GRL Engineers, Inc.

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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)

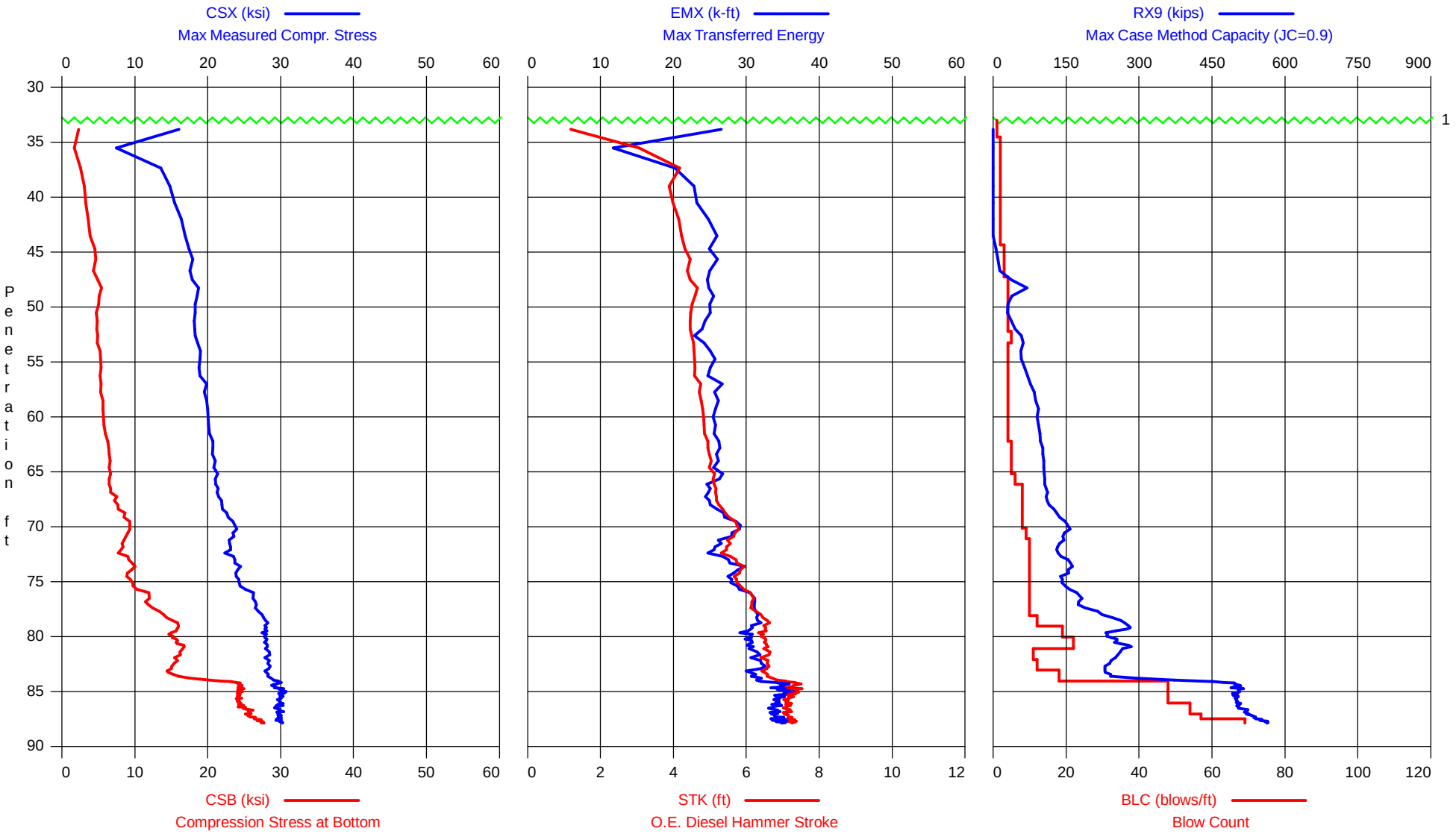
GRL Engineers, Inc. - Case Method & iCAP® Results

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

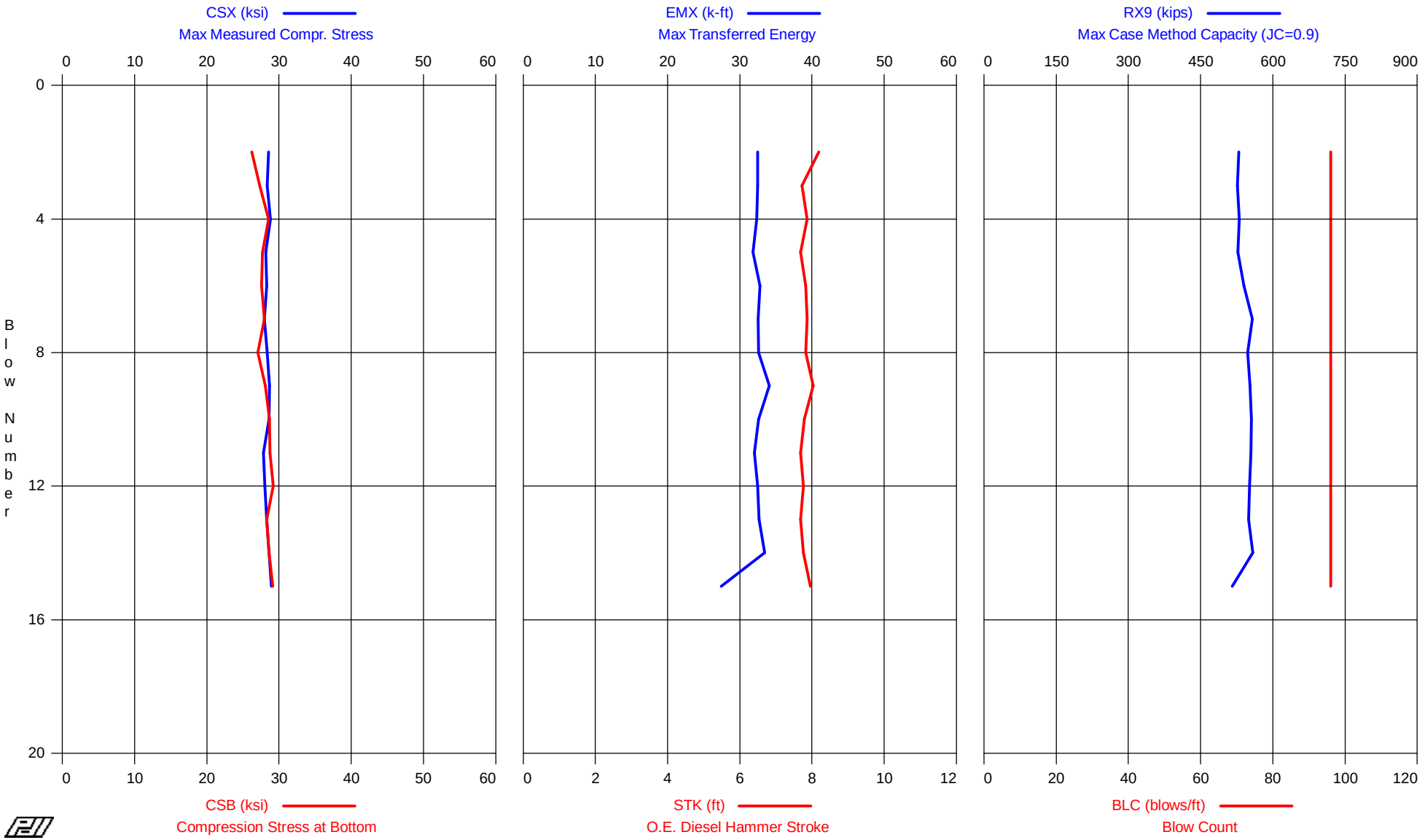
GRL Engineers, Inc. - Case Method & iCAP® Results

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

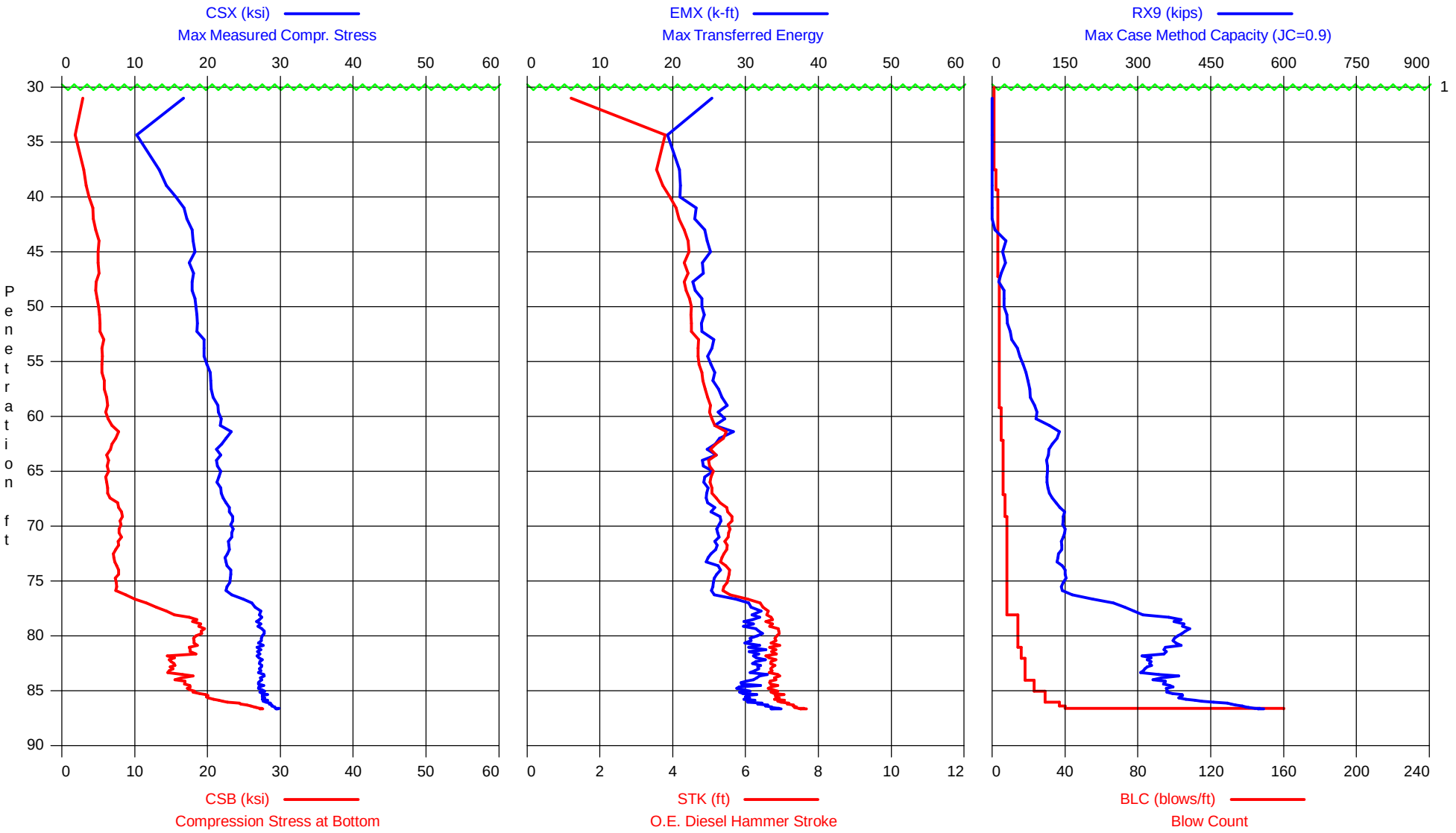
GRL Engineers, Inc. - Case Method & iCAP® Results

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



1 - Reported reference EL 740.39

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# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 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

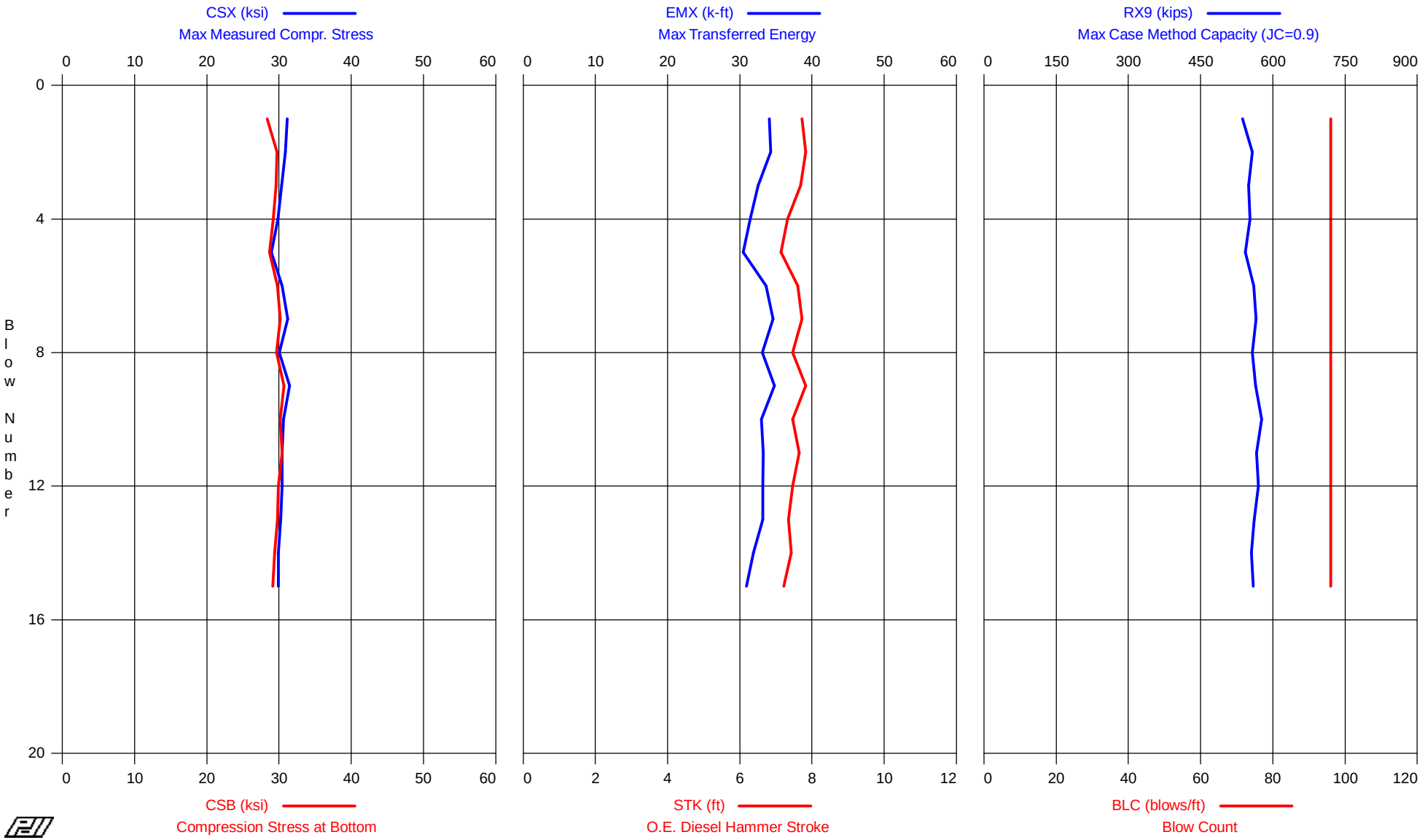
GRL Engineers, Inc. - Case Method & iCAP® Results

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

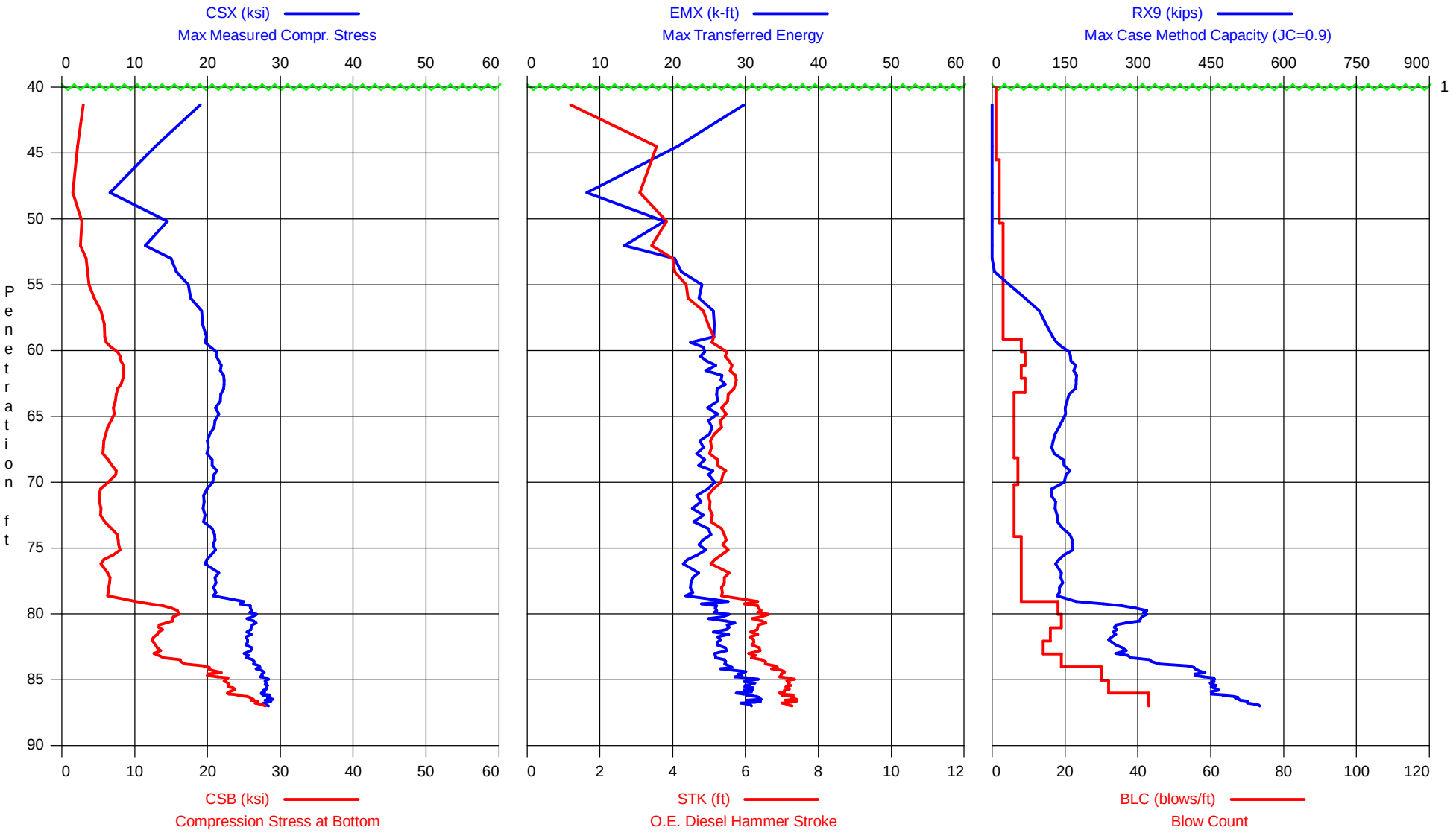
GRL Engineers, Inc. - Case Method & iCAP® Results

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



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])

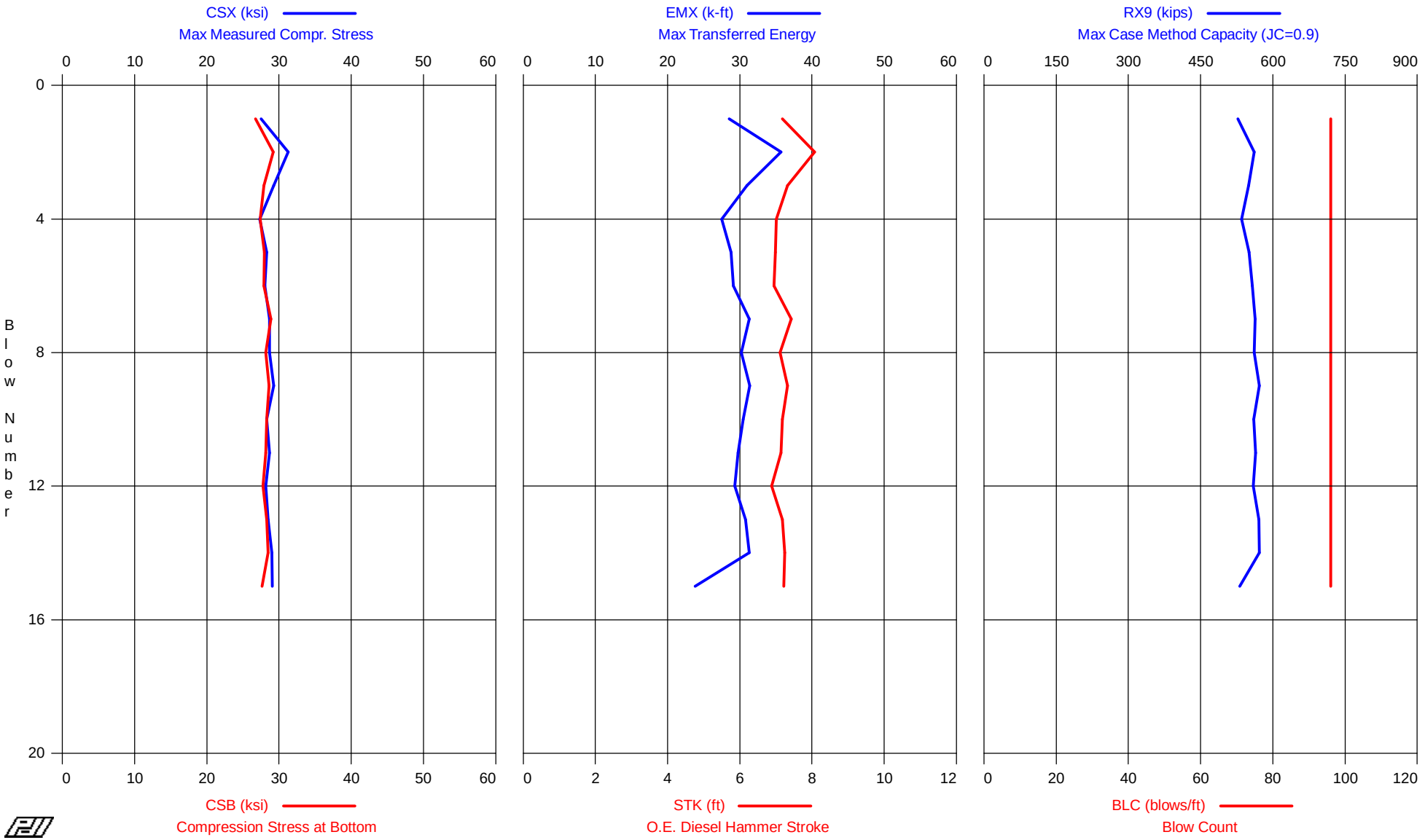
GRL Engineers, Inc. - Case Method & iCAP® Results

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

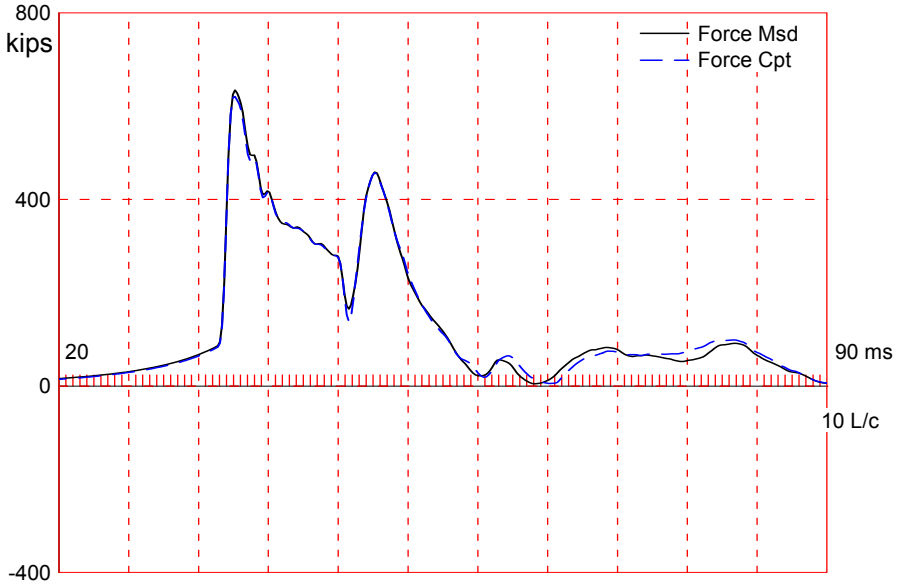
EMX: Max Transferred Energy
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

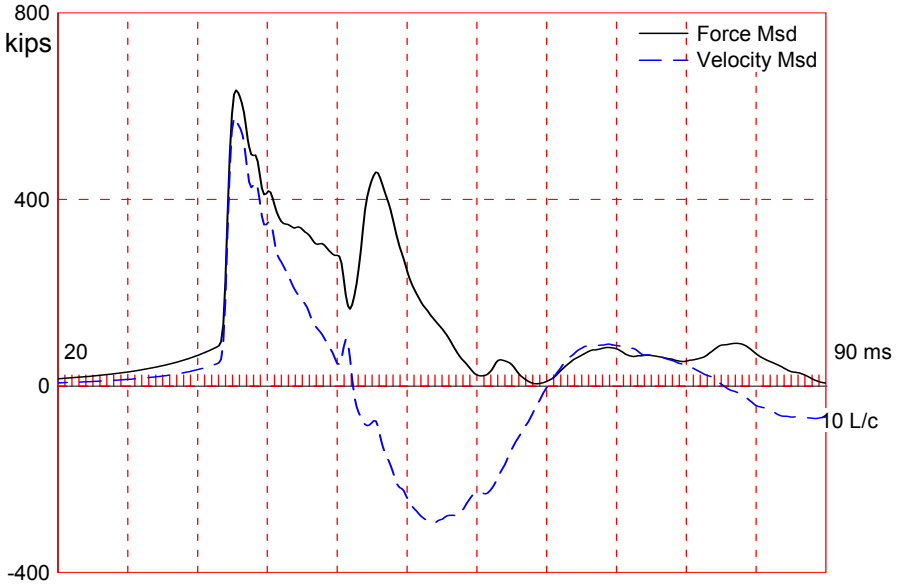
BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
5	87.05	96	AV5	28.7	27.8	7.3	30	44	545
			STD	1.4	0.8	0.4	3	1	12
			MAX	31.3	29.2	8.1	36	45	562
			MIN	27.3	26.7	7.0	27	42	527
10	87.10	96	AV5	28.6	28.4	7.2	30	44	563
			STD	0.4	0.3	0.2	1	0	5
			MAX	29.3	28.9	7.4	31	45	572
			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

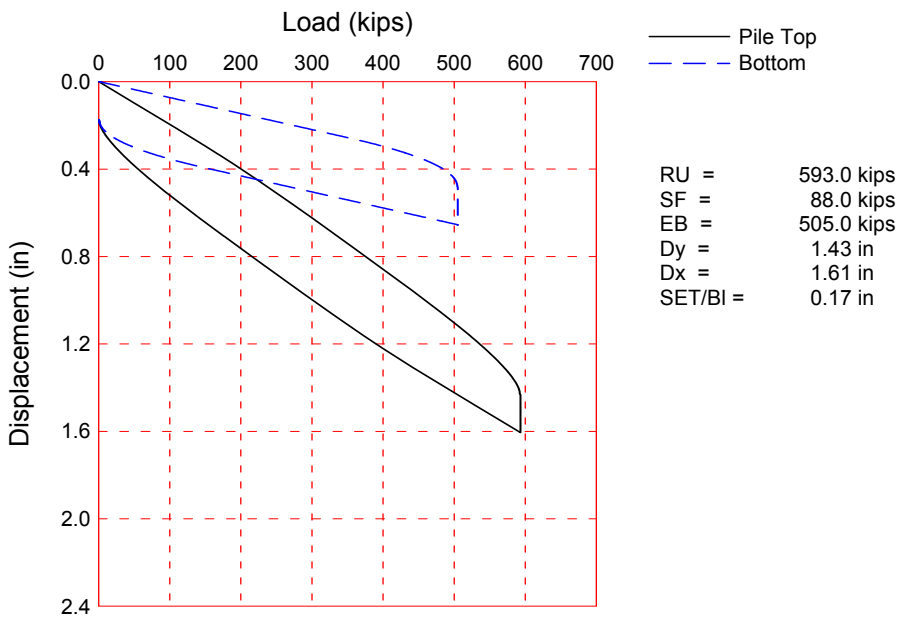
Total number of blows analyzed: 15

Time Summary

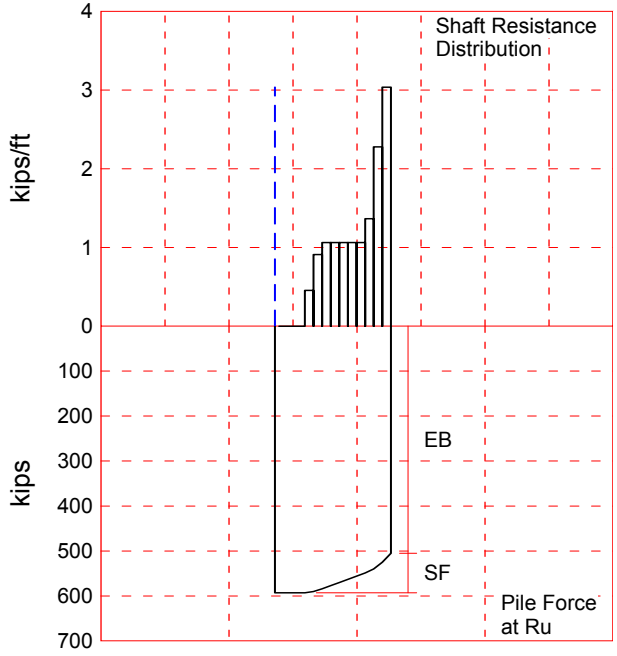
Drive 19 seconds 8:12:48 AM - 8:13:07 AM (12/18/2014) BN 1 - 15







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

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

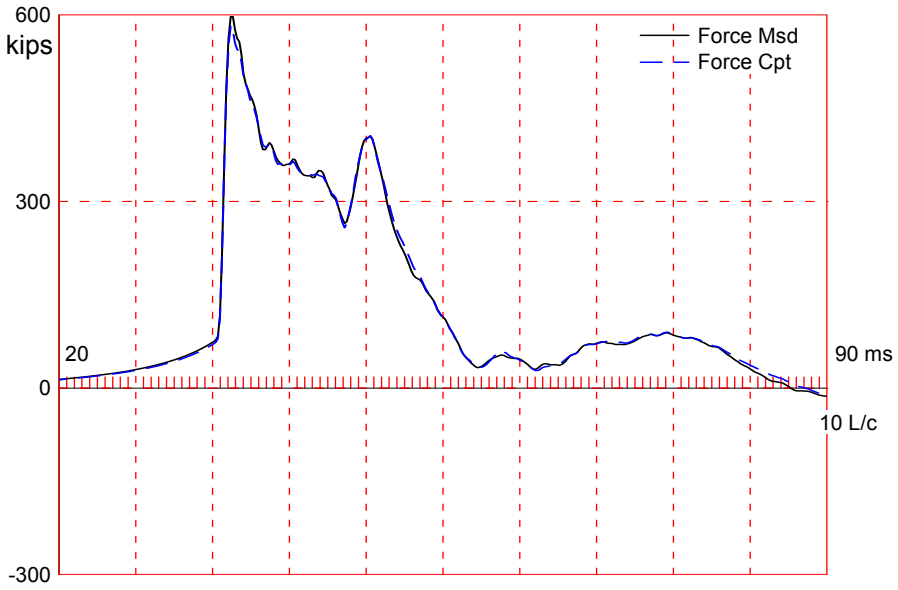
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
88.9	21.4	29992.2	492.000	4.70

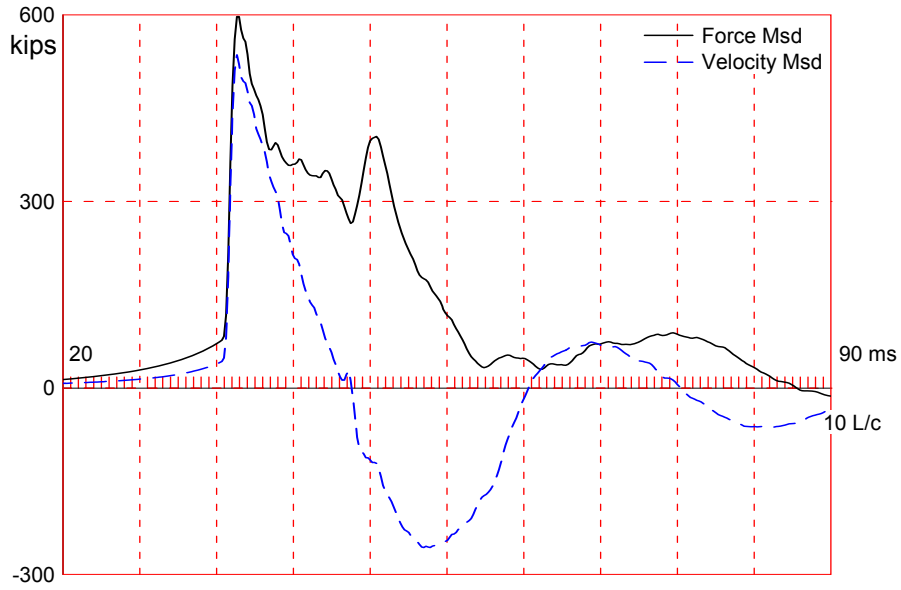
Toe Area 198.5 in^2

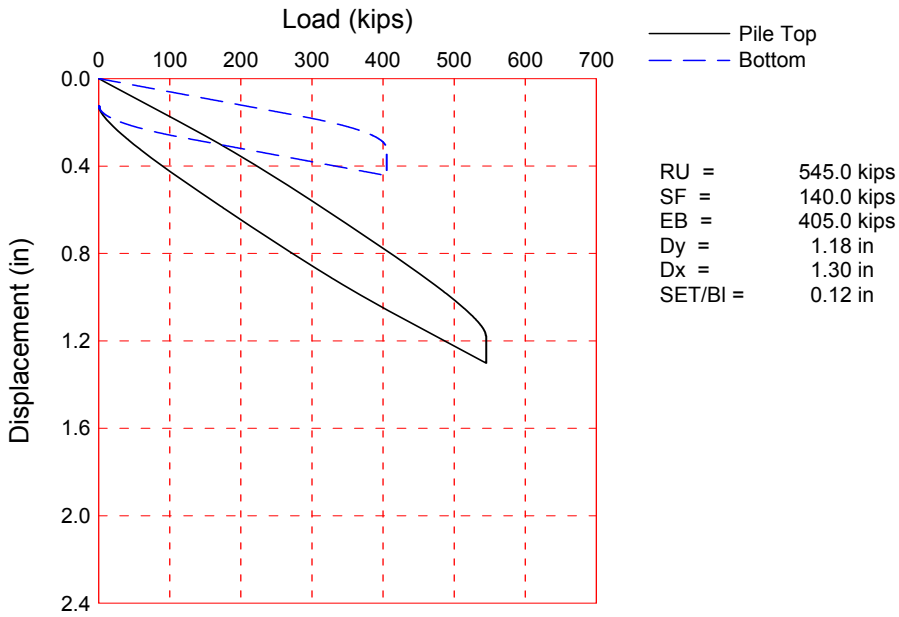
Top Segment Length 3.29 ft, Top Impedance 38 kips/ft/s

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

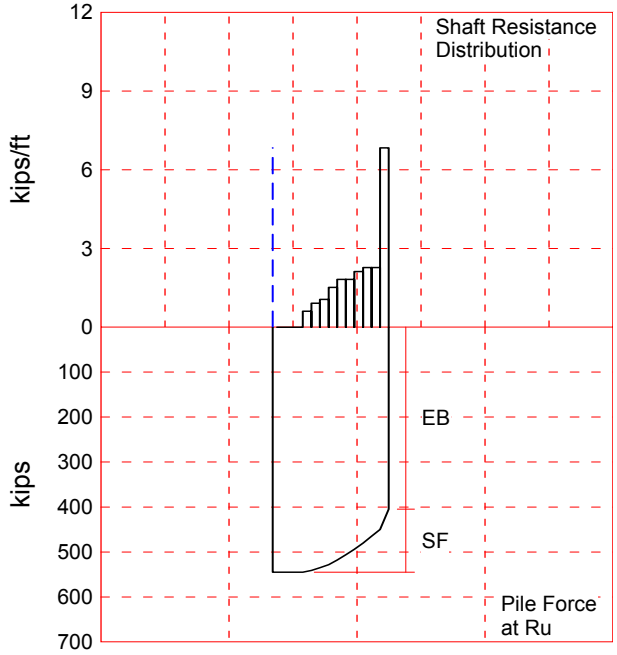
Total volume: 13.212 ft^3; Volume ratio considering added impedance: 1.000







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

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: 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

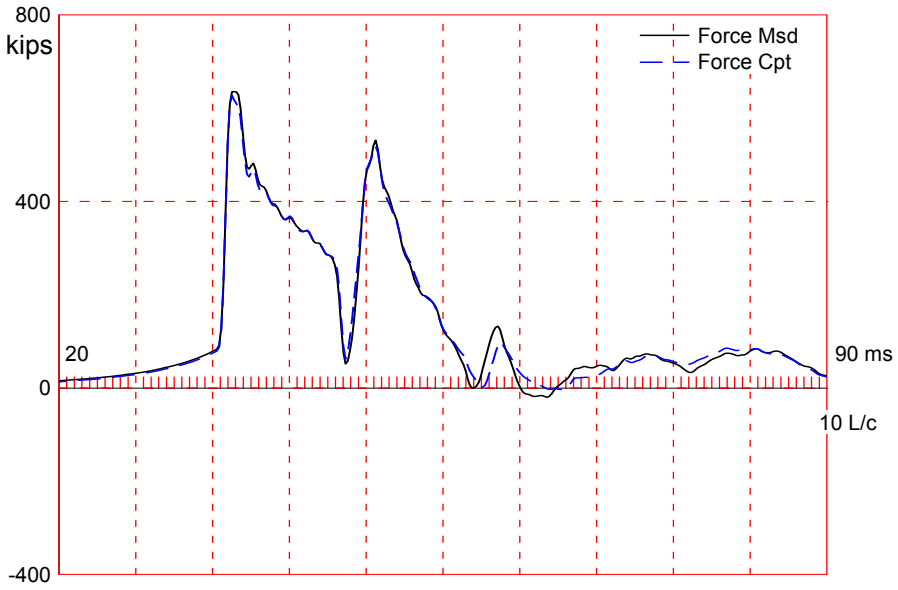
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
88.9	21.4	29992.2	492.000	4.70

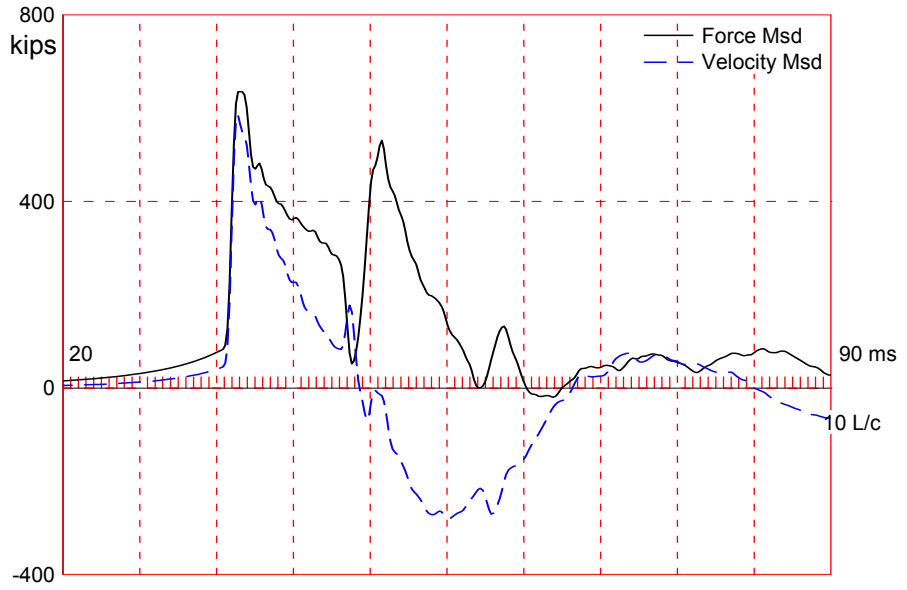
Toe Area 198.5 in^2

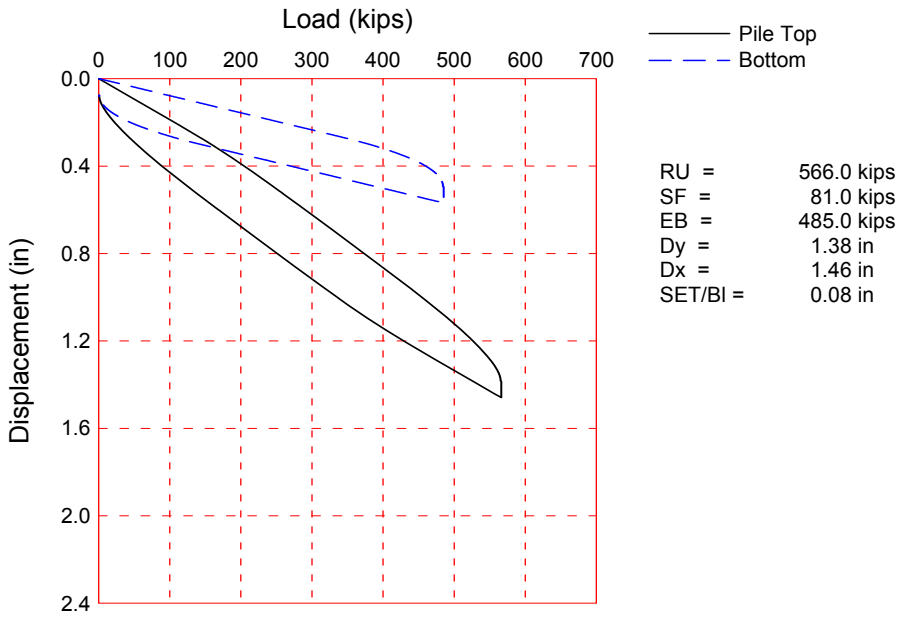
Top Segment Length 3.29 ft, Top Impedance 38 kips/ft/s

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

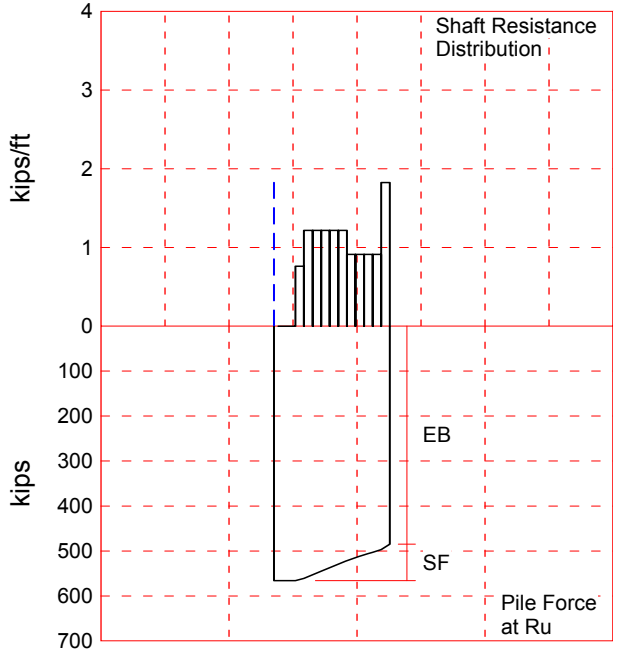
Total volume: 13.212 ft^3; Volume ratio considering added impedance: 1.000







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

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

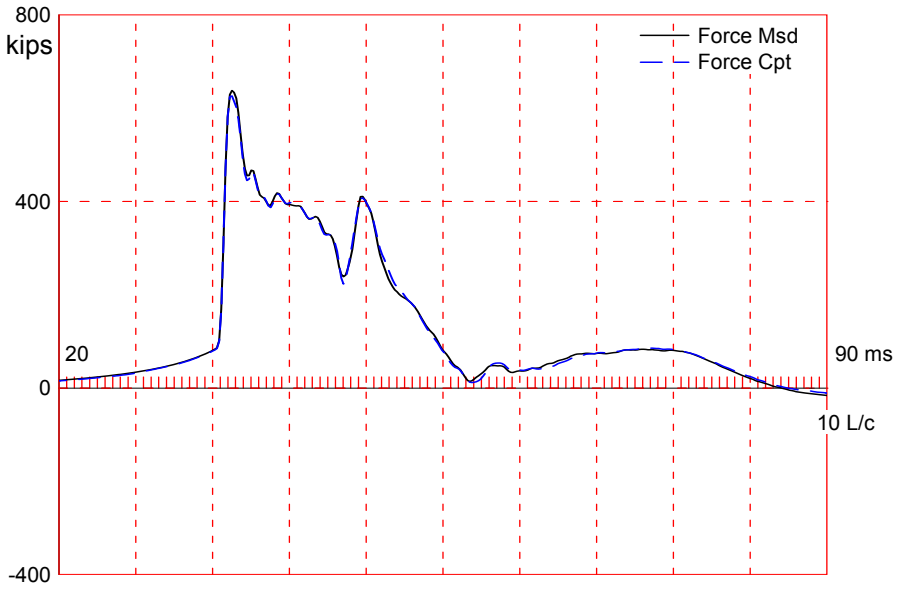
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
88.7	21.4	29992.2	492.000	4.70

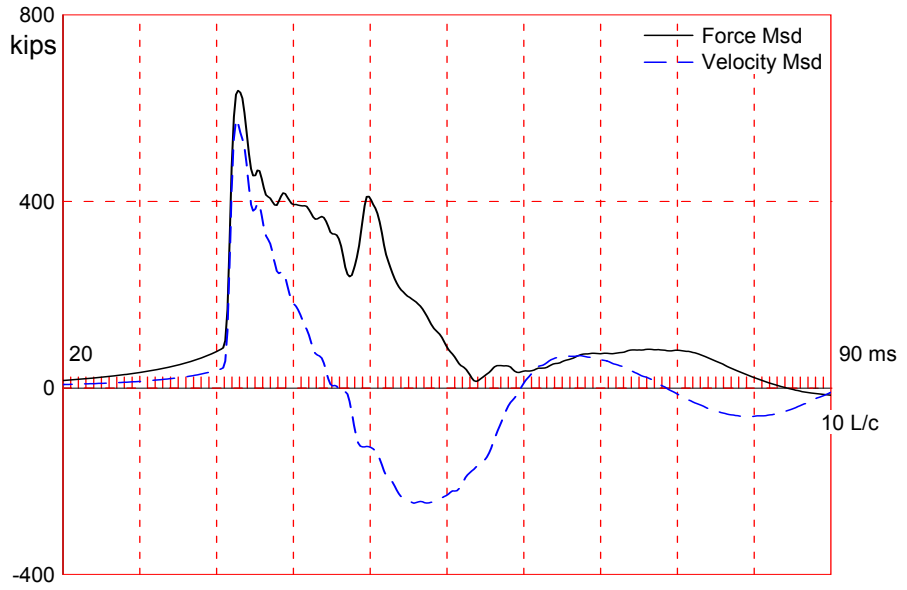
Toe Area 198.5 in^2

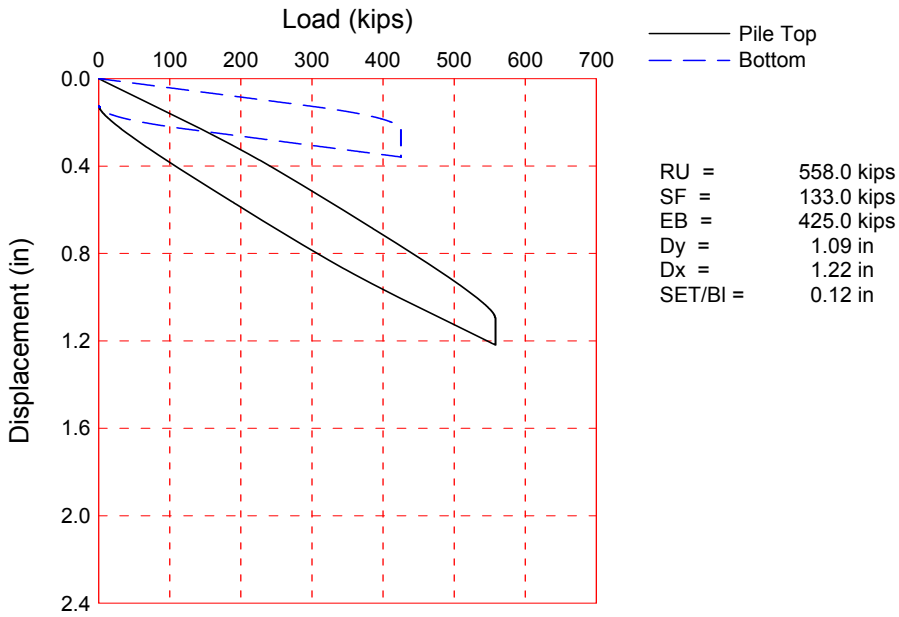
Top Segment Length 3.29 ft, Top Impedance 38 kips/ft/s

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

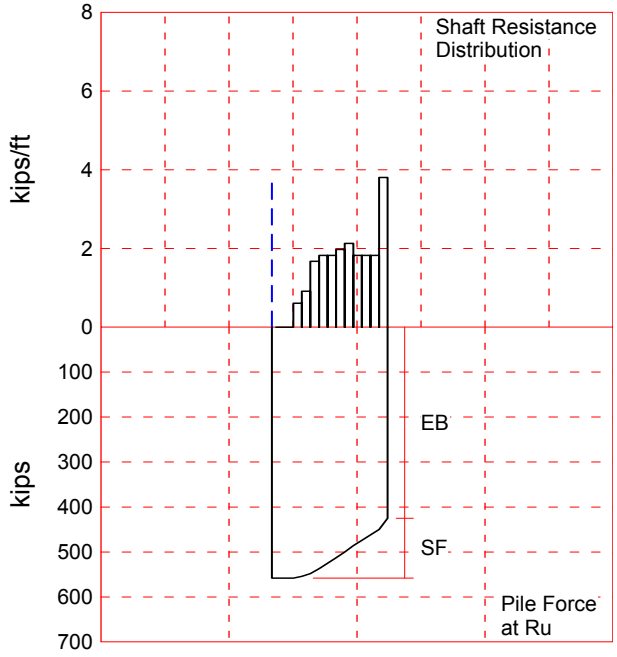
Total volume: 13.182 ft^3; Volume ratio considering added impedance: 1.000







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

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: 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

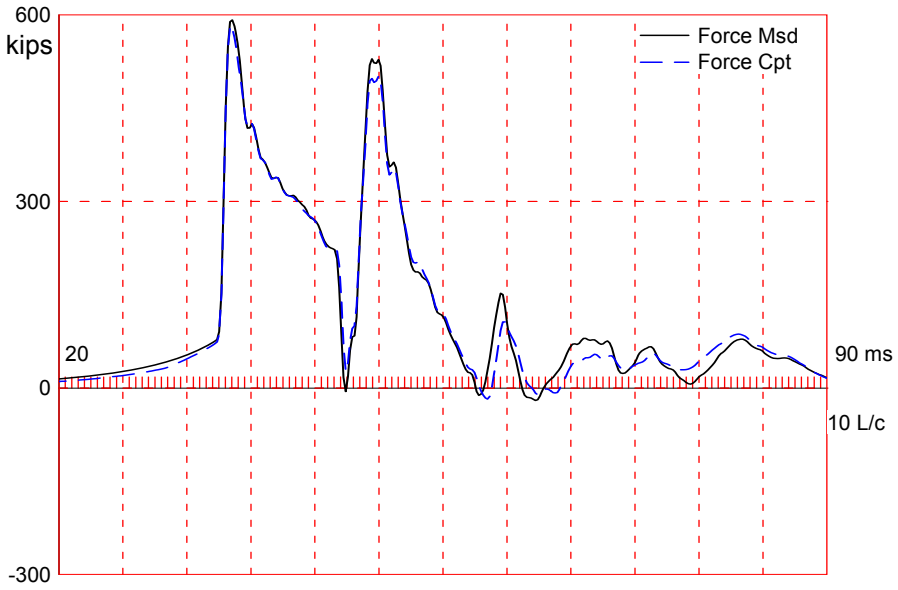
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
88.7	21.4	29992.2	492.000	4.70

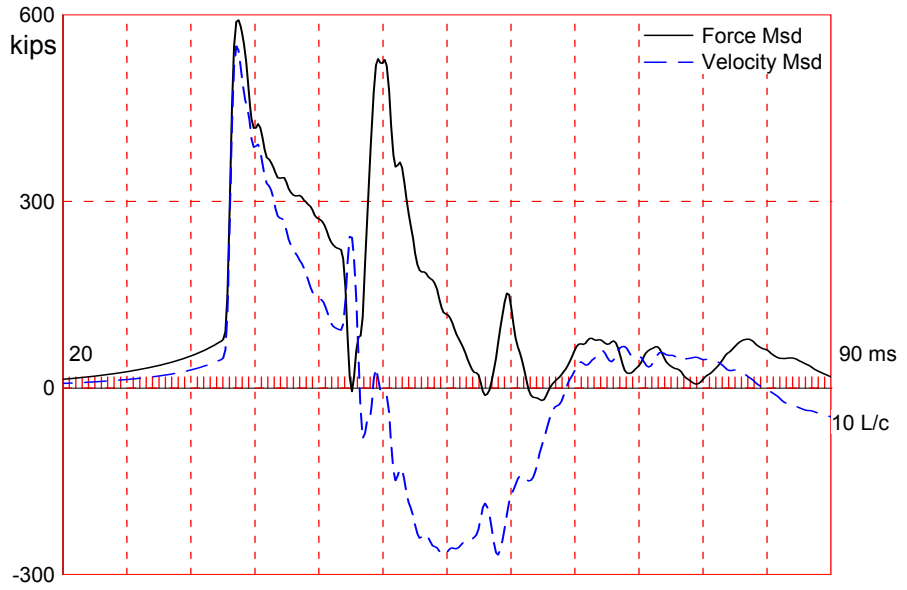
Toe Area 198.5 in^2

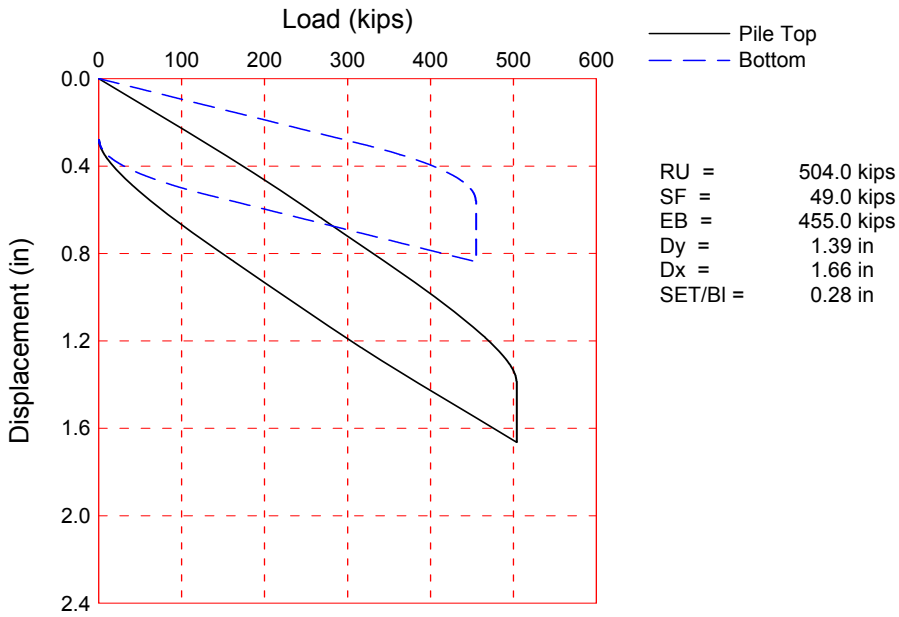
Top Segment Length 3.29 ft, Top Impedance 38 kips/ft/s

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

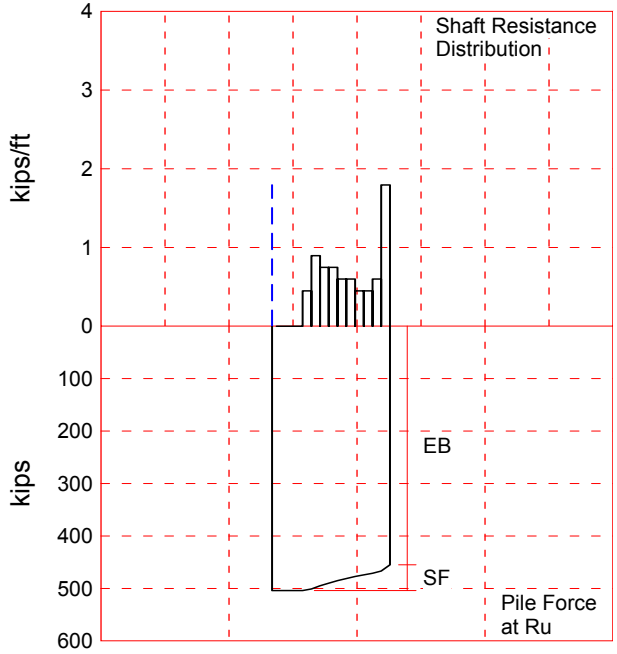
Total volume: 13.182 ft^3; Volume ratio considering added impedance: 1.000







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

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

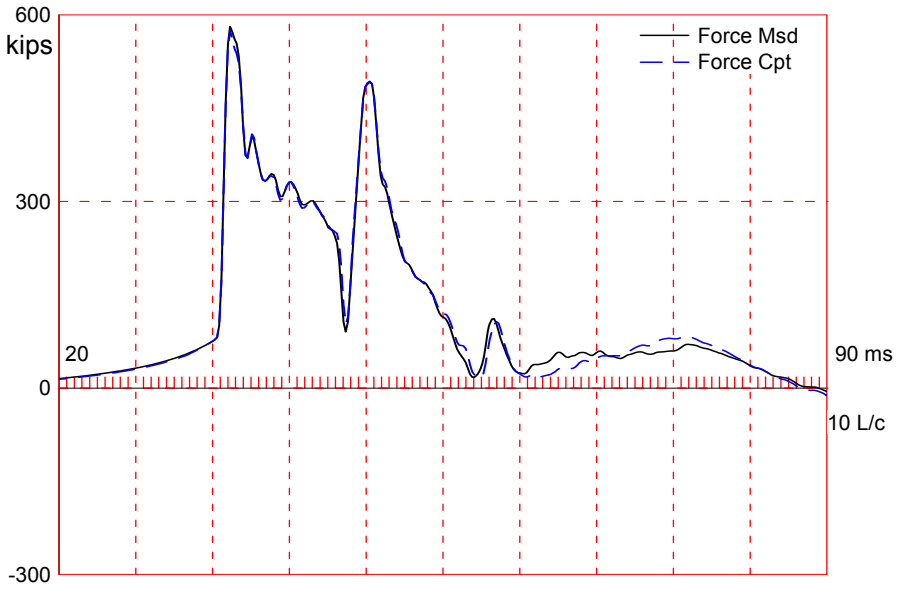
PILE PROFILE AND PILE MODEL

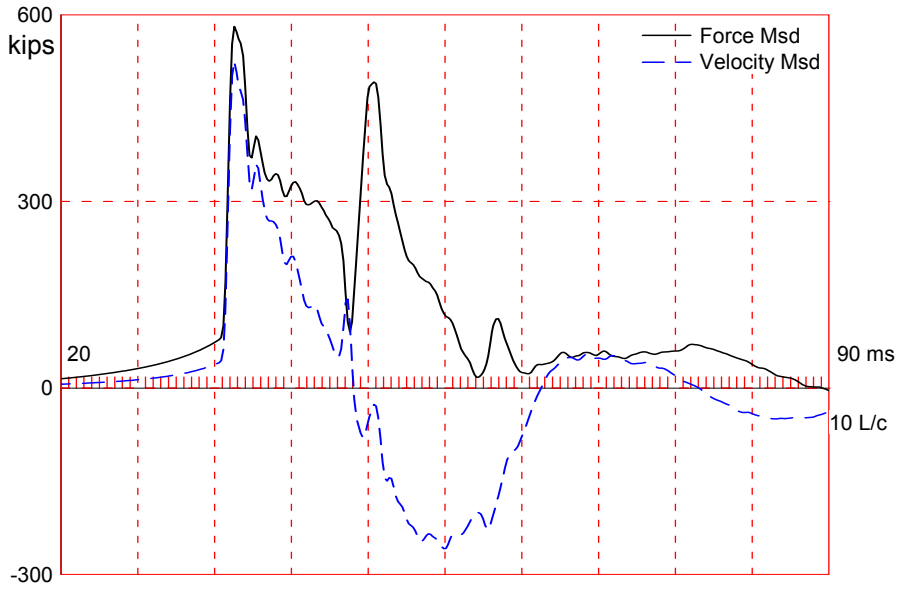
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
90.3	21.4	29992.2	492.000	4.70

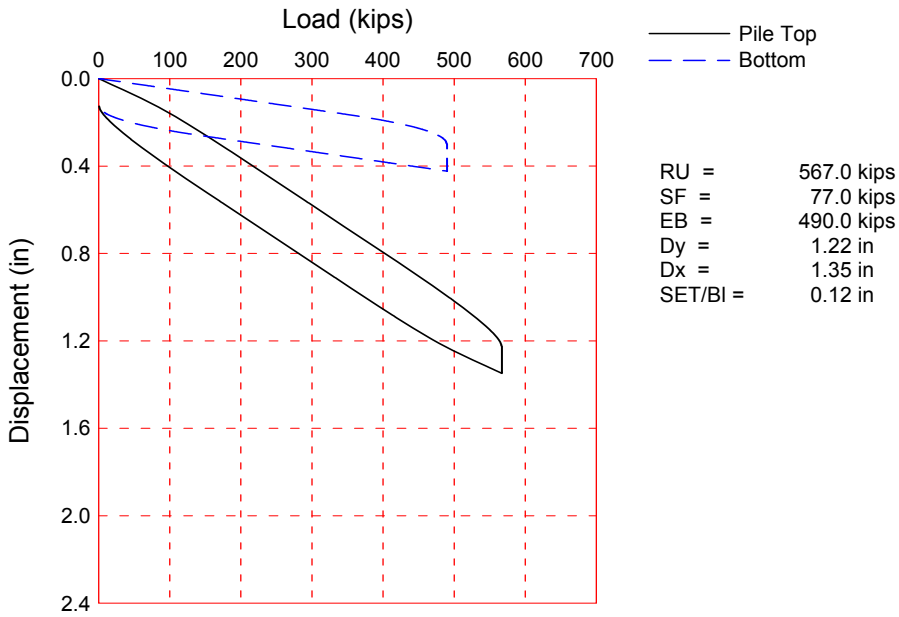
Toe Area 198.5 in^2

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

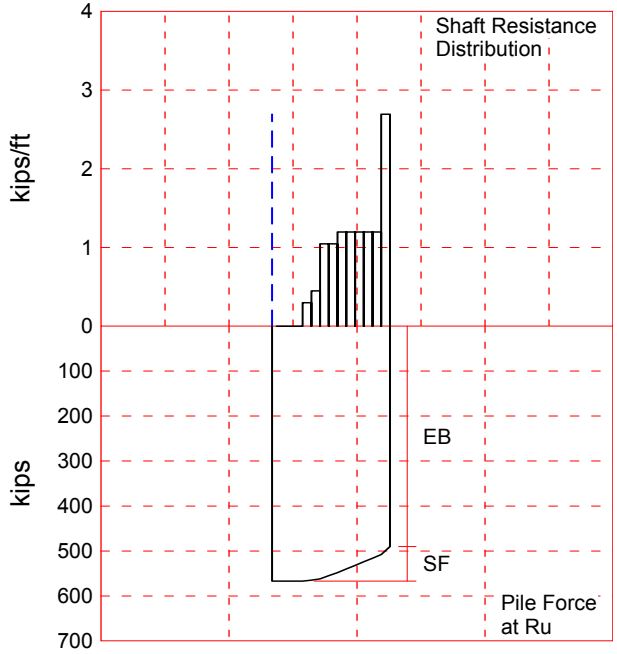
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.199 ms, 2L/c 10.7 ms
Total volume: 13.412 ft^3; Volume ratio considering added impedance: 1.000







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

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: 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