.79	0.38	0.22
8	60.4	49.7	12.0	534.0	39.0	1.79	0.38	0.22
9	67.1	56.4	8.0	526.0	47.0	1.19	0.25	0.22
10	73.8	63.1	6.0	520.0	53.0	0.89	0.19	0.22
11	80.5	69.8	6.0	514.0	59.0	0.89	0.19	0.22
12	87.2	76.5	7.0	507.0	66.0	1.04	0.22	0.22
13	93.9	83.2	7.0	500.0	73.0	1.04	0.22	0.22
Avg. Shaft			5.6			0.88	0.19	0.22
Toe			500.0				362.72	0.09

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.05	0.28
Case Damping Factor		0.42	1.18
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	80	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	44	
Resistance Gap (included in Toe Quake)	(in)		0.02
Soil Plug Weight	(kips)	0.030	

CAPWAP match quality = 2.59 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.13 in; Blow Count = 96 b/ft
Computed: Final Set = 0.12 in; Blow Count = 99 b/ft

max. Top Comp. Stress = 29.3 ksi (T= 35.9 ms, max= 1.029 x Top)
max. Comp. Stress = 30.1 ksi (Z= 33.5 ft, T= 37.7 ms)
max. Tens. Stress = -5.25 ksi (Z= 47.0 ft, T= 62.3 ms)
max. Energy (EMX) = 33.1 kip-ft; max. Measured Top Displ. (DMX)= 1.04 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	626.4	-23.8	29.3	-1.11	33.1	15.3	1.04
2	6.7	627.1	-26.3	29.3	-1.23	32.9	15.3	1.03
4	13.4	630.6	-31.4	29.5	-1.47	32.6	15.1	0.99
6	20.1	633.4	-42.2	29.6	-1.97	32.1	15.1	0.96
8	26.8	637.0	-46.6	29.8	-2.18	31.5	15.0	0.91
10	33.5	644.3	-75.5	30.1	-3.53	30.7	14.8	0.86
12	40.3	641.6	-98.8	30.0	-4.61	29.1	14.5	0.81
14	47.0	634.3	-112.3	29.6	-5.25	27.1	14.1	0.75
15	50.3	616.5	-109.0	28.8	-5.09	25.3	13.8	0.72
16	53.7	624.2	-111.3	29.2	-5.20	24.7	13.6	0.69
17	57.0	587.1	-104.0	27.4	-4.86	22.2	13.3	0.66
18	60.4	593.3	-104.6	27.7	-4.89	21.5	13.2	0.63
19	63.7	554.7	-96.0	25.9	-4.49	19.1	12.9	0.60
20	67.1	565.5	-96.6	26.4	-4.51	18.5	12.7	0.57
21	70.4	545.8	-90.3	25.5	-4.22	16.8	12.4	0.54
22	73.8	544.2	-90.8	25.4	-4.24	16.1	12.6	0.51
23	77.1	532.1	-86.8	24.9	-4.05	14.6	12.5	0.47
24	80.5	546.1	-87.5	25.5	-4.09	13.8	13.1	0.44
25	83.9	567.4	-83.4	26.5	-3.89	12.4	14.7	0.41
26	87.2	596.8	-83.5	27.9	-3.90	11.7	15.8	0.37
27	90.6	602.7	-78.0	28.2	-3.64	10.4	16.3	0.34
28	93.9	615.6	-78.1	28.8	-3.65	10.1	14.4	0.31
Absolute	33.5			30.1			(T =	37.7 ms)
	47.0				-5.25		(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	631.5	572.0	512.5	453.0	393.4	333.9	274.4	214.9	155.3	95.8
RX	744.6	726.3	710.2	694.1	678.0	662.7	647.7	632.7	618.5	606.6
RU	631.5	572.0	512.5	453.0	393.4	333.9	274.4	214.9	155.3	95.8

RAU = 380.1 (kips); RA2 = 588.1 (kips)

Current CAPWAP Ru = 573.0 (kips); RMX requires J > 0.9;

Check with PDA-W; RA2 may be a better Case Method

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
15.3	35.72	583.5	643.3	643.3	1.04	0.13	0.13	33.2	681.3	1923

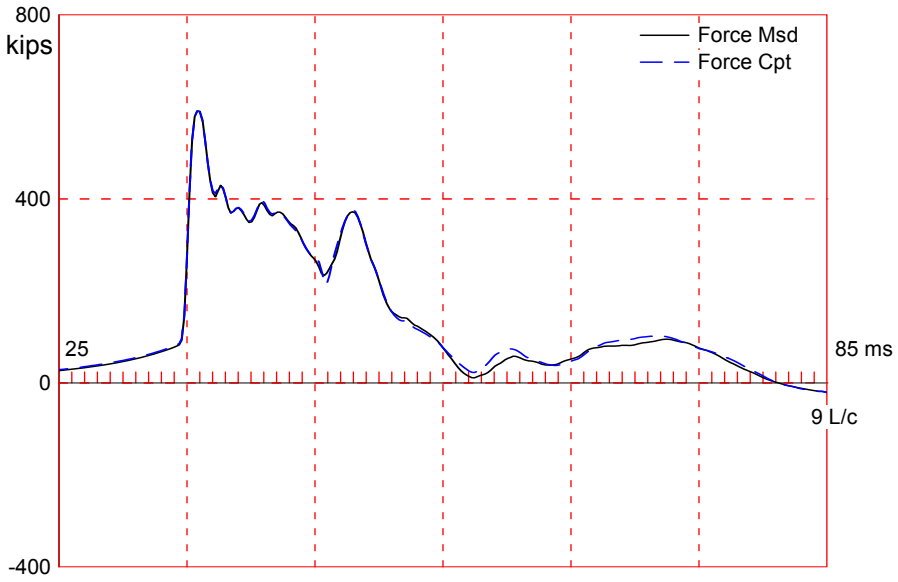
PILE PROFILE AND PILE MODEL

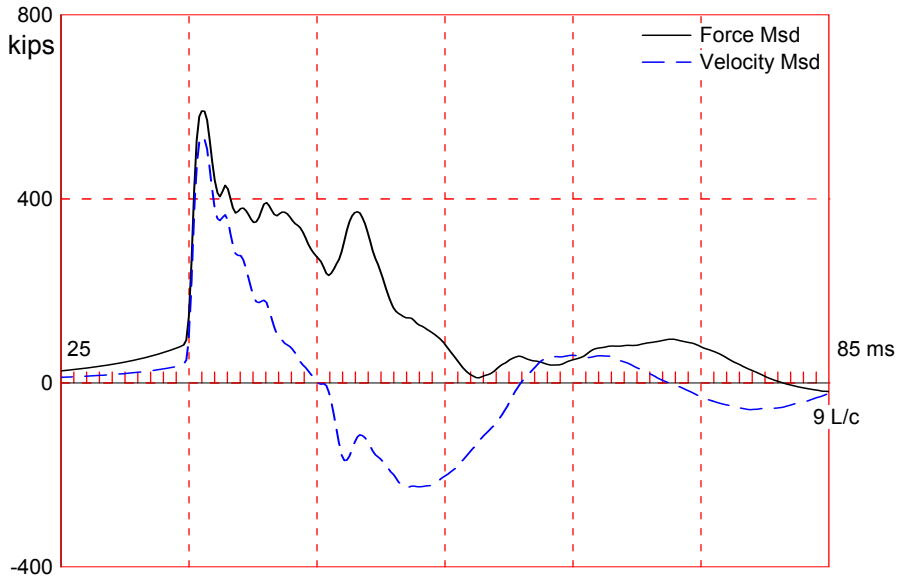
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
93.9	21.4	29992.2	492.000	4.70

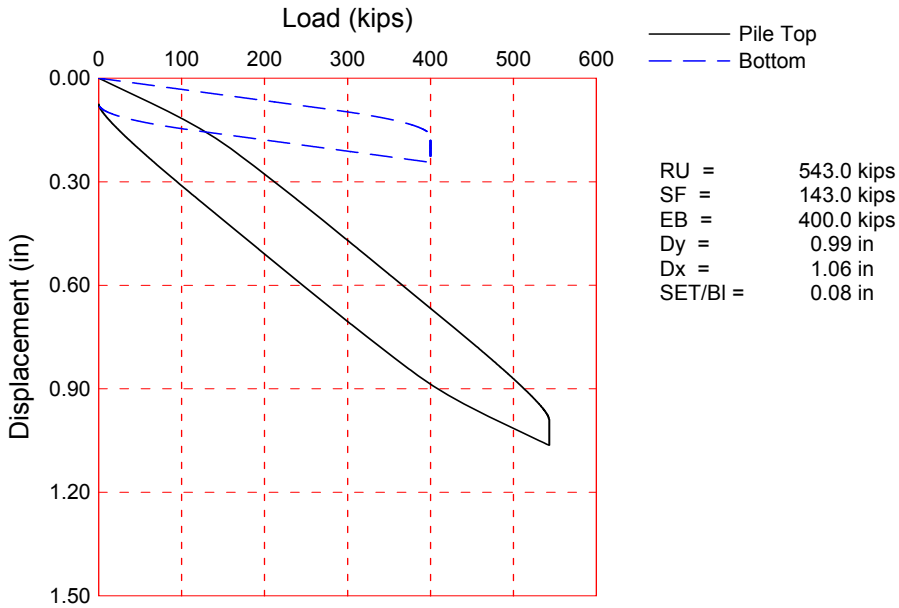
Toe Area 198.5 in^2

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
22	73.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.015
24	80.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
28	93.9	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

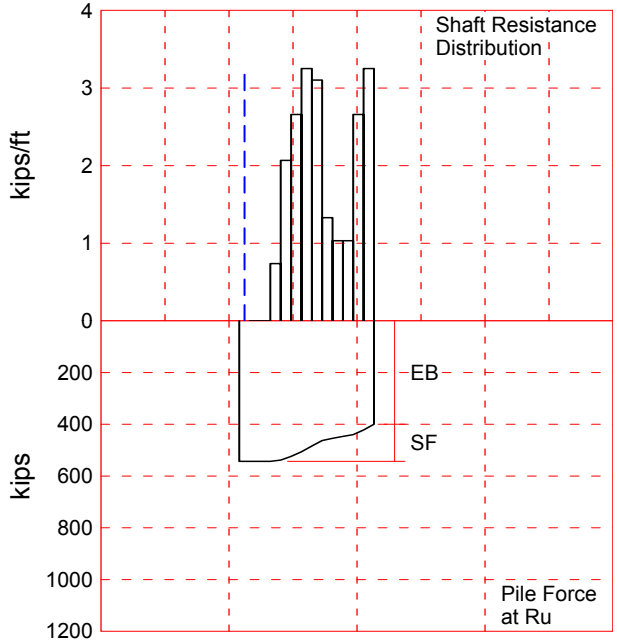
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 11.2 ms
Total volume: 13.958 ft^3; Volume ratio considering added impedance: 1.000







RU =	543.0 kips
SF =	143.0 kips
EB =	400.0 kips
Dy =	0.99 in
Dx =	1.06 in
SET/Bl =	0.08 in



Length b. Sensors	88.0 ft
Embedment	83.3 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.	16731 ft/s
Match Quality	1.61
Top Compr. Stress	27.7 ksi
Max Compr. Stress	29.5 ksi
Max Tension Stress	-2.28 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.13 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.16 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: 543.0; along Shaft 143.0; at Toe 400.0 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
				543.0				
1	13.5	8.8	0.0	543.0	0.0	0.00	0.00	0.00
2	20.3	15.6	0.0	543.0	0.0	0.00	0.00	0.00
3	27.1	22.3	5.0	538.0	5.0	0.74	0.16	0.27
4	33.8	29.1	14.0	524.0	19.0	2.07	0.44	0.27
5	40.6	35.9	18.0	506.0	37.0	2.66	0.57	0.27
6	47.4	42.6	22.0	484.0	59.0	3.25	0.69	0.27
7	54.2	49.4	21.0	463.0	80.0	3.10	0.66	0.27
8	60.9	56.2	9.0	454.0	89.0	1.33	0.28	0.27
9	67.7	62.9	7.0	447.0	96.0	1.03	0.22	0.27
10	74.5	69.7	7.0	440.0	103.0	1.03	0.22	0.27
11	81.2	76.5	18.0	422.0	121.0	2.66	0.57	0.27
12	88.0	83.3	22.0	400.0	143.0	3.25	0.69	0.27
Avg. Shaft			11.9			1.72	0.37	0.27
Toe			400.0				290.17	0.16

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.05	0.13
Case Damping Factor		1.01	1.68
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	63	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	14	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.025	0.060

CAPWAP match quality = 1.61 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.05 in; Blow Count = 246 b/ft
Transducer F1(D815) CAL: 93.0; RF: 1.00; F2(F607) CAL: 93.6; RF: 1.00
A1(K3550) CAL: 360; RF: 1.08; A2(K2524) CAL: 360; RF: 1.08

max. Top Comp. Stress = 27.7 ksi (T= 36.2 ms, max= 1.066 x Top)
max. Comp. Stress = 29.5 ksi (Z= 33.8 ft, T= 38.2 ms)
max. Tens. Stress = -2.28 ksi (Z= 74.5 ft, T= 61.9 ms)
max. Energy (EMX) = 25.8 kip-ft; max. Measured Top Displ. (DMX)= 0.81 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	592.7	-24.5	27.7	-1.15	25.8	14.0	0.78
2	6.8	594.0	-26.5	27.7	-1.24	25.6	13.9	0.77
4	13.5	596.7	-29.8	27.9	-1.39	25.2	13.8	0.73
6	20.3	604.9	-32.5	28.3	-1.52	24.7	13.6	0.69
8	27.1	625.6	-34.6	29.2	-1.61	23.9	13.2	0.64
10	33.8	632.0	-38.4	29.5	-1.79	22.2	12.5	0.59
11	37.2	586.7	-38.7	27.4	-1.81	19.8	12.0	0.56
12	40.6	605.3	-45.8	28.3	-2.14	19.3	11.6	0.53
13	44.0	548.7	-43.2	25.6	-2.02	16.7	11.1	0.50
14	47.4	565.0	-48.7	26.4	-2.27	16.1	10.7	0.47
15	50.8	495.7	-43.6	23.2	-2.03	13.3	10.3	0.45
16	54.2	503.7	-48.0	23.5	-2.24	12.8	10.0	0.42
17	57.5	458.3	-44.3	21.4	-2.07	10.5	9.8	0.39
18	60.9	460.8	-47.8	21.5	-2.23	10.0	9.6	0.37
19	64.3	450.3	-46.7	21.0	-2.18	8.8	9.3	0.34
20	67.7	452.8	-48.0	21.2	-2.24	8.3	9.2	0.31
21	71.1	452.5	-47.2	21.1	-2.20	7.3	9.1	0.28
22	74.5	465.5	-48.8	21.7	-2.28	6.7	8.9	0.25
23	77.8	479.8	-47.7	22.4	-2.23	5.8	8.9	0.22
24	81.2	486.1	-48.6	22.7	-2.27	5.3	9.6	0.19
25	84.6	471.4	-43.7	22.0	-2.04	4.0	9.2	0.17
26	88.0	509.6	-43.8	23.8	-2.05	3.4	7.6	0.14
Absolute	33.8			29.5			(T =	38.2 ms)
	74.5				-2.28		(T =	61.9 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	737.4	698.4	659.3	620.3	581.3	542.2	503.2	464.1	425.1	386.1
RX	765.9	731.2	699.6	668.2	636.7	607.0	581.4	559.9	542.3	526.2
RU	737.0	698.0	658.9	619.8	580.7	541.7	502.6	463.5	424.4	385.3

RAU = 168.5 (kips); RA2 = 526.1 (kips)

Current CAPWAP Ru = 543.0 (kips); Corresponding J(RP)= 0.50; J(RX) = 0.80

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
14.1	36.01	537.4	590.4	597.1	0.81	0.08	0.08	26.1	705.8	3333

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
88.0	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	16730.8	0.000
21	71.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16730.8	0.015
22	74.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16730.8	0.010
23	77.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16730.8	0.000
26	88.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16730.8	0.000

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16730.8 ft/s
Pile Damping 1.00 %, Time Incr 0.202 ms, 2L/c 10.5 ms
Total volume: 13.078 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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TRANSMITTAL

To: Mr. Kevin Weber	From: Travis Coleman
Company: Lunda Construction Co.	No. of Sheets: 23
E-mail: kweber@lundaconstruction.com	Date: March 31, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 14
Winnebago County, Wisconsin

On March 27, 2015, Pier 14 #1, Pier 14 #36, and Pier 14 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on March 30. 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 elevation for the piles was the top of the ring at EL 740.3. We understand the pier was excavated to an elevation of EL 716.97. The piles have a required minimum tip elevation of EL 670.5. 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 14 #1 was driven to a depth of 74.4 feet, which corresponds to a pile tip elevation of EL 665.9. The blow count over the final increment of driving was 10 blows for 4 inches of penetration at an average hammer stroke of 7.1 feet. The blow count at the beginning of restrike was 10 blows for 2 ½ inches of penetration at an average hammer stroke of 6.9 feet.

Pier 14 #36 was driven to a depth of 73.0 feet, which corresponds to a pile tip elevation of EL 667.3. The blow count over the final increment of driving was 10 blows for 5½ inches of penetration at an average hammer stroke of 6.9 feet. The blow count at the beginning of restrike was 10 blows for 2 ¾ inches of penetration at an average hammer stroke of 6.8 feet.

Pier 14 #44 was driven to a depth of 74.8 feet, which corresponds to a pile tip elevation of EL 665.5. The blow count over the final increment of driving was 10 blows for 3 ⅞ inches of penetration at an average hammer stroke of 7.1 feet. The blow count at the beginning of restrike was 10 blows for 3¼ inch of penetration at an average hammer stroke of 6.5 feet

We recommend the production piles at Pier 14 of Structure B-70-403 driven with the APE D30-42 hammer PD0256 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. Additionally, all production piles should achieve the minimum pile tip elevation of EL 670.5 for uplift, as indicated on the plans.

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	5	3
7.0	5	3
7.5	4	3
8.0	4	3
8.5	4	3

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 the tested piles did not meet the recommended driving criteria. Pier 14 #36 did achieve the required capacity, thus we do not recommend re-driving. Pier 14 #1 and #44 should be re-driven to the recommended driving criteria.

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.

Travis Coleman, P.E.

Alexander McCaskill, E.I.

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

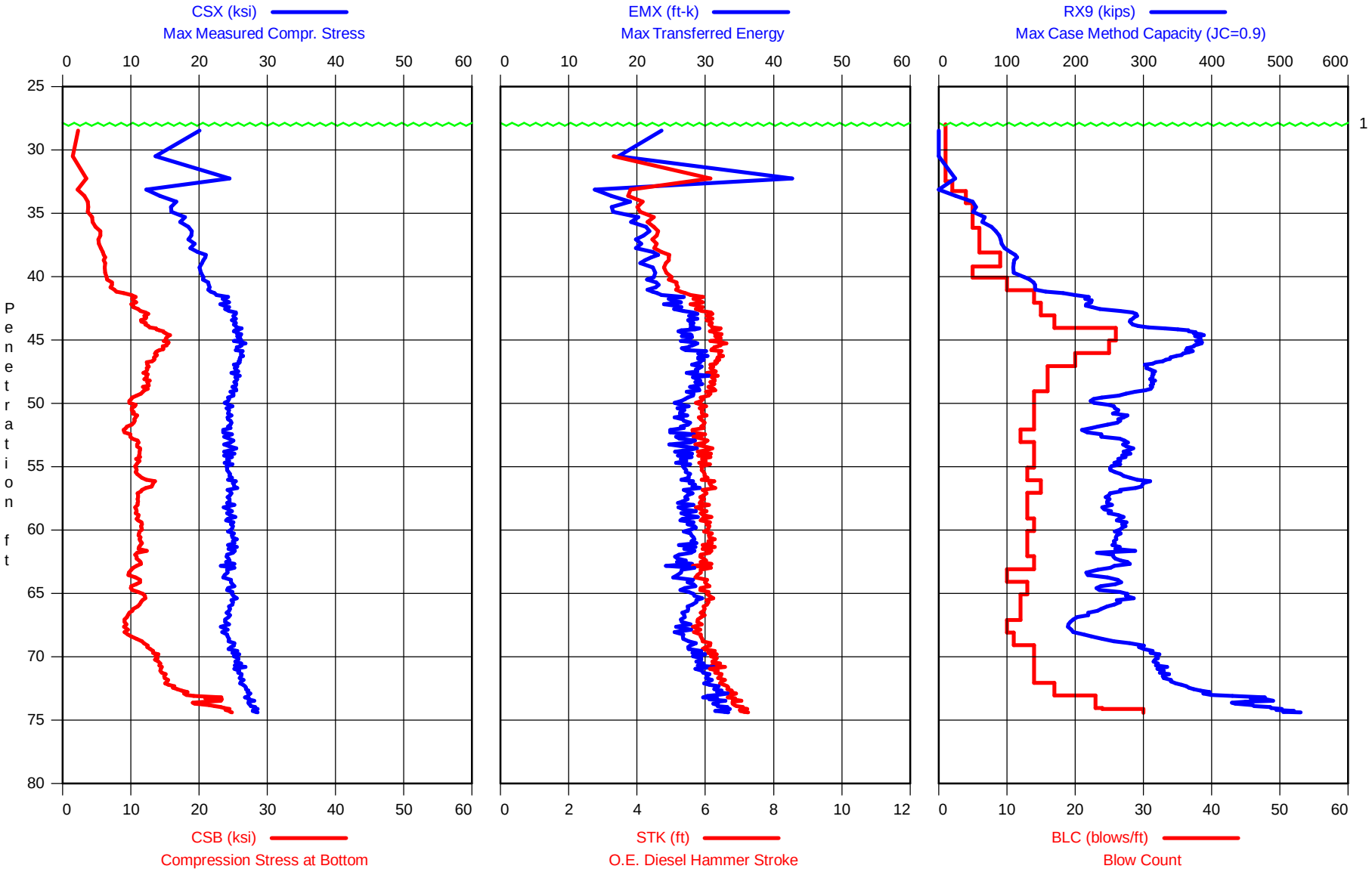
Attachments:
Dynamic Test Results - (pages 4 – 23)

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

PDIPLOT Ver. 2014.2 - Printed: 27-Mar-2015

Test date: 27-Mar-2015

USH 10 over Little Lake Butte des Morts - Pier 14 #1
APE D30-42, HP 14 x 73



1 - Depth reference at El. 740.3; Mud line at El. 717.0

USH 10 over Little Lake Butte des Morts - Pier 14 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

AR: 21.40 in^2
LE: 91.42 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.20

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 ft-k	STK ft	BPM **	RX9 kips
1	28.00	1	AV1	20.0	2.4	18	**	**	0
			MAX	20.0	2.4	18	**	**	0
			MIN	20.0	2.4	18	**	**	0
2	29.00	1	AV1	20.1	2.2	30	**	**	0
			MAX	20.1	2.2	30	**	**	0
			MIN	20.1	2.2	30	**	**	0
3	30.00	1	AV1	15.3	1.5	21	3.5	61.9	0
			MAX	15.3	1.5	21	3.5	61.9	0
			MIN	15.3	1.5	21	3.5	61.9	0
4	31.00	1	AV1	11.9	1.4	14	3.1	64.8	0
			MAX	11.9	1.4	14	3.1	64.8	0
			MIN	11.9	1.4	14	3.1	64.8	0
5	32.00	1	AV1	23.5	3.2	50	**	**	0
			MAX	23.5	3.2	50	**	**	0
			MIN	23.5	3.2	50	**	**	0
7	33.00	2	AV2	20.9	3.3	29	5.0	53.2	25
			STD	4.5	0.4	6	1.1	5.7	25
			MAX	25.4	3.7	35	6.1	58.9	49
			MIN	16.5	2.8	22	3.9	47.4	0
11	34.00	4	AV4	13.3	2.9	14	3.8	59.2	23
			STD	3.1	0.8	5	0.2	1.3	15
			MAX	16.5	3.6	20	4.2	60.4	42
			MIN	8.1	1.6	5	3.7	57.0	0
16	35.00	5	AV5	16.1	3.7	17	4.1	57.5	54
			STD	0.3	0.1	1	0.1	0.4	3
			MAX	16.8	3.8	18	4.2	58.0	57
			MIN	15.9	3.6	16	4.0	56.9	48
21	36.00	5	AV5	17.6	4.5	20	4.4	55.6	66
			STD	1.0	0.2	1	0.2	1.0	3
			MAX	19.3	4.8	22	4.7	56.4	70
			MIN	16.5	4.2	19	4.3	53.7	63
27	37.00	6	AV6	18.8	5.4	21	4.6	54.5	87
			STD	0.3	0.3	1	0.1	0.5	3
			MAX	19.3	5.7	22	4.7	55.2	90
			MIN	18.5	4.8	19	4.5	53.6	83
33	38.00	6	AV6	19.0	5.5	21	4.5	54.7	95
			STD	0.7	0.2	1	0.1	0.6	5
			MAX	19.8	5.9	22	4.7	55.8	102
			MIN	17.7	5.2	19	4.4	54.0	91
42	39.00	9	AV9	20.7	6.1	22	4.9	52.8	112
			STD	0.4	0.2	1	0.1	0.3	3
			MAX	21.4	6.4	24	5.0	53.3	117
			MIN	20.2	5.8	20	4.8	52.2	108
47	40.00	5	AV5	20.1	6.2	22	4.8	53.1	112
			STD	0.3	0.1	1	0.1	0.5	4
			MAX	20.5	6.3	23	5.0	53.7	120
			MIN	19.7	6.0	22	4.7	52.4	108
57	41.00	10	AV10	21.3	7.0	23	5.1	51.7	138
			STD	0.5	0.4	1	0.1	0.6	4
			MAX	22.1	7.5	24	5.3	52.7	143
			MIN	20.4	6.5	21	4.9	50.9	132

USH 10 over Little Lake Butte des Morts - Pier 14 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX ft-k	STK ft	BPM **	RX9 kips
71	42.00	14	AV14	22.9	9.6	24	5.6	49.6	197
			STD	1.2	1.1	2	0.3	1.2	28
			MAX	24.5	11.0	27	6.0	51.8	230
			MIN	20.8	7.4	20	5.1	47.9	145
86	43.00	15	AV15	24.3	11.1	26	5.9	48.4	246
			STD	1.0	0.9	2	0.3	1.0	29
			MAX	25.7	12.6	29	6.3	50.2	293
			MIN	22.3	10.0	23	5.4	46.9	210
103	44.00	17	AV17	25.2	12.1	28	6.1	47.5	286
			STD	0.4	0.4	1	0.1	0.4	6
			MAX	25.8	13.0	29	6.3	48.3	302
			MIN	24.4	11.3	27	5.9	46.8	279
129	45.00	26	AV26	25.8	14.8	27	6.4	46.7	370
			STD	0.5	0.8	1	0.1	0.5	20
			MAX	26.5	15.9	29	6.5	48.1	391
			MIN	24.6	12.5	25	6.0	46.0	313
154	46.00	25	AV25	25.9	14.7	28	6.4	46.6	374
			STD	0.6	0.6	1	0.2	0.6	9
			MAX	26.8	15.7	31	6.7	47.9	391
			MIN	24.7	13.7	25	6.0	45.6	354
174	47.00	20	AV20	25.9	13.2	29	6.4	46.6	334
			STD	0.5	0.6	1	0.1	0.5	18
			MAX	26.5	14.2	31	6.5	48.4	361
			MIN	24.1	12.0	27	5.9	46.1	297
190	48.00	16	AV16	25.4	12.3	29	6.2	47.2	312
			STD	0.4	0.4	1	0.1	0.4	5
			MAX	26.0	12.9	31	6.4	48.3	323
			MIN	24.2	11.6	26	5.9	46.5	302
206	49.00	16	AV16	25.3	12.3	29	6.2	47.1	311
			STD	0.4	0.4	1	0.1	0.5	5
			MAX	25.8	13.1	30	6.4	48.5	322
			MIN	24.0	11.7	26	5.9	46.4	300
220	50.00	14	AV14	24.5	10.6	27	6.0	48.1	249
			STD	0.5	0.8	1	0.2	0.6	25
			MAX	25.5	12.1	29	6.2	49.3	293
			MIN	23.5	9.7	25	5.7	47.2	219
234	51.00	14	AV14	24.4	10.5	27	5.9	48.2	260
			STD	0.7	0.4	1	0.2	0.8	9
			MAX	25.9	11.1	29	6.3	49.3	283
			MIN	23.5	9.9	25	5.7	46.9	247
248	52.00	14	AV14	24.5	10.1	27	5.9	48.3	253
			STD	0.6	0.6	1	0.2	0.6	17
			MAX	25.3	10.8	29	6.1	49.6	277
			MIN	23.1	9.2	25	5.6	47.4	216
260	53.00	12	AV12	24.2	9.9	26	5.8	48.7	241
			STD	0.7	0.7	2	0.2	0.7	23
			MAX	25.1	11.3	29	6.1	49.7	278
			MIN	23.2	8.8	24	5.6	47.6	208
274	54.00	14	AV14	24.5	11.2	27	6.0	48.0	277
			STD	0.8	0.2	2	0.2	0.8	6
			MAX	25.6	11.6	29	6.3	49.5	289
			MIN	23.1	10.8	24	5.6	47.0	263
288	55.00	14	AV14	24.2	11.0	27	6.0	48.1	264
			STD	0.7	0.3	1	0.2	0.7	8
			MAX	25.0	11.6	29	6.2	49.2	276
			MIN	23.0	10.4	25	5.7	47.2	247

USH 10 over Little Lake Butte des Morts - Pier 14 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX ft-k	STK ft	BPM **	RX9 kips
301	56.00	13	AV13	24.3	11.1	27	5.9	48.2	265
			STD	0.4	0.4	1	0.1	0.3	12
			MAX	24.9	11.9	28	6.1	48.9	287
			MIN	23.6	10.6	26	5.8	47.7	248
316	57.00	15	AV15	25.0	12.6	28	6.1	47.5	290
			STD	0.5	0.8	1	0.1	0.5	16
			MAX	25.9	13.6	30	6.4	48.3	315
			MIN	24.0	11.4	27	5.9	46.6	257
329	58.00	13	AV13	24.4	11.0	27	5.9	48.2	249
			STD	0.5	0.1	1	0.1	0.6	5
			MAX	25.2	11.2	29	6.1	49.3	256
			MIN	23.4	10.8	25	5.7	47.6	240
342	59.00	13	AV13	24.5	10.9	27	6.0	48.1	253
			STD	0.8	0.3	1	0.2	0.8	12
			MAX	25.4	11.3	29	6.2	49.5	272
			MIN	23.2	10.4	26	5.6	47.2	236
356	60.00	14	AV14	24.6	11.4	28	6.0	47.8	268
			STD	0.6	0.3	1	0.2	0.6	6
			MAX	25.3	11.8	29	6.2	49.4	278
			MIN	23.1	10.8	25	5.6	47.1	257
369	61.00	13	AV13	24.9	11.3	28	6.1	47.5	260
			STD	0.7	0.2	1	0.2	0.7	5
			MAX	25.8	11.6	30	6.4	49.2	269
			MIN	23.2	11.0	26	5.7	46.6	249
382	62.00	13	AV13	24.8	11.3	28	6.1	47.7	259
			STD	0.9	0.6	2	0.2	0.9	17
			MAX	25.5	12.8	30	6.3	49.6	294
			MIN	22.9	10.2	24	5.6	46.8	225
396	63.00	14	AV14	24.3	11.0	26	6.0	48.1	264
			STD	0.8	0.4	2	0.2	0.9	11
			MAX	25.4	11.5	29	6.3	49.5	283
			MIN	23.0	10.0	24	5.6	47.0	248
406	64.00	10	AV10	24.0	10.3	26	5.9	48.6	236
			STD	1.0	0.7	2	0.3	1.0	19
			MAX	25.4	11.3	29	6.2	50.0	267
			MIN	22.6	9.3	24	5.5	47.1	206
419	65.00	13	AV13	24.6	10.6	27	6.0	48.0	251
			STD	0.6	0.6	1	0.1	0.5	16
			MAX	25.5	11.5	29	6.2	48.9	273
			MIN	23.7	9.8	26	5.8	47.1	226
431	66.00	12	AV12	24.9	11.7	28	6.1	47.7	269
			STD	0.7	0.4	1	0.2	0.7	13
			MAX	25.8	12.2	30	6.3	49.7	291
			MIN	22.9	10.9	25	5.6	46.7	244
443	67.00	12	AV12	24.4	9.9	27	5.9	48.2	223
			STD	0.6	0.5	1	0.2	0.6	15
			MAX	25.8	11.0	30	6.3	49.2	249
			MIN	23.5	9.1	25	5.7	46.7	201
453	68.00	10	AV10	23.9	9.2	27	5.8	48.8	192
			STD	0.7	0.3	1	0.2	0.7	4
			MAX	24.8	9.8	29	6.0	49.8	200
			MIN	22.6	8.9	25	5.5	48.0	188
464	69.00	11	AV11	24.4	10.6	27	5.9	48.2	239
			STD	0.7	1.0	1	0.2	0.6	26
			MAX	26.0	12.2	30	6.3	49.0	284
			MIN	23.5	8.9	25	5.7	46.8	204

USH 10 over Little Lake Butte des Morts - Pier 14 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX ft-k	STK ft	BPM **	RX9 kips
478	70.00	14	AV14	25.1	13.1	28	6.1	47.5	309
			STD	0.6	0.6	1	0.2	0.6	11
			MAX	26.2	14.1	31	6.4	48.8	330
			MIN	23.9	12.3	26	5.8	46.5	287
492	71.00	14	AV14	25.7	14.1	29	6.3	46.8	321
			STD	0.6	0.3	1	0.2	0.6	7
			MAX	27.1	14.7	32	6.7	47.6	336
			MIN	25.0	13.5	28	6.1	45.5	309
506	72.00	14	AV14	26.1	14.9	30	6.4	46.4	333
			STD	0.4	0.4	1	0.1	0.4	7
			MAX	26.7	15.5	32	6.6	47.2	345
			MIN	25.2	13.9	28	6.2	45.7	321
523	73.00	17	AV17	26.9	16.8	32	6.7	45.6	373
			STD	0.5	1.1	1	0.1	0.5	16
			MAX	27.6	18.3	34	6.9	46.7	399
			MIN	25.7	14.9	29	6.3	44.8	342
546	74.00	23	AV23	27.4	21.3	32	6.9	45.0	458
			STD	0.5	1.8	1	0.2	0.5	24
			MAX	28.3	23.7	34	7.1	45.8	497
			MIN	26.6	18.2	30	6.6	44.2	413
548	74.08	24	AV2	28.2	23.7	33	7.1	44.3	488
			STD	0.6	0.1	1	0.2	0.5	4
			MAX	28.8	23.8	33	7.2	44.8	491
			MIN	27.5	23.6	32	6.9	43.8	484
558	74.42	30	AV10	28.3	24.4	33	7.1	44.1	511
			STD	0.4	0.4	1	0.1	0.4	17
			MAX	28.7	25.3	34	7.3	44.9	547
			MIN	27.6	23.6	31	6.9	43.7	485
			Average	24.5	11.9	27	6.0	48.1	276
			Std. Dev.	2.4	3.9	3	0.6	2.6	93
			Maximum	28.8	25.3	50	7.3	64.8	547
			Minimum	8.1	1.4	5	3.1	43.7	0

Total number of blows analyzed: 558

BL#	depth (ft)	Comments
1	28.00	Depth reference at El. 740.3; Mud line at El. 717.0

Time Summary

Drive 12 minutes 19 seconds 12:23:29 PM - 12:35:48 PM (3/27/2015) BN 1 - 558

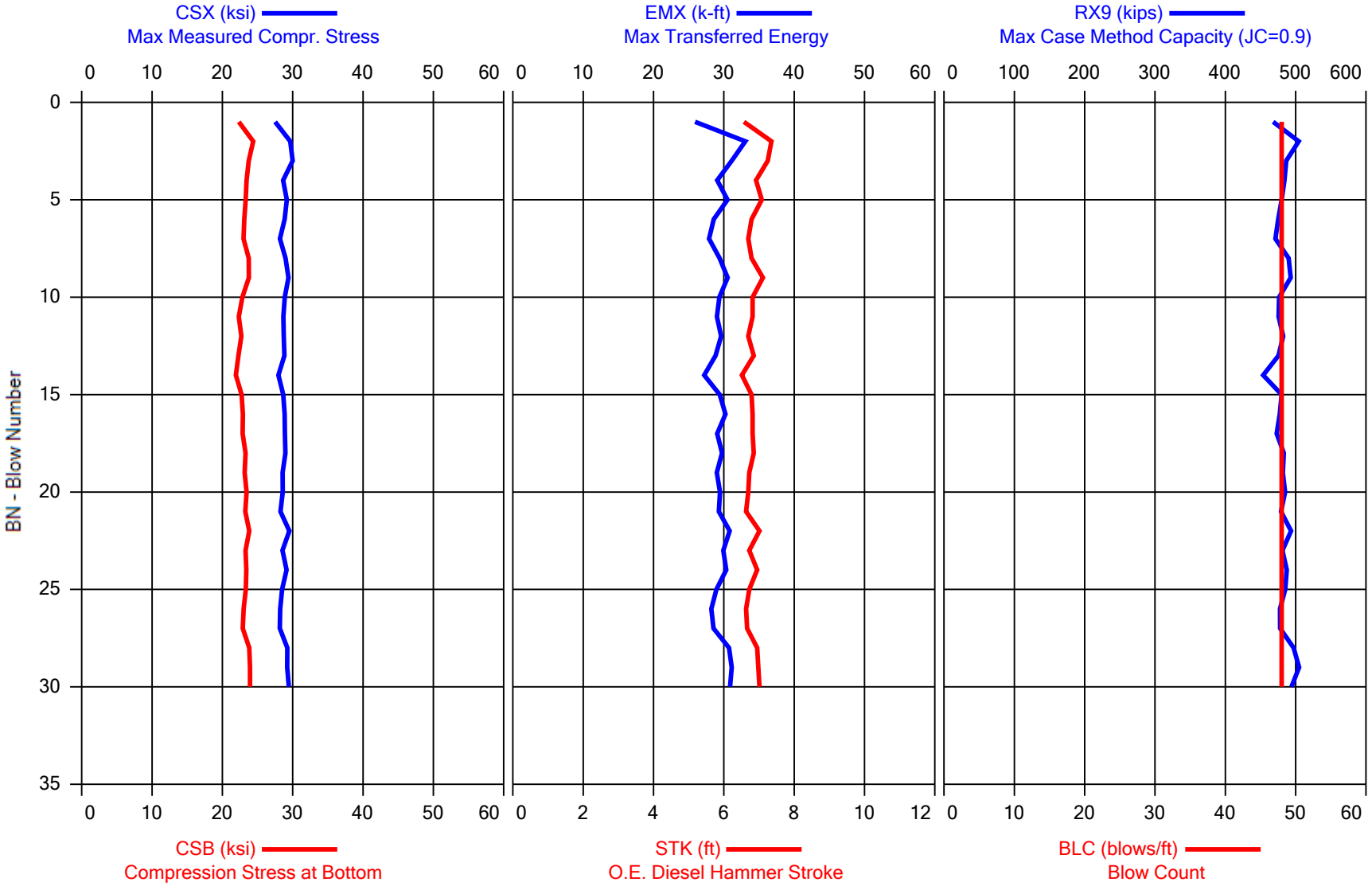
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 31-March-2015

Test started: 30-March-2015

USH 10 over Little Lake Butte des Morts - Pier 14 #1 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 14 #1 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 30-March-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 78.00 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	74.63	48	AV10	28.9	23.4	30	6.9	44.8	483
			STD	0.7	0.5	2	0.2	0.7	10
			MAX	30.0	24.4	33	7.4	45.9	504
			MIN	27.5	22.3	26	6.6	43.5	468
20	74.83	48	AV10	28.7	22.8	29	6.8	45.3	477
			STD	0.3	0.5	1	0.1	0.3	8
			MAX	29.0	23.4	30	6.8	46.1	485
			MIN	28.0	21.9	27	6.5	45.0	454
30	75.04	48	AV10	28.8	23.5	30	6.8	45.1	488
			STD	0.5	0.4	1	0.2	0.5	9
			MAX	29.5	23.9	31	7.0	45.7	505
			MIN	28.2	22.9	28	6.6	44.5	478
			Average	28.8	23.2	30	6.8	45.0	482
			Std. Dev.	0.5	0.6	1	0.2	0.6	10
			Maximum	30.0	24.4	33	7.4	46.1	505
			Minimum	27.5	21.9	26	6.5	43.5	454

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.00); A4: [K3550] 360.0 (1.00)

Time Summary

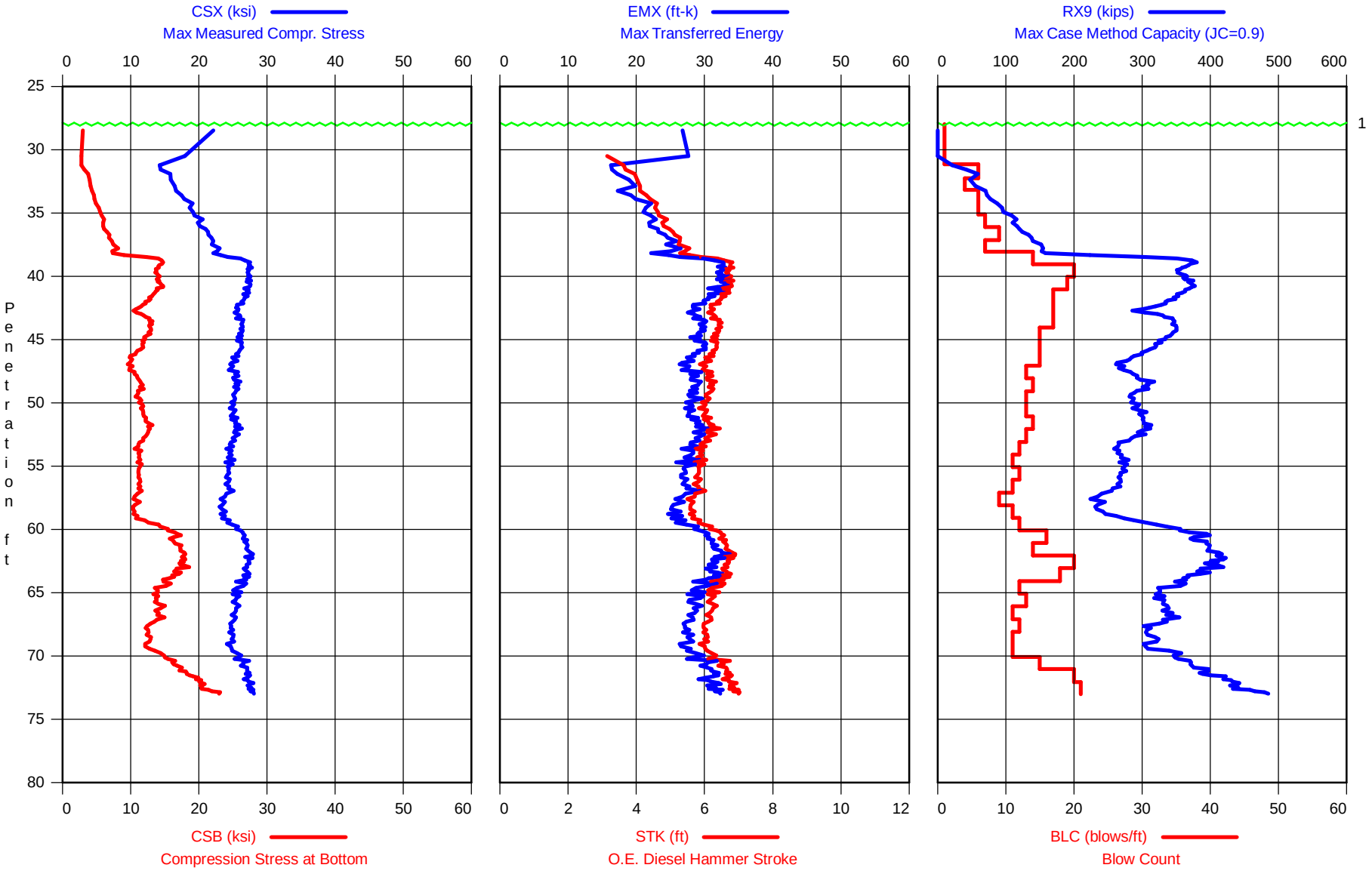
Drive 38 seconds 7:55 AM - 7:56 AM BN 1 - 30

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

PDIPLOT Ver. 2014.2 - Printed: 27-Mar-2015

Test date: 27-Mar-2015

USH 10 over Little Lake Butte des Morts - Pier 14 #36
APE D30-42, HP 14 x 73



1 - Depth reference at El. 740.3; Mud line at El. 717.0

USH 10 over Little Lake Butte des Morts - Pier 14 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

AR: 21.40 in^2
LE: 90.25 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.20

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 ft-k	STK ft	BPM **	RX9 kips
1	28.00	1	AV1	21.7	3.1	21	**	**	0
			MAX	21.7	3.1	21	**	**	0
			MIN	21.7	3.1	21	**	**	0
2	29.00	1	AV1	22.5	2.9	32	**	**	0
			MAX	22.5	2.9	32	**	**	0
			MIN	22.5	2.9	32	**	**	0
3	30.00	1	AV1	12.5	2.0	15	3.1	64.9	0
			MAX	12.5	2.0	15	3.1	64.9	0
			MIN	12.5	2.0	15	3.1	64.9	0
4	31.00	1	AV1	23.3	3.4	40	**	**	0
			MAX	23.3	3.4	40	**	**	0
			MIN	23.3	3.4	40	**	**	0
10	32.00	6	AV6	14.8	3.2	17	3.8	59.8	41
			STD	1.0	0.4	1	0.2	1.2	18
			MAX	16.5	4.0	18	4.0	61.4	63
			MIN	13.4	2.6	15	3.5	57.7	9
14	33.00	4	AV4	16.2	4.0	19	4.1	57.6	52
			STD	0.8	0.1	1	0.1	0.7	5
			MAX	17.2	4.2	21	4.2	58.6	60
			MIN	15.2	3.9	17	3.9	56.8	47
20	34.00	6	AV6	17.3	4.5	19	4.3	56.3	73
			STD	0.6	0.2	1	0.1	0.8	3
			MAX	18.0	4.8	20	4.5	57.8	79
			MIN	16.2	4.3	17	4.0	55.1	69
26	35.00	6	AV6	18.9	5.2	22	4.6	54.4	93
			STD	0.4	0.3	1	0.1	0.4	4
			MAX	19.5	5.7	23	4.7	54.9	97
			MIN	18.3	4.9	21	4.5	53.9	84
33	36.00	7	AV7	19.9	5.9	22	4.8	53.4	111
			STD	0.6	0.2	1	0.1	0.6	3
			MAX	20.8	6.2	23	4.9	54.5	119
			MIN	18.9	5.5	21	4.6	52.6	108
42	37.00	9	AV9	21.3	6.5	23	5.1	51.9	128
			STD	0.6	0.4	1	0.2	0.8	8
			MAX	22.1	6.9	25	5.3	53.3	141
			MIN	20.1	6.0	21	4.8	50.9	115
49	38.00	7	AV7	22.4	7.6	26	5.4	50.5	149
			STD	0.5	0.4	1	0.1	0.7	7
			MAX	23.1	8.3	27	5.6	51.5	155
			MIN	21.5	7.1	24	5.2	49.6	133
63	39.00	14	AV14	25.0	11.8	28	6.1	47.8	294
			STD	2.0	3.1	4	0.6	2.2	87
			MAX	27.5	14.9	34	6.8	51.3	389
			MIN	21.9	7.0	22	5.2	45.1	156
83	40.00	20	AV20	27.3	13.9	32	6.7	45.4	359
			STD	0.4	0.3	1	0.1	0.4	7
			MAX	28.1	14.5	34	6.9	46.4	372
			MIN	26.4	13.4	30	6.4	44.7	348
102	41.00	19	AV19	27.3	14.2	33	6.7	45.4	370
			STD	0.3	0.4	1	0.1	0.4	6
			MAX	27.7	15.2	34	6.9	46.3	380
			MIN	26.4	13.6	30	6.5	44.9	359

USH 10 over Little Lake Butte des Morts - Pier 14 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX ft-k	STK ft	BPM **	RX9 kips
119	42.00	17	AV17	26.9	13.2	31	6.6	45.9	352
			STD	0.4	0.5	1	0.1	0.4	10
			MAX	27.5	14.1	33	6.8	46.6	366
			MIN	26.2	12.3	30	6.4	45.2	334
136	43.00	17	AV17	25.7	11.3	29	6.2	47.1	315
			STD	0.5	0.6	1	0.1	0.5	16
			MAX	26.8	12.4	30	6.5	48.2	339
			MIN	24.6	10.4	26	5.9	46.2	282
153	44.00	17	AV17	26.2	12.7	29	6.4	46.5	343
			STD	0.4	0.4	1	0.1	0.4	8
			MAX	26.8	13.4	31	6.6	47.3	355
			MIN	25.4	11.8	28	6.2	45.7	326
168	45.00	15	AV15	26.1	12.5	29	6.3	46.7	343
			STD	0.3	0.4	1	0.1	0.4	7
			MAX	26.6	13.2	30	6.5	47.6	352
			MIN	25.2	11.8	27	6.1	46.0	333
183	46.00	15	AV15	26.1	11.5	30	6.3	46.8	317
			STD	0.4	0.5	1	0.1	0.4	9
			MAX	26.7	12.1	32	6.5	47.7	333
			MIN	25.0	10.6	28	6.1	46.2	297
198	47.00	15	AV15	25.2	10.1	28	6.1	47.6	281
			STD	0.7	0.4	1	0.2	0.7	14
			MAX	26.4	11.0	30	6.4	48.6	303
			MIN	24.2	9.4	26	5.8	46.4	259
211	48.00	13	AV13	25.1	10.4	28	6.1	47.7	280
			STD	0.8	0.5	1	0.2	0.8	12
			MAX	26.1	11.1	30	6.3	48.9	296
			MIN	23.6	9.5	25	5.8	46.7	258
225	49.00	14	AV14	25.6	11.5	29	6.2	47.1	306
			STD	0.5	0.4	1	0.2	0.6	9
			MAX	26.4	12.3	31	6.4	48.2	326
			MIN	24.7	10.9	27	5.9	46.4	293
238	50.00	13	AV13	25.1	11.1	28	6.1	47.7	286
			STD	0.5	0.4	1	0.1	0.5	5
			MAX	26.0	11.9	31	6.3	48.7	295
			MIN	24.3	10.5	27	5.8	46.7	278
251	51.00	13	AV13	25.0	11.7	28	6.0	48.0	296
			STD	0.4	0.3	1	0.1	0.4	8
			MAX	25.7	12.3	29	6.2	48.8	315
			MIN	24.2	11.3	26	5.8	47.3	282
265	52.00	14	AV14	25.4	12.5	29	6.1	47.4	305
			STD	0.7	0.4	1	0.2	0.7	7
			MAX	26.6	13.3	31	6.5	48.2	321
			MIN	24.6	11.9	28	5.9	46.0	296
278	53.00	13	AV13	25.4	12.3	29	6.2	47.4	294
			STD	0.5	0.3	1	0.2	0.6	10
			MAX	26.2	12.8	31	6.5	48.4	309
			MIN	24.5	11.7	28	5.9	46.2	276
290	54.00	12	AV12	24.6	11.1	28	5.9	48.3	264
			STD	0.6	0.4	1	0.2	0.6	5
			MAX	25.5	11.8	31	6.1	49.6	272
			MIN	23.4	10.4	26	5.6	47.4	256
301	55.00	11	AV11	24.6	11.3	28	5.9	48.4	273
			STD	0.6	0.2	1	0.2	0.7	7
			MAX	25.3	11.6	30	6.1	49.6	281
			MIN	23.5	10.9	26	5.6	47.6	261

USH 10 over Little Lake Butte des Morts - Pier 14 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX ft-k	STK ft	BPM **	RX9 kips
313	56.00	12	AV12	24.3	11.2	27	5.8	48.7	270
			STD	0.3	0.2	1	0.1	0.3	6
			MAX	24.8	11.5	28	6.0	49.1	286
			MIN	23.9	10.9	26	5.7	48.1	264
324	57.00	11	AV11	24.4	11.3	28	5.8	48.6	264
			STD	0.5	0.3	1	0.1	0.6	6
			MAX	25.2	11.9	30	6.1	49.2	272
			MIN	23.8	10.8	26	5.7	47.6	253
333	58.00	9	AV9	23.8	10.9	27	5.7	49.3	237
			STD	0.4	0.4	1	0.1	0.5	9
			MAX	24.3	11.6	28	5.8	50.3	252
			MIN	22.9	10.4	25	5.4	48.7	222
344	59.00	11	AV11	23.4	10.5	25	5.6	49.5	242
			STD	0.5	0.3	1	0.1	0.5	12
			MAX	24.4	11.4	27	5.9	50.4	268
			MIN	22.8	10.2	24	5.4	48.5	230
356	60.00	12	AV12	24.7	13.2	27	5.9	48.2	314
			STD	1.0	1.6	2	0.2	0.9	29
			MAX	26.2	16.4	30	6.4	49.6	369
			MIN	23.3	10.6	25	5.6	46.5	271
372	61.00	16	AV16	26.6	16.3	30	6.5	46.2	380
			STD	0.4	0.6	1	0.1	0.5	15
			MAX	27.2	17.9	32	6.8	46.9	407
			MIN	25.9	15.5	29	6.3	45.3	353
386	62.00	14	AV14	27.3	17.4	32	6.7	45.5	402
			STD	0.5	0.6	1	0.1	0.5	11
			MAX	28.1	18.3	35	6.9	46.5	419
			MIN	26.2	16.2	30	6.4	44.7	381
406	63.00	20	AV20	27.3	17.7	32	6.7	45.5	410
			STD	0.6	0.5	1	0.2	0.6	11
			MAX	28.6	19.0	34	7.1	46.5	431
			MIN	26.2	16.9	30	6.4	44.2	390
424	64.00	18	AV18	27.0	16.3	31	6.6	45.8	378
			STD	0.5	0.8	1	0.1	0.5	14
			MAX	27.7	17.4	33	6.8	46.6	402
			MIN	26.1	14.7	29	6.4	45.1	352
436	65.00	12	AV12	26.0	14.5	30	6.3	46.7	341
			STD	0.7	0.9	1	0.2	0.7	17
			MAX	27.0	16.1	32	6.7	47.6	375
			MIN	24.9	13.6	28	6.1	45.6	319
449	66.00	13	AV13	25.5	13.8	29	6.2	47.2	329
			STD	0.6	0.5	1	0.1	0.5	12
			MAX	26.4	15.1	31	6.5	48.0	347
			MIN	24.7	13.2	27	6.0	46.2	314
460	67.00	11	AV11	25.3	14.3	28	6.2	47.3	340
			STD	0.5	0.6	1	0.1	0.5	11
			MAX	26.1	15.2	29	6.4	48.2	362
			MIN	24.3	13.4	27	5.9	46.5	327
472	68.00	12	AV12	24.9	12.9	27	6.0	47.8	319
			STD	0.5	0.7	1	0.2	0.6	16
			MAX	25.7	14.2	29	6.3	49.1	347
			MIN	23.7	11.8	26	5.7	47.0	291
483	69.00	11	AV11	24.9	12.6	28	6.0	47.8	314
			STD	0.4	0.4	1	0.1	0.4	12
			MAX	25.5	13.4	29	6.2	48.5	336
			MIN	24.1	12.0	27	5.9	47.2	299

USH 10 over Little Lake Butte des Morts - Pier 14 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX ft-k	STK ft	BPM **	RX9 kips
494	70.00	11	AV11	25.1	13.4	28	6.1	47.6	329
			STD	0.7	1.1	1	0.2	0.7	23
			MAX	26.4	14.9	30	6.4	48.9	369
			MIN	23.8	11.8	26	5.8	46.5	298
509	71.00	15	AV15	26.4	16.3	30	6.5	46.3	367
			STD	0.8	0.8	2	0.2	0.8	13
			MAX	27.8	18.1	33	6.9	48.0	384
			MIN	24.8	14.7	27	6.0	45.0	337
529	72.00	20	AV20	27.1	18.8	31	6.7	45.5	408
			STD	0.4	1.1	1	0.1	0.4	16
			MAX	27.8	20.7	32	6.9	46.3	433
			MIN	26.3	16.9	28	6.5	44.8	381
550	73.00	21	AV21	27.7	21.2	32	6.9	44.9	450
			STD	0.5	1.1	1	0.2	0.5	20
			MAX	28.4	23.7	34	7.1	46.0	492
			MIN	26.6	19.9	29	6.5	44.2	421
			Average	25.3	12.9	29	6.2	47.6	311
			Std. Dev.	2.4	3.7	3	0.6	2.7	88
			Maximum	28.6	23.7	40	7.1	64.9	492
			Minimum	12.5	2.0	15	3.1	44.2	0

Total number of blows analyzed: 550

BL#	depth (ft)	Comments
1	28.00	Depth reference at El. 740.3; Mud line at El. 717.0

Time Summary

Drive	12 minutes 11 seconds	12:54:19 PM - 1:06:30 PM (3/27/2015) BN 1 - 550

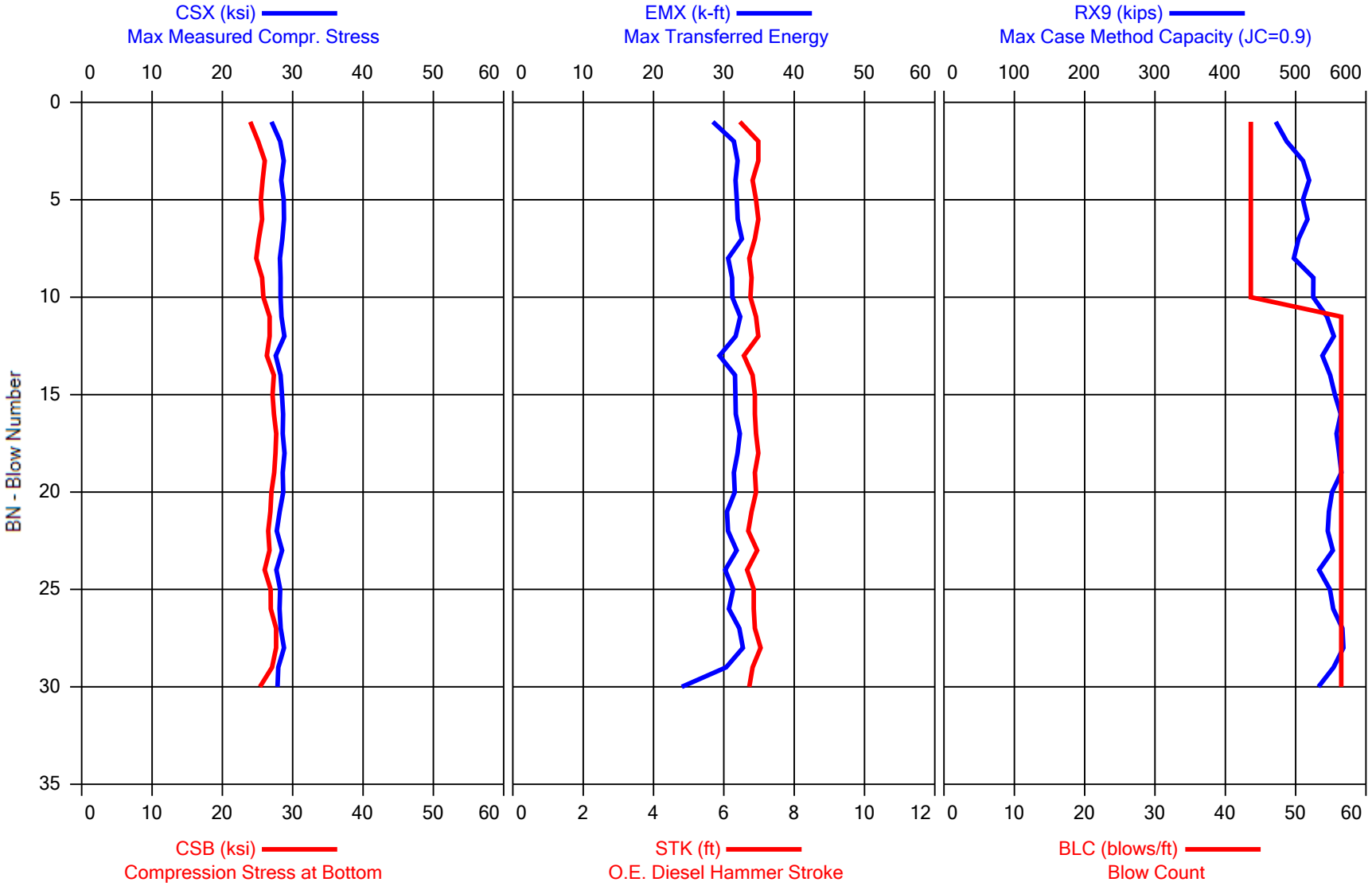
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 31-March-2015

Test started: 30-March-2015

USH 10 over Little Lake Butte des Morts - Pier 14 #36 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 14 #36 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 30-March-2015

AR: 21.40 in² 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
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	73.23	44	AV10	28.3	25.3	31	6.8	45.1	507
			STD	0.5	0.6	1	0.2	0.5	16
			MAX	28.8	26.0	33	7.0	46.3	525
			MIN	27.0	24.0	28	6.5	44.6	472
20	73.41	56	AV10	28.5	27.1	32	6.9	44.9	554
			STD	0.3	0.4	1	0.1	0.4	8
			MAX	28.8	27.7	32	7.0	45.9	565
			MIN	27.6	26.3	29	6.6	44.6	538
30	73.58	56	AV10	28.1	26.7	30	6.8	45.1	550
			STD	0.3	0.7	2	0.1	0.3	11
			MAX	28.8	27.6	33	7.0	45.6	568
			MIN	27.7	25.3	24	6.7	44.4	532
			Average	28.3	26.4	31	6.8	45.0	537
			Std. Dev.	0.4	0.9	2	0.1	0.4	25
			Maximum	28.8	27.7	33	7.0	46.3	568
			Minimum	27.0	24.0	24	6.5	44.4	472

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.05); A4: [K3550] 360.0 (1.05)

Time Summary

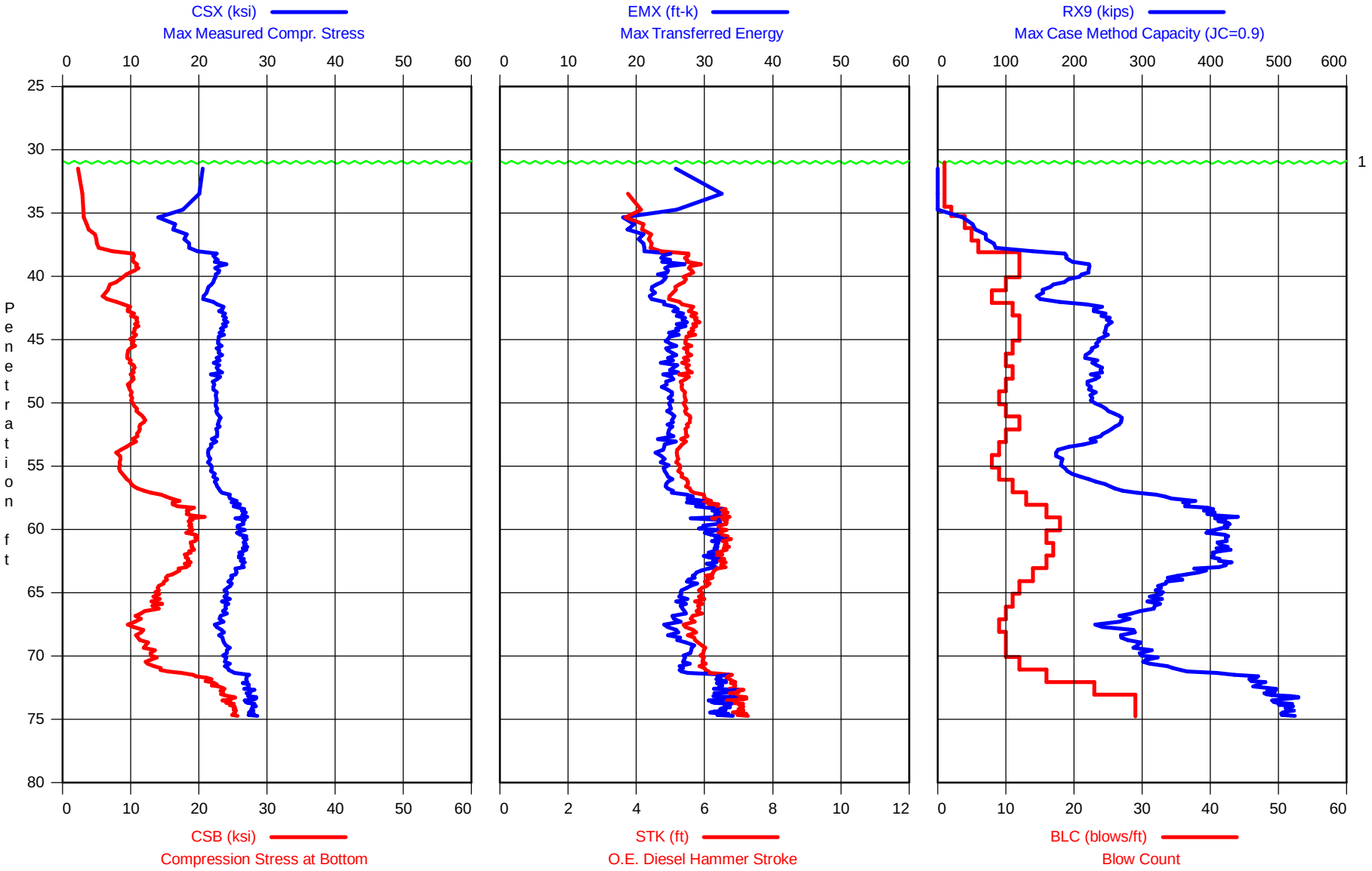
Drive 38 seconds 8:03 AM - 8:04 AM BN 1 - 30

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

PDIPLOT Ver. 2014.2 - Printed: 27-Mar-2015

Test date: 27-Mar-2015

USH 10 over Little Lake Butte des Morts - Pier 14 #44
APE D30-42, HP 14 x 73



1 - Depth reference at El. 740.3; Mud line at El. 717.0

USH 10 over Little Lake Butte des Morts - Pier 14 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

AR: 21.40 in^2
LE: 91.08 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.20

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 ft-k	STK ft	BPM **	RX9 kips
1	31.00	1	AV1	20.0	2.2	17	**	**	0
			MAX	20.0	2.2	17	**	**	0
			MIN	20.0	2.2	17	**	**	0
2	32.00	1	AV1	21.2	2.3	35	**	**	0
			MAX	21.2	2.3	35	**	**	0
			MIN	21.2	2.3	35	**	**	0
3	33.00	1	AV1	17.4	2.5	23	3.7	59.8	0
			MAX	17.4	2.5	23	3.7	59.8	0
			MIN	17.4	2.5	23	3.7	59.8	0
4	34.00	1	AV1	22.8	3.3	42	**	**	0
			MAX	22.8	3.3	42	**	**	0
			MIN	22.8	3.3	42	**	**	0
6	35.00	2	AV2	17.7	3.0	26	4.1	57.3	0
			STD	2.6	0.1	4	0.4	2.6	0
			MAX	20.3	3.1	30	4.5	59.9	0
			MIN	15.1	3.0	21	3.7	54.7	0
10	36.00	4	AV4	15.3	3.3	19	3.9	58.5	44
			STD	1.4	0.3	2	0.3	2.0	8
			MAX	17.6	3.9	22	4.4	60.4	57
			MIN	14.0	3.0	17	3.7	55.5	36
15	37.00	5	AV5	17.3	4.4	20	4.3	56.1	64
			STD	1.0	0.5	1	0.1	0.8	8
			MAX	18.4	5.0	22	4.5	57.3	70
			MIN	15.7	3.6	18	4.1	55.0	47
21	38.00	6	AV6	18.5	5.4	21	4.4	55.3	88
			STD	0.4	0.6	1	0.0	0.2	13
			MAX	19.1	6.6	22	4.5	55.5	117
			MIN	18.0	4.9	19	4.4	55.0	76
33	39.00	12	AV12	22.5	10.2	24	5.5	50.0	191
			STD	0.8	0.7	2	0.2	1.1	12
			MAX	24.2	11.1	28	6.0	52.6	219
			MIN	20.8	7.9	21	4.9	47.8	161
45	40.00	12	AV12	22.8	10.3	24	5.6	49.6	220
			STD	0.7	0.7	1	0.2	0.7	6
			MAX	24.1	11.3	27	5.9	50.7	229
			MIN	21.8	9.1	22	5.3	48.3	207
55	41.00	10	AV10	21.9	7.6	23	5.3	50.8	178
			STD	0.6	0.7	1	0.2	0.7	15
			MAX	23.0	8.7	25	5.7	51.8	201
			MIN	21.3	6.7	21	5.1	49.3	154
63	42.00	8	AV8	21.0	6.4	23	5.0	52.1	152
			STD	0.5	0.5	1	0.1	0.5	6
			MAX	22.2	7.3	25	5.3	52.7	156
			MIN	20.5	5.9	21	4.9	50.9	140
74	43.00	11	AV11	23.2	9.6	25	5.6	49.8	230
			STD	0.7	0.7	2	0.2	0.9	14
			MAX	24.4	10.8	28	5.9	51.1	247
			MIN	22.0	8.5	23	5.2	48.4	201
86	44.00	12	AV12	23.8	10.8	27	5.7	49.0	249
			STD	0.5	0.4	1	0.1	0.6	6
			MAX	24.2	11.3	28	5.9	50.3	259
			MIN	22.9	9.8	25	5.4	48.3	235

USH 10 over Little Lake Butte des Morts - Pier 14 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX ft-k	STK ft	BPM **	RX9 kips
98	45.00	12	AV12	23.2	10.4	25	5.6	49.6	245
			STD	0.6	0.3	1	0.2	0.8	6
			MAX	24.5	11.1	28	6.0	50.5	256
			MIN	22.5	9.9	24	5.4	48.0	234
109	46.00	11	AV11	22.9	10.1	25	5.5	50.1	231
			STD	0.3	0.4	1	0.1	0.4	5
			MAX	23.9	10.7	27	5.8	50.5	241
			MIN	22.5	9.5	24	5.4	48.9	223
119	47.00	10	AV10	22.7	9.7	25	5.5	50.2	224
			STD	0.6	0.3	1	0.2	0.7	7
			MAX	24.0	10.3	27	5.8	50.9	236
			MIN	22.0	9.4	23	5.3	48.9	215
130	48.00	11	AV11	22.9	10.4	25	5.5	49.9	237
			STD	0.8	0.3	1	0.2	0.8	8
			MAX	23.9	10.7	27	5.8	51.1	248
			MIN	21.7	9.8	23	5.2	48.8	223
140	49.00	10	AV10	22.3	9.9	24	5.3	50.7	224
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	23.3	10.5	26	5.6	51.2	236
			MIN	21.8	9.5	23	5.2	49.7	217
149	50.00	9	AV9	22.5	10.1	25	5.4	50.4	227
			STD	0.5	0.2	1	0.1	0.6	6
			MAX	23.6	10.4	27	5.7	51.4	240
			MIN	21.6	9.8	23	5.2	49.2	222
159	51.00	10	AV10	22.7	10.9	25	5.5	50.1	251
			STD	0.3	0.4	1	0.1	0.3	10
			MAX	23.5	11.7	26	5.7	50.4	271
			MIN	22.3	10.3	24	5.4	49.2	239
171	52.00	12	AV12	22.9	11.7	25	5.5	49.9	266
			STD	0.3	0.4	0	0.1	0.3	5
			MAX	23.5	12.5	26	5.7	50.4	274
			MIN	22.3	11.1	24	5.4	49.3	255
181	53.00	10	AV10	22.4	10.9	24	5.4	50.4	239
			STD	0.7	0.4	1	0.1	0.6	12
			MAX	23.5	11.4	27	5.7	51.4	256
			MIN	21.2	10.1	23	5.2	49.2	224
190	54.00	9	AV9	21.8	9.2	24	5.3	50.9	195
			STD	0.8	1.0	1	0.2	0.7	22
			MAX	23.9	11.1	28	5.7	51.5	240
			MIN	21.2	7.8	23	5.2	49.0	170
198	55.00	8	AV8	21.5	8.4	24	5.2	51.3	180
			STD	0.2	0.1	1	0.1	0.3	5
			MAX	21.9	8.6	25	5.4	51.7	186
			MIN	21.3	8.3	23	5.1	50.6	171
207	56.00	9	AV9	22.0	8.8	24	5.3	50.9	198
			STD	0.5	0.4	1	0.1	0.6	11
			MAX	23.1	9.4	26	5.6	51.9	218
			MIN	21.1	8.3	23	5.1	49.6	185
218	57.00	11	AV11	22.8	10.6	25	5.5	49.8	250
			STD	0.5	0.8	1	0.1	0.5	15
			MAX	23.5	12.3	26	5.7	50.6	274
			MIN	21.9	9.6	23	5.4	49.0	227
231	58.00	13	AV13	24.6	15.4	28	6.0	48.0	341
			STD	0.9	1.3	2	0.2	0.9	30
			MAX	26.5	17.6	32	6.5	49.3	380
			MIN	23.4	12.5	24	5.7	46.3	279

USH 10 over Little Lake Butte des Morts - Pier 14 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX ft-k	STK ft	BPM **	RX9 kips
247	59.00	16	AV16	26.3	18.4	31	6.5	46.2	396
			STD	0.6	1.2	2	0.2	0.7	20
			MAX	27.2	20.8	34	6.8	48.5	440
			MIN	24.2	16.2	26	5.9	45.3	359
265	60.00	18	AV18	26.2	18.9	31	6.5	46.1	420
			STD	0.6	0.5	2	0.2	0.6	10
			MAX	27.3	20.9	33	6.8	47.6	441
			MIN	25.0	18.4	27	6.1	45.2	404
281	61.00	16	AV16	26.4	19.2	32	6.6	45.9	415
			STD	0.7	0.7	1	0.2	0.6	15
			MAX	27.4	20.5	34	6.9	47.8	440
			MIN	24.4	17.4	28	6.0	44.9	381
298	62.00	17	AV17	26.6	18.8	32	6.6	45.9	414
			STD	0.4	0.4	1	0.1	0.4	10
			MAX	27.2	19.4	33	6.7	47.0	435
			MIN	25.7	17.9	30	6.3	45.4	397
314	63.00	16	AV16	26.3	18.3	31	6.5	46.2	415
			STD	0.6	0.4	2	0.2	0.6	10
			MAX	27.6	19.3	33	6.9	47.4	432
			MIN	25.2	17.7	27	6.1	45.0	398
328	64.00	14	AV14	25.1	16.1	29	6.2	47.1	367
			STD	0.5	0.8	1	0.2	0.6	20
			MAX	25.6	17.5	31	6.5	48.5	400
			MIN	24.0	14.9	26	5.9	46.2	329
340	65.00	12	AV12	24.3	14.3	27	6.0	48.0	329
			STD	0.8	0.5	2	0.2	0.9	9
			MAX	25.4	15.0	30	6.3	49.6	346
			MIN	22.9	13.1	24	5.6	46.8	316
351	66.00	11	AV11	24.0	13.9	27	5.9	48.4	321
			STD	0.7	0.6	1	0.2	0.7	10
			MAX	25.5	14.7	29	6.2	49.4	338
			MIN	23.1	12.9	25	5.6	47.1	306
361	67.00	10	AV10	23.6	12.1	26	5.8	48.9	293
			STD	0.6	1.2	1	0.2	0.6	17
			MAX	24.2	14.5	28	5.9	50.1	323
			MIN	22.6	10.6	24	5.5	48.2	265
370	68.00	9	AV9	23.0	10.7	25	5.6	49.7	259
			STD	0.6	1.0	1	0.2	0.7	23
			MAX	23.9	12.5	27	5.8	50.9	289
			MIN	22.2	9.5	24	5.3	48.7	228
380	69.00	10	AV10	23.5	11.5	26	5.7	49.1	281
			STD	0.5	0.9	1	0.2	0.6	17
			MAX	24.2	13.5	29	6.0	50.0	321
			MIN	22.9	10.5	24	5.5	47.9	263
390	70.00	10	AV10	24.1	12.7	28	6.0	48.1	298
			STD	0.5	0.7	1	0.1	0.6	12
			MAX	24.9	14.2	29	6.2	49.1	330
			MIN	23.0	11.7	26	5.7	47.2	282
402	71.00	12	AV12	24.1	13.2	27	6.0	48.1	321
			STD	0.7	0.8	1	0.2	0.8	21
			MAX	25.0	14.5	29	6.2	49.7	359
			MIN	22.6	12.0	24	5.6	47.3	282
418	72.00	16	AV16	26.2	18.7	30	6.5	46.2	428
			STD	1.3	2.6	3	0.4	1.2	44
			MAX	27.9	21.9	35	6.9	48.5	481
			MIN	23.4	13.6	25	5.9	44.7	342

USH 10 over Little Lake Butte des Morts - Pier 14 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 27-Mar-2015

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX ft-k	STK ft	BPM **	RX9 kips
441	73.00	23	AV23	27.2	23.0	33	6.9	44.9	481
			STD	0.6	0.8	1	0.2	0.5	14
			MAX	28.3	24.1	35	7.2	45.7	501
			MIN	25.9	21.0	31	6.6	43.9	451
470	74.00	29	AV29	27.8	24.5	33	7.0	44.5	508
			STD	0.7	0.7	1	0.2	0.6	15
			MAX	28.8	26.0	35	7.4	45.6	537
			MIN	26.7	23.4	30	6.7	43.5	487
492	74.75	29	AV22	27.8	25.2	33	7.1	44.3	513
			STD	0.5	0.3	1	0.2	0.5	10
			MAX	28.9	26.1	35	7.4	45.2	545
			MIN	26.7	24.5	31	6.8	43.3	495
			Average	24.2	14.3	28	6.0	48.4	315
			Std. Dev.	2.5	5.8	4	0.7	2.8	120
			Maximum	28.9	26.1	42	7.4	60.4	545
			Minimum	14.0	2.2	17	3.7	43.3	0

Total number of blows analyzed: 492

BL#	depth (ft)	Comments
1	31.00	Depth reference at El. 740.3; Mud line at El. 717.0

Time Summary

Drive	10 minutes 50 seconds	1:23:19 PM - 1:34:09 PM (3/27/2015) BN 1 - 492

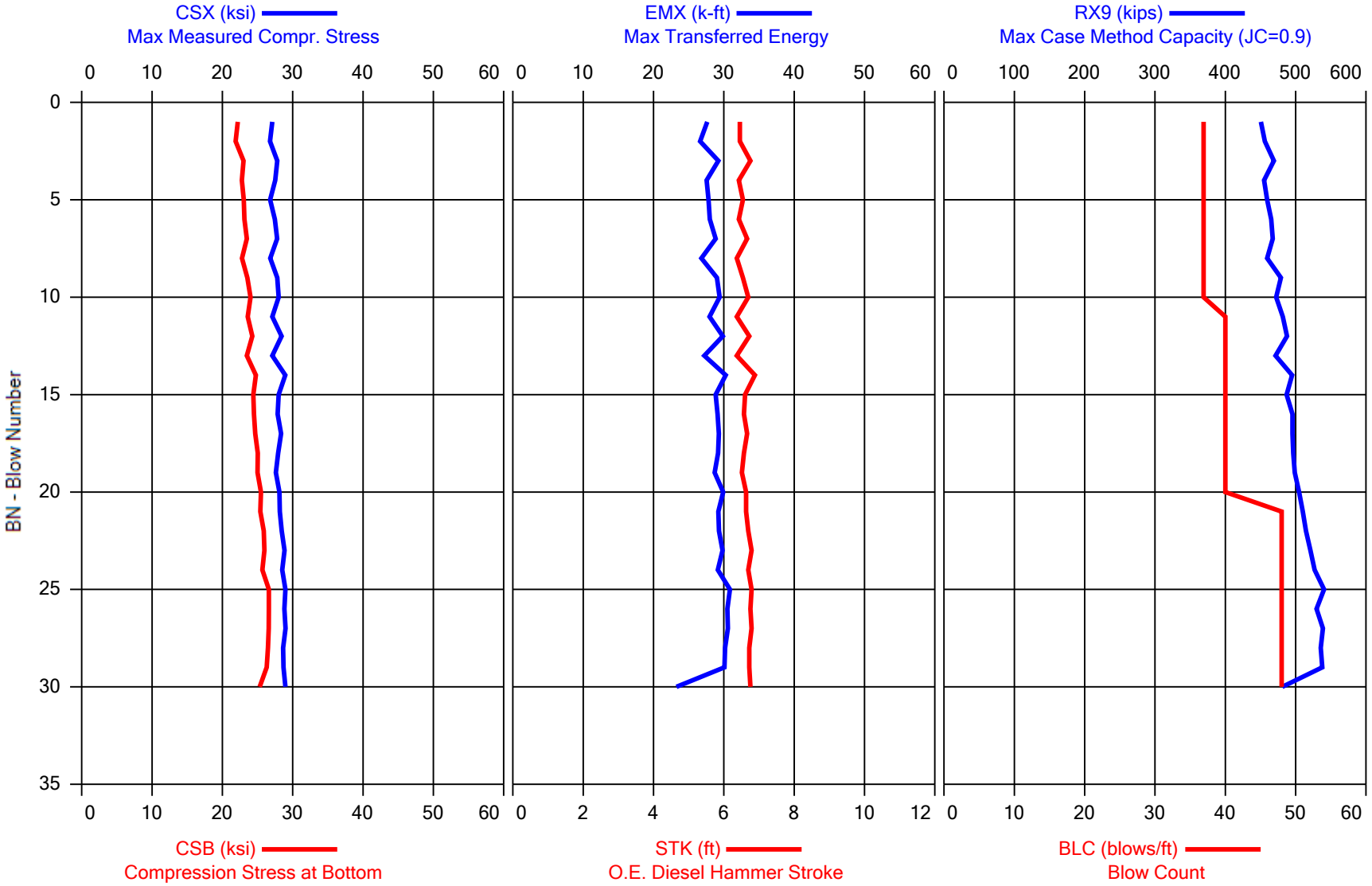
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 31-March-2015

Test started: 30-March-2015

USH 10 over Little Lake Butte des Morts - Pier 14 #44 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 14 #44 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 30-March-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 78.00 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	75.02	37	AV10	27.4	23.0	28	6.5	46.0	463
			STD	0.5	0.6	1	0.1	0.4	8
			MAX	28.0	24.0	29	6.8	46.6	479
			MIN	26.8	21.9	27	6.4	45.3	451
20	75.27	40	AV10	27.9	24.5	29	6.6	45.9	491
			STD	0.5	0.6	1	0.1	0.5	9
			MAX	28.9	25.5	30	6.9	46.6	505
			MIN	27.1	23.5	27	6.4	44.9	471
30	75.48	48	AV10	28.7	26.1	29	6.7	45.4	524
			STD	0.3	0.5	2	0.0	0.2	17
			MAX	29.0	26.6	31	6.8	45.7	540
			MIN	28.2	25.3	23	6.6	45.2	481
			Average	28.0	24.5	29	6.6	45.8	493
			Std. Dev.	0.7	1.4	2	0.1	0.5	27
			Maximum	29.0	26.6	31	6.9	46.6	540
			Minimum	26.8	21.9	23	6.4	44.9	451

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.00); A4: [K2524] 360.0 (1.00)

Time Summary

Drive 38 seconds 8:10 AM - 8:10 AM BN 1 - 30

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Alexander McCaskill
Company: Lunda Construction Co.	No. of Sheets: 53
E-mail: kweber@lundaconstruction.com	Date: April 5, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 15
Winnebago County, Wisconsin

On April 2, 2015, Pier 15 #1, Pier 15 #36, and Pier 15 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on April 3. 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 elevation for the piles was the top of the ring at EL 740.8. We understand the pier was excavated to an elevation of EL 717.3. The piles have a required minimum tip elevation of EL 678.0. 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 15 #1 was driven to a depth of 68.4 feet, which corresponds to a pile tip elevation of EL 672.4. The blow count over the final increment of driving was 10 blows for 1 ¼ inches of penetration at an average hammer stroke of 7.2 feet. The blow count at the beginning of restrike was 10 blows for ⅞ inches of penetration at an average hammer stroke of 6.8 feet.

Pier 15 #36 was driven to a depth of 68.1 feet, which corresponds to a pile tip elevation of EL 672.7. The blow count over the final increment of driving was 10 blows for 2 ⅜ inches of penetration at an average hammer stroke of 7.0 feet. The blow count at the beginning of restrike was 10 blows for 1 ¾ inches of penetration at an average hammer stroke of 6.5 feet.

Pier 15 #44 was driven to a depth of 70.1 feet, which corresponds to a pile tip elevation of EL 670.7. The blow count over the final increment of driving was 10 blows for 2 inches of penetration at an average hammer stroke of 7.3 feet. The blow count at the beginning of restrike was 10 blows for 1 ½ inches of penetration at an average hammer stroke of 6.7 feet

We recommend the production piles at Pier 15 of Structure B-70-403, driven with the APE D30-42 hammer PD0256, 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. Additionally, all production piles should achieve the minimum pile tip elevation of EL 678.0 for uplift, as indicated on the plans.

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	7	5
7.0	6	4
7.5	5	4
8.0	4	3
8.5	4	3

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.

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.

Alexander McCaskill, E.I.

Travis Coleman, P.E.

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

Attachments:

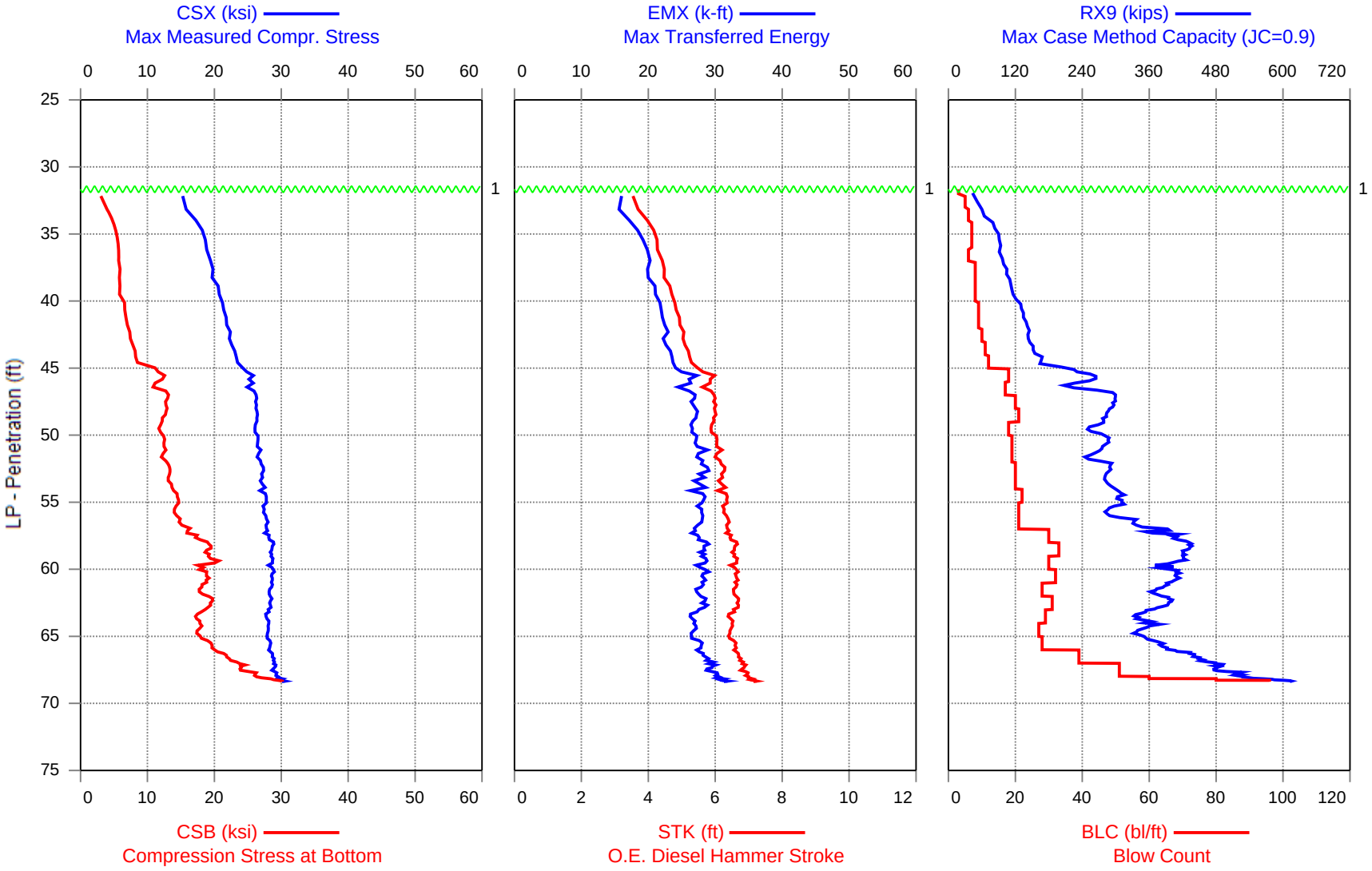
Dynamic Test Results - (pages 3 – 23)
CAPWAP Analysis Results - (pages 24 – 53)

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 02-April-2015

Test started: 02-April-2015

USH 10 over Little Lake Butte des Morts - Pier 15 #1
APE D30-42, HP 14 x 73



1 - Reported reference at El. 740.79

USH 10 over Little Lake Butte des Morts - Pier 15 #1 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.40 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
9	31.67	3	AV1	22.4	3.6	28	4.8	53.5	61
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	22.4	3.6	28	4.8	53.5	61
			MIN	22.4	3.6	28	4.8	53.5	61
10	32.00	3	AV1	15.7	2.9	16	3.5	61.9	31
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	15.7	2.9	16	3.5	61.9	31
			MIN	15.7	2.9	16	3.5	61.9	31
15	33.00	5	AV5	13.9	3.3	14	3.4	63.0	50
			STD	1.5	0.5	2	0.3	2.3	9
			MAX	16.0	3.9	16	3.7	66.2	62
			MIN	11.8	2.7	10	3.0	60.4	38
21	34.00	6	AV6	16.3	4.3	16	3.8	59.5	66
			STD	0.7	0.3	1	0.1	1.0	8
			MAX	17.9	4.8	18	4.1	60.4	79
			MIN	15.7	3.9	15	3.7	57.5	56
28	35.00	7	AV7	18.1	5.2	18	4.1	57.1	84
			STD	0.6	0.2	1	0.1	0.9	6
			MAX	19.1	5.5	20	4.4	58.3	92
			MIN	17.2	4.8	17	4.0	55.7	78
35	36.00	7	AV7	18.6	5.5	19	4.2	56.5	92
			STD	0.5	0.1	0	0.1	0.6	3
			MAX	19.6	5.8	20	4.4	57.3	96
			MIN	18.0	5.3	19	4.1	55.3	88
41	37.00	6	AV6	19.2	5.6	21	4.4	55.7	94
			STD	0.3	0.3	0	0.1	0.5	3
			MAX	19.5	5.9	21	4.5	56.6	98
			MIN	18.5	5.2	20	4.2	54.9	90
49	38.00	8	AV8	19.5	5.9	20	4.4	55.4	102
			STD	0.9	0.2	1	0.2	1.0	4
			MAX	20.8	6.3	21	4.7	57.0	110
			MIN	18.2	5.6	18	4.2	53.9	95
57	39.00	8	AV8	20.3	5.8	21	4.6	54.4	111
			STD	1.0	0.4	2	0.2	1.2	3
			MAX	21.8	6.4	23	4.9	56.1	116
			MIN	18.7	5.5	19	4.3	52.6	105
65	40.00	8	AV8	20.7	6.1	21	4.7	53.9	117
			STD	0.5	0.4	1	0.1	0.7	4
			MAX	21.5	6.7	22	4.9	55.1	122
			MIN	19.9	5.3	20	4.5	52.7	111
74	41.00	9	AV9	21.5	6.6	22	4.9	53.0	132
			STD	0.6	0.3	1	0.1	0.7	5
			MAX	22.4	7.2	24	5.0	54.4	139
			MIN	20.4	6.1	20	4.6	52.2	124
83	42.00	9	AV9	21.8	6.9	22	4.9	52.6	139

USH 10 over Little Lake Butte des Morts - Pier 15 #1 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.5	0.5	1	0.1	0.5	6
			MAX	22.4	8.1	23	5.1	53.4	147
			MIN	20.9	6.3	21	4.8	51.8	130
93	43.00	10	AV10	22.3	7.4	23	5.0	52.0	144
			STD	0.8	0.2	1	0.2	0.7	5
			MAX	23.4	7.6	24	5.3	53.3	151
			MIN	21.1	7.1	20	4.8	51.0	136
104	44.00	11	AV11	22.8	8.0	23	5.1	51.6	152
			STD	0.6	0.3	1	0.1	0.7	4
			MAX	23.6	8.6	24	5.4	52.7	158
			MIN	21.8	7.5	20	4.9	50.5	146
116	45.00	12	AV12	23.6	9.0	24	5.3	50.8	175
			STD	0.2	1.1	0	0.1	0.2	17
			MAX	24.1	11.3	25	5.4	51.2	218
			MIN	23.2	8.1	23	5.2	50.2	157
134	46.00	18	AV18	25.3	12.1	26	5.8	48.7	249
			STD	0.7	0.5	1	0.2	0.8	16
			MAX	26.4	13.2	28	6.1	50.0	268
			MIN	24.1	11.3	24	5.5	47.7	222
151	47.00	17	AV17	25.6	11.9	26	5.8	48.7	251
			STD	0.7	1.1	1	0.2	0.7	36
			MAX	26.8	13.6	29	6.1	50.2	307
			MIN	24.2	10.3	24	5.4	47.5	205
171	48.00	20	AV20	26.3	12.9	27	6.0	47.9	297
			STD	0.3	0.5	1	0.1	0.4	5
			MAX	27.1	13.7	29	6.3	48.4	307
			MIN	25.8	12.1	25	5.9	47.0	287
192	49.00	21	AV21	26.3	12.5	27	6.0	48.1	283
			STD	0.5	0.4	1	0.1	0.4	5
			MAX	27.0	13.2	28	6.1	48.9	292
			MIN	25.3	11.8	25	5.8	47.5	274
210	50.00	18	AV18	26.2	12.0	27	5.9	48.3	263
			STD	0.5	0.4	1	0.2	0.6	12
			MAX	27.0	12.7	28	6.2	49.6	280
			MIN	25.2	11.4	25	5.6	47.3	244
229	51.00	19	AV19	26.5	12.5	27	6.0	47.8	283
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	27.0	13.2	29	6.2	48.4	291
			MIN	25.7	11.8	25	5.9	47.1	273
248	52.00	19	AV19	26.7	12.5	28	6.1	47.6	261
			STD	0.4	0.5	1	0.1	0.5	12
			MAX	27.3	13.4	30	6.3	48.4	278
			MIN	26.0	11.6	26	5.9	46.8	235
268	53.00	20	AV20	27.2	13.3	28	6.2	47.1	288
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	27.8	13.9	30	6.4	48.0	296
			MIN	26.2	13.0	26	6.0	46.5	280
288	54.00	20	AV20	27.2	13.4	28	6.2	47.2	286
			STD	0.3	0.3	1	0.1	0.4	7
			MAX	27.8	14.0	29	6.4	47.9	298
			MIN	26.6	12.9	26	6.0	46.5	275

USH 10 over Little Lake Butte des Morts - Pier 15 #1 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
310	55.00	22	AV22	27.5	14.4	28	6.3	46.9	307
			STD	0.5	0.4	1	0.1	0.5	6
			MAX	28.2	15.1	30	6.5	48.0	321
			MIN	26.3	13.8	25	6.0	46.3	296
331	56.00	21	AV21	27.4	14.2	28	6.3	46.9	293
			STD	0.4	0.4	1	0.1	0.4	13
			MAX	28.2	15.0	30	6.5	47.5	322
			MIN	26.9	13.6	26	6.1	46.3	277
352	57.00	21	AV21	27.8	15.1	28	6.4	46.6	335
			STD	0.3	0.6	1	0.1	0.3	21
			MAX	28.2	16.5	29	6.5	47.3	389
			MIN	27.2	14.1	26	6.2	46.1	294
382	58.00	30	AV30	28.1	17.2	27	6.5	46.3	401
			STD	0.5	1.3	1	0.1	0.5	23
			MAX	29.5	19.3	30	6.8	47.4	431
			MIN	27.0	14.9	25	6.1	45.1	346
415	59.00	33	AV33	28.6	19.1	28	6.6	45.9	428
			STD	0.4	0.4	1	0.1	0.4	7
			MAX	29.7	20.3	30	6.8	46.8	441
			MIN	27.9	18.3	27	6.3	45.0	416
445	60.00	30	AV30	28.5	19.1	28	6.6	45.9	403
			STD	0.4	1.5	1	0.1	0.4	20
			MAX	29.3	20.9	30	6.8	46.6	434
			MIN	27.8	16.2	26	6.4	45.2	356
477	61.00	32	AV32	28.7	18.8	28	6.6	45.7	408
			STD	0.4	0.3	1	0.1	0.4	6
			MAX	29.4	19.4	30	6.8	46.7	420
			MIN	27.8	17.8	27	6.3	45.1	394
505	62.00	28	AV28	28.4	18.1	28	6.6	45.9	378
			STD	0.4	0.4	1	0.1	0.3	11
			MAX	29.4	18.9	29	6.8	46.5	398
			MIN	27.5	17.4	26	6.4	45.0	359
536	63.00	31	AV31	28.4	19.4	28	6.7	45.6	390
			STD	0.3	0.4	1	0.1	0.2	11
			MAX	28.9	20.0	30	6.8	46.1	409
			MIN	27.8	18.6	27	6.5	45.1	367
565	64.00	29	AV29	27.9	17.6	27	6.5	46.3	347
			STD	0.4	0.4	1	0.1	0.4	10
			MAX	28.6	18.4	28	6.7	47.0	366
			MIN	27.2	17.0	25	6.3	45.5	330
592	65.00	27	AV27	28.0	17.7	27	6.5	46.3	349
			STD	0.5	0.4	1	0.2	0.5	14
			MAX	29.3	19.1	29	6.8	47.3	380
			MIN	26.9	17.1	25	6.2	45.1	330
620	66.00	28	AV28	28.2	19.2	28	6.6	46.0	375
			STD	0.4	0.7	1	0.1	0.4	15
			MAX	29.0	20.2	29	6.8	46.6	400
			MIN	27.3	17.7	26	6.4	45.1	348
659	67.00	39	AV39	28.7	21.8	29	6.7	45.4	443
			STD	0.5	1.1	1	0.1	0.4	20

USH 10 over Little Lake Butte des Morts - Pier 15 #1 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	29.7	24.3	30	6.9	46.4	486
			MIN	27.7	19.7	27	6.4	44.7	402
709	67.98	51	AV50	29.0	24.8	30	6.9	44.9	496
			STD	0.5	1.0	1	0.1	0.4	20
			MAX	30.3	27.0	32	7.2	45.7	542
			MIN	28.1	23.3	28	6.6	43.8	467
719	68.15	60	AV10	29.7	26.9	31	7.0	44.5	536
			STD	0.5	0.6	1	0.1	0.3	11
			MAX	30.5	28.1	32	7.2	45.0	556
			MIN	29.0	26.2	29	6.8	43.9	523
729	68.27	80	AV10	29.9	28.8	31	7.1	44.4	579
			STD	0.3	0.5	0	0.1	0.2	12
			MAX	30.7	29.7	32	7.2	44.6	602
			MIN	29.6	27.9	30	7.0	43.9	557
739	68.38	96	AV10	30.4	30.0	32	7.2	43.9	611
			STD	0.4	0.3	1	0.1	0.3	6
			MAX	31.0	30.5	32	7.4	44.4	619
			MIN	29.8	29.3	30	7.0	43.5	602
			Average	26.8	16.0	27	6.2	47.6	333
			Std. Dev.	3.0	5.8	3	0.7	3.3	120
			Maximum	31.0	30.5	32	7.4	66.2	619
			Minimum	11.8	2.7	10	3.0	43.5	31

Total number of blows analyzed: 731

BL# Sensors

1-739 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.00); A4: [K2524] 360.0 (1.00)

BL# Comments

9 Reported reference at El. 740.79
10 Mud line at El. 717.29

Time Summary

Drive 16 minutes 6 seconds 8:21 AM - 8:37 AM BN 1 - 739

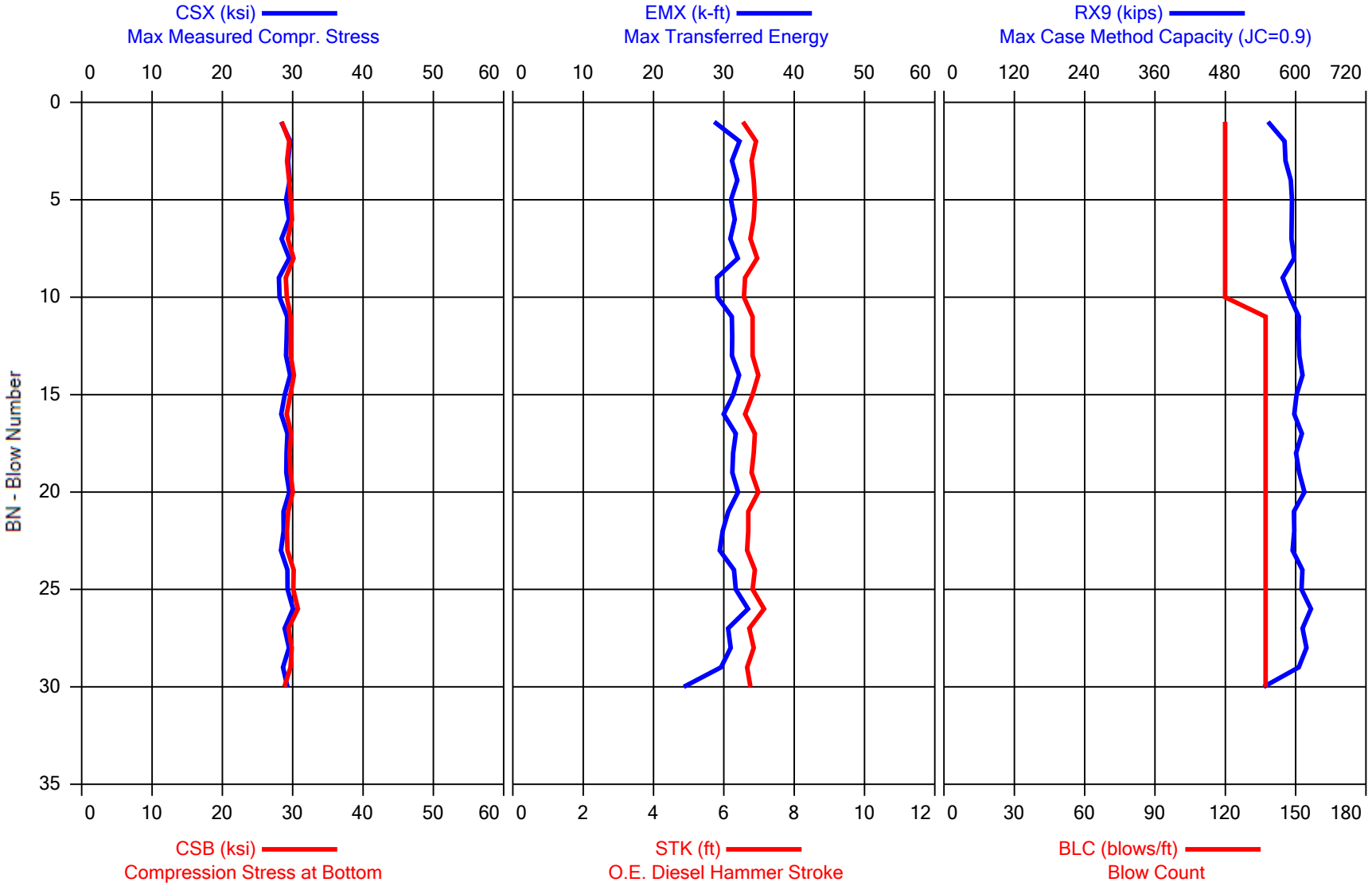
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 03-April-2015

Test started: 03-April-2015

USH 10 over Little Lake Butte des Morts - Pier 15 #1 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 15 #1 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 03-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 73.00 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	68.46	137	AV10	29.0	29.4	31	6.8	45.3	585
			STD	0.6	0.5	1	0.1	0.5	12
			MAX	29.7	30.1	32	6.9	46.0	597
			MIN	28.0	28.4	29	6.5	44.7	553
20	68.53	137	AV10	29.1	29.7	31	6.8	45.1	606
			STD	0.3	0.3	1	0.1	0.3	5
			MAX	29.6	30.2	32	7.0	45.8	615
			MIN	28.4	29.1	30	6.6	44.6	598
30	68.60	137	AV10	29.0	29.7	30	6.8	45.2	602
			STD	0.5	0.5	2	0.1	0.4	21
			MAX	30.1	30.7	33	7.1	45.6	626
			MIN	28.3	28.8	24	6.7	44.1	545
			Average	29.0	29.6	31	6.8	45.2	598
			Std. Dev.	0.5	0.5	2	0.1	0.4	17
			Maximum	30.1	30.7	33	7.1	46.0	626
			Minimum	28.0	28.4	24	6.5	44.1	545

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.10); A4: [K3550] 360.0 (1.10)

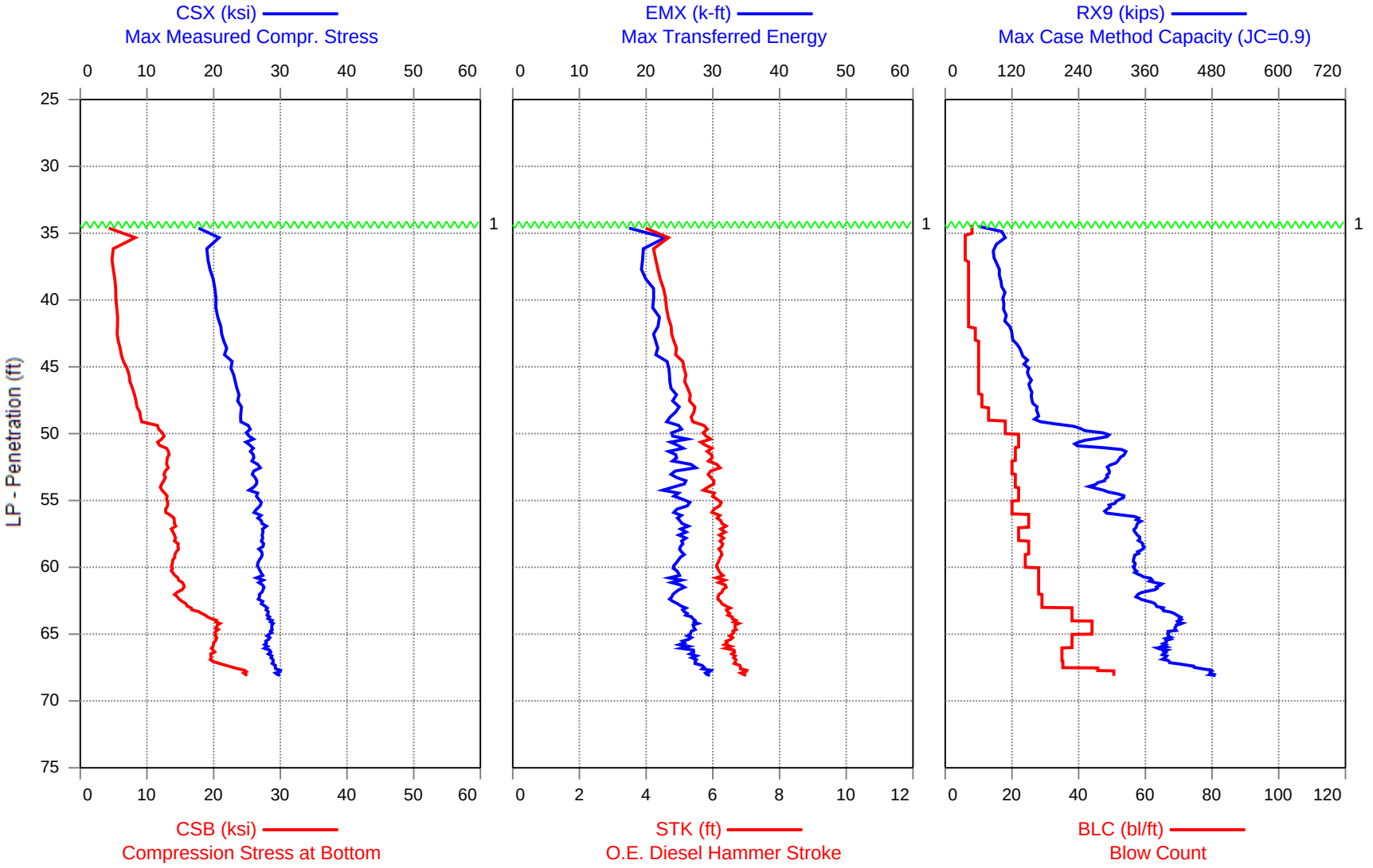
Time Summary

Drive 38 seconds 9:02 AM - 9:03 AM BN 1 - 30

Printed: 02-April-2015

Test started: 02-April-2015

USH 10 over Little Lake Butte des Morts - Pier 15 #36
APE D30-42, HP 14 x 73



1 - Reported Reference at El. 740.79

USH 10 over Little Lake Butte des Morts - Pier 15 #36 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.40 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
9	34.38	8	AV1	24.7	3.8	30	5.3	50.7	65
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	24.7	3.8	30	5.3	50.7	65
			MIN	24.7	3.8	30	5.3	50.7	65
14	35.00	8	AV5	16.6	5.1	15	3.8	59.8	84
			STD	1.6	2.0	2	0.3	2.0	31
			MAX	19.0	8.0	19	4.3	62.3	129
			MIN	14.3	3.4	12	3.4	56.3	56
20	36.00	6	AV6	20.6	7.4	23	4.6	54.4	100
			STD	1.1	1.7	2	0.3	1.5	10
			MAX	22.2	9.2	26	5.0	56.6	110
			MIN	18.8	5.0	19	4.2	52.4	83
26	37.00	6	AV6	18.8	4.7	19	4.2	56.6	87
			STD	0.2	0.1	1	0.1	0.4	3
			MAX	19.1	4.8	20	4.3	57.4	91
			MIN	18.4	4.5	18	4.1	56.2	83
33	38.00	7	AV7	19.4	4.9	19	4.3	55.8	95
			STD	0.3	0.1	0	0.1	0.3	3
			MAX	20.0	5.0	20	4.5	56.1	100
			MIN	19.1	4.7	19	4.3	55.1	90
40	39.00	7	AV7	20.0	5.2	20	4.5	55.2	100
			STD	0.3	0.1	1	0.1	0.5	3
			MAX	20.6	5.4	21	4.6	55.8	105
			MIN	19.5	5.0	20	4.3	54.6	96
47	40.00	7	AV7	20.2	5.3	21	4.5	54.7	105
			STD	0.5	0.2	1	0.1	0.6	4
			MAX	21.0	5.6	22	4.7	55.4	111
			MIN	19.6	5.0	20	4.4	53.9	99
54	41.00	7	AV7	20.3	5.5	21	4.6	54.4	106
			STD	0.6	0.3	1	0.1	0.7	3
			MAX	21.1	5.8	23	4.8	55.3	109
			MIN	19.5	4.9	19	4.4	53.2	100
61	42.00	7	AV7	20.9	5.7	22	4.7	53.7	110
			STD	0.6	0.1	1	0.1	0.5	4
			MAX	22.0	5.8	24	4.9	54.2	117
			MIN	20.3	5.5	21	4.6	52.7	105
70	43.00	9	AV9	21.3	5.5	21	4.8	53.4	119
			STD	0.4	0.3	1	0.1	0.4	3
			MAX	22.1	6.1	22	5.0	53.9	124
			MIN	20.8	5.0	20	4.7	52.5	115
80	44.00	10	AV10	21.7	6.0	22	4.9	52.9	132
			STD	0.4	0.5	1	0.1	0.4	5
			MAX	22.5	6.7	22	5.0	53.6	138
			MIN	21.2	5.2	21	4.7	52.3	122
90	45.00	10	AV10	22.4	6.5	23	5.0	52.1	144

USH 10 over Little Lake Butte des Morts - Pier 15 #36 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.8	0.5	1	0.2	0.8	5
			MAX	23.5	7.3	25	5.2	54.0	151
			MIN	20.7	5.7	21	4.7	51.1	135
100	46.00	10	AV10	22.8	7.1	23	5.2	51.5	151
			STD	0.4	0.4	1	0.1	0.5	4
			MAX	23.7	7.6	25	5.4	52.3	156
			MIN	22.3	6.4	22	5.0	50.6	146
110	47.00	10	AV10	23.6	7.9	24	5.2	51.1	153
			STD	0.5	0.4	1	0.1	0.5	3
			MAX	24.5	8.7	25	5.4	51.9	158
			MIN	22.8	7.1	23	5.1	50.5	147
121	48.00	11	AV11	23.8	8.3	24	5.4	50.6	158
			STD	0.5	0.4	1	0.1	0.5	4
			MAX	24.4	8.9	26	5.5	51.4	164
			MIN	23.1	7.6	23	5.2	49.8	152
134	49.00	13	AV13	24.1	8.9	24	5.4	50.4	165
			STD	0.6	0.4	1	0.2	0.7	5
			MAX	25.1	9.5	26	5.6	51.9	176
			MIN	22.8	7.9	22	5.1	49.4	157
152	50.00	18	AV18	25.0	11.2	24	5.7	49.2	230
			STD	0.9	1.2	2	0.3	1.0	37
			MAX	26.7	12.7	28	6.1	51.7	292
			MIN	23.0	9.1	21	5.1	47.4	167
174	51.00	22	AV22	25.4	12.1	25	5.8	48.8	260
			STD	0.8	0.6	1	0.2	0.8	24
			MAX	27.1	13.1	27	6.1	50.5	298
			MIN	23.8	11.1	22	5.4	47.4	232
195	52.00	21	AV21	25.8	13.1	24	5.9	48.2	316
			STD	0.4	0.2	1	0.1	0.5	9
			MAX	26.8	13.5	27	6.2	49.2	327
			MIN	25.1	12.7	23	5.7	47.3	289
215	53.00	20	AV20	26.3	12.9	26	6.0	47.8	298
			STD	0.7	0.4	2	0.2	0.7	6
			MAX	27.9	13.6	29	6.4	48.9	313
			MIN	25.3	12.3	23	5.8	46.4	290
236	54.00	21	AV21	26.3	12.5	25	6.0	48.0	280
			STD	0.6	0.5	1	0.1	0.6	13
			MAX	27.9	13.4	29	6.3	48.8	298
			MIN	25.3	11.5	23	5.8	46.8	254
258	55.00	22	AV22	26.2	12.7	24	5.9	48.2	302
			STD	0.8	0.5	2	0.2	0.8	19
			MAX	28.0	13.3	28	6.4	49.8	325
			MIN	24.9	11.7	21	5.5	46.5	265
278	56.00	20	AV20	26.7	13.0	25	6.1	47.5	296
			STD	0.6	0.3	1	0.2	0.6	8
			MAX	27.7	13.6	27	6.4	48.6	310
			MIN	25.3	12.4	23	5.8	46.5	282
303	57.00	25	AV25	27.2	14.0	25	6.2	47.0	342
			STD	0.8	0.4	1	0.2	0.7	11
			MAX	28.7	15.1	28	6.6	48.2	355
			MIN	25.9	12.9	23	5.9	45.8	308

USH 10 over Little Lake Butte des Morts - Pier 15 #36
OP: AM

APE D30-42, HP 14 x 73
Date: 02-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
325	58.00	22	AV22	27.3	14.0	26	6.3	46.9	345
			STD	0.4	0.4	1	0.1	0.4	5
			MAX	28.2	14.6	27	6.5	47.8	352
			MIN	26.7	13.2	24	6.0	46.1	338
350	59.00	25	AV25	27.3	14.5	25	6.3	47.0	353
			STD	0.6	0.3	1	0.2	0.5	5
			MAX	29.2	15.2	29	6.8	47.7	362
			MIN	26.3	13.9	24	6.1	45.2	345
374	60.00	24	AV24	26.8	13.9	25	6.2	47.3	340
			STD	0.6	0.3	1	0.1	0.5	4
			MAX	28.2	14.7	26	6.5	48.2	352
			MIN	25.6	13.3	23	5.9	46.3	335
402	61.00	28	AV28	27.0	14.1	25	6.2	47.2	352
			STD	0.7	0.5	1	0.2	0.6	12
			MAX	28.3	15.0	26	6.5	48.9	376
			MIN	25.2	13.4	21	5.8	46.2	339
430	62.00	28	AV28	27.2	15.2	25	6.3	46.8	374
			STD	0.7	0.5	1	0.2	0.7	14
			MAX	28.2	16.0	28	6.7	48.7	395
			MIN	25.6	14.1	22	5.8	45.6	345
459	63.00	29	AV29	27.1	15.2	24	6.2	47.1	363
			STD	0.7	0.7	1	0.2	0.6	15
			MAX	28.7	16.4	27	6.6	48.4	385
			MIN	25.7	13.8	22	5.9	45.7	339
497	64.00	38	AV38	28.2	18.4	26	6.5	46.1	410
			STD	0.7	1.2	1	0.2	0.7	13
			MAX	29.4	20.7	29	6.9	47.6	430
			MIN	26.9	16.3	24	6.1	44.8	388
541	65.00	44	AV44	28.7	20.5	27	6.7	45.6	413
			STD	0.5	0.4	1	0.1	0.4	8
			MAX	29.9	21.7	29	7.1	46.5	432
			MIN	27.7	19.8	26	6.4	44.3	396
579	66.00	38	AV38	28.0	20.2	26	6.5	46.2	398
			STD	0.6	0.3	1	0.2	0.6	6
			MAX	29.3	21.1	28	6.8	47.2	411
			MIN	27.0	19.4	24	6.2	45.1	381
614	67.00	35	AV35	28.5	19.7	27	6.6	45.8	394
			STD	0.6	0.3	1	0.1	0.5	7
			MAX	29.7	20.3	29	6.9	47.1	404
			MIN	27.0	19.2	25	6.2	44.9	374
632	67.51	35	AV18	29.0	21.4	28	6.7	45.4	426
			STD	0.6	1.2	1	0.2	0.5	19
			MAX	30.3	23.4	30	7.1	46.1	452
			MIN	27.9	19.7	26	6.5	44.3	400
642	67.73	46	AV10	29.6	24.0	29	6.9	44.9	468
			STD	0.8	0.8	1	0.2	0.6	11
			MAX	30.7	25.1	31	7.2	46.0	483
			MIN	28.0	22.8	26	6.5	43.9	453
652	67.93	51	AV10	29.6	24.6	29	6.9	44.8	477
			STD	0.8	0.4	1	0.2	0.6	4

USH 10 over Little Lake Butte des Morts - Pier 15 #36 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	30.7	25.3	30	7.2	45.7	482
			MIN	28.4	24.0	28	6.6	43.9	468
662	68.13	51	AV10	29.8	24.9	29	7.0	44.7	481
			STD	0.7	0.4	1	0.2	0.5	6
			MAX	30.6	25.5	31	7.2	45.4	492
			MIN	28.8	24.4	28	6.7	43.9	472
			Average	26.3	14.4	25	6.0	48.1	314
			Std. Dev.	2.7	5.2	2	0.7	2.9	107
			Maximum	30.7	25.5	31	7.2	62.3	492
			Minimum	14.3	3.4	12	3.4	43.9	56

Total number of blows analyzed: 654

BL# Sensors

1-662 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.00); A4: [K2524] 360.0 (1.00)

BL# Comments

9 Reported Reference at El. 740.79
10 Mud line at El. 717.29

Time Summary

Drive 14 minutes 20 seconds 8:53 AM - 9:07 AM BN 1 - 662

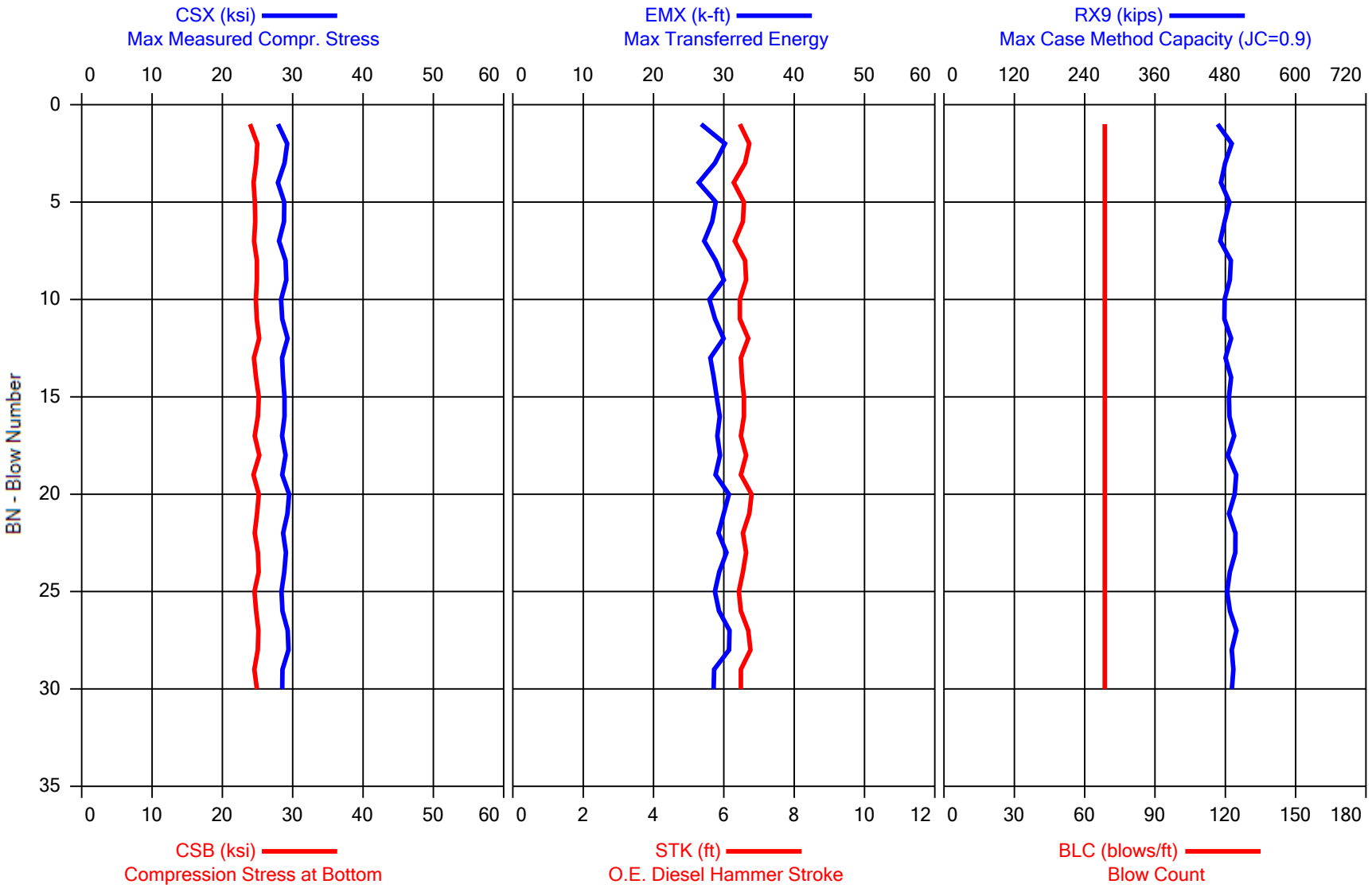
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 03-April-2015

Test started: 03-April-2015

USH 10 over Little Lake Butte des Morts - Pier 15 #36 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 15 #36 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 03-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 73.00 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	68.27	69	AV10	28.6	24.6	28	6.5	46.1	480
			STD	0.5	0.3	1	0.1	0.5	8
			MAX	29.2	25.0	30	6.7	46.9	491
			MIN	27.9	23.9	26	6.3	45.4	467
20	68.42	69	AV10	28.8	24.9	29	6.6	45.9	489
			STD	0.3	0.3	1	0.1	0.3	6
			MAX	29.5	25.3	31	6.8	46.3	498
			MIN	28.5	24.4	28	6.5	45.2	478
30	68.56	69	AV10	28.8	24.9	30	6.6	45.9	491
			STD	0.4	0.2	1	0.1	0.4	5
			MAX	29.4	25.2	31	6.8	46.4	499
			MIN	28.4	24.5	29	6.4	45.3	483
			Average	28.7	24.8	29	6.6	46.0	487
			Std. Dev.	0.4	0.3	1	0.1	0.4	8
			Maximum	29.5	25.3	31	6.8	46.9	499
			Minimum	27.9	23.9	26	6.3	45.2	467

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

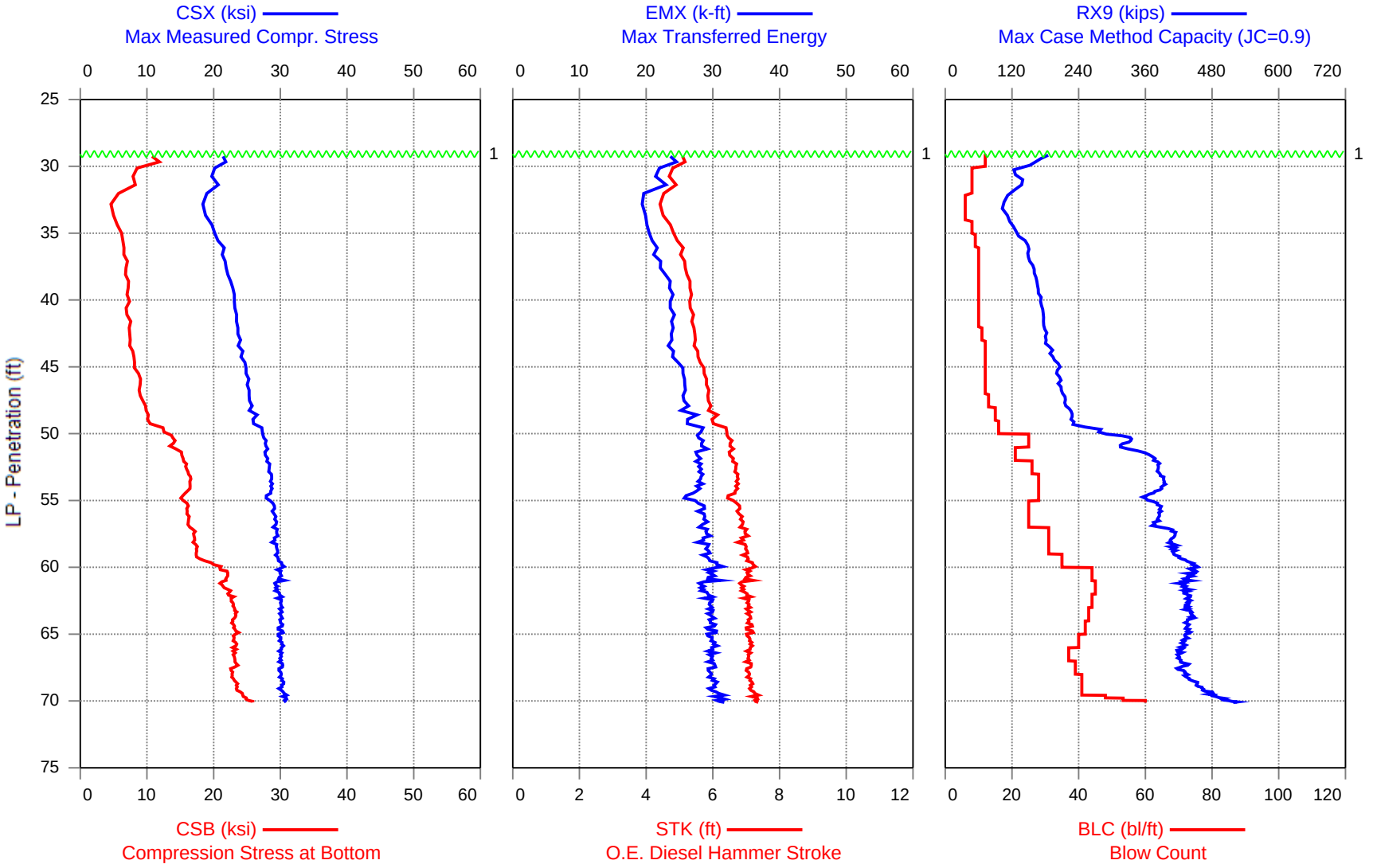
Time Summary

Drive 37 seconds 9:10 AM - 9:11 AM BN 1 - 30

Printed: 02-April-2015

Test started: 02-April-2015

USH 10 over Little Lake Butte des Morts - Pier 15 #44
APE D30-42, HP 14 x 73



1 - Reported reference at El. 740.79

USH 10 over Little Lake Butte des Morts - Pier 15 #44 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.60 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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
8	29.08	12	AV1	20.2	11.0	21	4.9	52.9	186
			STD	0.0	0.0	0	0.0	0.0	0
			MAX	20.2	11.0	21	4.9	52.9	186
			MIN	20.2	11.0	21	4.9	52.9	186
19	30.00	12	AV11	21.8	11.1	24	5.1	51.6	166
			STD	0.5	1.4	1	0.1	0.6	14
			MAX	22.6	12.8	25	5.3	52.8	187
			MIN	20.7	7.5	23	4.9	50.7	143
27	31.00	8	AV8	19.5	7.8	21	4.7	54.1	129
			STD	0.9	0.6	2	0.2	1.0	10
			MAX	21.4	8.9	24	5.0	55.6	143
			MIN	18.1	7.1	19	4.4	52.1	115
35	32.00	8	AV8	20.4	7.5	22	4.8	53.2	131
			STD	0.7	1.1	2	0.2	0.9	9
			MAX	21.3	9.0	24	5.0	54.6	142
			MIN	18.9	5.2	20	4.6	52.2	117
41	33.00	6	AV6	18.2	4.8	19	4.4	55.7	106
			STD	0.5	0.2	1	0.1	0.6	6
			MAX	19.1	5.0	21	4.5	56.4	116
			MIN	17.5	4.6	18	4.3	54.7	97
47	34.00	6	AV6	18.7	4.9	20	4.5	55.0	109
			STD	0.4	0.3	1	0.1	0.5	5
			MAX	19.1	5.2	21	4.6	55.8	117
			MIN	18.0	4.3	19	4.3	54.3	102
55	35.00	8	AV8	19.9	5.8	20	4.8	53.5	123
			STD	0.7	0.3	1	0.1	0.7	5
			MAX	20.6	6.3	22	4.9	55.2	131
			MIN	18.4	5.4	18	4.5	52.8	115
64	36.00	9	AV9	20.8	6.4	21	5.0	52.5	141
			STD	0.8	0.3	1	0.2	0.8	8
			MAX	22.4	6.8	23	5.3	53.6	154
			MIN	19.9	5.8	19	4.7	51.0	130
74	37.00	10	AV10	21.5	6.6	21	5.1	51.9	150
			STD	0.7	0.3	1	0.2	0.9	4
			MAX	22.8	7.0	23	5.4	53.4	155
			MIN	20.3	6.1	19	4.8	50.4	141
84	38.00	10	AV10	21.9	7.0	22	5.2	51.4	157
			STD	0.6	0.3	1	0.2	0.7	4
			MAX	23.0	7.5	24	5.5	52.3	163
			MIN	21.1	6.5	21	5.0	50.1	147
94	39.00	10	AV10	22.5	7.1	23	5.3	50.9	164
			STD	0.5	0.4	1	0.1	0.5	2
			MAX	23.1	7.6	25	5.4	52.1	167
			MIN	21.3	6.5	21	5.0	50.2	160
104	40.00	10	AV10	23.0	7.2	24	5.3	50.7	169

USH 10 over Little Lake Butte des Morts - Pier 15 #44 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.5	0.4	1	0.1	0.4	4
			MAX	23.7	8.0	26	5.6	51.2	177
			MIN	22.2	6.6	23	5.2	49.7	163
114	41.00	10	AV10	23.2	7.0	24	5.3	50.7	174
			STD	0.7	0.3	1	0.1	0.7	4
			MAX	24.5	7.5	26	5.6	51.8	183
			MIN	22.3	6.4	22	5.1	49.7	170
124	42.00	10	AV10	23.4	7.3	24	5.4	50.5	176
			STD	0.6	0.4	1	0.1	0.4	4
			MAX	24.3	7.9	26	5.6	51.1	182
			MIN	22.6	6.6	23	5.2	49.5	168
135	43.00	11	AV11	23.7	7.4	24	5.5	50.1	180
			STD	0.5	0.3	1	0.1	0.5	3
			MAX	24.7	7.9	25	5.6	51.1	187
			MIN	22.7	6.9	22	5.2	49.4	175
147	44.00	12	AV12	24.1	7.7	24	5.5	50.0	187
			STD	0.6	0.4	1	0.1	0.5	6
			MAX	25.4	8.5	25	5.7	51.0	196
			MIN	22.9	7.2	22	5.3	49.1	177
159	45.00	12	AV12	24.5	8.1	25	5.6	49.5	198
			STD	0.6	0.4	1	0.1	0.5	5
			MAX	25.9	8.8	26	5.9	50.1	207
			MIN	23.6	7.4	23	5.5	48.4	190
171	46.00	12	AV12	25.0	8.6	26	5.8	48.9	204
			STD	0.6	0.5	1	0.1	0.5	5
			MAX	25.9	9.2	27	6.0	49.7	213
			MIN	23.8	7.9	24	5.6	48.1	197
183	47.00	12	AV12	25.1	8.9	26	5.8	48.7	207
			STD	0.7	0.4	1	0.2	0.7	3
			MAX	26.6	9.4	27	6.2	50.0	211
			MIN	23.9	8.2	23	5.5	47.2	200
196	48.00	13	AV13	25.6	9.5	26	5.9	48.3	216
			STD	0.4	0.5	1	0.1	0.3	3
			MAX	26.3	10.3	28	6.1	48.9	219
			MIN	24.9	8.8	25	5.8	47.6	210
211	49.00	15	AV15	25.9	10.0	26	6.0	48.0	226
			STD	0.6	0.5	1	0.2	0.6	2
			MAX	26.9	10.8	28	6.3	49.0	230
			MIN	24.8	8.9	24	5.7	46.9	222
227	50.00	16	AV16	26.8	11.7	28	6.3	47.0	255
			STD	0.7	1.1	1	0.2	0.8	22
			MAX	27.7	12.9	29	6.6	48.5	284
			MIN	25.3	9.8	25	5.9	45.9	224
252	51.00	25	AV25	27.7	13.8	28	6.5	46.1	323
			STD	0.5	0.5	1	0.2	0.5	12
			MAX	29.0	14.9	31	6.8	47.4	339
			MIN	26.4	13.1	25	6.1	45.0	294
273	52.00	21	AV21	27.9	15.1	28	6.5	46.0	358
			STD	0.5	0.5	1	0.1	0.5	19
			MAX	28.7	15.8	31	6.8	46.8	379
			MIN	27.0	13.8	26	6.3	45.1	316

USH 10 over Little Lake Butte des Morts - Pier 15 #44
OP: AM

APE D30-42, HP 14 x 73
Date: 02-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
299	53.00	26	AV26	28.3	15.9	28	6.7	45.5	383
			STD	0.4	0.3	1	0.1	0.5	3
			MAX	29.4	16.4	30	7.0	46.6	390
			MIN	27.3	15.0	26	6.4	44.6	378
327	54.00	28	AV28	28.7	16.5	28	6.7	45.4	392
			STD	0.5	0.3	1	0.2	0.5	4
			MAX	29.7	16.8	30	7.0	46.7	399
			MIN	27.4	15.6	25	6.3	44.5	383
355	55.00	28	AV28	28.3	15.7	27	6.6	45.9	371
			STD	0.6	0.5	1	0.2	0.6	12
			MAX	29.3	16.8	29	6.9	46.9	393
			MIN	27.1	14.9	24	6.3	44.9	352
380	56.00	25	AV25	28.9	16.0	28	6.8	45.3	384
			STD	0.6	0.2	1	0.2	0.5	5
			MAX	29.9	16.3	31	7.1	46.3	392
			MIN	27.9	15.5	26	6.5	44.3	370
405	57.00	25	AV25	29.3	16.2	29	6.9	44.9	381
			STD	0.7	0.3	1	0.2	0.6	6
			MAX	30.4	16.8	31	7.2	46.2	388
			MIN	27.5	15.4	26	6.5	44.0	371
436	58.00	31	AV31	29.3	17.0	29	6.9	44.7	409
			STD	0.6	0.3	1	0.2	0.5	6
			MAX	30.4	17.6	31	7.2	46.1	419
			MIN	28.0	16.5	27	6.5	43.8	392
467	59.00	31	AV31	29.4	17.4	29	7.0	44.6	410
			STD	0.6	0.3	1	0.2	0.5	6
			MAX	30.4	17.8	31	7.3	45.7	420
			MIN	28.3	16.7	27	6.6	43.7	398
502	60.00	35	AV35	29.9	18.9	30	7.1	44.3	434
			STD	0.6	1.3	1	0.2	0.6	14
			MAX	31.1	21.7	33	7.5	45.6	459
			MIN	28.3	17.1	27	6.7	43.2	407
546	61.00	44	AV44	30.0	21.8	30	7.1	44.4	442
			STD	0.4	0.5	1	0.1	0.4	7
			MAX	31.0	22.9	32	7.4	45.2	455
			MIN	29.2	20.4	28	6.8	43.5	426
591	62.00	45	AV45	29.5	21.7	29	6.9	44.8	431
			STD	0.5	0.6	1	0.1	0.5	6
			MAX	31.3	23.0	32	7.5	45.6	446
			MIN	28.7	20.6	27	6.7	43.2	418
635	63.00	44	AV44	30.1	22.8	30	7.1	44.4	437
			STD	0.4	0.4	1	0.1	0.4	5
			MAX	31.1	23.8	32	7.4	45.1	450
			MIN	29.2	21.7	28	6.8	43.5	430
678	64.00	43	AV43	30.1	23.2	30	7.1	44.3	441
			STD	0.3	0.3	1	0.1	0.4	6
			MAX	30.7	23.7	31	7.3	45.2	450
			MIN	29.3	22.5	28	6.8	43.6	427
720	65.00	42	AV42	30.0	23.1	30	7.1	44.2	436
			STD	0.5	0.4	1	0.2	0.5	5

USH 10 over Little Lake Butte des Morts - Pier 15 #44 APE D30-42, HP 14 x 73
OP: AM Date: 02-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	31.2	24.3	32	7.4	45.0	456
			MIN	29.0	22.4	28	6.8	43.3	427
760	66.00	40	AV40	30.1	23.1	30	7.1	44.2	430
			STD	0.5	0.4	1	0.1	0.4	4
			MAX	31.0	23.9	32	7.5	45.1	438
			MIN	29.2	22.5	28	6.8	43.2	419
797	67.00	37	AV37	30.1	23.1	30	7.1	44.3	422
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	31.3	23.7	32	7.4	45.2	430
			MIN	29.0	22.6	28	6.8	43.3	413
836	68.00	39	AV39	30.1	23.0	30	7.1	44.3	428
			STD	0.4	0.4	1	0.1	0.4	7
			MAX	30.9	24.1	31	7.3	45.4	441
			MIN	28.9	22.2	28	6.7	43.7	413
900	69.56	41	AV64	30.3	23.4	30	7.2	44.1	455
			STD	0.4	0.5	1	0.1	0.4	16
			MAX	31.3	24.9	32	7.5	44.8	487
			MIN	29.2	22.4	28	6.9	43.1	429
910	69.77	48	AV10	30.7	24.5	31	7.3	43.8	487
			STD	0.4	0.3	1	0.1	0.3	5
			MAX	31.3	24.9	33	7.5	44.2	496
			MIN	30.0	24.0	29	7.1	43.2	479
920	69.96	53	AV10	30.9	25.0	31	7.3	43.6	500
			STD	0.4	0.2	1	0.1	0.4	3
			MAX	31.5	25.3	33	7.5	44.1	506
			MIN	30.4	24.7	30	7.1	43.0	496
930	70.13	60	AV10	30.7	25.8	31	7.3	43.7	518
			STD	0.3	0.2	1	0.1	0.3	6
			MAX	31.0	26.3	32	7.4	44.3	529
			MIN	30.1	25.4	30	7.1	43.3	509
			Average	28.1	17.5	28	6.6	46.0	363
			Std. Dev.	3.1	6.1	3	0.7	2.8	109
			Maximum	31.5	26.3	33	7.5	56.4	529
			Minimum	17.5	4.3	18	4.3	43.0	97

Total number of blows analyzed: 923

BL# Sensors

1-930 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.00); A4: [K2524] 360.0 (1.00)

BL# Comments

8 Reported reference at El. 740.79

Time Summary

Drive 20 minutes 26 seconds 9:19 AM - 9:39 AM BN 1 - 930

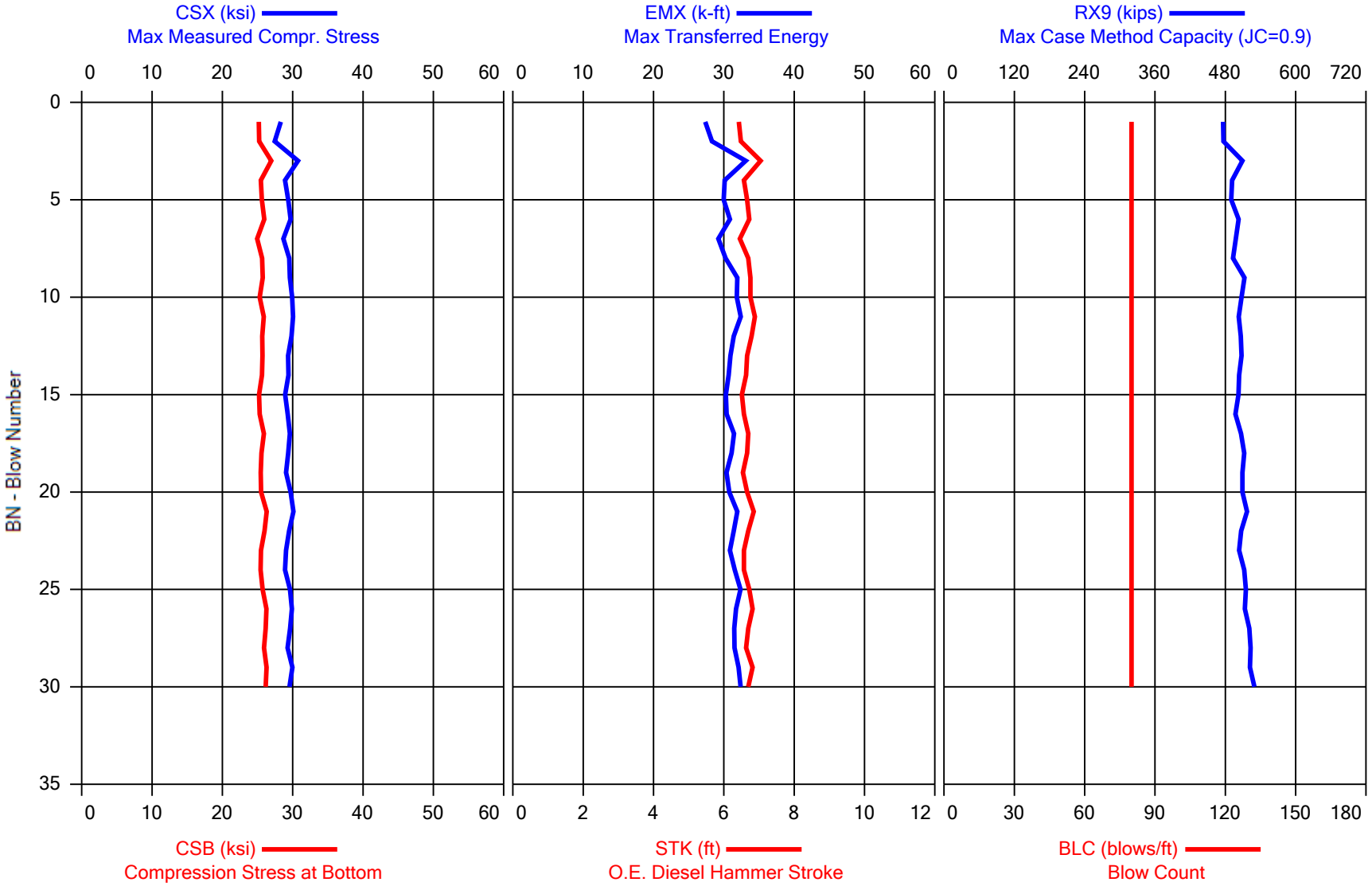
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 03-April-2015

Test started: 03-April-2015

USH 10 over Little Lake Butte des Morts - Pier 15 #44 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 15 #44 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 03-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 75.00 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	70.25	80	AV10	29.2	25.6	30	6.7	45.6	496
			STD	0.9	0.5	2	0.2	0.6	12
			MAX	30.7	27.0	33	7.0	46.4	513
			MIN	27.4	24.9	27	6.4	44.4	476
20	70.38	80	AV10	29.5	25.6	31	6.7	45.6	506
			STD	0.3	0.2	1	0.1	0.3	4
			MAX	30.1	25.9	32	6.9	46.1	512
			MIN	28.9	25.2	30	6.5	44.9	497
30	70.50	80	AV10	29.5	26.0	32	6.7	45.5	516
			STD	0.4	0.3	0	0.1	0.3	7
			MAX	30.1	26.3	32	6.8	45.9	530
			MIN	28.9	25.4	31	6.6	45.0	503
			Average	29.4	25.7	31	6.7	45.6	506
			Std. Dev.	0.6	0.4	1	0.1	0.4	12
			Maximum	30.7	27.0	33	7.0	46.4	530
			Minimum	27.4	24.9	27	6.4	44.4	476

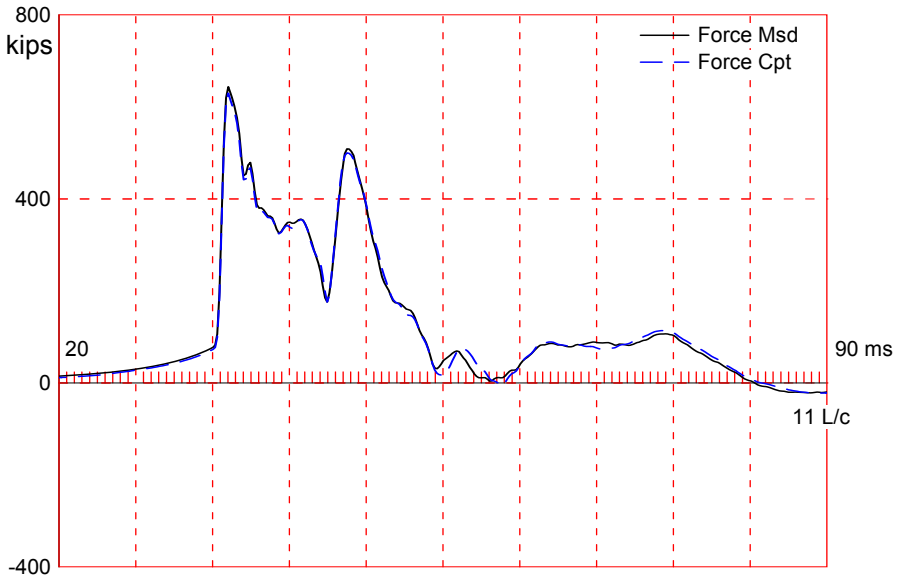
Total number of blows analyzed: 30

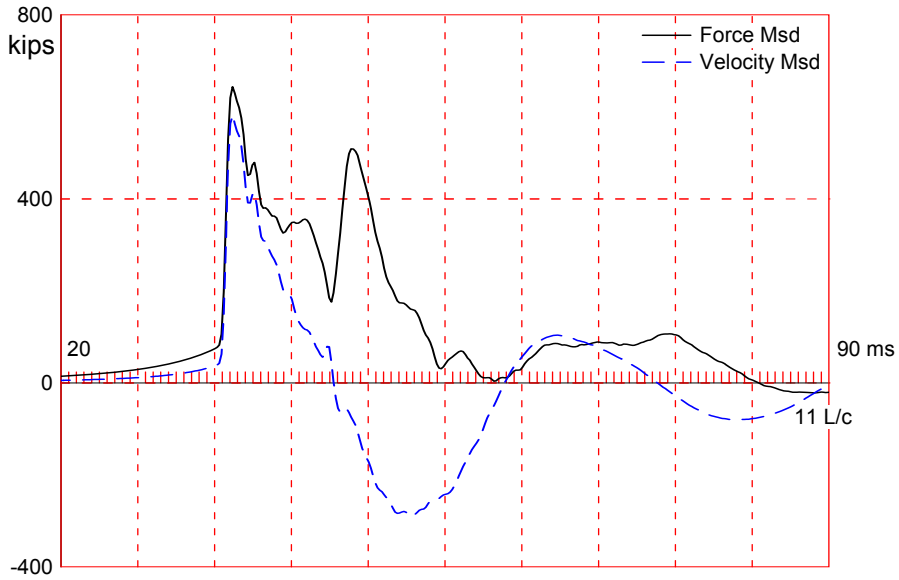
BL# Sensors

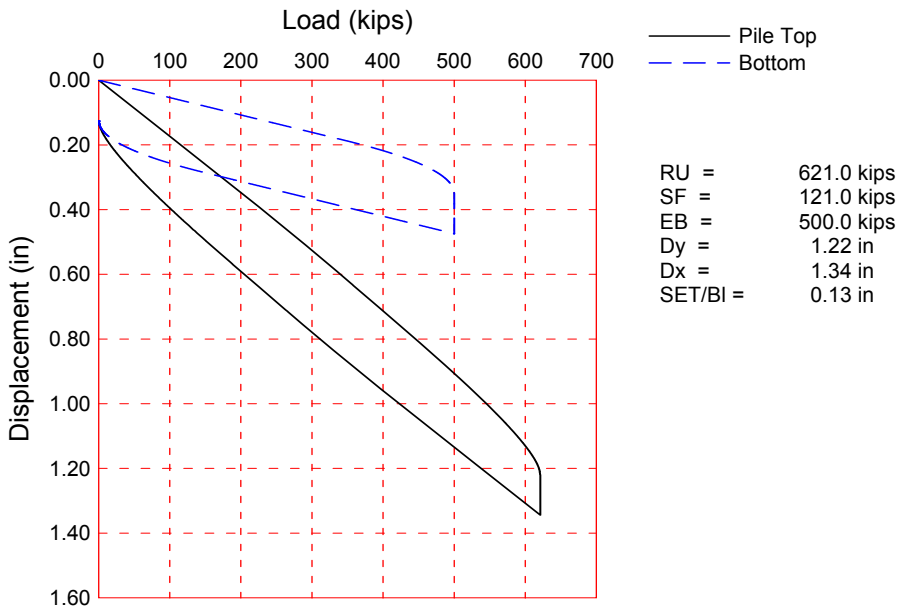
1-30 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.10); A4: [K2524] 360.0 (1.10)

Time Summary

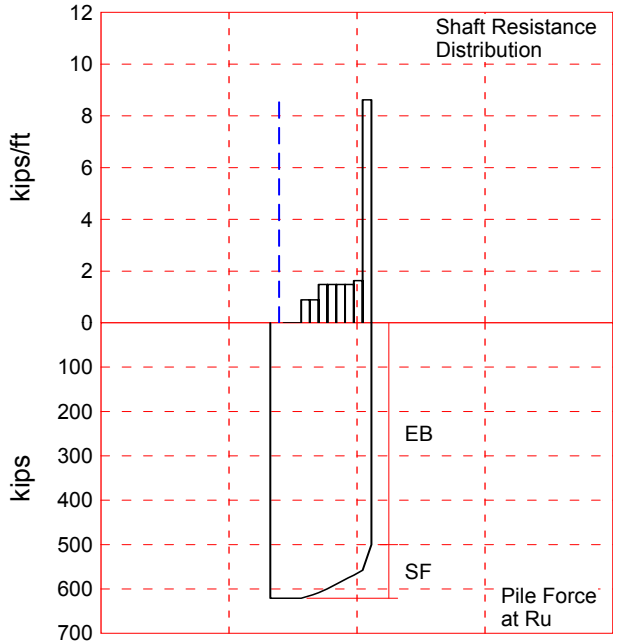
Drive 38 seconds 9:16 AM - 9:17 AM BN 1 - 30







RU =	621.0 kips
SF =	121.0 kips
EB =	500.0 kips
Dy =	1.22 in
Dx =	1.34 in
SET/Bl =	0.13 in



Length b. Sensors	77.4 ft
Embedment	68.4 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	2.16
Top Compr. Stress	29.5 ksi
Max Compr. Stress	30.4 ksi
Max Tension Stress	-4.70 ksi
Avg. Shaft Quake	0.25 in
Toe Quake	0.27 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.06 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: 621.0; along Shaft 121.0; 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
				621.0				
1	16.8	7.8	0.0	621.0	0.0	0.00	0.00	0.00
2	23.6	14.5	0.0	621.0	0.0	0.00	0.00	0.00
3	30.3	21.2	6.0	615.0	6.0	0.89	0.19	0.26
4	37.0	28.0	6.0	609.0	12.0	0.89	0.19	0.26
5	43.7	34.7	10.0	599.0	22.0	1.49	0.32	0.26
6	50.5	41.4	10.0	589.0	32.0	1.49	0.32	0.26
7	57.2	48.2	10.0	579.0	42.0	1.49	0.32	0.26
8	63.9	54.9	10.0	569.0	52.0	1.49	0.32	0.26
9	70.7	61.6	11.0	558.0	63.0	1.63	0.35	0.26
10	77.4	68.4	58.0	500.0	121.0	8.62	1.83	0.26
Avg. Shaft			12.1			1.77	0.38	0.26
Toe			500.0				362.72	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.25	0.27
Case Damping Factor		0.82	0.79
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	36	33
Unloading Level	(% of Ru)	38	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.080	

CAPWAP match quality = 2.16 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.13 in; Blow Count = 96 b/ft
Computed: Final Set = 0.01 in; Blow Count = 1857 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.00; A4(K2524) CAL: 360; RF: 1.00

max. Top Comp. Stress = 29.5 ksi (T= 35.8 ms, max= 1.033 x Top)
max. Comp. Stress = 30.4 ksi (Z= 30.3 ft, T= 37.4 ms)
max. Tens. Stress = -4.70 ksi (Z= 50.5 ft, T= 57.7 ms)
max. Energy (EMX) = 31.0 kip-ft; max. Measured Top Displ. (DMX)= 0.90 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	630.5	-26.8	29.5	-1.25	31.0	15.6	0.93
2	6.7	631.2	-29.5	29.5	-1.38	30.8	15.5	0.91
4	13.5	632.8	-44.5	29.6	-2.08	30.3	15.5	0.87
5	16.8	633.6	-57.3	29.6	-2.68	29.9	15.4	0.85
6	20.2	634.6	-66.0	29.6	-3.08	29.5	15.4	0.83
7	23.6	637.5	-68.3	29.8	-3.19	29.0	15.3	0.80
8	26.9	645.2	-68.2	30.1	-3.19	28.5	15.1	0.77
9	30.3	651.2	-70.6	30.4	-3.30	27.9	14.9	0.74
10	33.7	631.8	-69.8	29.5	-3.26	26.2	14.7	0.71
11	37.0	638.9	-83.0	29.8	-3.88	25.6	14.5	0.68
12	40.4	624.2	-89.8	29.2	-4.20	23.9	14.2	0.65
13	43.7	633.1	-97.8	29.6	-4.57	23.2	13.9	0.62
14	47.1	603.4	-95.2	28.2	-4.45	21.1	13.6	0.58
15	50.5	624.4	-100.7	29.2	-4.70	20.4	13.1	0.55
16	53.8	605.6	-91.6	28.3	-4.28	18.4	12.5	0.52
17	57.2	610.6	-91.0	28.5	-4.25	17.7	12.4	0.49
18	60.6	572.8	-82.5	26.8	-3.86	15.7	12.3	0.45
19	63.9	569.8	-80.8	26.6	-3.78	14.9	12.3	0.42
20	67.3	591.3	-71.9	27.6	-3.36	13.1	12.4	0.38
21	70.7	618.9	-73.3	28.9	-3.43	12.2	13.1	0.34
22	74.0	615.2	-60.7	28.7	-2.84	10.5	13.6	0.31
23	77.4	634.7	-57.4	29.6	-2.68	7.5	12.2	0.27
Absolute	30.3			30.4			(T =	37.4 ms)
	50.5				-4.70		(T =	57.7 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	698.4	644.0	589.5	535.1	480.6	426.2	371.7	317.3	262.8	208.4
RX	766.0	734.3	718.4	702.6	686.8	670.9	655.3	641.3	629.5	617.7
RU	698.4	644.0	589.5	535.1	480.6	426.2	371.7	317.3	262.8	208.4

RAU = 449.3 (kips); RA2 = 657.8 (kips)

Current CAPWAP Ru = 621.0 (kips); Corresponding J(RP)= 0.14; J(RX) = 0.87

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	35.64	591.0	652.0	652.0	0.90	0.13	0.13	31.2	726.9	1923

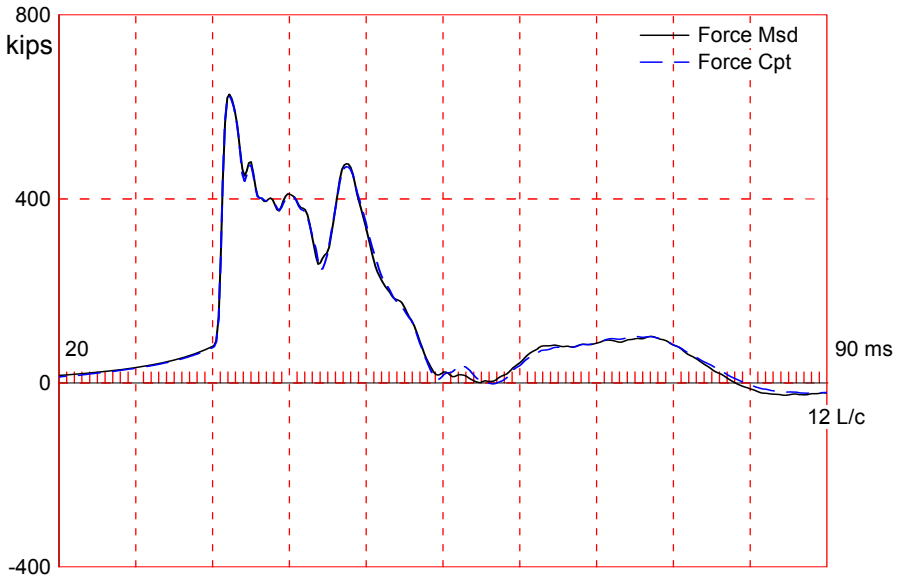
PILE PROFILE AND PILE MODEL

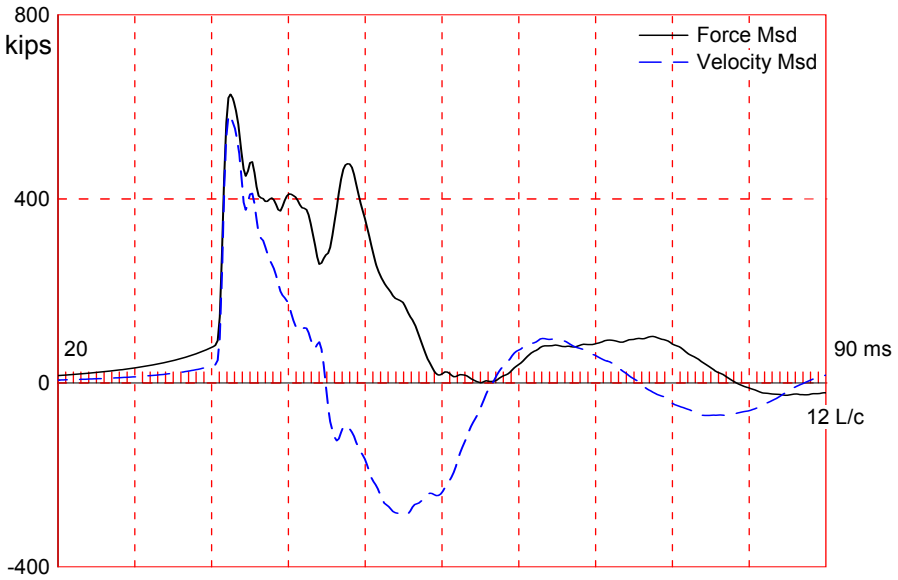
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.4	21.4	29992.2	492.000	4.70

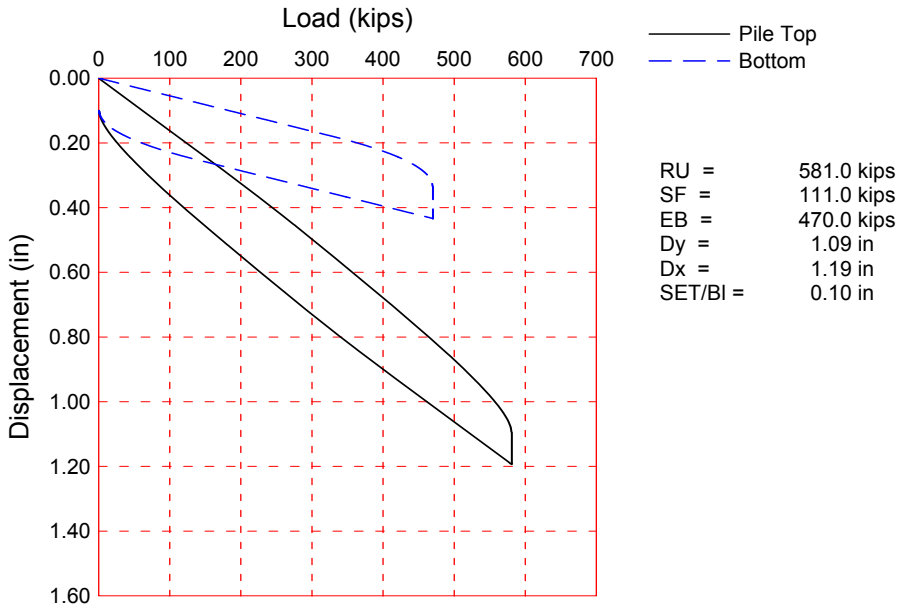
Toe Area 198.5 in^2

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	57.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.030
19	63.9	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
20	67.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	77.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

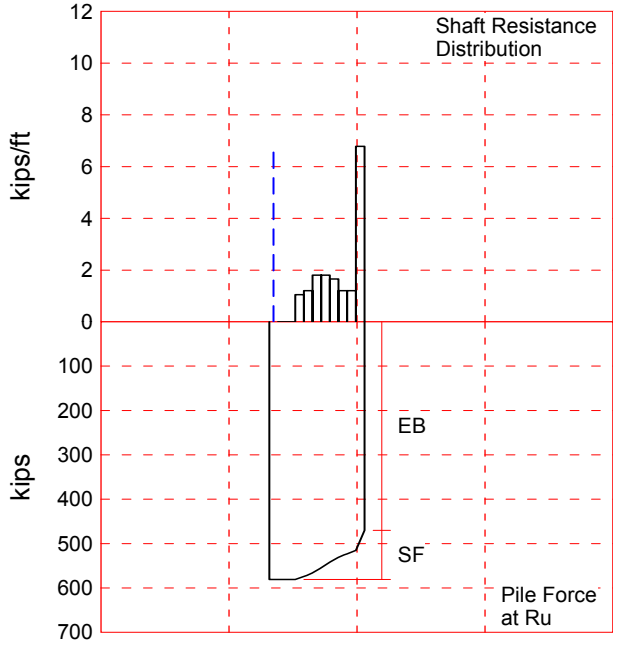
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.503 ft^3; Volume ratio considering added impedance: 1.000







RU =	581.0 kips
SF =	111.0 kips
EB =	470.0 kips
Dy =	1.09 in
Dx =	1.19 in
SET/BI =	0.10 in



Length b. Sensors	73.0 ft
Embedment	68.4 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	1.75
Top Compr. Stress	29.2 ksi
Max Compr. Stress	30.6 ksi
Max Tension Stress	-4.87 ksi
Avg. Shaft Quake	0.23 in
Toe Quake	0.26 in
Avg. Shaft Smith Dpg.	0.31 s/ft
Toe Smith Damping	0.07 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 581.0; along Shaft 111.0; at Toe 470.0 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
				581.0				
1	13.3	8.7	0.0	581.0	0.0	0.00	0.00	0.00
2	19.9	15.3	0.0	581.0	0.0	0.00	0.00	0.00
3	26.5	22.0	7.0	574.0	7.0	1.05	0.22	0.31
4	33.2	28.6	8.0	566.0	15.0	1.21	0.26	0.31
5	39.8	35.2	12.0	554.0	27.0	1.81	0.38	0.31
6	46.5	41.9	12.0	542.0	39.0	1.81	0.38	0.31
7	53.1	48.5	11.0	531.0	50.0	1.66	0.35	0.31
8	59.7	55.1	8.0	523.0	58.0	1.21	0.26	0.31
9	66.4	61.8	8.0	515.0	66.0	1.21	0.26	0.31
10	73.0	68.4	45.0	470.0	111.0	6.78	1.44	0.31
Avg. Shaft			11.1			1.62	0.35	0.31
Toe			470.0				340.95	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.23	0.26
Case Damping Factor		0.90	0.86
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	52	31
Unloading Level	(% of Ru)	31	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.070	

CAPWAP match quality = 1.75 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.02 in; Blow Count = 666 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.10; A4(K3550) CAL: 360; RF: 1.10

max. Top Comp. Stress = 29.2 ksi (T= 35.9 ms, max= 1.047 x Top)
max. Comp. Stress = 30.6 ksi (Z= 26.5 ft, T= 37.3 ms)
max. Tens. Stress = -4.87 ksi (Z= 46.5 ft, T= 57.6 ms)
max. Energy (EMX) = 31.6 kip-ft; max. Measured Top Displ. (DMX)= 0.90 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	625.7	-24.6	29.2	-1.15	31.6	15.2	0.91
2	6.6	626.7	-26.8	29.3	-1.25	31.3	15.2	0.89
3	10.0	627.8	-33.1	29.3	-1.54	31.0	15.2	0.87
4	13.3	629.0	-42.3	29.4	-1.97	30.6	15.1	0.84
5	16.6	630.5	-50.1	29.5	-2.34	30.2	15.1	0.82
6	19.9	636.4	-57.0	29.7	-2.66	29.6	14.9	0.79
7	23.2	646.5	-70.2	30.2	-3.28	29.0	14.7	0.76
8	26.5	655.4	-83.4	30.6	-3.90	28.3	14.4	0.73
9	29.9	630.0	-87.9	29.4	-4.11	26.3	14.1	0.70
10	33.2	641.1	-97.7	30.0	-4.57	25.6	13.8	0.67
11	36.5	616.4	-98.9	28.8	-4.62	23.5	13.4	0.63
12	39.8	628.3	-103.4	29.4	-4.83	22.7	13.1	0.60
13	43.1	590.2	-97.0	27.6	-4.53	20.1	12.7	0.57
14	46.5	616.5	-104.3	28.8	-4.87	19.4	12.2	0.53
15	49.8	582.0	-95.5	27.2	-4.46	17.0	11.5	0.50
16	53.1	578.1	-96.4	27.0	-4.50	16.3	11.6	0.47
17	56.4	536.1	-87.7	25.0	-4.10	14.3	11.7	0.43
18	59.7	545.7	-90.3	25.5	-4.22	13.5	11.5	0.40
19	63.0	566.0	-85.0	26.4	-3.97	11.9	11.8	0.37
20	66.4	585.8	-87.0	27.4	-4.06	11.2	12.5	0.33
21	69.7	583.9	-82.1	27.3	-3.83	9.9	12.8	0.30
22	73.0	597.7	-83.8	27.9	-3.92	7.3	11.5	0.27
Absolute	26.5			30.6			(T =	37.3 ms)
	46.5				-4.87		(T =	57.6 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	734.7	638.3	542.0	445.6	349.3					
RX	770.7	701.5	668.2	635.3	604.2	577.7	554.9	537.1	521.1	505.2
RU	734.7	638.3	542.0	445.6	349.3					

RAU = 451.1 (kips); RA2 = 648.6 (kips)

Current CAPWAP Ru = 581.0 (kips); Corresponding J(RP)= 0.32; J(RX) = 0.97

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
15.4	35.54	586.9	629.5	629.9	0.90	0.12	0.10	31.8	761.5	1880

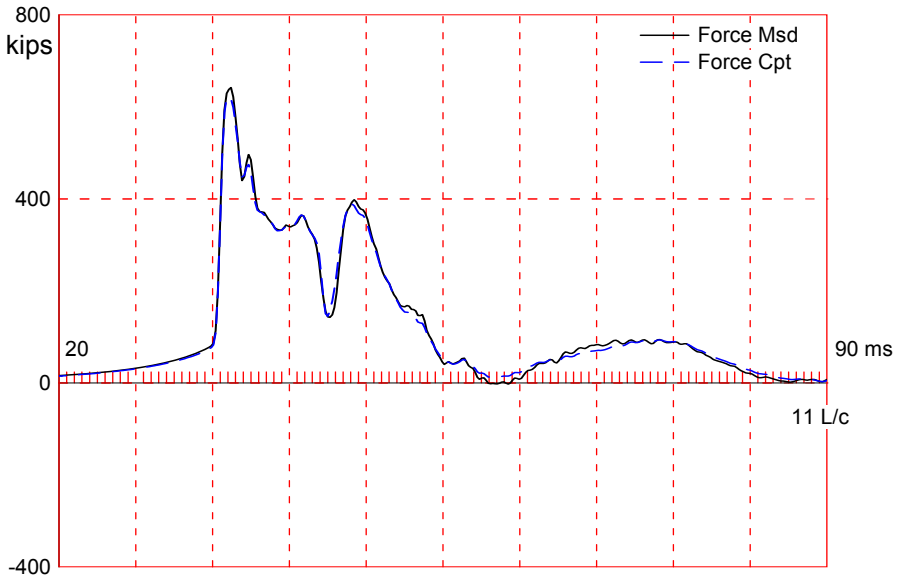
PILE PROFILE AND PILE MODEL

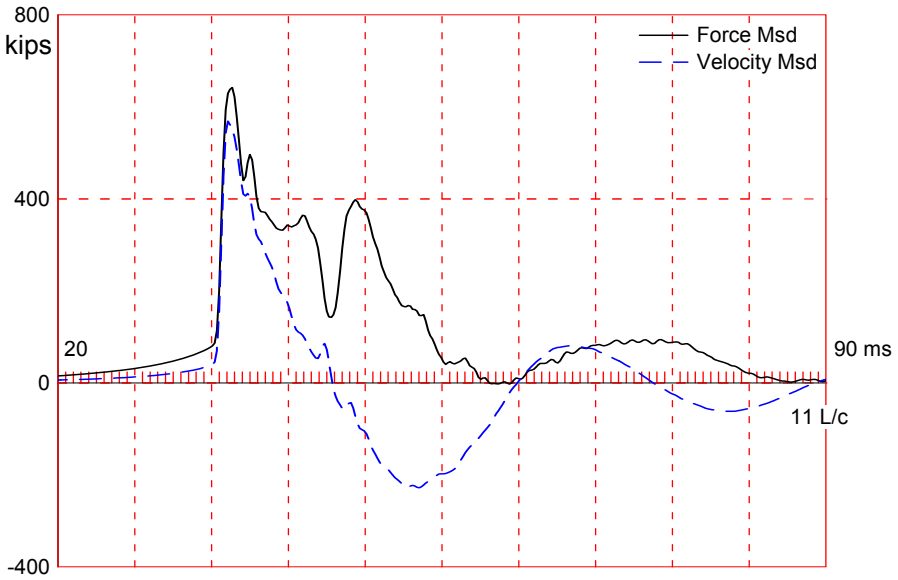
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
73.0	21.4	29992.2	492.000	4.70

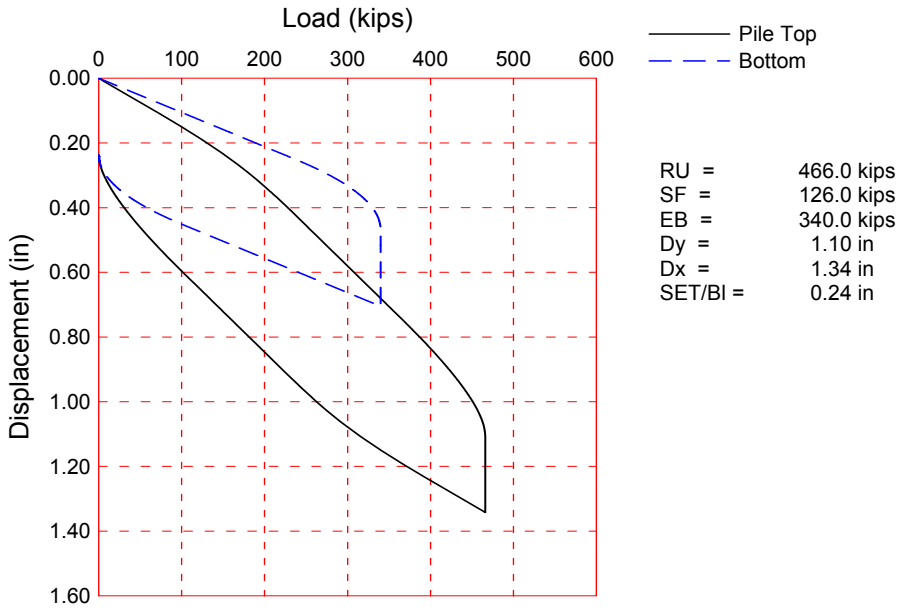
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
16	53.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.030
17	56.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.040
18	59.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
22	73.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

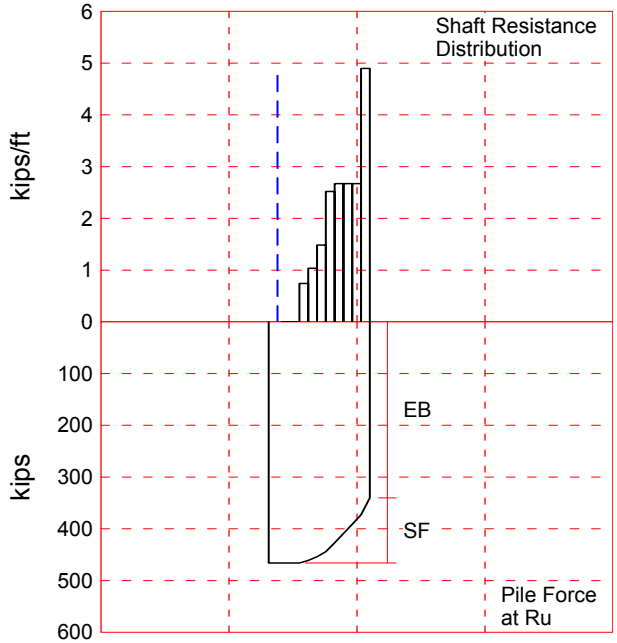
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 8.7 ms
Total volume: 10.849 ft^3; Volume ratio considering added impedance: 1.000







RU =	466.0 kips
SF =	126.0 kips
EB =	340.0 kips
Dy =	1.10 in
Dx =	1.34 in
SET/Bl =	0.24 in



Length b. Sensors	77.5 ft
Embedment	68.1 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	2.23
Top Compr. Stress	29.0 ksi
Max Compr. Stress	30.2 ksi
Max Tension Stress	-1.90 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.36 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.11 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: 466.0; along Shaft 126.0; at Toe 340.0 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
				466.0				
1	16.8	7.4	0.0	466.0	0.0	0.00	0.00	0.00
2	23.6	14.2	0.0	466.0	0.0	0.00	0.00	0.00
3	30.3	20.9	5.0	461.0	5.0	0.74	0.16	0.27
4	37.1	27.7	7.0	454.0	12.0	1.04	0.22	0.27
5	43.8	34.4	10.0	444.0	22.0	1.48	0.32	0.27
6	50.5	41.1	17.0	427.0	39.0	2.52	0.54	0.27
7	57.3	47.9	18.0	409.0	57.0	2.67	0.57	0.27
8	64.0	54.6	18.0	391.0	75.0	2.67	0.57	0.27
9	70.8	61.3	18.0	373.0	93.0	2.67	0.57	0.27
10	77.5	68.1	33.0	340.0	126.0	4.90	1.04	0.27
Avg. Shaft			12.6			1.85	0.39	0.27
Toe			340.0				246.65	0.11

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.09	0.36
Case Damping Factor		0.89	0.98
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	91	81
Resistance Gap (included in Toe Quake)	(in)		0.06
Soil Plug Weight	(kips)	0.060	0.005

CAPWAP match quality = 2.23 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.24 in; Blow Count = 51 b/ft
Computed: Final Set = 0.09 in; Blow Count = 138 b/ft

Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.03; A4(K2524) CAL: 360; RF: 1.03

max. Top Comp. Stress = 29.0 ksi (T= 35.9 ms, max= 1.043 x Top)
max. Comp. Stress = 30.2 ksi (Z= 30.3 ft, T= 37.7 ms)
max. Tens. Stress = -1.90 ksi (Z= 37.1 ft, T= 60.7 ms)
max. Energy (EMX) = 30.8 kip-ft; max. Measured Top Displ. (DMX)= 0.91 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	620.2	-12.3	29.0	-0.57	30.8	15.2	0.92
2	6.7	621.3	-13.2	29.0	-0.62	30.6	15.1	0.90
4	13.5	623.5	-16.0	29.1	-0.75	30.2	15.1	0.87
5	16.8	624.8	-22.2	29.2	-1.04	29.9	15.0	0.85
6	20.2	626.6	-27.0	29.3	-1.26	29.5	15.0	0.82
7	23.6	632.2	-32.1	29.5	-1.50	29.1	14.9	0.80
8	27.0	638.4	-36.0	29.8	-1.68	28.7	14.7	0.77
9	30.3	647.1	-40.2	30.2	-1.88	28.2	14.5	0.75
10	33.7	630.7	-36.7	29.5	-1.71	26.8	14.3	0.72
11	37.1	642.2	-40.6	30.0	-1.90	26.2	14.1	0.69
12	40.4	620.4	-35.3	29.0	-1.65	24.5	13.7	0.66
13	43.8	638.0	-39.8	29.8	-1.86	24.0	13.4	0.63
14	47.2	613.2	-31.4	28.6	-1.47	21.9	13.0	0.61
15	50.5	635.3	-35.0	29.7	-1.63	21.3	12.4	0.58
16	53.9	578.2	-18.0	27.0	-0.84	18.5	11.8	0.55
17	57.3	586.1	-21.1	27.4	-0.98	18.0	11.5	0.52
18	60.7	520.4	-3.1	24.3	-0.15	15.2	11.3	0.50
19	64.0	532.2	-5.5	24.9	-0.25	14.7	11.2	0.47
20	67.4	463.2	-0.0	21.6	-0.00	12.3	13.0	0.45
21	70.8	476.5	-0.0	22.3	-0.00	11.9	13.8	0.42
22	74.1	455.4	-0.0	21.3	-0.00	9.7	13.9	0.40
23	77.5	469.4	-0.0	21.9	-0.00	7.1	12.7	0.37
Absolute	30.3			30.2			(T =	37.7 ms)
	37.1				-1.90		(T =	60.7 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	648.7	536.4	424.1	311.8	199.5					
RX	682.1	617.8	572.1	535.5	508.5	485.1	464.2	447.1	431.9	421.7
RU	648.7	536.4	424.1	311.8	199.5					

RAU = 384.1 (kips); RA2 = 569.3 (kips)

Current CAPWAP Ru = 466.0 (kips); Corresponding J(RP)= 0.33; J(RX) = 1.18

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
15.1	35.48	576.1	634.1	648.1	0.91	0.24	0.24	31.0	649.6	1133

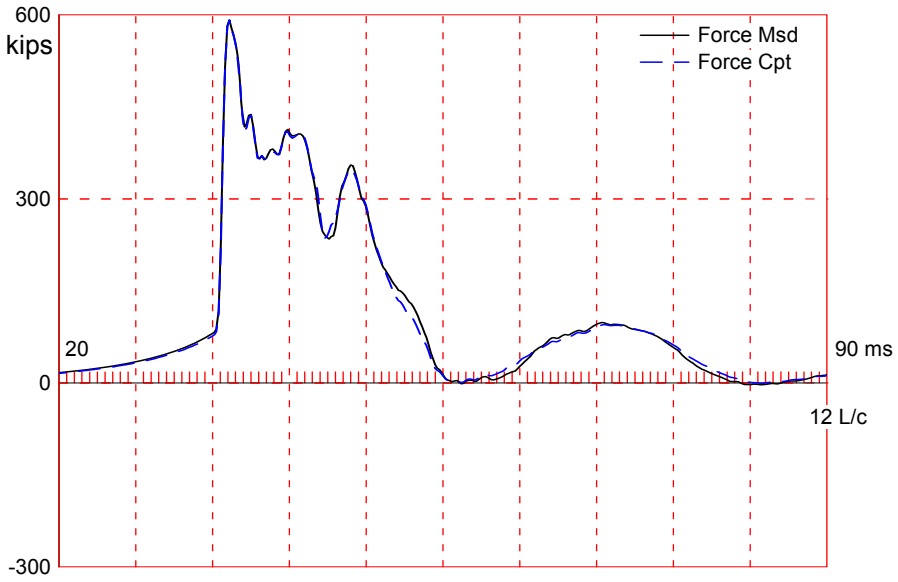
PILE PROFILE AND PILE MODEL

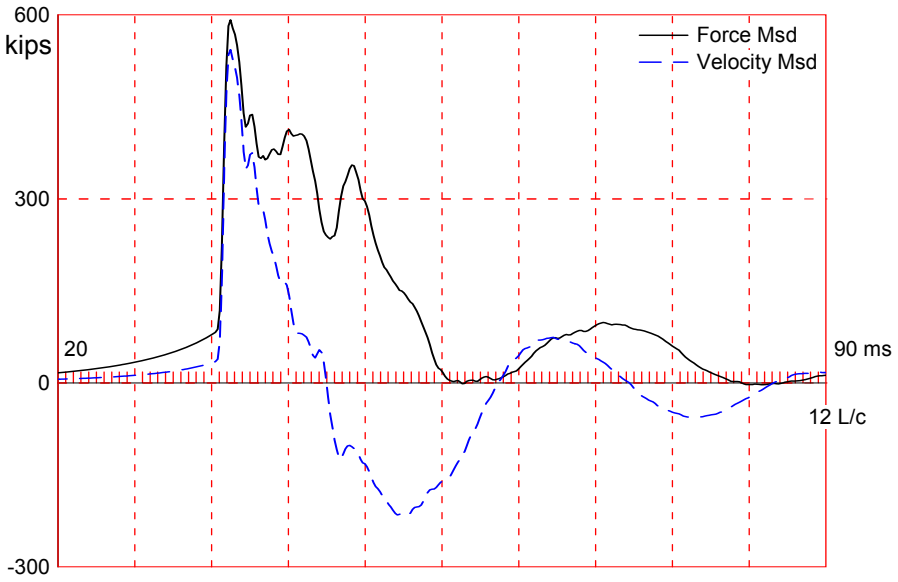
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

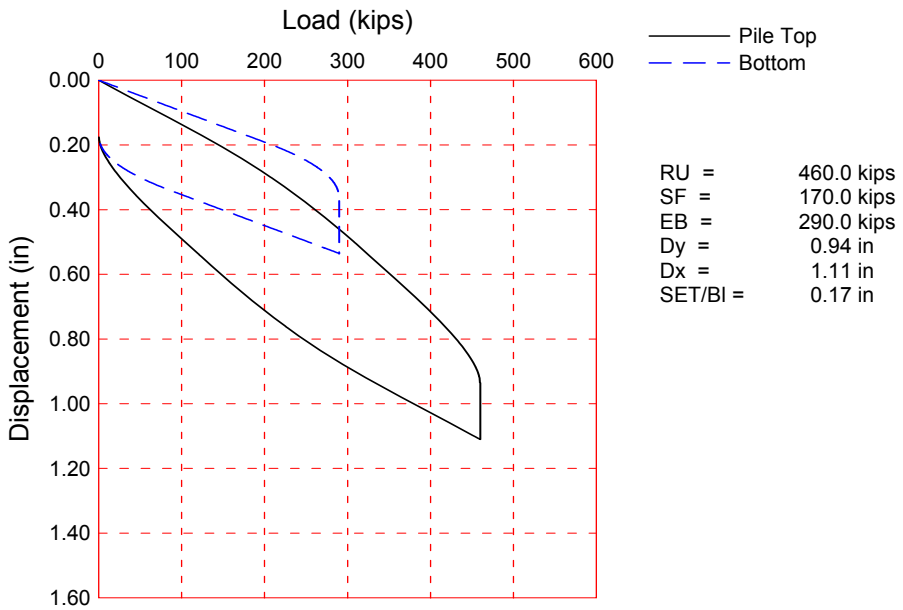
Toe Area 198.5 in^2

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
20	67.4	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

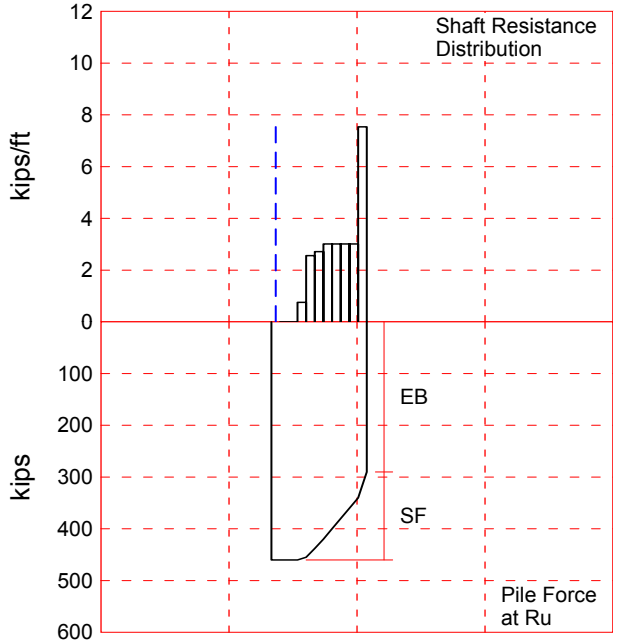
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	460.0 kips
SF =	170.0 kips
EB =	290.0 kips
Dy =	0.94 in
Dx =	1.11 in
SET/BI =	0.17 in



Length b. Sensors	73.0 ft
Embedment	68.2 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	1.67
Top Compr. Stress	27.6 ksi
Max Compr. Stress	29.3 ksi
Max Tension Stress	-2.35 ksi
Avg. Shaft Quake	0.11 in
Toe Quake	0.28 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.16 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 460.0; along Shaft 170.0; at Toe 290.0 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
				460.0				
1	13.3	8.5	0.0	460.0	0.0	0.00	0.00	0.00
2	19.9	15.1	0.0	460.0	0.0	0.00	0.00	0.00
3	26.5	21.7	5.0	455.0	5.0	0.75	0.16	0.29
4	33.2	28.4	17.0	438.0	22.0	2.56	0.55	0.29
5	39.8	35.0	18.0	420.0	40.0	2.71	0.58	0.29
6	46.5	41.6	20.0	400.0	60.0	3.01	0.64	0.29
7	53.1	48.3	20.0	380.0	80.0	3.01	0.64	0.29
8	59.7	54.9	20.0	360.0	100.0	3.01	0.64	0.29
9	66.4	61.5	20.0	340.0	120.0	3.01	0.64	0.29
10	73.0	68.2	50.0	290.0	170.0	7.53	1.60	0.29
Avg. Shaft			17.0			2.49	0.53	0.29
Toe			290.0				210.38	0.16

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.11	0.28
Case Damping Factor		1.29	1.21
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	62	119
Unloading Level	(% of Ru)	91	
Resistance Gap (included in Toe Quake)	(in)		0.05
Soil Plug Weight	(kips)	0.180	0.033

CAPWAP match quality = 1.67 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.17 in; Blow Count = 69 b/ft
Computed: Final Set = 0.06 in; Blow Count = 190 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.10; A4(K2524) CAL: 360; RF: 1.10

max. Top Comp. Stress = 27.6 ksi (T= 35.9 ms, max= 1.061 x Top)
max. Comp. Stress = 29.3 ksi (Z= 33.2 ft, T= 37.7 ms)
max. Tens. Stress = -2.35 ksi (Z= 33.2 ft, T= 57.8 ms)
max. Energy (EMX) = 26.2 kip-ft; max. Measured Top Displ. (DMX)= 0.79 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	591.8	-6.1	27.6	-0.28	26.2	14.2	0.79
2	6.6	592.8	-13.1	27.7	-0.61	25.9	14.2	0.77
3	10.0	594.0	-19.2	27.7	-0.89	25.7	14.2	0.75
4	13.3	595.2	-25.4	27.8	-1.19	25.3	14.1	0.73
5	16.6	596.6	-31.2	27.9	-1.46	25.0	14.1	0.70
6	19.9	600.2	-37.2	28.0	-1.74	24.6	14.0	0.68
7	23.2	607.6	-42.7	28.4	-1.99	24.1	13.8	0.65
8	26.5	617.9	-47.2	28.9	-2.21	23.6	13.5	0.63
9	29.9	613.4	-45.1	28.7	-2.10	22.4	13.0	0.60
10	33.2	627.9	-50.3	29.3	-2.35	21.9	12.6	0.57
11	36.5	569.5	-29.6	26.6	-1.38	19.1	12.1	0.55
12	39.8	586.0	-34.2	27.4	-1.60	18.7	11.7	0.52
13	43.1	538.0	-13.0	25.1	-0.61	16.2	11.0	0.49
14	46.5	561.5	-17.0	26.2	-0.80	15.7	10.4	0.47
15	49.8	505.3	0.0	23.6	0.00	13.3	9.7	0.44
16	53.1	519.0	-0.0	24.2	-0.00	12.9	9.3	0.42
17	56.4	460.2	-0.0	21.5	-0.00	10.9	9.0	0.39
18	59.7	460.4	-0.0	21.5	-0.00	10.4	8.9	0.37
19	63.0	398.7	-0.0	18.6	-0.00	8.6	9.4	0.35
20	66.4	421.2	-0.0	19.7	-0.00	8.3	9.9	0.32
21	69.7	399.0	-0.0	18.6	-0.00	6.7	10.3	0.30
22	73.0	407.5	-0.0	19.0	-0.00	4.3	9.5	0.28
Absolute	33.2			29.3			(T =	37.7 ms)
	33.2				-2.35		(T =	57.8 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	673.9	630.0	586.0	542.1	498.2	454.2	410.3	366.4	322.4	278.5
RX	673.9	632.9	594.3	570.2	552.3	534.3	516.3	498.6	483.3	474.4
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RAU = 318.9 (kips); RA2 = 538.3 (kips)

Current CAPWAP Ru = 460.0 (kips); Corresponding J(RP)= 0.97; matches RX20 within 5%

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
14.2	35.73	543.4	591.8	591.8	0.79	0.17	0.17	26.4	656.6	1261

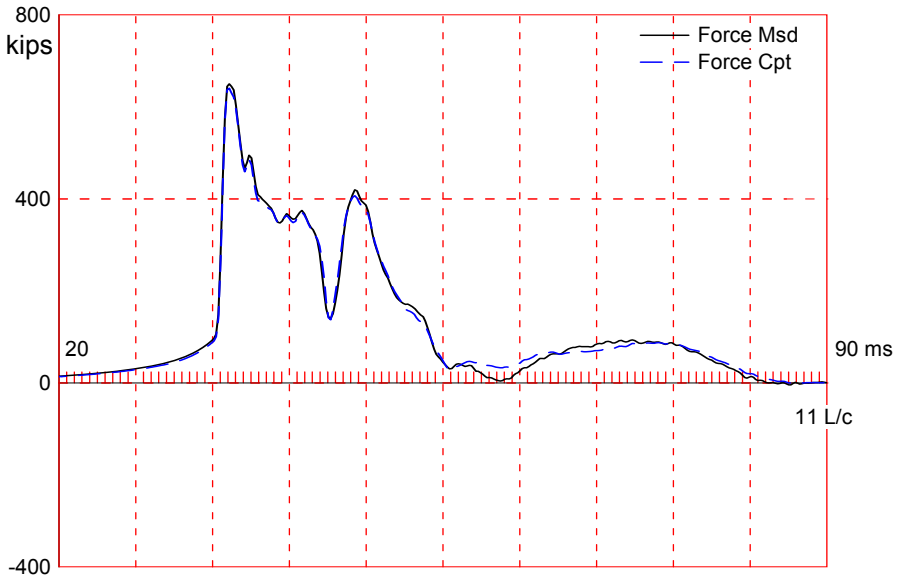
PILE PROFILE AND PILE MODEL

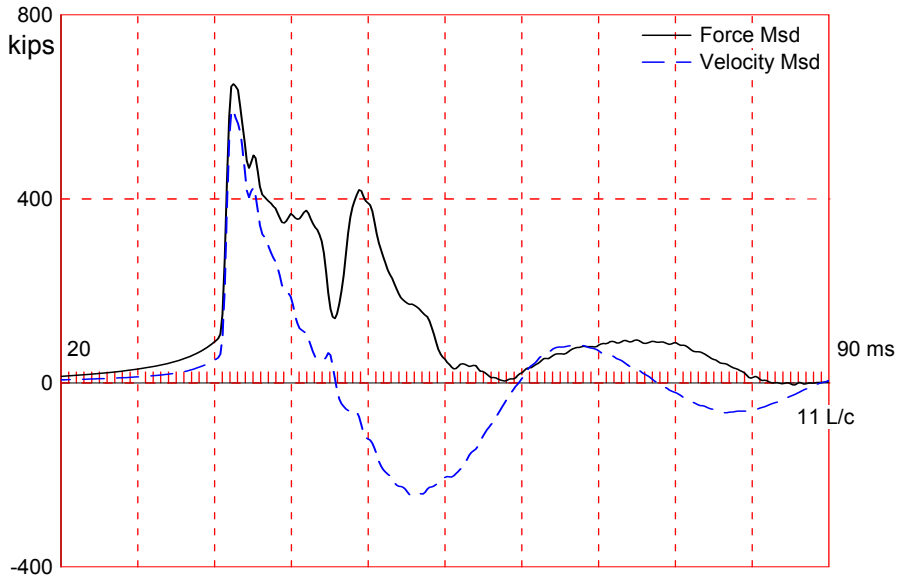
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
73.0	21.4	29992.2	492.000	4.70

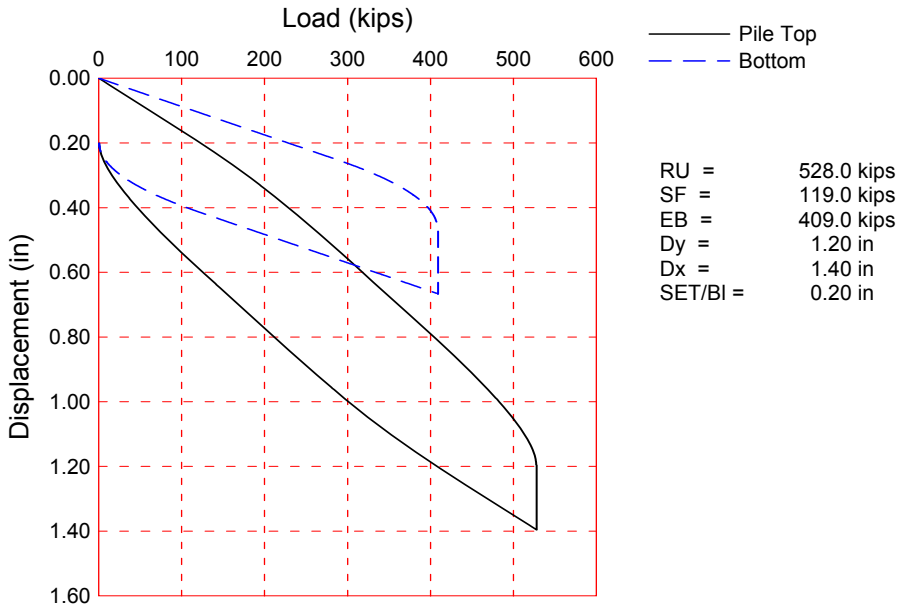
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
15	49.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
16	53.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.030
17	56.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.050
19	63.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.040
20	66.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
22	73.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

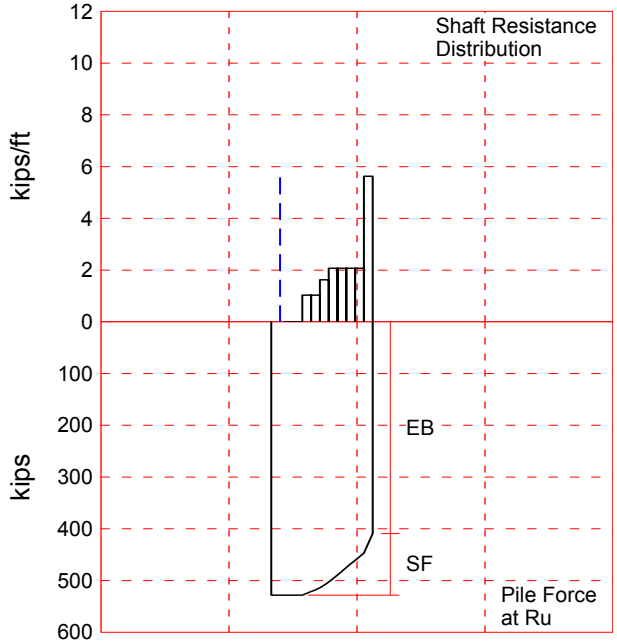
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.197 ms, 2L/c 8.7 ms
Total volume: 10.849 $ft^{3;}$ Volume ratio considering added impedance: 1.000







RU =	528.0 kips
SF =	119.0 kips
EB =	409.0 kips
Dy =	1.20 in
Dx =	1.40 in
SET/Bl =	0.20 in



Length b. Sensors	77.6 ft
Embedment	70.1 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	2.51
Top Compr. Stress	30.0 ksi
Max Compr. Stress	31.4 ksi
Max Tension Stress	-1.15 ksi
Avg. Shaft Quake	0.13 in
Toe Quake	0.36 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.06 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: 528.0; along Shaft 119.0; at Toe 409.0 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
				528.0				
1	16.9	9.4	0.0	528.0	0.0	0.00	0.00	0.00
2	23.6	16.1	0.0	528.0	0.0	0.00	0.00	0.00
3	30.4	22.9	7.0	521.0	7.0	1.04	0.22	0.27
4	37.1	29.6	7.0	514.0	14.0	1.04	0.22	0.27
5	43.9	36.4	11.0	503.0	25.0	1.63	0.35	0.27
6	50.6	43.1	14.0	489.0	39.0	2.07	0.44	0.27
7	57.4	49.9	14.0	475.0	53.0	2.07	0.44	0.27
8	64.1	56.6	14.0	461.0	67.0	2.07	0.44	0.27
9	70.9	63.4	14.0	447.0	81.0	2.07	0.44	0.27
10	77.6	70.1	38.0	409.0	119.0	5.63	1.20	0.27
Avg. Shaft			11.9			1.70	0.36	0.27
Toe			409.0				296.70	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.13	0.36
Case Damping Factor		0.84	0.64
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	55	82
Resistance Gap (included in Toe Quake)	(in)		0.02
Soil Plug Weight	(kips)	0.080	0.031

CAPWAP match quality = 2.51 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.06 in; Blow Count = 198 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.03; A4(K2524) CAL: 360; RF: 1.03

max. Top Comp. Stress = 30.0 ksi (T= 35.9 ms, max= 1.046 x Top)
max. Comp. Stress = 31.4 ksi (Z= 30.4 ft, T= 37.5 ms)
max. Tens. Stress = -1.15 ksi (Z= 30.4 ft, T= 60.0 ms)
max. Energy (EMX) = 32.4 kip-ft; max. Measured Top Displ. (DMX)= 0.93 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	641.7	-3.1	30.0	-0.15	32.4	15.7	0.94
2	6.7	642.9	-5.9	30.0	-0.28	32.3	15.7	0.93
4	13.5	645.6	-10.7	30.2	-0.50	31.9	15.6	0.89
5	16.9	647.1	-12.9	30.2	-0.60	31.6	15.6	0.87
6	20.2	648.9	-15.0	30.3	-0.70	31.3	15.5	0.85
7	23.6	654.1	-16.9	30.6	-0.79	30.9	15.4	0.83
8	27.0	664.1	-20.2	31.0	-0.95	30.4	15.1	0.80
9	30.4	671.2	-24.6	31.4	-1.15	30.0	14.9	0.77
10	33.7	646.1	-19.8	30.2	-0.93	28.1	14.7	0.75
11	37.1	655.0	-23.8	30.6	-1.11	27.5	14.4	0.72
12	40.5	634.7	-17.6	29.6	-0.82	25.7	14.1	0.69
13	43.9	645.9	-21.1	30.2	-0.99	25.1	13.8	0.66
14	47.2	615.3	-10.2	28.7	-0.47	22.8	13.3	0.63
15	50.6	634.4	-16.5	29.6	-0.77	22.2	12.8	0.60
16	54.0	589.9	-2.3	27.6	-0.11	19.6	12.2	0.57
17	57.4	600.6	-6.5	28.1	-0.30	19.0	12.0	0.54
18	60.7	554.9	-0.0	25.9	-0.00	16.6	11.6	0.51
19	64.1	559.6	-0.0	26.1	-0.00	16.0	11.5	0.48
20	67.5	508.9	-0.0	23.8	-0.00	13.8	12.3	0.45
21	70.9	507.6	-0.0	23.7	-0.00	13.2	13.4	0.42
22	74.2	503.8	-0.0	23.5	-0.00	11.3	13.7	0.40
23	77.6	515.9	-0.0	24.1	-0.00	8.2	13.3	0.37
Absolute	30.4			31.4			(T =	37.5 ms)
	30.4				-1.15		(T =	60.0 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	683.1	624.7	566.3	507.9	449.5	391.1	332.7	274.3	215.9	157.4
RX	707.8	669.8	645.9	622.0	598.3	577.0	561.4	547.6	535.2	524.8
RU	683.1	624.7	566.3	507.9	449.5	391.1	332.7	274.3	215.9	157.4

RAU = 402.1 (kips); RA2 = 603.2 (kips)

Current CAPWAP Ru = 528.0 (kips); Corresponding J(RP)= 0.27; J(RX) = 0.87

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
15.9	35.73	605.6	661.5	661.5	0.93	0.20	0.20	32.6	695.6	1203

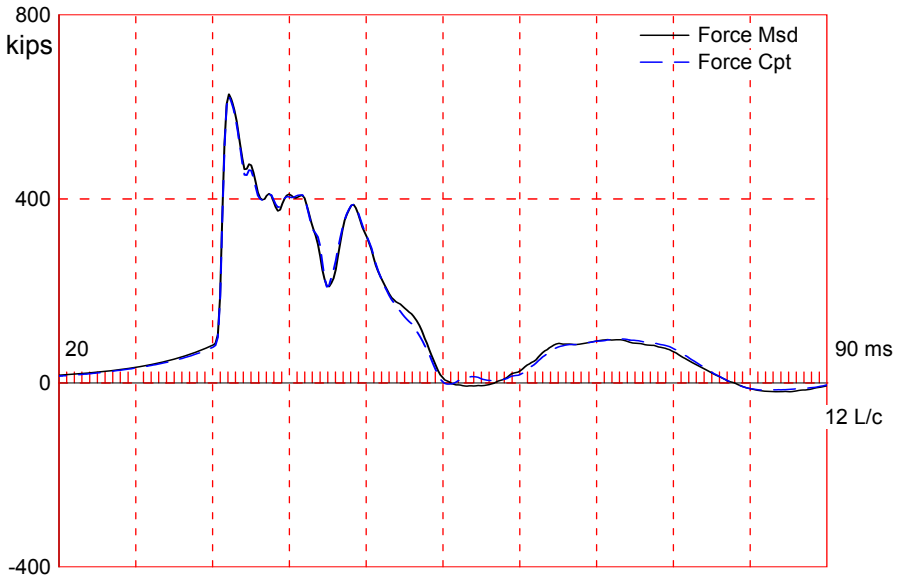
PILE PROFILE AND PILE MODEL

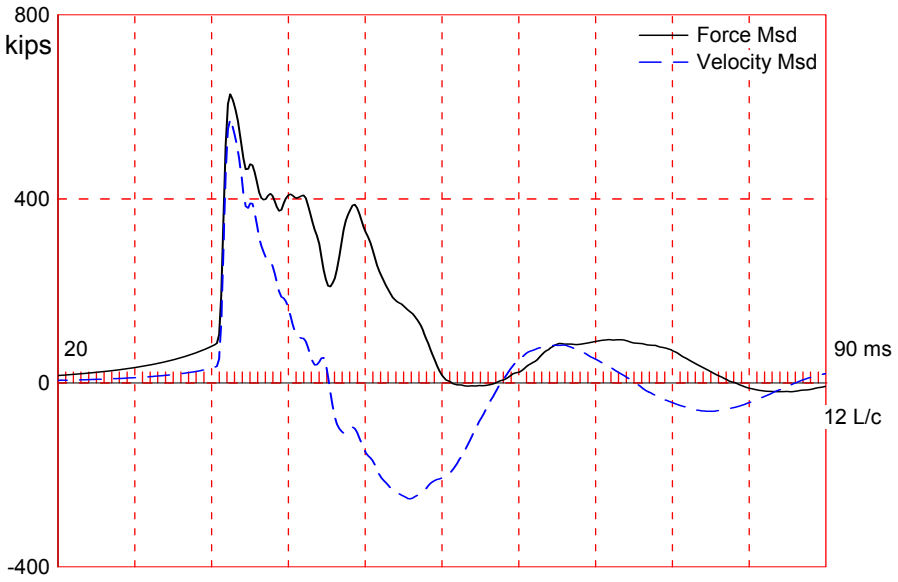
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.6	21.4	29992.2	492.000	4.70

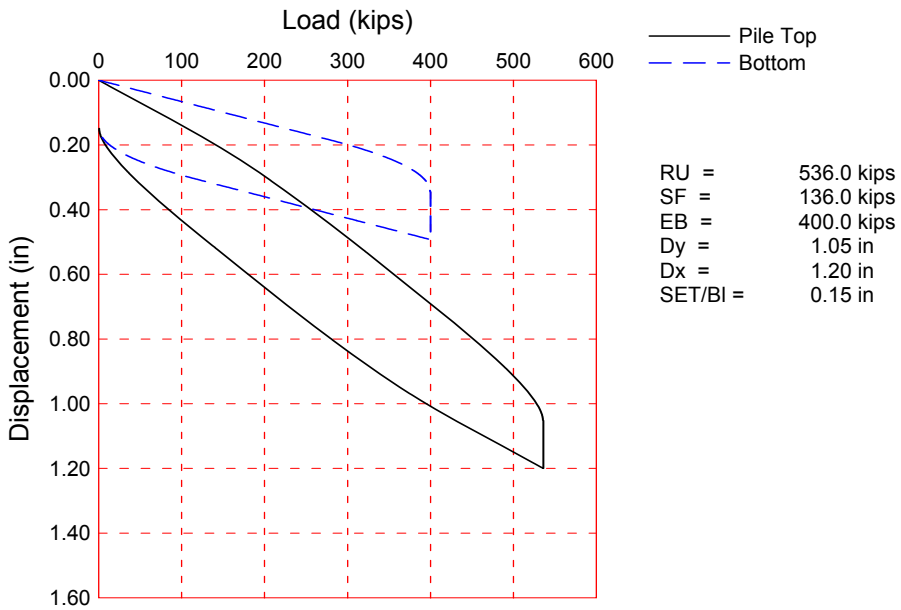
Toe Area 198.5 in^2

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
17	57.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
21	70.9	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

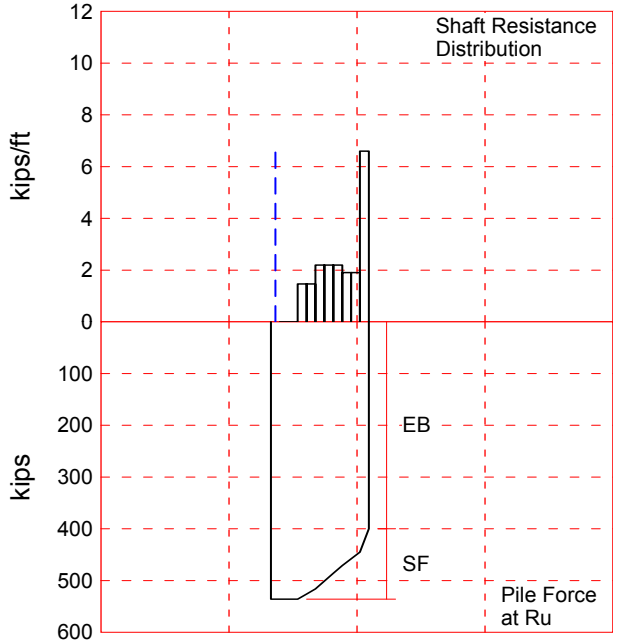
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 9.2 ms
Total volume: 11.532 ft^3; Volume ratio considering added impedance: 1.000







RU =	536.0 kips
SF =	136.0 kips
EB =	400.0 kips
Dy =	1.05 in
Dx =	1.20 in
SET/BI =	0.15 in



Length b. Sensors	75.0 ft
Embedment	70.2 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	1.81
Top Compr. Stress	29.2 ksi
Max Compr. Stress	30.8 ksi
Max Tension Stress	-4.09 ksi
Avg. Shaft Quake	0.11 in
Toe Quake	0.27 in
Avg. Shaft Smith Dpg.	0.31 s/ft
Toe Smith Damping	0.06 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 536.0; along Shaft 136.0; at Toe 400.0 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
				536.0				
1	13.6	8.8	0.0	536.0	0.0	0.00	0.00	0.00
2	20.5	15.7	0.0	536.0	0.0	0.00	0.00	0.00
3	27.3	22.5	10.0	526.0	10.0	1.47	0.31	0.31
4	34.1	29.3	10.0	516.0	20.0	1.47	0.31	0.31
5	40.9	36.1	15.0	501.0	35.0	2.20	0.47	0.31
6	47.7	42.9	15.0	486.0	50.0	2.20	0.47	0.31
7	54.5	49.7	15.0	471.0	65.0	2.20	0.47	0.31
8	61.4	56.6	13.0	458.0	78.0	1.91	0.41	0.31
9	68.2	63.4	13.0	445.0	91.0	1.91	0.41	0.31
10	75.0	70.2	45.0	400.0	136.0	6.60	1.40	0.31
Avg. Shaft			13.6			1.94	0.41	0.31
Toe			400.0				290.17	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.11	0.27
Case Damping Factor		1.10	0.63
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	38	30
Unloading Level	(% of Ru)	15	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.130	0.027

CAPWAP match quality = 1.81 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.05 in; Blow Count = 263 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.08; A4(K2524) CAL: 360; RF: 1.08

max. Top Comp. Stress = 29.2 ksi (T= 35.9 ms, max= 1.054 x Top)
max. Comp. Stress = 30.8 ksi (Z= 27.3 ft, T= 37.3 ms)
max. Tens. Stress = -4.09 ksi (Z= 47.7 ft, T= 59.2 ms)
max. Energy (EMX) = 30.0 kip-ft; max. Measured Top Displ. (DMX)= 0.84 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	625.1	-17.5	29.2	-0.82	30.0	15.1	0.85
2	6.8	626.1	-19.3	29.2	-0.90	29.8	15.0	0.83
3	10.2	627.2	-24.3	29.3	-1.13	29.5	15.0	0.81
4	13.6	628.4	-33.3	29.4	-1.56	29.2	14.9	0.79
5	17.0	629.8	-43.7	29.4	-2.04	28.8	14.9	0.77
6	20.5	634.6	-53.6	29.6	-2.50	28.4	14.8	0.74
7	23.9	649.2	-62.9	30.3	-2.94	27.9	14.4	0.71
8	27.3	659.1	-71.5	30.8	-3.34	27.4	14.1	0.69
9	30.7	619.8	-72.0	29.0	-3.36	25.0	13.7	0.66
10	34.1	631.1	-79.4	29.5	-3.71	24.4	13.4	0.63
11	37.5	599.0	-79.5	28.0	-3.71	22.1	12.9	0.60
12	40.9	613.1	-85.8	28.6	-4.01	21.5	12.5	0.57
13	44.3	565.6	-82.1	26.4	-3.83	18.8	12.0	0.54
14	47.7	592.8	-87.6	27.7	-4.09	18.2	11.3	0.51
15	51.1	547.6	-83.8	25.6	-3.92	15.8	10.6	0.48
16	54.5	554.5	-86.9	25.9	-4.06	15.2	10.3	0.45
17	58.0	499.3	-79.4	23.3	-3.71	13.0	10.2	0.42
18	61.4	501.4	-79.6	23.4	-3.72	12.3	10.1	0.39
19	64.8	470.0	-71.9	22.0	-3.36	10.6	10.3	0.36
20	68.2	488.4	-71.8	22.8	-3.35	10.0	11.1	0.33
21	71.6	481.4	-63.8	22.5	-2.98	8.4	11.7	0.30
22	75.0	491.8	-63.8	23.0	-2.98	5.8	11.0	0.27
Absolute	27.3			30.8			(T =	37.3 ms)
	47.7				-4.09		(T =	59.2 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	702.5	651.0	599.5	548.1	496.6	445.2	393.7	342.2	290.8	239.3
RX	706.1	662.7	634.0	613.6	593.2	572.9	552.5	534.7	517.8	502.4
RU	702.5	651.0	599.5	548.1	496.6	445.2	393.7	342.2	290.8	239.3

RAU = 404.5 (kips); RA2 = 592.9 (kips)

Current CAPWAP Ru = 536.0 (kips); Corresponding J(RP)= 0.32; J(RX) = 0.69

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
15.2	35.70	581.3	635.8	635.8	0.84	0.15	0.15	30.3	731.9	1538

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
75.0	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
16	54.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.040
18	61.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.030
19	64.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
20	68.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
22	75.0	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 0.203 ms, 2L/c 8.9 ms
Total volume: 11.146 $ft^{3;}$ Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Al Ziai
Company: Lunda Construction Co.	No. of Sheets: 55
E-mail: kweber@lundaconstruction.com	Date: April 14, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 16
Winnebago County, Wisconsin

On April 10, 2015, Pier 16 #1, Pier 16 #36, and Pier 16 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on April 13. 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 elevation for the piles was the top of the ring at EL 740.9. We understand the pier was excavated to an elevation of EL 718.0. The piles have a required minimum tip elevation of EL 678.0. 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 16 #1 was driven to a depth of 60.2 feet, which corresponds to a pile tip elevation of EL 680.7. The blow count over the final increment of driving was 10 blows for 1 ½ inches of penetration at an average hammer stroke of 7.0 feet. The blow count at the beginning of restrike was 10 blows per inch of penetration at an average hammer stroke of 6.6 feet. Please note this pile did not achieve the minimum tip requirement at the end of initial drive. Pier 16 #1 was re-driven to a penetration depth of 64.5 feet, which corresponds to a pile tip elevation of EL 676.4. The blow count at the end of re-drive was 10 blows for 1 ½ inches at an average hammer stroke of 6.9 feet

Pier 16 #36 was driven to a depth of 63.5 feet, which corresponds to a pile tip elevation of EL 677.4. The blow count over the final increment of driving was 10 blows for 2 ½ inches of penetration at an average hammer stroke of 6.9 feet. The blow count at the beginning of restrike was 10 blows for 2 inches of penetration at an average hammer stroke of 6.5 feet.

Pier 16 #44 was driven to a depth of 67.7 feet, which corresponds to a pile tip elevation of EL 673.2. The blow count over the final increment of driving was 10 blows for 1 ⅜ inches of penetration at an average hammer stroke of 7.3 feet. The blow count at the beginning of restrike was 10 blows for ¾ inch of penetration at an average hammer stroke of 7.0 feet

We recommend the production piles at Pier 16 of Structure B-70-403, driven with the APE D30-42 hammer PD0256, 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. Additionally, all production piles should achieve the minimum pile tip elevation of EL 678.0 for uplift, as indicated on the plans.

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	9	6
7.0	6	5
7.5	6	5
8.0	5	4
8.5	5	4

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.

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.

Al Ziai

Travis Coleman, P.E.

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

Attachments:

Dynamic Test Results - (pages 3 – 31)
CAPWAP Analysis Results - (pages 32 – 55)

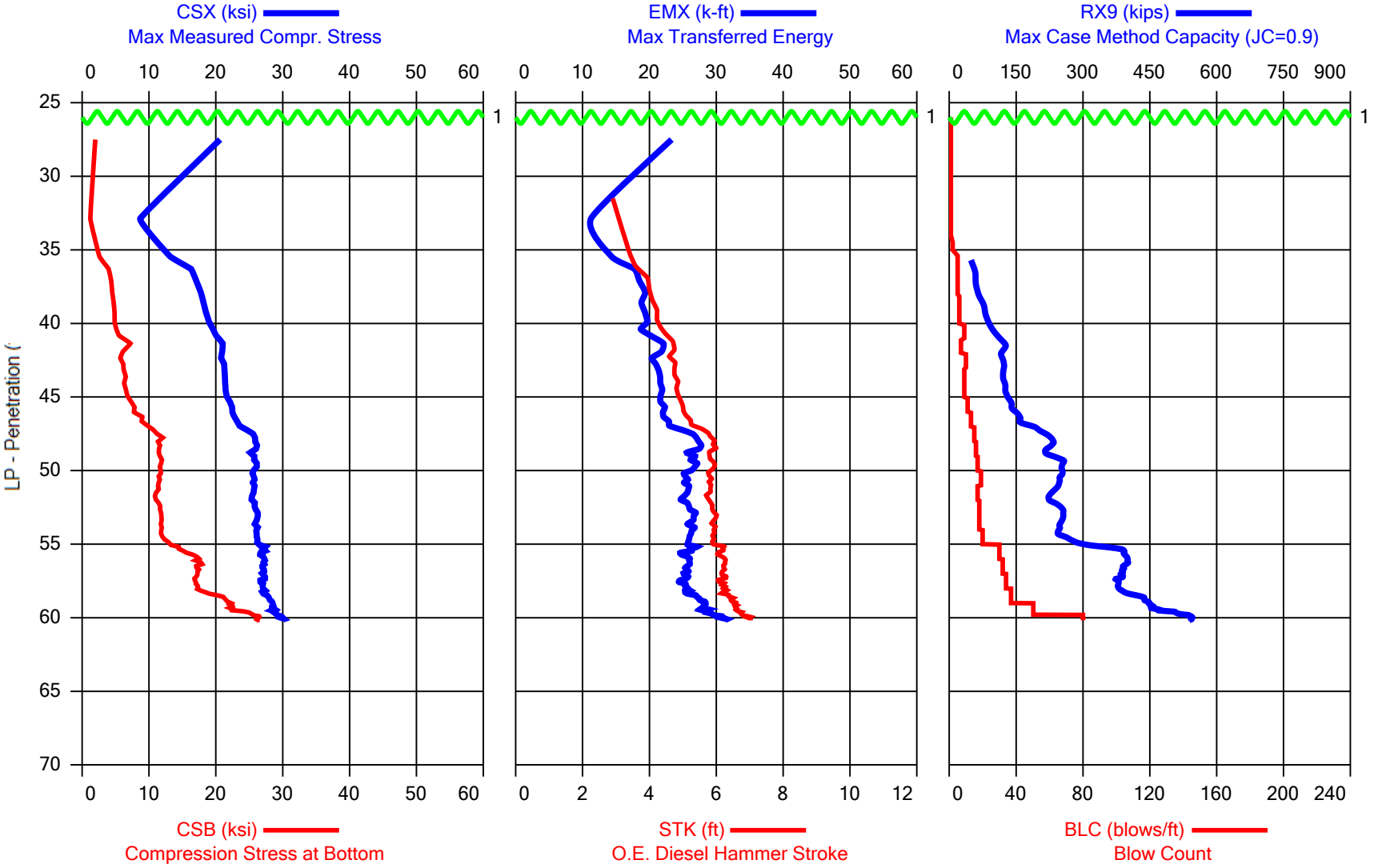
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 13-April-2015

Test started: 10-April-2015

USH 10 over LLBDM - Pier 16 # 1 - EOID

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.9

USH 10 over LLBDM - Pier 16 # 1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-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 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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
1	26.00	1	AV1	21.5	2.0	**	23	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	21.5	2.0	**	23	**	0
			MIN	21.5	2.0	**	23	**	0
2	27.00	1	AV1	23.6	2.1	**	23	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	23.6	2.1	**	23	**	0
			MIN	23.6	2.1	**	23	**	0
3	28.00	1	AV1	23.7	2.4	**	32	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	23.7	2.4	**	32	**	0
			MIN	23.7	2.4	**	32	**	0
4	29.00	1	AV1	13.8	1.3	3.1	16	65.7	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	13.8	1.3	3.1	16	65.7	0
			MIN	13.8	1.3	3.1	16	65.7	0
5	30.00	1	AV1	6.7	0.5	2.4	8	73.0	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	6.7	0.5	2.4	8	73.0	0
			MIN	6.7	0.5	2.4	8	73.0	0
8	33.00	1	AV1	14.3	1.4	3.3	18	63.5	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	14.3	1.4	3.3	18	63.5	0
			MIN	14.3	1.4	3.3	18	63.5	0
9	34.00	1	AV1	9.5	1.9	2.8	14	67.9	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	9.5	1.9	2.8	14	67.9	0
			MIN	9.5	1.9	2.8	14	67.9	0

USH 10 over LLBDM - Pier 16 # 1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
10	34.50	2	AV1	4.3	1.1	2.4	5	73.2	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	4.3	1.1	2.4	5	73.2	0
			MIN	4.3	1.1	2.4	5	73.2	0
11	35.00	2	AV1	0.1	0.0	2.5	0	71.3	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	0.1	0.0	2.5	0	71.3	0
			MIN	0.1	0.0	2.5	0	71.3	0
13	35.40	5	AV1	25.1	4.1	5.3	31	50.8	53
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	25.1	4.1	5.3	31	50.8	53
			MIN	25.1	4.1	5.3	31	50.8	53
16	36.00	5	AV3	14.0	3.2	3.3	14	63.1	47
			STD	0.9	0.2	0.1	1	1.1	2
			MAX	14.6	3.5	3.5	16	64.4	50
			MIN	12.7	3.0	3.2	12	61.7	45
21	37.00	5	AV5	16.8	4.1	3.9	18	59.0	58
			STD	0.5	0.1	0.1	1	0.7	2
			MAX	17.4	4.2	3.9	19	60.1	60
			MIN	16.1	4.1	3.7	18	58.4	55
26	38.00	5	AV5	17.4	4.5	4.0	19	57.9	61
			STD	0.4	0.1	0.1	1	0.6	3
			MAX	18.2	4.7	4.2	21	58.6	65
			MIN	16.9	4.3	3.9	18	56.9	57
32	39.00	6	AV6	18.3	4.8	4.1	19	57.1	76
			STD	0.4	0.1	0.1	1	0.6	5
			MAX	18.8	5.0	4.2	20	58.0	82
			MIN	17.7	4.6	4.0	18	56.5	69
38	40.00	6	AV6	18.8	4.8	4.2	20	56.6	83
			STD	0.5	0.1	0.1	1	0.7	3
			MAX	19.4	5.0	4.3	21	58.1	88
			MIN	17.7	4.6	4.0	18	55.8	80
47	41.00	9	AV9	19.7	5.3	4.4	19	55.3	99

USH 10 over LLBDM - Pier 16 # 1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
			STD	0.5	0.3	0.1	1	0.6	4
			MAX	20.4	5.8	4.5	21	56.7	104
			MIN	18.7	4.8	4.2	18	54.7	94
54	42.00	7	AV7	21.1	6.8	4.8	22	53.5	125
			STD	0.4	0.7	0.1	1	0.4	9
			MAX	21.6	8.0	4.9	24	54.3	137
			MIN	20.4	5.8	4.6	20	52.8	109
64	43.00	10	AV10	20.9	5.9	4.7	21	53.9	121
			STD	0.4	0.3	0.1	1	0.5	4
			MAX	21.5	6.3	4.8	22	54.8	127
			MIN	20.1	5.4	4.5	20	53.1	115
73	44.00	9	AV9	21.4	6.4	4.8	22	53.3	121
			STD	0.3	0.2	0.1	0	0.3	2
			MAX	21.9	6.8	4.9	22	53.9	125
			MIN	20.8	6.0	4.7	21	52.7	117
82	45.00	9	AV9	21.5	6.5	4.8	22	53.1	126
			STD	0.2	0.3	0.0	1	0.2	3
			MAX	21.8	7.0	4.9	22	53.6	131
			MIN	21.0	6.0	4.7	21	52.7	122
93	46.00	11	AV11	22.2	7.5	5.0	22	52.4	140
			STD	0.3	0.4	0.0	0	0.2	3
			MAX	22.6	8.0	5.0	23	52.8	145
			MIN	21.7	7.0	4.9	21	52.1	134
106	47.00	13	AV13	23.0	8.9	5.2	22	51.4	162
			STD	0.4	0.5	0.1	1	0.4	10
			MAX	23.9	9.9	5.4	24	52.1	189
			MIN	22.4	7.6	5.0	21	50.4	154
121	48.00	15	AV15	25.4	11.3	5.8	26	48.8	217
			STD	0.7	0.6	0.2	1	0.8	13
			MAX	26.7	12.3	6.1	29	50.2	232
			MIN	24.1	10.1	5.4	24	47.4	196
137	49.00	16	AV16	25.8	11.5	5.9	27	48.4	223
			STD	0.5	0.2	0.1	1	0.5	8

USH 10 over LLBDM - Pier 16 # 1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	26.7	12.0	6.1	28	49.4	239
			MIN	24.7	11.0	5.6	25	47.5	213
154	50.00	17	AV17	25.9	11.8	5.9	27	48.4	252
			STD	0.5	0.4	0.1	1	0.5	5
			MAX	26.8	12.5	6.1	28	49.3	260
			MIN	25.0	11.2	5.7	25	47.5	242
173	51.00	19	AV19	25.6	11.6	5.8	25	48.7	250
			STD	0.3	0.3	0.1	1	0.3	5
			MAX	26.1	12.1	5.9	27	49.2	258
			MIN	25.0	11.0	5.7	25	48.2	242
190	52.00	17	AV17	25.5	11.1	5.8	25	48.8	230
			STD	0.3	0.3	0.1	1	0.3	8
			MAX	26.1	11.7	5.9	26	49.4	244
			MIN	24.9	10.8	5.6	24	48.3	220
208	53.00	18	AV18	25.9	11.6	5.9	26	48.4	248
			STD	0.3	0.3	0.1	1	0.3	9
			MAX	26.7	12.0	6.1	27	48.8	259
			MIN	25.4	11.0	5.8	25	47.6	228
226	54.00	18	AV16	26.1	11.8	5.9	26	48.2	251
			STD	0.4	0.2	0.1	1	0.4	4
			MAX	26.8	12.1	6.1	28	49.1	261
			MIN	25.2	11.6	5.7	25	47.5	244
246	55.00	20	AV20	26.1	12.3	5.9	26	48.3	263
			STD	0.3	0.5	0.1	1	0.2	18
			MAX	26.6	13.4	6.0	27	48.6	293
			MIN	25.6	11.6	5.8	25	47.9	237
276	56.00	30	AV30	27.0	15.5	6.1	26	47.4	379
			STD	0.4	1.3	0.1	1	0.4	28
			MAX	27.7	17.6	6.3	28	48.5	404
			MIN	25.9	13.0	5.9	24	46.8	300
308	57.00	32	AV32	27.1	17.4	6.2	26	47.1	394
			STD	0.3	0.4	0.1	1	0.3	6
			MAX	27.6	18.4	6.4	27	47.7	406

USH 10 over LLBDM - Pier 16 # 1 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	26.6	16.7	6.1	25	46.6	382
342	58.00	34	AV34	27.0	17.1	6.2	25	47.2	381
			STD	0.4	0.4	0.1	1	0.4	6
			MAX	27.6	17.7	6.4	26	48.1	394
			MIN	26.1	16.0	6.0	24	46.6	372
379	59.00	37	AV37	27.7	20.0	6.4	27	46.6	418
			STD	0.6	1.7	0.2	1	0.6	24
			MAX	28.9	22.4	6.7	29	47.6	454
			MIN	26.6	16.9	6.1	24	45.5	375
419	59.80	50	AV40	28.6	23.2	6.6	28	45.7	475
			STD	0.4	1.3	0.1	1	0.4	27
			MAX	29.6	25.7	6.9	31	46.5	531
			MIN	27.9	21.4	6.4	27	44.8	443
429	59.92	80	AV10	29.5	26.1	6.9	30	44.9	540
			STD	0.4	0.4	0.1	1	0.3	4
			MAX	30.2	26.9	7.1	32	45.4	547
			MIN	29.0	25.4	6.7	29	44.3	532
439	60.04	80	AV10	29.9	26.3	7.0	31	44.6	545
			STD	0.2	0.3	0.1	0	0.3	5
			MAX	30.1	26.7	7.1	31	45.3	554
			MIN	29.2	25.7	6.8	30	44.3	538
449	60.17	80	AV10	30.0	26.1	7.0	31	44.5	541
			STD	0.3	0.2	0.1	1	0.3	3
			MAX	30.7	26.6	7.2	33	45.0	547
			MIN	29.6	25.7	6.8	30	43.8	537
450	60.18	80	AV1	29.9	26.6	7.0	31	44.4	542
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	29.9	26.6	7.0	31	44.4	542
			MIN	29.9	26.6	7.0	31	44.4	542
			Average	25.4	14.1	5.8	25	49.1	297
			Std. Dev.	3.8	6.4	0.8	4	4.2	142
			Maximum	30.7	26.9	7.2	33	73.2	554
			Minimum	0.1	0.0	2.4	0	43.8	0

Total number of blows analyzed: 445

BL#	Sensors
1-450	F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.05); A4: [K2524] 360.0 (1.05)

BL#	Comments
1	Reported Reference EL 740.9

Time Summary

Drive	10 minutes 14 seconds	11:22 AM - 11:32 AM	BN 1 - 450

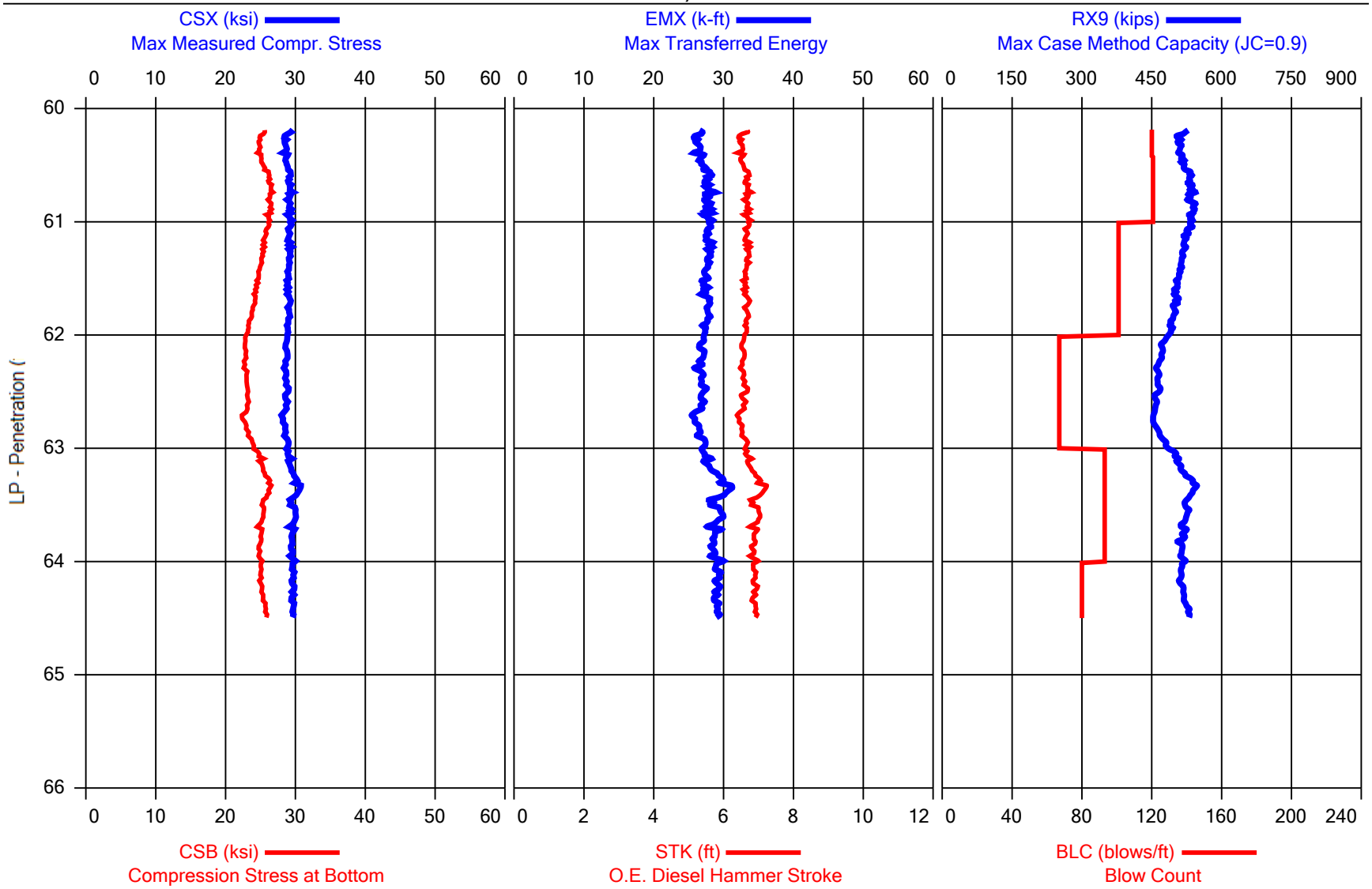
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 13-April-2015

Test started: 13-April-2015

USH 10 over LLBDM - Pier 16 # 1 - EOR

APE D30-42, HP 14 x 73



USH 10 over LLBDM - Pier 16 # 1 - EOR APE D30-42, HP 14 x 73
OP: AZ Date: 13-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 65.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
10	60.25	120	AV9	28.8	25.3	6.6	26	45.9	516
			STD	0.5	0.4	0.2	1	0.5	11
			MAX	29.7	25.9	6.8	28	46.6	536
			MIN	28.2	24.7	6.4	25	45.0	500
20	60.34	120	AV10	28.6	24.9	6.5	26	46.1	510
			STD	0.2	0.2	0.0	0	0.1	5
			MAX	29.0	25.2	6.6	27	46.4	519
			MIN	28.4	24.7	6.4	26	45.9	505
30	60.42	120	AV10	28.7	24.9	6.5	27	46.1	511
			STD	0.3	0.2	0.1	1	0.3	5
			MAX	29.0	25.2	6.6	27	46.6	519
			MIN	28.0	24.3	6.4	25	45.8	500
100	61.00	121	AV70	29.1	26.1	6.7	28	45.6	531
			STD	0.3	0.5	0.1	1	0.3	9
			MAX	29.7	26.9	6.8	29	46.3	548
			MIN	28.4	24.9	6.5	26	45.1	512
201	62.00	101	AV101	29.1	24.6	6.7	28	45.6	508
			STD	0.2	0.9	0.1	1	0.2	13
			MAX	29.6	26.4	6.8	29	46.2	541
			MIN	28.4	22.9	6.5	26	45.1	485
268	63.00	67	AV67	28.6	23.0	6.6	27	46.0	466
			STD	0.3	0.4	0.1	1	0.3	9
			MAX	29.2	24.2	6.7	28	46.7	485
			MIN	27.8	22.2	6.3	25	45.4	450
361	64.00	93	AV93	29.7	25.3	6.9	29	44.9	520
			STD	0.5	0.5	0.2	1	0.5	12
			MAX	30.9	26.7	7.3	32	46.2	548
			MIN	28.4	24.3	6.5	27	43.7	489

USH 10 over LLBDM - Pier 16 # 1 - EOR APE D30-42, HP 14 x 73
OP: AZ Date: 13-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
371	64.13	80	AV10	29.6	25.1	6.9	29	44.9	514
			STD	0.4	0.2	0.1	1	0.4	3
			MAX	30.4	25.3	7.1	31	45.5	519
			MIN	29.0	24.7	6.7	28	44.2	509
381	64.25	80	AV10	29.7	25.1	6.9	29	44.8	514
			STD	0.2	0.2	0.1	0	0.2	4
			MAX	30.1	25.3	7.0	30	45.1	520
			MIN	29.4	24.7	6.8	29	44.4	506
391	64.38	80	AV10	29.6	25.4	6.9	29	45.0	519
			STD	0.3	0.2	0.1	1	0.2	3
			MAX	30.1	25.8	7.0	30	45.4	525
			MIN	29.1	25.1	6.7	28	44.6	515
401	64.50	80	AV10	29.7	25.8	6.9	29	44.8	529
			STD	0.3	0.2	0.1	1	0.3	4
			MAX	30.0	26.0	7.0	30	45.1	534
			MIN	29.2	25.4	6.8	28	44.4	522
			Average	29.2	24.9	6.7	28	45.5	509
			Std. Dev.	0.5	1.1	0.2	1	0.6	23
			Maximum	30.9	26.9	7.3	32	46.7	548
			Minimum	27.8	22.2	6.3	25	43.7	450

Total number of blows analyzed: 400

BL# Sensors

1-401 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.03); A4: [K3550] 360.0 (1.03)

Time Summary

Drive 8 minutes 47 seconds 7:01 AM - 7:10 AM BN 1 - 401

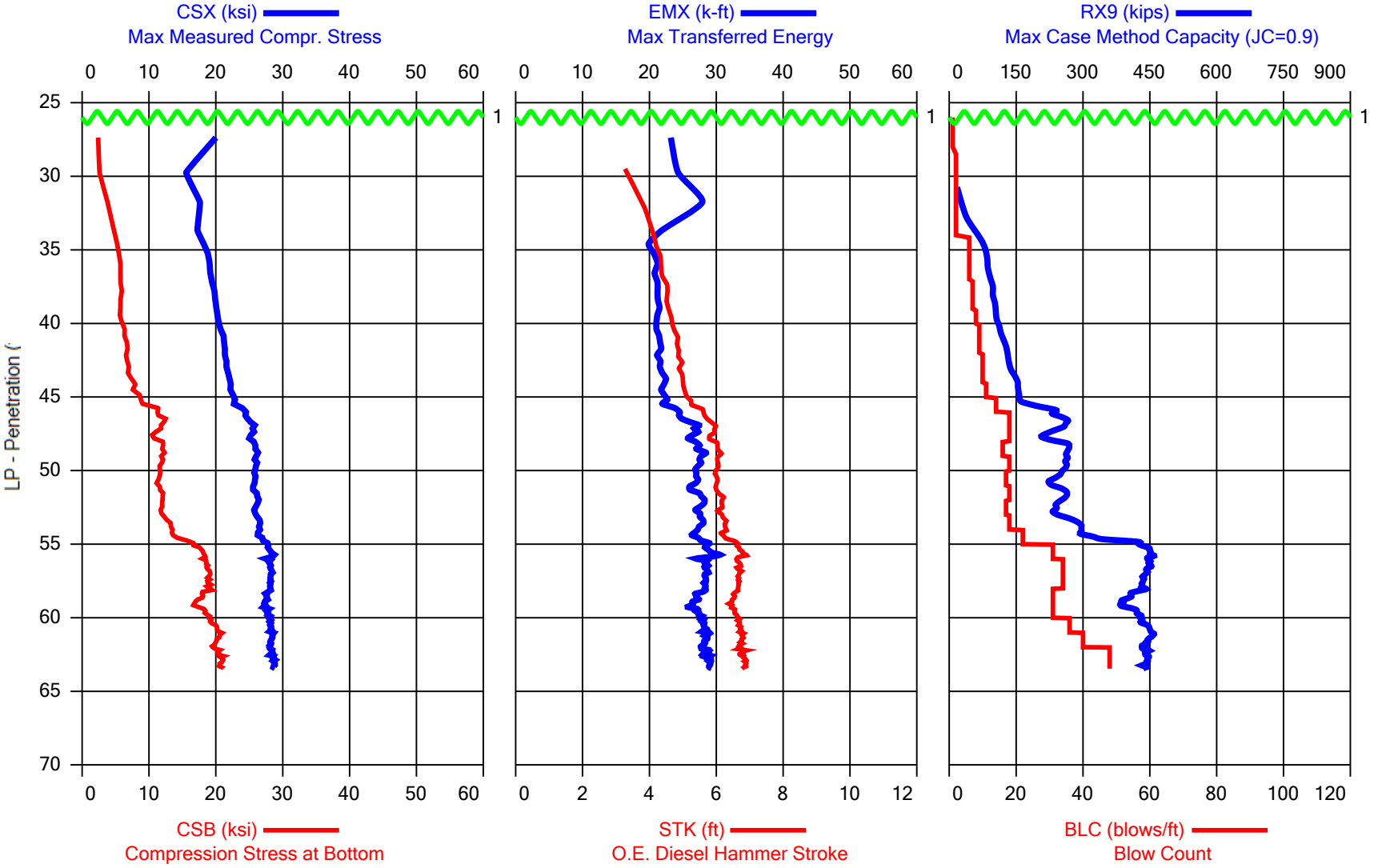
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 13-April-2015

Test started: 10-April-2015

USH 10 over LLBDM - Pier 16 # 36 - EOID

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.9

USH 10 over LLBDM - Pier 16 # 36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-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 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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
1	26.00	1	AV1	20.8	1.6	**	20	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	20.8	1.6	**	20	**	0
			MIN	20.8	1.6	**	20	**	0
2	27.00	1	AV1	22.9	2.3	**	22	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	22.9	2.3	**	22	**	0
			MIN	22.9	2.3	**	22	**	0
3	28.00	1	AV1	23.6	3.5	**	38	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	23.6	3.5	**	38	**	0
			MIN	23.6	3.5	**	38	**	0
5	29.00	2	AV2	8.3	1.4	2.8	10	68.8	0
			STD	4.3	0.6	0.2	4	1.9	0
			MAX	12.6	2.0	2.9	13	70.7	0
			MIN	4.1	0.8	2.6	6	66.9	0
7	30.00	2	AV2	23.5	3.5	4.6	39	54.4	6
			STD	1.1	0.1	0.0	9	0.0	6
			MAX	24.6	3.7	4.6	48	54.4	13
			MIN	22.5	3.4	4.6	30	54.4	0
9	31.00	2	AV2	7.7	2.1	2.8	10	68.6	0
			STD	3.5	0.4	0.2	4	1.9	0
			MAX	11.1	2.5	3.0	14	70.5	0
			MIN	4.2	1.7	2.6	5	66.7	0
11	32.00	2	AV2	24.9	4.6	5.3	42	50.9	49
			STD	0.5	0.0	0.0	3	0.0	8
			MAX	25.4	4.6	5.3	46	50.9	57
			MIN	24.4	4.6	5.3	39	50.9	40

USH 10 over LLBDM - Pier 16 # 36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
13	33.00	2	AV2	16.1	4.3	3.8	21	59.8	34
			STD	0.4	0.0	0.0	1	0.2	5
			MAX	16.5	4.3	3.8	22	59.9	39
			MIN	15.7	4.2	3.7	21	59.6	29
15	34.00	2	AV2	18.0	4.9	4.2	24	57.0	50
			STD	0.3	0.1	0.1	0	0.4	6
			MAX	18.4	5.0	4.2	24	57.4	57
			MIN	17.7	4.9	4.1	24	56.6	44
21	35.00	6	AV6	18.0	5.2	4.2	20	56.9	78
			STD	0.7	0.2	0.1	1	0.8	3
			MAX	19.1	5.5	4.3	21	57.9	82
			MIN	17.2	4.8	4.0	18	55.8	74
27	36.00	6	AV6	18.9	5.6	4.3	21	55.9	84
			STD	0.3	0.1	0.1	0	0.3	2
			MAX	19.4	5.8	4.4	21	56.5	87
			MIN	18.5	5.5	4.2	20	55.5	81
33	37.00	6	AV6	19.0	5.7	4.4	21	55.7	89
			STD	0.6	0.2	0.1	1	0.7	3
			MAX	19.5	6.0	4.5	22	56.8	94
			MIN	18.1	5.4	4.2	19	55.0	87
40	38.00	7	AV7	19.8	5.9	4.5	21	54.7	97
			STD	0.3	0.1	0.1	1	0.4	4
			MAX	20.3	6.0	4.6	23	55.3	104
			MIN	19.3	5.8	4.4	20	54.2	92
47	39.00	7	AV7	20.0	5.7	4.5	21	54.7	101
			STD	0.4	0.2	0.1	1	0.6	4
			MAX	20.3	6.1	4.6	22	56.0	108
			MIN	19.0	5.4	4.3	20	54.2	97
55	40.00	8	AV8	20.2	5.7	4.6	21	54.2	107
			STD	0.2	0.1	0.1	1	0.3	3
			MAX	20.5	5.9	4.7	22	54.6	112
			MIN	19.9	5.6	4.6	20	53.7	104
64	41.00	9	AV9	20.9	6.4	4.8	21	53.4	115

USH 10 over LLBDM - Pier 16 # 36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
			STD	0.3	0.2	0.1	1	0.4	3
			MAX	21.5	6.6	4.9	22	54.0	119
			MIN	20.4	6.0	4.7	20	52.7	109
73	42.00	9	AV9	21.3	6.7	4.9	22	53.0	127
			STD	0.3	0.3	0.1	0	0.3	3
			MAX	21.7	7.2	4.9	22	53.5	132
			MIN	20.9	6.0	4.8	21	52.6	121
83	43.00	10	AV10	21.6	6.8	4.9	22	52.6	133
			STD	0.5	0.3	0.1	1	0.5	3
			MAX	22.1	7.3	5.1	23	53.6	137
			MIN	20.7	6.3	4.7	20	51.9	130
93	44.00	10	AV10	21.8	7.1	5.0	22	52.5	147
			STD	0.5	0.5	0.1	1	0.4	5
			MAX	22.4	7.9	5.0	23	53.6	152
			MIN	20.5	6.6	4.7	19	52.1	138
104	45.00	11	AV11	22.3	8.1	5.1	22	52.0	155
			STD	0.3	0.5	0.1	0	0.4	3
			MAX	22.7	9.0	5.2	23	52.7	160
			MIN	21.8	7.3	4.9	21	51.3	151
118	46.00	14	AV14	23.4	9.9	5.4	23	50.6	194
			STD	0.8	1.3	0.2	1	0.9	34
			MAX	24.9	12.1	5.7	26	51.8	247
			MIN	22.4	8.4	5.1	21	49.0	159
136	47.00	18	AV18	25.0	11.9	5.8	25	48.8	254
			STD	0.6	0.5	0.2	1	0.7	14
			MAX	25.9	12.8	6.1	28	49.9	269
			MIN	23.9	11.0	5.5	23	47.7	226
154	48.00	18	AV18	25.4	11.1	5.9	27	48.4	226
			STD	0.4	0.6	0.1	1	0.4	18
			MAX	26.3	12.2	6.1	28	49.2	258
			MIN	24.7	10.3	5.7	25	47.5	199
170	49.00	16	AV16	26.1	12.1	6.1	28	47.6	266
			STD	0.3	0.4	0.1	1	0.4	5

USH 10 over LLBDM - Pier 16 # 36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	26.6	12.7	6.3	29	48.5	275
			MIN	25.4	11.5	5.9	26	46.9	259
188	50.00	18	AV18	25.9	11.8	6.0	27	47.8	262
			STD	0.4	0.3	0.1	1	0.3	4
			MAX	26.5	12.3	6.2	29	48.6	268
			MIN	24.9	11.2	5.8	26	47.3	256
205	51.00	17	AV17	25.8	11.5	6.0	27	47.9	236
			STD	0.3	0.4	0.1	1	0.3	12
			MAX	26.4	12.0	6.1	28	48.5	253
			MIN	25.3	10.9	5.9	26	47.4	218
223	52.00	18	AV18	26.0	11.9	6.1	27	47.6	257
			STD	0.5	0.3	0.1	1	0.5	8
			MAX	26.9	12.7	6.3	29	48.4	267
			MIN	25.2	11.2	5.9	26	46.7	238
240	53.00	17	AV17	26.0	11.9	6.1	28	47.4	239
			STD	0.4	0.3	0.1	1	0.3	7
			MAX	26.6	12.3	6.3	29	48.2	251
			MIN	25.1	11.4	5.9	26	47.0	223
258	54.00	18	AV18	26.5	12.9	6.3	28	47.0	284
			STD	0.3	0.5	0.1	1	0.3	14
			MAX	27.2	13.7	6.4	29	47.4	299
			MIN	26.1	12.1	6.1	26	46.5	255
280	55.00	22	AV22	26.8	14.6	6.3	27	46.7	343
			STD	0.8	1.4	0.2	1	0.8	52
			MAX	28.5	17.1	6.8	30	48.3	433
			MIN	25.3	13.2	5.9	24	45.1	287
311	56.00	31	AV31	28.1	17.8	6.7	29	45.4	448
			STD	0.5	0.6	0.1	1	0.5	9
			MAX	28.9	18.6	7.0	31	46.7	468
			MIN	26.9	16.4	6.3	26	44.6	427
345	57.00	34	AV34	28.2	18.7	6.7	28	45.5	447
			STD	0.4	0.4	0.1	1	0.4	6
			MAX	29.1	19.5	6.9	30	46.2	461

USH 10 over LLBDM - Pier 16 # 36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	27.4	18.1	6.5	27	44.8	432
379	58.00	34	AV34	28.2	18.9	6.7	28	45.6	435
			STD	0.3	0.4	0.1	0	0.2	5
			MAX	28.7	19.7	6.8	29	46.2	444
			MIN	27.6	18.3	6.5	27	45.2	425
410	59.00	31	AV31	27.7	17.9	6.5	27	46.0	407
			STD	0.4	0.8	0.1	1	0.4	17
			MAX	28.5	19.9	6.8	29	47.0	442
			MIN	26.6	16.3	6.3	25	45.3	379
441	60.00	31	AV31	27.6	18.0	6.5	27	46.0	412
			STD	0.4	0.8	0.1	1	0.4	17
			MAX	28.6	19.3	6.8	29	46.8	434
			MIN	26.8	16.4	6.3	25	45.2	380
477	61.00	36	AV36	28.2	19.8	6.7	28	45.5	442
			STD	0.3	0.6	0.1	1	0.3	9
			MAX	28.8	21.0	6.9	30	46.3	458
			MIN	27.4	18.9	6.5	26	44.9	426
517	62.00	40	AV40	28.3	20.2	6.8	28	45.3	447
			STD	0.3	0.5	0.1	1	0.3	9
			MAX	28.9	21.1	6.9	30	45.8	464
			MIN	27.7	19.3	6.6	27	44.8	428
557	62.83	48	AV40	28.4	20.5	6.8	29	45.2	442
			STD	0.3	0.5	0.1	1	0.3	7
			MAX	29.1	21.2	7.0	30	45.9	456
			MIN	27.7	19.2	6.6	26	44.6	431
567	63.04	48	AV10	28.7	21.0	6.9	29	44.9	444
			STD	0.3	0.2	0.1	1	0.2	3
			MAX	29.2	21.5	7.0	30	45.3	450
			MIN	28.2	20.7	6.8	28	44.6	438
577	63.25	48	AV10	28.8	20.6	6.9	29	44.9	438
			STD	0.3	0.2	0.1	0	0.2	4
			MAX	29.3	20.9	7.0	30	45.4	443
			MIN	28.2	20.2	6.7	28	44.5	430

USH 10 over LLBDM - Pier 16 # 36 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
587	63.46	48	AV10	28.7	20.7	6.9	29	45.0	439
			STD	0.2	0.3	0.1	0	0.2	4
			MAX	29.0	21.1	7.0	30	45.3	447
			MIN	28.4	20.4	6.8	29	44.6	434
			Average	26.0	14.7	6.1	27	47.8	324
			Std. Dev.	3.2	5.3	0.8	3	3.6	133
			Maximum	29.3	21.5	7.0	48	70.7	468
			Minimum	4.1	0.8	2.6	5	44.5	0

Total number of blows analyzed: 587

BL# Sensors

1-587 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.04); A4: [K2524] 360.0 (1.04)

BL# Comments

1 Reported Reference EL 740.9

Time Summary

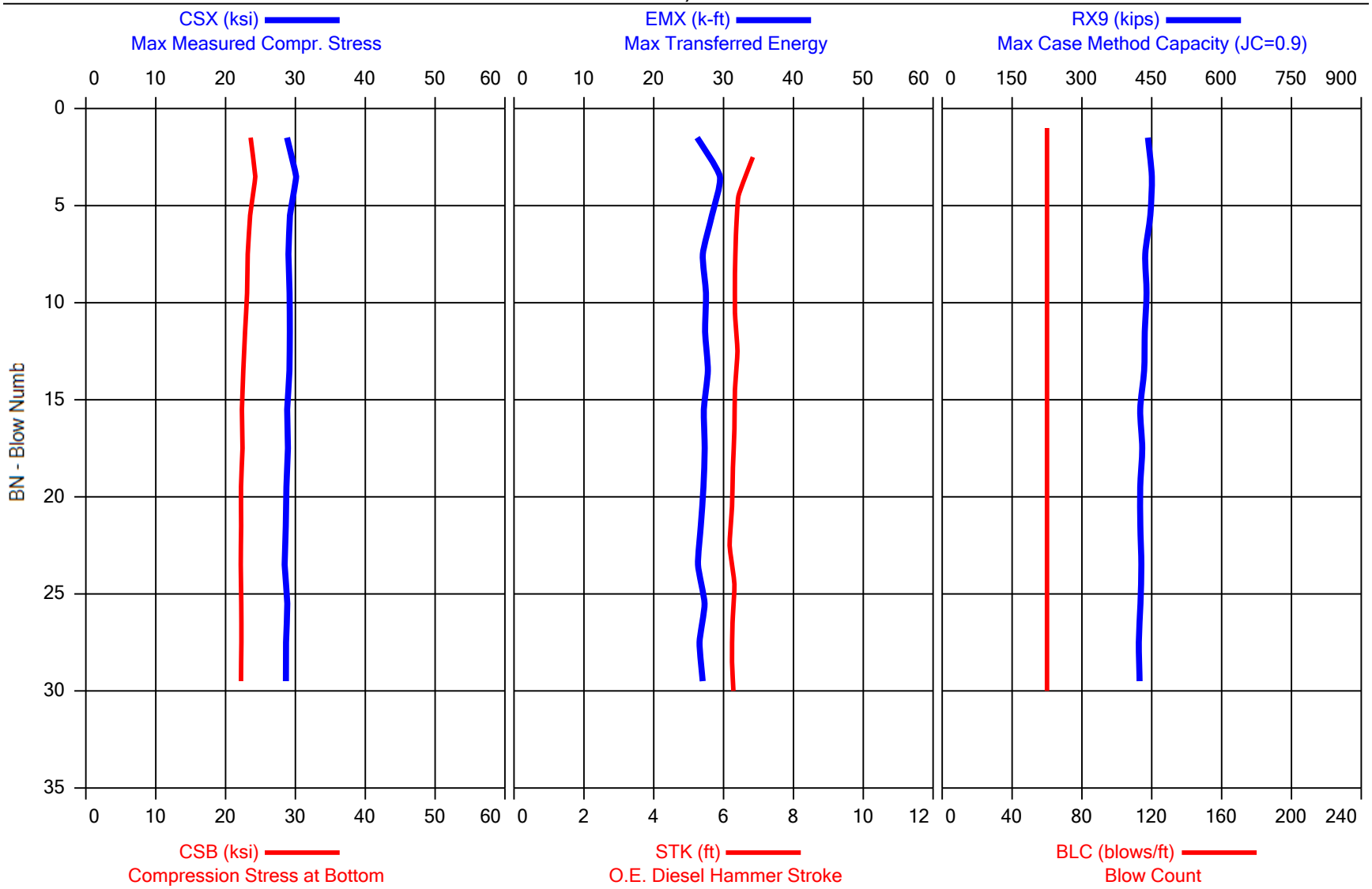
Drive 13 minutes 18 seconds 11:47 AM - 12:00 PM BN 1 - 587

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 13-April-2015 Test started: 13-April-2015

USH 10 over LLBDM - Pier 16 # 36 - BOR

APE D30-42, HP 14 x 73



USH 10 over LLBDM - Pier 16 # 36 - BOR APE D30-42, HP 14 x 73
OP: AZ Date: 13-April-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 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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
10	63.63	60	AV9	29.4	23.6	6.5	28	46.3	444
			STD	0.7	0.7	0.2	1	0.7	7
			MAX	31.2	24.9	7.0	31	46.9	452
			MIN	28.8	22.9	6.3	27	44.5	432
20	63.79	60	AV10	29.0	22.5	6.3	27	46.8	430
			STD	0.2	0.2	0.1	0	0.2	5
			MAX	29.4	22.9	6.5	28	47.0	439
			MIN	28.7	22.2	6.3	27	46.3	422
30	63.96	60	AV10	28.6	22.2	6.2	27	47.0	425
			STD	0.2	0.1	0.1	1	0.2	4
			MAX	28.9	22.4	6.3	28	47.5	433
			MIN	28.1	21.9	6.1	26	46.7	420
			Average	29.0	22.7	6.3	27	46.7	432
			Std. Dev.	0.5	0.7	0.2	1	0.5	9
			Maximum	31.2	24.9	7.0	31	47.5	452
			Minimum	28.1	21.9	6.1	26	44.5	420

Total number of blows analyzed: 29

BL# Sensors

1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.06); A4: [K3550] 360.0 (1.06)

Time Summary

Drive 37 seconds 6:53 AM - 6:54 AM BN 1 - 30

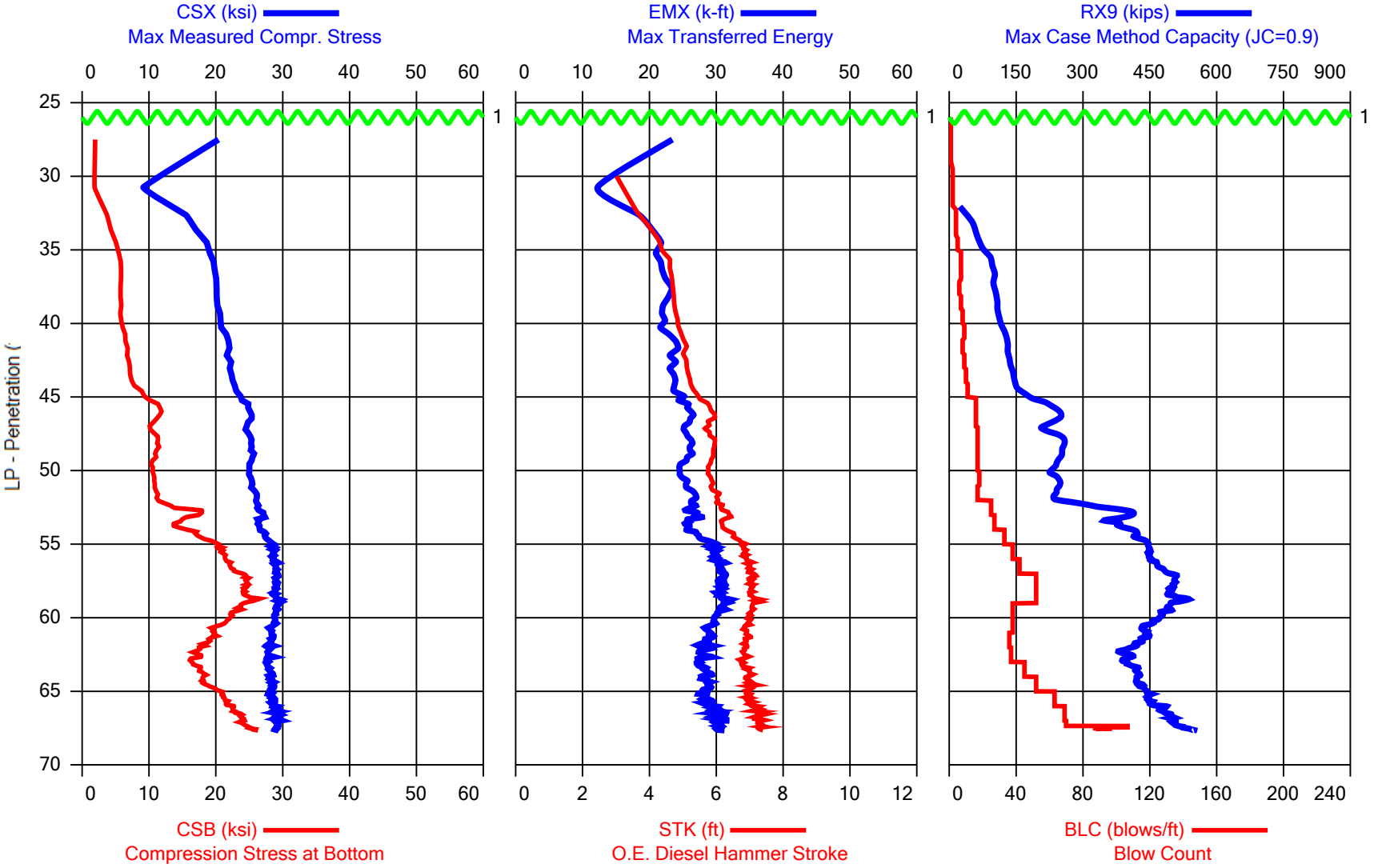
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 13-April-2015

Test started: 10-April-2015

USH 10 over LLBDM - Pier 16 # 44 - EOID

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.9

USH 10 over LLBDM - Pier 16 # 44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-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 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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
1	26.00	1	AV1	21.0	2.4	**	19	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	21.0	2.4	**	19	**	0
			MIN	21.0	2.4	**	19	**	0
2	27.00	1	AV1	23.1	1.9	**	22	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	23.1	1.9	**	22	**	0
			MIN	23.1	1.9	**	22	**	0
3	28.00	1	AV1	23.8	2.0	**	34	**	0
			STD	0.0	0.0	**	0	**	0
			MAX	23.8	2.0	**	34	**	0
			MIN	23.8	2.0	**	34	**	0
4	29.00	1	AV1	13.7	1.5	3.1	19	65.1	0
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	13.7	1.5	3.1	19	65.1	0
			MIN	13.7	1.5	3.1	19	65.1	0
6	30.00	2	AV2	3.1	0.7	2.6	5	71.4	0
			STD	2.5	0.7	0.2	4	2.3	0
			MAX	5.7	1.4	2.7	9	73.6	0
			MIN	0.6	0.0	2.4	0	69.1	0
9	31.50	2	AV1	17.0	3.1	3.8	23	59.1	16
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	17.0	3.1	3.8	23	59.1	16
			MIN	17.0	3.1	3.8	23	59.1	16
10	32.00	2	AV1	13.4	2.9	3.4	17	62.8	4
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	13.4	2.9	3.4	17	62.8	4
			MIN	13.4	2.9	3.4	17	62.8	4

USH 10 over LLBDM - Pier 16 # 44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
14	33.00	4	AV4	15.5	3.7	3.8	18	59.7	43
			STD	1.7	0.3	0.3	2	1.9	7
			MAX	17.4	4.2	4.0	20	62.7	50
			MIN	12.9	3.3	3.4	15	57.9	32
18	34.00	4	AV4	17.0	4.3	4.0	20	57.8	56
			STD	1.1	0.4	0.2	2	1.4	4
			MAX	18.3	4.9	4.3	23	59.9	62
			MIN	15.4	3.7	3.7	17	56.4	53
23	35.00	5	AV5	18.8	5.2	4.3	22	55.9	70
			STD	0.5	0.2	0.1	1	0.6	3
			MAX	19.3	5.6	4.5	23	56.7	76
			MIN	18.0	5.0	4.2	21	55.1	66
30	36.00	7	AV7	19.4	5.6	4.5	21	54.7	93
			STD	0.7	0.2	0.2	1	0.9	4
			MAX	20.0	5.9	4.7	22	56.8	98
			MIN	17.7	5.3	4.2	19	53.9	86
37	37.00	7	AV7	19.9	5.8	4.6	22	54.2	100
			STD	0.5	0.1	0.1	1	0.5	4
			MAX	20.4	6.0	4.7	23	55.4	105
			MIN	18.9	5.6	4.4	21	53.8	92
43	38.00	6	AV6	20.1	5.7	4.7	23	53.8	101
			STD	0.3	0.1	0.1	1	0.4	3
			MAX	20.3	5.8	4.8	24	54.5	107
			MIN	19.5	5.6	4.6	22	53.4	98
50	39.00	7	AV7	20.2	5.8	4.7	22	53.6	107
			STD	0.2	0.2	0.1	1	0.3	3
			MAX	20.5	6.1	4.8	23	54.2	112
			MIN	19.8	5.4	4.6	21	53.2	103
58	40.00	8	AV8	20.7	5.8	4.8	22	53.2	112
			STD	0.3	0.3	0.1	1	0.3	3
			MAX	21.2	6.1	4.9	23	53.8	117
			MIN	20.3	5.4	4.7	21	52.6	107
67	41.00	9	AV9	21.3	6.2	4.9	22	52.6	124

USH 10 over LLBDM - Pier 16 # 44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
			STD	0.5	0.4	0.1	1	0.5	5
			MAX	22.1	6.7	5.1	23	53.5	132
			MIN	20.4	5.6	4.8	21	51.9	118
75	42.00	8	AV8	21.9	6.7	5.1	24	51.9	130
			STD	0.4	0.3	0.1	1	0.4	4
			MAX	22.4	7.0	5.2	25	52.8	135
			MIN	21.2	6.1	4.9	22	51.2	124
84	43.00	9	AV9	22.1	7.0	5.1	23	51.8	136
			STD	0.4	0.3	0.1	1	0.4	2
			MAX	22.6	7.4	5.2	25	52.5	141
			MIN	21.5	6.3	5.0	22	51.3	134
94	44.00	10	AV10	22.3	7.3	5.2	24	51.5	145
			STD	0.3	0.3	0.1	1	0.3	3
			MAX	22.7	7.6	5.2	25	52.2	149
			MIN	21.7	6.9	5.0	22	51.1	140
105	45.00	11	AV11	23.1	8.5	5.3	24	50.6	160
			STD	0.4	0.7	0.1	1	0.6	11
			MAX	23.7	9.8	5.6	26	51.3	175
			MIN	22.6	7.6	5.2	22	49.7	147
121	46.00	16	AV16	24.6	11.1	5.7	25	49.0	223
			STD	0.6	0.8	0.2	1	0.6	20
			MAX	25.4	12.0	6.0	27	50.0	248
			MIN	23.7	9.8	5.5	24	48.1	189
137	47.00	16	AV16	25.2	11.0	5.9	26	48.5	238
			STD	0.5	0.6	0.1	1	0.6	14
			MAX	25.9	12.2	6.1	28	49.5	258
			MIN	24.2	10.0	5.6	24	47.5	214
154	48.00	17	AV17	24.9	10.8	5.8	26	48.7	236
			STD	0.5	0.6	0.1	1	0.6	21
			MAX	25.6	11.7	6.0	27	49.7	260
			MIN	23.9	9.7	5.6	24	47.9	201
171	49.00	17	AV17	25.4	11.2	5.9	26	48.2	255
			STD	0.5	0.4	0.1	1	0.4	4

USH 10 over LLBDM - Pier 16 # 44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	26.3	11.9	6.2	28	48.9	264
			MIN	24.6	10.5	5.8	25	47.2	251
188	50.00	17	AV17	25.1	10.6	5.8	25	48.7	240
			STD	0.3	0.4	0.1	1	0.3	7
			MAX	25.5	11.5	5.9	26	49.2	248
			MIN	24.6	10.1	5.7	24	48.3	221
206	51.00	18	AV18	25.3	10.8	5.8	25	48.6	241
			STD	0.3	0.2	0.1	1	0.4	10
			MAX	25.9	11.2	6.0	26	49.1	255
			MIN	24.7	10.3	5.7	24	47.9	220
223	52.00	17	AV17	25.9	11.1	6.0	27	48.0	238
			STD	0.5	0.3	0.1	1	0.5	5
			MAX	26.9	11.5	6.3	28	48.7	245
			MIN	25.0	10.6	5.8	25	47.0	227
248	53.00	25	AV25	26.5	14.8	6.2	26	47.2	349
			STD	0.5	2.6	0.2	1	0.6	56
			MAX	27.8	19.4	6.5	28	48.3	421
			MIN	25.5	11.2	5.9	25	46.0	258
275	54.00	27	AV27	26.6	14.8	6.2	26	47.1	382
			STD	0.5	1.4	0.2	1	0.5	21
			MAX	28.0	18.1	6.7	30	47.7	413
			MIN	25.7	13.1	6.1	25	45.5	336
308	55.00	33	AV33	27.6	18.0	6.6	28	45.9	428
			STD	0.7	1.3	0.2	1	0.7	13
			MAX	29.2	20.8	7.0	31	47.3	456
			MIN	26.3	15.7	6.2	25	44.6	407
346	56.00	38	AV38	28.5	21.0	6.9	30	45.0	449
			STD	0.4	0.6	0.1	1	0.4	5
			MAX	29.1	22.0	7.0	31	45.9	461
			MIN	27.6	20.0	6.6	28	44.4	439
388	57.00	42	AV42	28.9	22.3	7.0	31	44.6	472
			STD	0.4	0.7	0.1	1	0.3	13
			MAX	29.7	24.1	7.2	32	45.2	499

USH 10 over LLBDM - Pier 16 # 44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
			MIN	28.2	21.0	6.8	29	44.0	444
440	58.00	52	AV52	29.1	24.6	7.1	31	44.3	505
			STD	0.4	0.3	0.1	1	0.3	6
			MAX	30.1	25.2	7.4	33	45.2	517
			MIN	27.9	23.7	6.8	29	43.5	493
492	59.00	52	AV52	29.0	24.8	7.1	31	44.2	506
			STD	0.5	0.9	0.1	1	0.4	17
			MAX	30.1	27.1	7.5	33	45.1	541
			MIN	28.0	23.6	6.8	29	43.2	486
530	60.00	38	AV38	29.0	23.0	7.0	31	44.4	486
			STD	0.4	0.8	0.1	1	0.4	10
			MAX	29.6	24.3	7.3	32	45.2	503
			MIN	28.0	21.9	6.8	29	43.7	470
568	61.00	38	AV38	28.6	20.6	6.9	29	44.8	448
			STD	0.5	1.0	0.1	1	0.4	14
			MAX	29.5	22.4	7.2	31	45.6	475
			MIN	27.5	18.9	6.7	27	44.0	428
604	62.00	36	AV36	28.3	19.0	6.9	29	44.8	432
			STD	0.4	0.8	0.1	1	0.3	13
			MAX	29.1	20.6	7.1	30	45.3	453
			MIN	27.5	17.7	6.8	27	44.1	407
641	63.00	37	AV37	27.8	17.0	6.8	28	45.1	396
			STD	0.5	0.7	0.1	1	0.4	11
			MAX	29.0	18.3	7.1	30	45.9	421
			MIN	27.2	15.8	6.6	27	44.2	374
686	64.00	45	AV45	28.0	17.6	6.9	28	44.8	417
			STD	0.5	0.6	0.2	1	0.5	10
			MAX	29.0	18.8	7.2	30	45.8	433
			MIN	27.1	16.3	6.6	26	43.9	395
738	65.00	52	AV52	28.3	18.8	7.0	29	44.6	429
			STD	0.5	0.9	0.1	1	0.4	9
			MAX	29.4	20.7	7.4	31	45.4	448
			MIN	27.4	17.5	6.7	27	43.5	411

USH 10 over LLBDM - Pier 16 # 44 - EOID APE D30-42, HP 14 x 73
OP: AZ Date: 10-April-2015

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
801	66.00	63	AV63	28.4	21.3	7.0	28	44.6	450
			STD	0.5	0.5	0.1	1	0.4	8
			MAX	29.4	23.1	7.2	31	45.6	481
			MIN	27.1	20.4	6.7	26	43.8	436
870	67.00	69	AV69	29.2	23.3	7.3	30	43.7	490
			STD	0.5	0.7	0.1	1	0.4	12
			MAX	30.1	24.6	7.6	33	44.9	512
			MIN	27.9	22.0	6.9	28	42.8	466
895	67.35	70	AV25	29.2	24.0	7.3	30	43.7	504
			STD	0.3	0.4	0.1	1	0.3	5
			MAX	30.1	24.6	7.6	32	44.2	518
			MIN	28.5	23.4	7.1	29	42.9	495
905	67.45	107	AV10	29.3	24.9	7.4	31	43.4	523
			STD	0.3	0.3	0.1	1	0.3	5
			MAX	29.7	25.4	7.6	31	43.9	529
			MIN	28.9	24.2	7.2	30	42.9	515
915	67.55	96	AV10	29.0	25.1	7.3	30	43.8	531
			STD	0.2	0.4	0.1	1	0.3	7
			MAX	29.3	25.7	7.4	31	44.2	541
			MIN	28.6	24.6	7.1	29	43.3	516
925	67.67	87	AV10	29.1	26.0	7.3	31	43.5	547
			STD	0.3	0.3	0.1	1	0.3	5
			MAX	29.5	26.4	7.5	32	44.1	555
			MIN	28.5	25.6	7.1	29	43.0	537
			Average	27.1	18.0	6.6	28	46.2	389
			Std. Dev.	3.0	6.1	0.8	3	3.3	131
			Maximum	30.1	27.1	7.6	34	73.6	555
			Minimum	0.6	0.0	2.4	0	42.8	0

Total number of blows analyzed: 923

BL# Sensors

1-925 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.05); A4: [K2524] 360.0 (1.05)

BL# Comments

1 Reported Reference EL 740.9

Time Summary

Drive 20 minutes 54 seconds 12:13 PM - 12:34 PM BN 1 - 925

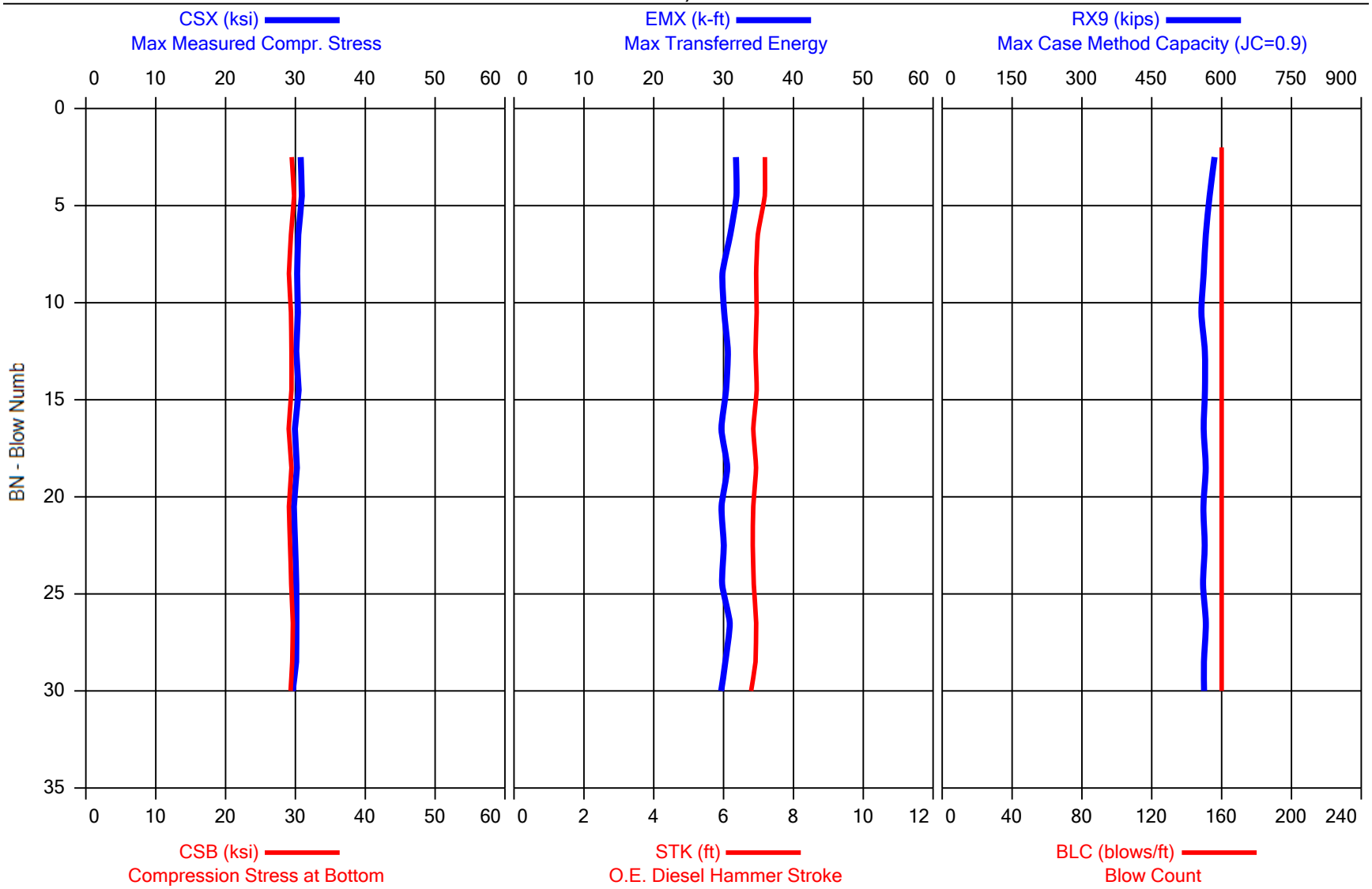
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.0 - Case Method & iCAP® Results

Printed: 13-April-2015

Test started: 13-April-2015

USH 10 over LLBDM - Pier 16 # 44 - BOR

APE D30-42, HP 14 x 73



USH 10 over LLBDM - Pier 16 # 44 - BOR APE D30-42, HP 14 x 73
OP: AZ Date: 13-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 72.00 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#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
10	67.73	160	AV9	30.5	29.4	7.0	31	44.4	570
			STD	0.5	0.5	0.2	1	0.5	10
			MAX	31.5	30.3	7.4	33	45.1	590
			MIN	29.9	28.7	6.8	29	43.3	556
20	67.80	160	AV10	30.1	29.3	6.9	30	44.8	563
			STD	0.3	0.2	0.1	1	0.3	5
			MAX	30.7	29.6	7.0	31	45.3	570
			MIN	29.4	28.9	6.8	29	44.5	555
30	67.86	160	AV10	30.0	29.4	6.9	30	44.9	562
			STD	0.2	0.2	0.1	0	0.2	5
			MAX	30.4	30.0	7.0	31	45.2	574
			MIN	29.6	29.2	6.8	30	44.4	556
			Average	30.2	29.4	6.9	30	44.7	565
			Std. Dev.	0.4	0.3	0.1	1	0.4	8
			Maximum	31.5	30.3	7.4	33	45.3	590
			Minimum	29.4	28.7	6.8	29	43.3	555

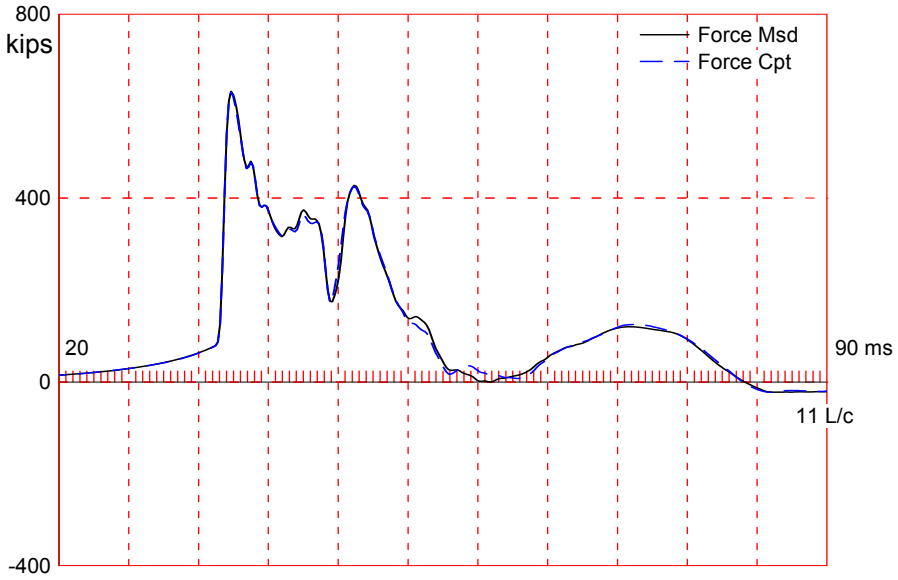
Total number of blows analyzed: 29

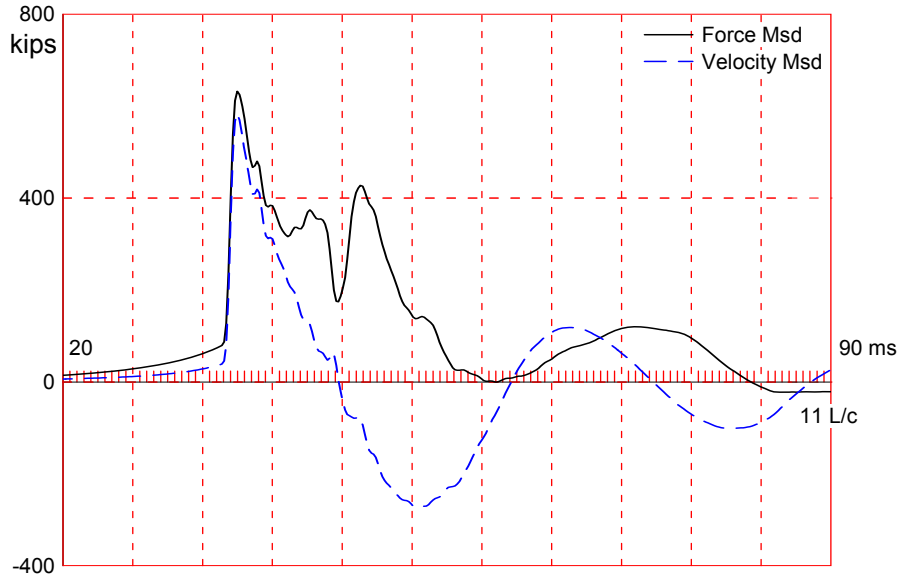
BL# Sensors

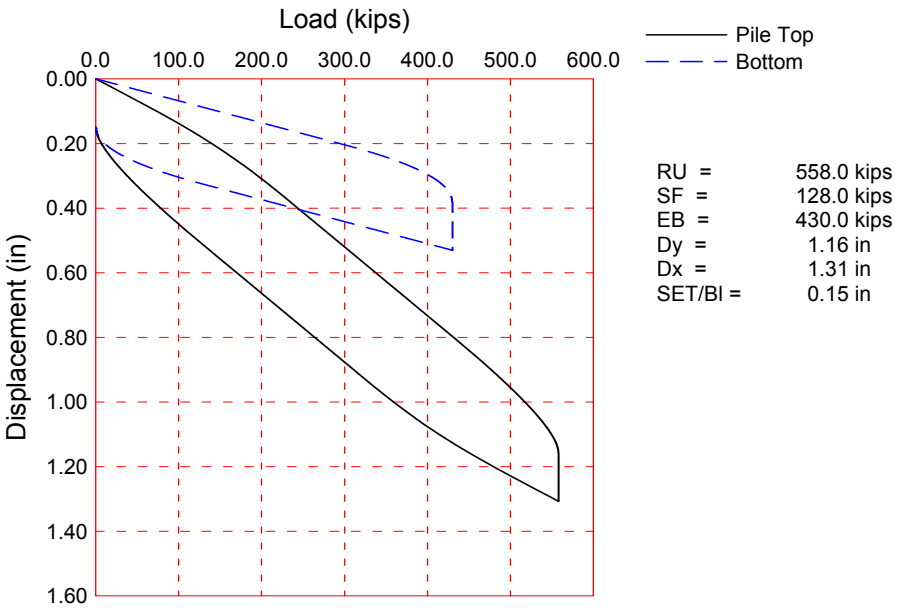
1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.06); A4: [K3550] 360.0 (1.06)

Time Summary

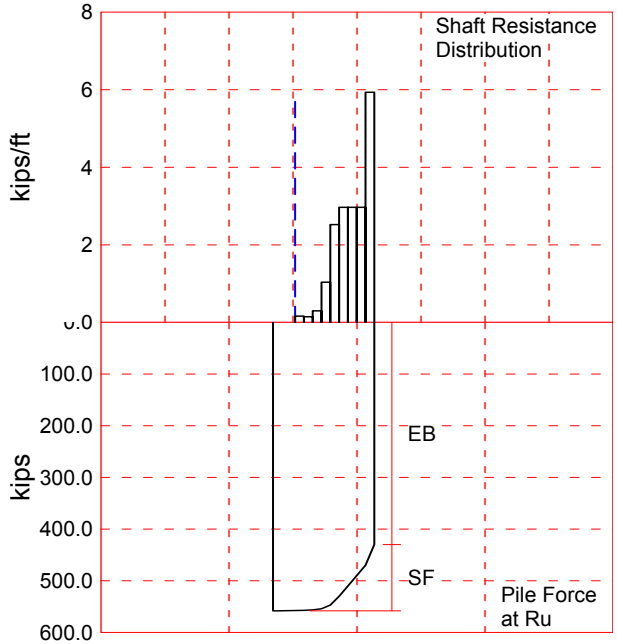
Drive 38 seconds 6:45 AM - 6:46 AM BN 1 - 30







RU =	558.0 kips
SF =	128.0 kips
EB =	430.0 kips
Dy =	1.16 in
Dx =	1.31 in
SET/Bl =	0.15 in



Length b. Sensors	77.5 ft
Embedment	60.0 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	1.61
Top Compr. Stress	29.5 ksi
Max Compr. Stress	30.7 ksi
Max Tension Stress	-5.25 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.29 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.06 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 558.0; along Shaft 128.0; 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	Quake in
				558.0				
1	23.6	6.1	1.0	557.0	1.0	0.16	0.03	0.05
2	30.3	12.8	1.0	556.0	2.0	0.15	0.03	0.05
3	37.1	19.6	2.0	554.0	4.0	0.30	0.06	0.05
4	43.8	26.3	7.0	547.0	11.0	1.04	0.22	0.05
5	50.5	33.0	17.0	530.0	28.0	2.52	0.54	0.05
6	57.3	39.8	20.0	510.0	48.0	2.97	0.63	0.05
7	64.0	46.5	20.0	490.0	68.0	2.97	0.63	0.05
8	70.8	53.3	20.0	470.0	88.0	2.97	0.63	0.05
9	77.5	60.0	40.0	430.0	128.0	5.94	1.26	0.05
Avg. Shaft			14.2			2.13	0.45	0.05
Toe			430.0				311.94	0.29

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.25	0.06
Case Damping Factor		0.84	0.68
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	51	33
Unloading Level	(% of Ru)	39	
Resistance Gap (included in Toe Quake) (in)			0.00
Soil Plug Weight	(kips)		0.028

CAPWAP match quality = 1.61 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.18 in; Blow Count = 67 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.05; A4(K2524) CAL: 360; RF: 1.05

max. Top Comp. Stress = 29.5 ksi (T= 36.1 ms, max= 1.043 x Top)
max. Comp. Stress = 30.7 ksi (Z= 50.5 ft, T= 39.1 ms)
max. Tens. Stress = -5.25 ksi (Z= 50.5 ft, T= 59.1 ms)
max. Energy (EMX) = 31.1 kip-ft; max. Measured Top Displ. (DMX)= 0.92 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	631.2	-26.5	29.5	-1.24	31.1	15.3	0.92
2	6.7	632.1	-30.2	29.5	-1.41	30.9	15.3	0.90
4	13.5	634.2	-37.0	29.6	-1.73	30.4	15.2	0.86
5	16.8	635.8	-45.1	29.7	-2.11	30.0	15.1	0.84
6	20.2	638.0	-54.5	29.8	-2.55	29.5	15.1	0.81
7	23.6	640.0	-62.9	29.9	-2.94	29.0	15.0	0.78
8	27.0	637.7	-72.3	29.8	-3.38	28.3	14.9	0.76
9	30.3	640.3	-80.7	29.9	-3.77	27.8	14.8	0.73
10	33.7	639.3	-86.8	29.9	-4.05	27.0	14.7	0.70
11	37.1	644.4	-92.4	30.1	-4.32	26.3	14.6	0.67
12	40.4	643.6	-96.9	30.1	-4.53	25.4	14.4	0.64
13	43.8	657.0	-104.3	30.7	-4.87	24.8	14.1	0.61
14	47.2	641.4	-105.7	30.0	-4.94	23.1	13.6	0.57
15	50.5	658.2	-112.5	30.7	-5.25	22.4	13.2	0.54
16	53.9	604.8	-106.0	28.3	-4.95	19.5	12.7	0.51
17	57.3	620.5	-111.4	29.0	-5.20	18.8	12.3	0.48
18	60.7	559.2	-98.9	26.1	-4.62	15.9	11.8	0.45
19	64.0	573.7	-99.1	26.8	-4.63	15.2	11.4	0.42
20	67.4	509.2	-84.2	23.8	-3.93	12.6	11.6	0.39
21	70.8	525.8	-84.3	24.6	-3.94	12.0	12.8	0.36
22	74.1	511.4	-69.5	23.9	-3.25	9.7	13.3	0.33
23	77.5	525.0	-69.1	24.5	-3.23	7.1	12.5	0.30
Absolute	50.5			30.7			(T =	39.1 ms)
	50.5				-5.25		(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	690.7	637.3	583.9	530.6	477.2	423.8	370.4	317.0	263.6	210.2
RX	705.4	684.8	664.1	643.5	622.8	602.5	582.7	564.1	553.0	544.8
RU	690.7	637.3	583.9	530.6	477.2	423.8	370.4	317.0	263.6	210.2

RAU = 407.2 (kips); RA2 = 591.5 (kips)

Current CAPWAP Ru = 558.0 (kips); Corresponding J(RP)= 0.25; J(RX) = 0.76

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
15.4	35.89	588.2	636.4	636.4	0.92	0.15	0.15	31.2	700.6	1483

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

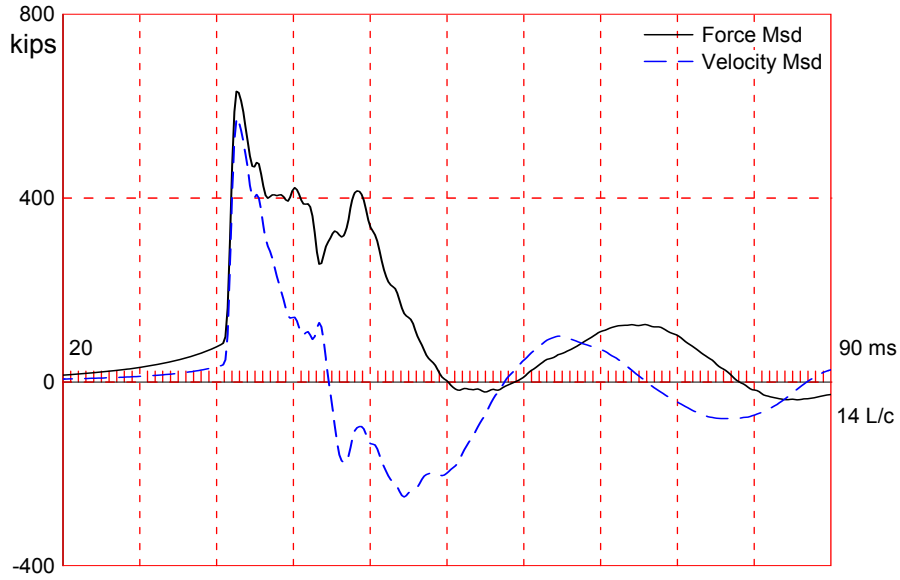
Toe Area 198.5 in^2

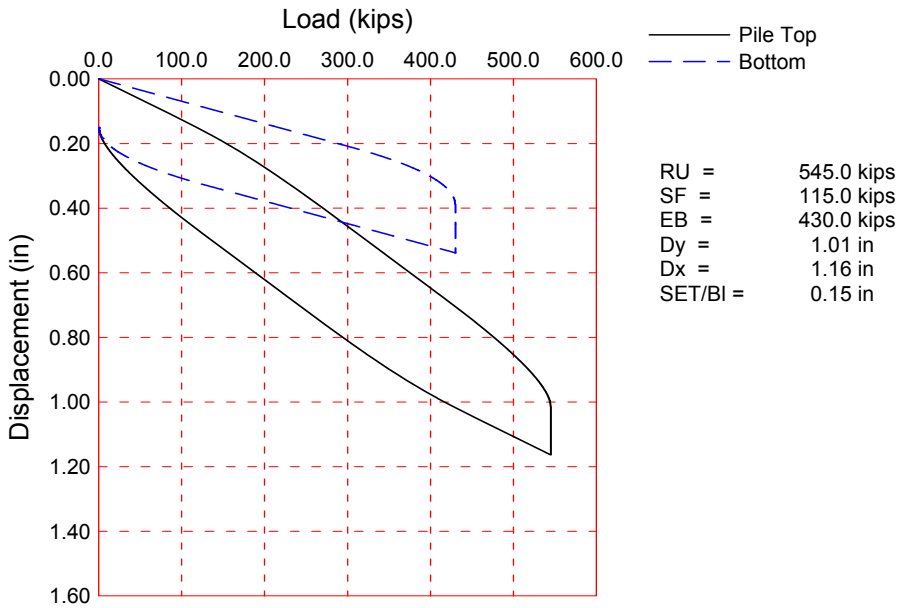
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

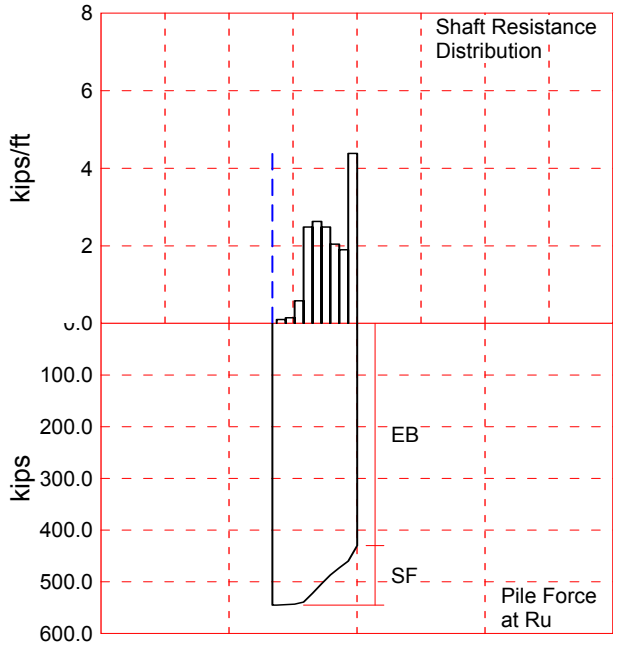
DYNAMIC RESISTANCE TABLE

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 W. Depth kips/ft	Unit Rt Resp. to Area ksf	Quake in
1	23.6	6.1	1.0	3.7	4.7	0.78	0.17	0.05
2	30.3	12.8	1.0	3.7	4.7	0.70	0.15	0.05
3	37.1	19.6	2.0	7.3	9.3	1.38	0.29	0.05
4	43.8	26.3	7.0	24.4	31.4	4.67	0.99	0.05
5	50.5	33.0	17.0	55.2	72.2	10.71	2.28	0.05
6	57.3	39.8	20.0	60.2	80.2	11.90	2.53	0.05
7	64.0	46.5	20.0	55.8	75.8	11.24	2.39	0.05
8	70.8	53.3	20.0	62.8	82.8	12.29	2.61	0.05
9	77.5	60.0	40.0	122.5	162.5	24.11	5.13	0.05
Avg. Shaft			14.2	44.0	58.2	8.73	1.86	0.05
Toe			430.0	25.5	455.5		330.45	0.29
Total					979.1			





RU =	545.0 kips
SF =	115.0 kips
EB =	430.0 kips
Dy =	1.01 in
Dx =	1.16 in
SET/BI =	0.15 in



Length b. Sensors	65.0 ft
Embedment	64.5 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	1.16
Top Compr. Stress	29.4 ksi
Max Compr. Stress	31.1 ksi
Max Tension Stress	-3.87 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.30 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.07 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 545.0; along Shaft 115.0; 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
				545.0			
1	10.3	9.8	1.0	544.0	1.0	0.10	0.02
2	17.1	16.6	1.0	543.0	2.0	0.15	0.03
3	23.9	23.4	4.0	539.0	6.0	0.58	0.12
4	30.8	30.3	17.0	522.0	23.0	2.48	0.53
5	37.6	37.1	18.0	504.0	41.0	2.63	0.56
6	44.5	44.0	17.0	487.0	58.0	2.48	0.53
7	51.3	50.8	14.0	473.0	72.0	2.05	0.44
8	58.2	57.7	13.0	460.0	85.0	1.90	0.40
9	65.0	64.5	30.0	430.0	115.0	4.38	0.93
Avg. Shaft			12.8			1.78	0.38
Toe			430.0				311.94

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.29	0.07
Quake	(in)	0.10	0.30
Case Damping Factor		0.87	0.79
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	68	51
Unloading Level	(% of Ru)	46	
Resistance Gap (included in Toe Quake)	(in)		0.02
Soil Plug Weight	(kips)	0.050	0.043

CAPWAP match quality = 1.16 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.16 in; Blow Count = 75 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.03; A4(K3550) CAL: 360; RF: 1.03

max. Top Comp. Stress = 29.4 ksi (T= 36.0 ms, max= 1.056 x Top)
max. Comp. Stress = 31.1 ksi (Z= 30.8 ft, T= 37.9 ms)
max. Tens. Stress = -3.87 ksi (Z= 30.8 ft, T= 58.0 ms)
max. Energy (EMX) = 29.2 kip-ft; max. Measured Top Displ. (DMX)= 0.84 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	630.2	-44.7	29.4	-2.09	29.2	15.1	0.83
2	6.8	632.3	-48.3	29.5	-2.26	28.9	15.0	0.80
3	10.3	634.2	-51.5	29.6	-2.40	28.5	14.9	0.78
4	13.7	631.2	-53.8	29.5	-2.52	27.8	14.8	0.75
5	17.1	634.7	-56.6	29.7	-2.64	27.3	14.8	0.73
6	20.5	636.4	-61.6	29.7	-2.88	26.6	14.6	0.70
7	23.9	649.7	-68.7	30.4	-3.21	25.9	14.3	0.67
8	27.4	650.5	-74.0	30.4	-3.46	24.6	13.8	0.63
9	30.8	665.2	-82.7	31.1	-3.87	24.0	13.4	0.60
10	34.2	606.1	-71.1	28.3	-3.32	20.8	12.8	0.57
11	37.6	624.7	-78.7	29.2	-3.68	20.1	12.3	0.54
12	41.1	568.8	-67.7	26.6	-3.16	17.1	11.7	0.51
13	44.5	580.9	-74.5	27.1	-3.48	16.5	11.2	0.48
14	47.9	516.2	-66.4	24.1	-3.10	13.8	11.0	0.45
15	51.3	522.2	-73.7	24.4	-3.44	13.2	10.9	0.42
16	54.7	477.6	-69.3	22.3	-3.24	11.2	11.3	0.39
17	58.2	497.9	-71.4	23.3	-3.33	10.6	12.4	0.36
18	61.6	497.0	-61.2	23.2	-2.86	8.9	13.1	0.33
19	65.0	510.7	-61.1	23.9	-2.85	6.9	12.3	0.30
Absolute	30.8			31.1			(T =	37.9 ms)
	30.8				-3.87		(T =	58.0 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	678.8	623.9	569.1	514.2	459.3	404.5	349.6	294.7	239.8	185.0
RX	702.9	671.4	651.0	630.6	610.2	589.8	570.1	552.3	540.4	530.8
RU	678.8	623.9	569.1	514.2	459.3	404.5	349.6	294.7	239.8	185.0

RAU = 411.2 (kips); RA2 = 610.3 (kips)

Current CAPWAP Ru = 545.0 (kips); Corresponding J(RP)= 0.24; J(RX) = 0.76

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
15.3	35.82	585.6	642.0	642.0	0.84	0.15	0.15	29.6	720.6	1536

PILE PROFILE AND PILE MODEL

Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
65.0	21.4	29992.2	492.000	4.70

Toe Area 198.5 in²

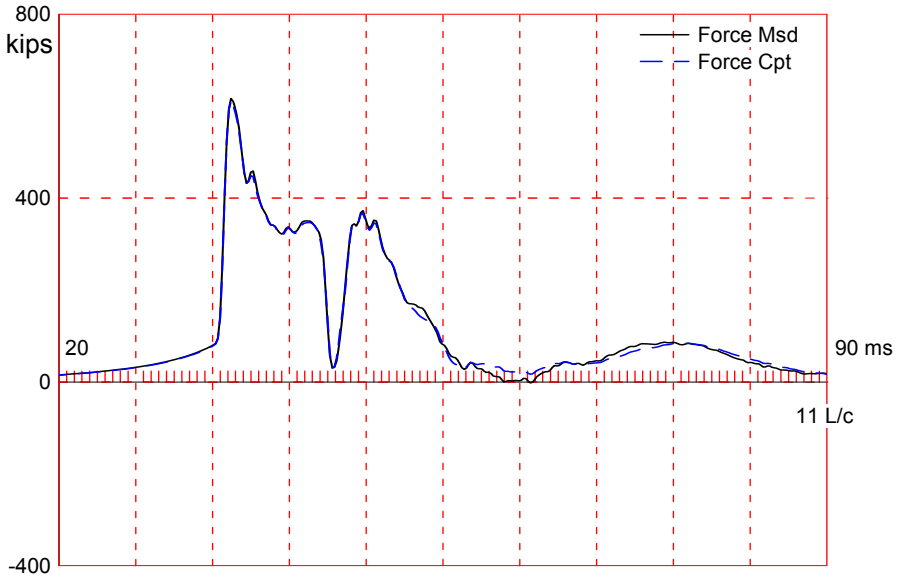
Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
13	44.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
14	47.9	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020

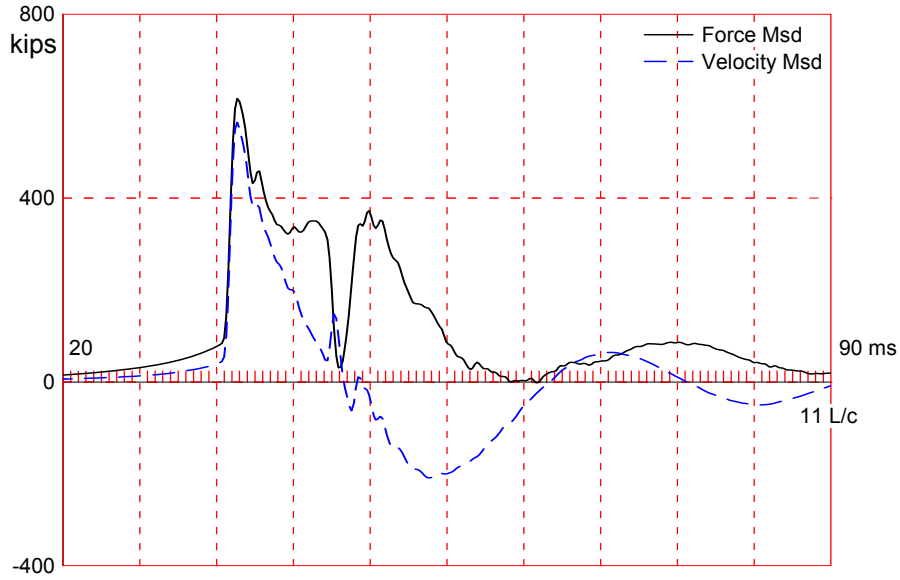
Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
16	54.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
19	65.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

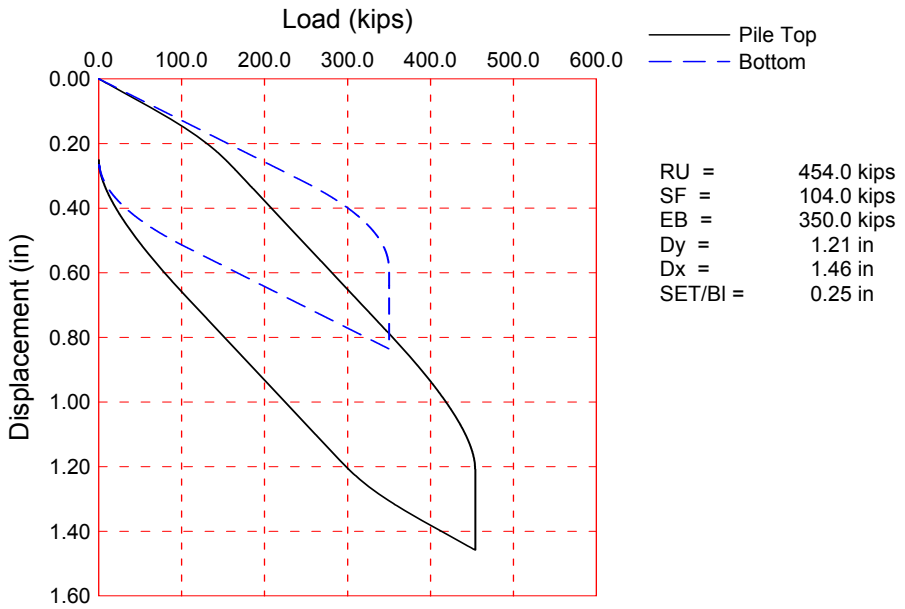
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.204 ms, 2L/c 7.7 ms
Total volume: 9.660 ft^{3}; Volume ratio considering added impedance: 1.000

DYNAMIC RESISTANCE TABLE

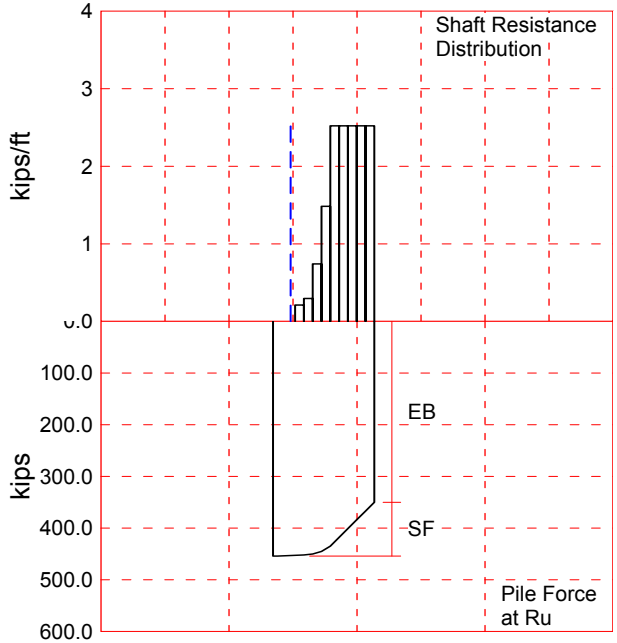
Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Damping Rd at Max. Rt kips	Max Rt (Ru+Rd) kips	Total Unit Rt W. Resp. to Depth kips/ft	Area ksf
1	10.3	9.8	1.0	4.3	5.3	0.55	0.12
2	17.1	16.6	1.0	4.3	5.3	0.77	0.16
3	23.9	23.4	4.0	16.6	20.6	3.01	0.64
4	30.8	30.3	17.0	64.8	81.8	11.95	2.54
5	37.6	37.1	18.0	63.1	81.1	11.85	2.52
6	44.5	44.0	17.0	53.6	70.6	10.32	2.20
7	51.3	50.8	14.0	42.9	56.9	8.32	1.77
8	58.2	57.7	13.0	46.1	59.1	8.64	1.84
9	65.0	64.5	30.0	102.3	132.3	19.34	4.12
Avg. Shaft			12.8	44.2	57.0	7.95	1.69
Toe			430.0	26.4	456.4		331.12
Total					969.4		







RU =	454.0 kips
SF =	104.0 kips
EB =	350.0 kips
Dy =	1.21 in
Dx =	1.46 in
SET/BI =	0.25 in



Length b. Sensors	77.5 ft
Embedment	63.4 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	1.94
Top Compr. Stress	28.6 ksi
Max Compr. Stress	29.2 ksi
Max Tension Stress	-1.26 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.45 in
Avg. Shaft Smith Dpg.	0.23 s/ft
Toe Smith Damping	0.07 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 454.0; along Shaft 104.0; at Toe 350.0 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
				454.0			
1	23.6	9.5	2.0	452.0	2.0	0.21	0.04
2	30.3	16.2	2.0	450.0	4.0	0.30	0.06
3	37.1	23.0	5.0	445.0	9.0	0.74	0.16
4	43.8	29.7	10.0	435.0	19.0	1.48	0.32
5	50.5	36.4	17.0	418.0	36.0	2.52	0.54
6	57.3	43.2	17.0	401.0	53.0	2.52	0.54
7	64.0	49.9	17.0	384.0	70.0	2.52	0.54
8	70.8	56.7	17.0	367.0	87.0	2.52	0.54
9	77.5	63.4	17.0	350.0	104.0	2.52	0.54
Avg. Shaft			11.6			1.64	0.35
Toe			350.0				253.90

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.23	0.07
Quake	(in)	0.06	0.45
Case Damping Factor		0.63	0.64
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	66
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)	0.110	0.002

CAPWAP match quality = 1.94 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.25 in; Blow Count = 48 b/ft
Computed: Final Set = 0.26 in; Blow Count = 46 b/ft

Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.04; A4(K2524) CAL: 360; RF: 1.04

max. Top Comp. Stress = 28.6 ksi (T= 36.1 ms, max= 1.019 x Top)
max. Comp. Stress = 29.2 ksi (Z= 43.8 ft, T= 38.7 ms)
max. Tens. Stress = -1.26 ksi (Z= 43.8 ft, T= 63.6 ms)
max. Energy (EMX) = 29.6 kip-ft; max. Measured Top Displ. (DMX)= 0.93 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	613.0	-14.4	28.6	-0.67	29.6	14.9	0.94
2	6.7	613.9	-14.8	28.7	-0.69	29.5	14.8	0.93
4	13.5	615.8	-15.7	28.8	-0.73	29.3	14.8	0.90
5	16.8	617.7	-15.9	28.9	-0.74	29.1	14.7	0.88
6	20.2	620.6	-16.4	29.0	-0.77	28.8	14.6	0.86
7	23.6	623.1	-17.6	29.1	-0.82	28.5	14.5	0.84
8	27.0	617.2	-18.0	28.8	-0.84	27.8	14.5	0.82
9	30.3	620.9	-21.0	29.0	-0.98	27.4	14.4	0.80
10	33.7	617.8	-22.3	28.9	-1.04	26.7	14.2	0.77
11	37.1	624.1	-26.1	29.2	-1.22	26.3	14.0	0.75
12	40.4	612.3	-23.5	28.6	-1.10	25.0	13.8	0.72
13	43.8	624.5	-26.9	29.2	-1.26	24.6	13.5	0.70
14	47.2	598.6	-18.6	28.0	-0.87	22.6	13.1	0.67
15	50.5	615.8	-23.3	28.8	-1.09	22.1	12.7	0.65
16	53.9	572.0	-7.2	26.7	-0.33	19.2	12.1	0.62
17	57.3	587.2	-10.4	27.4	-0.48	18.8	11.8	0.60
18	60.7	541.3	0.0	25.3	0.00	16.1	12.3	0.57
19	64.0	552.4	-0.0	25.8	-0.00	15.7	12.2	0.55
20	67.4	495.3	-0.0	23.1	-0.00	13.2	13.9	0.52
21	70.8	446.5	-0.0	20.9	-0.00	12.8	15.3	0.50
22	74.1	395.7	-0.0	18.5	-0.00	10.4	16.0	0.47
23	77.5	411.3	-0.0	19.2	-0.00	8.9	15.3	0.45
Absolute	43.8			29.2			(T =	38.7 ms)
	43.8				-1.26		(T =	63.6 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	553.7	489.8	426.0	362.1	298.2	234.3	170.4	106.6	42.7	0.0
RX	593.5	567.5	541.5	515.5	489.5	474.5	462.7	454.5	446.4	438.2
RU	553.7	489.8	426.0	362.1	298.2	234.3	170.4	106.6	42.7	0.0

RAU = 368.4 (kips); RA2 = 513.5 (kips)

Current CAPWAP Ru = 454.0 (kips); Corresponding J(RP)= 0.16; J(RX) = 0.71

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
15.0	35.89	571.8	620.7	620.7	0.93	0.25	0.25	29.6	604.3	833

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

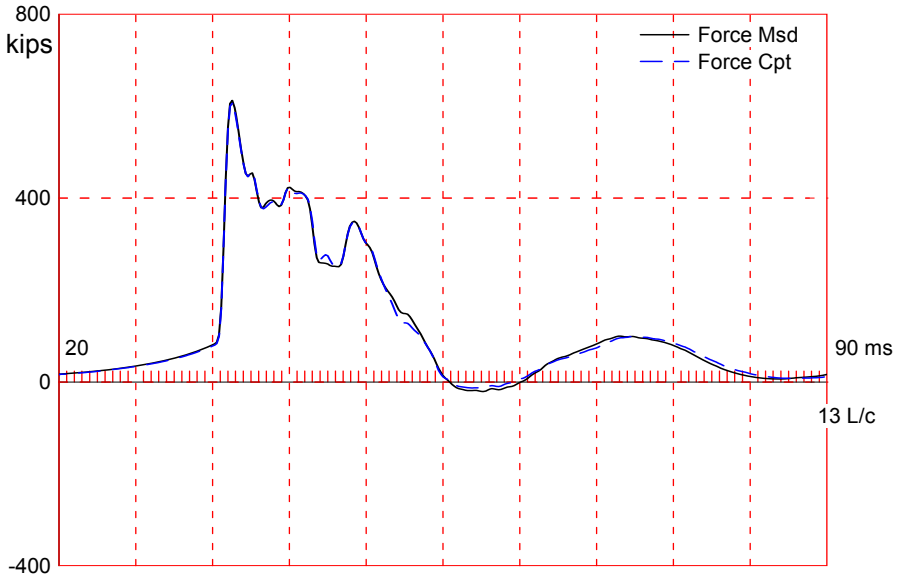
Toe Area 198.5 in^2

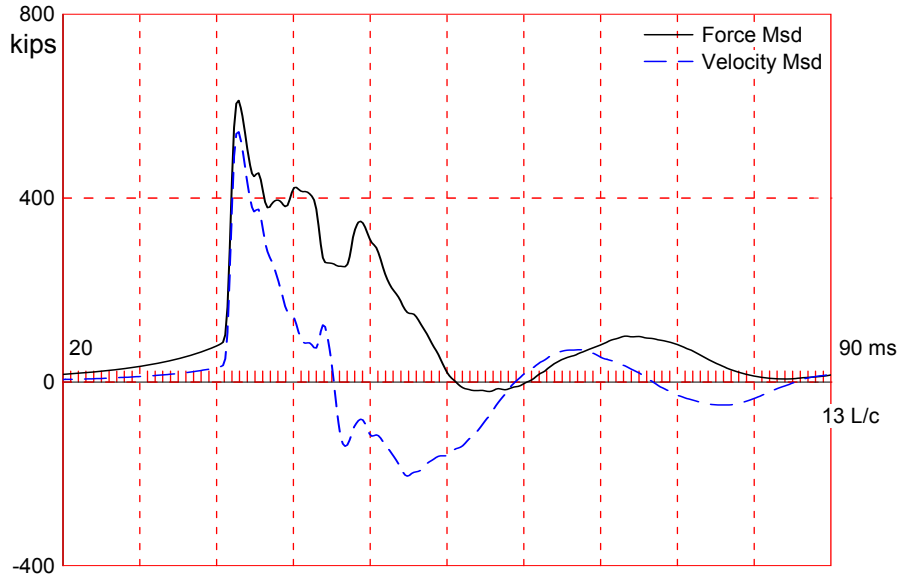
Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
18	60.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
20	67.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.030
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

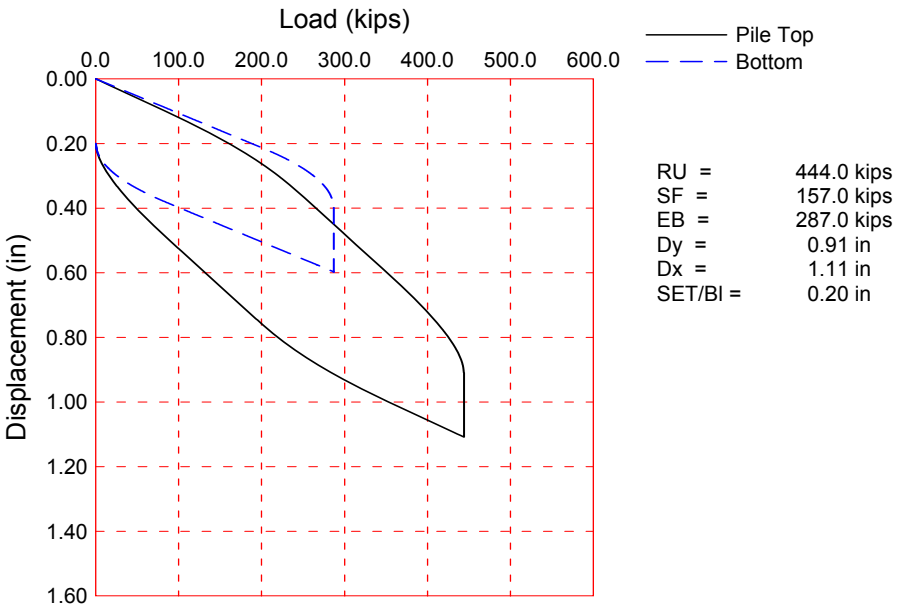
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000

DYNAMIC RESISTANCE TABLE

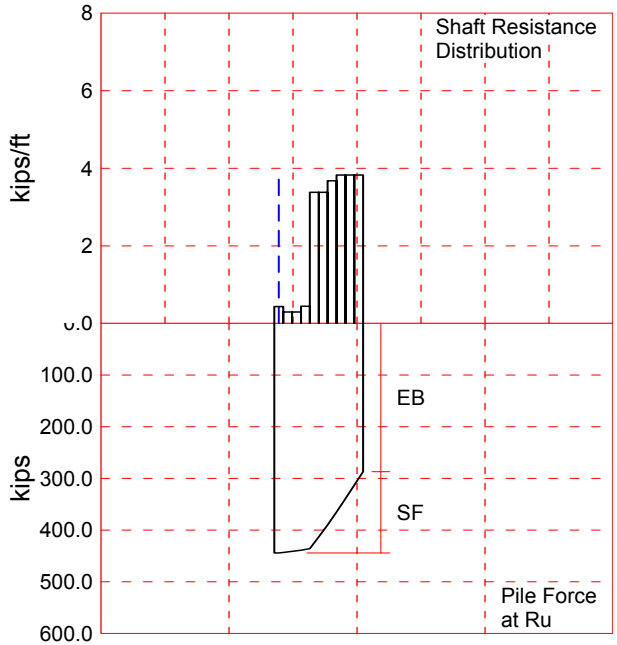
Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Damping Rd at Max. Rt kips	Max Rt (Ru+Rd) kips	Total Unit Rt W. Resp. to Depth kips/ft	Area ksf
1	23.6	9.5	2.0	6.7	8.7	0.91	0.19
2	30.3	16.2	2.0	6.6	8.6	1.27	0.27
3	37.1	23.0	5.0	16.0	21.0	3.12	0.66
4	43.8	29.7	10.0	30.6	40.6	6.03	1.28
5	50.5	36.4	17.0	48.7	65.7	9.75	2.08
6	57.3	43.2	17.0	45.1	62.1	9.22	1.96
7	64.0	49.9	17.0	46.9	63.9	9.49	2.02
8	70.8	56.7	17.0	58.2	75.2	11.16	2.37
9	77.5	63.4	17.0	59.9	76.9	11.41	2.43
Avg. Shaft			11.6	35.4	47.0	6.67	1.42
Toe			350.0	26.7	376.7		273.30
Total					799.6		







RU =	444.0 kips
SF =	157.0 kips
EB =	287.0 kips
Dy =	0.91 in
Dx =	1.11 in
SET/BI =	0.20 in



Length b. Sensors	68.0 ft
Embedment	63.5 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	1.64
Top Compr. Stress	28.5 ksi
Max Compr. Stress	30.3 ksi
Max Tension Stress	-2.57 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.31 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.08 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 444.0; along Shaft 157.0; at Toe 287.0 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	Quake in
				444.0				
1	6.8	2.3	1.0	443.0	1.0	0.44	0.09	0.08
2	13.6	9.1	2.0	441.0	3.0	0.29	0.06	0.08
3	20.4	15.9	2.0	439.0	5.0	0.29	0.06	0.08
4	27.2	22.7	3.0	436.0	8.0	0.44	0.09	0.08
5	34.0	29.5	23.0	413.0	31.0	3.38	0.72	0.08
6	40.8	36.3	23.0	390.0	54.0	3.38	0.72	0.08
7	47.6	43.1	25.0	365.0	79.0	3.68	0.78	0.08
8	54.4	49.9	26.0	339.0	105.0	3.82	0.81	0.08
9	61.2	56.7	26.0	313.0	131.0	3.82	0.81	0.08
10	68.0	63.5	26.0	287.0	157.0	3.82	0.81	0.08
Avg. Shaft			15.7			2.47	0.53	0.08
Toe			287.0				208.20	0.31

Soil Model Parameters/Extensions	Shaft	Toe
Smith Damping Factor	0.25	0.08
Case Damping Factor	1.03	0.60
Damping Type	Viscous	Sm+Visc
Unloading Quake (% of loading quake)	94	99
Resistance Gap (included in Toe Quake) (in)		0.02
Soil Plug Weight (kips)	0.080	

CAPWAP match quality = 1.64 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.22 in; Blow Count = 55 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.05; A4(K3550) CAL: 360; RF: 1.05

max. Top Comp. Stress = 28.5 ksi (T= 36.2 ms, max= 1.065 x Top)
max. Comp. Stress = 30.3 ksi (Z= 34.0 ft, T= 38.0 ms)
max. Tens. Stress = -2.57 ksi (Z= 34.0 ft, T= 59.5 ms)
max. Energy (EMX) = 27.2 kip-ft; max. Measured Top Displ. (DMX)= 0.81 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	609.0	-19.5	28.5	-0.91	27.2	14.3	0.80
2	6.8	611.9	-25.6	28.6	-1.20	26.9	14.3	0.78
3	10.2	610.6	-30.6	28.5	-1.43	26.4	14.2	0.75
4	13.6	613.7	-36.5	28.7	-1.70	26.0	14.1	0.73
5	17.0	608.2	-39.4	28.4	-1.84	25.3	14.0	0.70
6	20.4	611.9	-45.7	28.6	-2.13	24.9	13.9	0.68
7	23.8	608.4	-47.8	28.4	-2.23	24.1	13.7	0.65
8	27.2	622.5	-51.9	29.1	-2.42	23.6	13.4	0.63
9	30.6	632.2	-51.4	29.5	-2.40	22.7	12.8	0.60
10	34.0	648.4	-55.0	30.3	-2.57	22.3	12.3	0.57
11	37.4	579.0	-27.3	27.0	-1.28	19.0	11.8	0.55
12	40.8	602.0	-30.6	28.1	-1.43	18.6	11.2	0.52
13	44.2	540.5	-3.4	25.3	-0.16	15.8	10.5	0.49
14	47.6	555.6	-5.8	26.0	-0.27	15.4	10.1	0.47
15	51.0	487.1	-0.0	22.8	-0.00	12.7	9.7	0.45
16	54.4	497.7	-0.0	23.2	-0.00	12.3	9.4	0.42
17	57.8	423.9	-0.0	19.8	-0.00	9.9	10.3	0.40
18	61.2	398.6	-0.0	18.6	-0.00	9.6	11.5	0.38
19	64.6	348.9	-0.0	16.3	-0.00	7.4	12.1	0.36
20	68.0	361.9	-0.0	16.9	-0.00	5.8	11.4	0.34
Absolute	34.0			30.3			(T =	38.0 ms)
	34.0				-2.57		(T =	59.5 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	654.0	602.6	551.2	499.9	448.5	397.1	345.7	294.4	243.0	191.6
RX	660.9	611.4	570.5	548.3	526.0	503.7	481.4	464.9	454.0	443.1
RU	654.0	602.6	551.2	499.9	448.5	397.1	345.7	294.4	243.0	191.6

RAU = 324.5 (kips); RA2 = 541.5 (kips)

Current CAPWAP Ru = 444.0 (kips); Corresponding J(RP)= 0.41; J(RX) = 0.89

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
14.4	36.01	550.7	617.0	618.3	0.81	0.20	0.20	27.6	657.8	990

PILE PROFILE AND PILE MODEL

Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	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 in²

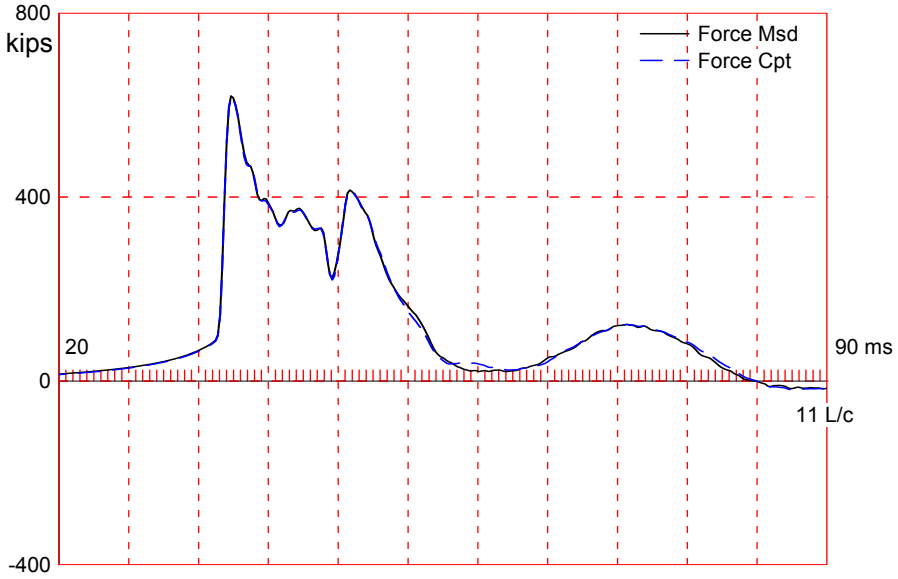
Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
14	47.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020

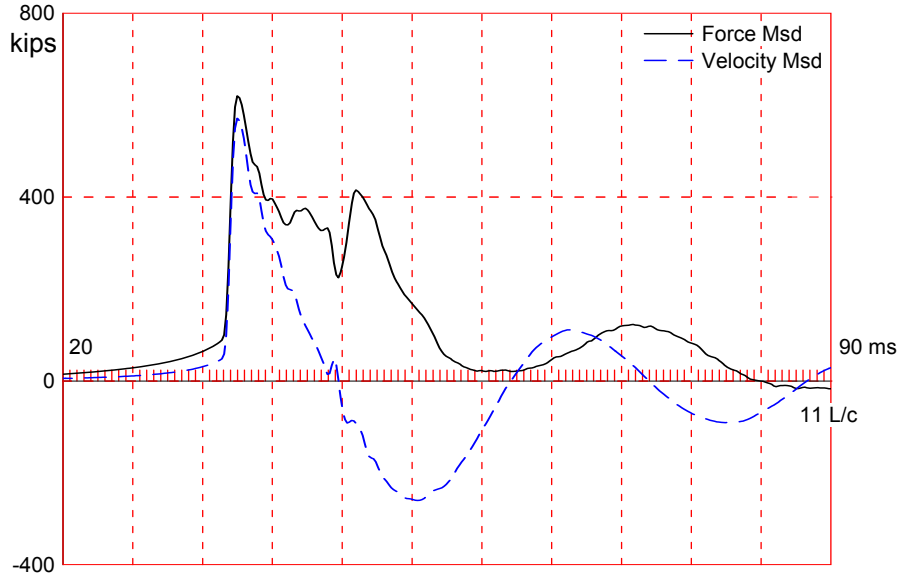
Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
18	61.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
20	68.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

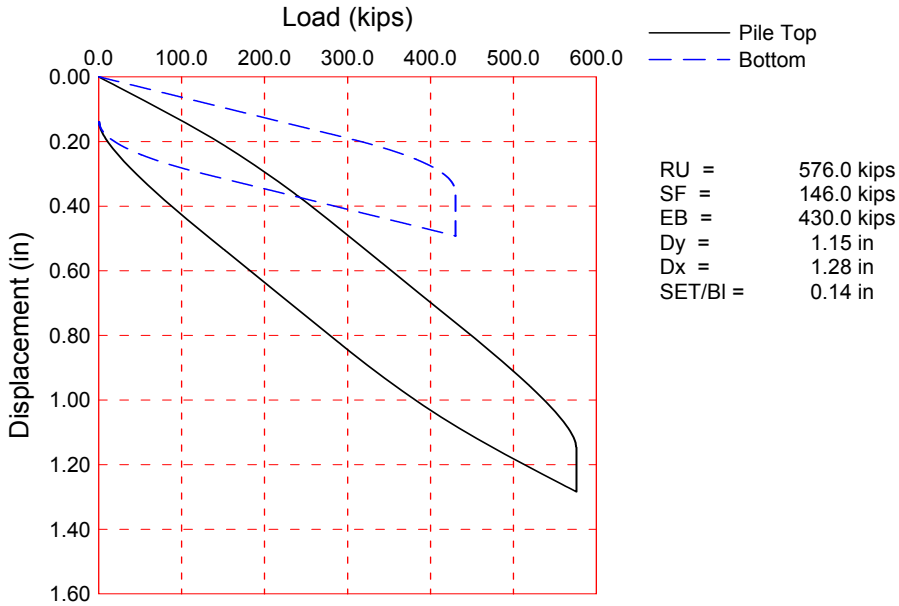
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.202 ms, 2L/c 8.1 ms
Total volume: 10.106 ft^{3}, Volume ratio considering added impedance: 1.000

DYNAMIC RESISTANCE TABLE

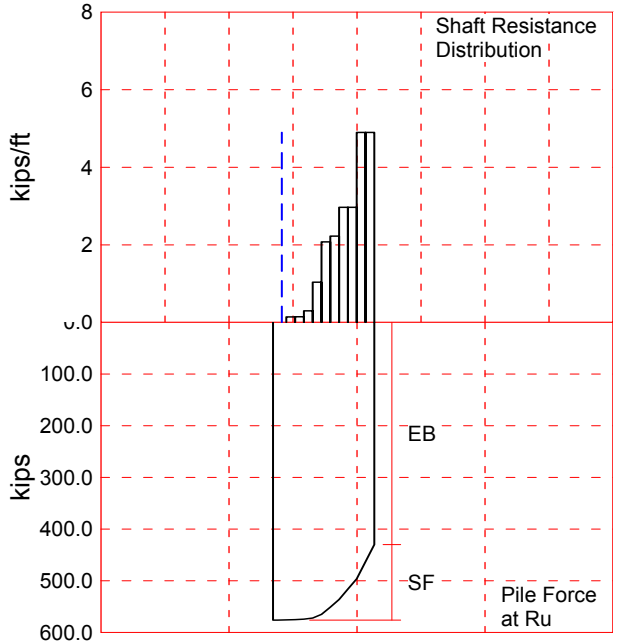
Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Damping Rd at Max. Rt kips	Max Rt (Ru+Rd) kips	Total Unit Rt W. Resp. to Depth kips/ft	Area ksf	Quake in
1	6.8	2.3	1.0	3.6	4.6	1.99	0.42	0.08
2	13.6	9.1	2.0	7.0	9.0	1.33	0.28	0.08
3	20.4	15.9	2.0	6.9	8.9	1.31	0.28	0.08
4	27.2	22.7	3.0	10.0	13.0	1.91	0.41	0.08
5	34.0	29.5	23.0	69.3	92.3	13.57	2.89	0.08
6	40.8	36.3	23.0	62.5	85.5	12.57	2.68	0.08
7	47.6	43.1	25.0	60.4	85.4	12.56	2.67	0.08
8	54.4	49.9	26.0	58.0	84.0	12.36	2.63	0.08
9	61.2	56.7	26.0	72.6	98.6	14.50	3.09	0.08
10	68.0	63.5	26.0	73.1	99.1	14.58	3.10	0.08
Avg. Shaft			15.7	42.3	58.0	9.14	1.95	0.08
Toe			287.0	28.7	315.7		229.04	0.31
Total					896.2			







RU =	576.0 kips
SF =	146.0 kips
EB =	430.0 kips
Dy =	1.15 in
Dx =	1.28 in
SET/BI =	0.14 in



Length b. Sensors	77.5 ft
Embedment	67.6 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	1.16
Top Compr. Stress	28.9 ksi
Max Compr. Stress	30.1 ksi
Max Tension Stress	-3.11 ksi
Avg. Shaft Quake	0.07 in
Toe Quake	0.27 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.06 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 576.0; along Shaft 146.0; 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
				576.0			
1	16.8	7.0	1.0	575.0	1.0	0.14	0.03
2	23.6	13.7	1.0	574.0	2.0	0.15	0.03
3	30.3	20.5	2.0	572.0	4.0	0.30	0.06
4	37.1	27.2	7.0	565.0	11.0	1.04	0.22
5	43.8	33.9	14.0	551.0	25.0	2.08	0.44
6	50.5	40.7	15.0	536.0	40.0	2.23	0.47
7	57.3	47.4	20.0	516.0	60.0	2.97	0.63
8	64.0	54.2	20.0	496.0	80.0	2.97	0.63
9	70.8	60.9	33.0	463.0	113.0	4.90	1.04
10	77.5	67.6	33.0	430.0	146.0	4.90	1.04
Avg. Shaft			14.6			2.16	0.46
Toe			430.0				311.94

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.26	0.06
Quake	(in)	0.07	0.27
Case Damping Factor		0.99	0.68
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	52
Unloading Level	(% of Ru)	49	
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)	0.060	0.059

CAPWAP match quality = 1.16 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.14 in; Blow Count = 87 b/ft
Computed: Final Set = 0.15 in; Blow Count = 78 b/ft
Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K3550) CAL: 360; RF: 1.05; A4(K2524) CAL: 360; RF: 1.05

max. Top Comp. Stress = 28.9 ksi (T= 36.1 ms, max= 1.041 x Top)
max. Comp. Stress = 30.1 ksi (Z= 37.1 ft, T= 38.3 ms)
max. Tens. Stress = -3.11 ksi (Z= 50.5 ft, T= 60.1 ms)
max. Energy (EMX) = 30.5 kip-ft; max. Measured Top Displ. (DMX)= 0.90 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	618.8	-22.2	28.9	-1.04	30.5	15.0	0.89
2	6.7	619.8	-25.4	29.0	-1.18	30.3	15.0	0.88
4	13.5	623.4	-31.4	29.1	-1.47	29.7	14.8	0.83
5	16.8	625.4	-34.5	29.2	-1.61	29.4	14.8	0.81
6	20.2	622.9	-36.9	29.1	-1.73	28.8	14.7	0.79
7	23.6	625.6	-40.0	29.2	-1.87	28.3	14.6	0.76
8	27.0	624.4	-42.4	29.2	-1.98	27.7	14.5	0.73
9	30.3	631.6	-46.6	29.5	-2.18	27.1	14.3	0.71
10	33.7	631.0	-52.1	29.5	-2.43	26.2	14.1	0.68
11	37.1	644.1	-58.7	30.1	-2.74	25.6	13.8	0.65
12	40.4	625.7	-59.8	29.2	-2.79	23.8	13.5	0.61
13	43.8	642.8	-65.8	30.0	-3.07	23.2	13.1	0.58
14	47.2	604.7	-61.3	28.2	-2.87	20.6	12.5	0.55
15	50.5	621.5	-66.6	29.0	-3.11	19.9	12.0	0.52
16	53.9	573.4	-60.8	26.8	-2.84	17.4	11.6	0.49
17	57.3	580.3	-66.3	27.1	-3.10	16.7	11.3	0.46
18	60.7	519.4	-60.0	24.3	-2.80	14.0	11.0	0.43
19	64.0	544.9	-64.1	25.5	-2.99	13.4	10.5	0.40
20	67.4	498.3	-54.5	23.3	-2.55	11.0	10.5	0.37
21	70.8	509.0	-55.4	23.8	-2.59	10.4	11.4	0.33
22	74.1	479.7	-37.5	22.4	-1.75	7.5	11.7	0.31
23	77.5	489.2	-38.5	22.9	-1.80	5.7	10.9	0.28
Absolute	37.1			30.1			(T =	38.3 ms)
	50.5				-3.11		(T =	60.1 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	702.6	652.9	603.2	553.5	503.7	454.0	404.3	354.6	304.8	255.1
RX	738.7	700.1	662.1	639.3	620.8	602.4	583.9	565.5	557.0	548.5
RU	702.6	652.9	603.2	553.5	503.7	454.0	404.3	354.6	304.8	255.1

RAU = 411.5 (kips); RA2 = 619.9 (kips)

Current CAPWAP Ru = 576.0 (kips); Corresponding J(RP)= 0.25; J(RX) = 0.64

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
15.1	35.89	575.8	624.1	624.1	0.90	0.14	0.14	30.8	714.3	1792

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

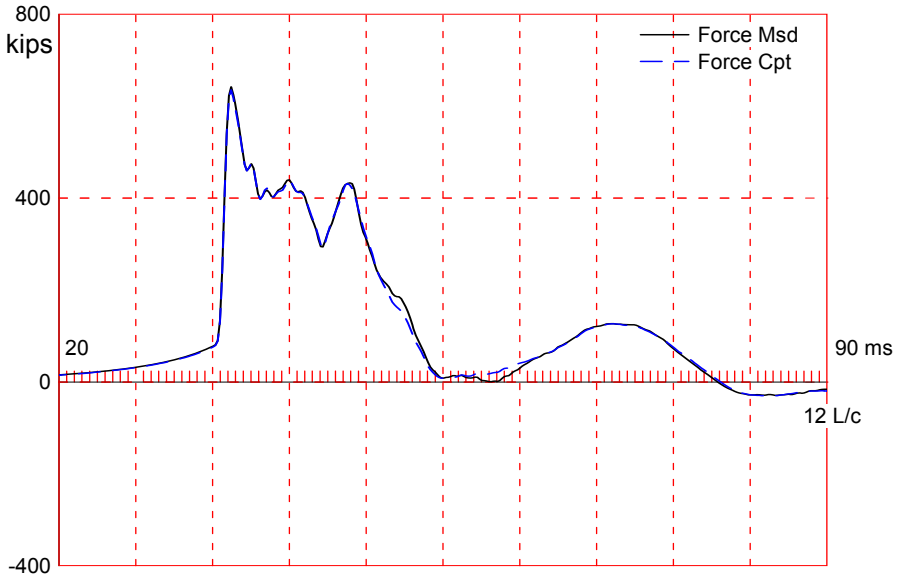
Toe Area 198.5 in^2

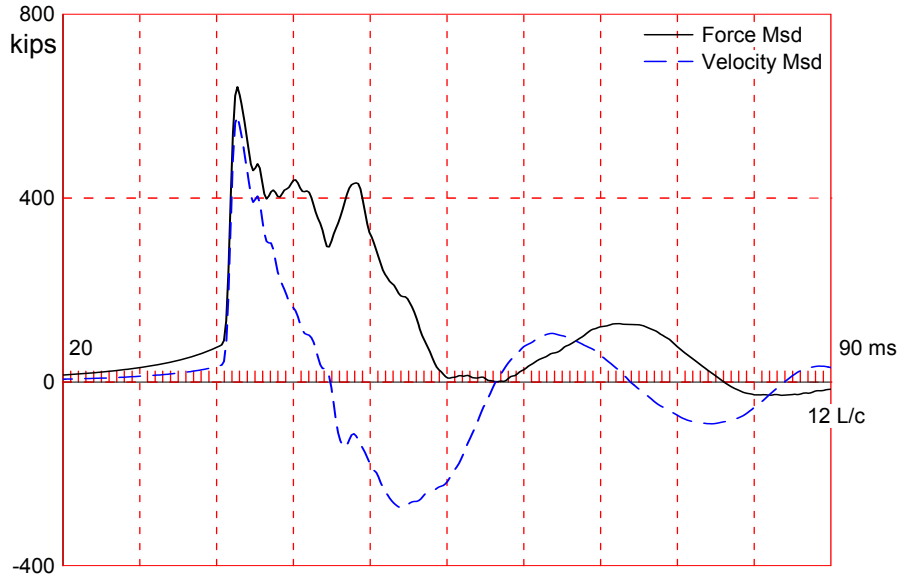
Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
16	53.9	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
19	64.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

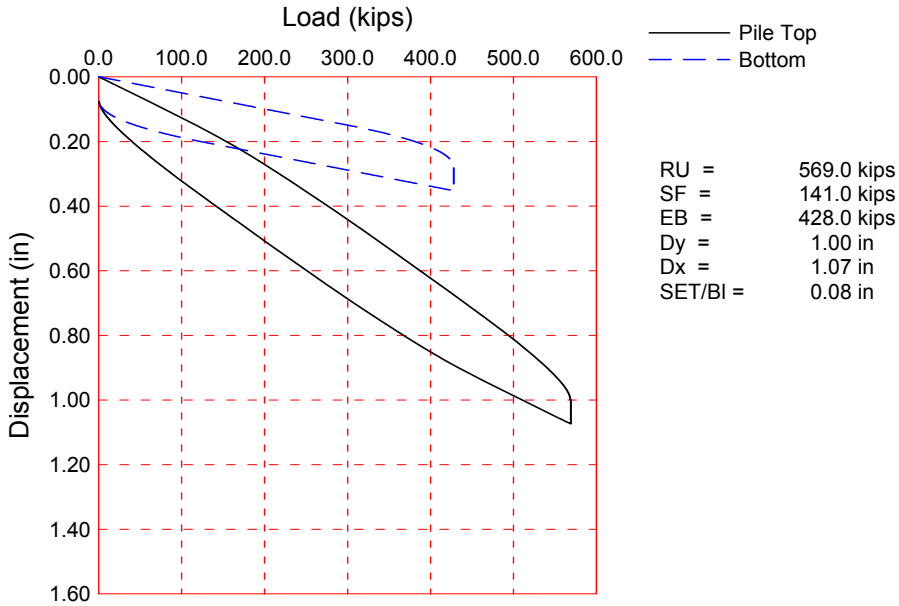
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000

DYNAMIC RESISTANCE TABLE

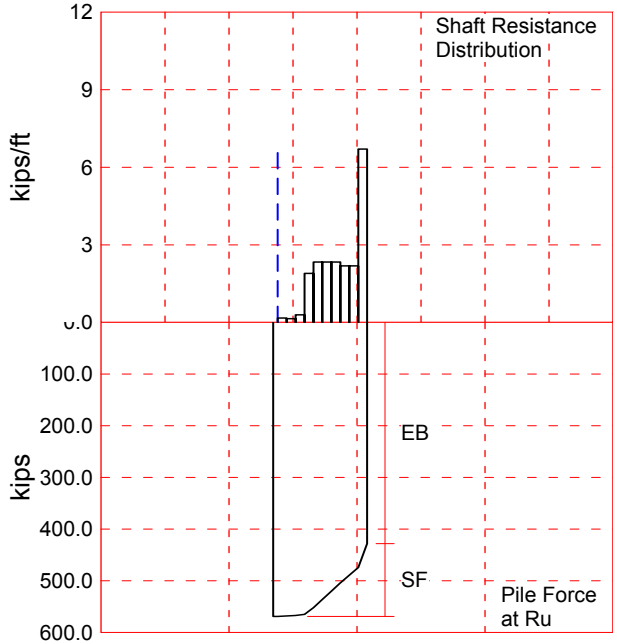
Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Damping Rd at Max. Rt kips	Max Rt (Ru+Rd) kips	Total Unit Rt W. Resp. to Depth kips/ft	Area ksf
1	16.8	7.0	1.0	3.8	4.8	0.69	0.15
2	23.6	13.7	1.0	3.8	4.8	0.71	0.15
3	30.3	20.5	2.0	7.4	9.4	1.40	0.30
4	37.1	27.2	7.0	25.0	32.0	4.75	1.01
5	43.8	33.9	14.0	47.0	61.0	9.05	1.93
6	50.5	40.7	15.0	46.1	61.1	9.06	1.93
7	57.3	47.4	20.0	57.2	77.2	11.45	2.44
8	64.0	54.2	20.0	53.4	73.4	10.89	2.32
9	70.8	60.9	33.0	94.5	127.5	18.93	4.03
10	77.5	67.6	33.0	90.2	123.2	18.28	3.89
Avg. Shaft			14.6	42.9	57.5	8.49	1.81
Toe			430.0	13.9	443.9		322.00
Total					1018.4		







RU =	569.0 kips
SF =	141.0 kips
EB =	428.0 kips
Dy =	1.00 in
Dx =	1.07 in
SET/BI =	0.08 in



Length b. Sensors	72.0 ft
Embedment	67.7 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	1.47
Top Compr. Stress	29.8 ksi
Max Compr. Stress	31.4 ksi
Max Tension Stress	-3.04 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.21 in
Avg. Shaft Smith Dpg.	0.32 s/ft
Toe Smith Damping	0.12 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 569.0; along Shaft 141.0; at Toe 428.0 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
				569.0			
1	10.3	6.0	1.0	568.0	1.0	0.17	0.04
2	17.1	12.8	1.0	567.0	2.0	0.15	0.03
3	24.0	19.7	2.0	565.0	4.0	0.29	0.06
4	30.9	26.6	13.0	552.0	17.0	1.90	0.40
5	37.7	33.4	16.0	536.0	33.0	2.33	0.50
6	44.6	40.3	16.0	520.0	49.0	2.33	0.50
7	51.4	47.1	16.0	504.0	65.0	2.33	0.50
8	58.3	54.0	15.0	489.0	80.0	2.19	0.47
9	65.1	60.8	15.0	474.0	95.0	2.19	0.47
10	72.0	67.7	46.0	428.0	141.0	6.71	1.43
Avg. Shaft			14.1			2.08	0.44
Toe			428.0				310.49

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.32	0.12
Quake	(in)	0.09	0.21
Case Damping Factor		1.18	1.34
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	83	98
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.080	0.080

CAPWAP match quality = 1.47 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.08 in; Blow Count = 147 b/ft

Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.04; A4(K3550) CAL: 360; RF: 1.04

max. Top Comp. Stress = 29.8 ksi (T= 36.1 ms, max= 1.053 x Top)
max. Comp. Stress = 31.4 ksi (Z= 30.9 ft, T= 37.7 ms)
max. Tens. Stress = -3.04 ksi (Z= 30.9 ft, T= 57.1 ms)
max. Energy (EMX) = 30.0 kip-ft; max. Measured Top Displ. (DMX)= 0.84 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	637.4	-34.3	29.8	-1.60	30.0	15.3	0.83
2	6.9	639.9	-38.4	29.9	-1.79	29.7	15.2	0.81
3	10.3	642.2	-42.8	30.0	-2.00	29.3	15.1	0.79
4	13.7	639.0	-45.6	29.9	-2.13	28.6	15.0	0.76
5	17.1	642.1	-49.4	30.0	-2.31	28.1	14.9	0.73
6	20.6	640.7	-51.8	29.9	-2.42	27.3	14.8	0.70
7	24.0	650.0	-55.1	30.4	-2.57	26.7	14.6	0.67
8	27.4	656.8	-56.9	30.7	-2.66	25.6	14.1	0.64
9	30.9	671.3	-65.1	31.4	-3.04	24.9	13.7	0.60
10	34.3	622.4	-48.3	29.1	-2.26	22.0	13.1	0.57
11	37.7	638.9	-55.5	29.8	-2.59	21.3	12.7	0.54
12	41.1	585.0	-34.4	27.3	-1.61	18.3	12.0	0.50
13	44.6	605.0	-41.2	28.3	-1.92	17.6	11.5	0.47
14	48.0	547.0	-23.0	25.6	-1.07	15.0	11.0	0.44
15	51.4	560.0	-30.5	26.2	-1.43	14.2	10.7	0.40
16	54.9	510.5	-16.6	23.9	-0.77	11.9	10.4	0.37
17	58.3	522.4	-23.4	24.4	-1.09	11.2	10.2	0.34
18	61.7	513.6	-11.4	24.0	-0.53	9.4	9.8	0.31
19	65.1	532.1	-16.2	24.9	-0.76	8.7	9.9	0.28
20	68.6	522.3	-1.7	24.4	-0.08	7.2	10.2	0.24
21	72.0	531.3	-5.2	24.8	-0.24	5.1	9.2	0.21
Absolute	30.9			31.4			(T =	37.7 ms)
	30.9				-3.04		(T =	57.1 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	774.8	728.7	682.6	636.5	590.4	544.3	498.2	452.1	405.9	359.8
RX	781.1	742.8	708.6	676.1	648.0	630.2	612.8	595.4	579.2	567.6
RU	774.8	728.7	682.6	636.5	590.4	544.3	498.2	452.1	405.9	359.8

RAU = 426.2 (kips); RA2 = 642.7 (kips)

Current CAPWAP Ru = 569.0 (kips); Corresponding J(RP)= 0.45; J(RX) = 0.89

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
15.4	35.90	586.7	649.3	649.3	0.84	0.08	0.08	30.3	796.2	2140

PILE PROFILE AND PILE MODEL

Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
72.0	21.4	29992.2	492.000	4.70

Toe Area 198.5 in²

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

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
14	48.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
18	61.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
21	72.0	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 0.204 ms, 2L/c 8.6 ms
Total volume: 10.700 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
1	10.3	6.0	1.0	4.8	5.8	0.97	0.21
2	17.1	12.8	1.0	4.8	5.8	0.84	0.18
3	24.0	19.7	2.0	9.3	11.3	1.65	0.35
4	30.9	26.6	13.0	56.2	69.2	10.09	2.15
5	37.7	33.4	16.0	63.9	79.9	11.66	2.48
6	44.6	40.3	16.0	57.6	73.6	10.74	2.29
7	51.4	47.1	16.0	52.7	68.7	10.02	2.13
8	58.3	54.0	15.0	47.0	62.0	9.04	1.92
9	65.1	60.8	15.0	46.7	61.7	9.00	1.91
10	72.0	67.7	46.0	116.4	162.4	23.68	5.04
Avg. Shaft			14.1	45.9	60.0	8.87	1.89
Toe			428.0	31.3	459.3		333.21
Total					1059.8		

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Al Ziai
Company: Lunda Construction Co.	No. of Sheets: 47
E-mail: kweber@lundaconstruction.com	Date: April 30, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 17
Winnebago County, Wisconsin

On April 28, 2015, Pier 17 #1, Pier 17 #36, and Pier 17 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on April 29. 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 ring at EL 740.9. We understand the pier was excavated to an elevation of EL 721.4.

Pier 17 #1 was driven to a depth of 65.4 feet, which corresponds to a pile tip elevation of EL 675.5. The blow count over the final increment of driving was 10 blows for 2 inches of penetration at an average hammer stroke of 9.0 feet. The blow count at the beginning of restrike was 10 blows per for 2 inches of penetration at an average hammer stroke of 7.9 feet.

Pier 17 #36 was driven to a depth of 55.5 feet, which corresponds to a pile tip elevation of EL 685.4. The blow count over the final increment of driving was 10 blows for 2 inches of penetration at an average hammer stroke of 9.2 feet. The blow count at the beginning of restrike was 10 blows for 1 ½ inches of penetration at an average hammer stroke of 8.1 feet.

Pier 16 #44 was driven to a depth of 61.1 feet, which corresponds to a pile tip elevation of EL 679.8. The blow count over the final increment of driving was 10 blows for 1 ¾ inches of penetration at an average hammer stroke of 9.3 feet. The blow count at the beginning of restrike was 10 blows for 1 ¼ inch of penetration at an average hammer stroke of 8.0 feet

We recommend the production piles at Pier 17 of Structure B-70-403, driven with an APE D30-42 hammer PD0256, 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	10	7
7.5	8	6
8.0	6	5
8.5	5	4
9.0	4	4
9.5	4	3

Additionally, all production piles should achieve the minimum pile tip elevation of EL 685.0 for uplift, as indicated on the plans. Please note that Pier 17 #36 terminated five inches above this minimum pile tip elevation. 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.

Al Ziai

Travis Coleman, P.E.

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

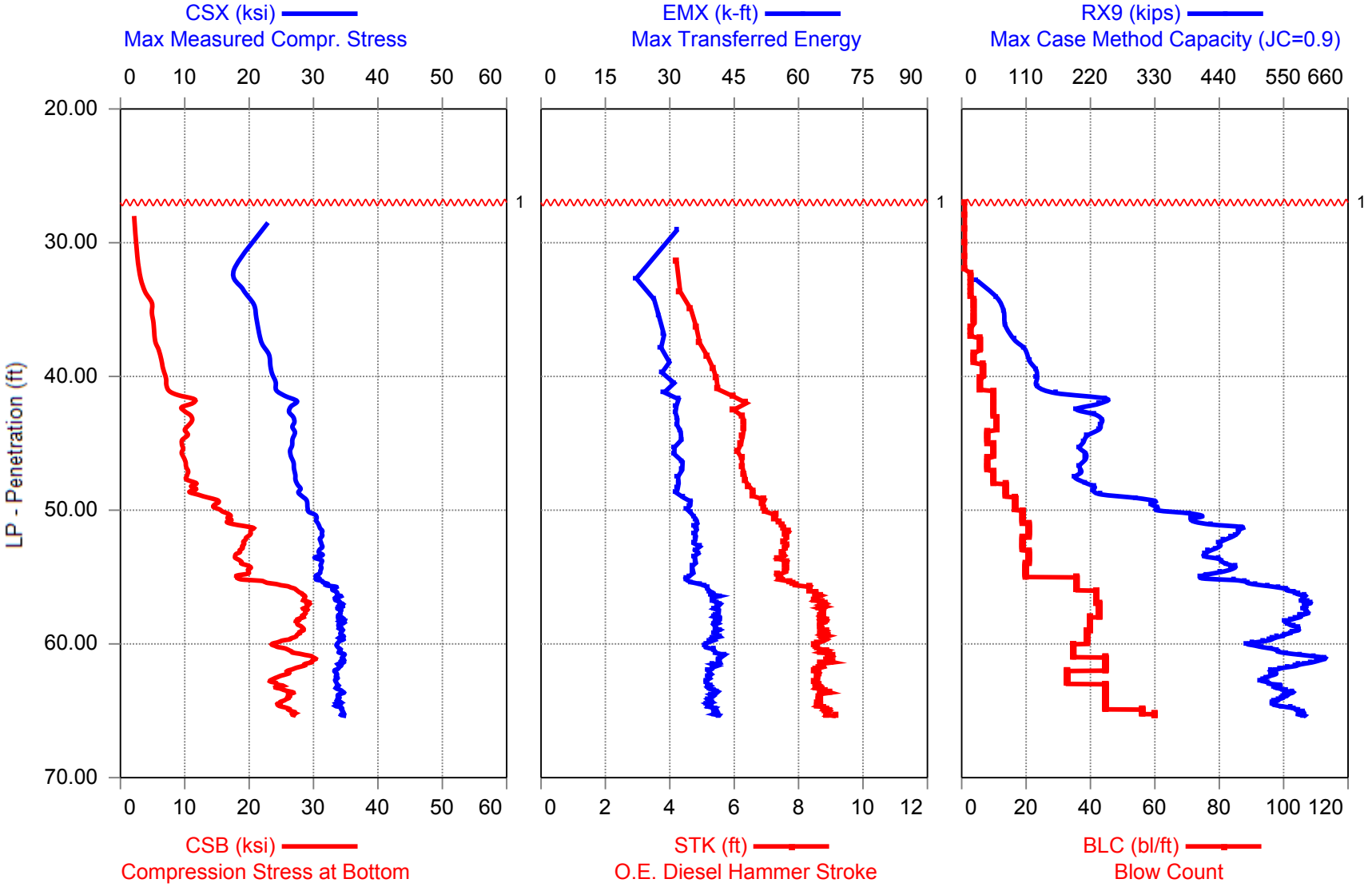
Attachments:

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

GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.49.5 - Case Method & iCAP® Results

Printed: 29-April-2015 Test started: 28-April-2015

USH 10 over LLBDM - PIER 17 #1 EOID - APE D30-42, HP 14 x 73



1 - Reference elevation EL 740.9. Mud line EL 721.4

USH 10 over LLBDM - PIER 17 #1 EOID APE D30-42, HP 14 x 73
OP: TC Date: 28-April-2015

AR: 21.40 in² 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
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#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
6	32.00	1	AV6	21.9	2.4	4.6	31	55.2	0
			MAX	24.1	3.4	5.2	42	61.8	0
			MIN	15.8	1.6	3.5	18	51.2	0
9	33.00	3	AV3	16.5	3.2	3.8	20	59.2	19
			MAX	18.2	3.4	4.2	23	61.8	34
			MIN	14.8	3.0	3.5	17	57.0	4
12	34.00	3	AV3	19.3	3.8	4.3	25	55.9	51
			MAX	19.8	4.0	4.4	26	56.9	55
			MIN	18.4	3.7	4.2	25	55.3	49
16	35.00	4	AV4	20.7	4.8	4.6	27	54.1	69
			MAX	21.2	5.2	4.7	28	55.3	73
			MIN	19.7	4.5	4.4	26	53.7	63
20	36.00	4	AV4	21.1	5.1	4.7	28	53.7	75
			MAX	21.9	5.3	4.9	30	54.9	81
			MIN	20.3	4.9	4.5	25	52.8	71
23	37.00	3	AV3	21.5	5.3	4.8	31	53.3	73
			MAX	21.9	5.3	4.9	31	53.8	77
			MIN	21.0	5.1	4.7	30	53.0	65
29	38.00	6	AV6	22.1	5.6	5.0	27	52.4	101
			MAX	23.0	5.9	5.2	29	53.6	111
			MIN	21.1	5.2	4.7	25	51.3	90
33	39.00	4	AV4	22.9	6.3	5.2	31	51.5	112
			MAX	23.6	6.6	5.3	31	52.3	116
			MIN	22.2	6.1	5.0	29	50.9	107
40	40.00	7	AV7	23.6	6.8	5.4	28	50.6	127
			MAX	24.1	7.1	5.5	29	51.2	130
			MIN	23.1	6.5	5.2	28	49.9	125
46	41.00	6	AV6	24.2	7.3	5.5	31	50.0	129
			MAX	24.6	7.9	5.6	32	50.5	135
			MIN	23.7	6.9	5.4	30	49.5	121
56	42.00	10	AV10	26.0	9.9	6.0	30	48.0	212
			MAX	27.7	12.0	6.5	33	50.1	256
			MIN	24.0	7.3	5.5	27	46.1	141
66	43.00	10	AV10	26.4	10.2	6.1	31	47.5	214
			MAX	27.3	11.4	6.4	33	48.3	242
			MIN	25.6	9.1	5.9	30	46.5	192

USH 10 over LLBDM - PIER 17 #1 EOID APE D30-42, HP 14 x 73
OP: TC Date: 28-April-2015

BL#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
77	44.00	11	AV11	26.9	10.6	6.3	32	46.9	239
			MAX	27.7	11.4	6.5	34	47.4	244
			MIN	26.4	9.5	6.1	30	46.1	231
85	45.00	8	AV8	26.8	10.1	6.2	33	47.0	212
			MAX	27.4	10.8	6.4	34	47.6	226
			MIN	26.3	9.1	6.1	32	46.5	200
95	46.00	10	AV10	26.5	9.6	6.1	31	47.4	208
			MAX	27.3	10.1	6.5	34	48.5	217
			MIN	25.4	9.0	5.9	28	46.3	193
103	47.00	8	AV8	27.0	10.2	6.3	33	46.9	205
			MAX	27.2	10.7	6.4	34	47.7	215
			MIN	26.4	9.6	6.1	32	46.4	194
113	48.00	10	AV10	27.2	10.7	6.3	32	46.7	202
			MAX	27.8	12.3	6.6	34	47.2	217
			MIN	26.7	9.7	6.2	31	45.9	192
127	49.00	14	AV14	27.8	11.5	6.5	32	46.1	233
			MAX	28.6	13.6	6.8	34	46.8	283
			MIN	27.0	10.2	6.3	29	45.1	204
144	50.00	17	AV17	29.0	14.8	6.9	34	44.8	325
			MAX	29.8	16.2	7.1	36	45.5	354
			MIN	28.3	13.7	6.7	32	44.1	284
163	51.00	19	AV19	30.1	16.7	7.2	36	43.8	391
			MAX	31.0	18.4	7.5	38	44.9	429
			MIN	29.1	14.9	6.9	33	43.1	333
184	52.00	21	AV21	31.2	19.8	7.6	36	42.8	467
			MAX	32.1	21.0	7.9	38	43.8	486
			MIN	30.2	17.2	7.2	34	41.9	419
203	53.00	19	AV19	31.1	19.1	7.6	36	42.9	442
			MAX	31.7	19.8	7.8	38	43.7	461
			MIN	30.3	18.2	7.3	34	42.3	427
224	54.00	21	AV21	31.0	18.3	7.5	36	43.0	429
			MAX	31.7	19.0	7.7	38	44.2	452
			MIN	29.7	17.1	7.1	34	42.5	402
244	55.00	20	AV20	30.9	19.5	7.5	35	43.0	444
			MAX	31.6	21.0	7.8	36	44.2	472
			MIN	29.5	17.9	7.1	34	42.4	399
280	56.00	36	AV36	32.0	23.5	7.9	36	42.0	496
			MAX	34.0	27.6	8.6	41	44.0	559
			MIN	30.0	17.8	7.2	32	40.3	401

USH 10 over LLBDM - PIER 17 #1 EOID APE D30-42, HP 14 x 73
OP: TC Date: 28-April-2015

BL#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
322	57.00	42	AV42	33.8	28.5	8.6	40	40.4	581
			MAX	35.2	29.6	9.1	43	41.1	598
			MIN	33.2	27.4	8.3	38	39.2	558
365	58.00	43	AV43	34.1	28.7	8.7	41	40.0	585
			MAX	35.3	29.7	9.1	44	40.7	606
			MIN	33.3	28.0	8.4	39	39.2	573
405	59.00	40	AV40	34.3	27.9	8.8	41	39.9	566
			MAX	35.4	28.7	9.2	44	40.7	589
			MIN	33.3	27.1	8.4	39	39.1	547
444	60.00	39	AV39	34.2	26.4	8.8	40	40.0	536
			MAX	35.1	28.3	9.1	43	40.6	571
			MIN	33.5	23.5	8.5	38	39.3	490
479	61.00	35	AV35	34.1	26.5	8.8	40	40.0	543
			MAX	35.7	30.0	9.3	45	41.0	615
			MIN	32.9	23.1	8.3	37	38.8	484
524	62.00	45	AV45	34.2	28.6	8.8	41	39.9	581
			MAX	35.8	30.7	9.4	44	41.2	627
			MIN	32.7	25.9	8.2	38	38.6	528
557	63.00	33	AV33	33.5	24.6	8.6	39	40.4	524
			MAX	34.1	26.7	8.9	41	40.9	547
			MIN	32.8	23.1	8.4	37	39.7	507
602	64.00	45	AV45	34.0	25.6	8.7	40	40.1	550
			MAX	35.3	27.0	9.2	42	40.9	574
			MIN	33.0	23.8	8.4	38	39.1	527
642	64.90	45	AV40	33.9	25.3	8.7	40	40.2	544
			MAX	34.5	26.5	8.9	41	40.9	571
			MIN	32.9	24.2	8.4	37	39.7	526
652	65.07	56	AV10	34.4	26.4	8.9	41	39.7	575
			MAX	35.1	27.2	9.2	42	40.3	585
			MIN	33.7	25.7	8.6	39	39.0	564
662	65.25	56	AV10	34.6	27.0	8.9	41	39.6	582
			MAX	35.1	27.4	9.1	42	39.9	586
			MIN	34.1	26.7	8.8	40	39.2	572
672	65.42	60	AV10	34.6	27.0	9.0	41	39.5	582
			MAX	35.2	27.5	9.2	42	40.0	594
			MIN	33.9	26.5	8.7	40	39.0	573
			Average	31.6	21.8	7.9	37	42.4	458
			Maximum	35.8	30.7	9.4	45	61.8	627
			Minimum	14.8	1.6	3.5	17	38.6	0

Total number of blows analyzed: 672

BL# Sensors

1-672 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.00); A4: [K3550] 360.0 (1.00)

BL# Comments

1 Reference elevation EL 740.9. Mud line EL 721.4
670 CW

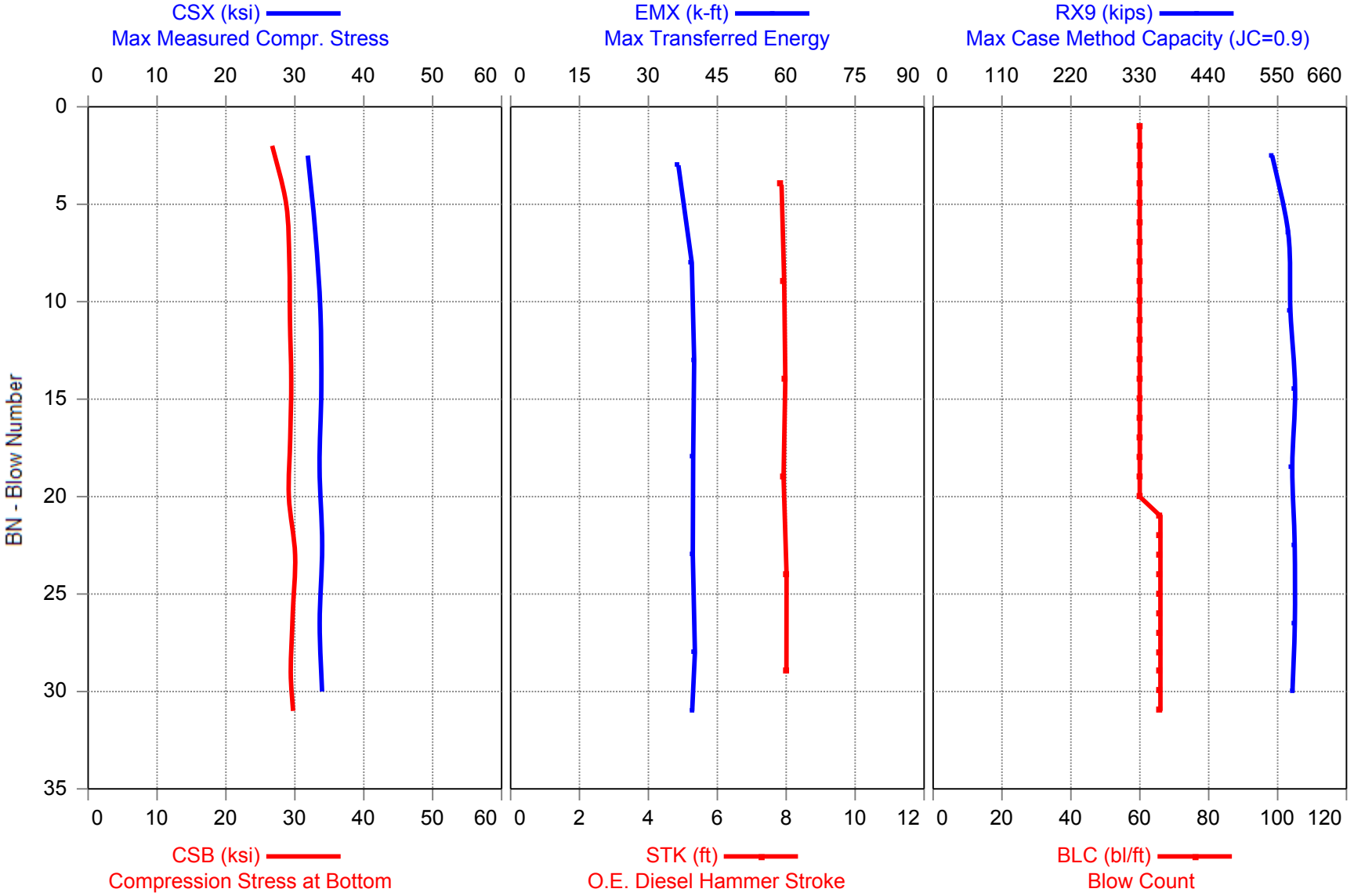
Time Summary

Drive 16 minutes 29 seconds 6:38 AM - 6:54 AM BN 1 - 672

GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.49.5 - Case Method & iCAP® Results

Printed: 29-April-2015 Test started: 29-April-2015

USH 10 over LLBDM - PIER 17 #1 BOR - APE D30-42, HP 14 x 73



USH 10 over LLBDM - PIER 17 #1 BOR APE D30-42, HP 14 x 73
OP: TC Date: 29-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.60 ft EM: 30,000 ksi
WS: 16,807.9 f/s 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#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	64.58	60	AV10	32.7	28.3	7.9	38	42.0	557
			MAX	33.9	29.4	8.2	42	42.6	575
			MIN	27.3	23.5	7.7	27	41.3	478
20	64.75	60	AV10	33.7	29.4	8.0	40	41.9	575
			MAX	34.5	29.8	8.3	42	42.3	586
			MIN	33.0	28.9	7.8	38	41.1	567
31	64.92	66	AV11	33.8	29.6	8.0	40	41.8	576
			MAX	34.4	30.3	8.2	41	42.4	585
			MIN	33.1	28.7	7.8	39	41.3	570
			Average	33.4	29.1	8.0	39	41.9	570
			Maximum	34.5	30.3	8.3	42	42.6	586
			Minimum	27.3	23.5	7.7	27	41.1	478

Total number of blows analyzed: 31

BL# Sensors

1-31 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.03); A4: [K3550] 360.0 (1.03)

BL# Comments

3 CW

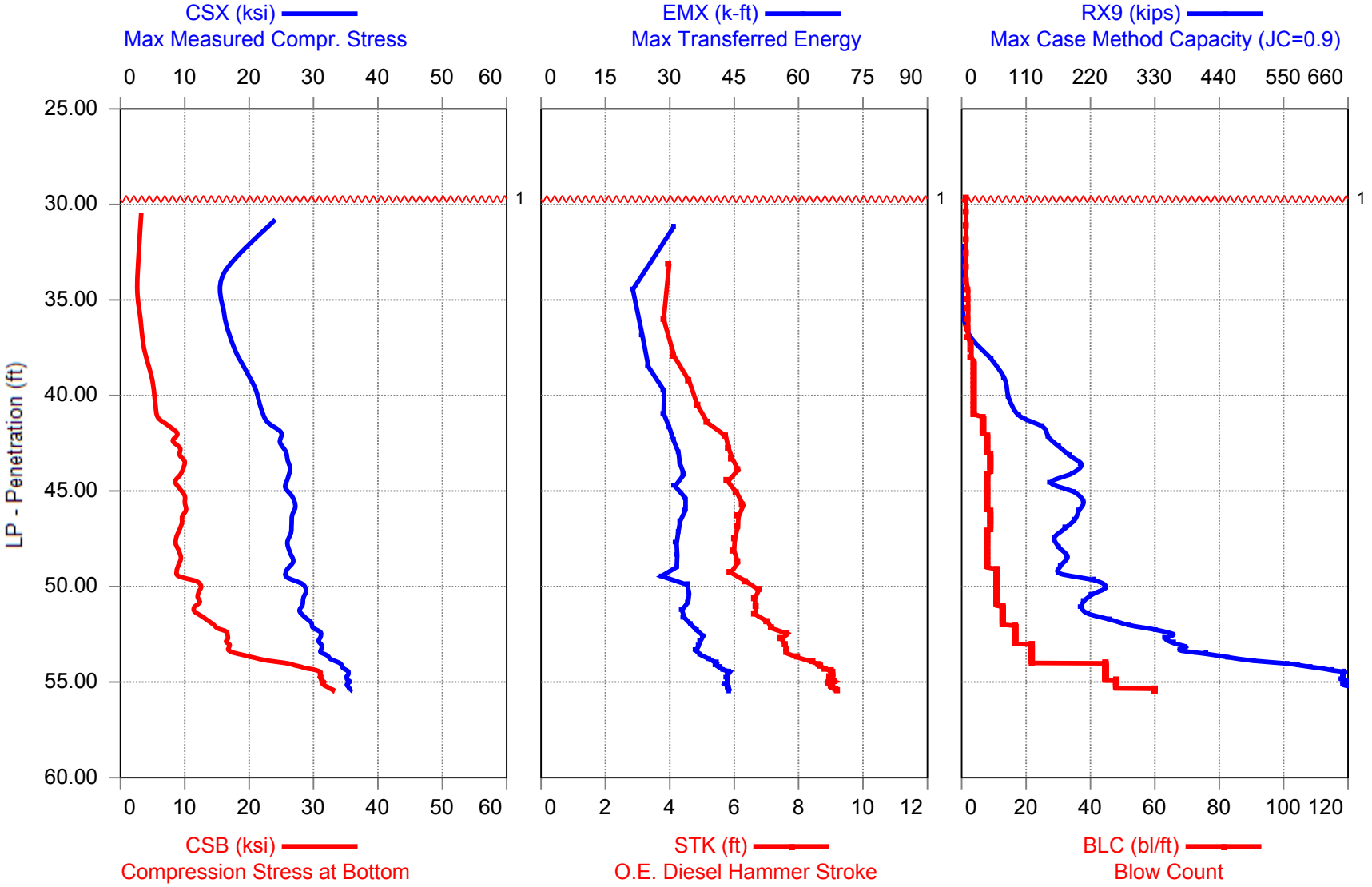
Time Summary

Drive 42 seconds 6:57 AM - 6:57 AM BN 1 - 31

GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.49.5 - Case Method & iCAP® Results

Printed: 29-April-2015 Test started: 28-April-2015

USH 10 over LLBDM - PIER 17 #36 EOID - APE D30-42, HP 14 x 73



1 - Reference elevation EL 740.9. Mud line EL 721.4

USH 10 over LLBDM - PIER 17 #36 EOID APE D30-42, HP 14 x 73
OP: TC Date: 28-April-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
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#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
7	34.00	1	AV7	21.0	3.0	4.1	28	57.7	3
			MAX	26.0	4.1	5.2	38	62.8	18
			MIN	14.0	2.3	3.4	20	51.4	0
9	35.00	2	AV2	14.2	2.6	3.4	21	62.2	0
			MAX	14.9	2.7	3.6	22	63.1	0
			MIN	13.4	2.4	3.3	19	61.3	0
11	36.00	2	AV2	16.3	3.3	3.8	24	59.5	0
			MAX	16.8	3.3	3.9	24	60.2	0
			MIN	15.9	3.2	3.7	23	58.7	0
13	37.00	2	AV2	17.2	3.2	3.9	26	58.4	0
			MAX	17.5	3.6	4.0	26	58.8	0
			MIN	16.9	2.9	3.9	25	58.0	0
16	38.00	3	AV3	17.7	3.6	4.0	22	57.8	44
			MAX	18.0	3.8	4.1	23	58.1	46
			MIN	17.6	3.4	4.0	21	57.6	40
20	39.00	4	AV4	19.4	4.6	4.4	26	55.7	63
			MAX	20.7	5.0	4.6	28	56.4	69
			MIN	18.8	4.0	4.3	22	54.1	57
24	40.00	4	AV4	20.9	5.2	4.7	28	53.9	78
			MAX	21.4	5.3	4.8	29	54.2	85
			MIN	20.7	5.1	4.6	28	53.4	73
28	41.00	4	AV4	21.8	5.5	4.9	30	52.7	87
			MAX	22.2	5.8	5.0	32	53.2	95
			MIN	21.5	5.3	4.8	30	52.1	76
35	42.00	7	AV7	23.6	7.4	5.3	29	50.8	131
			MAX	25.0	8.9	5.8	32	53.3	155
			MIN	21.6	5.6	4.8	25	48.8	103
43	43.00	8	AV8	25.3	8.8	5.8	31	48.8	159
			MAX	26.3	9.6	6.0	33	50.0	181
			MIN	24.1	7.7	5.5	29	47.8	133
52	44.00	9	AV9	26.1	9.7	6.0	32	47.9	198
			MAX	26.6	10.1	6.1	34	48.8	207
			MIN	25.3	8.8	5.8	31	47.4	191
60	45.00	8	AV8	25.8	9.0	5.9	32	48.3	167
			MAX	27.0	9.8	6.3	35	49.3	190
			MIN	24.8	8.3	5.7	30	46.9	144

USH 10 over LLBDM - PIER 17 #36 EOID APE D30-42, HP 14 x 73
OP: TC Date: 28-April-2015

BL#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
68	46.00	8	AV8	27.0	10.0	6.2	34	47.1	205
			MAX	27.8	10.4	6.5	36	47.7	212
			MIN	26.2	9.8	6.1	33	46.3	193
77	47.00	9	AV9	26.6	9.6	6.1	32	47.5	191
			MAX	27.1	10.2	6.3	34	48.4	204
			MIN	25.7	9.0	5.9	31	47.0	177
85	48.00	8	AV8	26.2	8.8	6.0	32	47.9	161
			MAX	26.6	9.2	6.1	33	48.6	178
			MIN	25.6	8.5	5.8	30	47.5	145
93	49.00	8	AV8	26.5	9.2	6.1	32	47.7	175
			MAX	27.5	10.0	6.3	34	48.5	185
			MIN	25.6	8.8	5.9	30	46.8	158
104	50.00	11	AV11	26.7	10.3	6.2	31	47.3	205
			MAX	28.6	12.8	6.7	35	49.4	254
			MIN	24.6	8.2	5.6	27	45.5	162
115	51.00	11	AV11	28.6	12.2	6.7	34	45.5	220
			MAX	29.4	13.5	7.0	36	46.4	253
			MIN	27.6	11.6	6.4	32	44.5	205
128	52.00	13	AV13	28.6	12.6	6.8	34	45.2	235
			MAX	30.4	14.8	7.4	36	46.2	288
			MIN	27.3	11.1	6.5	32	43.5	200
145	53.00	17	AV17	30.8	16.2	7.4	37	43.3	343
			MAX	32.3	17.2	8.0	40	44.3	379
			MIN	29.7	14.6	7.1	34	41.7	290
167	54.00	22	AV22	32.0	19.3	7.9	38	42.2	428
			MAX	34.3	25.3	8.7	42	43.3	533
			MIN	30.6	16.5	7.4	35	40.2	370
208	54.92	45	AV41	35.0	29.8	8.9	43	39.7	628
			MAX	36.1	31.9	9.3	45	40.5	666
			MIN	33.9	26.2	8.5	40	38.8	552
218	55.13	48	AV10	35.5	31.5	9.0	44	39.4	656
			MAX	36.4	32.3	9.4	46	39.8	666
			MIN	34.9	31.2	8.8	43	38.7	651
228	55.33	48	AV10	35.4	32.1	9.0	44	39.4	665
			MAX	35.8	32.9	9.2	45	39.7	678
			MIN	34.8	31.4	8.9	43	39.1	647
238	55.50	60	AV10	35.6	33.0	9.2	44	39.1	689
			MAX	36.0	33.6	9.3	45	39.4	700
			MIN	35.1	32.4	9.0	43	38.8	679
			Average	29.1	16.8	7.1	36	45.2	341

USH 10 over LLBDM - PIER 17 #36 EOID APE D30-42, HP 14 x 73
OP: TC Date: 28-April-2015

BL#	Depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
			Maximum	36.4	33.6	9.4	46	63.1	700
			Minimum	13.4	2.3	3.3	19	38.7	0

Total number of blows analyzed: 238

BL# Sensors

1-238 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.00); A4: [K3550] 360.0 (1.00)

BL# Comments

1 Reference elevation EL 740.9. Mud line EL 721.4
232 CW

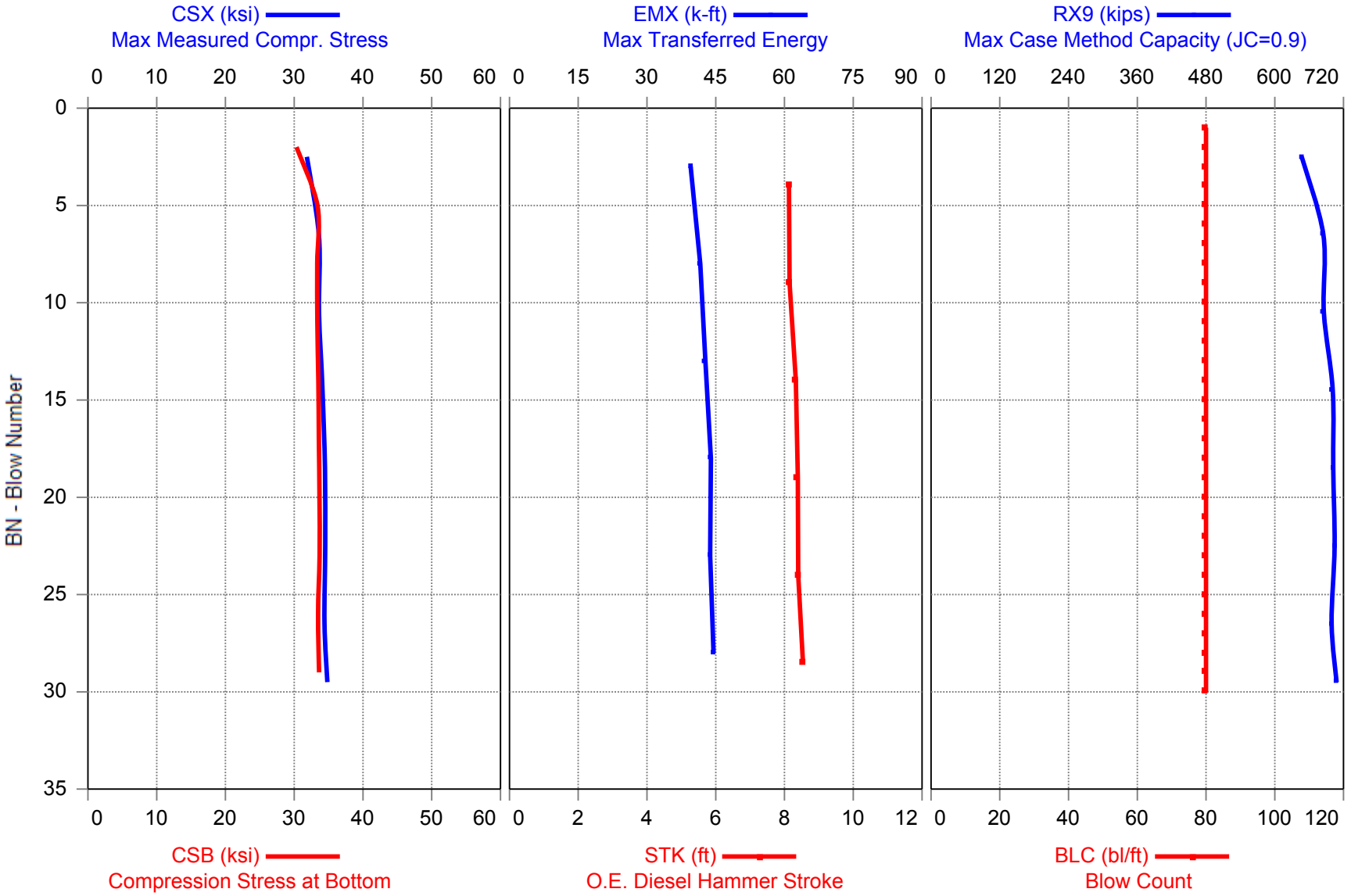
Time Summary

Drive 5 minutes 55 seconds 7:09 AM - 7:15 AM BN 1 - 238

GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.49.5 - Case Method & iCAP® Results

Printed: 29-April-2015 Test started: 29-April-2015

USH 10 over LLBDM - PIER 17 #36 BOR - APE D30-42, HP 14 x 73



USH 10 over LLBDM - PIER 17 #36 BOR APE D30-42, HP 14 x 73
OP: TC Date: 29-April-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
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#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	55.63	80	AV10	32.9	32.5	8.1	41	41.4	668
			MAX	34.1	33.5	8.2	43	41.6	689
			MIN	26.6	25.7	8.1	27	41.2	555
20	55.75	80	AV10	34.2	33.5	8.3	43	40.9	700
			MAX	34.9	34.1	8.5	45	41.4	707
			MIN	33.5	33.1	8.1	42	40.5	688
30	55.88	80	AV10	34.5	33.6	8.5	44	40.7	703
			MAX	35.1	34.1	8.7	46	41.0	715
			MIN	34.1	33.2	8.3	43	40.2	692
			Average	33.9	33.2	8.3	43	41.0	690
			Maximum	35.1	34.1	8.7	46	41.6	715
			Minimum	26.6	25.7	8.1	27	40.2	555

Total number of blows analyzed: 30

BL# Sensors

1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.04); A4: [K3550] 360.0 (1.04)

BL# Comments

4 CW

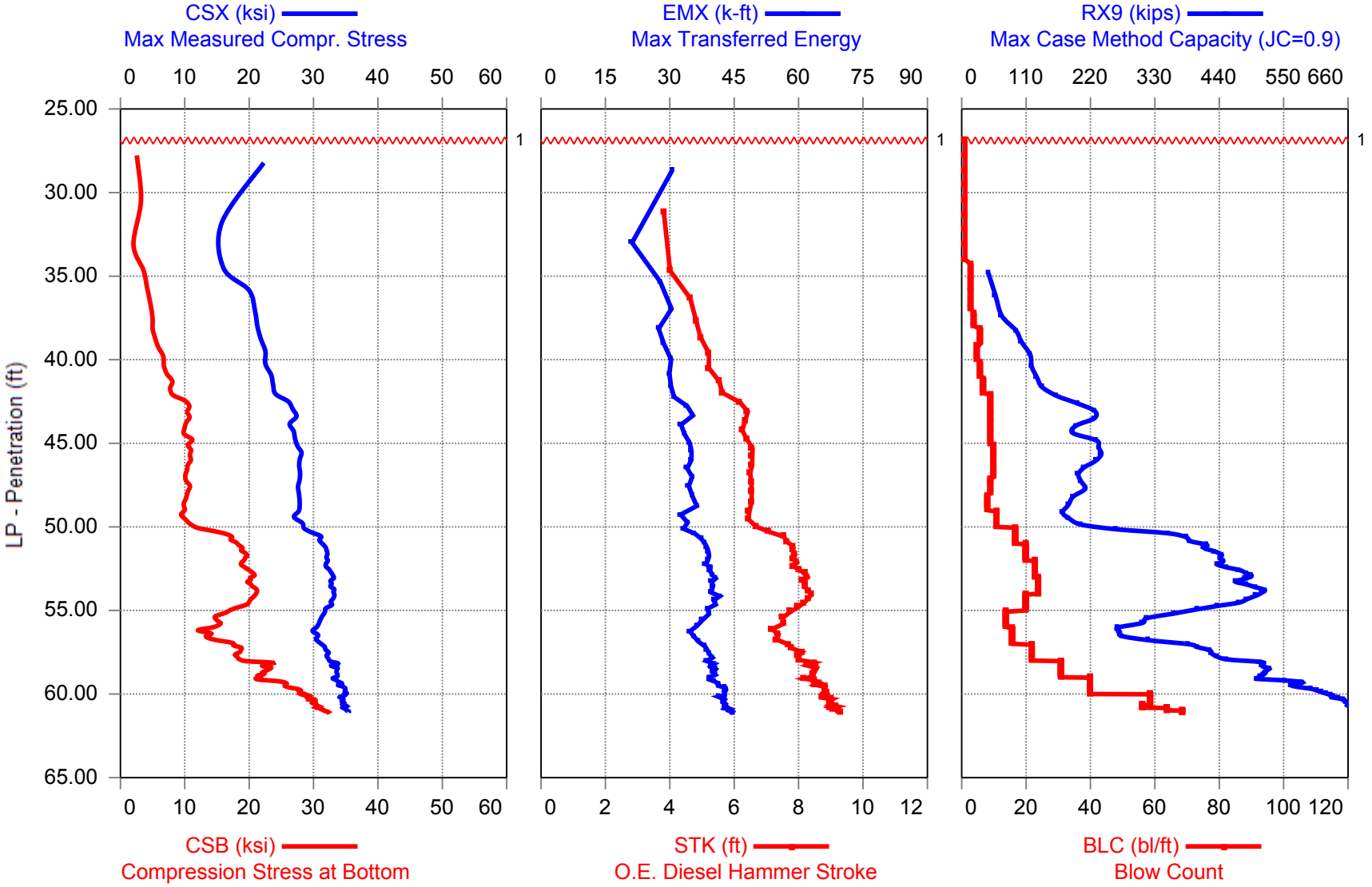
Time Summary

Drive 42 seconds 7:06 AM - 7:07 AM BN 1 - 30

GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.49.5 - Case Method & iCAP® Results

Printed: 29-April-2015 Test started: 28-April-2015

USH 10 over LLBDM - PIER 17 #44 EOID - APE D30-42, HP 14 x 73



1 - Reference elevation EL 740.9. Mud line EL 721.4

USH 10 over LLBDM - PIER 17 #44 EOID APE D30-42, HP 14 x 73
OP: TC Date: 28-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.60 ft EM: 30,000 ksi
WS: 16,807.9 f/s 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#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
9	34.00	1	AV9	18.2	2.6	3.7	27	60.3	0
			MAX	24.7	4.7	4.5	40	65.4	0
			MIN	11.5	1.9	3.1	19	55.0	0
12	35.00	3	AV3	17.3	3.6	4.1	24	57.7	40
			MAX	19.5	4.0	4.4	28	60.2	57
			MIN	15.0	3.3	3.7	20	55.3	17
15	36.00	3	AV3	19.8	4.1	4.5	29	55.1	59
			MAX	20.3	4.3	4.6	30	56.1	64
			MIN	19.0	4.0	4.3	28	54.5	53
18	37.00	3	AV3	21.1	4.7	4.8	32	53.5	58
			MAX	21.7	4.8	4.9	33	53.9	59
			MIN	20.6	4.6	4.7	31	52.7	57
22	38.00	4	AV4	20.9	5.0	4.8	29	53.4	74
			MAX	21.8	5.3	5.1	30	54.2	80
			MIN	20.4	4.7	4.6	28	52.0	69
28	39.00	6	AV6	21.7	5.3	5.0	27	52.5	99
			MAX	22.2	5.6	5.1	28	53.7	105
			MIN	20.9	5.0	4.7	25	51.7	94
33	40.00	5	AV5	22.5	6.4	5.2	31	51.3	114
			MAX	22.8	6.8	5.3	32	51.8	135
			MIN	21.8	5.7	5.1	30	50.9	104
39	41.00	6	AV6	22.8	7.0	5.2	29	51.1	121
			MAX	23.2	7.3	5.4	31	51.7	128
			MIN	22.2	6.5	5.1	28	50.5	116
46	42.00	7	AV7	23.9	7.8	5.6	31	49.6	136
			MAX	24.8	8.3	5.8	32	50.5	143
			MIN	23.1	7.1	5.4	29	48.8	132
55	43.00	9	AV9	25.9	9.9	6.1	33	47.6	194
			MAX	27.2	11.0	6.5	35	49.4	228
			MIN	24.0	8.3	5.6	30	46.3	150
64	44.00	9	AV9	26.9	10.4	6.4	34	46.6	218
			MAX	27.5	11.1	6.5	36	47.9	232
			MIN	25.5	9.2	6.0	31	46.0	187
73	45.00	9	AV9	27.1	10.4	6.3	34	46.7	208
			MAX	27.7	11.7	6.6	36	47.4	237
			MIN	26.1	9.8	6.1	32	45.9	178

USH 10 over LLBDM - PIER 17 #44 EOID APE D30-42, HP 14 x 73
OP: TC Date: 28-April-2015

BL#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
83	46.00	10	AV10	27.8	10.9	6.6	35	45.9	235
			MAX	28.9	11.7	6.8	36	46.8	243
			MIN	26.9	10.2	6.3	34	45.1	221
93	47.00	10	AV10	27.8	10.3	6.5	35	46.1	208
			MAX	28.5	10.9	6.8	36	47.1	225
			MIN	27.1	9.5	6.2	33	45.3	197
102	48.00	9	AV9	27.9	10.5	6.6	35	46.0	207
			MAX	28.6	11.0	6.8	36	47.0	218
			MIN	26.9	9.9	6.3	34	45.2	199
110	49.00	8	AV8	27.7	10.1	6.5	36	46.0	182
			MAX	28.5	10.7	6.8	37	46.5	189
			MIN	27.2	9.4	6.4	34	45.3	173
121	50.00	11	AV11	27.5	10.1	6.5	33	46.3	188
			MAX	28.6	11.4	6.8	35	47.2	212
			MIN	26.6	9.2	6.2	32	45.2	161
138	51.00	17	AV17	30.4	16.1	7.4	36	43.5	352
			MAX	32.5	19.2	8.0	40	45.2	412
			MIN	28.7	12.1	6.8	33	41.7	224
158	52.00	20	AV20	31.9	19.1	7.8	39	42.2	432
			MAX	33.0	20.3	8.1	40	42.9	452
			MIN	30.9	17.9	7.6	37	41.4	407
181	53.00	23	AV23	32.5	19.8	8.0	39	41.7	466
			MAX	33.6	21.1	8.4	42	42.6	501
			MIN	31.2	17.9	7.7	37	40.7	431
205	54.00	24	AV24	32.9	20.5	8.2	40	41.2	495
			MAX	33.9	21.4	8.6	43	41.9	521
			MIN	31.8	19.5	7.9	37	40.3	462
225	55.00	20	AV20	32.7	19.5	8.1	40	41.4	461
			MAX	33.6	21.0	8.6	43	42.7	506
			MIN	31.3	16.8	7.6	38	40.4	400
239	56.00	14	AV14	31.1	15.3	7.6	38	42.9	322
			MAX	32.2	16.7	7.9	41	44.0	391
			MIN	30.1	13.7	7.2	36	41.9	262
255	57.00	16	AV16	30.5	14.2	7.3	36	43.5	296
			MAX	31.5	17.7	7.8	39	44.8	387
			MIN	29.3	11.6	6.9	33	42.3	237
277	58.00	22	AV22	32.0	18.3	7.9	39	41.9	425
			MAX	33.4	19.4	8.4	42	42.9	468
			MIN	30.8	17.3	7.6	36	40.7	387

USH 10 over LLBDM - PIER 17 #44 EOID APE D30-42, HP 14 x 73
OP: TC Date: 28-April-2015

BL#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
308	59.00	31	AV31	33.5	22.3	8.4	40	40.7	517
			MAX	34.3	24.0	8.7	42	42.1	532
			MIN	31.7	19.0	7.9	37	40.0	463
348	60.00	40	AV40	34.3	25.6	8.7	42	40.2	576
			MAX	35.5	28.6	9.1	44	41.5	630
			MIN	32.8	20.4	8.1	37	39.3	490
386	60.65	59	AV38	34.5	29.6	8.9	42	39.6	647
			MAX	35.9	31.1	9.3	45	40.4	674
			MIN	33.4	28.0	8.6	40	38.9	622
396	60.82	56	AV10	34.7	30.5	9.0	43	39.4	666
			MAX	35.4	31.2	9.4	44	39.8	676
			MIN	34.2	30.1	8.8	42	38.7	659
406	60.98	64	AV10	35.0	31.3	9.2	44	39.1	683
			MAX	35.6	32.0	9.4	46	39.4	695
			MIN	34.3	30.6	9.0	42	38.7	672
416	61.13	69	AV10	35.3	32.0	9.3	44	38.9	695
			MAX	35.9	32.4	9.4	46	39.6	708
			MIN	34.3	31.2	8.9	43	38.6	680
			Average	30.7	18.4	7.6	38	43.4	404
			Maximum	35.9	32.4	9.4	46	65.4	708
			Minimum	11.5	1.9	3.1	19	38.6	0

Total number of blows analyzed: 416

BL# Sensors

1-416 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.02); A4: [K3550] 360.0 (1.02)

BL# Comments

1 Reference elevation EL 740.9. Mud line EL 721.4
414 CW

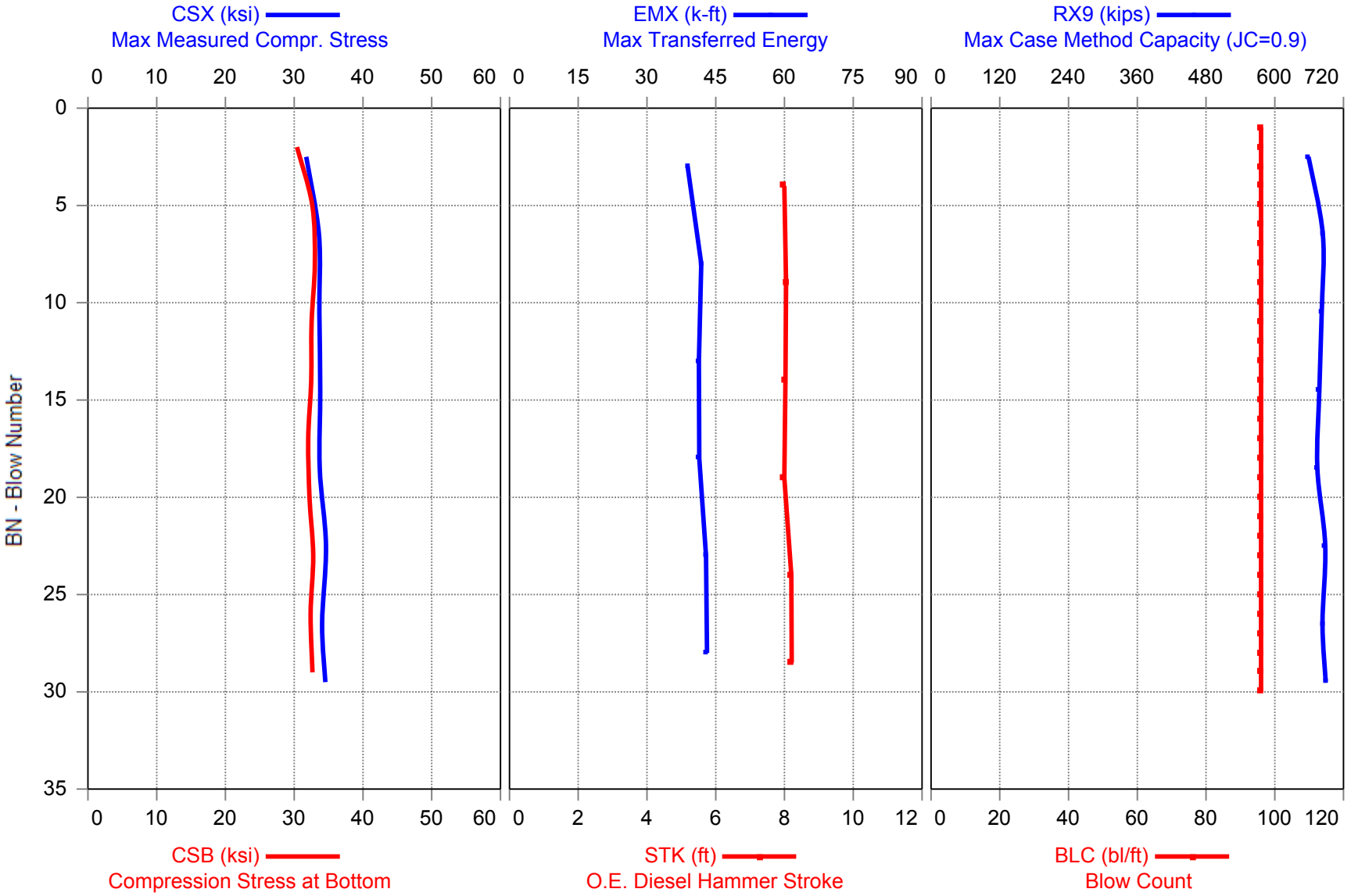
Time Summary

Drive 10 minutes 11 seconds 7:26 AM - 7:36 AM BN 1 - 416

GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.49.5 - Case Method & iCAP® Results

Printed: 29-April-2015 Test started: 29-April-2015

USH 10 over LLBDM - PIER 17 #44 BOR - APE D30-42, HP 14 x 73



USH 10 over LLBDM - PIER 17 #44 BOR APE D30-42, HP 14 x 73
OP: TC Date: 29-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.60 ft EM: 30,000 ksi
WS: 16,807.9 f/s 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#	Depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	61.23	96	AV10	32.9	32.1	8.0	40	41.7	674
			MAX	34.3	33.2	8.3	43	42.0	692
			MIN	26.3	25.2	7.9	27	41.1	578
20	61.33	96	AV10	33.7	32.2	8.0	41	41.8	676
			MAX	34.2	32.7	8.1	43	42.2	684
			MIN	33.0	31.7	7.8	40	41.4	670
30	61.44	96	AV10	34.4	32.6	8.2	43	41.3	686
			MAX	35.0	33.1	8.5	44	41.7	697
			MIN	33.8	32.2	8.0	41	40.6	678
			Average	33.7	32.3	8.1	42	41.6	679
			Maximum	35.0	33.2	8.5	44	42.2	697
			Minimum	26.3	25.2	7.8	27	40.6	578

Total number of blows analyzed: 30

BL# Sensors

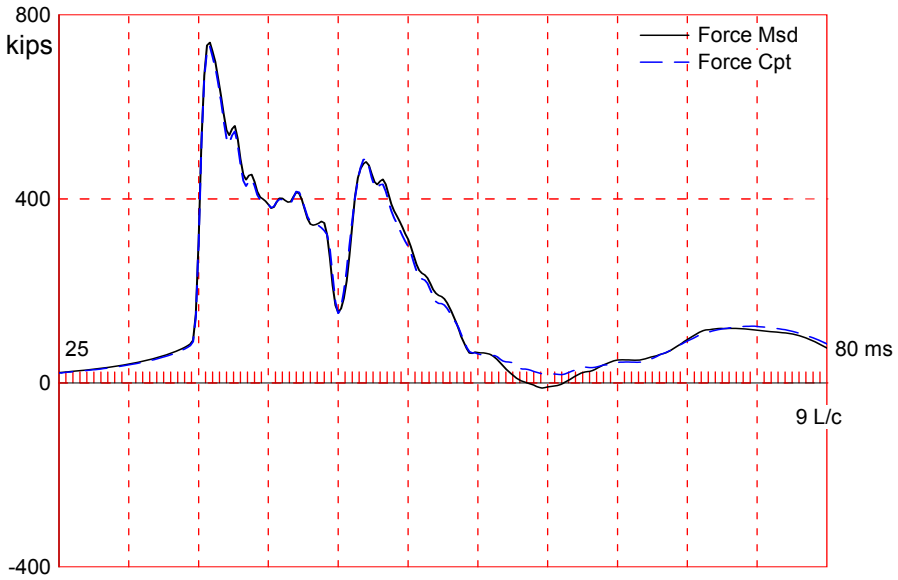
1-30 F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.04); A4: [K3550] 360.0 (1.04)

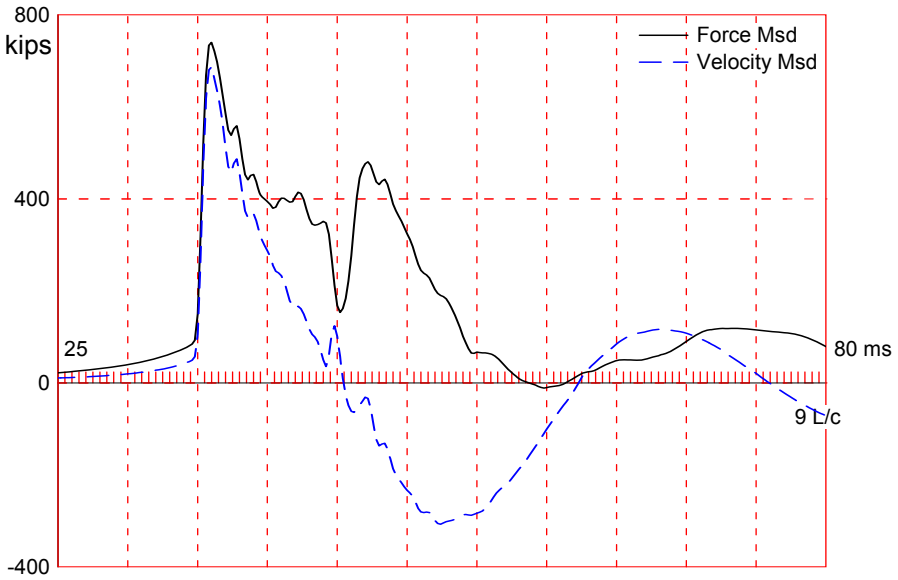
BL# Comments

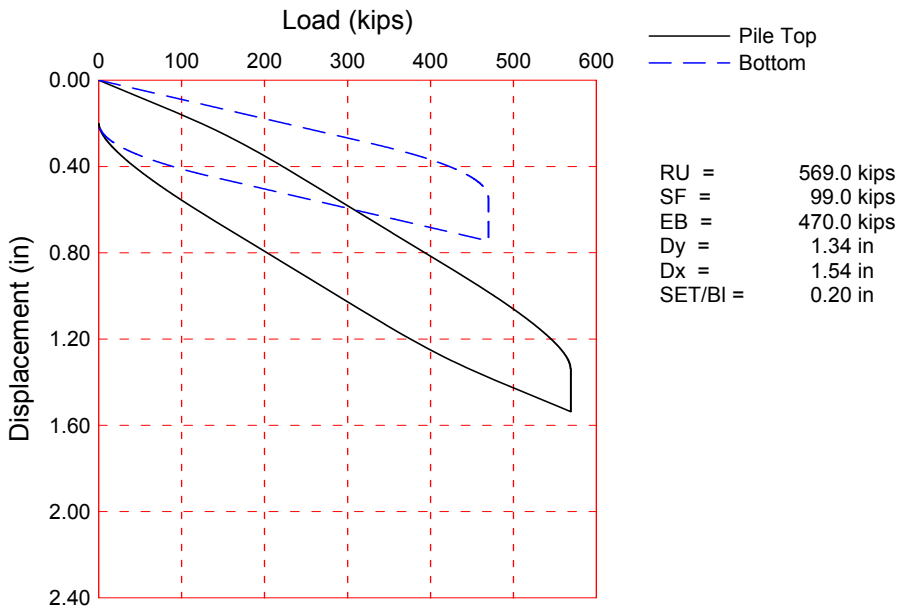
3 CW

Time Summary

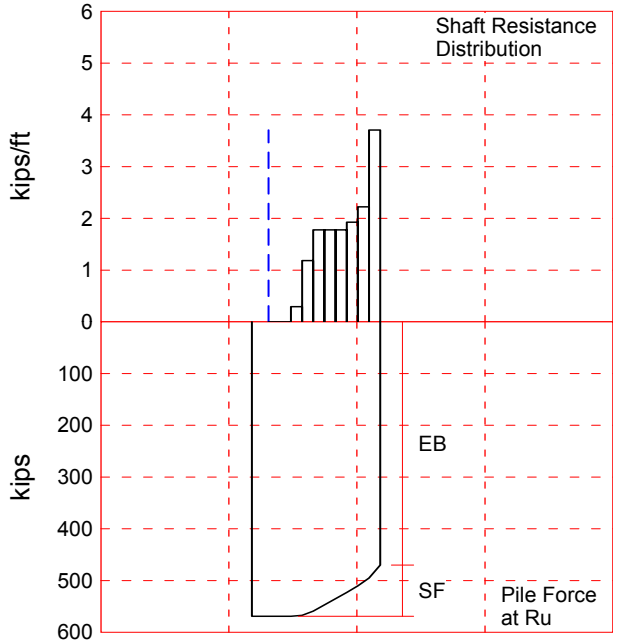
Drive 41 seconds 7:13 AM - 7:14 AM BN 1 - 30







RU =	569.0 kips
SF =	99.0 kips
EB =	470.0 kips
Dy =	1.34 in
Dx =	1.54 in
SET/Bl =	0.20 in



Length b. Sensors	77.6 ft
Embedment	65.4 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.	16866 ft/s
Match Quality	2.36
Top Compr. Stress	34.2 ksi
Max Compr. Stress	35.8 ksi
Max Tension Stress	-3.66 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.42 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.09 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: 569.0; along Shaft 99.0; at Toe 470.0 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
				569.0				
1	16.9	4.7	0.0	569.0	0.0	0.00	0.00	0.00
2	23.6	11.4	0.0	569.0	0.0	0.00	0.00	0.00
3	30.4	18.2	2.0	567.0	2.0	0.30	0.06	0.27
4	37.1	24.9	8.0	559.0	10.0	1.19	0.25	0.27
5	43.9	31.7	12.0	547.0	22.0	1.78	0.38	0.27
6	50.6	38.4	12.0	535.0	34.0	1.78	0.38	0.27
7	57.3	45.1	12.0	523.0	46.0	1.78	0.38	0.27
8	64.1	51.9	13.0	510.0	59.0	1.93	0.41	0.27
9	70.8	58.6	15.0	495.0	74.0	2.22	0.47	0.27
10	77.6	65.4	25.0	470.0	99.0	3.71	0.79	0.27
Avg. Shaft			9.9			1.51	0.32	0.27
Toe			470.0				340.95	0.09

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.10	0.42
Case Damping Factor		0.70	1.11
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	61
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	74	
Resistance Gap (included in Toe Quake)	(in)		0.02
Soil Plug Weight	(kips)	0.045	0.130

CAPWAP match quality = 2.36 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.06 in; Blow Count = 194 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.00; A4(K3550) CAL: 360; RF: 1.00

max. Top Comp. Stress = 34.2 ksi (T= 36.2 ms, max= 1.045 x Top)
max. Comp. Stress = 35.8 ksi (Z= 37.1 ft, T= 38.2 ms)
max. Tens. Stress = -3.66 ksi (Z= 43.9 ft, T= 61.2 ms)
max. Energy (EMX) = 41.9 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	732.7	-17.1	34.2	-0.80	41.9	18.2	1.08
2	6.7	733.8	-17.9	34.3	-0.84	41.7	18.1	1.07
4	13.5	736.3	-24.8	34.4	-1.16	41.0	18.1	1.02
5	16.9	737.6	-29.3	34.5	-1.37	40.6	18.0	1.00
6	20.2	739.0	-37.5	34.5	-1.75	40.1	18.0	0.97
7	23.6	741.9	-46.4	34.7	-2.17	39.6	17.9	0.95
8	27.0	746.2	-54.4	34.9	-2.54	39.1	17.8	0.92
9	30.4	753.6	-62.8	35.2	-2.93	38.5	17.6	0.89
10	33.7	754.2	-67.8	35.2	-3.17	37.3	17.3	0.86
11	37.1	765.4	-74.7	35.8	-3.49	36.6	17.0	0.82
12	40.5	737.9	-71.5	34.5	-3.34	34.0	16.5	0.79
13	43.9	750.3	-78.3	35.1	-3.66	33.2	16.2	0.76
14	47.2	709.1	-70.0	33.1	-3.27	29.9	15.6	0.72
15	50.6	728.2	-76.2	34.0	-3.56	29.1	15.1	0.69
16	54.0	682.4	-68.4	31.9	-3.20	26.0	14.7	0.65
17	57.3	684.2	-73.7	32.0	-3.44	25.3	14.6	0.62
18	60.7	635.2	-67.0	29.7	-3.13	22.4	14.4	0.59
19	64.1	647.2	-72.1	30.2	-3.37	21.7	14.0	0.55
20	67.5	602.3	-63.3	28.1	-2.96	19.0	13.9	0.52
21	70.8	597.7	-66.9	27.9	-3.13	18.3	15.3	0.49
22	74.2	586.6	-56.4	27.4	-2.64	15.6	16.3	0.46
23	77.6	607.0	-58.5	28.4	-2.73	12.8	16.0	0.43
Absolute	37.1			35.8			(T =	38.2 ms)
	43.9				-3.66		(T =	61.2 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	762.8	626.1	489.4	352.7	216.1					
RX	787.0	730.5	674.0	623.4	597.5	577.1	566.8	558.2	553.0	547.9
RU	762.8	626.1	489.4	352.7	216.1					

RAU = 498.6 (kips); RA2 = 653.8 (kips)

Current CAPWAP Ru = 569.0 (kips); Corresponding J(RP)= 0.28; J(RX) = 1.16

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
18.3	36.00	700.6	745.5	754.3	1.07	0.20	0.20	42.1	794.2	1175

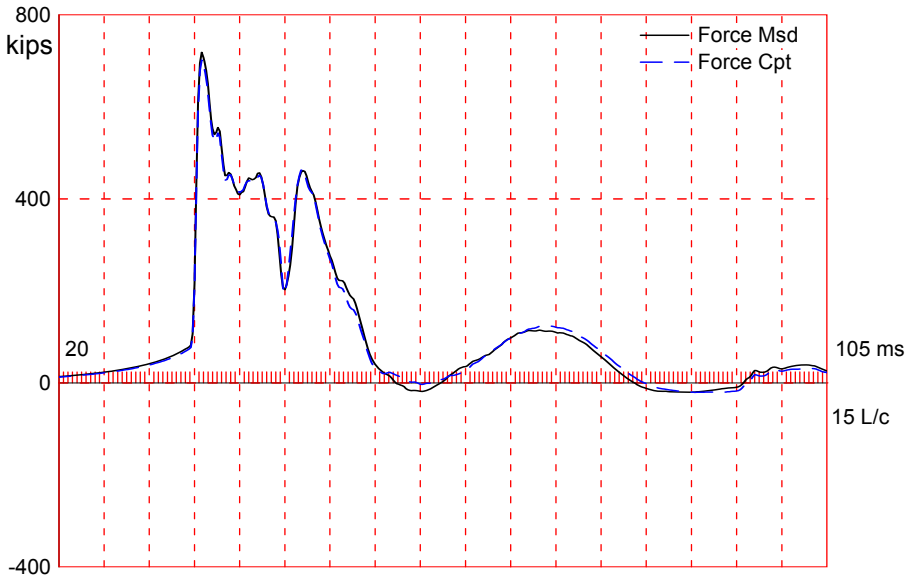
PILE PROFILE AND PILE MODEL

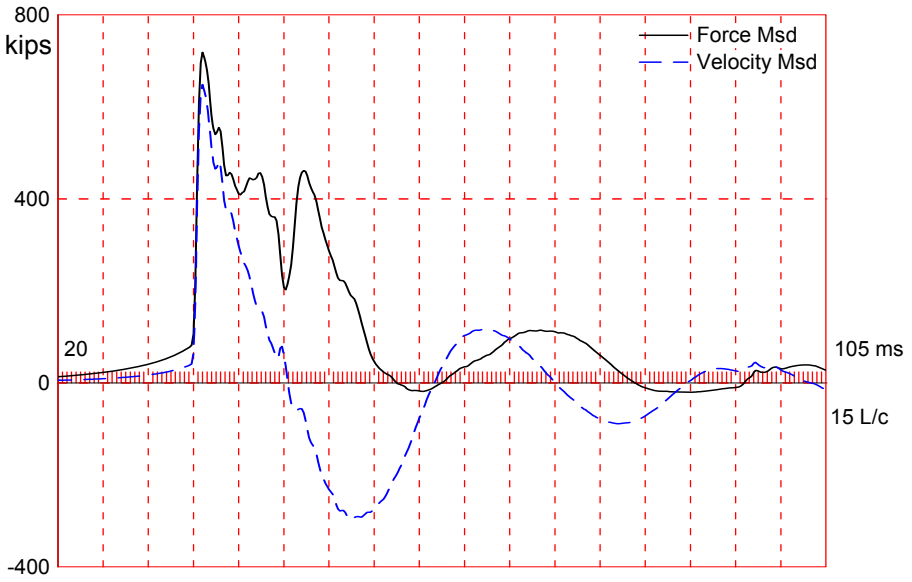
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.6	21.4	29992.2	492.000	4.70

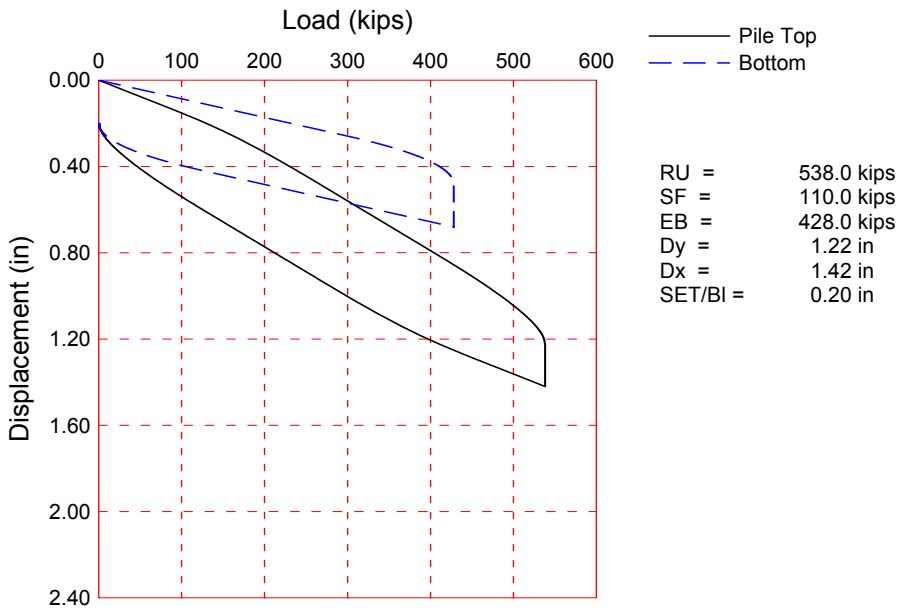
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	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	16865.9	0.000
16	54.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16865.9	0.010
17	57.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16865.9	0.020
18	60.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16865.9	0.015
19	64.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16865.9	0.000
23	77.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16865.9	0.000

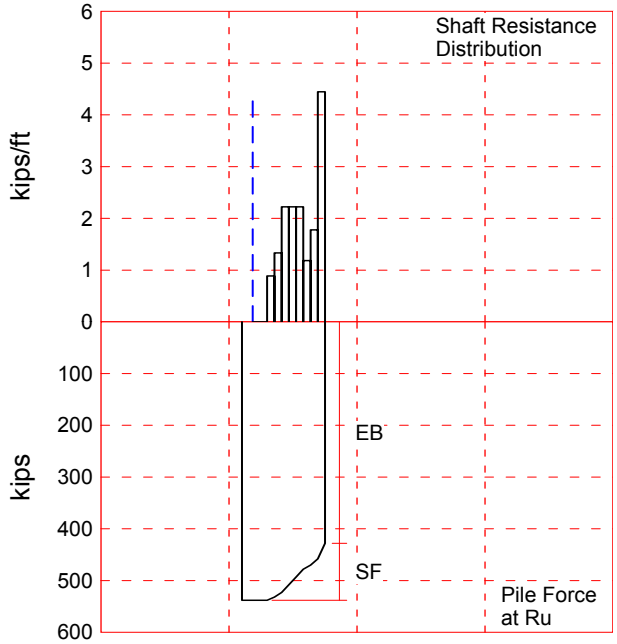
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16865.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.530 $ft^{3;}$ Volume ratio considering added impedance: 1.000







RU =	538.0 kips
SF =	110.0 kips
EB =	428.0 kips
Dy =	1.22 in
Dx =	1.42 in
SET/Bl =	0.20 in



Length b. Sensors	77.6 ft
Embedment	64.5 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.	16870 ft/s
Match Quality	2.35
Top Compr. Stress	32.9 ksi
Max Compr. Stress	34.2 ksi
Max Tension Stress	-4.78 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.37 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.11 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 538.0; along Shaft 110.0; at Toe 428.0 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
				538.0				
1	16.9	3.7	0.0	538.0	0.0	0.00	0.00	0.00
2	23.6	10.5	0.0	538.0	0.0	0.00	0.00	0.00
3	30.4	17.2	6.0	532.0	6.0	0.89	0.19	0.29
4	37.1	24.0	9.0	523.0	15.0	1.33	0.28	0.29
5	43.9	30.7	15.0	508.0	30.0	2.22	0.47	0.29
6	50.6	37.5	15.0	493.0	45.0	2.22	0.47	0.29
7	57.4	44.2	15.0	478.0	60.0	2.22	0.47	0.29
8	64.1	51.0	8.0	470.0	68.0	1.19	0.25	0.29
9	70.9	57.7	12.0	458.0	80.0	1.78	0.38	0.29
10	77.6	64.5	30.0	428.0	110.0	4.45	0.95	0.29
Avg. Shaft			11.0			1.71	0.36	0.29
Toe			428.0				310.49	0.11

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.10	0.37
Case Damping Factor		0.84	1.23
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	37
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	60	
Resistance Gap (included in Toe Quake)	(in)		0.02
Soil Plug Weight	(kips)	0.035	0.109

CAPWAP match quality = 2.35 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.09 in; Blow Count = 136 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.02; A4(K3550) CAL: 360; RF: 1.02

max. Top Comp. Stress = 32.9 ksi (T= 36.2 ms, max= 1.040 x Top)
max. Comp. Stress = 34.2 ksi (Z= 30.4 ft, T= 37.8 ms)
max. Tens. Stress = -4.78 ksi (Z= 43.9 ft, T= 61.4 ms)
max. Energy (EMX) = 41.4 kip-ft; max. Measured Top Displ. (DMX)= 1.04 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	703.2	-23.5	32.9	-1.10	41.4	17.4	1.06
2	6.7	704.4	-26.3	32.9	-1.23	41.2	17.3	1.04
4	13.5	706.8	-43.5	33.0	-2.03	40.5	17.2	0.99
5	16.9	708.1	-53.8	33.1	-2.52	40.1	17.2	0.97
6	20.2	709.4	-63.7	33.1	-2.98	39.6	17.2	0.94
7	23.6	713.5	-71.9	33.3	-3.36	39.1	17.0	0.91
8	27.0	723.7	-78.9	33.8	-3.69	38.5	16.7	0.88
9	30.4	731.5	-87.3	34.2	-4.08	37.8	16.5	0.85
10	33.7	711.1	-88.5	33.2	-4.13	35.6	16.1	0.82
11	37.1	724.1	-95.5	33.8	-4.46	34.9	15.8	0.79
12	40.5	693.6	-95.0	32.4	-4.44	32.1	15.3	0.75
13	43.9	711.0	-102.2	33.2	-4.78	31.3	14.9	0.72
14	47.2	657.1	-96.5	30.7	-4.51	27.5	14.2	0.69
15	50.6	673.5	-102.0	31.5	-4.76	26.8	13.8	0.65
16	54.0	616.9	-93.9	28.8	-4.38	23.4	13.3	0.62
17	57.4	622.3	-99.3	29.1	-4.64	22.7	13.0	0.59
18	60.7	555.5	-89.7	26.0	-4.19	19.6	12.9	0.55
19	64.1	567.6	-90.8	26.5	-4.24	18.9	12.7	0.52
20	67.5	542.8	-84.2	25.4	-3.93	17.2	12.6	0.49
21	70.9	567.6	-87.0	26.5	-4.07	16.5	13.9	0.46
22	74.2	567.6	-76.9	26.5	-3.59	14.5	14.7	0.43
23	77.6	582.9	-77.5	27.2	-3.62	11.6	14.1	0.40
Absolute	30.4			34.2			(T =	37.8 ms)
	43.9				-4.78		(T =	61.4 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	765.9	643.6	521.2	398.8	276.4					
RX	789.3	734.6	679.9	625.4	583.6	555.6	530.2	509.5	495.3	486.7
RU	765.9	643.6	521.2	398.8	276.4					

RAU = 480.1 (kips); RA2 = 640.7 (kips)

Current CAPWAP Ru = 538.0 (kips); Corresponding J(RP)= 0.37; 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
17.2	35.80	656.8	721.0	723.6	1.04	0.20	0.20	41.7	804.6	1223

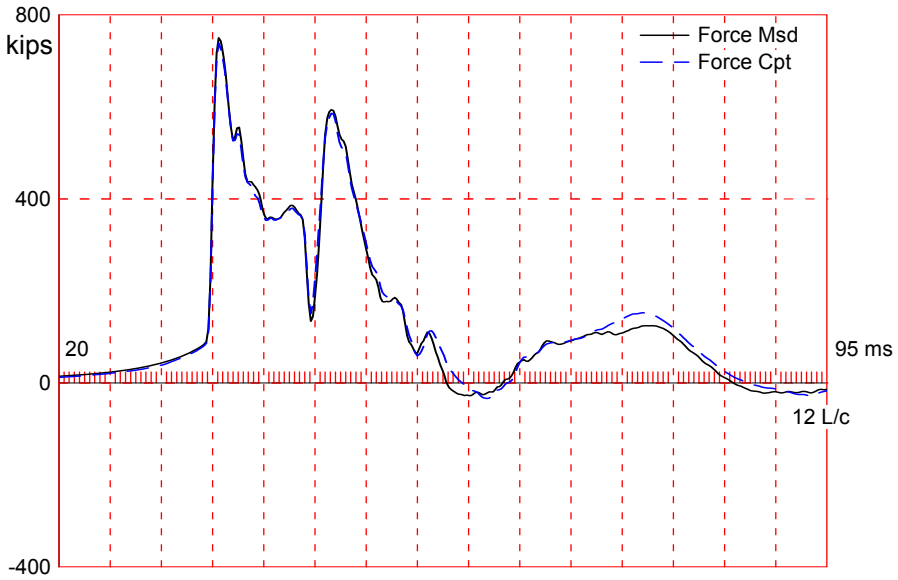
PILE PROFILE AND PILE MODEL

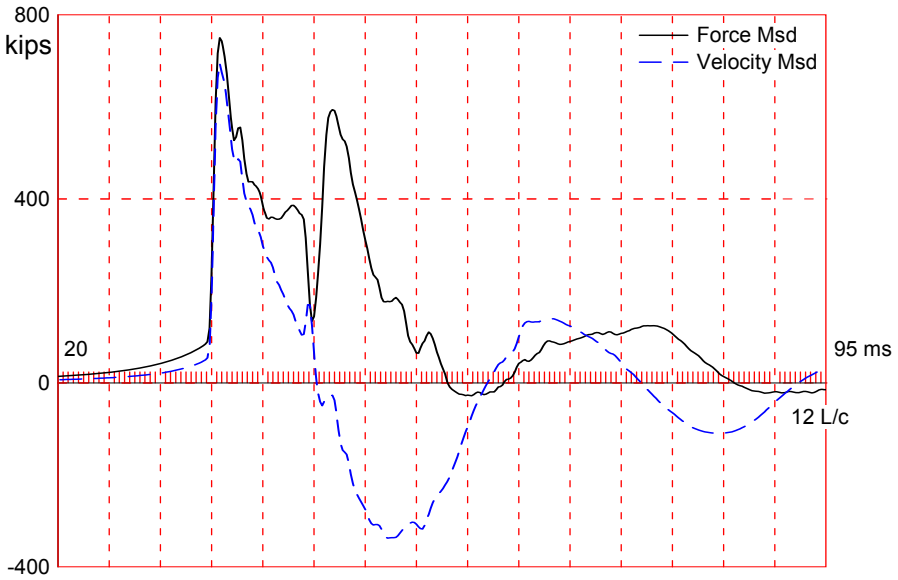
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.6	21.4	29992.2	492.000	4.70

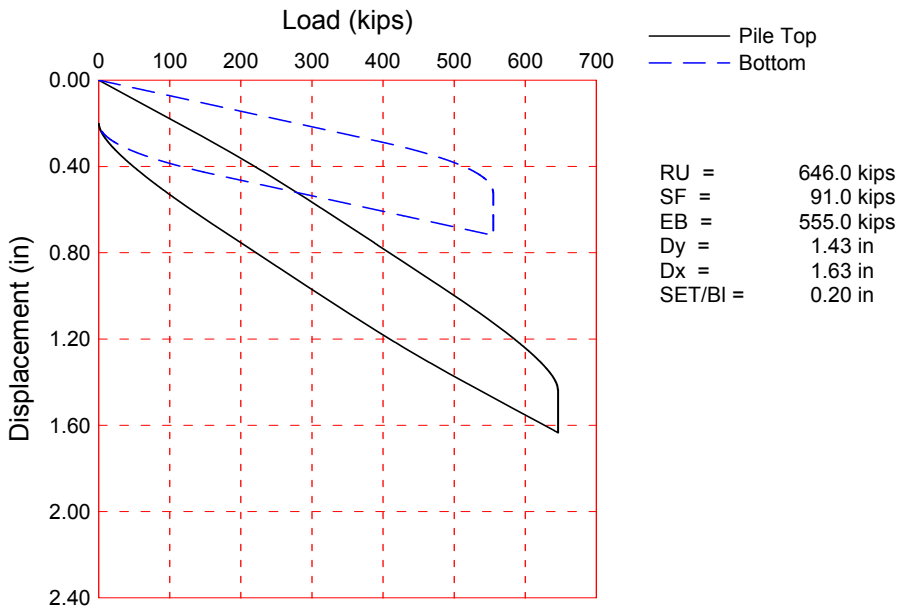
Toe Area 198.5 in^2

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	16869.6	0.000
16	54.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16869.6	0.010
18	60.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16869.6	0.015
19	64.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16869.6	0.000
23	77.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16869.6	0.000

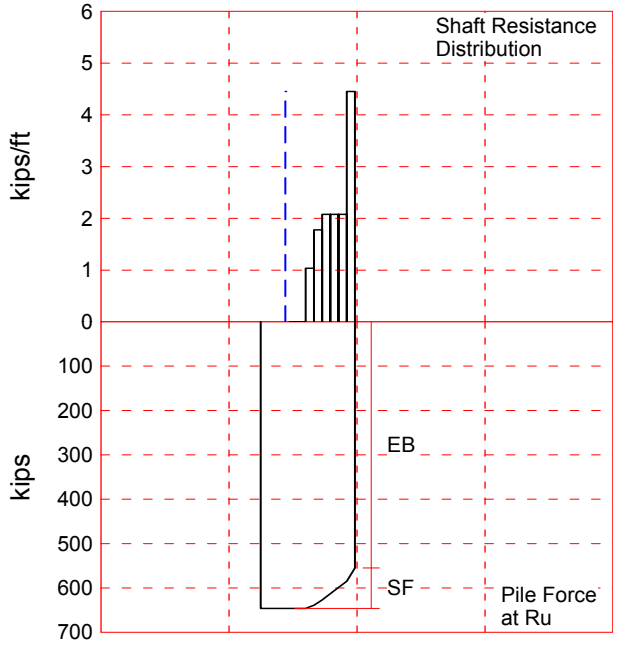
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16869.6 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.532 ft^3; Volume ratio considering added impedance: 1.000







RU =	646.0 kips
SF =	91.0 kips
EB =	555.0 kips
Dy =	1.43 in
Dx =	1.63 in
SET/BI =	0.20 in



Length b. Sensors	77.5 ft
Embedment	55.4 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.	16848 ft/s
Match Quality	3.34
Top Compr. Stress	34.6 ksi
Max Compr. Stress	36.0 ksi
Max Tension Stress	-6.54 ksi
Avg. Shaft Quake	0.15 in
Toe Quake	0.40 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.07 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: 646.0; along Shaft 91.0; at Toe 555.0 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
				646.0				
1	30.3	8.2	0.0	646.0	0.0	0.00	0.00	0.00
2	37.1	15.0	0.0	646.0	0.0	0.00	0.00	0.00
3	43.8	21.7	7.0	639.0	7.0	1.04	0.22	0.24
4	50.5	28.4	12.0	627.0	19.0	1.78	0.38	0.24
5	57.3	35.2	14.0	613.0	33.0	2.08	0.44	0.24
6	64.0	41.9	14.0	599.0	47.0	2.08	0.44	0.24
7	70.8	48.7	14.0	585.0	61.0	2.08	0.44	0.24
8	77.5	55.4	30.0	555.0	91.0	4.45	0.95	0.24
Avg. Shaft			11.4			1.64	0.35	0.24
Toe			555.0				402.62	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.15	0.40
Case Damping Factor		0.57	1.02
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	35
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	50	
Resistance Gap (included in Toe Quake)	(in)		0.02

CAPWAP match quality = 3.34 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.05 in; Blow Count = 243 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.00; A4(K3550) CAL: 360; RF: 1.00
max. Top Comp. Stress = 34.6 ksi (T= 36.0 ms, max= 1.041 x Top)
max. Comp. Stress = 36.0 ksi (Z= 43.8 ft, T= 38.4 ms)
max. Tens. Stress = -6.54 ksi (Z= 43.8 ft, T= 60.8 ms)
max. Energy (EMX) = 43.9 kip-ft; max. Measured Top Displ. (DMX)= 1.15 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	739.8	-43.5	34.6	-2.03	43.9	18.4	1.17
2	6.7	740.4	-51.7	34.6	-2.42	43.6	18.4	1.15
4	13.5	741.7	-74.3	34.6	-3.47	42.7	18.3	1.10
5	16.8	742.4	-86.0	34.7	-4.02	42.1	18.3	1.07
6	20.2	743.2	-98.2	34.7	-4.59	41.5	18.3	1.04
7	23.6	744.1	-110.4	34.8	-5.16	40.8	18.2	1.01
8	27.0	745.1	-120.2	34.8	-5.62	40.1	18.2	0.97
9	30.3	746.2	-128.9	34.9	-6.02	39.3	18.1	0.94
10	33.7	747.5	-135.1	34.9	-6.31	38.5	18.1	0.90
11	37.1	751.3	-137.1	35.1	-6.40	37.7	17.9	0.87
12	40.4	761.0	-137.9	35.6	-6.44	36.8	17.7	0.83
13	43.8	770.4	-139.9	36.0	-6.54	35.9	17.4	0.80
14	47.2	749.5	-134.5	35.0	-6.28	33.4	17.0	0.76
15	50.5	763.9	-135.9	35.7	-6.35	32.5	16.6	0.72
16	53.9	721.6	-125.6	33.7	-5.87	29.1	16.2	0.68
17	57.3	735.9	-129.6	34.4	-6.05	28.2	15.8	0.64
18	60.7	685.7	-118.0	32.0	-5.51	24.7	15.4	0.60
19	64.0	699.6	-119.9	32.7	-5.60	23.7	15.0	0.57
20	67.4	646.8	-107.4	30.2	-5.02	20.6	16.1	0.53
21	70.8	684.0	-109.9	32.0	-5.13	19.7	17.6	0.49
22	74.1	678.2	-97.4	31.7	-4.55	16.9	18.1	0.45
23	77.5	696.1	-99.1	32.5	-4.63	14.1	16.5	0.41
Absolute	43.8			36.0			(T =	38.4 ms)
	43.8				-6.54		(T =	60.8 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	758.2	616.2	474.2	332.2	190.1					
RX	842.5	798.7	755.0	713.9	693.2	679.6	666.0	652.3	638.7	628.4
RU	758.2	616.2	474.2	332.2	190.1					

RAU = 508.5 (kips); RA2 = 739.5 (kips)

Current CAPWAP Ru = 646.0 (kips); Corresponding J(RP)= 0.16; J(RX) = 1.49

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
18.5	35.80	707.9	760.4	760.4	1.15	0.20	0.20	44.1	785.0	1461

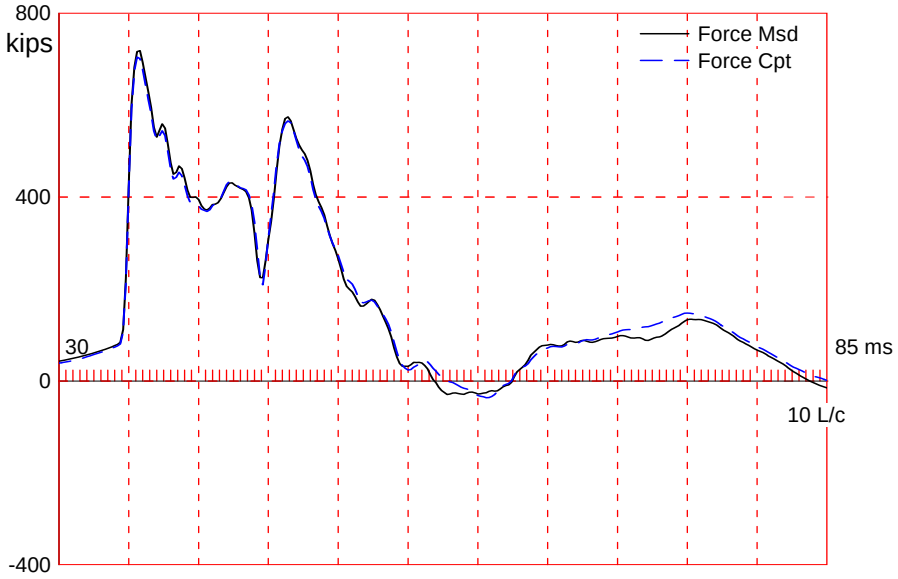
PILE PROFILE AND PILE MODEL

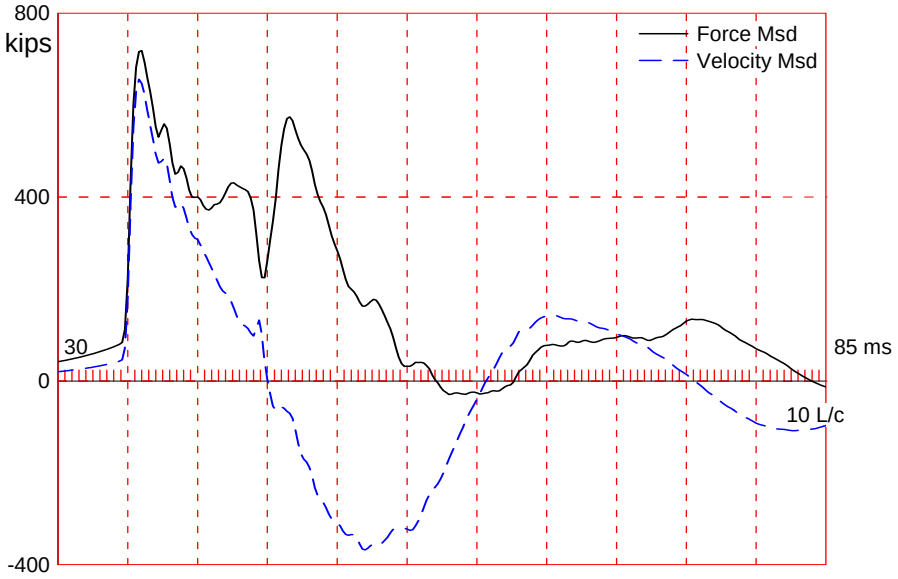
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

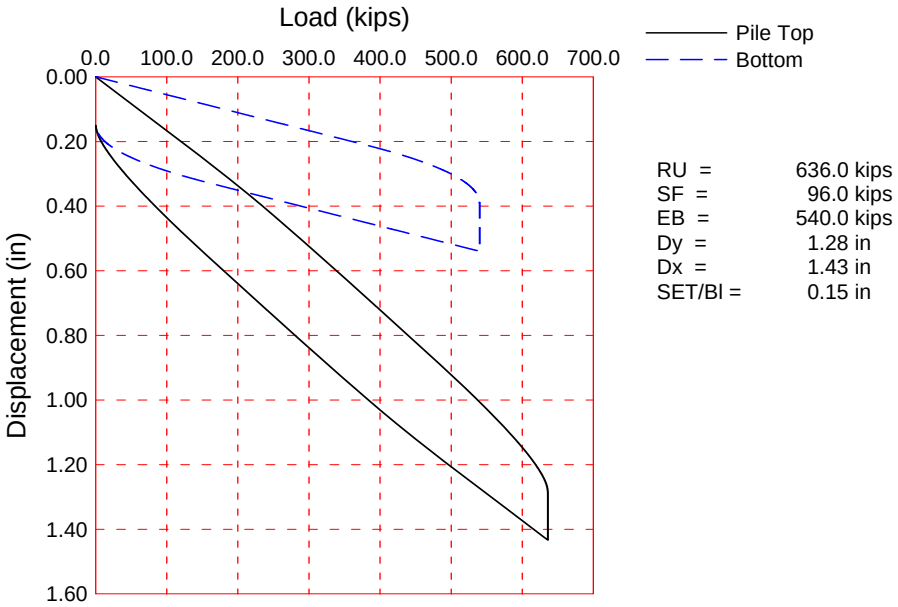
Toe Area 198.5 in^2

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

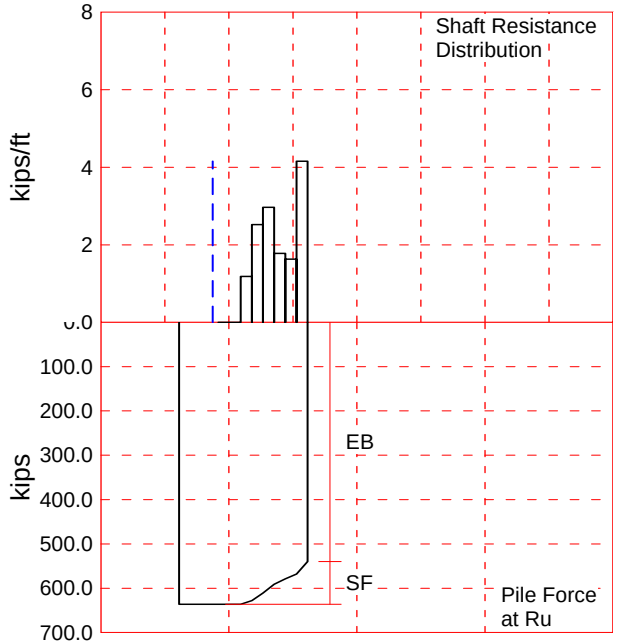
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16847.8 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	636.0 kips
SF =	96.0 kips
EB =	540.0 kips
Dy =	1.28 in
Dx =	1.43 in
SET/Bl =	0.15 in



Length b. Sensors	77.5 ft
Embedment	55.6 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.	16848 ft/s
Match Quality	2.71
Top Compr. Stress	33.0 ksi
Max Compr. Stress	35.4 ksi
Max Tension Stress	-8.06 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.30 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.08 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 636.0; along Shaft 96.0; at Toe 540.0 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
				636.0				
1	30.3	8.4	0.0	636.0	0.0	0.00	0.00	0.00
2	37.1	15.1	0.0	636.0	0.0	0.00	0.00	0.00
3	43.8	21.9	8.0	628.0	8.0	1.19	0.25	0.29
4	50.5	28.6	17.0	611.0	25.0	2.52	0.54	0.29
5	57.3	35.3	20.0	591.0	45.0	2.97	0.63	0.29
6	64.0	42.1	12.0	579.0	57.0	1.78	0.38	0.29
7	70.8	48.8	11.0	568.0	68.0	1.63	0.35	0.29
8	77.5	55.6	28.0	540.0	96.0	4.15	0.88	0.29
Avg. Shaft			12.0			1.73	0.37	0.29
Toe			540.0				391.74	0.08

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.14	0.30
Case Damping Factor		0.73	1.13
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	39	
Resistance Gap (included in Toe Quake)	(in)		0.02
Soil Plug Weight	(kips)	0.040	

CAPWAP match quality = 2.71 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.06 in; Blow Count = 202 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.04; A4(K3550) CAL: 360; RF: 1.04

max. Top Comp. Stress = 33.0 ksi (T= 36.0 ms, max= 1.073 x Top)
max. Comp. Stress = 35.4 ksi (Z= 43.8 ft, T= 38.6 ms)
max. Tens. Stress = -8.06 ksi (Z= 50.5 ft, T= 58.2 ms)
max. Energy (EMX) = 42.5 kip-ft; max. Measured Top Displ. (DMX)= 1.10 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	705.5	-48.4	33.0	-2.26	42.5	17.5	1.12
2	6.7	706.2	-61.1	33.0	-2.86	42.2	17.4	1.10
4	13.5	707.7	-85.2	33.1	-3.98	41.2	17.4	1.04
5	16.8	708.6	-98.3	33.1	-4.59	40.5	17.3	1.01
6	20.2	709.6	-112.4	33.1	-5.25	39.8	17.3	0.98
7	23.6	710.6	-127.5	33.2	-5.96	39.0	17.2	0.94
8	27.0	711.7	-138.6	33.2	-6.48	38.1	17.2	0.91
9	30.3	713.0	-146.6	33.3	-6.85	37.2	17.1	0.87
10	33.7	715.2	-150.3	33.4	-7.02	36.2	17.1	0.83
11	37.1	725.6	-151.0	33.9	-7.05	35.3	16.9	0.80
12	40.4	737.7	-154.0	34.5	-7.20	34.3	16.6	0.76
13	43.8	757.2	-166.4	35.4	-7.78	33.3	16.2	0.72
14	47.2	733.3	-168.1	34.3	-7.85	30.6	15.6	0.68
15	50.5	757.1	-172.5	35.4	-8.06	29.6	15.1	0.64
16	53.9	695.4	-154.5	32.5	-7.22	25.4	14.3	0.60
17	57.3	712.2	-156.3	33.3	-7.30	24.3	13.7	0.56
18	60.7	635.4	-135.7	29.7	-6.34	20.1	13.3	0.52
19	64.0	654.5	-138.3	30.6	-6.46	19.1	13.0	0.48
20	67.4	653.3	-127.1	30.5	-5.94	16.5	14.0	0.45
21	70.8	676.6	-130.2	31.6	-6.08	15.6	15.3	0.41
22	74.1	676.0	-120.5	31.6	-5.63	13.5	15.6	0.37
23	77.5	692.5	-121.7	32.4	-5.69	11.9	13.7	0.34
Absolute	43.8			35.4			(T =	38.6 ms)
	50.5				-8.06		(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	807.4	693.6	579.9	466.2	352.5					
RX	861.5	809.7	769.3	728.8	694.7	674.8	659.1	644.1	631.0	623.9
RU	807.4	693.6	579.9	466.2	352.5					

RAU = 532.0 (kips); RA2 = 745.7 (kips)

Current CAPWAP Ru = 636.0 (kips); Corresponding J(RP)= 0.30; J(RX) = 1.52

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
17.3	35.80	661.7	714.2	725.2	1.10	0.15	0.15	42.8	821.2	1929

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

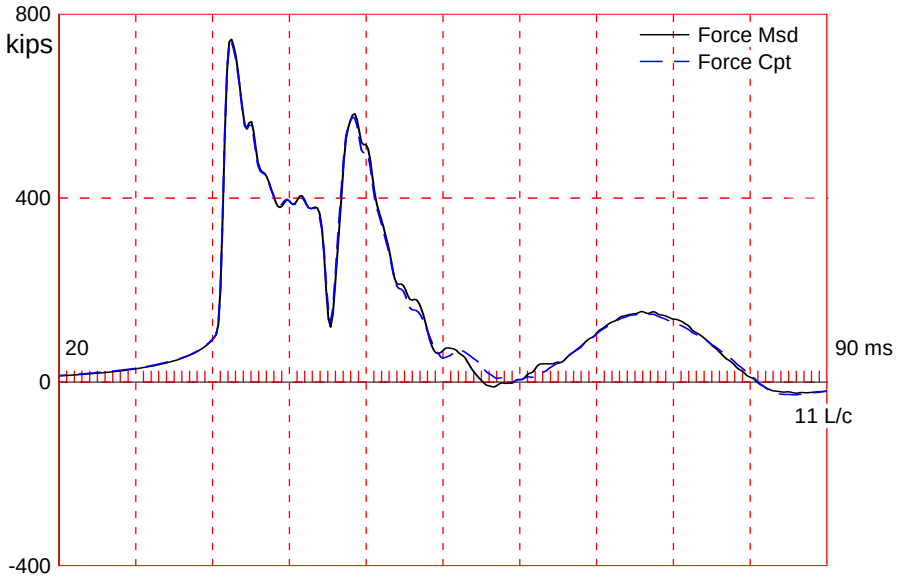
Toe Area 198.5 in^2

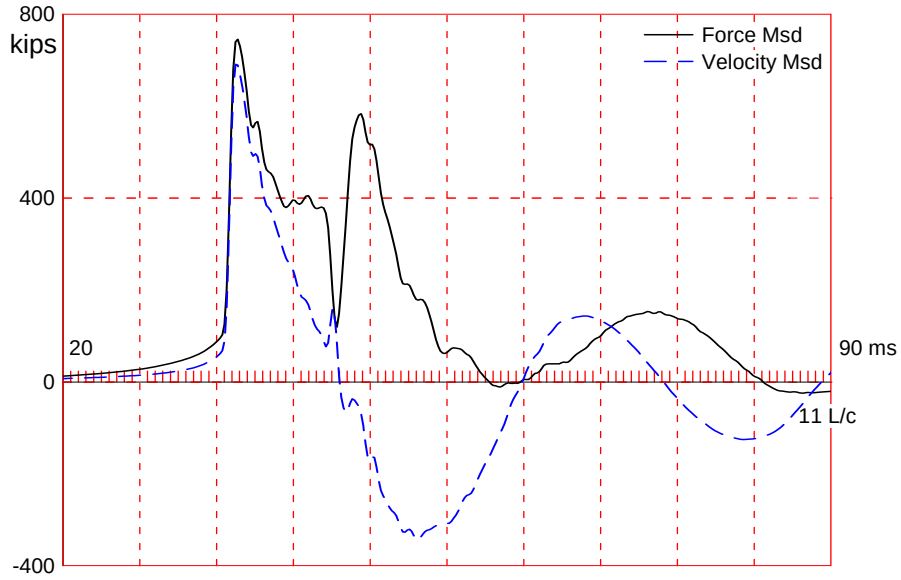
Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16847.8	0.000
18	60.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16847.8	0.010
22	74.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16847.8	0.000
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16847.8	0.000

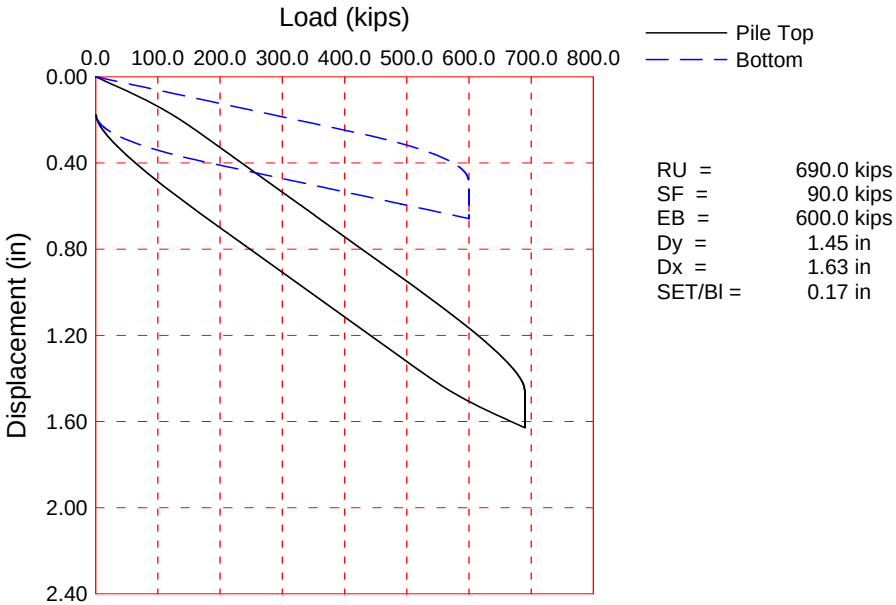
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16847.8 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000

DYNAMIC RESISTANCE TABLE

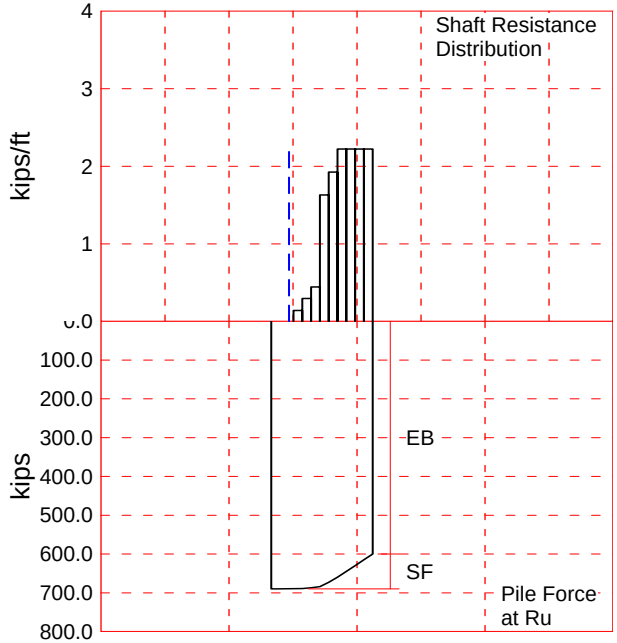
Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Damping Rd at Max. Rt kips	Max Rt (Ru+Rd) kips	Total Unit Rt W. Resp. to Depth kips/ft	Area ksf	Smith Damping Factor s/ft
1	30.3	8.4	0.0	0.0	0.0	0.00	0.00	0.00
2	37.1	15.1	0.0	0.0	0.0	0.00	0.00	0.00
3	43.8	21.9	8.0	37.4	45.4	6.74	1.43	0.29
4	50.5	28.6	17.0	73.3	90.3	13.39	2.85	0.29
5	57.3	35.3	20.0	77.8	97.8	14.51	3.09	0.29
6	64.0	42.1	12.0	44.5	56.5	8.39	1.79	0.29
7	70.8	48.8	11.0	48.3	59.3	8.80	1.87	0.29
8	77.5	55.6	28.0	101.5	129.5	19.22	4.09	0.29
Avg. Shaft			12.0	47.9	59.9	8.62	1.83	0.29
Toe			540.0	101.8	641.8		465.61	0.08
Total					1120.7			







RU =	690.0 kips
SF =	90.0 kips
EB =	600.0 kips
Dy =	1.45 in
Dx =	1.63 in
SET/Bl =	0.17 in



Length b. Sensors	77.6 ft
Embedment	61.1 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	1.91
Top Compr. Stress	34.7 ksi
Max Compr. Stress	36.1 ksi
Max Tension Stress	-5.78 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.37 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.06 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 690.0; along Shaft 90.0; at Toe 600.0 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
				690.0			
1	23.6	7.1	1.0	689.0	1.0	0.14	0.03
2	30.4	13.9	2.0	687.0	3.0	0.30	0.06
3	37.1	20.6	3.0	684.0	6.0	0.44	0.09
4	43.9	27.4	11.0	673.0	17.0	1.63	0.35
5	50.6	34.1	13.0	660.0	30.0	1.93	0.41
6	57.4	40.9	15.0	645.0	45.0	2.22	0.47
7	64.1	47.6	15.0	630.0	60.0	2.22	0.47
8	70.9	54.3	15.0	615.0	75.0	2.22	0.47
9	77.6	61.1	15.0	600.0	90.0	2.22	0.47
Avg. Shaft			10.0			1.47	0.31
Toe			600.0				435.26

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.25	0.06
Quake	(in)	0.04	0.37
Case Damping Factor		0.59	0.94
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	51
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	99	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)		0.039

CAPWAP match quality = 1.91 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.17 in; Blow Count = 69 b/ft
Computed: Final Set = 0.19 in; Blow Count = 64 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.02; A4(K3550) CAL: 360; RF: 1.02

max. Top Comp. Stress = 34.7 ksi (T= 36.1 ms, max= 1.041 x Top)
max. Comp. Stress = 36.1 ksi (Z= 43.9 ft, T= 38.5 ms)
max. Tens. Stress = -5.78 ksi (Z= 43.9 ft, T= 61.6 ms)
max. Energy (EMX) = 44.7 kip-ft; max. Measured Top Displ. (DMX)= 1.15 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	741.9	-33.1	34.7	-1.55	44.7	18.1	1.13
2	6.7	743.2	-38.3	34.7	-1.79	44.5	18.1	1.11
4	13.5	745.9	-48.2	34.8	-2.25	43.6	18.0	1.06
5	16.9	748.2	-59.7	35.0	-2.79	43.1	18.0	1.03
6	20.2	750.9	-70.8	35.1	-3.31	42.5	17.9	1.00
7	23.6	754.1	-80.4	35.2	-3.76	41.9	17.8	0.97
8	27.0	752.7	-88.8	35.2	-4.15	40.9	17.7	0.94
9	30.4	757.2	-97.3	35.4	-4.54	40.1	17.6	0.91
10	33.7	752.2	-102.9	35.1	-4.81	38.7	17.4	0.87
11	37.1	762.0	-111.5	35.6	-5.21	37.9	17.2	0.83
12	40.5	759.7	-116.5	35.5	-5.44	36.3	16.8	0.80
13	43.9	772.2	-123.8	36.1	-5.78	35.3	16.5	0.76
14	47.2	731.2	-114.4	34.2	-5.34	32.0	16.1	0.72
15	50.6	744.3	-117.7	34.8	-5.50	31.0	15.7	0.68
16	54.0	696.8	-104.9	32.5	-4.90	27.4	15.3	0.64
17	57.4	709.6	-107.1	33.1	-5.01	26.4	15.0	0.61
18	60.7	654.1	-89.8	30.6	-4.20	22.8	14.6	0.57
19	64.1	666.5	-89.8	31.1	-4.19	21.8	14.2	0.53
20	67.5	627.9	-72.2	29.3	-3.37	18.5	16.0	0.49
21	70.9	660.8	-76.8	30.9	-3.59	17.4	17.2	0.45
22	74.2	660.3	-61.4	30.8	-2.87	14.4	17.9	0.41
23	77.6	678.4	-64.0	31.7	-2.99	13.0	16.6	0.37
Absolute	43.9			36.1			(T =	38.5 ms)
	43.9				-5.78		(T =	61.6 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	736.7	593.0	449.3	305.5	161.8					
RX	849.4	806.0	762.7	722.2	703.9	689.1	674.3	659.5	644.8	630.0
RU	736.7	593.0	449.3	305.5	161.8					

RAU = 523.2 (kips); RA2 = 762.2 (kips)

Current CAPWAP Ru = 690.0 (kips); Corresponding J(RP)= 0.07; 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
18.4	35.73	702.5	752.8	752.8	1.15	0.18	0.17	44.9	815.5	1667

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

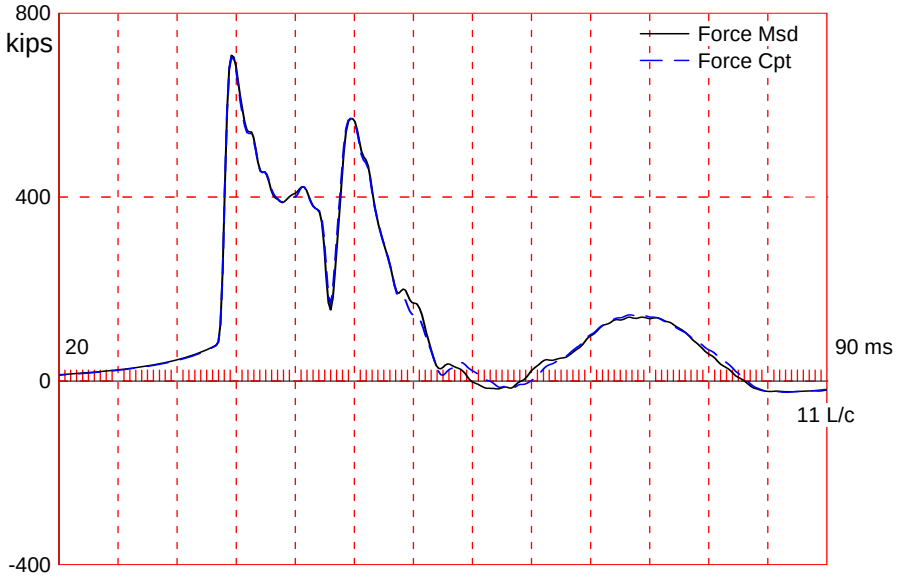
Toe Area 198.5 in^2

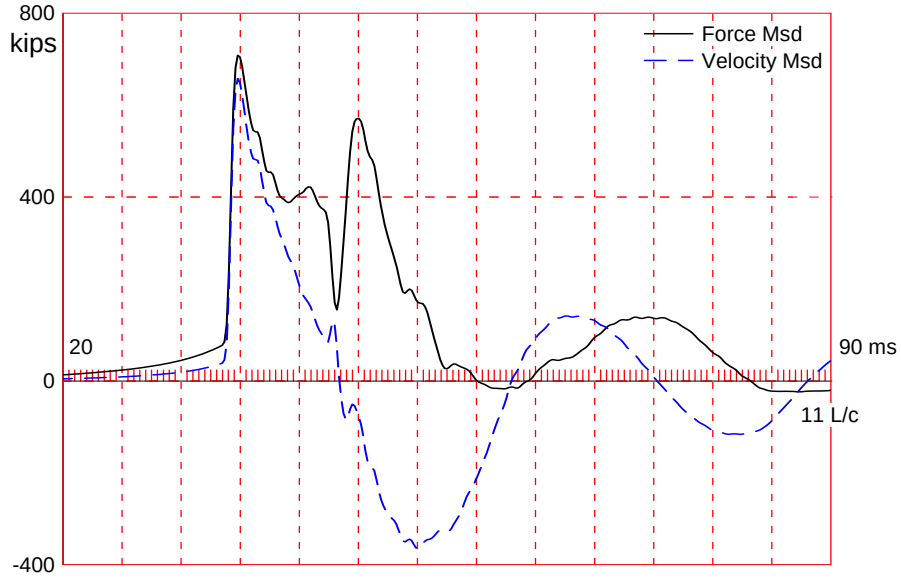
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

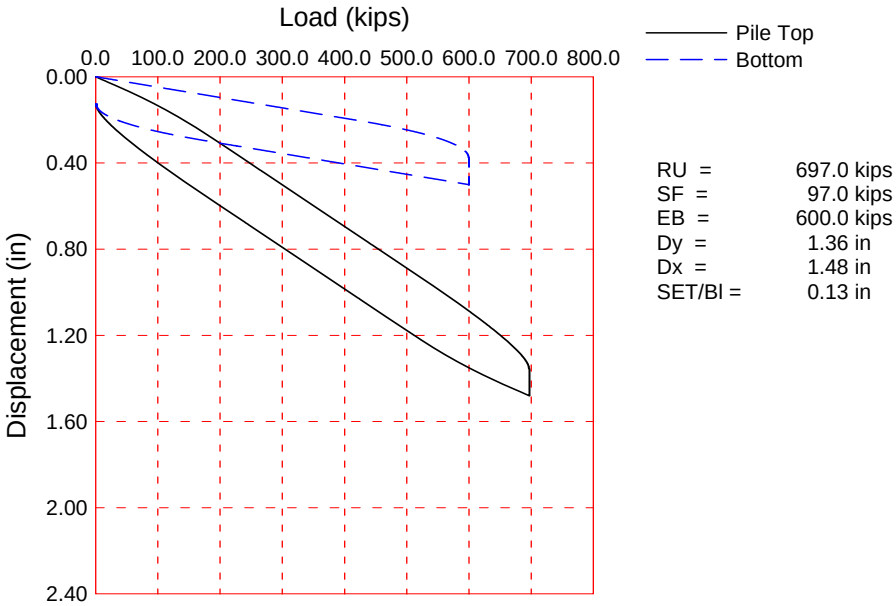
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 9.2 ms
Total volume: 11.532 ft^3; Volume ratio considering added impedance: 1.000

DYNAMIC RESISTANCE TABLE

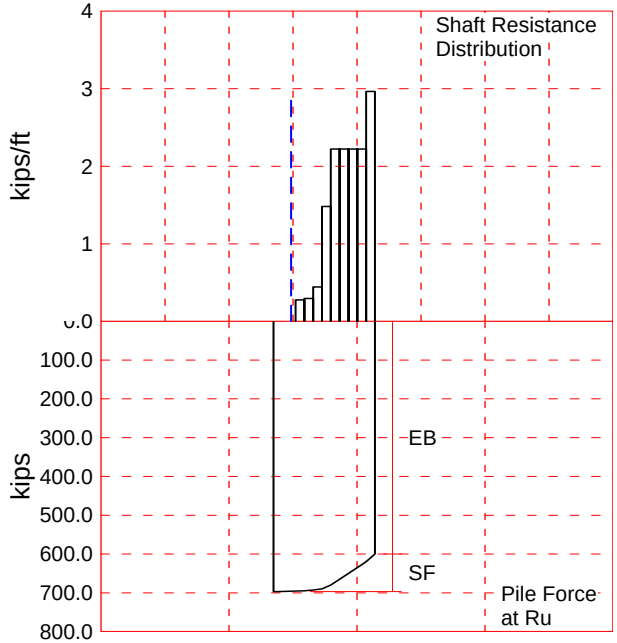
Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Damping Rd at Max. Rt kips	Max Rt (Ru+Rd) kips	Total Unit Rt W. Resp. to Depth kips/ft	Area ksf
1	23.6	7.1	1.0	4.4	5.4	0.77	0.16
2	30.4	13.9	2.0	8.8	10.8	1.60	0.34
3	37.1	20.6	3.0	12.8	15.8	2.35	0.50
4	43.9	27.4	11.0	44.9	55.9	8.29	1.76
5	50.6	34.1	13.0	50.6	63.6	9.42	2.00
6	57.4	40.9	15.0	55.4	70.4	10.43	2.22
7	64.1	47.6	15.0	52.7	67.7	10.03	2.13
8	70.9	54.3	15.0	63.7	78.7	11.67	2.48
9	77.6	61.1	15.0	60.4	75.4	11.18	2.38
Avg. Shaft			10.0	39.3	49.3	7.26	1.55
Toe			600.0	51.7	651.7		472.77
Total					1095.4		







RU =	697.0 kips
SF =	97.0 kips
EB =	600.0 kips
Dy =	1.36 in
Dx =	1.48 in
SET/Bl =	0.13 in



Length b. Sensors	77.6 ft
Embedment	61.2 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	1.85
Top Compr. Stress	33.0 ksi
Max Compr. Stress	34.1 ksi
Max Tension Stress	-7.05 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.29 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.07 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 697.0; along Shaft 97.0; at Toe 600.0 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
				697.0			
1	23.6	7.2	2.0	695.0	2.0	0.28	0.06
2	30.4	13.9	2.0	693.0	4.0	0.30	0.06
3	37.1	20.7	3.0	690.0	7.0	0.44	0.09
4	43.9	27.4	10.0	680.0	17.0	1.48	0.32
5	50.6	34.2	15.0	665.0	32.0	2.22	0.47
6	57.4	40.9	15.0	650.0	47.0	2.22	0.47
7	64.1	47.7	15.0	635.0	62.0	2.22	0.47
8	70.9	54.4	15.0	620.0	77.0	2.22	0.47
9	77.6	61.2	20.0	600.0	97.0	2.96	0.63
Avg. Shaft			10.8			1.59	0.34
Toe			600.0				435.26

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.27	0.07
Quake	(in)	0.04	0.29
Case Damping Factor		0.69	1.10
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	48
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	93	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.030	

CAPWAP match quality = 1.85 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.13 in; Blow Count = 96 b/ft
Computed: Final Set = 0.04 in; Blow Count = 325 b/ft
Transducer F3(F607) CAL: 93.6; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K2524) CAL: 360; RF: 1.05; A4(K3550) CAL: 360; RF: 1.05

max. Top Comp. Stress = 33.0 ksi (T= 36.1 ms, max= 1.035 x Top)
max. Comp. Stress = 34.1 ksi (Z= 43.9 ft, T= 38.7 ms)
max. Tens. Stress = -7.05 ksi (Z= 43.9 ft, T= 60.6 ms)
max. Energy (EMX) = 41.8 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	706.1	-30.2	33.0	-1.41	41.8	17.3	1.07
2	6.7	707.0	-43.7	33.0	-2.04	41.6	17.2	1.05
4	13.5	708.9	-68.2	33.1	-3.19	40.7	17.2	1.00
5	16.9	710.9	-81.7	33.2	-3.82	40.2	17.1	0.97
6	20.2	714.4	-93.8	33.4	-4.38	39.5	17.0	0.94
7	23.6	717.4	-104.9	33.5	-4.90	38.8	16.9	0.91
8	27.0	710.1	-112.9	33.2	-5.27	37.5	16.8	0.88
9	30.4	713.8	-122.8	33.3	-5.74	36.6	16.7	0.84
10	33.7	707.8	-129.9	33.1	-6.07	35.2	16.5	0.80
11	37.1	718.7	-138.4	33.6	-6.47	34.3	16.3	0.76
12	40.5	715.0	-142.4	33.4	-6.65	32.6	16.0	0.73
13	43.9	730.7	-150.9	34.1	-7.05	31.6	15.6	0.69
14	47.2	697.5	-146.0	32.6	-6.82	28.6	15.1	0.65
15	50.6	720.0	-148.9	33.6	-6.96	27.6	14.6	0.61
16	54.0	665.8	-133.0	31.1	-6.21	23.9	14.0	0.57
17	57.4	671.5	-141.3	31.4	-6.60	22.8	13.7	0.53
18	60.7	632.1	-127.4	29.5	-5.95	19.4	13.5	0.49
19	64.1	651.7	-131.9	30.4	-6.16	18.3	13.1	0.45
20	67.5	645.7	-117.6	30.2	-5.49	15.3	14.6	0.41
21	70.9	667.2	-119.9	31.2	-5.60	14.2	15.8	0.37
22	74.2	661.6	-100.8	30.9	-4.71	11.6	16.1	0.33
23	77.6	677.1	-101.2	31.6	-4.73	10.1	14.1	0.29
Absolute	43.9			34.1			(T =	38.7 ms)
	43.9				-7.05		(T =	60.6 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	771.3	710.5	649.8	589.0	528.2	467.4	406.7	345.9	285.1	224.3
RX	843.7	818.2	799.7	781.5	763.2	745.0	727.0	710.1	695.0	686.4
RU	771.3	710.5	649.8	589.0	528.2	467.4	406.7	345.9	285.1	224.3

RAU = 539.5 (kips); RA2 = 734.9 (kips)

Current CAPWAP Ru = 697.0 (kips); Corresponding J(RP)= 0.12; J(RX) = 0.79

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
17.4	35.93	664.7	714.5	714.5	1.08	0.11	0.13	42.2	841.8	2143

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
17	57.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
18	60.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.020
19	64.1	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: 11.532 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
1	23.6	7.2	2.0	9.1	11.1	1.54	0.33
2	30.4	13.9	2.0	9.0	11.0	1.63	0.35
3	37.1	20.7	3.0	13.2	16.2	2.40	0.51
4	43.9	27.4	10.0	41.8	51.8	7.68	1.63
5	50.6	34.2	15.0	58.4	73.4	10.89	2.32
6	57.4	40.9	15.0	54.4	69.4	10.29	2.19
7	64.1	47.7	15.0	52.4	67.4	9.99	2.13
8	70.9	54.4	15.0	63.2	78.2	11.59	2.47
9	77.6	61.2	20.0	76.2	96.2	14.26	3.03
Avg. Shaft			10.8	42.0	52.8	7.76	1.65
Toe			600.0	44.9	644.9		467.81
Total					1119.7		

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

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)

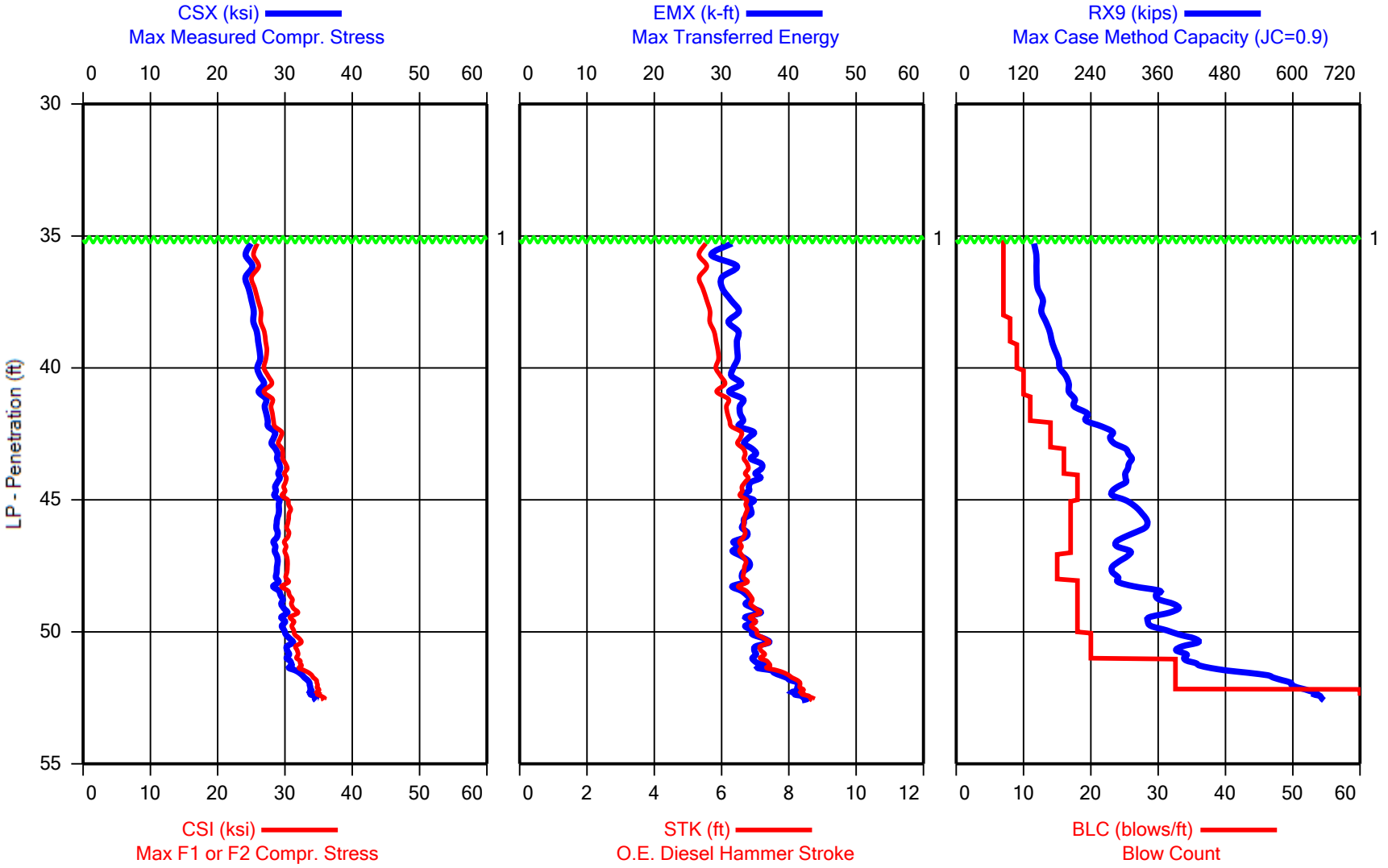
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

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

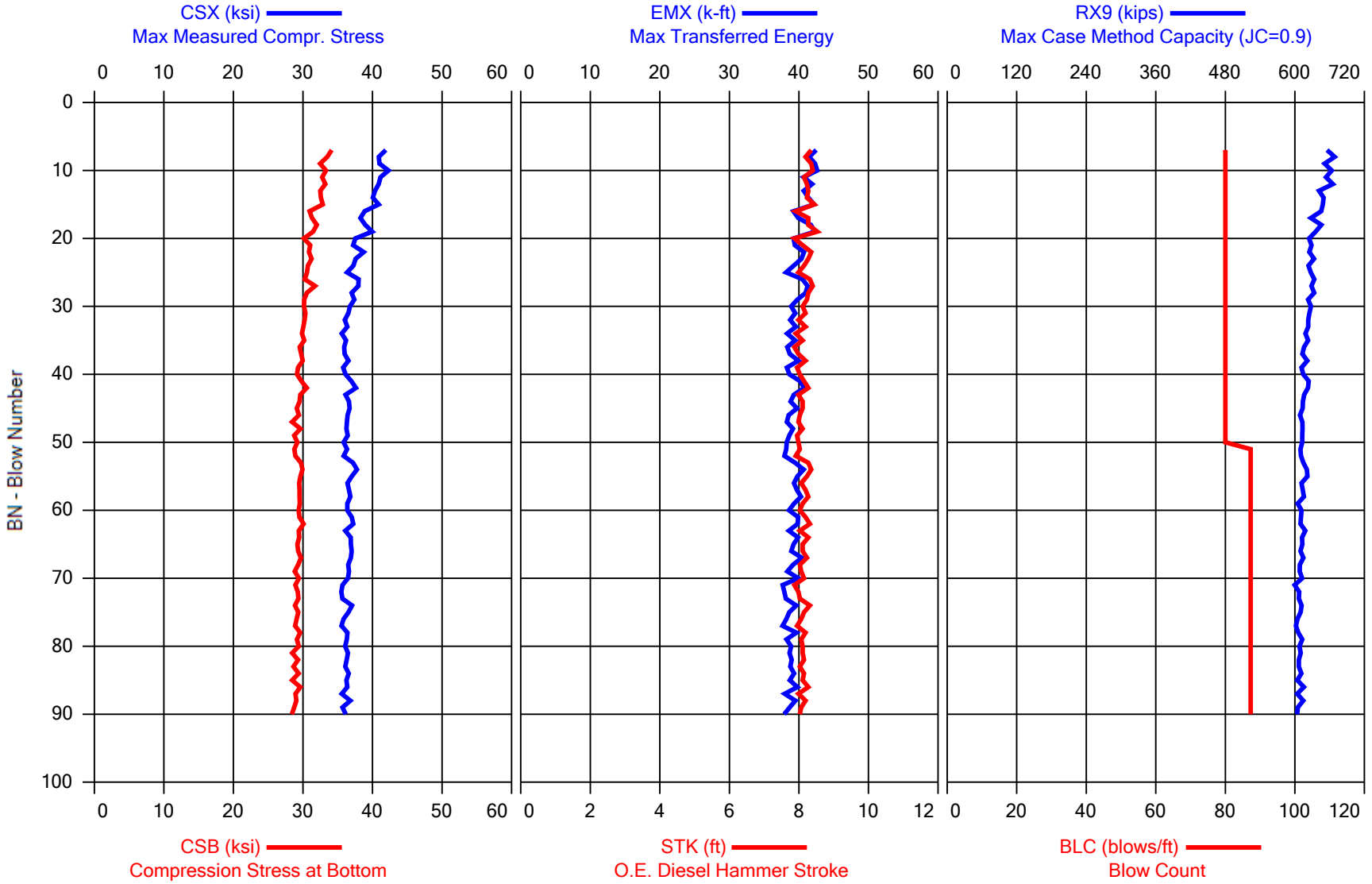
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

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

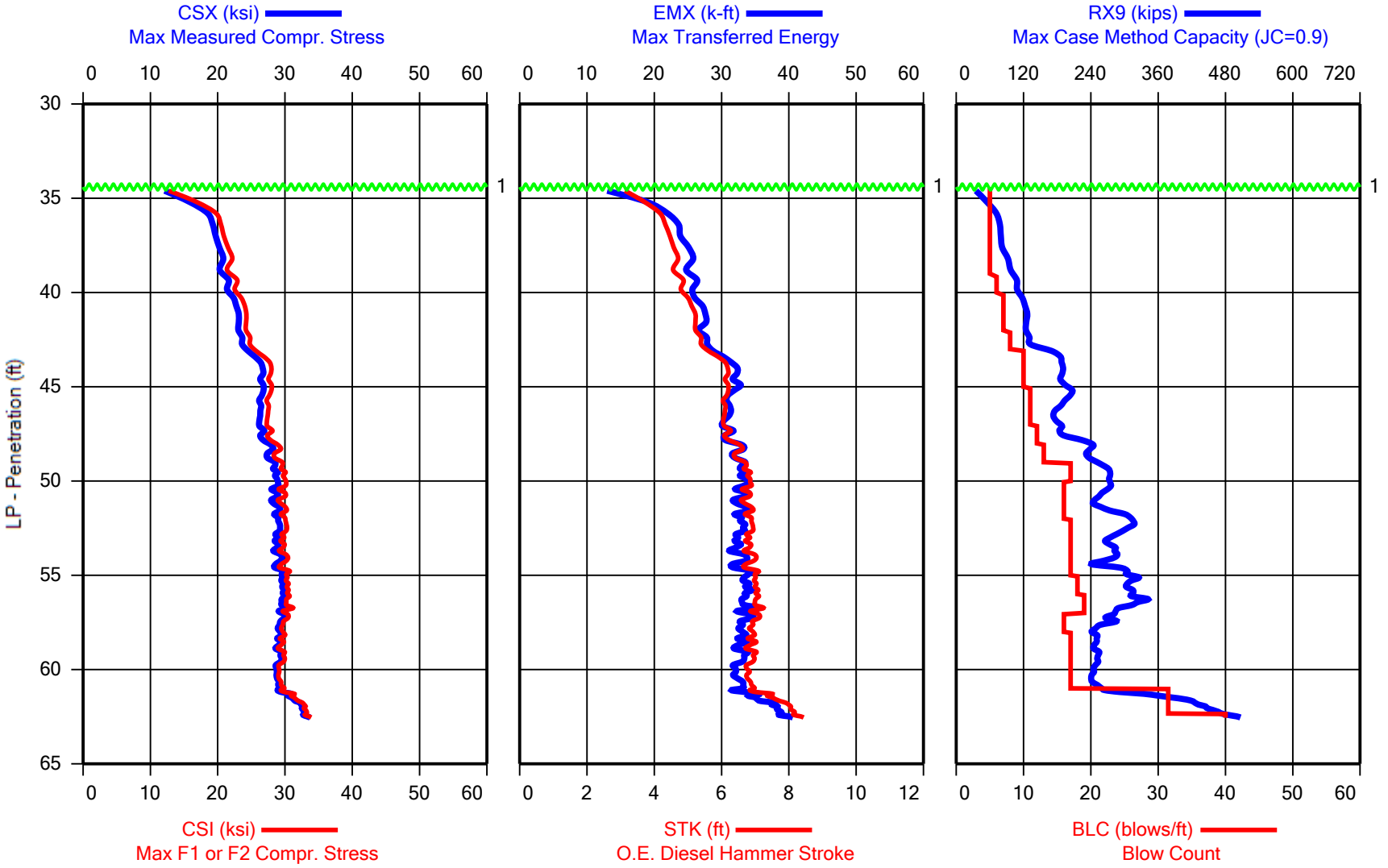
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

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
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	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

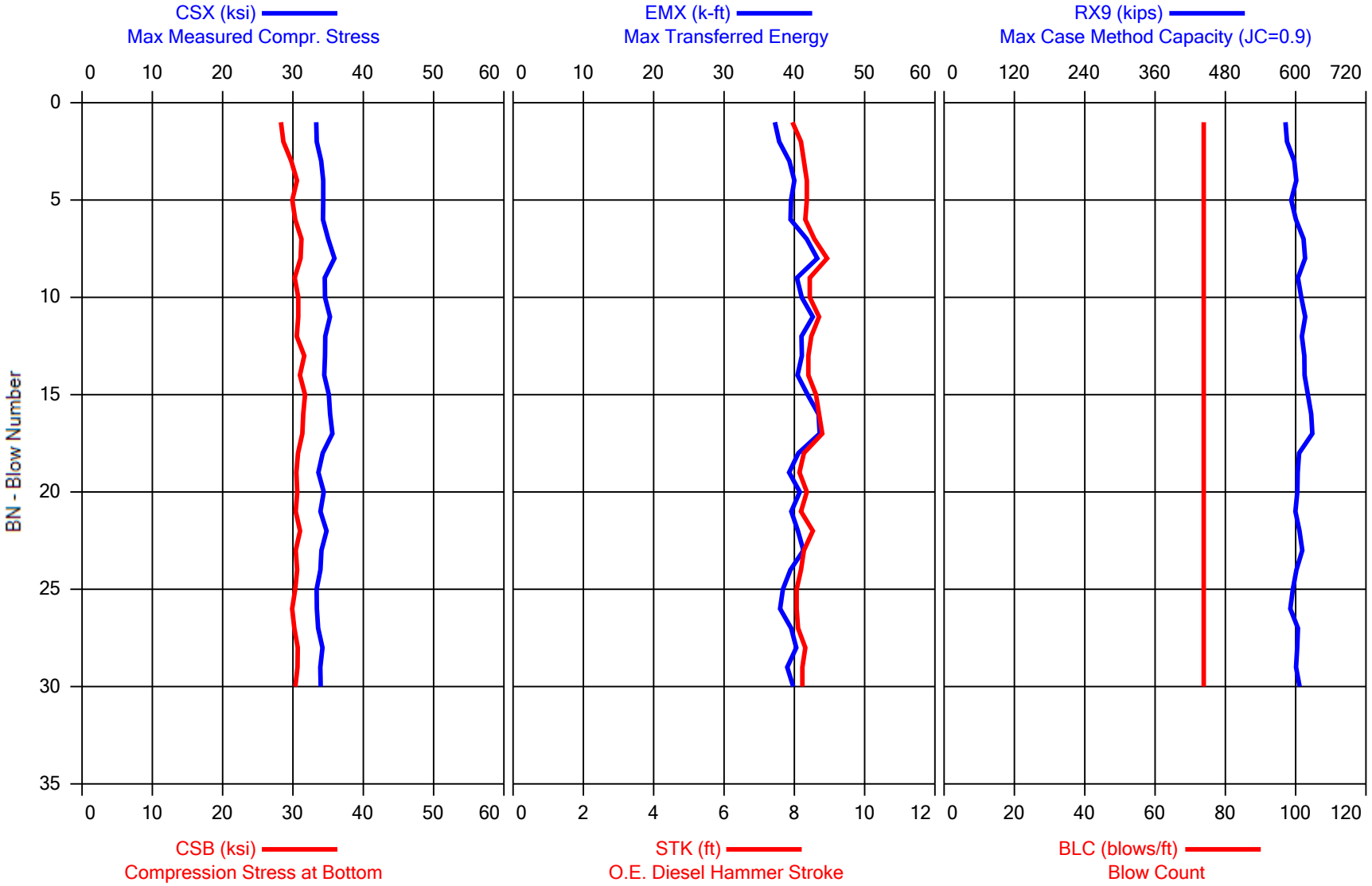
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

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
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	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

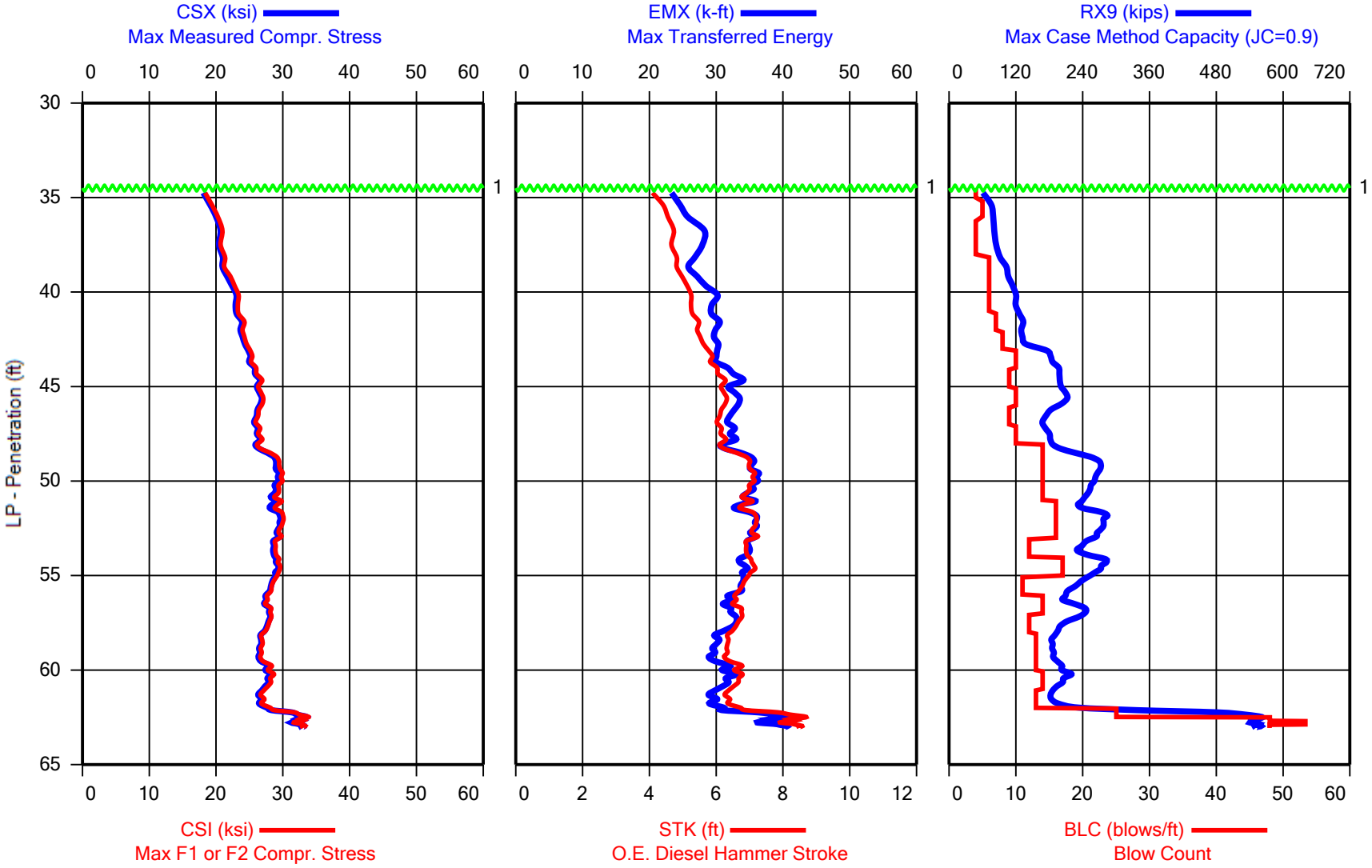
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

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

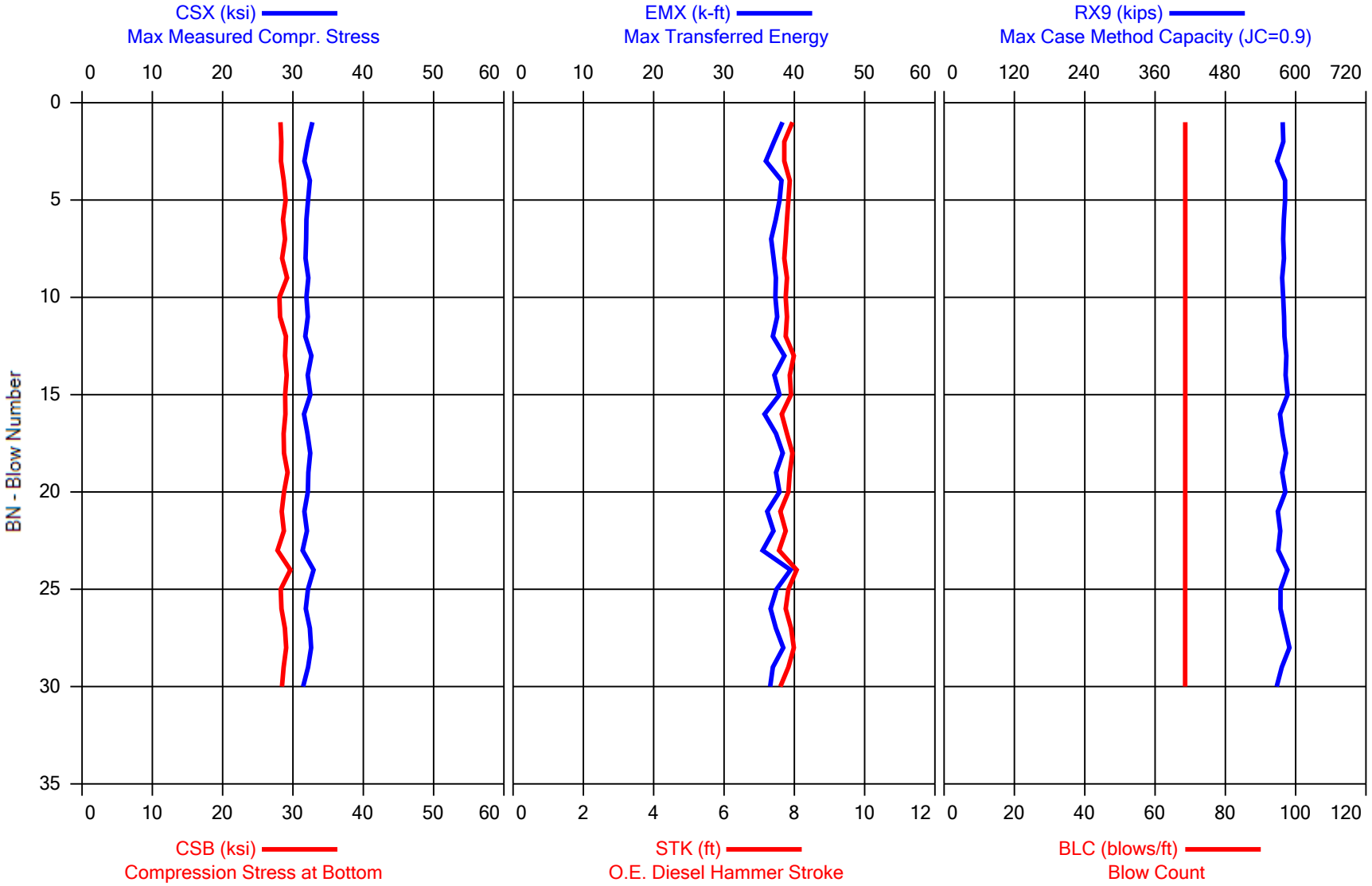
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

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

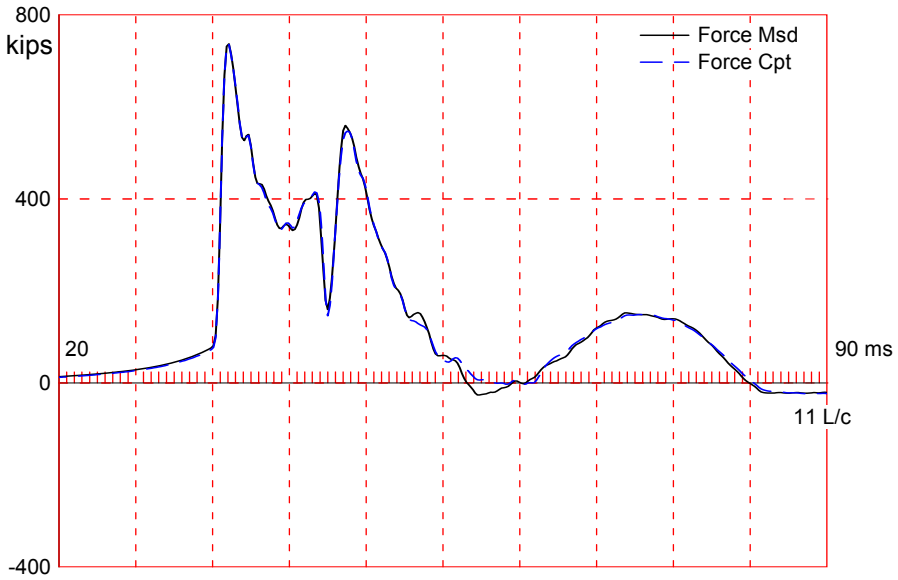
Total number of blows analyzed: 30

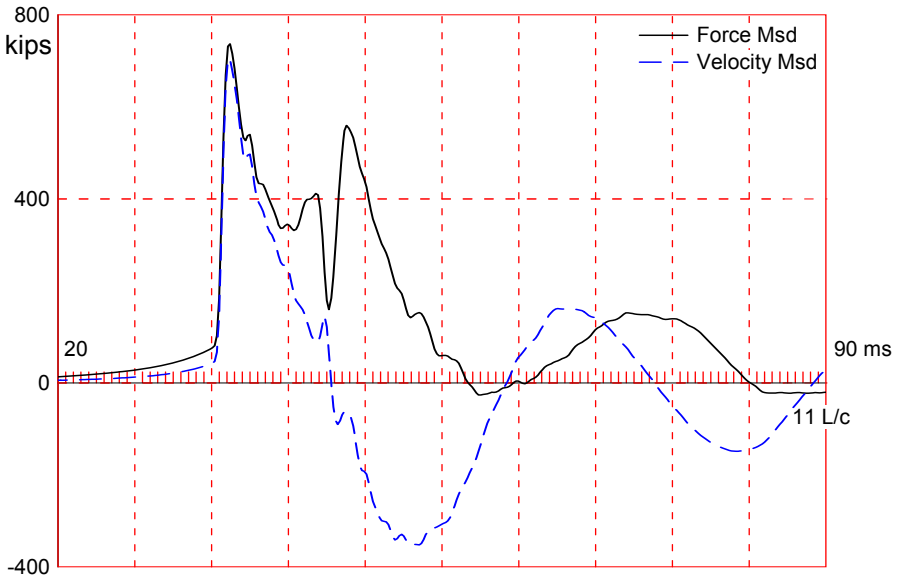
BL# Sensors

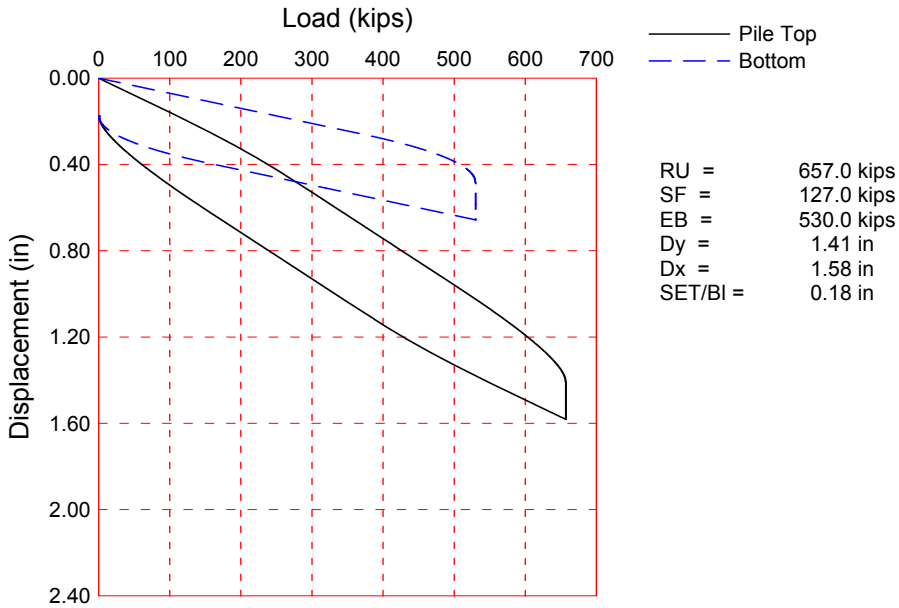
1-30 F3: [K769] 91.9 (1.00); F4: [D815] 93.0 (1.00); A3: [K3658] 362.0 (1.00); A4: [K3550] 360.0 (1.00)

Time Summary

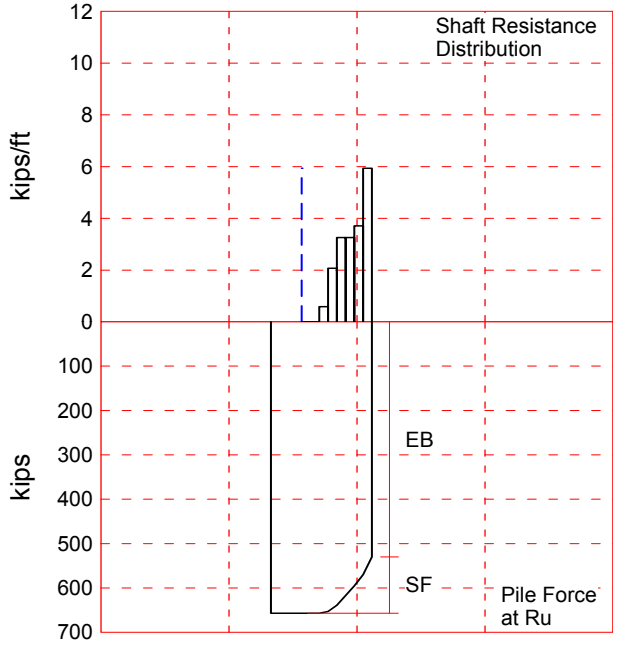
Drive 41 seconds 6:35 AM - 6:35 AM BN 1 - 30







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

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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: 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

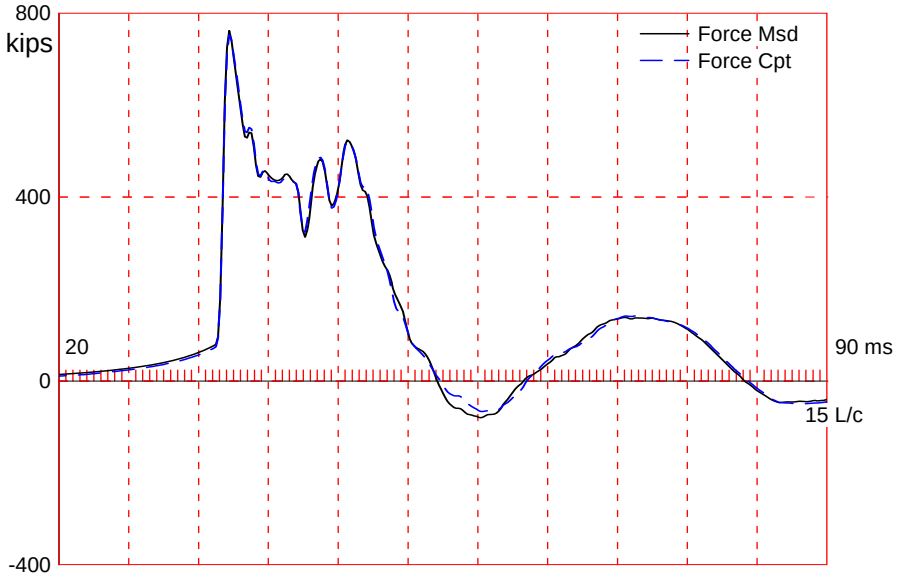
PILE PROFILE AND PILE MODEL

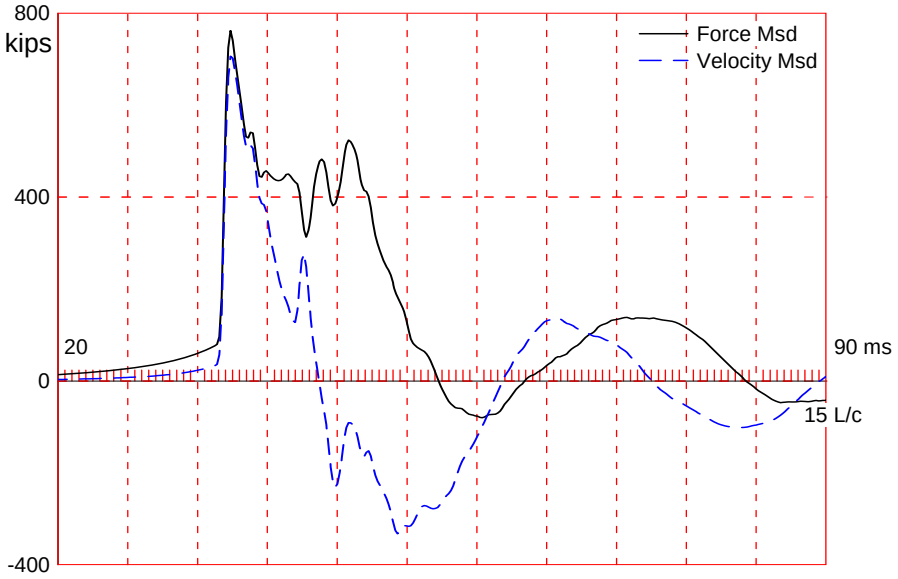
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

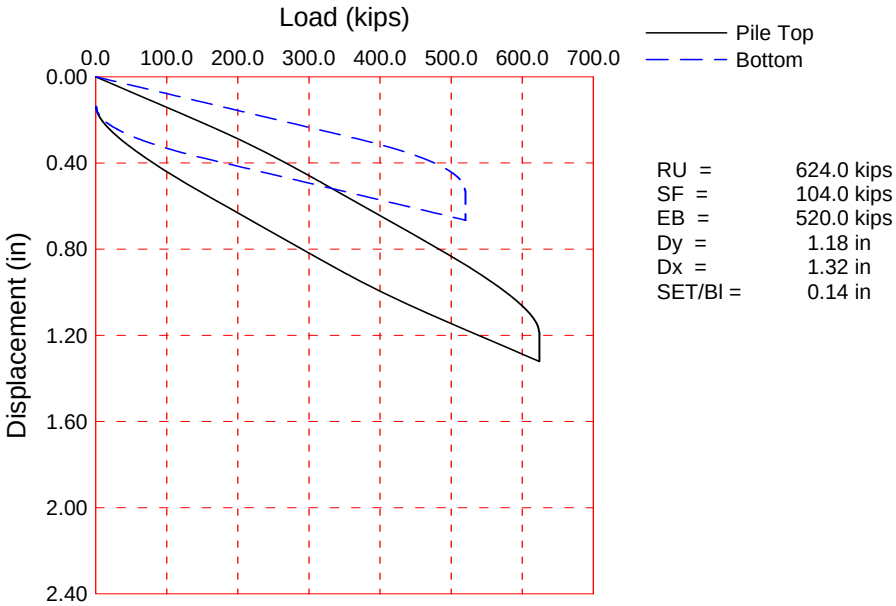
Toe Area 198.5 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	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
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

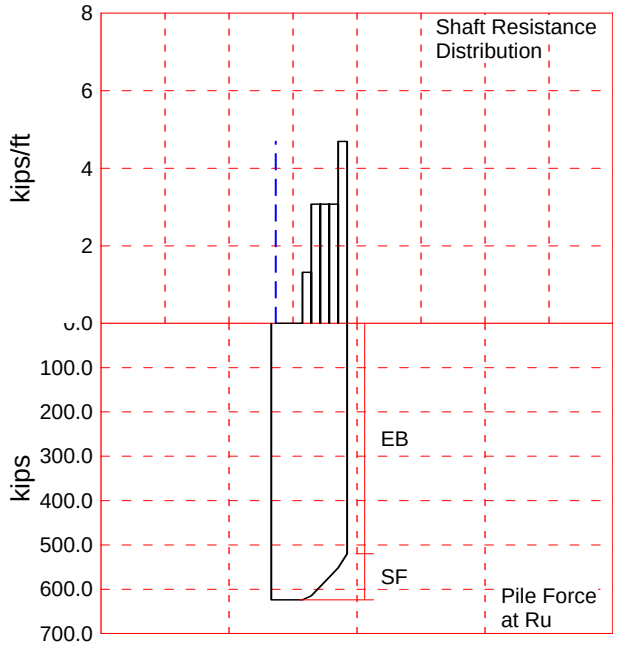
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







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

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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

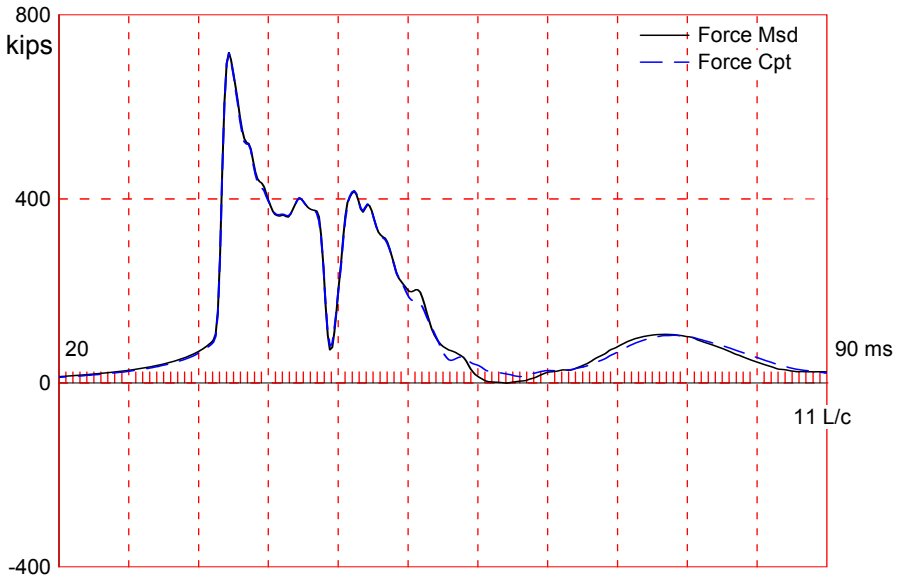
Toe Area 198.5 in^2

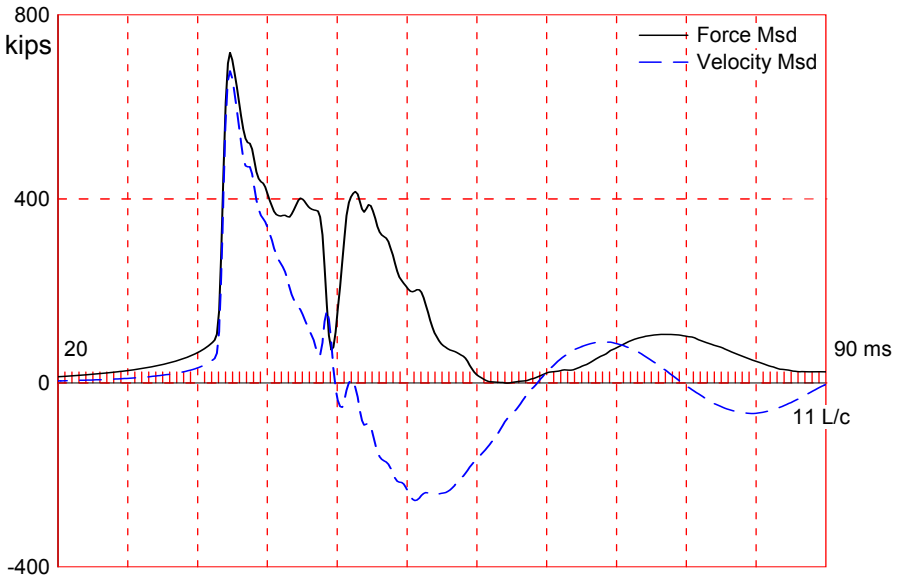
Top Segment Length 3.41 ft, Top Impedance 38 kips/ft/s

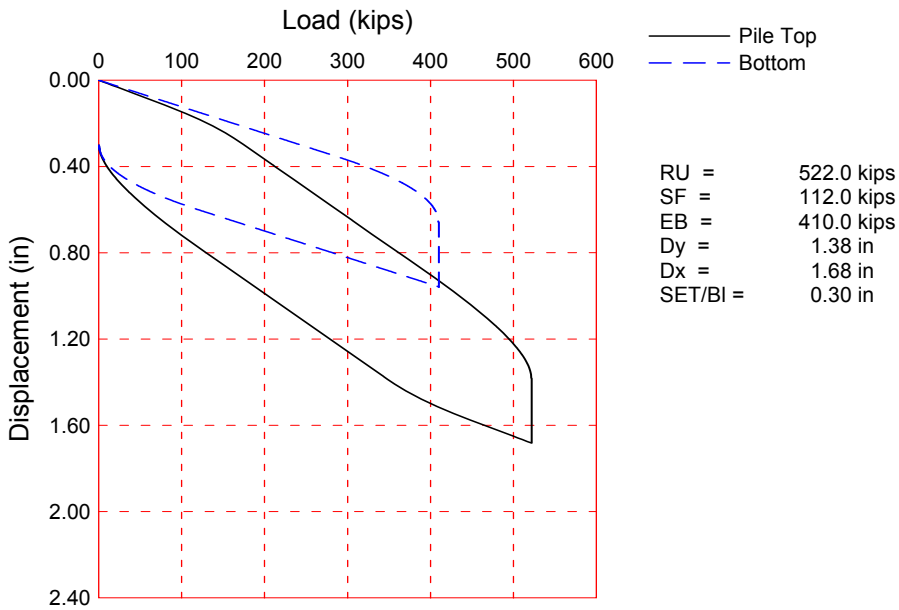
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.203 ms, 2L/c 6.9 ms
Total volume: 8.619 ft^3; Volume ratio considering added impedance: 1.000

DYNAMIC RESISTANCE TABLE

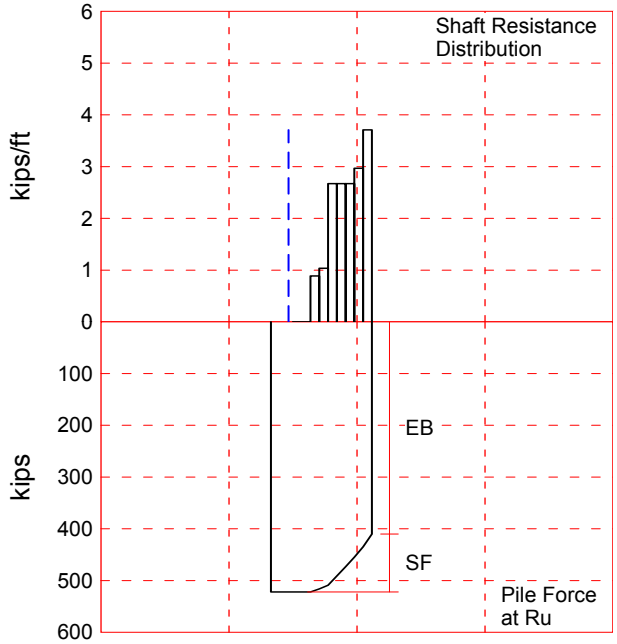
Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Damping Rd at Max. Rt kips	Max Rt (Ru+Rd) kips	Total W. Depth kips/ft	Unit Rt Resp. to Area ksf	Smith Damping Factor s/ft
1	10.2	5.9	0.0	0.0	0.0	0.00	0.00	0.00
2	17.1	12.7	0.0	0.0	0.0	0.00	0.00	0.00
3	23.9	19.6	0.0	0.0	0.0	0.00	0.00	0.00
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/Bl =	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

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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: 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

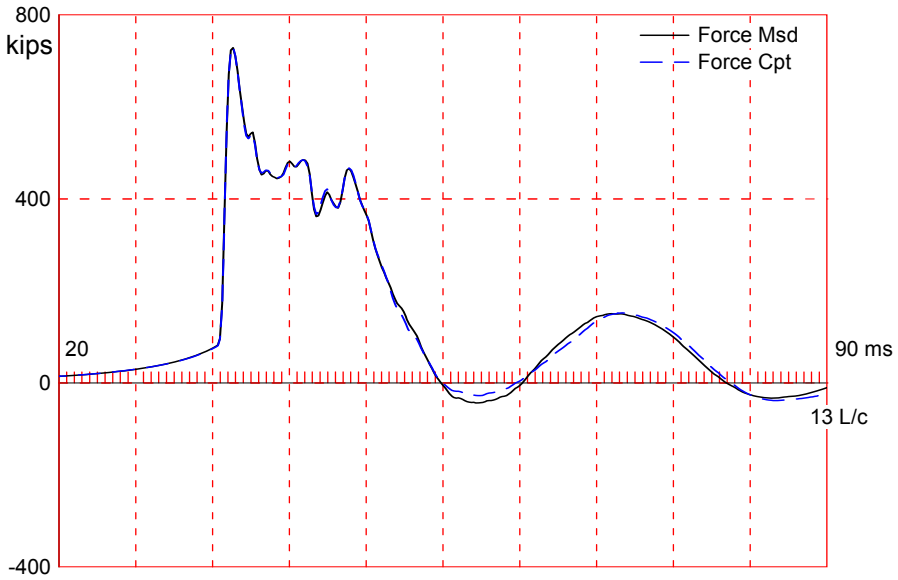
PILE PROFILE AND PILE MODEL

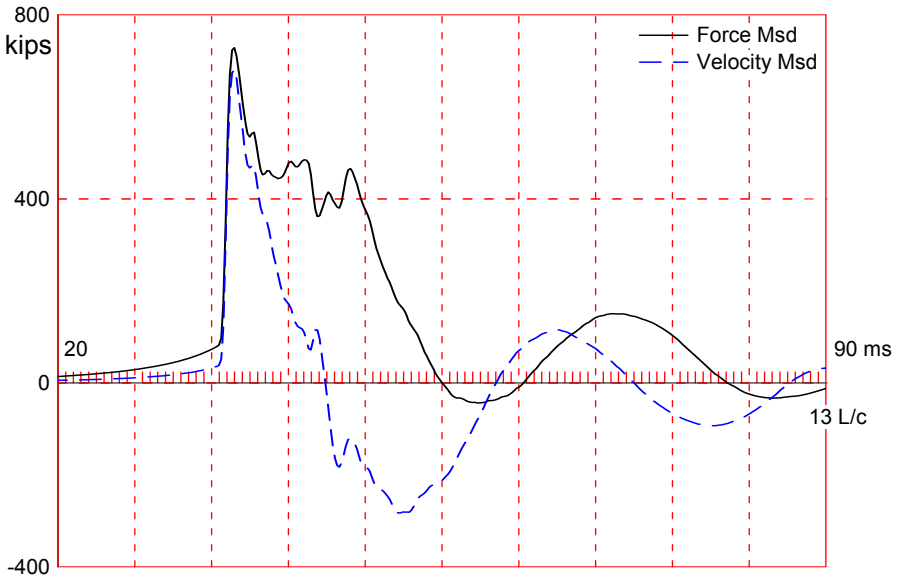
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

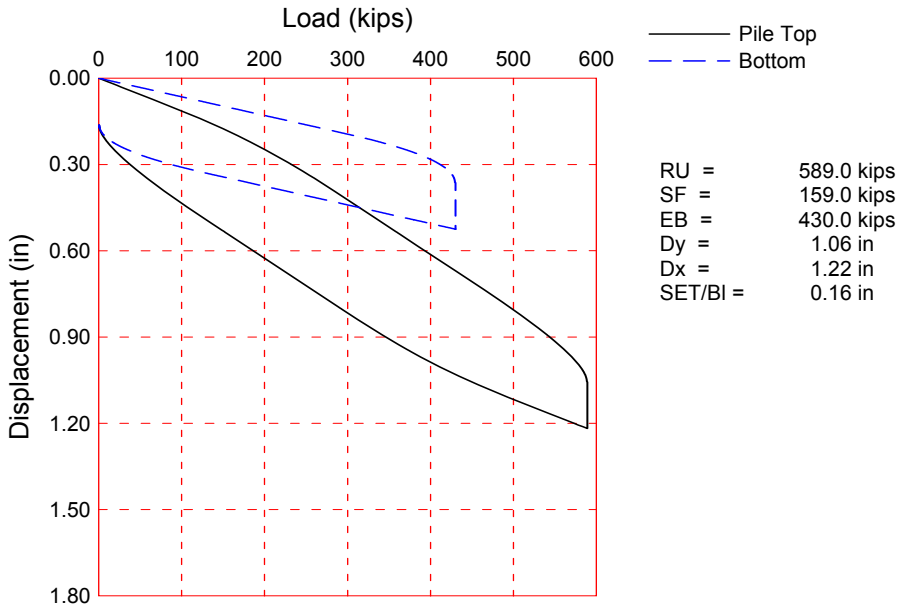
Toe Area 198.5 in^2

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

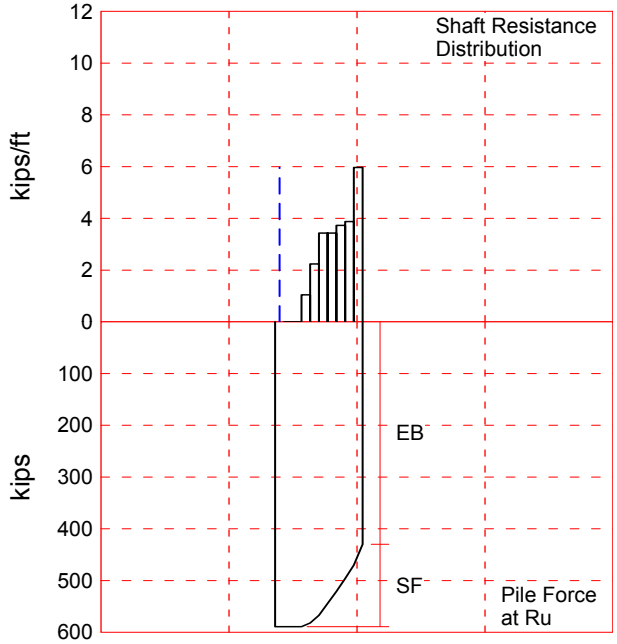
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 $ft^{3;}$ Volume ratio considering added impedance: 1.000







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

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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

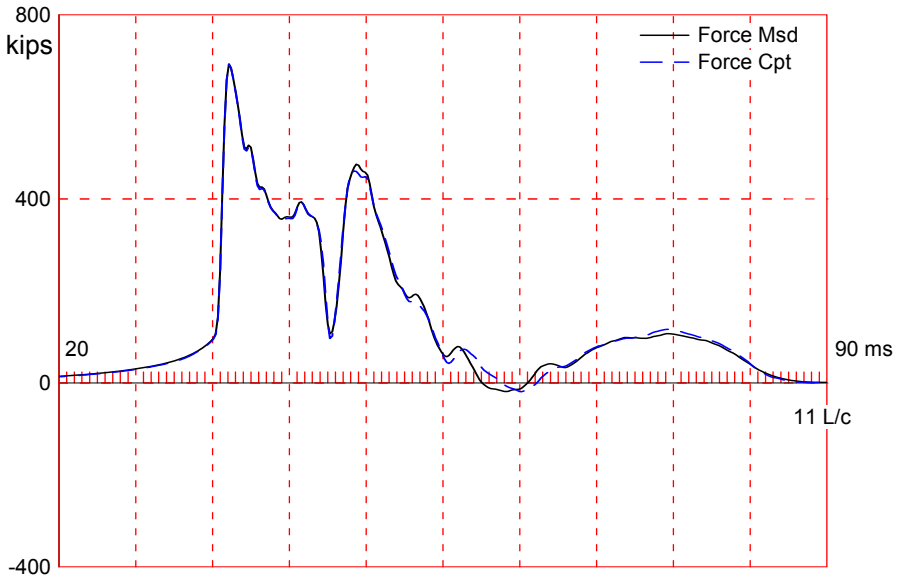
PILE PROFILE AND PILE MODEL

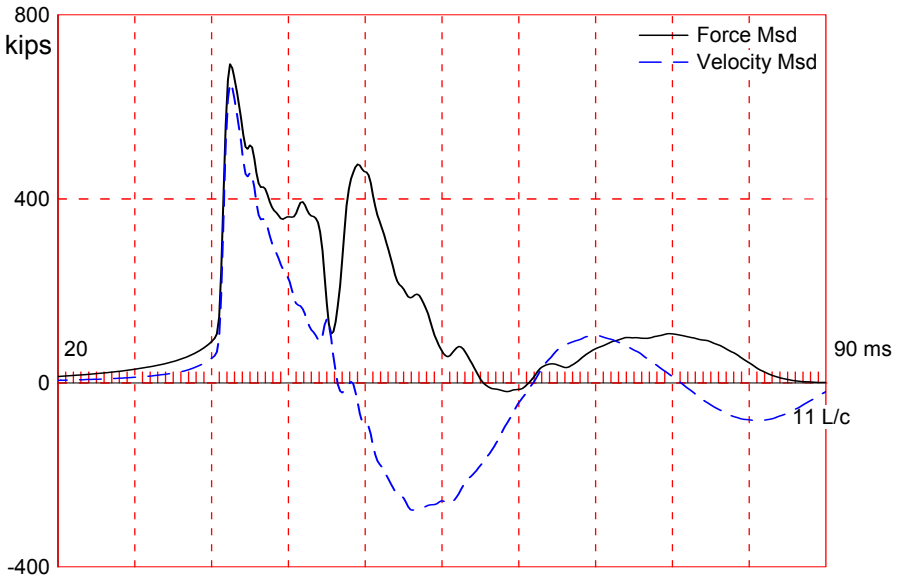
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
67.0	21.4	29992.2	492.000	4.70

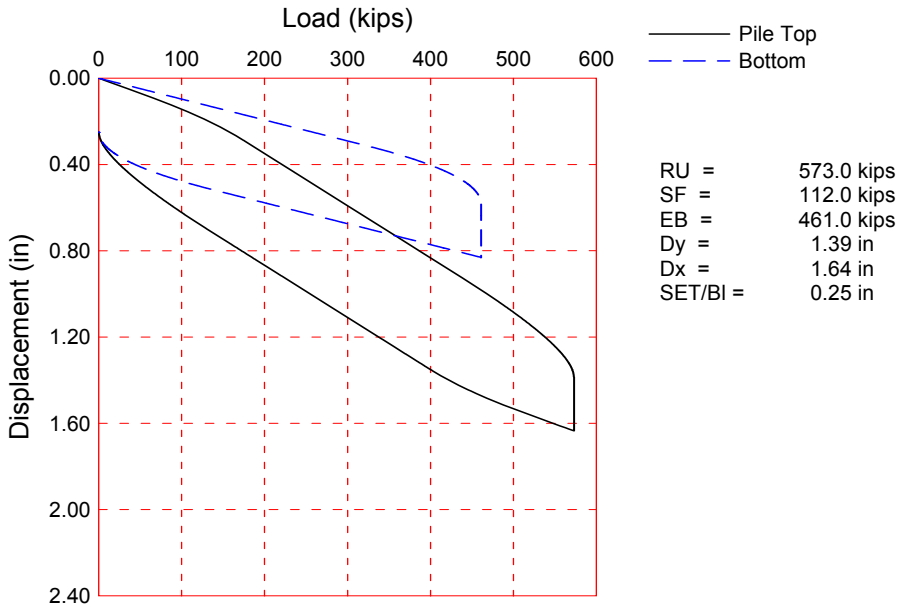
Toe Area 198.5 in^2

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

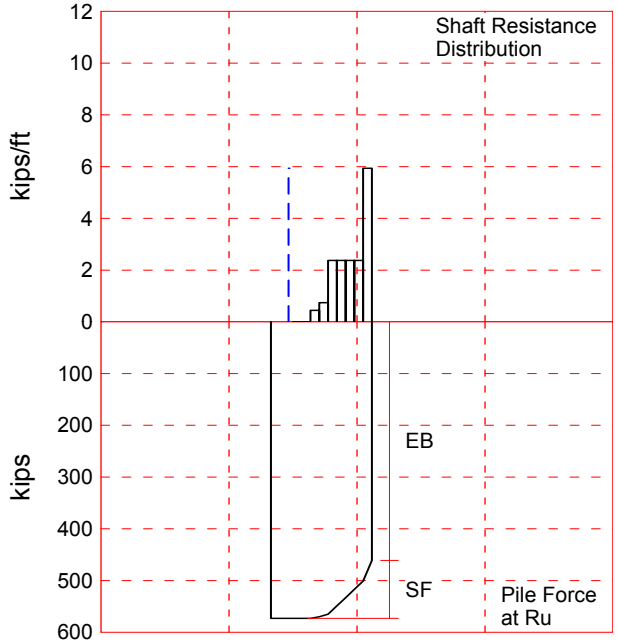
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 8.0 ms
Total volume: 9.957 ft^3; Volume ratio considering added impedance: 1.000







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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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: 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

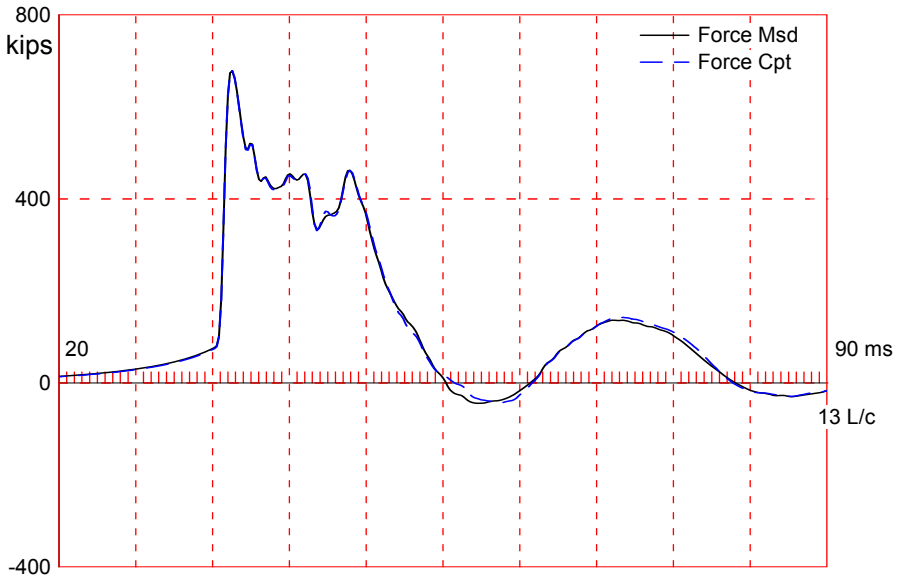
PILE PROFILE AND PILE MODEL

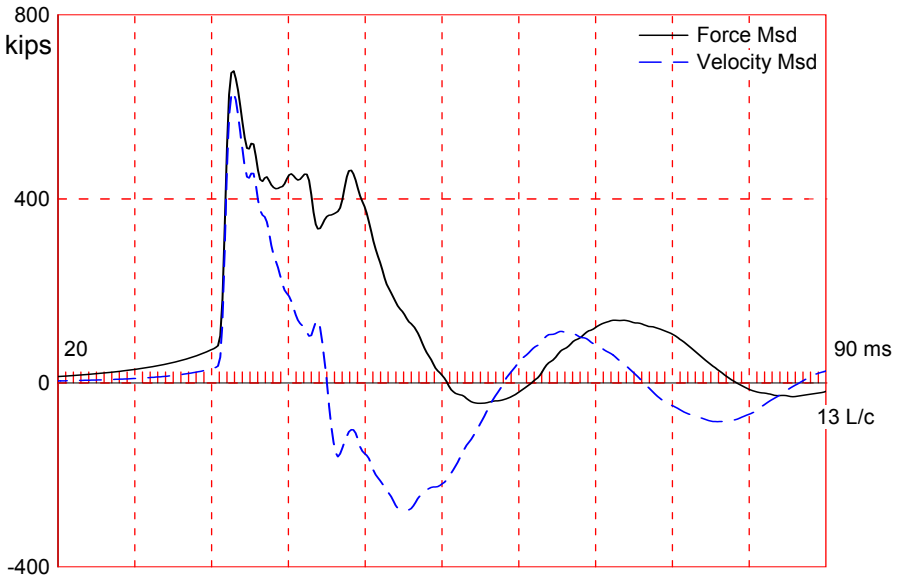
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

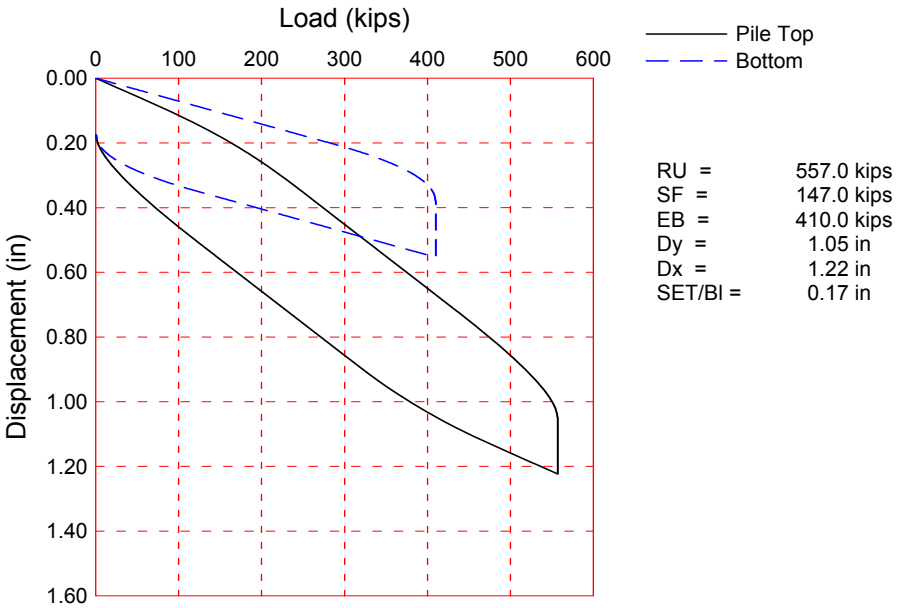
Toe Area 198.5 in^2

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

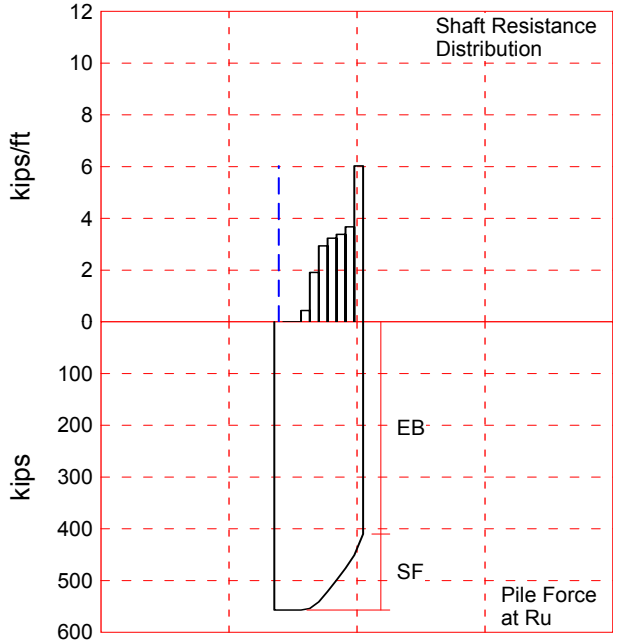
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 $ft^{3;}$ Volume ratio considering added impedance: 1.000







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

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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.

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: 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

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Alexander McCaskill
Company: Lunda Construction Co.	No. of Sheets: 51
E-mail: kweber@lundaconstruction.com	Date: June 11, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 19
Winnebago County, Wisconsin

On June 10, 2015, Pier 19 #1, Pier 19 #36, and Pier 19 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on June 11. Project plans indicated that 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 691. The HP 14x73 H-piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0256) operated on fuel setting 4. The reference elevation for the piles was the top of the cofferdam at EL 739.7 to EL 740.6. The pier was excavated to an elevation of EL 718.2.

Pier 19 #1 was driven to a depth of 52.0 feet, which corresponds to a pile tip elevation of EL 687.7. The blow count over the final increment of driving was 10 blows for 2 inches of penetration at an average hammer stroke of 8.6 feet. The blow count at the beginning of restrike was 10 blows per for 2 ¼ inches of penetration at an average hammer stroke of 8.2 feet.

Pier 19 #36 was driven to a depth of 65.9 feet, which corresponds to a pile tip elevation of EL 674.7. The blow count over the final increment of driving was 10 blows for 1 ½ inches of penetration at an average hammer stroke of 9.4 feet. The blow count at the beginning of restrike was 10 blows for 1 ¼ inches of penetration at an average hammer stroke of 9.1 feet.

Pier 19 #44 was driven to a depth of 65.8 feet, which corresponds to a pile tip elevation of EL 673.9. The blow count over the final increment of driving was 10 blows for 1 inch of penetration at an average hammer stroke of 9.4 feet. The blow count at the beginning of restrike was 10 blows for 1 ½ inches of penetration at an average hammer stroke of 9.2 feet

We recommend that the production piles at Pier 19 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	6	3
7.5	5	3
8.0	4	3
8.5	4	3
9.0	4	3

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 the plan minimum tip requirements.

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 – 51)

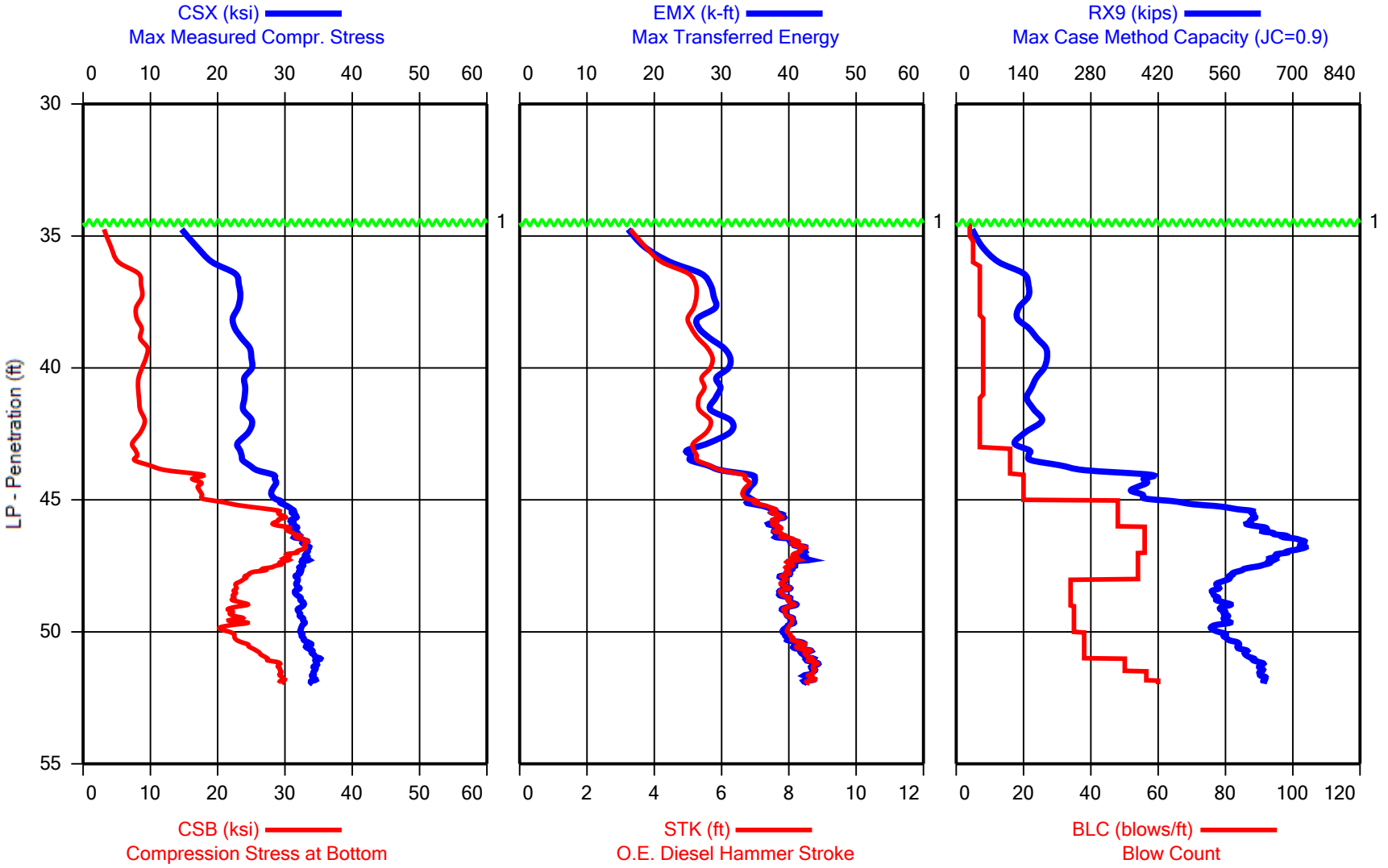
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 12-June-2015

Test started: 10-June-2015

USH 10 over Little Lake Butte des Morts - PIER 19 #1

APE D30-42, HP 14 x 73



1 - Reported reference at El. 739.7

USH 10 over Little Lake Butte des Morts - PIER 19 #1 APE D30-42, HP 14 x 73
OP: TC Date: 10-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	14.6	3.1	16	3.3	63.5	33
			STD	0.7	0.2	1	0.1	0.8	10
			MAX	15.1	3.3	17	3.4	64.4	44
			MIN	13.7	2.9	15	3.2	62.4	21
13	36.00	5	AV5	17.6	4.4	20	3.9	58.9	61
			STD	1.1	0.4	2	0.2	1.7	11
			MAX	19.1	5.1	23	4.2	61.5	82
			MIN	15.9	3.9	17	3.5	56.8	51
20	37.00	7	AV7	22.4	8.1	27	5.0	52.2	141
			STD	1.2	0.9	2	0.3	1.5	12
			MAX	23.7	8.8	30	5.3	55.5	154
			MIN	19.9	6.0	23	4.4	50.7	116
27	38.00	7	AV7	23.0	8.2	29	5.2	51.5	138
			STD	0.6	0.5	1	0.1	0.6	12
			MAX	24.1	9.0	30	5.4	52.8	155
			MIN	21.9	7.7	26	4.9	50.6	124
35	39.00	8	AV8	22.9	8.5	27	5.2	51.5	152
			STD	0.7	0.5	1	0.1	0.7	17
			MAX	24.2	9.3	29	5.4	52.5	176
			MIN	21.7	7.7	26	5.0	50.4	125
43	40.00	8	AV8	24.9	9.3	31	5.7	49.3	188
			STD	0.2	0.4	1	0.1	0.4	3
			MAX	25.3	9.9	32	5.8	50.0	194
			MIN	24.6	8.7	30	5.5	48.6	184
51	41.00	8	AV8	24.3	8.2	30	5.5	50.0	163
			STD	0.7	0.4	1	0.1	0.5	7
			MAX	25.2	8.8	31	5.7	50.6	174
			MIN	23.1	7.8	28	5.4	49.3	156
58	42.00	7	AV7	24.1	8.6	29	5.4	50.5	162
			STD	0.9	0.3	2	0.2	1.0	18
			MAX	25.7	9.3	33	5.8	51.7	189
			MIN	22.8	8.2	27	5.1	48.7	137
65	43.00	7	AV7	23.9	8.1	30	5.4	50.4	139
			STD	1.0	0.9	2	0.2	1.0	19
			MAX	25.5	9.4	33	5.7	51.7	172
			MIN	22.7	7.0	27	5.1	49.0	116
81	44.00	16	AV16	24.4	9.6	27	5.5	50.0	201
			STD	1.2	2.7	2	0.4	1.6	73
			MAX	26.5	16.9	31	6.2	52.2	398
			MIN	22.8	7.1	24	5.0	47.2	144
101	45.00	20	AV20	28.4	17.4	34	6.7	45.4	387
			STD	0.7	0.8	1	0.2	0.6	17
			MAX	29.6	18.6	37	7.0	46.3	414
			MIN	27.3	14.9	32	6.5	44.5	354
149	46.00	48	AV48	30.8	26.9	37	7.5	43.2	578

USH 10 over Little Lake Butte des Morts - PIER 19 #1 APE D30-42, HP 14 x 73
OP: TC Date: 10-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			STD	0.8	3.3	2	0.3	0.7	57
			MAX	32.3	30.4	40	7.9	45.1	631
			MIN	28.8	19.4	33	6.8	41.9	438
205	47.00	56	AV56	32.5	32.0	40	8.0	41.7	688
			STD	0.9	1.1	2	0.3	0.7	32
			MAX	33.9	34.0	43	8.6	43.2	736
			MIN	30.8	29.9	37	7.5	40.3	630
259	48.00	54	AV54	32.5	27.8	41	8.0	41.7	621
			STD	0.6	2.5	1	0.2	0.5	39
			MAX	33.9	31.3	44	8.4	43.2	678
			MIN	30.7	23.6	37	7.5	40.7	553
293	49.00	34	AV34	32.0	22.9	40	7.9	42.0	546
			STD	0.7	0.8	1	0.2	0.5	12
			MAX	33.3	25.2	42	8.4	43.0	582
			MIN	30.7	21.9	37	7.5	40.9	526
328	50.00	35	AV35	32.4	22.1	40	8.0	41.8	551
			STD	0.4	1.4	1	0.1	0.3	14
			MAX	33.1	24.6	42	8.3	42.4	577
			MIN	31.4	19.7	38	7.8	41.0	522
366	51.00	38	AV38	33.5	24.5	41	8.3	41.0	584
			STD	0.8	1.7	2	0.3	0.6	20
			MAX	35.6	27.5	45	8.9	42.4	619
			MIN	31.7	21.9	37	7.8	39.7	551
390	51.48	50	AV24	34.6	28.7	44	8.7	40.0	631
			STD	0.4	0.8	1	0.1	0.2	8
			MAX	35.4	29.7	45	8.9	40.5	647
			MIN	33.8	27.1	42	8.5	39.6	617
400	51.66	56	AV10	34.2	29.3	43	8.7	40.2	632
			STD	0.3	0.4	1	0.1	0.2	2
			MAX	34.8	30.1	44	8.8	40.4	636
			MIN	33.9	28.9	42	8.6	39.8	628
410	51.83	56	AV10	34.3	29.7	43	8.7	40.1	641
			STD	0.3	0.3	1	0.1	0.3	4
			MAX	34.6	30.4	44	8.8	40.6	648
			MIN	33.7	29.3	42	8.5	39.8	635
419	51.98	60	AV9	34.0	29.4	43	8.6	40.4	639
			STD	0.4	0.4	1	0.1	0.3	5
			MAX	34.7	30.1	44	8.8	41.0	650
			MIN	33.3	29.0	41	8.3	39.8	630
			Average	30.7	23.1	38	7.5	43.6	514
			Std. Dev.	4.0	8.1	6	1.2	4.2	186
			Maximum	35.6	34.0	45	8.9	64.4	736
			Minimum	13.7	2.9	15	3.2	39.6	21

Total number of blows analyzed: 414

BL# Sensors

1-419 F3: [K769] 91.9 (1.00); F4: [D815] 93.0 (1.00); A3: [K3658] 362.0 (1.00); A4: [K3550] 360.0 (1.00)

BL# Comments

6 Reported reference at El. 739.7
7 Mud line at El. 718.2

Time Summary

Drive 9 minutes 51 seconds 6:15 AM - 6:25 AM BN 1 - 419

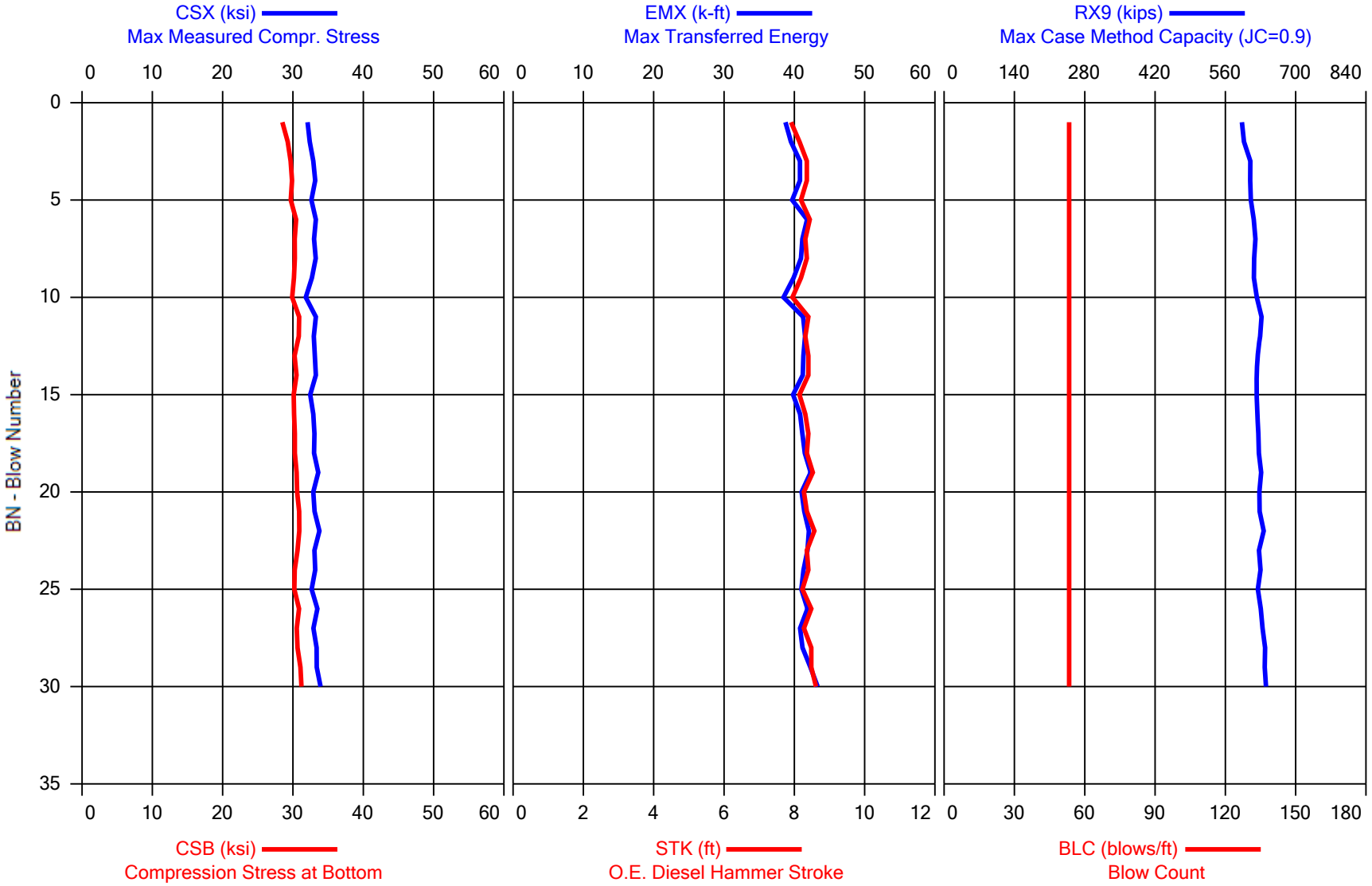
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 11-June-2015

Test started: 11-June-2015

USH 10 over Little Lake Butte des Morts - PIER 19 #1 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - PIER 19 #1 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 11-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
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	52.19	53	AV10	32.7	29.8	40	8.2	41.2	611
			STD	0.5	0.5	1	0.2	0.4	9
			MAX	33.3	30.4	42	8.4	42.0	623
			MIN	31.8	28.5	38	7.9	40.7	593
20	52.38	53	AV10	33.0	30.4	41	8.4	40.9	627
			STD	0.3	0.3	1	0.1	0.2	3
			MAX	33.6	30.9	42	8.5	41.4	632
			MIN	32.5	30.1	40	8.1	40.5	622
30	52.56	53	AV10	33.3	30.7	42	8.4	40.7	633
			STD	0.4	0.3	1	0.1	0.3	5
			MAX	33.9	31.2	43	8.6	41.2	641
			MIN	32.6	30.2	41	8.2	40.3	625
			Average	33.0	30.3	41	8.3	41.0	624
			Std. Dev.	0.4	0.5	1	0.2	0.4	11
			Maximum	33.9	31.2	43	8.6	42.0	641
			Minimum	31.8	28.5	38	7.9	40.3	593

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)

BL# Comments

3 CW

Time Summary

Drive 42 seconds 6:55 AM - 6:56 AM BN 1 - 30

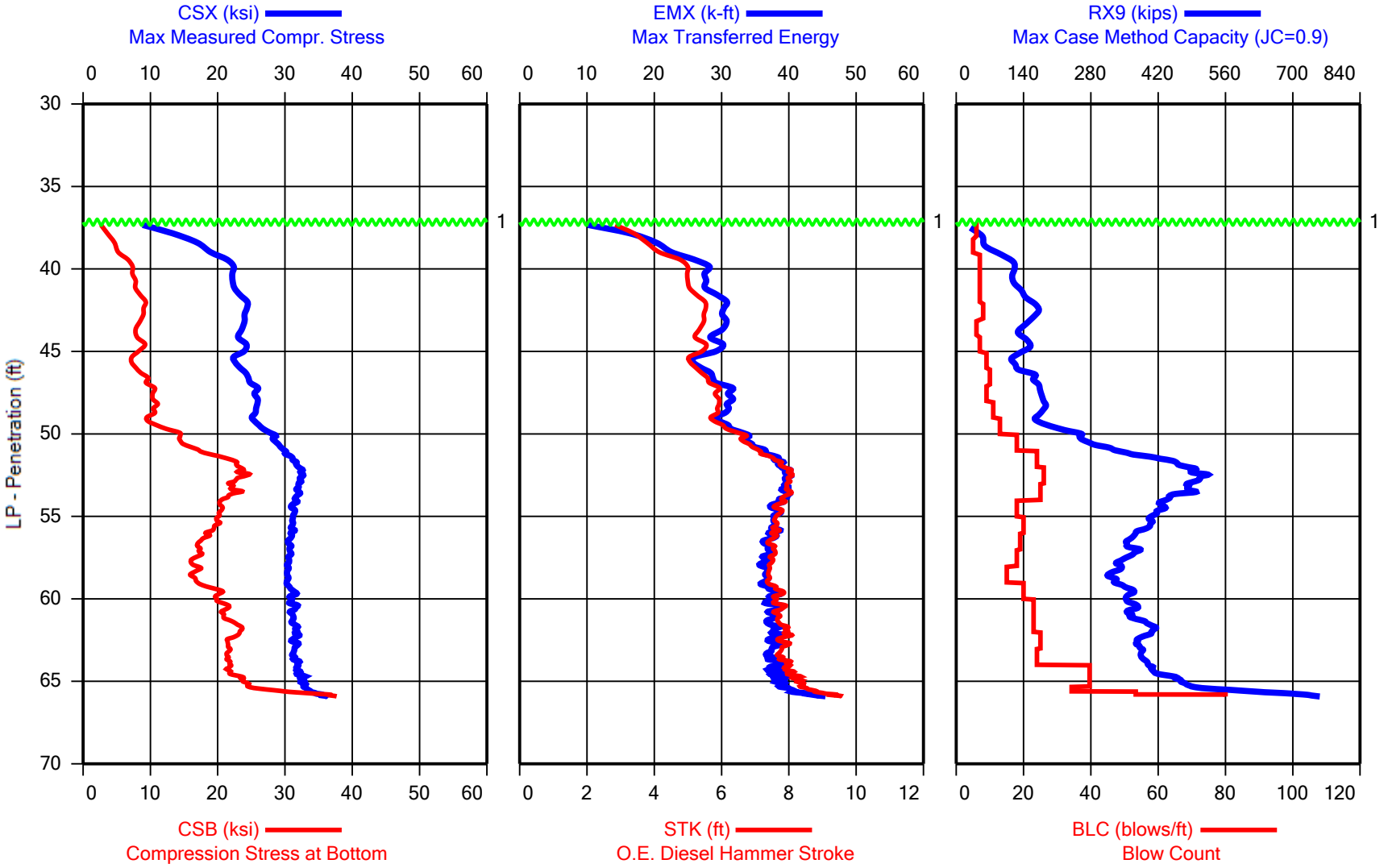
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 12-June-2015

Test started: 10-June-2015

USH 10 over Little Lake Butte des Morts - PIER 19 #36

APE D30-42, HP 14 x 73



1 - Reported reference at El. 740.57

USH 10 over Little Lake Butte des Morts - PIER 19 #36 APE D30-42, HP 14 x 73
OP: TC Date: 10-June-2015

AR: 21.40 in² 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 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
12	38.00	6	AV6	11.0	3.1	13	3.1	65.4	33
			STD	3.5	0.6	4	0.4	3.4	19
			MAX	17.5	4.2	21	3.8	68.3	59
			MIN	7.7	2.5	9	2.8	59.1	0
17	39.00	5	AV5	17.6	4.8	21	3.9	58.8	63
			STD	0.9	0.5	2	0.2	1.4	10
			MAX	18.8	5.4	23	4.1	60.6	81
			MIN	16.3	4.3	19	3.6	57.3	55
24	40.00	7	AV7	21.6	6.8	26	4.8	53.4	115
			STD	1.1	0.7	2	0.3	1.5	10
			MAX	22.8	7.5	29	5.1	56.2	126
			MIN	19.7	5.4	22	4.3	51.8	95
31	41.00	7	AV7	22.4	7.5	28	5.0	52.2	118
			STD	0.6	0.4	1	0.1	0.7	4
			MAX	23.4	8.2	29	5.2	53.4	125
			MIN	21.3	7.2	26	4.8	51.1	110
38	42.00	7	AV7	23.3	8.6	29	5.2	51.2	143
			STD	1.1	0.6	2	0.3	1.2	10
			MAX	25.4	9.7	33	5.7	52.9	160
			MIN	21.9	7.6	26	4.9	49.1	132
46	43.00	8	AV8	24.2	9.0	30	5.5	50.0	167
			STD	0.5	0.2	1	0.1	0.4	6
			MAX	24.7	9.3	31	5.7	50.8	177
			MIN	23.3	8.6	29	5.3	49.3	158
52	44.00	6	AV6	23.7	8.0	30	5.4	50.5	137
			STD	0.3	0.3	1	0.1	0.4	9
			MAX	24.5	8.5	32	5.6	50.8	151
			MIN	23.5	7.7	30	5.3	49.6	126
59	45.00	7	AV7	23.8	8.7	30	5.4	50.3	149
			STD	0.7	0.5	2	0.2	0.8	10
			MAX	24.6	9.3	32	5.6	51.7	164
			MIN	22.8	7.8	27	5.1	49.4	135
68	46.00	9	AV9	22.7	7.4	26	5.1	51.8	122
			STD	0.4	0.3	1	0.1	0.4	7
			MAX	23.3	7.9	27	5.2	52.4	135
			MIN	22.1	6.9	25	5.0	51.1	112
78	47.00	10	AV10	24.5	9.1	29	5.5	49.8	155
			STD	0.6	0.7	1	0.2	0.7	16
			MAX	25.4	10.1	30	5.8	51.3	176
			MIN	23.3	7.9	27	5.2	48.7	128
87	48.00	9	AV9	25.8	10.5	31	5.9	48.4	176
			STD	0.4	0.4	1	0.1	0.4	6
			MAX	26.4	11.3	32	6.1	48.8	191
			MIN	25.4	10.0	30	5.8	47.7	166
98	49.00	11	AV11	25.7	10.5	31	5.9	48.5	180

USH 10 over Little Lake Butte des Morts - PIER 19 #36 APE D30-42, HP 14 x 73
OP: TC Date: 10-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			STD	0.3	0.7	1	0.1	0.3	13
			MAX	26.3	11.8	32	6.0	49.1	204
			MIN	25.2	9.6	29	5.7	47.8	152
111	50.00	13	AV13	26.4	11.6	31	6.1	47.7	203
			STD	1.2	1.9	2	0.3	1.3	31
			MAX	29.0	15.1	36	6.9	49.8	260
			MIN	24.6	9.1	28	5.5	44.8	157
129	51.00	18	AV18	28.9	15.2	34	6.8	45.2	285
			STD	0.6	1.0	1	0.2	0.6	27
			MAX	30.1	17.4	37	7.2	46.5	337
			MIN	27.5	14.2	32	6.4	44.0	251
153	52.00	24	AV24	31.1	21.0	38	7.5	43.0	418
			STD	0.7	2.0	1	0.3	0.7	46
			MAX	32.1	23.2	40	7.9	44.5	483
			MIN	29.7	17.2	35	7.0	42.0	330
179	53.00	26	AV26	32.4	23.3	40	8.0	41.7	500
			STD	0.4	1.1	1	0.1	0.3	14
			MAX	33.3	26.7	41	8.3	42.3	531
			MIN	31.7	21.5	38	7.8	41.1	469
204	54.00	25	AV25	31.9	22.0	39	7.9	41.9	468
			STD	0.4	1.0	1	0.1	0.3	22
			MAX	32.7	24.7	41	8.2	42.5	510
			MIN	31.0	20.4	38	7.7	41.2	434
222	55.00	18	AV18	31.3	20.4	38	7.7	42.5	423
			STD	0.5	0.4	1	0.2	0.4	10
			MAX	32.4	21.5	40	8.1	43.4	443
			MIN	30.4	19.7	36	7.4	41.6	405
242	56.00	20	AV20	31.1	19.6	38	7.6	42.8	396
			STD	0.4	0.7	1	0.1	0.4	14
			MAX	32.2	20.6	41	8.0	43.5	416
			MIN	30.2	17.8	36	7.4	41.8	359
261	57.00	19	AV19	30.8	17.6	37	7.5	43.0	364
			STD	0.3	0.7	1	0.1	0.3	12
			MAX	31.4	19.6	39	7.8	43.6	389
			MIN	30.0	16.7	36	7.3	42.4	352
279	58.00	18	AV18	30.6	16.7	37	7.5	43.1	353
			STD	0.6	0.7	1	0.2	0.5	17
			MAX	31.9	18.0	38	7.9	44.1	381
			MIN	29.5	15.8	35	7.1	42.1	324
294	59.00	15	AV15	30.4	16.7	37	7.4	43.4	330
			STD	0.3	0.5	1	0.1	0.2	12
			MAX	31.1	17.6	38	7.6	43.6	356
			MIN	30.0	15.6	36	7.3	42.7	307
314	60.00	20	AV20	31.0	19.4	37	7.6	42.7	356
			STD	0.6	1.2	1	0.2	0.5	11
			MAX	32.3	20.9	40	8.0	44.1	372
			MIN	29.4	16.9	34	7.1	41.8	328
337	61.00	23	AV23	31.2	20.9	38	7.7	42.6	365
			STD	0.5	0.6	1	0.2	0.4	10
			MAX	32.1	22.0	40	8.0	43.4	380
			MIN	30.3	19.8	36	7.4	41.8	352

USH 10 over Little Lake Butte des Morts - PIER 19 #36 APE D30-42, HP 14 x 73
OP: TC Date: 10-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
360	62.00	23	AV23	31.4	22.5	38	7.8	42.3	395
			STD	0.5	1.1	1	0.2	0.4	18
			MAX	32.4	23.8	40	8.1	43.1	420
			MIN	30.6	20.5	36	7.5	41.5	357
385	63.00	25	AV25	31.6	22.0	38	7.9	42.1	385
			STD	0.6	0.7	1	0.2	0.4	12
			MAX	32.9	23.4	40	8.3	43.1	409
			MIN	30.6	21.1	36	7.5	41.0	364
409	64.00	24	AV24	31.5	21.6	38	7.8	42.3	390
			STD	0.5	0.3	1	0.2	0.4	7
			MAX	32.8	22.0	41	8.2	42.9	400
			MIN	30.7	21.0	36	7.6	41.2	379
461	65.31	40	AV52	32.3	22.9	38	8.2	41.4	441
			STD	0.6	1.2	1	0.2	0.5	30
			MAX	33.5	25.8	41	8.7	42.3	493
			MIN	31.2	20.9	36	7.8	40.1	395
471	65.60	34	AV10	33.3	27.0	40	8.6	40.3	546
			STD	0.4	1.7	1	0.2	0.4	40
			MAX	34.0	29.5	41	8.9	40.9	604
			MIN	32.5	24.7	39	8.4	39.6	492
481	65.79	53	AV10	34.4	33.1	42	9.0	39.4	672
			STD	0.6	2.1	2	0.2	0.5	32
			MAX	35.4	36.7	45	9.5	40.1	724
			MIN	33.4	30.2	40	8.7	38.5	625
491	65.92	80	AV10	35.7	37.0	45	9.4	38.6	740
			STD	0.5	0.6	1	0.1	0.2	10
			MAX	36.9	38.1	46	9.7	38.9	756
			MIN	35.2	36.3	44	9.3	38.1	727
			Average	29.8	18.8	36	7.3	44.2	361
			Std. Dev.	4.0	6.6	5	1.2	4.4	140
			Maximum	36.9	38.1	46	9.7	68.3	756
			Minimum	7.7	2.5	9	2.8	38.1	0

Total number of blows analyzed: 485

BL# Sensors

1-491 F3: [K769] 91.9 (1.00); F4: [D815] 93.0 (1.00); A3: [K3658] 362.0 (1.00); A4: [K3550] 360.0 (1.00)

BL# Comments

7 Reported reference at El. 740.57
8 Mud line at El. 718.2

Time Summary

Drive 11 minutes 26 seconds 6:38 AM - 6:50 AM BN 1 - 491

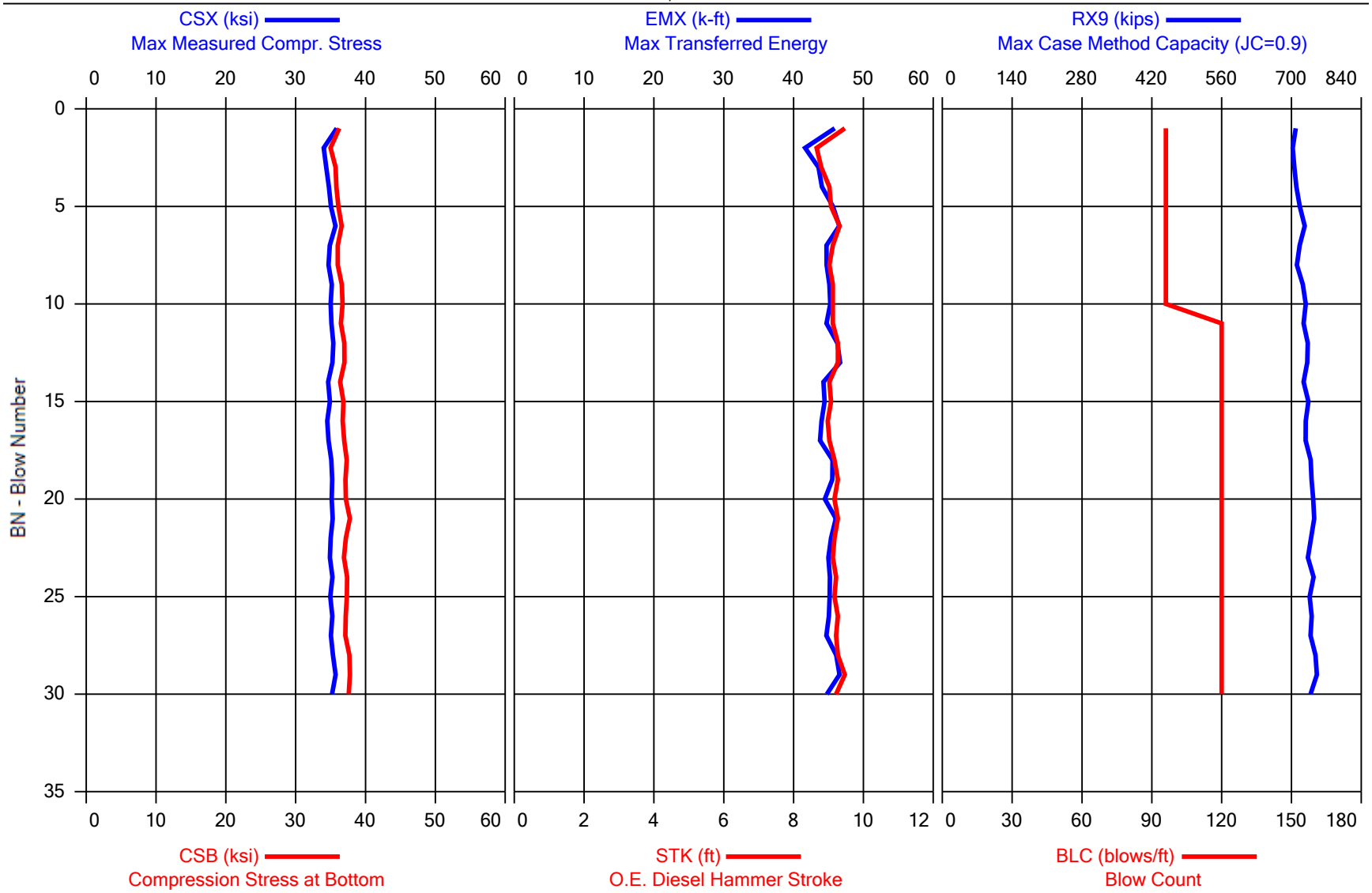
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 11-June-2015

Test started: 11-June-2015

USH 10 over Little Lake Butte des Morts - PIER 19 #36 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - PIER 19 #36 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 11-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.60 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	66.02	96	AV10	35.0	36.1	45	9.1	39.3	715
			STD	0.5	0.5	1	0.2	0.5	8
			MAX	35.9	36.7	47	9.5	40.2	729
			MIN	34.0	35.0	42	8.7	38.5	703
20	66.10	120	AV10	35.0	36.9	45	9.1	39.2	733
			STD	0.3	0.3	1	0.1	0.2	6
			MAX	35.4	37.3	47	9.3	39.5	744
			MIN	34.5	36.4	44	9.0	38.9	724
30	66.19	120	AV10	35.2	37.4	45	9.2	39.0	741
			STD	0.2	0.3	1	0.1	0.2	5
			MAX	35.7	37.8	47	9.5	39.2	751
			MIN	34.9	36.9	45	9.1	38.5	733
			Average	35.1	36.8	45	9.1	39.1	730
			Std. Dev.	0.4	0.6	1	0.2	0.3	13
			Maximum	35.9	37.8	47	9.5	40.2	751
			Minimum	34.0	35.0	42	8.7	38.5	703

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 44 seconds 6:44 AM - 6:45 AM BN 1 - 30

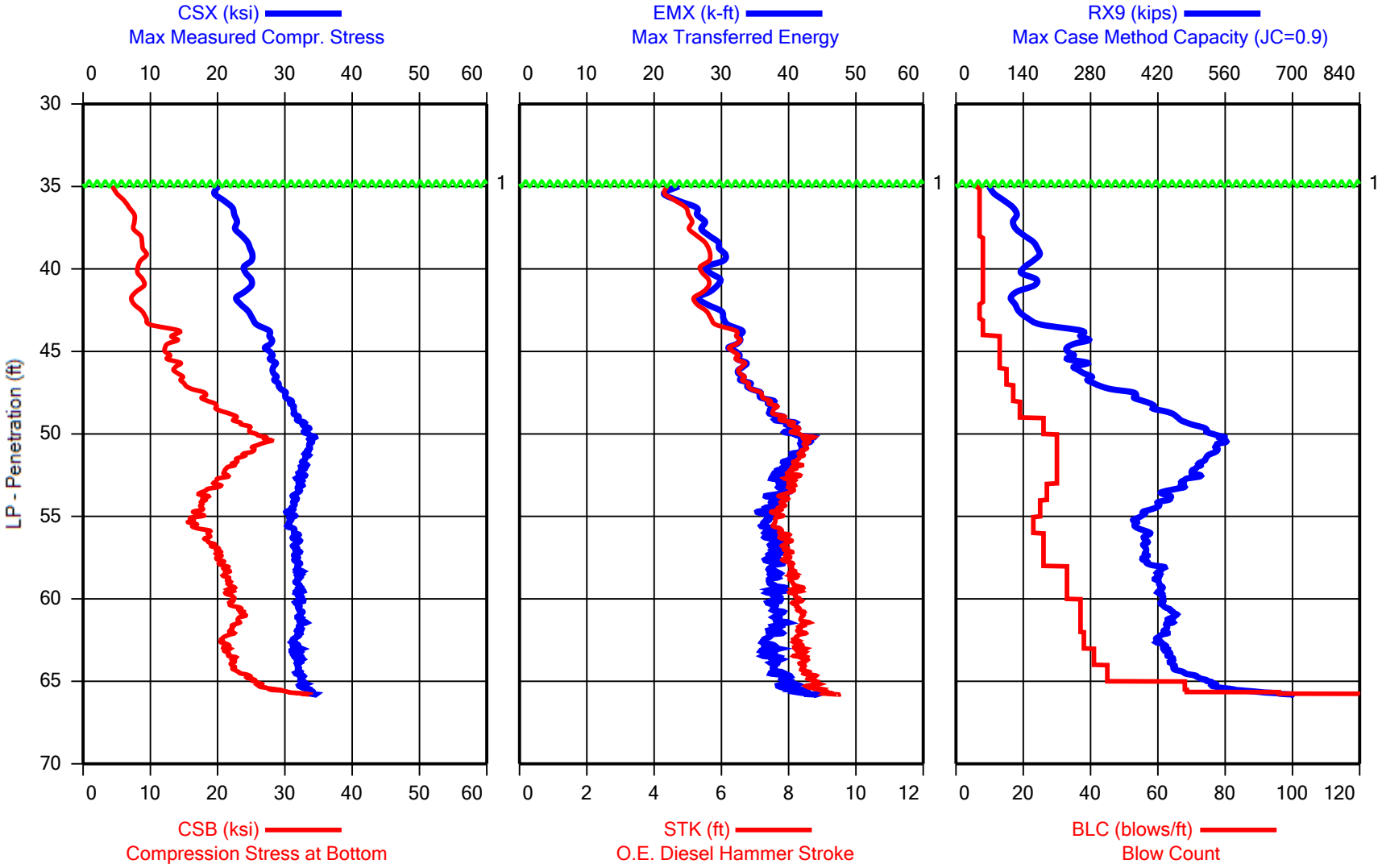
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 12-June-2015

Test started: 10-June-2015

USH 10 over Little Lake Butte des Morts - PIER 19 #44

APE D30-42, HP 14 x 73



1 - Reported reference at El. 739.7

USH 10 over Little Lake Butte des Morts - PIER 19 #44 APE D30-42, HP 14 x 73
OP: TC Date: 10-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
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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
6	35.00	6	AV2	21.4	4.4	26	4.6	54.5	68
			STD	2.5	0.2	6	0.4	2.5	7
			MAX	24.0	4.6	32	5.1	57.0	75
			MIN	18.9	4.2	20	4.2	52.0	61
13	36.00	7	AV7	19.8	5.4	22	4.4	55.6	87
			STD	1.2	0.7	2	0.3	1.5	13
			MAX	21.4	6.4	24	4.7	58.3	106
			MIN	17.5	4.3	19	4.0	53.7	70
20	37.00	7	AV7	22.4	7.3	27	5.0	52.2	122
			STD	0.5	0.4	1	0.1	0.6	8
			MAX	23.1	7.7	28	5.2	53.1	135
			MIN	21.7	6.7	26	4.8	51.4	112
27	38.00	7	AV7	22.9	7.8	27	5.1	51.8	128
			STD	0.5	0.5	1	0.1	0.5	11
			MAX	24.0	8.6	29	5.3	52.1	141
			MIN	22.4	7.3	27	5.0	50.7	112
35	39.00	8	AV8	24.7	8.9	30	5.6	49.7	165
			STD	0.4	0.3	1	0.1	0.4	9
			MAX	25.5	9.5	32	5.7	50.4	178
			MIN	24.0	8.3	28	5.4	49.1	149
43	40.00	8	AV8	24.6	8.6	29	5.5	49.8	157
			STD	0.7	0.5	1	0.2	0.7	12
			MAX	25.6	9.6	31	5.8	50.6	172
			MIN	23.8	8.0	27	5.4	48.8	137
51	41.00	8	AV8	24.7	8.7	29	5.6	49.7	156
			STD	0.7	0.6	1	0.1	0.6	16
			MAX	25.6	9.5	31	5.8	50.5	175
			MIN	23.8	7.9	28	5.4	48.9	135
59	42.00	8	AV8	23.5	7.6	27	5.3	50.8	124
			STD	1.0	0.6	2	0.2	1.0	12
			MAX	24.8	8.6	30	5.6	52.2	151
			MIN	22.1	7.0	25	5.0	49.4	113
66	43.00	7	AV7	24.4	8.6	30	5.5	49.8	133
			STD	0.5	0.7	1	0.1	0.6	9
			MAX	25.1	9.6	31	5.7	50.8	153
			MIN	23.5	7.3	28	5.3	49.0	124
74	44.00	8	AV8	26.7	11.9	32	6.1	47.6	215
			STD	1.1	2.2	2	0.4	1.4	44
			MAX	28.3	15.1	34	6.7	49.3	266
			MIN	25.1	9.4	30	5.7	45.6	158
87	45.00	13	AV13	27.7	12.9	32	6.4	46.5	250
			STD	0.5	0.8	1	0.2	0.5	20
			MAX	28.8	14.4	34	6.8	47.4	291
			MIN	26.8	11.6	31	6.1	45.3	217
100	46.00	13	AV13	28.2	13.3	33	6.5	46.0	248

USH 10 over Little Lake Butte des Morts - PIER 19 #44 APE D30-42, HP 14 x 73
OP: TC Date: 10-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			STD	0.6	1.0	1	0.2	0.6	18
			MAX	29.1	15.2	35	6.8	47.1	292
			MIN	26.9	11.9	31	6.2	45.2	229
115	47.00	15	AV15	28.5	14.4	33	6.6	45.7	273
			STD	0.6	0.6	1	0.2	0.6	13
			MAX	30.0	15.6	36	7.1	46.5	299
			MIN	27.7	13.3	31	6.4	44.3	253
132	48.00	17	AV17	29.9	17.3	35	7.1	44.3	352
			STD	0.8	1.2	2	0.3	0.8	31
			MAX	31.2	18.7	38	7.5	45.4	388
			MIN	28.7	14.7	33	6.7	43.1	294
151	49.00	19	AV19	31.3	20.6	38	7.6	42.8	427
			STD	0.6	1.4	1	0.2	0.5	22
			MAX	32.7	23.2	40	8.1	43.5	460
			MIN	30.6	18.3	35	7.4	41.6	394
177	50.00	26	AV26	32.8	24.0	40	8.1	41.6	499
			STD	0.6	1.1	1	0.2	0.5	24
			MAX	34.0	25.7	42	8.4	42.6	530
			MIN	31.5	21.6	37	7.7	40.9	461
207	51.00	30	AV30	33.8	26.4	42	8.5	40.5	549
			STD	0.5	1.1	1	0.2	0.4	9
			MAX	35.0	28.2	45	8.9	41.2	569
			MIN	32.7	24.5	40	8.2	39.7	533
237	52.00	30	AV30	33.0	23.3	40	8.3	41.1	520
			STD	0.5	1.1	1	0.1	0.3	13
			MAX	33.7	25.9	43	8.5	41.8	551
			MIN	32.3	21.2	39	8.0	40.5	496
267	53.00	30	AV30	32.4	20.7	39	8.1	41.5	490
			STD	0.5	1.0	1	0.2	0.4	14
			MAX	33.3	22.9	41	8.4	42.3	514
			MIN	31.3	19.0	37	7.8	40.7	463
294	54.00	27	AV27	31.9	18.6	39	8.0	41.8	450
			STD	0.6	1.2	1	0.2	0.5	17
			MAX	33.1	20.9	42	8.4	42.7	480
			MIN	30.9	16.5	36	7.6	40.7	423
319	55.00	25	AV25	31.1	17.5	37	7.7	42.4	408
			STD	0.5	0.7	1	0.2	0.4	16
			MAX	31.9	18.5	39	7.9	43.5	440
			MIN	29.8	15.7	35	7.4	41.9	380
342	56.00	23	AV23	30.9	16.9	37	7.7	42.7	380
			STD	0.6	1.2	1	0.2	0.5	13
			MAX	31.9	20.5	39	8.0	43.6	414
			MIN	29.6	14.7	35	7.3	41.7	363
368	57.00	26	AV26	31.6	19.0	38	7.9	42.1	394
			STD	0.7	0.8	2	0.2	0.5	5
			MAX	32.8	20.4	41	8.3	43.3	404
			MIN	30.0	17.4	34	7.4	41.1	387
394	58.00	26	AV26	31.8	20.3	38	8.0	41.8	396
			STD	0.5	0.7	1	0.2	0.4	8
			MAX	32.7	21.5	41	8.3	42.8	411
			MIN	30.3	19.1	35	7.6	41.1	384

USH 10 over Little Lake Butte des Morts - PIER 19 #44 APE D30-42, HP 14 x 73
OP: TC Date: 10-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
427	59.00	33	AV33	32.0	21.4	38	8.1	41.5	423
			STD	0.5	0.7	1	0.1	0.4	7
			MAX	33.1	22.5	39	8.4	42.2	443
			MIN	31.0	19.9	36	7.8	40.8	412
460	60.00	33	AV33	32.2	21.9	38	8.2	41.2	426
			STD	0.6	0.6	1	0.2	0.4	4
			MAX	33.7	23.3	41	8.6	42.1	434
			MIN	30.8	20.9	36	7.9	40.4	415
497	61.00	37	AV37	32.2	22.8	38	8.3	41.0	440
			STD	0.6	0.9	1	0.2	0.5	11
			MAX	33.6	24.6	41	8.7	42.3	462
			MIN	30.6	21.4	35	7.8	40.2	418
534	62.00	37	AV37	32.3	22.7	38	8.4	40.8	442
			STD	0.7	0.7	1	0.2	0.4	8
			MAX	34.0	24.2	41	8.8	41.7	464
			MIN	30.4	21.6	35	8.0	39.9	428
572	63.00	38	AV38	31.7	21.2	37	8.3	41.1	427
			STD	0.6	0.7	1	0.2	0.4	8
			MAX	33.0	23.3	40	8.6	42.1	446
			MIN	30.6	19.9	35	7.9	40.3	413
613	64.00	41	AV41	31.9	21.9	38	8.4	40.8	444
			STD	0.7	0.6	1	0.2	0.4	6
			MAX	33.0	23.3	40	8.7	41.9	455
			MIN	30.3	20.8	34	7.9	40.0	428
658	65.00	45	AV45	32.2	23.7	39	8.6	40.4	482
			STD	0.6	1.2	1	0.2	0.4	25
			MAX	33.9	26.7	43	9.0	41.4	526
			MIN	31.0	21.9	36	8.1	39.5	449
692	65.50	68	AV34	32.8	26.6	40	8.8	39.9	544
			STD	0.6	0.9	1	0.2	0.4	15
			MAX	34.5	29.7	43	9.2	40.7	579
			MIN	31.9	25.2	38	8.4	39.1	525
702	65.65	69	AV10	33.7	29.5	42	9.0	39.4	605
			STD	0.5	0.9	1	0.2	0.4	17
			MAX	34.4	30.9	43	9.4	40.1	635
			MIN	32.7	27.9	40	8.7	38.7	579
712	65.75	96	AV10	33.9	31.7	42	9.2	39.1	657
			STD	0.6	1.0	1	0.1	0.3	14
			MAX	34.8	33.4	44	9.4	39.5	675
			MIN	33.0	30.2	41	9.0	38.6	638
721	65.83	120	AV9	34.3	33.4	43	9.4	38.7	691
			STD	0.5	0.8	1	0.2	0.3	11
			MAX	35.0	34.8	45	9.6	39.2	711
			MIN	33.6	32.1	41	9.1	38.3	674
			Average	31.1	20.4	37	7.8	42.5	419
			Std. Dev.	2.8	5.5	4	1.0	3.2	120
			Maximum	35.0	34.8	45	9.6	58.3	711
			Minimum	17.5	4.2	19	4.0	38.3	61

Total number of blows analyzed: 717

BL#	Sensors
1-721	F3: [K769] 91.9 (1.00); F4: [D815] 93.0 (1.00); A3: [K3658] 362.0 (1.00); A4: [K3550] 360.0 (1.00)

BL#	Comments
5	Reported reference at El. 739.7
6	Mud line at El. 718.2

Time Summary

Drive 17 minutes 16 seconds 7:02 AM - 7:20 AM BN 1 - 721

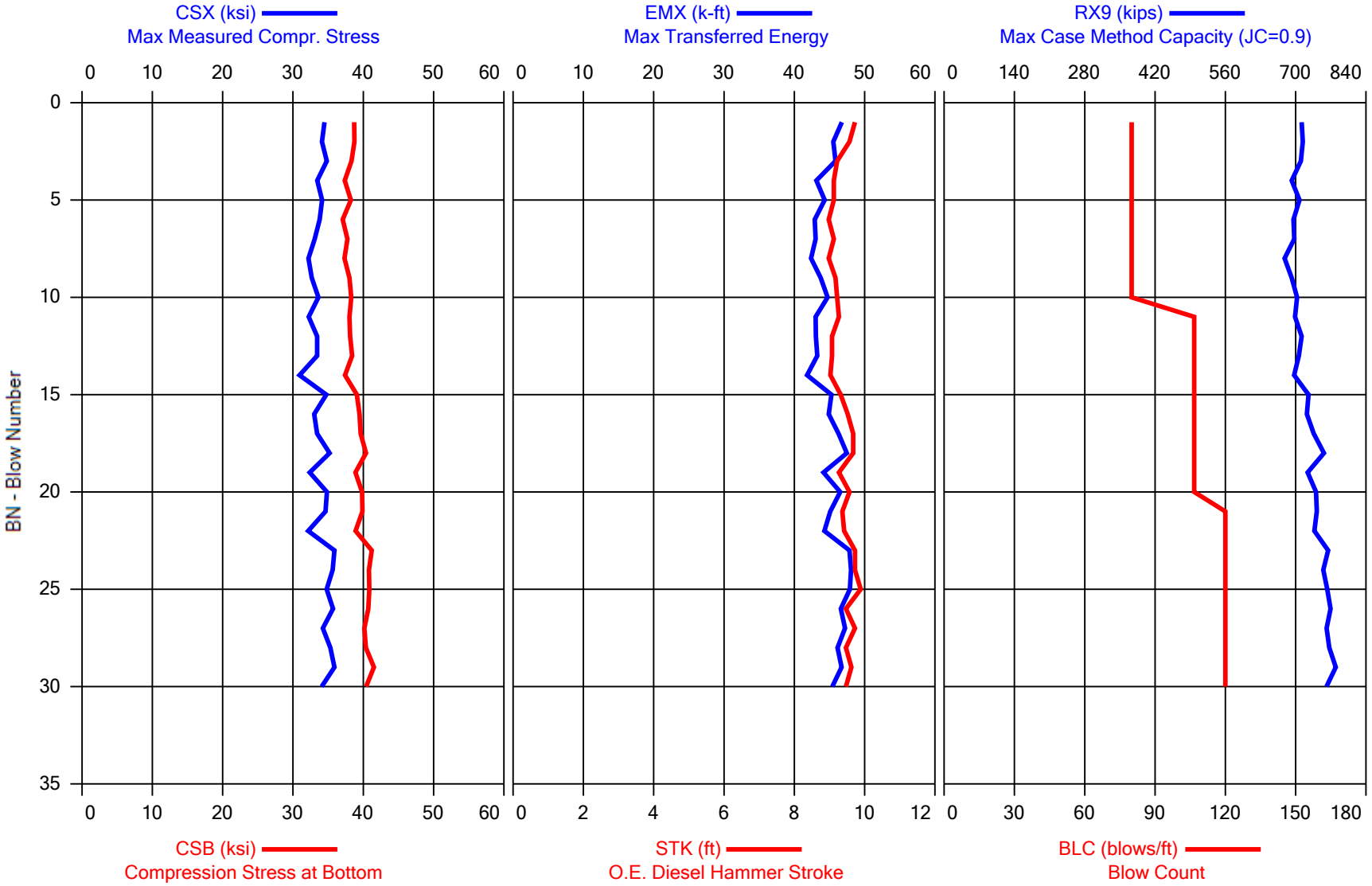
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 11-June-2015

Test started: 11-June-2015

USH 10 over Little Lake Butte des Morts - PIER 19 #44 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - PIER 19 #44 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 11-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
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	65.96	80	AV10	33.6	38.0	44	9.2	39.0	700
			STD	0.8	0.6	1	0.2	0.5	11
			MAX	34.8	38.7	47	9.7	39.5	714
			MIN	32.2	37.1	42	9.0	38.0	678
20	66.05	107	AV10	33.4	38.9	45	9.3	38.8	722
			STD	1.3	0.9	2	0.2	0.5	18
			MAX	35.2	40.4	47	9.7	39.4	756
			MIN	30.9	37.4	42	9.0	38.1	697
30	66.14	120	AV10	34.8	40.5	47	9.6	38.3	760
			STD	1.1	0.7	1	0.2	0.3	12
			MAX	35.9	41.5	48	9.9	38.7	780
			MIN	32.2	38.9	44	9.4	37.7	737
			Average	33.9	39.1	45	9.4	38.7	727
			Std. Dev.	1.2	1.3	2	0.3	0.5	28
			Maximum	35.9	41.5	48	9.9	39.5	780
			Minimum	30.9	37.1	42	9.0	37.7	678

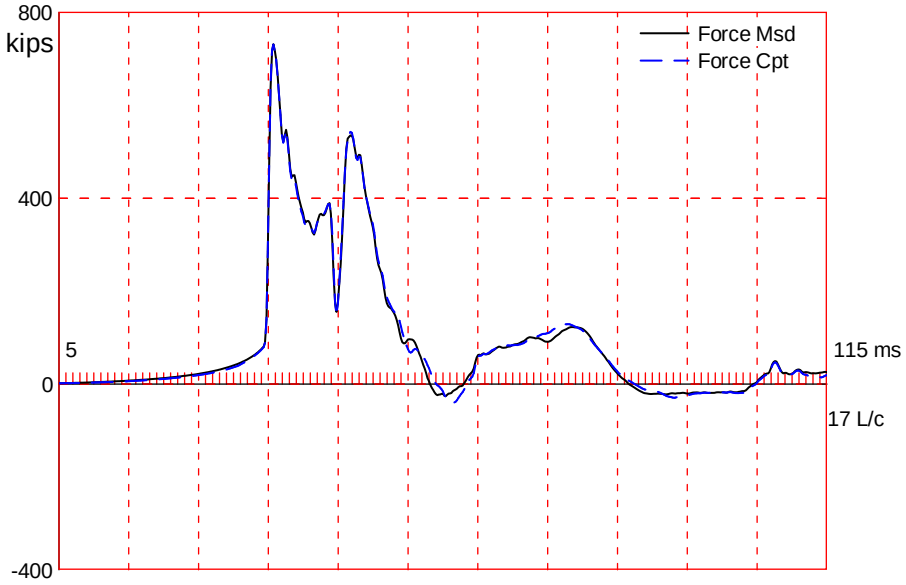
Total number of blows analyzed: 30

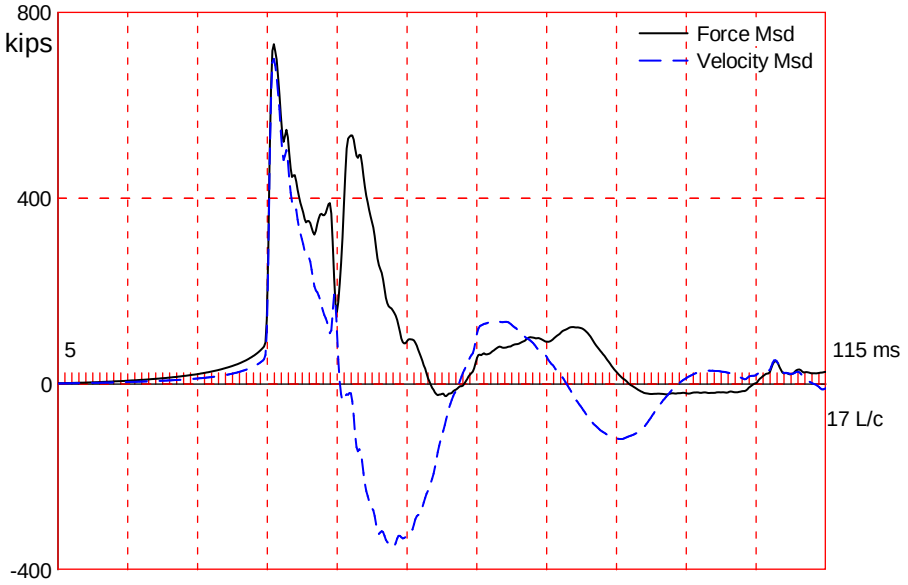
BL# Sensors

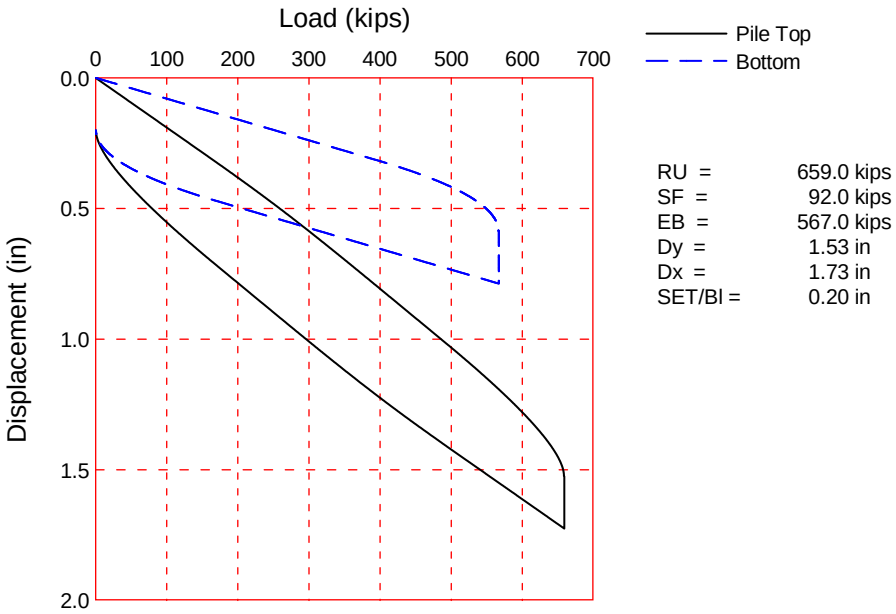
1-30 F3: [D815] 93.0 (1.00); F4: [K769] 91.9 (1.00); A3: [K3550] 360.0 (1.00); A4: [K3658] 362.0 (1.00)

Time Summary

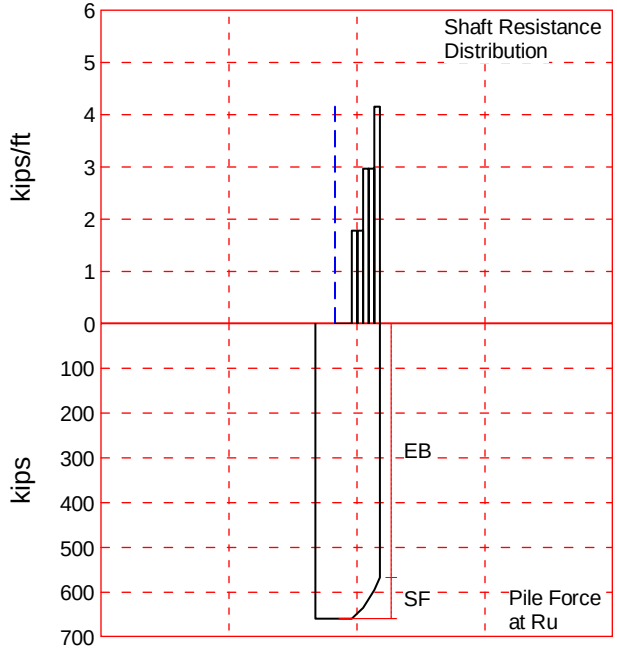
Drive 44 seconds 6:35 AM - 6:36 AM BN 1 - 30







RU =	659.0 kips
SF =	92.0 kips
EB =	567.0 kips
Dy =	1.53 in
Dx =	1.73 in
SET/Bl =	0.20 in



Length b. Sensors	77.5 ft
Embedment	52.0 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.	16790 ft/s
Match Quality	1.98
Top Compr. Stress	34.2 ksi
Max Compr. Stress	36.5 ksi
Max Tension Stress	-6.46 ksi
Avg. Shaft Quake	0.19 in
Toe Quake	0.45 in
Avg. Shaft Smith Dpg.	0.25 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: 659.0; along Shaft 92.0; at Toe 567.0 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
				659.0				
1	30.3	4.8	0.0	659.0	0.0	0.00	0.00	0.00
2	37.1	11.5	0.0	659.0	0.0	0.00	0.00	0.00
3	43.8	18.3	0.0	659.0	0.0	0.00	0.00	0.00
4	50.5	25.0	12.0	647.0	12.0	1.78	0.38	0.25
5	57.3	31.7	12.0	635.0	24.0	1.78	0.38	0.25
6	64.0	38.5	20.0	615.0	44.0	2.97	0.63	0.25
7	70.8	45.2	20.0	595.0	64.0	2.97	0.63	0.25
8	77.5	52.0	28.0	567.0	92.0	4.15	0.88	0.25
Avg. Shaft			11.5			1.77	0.38	0.25
Toe			567.0				411.32	0.05

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.19	0.45
Case Damping Factor		0.60	0.74
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	95	30
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	67	
Resistance Gap (included in Toe Quake)	(in)		0.02

CAPWAP match quality = 1.98 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.04 in; Blow Count = 319 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 = 34.2 ksi (T= 36.1 ms, max= 1.067 x Top)
max. Comp. Stress = 36.5 ksi (Z= 50.5 ft, T= 38.9 ms)
max. Tens. Stress = -6.46 ksi (Z= 50.5 ft, T= 61.4 ms)
max. Energy (EMX) = 44.2 kip-ft; max. Measured Top Displ. (DMX)= 1.19 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	731.7	-50.1	34.2	-2.34	44.2	18.3	1.20
2	6.7	732.4	-61.3	34.2	-2.87	44.0	18.3	1.18
4	13.5	734.0	-84.5	34.3	-3.95	43.2	18.2	1.13
5	16.8	734.9	-96.3	34.3	-4.50	42.6	18.2	1.10
6	20.2	735.8	-111.3	34.4	-5.20	41.9	18.2	1.07
7	23.6	736.8	-122.6	34.4	-5.73	41.2	18.2	1.04
8	27.0	737.8	-129.9	34.5	-6.07	40.5	18.1	1.00
9	30.3	739.0	-132.8	34.5	-6.20	39.8	18.1	0.97
10	33.7	740.2	-133.9	34.6	-6.26	39.0	18.0	0.93
11	37.1	741.6	-135.3	34.6	-6.32	38.2	18.0	0.90
12	40.4	743.3	-136.1	34.7	-6.36	37.4	17.9	0.87
13	43.8	751.4	-136.6	35.1	-6.38	36.6	17.7	0.83
14	47.2	767.3	-137.2	35.8	-6.41	35.8	17.3	0.79
15	50.5	780.8	-138.4	36.5	-6.46	34.8	16.9	0.76
16	53.9	733.8	-125.7	34.3	-5.87	31.3	16.5	0.72
17	57.3	752.8	-127.2	35.2	-5.94	30.3	16.1	0.68
18	60.7	714.4	-115.0	33.4	-5.37	27.1	15.5	0.64
19	64.0	735.2	-116.4	34.3	-5.44	26.1	15.0	0.60
20	67.4	659.6	-94.4	30.8	-4.41	21.9	16.3	0.57
21	70.8	661.0	-95.2	30.9	-4.45	20.9	17.8	0.53
22	74.1	641.3	-77.7	30.0	-3.63	17.1	18.6	0.49
23	77.5	660.2	-78.5	30.8	-3.67	14.1	17.4	0.45
Absolute	50.5			36.5			(T =	38.9 ms)
	50.5				-6.46		(T =	61.4 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	764.2	694.6	625.1	555.5	485.9	416.4	346.8	277.3	207.7	138.1
RX	821.6	783.1	757.4	731.7	706.1	688.5	677.1	665.7	656.1	649.1
RU	764.2	694.6	625.1	555.5	485.9	416.4	346.8	277.3	207.7	138.1

RAU = 620.1 (kips); RA2 = 705.1 (kips)

Current CAPWAP Ru = 659.0 (kips); Corresponding J(RP)= 0.15; J(RX) = 0.77

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
18.8	35.92	716.5	743.3	743.3	1.19	0.20	0.20	44.6	769.4	1319

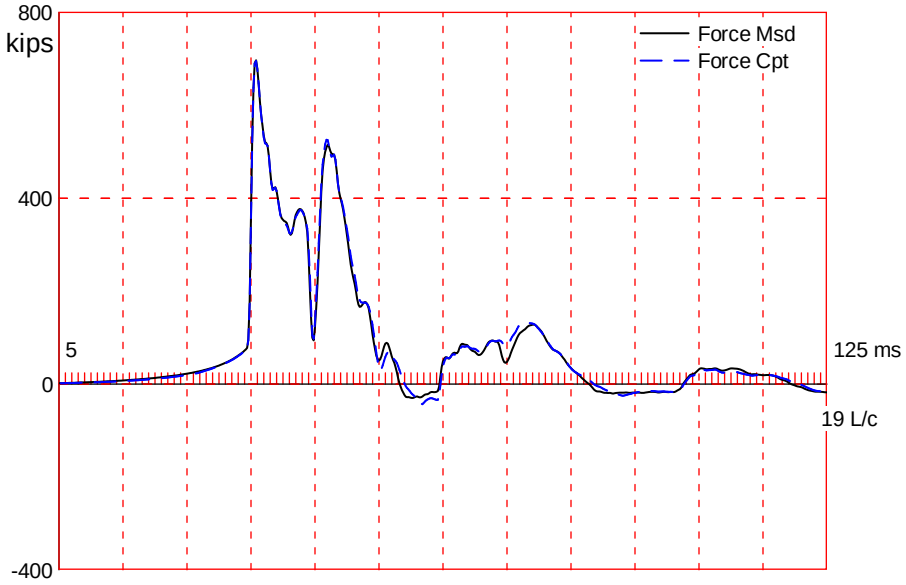
PILE PROFILE AND PILE MODEL

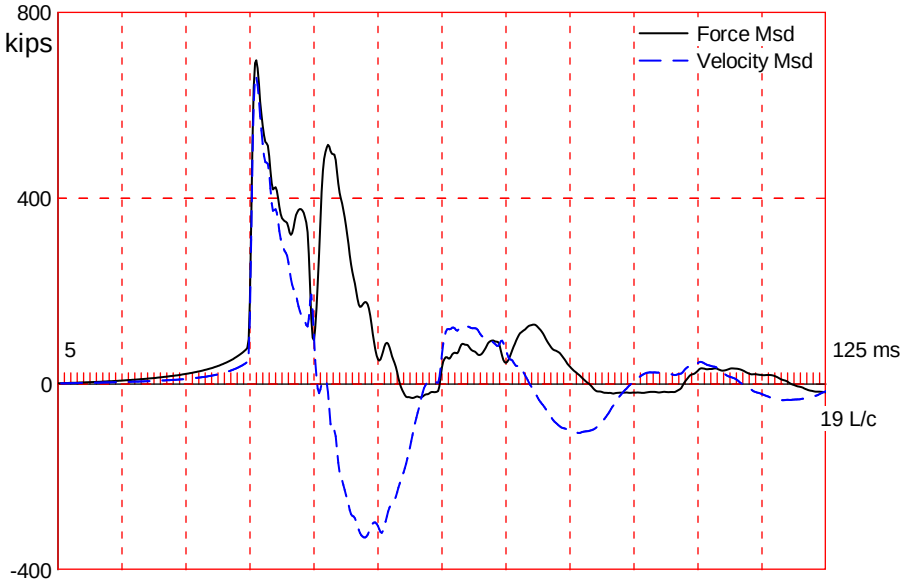
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

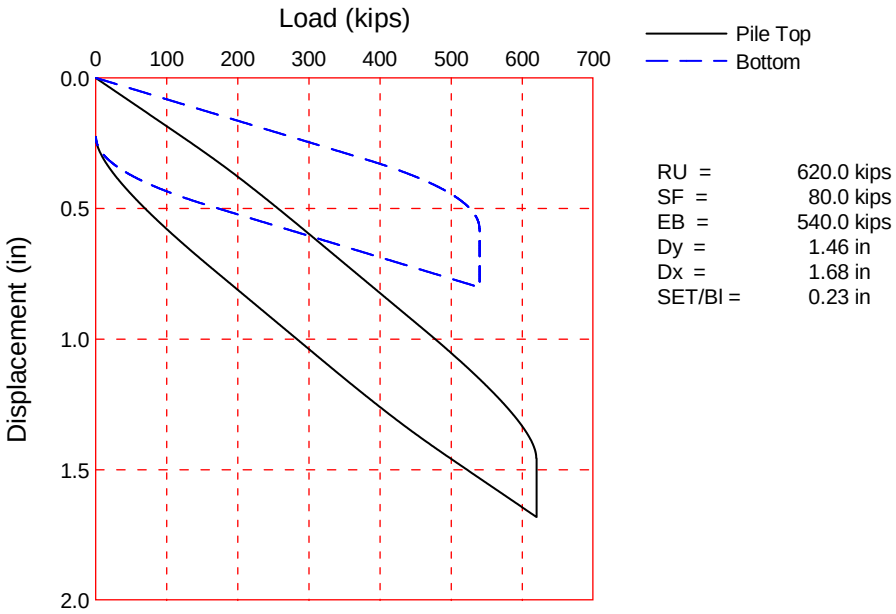
Toe Area 198.5 in^2

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

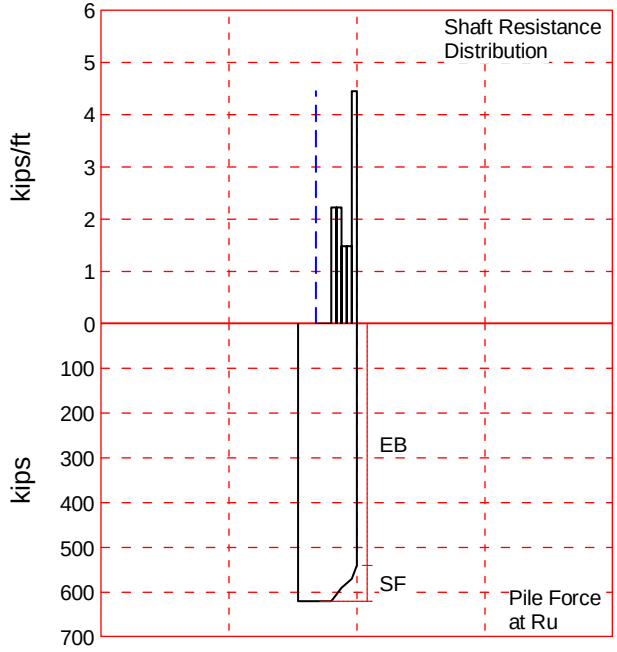
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16790.1 ft/s
Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	620.0 kips
SF =	80.0 kips
EB =	540.0 kips
Dy =	1.46 in
Dx =	1.68 in
SET/Bl =	0.23 in



Length b. Sensors	77.5 ft
Embedment	52.1 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.	16848 ft/s
Match Quality	2.48
Top Compr. Stress	32.5 ksi
Max Compr. Stress	35.2 ksi
Max Tension Stress	-6.50 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.44 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.06 s/ft

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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: 620.0; along Shaft 80.0; at Toe 540.0 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
				620.0				
1	30.3	4.9	0.0	620.0	0.0	0.00	0.00	0.00
2	37.1	11.6	0.0	620.0	0.0	0.00	0.00	0.00
3	43.8	18.4	0.0	620.0	0.0	0.00	0.00	0.00
4	50.5	25.1	15.0	605.0	15.0	2.23	0.47	0.25
5	57.3	31.8	15.0	590.0	30.0	2.23	0.47	0.25
6	64.0	38.6	10.0	580.0	40.0	1.48	0.32	0.25
7	70.8	45.3	10.0	570.0	50.0	1.48	0.32	0.25
8	77.5	52.1	30.0	540.0	80.0	4.45	0.95	0.25
Avg. Shaft			10.0			1.54	0.33	0.25
Toe			540.0				391.74	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.14	0.44
Case Damping Factor		0.52	0.85
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	30
Unloading Level	(% of Ru)	53	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.030	

CAPWAP match quality = 2.48 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 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 = 32.5 ksi (T= 36.2 ms, max= 1.082 x Top)
max. Comp. Stress = 35.2 ksi (Z= 50.5 ft, T= 39.0 ms)
max. Tens. Stress = -6.50 ksi (Z= 50.5 ft, T= 58.8 ms)
max. Energy (EMX) = 40.7 kip-ft; max. Measured Top Displ. (DMX)= 1.15 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	696.1	-55.9	32.5	-2.61	40.7	17.4	1.15
2	6.7	696.8	-65.8	32.6	-3.07	40.6	17.3	1.13
4	13.5	698.4	-91.5	32.6	-4.28	40.0	17.3	1.09
5	16.8	699.3	-104.3	32.7	-4.87	39.5	17.3	1.06
6	20.2	700.2	-116.4	32.7	-5.44	39.0	17.2	1.04
7	23.6	701.2	-124.3	32.8	-5.81	38.3	17.2	1.01
8	27.0	702.3	-128.5	32.8	-6.00	37.7	17.2	0.97
9	30.3	703.5	-130.3	32.9	-6.09	37.0	17.1	0.94
10	33.7	704.7	-131.1	32.9	-6.12	36.2	17.1	0.91
11	37.1	706.1	-131.5	33.0	-6.14	35.5	17.1	0.87
12	40.4	708.2	-131.8	33.1	-6.16	34.7	17.0	0.84
13	43.8	720.3	-132.5	33.6	-6.19	33.9	16.7	0.80
14	47.2	737.9	-133.9	34.5	-6.25	33.1	16.2	0.77
15	50.5	753.2	-139.1	35.2	-6.50	32.3	15.8	0.73
16	53.9	698.7	-134.6	32.6	-6.29	28.4	15.3	0.70
17	57.3	719.9	-138.4	33.6	-6.47	27.5	14.7	0.66
18	60.7	660.6	-122.1	30.9	-5.71	23.9	14.5	0.63
19	64.0	662.4	-123.3	30.9	-5.76	23.1	14.6	0.59
20	67.4	620.5	-112.8	29.0	-5.27	20.5	16.1	0.55
21	70.8	622.0	-114.1	29.1	-5.33	19.6	17.6	0.52
22	74.1	628.1	-103.9	29.3	-4.85	17.3	18.1	0.48
23	77.5	650.5	-105.2	30.4	-4.92	14.4	16.6	0.45
Absolute	50.5			35.2			(T =	39.0 ms)
	50.5				-6.50		(T =	58.8 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	660.6	591.6	522.7	453.7	384.8	315.8	246.8	177.9	108.9	40.0
RX	750.9	725.9	700.8	677.4	660.5	647.3	637.5	628.2	619.0	609.7
RU	690.5	622.0	553.5	485.0	416.5	348.0	279.5	211.0	142.5	74.0

RAU = 549.7 (kips); RA2 = 652.7 (kips)

Current CAPWAP Ru = 620.0 (kips); Corresponding J(RP)= 0.06; J(RX) = 0.79

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
17.6	36.00	658.9	691.2	703.8	1.15	0.23	0.23	41.0	716.0	1256

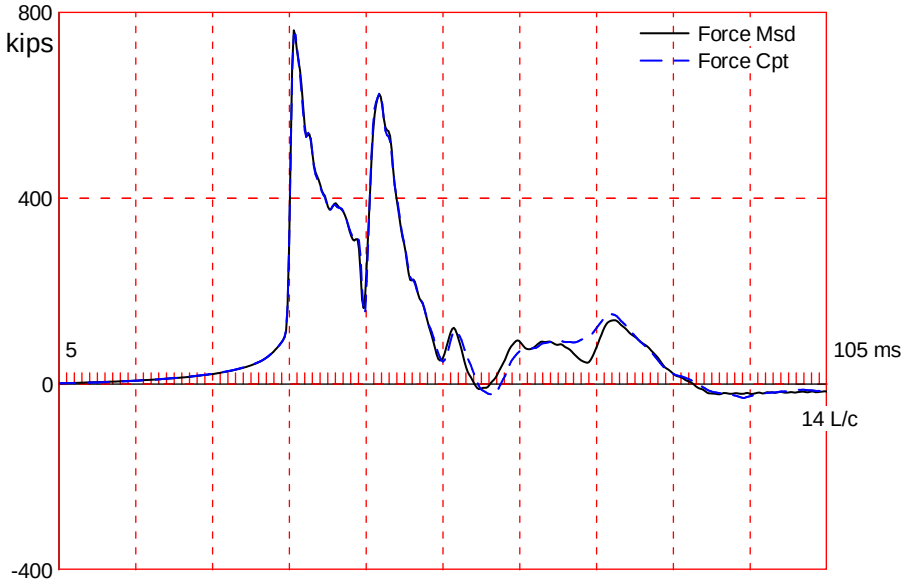
PILE PROFILE AND PILE MODEL

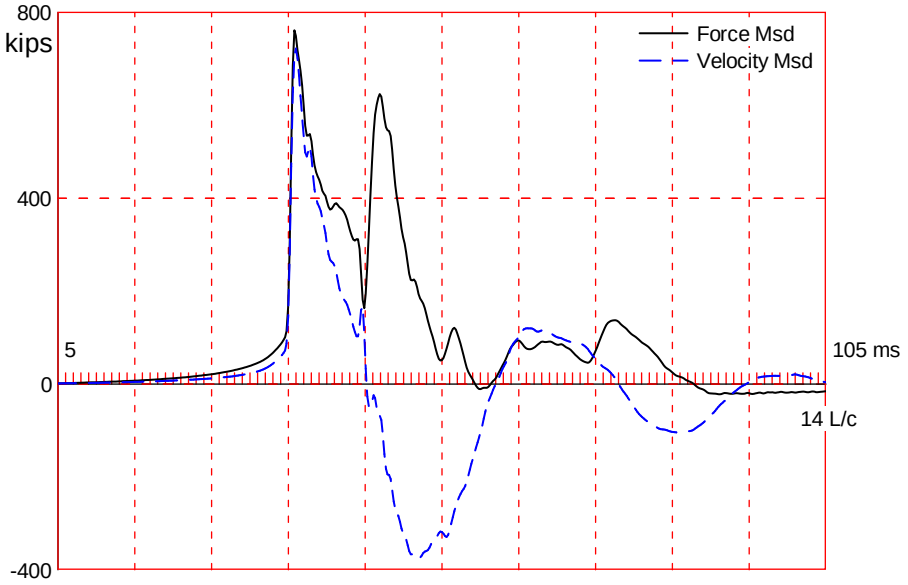
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

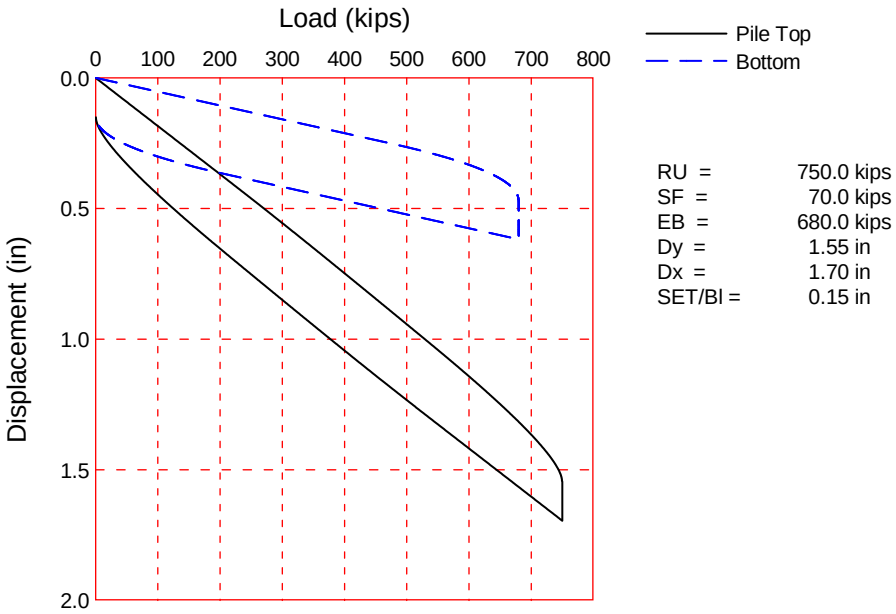
Toe Area 198.5 in^2

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	16847.8	0.000
19	64.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16847.8	0.020
20	67.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16847.8	0.010
21	70.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16847.8	0.000
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16847.8	0.000

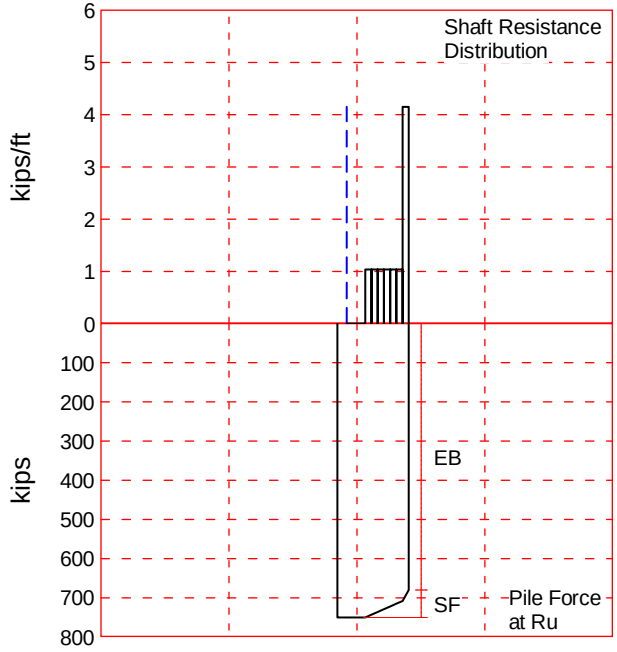
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16847.8 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	750.0 kips
SF =	70.0 kips
EB =	680.0 kips
Dy =	1.55 in
Dx =	1.70 in
SET/Bl =	0.15 in



Length b. Sensors	77.6 ft
Embedment	65.9 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.	16684 ft/s
Match Quality	2.87
Top Compr. Stress	35.2 ksi
Max Compr. Stress	37.5 ksi
Max Tension Stress	-6.53 ksi
Avg. Shaft Quake	0.30 in
Toe Quake	0.36 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.06 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: 750.0; along Shaft 70.0; at Toe 680.0 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
				750.0				
1	16.9	5.2	0.0	750.0	0.0	0.00	0.00	0.00
2	23.6	11.9	0.0	750.0	0.0	0.00	0.00	0.00
3	30.4	18.7	0.0	750.0	0.0	0.00	0.00	0.00
4	37.1	25.4	7.0	743.0	7.0	1.04	0.22	0.27
5	43.8	32.1	7.0	736.0	14.0	1.04	0.22	0.27
6	50.6	38.9	7.0	729.0	21.0	1.04	0.22	0.27
7	57.3	45.6	7.0	722.0	28.0	1.04	0.22	0.27
8	64.1	52.4	7.0	715.0	35.0	1.04	0.22	0.27
9	70.8	59.1	7.0	708.0	42.0	1.04	0.22	0.27
10	77.6	65.9	28.0	680.0	70.0	4.15	0.88	0.27
Avg. Shaft			7.0			1.06	0.23	0.27
Toe			680.0				493.30	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.30	0.36
Case Damping Factor		0.49	1.07
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	44
Unloading Level	(% of Ru)	37	
Soil Plug Weight	(kips)	0.030	

CAPWAP match quality = 2.87 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.01 in; Blow Count = 1538 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 = 35.2 ksi (T= 36.2 ms, max= 1.066 x Top)
max. Comp. Stress = 37.5 ksi (Z= 77.6 ft, T= 41.4 ms)
max. Tens. Stress = -6.53 ksi (Z= 57.3 ft, T= 58.8 ms)
max. Energy (EMX) = 44.9 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	753.2	-35.5	35.2	-1.66	44.9	18.8	1.17
2	6.7	754.1	-48.4	35.2	-2.26	44.6	18.8	1.15
4	13.5	756.0	-77.4	35.3	-3.62	43.8	18.7	1.10
5	16.9	757.2	-89.2	35.4	-4.17	43.3	18.7	1.07
6	20.2	758.5	-96.9	35.4	-4.53	42.8	18.7	1.04
7	23.6	759.9	-102.4	35.5	-4.78	42.2	18.6	1.01
8	27.0	761.7	-108.9	35.6	-5.09	41.5	18.6	0.98
9	30.4	767.4	-114.8	35.9	-5.37	40.7	18.4	0.95
10	33.7	778.3	-117.0	36.4	-5.46	39.8	18.1	0.91
11	37.1	787.0	-117.6	36.8	-5.50	38.9	17.9	0.87
12	40.5	759.1	-113.0	35.5	-5.28	36.1	17.6	0.83
13	43.8	769.3	-114.2	35.9	-5.34	35.1	17.3	0.79
14	47.2	751.8	-118.3	35.1	-5.53	32.4	16.8	0.76
15	50.6	762.7	-132.5	35.6	-6.19	31.3	16.5	0.72
16	54.0	726.8	-135.1	34.0	-6.31	28.7	16.5	0.67
17	57.3	730.9	-139.7	34.1	-6.53	27.5	16.4	0.63
18	60.7	706.7	-134.3	33.0	-6.27	24.9	16.1	0.59
19	64.1	715.4	-135.5	33.4	-6.33	23.6	15.9	0.54
20	67.5	729.2	-129.4	34.1	-6.04	21.2	16.1	0.50
21	70.8	765.3	-130.6	35.8	-6.10	19.8	17.6	0.45
22	74.2	771.7	-124.1	36.1	-5.80	17.6	18.4	0.41
23	77.6	802.8	-124.3	37.5	-5.80	14.9	16.5	0.36
Absolute	77.6			37.5			(T =	41.4 ms)
	57.3				-6.53		(T =	58.8 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	876.9	816.1	755.2	694.4	633.6	572.8	512.0	451.1	390.3	329.5
RX	910.0	866.6	841.2	822.8	804.5	786.2	768.3	760.1	753.2	747.2
RU	876.9	816.1	755.2	694.4	633.6	572.8	512.0	451.1	390.3	329.5

RAU = 647.0 (kips); RA2 = 794.0 (kips)

Current CAPWAP Ru = 750.0 (kips); Corresponding J(RP)= 0.21; J(RX) = 0.85

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
19.1	35.99	728.3	756.8	779.4	1.18	0.15	0.15	45.3	814.9	1889

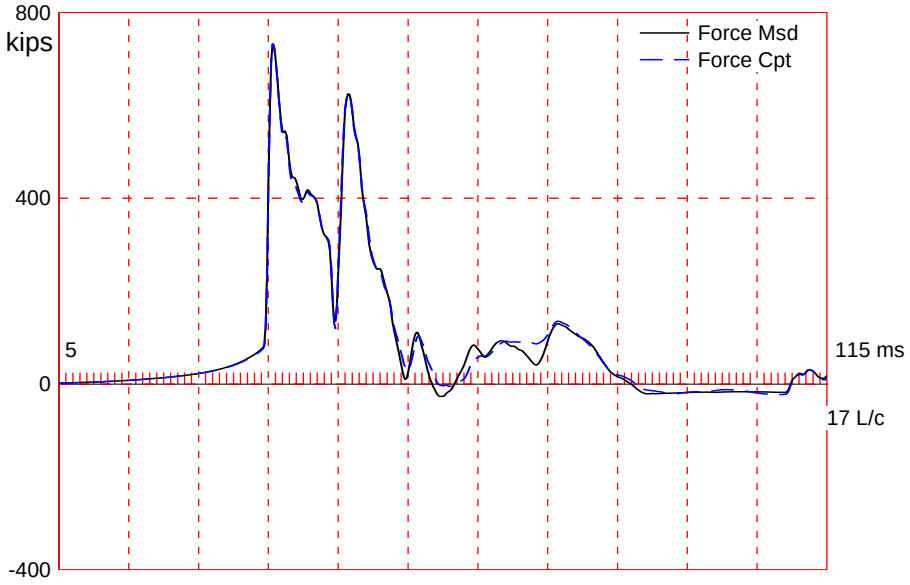
PILE PROFILE AND PILE MODEL

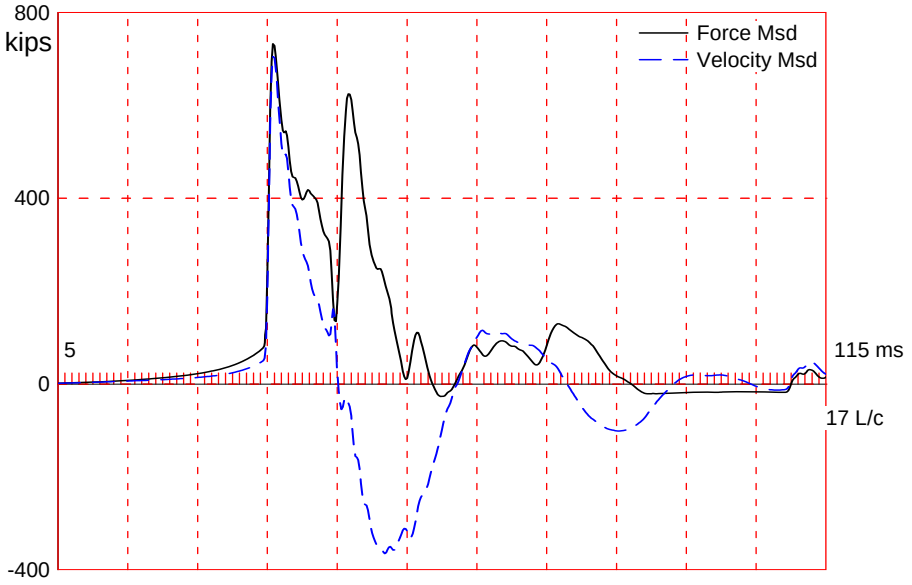
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.6	21.4	29992.2	492.000	4.70

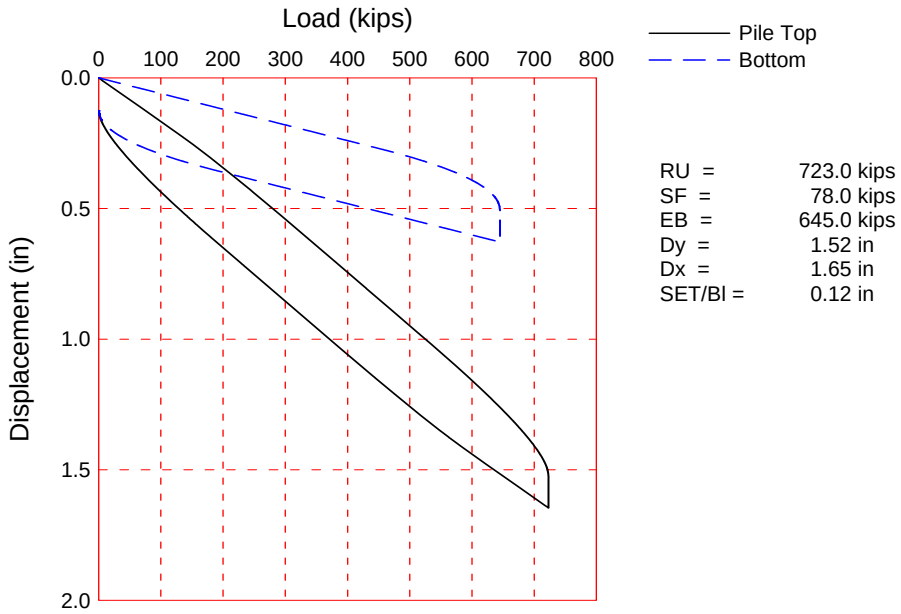
Toe Area 198.5 in²

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	16683.9	0.000
16	54.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16683.9	0.020
17	57.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16683.9	0.010
18	60.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16683.9	0.000
23	77.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16683.9	0.000

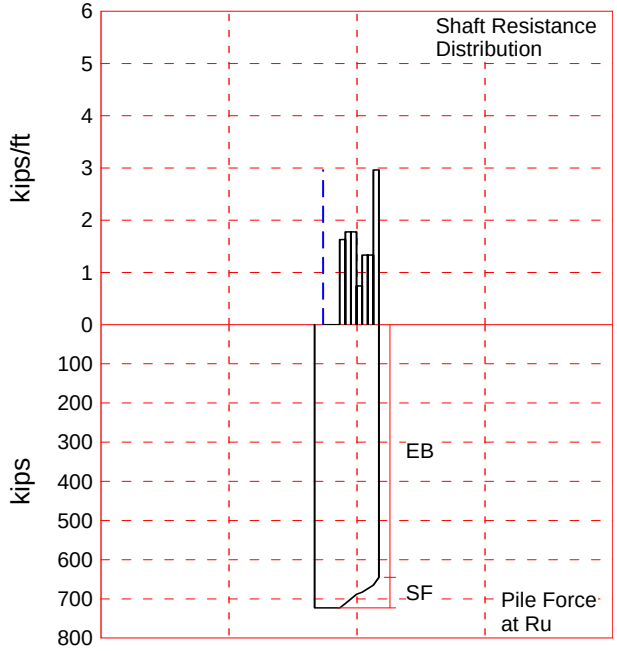
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16683.9 ft/s
Pile Damping 1.00 %, Time Incr 0.202 ms, 2L/c 9.3 ms
Total volume: 11.529 ft³; Volume ratio considering added impedance: 1.000







RU =	723.0 kips
SF =	78.0 kips
EB =	645.0 kips
Dy =	1.52 in
Dx =	1.65 in
SET/Bl =	0.12 in



Length b. Sensors	77.6 ft
Embedment	66.0 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.	16870 ft/s
Match Quality	2.74
Top Compr. Stress	34.2 ksi
Max Compr. Stress	36.5 ksi
Max Tension Stress	-5.71 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.39 in
Avg. Shaft Smith Dpg.	0.32 s/ft
Toe Smith Damping	0.06 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 723.0; along Shaft 78.0; at Toe 645.0 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
				723.0				
1	16.9	5.2	0.0	723.0	0.0	0.00	0.00	0.00
2	23.6	12.0	0.0	723.0	0.0	0.00	0.00	0.00
3	30.4	18.7	0.0	723.0	0.0	0.00	0.00	0.00
4	37.1	25.5	11.0	712.0	11.0	1.63	0.35	0.32
5	43.9	32.2	12.0	700.0	23.0	1.78	0.38	0.32
6	50.6	39.0	12.0	688.0	35.0	1.78	0.38	0.32
7	57.4	45.7	5.0	683.0	40.0	0.74	0.16	0.32
8	64.1	52.5	9.0	674.0	49.0	1.33	0.28	0.32
9	70.9	59.2	9.0	665.0	58.0	1.33	0.28	0.32
10	77.6	66.0	20.0	645.0	78.0	2.96	0.63	0.32
Avg. Shaft			7.8			1.18	0.25	0.32
Toe			645.0				467.91	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.14	0.39
Case Damping Factor		0.65	1.01
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	83
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	50	
Resistance Gap (included in Toe Quake)	(in)		0.11
Soil Plug Weight	(kips)	0.030	

CAPWAP match quality = 2.74 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.09 in; Blow Count = 137 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 = 34.2 ksi (T= 36.0 ms, max= 1.066 x Top)
max. Comp. Stress = 36.5 ksi (Z= 37.1 ft, T= 38.2 ms)
max. Tens. Stress = -5.71 ksi (Z= 37.1 ft, T= 61.4 ms)
max. Energy (EMX) = 43.8 kip-ft; max. Measured Top Displ. (DMX)= 1.16 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	732.4	-26.1	34.2	-1.22	43.8	18.5	1.16
2	6.7	732.7	-30.7	34.2	-1.43	43.6	18.4	1.15
4	13.5	733.4	-53.7	34.3	-2.51	42.8	18.4	1.10
5	16.9	733.8	-64.1	34.3	-3.00	42.4	18.3	1.07
6	20.2	734.3	-74.0	34.3	-3.46	41.8	18.3	1.04
7	23.6	734.8	-84.8	34.3	-3.96	41.3	18.3	1.02
8	27.0	737.0	-95.8	34.4	-4.48	40.6	18.2	0.98
9	30.4	750.3	-106.8	35.1	-4.99	39.8	18.0	0.95
10	33.7	766.0	-116.8	35.8	-5.46	38.9	17.6	0.91
11	37.1	780.8	-122.2	36.5	-5.71	37.9	17.2	0.87
12	40.5	726.5	-115.9	33.9	-5.42	33.7	16.7	0.84
13	43.9	744.0	-118.5	34.8	-5.54	32.7	16.4	0.80
14	47.2	692.4	-109.4	32.3	-5.11	28.5	15.7	0.76
15	50.6	694.8	-109.4	32.5	-5.11	27.4	15.5	0.72
16	54.0	647.7	-97.8	30.3	-4.57	23.6	15.4	0.68
17	57.4	652.6	-96.6	30.5	-4.51	22.5	15.3	0.64
18	60.7	650.4	-102.5	30.4	-4.79	20.3	15.1	0.60
19	64.1	666.1	-115.9	31.1	-5.42	19.2	14.9	0.56
20	67.5	670.5	-116.7	31.3	-5.45	16.3	16.6	0.52
21	70.9	705.2	-121.2	32.9	-5.66	15.2	18.0	0.47
22	74.2	710.1	-111.1	33.2	-5.19	12.6	18.1	0.43
23	77.6	724.8	-111.4	33.9	-5.21	10.6	15.7	0.39
Absolute	37.1			36.5			(T =	38.2 ms)
	37.1				-5.71		(T =	61.4 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	813.9	750.0	686.1	622.2	558.3	494.5	430.6	366.7	302.8	238.9
RX	872.6	840.8	822.1	804.0	785.9	767.8	750.1	735.1	722.4	711.5
RU	813.9	750.0	686.1	622.2	558.3	494.5	430.6	366.7	302.8	238.9

RAU = 595.4 (kips); RA2 = 740.6 (kips)

Current CAPWAP Ru = 723.0 (kips); Corresponding J(RP)= 0.14; J(RX) = 0.80

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
18.7	35.80	712.8	739.9	739.9	1.16	0.13	0.12	44.0	821.0	2304

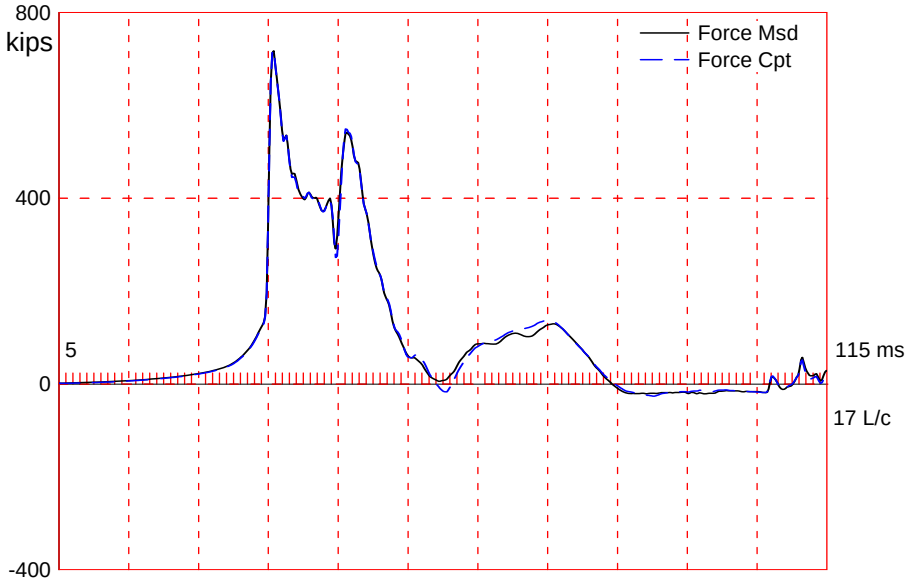
PILE PROFILE AND PILE MODEL

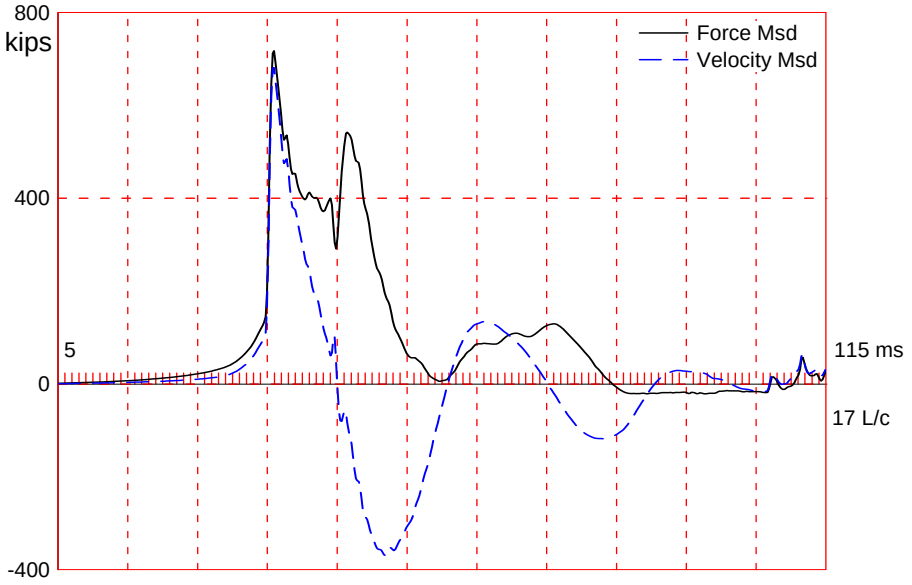
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.6	21.4	29992.2	492.000	4.70

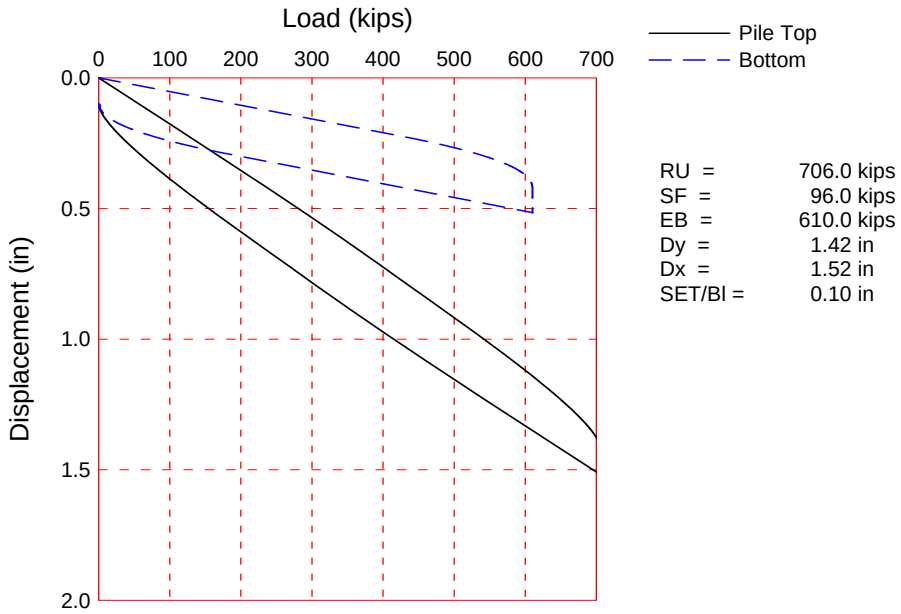
Toe Area 198.5 in^2

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	16869.6	0.000
16	54.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16869.6	0.020
17	57.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16869.6	0.000
18	60.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16869.6	0.010
19	64.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16869.6	0.000
23	77.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16869.6	0.000

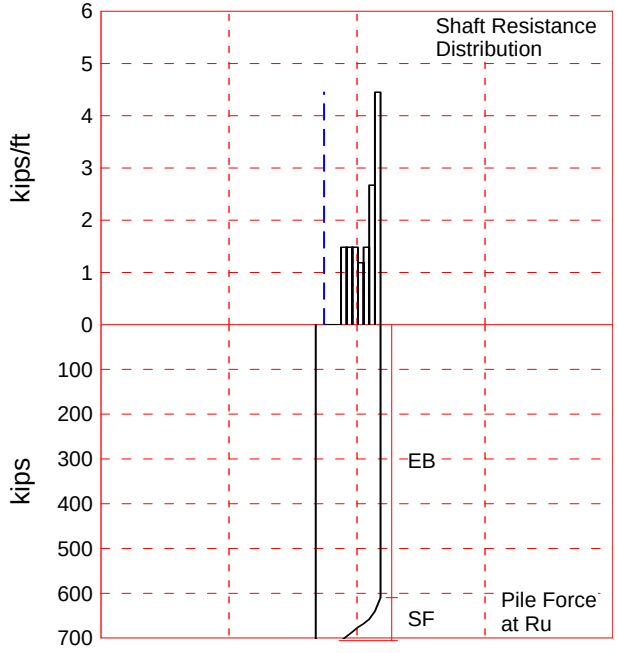
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16869.6 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.532 ft^3; Volume ratio considering added impedance: 1.000







RU =	706.0 kips
SF =	96.0 kips
EB =	610.0 kips
Dy =	1.42 in
Dx =	1.52 in
SET/Bl =	0.10 in



Length b. Sensors	77.5 ft
Embedment	65.8 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.	16684 ft/s
Match Quality	1.74
Top Compr. Stress	33.6 ksi
Max Compr. Stress	35.8 ksi
Max Tension Stress	-6.00 ksi
Avg. Shaft Quake	0.26 in
Toe Quake	0.32 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.07 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: 706.0; along Shaft 96.0; at Toe 610.0 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
				706.0				
1	16.8	5.2	0.0	706.0	0.0	0.00	0.00	0.00
2	23.6	11.9	0.0	706.0	0.0	0.00	0.00	0.00
3	30.3	18.6	0.0	706.0	0.0	0.00	0.00	0.00
4	37.1	25.4	10.0	696.0	10.0	1.48	0.32	0.28
5	43.8	32.1	10.0	686.0	20.0	1.48	0.32	0.28
6	50.5	38.9	10.0	676.0	30.0	1.48	0.32	0.28
7	57.3	45.6	8.0	668.0	38.0	1.19	0.25	0.28
8	64.0	52.3	10.0	658.0	48.0	1.48	0.32	0.28
9	70.8	59.1	18.0	640.0	66.0	2.67	0.57	0.28
10	77.5	65.8	30.0	610.0	96.0	4.45	0.95	0.28
Avg. Shaft			9.6			1.46	0.31	0.28
Toe			610.0				442.52	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.26	0.32
Case Damping Factor		0.70	1.12
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	59	
Soil Plug Weight	(kips)	0.040	

CAPWAP match quality = 1.74 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.01 in; Blow Count = 1047 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 = 33.6 ksi (T= 36.2 ms, max= 1.066 x Top)
max. Comp. Stress = 35.8 ksi (Z= 37.1 ft, T= 38.2 ms)
max. Tens. Stress = -6.00 ksi (Z= 43.8 ft, T= 58.4 ms)
max. Energy (EMX) = 43.1 kip-ft; max. Measured Top Displ. (DMX)= 1.14 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	718.4	-29.9	33.6	-1.40	43.1	17.8	1.13
2	6.7	719.6	-42.2	33.6	-1.97	42.7	17.8	1.11
4	13.5	722.7	-65.3	33.8	-3.05	41.6	17.7	1.05
5	16.8	724.5	-76.1	33.8	-3.56	41.0	17.6	1.02
6	20.2	726.6	-88.4	33.9	-4.13	40.4	17.6	0.99
7	23.6	728.8	-96.6	34.0	-4.51	39.7	17.5	0.96
8	27.0	731.5	-102.4	34.2	-4.79	39.0	17.4	0.92
9	30.3	739.8	-108.8	34.6	-5.08	38.2	17.2	0.89
10	33.7	754.2	-117.8	35.2	-5.50	37.2	16.8	0.85
11	37.1	766.0	-124.0	35.8	-5.79	36.3	16.5	0.81
12	40.4	725.5	-120.7	33.9	-5.64	33.0	16.2	0.77
13	43.8	737.4	-128.5	34.4	-6.00	32.0	15.8	0.73
14	47.2	699.3	-120.7	32.7	-5.64	28.9	15.5	0.69
15	50.5	710.2	-123.1	33.2	-5.75	27.8	15.2	0.65
16	53.9	672.1	-112.3	31.4	-5.25	25.0	14.9	0.61
17	57.3	683.1	-115.3	31.9	-5.39	23.9	14.6	0.57
18	60.7	661.8	-107.8	30.9	-5.04	21.6	14.1	0.53
19	64.0	691.2	-109.0	32.3	-5.09	20.4	13.5	0.49
20	67.4	682.2	-101.0	31.9	-4.72	18.0	12.9	0.45
21	70.8	710.5	-101.9	33.2	-4.76	16.9	14.1	0.41
22	74.1	700.7	-92.7	32.7	-4.33	14.0	14.6	0.36
23	77.5	718.8	-93.2	33.6	-4.35	11.7	13.1	0.32
Absolute	37.1			35.8			(T =	38.2 ms)
	43.8				-6.00		(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	908.1	856.0	803.9	751.8	699.7	647.5	595.4	543.3	491.2	439.1
RX	922.7	879.4	840.2	802.1	769.8	750.6	731.6	713.5	702.9	694.9
RU	908.9	856.9	804.9	752.9	700.8	648.8	596.8	544.8	492.7	440.7

RAU = 599.2 (kips); RA2 = 754.5 (kips)

Current CAPWAP Ru = 706.0 (kips); Corresponding J(RP)= 0.39; J(RX) = 0.77

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
18.3	35.95	698.6	730.6	730.6	1.14	0.10	0.10	43.5	843.5	1906

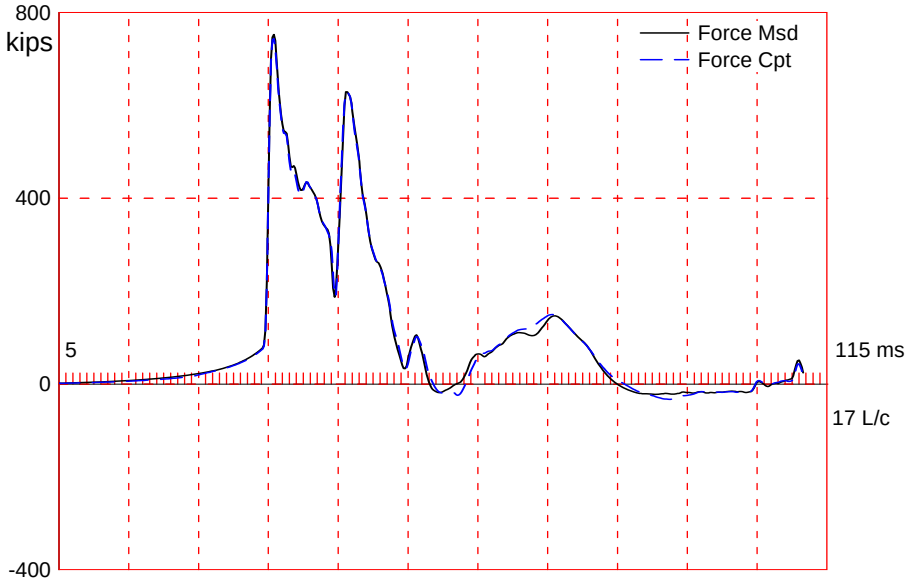
PILE PROFILE AND PILE MODEL

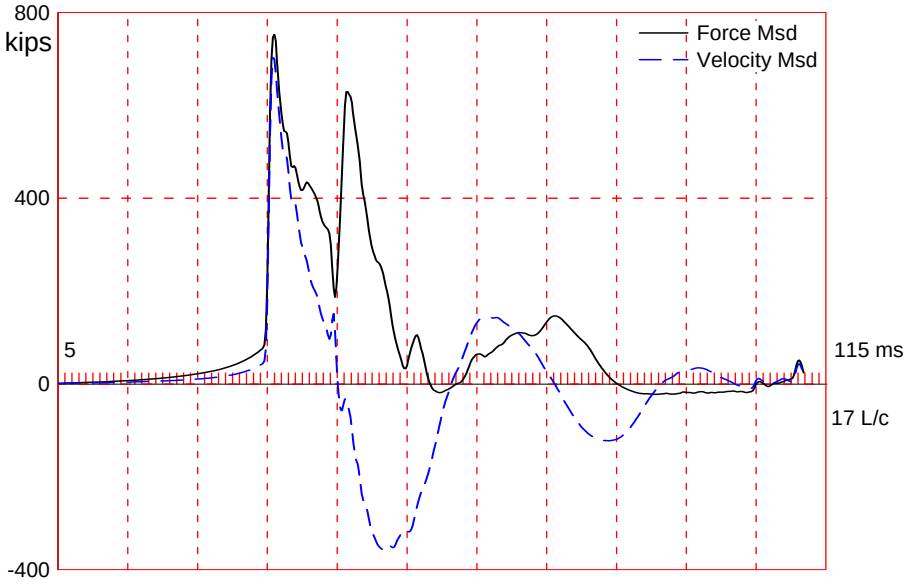
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

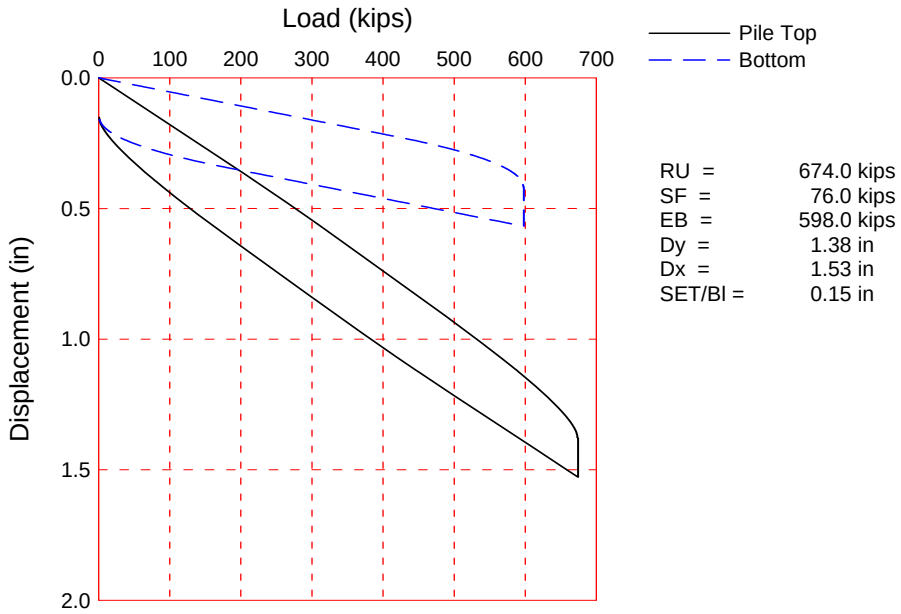
Toe Area 198.5 in^2

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	16683.9	0.000
21	70.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16683.9	0.040
22	74.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16683.9	0.000
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16683.9	0.000

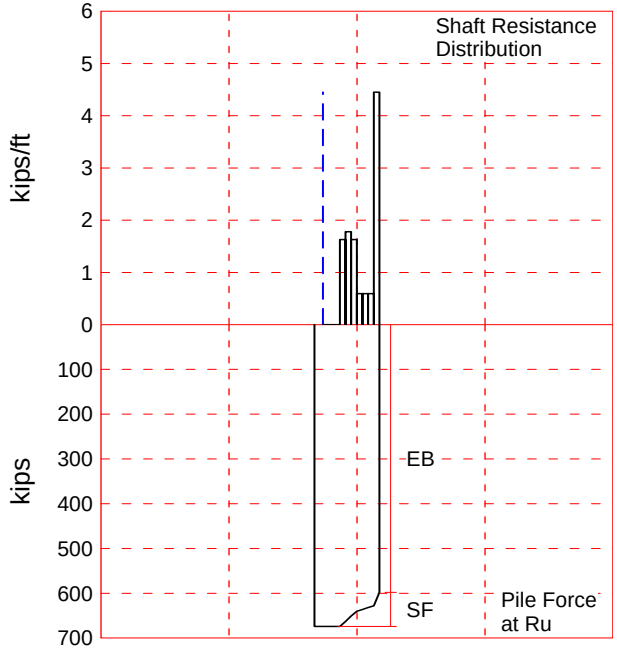
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16683.9 ft/s
Pile Damping 1.00 %, Time Incr 0.202 ms, 2L/c 9.3 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	674.0 kips
SF =	76.0 kips
EB =	598.0 kips
Dy =	1.38 in
Dx =	1.53 in
SET/Bl =	0.15 in



Length b. Sensors	77.5 ft
Embedment	65.9 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.	16667 ft/s
Match Quality	1.96
Top Compr. Stress	34.8 ksi
Max Compr. Stress	38.1 ksi
Max Tension Stress	-6.31 ksi
Avg. Shaft Quake	0.25 in
Toe Quake	0.32 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.10 s/ft

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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.

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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.

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 674.0; along Shaft 76.0; at Toe 598.0 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
				674.0				
1	16.8	5.2	0.0	674.0	0.0	0.00	0.00	0.00
2	23.6	12.0	0.0	674.0	0.0	0.00	0.00	0.00
3	30.3	18.7	0.0	674.0	0.0	0.00	0.00	0.00
4	37.1	25.4	11.0	663.0	11.0	1.63	0.35	0.28
5	43.8	32.2	12.0	651.0	23.0	1.78	0.38	0.28
6	50.5	38.9	11.0	640.0	34.0	1.63	0.35	0.28
7	57.3	45.7	4.0	636.0	38.0	0.59	0.13	0.28
8	64.0	52.4	4.0	632.0	42.0	0.59	0.13	0.28
9	70.8	59.1	4.0	628.0	46.0	0.59	0.13	0.28
10	77.5	65.9	30.0	598.0	76.0	4.45	0.95	0.28
Avg. Shaft			7.6			1.15	0.25	0.28
Toe			598.0				433.81	0.10

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.25	0.32
Case Damping Factor		0.56	1.57
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	62	36
Reloading Level	(% of Ru)	100	0
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.030	

CAPWAP match quality = 1.96 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.18 in; Blow Count = 68 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 = 34.8 ksi (T= 36.2 ms, max= 1.095 x Top)
max. Comp. Stress = 38.1 ksi (Z= 77.5 ft, T= 41.0 ms)
max. Tens. Stress = -6.31 ksi (Z= 37.1 ft, T= 60.5 ms)
max. Energy (EMX) = 45.3 kip-ft; max. Measured Top Displ. (DMX)= 1.14 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	744.3	-35.3	34.8	-1.65	45.3	18.5	1.15
2	6.7	745.2	-46.4	34.8	-2.17	45.0	18.5	1.13
4	13.5	747.2	-70.0	34.9	-3.27	44.1	18.5	1.08
5	16.8	748.3	-81.1	35.0	-3.79	43.6	18.4	1.05
6	20.2	749.4	-91.8	35.0	-4.29	43.0	18.4	1.02
7	23.6	750.7	-103.4	35.1	-4.83	42.3	18.4	0.99
8	27.0	753.2	-114.9	35.2	-5.37	41.6	18.3	0.96
9	30.3	764.9	-124.6	35.7	-5.82	40.7	18.0	0.92
10	33.7	782.0	-130.7	36.5	-6.11	39.7	17.6	0.88
11	37.1	803.0	-135.0	37.5	-6.31	38.7	17.1	0.84
12	40.4	759.4	-123.6	35.5	-5.78	34.9	16.6	0.80
13	43.8	771.0	-125.6	36.0	-5.87	33.7	16.2	0.76
14	47.2	715.3	-113.1	33.4	-5.28	29.9	16.0	0.72
15	50.5	720.7	-114.6	33.7	-5.35	28.7	15.9	0.68
16	53.9	670.6	-104.8	31.3	-4.90	25.3	15.7	0.64
17	57.3	676.6	-116.6	31.6	-5.45	24.2	15.6	0.59
18	60.7	686.6	-118.4	32.1	-5.53	22.3	15.4	0.55
19	64.0	698.9	-123.0	32.7	-5.75	21.0	15.2	0.51
20	67.4	721.7	-119.5	33.7	-5.58	19.2	15.7	0.46
21	70.8	748.2	-121.9	35.0	-5.70	18.0	16.9	0.42
22	74.1	753.8	-120.5	35.2	-5.63	16.4	17.0	0.38
23	77.5	815.2	-121.6	38.1	-5.68	14.2	14.4	0.34
Absolute	77.5			38.1			(T =	41.0 ms)
	37.1				-6.31		(T =	60.5 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	855.8	733.5	611.2	488.9	366.6					
RX	912.7	840.7	796.6	763.8	733.8	709.7	689.4	671.9	655.5	639.1
RU	855.8	733.5	611.2	488.9	366.6					

RAU = 610.5 (kips); RA2 = 754.3 (kips)

Current CAPWAP Ru = 674.0 (kips); Corresponding J(RP)= 0.30; J(RX) = 1.37

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
18.7	35.78	713.5	753.9	754.0	1.14	0.15	0.15	45.6	847.1	1929

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	16666.7	0.000
13	43.8	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16666.7	0.010
16	53.9	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16666.7	0.000
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16666.7	0.000

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16666.7 ft/s
Pile Damping 1.00 %, Time Incr 0.202 ms, 2L/c 9.3 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Rory Flynn
Company: Lunda Construction Co.	No. of Sheets: 48
E-mail: kweber@lundaconstruction.com	Date: June 17, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 20
Winnebago County, Wisconsin

On June 15, 2015, Pier 20 #1, Pier 20 #36, and Pier 20 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on June 16. Project plans indicated that 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 691. The HP 14x73 H-piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0256) operated on fuel setting 4. The reference elevation for the piles was the top of the cofferdam at EL 740.1 to EL 740.9. The pier was excavated to an elevation of EL 720.1.

Pier 20 #1 was driven to a depth of 52.0 feet, which corresponds to a pile tip elevation of EL 688.1. The blow count over the final increment of driving was 10 blows for 2 1/2 inches of penetration at an average hammer stroke of 7.8 feet. The blow count at the beginning of restrike was 10 blows per for 2 3/4 inches of penetration at an average hammer stroke of 7.8 feet.

Pier 20 #36 was driven to a depth of 46.3 feet, which corresponds to a pile tip elevation of EL 694.6. The blow count over the final increment of driving was 10 blows for 2 1/4 inches of penetration at an average hammer stroke of 8.2 feet. The blow count at the beginning of restrike was 10 blows for 1 1/2 inches of penetration at an average hammer stroke of 7.9 feet.

Pier 20 #44 was driven to a depth of 45.6 feet, which corresponds to a pile tip elevation of EL 694.5. The blow count over the final increment of driving was 10 blows for 2 1/4 inch of penetration at an average hammer stroke of 7.9 feet. The blow count at the beginning of restrike was 10 blows for 2 1/4 inches of penetration at an average hammer stroke of 7.6 feet

We recommend that the production piles at Pier 20 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	3	3
9.0	3	3

Following additional discussion with WisDOT geotechnical personnel, the minimum pile tip elevation was revised to EL 696 at Pier 20. 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 revised 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.

Rory Flynn, E.I.

Travis Coleman, P.E.

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

Attachments:

Dynamic Test Results - (pages 3 – 18)
CAPWAP Analysis Results - (pages 19 – 38)

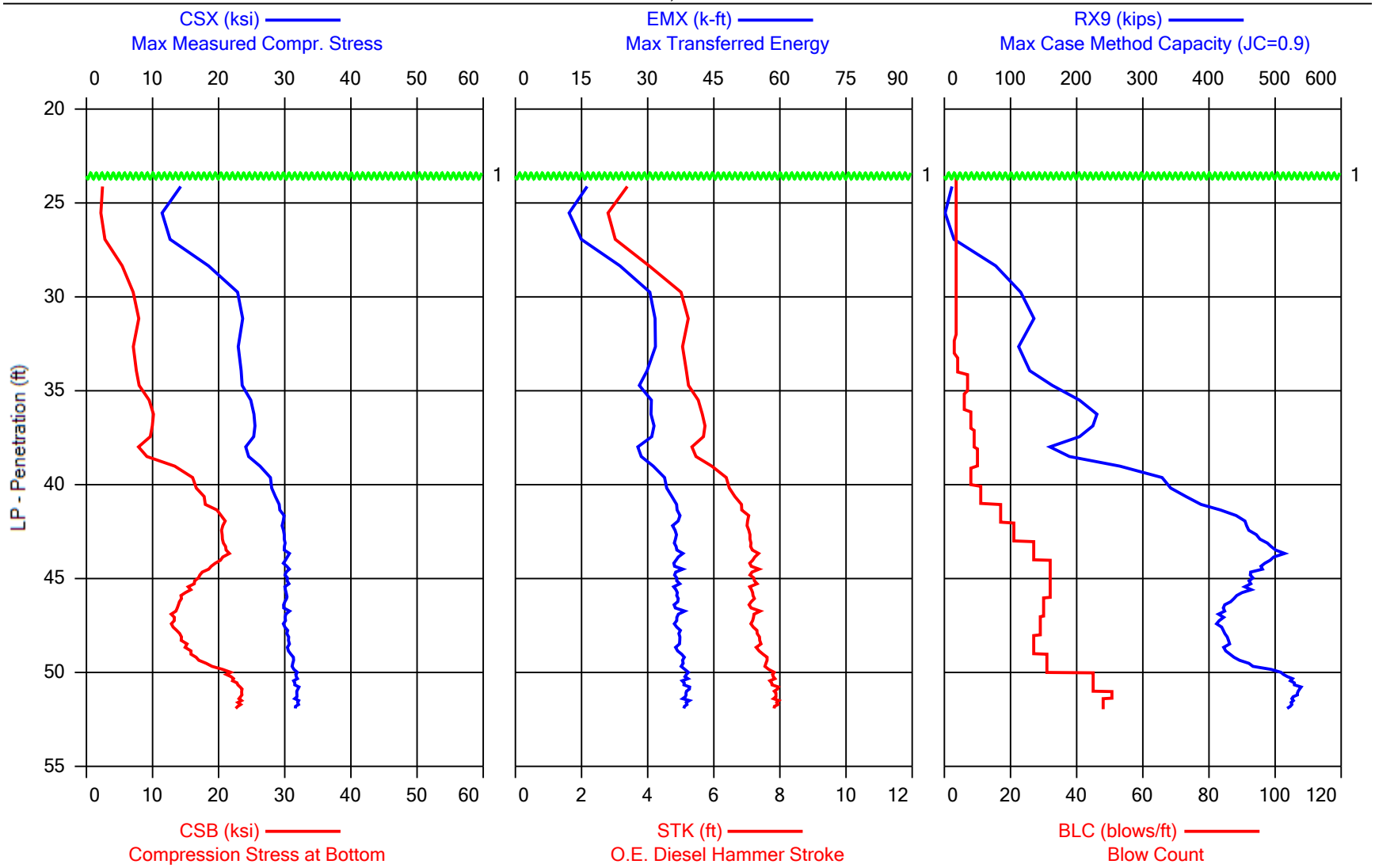
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 17-June-2015

Test started: 15-June-2015

USH 10 over LLBDM - PIER 20 #1

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.1 - Mudline EL 720.1

USH 10 over LLBDM - PIER 20 #1 APE D30-42, HP 14 x 73
OP: TC Date: 15-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 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#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
32	32.00	4	AV31	17.4	4.7	4.0	22	59.7	61
			MAX	24.8	8.3	5.5	34	69.0	143
			MIN	10.3	1.9	2.7	11	50.0	0
35	33.00	3	AV3	23.1	6.9	5.1	32	52.0	110
			MAX	23.9	7.0	5.3	34	53.0	114
			MIN	22.1	6.7	4.9	29	50.9	106
39	34.00	4	AV4	23.1	7.5	5.1	30	51.8	118
			MAX	23.8	7.9	5.3	32	52.8	121
			MIN	22.3	7.0	4.9	29	50.9	110
46	35.00	7	AV7	23.5	7.8	5.2	28	51.2	157
			MAX	24.2	8.7	5.4	29	52.1	182
			MIN	23.0	7.0	5.0	26	50.3	139
52	36.00	6	AV6	25.0	9.6	5.6	31	49.8	209
			MAX	25.6	10.1	5.7	32	50.8	233
			MIN	24.0	8.4	5.3	29	49.0	186
60	37.00	8	AV8	25.4	10.2	5.7	31	49.2	229
			MAX	26.4	11.0	6.0	33	50.6	241
			MIN	24.3	9.6	5.4	28	48.1	220
69	38.00	9	AV9	25.2	9.2	5.7	31	49.3	194
			MAX	25.7	10.2	5.8	32	50.3	216
			MIN	24.4	7.4	5.4	29	48.8	150
79	39.00	10	AV10	24.7	9.6	5.5	29	50.0	197
			MAX	26.6	13.3	6.1	32	53.0	254
			MIN	22.2	6.7	4.9	24	47.6	136
87	40.00	8	AV8	27.6	15.8	6.3	34	46.8	320
			MAX	28.9	16.6	6.7	37	48.5	348
			MIN	25.8	14.5	5.9	30	45.5	276
98	41.00	11	AV11	28.3	17.4	6.6	35	45.9	361
			MAX	30.1	18.6	7.1	39	46.7	383
			MIN	27.6	16.5	6.3	33	44.3	337
115	42.00	17	AV17	29.6	19.9	6.9	37	44.7	429
			MAX	30.8	21.5	7.3	39	45.4	462
			MIN	28.8	18.2	6.7	35	43.6	386
136	43.00	21	AV21	29.8	20.6	7.1	36	44.3	466
			MAX	30.9	21.6	7.4	38	45.1	487
			MIN	29.0	19.7	6.8	34	43.5	450

USH 10 over LLBDM - PIER 20 #1 APE D30-42, HP 14 x 73
OP: TC Date: 15-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
163	44.00	27	AV27	30.2	21.0	7.2	37	43.9	499
			MAX	31.5	21.9	7.5	39	45.0	521
			MIN	28.8	20.1	6.8	34	43.0	477
195	45.00	32	AV32	30.2	18.3	7.2	36	44.0	474
			MAX	31.4	20.3	7.6	39	44.8	498
			MIN	29.2	16.7	6.9	34	42.9	455
227	46.00	32	AV32	30.3	15.5	7.2	37	44.0	456
			MAX	31.1	16.8	7.5	38	45.2	476
			MIN	28.8	14.1	6.8	34	43.2	436
257	47.00	30	AV30	30.1	13.7	7.2	37	44.0	425
			MAX	31.6	14.5	7.8	40	44.8	445
			MIN	29.0	12.6	6.9	35	42.4	404
286	48.00	29	AV29	30.1	13.4	7.2	37	43.9	419
			MAX	31.2	14.6	7.5	39	44.9	430
			MIN	29.1	12.3	6.9	35	43.0	407
313	49.00	27	AV27	30.6	15.0	7.4	37	43.5	427
			MAX	31.3	16.3	7.6	39	44.5	447
			MIN	29.3	13.5	7.0	35	42.7	413
344	50.00	31	AV31	31.3	18.4	7.6	38	42.8	463
			MAX	32.7	22.8	8.1	41	43.5	524
			MIN	30.3	15.6	7.4	37	41.6	432
389	51.00	45	AV45	31.7	22.5	7.8	39	42.2	527
			MAX	33.1	23.9	8.3	41	43.2	542
			MIN	30.6	20.7	7.5	36	41.1	503
408	51.38	51	AV19	31.8	23.3	7.9	39	42.1	531
			MAX	32.9	24.3	8.2	41	42.8	548
			MIN	30.9	22.5	7.6	37	41.2	517
418	51.58	48	AV10	31.8	23.1	7.9	39	42.0	526
			MAX	33.2	24.5	8.3	42	42.7	535
			MIN	30.9	22.1	7.6	37	41.0	516
428	51.79	48	AV10	32.0	23.3	7.9	39	42.0	525
			MAX	32.6	23.8	8.1	40	42.6	535
			MIN	31.5	22.6	7.7	38	41.5	515
437	51.98	48	AV8	31.6	22.6	7.8	38	42.2	519
			MAX	32.4	23.4	8.1	40	42.7	525
			MIN	31.0	22.2	7.6	37	41.6	514
			Average	29.0	16.5	6.9	35	45.4	406
			Maximum	33.2	24.5	8.3	42	69.0	548
			Minimum	10.3	1.9	2.7	11	41.0	0

Total number of blows analyzed: 435

BL#	Sensors
1-434	F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (1.00); A2: [K3658] 362.0 (1.00)
435-435	F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (0.98); A2: [K3658] 362.0 (0.98)
436-437	F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (1.00); A2: [K3658] 362.0 (1.00)

BL#	Comments
2	Reported Reference EL 740.1 - Mudline EL 720.1
435	CW

Time Summary

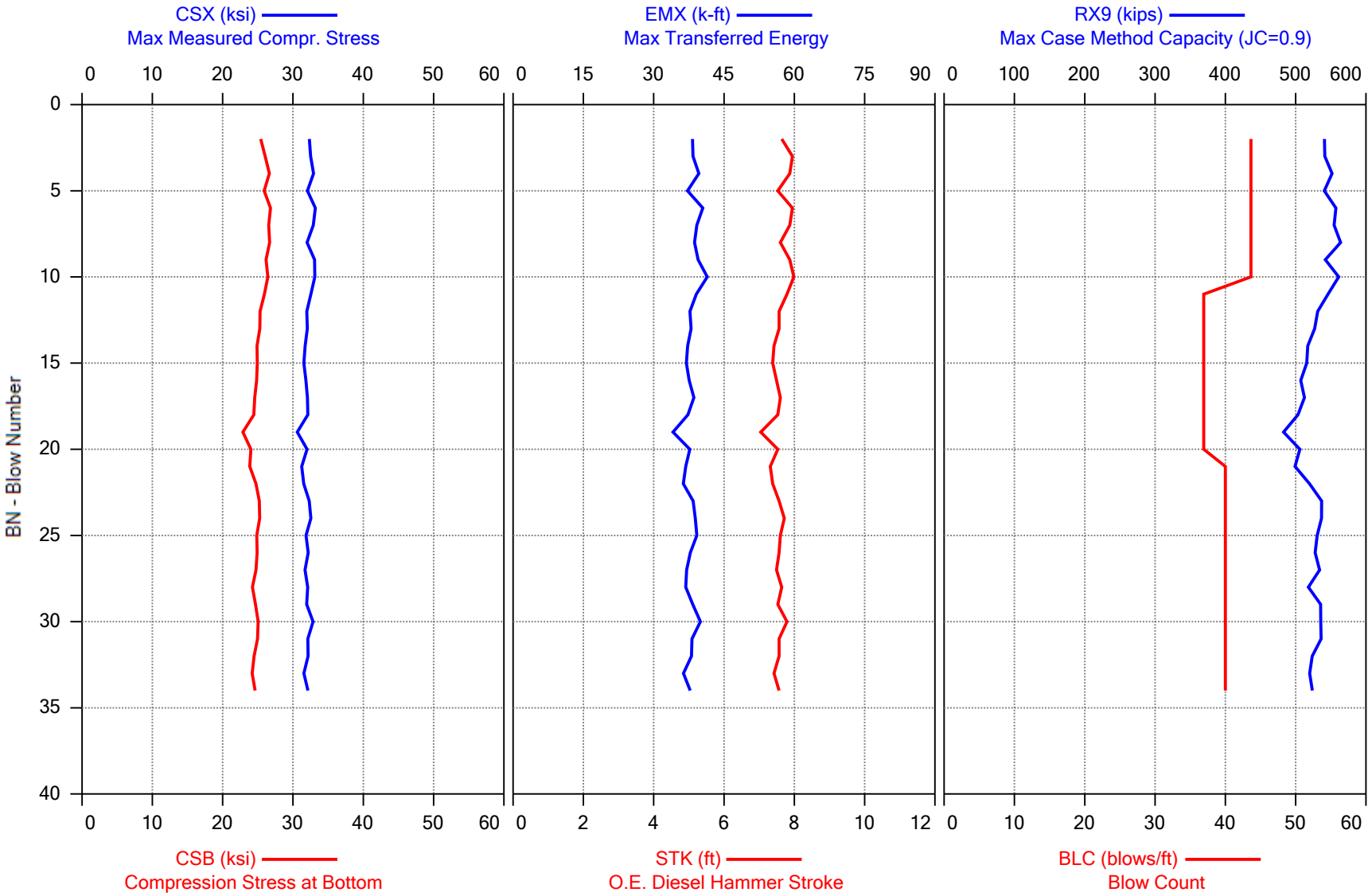
Drive 9 minutes 41 seconds 12:18 PM - 12:28 PM BN 1 - 437

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

Printed: 17-June-2015

Test started: 16-June-2015

USH 10 over LLBDM - PIER 20 #1 RESTRIKE
APE D30-42, HP 14 x 73



USH 10 over LLBDM - PIER 20 #1 RESTRIKE APE D30-42, HP 14 x 73
OP: RF Date: 16-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
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#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	52.23	44	AV9	32.7	26.3	7.8	39	42.3	550
			MAX	33.2	26.8	8.0	41	43.0	564
			MIN	32.0	25.4	7.5	37	41.8	541
20	52.50	37	AV10	31.8	24.7	7.5	37	43.1	515
			MAX	32.5	25.9	7.8	39	44.4	546
			MIN	30.6	22.9	7.0	34	42.3	483
35	52.88	40	AV14	32.0	24.7	7.6	38	42.9	527
			MAX	32.9	25.3	7.8	40	43.6	537
			MIN	31.2	23.9	7.3	36	42.3	499
			Average	32.1	25.1	7.6	38	42.8	530
			Maximum	33.2	26.8	8.0	41	44.4	564
			Minimum	30.6	22.9	7.0	34	41.8	483

Total number of blows analyzed: 33

BL# Sensors

1-35 F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (1.00); A2: [K3658] 362.0 (1.00)

Time Summary

Drive 47 seconds 6:50 AM - 6:50 AM BN 1 - 35

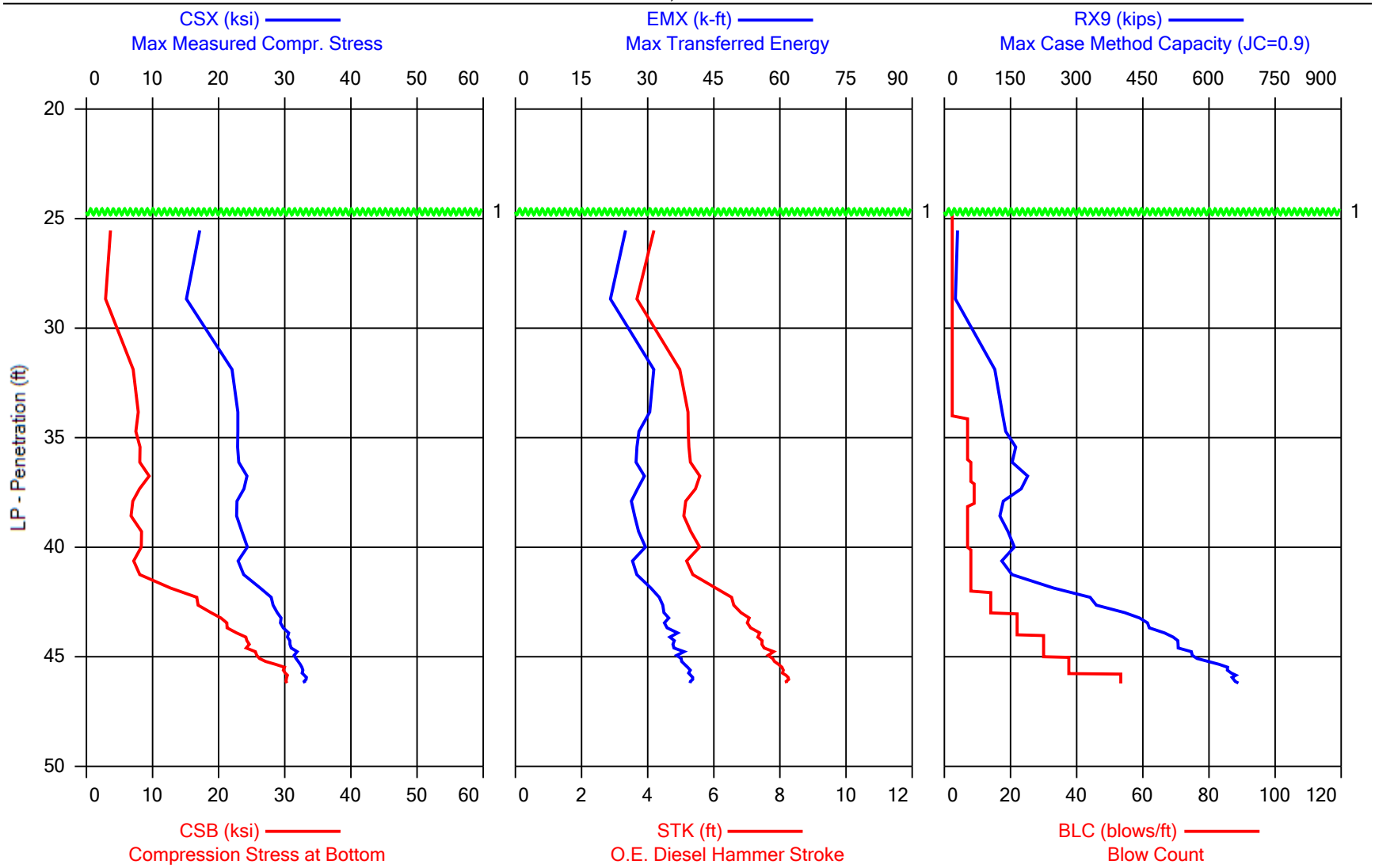
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 17-June-2015

Test started: 15-June-2015

USH 10 over LLBDM - PIER 20 #36

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.9 - Mudline EL 720.1

USH 10 over LLBDM - PIER 20 #36 APE D30-42, HP 14 x 73
OP: TC Date: 15-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 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#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
26	34.00	2	AV18	18.9	5.1	4.4	27	56.1	67
			MAX	23.4	8.3	5.3	36	73.5	125
			MIN	3.2	0.4	2.4	4	50.9	0
33	35.00	7	AV7	22.9	7.6	5.2	28	51.1	140
			MAX	23.5	8.1	5.4	30	51.8	152
			MIN	22.4	7.3	5.1	27	50.2	132
40	36.00	7	AV7	22.9	7.9	5.3	28	51.1	154
			MAX	23.6	8.5	5.4	30	51.4	180
			MIN	22.6	7.3	5.2	27	50.3	132
48	37.00	8	AV8	23.8	9.1	5.5	28	50.1	180
			MAX	24.8	10.0	5.8	31	52.3	196
			MIN	21.8	7.9	5.0	25	48.8	139
57	38.00	9	AV9	23.4	7.6	5.3	27	50.7	156
			MAX	24.3	8.5	5.5	28	52.1	183
			MIN	22.1	6.7	5.0	25	49.8	128
64	39.00	7	AV7	22.8	6.9	5.1	27	51.7	129
			MAX	23.5	7.5	5.3	29	52.2	138
			MIN	22.4	6.6	5.0	26	50.9	118
71	40.00	7	AV7	24.0	8.6	5.5	29	50.2	157
			MAX	24.7	10.3	5.7	31	52.2	177
			MIN	22.3	7.6	5.0	26	49.1	127
79	41.00	8	AV8	23.3	7.4	5.3	27	51.0	133
			MAX	25.2	7.9	5.8	30	51.8	140
			MIN	22.5	6.7	5.1	26	48.9	121
87	42.00	8	AV8	24.9	10.0	5.7	29	49.3	197
			MAX	27.5	13.6	6.5	33	50.9	286
			MIN	23.4	7.3	5.3	26	46.2	139
101	43.00	14	AV14	28.3	17.1	6.6	33	45.7	348
			MAX	30.2	18.9	7.1	36	46.6	403
			MIN	27.5	15.1	6.4	31	44.1	294
123	44.00	22	AV22	29.7	21.2	7.1	35	44.2	463
			MAX	31.5	23.1	7.7	39	45.5	506
			MIN	28.3	18.9	6.7	32	42.5	418
153	45.00	30	AV30	31.0	24.7	7.5	36	43.0	538
			MAX	32.8	26.2	8.1	40	43.8	576
			MIN	30.0	23.4	7.2	35	41.4	509

USH 10 over LLBDM - PIER 20 #36 APE D30-42, HP 14 x 73
OP: TC Date: 15-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
182	45.77	38	AV29	32.3	28.5	8.0	39	41.9	620
			MAX	33.7	30.8	8.4	41	43.1	656
			MIN	31.0	25.6	7.5	36	40.8	560
192	45.96	53	AV10	33.0	30.3	8.2	40	41.3	657
			MAX	33.3	30.8	8.3	41	41.6	666
			MIN	32.5	30.0	8.1	39	41.0	646
202	46.15	53	AV10	33.1	30.3	8.3	40	41.2	657
			MAX	33.7	30.8	8.4	41	41.7	668
			MIN	32.4	29.7	8.0	39	40.8	649
206	46.22	53	AV4	33.0	30.2	8.2	40	41.3	665
			MAX	33.3	30.8	8.4	40	41.6	679
			MIN	32.7	29.9	8.1	39	40.9	652
			Average	27.7	18.1	6.6	33	46.5	383
			Maximum	33.7	30.8	8.4	41	73.5	679
			Minimum	3.2	0.4	2.4	4	40.8	0

Total number of blows analyzed: 198

BL# Sensors

1-206 F1: [K769] 91.9 (1.00); F2: [D815] 93.0 (1.00); A1: [K3658] 362.0 (1.00); A2: [K3550] 360.0 (1.00)

BL# Comments

4 Reported Reference EL 740.9 - Mudline EL 720.1
203 CW

Time Summary

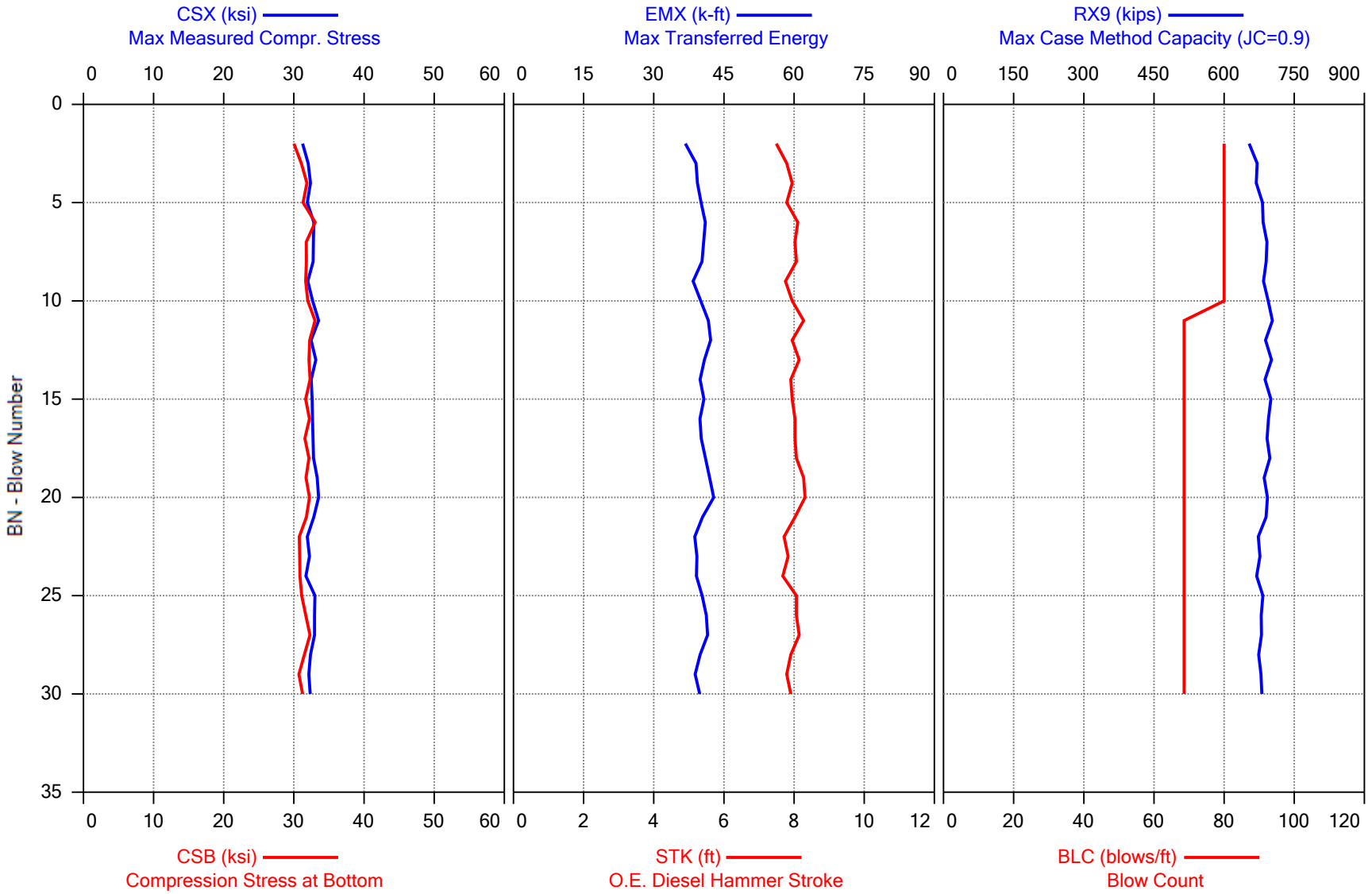
Drive 5 minutes 20 seconds 12:42 PM - 12:48 PM BN 1 - 206

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

Printed: 17-June-2015

Test started: 16-June-2015

USH 10 over LLBDM - PIER 20 #36 RESTRIKE
APE D30-42, HP 14 x 73



USH 10 over LLBDM - PIER 20 #36 RESTRIKE APE D30-42, HP 14 x 73
OP: RF Date: 16-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
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#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	46.46	80	AV9	32.3	31.6	7.9	40	42.1	680
			MAX	32.8	33.0	8.1	41	43.1	694
			MIN	31.2	30.0	7.5	37	41.5	653
20	46.60	69	AV10	32.9	32.1	8.1	41	41.5	694
			MAX	33.5	33.0	8.3	43	42.0	703
			MIN	32.5	31.6	7.9	40	41.0	685
31	46.76	69	AV10	32.4	31.3	7.9	40	42.0	678
			MAX	33.0	32.3	8.1	42	42.6	690
			MIN	31.7	30.7	7.7	39	41.4	669
			Average	32.6	31.7	8.0	40	41.9	684
			Maximum	33.5	33.0	8.3	43	43.1	703
			Minimum	31.2	30.0	7.5	37	41.0	653

Total number of blows analyzed: 29

BL# Sensors

1-31 F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (1.00); A2: [K3658] 362.0 (1.00)

Time Summary

Drive 42 seconds 7:01 AM - 7:01 AM BN 1 - 31

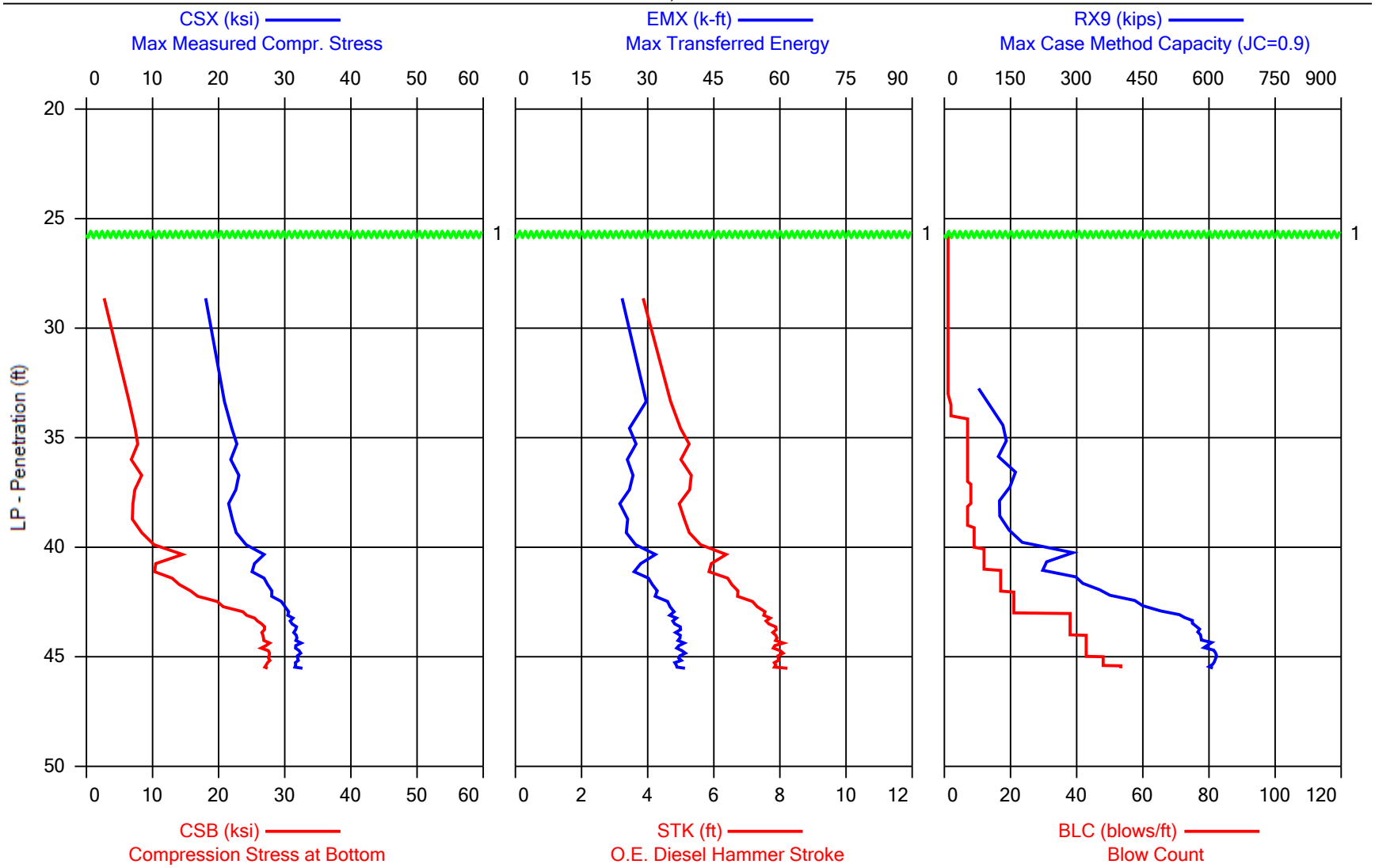
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 17-June-2015

Test started: 15-June-2015

USH 10 over LLBDM - PIER 20 #44

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.1 - Mudline EL 720.1

USH 10 over LLBDM - PIER 20 #44 APE D30-42, HP 14 x 73
OP: TC Date: 15-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 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#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
11	33.00	1	AV7	18.5	3.6	4.0	26	58.4	29
			MAX	22.8	6.3	4.8	38	66.6	80
			MIN	11.6	1.4	3.0	14	53.1	0
13	34.00	2	AV2	22.0	6.7	4.9	31	52.6	93
			MAX	22.1	6.9	5.0	31	52.8	97
			MIN	21.9	6.5	4.9	31	52.3	88
20	35.00	7	AV7	21.9	7.4	5.0	26	52.3	135
			MAX	22.5	8.1	5.1	27	53.5	143
			MIN	21.1	6.7	4.8	24	51.8	126
27	36.00	7	AV7	22.4	7.2	5.1	27	51.6	129
			MAX	23.3	8.0	5.4	29	53.6	146
			MIN	20.7	6.3	4.7	24	50.5	112
34	37.00	7	AV7	22.8	8.0	5.3	27	51.0	156
			MAX	23.5	8.7	5.4	28	51.9	181
			MIN	21.9	6.5	5.1	25	50.4	128
42	38.00	8	AV8	22.0	7.0	5.1	25	51.8	133
			MAX	23.9	7.9	5.5	28	53.2	157
			MIN	20.9	5.9	4.8	23	50.0	111
49	39.00	7	AV7	22.2	7.2	5.1	25	51.7	127
			MAX	23.1	8.1	5.4	27	53.7	150
			MIN	20.4	6.1	4.7	23	50.6	101
58	40.00	9	AV9	23.3	8.9	5.4	26	50.4	167
			MAX	24.4	10.9	5.8	28	52.7	182
			MIN	21.2	6.4	4.9	23	48.9	121
70	41.00	12	AV12	25.9	12.3	6.1	30	47.7	253
			MAX	27.8	15.6	6.7	35	49.5	315
			MIN	24.4	9.3	5.6	26	45.6	201
87	42.00	17	AV17	26.7	13.1	6.4	30	46.7	302
			MAX	28.0	15.7	6.8	32	49.3	364
			MIN	24.4	9.2	5.7	25	45.3	216
108	43.00	21	AV21	29.3	19.6	7.1	34	44.2	434
			MAX	30.6	25.6	7.5	37	45.7	533
			MIN	27.8	16.0	6.6	32	43.0	362
146	44.00	38	AV38	31.2	26.1	7.7	36	42.5	562
			MAX	32.3	28.0	8.1	39	43.6	586
			MIN	30.0	23.3	7.3	34	41.4	516

USH 10 over LLBDM - PIER 20 #44 APE D30-42, HP 14 x 73
OP: TC Date: 15-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
188	44.98	43	AV42	32.0	27.2	7.9	37	41.9	599
			MAX	32.8	28.3	8.2	39	42.8	628
			MIN	31.0	26.2	7.6	35	41.2	576
198	45.19	48	AV10	31.9	27.6	7.9	37	42.0	615
			MAX	32.3	28.1	8.0	38	42.6	621
			MIN	31.4	27.2	7.7	36	41.7	606
208	45.40	48	AV10	31.7	27.4	7.9	37	42.1	610
			MAX	32.9	28.4	8.2	39	42.9	620
			MIN	30.8	26.7	7.6	35	41.2	602
216	45.55	53	AV7	31.7	27.1	7.9	37	42.0	603
			MAX	32.7	27.4	8.2	38	42.5	610
			MIN	31.0	26.9	7.7	36	41.2	596
			Average	28.2	19.1	6.8	33	45.6	413
			Maximum	32.9	28.4	8.2	39	66.6	628
			Minimum	11.6	1.4	3.0	14	41.2	0

Total number of blows analyzed: 211

BL# Sensors

1-216 F1: [K769] 91.9 (1.00); F2: [D815] 93.0 (1.00); A1: [K3658] 362.0 (1.00); A2: [K3550] 360.0 (1.00)

BL# Comments

3 Reported Reference EL 740.1 - Mudline EL 720.1
213 CW

Time Summary

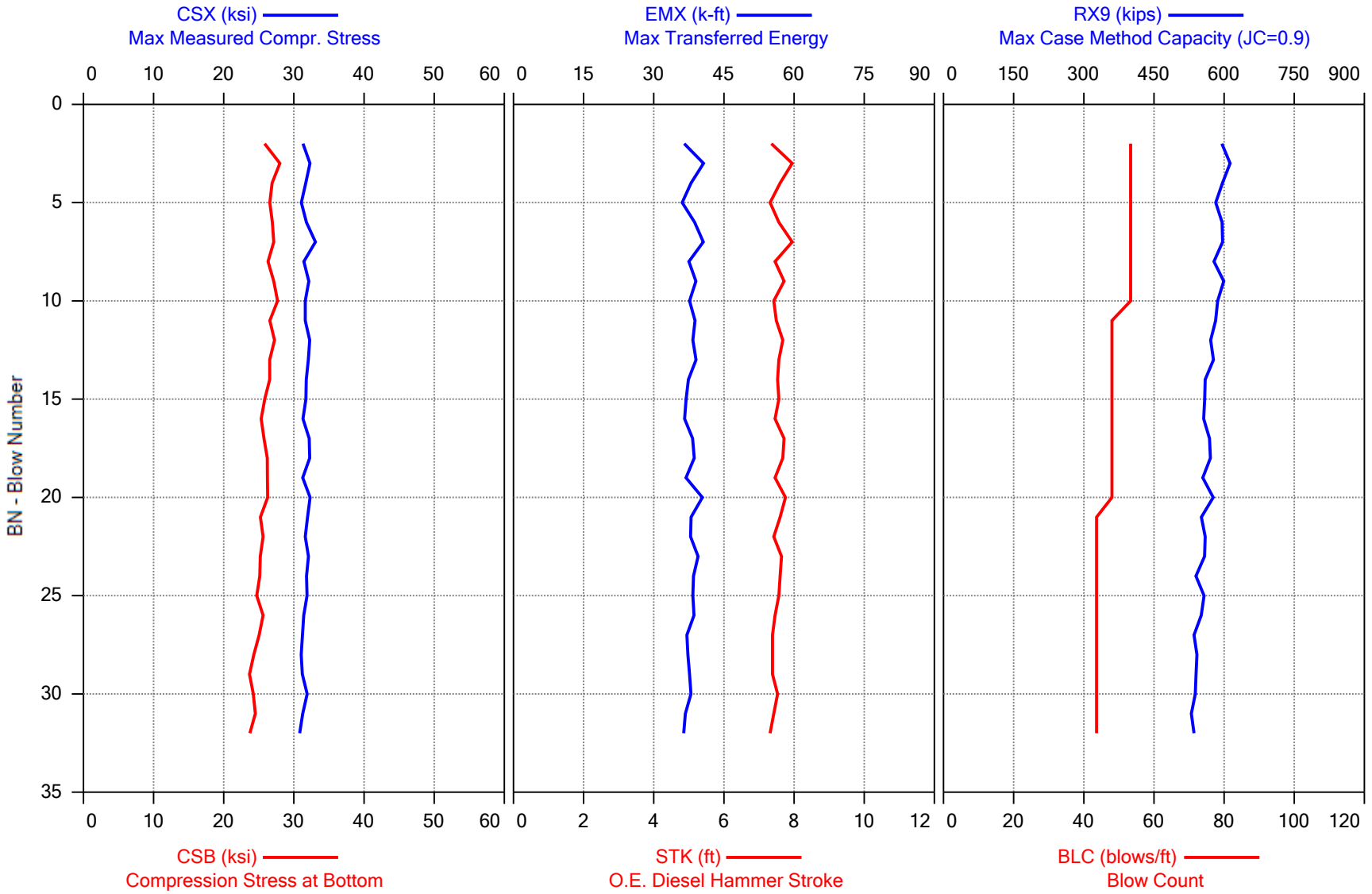
Drive 5 minutes 33 seconds 12:58 PM - 1:04 PM BN 1 - 216

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

Printed: 17-June-2015

Test started: 16-June-2015

USH 10 over LLBDM - PIER 20 #44 RESTRIKE
APE D30-42, HP 14 x 73



USH 10 over LLBDM - PIER 20 #44 RESTRIKE APE D30-42, HP 14 x 73
OP: RF Date: 16-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
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#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	45.77	53	AV9	31.8	26.9	7.6	38	42.8	594
			MAX	33.1	28.0	7.9	41	43.6	613
			MIN	31.1	25.8	7.3	36	41.9	578
20	45.98	48	AV10	31.9	26.3	7.6	38	42.8	567
			MAX	32.3	27.2	7.8	40	43.2	582
			MIN	31.3	25.3	7.5	37	42.4	554
32	46.25	44	AV12	31.5	24.8	7.5	38	43.2	545
			MAX	32.1	25.6	7.6	39	43.6	559
			MIN	30.8	23.7	7.3	36	42.7	530
			Average	31.7	25.9	7.5	38	43.0	566
			Maximum	33.1	28.0	7.9	41	43.6	613
			Minimum	30.8	23.7	7.3	36	41.9	530

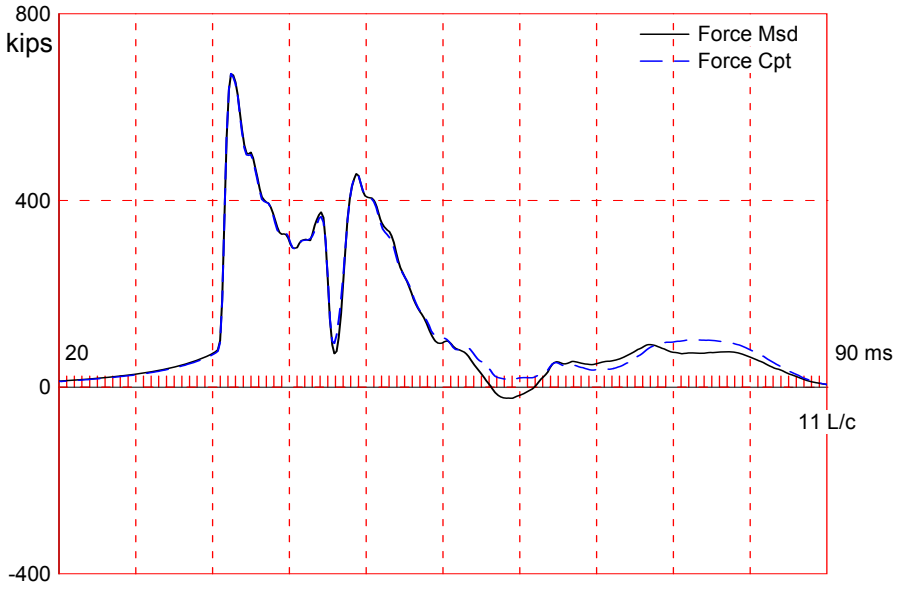
Total number of blows analyzed: 31

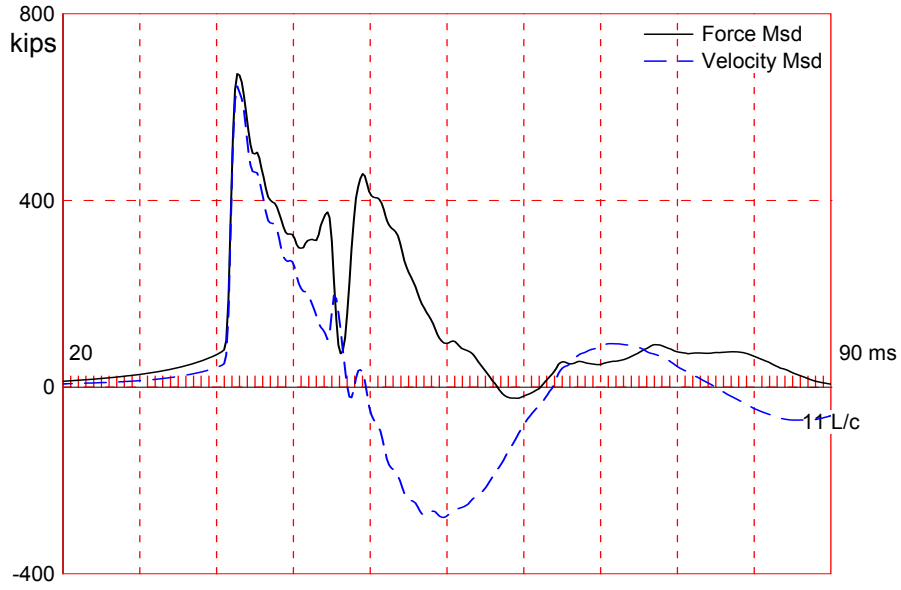
BL# Sensors

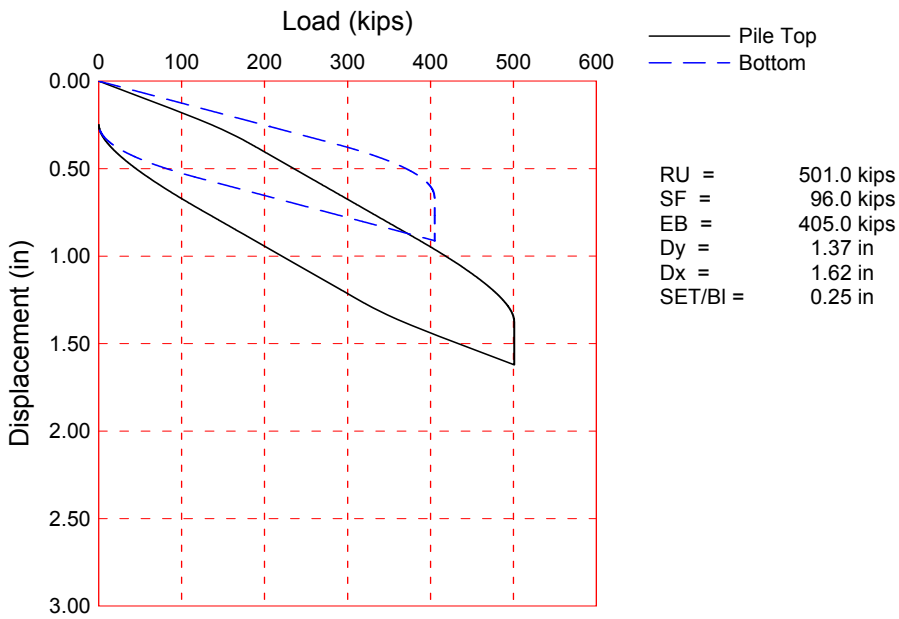
1-32 F1: [K769] 91.9 (1.00); F2: [D815] 93.0 (1.00); A1: [K3658] 362.0 (1.00); A2: [K3550] 360.0 (1.00)

Time Summary

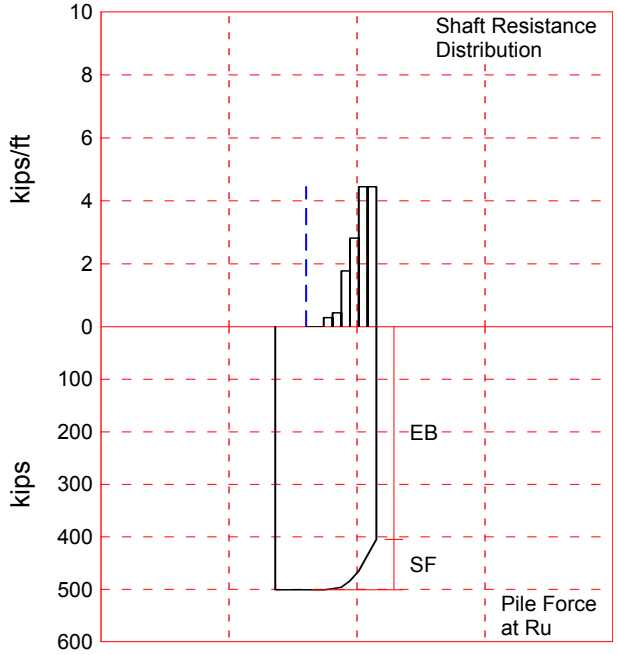
Drive 43 seconds 7:11 AM - 7:12 AM BN 1 - 32







RU =	501.0 kips
SF =	96.0 kips
EB =	405.0 kips
Dy =	1.37 in
Dx =	1.62 in
SET/Bl =	0.25 in



Length b. Sensors	77.5 ft
Embedment	51.9 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	3.32
Top Compr. Stress	31.4 ksi
Max Compr. Stress	33.0 ksi
Max Tension Stress	-4.40 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.51 in
Avg. Shaft Smith Dpg.	0.22 s/ft
Toe Smith Damping	0.07 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: 501.0; along Shaft 96.0; at Toe 405.0 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
				501.0				
1	30.3	4.8	0.0	501.0	0.0	0.00	0.00	0.00
2	37.1	11.5	0.0	501.0	0.0	0.00	0.00	0.00
3	43.8	18.2	2.0	499.0	2.0	0.30	0.06	0.22
4	50.5	25.0	3.0	496.0	5.0	0.45	0.09	0.22
5	57.3	31.7	12.0	484.0	17.0	1.78	0.38	0.22
6	64.0	38.5	19.0	465.0	36.0	2.82	0.60	0.22
7	70.8	45.2	30.0	435.0	66.0	4.45	0.95	0.22
8	77.5	51.9	30.0	405.0	96.0	4.45	0.95	0.22
Avg. Shaft			12.0			1.85	0.39	0.22
Toe			405.0				293.80	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.09	0.51
Case Damping Factor		0.55	0.74
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	55	69
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	86	
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)	0.035	0.045

CAPWAP match quality = 3.32 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.25 in; Blow Count = 48 b/ft
Computed: Final Set = 0.22 in; Blow Count = 55 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 = 31.4 ksi (T= 36.1 ms, max= 1.052 x Top)
max. Comp. Stress = 33.0 ksi (Z= 57.3 ft, T= 39.5 ms)
max. Tens. Stress = -4.40 ksi (Z= 57.3 ft, T= 63.6 ms)
max. Energy (EMX) = 38.3 kip-ft; max. Measured Top Displ. (DMX)= 1.14 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	672.6	-15.8	31.4	-0.74	38.3	16.9	1.14
2	6.7	672.9	-16.5	31.4	-0.77	38.2	16.8	1.13
4	13.5	673.6	-19.7	31.5	-0.92	37.7	16.8	1.09
5	16.8	674.4	-23.5	31.5	-1.10	37.4	16.7	1.06
6	20.2	675.6	-31.3	31.6	-1.46	36.9	16.7	1.04
7	23.6	676.9	-38.6	31.6	-1.80	36.4	16.6	1.01
8	27.0	678.0	-44.9	31.7	-2.10	35.9	16.6	0.98
9	30.3	679.2	-52.2	31.7	-2.44	35.3	16.5	0.95
10	33.7	680.5	-60.0	31.8	-2.80	34.7	16.5	0.92
11	37.1	682.2	-67.2	31.9	-3.14	34.1	16.4	0.89
12	40.4	685.5	-73.6	32.0	-3.44	33.5	16.3	0.86
13	43.8	688.5	-79.2	32.2	-3.70	32.9	16.2	0.83
14	47.2	683.8	-82.2	31.9	-3.84	31.9	16.1	0.80
15	50.5	693.7	-87.7	32.4	-4.10	31.2	15.9	0.77
16	53.9	692.8	-89.2	32.4	-4.17	30.0	15.5	0.74
17	57.3	707.4	-94.2	33.0	-4.40	29.4	15.2	0.71
18	60.7	674.3	-83.7	31.5	-3.91	26.6	14.7	0.68
19	64.0	698.4	-87.9	32.6	-4.11	26.0	14.3	0.65
20	67.4	644.2	-70.4	30.1	-3.29	22.4	14.9	0.62
21	70.8	629.5	-74.5	29.4	-3.48	21.9	16.8	0.59
22	74.1	501.4	-46.2	23.4	-2.16	17.0	17.7	0.56
23	77.5	521.9	-50.1	24.4	-2.34	13.4	17.6	0.54
Absolute	57.3			33.0			(T =	39.5 ms)
	57.3				-4.40		(T =	63.6 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	629.6	488.7	347.8	206.8	65.9					
RX	682.3	624.6	568.4	536.7	523.6	515.8	511.5	509.4	508.6	507.8
RU	629.6	488.7	347.8	206.8	65.9					

RAU = 504.4 (kips); RA2 = 563.9 (kips)

Current CAPWAP Ru = 501.0 (kips); Corresponding J(RP)= 0.18; matches RX20 within 5%

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
17.1	36.09	654.1	680.1	680.1	1.14	0.25	0.25	38.8	667.2	844

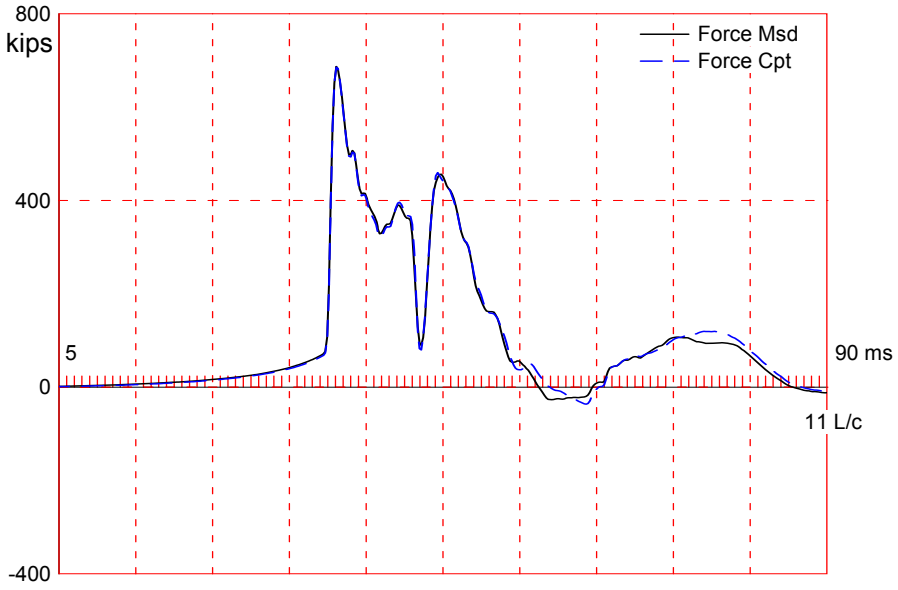
PILE PROFILE AND PILE MODEL

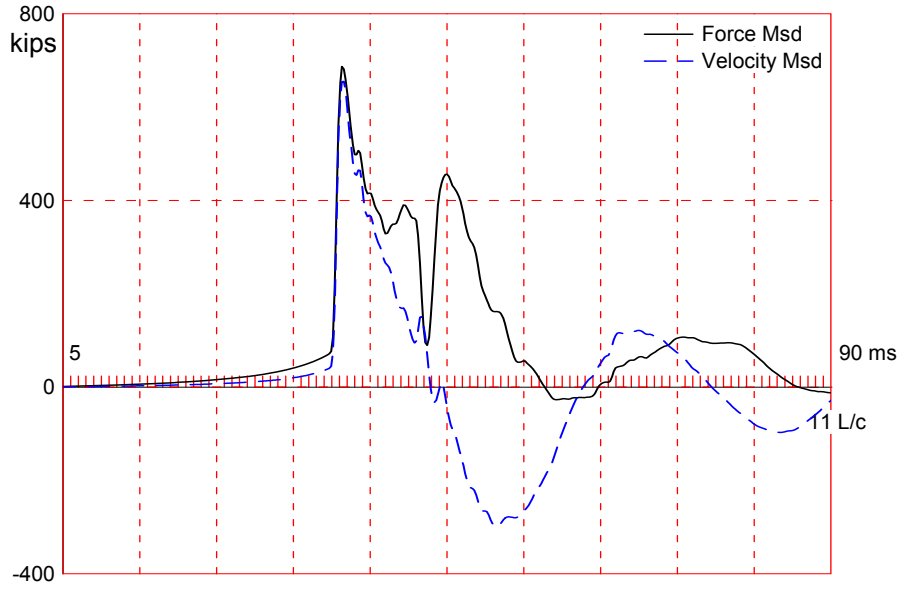
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

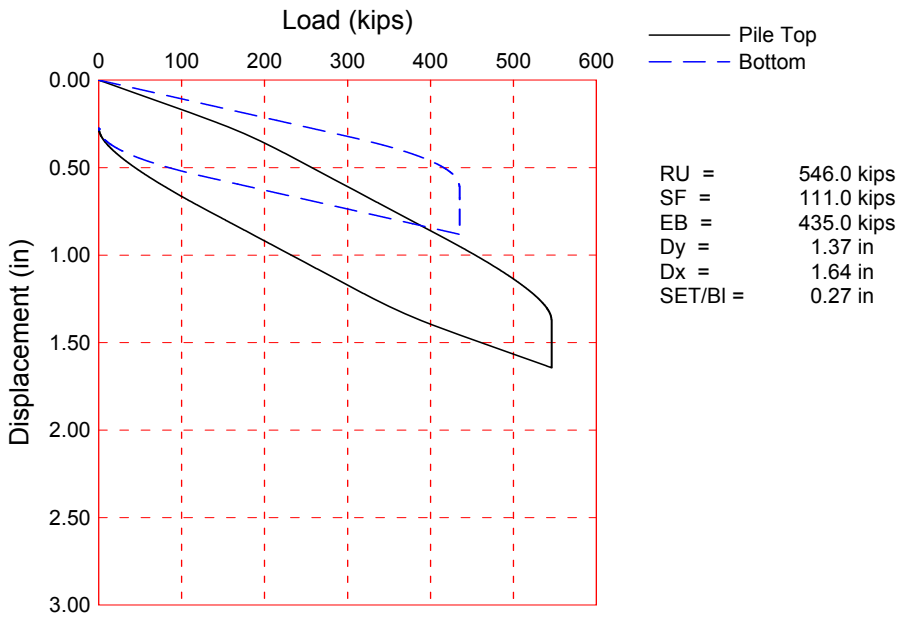
Toe Area 198.5 in²

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
22	74.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.025

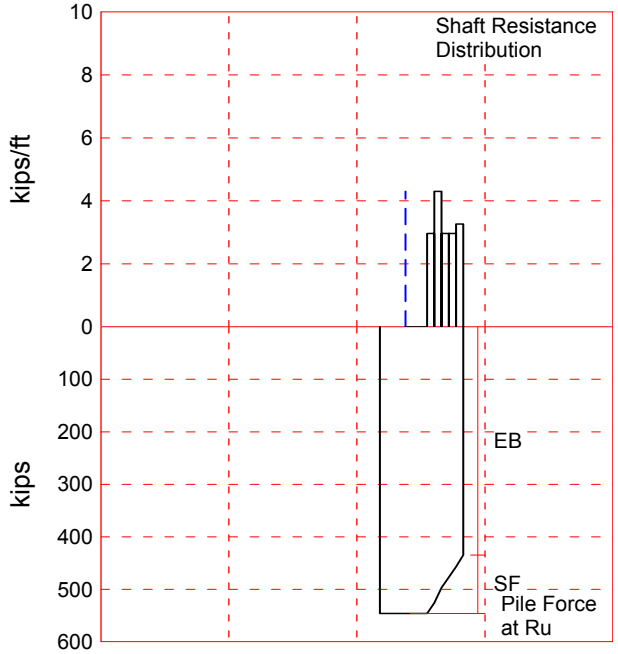
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	546.0 kips
SF =	111.0 kips
EB =	435.0 kips
Dy =	1.37 in
Dx =	1.64 in
SET/Bl =	0.27 in



Length b. Sensors	77.5 ft
Embedment	52.1 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	2.54
Top Compr. Stress	32.0 ksi
Max Compr. Stress	35.4 ksi
Max Tension Stress	-6.40 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.47 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.06 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 546.0; along Shaft 111.0; at Toe 435.0 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	30.3	4.9	0.0	546.0	0.0	0.00	0.00	0.00
2	37.1	11.7	0.0	546.0	0.0	0.00	0.00	0.00
3	43.8	18.4	0.0	546.0	0.0	0.00	0.00	0.00
4	50.5	25.1	20.0	526.0	20.0	2.97	0.63	0.24
5	57.3	31.9	29.0	497.0	49.0	4.30	0.92	0.24
6	64.0	38.6	20.0	477.0	69.0	2.97	0.63	0.24
7	70.8	45.4	20.0	457.0	89.0	2.97	0.63	0.24
8	77.5	52.1	22.0	435.0	111.0	3.26	0.69	0.24
Avg. Shaft			13.9			2.13	0.45	0.24
Toe			435.0				315.56	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.10	0.47
Case Damping Factor		0.69	0.68
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	31
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	56	
Resistance Gap (included in Toe Quake)	(in)		0.08
Soil Plug Weight	(kips)		0.135

CAPWAP match quality = 2.54 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.27 in; Blow Count = 44 b/ft
Computed: Final Set = 0.26 in; Blow Count = 46 b/ft

Transducer F3(D815) CAL: 93.0; RF: 0.99; F4(K769) CAL: 91.9; RF: 0.99
A3(K3550) CAL: 360; RF: 1.01; A4(K3658) CAL: 362; RF: 1.01

max. Top Comp. Stress = 32.0 ksi (T= 36.1 ms, max= 1.104 x Top)
max. Comp. Stress = 35.4 ksi (Z= 50.5 ft, T= 39.1 ms)
max. Tens. Stress = -6.40 ksi (Z= 50.5 ft, T= 60.9 ms)
max. Energy (EMX) = 39.4 kip-ft; max. Measured Top Displ. (DMX)= 1.11 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	685.9	-40.5	32.0	-1.89	39.4	17.2	1.12
2	6.7	686.2	-46.0	32.1	-2.15	39.3	17.1	1.11
4	13.5	687.0	-62.2	32.1	-2.91	38.8	17.1	1.07
5	16.8	687.5	-72.2	32.1	-3.37	38.4	17.1	1.04
6	20.2	688.0	-83.7	32.1	-3.91	37.9	17.0	1.02
7	23.6	688.9	-95.0	32.2	-4.44	37.3	17.0	0.99
8	27.0	690.0	-105.8	32.2	-4.94	36.8	16.9	0.96
9	30.3	691.1	-115.6	32.3	-5.40	36.2	16.9	0.93
10	33.7	692.3	-123.6	32.3	-5.77	35.6	16.9	0.90
11	37.1	693.6	-130.1	32.4	-6.08	34.9	16.8	0.87
12	40.4	696.5	-133.2	32.5	-6.22	34.3	16.8	0.84
13	43.8	713.6	-134.6	33.3	-6.29	33.5	16.5	0.80
14	47.2	734.3	-136.6	34.3	-6.38	32.8	15.9	0.77
15	50.5	757.3	-137.1	35.4	-6.40	32.0	15.4	0.73
16	53.9	692.9	-118.7	32.4	-5.55	27.6	14.7	0.70
17	57.3	709.2	-120.6	33.1	-5.63	26.9	14.2	0.67
18	60.7	603.8	-96.8	28.2	-4.52	21.4	13.7	0.64
19	64.0	617.8	-96.8	28.9	-4.52	20.7	13.5	0.61
20	67.4	548.1	-81.0	25.6	-3.78	17.1	14.9	0.58
21	70.8	528.5	-81.8	24.7	-3.82	16.5	16.5	0.55
22	74.1	495.7	-62.3	23.2	-2.91	13.1	17.7	0.52
23	77.5	506.7	-60.9	23.7	-2.84	10.7	17.6	0.49
Absolute	50.5			35.4			(T =	39.1 ms)
	50.5				-6.40		(T =	60.9 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	662.8	525.3	387.8	250.3	112.8					
RX	710.6	655.5	605.0	575.3	558.3	543.5	529.8	520.2	513.4	506.6
RU	671.0	533.0	394.9	256.9	118.9					

RAU = 461.6 (kips); RA2 = 609.1 (kips)

Current CAPWAP Ru = 546.0 (kips); Corresponding J(RP)= 0.17; J(RX) = 0.97

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
17.4	36.09	658.6	691.7	697.6	1.11	0.28	0.27	39.7	687.5	1130

PILE PROFILE AND PILE MODEL

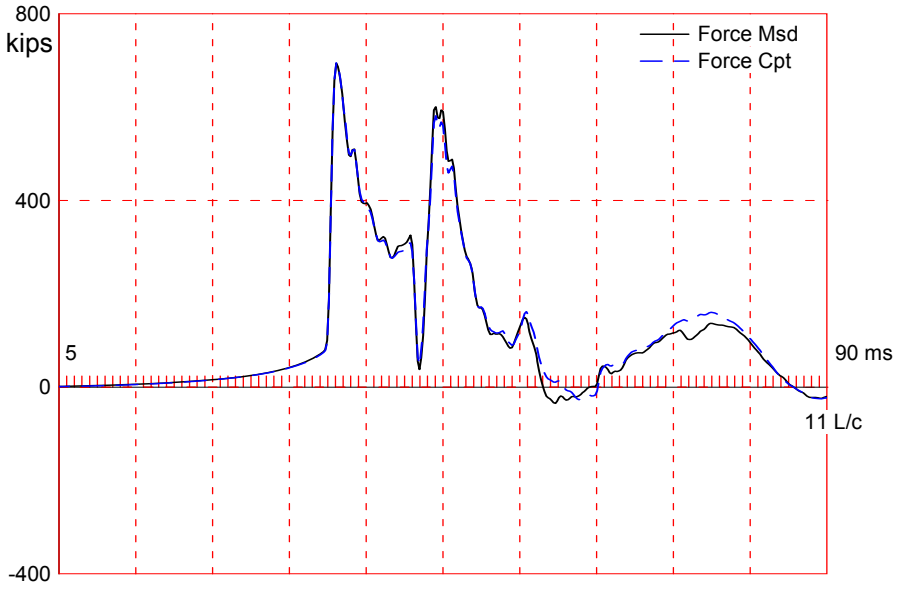
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

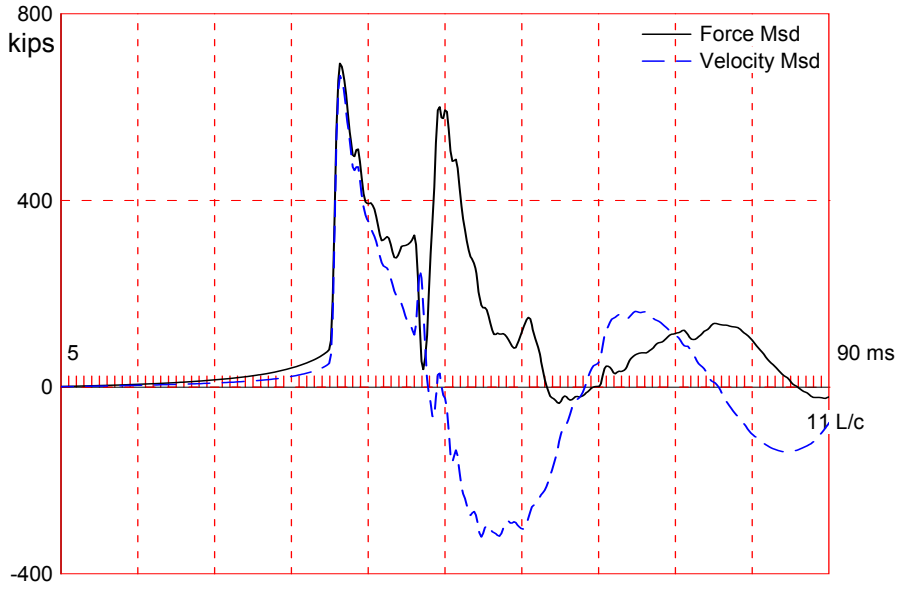
Toe Area 198.5 in^2

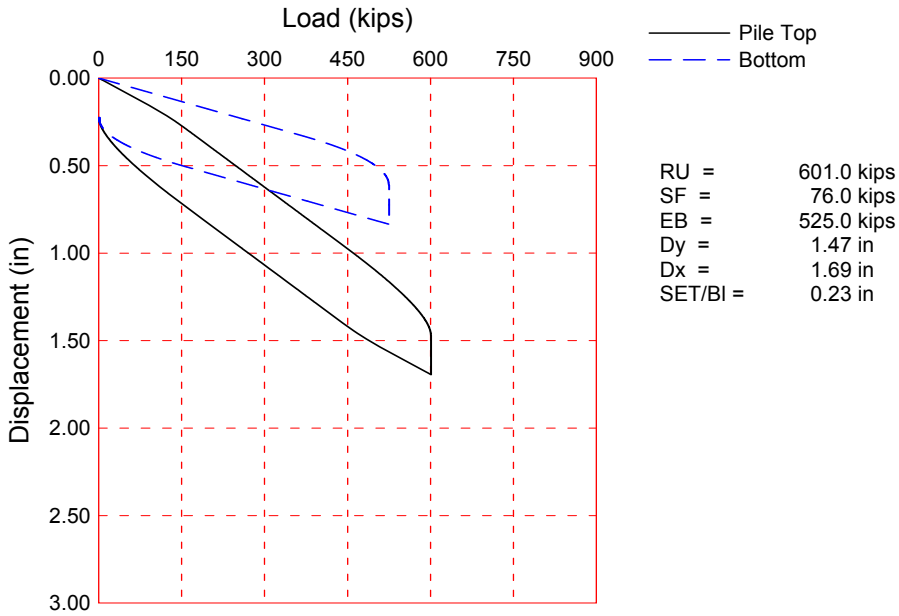
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

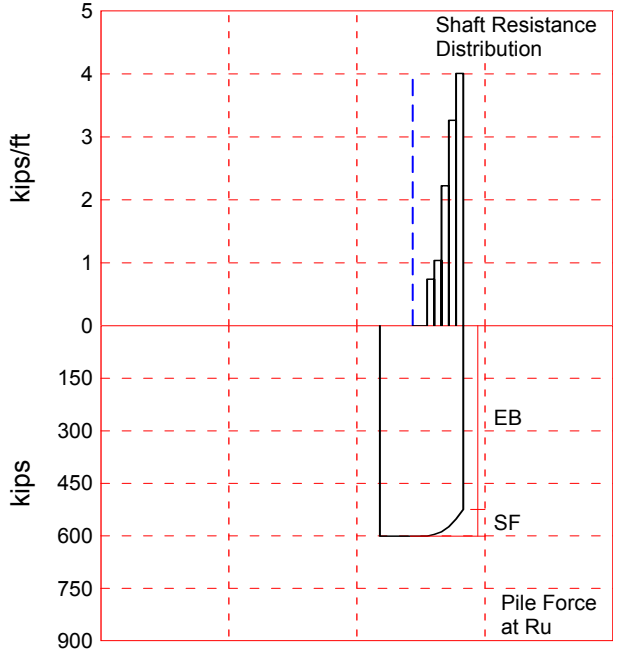
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	601.0 kips
SF =	76.0 kips
EB =	525.0 kips
Dy =	1.47 in
Dx =	1.69 in
SET/Bl =	0.23 in



Length b. Sensors	77.5 ft
Embedment	46.3 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	3.51
Top Compr. Stress	32.5 ksi
Max Compr. Stress	33.3 ksi
Max Tension Stress	-6.98 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.47 in
Avg. Shaft Smith Dpg.	0.20 s/ft
Toe Smith Damping	0.07 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: 601.0; along Shaft 76.0; at Toe 525.0 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
				601.0				
1	37.1	5.8	0.0	601.0	0.0	0.00	0.00	0.00
2	43.8	12.6	0.0	601.0	0.0	0.00	0.00	0.00
3	50.5	19.3	5.0	596.0	5.0	0.74	0.16	0.20
4	57.3	26.0	7.0	589.0	12.0	1.04	0.22	0.20
5	64.0	32.8	15.0	574.0	27.0	2.23	0.47	0.20
6	70.8	39.5	22.0	552.0	49.0	3.26	0.69	0.20
7	77.5	46.3	27.0	525.0	76.0	4.01	0.85	0.20
Avg. Shaft			10.9			1.64	0.35	0.20
Toe			525.0				380.85	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.06	0.47
Case Damping Factor		0.40	0.96
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	35	47
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.05
Soil Plug Weight	(kips)		0.045

CAPWAP match quality = 3.51 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.19 in; Blow Count = 65 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 = 32.5 ksi (T= 36.1 ms, max= 1.024 x Top)
max. Comp. Stress = 33.3 ksi (Z= 50.5 ft, T= 39.1 ms)
max. Tens. Stress = -6.98 ksi (Z= 47.2 ft, T= 61.7 ms)
max. Energy (EMX) = 39.3 kip-ft; max. Measured Top Displ. (DMX)= 1.17 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	695.8	-40.8	32.5	-1.91	39.3	17.4	1.17
2	6.7	696.1	-47.3	32.5	-2.21	39.1	17.4	1.15
4	13.5	696.8	-62.9	32.6	-2.94	38.4	17.3	1.11
5	16.8	697.2	-70.9	32.6	-3.31	37.9	17.3	1.08
6	20.2	697.6	-83.4	32.6	-3.89	37.4	17.3	1.05
7	23.6	698.0	-96.4	32.6	-4.51	36.9	17.3	1.02
8	27.0	698.6	-108.1	32.6	-5.05	36.3	17.2	0.99
9	30.3	699.0	-118.8	32.7	-5.55	35.8	17.2	0.96
10	33.7	699.5	-129.2	32.7	-6.04	35.1	17.2	0.93
11	37.1	700.1	-138.0	32.7	-6.45	34.5	17.1	0.90
12	40.4	700.7	-145.4	32.7	-6.79	33.9	17.1	0.87
13	43.8	702.4	-149.2	32.8	-6.97	33.2	17.0	0.84
14	47.2	707.5	-149.5	33.1	-6.98	32.4	16.8	0.81
15	50.5	712.9	-148.8	33.3	-6.95	31.6	16.7	0.77
16	53.9	697.9	-141.8	32.6	-6.62	29.8	16.5	0.74
17	57.3	709.8	-141.7	33.2	-6.62	28.9	16.3	0.70
18	60.7	694.9	-133.8	32.5	-6.25	26.8	15.9	0.66
19	64.0	710.1	-135.3	33.2	-6.32	25.9	15.5	0.63
20	67.4	661.0	-116.6	30.9	-5.45	22.6	17.2	0.59
21	70.8	653.5	-117.6	30.5	-5.49	21.7	18.9	0.55
22	74.1	642.6	-90.8	30.0	-4.24	17.8	19.9	0.52
23	77.5	663.0	-90.4	31.0	-4.22	14.9	18.8	0.48
Absolute	50.5			33.3			(T =	39.1 ms)
	47.2				-6.98		(T =	61.7 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	606.6	451.9	297.1	142.4	0.0					
RX	786.6	743.2	699.8	676.0	665.8	655.5	645.3	635.6	626.1	616.7
RU	606.6	451.9	297.1	142.4	0.0					

RAU = 578.9 (kips); RA2 = 675.4 (kips)

Current CAPWAP Ru = 601.0 (kips); Corresponding J(RP)= 0.01; matches RX20 within 5%

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
17.7	36.09	675.6	704.8	704.8	1.17	0.22	0.23	39.4	679.7	1250

PILE PROFILE AND PILE MODEL

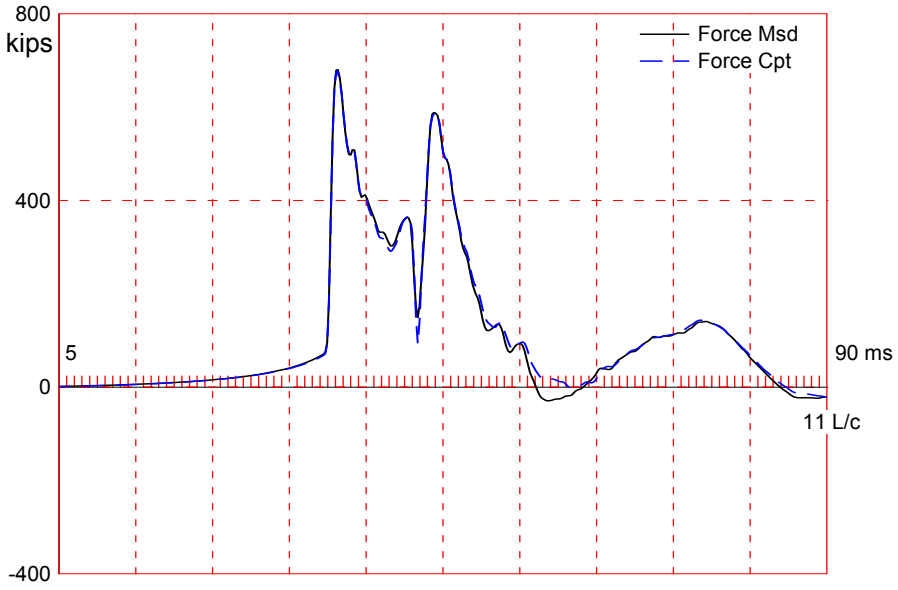
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

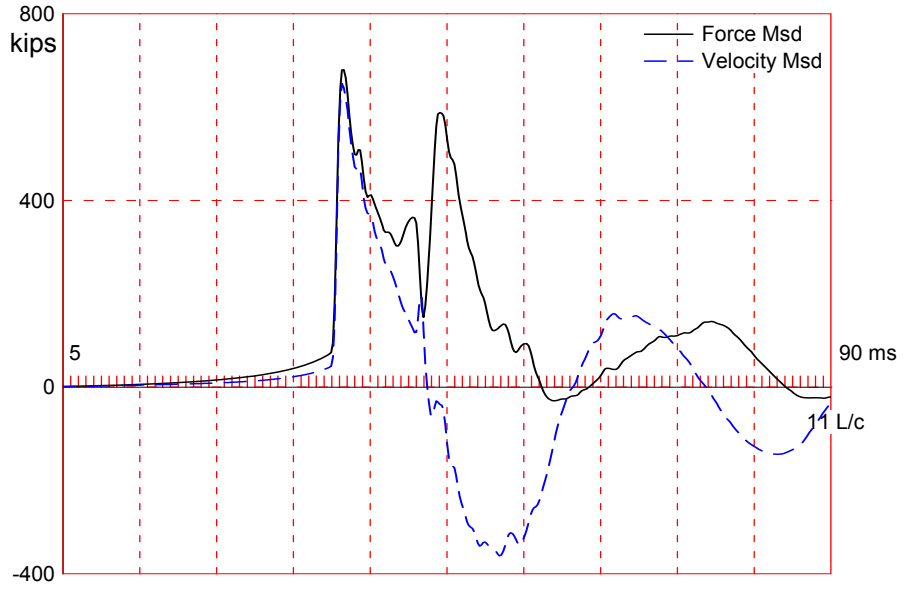
Toe Area 198.5 in^2

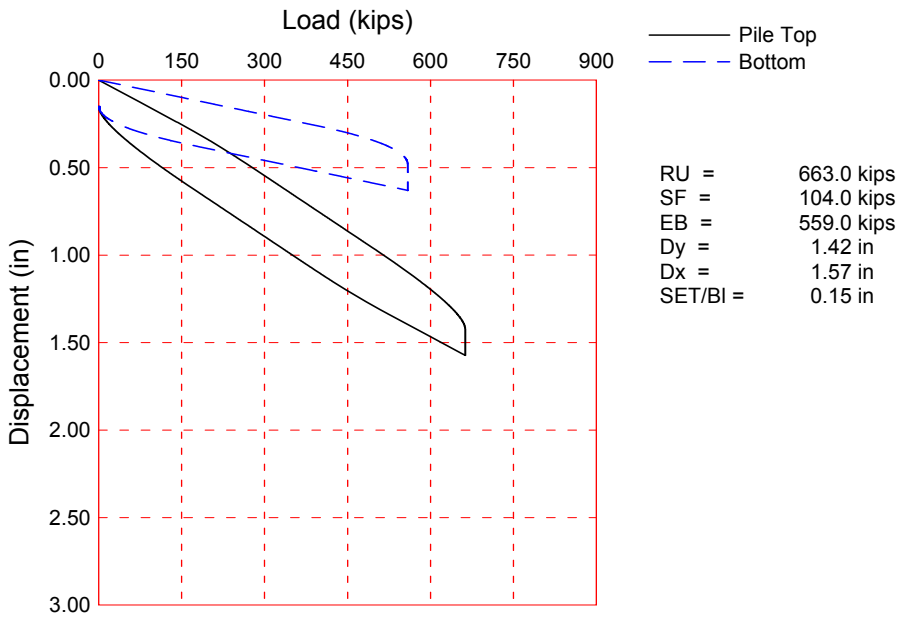
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

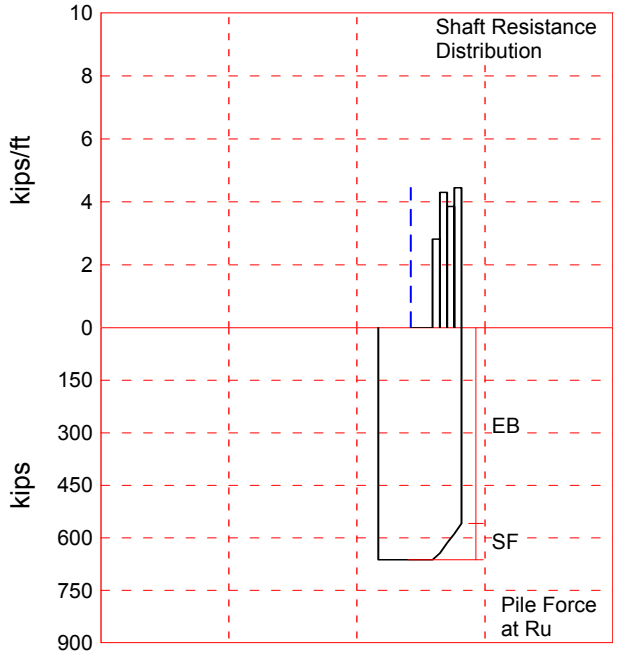
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	663.0 kips
SF =	104.0 kips
EB =	559.0 kips
Dy =	1.42 in
Dx =	1.57 in
SET/Bl =	0.15 in



Length b. Sensors	77.5 ft
Embedment	46.4 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	2.60
Top Compr. Stress	31.7 ksi
Max Compr. Stress	34.8 ksi
Max Tension Stress	-7.93 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.37 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.07 s/ft

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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: 663.0; along Shaft 104.0; at Toe 559.0 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
				663.0				
1	37.1	5.9	0.0	663.0	0.0	0.00	0.00	0.00
2	43.8	12.7	0.0	663.0	0.0	0.00	0.00	0.00
3	50.5	19.4	0.0	663.0	0.0	0.00	0.00	0.00
4	57.3	26.2	19.0	644.0	19.0	2.82	0.60	0.24
5	64.0	32.9	29.0	615.0	48.0	4.30	0.92	0.24
6	70.8	39.6	26.0	589.0	74.0	3.86	0.82	0.24
7	77.5	46.4	30.0	559.0	104.0	4.45	0.95	0.24
Avg. Shaft			14.9			2.24	0.48	0.24
Toe			559.0				405.52	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.10	0.37
Case Damping Factor		0.65	1.10
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	90
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	72	
Resistance Gap (included in Toe Quake)	(in)		0.10

CAPWAP match quality = 2.60 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.11 in; Blow Count = 108 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 = 31.7 ksi (T= 36.1 ms, max= 1.097 x Top)
max. Comp. Stress = 34.8 ksi (Z= 57.3 ft, T= 39.5 ms)
max. Tens. Stress = -7.93 ksi (Z= 57.3 ft, T= 61.1 ms)
max. Energy (EMX) = 39.1 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	679.1	-35.6	31.7	-1.66	39.1	17.0	1.14
2	6.7	679.4	-39.6	31.7	-1.85	38.8	17.0	1.12
4	13.5	679.9	-49.5	31.8	-2.31	37.8	17.0	1.07
5	16.8	680.2	-62.1	31.8	-2.90	37.2	16.9	1.04
6	20.2	680.5	-75.5	31.8	-3.53	36.6	16.9	1.01
7	23.6	681.0	-89.2	31.8	-4.17	35.9	16.9	0.97
8	27.0	681.4	-101.6	31.8	-4.75	35.2	16.8	0.94
9	30.3	681.9	-113.2	31.9	-5.29	34.6	16.8	0.91
10	33.7	682.7	-123.8	31.9	-5.78	33.9	16.8	0.88
11	37.1	683.8	-132.7	31.9	-6.20	33.1	16.7	0.84
12	40.4	685.0	-140.4	32.0	-6.56	32.3	16.7	0.81
13	43.8	686.2	-146.8	32.1	-6.86	31.4	16.6	0.77
14	47.2	688.5	-153.6	32.2	-7.18	30.4	16.6	0.73
15	50.5	703.3	-160.4	32.9	-7.49	29.5	16.4	0.70
16	53.9	723.5	-166.3	33.8	-7.77	28.5	15.8	0.66
17	57.3	744.9	-169.7	34.8	-7.93	27.4	15.4	0.62
18	60.7	685.3	-150.4	32.0	-7.03	23.1	14.6	0.58
19	64.0	703.8	-149.9	32.9	-7.00	22.0	14.8	0.53
20	67.4	648.2	-120.1	30.3	-5.61	16.9	16.7	0.50
21	70.8	671.0	-120.4	31.3	-5.62	15.9	18.3	0.46
22	74.1	646.1	-99.5	30.2	-4.65	11.8	18.8	0.42
23	77.5	664.1	-101.3	31.0	-4.73	9.3	17.4	0.38
Absolute	57.3			34.8			(T =	39.5 ms)
	57.3				-7.93		(T =	61.1 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	748.0	627.3	506.7	386.1	265.5					
RX	817.5	775.0	738.1	701.2	673.4	661.5	650.2	639.0	627.8	616.6
RU	748.0	627.3	506.7	386.1	265.5					

RAU = 601.6 (kips); RA2 = 684.6 (kips)

Current CAPWAP Ru = 663.0 (kips); Corresponding J(RP)= 0.14; J(RX) = 0.97

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
17.3	35.89	661.8	689.3	689.3	1.13	0.15	0.15	39.3	735.8	2098

PILE PROFILE AND PILE MODEL

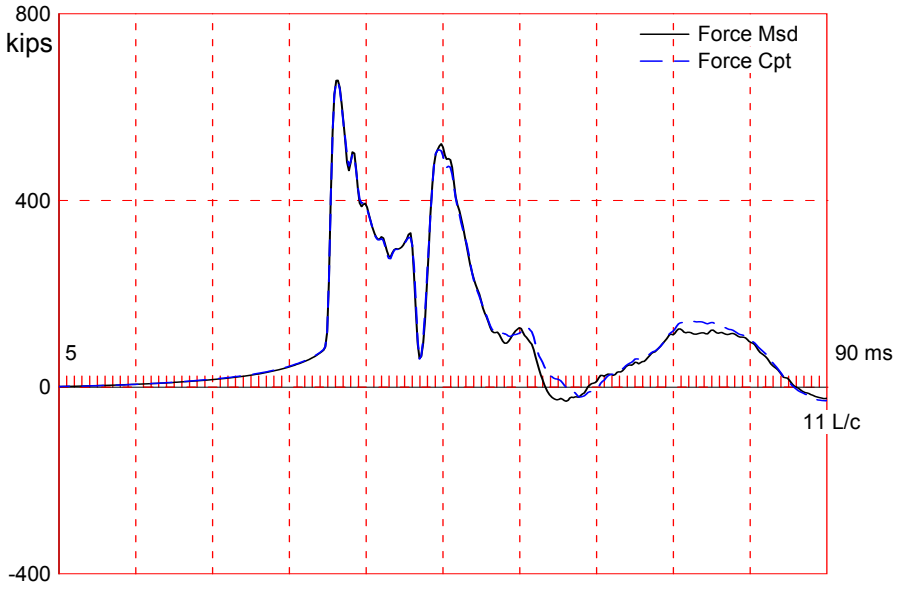
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

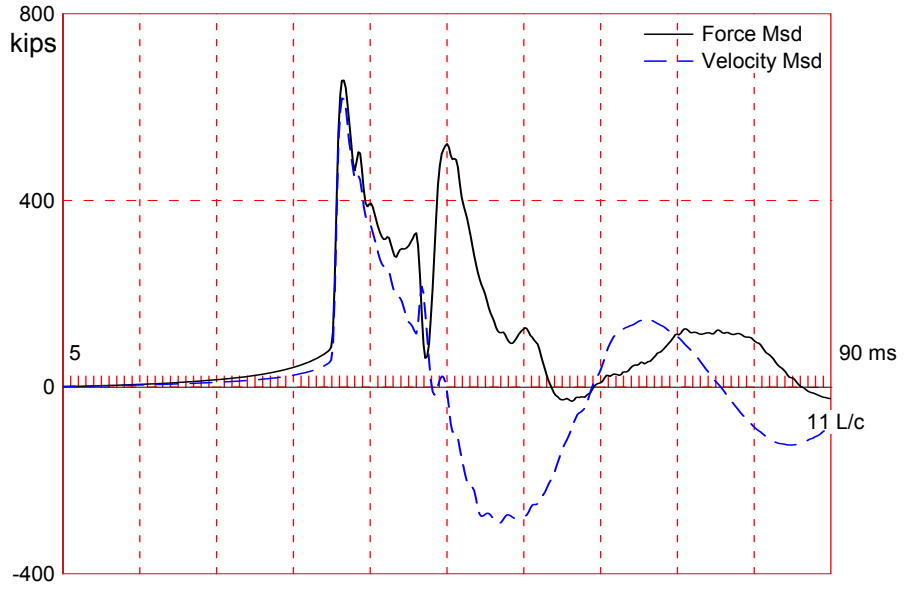
Toe Area 198.5 in^2

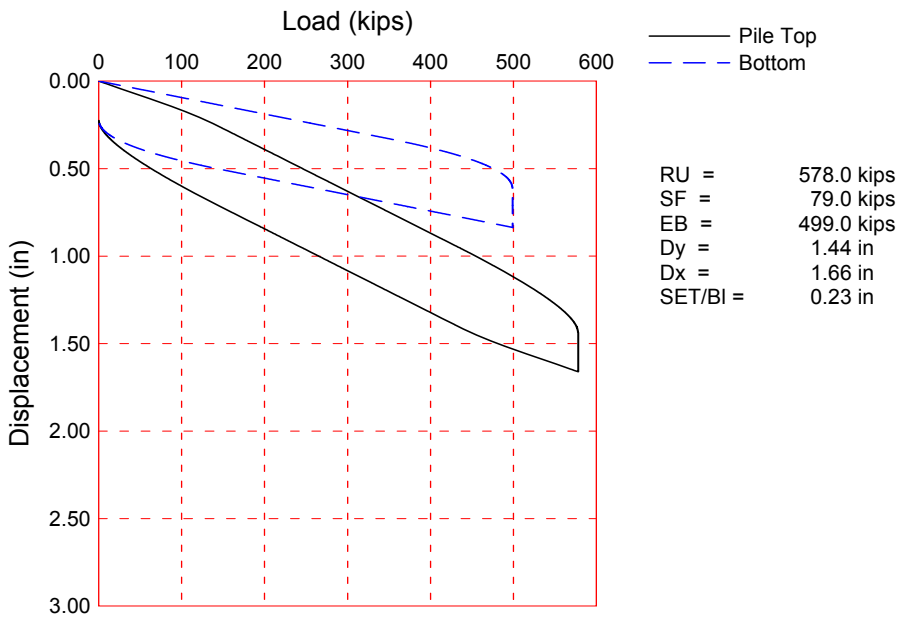
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

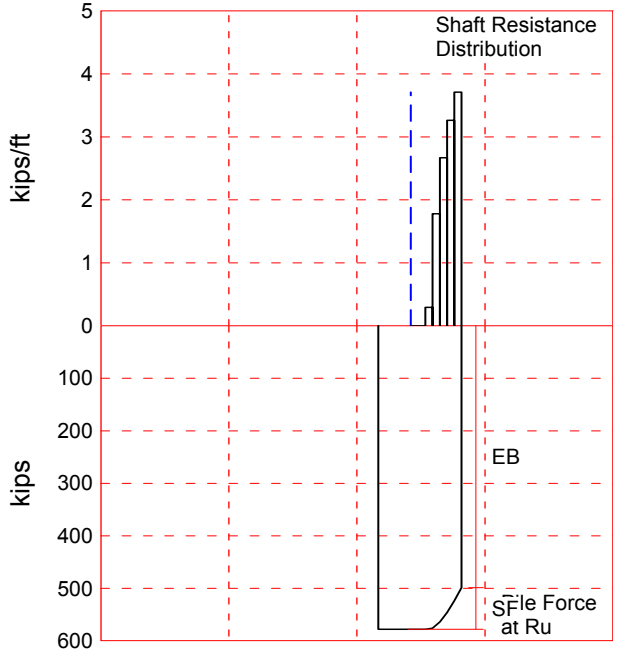
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	578.0 kips
SF =	79.0 kips
EB =	499.0 kips
Dy =	1.44 in
Dx =	1.66 in
SET/Bl =	0.23 in



Length b. Sensors	77.5 ft
Embedment	45.5 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	2.93
Top Compr. Stress	30.6 ksi
Max Compr. Stress	32.7 ksi
Max Tension Stress	-6.63 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.47 in
Avg. Shaft Smith Dpg.	0.21 s/ft
Toe Smith Damping	0.06 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: 578.0; along Shaft 79.0; at Toe 499.0 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
				578.0				
1	37.1	5.1	0.0	578.0	0.0	0.00	0.00	0.00
2	43.8	11.8	0.0	578.0	0.0	0.00	0.00	0.00
3	50.5	18.6	2.0	576.0	2.0	0.30	0.06	0.21
4	57.3	25.3	12.0	564.0	14.0	1.78	0.38	0.21
5	64.0	32.0	18.0	546.0	32.0	2.67	0.57	0.21
6	70.8	38.8	22.0	524.0	54.0	3.26	0.69	0.21
7	77.5	45.5	25.0	499.0	79.0	3.71	0.79	0.21
Avg. Shaft			11.3			1.74	0.37	0.21
Toe			499.0				361.99	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.05	0.47
Case Damping Factor		0.43	0.78
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	34	47
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.04
Soil Plug Weight	(kips)		0.121

CAPWAP match quality = 2.93 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.19 in; Blow Count = 65 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 = 30.6 ksi (T= 36.1 ms, max= 1.066 x Top)
max. Comp. Stress = 32.7 ksi (Z= 57.3 ft, T= 39.5 ms)
max. Tens. Stress = -6.63 ksi (Z= 50.5 ft, T= 62.3 ms)
max. Energy (EMX) = 36.3 kip-ft; max. Measured Top Displ. (DMX)= 1.14 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	656.0	-37.8	30.6	-1.77	36.3	16.3	1.12
2	6.7	656.5	-45.0	30.7	-2.10	36.1	16.2	1.11
4	13.5	658.1	-61.0	30.7	-2.85	35.6	16.2	1.07
5	16.8	659.1	-68.7	30.8	-3.21	35.2	16.1	1.04
6	20.2	660.0	-75.0	30.8	-3.51	34.7	16.1	1.01
7	23.6	661.1	-83.3	30.9	-3.89	34.1	16.1	0.98
8	27.0	662.1	-91.1	30.9	-4.25	33.6	16.0	0.96
9	30.3	663.3	-100.3	31.0	-4.69	33.1	16.0	0.93
10	33.7	664.3	-108.7	31.0	-5.08	32.5	16.0	0.90
11	37.1	665.3	-117.0	31.1	-5.47	31.9	16.0	0.87
12	40.4	666.7	-124.6	31.1	-5.82	31.3	15.9	0.84
13	43.8	669.2	-132.4	31.3	-6.18	30.7	15.9	0.81
14	47.2	672.3	-138.9	31.4	-6.49	30.0	15.8	0.78
15	50.5	682.4	-142.0	31.9	-6.63	29.4	15.6	0.74
16	53.9	685.3	-140.1	32.0	-6.55	28.3	15.2	0.71
17	57.3	699.4	-140.2	32.7	-6.55	27.5	14.9	0.68
18	60.7	664.2	-126.3	31.0	-5.90	24.7	14.5	0.64
19	64.0	679.0	-126.5	31.7	-5.91	23.9	14.2	0.61
20	67.4	617.2	-104.0	28.8	-4.86	20.4	15.1	0.58
21	70.8	595.5	-103.6	27.8	-4.84	19.7	16.9	0.54
22	74.1	580.2	-75.8	27.1	-3.54	15.9	18.1	0.51
23	77.5	596.9	-75.7	27.9	-3.53	13.2	17.8	0.47
Absolute	57.3			32.7			(T =	39.5 ms)
	50.5				-6.63		(T =	62.3 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	586.3	446.3	306.2	166.1	26.0					
RX	724.7	675.4	635.1	619.3	603.5	587.7	572.9	567.3	566.9	566.6
RU	586.3	446.3	306.2	166.1	26.0					

RAU = 501.7 (kips); RA2 = 638.1 (kips)

Current CAPWAP Ru = 578.0 (kips); Corresponding J(RP)= 0.01; J(RX) = 1.13

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
16.3	35.89	624.4	662.4	662.4	1.14	0.23	0.23	36.6	643.8	1160

PILE PROFILE AND PILE MODEL

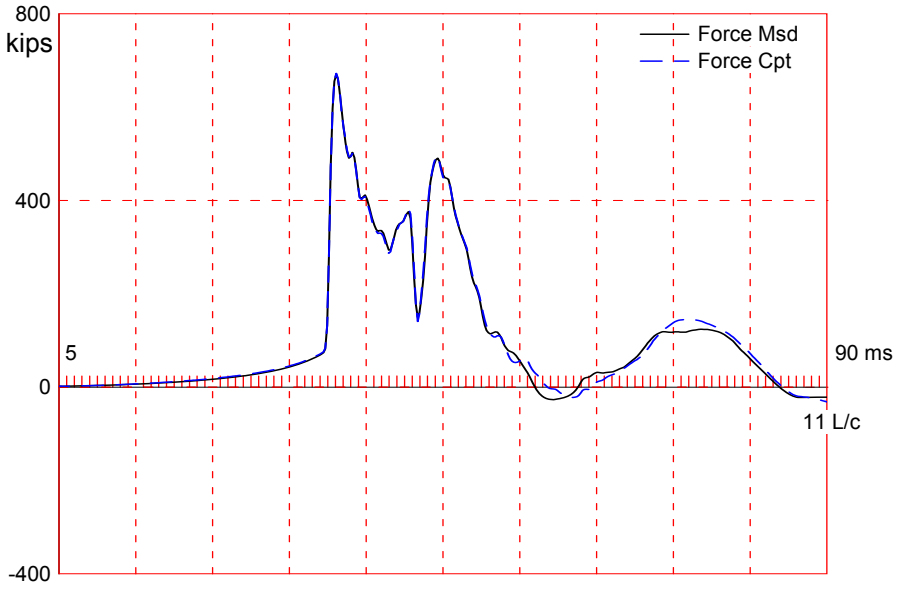
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

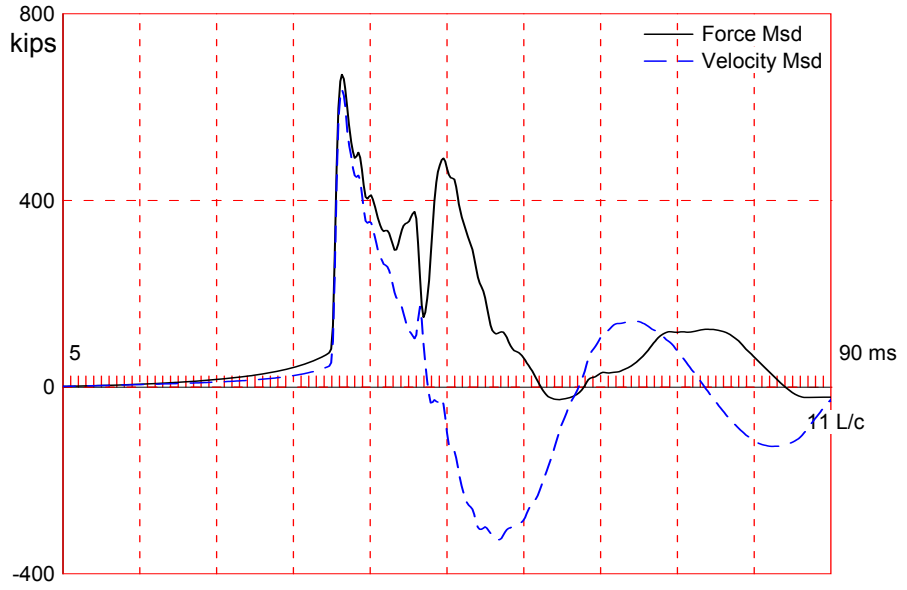
Toe Area 198.5 in²

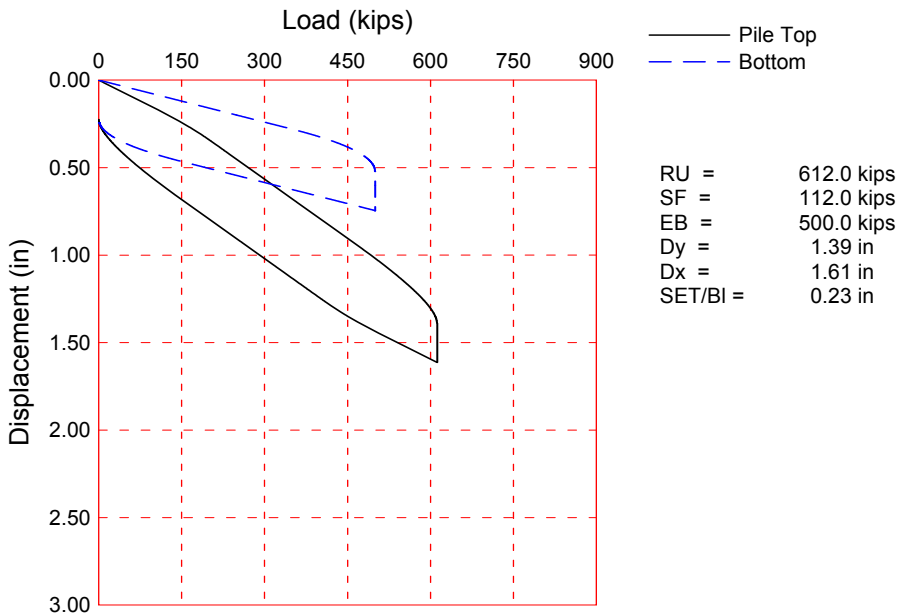
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

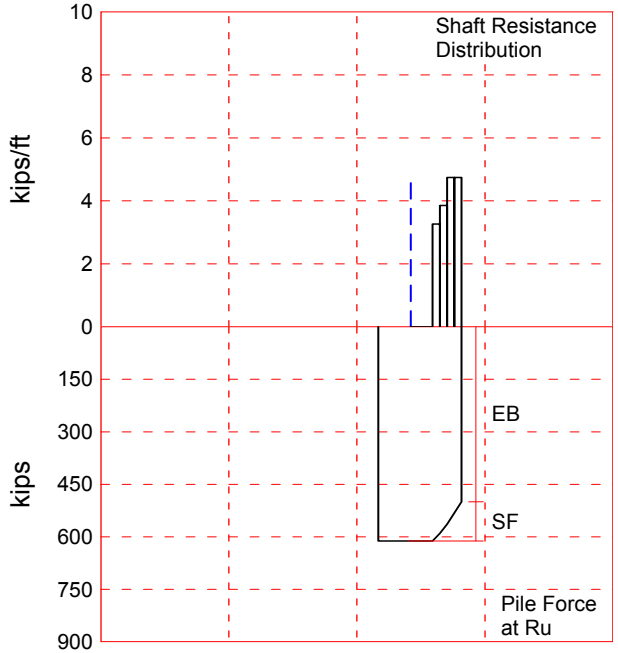
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	612.0 kips
SF =	112.0 kips
EB =	500.0 kips
Dy =	1.39 in
Dx =	1.61 in
SET/Bl =	0.23 in



Length b. Sensors	77.5 ft
Embedment	45.7 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	31.4 ksi
Max Compr. Stress	35.0 ksi
Max Tension Stress	-8.00 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.40 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.05 s/ft

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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.

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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: 612.0; along Shaft 112.0; 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	Quake in
				612.0					
1	37.1	5.2	0.0	612.0	0.0	0.00	0.00	0.00	0.06
2	43.8	12.0	0.0	612.0	0.0	0.00	0.00	0.00	0.06
3	50.5	18.7	0.0	612.0	0.0	0.00	0.00	0.00	0.06
4	57.3	25.4	22.0	590.0	22.0	3.26	0.69	0.25	0.06
5	64.0	32.2	26.0	564.0	48.0	3.86	0.82	0.25	0.06
6	70.8	38.9	32.0	532.0	80.0	4.75	1.01	0.25	0.06
7	77.5	45.7	32.0	500.0	112.0	4.75	1.01	0.25	0.06
Avg. Shaft			16.0			2.45	0.52	0.25	0.06
Toe			500.0				362.72	0.05	0.40

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		0.73	0.65
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	81	44
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.05
Soil Plug Weight	(kips)		0.018

CAPWAP match quality = 2.88 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.19 in; Blow Count = 65 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 = 31.4 ksi (T= 36.1 ms, max= 1.113 x Top)
max. Comp. Stress = 35.0 ksi (Z= 57.3 ft, T= 39.5 ms)
max. Tens. Stress = -8.00 ksi (Z= 57.3 ft, T= 60.9 ms)
max. Energy (EMX) = 37.7 kip-ft; max. Measured Top Displ. (DMX)= 1.11 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	672.9	-40.2	31.4	-1.88	37.7	16.6	1.09
2	6.7	673.5	-46.7	31.5	-2.18	37.5	16.6	1.07
4	13.5	675.0	-66.0	31.5	-3.08	36.7	16.5	1.03
5	16.8	675.8	-75.7	31.6	-3.53	36.2	16.5	1.00
6	20.2	676.6	-86.4	31.6	-4.04	35.6	16.5	0.97
7	23.6	677.5	-98.1	31.7	-4.58	35.0	16.4	0.94
8	27.0	678.5	-110.3	31.7	-5.15	34.3	16.4	0.91
9	30.3	679.6	-121.5	31.7	-5.68	33.7	16.4	0.88
10	33.7	680.8	-132.2	31.8	-6.18	33.0	16.3	0.84
11	37.1	682.0	-141.6	31.9	-6.61	32.4	16.3	0.81
12	40.4	683.4	-149.4	31.9	-6.98	31.7	16.2	0.78
13	43.8	684.8	-156.2	32.0	-7.30	31.0	16.2	0.75
14	47.2	686.8	-162.1	32.1	-7.57	30.3	16.1	0.72
15	50.5	706.1	-167.2	33.0	-7.81	29.5	15.8	0.68
16	53.9	724.3	-170.2	33.8	-7.95	28.7	15.2	0.65
17	57.3	748.9	-171.2	35.0	-8.00	27.8	14.7	0.61
18	60.7	670.1	-143.9	31.3	-6.72	23.4	14.0	0.57
19	64.0	696.2	-143.8	32.5	-6.72	22.5	13.4	0.54
20	67.4	601.4	-111.8	28.1	-5.22	18.0	14.1	0.50
21	70.8	592.6	-112.1	27.7	-5.23	17.2	15.9	0.47
22	74.1	558.3	-73.4	26.1	-3.43	12.6	16.7	0.44
23	77.5	565.0	-73.3	26.4	-3.42	9.5	15.7	0.40
Absolute	57.3			35.0			(T =	39.5 ms)
	57.3				-8.00		(T =	60.9 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	703.9	642.1	580.3	518.5	456.7	394.9	333.1	271.3	209.5	147.7
RX	739.3	716.0	693.2	670.6	648.9	630.7	620.5	611.2	602.5	594.4
RU	703.9	642.1	580.3	518.5	456.7	394.9	333.1	271.3	209.5	147.7

RAU = 546.3 (kips); RA2 = 643.3 (kips)

Current CAPWAP Ru = 612.0 (kips); Corresponding J(RP)= 0.15; J(RX) = 0.69

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
16.9	35.89	647.3	674.8	674.8	1.11	0.23	0.23	38.0	680.6	1423

PILE PROFILE AND PILE MODEL

Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	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 in²

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

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Al Ziai
Company: Lunda Construction Co.	No. of Sheets: 52
E-mail: kweber@lundaconstruction.com	Date: November 25, 2014

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 21
Winnebago County, Wisconsin

On November 18, 2014, Pier 21 #1, Pier 21 #36, and Pier 21 #44 at the above structure were dynamically tested during initial driving. 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 or ultimate capacity of 400 kips (200 tons). The reference grade at the bottom of the footing excavations was reported to be at elevation EL 735.8. The piles have a required minimum tip elevation of EL 692.5. The HP 14 x 73 H-piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0234) operated on fuel setting 4.

Pier 21 #1 was driven to a depth of 47.7 feet which corresponds to a pile tip elevation of EL 688.1. The reported pile set over the final ten blows of driving was 2 inches. The average hammer stroke over this increment was 8.7 feet. Pier 21 #36 was driven to a depth of 45.2 feet which corresponds to a pile tip elevation of EL 690.6. The reported pile set over the final ten blows was 4 inches. The average hammer stroke over this increment was 8.7 feet. Pier 21 #44 was driven to a depth of 47.1 feet which corresponds to a pile tip elevation of EL 688.7. The reported pile set over the final ten blows was 1⅜ inch. The average hammer stroke over this increment was 9.9 feet.

Restrike testing was performed on these three piles on November 19. Pier 21 #1 had a reported pile set of 1 inch for five blows at the beginning of the restrike at an average hammer stroke of 8.8 feet. Pier 21 #36 had a reported pile set of 1⅛ inch for five blows at the beginning of the restrike at an average hammer stroke of 8.8 feet. Pier 21 #44 had a reported pile set of no movement for five blows at the beginning of the restrike at an average hammer stroke of 9.5 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 kip piles driven with an APE D30-42 hammer (PD 0234) in Pier 21 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)
7.0	8	4
7.5	7	4
8.0	6	4
8.5	5	4
9.0	5	3
9.5	5	3
10.0	5	3

We recommend the above blow counts at the required stroke be maintained for **three consecutive inches** of driving. We recommend terminating driving **if the blow counts exceed 10** blows over an increment of one inch or less at hammer strokes of 9.0 feet, after satisfying any minimum tip requirements. We anticipate the production piles will terminate at depths similar to those of the test piles.

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:

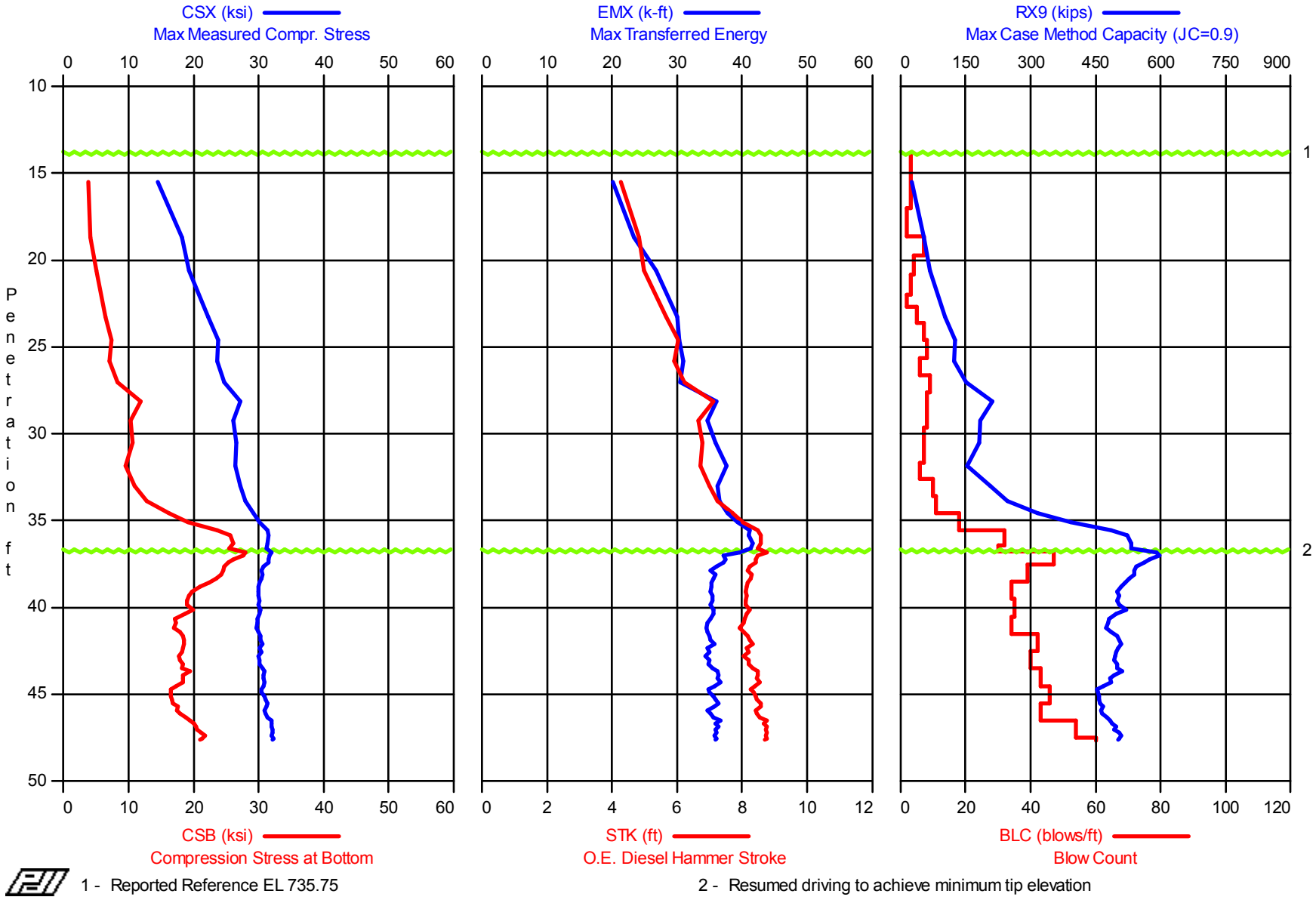
Dynamic Test Results - (pages 3 – 20)
CAPWAP Analysis Results - (pages 21 – 52)

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

PDIPLOT Ver. 2014.1 - Printed: 24-Nov-2014

Test date: 18-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 21 #1
APE D30-42, HP 14 x 73



1 - Reported Reference EL 735.75

2 - Resumed driving to achieve minimum tip elevation

USH 10 over Little Lake Butte des Morts - Pier 21 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-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: 1.20

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
7	11.50	3	AV1	9.4	2.9	9	3.5	61.5	0
			MAX	9.4	2.9	9	3.5	61.5	0
			MIN	9.4	2.9	9	3.5	61.5	0
7	13.50	3	AV1	23.6	4.9	38	6.3	46.7	33
			MAX	23.6	4.9	38	6.3	46.7	33
			MIN	23.6	4.9	38	6.3	46.7	33
9	14.50	3	AV1	13.1	3.5	17	3.6	60.7	0
			MAX	13.1	3.5	17	3.6	60.7	0
			MIN	13.1	3.5	17	3.6	60.7	0
12	15.50	3	AV2	9.7	3.1	15	3.4	62.9	16
			STD	2.4	0.4	5	0.4	3.2	13
			MAX	12.1	3.6	20	3.8	66.1	29
			MIN	7.3	2.7	11	3.0	59.7	3
15	16.50	3	AV3	16.2	4.1	22	4.5	54.7	47
			STD	1.0	0.1	2	0.2	1.1	7
			MAX	17.5	4.2	24	4.8	55.6	56
			MIN	15.1	4.0	20	4.4	53.2	39
17	17.50	2	AV2	14.9	3.8	20	4.3	56.2	35
			STD	0.9	0.2	1	0.1	0.8	1
			MAX	15.8	4.0	21	4.4	57.0	36
			MIN	14.0	3.6	19	4.2	55.4	34
19	18.50	2	AV2	17.1	4.1	27	4.6	54.2	37
			STD	1.6	0.3	4	0.3	1.9	1
			MAX	18.7	4.3	30	5.0	56.1	38
			MIN	15.4	3.8	23	4.3	52.3	36
26	19.50	7	AV7	19.0	4.3	22	4.9	52.7	63
			STD	1.4	0.2	4	0.4	1.8	11
			MAX	20.9	4.7	27	5.4	55.2	75
			MIN	16.9	3.9	17	4.5	50.5	42
30	20.50	4	AV4	17.4	4.8	22	4.6	54.6	68
			STD	3.0	0.5	7	0.6	3.4	6
			MAX	21.7	5.3	32	5.5	58.5	78
			MIN	14.1	4.2	15	3.9	49.9	64
33	21.50	3	AV3	21.7	5.4	33	5.5	49.9	63
			STD	0.6	0.2	3	0.2	0.7	8
			MAX	22.4	5.7	37	5.7	50.7	70
			MIN	20.9	5.3	30	5.3	49.1	52
35	22.50	2	AV2	22.1	5.7	38	5.6	49.6	65
			STD	0.5	0.1	1	0.1	0.6	4
			MAX	22.7	5.8	39	5.7	50.2	69
			MIN	21.6	5.6	36	5.4	49.0	61
40	23.50	5	AV5	22.2	6.3	30	5.7	49.3	103
			STD	0.6	0.3	1	0.2	0.7	3
			MAX	22.9	6.8	32	5.9	50.3	105
			MIN	21.4	6.1	28	5.4	48.4	97
47	24.50	7	AV7	23.3	7.2	29	5.9	48.2	122
			STD	1.1	0.4	3	0.3	1.2	7
			MAX	24.8	7.9	33	6.4	49.9	130
			MIN	21.8	6.6	25	5.5	46.6	111

USH 10 over Little Lake Butte des Morts - Pier 21 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
55	25.50	8	AV8	23.7	7.1	30	6.0	48.1	126
			STD	0.5	0.2	1	0.1	0.6	3
			MAX	24.3	7.4	31	6.1	49.3	130
			MIN	22.5	6.9	27	5.7	47.4	122
61	26.50	6	AV6	23.4	7.0	31	5.9	48.5	123
			STD	0.5	0.2	1	0.1	0.6	3
			MAX	24.2	7.3	32	6.0	49.4	127
			MIN	22.6	6.7	30	5.6	47.8	119
70	27.50	9	AV9	24.7	8.3	30	6.2	47.1	152
			STD	0.7	1.3	1	0.2	0.7	27
			MAX	25.7	10.9	32	6.5	48.6	205
			MIN	23.3	7.0	27	5.8	46.1	129
78	28.50	8	AV8	27.1	12.0	36	7.1	44.3	213
			STD	0.6	0.4	2	0.2	0.6	7
			MAX	28.4	12.5	39	7.6	45.0	221
			MIN	26.3	11.3	33	6.9	42.9	202
86	29.50	8	AV8	26.2	10.1	34	6.7	45.6	184
			STD	0.7	0.5	1	0.2	0.7	13
			MAX	27.8	10.9	37	7.2	46.4	201
			MIN	25.6	9.3	34	6.4	43.9	163
93	30.50	7	AV7	26.8	11.1	36	6.9	45.0	193
			STD	0.4	0.2	1	0.1	0.3	3
			MAX	27.6	11.4	38	7.0	45.4	199
			MIN	26.4	11.0	34	6.7	44.4	188
100	31.50	7	AV7	26.3	9.5	36	6.7	45.6	157
			STD	0.5	0.5	1	0.2	0.5	13
			MAX	27.2	10.3	38	7.0	46.5	178
			MIN	25.4	8.8	35	6.4	44.6	136
106	32.50	6	AV6	26.6	9.8	38	6.8	45.3	157
			STD	0.5	0.3	1	0.1	0.5	11
			MAX	27.2	10.4	39	6.9	45.9	176
			MIN	25.8	9.4	36	6.6	44.7	145
116	33.50	10	AV10	27.2	11.1	36	7.0	44.5	210
			STD	0.4	1.0	1	0.1	0.4	24
			MAX	28.1	12.4	38	7.3	45.1	245
			MIN	26.6	9.8	34	6.8	43.6	173
127	34.50	11	AV11	28.2	13.6	37	7.4	43.5	258
			STD	0.5	1.1	1	0.2	0.5	21
			MAX	29.3	15.8	38	7.8	44.1	297
			MIN	27.6	12.3	36	7.1	42.4	218
145	35.50	18	AV18	30.0	18.8	39	8.0	41.8	382
			STD	0.7	2.0	1	0.2	0.6	46
			MAX	31.4	23.0	42	8.5	42.8	473
			MIN	28.8	15.6	37	7.6	40.5	292
174	36.42	32	AV24	31.4	25.5	41	8.6	40.4	522
			STD	0.4	0.9	1	0.1	0.3	12
			MAX	32.1	26.6	44	9.0	40.8	540
			MIN	30.8	23.5	40	8.4	39.4	491
184	36.75	30	AV10	31.3	25.6	41	8.5	40.6	532
			STD	0.2	0.6	1	0.1	0.2	8
			MAX	31.4	26.6	43	8.6	41.1	542
			MIN	30.6	24.5	39	8.3	40.4	519
219	37.50	47	AV35	31.7	26.8	38	8.5	40.5	582
			STD	0.6	1.5	1	0.2	0.6	24
			MAX	33.9	30.2	42	9.5	41.5	635
			MIN	30.6	24.2	35	8.1	38.5	543

USH 10 over Little Lake Butte des Morts - Pier 21 #1
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
258	38.50	39	AV39	30.5	24.1	36	8.2	41.2	536
			STD	0.4	0.8	1	0.1	0.3	10
			MAX	31.5	25.5	38	8.5	41.7	553
			MIN	29.9	22.5	34	8.0	40.5	517
292	39.50	34	AV34	30.0	20.4	35	8.1	41.4	507
			STD	0.5	1.1	1	0.2	0.4	9
			MAX	31.0	22.7	37	8.5	42.3	524
			MIN	28.9	18.7	33	7.8	40.5	491
327	40.50	35	AV35	30.1	19.1	35	8.1	41.4	506
			STD	0.4	0.9	1	0.2	0.4	15
			MAX	31.6	20.8	38	8.7	42.1	532
			MIN	29.3	17.1	33	7.9	40.2	478
361	41.50	34	AV34	29.8	17.3	35	8.0	41.7	479
			STD	0.4	0.4	1	0.2	0.4	7
			MAX	30.9	18.4	37	8.4	42.5	494
			MIN	28.9	16.7	33	7.7	40.8	464
403	42.50	42	AV40	30.3	18.4	35	8.2	41.3	503
			STD	0.4	0.3	1	0.2	0.4	6
			MAX	31.0	19.1	37	8.5	42.0	518
			MIN	29.5	17.9	33	7.9	40.5	486
443	43.50	40	AV40	30.2	18.1	35	8.2	41.3	497
			STD	0.3	0.4	1	0.1	0.3	6
			MAX	30.9	19.3	37	8.4	42.0	507
			MIN	29.5	17.4	33	7.9	40.7	486
486	44.50	43	AV43	30.8	18.5	36	8.5	40.6	491
			STD	0.4	0.7	1	0.1	0.3	13
			MAX	31.6	20.3	39	8.8	41.3	523
			MIN	30.1	17.1	34	8.2	39.9	465
532	45.50	46	AV46	30.8	16.6	35	8.4	40.8	458
			STD	0.5	0.3	1	0.2	0.4	5
			MAX	31.9	17.7	38	8.8	41.7	468
			MIN	29.9	15.9	33	8.0	39.8	447
575	46.50	43	AV43	31.2	17.9	35	8.5	40.5	468
			STD	0.5	0.7	1	0.2	0.4	7
			MAX	32.2	19.3	37	8.8	41.5	481
			MIN	29.9	16.6	32	8.1	39.9	454
629	47.50	54	AV54	32.1	20.7	36	8.7	40.0	497
			STD	0.5	0.8	1	0.2	0.4	10
			MAX	33.2	22.6	38	9.1	40.7	517
			MIN	31.2	19.3	34	8.4	39.2	472
639	47.67	60	AV10	32.2	21.1	36	8.7	40.0	504
			STD	0.4	0.4	1	0.2	0.3	6
			MAX	32.8	21.8	38	9.0	40.4	511
			MIN	31.6	20.4	35	8.6	39.4	492
			Average	29.4	17.9	35	7.9	42.3	430
			Std. Dev.	3.4	5.6	4	1.0	3.4	147
			Maximum	33.9	30.2	44	9.5	66.1	635
			Minimum	7.3	2.7	9	3.0	38.5	0

Total number of blows analyzed: 625

BL#	depth (ft)	Comments
7	13.83	Reported Reference EL 735.75
184	36.75	Resumed driving to achieve minimum tip elevation

Time Summary

Drive	8 minutes 17 seconds	2:50:30 PM - 2:58:47 PM (11/18/2014) BN 1 - 186
Stop	1 hour 48 minutes 35 seconds	2:58:47 PM - 4:47:22 PM
Drive	11 minutes 4 seconds	4:47:22 PM - 4:58:26 PM BN 187 - 640

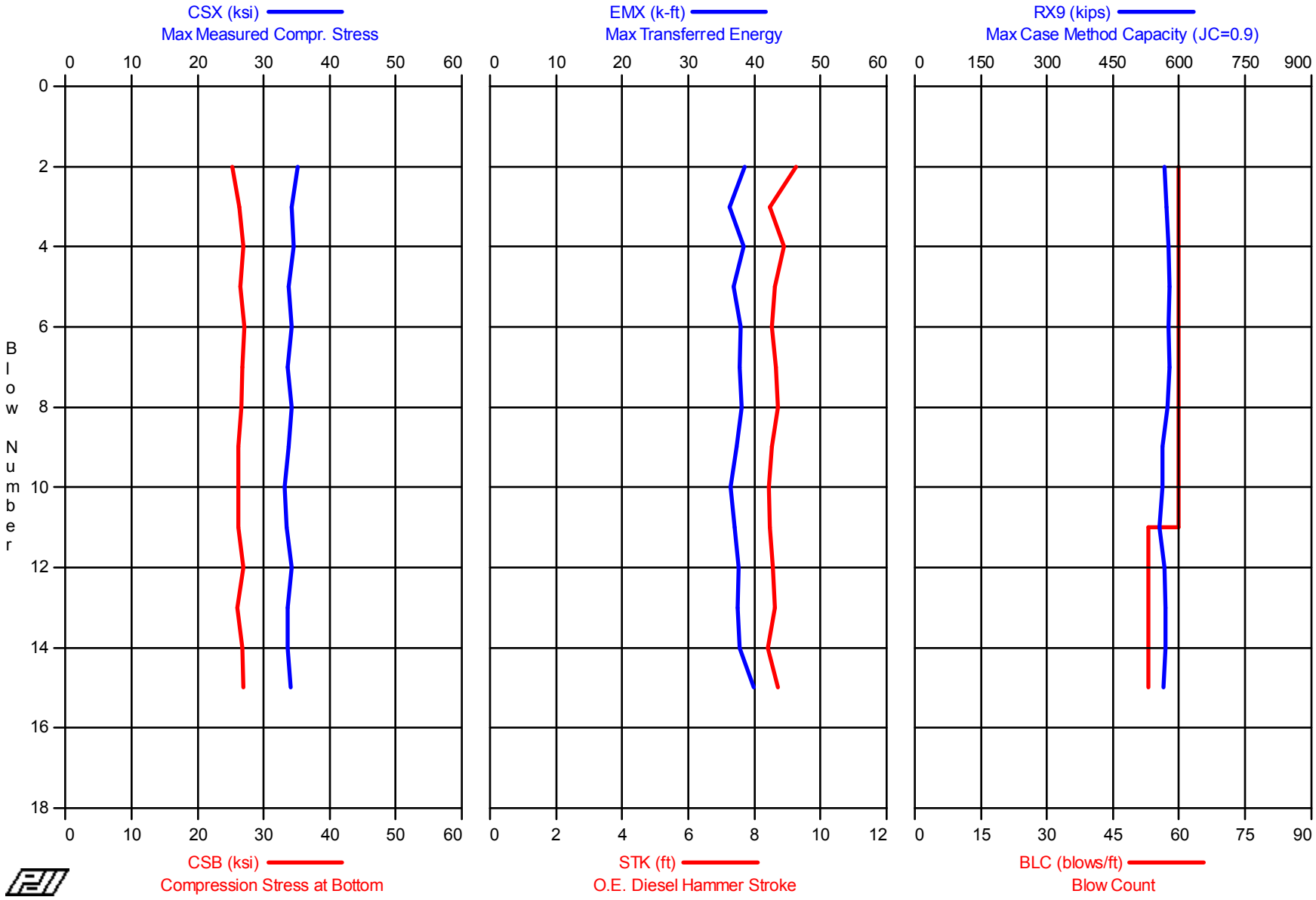
Total time [2:07:56] = (Driving [0:19:21] + Stop [1:48:35])

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

PDIPLOT Ver. 2014.1 - Printed: 24-Nov-2014

Test date: 19-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 21 #1 Restrike
APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - Pier 21 #1 Restrike
OP: MR

APE D30-42, HP 14 x 73
Test date: 19-Nov-2014

AR: 21.40 in^2
LE: 51.00 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.20

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	47.73	60	AV4	34.4	26.2	38	8.8	39.9	573
			STD	0.5	0.6	1	0.3	0.6	4
			MAX	35.2	27.0	39	9.3	40.6	578
			MIN	33.8	25.2	36	8.5	38.9	568
10	47.82	60	AV5	33.8	26.5	37	8.6	40.4	571
			STD	0.4	0.3	1	0.1	0.2	7
			MAX	34.2	27.0	38	8.7	40.7	579
			MIN	33.2	26.2	36	8.4	40.1	563
15	47.91	53	AV5	33.8	26.5	38	8.6	40.4	566
			STD	0.3	0.4	1	0.1	0.2	5
			MAX	34.2	26.9	40	8.7	40.8	570
			MIN	33.5	26.0	37	8.4	40.1	557
			Average	34.0	26.4	38	8.6	40.3	570
			Std. Dev.	0.5	0.5	1	0.2	0.5	6
			Maximum	35.2	27.0	40	9.3	40.8	579
			Minimum	33.2	25.2	36	8.4	38.9	557

Total number of blows analyzed: 14

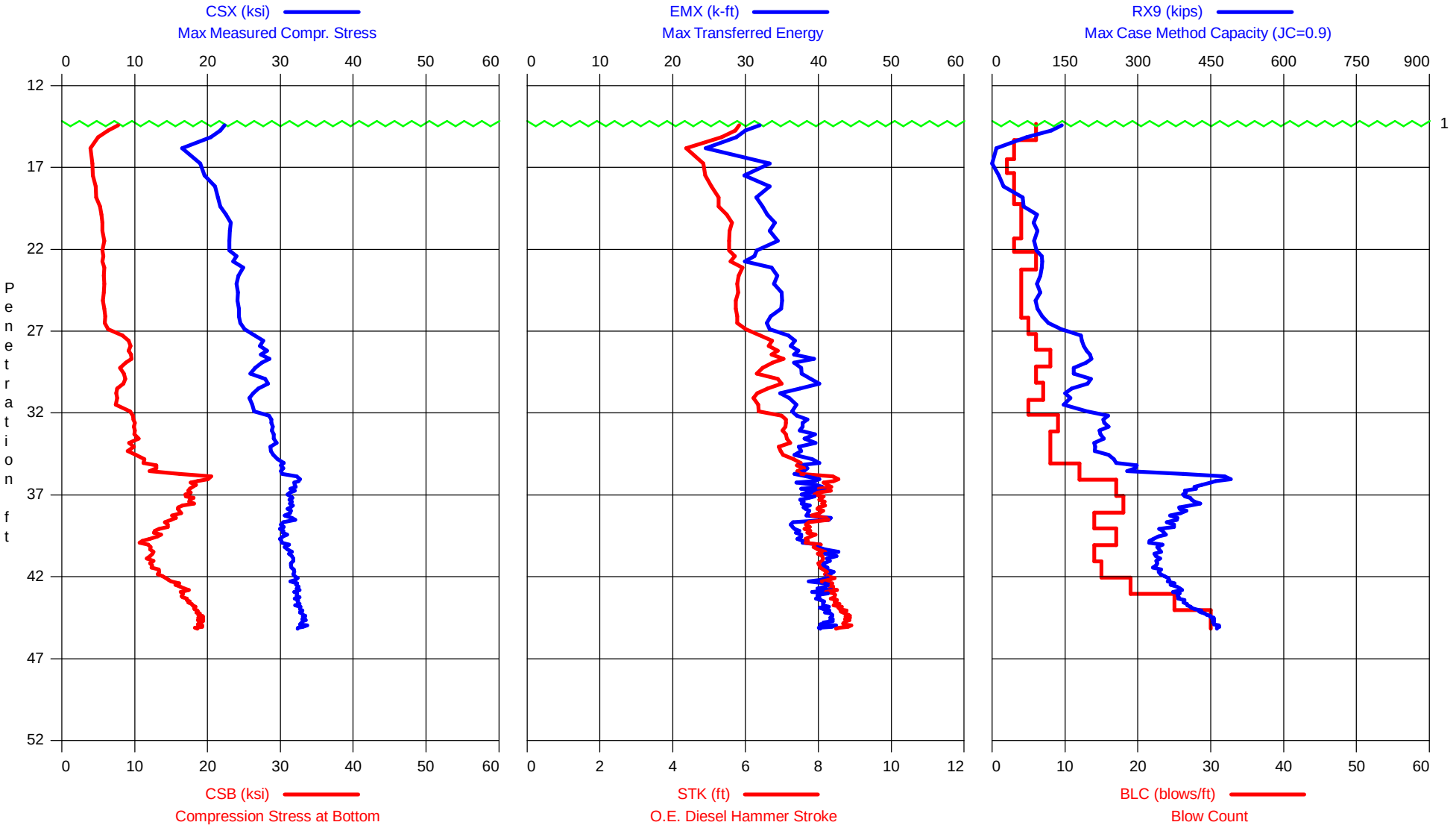
Time Summary

Drive 21 seconds 9:19:58 AM - 9:20:19 AM (11/19/2014) BN 1 - 15

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 18-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 21 #36
APE D30-42, HP 14 x 73



1 - Reference Elevation EL 735.75

USH 10 over Little Lake Butte des Morts - Pier 21 #36 APE D30-42, HP 14 x 73
OP: MR Test date: 18-Nov-2014

AR: 21.40 in^2 SP: 0.492 k/ft3
LE: 51.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.20

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
7	12.00	6	AV1	21.5	7.8	31	5.5	50.0	145
			MAX	21.5	7.8	31	5.5	50.0	145
			MIN	21.5	7.8	31	5.5	50.0	145
7	13.00	6	AV1	23.2	7.6	33	6.1	47.4	142
			MAX	23.2	7.6	33	6.1	47.4	142
			MIN	23.2	7.6	33	6.1	47.4	142
7	14.00	6	AV1	22.9	6.7	32	6.1	47.7	128
			MAX	22.9	6.7	32	6.1	47.7	128
			MIN	22.9	6.7	32	6.1	47.7	128
11	15.00	6	AV2	20.2	5.6	27	5.3	51.0	104
			STD	0.4	0.4	1	0.1	0.4	13
			MAX	20.6	6.0	28	5.4	51.4	116
			MIN	19.8	5.3	26	5.2	50.5	91
14	16.00	3	AV3	18.0	4.2	27	4.7	53.8	23
			STD	2.5	0.4	3	0.6	2.9	21
			MAX	21.0	4.7	31	5.5	57.1	50
			MIN	14.8	3.6	23	4.1	50.0	0
16	17.00	2	AV2	19.0	4.2	33	4.8	53.1	0
			STD	0.4	0.0	1	0.2	1.0	0
			MAX	19.5	4.2	34	5.0	54.1	0
			MIN	18.6	4.1	33	4.6	52.1	0
19	18.00	3	AV3	19.9	4.3	31	4.9	52.7	21
			STD	0.6	0.1	1	0.2	0.9	10
			MAX	20.4	4.5	32	5.1	53.9	35
			MIN	19.0	4.2	29	4.7	51.8	10
22	19.00	3	AV3	21.5	4.8	32	5.2	51.2	46
			STD	0.7	0.1	2	0.1	0.6	26
			MAX	22.2	4.8	34	5.4	51.8	73
			MIN	20.6	4.6	29	5.1	50.3	11
26	20.00	4	AV4	22.1	5.4	33	5.4	50.5	79
			STD	0.9	0.1	1	0.2	0.9	14
			MAX	22.9	5.5	34	5.5	52.0	96
			MIN	20.7	5.2	31	5.1	49.8	61
30	21.00	4	AV4	23.1	5.6	34	5.6	49.6	89
			STD	0.2	0.1	1	0.1	0.3	6
			MAX	23.4	5.8	34	5.7	50.1	93
			MIN	22.8	5.4	33	5.5	49.3	79
33	22.00	3	AV3	23.1	5.8	34	5.5	49.8	85
			STD	0.5	0.0	0	0.1	0.4	2
			MAX	23.6	5.9	35	5.7	50.2	88
			MIN	22.4	5.8	34	5.4	49.3	84
39	23.00	6	AV6	23.8	5.6	31	5.7	49.2	102
			STD	0.8	0.2	1	0.2	0.6	4
			MAX	24.9	5.8	32	6.0	49.7	107
			MIN	22.6	5.3	29	5.6	48.1	97
43	24.00	4	AV4	24.4	5.9	35	5.8	48.6	97
			STD	0.6	0.2	1	0.1	0.6	4
			MAX	25.0	6.2	36	6.0	49.5	104
			MIN	23.5	5.7	33	5.6	47.9	93
47	25.00	4	AV4	23.9	5.7	34	5.7	49.0	94
			STD	0.3	0.1	1	0.1	0.4	6
			MAX	24.5	5.8	35	5.9	49.4	103
			MIN	23.6	5.5	33	5.6	48.4	87
51	26.00	4	AV4	24.4	5.8	35	5.8	48.8	92
			STD	0.1	0.2	0	0.0	0.2	3
			MAX	24.4	6.0	35	5.8	49.1	96
			MIN	24.2	5.5	34	5.7	48.6	89

USH 10 over Little Lake Butte des Morts - Pier 21 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
56	27.00	5	AV5	24.7	6.1	33	5.9	48.5	126
			STD	0.4	0.2	1	0.1	0.5	16
			MAX	25.5	6.5	34	6.1	49.0	156
			MIN	24.2	5.8	32	5.7	47.6	106
62	28.00	6	AV6	27.1	9.0	36	6.6	45.9	185
			STD	0.7	0.6	1	0.2	0.7	4
			MAX	27.9	9.6	37	6.8	47.3	189
			MIN	25.9	7.8	35	6.2	45.1	178
70	29.00	8	AV8	27.9	9.3	37	6.8	45.0	198
			STD	0.6	0.5	1	0.2	0.5	6
			MAX	28.7	10.0	39	7.1	45.9	207
			MIN	26.8	8.4	35	6.6	44.3	187
76	30.00	6	AV6	26.8	8.4	38	6.6	46.0	180
			STD	0.8	0.4	1	0.2	0.8	18
			MAX	28.0	8.8	39	6.9	46.9	207
			MIN	25.8	7.8	36	6.3	44.7	155
83	31.00	7	AV7	27.0	7.8	37	6.6	45.9	168
			STD	1.0	0.5	2	0.3	1.1	20
			MAX	28.5	8.8	41	7.0	47.5	204
			MIN	25.6	7.4	34	6.1	44.4	148
88	32.00	5	AV5	26.2	8.2	37	6.3	46.7	170
			STD	0.6	1.7	2	0.1	0.5	32
			MAX	27.0	11.7	39	6.5	47.4	233
			MIN	25.3	7.1	34	6.1	46.0	147
97	33.00	9	AV9	28.7	9.9	38	7.1	44.3	234
			STD	0.3	0.4	1	0.1	0.3	7
			MAX	29.2	10.5	39	7.2	44.7	247
			MIN	28.3	9.2	37	6.9	43.8	222
105	34.00	8	AV8	29.1	10.0	39	7.1	44.2	219
			STD	0.3	0.5	1	0.1	0.3	11
			MAX	29.5	10.8	40	7.2	44.6	242
			MIN	28.8	9.0	37	7.0	43.8	204
113	35.00	8	AV8	29.2	10.2	38	7.1	44.1	230
			STD	0.8	0.9	2	0.3	0.8	18
			MAX	30.8	11.8	43	7.6	45.2	250
			MIN	28.4	8.7	35	6.8	42.8	201
125	36.00	12	AV12	30.7	15.1	38	7.7	42.6	355
			STD	1.0	3.8	2	0.5	1.1	93
			MAX	33.1	21.9	41	8.8	44.1	492
			MIN	29.3	11.5	34	7.1	39.9	276
142	37.00	17	AV17	31.8	17.9	39	8.2	41.3	425
			STD	0.6	0.9	2	0.2	0.6	29
			MAX	33.0	19.8	41	8.7	42.5	491
			MIN	30.5	16.3	37	7.7	40.2	384
160	38.00	18	AV18	31.4	17.0	38	8.1	41.5	404
			STD	0.3	0.9	1	0.1	0.3	15
			MAX	31.8	18.5	40	8.3	42.4	432
			MIN	30.5	15.2	37	7.8	41.1	378
174	39.00	14	AV14	30.9	15.1	38	7.9	42.0	375
			STD	0.8	0.8	2	0.3	0.7	13
			MAX	32.7	16.9	43	8.5	43.0	398
			MIN	30.0	14.1	35	7.5	40.6	359
191	40.00	17	AV17	30.3	12.3	38	7.7	42.4	341
			STD	0.5	1.0	1	0.2	0.4	14
			MAX	31.3	13.8	40	8.1	43.1	366
			MIN	29.5	10.6	36	7.5	41.5	316
205	41.00	14	AV14	31.3	12.2	41	8.0	41.7	342
			STD	0.5	0.4	1	0.1	0.3	9
			MAX	32.2	12.9	44	8.3	42.2	359
			MIN	30.4	11.6	40	7.8	41.0	328

USH 10 over Little Lake Butte des Morts - Pier 21 #36
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
220	42.00	15	AV15	31.7	12.9	41	8.1	41.5	343
			STD	0.4	0.6	1	0.2	0.4	8
			MAX	32.3	14.0	43	8.4	42.2	357
			MIN	30.8	12.1	39	7.8	40.9	326
239	43.00	19	AV19	32.2	15.9	41	8.3	40.9	374
			STD	0.5	1.0	1	0.2	0.4	11
			MAX	33.1	17.7	43	8.7	41.7	392
			MIN	31.2	13.9	38	8.0	40.2	357
264	44.00	25	AV25	32.4	17.4	40	8.5	40.6	396
			STD	0.4	0.7	1	0.1	0.3	12
			MAX	33.4	19.1	42	8.8	41.1	419
			MIN	31.8	16.3	39	8.3	39.9	376
294	45.00	30	AV30	33.1	18.9	41	8.8	40.0	448
			STD	0.5	0.5	1	0.2	0.4	12
			MAX	34.4	19.9	44	9.1	40.8	469
			MIN	32.0	18.2	39	8.4	39.2	422
299	45.17	30	AV5	32.7	18.7	41	8.7	40.2	465
			STD	0.4	0.5	1	0.2	0.3	6
			MAX	33.1	19.3	42	8.9	40.6	471
			MIN	32.1	18.2	39	8.5	39.7	455
			Average	29.5	12.9	38	7.5	43.5	301
			Std. Dev.	3.7	4.8	3	1.1	3.5	130
			Maximum	34.4	21.9	44	9.1	57.1	492
			Minimum	14.8	3.6	23	4.1	39.2	0

Total number of blows analyzed: 293

BL#	depth (ft)	Comments
7	14.33	Reference Elevation EL 735.75

Time Summary

Drive 6 minutes 54 seconds 3:42:32 PM - 3:49:26 PM (11/18/2014) BN 1 - 299

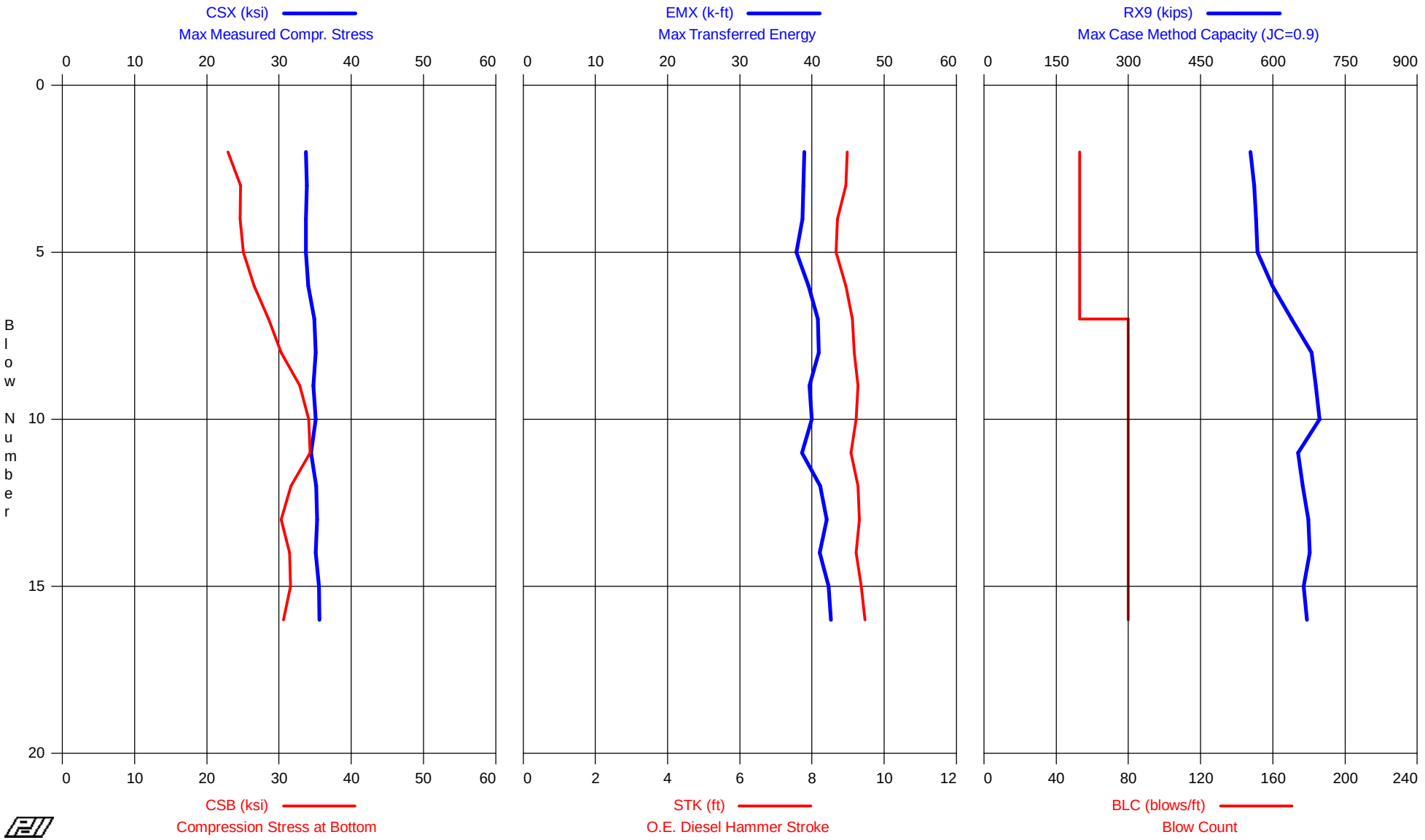
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 19-Nov-2014

USH 10 over LLBDM - Pier 21 #36 Restrike

APE D30-42, HP 14 x 73



USH 10 over LLBDM - Pier 21 #36 Restrike APE D30-42, HP 14 x 73
OP: MR Test date: 19-Nov-2014

AR: 21.40 in^2 SP: 0.492 k/ft3
LE: 51.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.20

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	45.25	53	AV5	33.8	24.8	8.8	39	40	570
			STD	0.1	1.1	0.1	1	0	15
			MAX	34.1	26.5	9.0	40	40	599
			MIN	33.7	22.9	8.7	38	40	554
11	45.32	80	AV5	34.9	32.0	9.2	40	39	671
			STD	0.2	2.3	0.1	1	0	22
			MAX	35.1	34.3	9.3	41	39	697
			MIN	34.4	28.5	9.1	39	39	638
16	45.38	80	AV5	35.3	31.1	9.3	42	39	669
			STD	0.2	0.5	0.1	1	0	6
			MAX	35.6	31.7	9.5	43	39	676
			MIN	35.0	30.3	9.2	41	39	662
			Average	34.7	29.3	9.1	40	39	637
			Std. Dev.	0.7	3.6	0.2	1	0	50
			Maximum	35.6	34.3	9.5	43	40	697
			Minimum	33.7	22.9	8.7	38	39	554

Total number of blows analyzed: 15

Time Summary

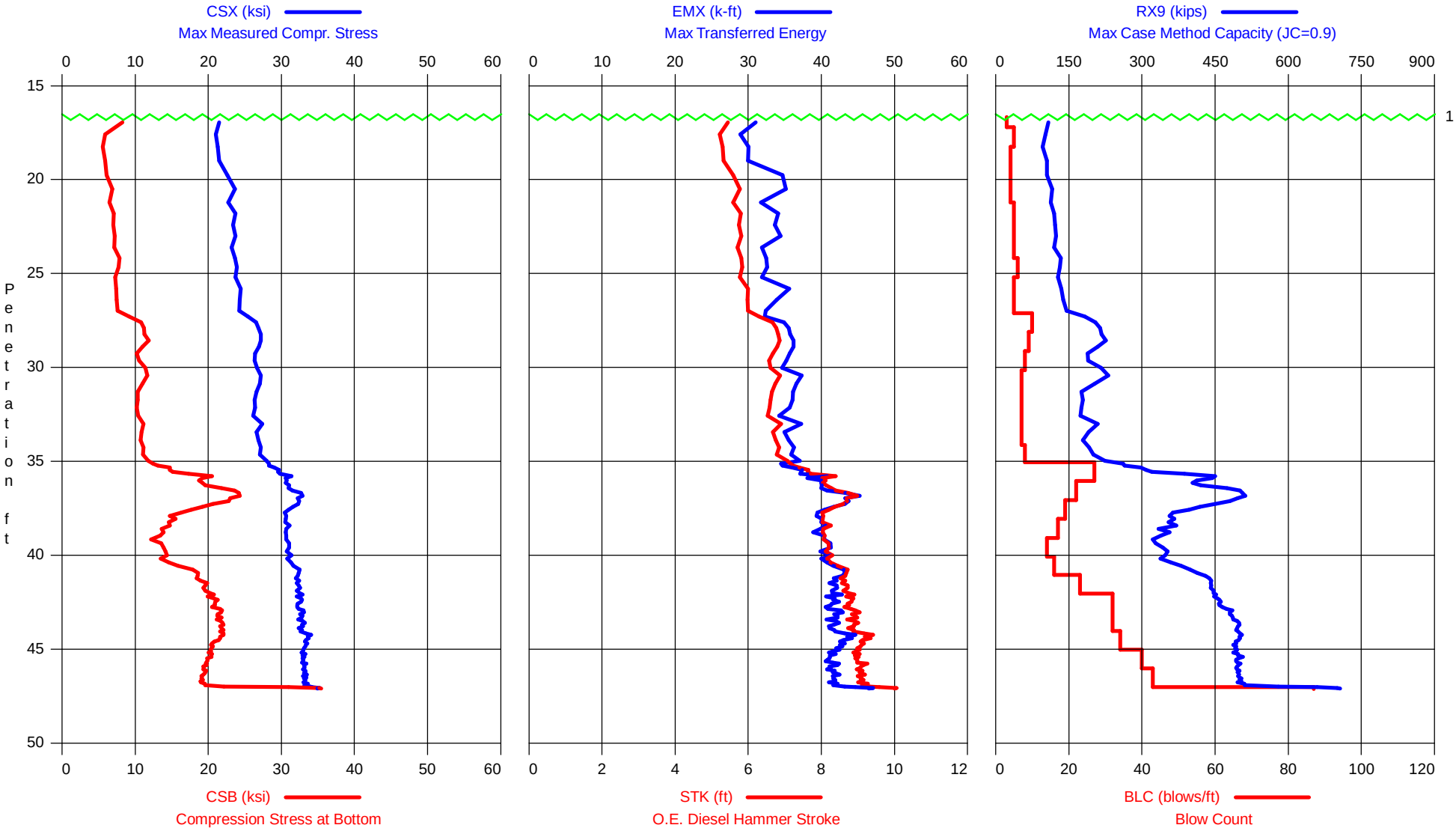
Drive 22 seconds 9:32:55 AM - 9:33:17 AM (11/19/2014) BN 2 - 16

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

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 18-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 21 #44
APE D30-42, HP 14 x 73



1 - Reference Elevation EL 735.75

USH 10 over Little Lake Butte des Morts - Pier 21 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-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: 1.20

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
13	12.00	3	AV1	18.2	7.9	22	4.4	55.3	106
			MAX	18.2	7.9	22	4.4	55.3	106
			MIN	18.2	7.9	22	4.4	55.3	106
13	13.00	3	AV1	21.9	8.2	34	5.6	49.7	99
			MAX	21.9	8.2	34	5.6	49.7	99
			MIN	21.9	8.2	34	5.6	49.7	99
13	14.00	3	AV1	24.5	8.7	37	6.3	46.7	118
			MAX	24.5	8.7	37	6.3	46.7	118
			MIN	24.5	8.7	37	6.3	46.7	118
13	15.00	3	AV1	21.8	6.5	31	5.4	50.4	107
			MAX	21.8	6.5	31	5.4	50.4	107
			MIN	21.8	6.5	31	5.4	50.4	107
13	16.00	3	AV1	20.5	5.7	28	5.1	51.8	103
			MAX	20.5	5.7	28	5.1	51.8	103
			MIN	20.5	5.7	28	5.1	51.8	103
14	17.00	3	AV1	20.7	5.4	28	5.2	51.4	97
			MAX	20.7	5.4	28	5.2	51.4	97
			MIN	20.7	5.4	28	5.2	51.4	97
19	18.00	5	AV1	21.4	5.4	28	5.4	50.5	101
			MAX	21.4	5.4	28	5.4	50.5	101
			MIN	21.4	5.4	28	5.4	50.5	101
23	19.00	4	AV4	21.2	5.7	30	5.3	51.0	99
			STD	0.6	0.3	1	0.2	0.8	7
			MAX	22.0	6.1	32	5.5	52.2	108
			MIN	20.4	5.2	29	5.0	49.9	89
27	20.00	4	AV4	22.4	6.2	34	5.5	49.8	106
			STD	0.4	0.2	2	0.1	0.4	6
			MAX	23.0	6.3	36	5.7	50.4	110
			MIN	22.0	5.9	31	5.4	49.3	96
31	21.00	4	AV4	23.6	6.9	35	5.8	48.9	115
			STD	0.5	0.3	2	0.1	0.5	2
			MAX	24.1	7.3	37	5.9	49.7	117
			MIN	22.8	6.6	33	5.6	48.4	112
36	22.00	5	AV5	23.2	6.8	33	5.7	49.2	117
			STD	0.8	0.4	2	0.2	0.7	4
			MAX	24.0	7.4	35	5.9	50.5	122
			MIN	21.6	6.3	31	5.4	48.3	112
41	23.00	5	AV5	23.5	7.0	34	5.8	48.8	123
			STD	0.7	0.2	2	0.2	0.7	6
			MAX	24.4	7.2	37	6.0	49.5	129
			MIN	22.7	6.7	30	5.6	48.0	112
46	24.00	5	AV5	23.2	7.2	32	5.7	49.2	122
			STD	0.8	0.3	2	0.2	0.8	4
			MAX	24.5	7.7	35	6.0	50.1	130
			MIN	22.2	6.7	29	5.5	47.8	119
52	25.00	6	AV6	24.0	7.8	33	5.9	48.5	132
			STD	0.3	0.5	1	0.1	0.4	2
			MAX	24.5	8.5	34	6.0	49.2	136
			MIN	23.5	7.3	32	5.7	48.0	129
57	26.00	5	AV5	24.1	7.3	34	5.9	48.4	132
			STD	0.6	0.2	2	0.2	0.6	6
			MAX	24.9	7.6	36	6.1	49.4	136
			MIN	23.1	7.0	30	5.6	47.6	120

USH 10 over Little Lake Butte des Morts - Pier 21 #44
OP: MR

APE D30-42, HP 14 x 73
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
62	27.00	5	AV5	24.2	7.5	33	6.0	48.1	139
			STD	0.3	0.1	1	0.1	0.5	2
			MAX	24.5	7.7	34	6.1	48.9	141
			MIN	23.7	7.4	31	5.8	47.5	135
72	28.00	10	AV10	26.1	10.1	34	6.5	46.1	196
			STD	0.8	1.3	2	0.3	0.9	20
			MAX	27.2	11.4	38	6.9	47.5	221
			MIN	24.5	7.6	31	6.1	44.9	160
81	29.00	9	AV9	27.1	11.4	36	6.8	45.1	217
			STD	0.4	0.4	1	0.1	0.4	8
			MAX	27.9	12.3	38	7.0	45.7	232
			MIN	26.7	10.8	34	6.6	44.5	205
89	30.00	8	AV8	26.4	10.6	35	6.6	45.7	194
			STD	0.7	0.4	1	0.2	0.6	9
			MAX	27.5	11.3	37	6.9	46.5	213
			MIN	25.6	10.1	33	6.4	45.0	183
96	31.00	7	AV7	27.0	11.4	37	6.8	45.3	219
			STD	0.9	0.4	2	0.3	0.9	16
			MAX	28.6	11.8	39	7.2	46.4	237
			MIN	26.0	10.8	33	6.4	43.8	195
103	32.00	7	AV7	26.6	10.4	36	6.7	45.6	178
			STD	0.5	0.2	1	0.1	0.5	3
			MAX	27.2	10.5	37	6.9	46.2	181
			MIN	25.9	10.1	35	6.5	44.9	173
110	33.00	7	AV7	26.4	10.6	35	6.6	45.8	186
			STD	0.8	0.5	2	0.3	0.9	21
			MAX	28.4	11.6	40	7.2	46.7	223
			MIN	25.7	10.1	33	6.3	43.9	166
117	34.00	7	AV7	26.9	10.8	36	6.8	45.3	186
			STD	0.7	0.3	2	0.2	0.6	10
			MAX	27.7	11.2	39	7.0	46.4	202
			MIN	25.6	10.3	33	6.4	44.6	171
125	35.00	8	AV8	27.4	11.3	37	6.9	44.9	200
			STD	0.7	0.4	2	0.2	0.6	9
			MAX	29.1	11.9	41	7.4	45.5	215
			MIN	26.6	10.6	35	6.7	43.4	189
152	36.00	27	AV27	29.6	16.0	37	7.7	42.7	343
			STD	1.2	2.9	2	0.4	1.2	74
			MAX	31.9	21.0	43	8.7	44.8	465
			MIN	27.4	11.7	33	6.9	40.0	247
174	37.00	22	AV22	31.6	22.1	42	8.4	40.7	470
			STD	1.0	2.2	2	0.4	0.8	43
			MAX	33.3	25.2	46	9.2	42.3	521
			MIN	30.1	18.5	38	7.8	39.0	401
193	38.00	19	AV19	31.4	18.4	41	8.3	41.0	410
			STD	1.0	2.7	2	0.3	0.8	44
			MAX	33.3	23.1	45	8.9	42.7	483
			MIN	29.5	14.4	37	7.6	39.7	346
210	39.00	17	AV17	30.7	14.2	40	8.1	41.5	352
			STD	0.5	0.8	1	0.2	0.5	17
			MAX	31.7	15.7	43	8.4	42.8	376
			MIN	29.4	12.9	37	7.6	40.8	315
224	40.00	14	AV14	31.0	13.6	41	8.2	41.3	339
			STD	0.5	0.9	1	0.2	0.5	17
			MAX	31.8	14.9	43	8.5	42.1	370
			MIN	30.2	11.7	39	7.9	40.6	314
240	41.00	16	AV16	31.7	16.0	42	8.4	40.7	376
			STD	0.7	2.0	1	0.2	0.6	28
			MAX	33.0	18.9	44	8.8	41.7	417
			MIN	30.4	12.9	40	8.0	39.9	334

USH 10 over Little Lake Butte des Morts - Pier 21 #44
APE D30-42, HP 14 x 73
OP: MR
Test date: 18-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
263	42.00	23	AV23	32.3	19.3	42	8.6	40.2	441
			STD	0.4	0.7	1	0.1	0.3	6
			MAX	33.0	21.0	44	8.9	40.8	452
			MIN	31.6	17.8	40	8.4	39.7	424
295	43.00	32	AV32	32.5	21.0	42	8.8	39.9	462
			STD	0.5	0.7	1	0.2	0.3	11
			MAX	33.4	22.7	44	9.1	40.6	490
			MIN	31.7	19.8	39	8.5	39.3	443
327	44.00	32	AV32	32.8	21.7	42	8.9	39.7	491
			STD	0.5	0.5	1	0.2	0.3	8
			MAX	33.8	22.5	44	9.2	40.7	509
			MIN	31.7	20.6	39	8.4	39.1	472
361	45.00	34	AV34	33.4	21.2	43	9.1	39.2	496
			STD	0.5	0.7	1	0.2	0.4	7
			MAX	34.6	22.8	46	9.6	40.3	512
			MIN	32.0	20.0	41	8.6	38.2	483
401	46.00	40	AV40	33.0	20.0	41	9.0	39.4	496
			STD	0.4	0.5	1	0.2	0.3	6
			MAX	34.0	21.0	44	9.5	40.2	520
			MIN	32.0	19.2	39	8.7	38.5	484
444	47.00	43	AV43	33.3	19.5	42	9.1	39.2	506
			STD	0.4	1.0	1	0.2	0.3	22
			MAX	34.2	24.7	43	9.4	39.9	614
			MIN	32.4	18.6	40	8.8	38.6	490
453	47.10	87	AV9	34.8	33.9	46	9.9	37.7	689
			STD	0.6	2.2	1	0.2	0.5	22
			MAX	35.5	36.0	47	10.2	38.7	709
			MIN	33.7	29.4	44	9.4	37.1	650
			Average	30.4	16.9	40	8.1	42.0	381
			Std. Dev.	3.5	5.7	4	1.2	3.4	145
			Maximum	35.5	36.0	47	10.2	55.3	709
			Minimum	18.2	5.2	22	4.4	37.1	89

Total number of blows analyzed: 441

BL#	depth (ft)	Comments
13	16.67	Reference Elevation EL 735.75

Time Summary

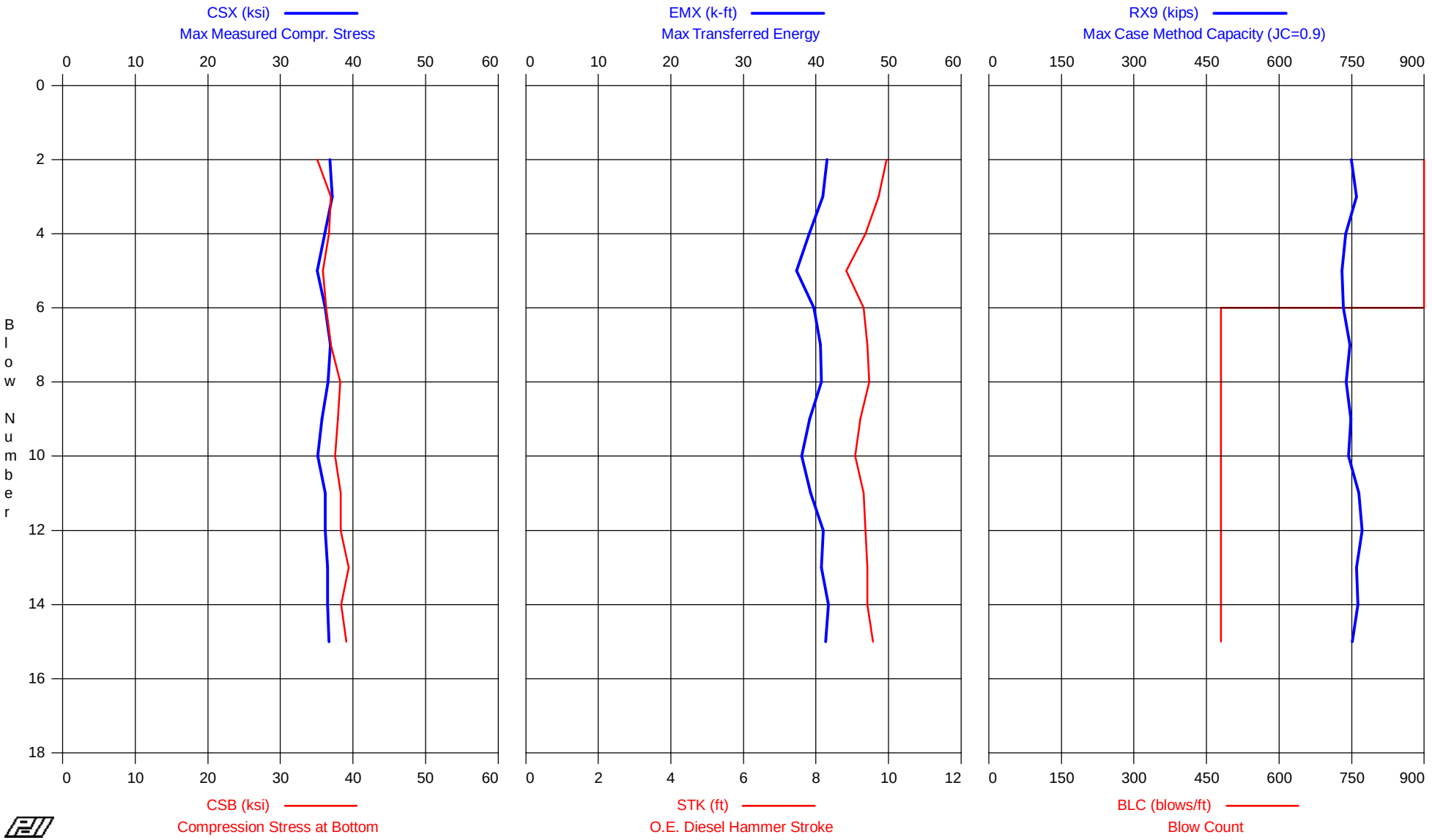
Drive 11 minutes 18 seconds 4:12:33 PM - 4:23:51 PM (11/18/2014) BN 1 - 454

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

PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

Test date: 19-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 21 #44 Restrike
APE D30-42, HP 14 x 73



Case Method & iCAP® Results PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

USH 10 over Little Lake Butte des Morts - Pier 21 #44 Restrike APE D30-42, HP 14 x 73
OP: MR Test date: 19-Nov-2014

AR: 21.40 in^2 SP: 0.492 k/ft3
LE: 52.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.20

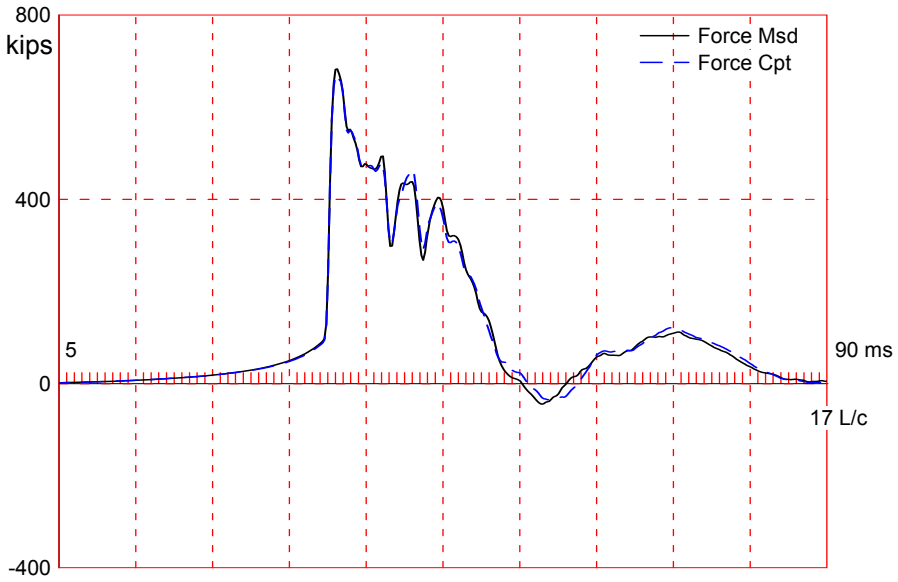
CSX: Max Measured Compr. Stress STK: O.E. Diesel Hammer Stroke
CSB: Compression Stress at Bottom BPM: Blows per Minute
EMX: Max Transferred Energy RX9: Max Case Method Capacity (JC=0.9)

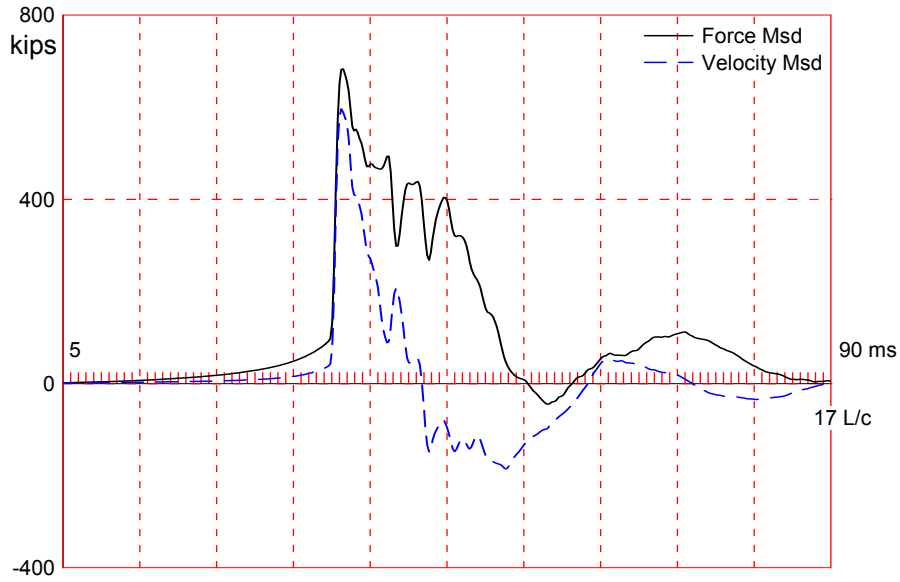
BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
5	47.09	960	AV4	36.3	36.1	40	9.5	38.5	745
			STD	0.8	0.7	2	0.4	0.8	11
			MAX	37.2	36.9	42	9.9	39.8	760
			MIN	35.0	35.1	37	8.8	37.6	730
10	47.10	480	AV5	36.1	37.4	40	9.3	38.8	742
			STD	0.6	0.7	1	0.1	0.3	5
			MAX	36.9	38.3	41	9.5	39.3	749
			MIN	35.2	36.3	38	9.1	38.5	733
15	47.11	480	AV5	36.4	38.7	41	9.4	38.6	762
			STD	0.2	0.5	1	0.1	0.2	7
			MAX	36.7	39.4	42	9.6	38.8	772
			MIN	36.2	38.3	39	9.3	38.3	751
			Average	36.3	37.5	40	9.4	38.7	750
			Std. Dev.	0.6	1.2	1	0.3	0.5	12
			Maximum	37.2	39.4	42	9.9	39.8	772
			Minimum	35.0	35.1	37	8.8	37.6	730

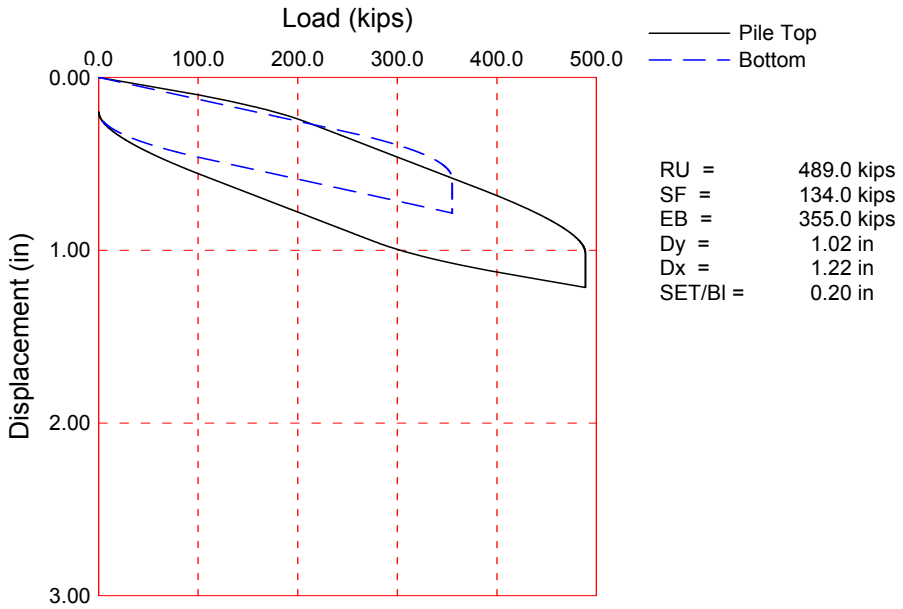
Total number of blows analyzed: 14

Time Summary

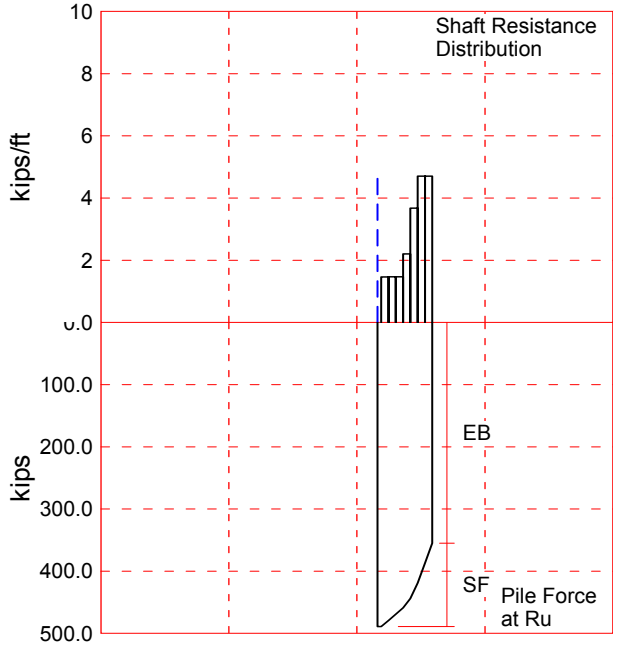
Drive 22 seconds 9:41:32 AM - 9:41:54 AM (11/19/2014) BN 1 - 15







RU =	489.0 kips
SF =	134.0 kips
EB =	355.0 kips
Dy =	1.02 in
Dx =	1.22 in
SET/Bl =	0.20 in



Length b. Sensors	51.0 ft
Embedment	47.6 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	2.76
Top Compr. Stress	31.7 ksi
Max Compr. Stress	32.8 ksi
Max Tension Stress	-3.00 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.45 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.09 s/ft

CAPWAP(R) 2014 Licensed to GRL Engineers, Inc.

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: 489.0; along Shaft 134.0; at Toe 355.0 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
				489.0			
1	10.2	6.8	10.0	479.0	10.0	1.46	0.31
2	17.0	13.6	10.0	469.0	20.0	1.47	0.31
3	23.8	20.4	10.0	459.0	30.0	1.47	0.31
4	30.6	27.2	15.0	444.0	45.0	2.21	0.47
5	37.4	34.0	25.0	419.0	70.0	3.68	0.78
6	44.2	40.8	32.0	387.0	102.0	4.71	1.00
7	51.0	47.6	32.0	355.0	134.0	4.71	1.00
Avg. Shaft			19.1			2.81	0.60
Toe			355.0				257.53

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.27	0.09
Quake	(in)	0.08	0.45
Case Damping Factor		0.95	0.84
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	31
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	7	
Resistance Gap (included in Toe Quake)	(in)		0.06
Soil Plug Weight	(kips)	0.200	0.050

CAPWAP match quality = 2.76 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.20 in; Blow Count = 60 b/ft
Transducer F3(F590) CAL: 95.0; RF: 0.95; F4(F607) CAL: 93.6; RF: 0.95
A3(K2253) CAL: 325; RF: 1.05; A4(K2524) CAL: 360; RF: 1.05

max. Top Comp. Stress = 31.7 ksi (T= 36.2 ms, max= 1.033 x Top)
max. Comp. Stress = 32.8 ksi (Z= 10.2 ft, T= 36.6 ms)
max. Tens. Stress = -3.00 ksi (Z= 23.8 ft, T= 60.1 ms)
max. Energy (EMX) = 34.6 kip-ft; max. Measured Top Displ. (DMX)= 0.87 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	678.9	-41.2	31.7	-1.92	34.6	15.8	0.85
2	6.8	689.2	-47.3	32.2	-2.21	34.0	15.4	0.82
3	10.2	701.0	-52.4	32.8	-2.45	33.4	15.2	0.79
4	13.6	661.2	-55.3	30.9	-2.59	30.7	14.8	0.76
5	17.0	672.6	-60.0	31.4	-2.80	30.1	14.6	0.73
6	20.4	634.7	-61.2	29.7	-2.86	27.6	14.3	0.70
7	23.8	649.6	-64.1	30.3	-3.00	27.1	14.0	0.67
8	27.2	619.5	-59.5	28.9	-2.78	24.8	13.5	0.64
9	30.6	644.9	-60.6	30.1	-2.83	24.2	13.1	0.61
10	34.0	620.5	-53.8	29.0	-2.51	21.4	12.4	0.59
11	37.4	646.2	-53.3	30.2	-2.49	20.8	11.6	0.56
12	40.8	567.2	-39.2	26.5	-1.83	17.0	12.1	0.53
13	44.2	556.9	-38.3	26.0	-1.79	16.5	13.6	0.50
14	47.6	424.5	-20.2	19.8	-0.95	12.2	14.3	0.48
15	51.0	439.5	-18.7	20.5	-0.87	8.7	14.3	0.45
Absolute	10.2			32.8			(T =	36.6 ms)
	23.8				-3.00		(T =	60.1 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	683.9	563.7	443.5	323.4	203.2					
RX	734.5	645.5	564.8	511.4	502.7	494.9	487.3	480.7	476.4	472.9
RU	683.9	563.7	443.5	323.4	203.2					

RAU = 309.9 (kips); RA2 = 571.5 (kips)

Current CAPWAP Ru = 489.0 (kips); Corresponding J(RP)= 0.32; J(RX) = 1.16

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	35.80	600.4	684.3	688.1	0.87	0.20	0.20	35.3	790.8	910

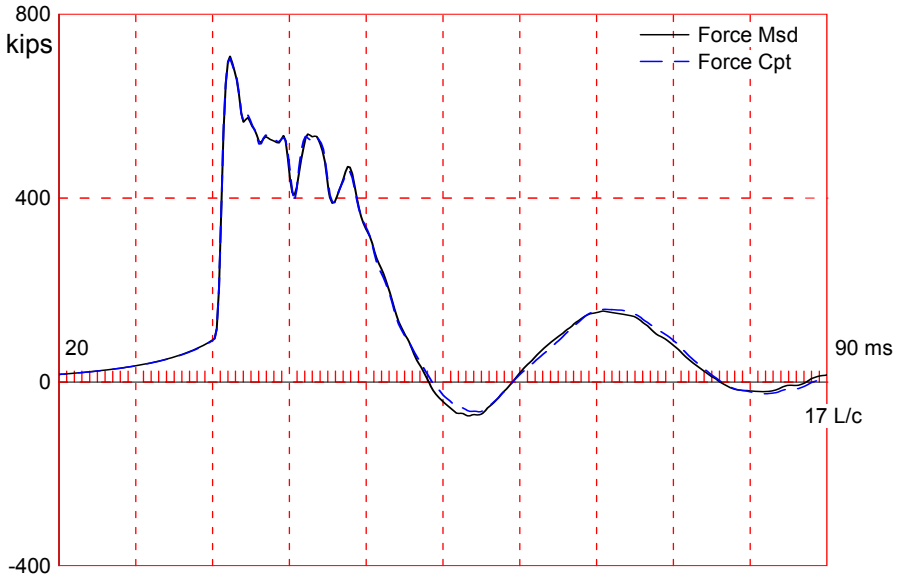
PILE PROFILE AND PILE MODEL

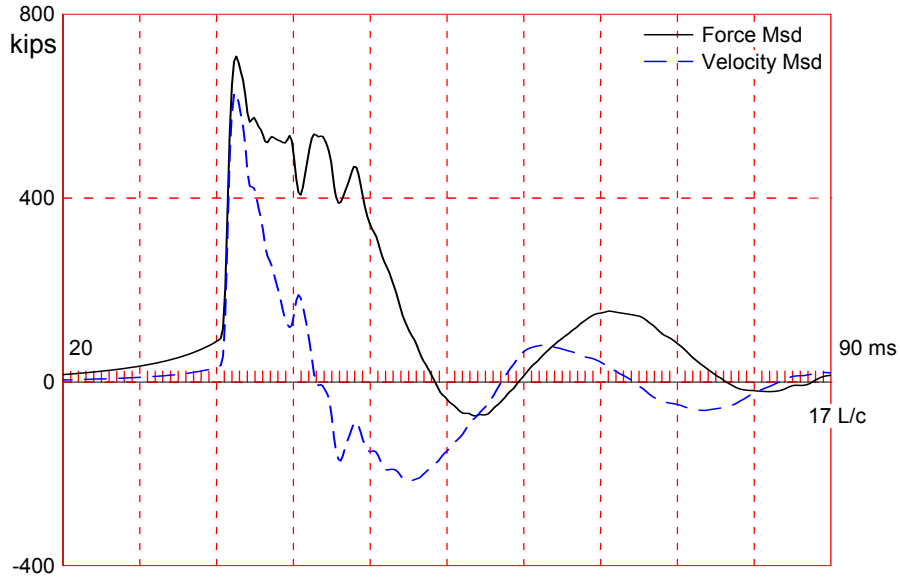
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
51.0	21.4	29992.2	492.000	4.70

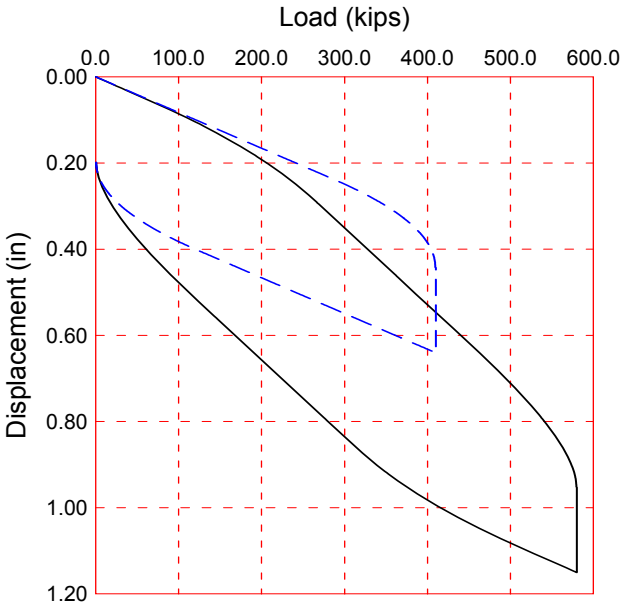
Toe Area 198.5 in^2

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
13	44.2	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.040
14	47.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.060
15	51.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.100

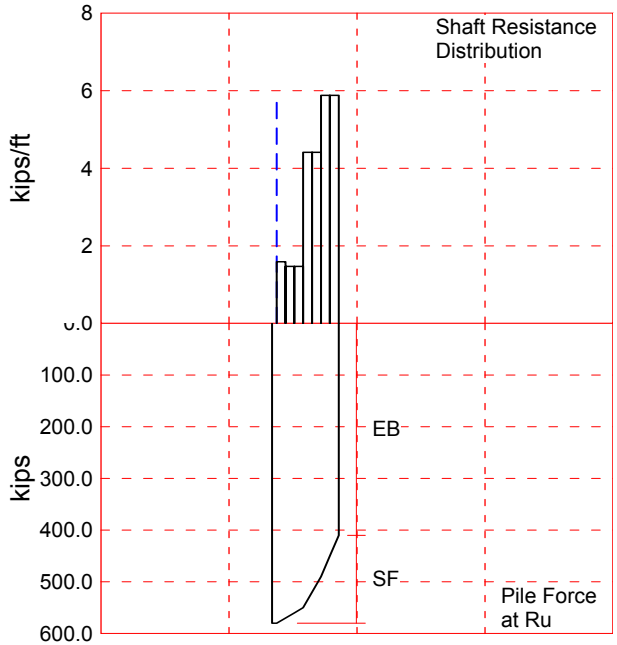
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.202 ms, 2L/c 6.1 ms
Total volume: 7.579 ft^3; Volume ratio considering added impedance: 1.000







RU =	580.0 kips
SF =	170.0 kips
EB =	410.0 kips
Dy =	0.95 in
Dx =	1.15 in
SET/Bl =	0.20 in



Length b. Sensors	51.0 ft
Embedment	47.1 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	33.4 ksi
Max Compr. Stress	34.6 ksi
Max Tension Stress	-3.83 ksi
Avg. Shaft Quake	0.07 in
Toe Quake	0.34 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.12 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 580.0; along Shaft 170.0; 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
				580.0			
1	10.2	6.3	10.0	570.0	10.0	1.59	0.34
2	17.0	13.1	10.0	560.0	20.0	1.47	0.31
3	23.8	19.9	10.0	550.0	30.0	1.47	0.31
4	30.6	26.7	30.0	520.0	60.0	4.41	0.94
5	37.4	33.5	30.0	490.0	90.0	4.41	0.94
6	44.2	40.3	40.0	450.0	130.0	5.88	1.25
7	51.0	47.1	40.0	410.0	170.0	5.88	1.25
Avg. Shaft			24.3			3.61	0.77
Toe			410.0				297.43

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.29	0.12
Quake	(in)	0.07	0.34
Case Damping Factor		1.29	1.29
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	98
Resistance Gap (included in Toe Quake)	(in)		0.09
Soil Plug Weight	(kips)		0.066

CAPWAP match quality = 1.72 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.20 in; Blow Count = 61 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.14; A4(K2524) CAL: 360; RF: 1.14

max. Top Comp. Stress = 33.4 ksi (T= 36.0 ms, max= 1.035 x Top)
max. Comp. Stress = 34.6 ksi (Z= 10.2 ft, T= 36.4 ms)
max. Tens. Stress = -3.83 ksi (Z= 10.2 ft, T= 58.3 ms)
max. Energy (EMX) = 36.0 kip-ft; max. Measured Top Displ. (DMX)= 0.84 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	715.4	-70.5	33.4	-3.29	36.0	16.3	0.81
2	6.8	728.0	-76.3	34.0	-3.56	35.2	16.0	0.77
3	10.2	740.4	-82.1	34.6	-3.83	34.4	15.6	0.74
4	13.6	697.7	-72.7	32.6	-3.40	31.4	15.3	0.70
5	17.0	709.7	-78.0	33.2	-3.64	30.6	15.0	0.67
6	20.4	670.1	-69.1	31.3	-3.23	27.8	14.6	0.63
7	23.8	697.6	-73.4	32.6	-3.43	27.0	14.1	0.60
8	27.2	676.6	-63.0	31.6	-2.95	24.6	13.2	0.56
9	30.6	701.2	-67.8	32.8	-3.17	23.8	12.6	0.53
10	34.0	596.6	-32.4	27.9	-1.51	19.0	11.8	0.49
11	37.4	626.7	-35.6	29.3	-1.66	18.3	11.1	0.46
12	40.8	528.0	-2.9	24.7	-0.13	14.2	11.6	0.43
13	44.2	528.5	-5.1	24.7	-0.24	13.6	12.8	0.40
14	47.6	480.7	0.0	22.5	0.00	9.2	13.6	0.37
15	51.0	487.3	0.0	22.8	0.00	6.0	13.8	0.34
Absolute	10.2			34.6			(T =	36.4 ms)
	10.2				-3.83		(T =	58.3 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	801.3	746.3	691.2	636.2	581.2	526.1	471.1	416.1	361.0	306.0
RX	827.4	788.9	753.5	718.4	687.2	658.9	633.4	610.4	587.4	574.8
RU	801.3	746.3	691.2	636.2	581.2	526.1	471.1	416.1	361.0	306.0

RAU = 346.1 (kips); RA2 = 722.0 (kips)

Current CAPWAP Ru = 580.0 (kips); Corresponding J(RP)= 0.40; J(RX) = 0.86

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	35.80	637.4	714.2	714.2	0.84	0.20	0.20	37.0	851.9	1640

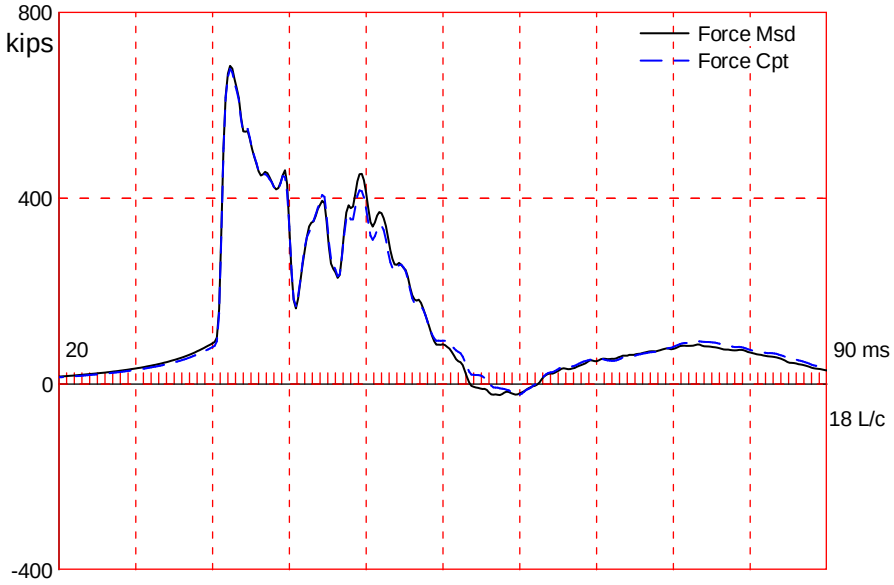
PILE PROFILE AND PILE MODEL

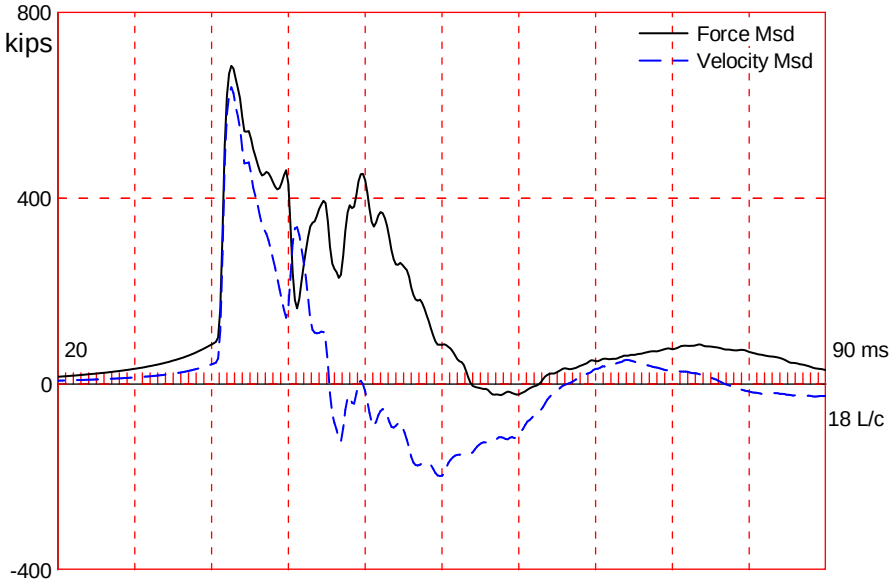
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
51.0	21.4	29992.2	492.000	4.70

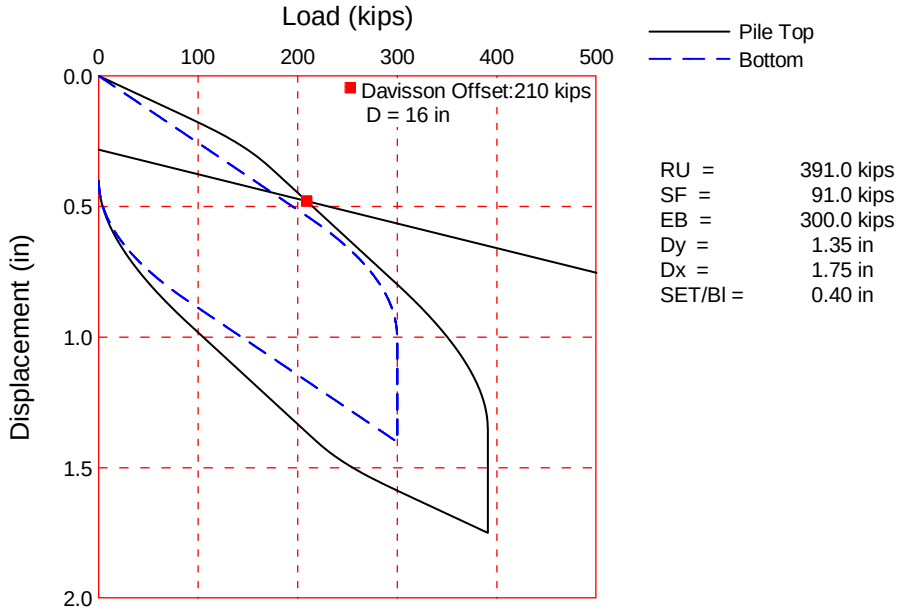
Toe Area 198.5 in^2

Top Segment Length 3.40 ft, Top Impedance 38 kips/ft/s

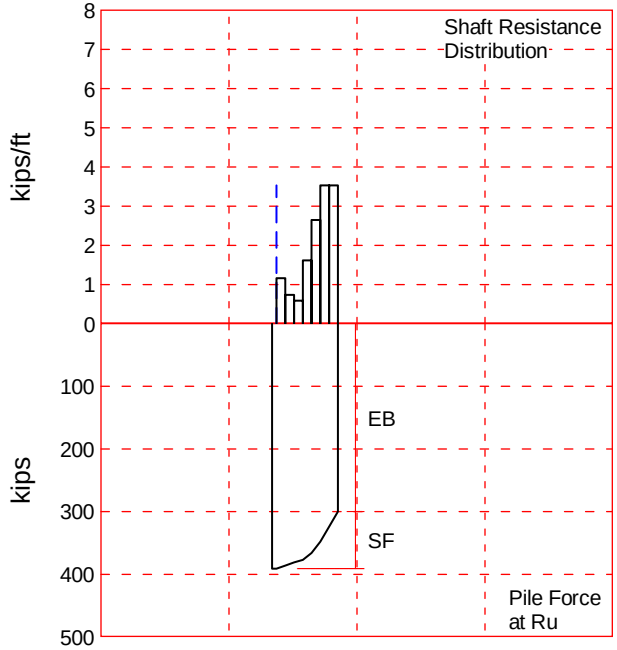
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.202 ms, 2L/c 6.1 ms
Total volume: 7.579 ft^3; Volume ratio considering added impedance: 1.000







RU =	391.0 kips
SF =	91.0 kips
EB =	300.0 kips
Dy =	1.35 in
Dx =	1.75 in
SET/Bl =	0.40 in



Length b. Sensors	51.0 ft
Embedment	45.1 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.	17000 ft/s
Match Quality	2.38
Top Compr. Stress	31.9 ksi
Max Compr. Stress	32.4 ksi
Max Tension Stress	-1.68 ksi
Avg. Shaft Quake	0.17 in
Toe Quake	0.77 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.12 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: 391.0; along Shaft 91.0; at Toe 300.0 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
				391.0			
1	10.2	4.3	5.0	386.0	5.0	1.16	0.25
2	17.0	11.1	5.0	381.0	10.0	0.74	0.16
3	23.8	17.9	4.0	377.0	14.0	0.59	0.13
4	30.6	24.7	11.0	366.0	25.0	1.62	0.34
5	37.4	31.5	18.0	348.0	43.0	2.65	0.56
6	44.2	38.3	24.0	324.0	67.0	3.53	0.75
7	51.0	45.1	24.0	300.0	91.0	3.53	0.75
Avg. Shaft			13.0			2.02	0.43
Toe			300.0				217.63

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.26	0.12
Quake	(in)	0.17	0.77
Case Damping Factor		0.62	0.94
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	55	81
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.15
Soil Plug Weight	(kips)	0.160	0.029

CAPWAP match quality = 2.38 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.40 in; Blow Count = 30 b/ft
Computed: Final Set = 0.41 in; Blow Count = 29 b/ft
Transducer F3(F590) CAL: 95.0; RF: 0.98; F4(F607) CAL: 93.6; RF: 0.98
A3(K2253) CAL: 325; RF: 1.13; A4(K2524) CAL: 360; RF: 1.13

max. Top Comp. Stress = 31.9 ksi (T= 36.0 ms, max= 1.017 x Top)
max. Comp. Stress = 32.4 ksi (Z= 10.2 ft, T= 36.4 ms)
max. Tens. Stress = -1.68 ksi (Z= 10.2 ft, T= 62.4 ms)
max. Energy (EMX) = 39.4 kip-ft; max. Measured Top Displ. (DMX)= 1.09 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	683.2	-30.0	31.9	-1.40	39.4	16.8	1.09
2	6.8	689.4	-33.7	32.2	-1.57	39.1	16.6	1.07
3	10.2	694.6	-35.9	32.4	-1.68	38.7	16.5	1.05
4	13.6	674.4	-28.5	31.5	-1.33	36.9	16.3	1.03
5	17.0	678.9	-28.1	31.7	-1.31	36.6	16.2	1.00
6	20.4	657.9	-21.1	30.7	-0.99	34.8	16.0	0.98
7	23.8	666.3	-24.6	31.1	-1.15	34.5	15.8	0.96
8	27.2	657.7	-21.3	30.7	-1.00	33.0	15.5	0.93
9	30.6	674.1	-23.5	31.5	-1.10	32.6	15.1	0.91
10	34.0	637.4	-8.0	29.8	-0.37	29.6	15.1	0.89
11	37.4	677.1	-10.4	31.6	-0.48	29.2	15.6	0.86
12	40.8	626.3	0.0	29.3	0.00	24.8	16.6	0.84
13	44.2	607.4	0.0	28.4	0.00	24.4	18.2	0.82
14	47.6	429.8	0.0	20.1	0.00	18.9	19.4	0.80
15	51.0	423.7	-0.0	19.8	-0.00	14.0	18.9	0.78
Absolute	10.2			32.4			(T = 36.4 ms)	
	10.2				-1.68		(T = 62.4 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	576.1	424.4	272.7	121.0	0.0					
RX	636.7	556.7	476.8	466.6	461.1	456.5	452.0	447.5	443.3	439.5
RU	576.1	424.4	272.7	121.0	0.0					

RAU = 318.8 (kips); RA2 = 517.5 (kips)

Current CAPWAP Ru = 391.0 (kips); Corresponding J(RP)= 0.24;

RMX requires higher damping; see PDA-W

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
16.9	35.80	647.1	687.6	687.6	1.09	0.40	0.40	39.8	640.5	484

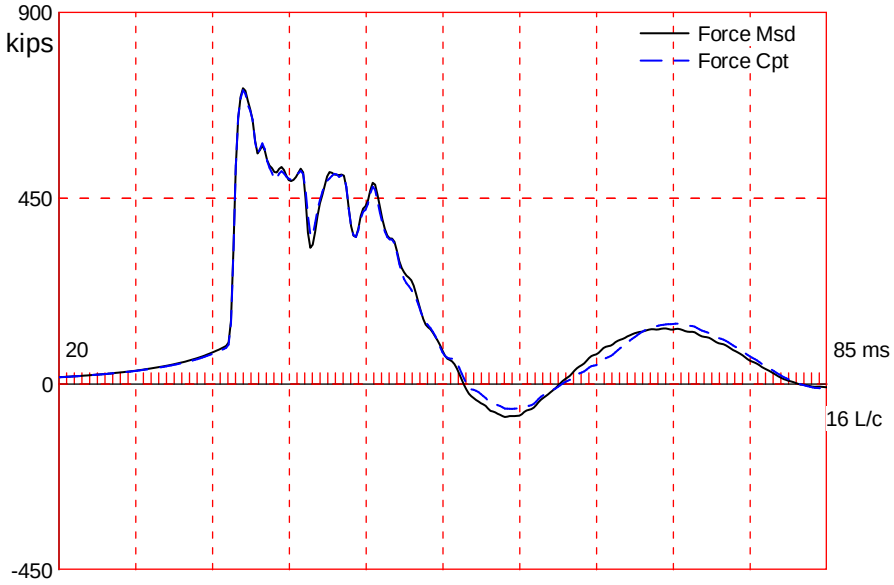
PILE PROFILE AND PILE MODEL

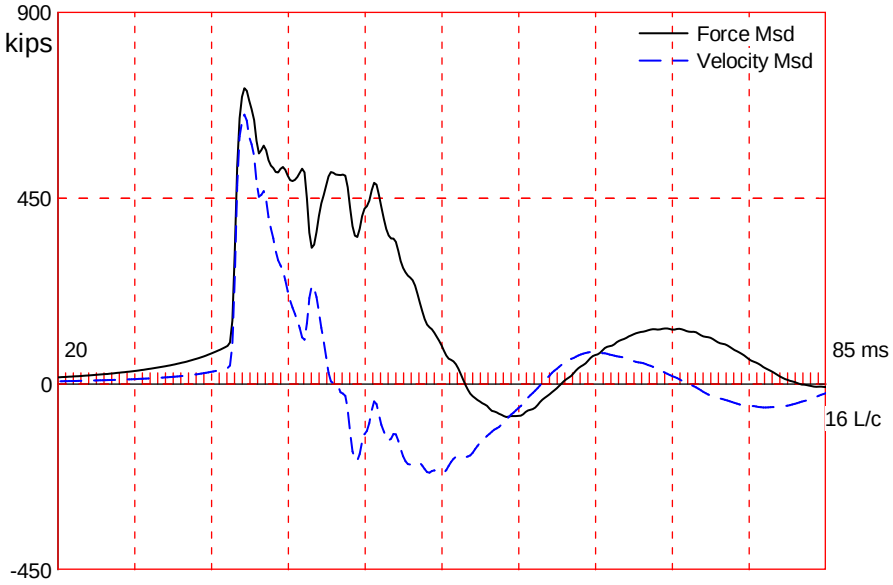
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
51.0	21.4	29992.2	492.000	4.70

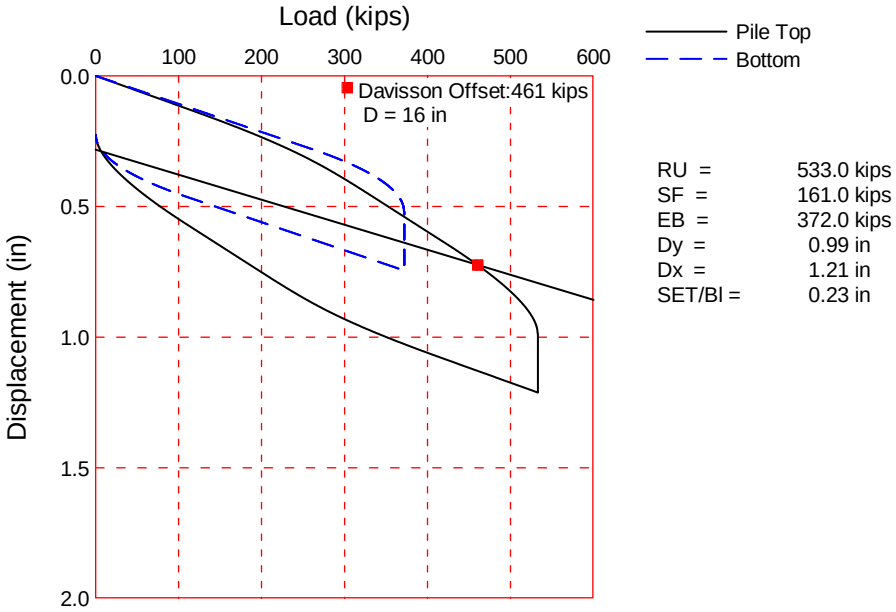
Toe Area 198.5 in^2

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	17000.0	0.000
14	47.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	17000.0	0.080
15	51.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	17000.0	0.080

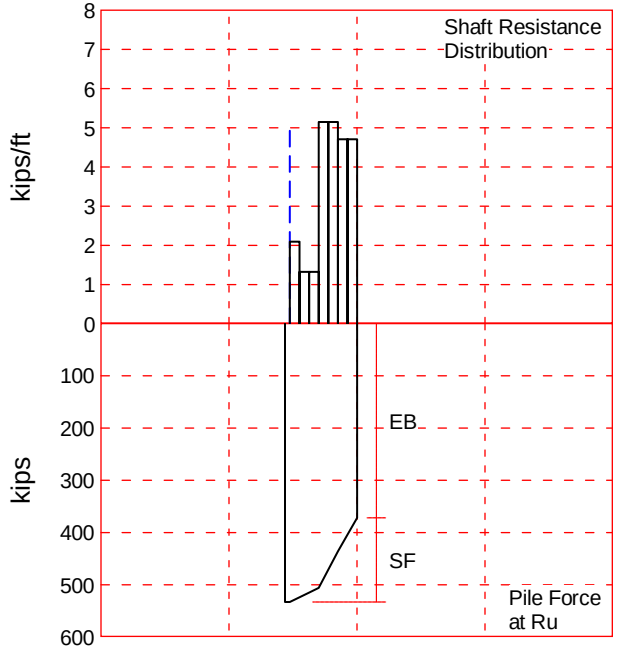
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 17000.0 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 6.0 ms
Total volume: 7.579 ft^3; Volume ratio considering added impedance: 1.000







RU =	533.0 kips
SF =	161.0 kips
EB =	372.0 kips
Dy =	0.99 in
Dx =	1.21 in
SET/BI =	0.23 in



Length b. Sensors	51.0 ft
Embedment	45.1 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.	16721 ft/s
Match Quality	2.88
Top Compr. Stress	33.5 ksi
Max Compr. Stress	34.4 ksi
Max Tension Stress	-3.71 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.40 in
Avg. Shaft Smith Dpg.	0.20 s/ft
Toe Smith Damping	0.10 s/ft

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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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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.

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no liability whatsoever of any kind for the analysis solution and/or the application of the analysis result.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 533.0; along Shaft 161.0; at Toe 372.0 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
				533.0			
1	10.2	4.3	9.0	524.0	9.0	2.09	0.45
2	17.0	11.1	9.0	515.0	18.0	1.32	0.28
3	23.8	17.9	9.0	506.0	27.0	1.32	0.28
4	30.6	24.7	35.0	471.0	62.0	5.15	1.10
5	37.4	31.5	35.0	436.0	97.0	5.15	1.10
6	44.2	38.3	32.0	404.0	129.0	4.71	1.00
7	51.0	45.1	32.0	372.0	161.0	4.71	1.00
Avg. Shaft			23.0			3.57	0.76
Toe			372.0				269.86

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.20	0.10
Quake	(in)	0.14	0.40
Case Damping Factor		0.86	0.98
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	54	74
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.05

CAPWAP match quality = 2.88 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.26 in; Blow Count = 47 b/ft
Transducer F3(F590) CAL: 95.0; RF: 1.00; F4(F607) CAL: 93.6; RF: 1.00
A3(K2253) CAL: 325; RF: 1.13; A4(K2524) CAL: 360; RF: 1.13

max. Top Comp. Stress = 33.5 ksi (T= 36.0 ms, max= 1.025 x Top)
max. Comp. Stress = 34.4 ksi (Z= 10.2 ft, T= 36.4 ms)
max. Tens. Stress = -3.71 ksi (Z= 17.0 ft, T= 59.0 ms)
max. Energy (EMX) = 37.9 kip-ft; max. Measured Top Displ. (DMX)= 0.91 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	717.8	-67.7	33.5	-3.16	37.9	17.1	0.88
2	6.8	727.9	-73.3	34.0	-3.42	37.1	16.8	0.85
3	10.2	735.8	-79.0	34.4	-3.69	36.4	16.6	0.82
4	13.6	706.4	-73.3	33.0	-3.42	33.9	16.3	0.78
5	17.0	714.3	-79.4	33.4	-3.71	33.1	16.1	0.75
6	20.4	685.8	-70.6	32.0	-3.30	30.8	15.8	0.72
7	23.8	714.2	-73.0	33.4	-3.41	30.1	15.3	0.68
8	27.2	702.6	-63.1	32.8	-2.95	28.0	14.5	0.65
9	30.6	731.9	-67.9	34.2	-3.17	27.3	13.8	0.62
10	34.0	627.5	-30.6	29.3	-1.43	22.2	13.0	0.58
11	37.4	665.4	-35.7	31.1	-1.67	21.6	12.4	0.55
12	40.8	574.1	-0.5	26.8	-0.02	17.2	13.4	0.53
13	44.2	557.6	-5.3	26.0	-0.25	16.7	14.4	0.50
14	47.6	486.2	0.0	22.7	0.00	13.1	15.2	0.47
15	51.0	511.6	-0.0	23.9	-0.00	10.5	14.3	0.45
Absolute	10.2			34.4			(T =	36.4 ms)
	17.0				-3.71		(T =	59.0 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	781.3	660.3	539.3	418.4	297.4					
RX	811.5	730.9	671.5	615.3	575.8	549.7	535.2	524.2	521.1	517.9
RU	781.3	660.3	539.3	418.4	297.4					

RAU = 365.5 (kips); RA2 = 695.8 (kips)

Current CAPWAP Ru = 533.0 (kips); Corresponding J(RP)= 0.41; J(RX) = 1.23

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
17.3	35.79	661.2	725.0	725.0	0.91	0.23	0.23	38.7	818.1	1063

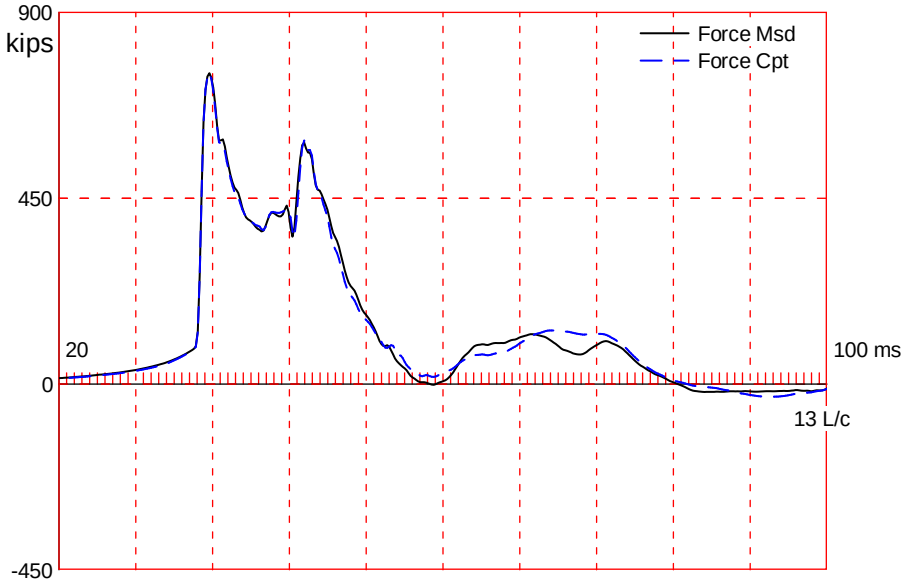
PILE PROFILE AND PILE MODEL

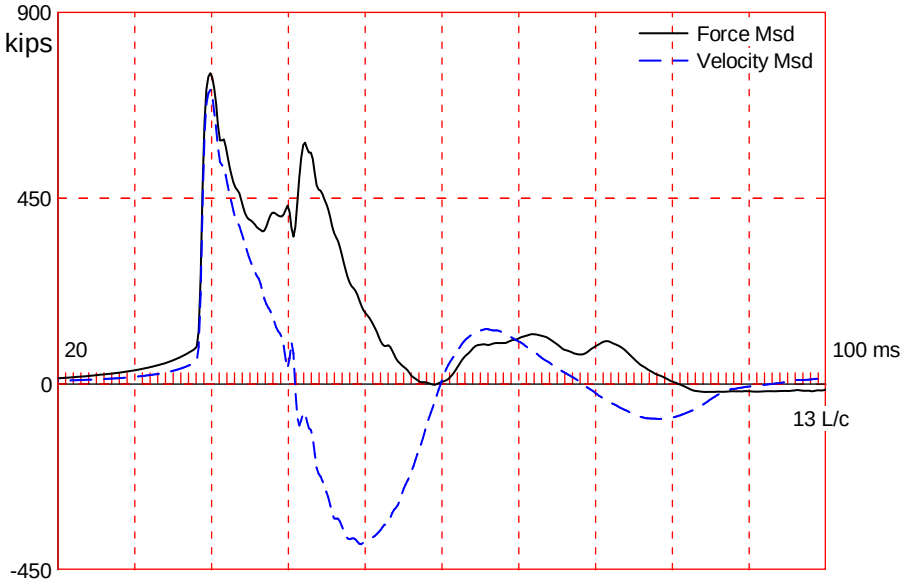
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
51.0	21.4	29992.2	492.000	4.70

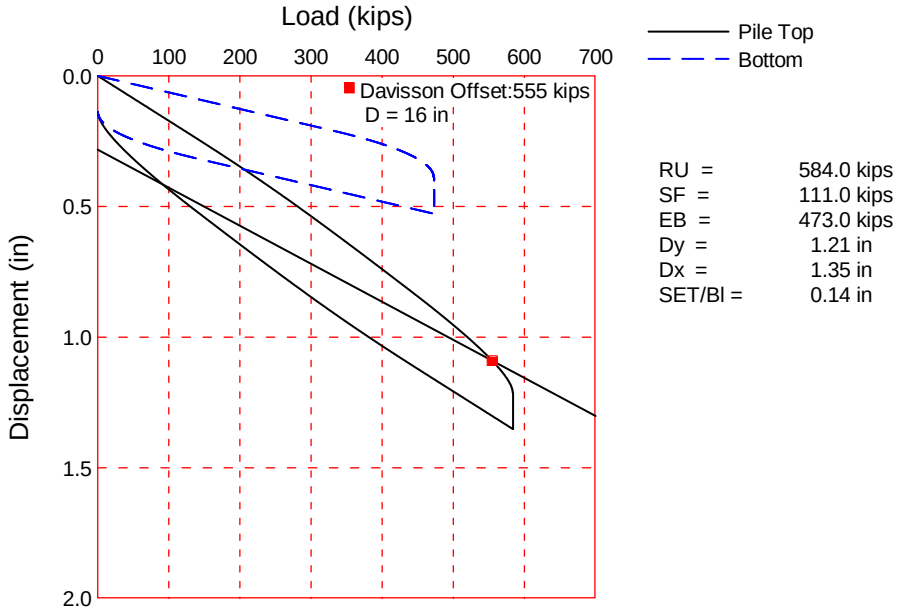
Toe Area 198.5 in^2

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	16721.3	0.000
14	47.6	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16721.3	0.060
15	51.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16721.3	0.060

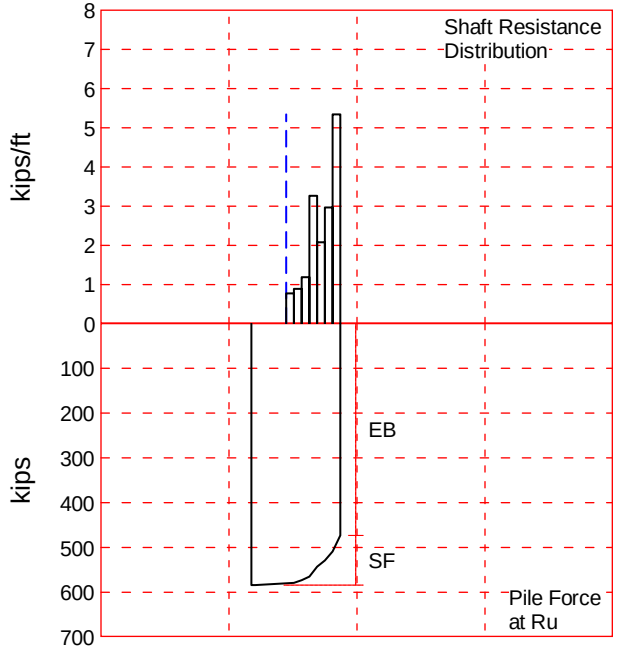
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16721.3 ft/s
Pile Damping 1.00 %, Time Incr 0.203 ms, 2L/c 6.1 ms
Total volume: 7.579 ft^3; Volume ratio considering added impedance: 1.000







RU =	584.0 kips
SF =	111.0 kips
EB =	473.0 kips
Dy =	1.21 in
Dx =	1.35 in
SET/Bl =	0.14 in



Length b. Sensors	77.5 ft
Embedment	46.9 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.	16721 ft/s
Match Quality	3.78
Top Compr. Stress	35.2 ksi
Max Compr. Stress	36.8 ksi
Max Tension Stress	-5.40 ksi
Avg. Shaft Quake	0.16 in
Toe Quake	0.30 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.21 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: 584.0; along Shaft 111.0; at Toe 473.0 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
				584.0			
1	37.1	6.5	5.0	579.0	5.0	0.77	0.16
2	43.8	13.2	6.0	573.0	11.0	0.89	0.19
3	50.5	19.9	8.0	565.0	19.0	1.19	0.25
4	57.3	26.7	22.0	543.0	41.0	3.26	0.69
5	64.0	33.4	14.0	529.0	55.0	2.08	0.44
6	70.8	40.2	20.0	509.0	75.0	2.97	0.63
7	77.5	46.9	36.0	473.0	111.0	5.34	1.14
Avg. Shaft			15.9			2.37	0.50
Toe			473.0				343.13

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.29	0.21
Quake	(in)	0.16	0.30
Case Damping Factor		0.84	2.60
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	96
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.02

CAPWAP match quality = 3.78 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.14 in; Blow Count = 87 b/ft
Computed: Final Set = 0.10 in; Blow Count = 116 b/ft
Transducer F3(F590) CAL: 95.0; RF: 0.97; F4(F607) CAL: 93.6; RF: 0.97
A3(K2253) CAL: 325; RF: 1.12; A4(K2524) CAL: 360; RF: 1.12

max. Top Comp. Stress = 35.2 ksi (T= 36.1 ms, max= 1.046 x Top)
max. Comp. Stress = 36.8 ksi (Z= 77.5 ft, T= 40.9 ms)
max. Tens. Stress = -5.40 ksi (Z= 50.5 ft, T= 59.8 ms)
max. Energy (EMX) = 46.9 kip-ft; max. Measured Top Displ. (DMX)= 1.17 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	752.4	-31.1	35.2	-1.45	46.9	18.7	1.16
2	6.7	753.4	-31.9	35.2	-1.49	46.3	18.6	1.13
4	13.5	755.5	-38.0	35.3	-1.78	45.0	18.6	1.06
5	16.8	756.7	-49.6	35.4	-2.32	44.3	18.5	1.03
6	20.2	758.1	-59.9	35.4	-2.80	43.5	18.5	1.00
7	23.6	759.5	-70.7	35.5	-3.30	42.7	18.4	0.96
8	27.0	761.7	-79.7	35.6	-3.72	41.8	18.4	0.92
9	30.3	769.3	-89.6	35.9	-4.19	40.9	18.2	0.89
10	33.7	777.3	-98.8	36.3	-4.62	40.0	18.0	0.85
11	37.1	786.8	-106.7	36.8	-4.99	39.0	17.7	0.81
12	40.4	765.5	-105.2	35.8	-4.91	36.6	17.5	0.77
13	43.8	777.4	-112.3	36.3	-5.25	35.5	17.1	0.73
14	47.2	755.8	-109.5	35.3	-5.12	32.9	16.8	0.69
15	50.5	784.6	-115.5	36.7	-5.40	31.7	16.2	0.64
16	53.9	760.9	-108.6	35.5	-5.08	28.9	15.5	0.60
17	57.3	779.0	-115.2	36.4	-5.38	27.6	15.0	0.56
18	60.7	703.9	-88.7	32.9	-4.14	22.9	14.5	0.51
19	64.0	724.2	-93.8	33.8	-4.38	21.7	13.9	0.47
20	67.4	727.0	-78.3	34.0	-3.66	18.8	13.0	0.43
21	70.8	754.7	-81.6	35.3	-3.81	17.9	13.6	0.40
22	74.1	725.1	-62.9	33.9	-2.94	15.2	13.5	0.36
23	77.5	787.4	-67.6	36.8	-3.16	12.8	11.5	0.33
Absolute	77.5			36.8			(T =	40.9 ms)
	50.5				-5.40		(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	1051.2	967.0	882.7	798.5	714.2					
RX	1051.2	967.0	884.3	802.6	724.0	698.1	688.7	680.9	673.7	667.2
RU	1064.0	982.3	900.6	818.9	737.2					

RAU = 638.8 (kips); RA2 = 776.6 (kips)

Current CAPWAP Ru = 584.0 (kips);

Case Method matching requires higher damping factor

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
18.8	35.87	717.0	755.4	757.1	1.17	0.14	0.14	47.6	875.3	1689

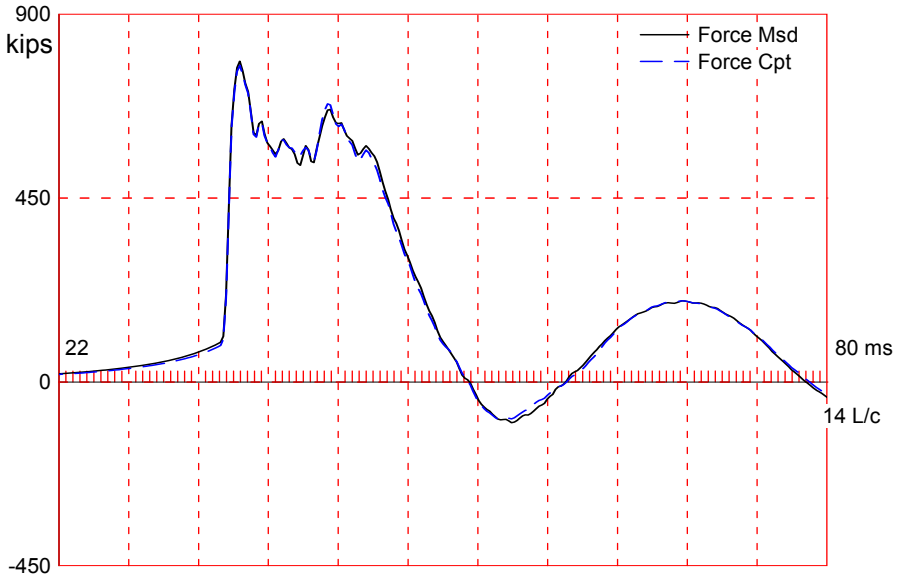
PILE PROFILE AND PILE MODEL

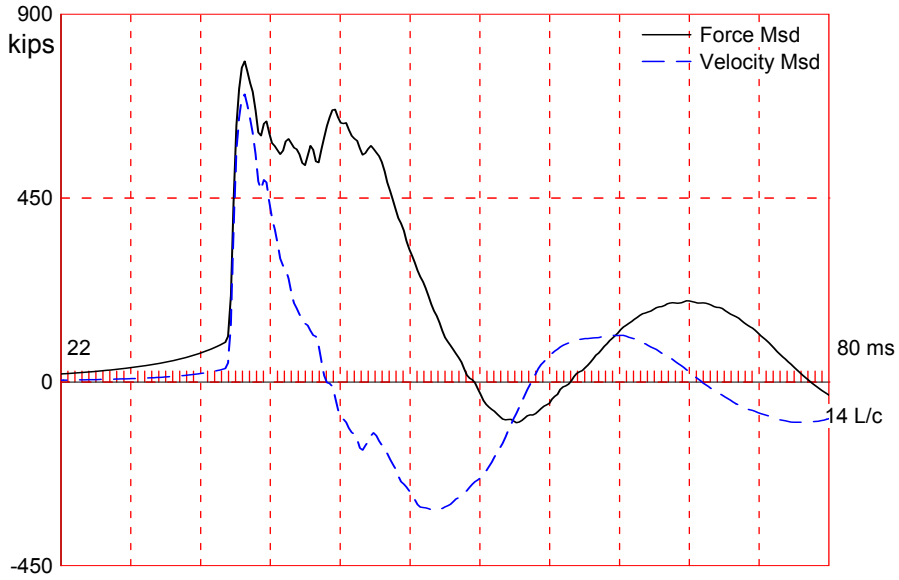
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

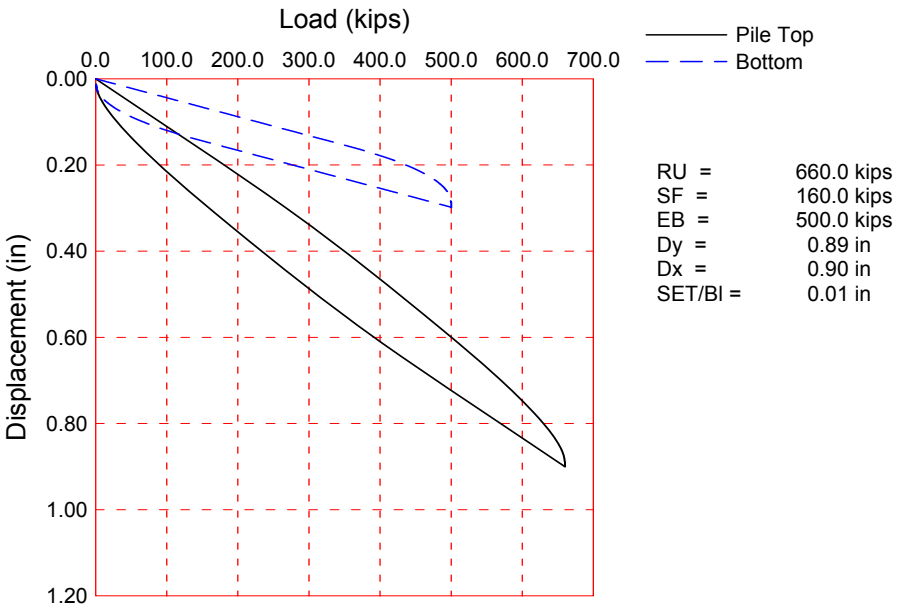
Toe Area 198.5 in^2

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	16721.3	0.000
22	74.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16721.3	0.040
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16721.3	0.040

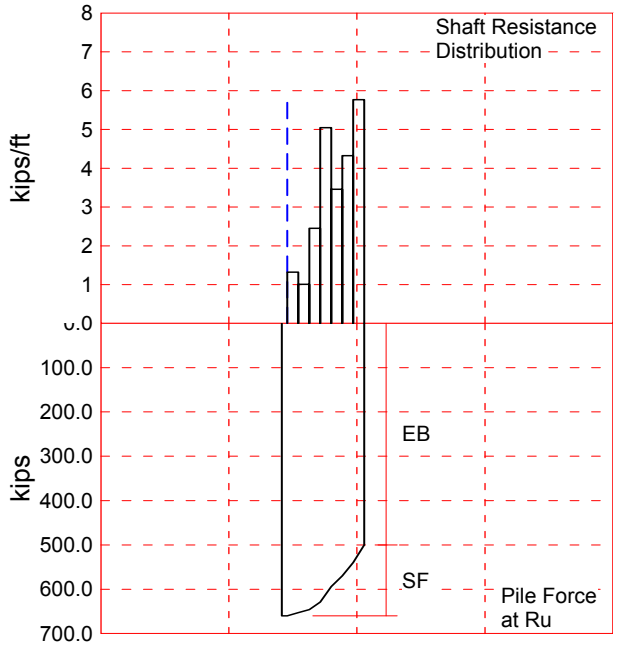
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16721.3 ft/s
Pile Damping 1.00 %, Time Incr 0.202 ms, 2L/c 9.3 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	660.0 kips
SF =	160.0 kips
EB =	500.0 kips
Dy =	0.89 in
Dx =	0.90 in
SET/Bl =	0.01 in



Length b. Sensors	52.0 ft
Embedment	46.9 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.	16774 ft/s
Match Quality	1.59
Top Compr. Stress	36.6 ksi
Max Compr. Stress	38.1 ksi
Max Tension Stress	-6.43 ksi
Avg. Shaft Quake	0.19 in
Toe Quake	0.22 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.28 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 660.0; along Shaft 160.0; 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
				660.0			
1	10.4	5.3	7.0	653.0	7.0	1.32	0.28
2	17.3	12.2	7.0	646.0	14.0	1.01	0.21
3	24.3	19.2	17.0	629.0	31.0	2.45	0.52
4	31.2	26.1	35.0	594.0	66.0	5.05	1.07
5	38.1	33.0	24.0	570.0	90.0	3.46	0.74
6	45.1	40.0	30.0	540.0	120.0	4.33	0.92
7	52.0	46.9	40.0	500.0	160.0	5.77	1.23
Avg. Shaft			22.9			3.41	0.73
Toe			500.0				362.72

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.29	0.28
Quake	(in)	0.19	0.22
Case Damping Factor		1.21	3.67
Damping Type		Viscous	Sm+Visc
Reloading Level	(% of Ru)	100	100
Soil Plug Weight	(kips)		0.028

CAPWAP match quality = 1.59 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.01 in; Blow Count = 960 b/ft
Computed: Final Set = 0.05 in; Blow Count = 248 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 = 36.6 ksi (T= 36.1 ms, max= 1.038 x Top)
max. Comp. Stress = 38.1 ksi (Z= 24.3 ft, T= 37.3 ms)
max. Tens. Stress = -6.43 ksi (Z= 24.3 ft, T= 56.8 ms)
max. Energy (EMX) = 40.4 kip-ft; max. Measured Top Displ. (DMX)= 0.84 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	3.5	784.5	-103.3	36.6	-4.83	40.4	18.4	0.82
2	6.9	794.7	-116.5	37.1	-5.44	39.3	18.2	0.78
3	10.4	807.0	-127.7	37.7	-5.97	38.1	17.8	0.74
4	13.9	774.5	-126.0	36.2	-5.88	35.1	17.6	0.69
5	17.3	796.6	-135.6	37.2	-6.34	33.8	17.0	0.65
6	20.8	776.5	-131.3	36.3	-6.13	31.1	16.4	0.60
7	24.3	814.5	-137.5	38.1	-6.43	29.7	15.7	0.56
8	27.7	759.1	-118.8	35.5	-5.55	25.6	14.5	0.51
9	31.2	789.4	-124.6	36.9	-5.82	24.3	13.8	0.46
10	34.7	700.7	-82.0	32.7	-3.83	18.6	13.1	0.42
11	38.1	732.1	-89.0	34.2	-4.16	17.4	12.5	0.38
12	41.6	720.7	-68.5	33.7	-3.20	14.1	11.7	0.33
13	45.1	736.9	-71.4	34.4	-3.34	13.0	11.5	0.29
14	48.5	685.2	-54.8	32.0	-2.56	10.3	10.8	0.26
15	52.0	715.7	-56.9	33.4	-2.66	8.6	8.5	0.22
Absolute	24.3			38.1			(T =	37.3 ms)
	24.3				-6.43		(T =	56.8 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	1055.5	963.8	872.1	780.5	688.8					
RX	1068.4	982.3	899.8	828.4	777.6	740.8	721.5	702.1	688.4	688.2
RU	1055.5	963.8	872.1	780.5	688.8					

RAU = 665.9 (kips); RA2 = 881.9 (kips)

Current CAPWAP Ru = 660.0 (kips); Corresponding J(RP)= 0.86; matches RX20 within 5%

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	35.87	718.7	795.0	795.0	0.84	0.01	0.01	41.8	1177.1	2273

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
52.0	21.4	29992.2	492.000	4.70

Toe Area 198.5 in^2

Top Segment Length 3.47 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16774.2 ft/s
Pile Damping 1.00 %, Time Incr 0.207 ms, 2L/c 6.2 ms
Total volume: 7.728 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

1540 E. Dundee Road, Suite 102 Palatine, IL 60074 USA
Phone: (847) 221-2750 Fax: (847) 221-2752

TRANSMITTAL

To: Mr. Kevin Weber	From: Rory Flynn
Company: Lunda Construction Co.	No. of Sheets: 42
E-mail: kweber@lundaconstruction.com	Date: April 20, 2015

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

On April 16, 2015, West Abutment Pile #3 and #8 at the above structure were dynamically tested during initial driving. Restrike testing was performed on April 17. Project plans indicate the HP 14 x 73 H-piles at the abutment have a required driving resistance, or ultimate capacity, of 400 kips (200 tons). The abutment consists of both vertical and 1H:4V battered piles with a minimum tip elevation of EL 707.0. The piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0234) operated on fuel setting 4.

West Abutment #3 was driven to a depth of 81.5 feet which corresponds to a pile tip elevation of EL 696.0. The reported pile set over the final ten blows of driving was $2^{1}/_{4}$ inches. The average hammer stroke over this increment was 8.4 feet. During the beginning of restrike the pile was driven $1^{3}/_{4}$ inches over ten blows at an average stroke of 8.5 feet.

West Abutment #8 was driven to a depth of 83.0 feet which corresponds to a pile tip elevation of El. 694.5. The reported pile set over the final ten blows of driving was $1^{1}/_{4}$ inches. The average hammer stroke over this increment was 8.3 feet. During the beginning of restrike the pile was driven $1^{1}/_{8}$ inches over ten blows at an average stroke of 8.6 feet.

We recommend the production piles at the West Abutment of Structure B-70-403, driven with the APE D30-42 hammer PD0234, 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. Additionally, all production piles should achieve the minimum pile tip elevation of EL 707.0 for uplift, as indicated on the plans. The criteria is applicable to both the vertical and the 1H:4V batter piles.

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.0	5
7.5	4
8.0	4
8.5	4
9.0	4
9.5	3

Driving should be halted if a blow count of 10 blows per inch at a 8.5 foot stroke or higher is achieved prior to attaining the criteria. We anticipate the production piles will terminate at depths similar to those of the test pile.

Please call if you have any questions on these recommendations.

GRL Engineers, Inc.

Rory Flynn, E.I.

Travis Coleman, P.E.

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

Attachments:

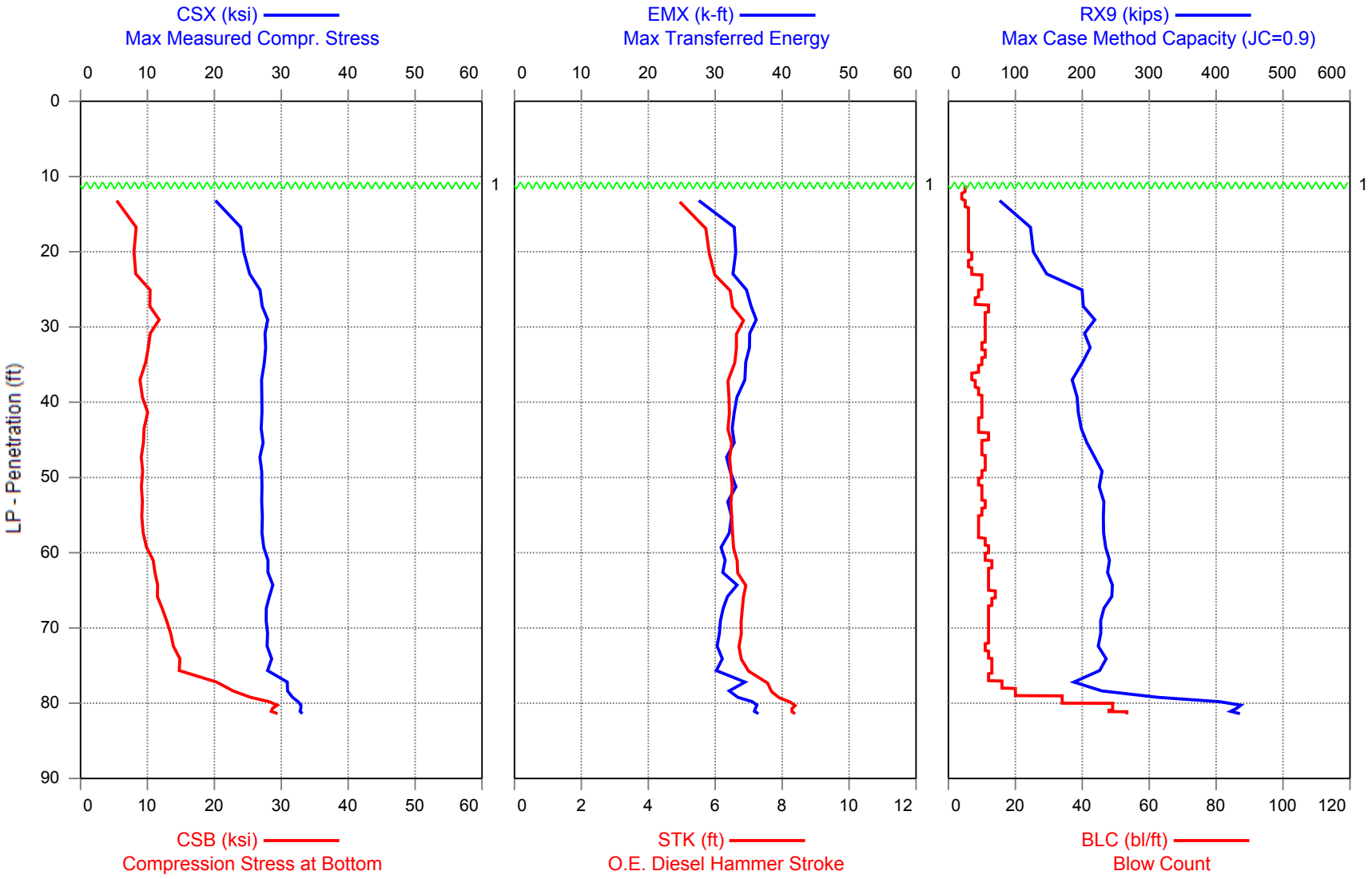
Dynamic Test Results - (pages 3 - 22)
CAPWAP Analysis Results - (pages 23 - 42)

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 17-April-2015

Test started: 16-April-2015

USH 10 over LLBDM - WEST ABUTMENT #3
APE D30-42, HP 14 x 73



1 - Reported Reference EL 777.46

USH 10 over LLBDM - WEST ABUTMENT #3 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-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
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#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
3	11.20	5	AV1	20.9	3.0	4.8	30	53.2	43
			MAX	20.9	3.0	4.8	30	53.2	43
			MIN	20.9	3.0	4.8	30	53.2	43
7	12.00	5	AV3	18.9	4.4	4.7	25	55.1	65
			MAX	25.7	5.1	6.1	39	64.0	84
			MIN	11.2	3.0	3.2	12	47.7	36
11	13.00	4	AV4	19.0	5.1	4.7	26	54.0	64
			MAX	19.6	5.5	4.8	27	55.1	69
			MIN	18.0	4.8	4.5	24	53.2	57
16	14.00	5	AV5	18.9	5.2	4.7	24	54.0	76
			MAX	20.1	5.4	4.9	26	56.8	84
			MIN	16.3	4.9	4.2	21	52.6	68
22	15.00	6	AV6	21.9	6.9	5.3	29	51.0	108
			MAX	24.7	8.9	6.0	36	53.8	125
			MIN	19.1	5.6	4.7	24	48.0	84
28	16.00	6	AV6	24.8	9.4	6.0	34	47.8	126
			MAX	25.3	9.8	6.1	37	49.0	133
			MIN	23.7	9.0	5.7	32	47.4	119
34	17.00	6	AV6	23.8	8.4	5.7	33	49.1	122
			MAX	24.9	9.0	5.9	34	49.7	127
			MIN	23.1	7.3	5.6	32	48.3	119
40	18.00	6	AV6	23.2	7.4	5.5	31	50.1	120
			MAX	24.0	7.9	5.6	33	51.1	126
			MIN	22.2	7.0	5.2	29	49.4	113
46	19.00	6	AV6	23.6	7.6	5.7	33	49.3	125
			MAX	24.2	8.5	5.8	35	49.9	133
			MIN	23.0	7.2	5.5	31	48.8	117
52	20.00	6	AV6	24.3	7.8	5.8	33	48.6	123
			MAX	24.9	8.3	6.0	34	49.2	125
			MIN	23.5	7.2	5.7	32	47.9	121
59	21.00	7	AV7	24.8	8.1	5.9	33	48.3	129
			MAX	25.4	8.7	6.0	35	49.0	137
			MIN	24.1	7.4	5.7	31	47.8	121
65	22.00	6	AV6	24.8	8.4	5.8	33	48.6	130
			MAX	25.3	9.0	5.9	34	49.3	134
			MIN	24.0	8.1	5.7	33	48.2	126

USH 10 over LLBDM - WEST ABUTMENT #3 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
72	23.00	7	AV7	24.8	7.7	5.8	33	48.7	134
			MAX	25.5	8.1	6.0	34	49.2	142
			MIN	24.2	7.3	5.7	31	48.1	129
82	24.00	10	AV10	25.8	8.6	6.1	32	47.6	161
			MAX	27.1	10.0	6.3	34	48.7	181
			MIN	24.5	7.2	5.8	31	46.7	138
92	25.00	10	AV10	26.6	10.1	6.3	34	46.7	197
			MAX	27.4	11.3	6.5	35	47.4	208
			MIN	25.8	9.5	6.1	32	46.1	182
101	26.00	9	AV9	27.0	10.7	6.5	35	46.1	203
			MAX	27.6	11.6	6.7	37	46.9	208
			MIN	26.4	9.8	6.3	34	45.5	196
109	27.00	8	AV8	27.3	10.6	6.6	36	45.9	206
			MAX	28.0	11.3	6.8	38	46.9	212
			MIN	26.2	10.0	6.3	34	45.1	201
121	28.00	12	AV12	27.0	10.3	6.5	35	46.1	200
			MAX	27.5	11.1	6.7	37	46.7	216
			MIN	26.3	9.6	6.3	33	45.5	186
132	29.00	11	AV11	27.3	10.6	6.6	35	45.8	206
			MAX	28.9	12.6	7.0	38	47.2	236
			MIN	26.1	8.1	6.2	32	44.4	182
143	30.00	11	AV11	28.6	12.7	7.0	37	44.6	229
			MAX	29.2	13.6	7.1	38	45.1	235
			MIN	27.9	12.2	6.8	36	44.1	215
154	31.00	11	AV11	27.7	11.0	6.7	35	45.6	208
			MAX	28.7	12.8	7.1	38	46.7	219
			MIN	26.1	9.8	6.3	33	44.3	183
165	32.00	11	AV11	27.5	9.6	6.6	35	45.8	201
			MAX	28.4	10.5	6.8	36	46.6	221
			MIN	26.5	8.7	6.4	33	45.2	188
175	33.00	10	AV10	27.9	10.9	6.8	36	45.3	222
			MAX	28.4	11.8	6.9	37	45.9	228
			MIN	27.4	9.8	6.6	35	44.9	209
186	34.00	11	AV11	27.2	9.2	6.5	34	46.2	195
			MAX	27.6	9.9	6.6	35	47.3	206
			MIN	25.8	8.3	6.2	31	45.7	187
196	35.00	10	AV10	27.5	9.9	6.6	35	45.7	204
			MAX	28.6	10.7	6.8	37	46.3	213
			MIN	26.7	8.9	6.5	33	45.0	196

USH 10 over LLBDM - WEST ABUTMENT #3 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
205	36.00	9	AV9	27.3	9.4	6.5	34	46.2	196
			MAX	27.9	10.6	6.7	35	46.6	216
			MIN	26.7	8.3	6.4	33	45.6	184
212	37.00	7	AV7	27.4	9.3	6.5	35	46.3	187
			MAX	27.6	9.9	6.5	37	46.7	196
			MIN	26.9	8.4	6.3	33	46.0	175
220	38.00	8	AV8	26.8	8.6	6.3	34	46.8	182
			MAX	27.7	9.5	6.5	35	47.5	187
			MIN	26.0	7.9	6.1	32	46.3	178
229	39.00	9	AV9	26.9	8.8	6.3	33	46.7	188
			MAX	27.9	9.6	6.6	35	47.5	195
			MIN	25.9	8.0	6.1	31	45.9	171
239	40.00	10	AV10	27.3	9.6	6.5	34	46.2	194
			MAX	28.0	10.7	6.6	34	47.0	204
			MIN	26.3	8.7	6.3	32	45.7	180
249	41.00	10	AV10	27.0	9.9	6.4	33	46.4	197
			MAX	27.6	11.6	6.5	34	47.0	204
			MIN	26.2	8.5	6.3	31	46.0	193
259	42.00	10	AV10	27.1	9.9	6.4	32	46.5	192
			MAX	28.2	11.2	6.6	34	47.4	201
			MIN	26.3	8.9	6.1	31	45.7	183
268	43.00	9	AV9	27.2	9.9	6.4	34	46.3	192
			MAX	28.0	10.7	6.7	35	47.2	198
			MIN	26.2	9.1	6.2	31	45.6	186
277	44.00	9	AV9	27.0	9.1	6.4	33	46.6	198
			MAX	28.1	9.8	6.6	34	47.7	204
			MIN	26.0	8.6	6.1	30	45.9	187
289	45.00	12	AV12	27.3	9.7	6.5	32	46.3	208
			MAX	28.2	10.7	6.7	34	47.3	220
			MIN	26.3	8.7	6.2	30	45.5	195
299	46.00	10	AV10	27.1	9.3	6.4	33	46.3	206
			MAX	27.8	9.9	6.6	34	47.1	218
			MIN	26.5	8.6	6.2	31	45.8	197
309	47.00	10	AV10	26.7	9.0	6.4	32	46.5	211
			MAX	27.5	9.7	6.6	34	47.2	217
			MIN	26.0	8.4	6.2	31	45.8	204
320	48.00	11	AV11	26.8	9.1	6.4	31	46.4	220
			MAX	27.3	9.7	6.5	32	46.9	228
			MIN	26.3	8.5	6.3	31	46.0	210
331	49.00	11	AV11	27.4	9.6	6.6	33	45.9	232

USH 10 over LLBDM - WEST ABUTMENT #3 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	28.1	10.0	6.8	35	47.2	240
			MIN	26.0	9.1	6.2	30	45.2	223
341	50.00	10	AV10	26.9	9.1	6.4	32	46.4	229
			MAX	27.6	9.8	6.7	33	47.1	234
			MIN	26.1	8.7	6.2	30	45.6	225
350	51.00	9	AV9	27.2	9.1	6.5	34	46.0	226
			MAX	28.3	10.1	6.9	37	46.9	239
			MIN	26.5	8.8	6.3	31	44.8	218
360	52.00	10	AV10	27.0	9.1	6.5	33	46.2	224
			MAX	27.5	9.6	6.7	33	46.7	231
			MIN	26.5	8.9	6.3	31	45.4	220
370	53.00	10	AV10	27.1	9.0	6.4	32	46.4	230
			MAX	27.9	9.4	6.7	34	47.2	243
			MIN	26.4	8.8	6.2	31	45.4	222
381	54.00	11	AV11	27.1	9.4	6.5	32	46.3	233
			MAX	28.1	10.6	6.7	33	47.0	239
			MIN	26.3	8.9	6.3	30	45.6	229
391	55.00	10	AV10	27.2	9.2	6.5	32	46.1	230
			MAX	27.8	9.6	6.8	34	46.8	240
			MIN	26.7	8.8	6.3	31	45.3	226
400	56.00	9	AV9	27.1	9.1	6.5	32	46.2	231
			MAX	27.7	9.5	6.6	34	46.9	239
			MIN	26.4	8.9	6.3	31	45.7	227
409	57.00	9	AV9	27.1	9.4	6.5	33	46.1	231
			MAX	28.1	10.4	6.8	35	46.8	241
			MIN	26.3	9.0	6.3	31	45.3	223
418	58.00	9	AV9	27.1	9.3	6.5	32	46.2	231
			MAX	27.6	10.3	6.6	34	46.7	238
			MIN	26.6	9.0	6.3	31	45.7	227
429	59.00	11	AV11	27.4	9.6	6.5	32	46.0	236
			MAX	28.3	9.9	6.9	34	47.2	246
			MIN	26.4	9.2	6.2	30	44.9	229
441	60.00	12	AV12	27.3	10.0	6.5	30	46.2	235
			MAX	28.2	10.4	6.7	31	46.8	240
			MIN	26.5	9.6	6.3	29	45.6	230
452	61.00	11	AV11	28.1	10.6	6.7	32	45.6	239
			MAX	29.7	11.3	7.1	35	46.5	248
			MIN	27.5	10.1	6.4	30	44.3	233
465	62.00	13	AV13	27.9	11.0	6.7	31	45.6	242
			MAX	29.1	11.8	6.9	33	46.4	246

USH 10 over LLBDM - WEST ABUTMENT #3 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	27.2	10.3	6.4	28	44.7	233
477	63.00	12	AV12	28.1	11.3	6.7	31	45.5	238
			MAX	29.9	12.0	7.1	35	46.3	248
			MIN	27.3	10.3	6.5	29	44.1	233
489	64.00	12	AV12	28.3	11.3	6.8	32	45.3	241
			MAX	29.2	12.2	7.0	34	45.9	253
			MIN	27.3	10.9	6.6	30	44.4	234
501	65.00	12	AV12	28.8	11.6	7.0	34	44.6	246
			MAX	29.1	12.2	7.1	35	45.2	252
			MIN	28.4	10.9	6.8	33	44.2	241
515	66.00	14	AV14	28.2	11.4	6.8	32	45.1	244
			MAX	28.8	12.0	7.0	33	46.0	251
			MIN	27.4	11.0	6.5	30	44.4	238
528	67.00	13	AV13	28.1	11.7	6.8	32	45.1	240
			MAX	28.9	12.2	7.1	33	45.8	251
			MIN	27.1	11.2	6.6	30	44.2	230
540	68.00	12	AV12	27.6	12.3	6.8	31	45.2	230
			MAX	28.5	13.0	7.1	33	46.1	240
			MIN	26.7	11.3	6.5	29	44.2	222
552	69.00	12	AV12	27.8	13.0	6.8	31	45.1	229
			MAX	28.7	13.5	7.1	33	45.9	236
			MIN	26.9	12.1	6.6	29	44.2	218
564	70.00	12	AV12	27.8	12.8	6.8	31	45.2	227
			MAX	28.6	13.3	7.0	32	45.8	233
			MIN	26.7	12.2	6.6	29	44.5	217
576	71.00	12	AV12	28.0	13.5	6.8	31	45.1	228
			MAX	28.9	14.1	7.1	32	45.7	236
			MIN	27.4	12.4	6.6	30	44.2	223
588	72.00	12	AV12	27.7	13.8	6.7	30	45.5	224
			MAX	29.6	14.5	7.2	33	46.2	235
			MIN	27.1	13.1	6.5	28	43.8	217
599	73.00	11	AV11	27.8	13.8	6.7	30	45.5	224
			MAX	28.6	14.5	6.8	31	46.1	229
			MIN	26.9	13.4	6.5	28	45.0	219
611	74.00	12	AV12	28.6	14.6	6.7	31	45.3	230
			MAX	29.5	15.2	6.9	32	46.0	237
			MIN	27.9	13.8	6.5	29	44.7	220
624	75.00	13	AV13	28.4	14.9	6.8	31	45.2	238
			MAX	29.6	15.4	7.2	33	46.1	253
			MIN	27.4	14.6	6.5	29	43.9	232

USH 10 over LLBDM - WEST ABUTMENT #3 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
637	76.00	13	AV13	28.4	15.0	6.8	31	45.2	231
			MAX	29.2	15.8	7.0	33	46.1	238
			MIN	27.4	14.3	6.5	29	44.4	226
649	77.00	12	AV11	30.4	17.8	7.6	35	43.1	214
			MAX	33.1	20.1	9.1	42	45.3	229
			MIN	28.0	14.9	6.8	30	39.3	193
665	78.00	16	AV16	30.5	20.9	7.5	33	43.0	179
			MAX	31.8	22.2	7.9	35	43.7	196
			MIN	29.8	18.9	7.3	30	41.9	165
685	79.00	20	AV20	31.2	23.3	7.7	33	42.5	245
			MAX	32.1	25.6	7.9	35	43.2	306
			MIN	30.3	22.0	7.5	31	41.9	208
719	80.00	34	AV34	32.0	26.8	8.0	34	41.7	359
			MAX	33.5	30.2	8.6	38	42.9	440
			MIN	30.7	24.5	7.6	31	40.4	283
764	80.92	49	AV45	32.9	29.0	8.3	36	40.9	432
			MAX	33.8	30.3	8.6	38	41.6	459
			MIN	32.3	27.7	8.1	35	40.3	408
774	81.13	48	AV10	32.7	28.2	8.2	36	41.2	416
			MAX	33.1	29.1	8.4	36	41.9	430
			MIN	31.9	27.6	7.9	34	40.8	406
784	81.31	53	AV10	33.0	29.0	8.4	36	40.9	431
			MAX	33.5	29.6	8.5	37	41.3	437
			MIN	32.5	28.4	8.2	35	40.5	422
794	81.50	53	AV9	33.3	29.5	8.4	37	40.8	438
			MAX	33.7	30.0	8.6	38	41.3	442
			MIN	32.5	28.7	8.2	36	40.3	433
			Average	28.0	13.5	6.8	33	45.4	235
			Maximum	33.8	30.3	9.1	42	64.0	459
			Minimum	11.2	3.0	3.2	12	39.3	36

Total number of blows analyzed: 789

BL# Sensors

1-794 F3: [F607] 93.6 (0.98); F4: [D815] 93.0 (0.98); A3: [K2524] 360.0 (1.03); A4: [K3550] 360.0 (1.03)

BL# Comments

3 Reported Reference EL 777.46
642 LE = 90.00 ft; WC = 16,822.4 f/s

Time Summary

Drive	14 minutes 22 seconds	7:16 AM - 7:31 AM (4/16/2015) BN 1 - 641
Stop	2 hours 18 minutes 40 seconds	7:31 AM - 9:49 AM
Drive	3 minutes 39 seconds	9:49 AM - 9:53 AM BN 642 - 794

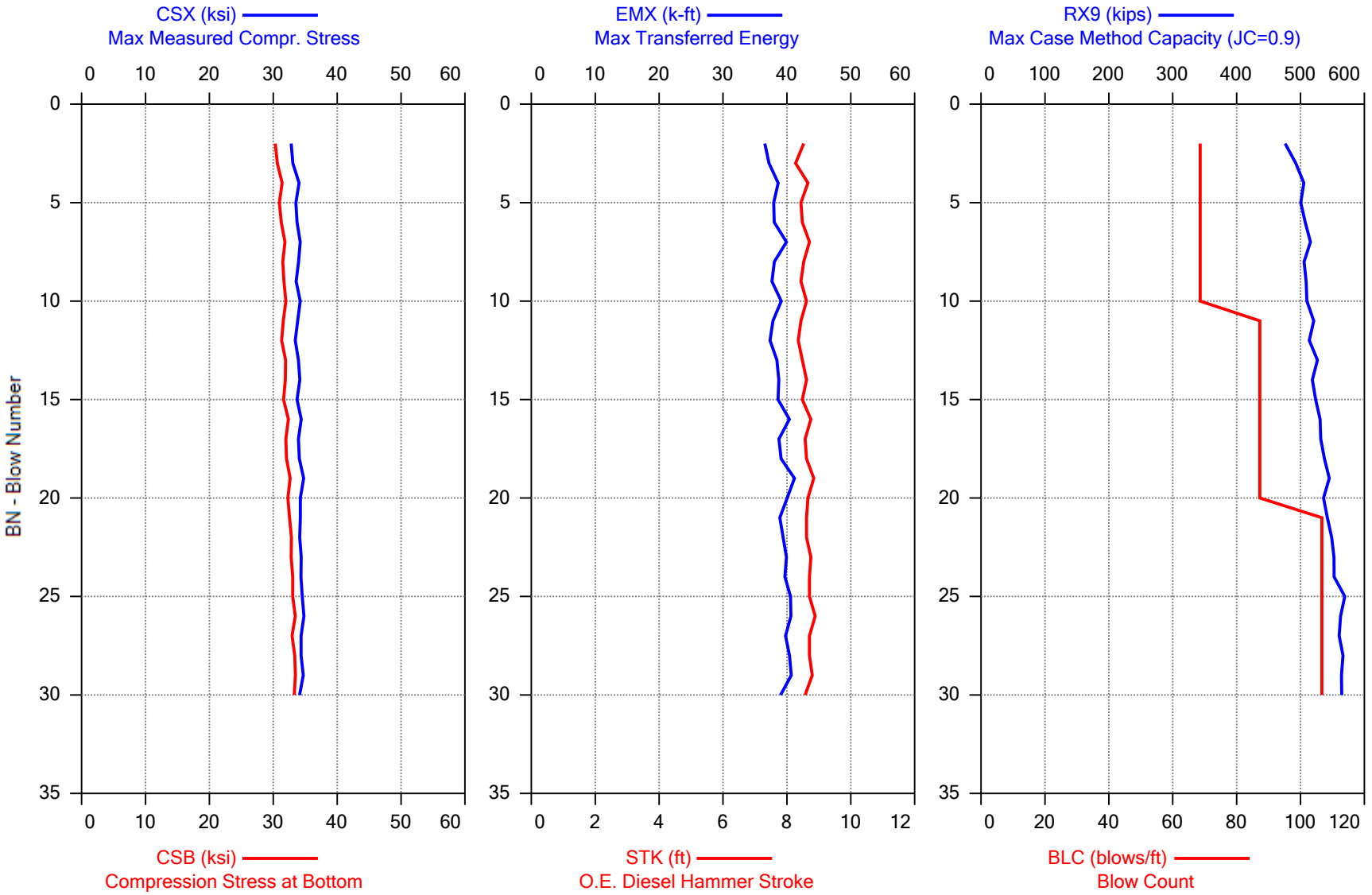
Total time [02:36:42] = (Driving [00:18:01] + Stop [02:18:40])

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 17-April-2015

Test started: 17-April-2015

USH 10 over LLBDM - WEST ABUTMENT #3-BOR
APE D30-42, HP 14 x 73



USH 10 over LLBDM - WEST ABUTMENT #3-BOR APE D30-42, HP 14 x 73
OP: RF Date: 17-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 90.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	81.65	69	AV9	33.7	31.3	8.5	38	40.5	502
			MAX	34.2	32.0	8.7	40	41.1	516
			MIN	32.8	30.3	8.3	37	40.1	476
20	81.76	87	AV10	34.0	32.0	8.6	39	40.4	528
			MAX	34.7	32.6	8.8	41	40.9	545
			MIN	33.4	31.3	8.4	37	39.8	514
30	81.85	107	AV10	34.4	33.1	8.7	40	40.1	558
			MAX	34.8	33.5	8.9	41	40.4	569
			MIN	34.1	32.5	8.6	39	39.7	542
			Average	34.0	32.1	8.6	39	40.3	531
			Maximum	34.8	33.5	8.9	41	41.1	569
			Minimum	32.8	30.3	8.3	37	39.7	476

Total number of blows analyzed: 29

BL# Sensors

1-30 F3: [F607] 93.6 (0.97); F4: [D815] 93.0 (0.97); A3: [K2524] 360.0 (1.03); A4: [K3550] 360.0 (1.03)

Time Summary

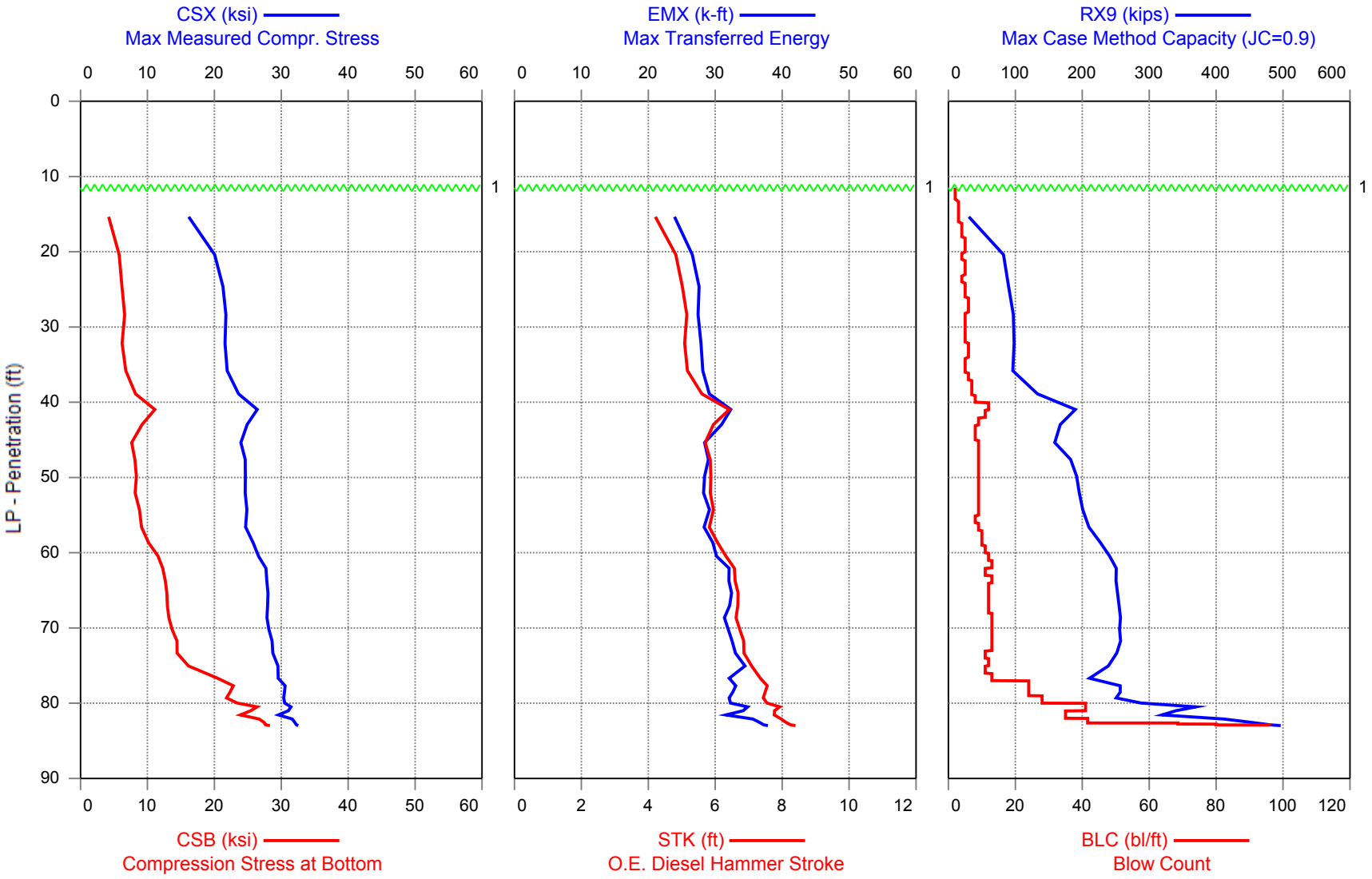
Drive 43 seconds 7:07 AM - 7:08 AM BN 1 - 30

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 17-April-2015

Test started: 16-April-2015

USH 10 over LLBDM - WEST ABUTMENT #8
APE D30-42, HP 14 x 73



1 - Reported Reference EL 777.46

USH 10 over LLBDM - WEST ABUTMENT #8 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-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
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#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
3	11.50	2	AV1	22.9	3.7	5.4	40	50.6	1
			MAX	22.9	3.7	5.4	40	50.6	1
			MIN	22.9	3.7	5.4	40	50.6	1
4	12.00	2	AV1	15.3	3.2	3.9	23	58.9	0
			MAX	15.3	3.2	3.9	23	58.9	0
			MIN	15.3	3.2	3.9	23	58.9	0
6	13.00	2	AV2	8.6	2.3	3.2	13	64.8	0
			MAX	10.6	2.6	3.3	16	66.6	0
			MIN	6.5	2.0	3.0	11	63.0	0
9	14.00	3	AV2	11.9	2.4	4.0	21	59.9	0
			MAX	22.5	4.3	5.2	42	68.2	0
			MIN	1.4	0.5	2.8	1	51.5	0
12	15.00	3	AV3	14.4	3.3	3.7	21	60.2	0
			MAX	16.4	3.7	3.9	27	61.9	0
			MIN	12.7	3.0	3.5	16	58.4	0
15	16.00	3	AV2	20.8	4.8	4.8	33	53.3	31
			MAX	23.0	5.3	5.3	37	55.8	62
			MIN	18.5	4.3	4.3	29	50.8	0
19	17.00	4	AV4	17.6	5.6	4.4	24	55.4	59
			MAX	18.7	6.0	4.6	26	56.2	63
			MIN	16.9	5.2	4.3	22	54.6	54
23	18.00	4	AV4	17.7	5.2	4.4	24	55.3	60
			MAX	19.2	5.3	4.7	26	56.6	74
			MIN	16.5	4.9	4.2	22	53.7	52
28	19.00	5	AV5	19.1	5.5	4.7	25	54.0	78
			MAX	20.3	5.6	4.9	27	54.8	85
			MIN	18.1	5.3	4.5	23	52.9	70
33	20.00	5	AV5	20.6	6.4	5.0	28	52.4	91
			MAX	21.2	7.0	5.1	29	53.1	96
			MIN	20.0	5.7	4.8	26	51.7	80
37	21.00	4	AV4	20.3	5.9	4.9	28	52.8	77
			MAX	20.9	6.7	5.1	30	54.4	83
			MIN	18.9	5.1	4.6	24	51.8	73
42	22.00	5	AV5	19.7	5.6	4.7	25	53.9	81
			MAX	21.1	6.0	5.0	27	54.7	83
			MIN	18.8	5.3	4.5	24	52.1	79

USH 10 over LLBDM - WEST ABUTMENT #8 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
47	23.00	5	AV5	20.5	5.5	4.8	27	53.3	85
			MAX	21.3	6.0	4.9	28	54.7	89
			MIN	19.5	5.2	4.5	25	52.7	78
51	24.00	4	AV4	21.2	6.3	5.0	28	52.5	84
			MAX	21.9	6.4	5.1	29	53.0	88
			MIN	20.7	6.2	4.9	27	51.7	81
56	25.00	5	AV5	21.1	6.5	5.0	27	52.3	91
			MAX	21.7	6.7	5.1	29	52.7	94
			MIN	20.7	6.3	4.9	26	51.9	87
61	26.00	5	AV5	21.5	6.2	5.1	28	51.8	90
			MAX	22.0	6.7	5.2	29	53.2	95
			MIN	20.3	5.8	4.8	26	51.1	84
67	27.00	6	AV6	22.1	6.3	5.2	28	51.2	98
			MAX	22.4	6.8	5.3	28	51.8	101
			MIN	21.6	6.1	5.1	27	50.7	96
73	28.00	6	AV6	22.0	6.8	5.2	27	51.2	105
			MAX	22.7	7.0	5.4	29	51.7	107
			MIN	21.6	6.5	5.1	26	50.6	102
78	29.00	5	AV5	21.8	6.4	5.2	28	51.5	99
			MAX	22.3	6.9	5.3	29	52.6	102
			MIN	20.7	6.0	4.9	26	50.8	93
83	30.00	5	AV5	21.4	6.7	5.1	28	51.8	90
			MAX	22.1	6.9	5.2	29	52.8	94
			MIN	20.5	6.3	4.9	26	51.2	81
88	31.00	5	AV5	20.8	5.7	4.9	27	52.8	86
			MAX	21.6	6.1	5.1	28	53.4	97
			MIN	20.2	5.5	4.8	26	51.8	72
93	32.00	5	AV5	22.3	6.2	5.2	30	51.2	103
			MAX	23.5	6.5	5.5	33	53.3	108
			MIN	20.3	5.9	4.8	26	50.1	92
99	33.00	6	AV6	21.8	6.1	5.2	28	51.5	101
			MAX	22.7	6.5	5.4	30	52.4	105
			MIN	21.0	5.8	5.0	26	50.5	96
105	34.00	6	AV6	21.3	7.0	5.0	27	52.3	98
			MAX	22.6	8.5	5.3	29	54.4	105
			MIN	19.6	5.9	4.6	24	50.7	92
110	35.00	5	AV5	22.3	7.9	5.3	29	51.0	99
			MAX	23.4	8.7	5.5	32	51.6	104
			MIN	21.7	7.0	5.1	27	49.9	96

USH 10 over LLBDM - WEST ABUTMENT #8 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
115	36.00	5	AV5	22.0	6.3	5.2	29	51.3	92
			MAX	23.2	6.7	5.5	32	52.7	99
			MIN	20.8	6.0	4.9	27	50.0	89
121	37.00	6	AV6	21.8	6.2	5.1	28	51.7	96
			MAX	22.2	6.3	5.2	29	52.5	101
			MIN	21.0	6.1	5.0	27	51.4	93
128	38.00	7	AV7	22.2	6.9	5.2	27	51.2	112
			MAX	23.4	8.1	5.6	30	52.2	133
			MIN	21.3	6.2	5.0	25	49.7	96
135	39.00	7	AV7	23.0	7.6	5.4	28	50.3	123
			MAX	24.4	8.8	5.8	31	52.2	143
			MIN	21.0	7.0	5.0	25	48.9	113
143	40.00	8	AV8	24.4	9.0	5.8	30	48.7	144
			MAX	24.9	10.3	5.9	32	49.3	169
			MIN	24.0	8.5	5.7	29	48.2	132
155	41.00	12	AV12	25.9	10.4	6.3	31	47.1	183
			MAX	27.6	12.4	6.8	34	49.9	208
			MIN	23.5	8.0	5.5	26	45.2	137
166	42.00	11	AV11	26.9	11.7	6.6	34	45.9	195
			MAX	28.5	12.8	7.1	37	47.1	201
			MIN	25.6	10.5	6.2	32	44.1	188
175	43.00	9	AV9	25.8	10.4	6.2	33	47.3	181
			MAX	26.8	11.9	6.6	35	48.2	191
			MIN	25.1	9.6	5.9	31	45.8	168
183	44.00	8	AV8	23.7	7.7	5.6	29	49.5	148
			MAX	25.8	9.2	6.1	32	51.3	166
			MIN	22.4	7.0	5.2	25	47.6	134
191	45.00	8	AV8	23.6	7.3	5.6	28	49.6	146
			MAX	24.4	7.7	5.8	29	50.1	156
			MIN	23.0	7.1	5.5	27	48.7	139
200	46.00	9	AV9	24.3	7.8	5.8	29	48.7	163
			MAX	25.1	8.2	6.0	31	50.4	169
			MIN	22.7	7.6	5.4	26	47.9	155
209	47.00	9	AV9	24.3	8.0	5.8	29	48.8	173
			MAX	25.1	8.4	6.0	30	50.0	185
			MIN	23.1	7.5	5.5	27	48.1	163
218	48.00	9	AV9	24.7	8.1	5.9	29	48.5	184
			MAX	26.2	8.8	6.2	33	50.1	194
			MIN	23.2	7.7	5.5	26	47.1	175
227	49.00	9	AV9	24.6	8.2	5.9	29	48.4	186

USH 10 over LLBDM - WEST ABUTMENT #8 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MAX	25.3	8.7	6.0	30	49.5	190
			MIN	23.6	7.9	5.6	27	47.9	182
236	50.00	9	AV9	24.4	8.3	5.8	28	48.7	188
			MAX	25.6	8.9	6.1	30	49.5	196
			MIN	23.6	7.8	5.6	26	47.7	182
245	51.00	9	AV9	24.7	8.4	5.9	28	48.3	196
			MAX	25.6	9.0	6.1	31	48.9	205
			MIN	23.9	7.8	5.8	27	47.4	187
254	52.00	9	AV9	24.2	8.1	5.8	27	48.8	194
			MAX	24.7	8.7	5.9	28	49.4	199
			MIN	23.8	7.9	5.6	26	48.2	189
263	53.00	9	AV9	25.1	8.2	5.9	29	48.2	198
			MAX	26.2	8.4	6.2	31	49.7	203
			MIN	23.5	7.7	5.6	27	47.1	189
272	54.00	9	AV9	24.6	8.5	5.9	28	48.3	198
			MAX	25.6	9.5	6.2	30	49.4	207
			MIN	23.6	8.2	5.6	27	47.2	191
281	55.00	9	AV9	24.9	8.9	5.9	29	48.1	202
			MAX	25.7	9.5	6.1	32	48.8	207
			MIN	24.4	8.5	5.8	28	47.5	197
289	56.00	8	AV8	24.9	8.8	5.9	29	48.5	202
			MAX	26.5	9.9	6.4	32	49.3	209
			MIN	24.1	8.2	5.7	28	46.6	197
298	57.00	9	AV9	24.8	9.2	5.9	29	48.5	211
			MAX	26.1	9.6	6.2	31	49.5	219
			MIN	23.8	8.8	5.6	27	47.1	203
308	58.00	10	AV10	25.1	9.6	5.9	29	48.2	219
			MAX	26.7	10.7	6.3	31	49.2	231
			MIN	24.2	9.0	5.7	26	46.9	208
318	59.00	10	AV10	25.5	9.8	6.0	29	48.0	224
			MAX	26.5	10.5	6.3	31	48.9	234
			MIN	24.6	9.0	5.8	28	46.9	217
329	60.00	11	AV11	26.1	11.1	6.2	30	47.3	233
			MAX	26.8	11.7	6.4	32	47.9	240
			MIN	25.5	10.4	6.0	29	46.6	227
341	61.00	12	AV12	26.8	11.6	6.4	30	46.6	243
			MAX	27.6	12.6	6.7	33	47.2	252
			MIN	26.3	11.0	6.2	29	45.5	238
354	62.00	13	AV13	27.4	12.2	6.5	31	46.2	250
			MAX	28.2	12.8	6.8	33	47.1	263

USH 10 over LLBDM - WEST ABUTMENT #8 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
			MIN	26.7	11.7	6.2	29	45.2	243
365	63.00	11	AV11	27.8	12.4	6.6	32	45.9	249
			MAX	28.7	12.8	6.8	34	46.9	257
			MIN	26.5	12.1	6.3	30	45.0	242
378	64.00	13	AV13	28.0	12.6	6.6	32	45.8	252
			MAX	29.2	13.2	6.9	35	46.6	260
			MIN	26.9	12.1	6.4	31	44.7	247
390	65.00	12	AV12	27.7	12.8	6.6	32	45.8	249
			MAX	28.8	13.4	7.0	34	46.4	257
			MIN	27.0	12.3	6.4	31	44.6	243
402	66.00	12	AV12	28.1	13.1	6.7	33	45.4	255
			MAX	29.1	13.7	7.0	35	46.5	263
			MIN	27.0	12.5	6.4	30	44.6	247
414	67.00	12	AV12	28.0	12.9	6.7	32	45.5	254
			MAX	29.0	14.1	6.9	34	46.2	262
			MIN	27.1	12.2	6.5	31	44.8	246
426	68.00	12	AV12	28.0	13.0	6.7	32	45.6	256
			MAX	28.9	14.1	6.8	34	46.4	261
			MIN	27.0	12.4	6.4	31	45.0	249
439	69.00	13	AV13	28.0	13.1	6.6	32	45.7	259
			MAX	28.7	14.1	6.8	33	46.2	265
			MIN	27.5	12.5	6.5	31	45.0	254
452	70.00	13	AV13	27.7	13.4	6.6	31	45.7	254
			MAX	28.7	14.1	6.8	32	46.4	264
			MIN	26.8	12.7	6.4	30	45.1	247
465	71.00	13	AV13	28.3	13.8	6.8	32	45.3	256
			MAX	28.9	14.6	6.9	33	46.0	260
			MIN	27.5	13.4	6.5	31	44.8	249
478	72.00	13	AV13	28.6	14.4	6.8	32	45.0	257
			MAX	29.1	15.1	7.0	34	45.6	263
			MIN	28.0	13.5	6.7	31	44.4	250
491	73.00	13	AV13	28.7	14.4	6.9	33	45.0	258
			MAX	29.8	15.0	7.1	35	45.5	262
			MIN	28.1	14.0	6.7	31	44.1	252
502	74.00	11	AV11	28.8	14.4	6.9	33	45.0	248
			MAX	29.8	14.8	7.1	36	45.8	255
			MIN	27.7	13.9	6.6	31	44.1	239
514	75.00	12	AV12	28.8	14.7	6.9	33	44.9	246
			MAX	29.7	15.4	7.1	35	45.4	252
			MIN	28.1	14.3	6.7	32	44.1	240

USH 10 over LLBDM - WEST ABUTMENT #8 APE D30-42, HP 14 x 73
OP: RF Date: 16-April-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
525	76.00	11	AV11	30.1	17.5	7.3	36	43.7	232
			MAX	31.0	19.1	7.6	38	44.1	243
			MIN	29.4	15.2	7.1	34	42.8	223
538	77.00	13	AV13	29.4	20.1	7.3	32	43.6	195
			MAX	31.4	21.9	7.9	36	44.6	226
			MIN	27.5	18.0	7.0	30	42.1	155
562	78.00	24	AV24	30.4	22.7	7.5	33	43.0	254
			MAX	31.4	23.9	7.8	35	43.9	275
			MIN	29.4	21.7	7.2	30	42.2	232
586	79.00	24	AV24	30.5	22.2	7.5	33	43.1	254
			MAX	31.5	22.9	7.8	35	44.2	269
			MIN	29.3	21.3	7.1	30	42.2	233
614	80.00	28	AV28	30.3	22.1	7.4	32	43.3	255
			MAX	31.8	23.5	7.9	34	44.3	283
			MIN	29.3	20.8	7.1	30	42.1	236
655	81.00	41	AV41	31.2	25.8	7.8	34	42.2	353
			MAX	32.2	27.0	8.2	37	43.2	380
			MIN	30.3	23.3	7.5	32	41.2	289
690	82.00	35	AV35	30.2	24.5	7.8	33	42.4	331
			MAX	32.1	26.8	8.1	37	43.2	407
			MIN	15.4	12.7	7.5	9	41.5	187
716	82.63	42	AV26	31.9	27.1	8.1	36	41.6	433
			MAX	33.0	28.1	8.4	40	42.7	459
			MIN	30.6	26.1	7.6	33	40.7	411
726	82.77	69	AV10	32.1	27.5	8.1	37	41.4	465
			MAX	33.4	28.5	8.6	39	42.2	472
			MIN	31.2	26.7	7.8	35	40.4	455
736	82.90	80	AV10	32.3	27.7	8.3	37	41.1	477
			MAX	33.1	28.3	8.6	39	41.7	487
			MIN	31.6	27.1	8.0	36	40.4	470
746	83.00	96	AV10	32.3	27.8	8.3	37	41.1	488
			MAX	32.8	28.5	8.5	38	41.5	499
			MIN	31.9	27.3	8.1	36	40.6	478
			Average	26.8	14.3	6.5	31	46.5	230
			Maximum	33.4	28.5	8.6	42	68.2	499
			Minimum	1.4	0.5	2.8	1	40.4	0

Total number of blows analyzed: 742

BL# Sensors

1-746 F3: [D815] 93.0 (0.99); F4: [F607] 93.6 (0.99); A3: [K3550] 360.0 (1.01); A4: [K2524] 360.0 (1.01)

BL# Comments

3 Reported Reference EL 777.46
526 LE = 90.00 ft

Time Summary

Drive	11 minutes 47 seconds	8:54 AM - 9:06 AM (4/16/2015) BN 1 - 525
Stop	1 hour 9 minutes 25 seconds	9:06 AM - 10:16 AM
Drive	5 minutes 11 seconds	10:16 AM - 10:21 AM BN 526 - 746

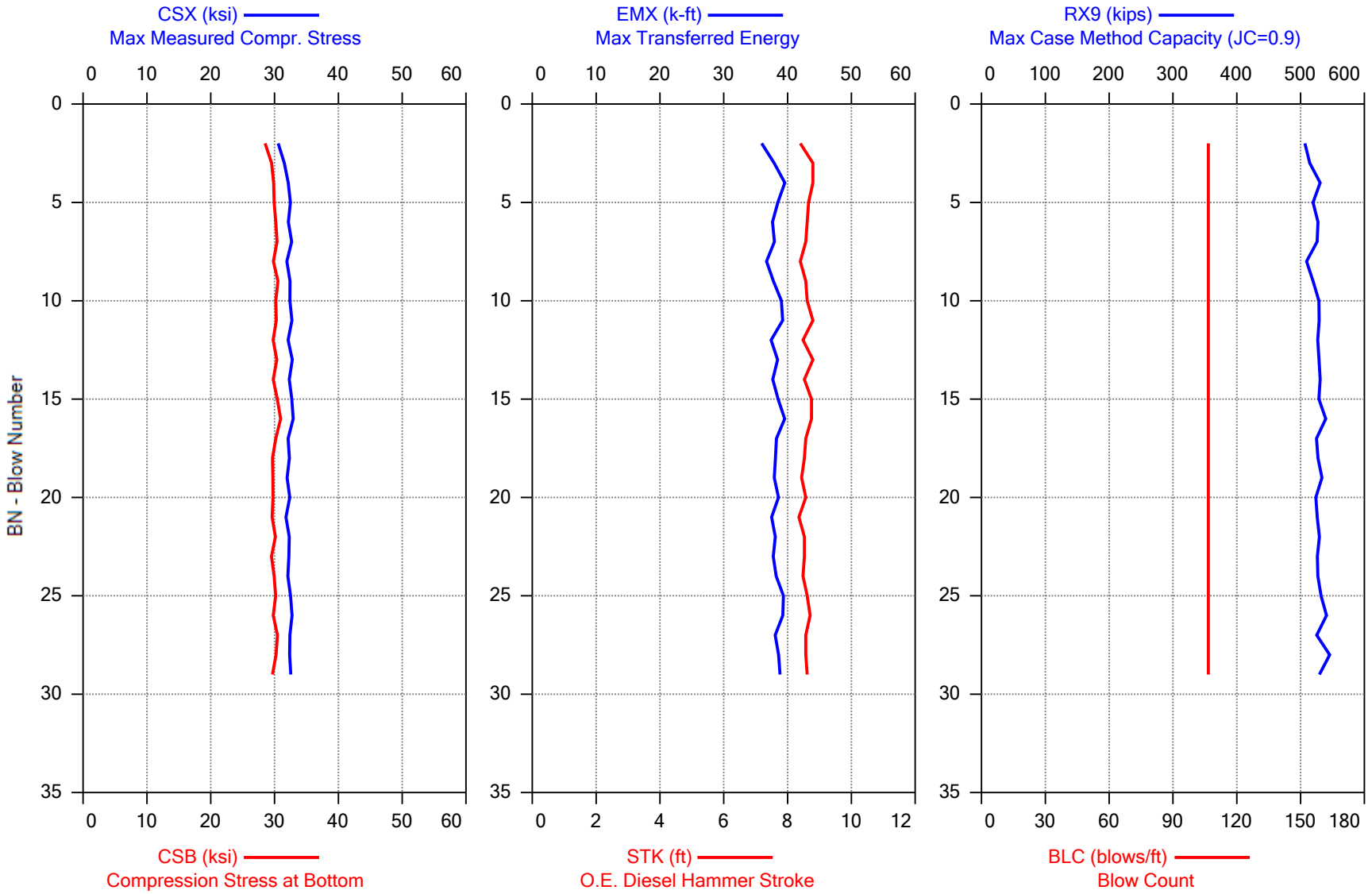
Total time [01:26:23] = (Driving [00:16:58] + Stop [01:09:25])

GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 17-April-2015

Test started: 17-April-2015

USH 10 over LLBDM - WEST ABUTMENT #8-BOR
APE D30-42, HP 14 x 73



USH 10 over LLBDM - WEST ABUTMENT #8-BOR APE D30-42, HP 14 x 73
OP: RF Date: 17-April-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 90.00 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	83.09	107	AV9	32.0	29.9	8.6	38	40.3	520
			MAX	32.7	30.5	8.8	40	40.8	531
			MIN	30.6	28.5	8.4	36	39.9	507
20	83.19	107	AV10	32.4	30.1	8.6	38	40.3	529
			MAX	32.9	31.0	8.8	40	40.7	539
			MIN	32.0	29.7	8.4	37	39.9	524
30	83.28	107	AV9	32.3	29.9	8.6	38	40.4	531
			MAX	32.7	30.5	8.7	39	40.9	545
			MIN	31.8	29.5	8.4	37	40.1	525
			Average	32.3	30.0	8.6	38	40.4	527
			Maximum	32.9	31.0	8.8	40	40.9	545
			Minimum	30.6	28.5	8.4	36	39.9	507

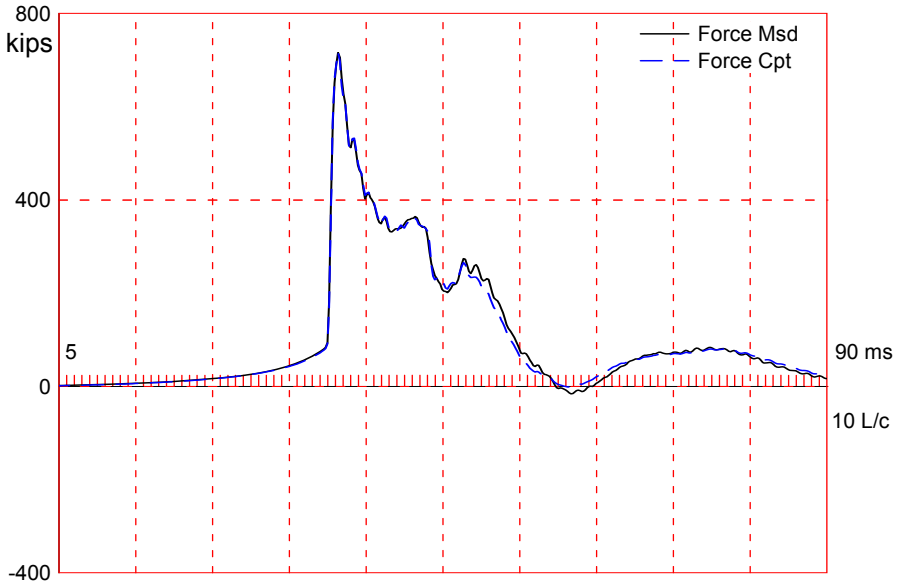
Total number of blows analyzed: 28

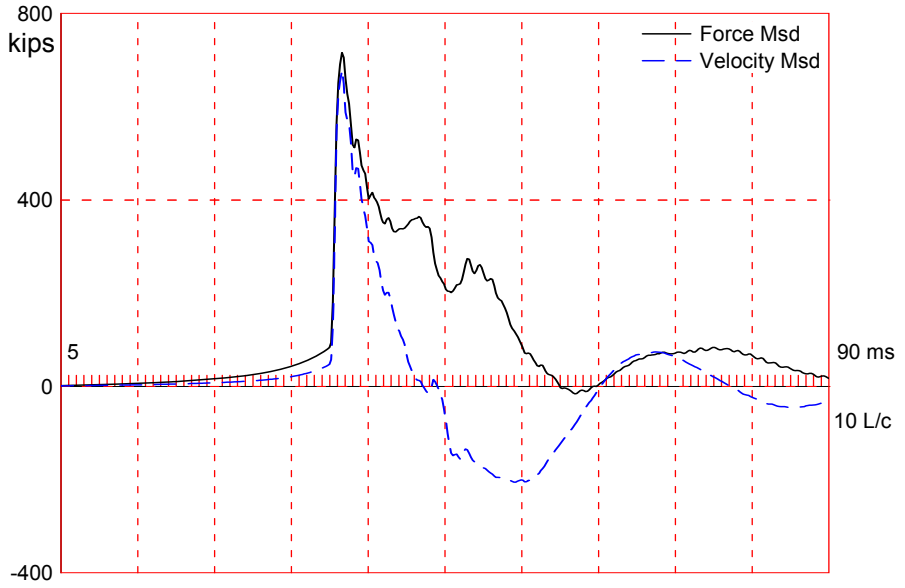
BL# Sensors

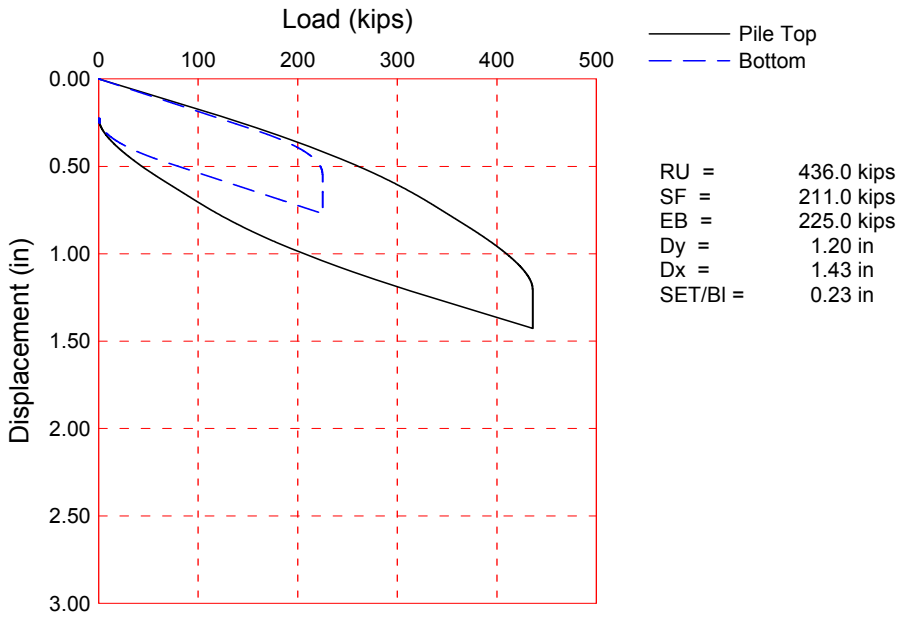
1-30 F3: [D815] 93.0 (0.97); F4: [F607] 93.6 (0.97); A3: [K3550] 360.0 (1.03); A4: [K2524] 360.0 (1.03)

Time Summary

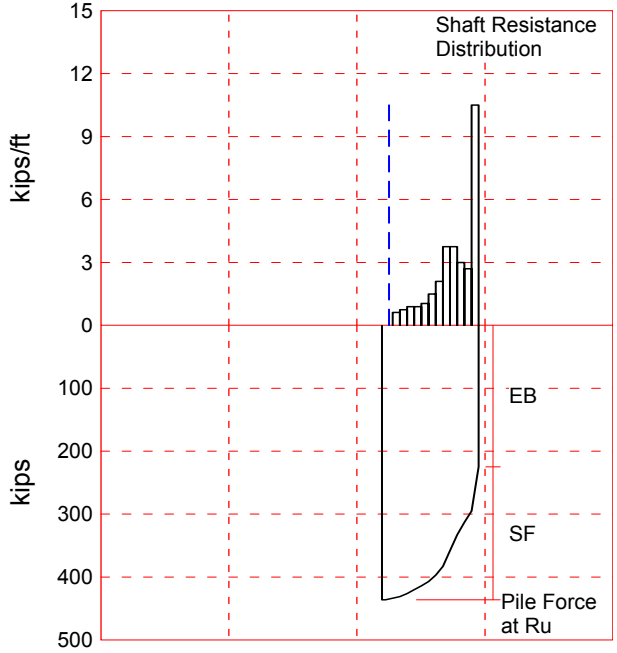
Drive 43 seconds 6:57 AM - 6:57 AM BN 1 - 30







RU =	436.0 kips
SF =	211.0 kips
EB =	225.0 kips
Dy =	1.20 in
Dx =	1.43 in
SET/Bl =	0.23 in



Length b. Sensors	90.0 ft
Embedment	81.5 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	1.98
Top Compr. Stress	33.5 ksi
Max Compr. Stress	34.3 ksi
Max Tension Stress	-1.23 ksi
Avg. Shaft Quake	0.18 in
Toe Quake	0.42 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.07 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: 436.0; along Shaft 211.0; at Toe 225.0 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
				436.0			
1	16.7	8.1	5.0	431.0	5.0	0.62	0.13
2	23.3	14.8	5.0	426.0	10.0	0.75	0.16
3	30.0	21.5	6.0	420.0	16.0	0.90	0.19
4	36.7	28.1	6.0	414.0	22.0	0.90	0.19
5	43.3	34.8	7.0	407.0	29.0	1.05	0.22
6	50.0	41.5	10.0	397.0	39.0	1.50	0.32
7	56.7	48.1	14.0	383.0	53.0	2.10	0.45
8	63.3	54.8	25.0	358.0	78.0	3.75	0.80
9	70.0	61.5	25.0	333.0	103.0	3.75	0.80
10	76.7	68.1	20.0	313.0	123.0	3.00	0.64
11	83.3	74.8	18.0	295.0	141.0	2.70	0.57
12	90.0	81.5	70.0	225.0	211.0	10.50	2.23
Avg. Shaft			17.6			2.59	0.55
Toe			225.0				163.22

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.24	0.07
Quake	(in)	0.18	0.42
Case Damping Factor		1.33	0.41
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	76	115
Unloading Level	(% of Ru)	78	
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)		0.121

CAPWAP match quality = 1.98 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.26 in; Blow Count = 46 b/ft

Transducer F3(F607) CAL: 93.6; RF: 0.97; F4(D815) CAL: 93.0; RF: 0.97
A3(K2524) CAL: 360; RF: 1.02; A4(K3550) CAL: 360; RF: 1.02

max. Top Comp. Stress = 33.5 ksi (T= 36.3 ms, max= 1.026 x Top)
max. Comp. Stress = 34.3 ksi (Z= 16.7 ft, T= 37.1 ms)
max. Tens. Stress = -1.23 ksi (Z= 30.0 ft, T= 63.7 ms)
max. Energy (EMX) = 37.5 kip-ft; max. Measured Top Displ. (DMX)= 0.98 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	716.3	-10.8	33.5	-0.51	37.5	17.7	0.97
2	6.7	717.3	-11.8	33.5	-0.55	37.3	17.7	0.96
4	13.3	728.3	-19.6	34.0	-0.92	36.8	17.4	0.92
6	20.0	715.0	-22.1	33.4	-1.03	35.1	17.0	0.88
8	26.7	703.9	-23.0	32.9	-1.08	33.3	16.6	0.84
10	33.3	688.6	-22.8	32.2	-1.06	31.4	16.2	0.79
12	40.0	675.4	-22.1	31.6	-1.03	29.6	15.8	0.75
13	43.3	685.7	-25.2	32.0	-1.18	29.3	15.5	0.72
14	46.7	663.2	-20.0	31.0	-0.93	27.7	15.2	0.70
15	50.0	676.6	-23.1	31.6	-1.08	27.3	14.9	0.68
16	53.3	645.6	-15.9	30.2	-0.74	25.4	14.5	0.66
17	56.7	668.0	-17.9	31.2	-0.84	25.1	14.0	0.63
18	60.0	628.5	-6.0	29.4	-0.28	22.8	13.4	0.61
19	63.3	652.1	-9.1	30.5	-0.43	22.4	12.8	0.59
20	66.7	573.3	0.0	26.8	0.00	19.0	12.3	0.57
21	70.0	590.2	0.0	27.6	0.00	18.7	11.8	0.55
22	73.3	516.5	0.0	24.1	0.00	15.7	11.4	0.52
23	76.7	530.2	0.0	24.8	0.00	15.4	11.1	0.50
24	80.0	476.4	0.0	22.3	0.00	13.1	10.7	0.48
25	83.3	478.0	0.0	22.3	0.00	12.9	11.3	0.47
26	86.7	383.4	0.0	17.9	0.00	11.0	12.5	0.45
27	90.0	383.4	0.0	17.9	0.00	5.2	12.5	0.43
Absolute	16.7			34.3			(T =	37.1 ms)
	30.0				-1.23		(T =	63.7 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	801.9	749.2	696.5	643.8	591.1	538.4	485.7	433.0	380.3	327.6
RX	801.9	749.2	696.5	643.8	591.1	538.4	493.6	466.9	452.5	442.0
RU	834.4	730.2	626.1	521.9	417.7	313.6	209.4	105.2	1.1	0.0

RAU = 253.4 (kips); RA2 = 530.7 (kips)

Current CAPWAP Ru = 436.0 (kips); Corresponding J(RP)= 1.39; matches RX20 within 5%

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
17.7	36.29	649.7	705.5	715.7	0.98	0.23	0.23	37.6	747.6	577

PILE PROFILE AND PILE MODEL

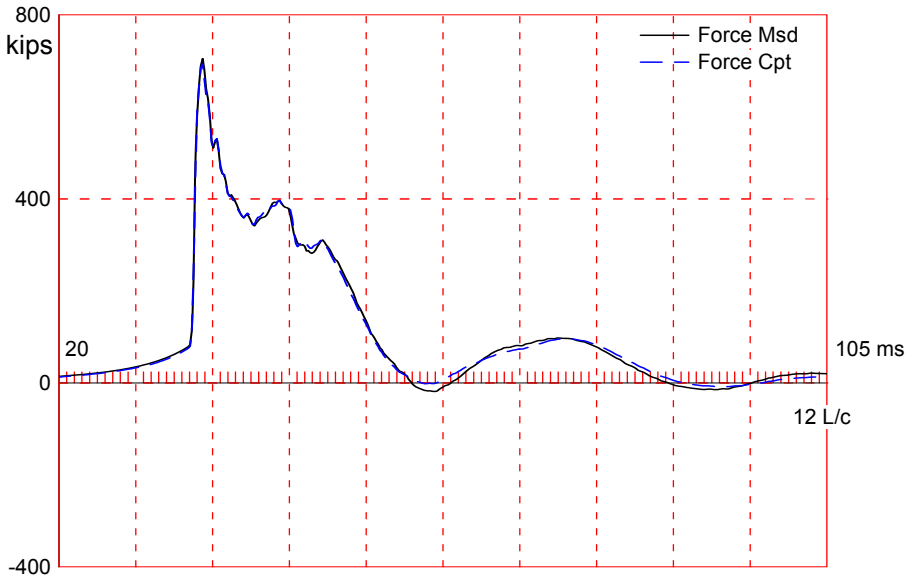
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
90.0	21.4	29992.2	492.000	4.70

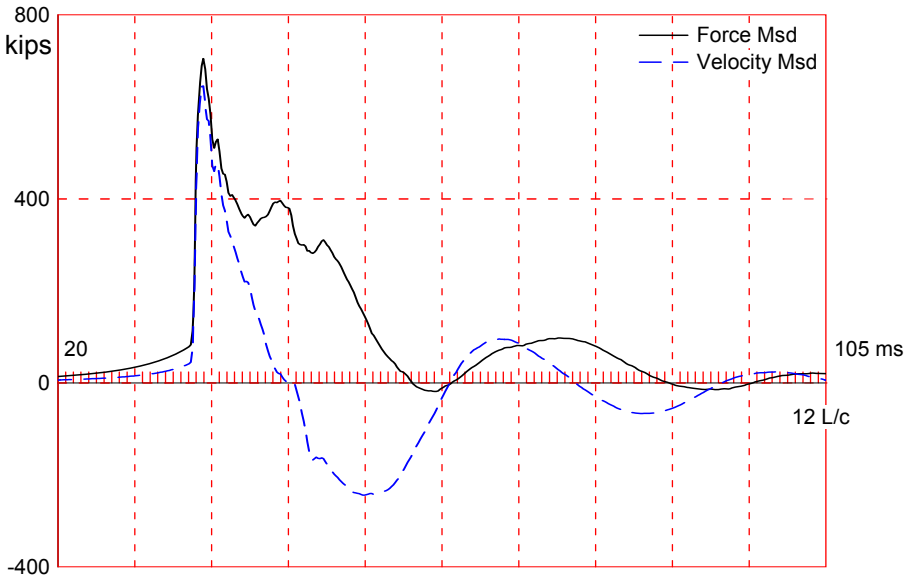
Toe Area 198.5 in²

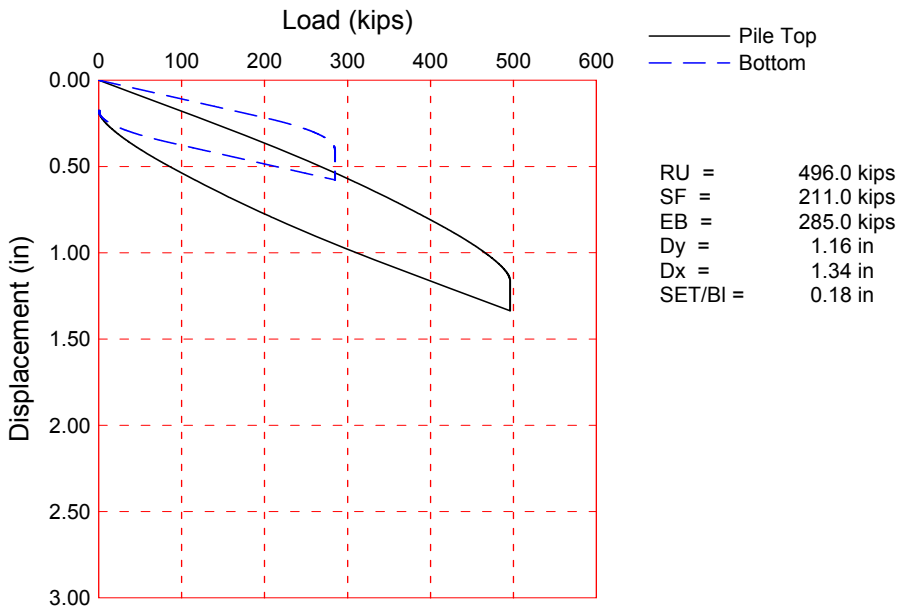
Top Segment Length 3.33 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.198 ms, 2L/c 10.7 ms

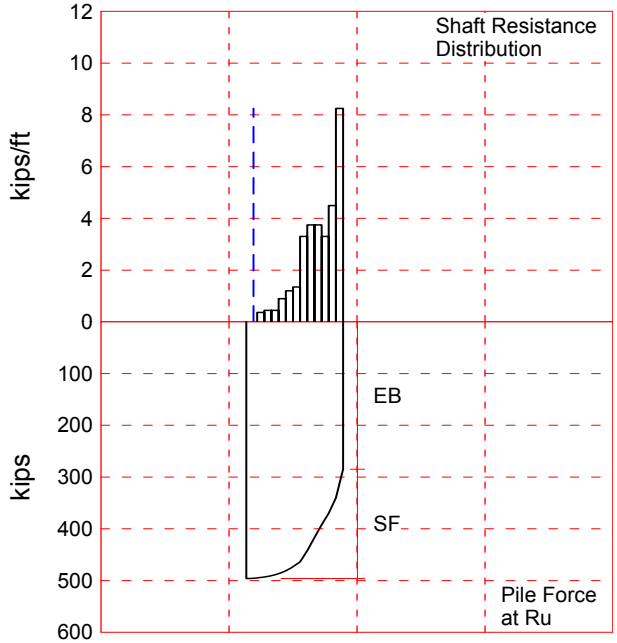
Total volume: 13.375 ft^3; Volume ratio considering added impedance: 1.000







RU =	496.0 kips
SF =	211.0 kips
EB =	285.0 kips
Dy =	1.16 in
Dx =	1.34 in
SET/Bl =	0.18 in



Length b. Sensors	90.0 ft
Embedment	81.5 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	1.96
Top Compr. Stress	32.4 ksi
Max Compr. Stress	33.1 ksi
Max Tension Stress	-2.57 ksi
Avg. Shaft Quake	0.22 in
Toe Quake	0.31 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.13 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 496.0; along Shaft 211.0; at Toe 285.0 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
				496.0			
1	16.7	8.2	3.0	493.0	3.0	0.37	0.08
2	23.3	14.9	3.0	490.0	6.0	0.45	0.10
3	30.0	21.5	3.0	487.0	9.0	0.45	0.10
4	36.7	28.2	6.0	481.0	15.0	0.90	0.19
5	43.3	34.9	8.0	473.0	23.0	1.20	0.26
6	50.0	41.5	9.0	464.0	32.0	1.35	0.29
7	56.7	48.2	22.0	442.0	54.0	3.30	0.70
8	63.3	54.9	25.0	417.0	79.0	3.75	0.80
9	70.0	61.5	25.0	392.0	104.0	3.75	0.80
10	76.7	68.2	22.0	370.0	126.0	3.30	0.70
11	83.3	74.9	30.0	340.0	156.0	4.50	0.96
12	90.0	81.5	55.0	285.0	211.0	8.25	1.76
Avg. Shaft			17.6			2.59	0.55
Toe			285.0				206.75

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.26	0.13
Quake	(in)	0.22	0.31
Case Damping Factor		1.44	0.97
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	73	107
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	97	
Resistance Gap (included in Toe Quake)	(in)		0.01
Soil Plug Weight	(kips)	0.025	0.081

CAPWAP match quality = 1.96 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.18 in; Blow Count = 69 b/ft
Computed: Final Set = 0.14 in; Blow Count = 85 b/ft
Transducer F1(F607) CAL: 93.6; RF: 0.97; F2(D815) CAL: 93.0; RF: 0.97
A1(K2524) CAL: 360; RF: 1.03; A2(K3550) CAL: 360; RF: 1.03

max. Top Comp. Stress = 32.4 ksi (T= 36.3 ms, max= 1.021 x Top)
max. Comp. Stress = 33.1 ksi (Z= 16.7 ft, T= 37.1 ms)
max. Tens. Stress = -2.57 ksi (Z= 43.3 ft, T= 62.1 ms)
max. Energy (EMX) = 36.8 kip-ft; max. Measured Top Displ. (DMX)= 0.98 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	694.4	-11.4	32.4	-0.53	36.8	17.2	0.98
2	6.7	695.6	-15.4	32.5	-0.72	36.5	17.1	0.96
4	13.3	703.6	-28.9	32.9	-1.35	35.8	16.9	0.91
6	20.0	696.5	-36.3	32.5	-1.69	34.2	16.7	0.86
8	26.7	690.0	-43.0	32.2	-2.01	32.7	16.4	0.81
10	33.3	689.4	-49.1	32.2	-2.29	31.1	16.0	0.76
12	40.0	678.5	-50.2	31.7	-2.34	29.0	15.5	0.70
13	43.3	690.9	-55.0	32.3	-2.57	28.5	15.2	0.67
14	46.7	661.9	-48.0	30.9	-2.24	26.6	14.9	0.65
15	50.0	685.0	-52.3	32.0	-2.44	26.0	14.4	0.62
16	53.3	661.7	-44.0	30.9	-2.05	24.2	13.8	0.59
17	56.7	687.8	-47.7	32.1	-2.23	23.6	13.3	0.56
18	60.0	614.9	-24.0	28.7	-1.12	20.4	12.7	0.53
19	63.3	639.2	-27.4	29.9	-1.28	19.9	12.2	0.51
20	66.7	563.8	-1.1	26.3	-0.05	16.8	11.6	0.48
21	70.0	588.6	-4.1	27.5	-0.19	16.3	11.0	0.45
22	73.3	515.2	0.0	24.1	0.00	13.7	10.6	0.43
23	76.7	531.7	0.0	24.8	0.00	13.3	10.2	0.40
24	80.0	477.9	-0.0	22.3	-0.00	11.2	9.8	0.38
25	83.3	468.7	-0.0	21.9	-0.00	10.8	10.4	0.36
26	86.7	418.3	-0.0	19.5	-0.00	8.6	11.1	0.34
27	90.0	431.4	-0.0	20.2	-0.00	5.7	10.3	0.31
Absolute	16.7			33.1			(T =	37.1 ms)
	43.3				-2.57		(T =	62.1 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	825.8	781.9	738.0	694.1	650.2	606.3	562.4	518.5	474.6	430.7
RX	825.8	781.9	738.0	694.1	650.2	606.7	569.3	541.2	514.8	498.0
RU	853.6	767.0	680.4	593.7	507.1	420.5	333.9	247.2	160.6	74.0

RAU = 235.4 (kips); RA2 = 578.2 (kips)

Current CAPWAP Ru = 496.0 (kips); Corresponding J(RP)= 1.50; J(RX) = 1.83

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
16.9	36.29	604.7	682.0	704.7	0.98	0.18	0.18	37.1	768.8	950

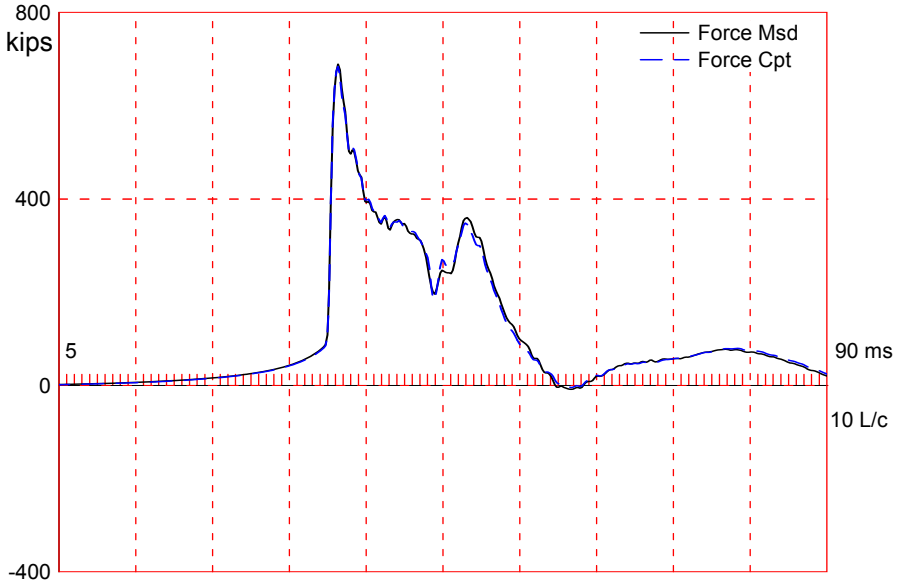
PILE PROFILE AND PILE MODEL

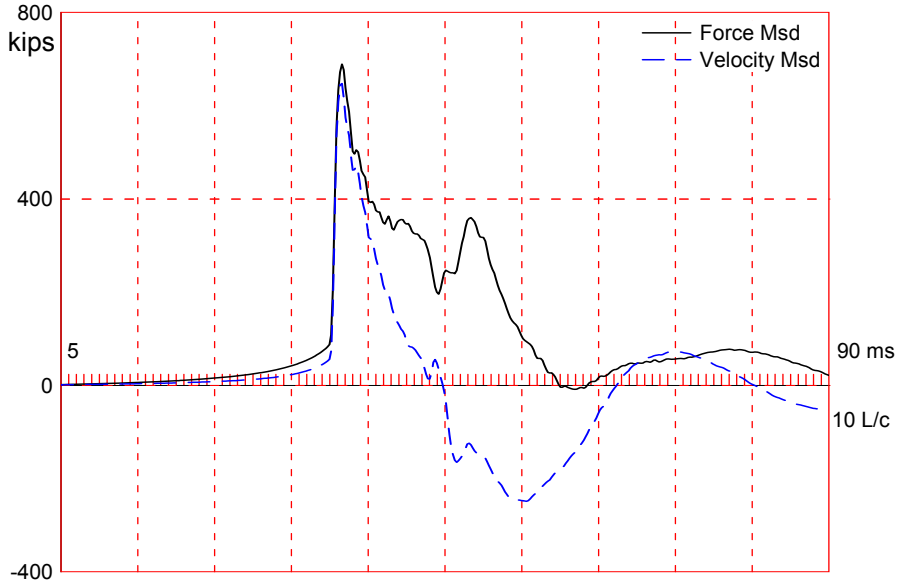
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
90.0	21.4	29992.2	492.000	4.70

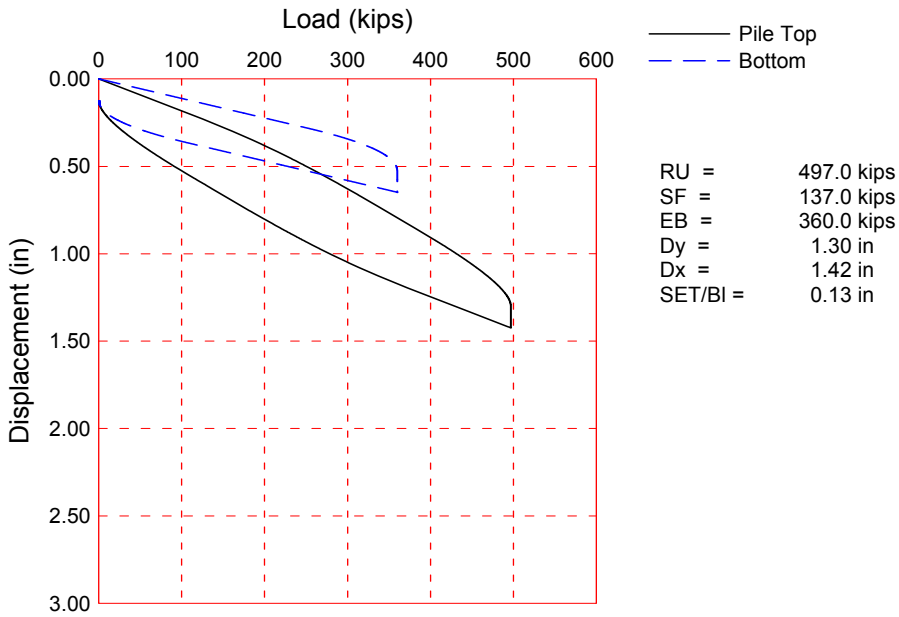
Toe Area 198.5 in^2

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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
23	76.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.015
24	80.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
25	83.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
27	90.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000

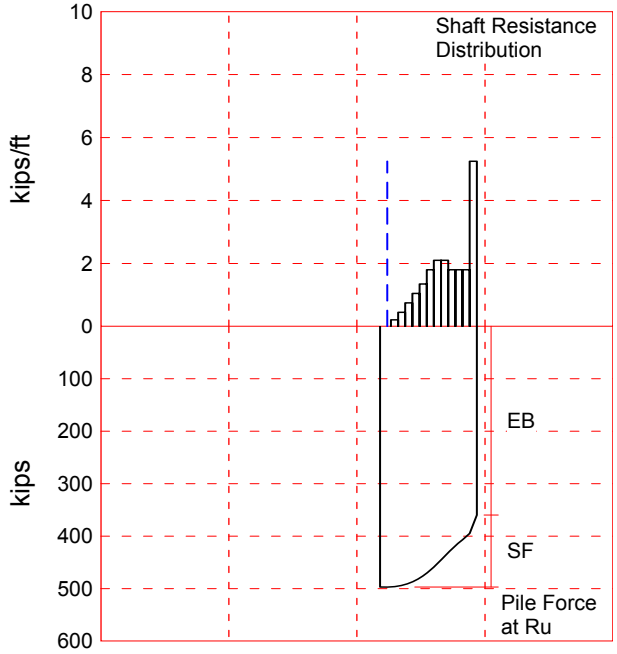
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.198 ms, 2L/c 10.7 ms
Total volume: 13.375 ft^3; Volume ratio considering added impedance: 1.000







RU =	497.0 kips
SF =	137.0 kips
EB =	360.0 kips
Dy =	1.30 in
Dx =	1.42 in
SET/Bl =	0.13 in



Length b. Sensors	90.0 ft
Embedment	83.0 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	1.59
Top Compr. Stress	32.0 ksi
Max Compr. Stress	32.5 ksi
Max Tension Stress	-1.89 ksi
Avg. Shaft Quake	0.18 in
Toe Quake	0.40 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.08 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: 497.0; along Shaft 137.0; at Toe 360.0 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
				497.0			
1	16.7	9.7	2.0	495.0	2.0	0.21	0.04
2	23.3	16.3	3.0	492.0	5.0	0.45	0.10
3	30.0	23.0	5.0	487.0	10.0	0.75	0.16
4	36.7	29.7	7.0	480.0	17.0	1.05	0.22
5	43.3	36.3	9.0	471.0	26.0	1.35	0.29
6	50.0	43.0	12.0	459.0	38.0	1.80	0.38
7	56.7	49.7	14.0	445.0	52.0	2.10	0.45
8	63.3	56.3	14.0	431.0	66.0	2.10	0.45
9	70.0	63.0	12.0	419.0	78.0	1.80	0.38
10	76.7	69.7	12.0	407.0	90.0	1.80	0.38
11	83.3	76.3	12.0	395.0	102.0	1.80	0.38
12	90.0	83.0	35.0	360.0	137.0	5.25	1.12
Avg. Shaft			11.4			1.65	0.35
Toe			360.0				261.16

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.28	0.08
Quake	(in)	0.18	0.40
Case Damping Factor		0.99	0.75
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	122
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	99	
Resistance Gap (included in Toe Quake)	(in)		0.07
Soil Plug Weight	(kips)		0.185

CAPWAP match quality = 1.59 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.13 in; Blow Count = 96 b/ft
Computed: Final Set = 0.14 in; Blow Count = 86 b/ft

Transducer F3(D815) CAL: 93.0; RF: 0.99; F4(F607) CAL: 93.6; RF: 0.99
A3(K3550) CAL: 360; RF: 1.01; A4(K2524) CAL: 360; RF: 1.01

max. Top Comp. Stress = 32.0 ksi (T= 36.3 ms, max= 1.017 x Top)
max. Comp. Stress = 32.5 ksi (Z= 16.7 ft, T= 37.1 ms)
max. Tens. Stress = -1.89 ksi (Z= 36.7 ft, T= 64.3 ms)
max. Energy (EMX) = 37.4 kip-ft; max. Measured Top Displ. (DMX)= 1.04 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	685.2	-11.0	32.0	-0.51	37.4	17.1	1.03
2	6.7	686.1	-14.1	32.1	-0.66	37.3	17.0	1.02
4	13.3	692.2	-24.0	32.3	-1.12	36.8	16.8	0.98
6	20.0	689.7	-29.6	32.2	-1.38	35.8	16.6	0.94
8	26.7	686.0	-34.8	32.0	-1.62	34.3	16.3	0.90
10	33.3	676.0	-35.0	31.6	-1.63	32.4	15.8	0.85
12	40.0	659.9	-34.1	30.8	-1.59	30.0	15.2	0.80
13	43.3	673.2	-38.3	31.5	-1.79	29.6	14.9	0.77
14	46.7	639.6	-28.2	29.9	-1.32	27.3	14.6	0.75
15	50.0	654.5	-32.7	30.6	-1.53	26.8	14.2	0.72
16	53.3	609.0	-19.6	28.5	-0.92	24.2	13.8	0.70
17	56.7	623.7	-22.7	29.1	-1.06	23.7	13.4	0.67
18	60.0	570.5	-7.6	26.7	-0.36	21.0	13.1	0.64
19	63.3	582.8	-11.4	27.2	-0.53	20.5	12.8	0.62
20	66.7	530.4	0.0	24.8	0.00	18.0	12.5	0.59
21	70.0	541.1	0.0	25.3	0.00	17.5	12.2	0.57
22	73.3	498.8	0.0	23.3	0.00	15.4	12.0	0.54
23	76.7	509.4	0.0	23.8	0.00	15.0	11.7	0.51
24	80.0	471.9	0.0	22.0	0.00	13.1	11.7	0.49
25	83.3	469.4	0.0	21.9	0.00	12.6	12.6	0.46
26	86.7	453.6	0.0	21.2	0.00	10.9	13.6	0.44
27	90.0	470.1	0.0	22.0	0.00	7.8	13.6	0.41
Absolute	16.7			32.5			(T =	37.1 ms)
	36.7				-1.89		(T =	64.3 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	745.6	626.8	507.9	389.1	270.2					
RX	749.7	634.0	569.7	531.5	507.9	492.1	478.4	464.7	451.0	441.7
RU	745.6	626.8	507.9	389.1	270.2					

RAU = 368.6 (kips); RA2 = 583.1 (kips)

Current CAPWAP Ru = 497.0 (kips); Corresponding J(RP)= 0.42; J(RX) = 0.93

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
17.1	36.09	654.1	685.8	691.5	1.04	0.13	0.13	37.7	774.2	1075

PILE PROFILE AND PILE MODEL

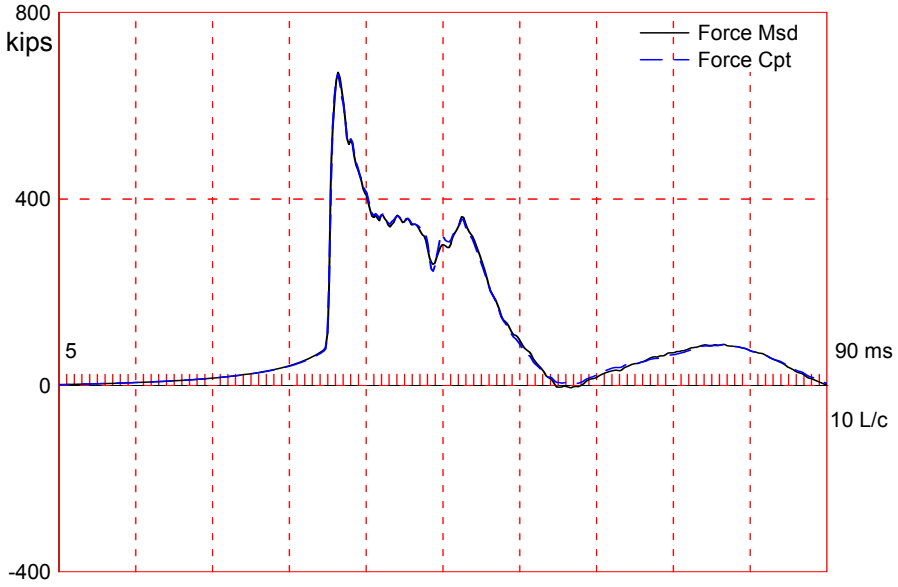
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
90.0	21.4	29992.2	492.000	4.70

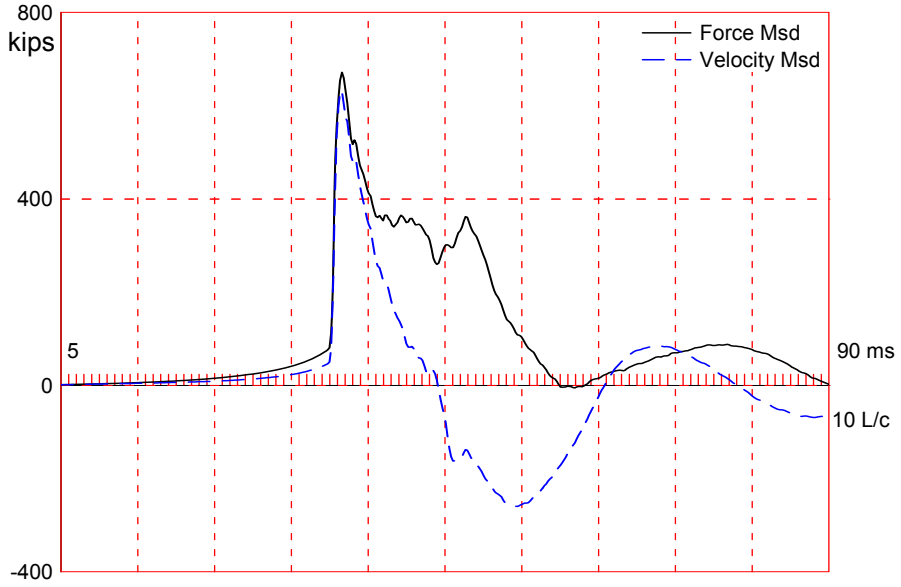
Toe Area 198.5 in²

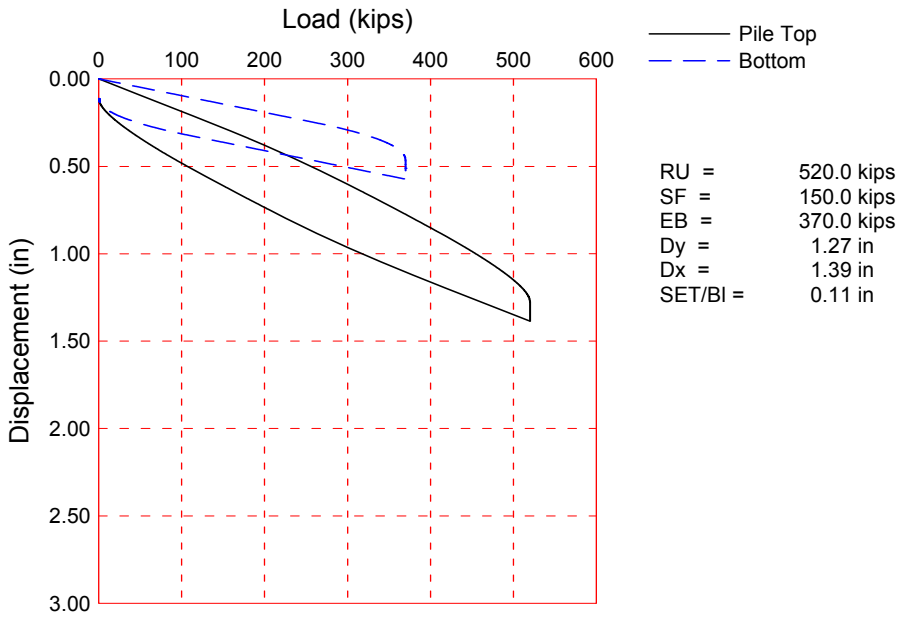
Top Segment Length 3.33 ft, Top Impedance 38 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.198 ms, 2L/c 10.7 ms

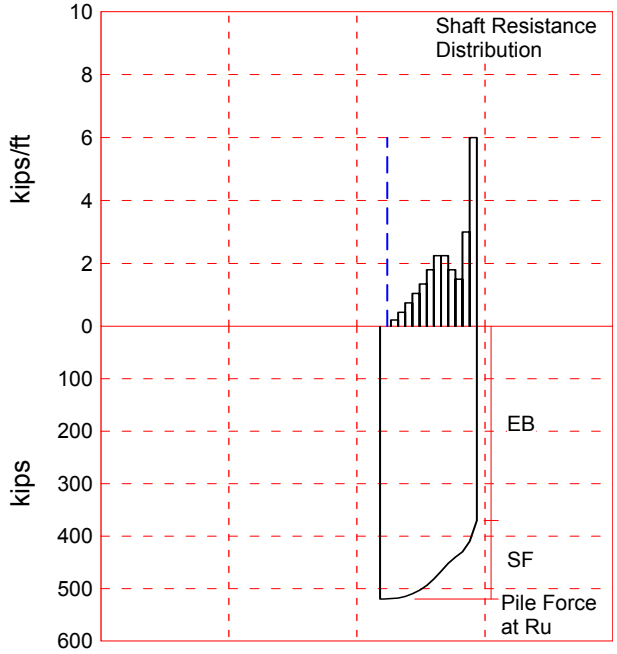
Total volume: 13.375 ft^3; Volume ratio considering added impedance: 1.000







RU =	520.0 kips
SF =	150.0 kips
EB =	370.0 kips
Dy =	1.27 in
Dx =	1.39 in
SET/Bl =	0.11 in



Length b. Sensors	90.0 ft
Embedment	83.0 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	1.33
Top Compr. Stress	31.2 ksi
Max Compr. Stress	31.7 ksi
Max Tension Stress	-2.28 ksi
Avg. Shaft Quake	0.22 in
Toe Quake	0.36 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.12 s/ft

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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: 520.0; along Shaft 150.0; at Toe 370.0 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
				520.0			
1	16.7	9.7	2.0	518.0	2.0	0.21	0.04
2	23.3	16.4	3.0	515.0	5.0	0.45	0.10
3	30.0	23.0	5.0	510.0	10.0	0.75	0.16
4	36.7	29.7	7.0	503.0	17.0	1.05	0.22
5	43.3	36.4	9.0	494.0	26.0	1.35	0.29
6	50.0	43.0	12.0	482.0	38.0	1.80	0.38
7	56.7	49.7	15.0	467.0	53.0	2.25	0.48
8	63.3	56.4	15.0	452.0	68.0	2.25	0.48
9	70.0	63.0	12.0	440.0	80.0	1.80	0.38
10	76.7	69.7	10.0	430.0	90.0	1.50	0.32
11	83.3	76.4	20.0	410.0	110.0	3.00	0.64
12	90.0	83.0	40.0	370.0	150.0	6.00	1.28
Avg. Shaft			12.5			1.81	0.38
Toe			370.0				268.41

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.27	0.12
Quake	(in)	0.22	0.36
Case Damping Factor		1.06	1.16
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	90	109
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.05
Soil Plug Weight	(kips)		0.131

CAPWAP match quality = 1.33 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.11 in; Blow Count = 107 b/ft
Computed: Final Set = 0.12 in; Blow Count = 101 b/ft
Transducer F1(D815) CAL: 93.0; RF: 0.97; F2(F607) CAL: 93.6; RF: 0.97
A1(K3550) CAL: 360; RF: 1.03; A2(K2524) CAL: 360; RF: 1.03

max. Top Comp. Stress = 31.2 ksi (T= 36.3 ms, max= 1.017 x Top)
max. Comp. Stress = 31.7 ksi (Z= 16.7 ft, T= 37.1 ms)
max. Tens. Stress = -2.28 ksi (Z= 36.7 ft, T= 62.7 ms)
max. Energy (EMX) = 37.5 kip-ft; max. Measured Top Displ. (DMX)= 1.05 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	667.7	-23.6	31.2	-1.10	37.5	16.6	1.03
2	6.7	668.6	-25.5	31.2	-1.19	37.3	16.6	1.01
4	13.3	674.3	-29.2	31.5	-1.37	36.7	16.5	0.97
6	20.0	671.8	-32.7	31.4	-1.53	35.5	16.2	0.93
8	26.7	668.2	-39.9	31.2	-1.86	33.9	15.9	0.88
10	33.3	658.7	-42.9	30.8	-2.01	31.8	15.4	0.82
12	40.0	643.5	-42.2	30.1	-1.97	29.4	14.9	0.77
13	43.3	657.1	-47.6	30.7	-2.22	28.9	14.5	0.74
14	46.7	624.7	-38.7	29.2	-1.81	26.7	14.3	0.71
15	50.0	641.5	-42.9	30.0	-2.00	26.2	13.8	0.69
16	53.3	600.6	-29.7	28.1	-1.39	23.6	13.4	0.66
17	56.7	617.5	-34.3	28.8	-1.60	23.1	13.0	0.63
18	60.0	565.8	-16.8	26.4	-0.78	20.3	12.7	0.60
19	63.3	579.5	-21.1	27.1	-0.99	19.8	12.3	0.57
20	66.7	528.6	-4.9	24.7	-0.23	17.3	12.0	0.55
21	70.0	539.7	-8.3	25.2	-0.39	16.8	11.7	0.52
22	73.3	502.0	0.0	23.5	0.00	14.9	11.5	0.49
23	76.7	518.0	0.0	24.2	0.00	14.4	11.1	0.46
24	80.0	494.6	0.0	23.1	0.00	12.9	10.7	0.43
25	83.3	503.9	0.0	23.5	0.00	12.4	11.6	0.41
26	86.7	487.2	0.0	22.8	0.00	10.3	12.4	0.38
27	90.0	506.0	0.0	23.6	0.00	7.6	11.7	0.36
Absolute	16.7			31.7			(T =	37.1 ms)
	36.7				-2.28		(T =	62.7 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	787.2	738.0	688.8	639.6	590.4	541.3	492.1	442.9	393.7	344.6
RX	787.2	738.0	692.2	650.8	625.0	599.3	573.5	547.8	531.7	518.1
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RAU = 353.2 (kips); RA2 = 577.8 (kips)

Current CAPWAP Ru = 520.0 (kips); Corresponding J(RP)= 1.09; J(RX) = 1.77

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
16.5	36.09	631.9	671.6	671.6	1.05	0.11	0.11	37.8	778.6	1194

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
90.0	21.4	29992.2	492.000	4.70

Toe Area 198.5 in^2

Top Segment Length 3.33 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 0.198 ms, 2L/c 10.7 ms

Total volume: 13.375 ft^3; Volume ratio considering added impedance: 1.000

We recommend the above blow counts at the required stroke be maintained for **two consecutive feet** of driving. We recommend immediately terminating driving **if the blow counts exceed 10** blows per inch or less at hammer strokes of 8.0 feet. We anticipate the production piles will terminate at depths similar to those of the test piles. Please note the tested piles had a tip elevation of approximately 4 feet above the minimum required pile tip elevation. Based upon the dynamic test results, we request the designer allow the minimum pile tip elevation to be revised to EL 705.

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.

Travis Coleman, P.E.

Alex McCaskill, E.I.

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

Attachments:

Dynamic Test Results - (pages 3 – 15)
CAPWAP Analysis Results - (pages 16 – 29)

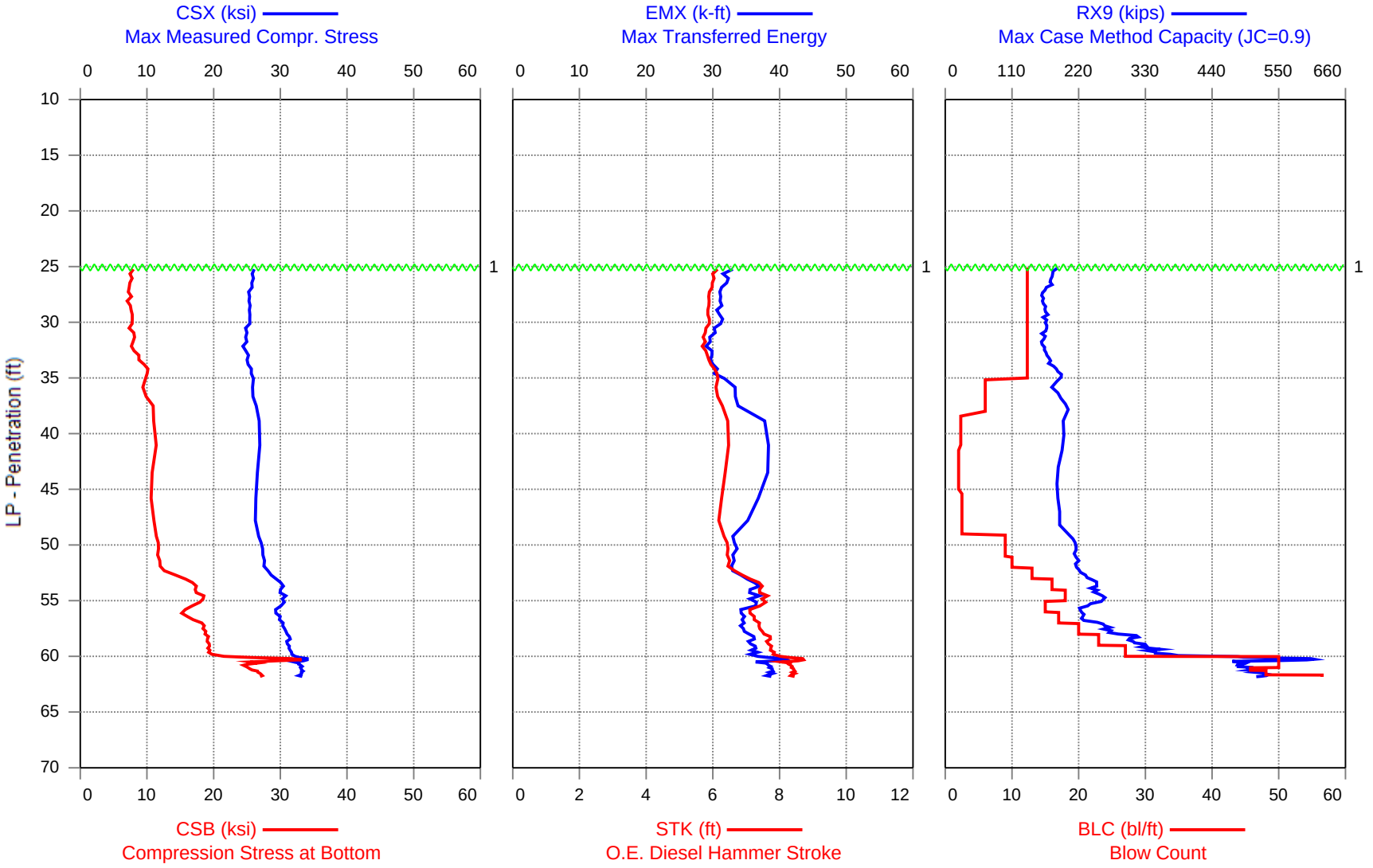
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-March-2015

Test started: 10-March-2015

USH 10 over Little Lake Butte des Morts - East Abutment #3

APE D30-42, HP 14 x 73



1 - Reported reference at El. 765.79

USH 10 over Little Lake Butte des Morts - East Abutment #3 APE D30-42, HP 14 x 73
OP: AM Date: 10-March-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
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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
123	35.00	12	AV123	25.3	8.1	31	5.9	48.3	169
			STD	0.6	1.0	1	0.2	0.6	10
			MAX	27.0	10.8	35	6.4	49.7	201
			MIN	24.0	6.8	28	5.6	46.6	154
129	36.00	6	AV6	25.8	9.5	33	6.1	47.6	180
			STD	0.6	0.3	2	0.2	0.6	6
			MAX	26.6	9.8	35	6.3	48.4	185
			MIN	24.9	9.1	31	5.9	47.0	167
135	37.00	6	AV6	25.9	9.8	33	6.2	47.4	188
			STD	0.7	0.6	2	0.2	0.7	4
			MAX	27.0	10.5	36	6.4	48.6	195
			MIN	24.7	9.1	30	5.8	46.4	182
141	38.00	6	AV6	26.4	11.0	34	6.3	46.9	200
			STD	0.5	0.5	1	0.1	0.4	4
			MAX	27.2	11.7	35	6.5	47.4	206
			MIN	25.7	10.1	33	6.1	46.1	195
148	41.00	2	AV7	27.0	11.2	39	6.5	46.2	195
			STD	0.4	0.4	1	0.1	0.4	4
			MAX	27.5	11.7	41	6.6	46.9	199
			MIN	26.4	10.4	37	6.3	45.7	188
156	45.00	2	AV8	26.6	10.9	38	6.4	46.6	187
			STD	0.4	0.4	1	0.1	0.4	4
			MAX	27.3	11.5	40	6.5	47.2	192
			MIN	25.9	10.4	37	6.2	46.1	180
166	49.00	3	AV10	26.3	10.9	36	6.2	47.2	189
			STD	0.7	0.4	2	0.2	0.7	6
			MAX	27.9	11.9	39	6.6	48.6	199
			MIN	25.1	10.2	33	5.8	45.8	177
175	50.00	9	AV9	26.9	11.6	33	6.4	46.5	212
			STD	0.6	0.4	1	0.1	0.4	5
			MAX	28.1	12.3	35	6.6	47.1	222
			MIN	26.1	10.7	31	6.2	45.7	206
184	51.00	9	AV9	27.4	11.6	33	6.4	46.3	214
			STD	0.6	0.3	1	0.2	0.6	5
			MAX	28.3	12.1	36	6.8	47.1	222
			MIN	26.5	11.2	31	6.2	45.3	207
194	52.00	10	AV10	27.6	12.0	33	6.5	46.2	217
			STD	0.5	0.3	1	0.1	0.5	5
			MAX	28.3	12.8	34	6.7	47.4	223
			MIN	26.4	11.6	31	6.1	45.6	207
207	53.00	13	AV13	28.4	13.6	34	6.8	45.3	226
			STD	0.8	1.3	2	0.3	0.8	7
			MAX	30.2	15.8	37	7.4	46.6	238
			MIN	27.4	11.9	31	6.4	43.4	216
223	54.00	16	AV16	30.0	16.9	36	7.4	43.5	246

USH 10 over Little Lake Butte des Morts - East Abutment #3 APE D30-42, HP 14 x 73
OP: AM Date: 10-March-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.4	0.6	1	0.1	0.4	5
			MAX	30.9	17.8	38	7.6	44.3	252
			MIN	29.3	15.8	34	7.1	42.9	237
241	55.00	18	AV18	30.4	18.1	36	7.5	43.1	256
			STD	0.5	0.6	1	0.2	0.5	7
			MAX	31.3	19.0	38	7.8	44.0	265
			MIN	29.3	17.2	34	7.2	42.2	242
256	56.00	15	AV15	29.9	16.6	36	7.3	43.6	232
			STD	0.7	1.0	1	0.3	0.7	12
			MAX	30.9	18.6	37	7.7	44.8	259
			MIN	28.7	15.3	33	6.9	42.5	216
273	57.00	17	AV17	29.9	16.4	35	7.2	43.8	232
			STD	0.5	1.1	1	0.2	0.5	10
			MAX	30.7	19.1	36	7.5	44.9	256
			MIN	28.8	15.0	33	6.9	43.1	219
293	58.00	20	AV20	30.6	18.6	35	7.4	43.3	268
			STD	0.5	0.4	1	0.1	0.4	8
			MAX	31.2	19.3	36	7.6	44.1	287
			MIN	29.6	17.8	33	7.1	42.9	257
316	59.00	23	AV23	31.2	19.2	36	7.7	42.6	313
			STD	0.5	0.4	1	0.2	0.4	12
			MAX	32.3	20.0	37	7.9	44.0	351
			MIN	30.0	18.1	34	7.2	41.9	293
343	60.00	27	AV27	31.6	19.5	36	7.8	42.3	351
			STD	0.5	0.6	1	0.1	0.3	25
			MAX	32.6	20.6	38	7.9	42.9	429
			MIN	30.9	18.3	34	7.6	41.9	316
393	61.00	50	AV50	33.1	27.1	39	8.4	40.8	516
			STD	0.8	3.3	2	0.2	0.6	47
			MAX	35.1	33.9	42	9.0	41.8	626
			MIN	31.9	22.8	35	8.0	39.4	458
404	61.24	46	AV11	33.2	25.5	39	8.4	40.7	503
			STD	0.4	0.5	1	0.1	0.3	5
			MAX	34.0	26.3	41	8.7	41.0	512
			MIN	32.6	24.6	38	8.3	40.1	496
414	61.45	48	AV10	33.3	26.5	39	8.4	40.8	514
			STD	0.4	0.4	1	0.1	0.3	6
			MAX	33.9	27.1	40	8.6	41.4	521
			MIN	32.5	25.7	37	8.1	40.4	501
424	61.66	48	AV10	33.2	27.1	39	8.4	40.7	528
			STD	0.4	0.4	1	0.1	0.3	5
			MAX	33.6	27.5	40	8.6	41.2	534
			MIN	32.5	26.2	38	8.2	40.3	521
434	61.83	56	AV10	32.9	27.1	38	8.4	40.9	524
			STD	0.4	0.4	1	0.1	0.3	7
			MAX	33.7	27.8	39	8.6	41.4	535
			MIN	32.3	26.6	37	8.1	40.3	512
			Average	29.0	15.8	35	7.0	44.7	283
			Std. Dev.	3.1	7.1	3	1.0	3.0	132
			Maximum	35.1	33.9	42	9.0	49.7	626
			Minimum	24.0	6.8	28	5.6	39.4	154

Total number of blows analyzed: 434

BL#	Sensors
1-434	F3: [F607] 93.6 (1.00); F4: [D815] 93.0 (1.00); A3: [K2524] 360.0 (1.03); A4: [K3550] 360.0 (1.03)

BL#	Comments
1	Reported reference at El. 765.79
430	CW

Time Summary

Drive 9 minutes 42 seconds 1:36 PM - 1:46 PM BN 1 - 434

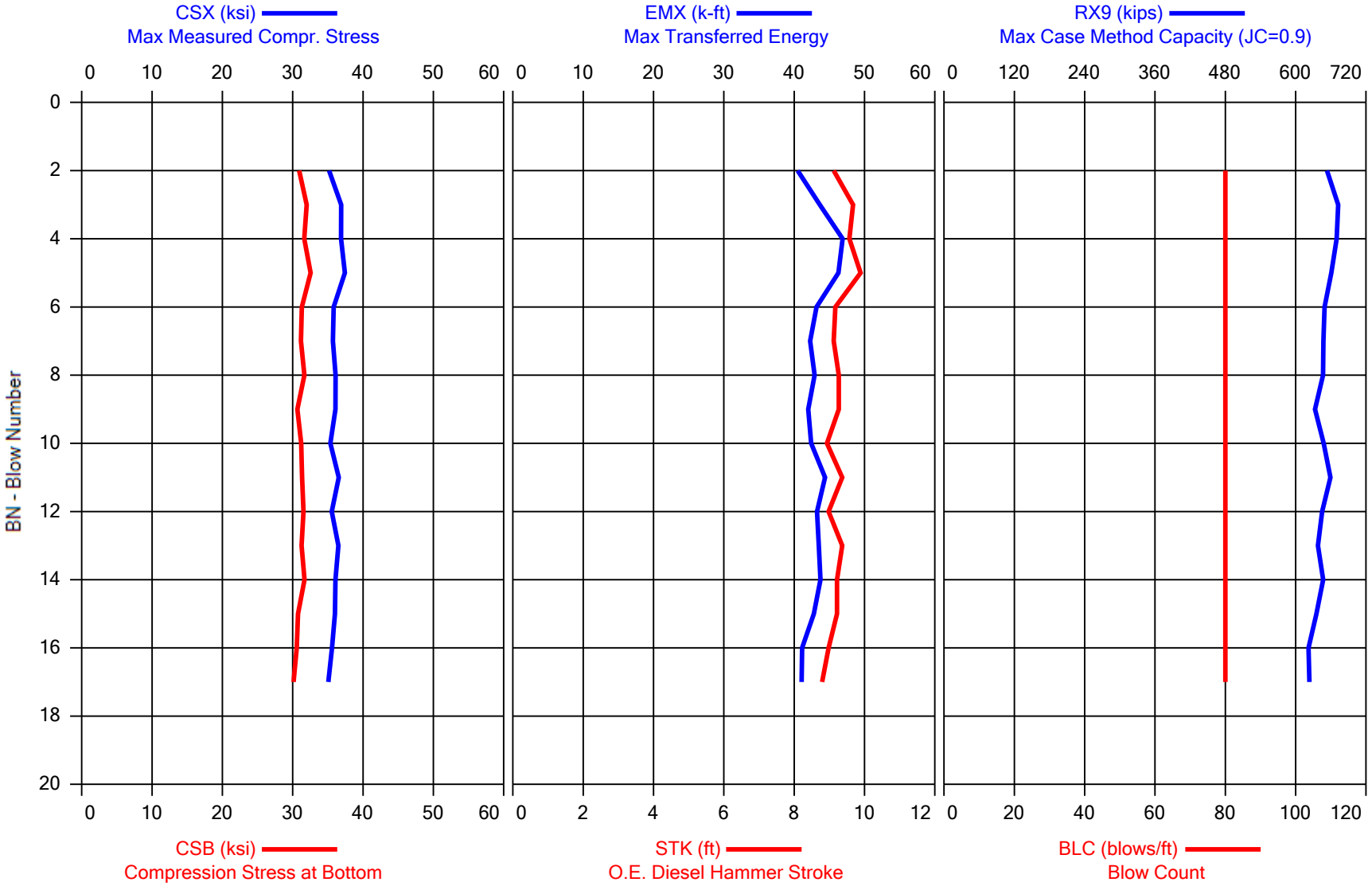
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-March-2015

Test started: 11-March-2015

USH 10 over Little Lake Butte des Morts - East Abutment #3 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - East Abutment #3 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 11-March-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
5	61.89	80	AV4	36.6	31.8	44	9.6	38.3	664
			STD	0.8	0.6	3	0.3	0.5	8
			MAX	37.4	32.6	47	9.9	39.2	673
			MIN	35.2	30.9	41	9.1	37.7	653
10	61.95	80	AV5	35.8	31.2	43	9.2	39.1	645
			STD	0.3	0.3	0	0.1	0.3	6
			MAX	36.1	31.7	43	9.3	39.6	649
			MIN	35.4	30.7	42	8.9	38.9	633
15	62.02	80	AV5	36.1	31.3	44	9.2	39.0	645
			STD	0.4	0.3	1	0.1	0.3	8
			MAX	36.5	31.7	44	9.4	39.5	659
			MIN	35.6	30.7	43	9.0	38.7	635
17	62.04	80	AV2	35.3	30.3	41	8.9	39.7	623
			STD	0.3	0.2	0	0.1	0.2	1
			MAX	35.6	30.6	41	9.0	39.9	623
			MIN	35.1	30.1	41	8.8	39.5	622
			Average	36.0	31.3	43	9.2	39.0	647
			Std. Dev.	0.6	0.6	2	0.3	0.6	14
			Maximum	37.4	32.6	47	9.9	39.9	673
			Minimum	35.1	30.1	41	8.8	37.7	622

Total number of blows analyzed: 16

BL# Sensors

1-17 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.08); A4: [K2524] 360.0 (1.08)

BL# Comments

4 CW

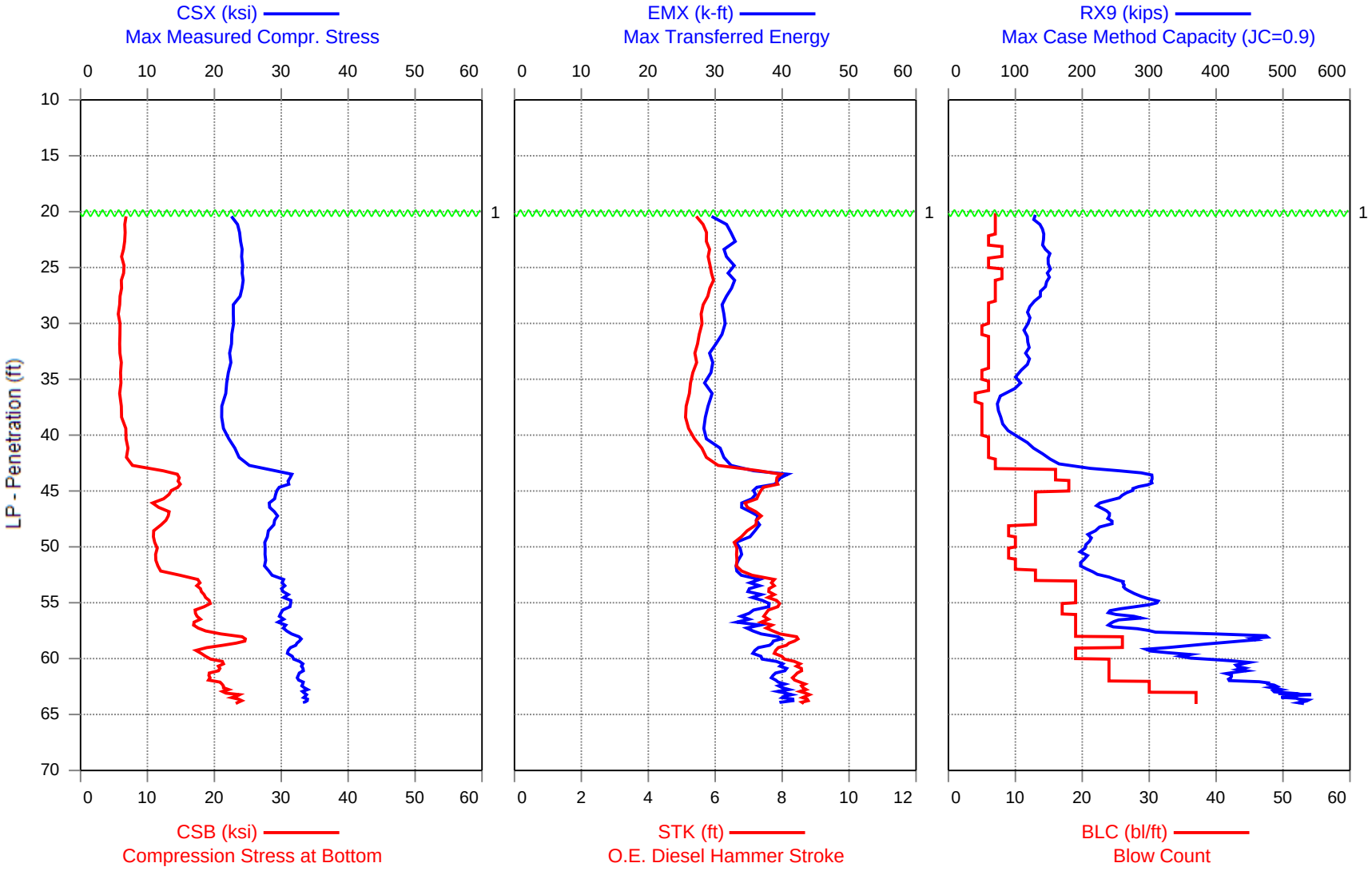
Time Summary

Drive 24 seconds 6:37 AM - 6:38 AM BN 1 - 17

Printed: 12-March-2015

Test started: 10-March-2015

USH 10 over Little Lake Butte des Morts - East Abutment #9
APE D30-42, HP 14 x 73



1 - Reported reference at El. 767.96

USH 10 over Little Lake Butte des Morts - East Abutment #9 APE D30-42, HP 14 x 73
OP: AM Date: 10-March-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
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	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
7	21.00	7	AV7	22.8	6.8	30	5.5	50.0	130
			STD	0.8	0.2	2	0.2	0.8	5
			MAX	24.2	7.0	33	5.8	51.0	135
			MIN	21.9	6.5	28	5.3	48.6	121
14	22.00	7	AV7	23.5	6.6	32	5.7	49.3	140
			STD	0.5	0.2	1	0.1	0.5	2
			MAX	24.3	7.0	32	5.8	50.3	143
			MIN	22.8	6.4	30	5.4	48.7	136
20	23.00	6	AV6	24.1	6.6	33	5.8	48.8	141
			STD	0.5	0.2	1	0.2	0.6	4
			MAX	24.8	6.9	35	6.0	49.6	148
			MIN	23.5	6.4	32	5.6	47.9	137
28	24.00	8	AV8	24.1	6.3	31	5.8	48.7	148
			STD	0.3	0.2	1	0.1	0.3	4
			MAX	24.5	6.7	32	5.9	49.0	156
			MIN	23.7	5.9	30	5.7	48.2	143
34	25.00	6	AV6	24.2	6.4	33	5.8	48.7	148
			STD	0.2	0.3	1	0.1	0.2	2
			MAX	24.5	6.8	34	5.9	48.9	153
			MIN	23.9	5.7	32	5.8	48.2	147
42	26.00	8	AV8	24.3	6.4	32	5.9	48.3	151
			STD	0.4	0.5	1	0.1	0.3	5
			MAX	24.8	7.1	34	6.0	48.8	159
			MIN	23.8	5.4	31	5.8	47.9	141
49	27.00	7	AV7	24.3	6.1	33	5.9	48.3	145
			STD	0.4	0.2	0	0.1	0.3	3
			MAX	25.0	6.5	33	6.0	48.7	150
			MIN	23.8	5.7	33	5.8	47.9	142
56	28.00	7	AV7	23.5	6.0	31	5.7	49.1	135
			STD	0.7	0.4	1	0.1	0.5	4
			MAX	24.2	6.7	32	5.9	50.1	138
			MIN	22.1	5.6	29	5.5	48.4	127
62	29.00	6	AV6	22.9	5.7	31	5.6	49.4	121
			STD	0.2	0.4	0	0.1	0.4	4
			MAX	23.3	6.4	32	5.8	50.0	125
			MIN	22.5	5.4	31	5.5	48.8	114
68	30.00	6	AV6	22.9	5.7	31	5.6	49.5	122
			STD	0.6	0.1	1	0.1	0.6	3
			MAX	23.9	5.9	34	5.9	50.4	127
			MIN	22.2	5.5	30	5.4	48.5	117
73	31.00	5	AV5	22.7	5.9	32	5.5	49.9	113
			STD	0.8	0.4	2	0.2	0.7	6
			MAX	23.8	6.7	34	5.8	50.7	121
			MIN	21.9	5.6	29	5.3	48.9	102
79	32.00	6	AV6	22.5	5.9	30	5.5	50.0	119

USH 10 over Little Lake Butte des Morts - East Abutment #9 APE D30-42, HP 14 x 73
OP: AM Date: 10-March-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			STD	0.4	0.2	1	0.1	0.5	4
			MAX	23.3	6.2	32	5.7	50.5	124
			MIN	22.0	5.5	29	5.4	49.1	113
85	33.00	6	AV6	22.4	5.9	29	5.4	50.4	118
			STD	0.8	0.2	1	0.2	0.7	6
			MAX	22.9	6.1	31	5.5	51.8	123
			MIN	20.8	5.6	26	5.1	49.8	105
91	34.00	6	AV6	22.6	6.1	30	5.5	50.1	119
			STD	0.4	0.1	1	0.1	0.3	3
			MAX	23.0	6.2	31	5.6	50.6	122
			MIN	21.9	6.0	28	5.4	49.7	112
96	35.00	5	AV5	21.8	5.9	29	5.3	51.0	102
			STD	0.8	0.3	1	0.2	0.8	4
			MAX	22.8	6.3	31	5.5	52.2	107
			MIN	20.6	5.4	27	5.0	50.0	95
102	36.00	6	AV6	21.8	6.1	28	5.2	51.1	104
			STD	0.4	0.3	1	0.1	0.4	5
			MAX	22.5	6.4	29	5.4	51.7	108
			MIN	21.3	5.7	27	5.1	50.5	96
106	37.00	4	AV4	21.7	5.9	31	5.2	51.2	77
			STD	0.3	0.2	1	0.1	0.3	2
			MAX	21.9	6.3	31	5.3	51.6	79
			MIN	21.3	5.7	30	5.1	50.9	75
111	38.00	5	AV5	21.0	6.1	29	5.1	51.7	74
			STD	0.4	0.4	1	0.1	0.3	4
			MAX	21.6	6.5	29	5.2	52.1	78
			MIN	20.7	5.4	28	5.0	51.2	69
116	39.00	5	AV5	21.4	6.2	29	5.2	51.3	78
			STD	0.7	0.2	1	0.2	0.8	7
			MAX	22.6	6.5	30	5.5	52.4	88
			MIN	20.5	5.8	27	5.0	50.1	67
121	40.00	5	AV5	21.3	6.8	28	5.2	51.4	92
			STD	0.9	0.2	2	0.2	0.8	7
			MAX	22.3	7.2	29	5.4	52.9	101
			MIN	19.8	6.4	25	4.9	50.5	81
127	41.00	6	AV6	22.1	7.0	28	5.4	50.6	113
			STD	0.4	0.5	1	0.1	0.4	7
			MAX	22.5	7.9	30	5.5	51.1	126
			MIN	21.5	6.4	27	5.2	50.0	106
133	42.00	6	AV6	23.7	6.8	32	5.7	49.0	140
			STD	0.3	0.5	1	0.1	0.4	6
			MAX	24.2	7.6	33	5.9	49.5	151
			MIN	23.2	6.3	31	5.6	48.4	132
140	43.00	7	AV7	24.9	7.6	32	6.0	48.0	171
			STD	0.9	0.8	1	0.2	0.8	18
			MAX	26.3	9.4	34	6.4	49.3	202
			MIN	23.6	6.8	31	5.7	46.6	151
156	44.00	16	AV16	30.7	13.9	39	7.7	42.5	288
			STD	1.2	1.2	2	0.3	0.9	23
			MAX	31.9	15.1	42	8.1	45.2	308
			MIN	27.7	10.9	34	6.8	41.5	240

USH 10 over Little Lake Butte des Morts - East Abutment #9 APE D30-42, HP 14 x 73
OP: AM Date: 10-March-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
174	45.00	18	AV18	30.3	14.4	37	7.6	42.8	290
			STD	0.9	0.6	2	0.2	0.7	12
			MAX	31.6	15.4	40	8.0	43.8	307
			MIN	28.8	13.1	35	7.2	41.7	272
187	46.00	13	AV13	29.1	12.6	36	7.3	43.8	253
			STD	0.5	0.9	1	0.2	0.5	13
			MAX	30.1	13.7	39	7.7	44.3	270
			MIN	28.3	10.9	34	7.1	42.6	223
200	47.00	13	AV13	28.4	12.0	34	7.0	44.5	231
			STD	0.7	1.2	1	0.2	0.7	7
			MAX	29.4	13.8	36	7.3	46.0	244
			MIN	27.1	10.0	32	6.5	43.6	220
213	48.00	13	AV13	29.2	12.8	36	7.3	43.6	242
			STD	0.5	0.6	1	0.2	0.5	3
			MAX	30.1	13.7	38	7.6	44.3	247
			MIN	28.7	11.8	35	7.1	42.7	234
222	49.00	9	AV9	28.1	11.0	36	6.9	44.7	218
			STD	0.4	0.9	1	0.1	0.4	9
			MAX	28.6	12.5	37	7.1	45.5	230
			MIN	27.4	10.2	35	6.7	44.1	205
232	50.00	10	AV10	27.6	11.2	33	6.6	45.8	209
			STD	0.5	0.5	1	0.2	0.5	6
			MAX	28.2	11.9	36	6.8	46.6	217
			MIN	26.7	10.1	32	6.4	45.0	201
241	51.00	9	AV9	27.7	11.3	34	6.7	45.6	202
			STD	0.7	0.6	1	0.2	0.6	6
			MAX	28.8	12.2	36	6.9	46.7	210
			MIN	26.3	10.4	32	6.3	44.7	194
251	52.00	10	AV10	27.6	11.5	33	6.7	45.6	201
			STD	0.8	0.4	1	0.2	0.7	4
			MAX	28.9	12.2	36	7.0	46.6	209
			MIN	26.4	10.8	31	6.4	44.6	196
264	53.00	13	AV13	29.1	14.8	35	7.2	43.9	231
			STD	1.2	2.3	2	0.5	1.3	14
			MAX	32.0	17.8	41	8.2	45.9	253
			MIN	27.3	11.5	32	6.6	41.3	212
283	54.00	19	AV19	30.2	17.8	35	7.7	42.6	264
			STD	0.8	0.4	2	0.2	0.4	3
			MAX	31.7	18.5	38	7.9	43.4	271
			MIN	28.7	16.9	33	7.4	41.9	259
302	55.00	19	AV19	30.9	18.8	36	7.7	42.5	295
			STD	0.7	0.6	1	0.2	0.5	14
			MAX	32.3	20.0	39	8.1	43.2	317
			MIN	29.8	18.0	34	7.5	41.5	272
319	56.00	17	AV17	30.7	17.9	37	7.7	42.5	265
			STD	0.8	0.9	2	0.2	0.6	25
			MAX	31.9	19.4	39	8.1	43.5	306
			MIN	29.3	16.4	33	7.4	41.5	235
338	57.00	19	AV19	30.0	17.4	34	7.5	43.1	258
			STD	0.6	0.6	1	0.1	0.4	19

USH 10 over Little Lake Butte des Morts - East Abutment #9 APE D30-42, HP 14 x 73
OP: AM Date: 10-March-2015

BL#	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
			MAX	31.0	18.8	37	7.9	43.7	303
			MIN	29.0	16.7	32	7.3	42.1	237
357	58.00	19	AV19	31.0	19.3	36	7.8	42.3	330
			STD	0.8	2.3	2	0.3	0.7	82
			MAX	32.6	24.2	39	8.4	43.3	481
			MIN	29.9	16.8	34	7.4	40.7	240
383	59.00	26	AV26	32.5	23.1	39	8.3	41.1	412
			STD	0.6	2.0	1	0.2	0.6	48
			MAX	33.8	26.4	41	8.7	42.4	488
			MIN	31.0	19.0	36	7.8	40.1	319
402	60.00	19	AV19	31.2	18.1	36	7.9	42.1	333
			STD	0.5	0.8	1	0.1	0.4	27
			MAX	32.6	19.6	39	8.3	42.9	366
			MIN	30.5	16.8	35	7.6	41.1	286
426	61.00	24	AV24	32.9	20.8	40	8.4	40.7	431
			STD	0.6	0.7	1	0.2	0.4	16
			MAX	34.2	22.2	42	8.8	41.6	462
			MIN	31.8	19.5	36	8.1	39.8	390
450	62.00	24	AV24	32.7	19.4	39	8.4	40.8	424
			STD	0.4	0.6	1	0.1	0.3	10
			MAX	33.9	20.8	41	8.7	41.2	449
			MIN	32.2	18.6	38	8.2	40.1	414
480	63.00	30	AV30	33.4	21.3	40	8.6	40.3	484
			STD	0.6	0.6	1	0.2	0.4	10
			MAX	34.5	22.6	43	8.9	41.4	500
			MIN	32.0	19.9	37	8.1	39.7	447
519	64.05	37	AV39	33.6	23.2	41	8.7	40.1	520
			STD	0.4	0.9	1	0.1	0.3	16
			MAX	34.3	25.0	43	8.9	40.7	549
			MIN	32.8	21.2	39	8.4	39.6	489
			Average	28.9	14.7	36	7.2	44.3	282
			Std. Dev.	4.0	6.2	4	1.2	3.7	133
			Maximum	34.5	26.4	43	8.9	52.9	549
			Minimum	19.8	5.4	25	4.9	39.6	67

Total number of blows analyzed: 519

BL# Sensors

1-519 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.04); A4: [K2524] 360.0 (1.04)

BL# Comments

1 Reported reference at El. 767.96
514 CW

Time Summary

Drive 11 minutes 46 seconds 2:19 PM - 2:31 PM BN 1 - 519

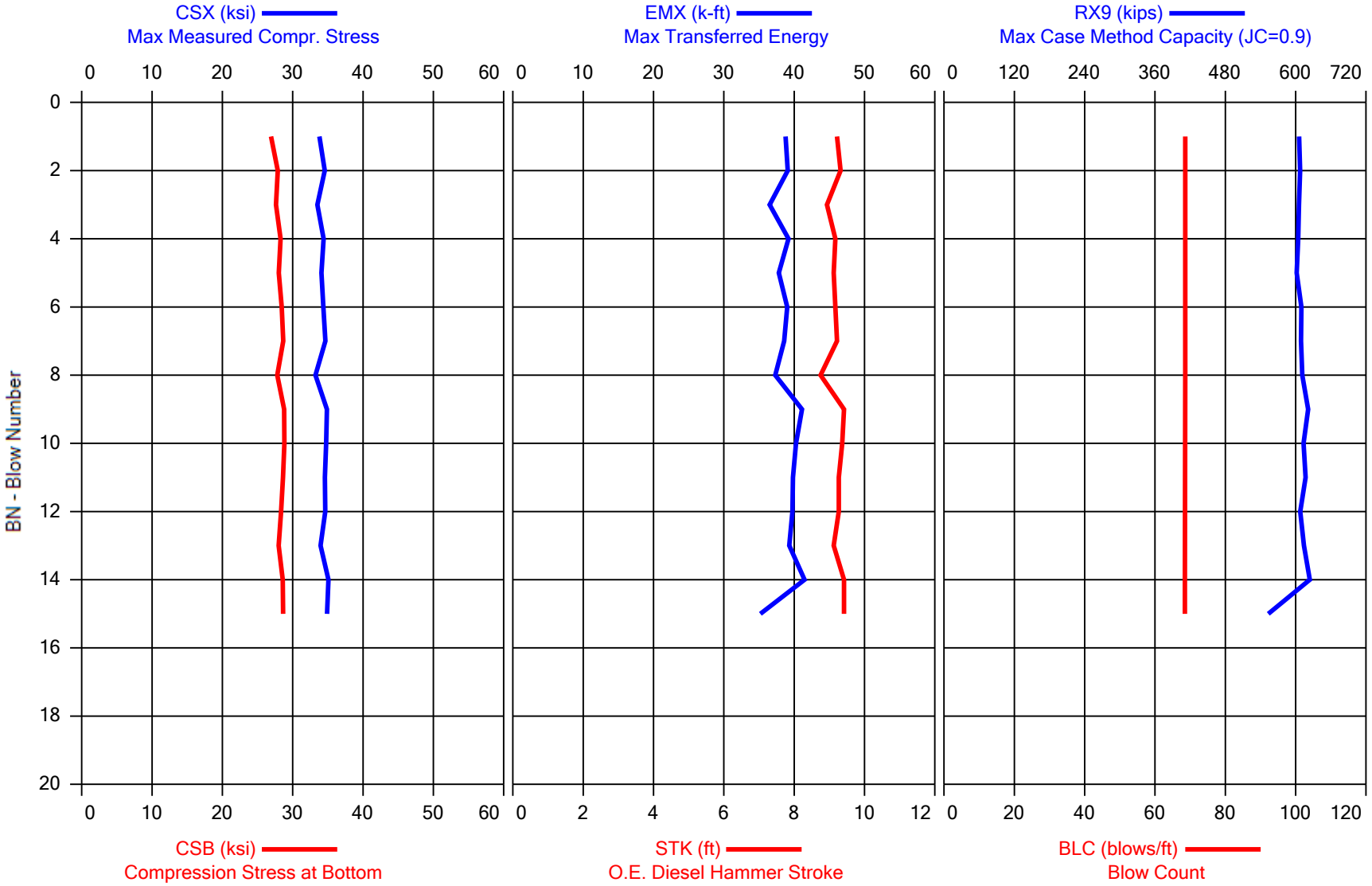
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 12-March-2015

Test started: 11-March-2015

USH 10 over Little Lake Butte des Morts - East Abutment #9 Restrike

APE D30-42, HP 14 x 73



USH 10 over Little Lake Butte des Morts - East Abutment #9 Restrike APE D30-42, HP 14 x 73
OP: AM Date: 11-March-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 69.00 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 ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM bpm	RX9 kips
5	64.11	69	AV5	34.1	27.7	38	9.2	39.1	605
			STD	0.4	0.5	1	0.1	0.3	2
			MAX	34.6	28.3	39	9.3	39.6	608
			MIN	33.5	26.9	37	8.9	38.8	602
10	64.19	69	AV5	34.4	28.5	39	9.2	39.1	613
			STD	0.6	0.4	1	0.2	0.5	4
			MAX	34.9	28.8	41	9.4	40.0	621
			MIN	33.2	27.8	37	8.7	38.6	609
15	64.26	68	AV5	34.6	28.4	39	9.3	38.8	603
			STD	0.4	0.2	2	0.1	0.2	25
			MAX	35.1	28.6	41	9.4	39.2	624
			MIN	34.0	28.0	35	9.1	38.6	553
			Average	34.4	28.2	39	9.2	39.0	607
			Std. Dev.	0.5	0.5	2	0.2	0.4	16
			Maximum	35.1	28.8	41	9.4	40.0	624
			Minimum	33.2	26.9	35	8.7	38.6	553

Total number of blows analyzed: 15

BL# Sensors

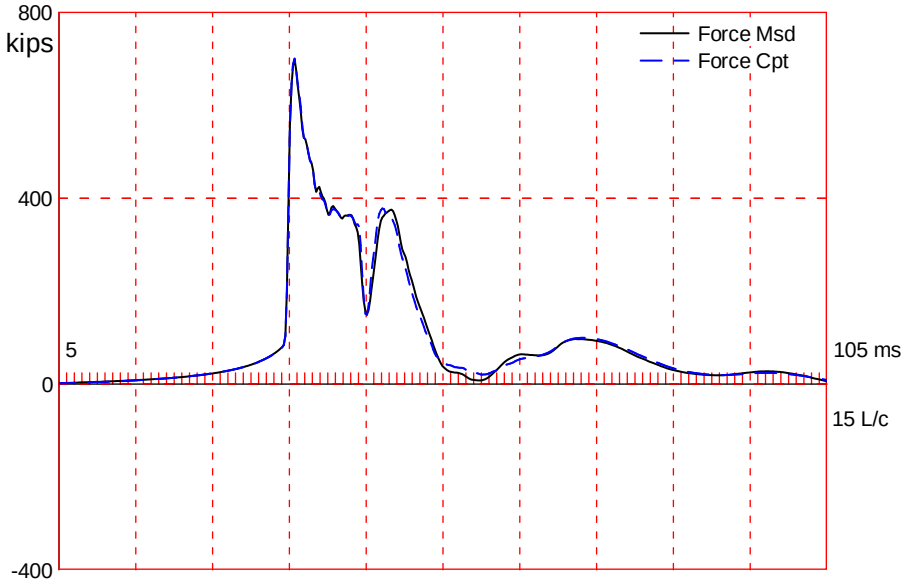
1-15 F3: [D815] 93.0 (1.00); F4: [F607] 93.6 (1.00); A3: [K3550] 360.0 (1.06); A4: [K2524] 360.0 (1.06)

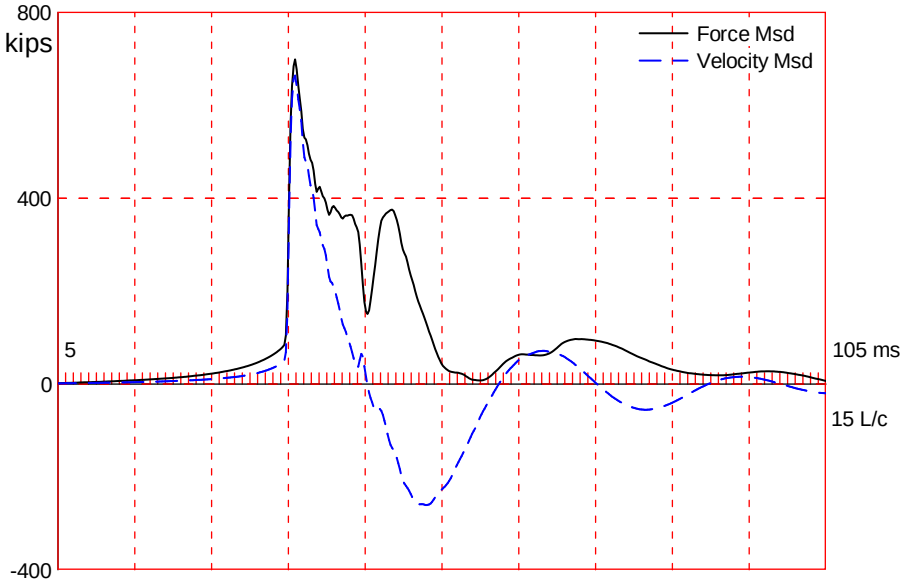
BL# Comments

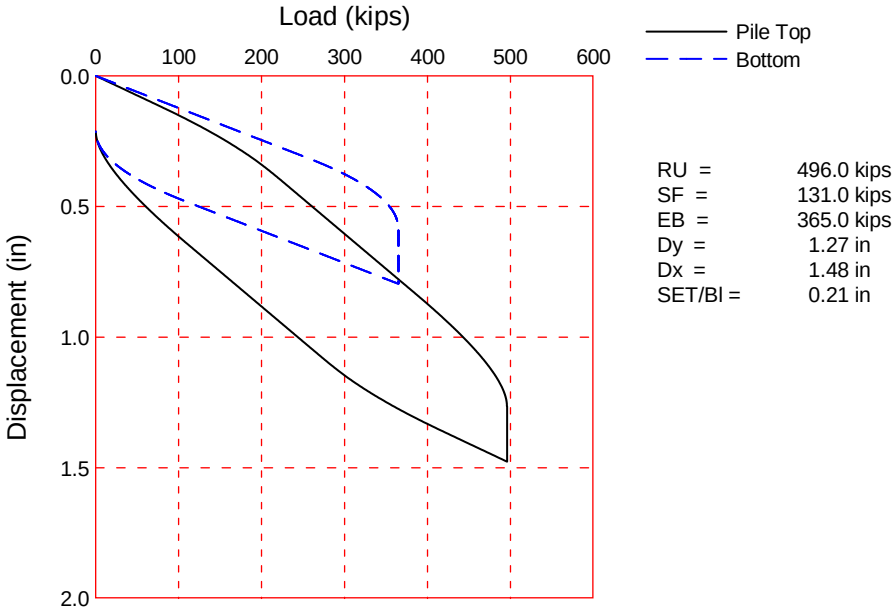
4 CW

Time Summary

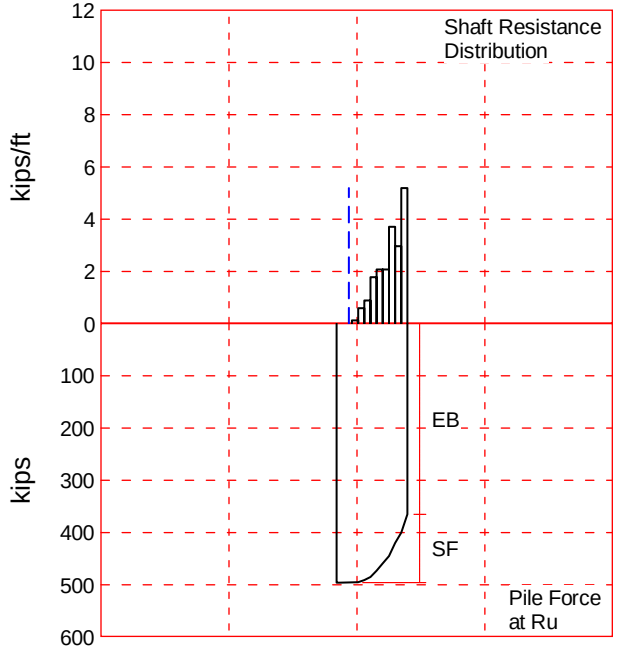
Drive 21 seconds 6:49 AM - 6:49 AM BN 1 - 15







RU =	496.0 kips
SF =	131.0 kips
EB =	365.0 kips
Dy =	1.27 in
Dx =	1.48 in
SET/Bl =	0.21 in



Length b. Sensors	77.5 ft
Embedment	61.8 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	2.46
Top Compr. Stress	32.8 ksi
Max Compr. Stress	33.7 ksi
Max Tension Stress	-1.87 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.45 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.12 s/ft

CAPWAP(R) 2014-1 Licensed to GRL Engineers, Inc.

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: 496.0; along Shaft 131.0; at Toe 365.0 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
				496.0			
1	23.6	7.8	1.0	495.0	1.0	0.13	0.03
2	30.3	14.6	4.0	491.0	5.0	0.59	0.13
3	37.1	21.3	6.0	485.0	11.0	0.89	0.19
4	43.8	28.1	12.0	473.0	23.0	1.78	0.38
5	50.5	34.8	14.0	459.0	37.0	2.08	0.44
6	57.3	41.5	14.0	445.0	51.0	2.08	0.44
7	64.0	48.3	25.0	420.0	76.0	3.71	0.79
8	70.8	55.0	20.0	400.0	96.0	2.97	0.63
9	77.5	61.8	35.0	365.0	131.0	5.19	1.11
Avg. Shaft			14.6			2.12	0.45
Toe			365.0				264.78

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.26	0.12
Quake	(in)	0.09	0.45
Case Damping Factor		0.89	1.15
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	94
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.06
Soil Plug Weight	(kips)		0.286

CAPWAP match quality = 2.46 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.21 in; Blow Count = 56 b/ft
Computed: Final Set = 0.22 in; Blow Count = 54 b/ft

max. Top Comp. Stress = 32.8 ksi (T= 36.1 ms, max= 1.029 x Top)
max. Comp. Stress = 33.7 ksi (Z= 30.3 ft, T= 37.7 ms)
max. Tens. Stress = -1.87 ksi (Z= 43.8 ft, T= 59.5 ms)
max. Energy (EMX) = 38.5 kip-ft; max. Measured Top Displ. (DMX)= 1.03 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	701.7	-12.6	32.8	-0.59	38.5	17.3	1.02
2	6.7	702.6	-13.2	32.8	-0.62	38.4	17.3	1.00
4	13.5	704.9	-14.4	32.9	-0.67	37.9	17.2	0.96
5	16.8	707.0	-15.0	33.0	-0.70	37.6	17.1	0.94
6	20.2	709.5	-19.3	33.1	-0.90	37.2	17.1	0.92
7	23.6	714.7	-25.4	33.4	-1.19	36.8	16.9	0.89
8	27.0	714.7	-30.0	33.4	-1.40	36.1	16.8	0.87
9	30.3	722.1	-35.7	33.7	-1.67	35.6	16.6	0.84
10	33.7	708.5	-34.9	33.1	-1.63	34.1	16.4	0.81
11	37.1	720.9	-39.6	33.7	-1.85	33.6	16.0	0.78
12	40.4	703.1	-35.2	32.8	-1.64	31.7	15.7	0.75
13	43.8	717.1	-40.1	33.5	-1.87	31.1	15.3	0.72
14	47.2	672.4	-27.7	31.4	-1.29	28.3	14.9	0.70
15	50.5	686.0	-32.7	32.0	-1.53	27.7	14.6	0.67
16	53.9	634.2	-16.5	29.6	-0.77	24.7	14.2	0.64
17	57.3	653.5	-21.1	30.5	-0.98	24.2	13.7	0.61
18	60.7	612.8	-5.6	28.6	-0.26	21.4	13.1	0.58
19	64.0	628.9	-10.3	29.4	-0.48	20.9	12.6	0.55
20	67.4	542.4	0.0	25.3	0.00	17.0	12.2	0.53
21	70.8	555.2	0.0	25.9	0.00	16.5	13.5	0.50
22	74.1	466.8	0.0	21.8	0.00	13.6	14.6	0.47
23	77.5	484.8	0.0	22.6	0.00	9.9	14.8	0.45
Absolute	30.3			33.7			(T =	37.7 ms)
	43.8				-1.87		(T =	59.5 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	753.6	691.8	629.9	568.1	506.3	444.5	382.6	320.8	259.0	197.1
RX	759.9	697.5	635.1	593.6	580.8	568.7	556.5	545.3	535.4	525.4
RU	753.6	691.8	629.9	568.1	506.3	444.5	382.6	320.8	259.0	197.1

RAU = 394.5 (kips); RA2 = 614.8 (kips)

Current CAPWAP Ru = 496.0 (kips); Corresponding J(RP)= 0.42;

RMX requires higher damping; see PDA-W

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
17.6	35.89	672.5	699.4	711.7	1.03	0.21	0.21	38.9	752.7	938

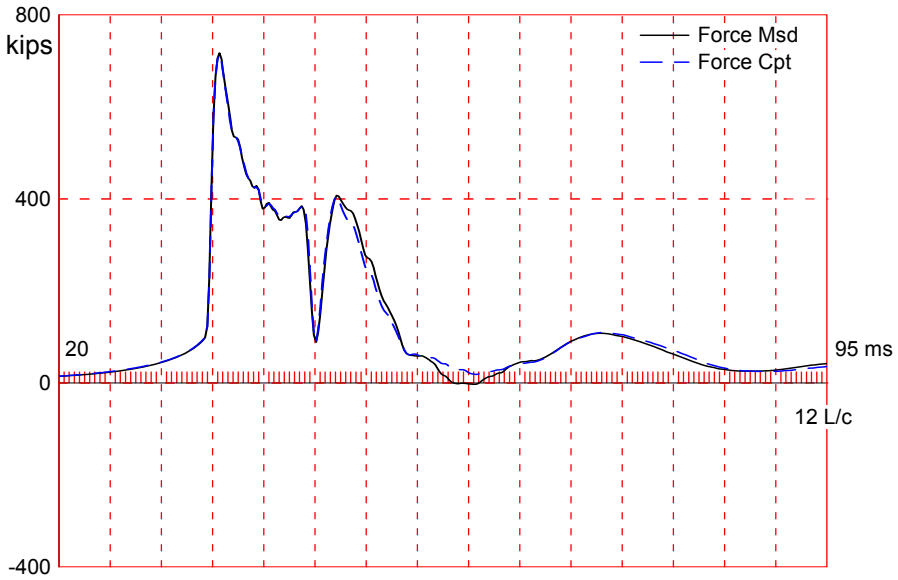
PILE PROFILE AND PILE MODEL

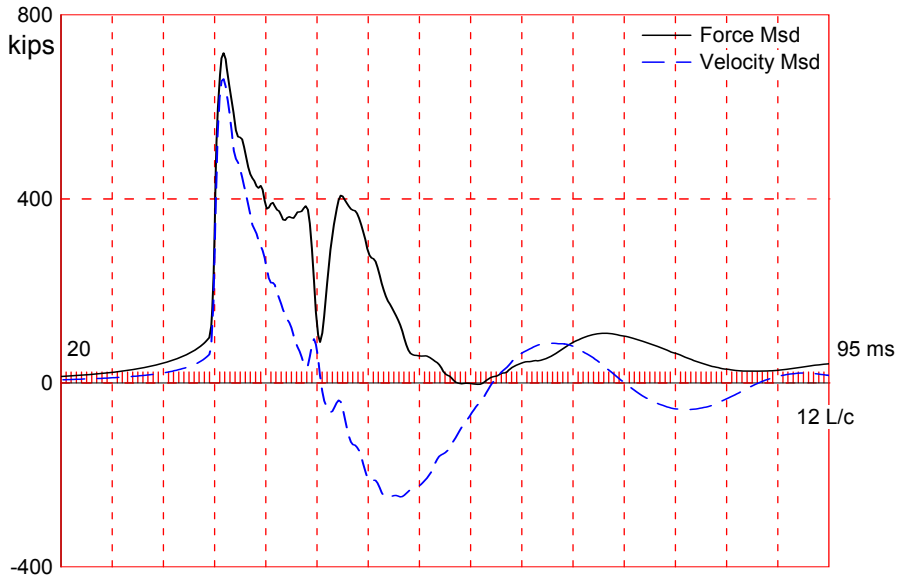
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

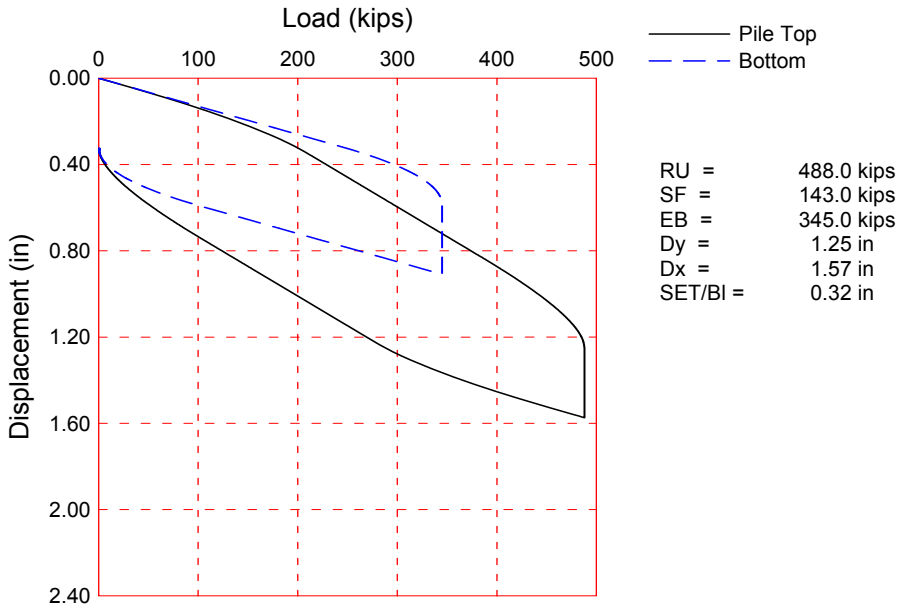
Toe Area 198.5 in^2

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

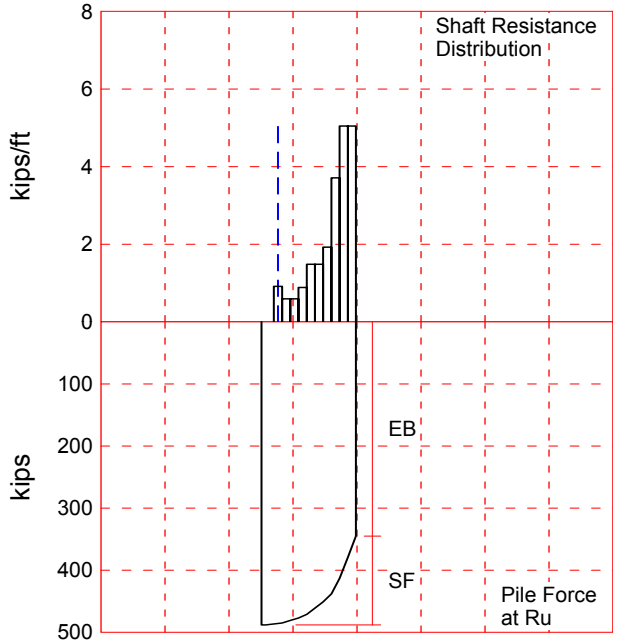
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	488.0 kips
SF =	143.0 kips
EB =	345.0 kips
Dy =	1.25 in
Dx =	1.57 in
SET/Bl =	0.32 in



Length b. Sensors	77.5 ft
Embedment	63.9 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	2.27
Top Compr. Stress	33.4 ksi
Max Compr. Stress	34.1 ksi
Max Tension Stress	-2.49 ksi
Avg. Shaft Quake	0.07 in
Toe Quake	0.45 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.10 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: 488.0; along Shaft 143.0; at Toe 345.0 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
				488.0			
1	16.8	3.3	3.0	485.0	3.0	0.92	0.20
2	23.6	10.0	4.0	481.0	7.0	0.59	0.13
3	30.3	16.7	4.0	477.0	11.0	0.59	0.13
4	37.1	23.5	6.0	471.0	17.0	0.89	0.19
5	43.8	30.2	10.0	461.0	27.0	1.48	0.32
6	50.5	37.0	10.0	451.0	37.0	1.48	0.32
7	57.3	43.7	13.0	438.0	50.0	1.93	0.41
8	64.0	50.4	25.0	413.0	75.0	3.71	0.79
9	70.8	57.2	34.0	379.0	109.0	5.05	1.07
10	77.5	63.9	34.0	345.0	143.0	5.05	1.07
Avg. Shaft			14.3			2.24	0.48
Toe			345.0				250.27

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.27	0.10
Quake	(in)	0.07	0.45
Case Damping Factor		1.01	0.90
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	51
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	35	
Resistance Gap (included in Toe Quake)	(in)		0.12
Soil Plug Weight	(kips)		0.209

CAPWAP match quality = 2.27 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.32 in; Blow Count = 37 b/ft
Computed: Final Set = 0.30 in; Blow Count = 40 b/ft

max. Top Comp. Stress = 33.4 ksi (T= 36.1 ms, max= 1.022 x Top)
max. Comp. Stress = 34.1 ksi (Z= 16.8 ft, T= 36.9 ms)
max. Tens. Stress = -2.49 ksi (Z= 57.3 ft, T= 61.9 ms)
max. Energy (EMX) = 39.9 kip-ft; max. Measured Top Displ. (DMX)= 1.04 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	713.9	-15.2	33.4	-0.71	39.9	17.4	1.03
2	6.7	715.4	-15.2	33.4	-0.71	39.8	17.3	1.01
4	13.5	724.0	-16.6	33.8	-0.78	39.4	17.1	0.98
5	16.8	729.6	-17.6	34.1	-0.82	39.0	17.0	0.95
6	20.2	718.3	-19.8	33.6	-0.93	37.7	16.8	0.93
7	23.6	724.2	-25.9	33.8	-1.21	37.2	16.6	0.90
8	27.0	708.0	-29.1	33.1	-1.36	35.7	16.5	0.87
9	30.3	715.6	-35.6	33.4	-1.66	35.2	16.3	0.85
10	33.7	701.8	-38.2	32.8	-1.79	33.8	16.1	0.82
11	37.1	713.0	-43.4	33.3	-2.03	33.3	15.8	0.79
12	40.4	692.6	-43.5	32.4	-2.03	31.4	15.5	0.76
13	43.8	704.0	-48.8	32.9	-2.28	30.9	15.2	0.74
14	47.2	664.6	-46.9	31.0	-2.19	28.3	14.9	0.71
15	50.5	677.7	-51.3	31.7	-2.40	27.7	14.5	0.68
16	53.9	643.0	-49.4	30.0	-2.31	25.3	14.2	0.65
17	57.3	666.7	-53.4	31.1	-2.49	24.8	13.6	0.62
18	60.7	627.8	-49.2	29.3	-2.30	22.1	13.0	0.59
19	64.0	655.5	-52.8	30.6	-2.47	21.6	12.4	0.57
20	67.4	570.0	-43.9	26.6	-2.05	17.4	13.1	0.54
21	70.8	566.0	-45.5	26.4	-2.13	16.9	14.5	0.51
22	74.1	431.7	-31.9	20.2	-1.49	12.0	15.9	0.49
23	77.5	444.0	-33.6	20.7	-1.57	7.8	16.5	0.47
Absolute	16.8			34.1			(T =	36.9 ms)
	57.3				-2.49		(T =	61.9 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	721.4	654.8	588.1	521.5	454.9	388.2	321.6	254.9	188.3	121.7
RX	721.4	673.4	644.0	614.7	588.1	569.6	555.9	543.1	532.2	521.2
RU	721.4	654.8	588.1	521.5	454.9	388.2	321.6	254.9	188.3	121.7

RAU = 280.5 (kips); RA2 = 619.9 (kips)

Current CAPWAP Ru = 488.0 (kips); Corresponding J(RP)= 0.35;

RMX requires higher damping; see PDA-W

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
17.5	35.89	669.6	718.1	718.1	1.04	0.32	0.32	40.3	706.8	1046

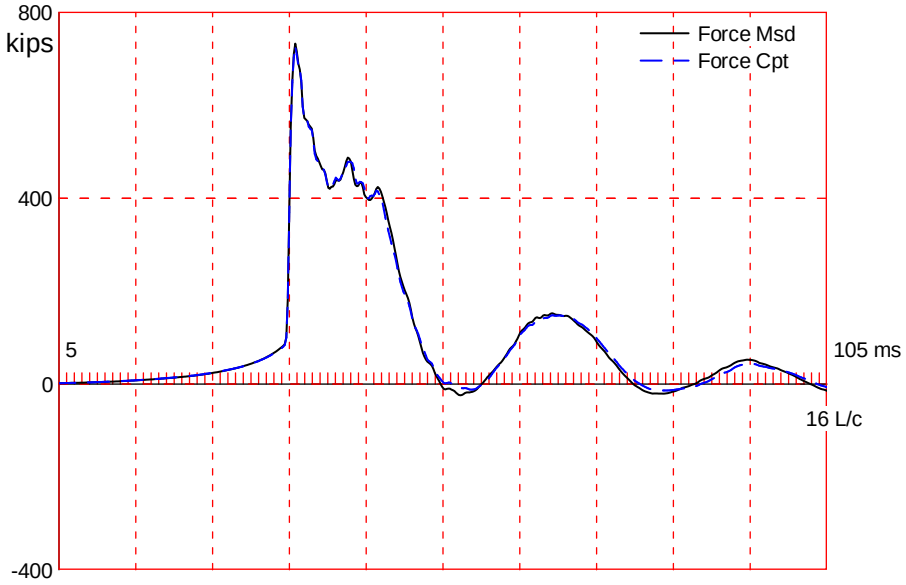
PILE PROFILE AND PILE MODEL

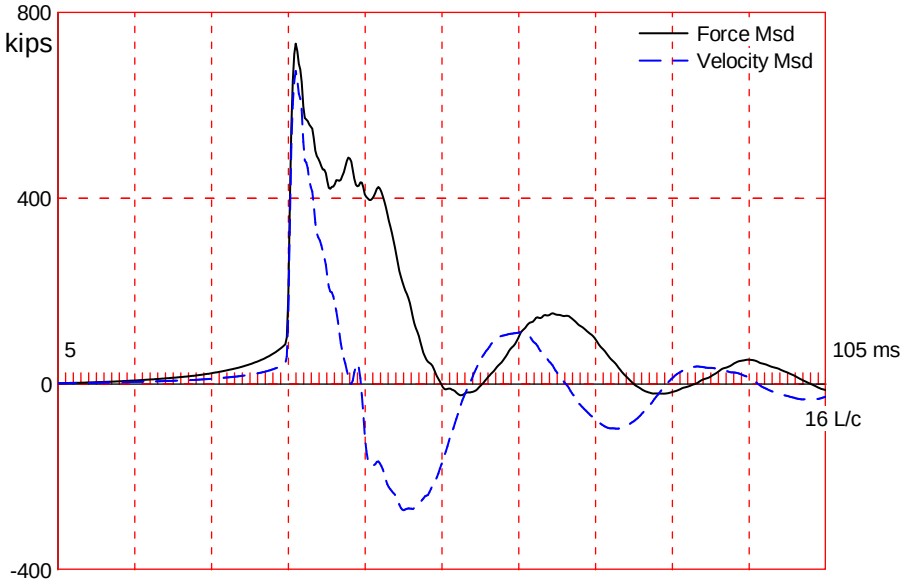
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

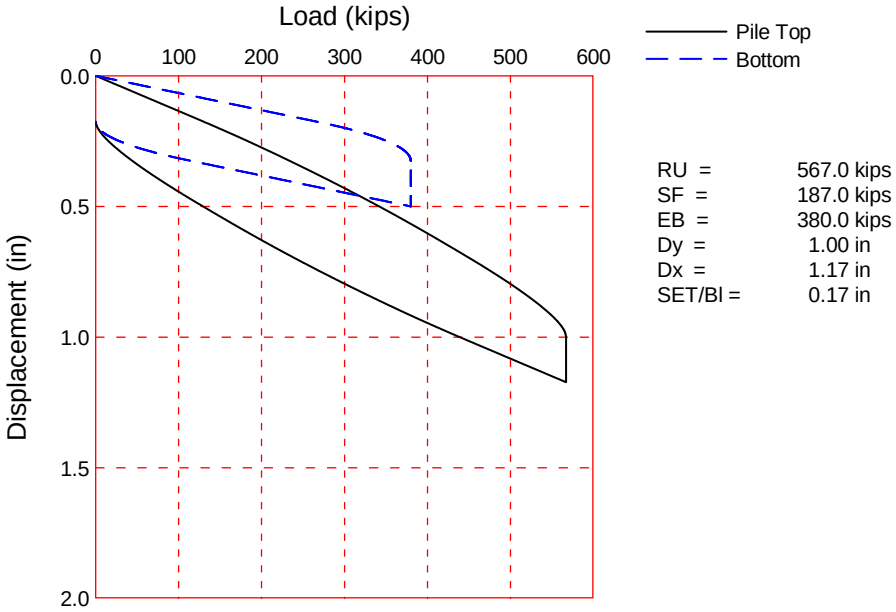
Toe Area 198.5 in^2

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

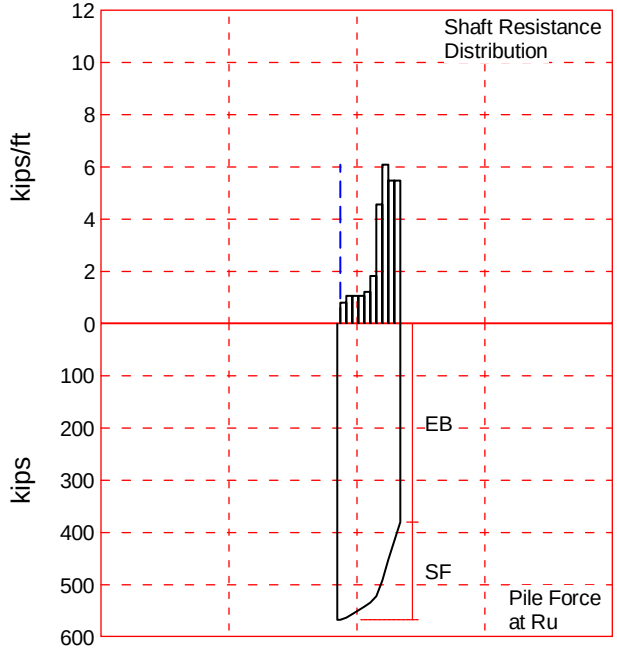
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	567.0 kips
SF =	187.0 kips
EB =	380.0 kips
Dy =	1.00 in
Dx =	1.17 in
SET/Bl =	0.17 in



Length b. Sensors	69.0 ft
Embedment	64.1 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	1.90
Top Compr. Stress	34.2 ksi
Max Compr. Stress	34.8 ksi
Max Tension Stress	-3.77 ksi
Avg. Shaft Quake	0.17 in
Toe Quake	0.25 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.15 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 567.0; along Shaft 187.0; at Toe 380.0 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
				567.0			
1	9.9	5.0	4.0	563.0	4.0	0.81	0.17
2	16.4	11.5	7.0	556.0	11.0	1.07	0.23
3	23.0	18.1	7.0	549.0	18.0	1.07	0.23
4	29.6	24.7	7.0	542.0	25.0	1.07	0.23
5	36.1	31.2	8.0	534.0	33.0	1.22	0.26
6	42.7	37.8	12.0	522.0	45.0	1.83	0.39
7	49.3	44.4	30.0	492.0	75.0	4.57	0.97
8	55.9	51.0	40.0	452.0	115.0	6.09	1.30
9	62.4	57.5	36.0	416.0	151.0	5.48	1.17
10	69.0	64.1	36.0	380.0	187.0	5.48	1.17
Avg. Shaft			18.7			2.92	0.62
Toe			380.0				275.66

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.28	0.15
Quake	(in)	0.17	0.25
Case Damping Factor		1.37	1.49
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	83	
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)	0.100	0.202

CAPWAP match quality = 1.90 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.17 in; Blow Count = 69 b/ft
Computed: Final Set = 0.18 in; Blow Count = 65 b/ft

max. Top Comp. Stress = 34.2 ksi (T= 36.2 ms, max= 1.020 x Top)
max. Comp. Stress = 34.8 ksi (Z= 9.9 ft, T= 36.6 ms)
max. Tens. Stress = -3.77 ksi (Z= 42.7 ft, T= 57.9 ms)
max. Energy (EMX) = 38.5 kip-ft; max. Measured Top Displ. (DMX)= 0.93 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	731.2	-22.3	34.2	-1.04	38.5	17.7	0.91
2	6.6	737.1	-29.0	34.4	-1.36	37.9	17.5	0.88
3	9.9	745.9	-38.3	34.8	-1.79	37.3	17.3	0.85
4	13.1	731.6	-43.4	34.2	-2.03	35.7	17.0	0.82
5	16.4	741.2	-51.9	34.6	-2.43	35.1	16.8	0.79
6	19.7	710.4	-52.7	33.2	-2.46	32.8	16.5	0.76
7	23.0	720.8	-59.2	33.7	-2.77	32.2	16.2	0.73
8	26.3	691.9	-59.2	32.3	-2.77	30.0	16.0	0.69
9	29.6	703.2	-68.1	32.9	-3.18	29.3	15.7	0.66
10	32.9	676.3	-68.4	31.6	-3.19	27.2	15.4	0.63
11	36.1	690.5	-75.8	32.3	-3.54	26.4	15.0	0.59
12	39.4	663.6	-73.6	31.0	-3.44	24.3	14.6	0.56
13	42.7	694.2	-80.7	32.4	-3.77	23.5	13.9	0.52
14	46.0	669.9	-73.0	31.3	-3.41	21.1	13.2	0.49
15	49.3	701.8	-75.2	32.8	-3.51	20.3	12.3	0.46
16	52.6	618.8	-53.3	28.9	-2.49	16.5	11.4	0.42
17	55.9	645.0	-54.3	30.1	-2.54	15.8	10.6	0.39
18	59.1	536.0	-39.5	25.0	-1.85	12.0	9.5	0.36
19	62.4	558.7	-40.2	26.1	-1.88	11.5	9.6	0.33
20	65.7	514.8	-38.2	24.0	-1.79	8.8	10.4	0.31
21	69.0	523.0	-38.7	24.4	-1.81	7.0	10.0	0.28
Absolute	9.9			34.8			(T =	36.6 ms)
	42.7				-3.77		(T =	57.9 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	902.6	851.3	800.0	748.7	697.4	646.1	594.8	543.4	492.1	440.8
RX	902.6	855.1	816.4	777.8	739.2	700.6	665.8	642.2	622.7	604.4
RU	916.6	866.6	816.7	766.8	716.9	667.0	617.1	567.2	517.2	467.3

RAU = 285.2 (kips); RA2 = 720.0 (kips)

Current CAPWAP Ru = 567.0 (kips); Corresponding J(RP)= 0.65;

RMX requires higher damping; see PDA-W

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
17.8	35.97	679.5	736.2	736.2	0.93	0.17	0.17	39.2	849.0	1727

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
69.0	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	3.3	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
20	65.7	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.050
21	69.0	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.050

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.195 ms, 2L/c 8.2 ms
Total volume: 10.254 ft^3; Volume ratio considering added impedance: 1.000