GRL Engineers, Inc.

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TRANSMITTAL

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

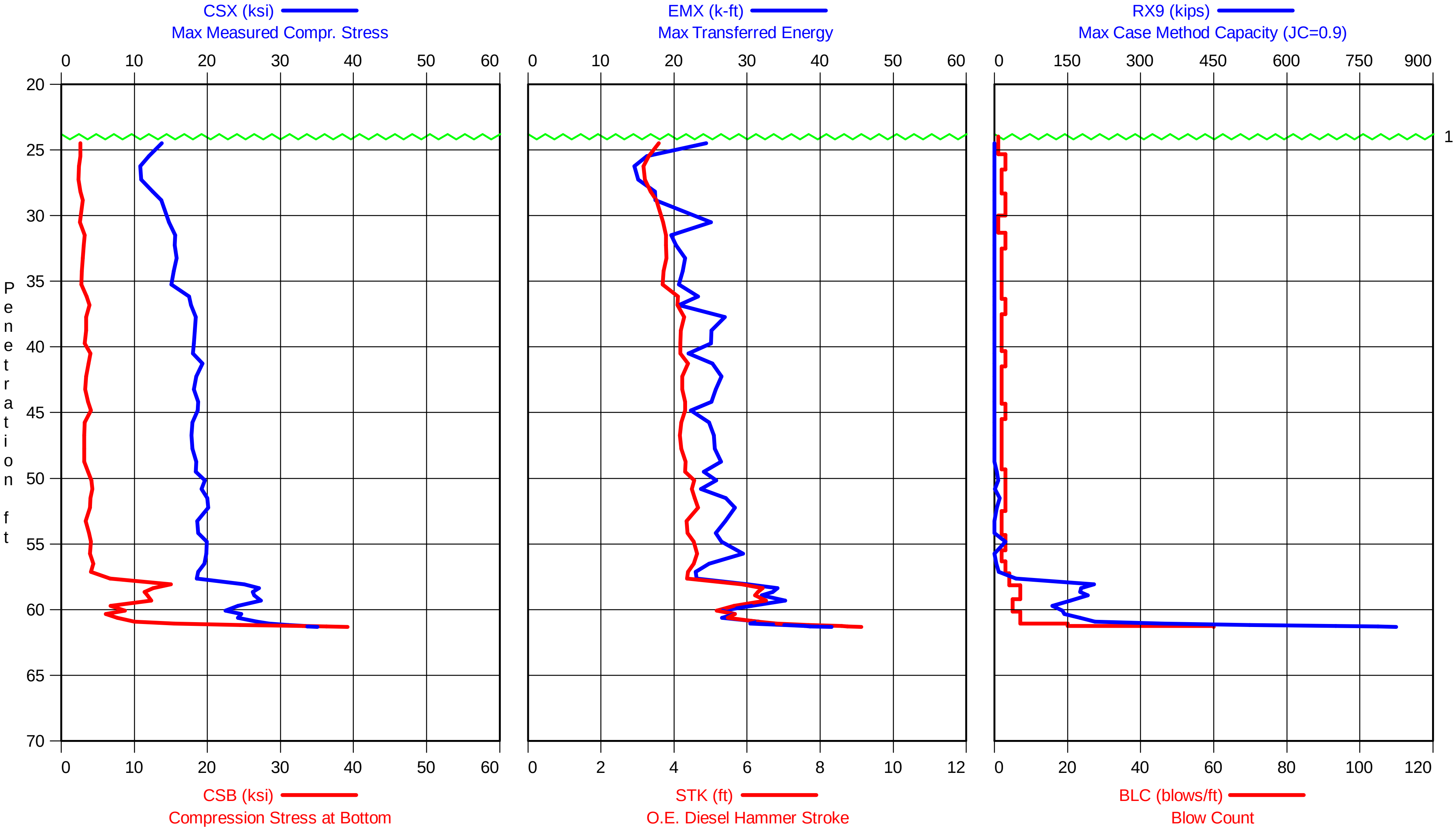
Dynamic Test Results - (pages 3 – 20)
CAPWAP Analysis Results - (pages 21 – 50)

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
APE D30-42, HP 14 x 73
OP: MR
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 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
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 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
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

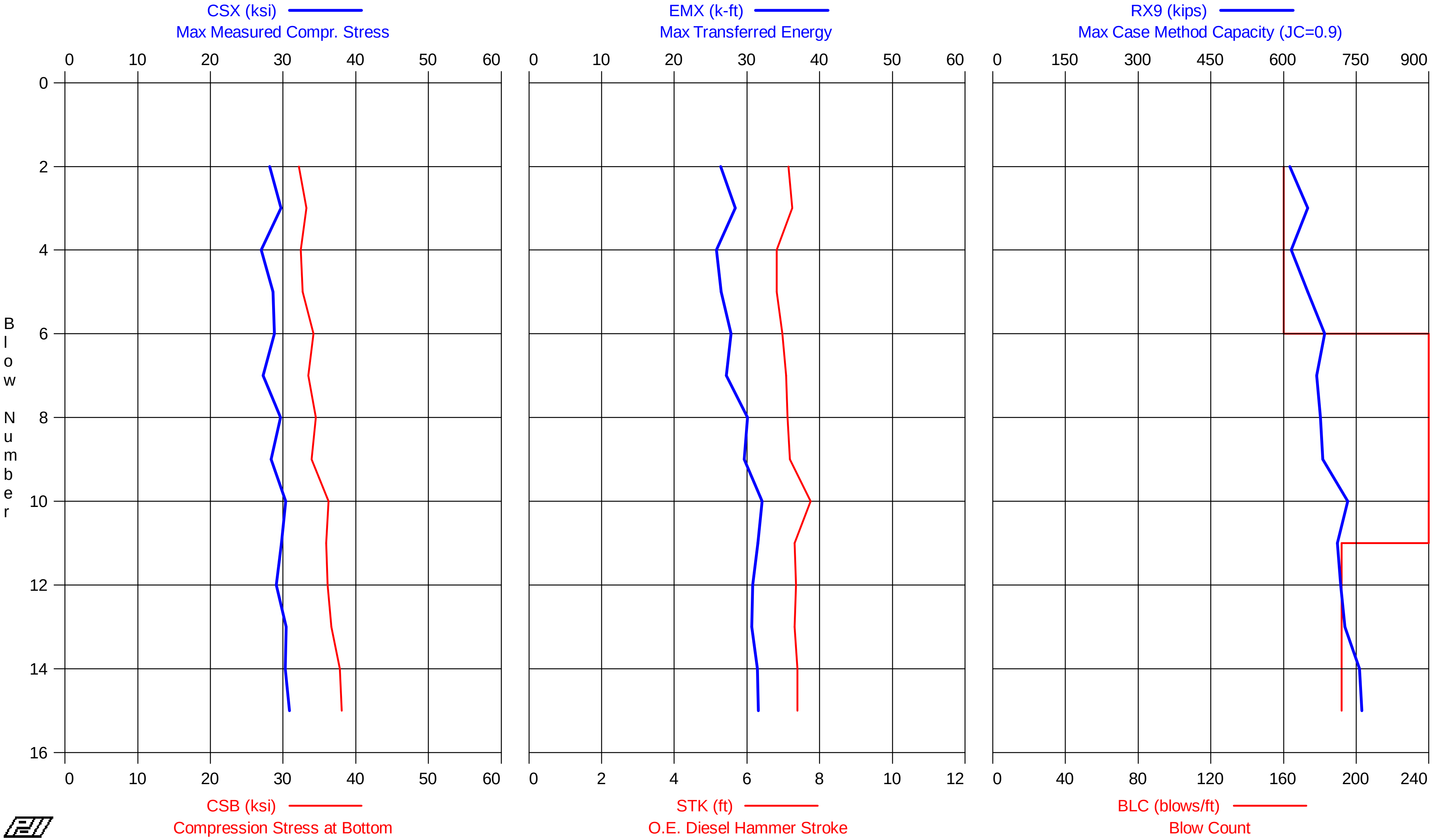
Drive 2 minutes 1 second 1:05:29 PM - 1:07:30 PM (11/18/2014) BN 1 - 109

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)

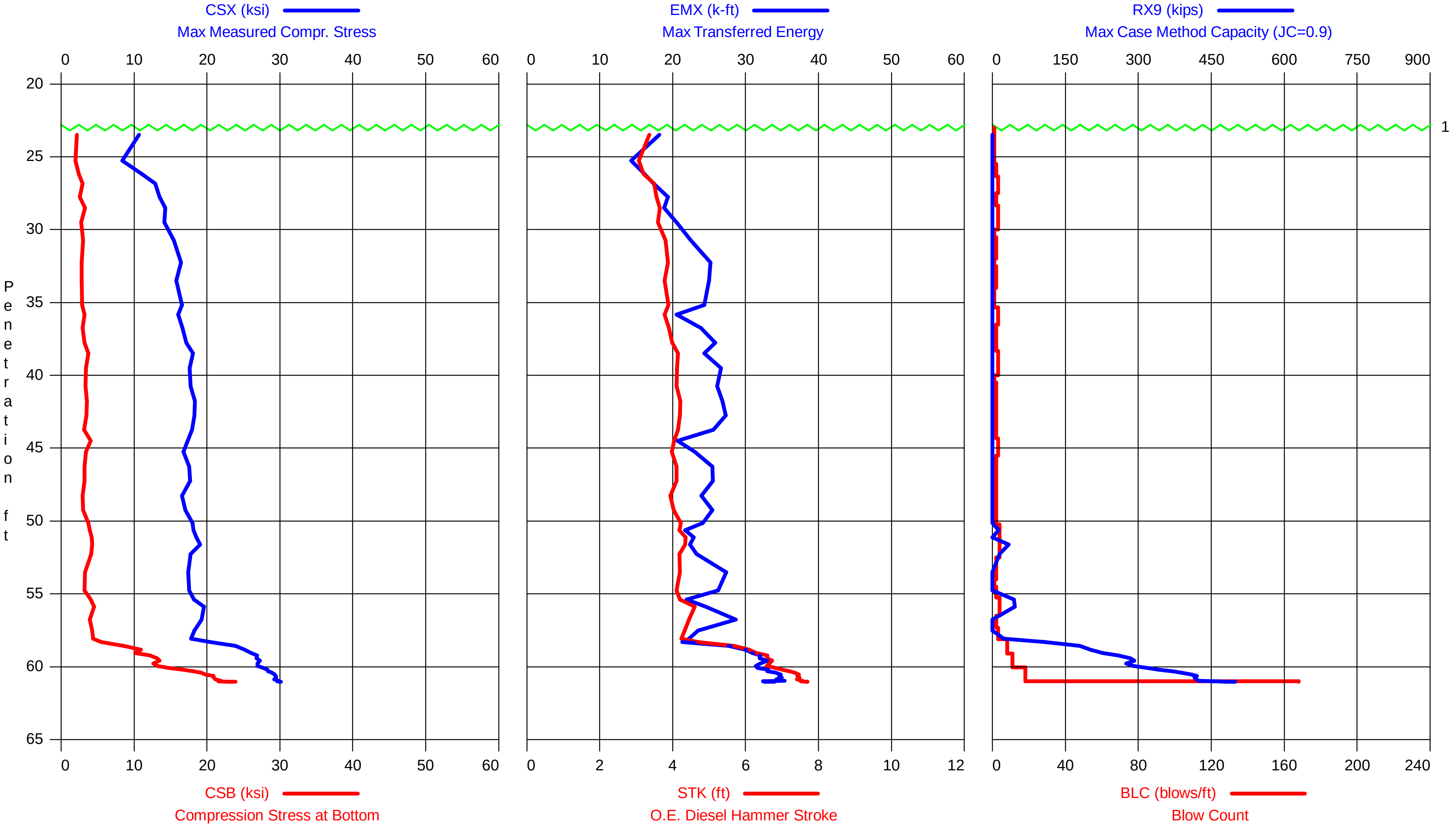
BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
5	61.36	160	AV4	28.4	32.6	27	7.0	44.5	632
			STD	1.0	0.4	1	0.2	0.6	18
			MAX	29.7	33.2	28	7.2	45.1	650
			MIN	27.0	32.2	26	6.8	43.8	613
10	61.39	240	AV5	28.9	34.5	29	7.2	43.9	689
			STD	1.1	1.0	2	0.3	0.8	23
			MAX	30.3	36.3	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

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

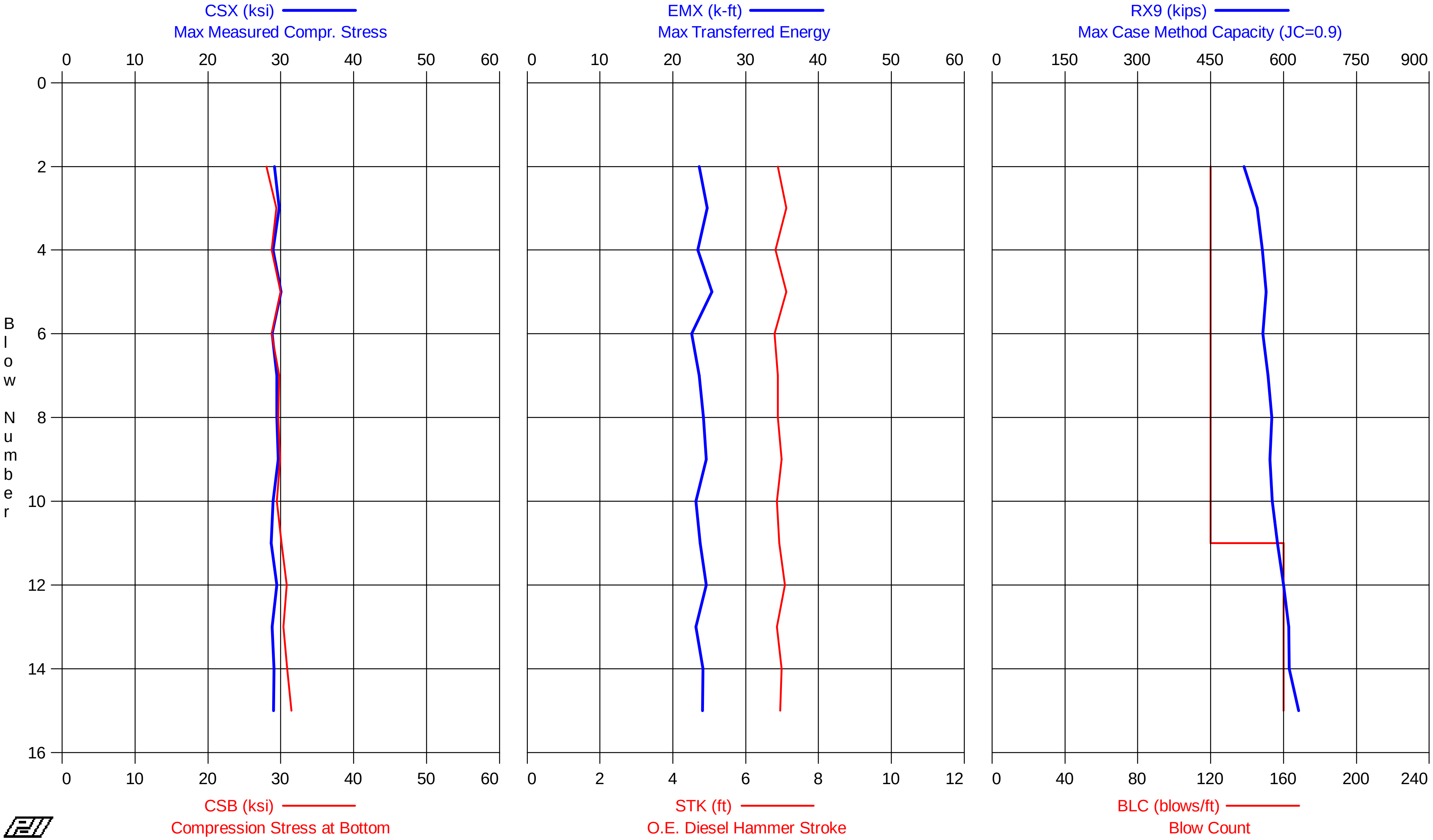
Drive 2 minutes 16 seconds 12:45:08 PM - 12:47:24 PM (11/18/2014) BN 1 - 120

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



USH 10 over Little Lake Butte des Morts - Pier 2 #36 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	61.46	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

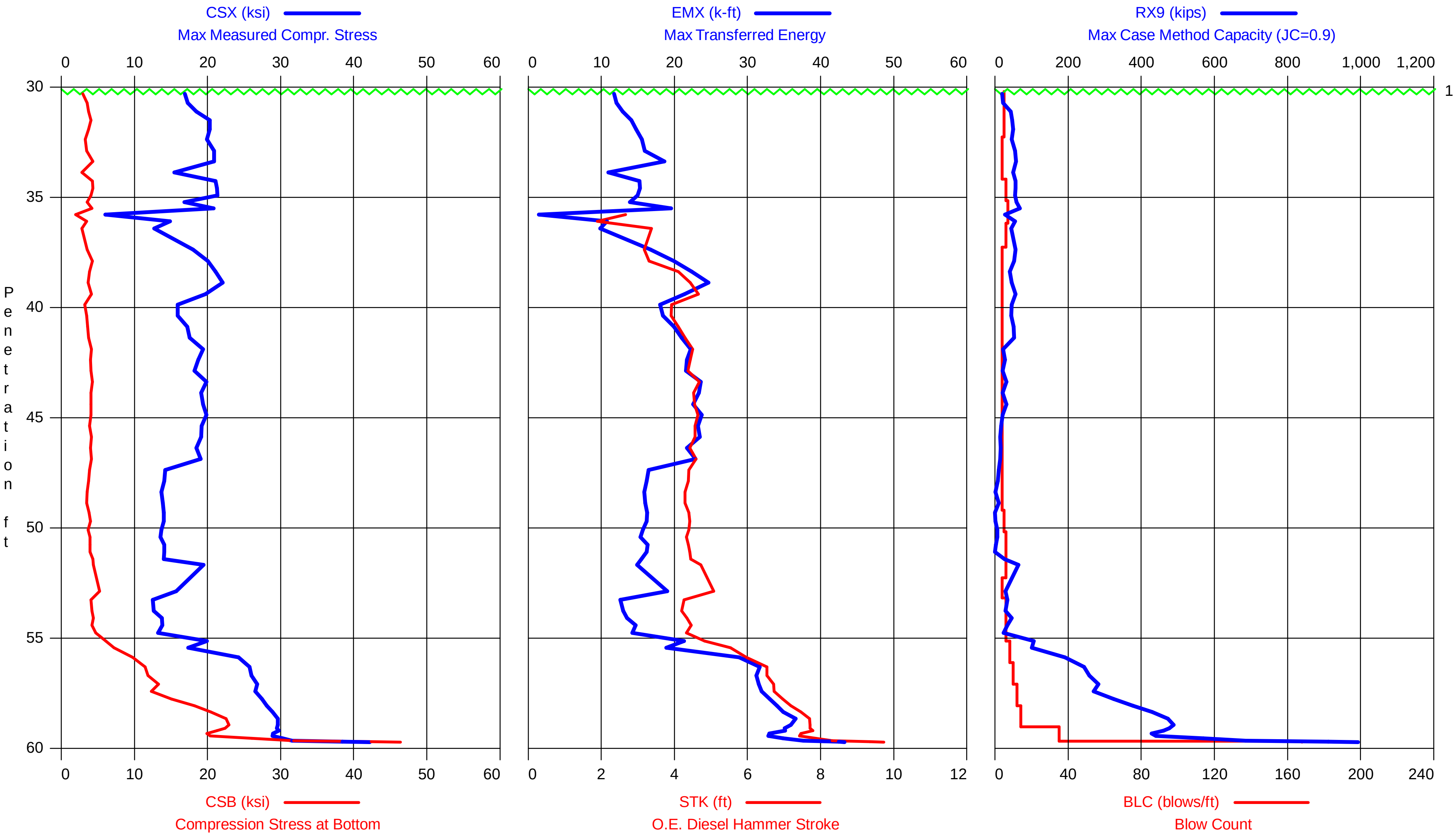
PDIPLOT Ver. 2014.1 - Printed: 25-Nov-2014

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

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
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	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 | 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	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

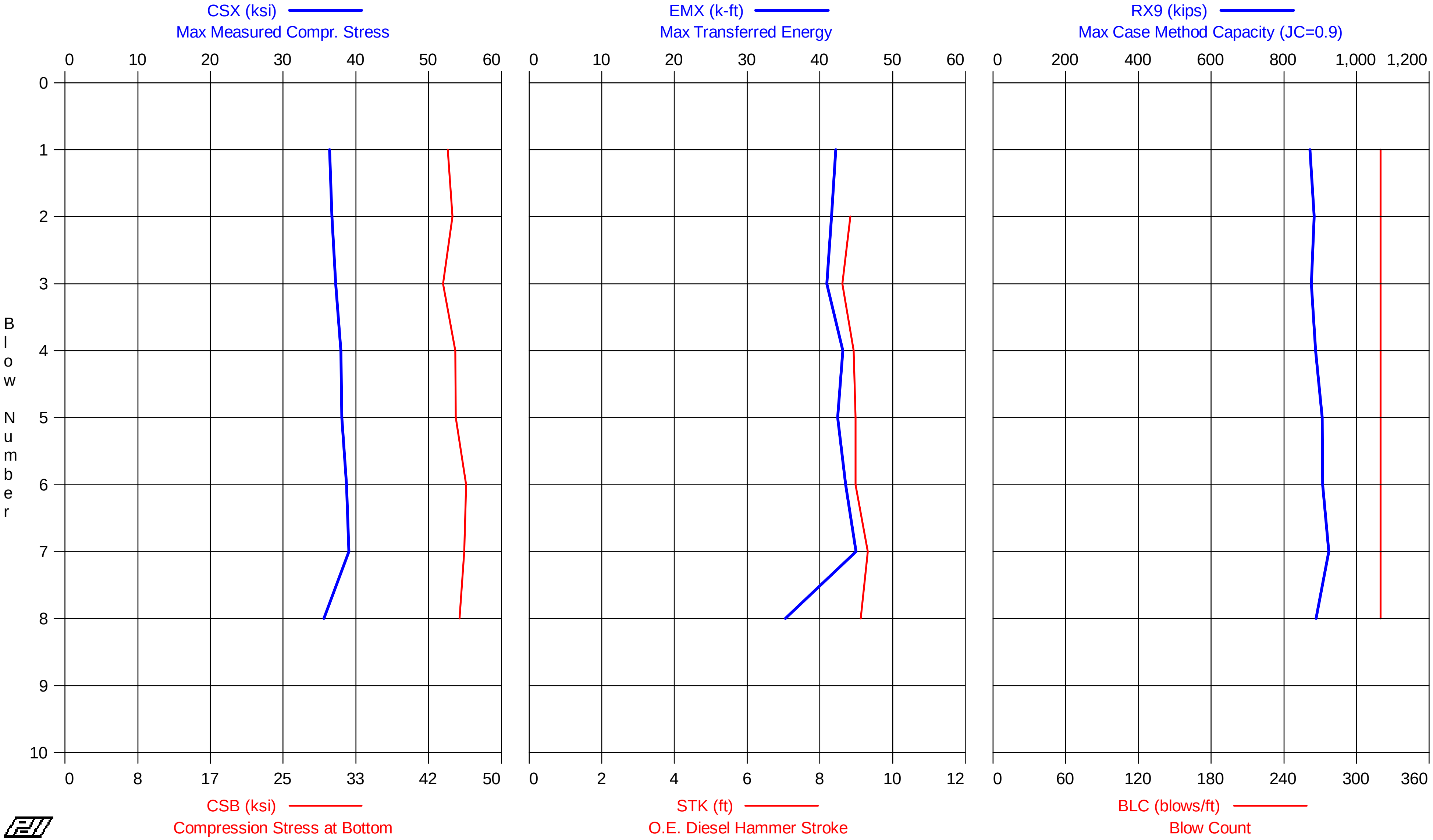
Drive 17 minutes 50 seconds 12:07:18 PM - 12:25:08 PM (11/18/2014) BN 1 - 192

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 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

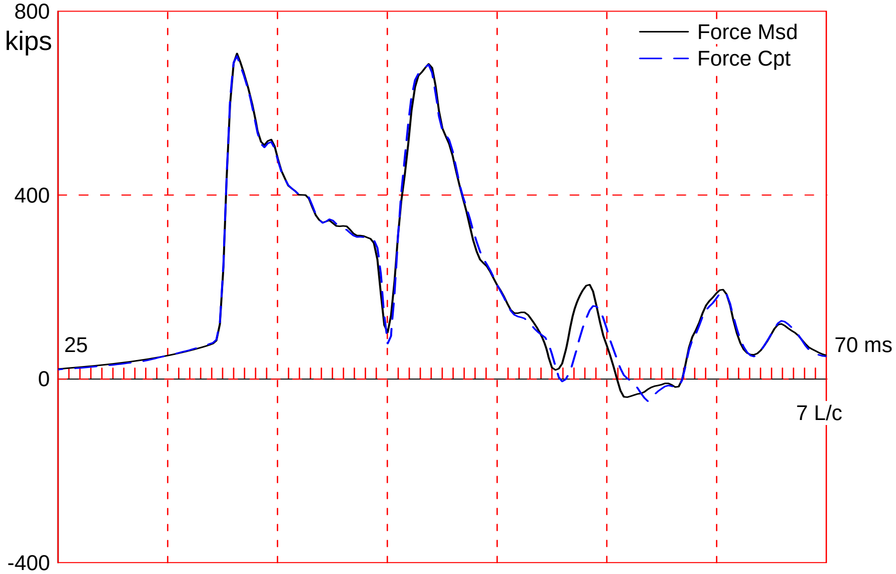
CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
EMX: Max Transferred Energy
STK: O.E. Diesel Hammer Stroke
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

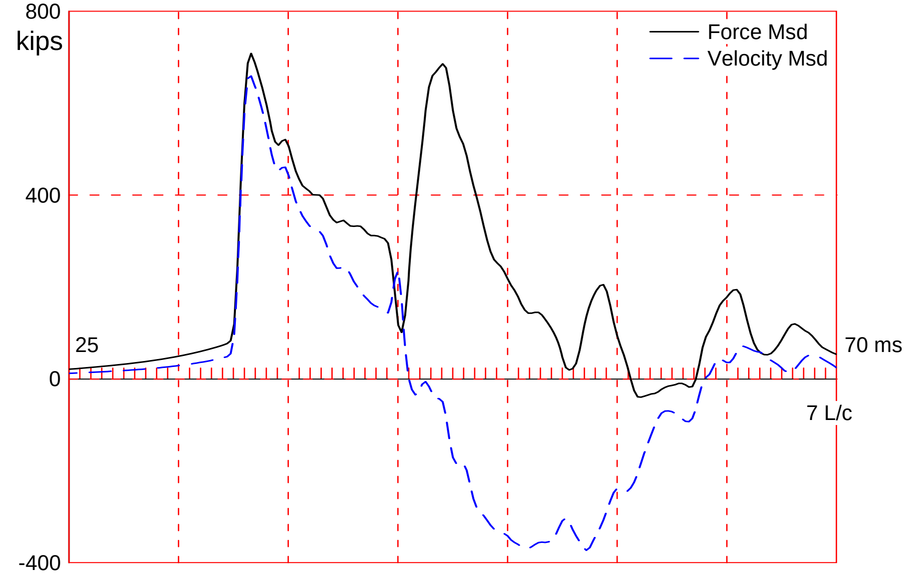
BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
8	59.69	320	AV8	37.4	44.8	42	9.0	39.5	893
			STD	1.1	0.8	3	0.2	0.4	16
			MAX	39.0	46.0	45	9.3	40.3	923
			MIN	35.6	43.3	35	8.6	38.8	872
			Average	37.4	44.8	42	9.0	39.5	893
			Std. Dev.	1.1	0.8	3	0.2	0.4	16
			Maximum	39.0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

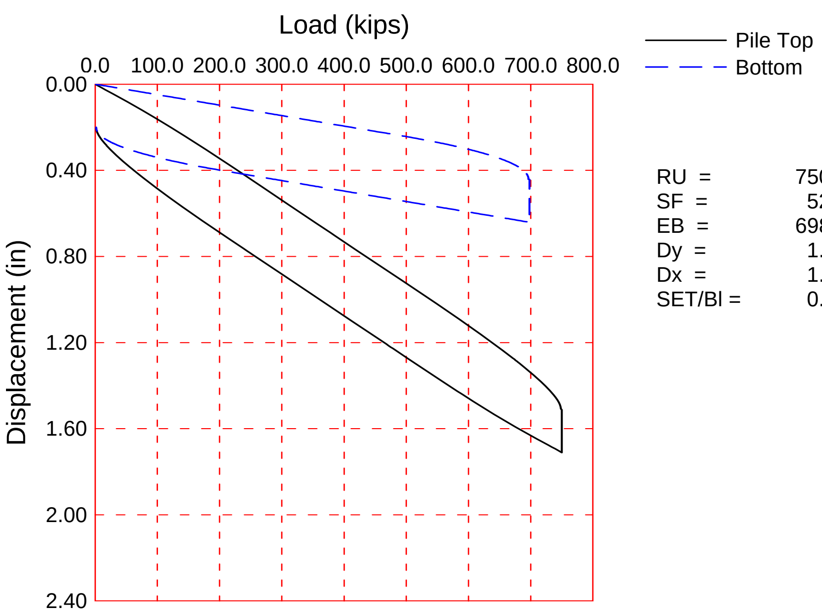
Total number of blows analyzed: 8

Time Summary

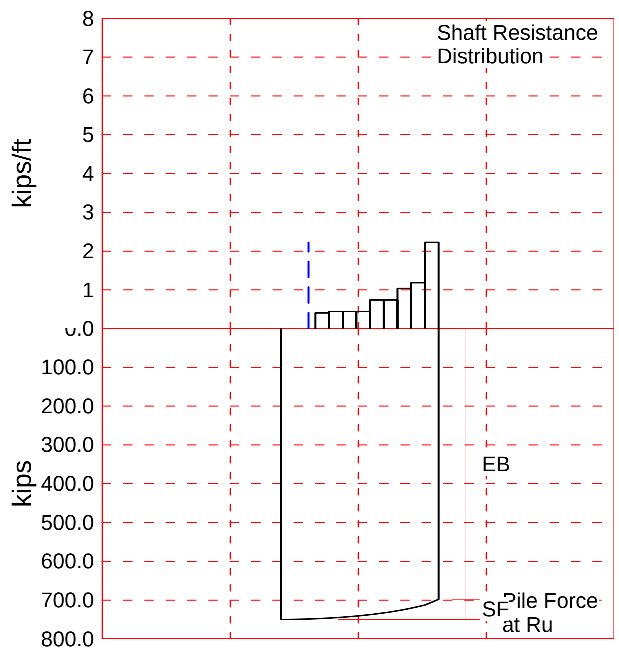
Drive 12 seconds 8:16:54 AM - 8:17:06 AM (11/19/2014) BN 1 - 10







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

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

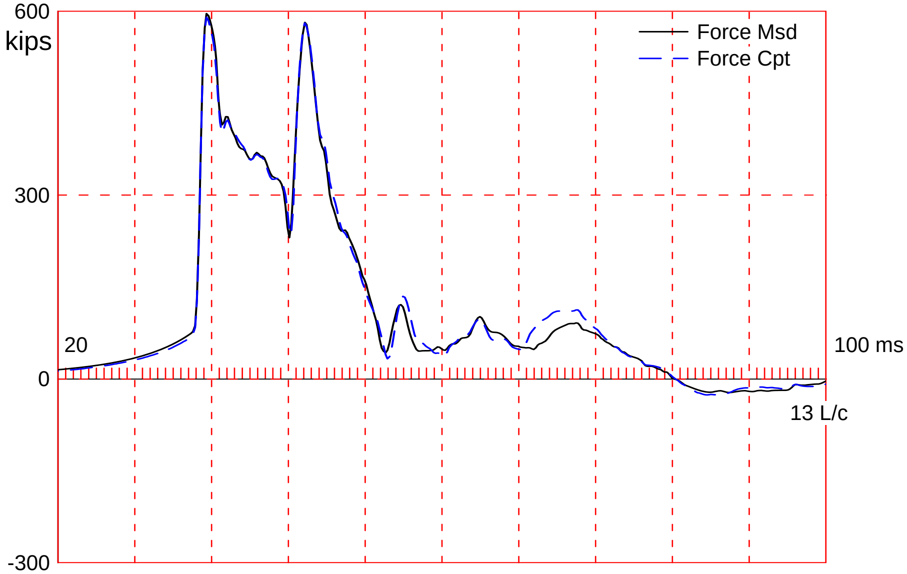
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

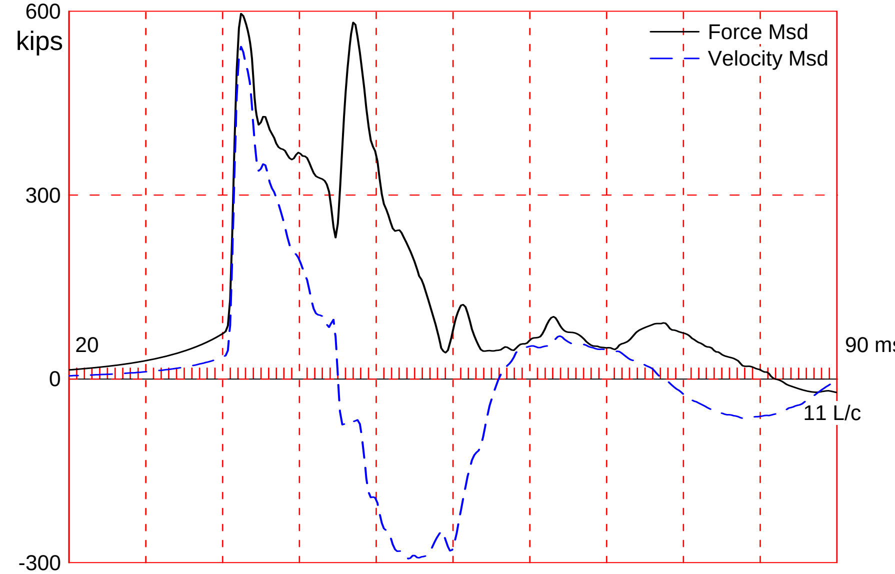
Toe Area 198.5 in^2

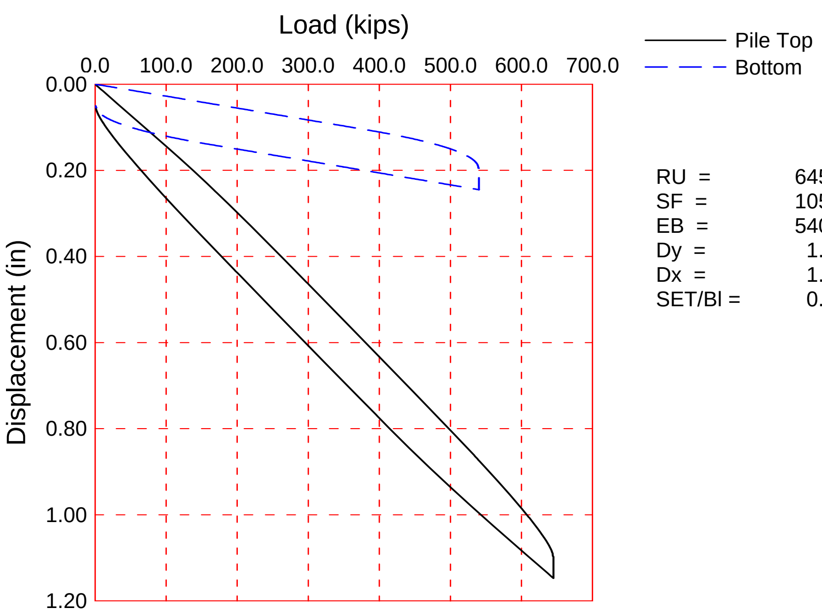
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

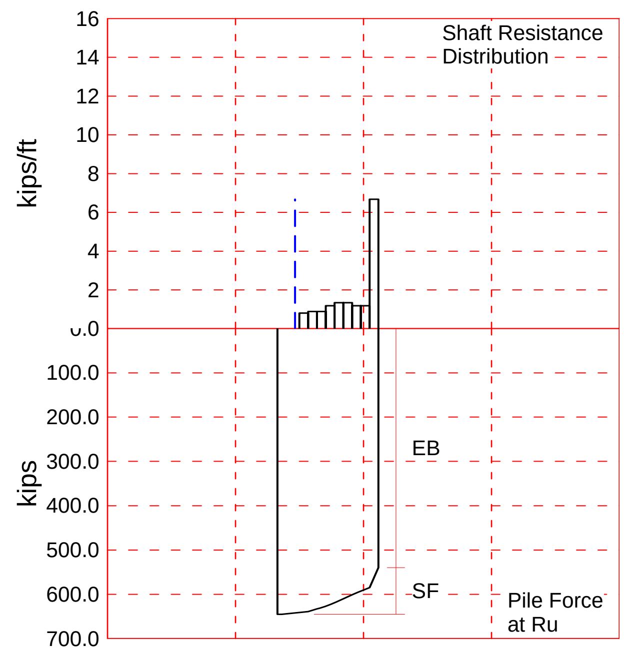
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







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

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.

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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: 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

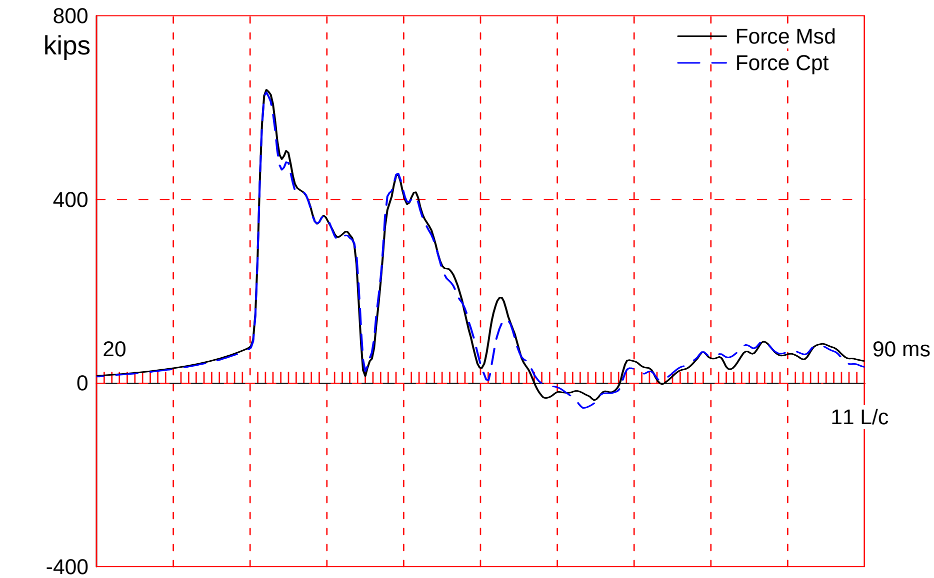
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

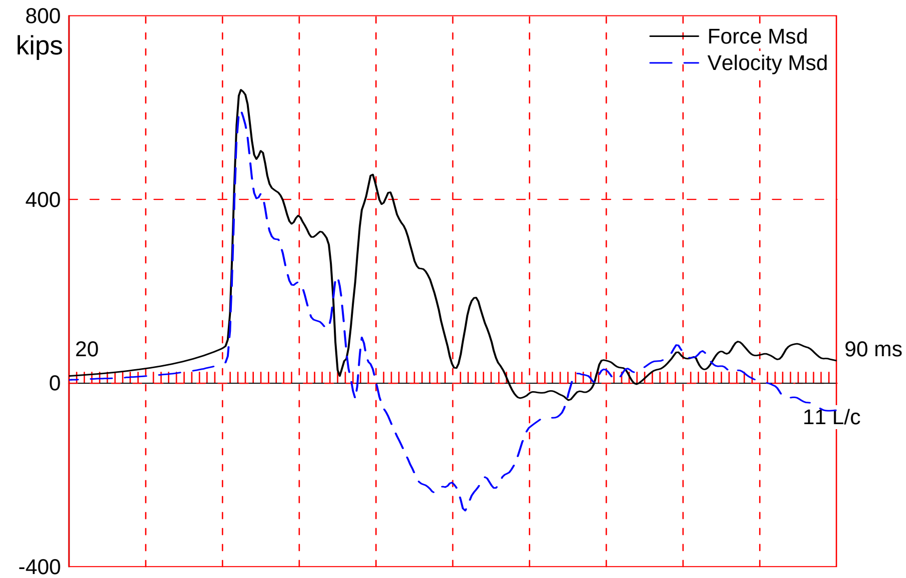
Toe Area 198.5 in^2

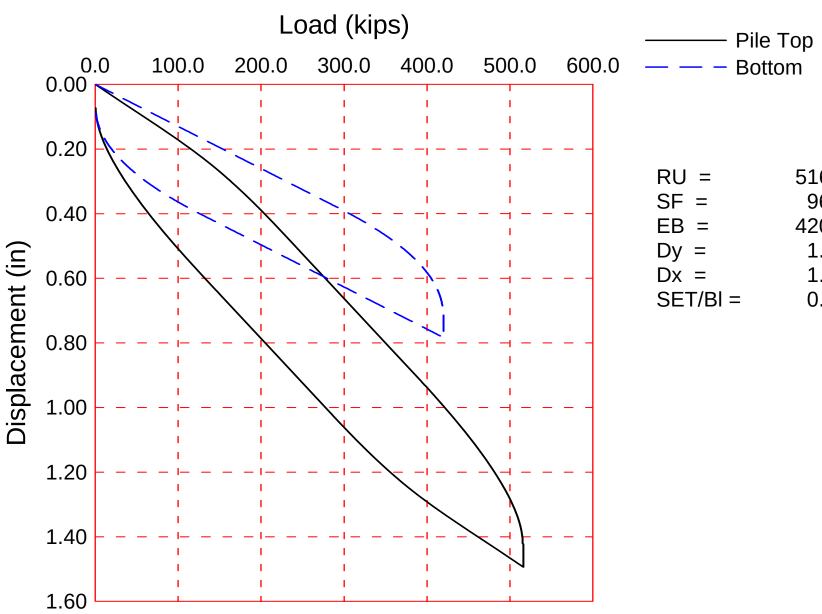
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

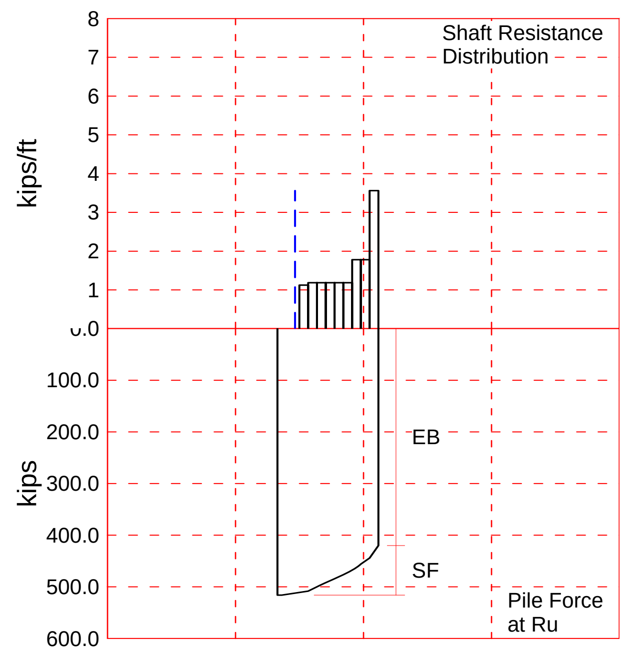
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







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

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	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
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

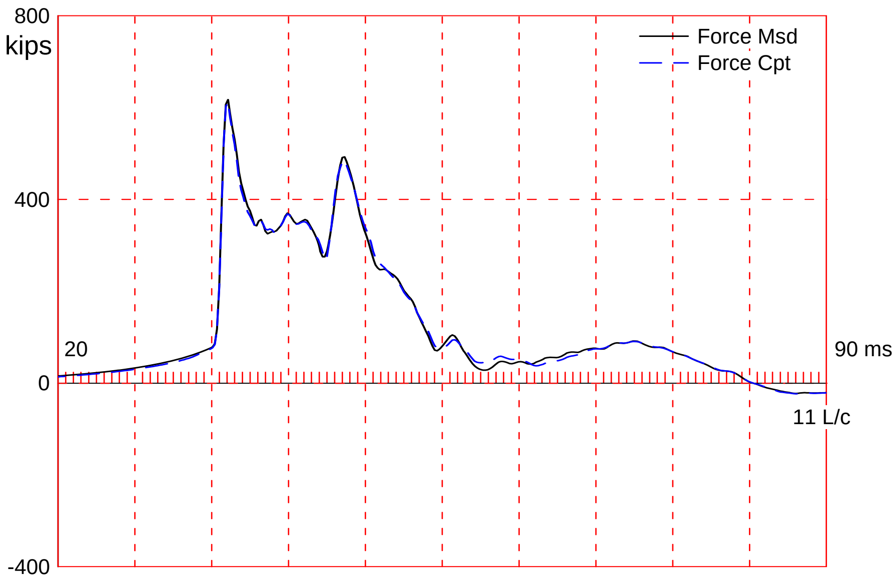
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

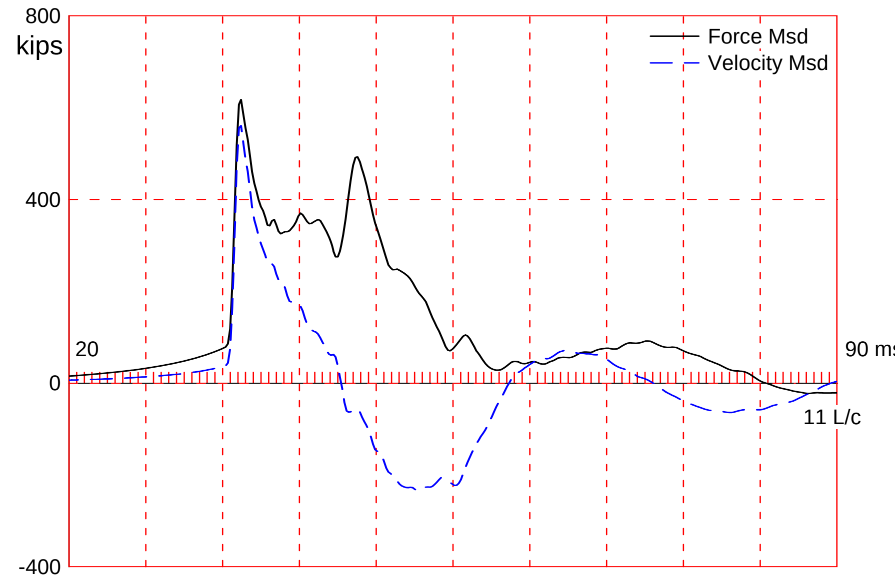
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms

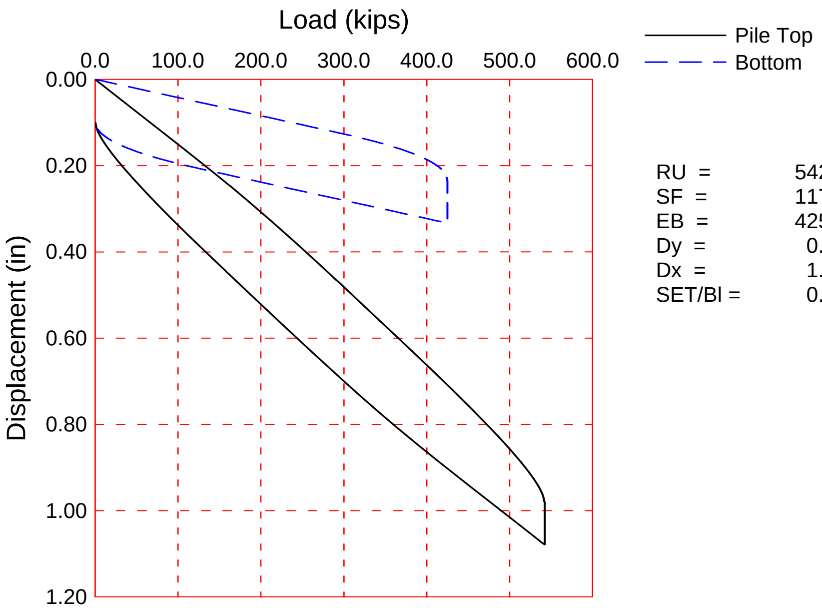
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000

USH 10 over LLBDM; Pile: Pier 2 #36 Restrike; APE D30-42, HP 14 x 73; Blow: 5 (Test: 19-Nov-2014 08:26:) 25-Nov-2014

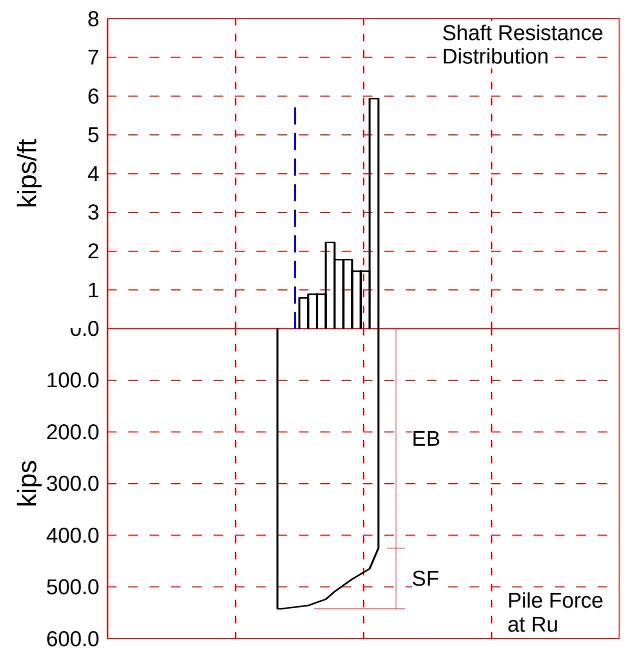
GRL Engineers, Inc. CAPWAP(R) 2014







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

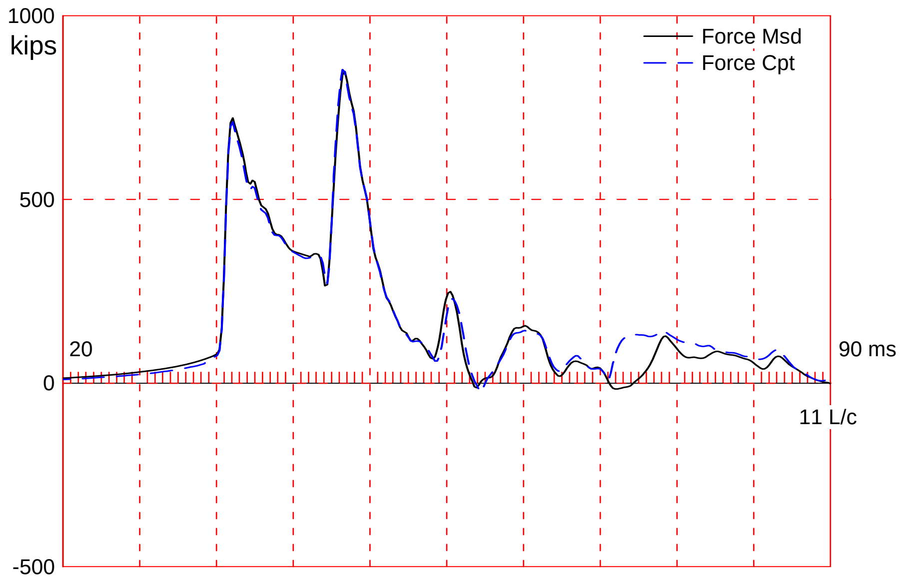
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

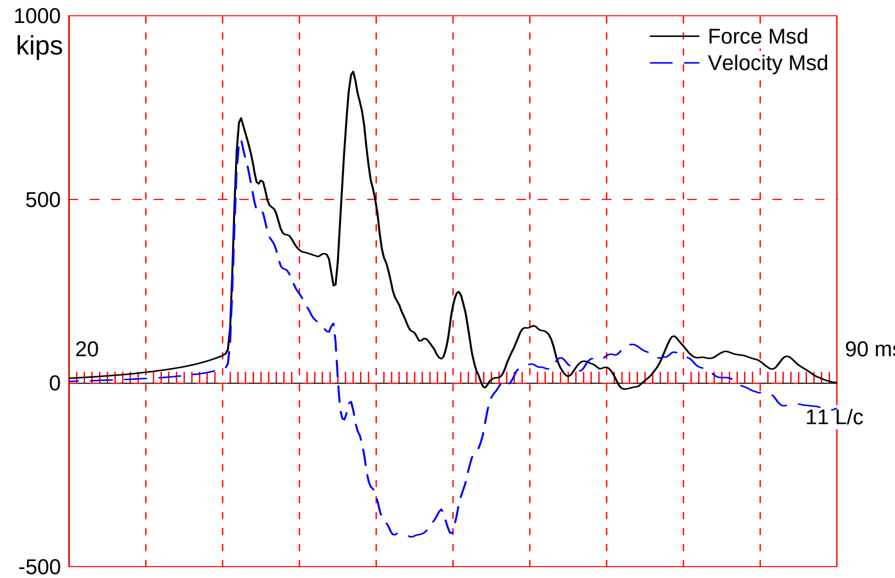
Toe Area 198.5 in^2

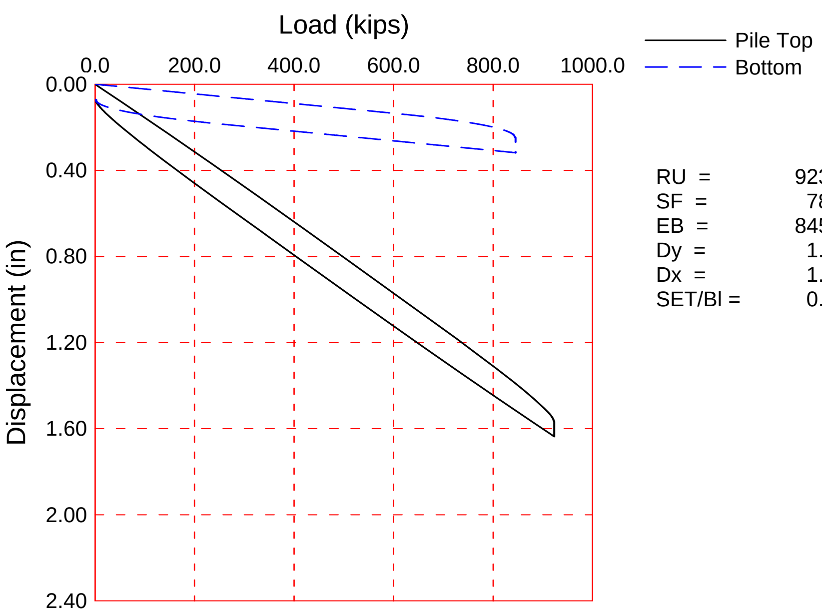
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

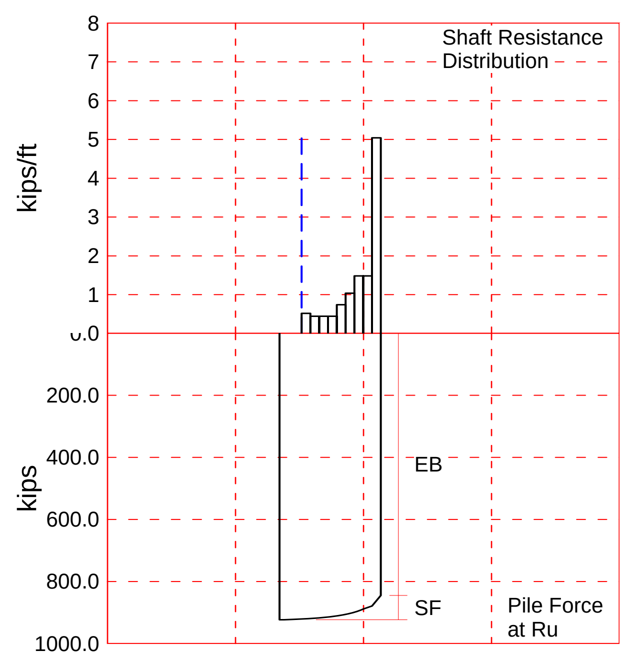
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







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

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

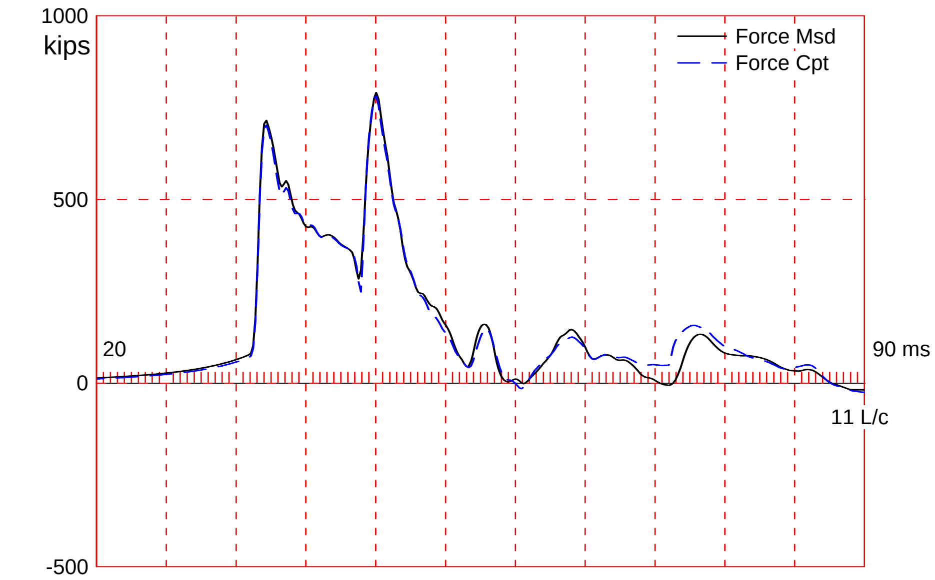
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

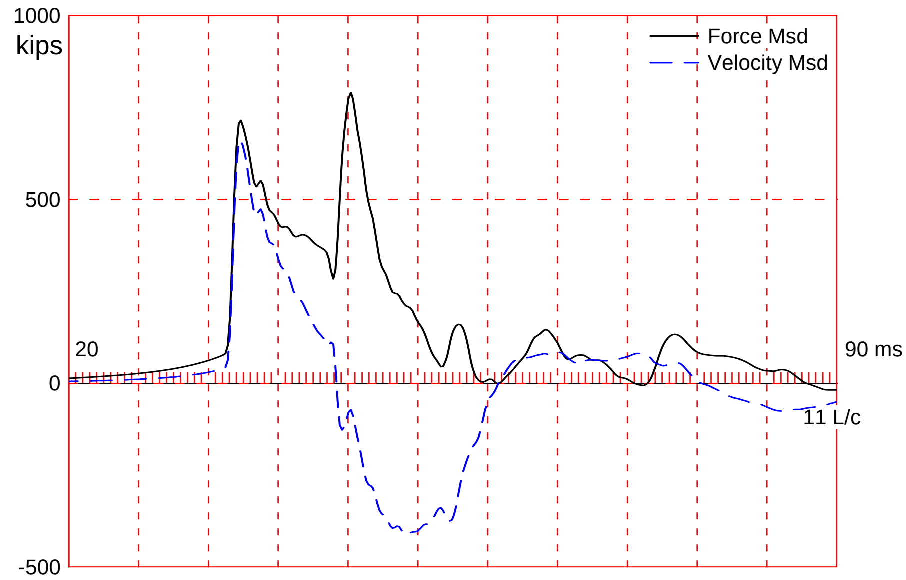
Toe Area 198.5 in^2

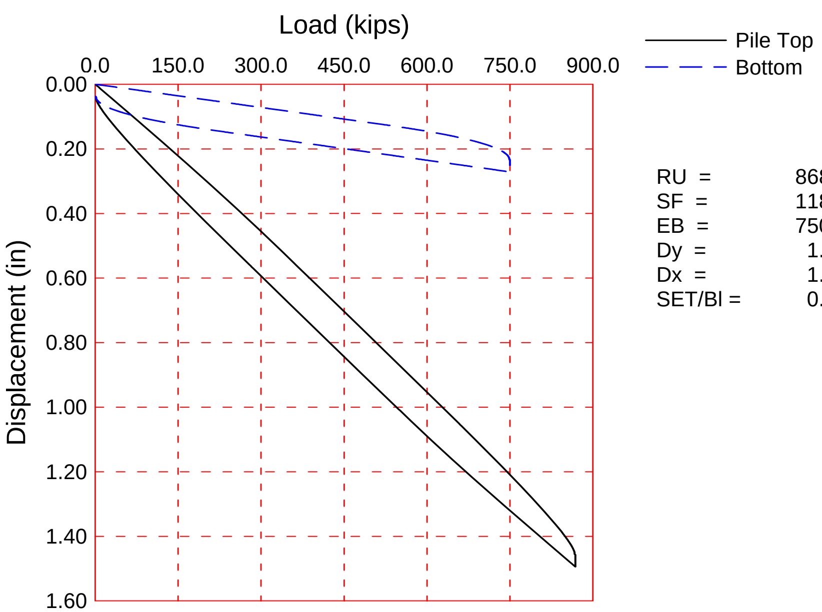
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

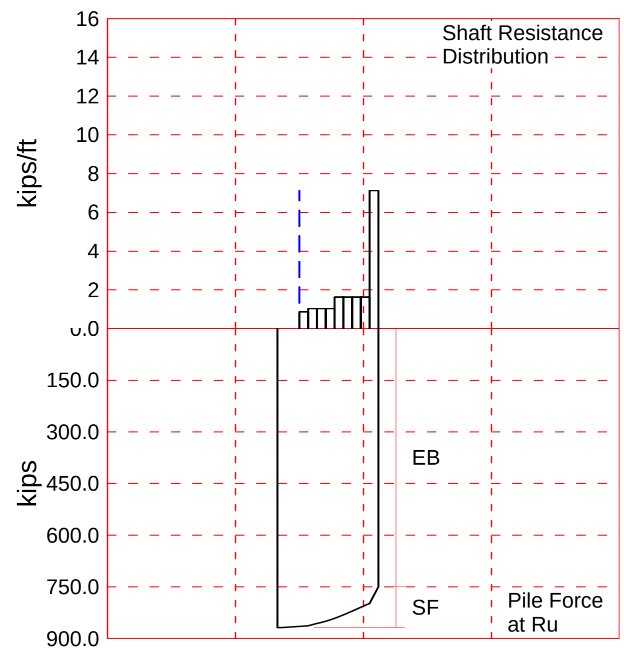
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







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