GRL Engineers, Inc.

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TRANSMITTAL

To: Mr. Kevin Weber	From: Rory Flynn
Company: Lunda Construction Co.	No. of Sheets: 48
E-mail: kweber@lundaconstruction.com	Date: June 17, 2015

RE: Dynamic Testing Results – USH 10 over Little Lake Butte des Morts
Structure B-70-403 - Pier 20
Winnebago County, Wisconsin

On June 15, 2015, Pier 20 #1, Pier 20 #36, and Pier 20 #44 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on June 16. Project plans indicated that the exterior row piles have a required driving resistance, or ultimate capacity, of 480 kips (240 tons) and the interior row piles have a required driving resistance of 400 kips (200 tons). The piles have a required minimum tip elevation of EL 691. The HP 14x73 H-piles were equipped with driving shoes and were driven with an APE D30-42 hammer (number PD 0256) operated on fuel setting 4. The reference elevation for the piles was the top of the cofferdam at EL 740.1 to EL 740.9. The pier was excavated to an elevation of EL 720.1.

Pier 20 #1 was driven to a depth of 52.0 feet, which corresponds to a pile tip elevation of EL 688.1. The blow count over the final increment of driving was 10 blows for 2 1/2 inches of penetration at an average hammer stroke of 7.8 feet. The blow count at the beginning of restrike was 10 blows per for 2 3/4 inches of penetration at an average hammer stroke of 7.8 feet.

Pier 20 #36 was driven to a depth of 46.3 feet, which corresponds to a pile tip elevation of EL 694.6. The blow count over the final increment of driving was 10 blows for 2 1/4 inches of penetration at an average hammer stroke of 8.2 feet. The blow count at the beginning of restrike was 10 blows for 1 1/2 inches of penetration at an average hammer stroke of 7.9 feet.

Pier 20 #44 was driven to a depth of 45.6 feet, which corresponds to a pile tip elevation of EL 694.5. The blow count over the final increment of driving was 10 blows for 2 1/4 inch of penetration at an average hammer stroke of 7.9 feet. The blow count at the beginning of restrike was 10 blows for 2 1/4 inches of penetration at an average hammer stroke of 7.6 feet

We recommend that the production piles at Pier 20 of Structure B-70-403, driven with an APE D30-42 hammer PD 0256, obtain the minimum recommended blow count, noted below, based on the field observed hammer stroke. We recommend maintaining the minimum blow count for **three consecutive inches** of driving at the recommended average hammer stroke.

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

Following additional discussion with WisDOT geotechnical personnel, the minimum pile tip elevation was revised to EL 696 at Pier 20. We recommend immediately terminating driving **if the blow counts exceed 10** blows over an increment of one inch or less at hammer strokes of 8.0 feet. If the piles terminate above the revised minimum pile tip elevation please notify the engineer of record.

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

Please call if you have any questions on these recommendations.

GRL Engineers, Inc.

Rory Flynn, E.I.

Travis Coleman, P.E.

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

Attachments:

Dynamic Test Results - (pages 3 – 18)
CAPWAP Analysis Results - (pages 19 – 38)

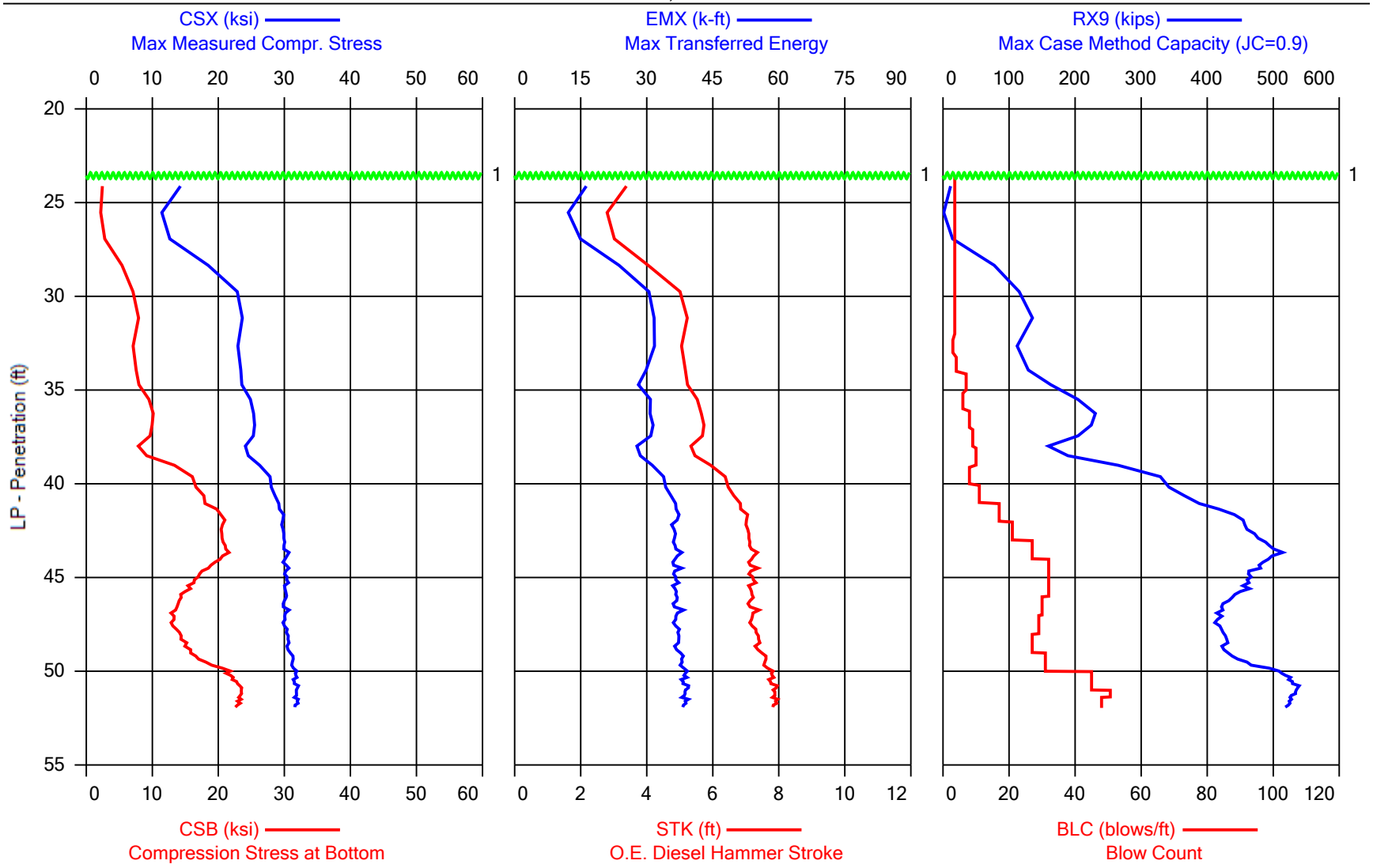
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 17-June-2015

Test started: 15-June-2015

USH 10 over LLBDM - PIER 20 #1

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.1 - Mudline EL 720.1

USH 10 over LLBDM - PIER 20 #1 APE D30-42, HP 14 x 73
OP: TC Date: 15-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
32	32.00	4	AV31	17.4	4.7	4.0	22	59.7	61
			MAX	24.8	8.3	5.5	34	69.0	143
			MIN	10.3	1.9	2.7	11	50.0	0
35	33.00	3	AV3	23.1	6.9	5.1	32	52.0	110
			MAX	23.9	7.0	5.3	34	53.0	114
			MIN	22.1	6.7	4.9	29	50.9	106
39	34.00	4	AV4	23.1	7.5	5.1	30	51.8	118
			MAX	23.8	7.9	5.3	32	52.8	121
			MIN	22.3	7.0	4.9	29	50.9	110
46	35.00	7	AV7	23.5	7.8	5.2	28	51.2	157
			MAX	24.2	8.7	5.4	29	52.1	182
			MIN	23.0	7.0	5.0	26	50.3	139
52	36.00	6	AV6	25.0	9.6	5.6	31	49.8	209
			MAX	25.6	10.1	5.7	32	50.8	233
			MIN	24.0	8.4	5.3	29	49.0	186
60	37.00	8	AV8	25.4	10.2	5.7	31	49.2	229
			MAX	26.4	11.0	6.0	33	50.6	241
			MIN	24.3	9.6	5.4	28	48.1	220
69	38.00	9	AV9	25.2	9.2	5.7	31	49.3	194
			MAX	25.7	10.2	5.8	32	50.3	216
			MIN	24.4	7.4	5.4	29	48.8	150
79	39.00	10	AV10	24.7	9.6	5.5	29	50.0	197
			MAX	26.6	13.3	6.1	32	53.0	254
			MIN	22.2	6.7	4.9	24	47.6	136
87	40.00	8	AV8	27.6	15.8	6.3	34	46.8	320
			MAX	28.9	16.6	6.7	37	48.5	348
			MIN	25.8	14.5	5.9	30	45.5	276
98	41.00	11	AV11	28.3	17.4	6.6	35	45.9	361
			MAX	30.1	18.6	7.1	39	46.7	383
			MIN	27.6	16.5	6.3	33	44.3	337
115	42.00	17	AV17	29.6	19.9	6.9	37	44.7	429
			MAX	30.8	21.5	7.3	39	45.4	462
			MIN	28.8	18.2	6.7	35	43.6	386
136	43.00	21	AV21	29.8	20.6	7.1	36	44.3	466
			MAX	30.9	21.6	7.4	38	45.1	487
			MIN	29.0	19.7	6.8	34	43.5	450

USH 10 over LLBDM - PIER 20 #1 APE D30-42, HP 14 x 73
OP: TC Date: 15-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
163	44.00	27	AV27	30.2	21.0	7.2	37	43.9	499
			MAX	31.5	21.9	7.5	39	45.0	521
			MIN	28.8	20.1	6.8	34	43.0	477
195	45.00	32	AV32	30.2	18.3	7.2	36	44.0	474
			MAX	31.4	20.3	7.6	39	44.8	498
			MIN	29.2	16.7	6.9	34	42.9	455
227	46.00	32	AV32	30.3	15.5	7.2	37	44.0	456
			MAX	31.1	16.8	7.5	38	45.2	476
			MIN	28.8	14.1	6.8	34	43.2	436
257	47.00	30	AV30	30.1	13.7	7.2	37	44.0	425
			MAX	31.6	14.5	7.8	40	44.8	445
			MIN	29.0	12.6	6.9	35	42.4	404
286	48.00	29	AV29	30.1	13.4	7.2	37	43.9	419
			MAX	31.2	14.6	7.5	39	44.9	430
			MIN	29.1	12.3	6.9	35	43.0	407
313	49.00	27	AV27	30.6	15.0	7.4	37	43.5	427
			MAX	31.3	16.3	7.6	39	44.5	447
			MIN	29.3	13.5	7.0	35	42.7	413
344	50.00	31	AV31	31.3	18.4	7.6	38	42.8	463
			MAX	32.7	22.8	8.1	41	43.5	524
			MIN	30.3	15.6	7.4	37	41.6	432
389	51.00	45	AV45	31.7	22.5	7.8	39	42.2	527
			MAX	33.1	23.9	8.3	41	43.2	542
			MIN	30.6	20.7	7.5	36	41.1	503
408	51.38	51	AV19	31.8	23.3	7.9	39	42.1	531
			MAX	32.9	24.3	8.2	41	42.8	548
			MIN	30.9	22.5	7.6	37	41.2	517
418	51.58	48	AV10	31.8	23.1	7.9	39	42.0	526
			MAX	33.2	24.5	8.3	42	42.7	535
			MIN	30.9	22.1	7.6	37	41.0	516
428	51.79	48	AV10	32.0	23.3	7.9	39	42.0	525
			MAX	32.6	23.8	8.1	40	42.6	535
			MIN	31.5	22.6	7.7	38	41.5	515
437	51.98	48	AV8	31.6	22.6	7.8	38	42.2	519
			MAX	32.4	23.4	8.1	40	42.7	525
			MIN	31.0	22.2	7.6	37	41.6	514
			Average	29.0	16.5	6.9	35	45.4	406
			Maximum	33.2	24.5	8.3	42	69.0	548
			Minimum	10.3	1.9	2.7	11	41.0	0

Total number of blows analyzed: 435

BL#	Sensors
1-434	F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (1.00); A2: [K3658] 362.0 (1.00)
435-435	F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (0.98); A2: [K3658] 362.0 (0.98)
436-437	F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (1.00); A2: [K3658] 362.0 (1.00)

BL#	Comments
2	Reported Reference EL 740.1 - Mudline EL 720.1
435	CW

Time Summary

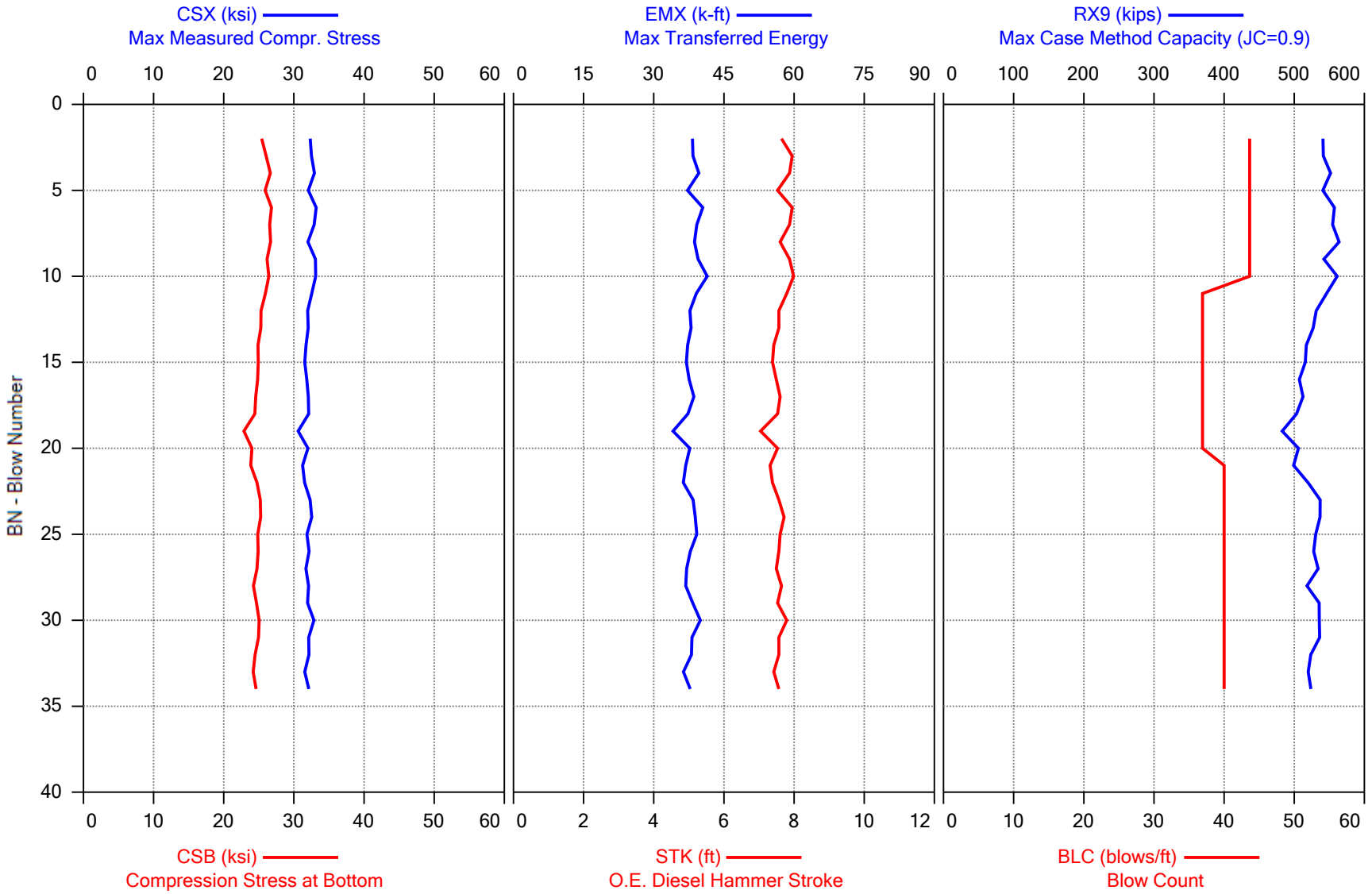
Drive 9 minutes 41 seconds 12:18 PM - 12:28 PM BN 1 - 437

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

Printed: 17-June-2015

Test started: 16-June-2015

USH 10 over LLBDM - PIER 20 #1 RESTRIKE
APE D30-42, HP 14 x 73



USH 10 over LLBDM - PIER 20 #1 RESTRIKE APE D30-42, HP 14 x 73
OP: RF Date: 16-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	52.23	44	AV9	32.7	26.3	7.8	39	42.3	550
			MAX	33.2	26.8	8.0	41	43.0	564
			MIN	32.0	25.4	7.5	37	41.8	541
20	52.50	37	AV10	31.8	24.7	7.5	37	43.1	515
			MAX	32.5	25.9	7.8	39	44.4	546
			MIN	30.6	22.9	7.0	34	42.3	483
35	52.88	40	AV14	32.0	24.7	7.6	38	42.9	527
			MAX	32.9	25.3	7.8	40	43.6	537
			MIN	31.2	23.9	7.3	36	42.3	499
			Average	32.1	25.1	7.6	38	42.8	530
			Maximum	33.2	26.8	8.0	41	44.4	564
			Minimum	30.6	22.9	7.0	34	41.8	483

Total number of blows analyzed: 33

BL# Sensors

1-35 F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (1.00); A2: [K3658] 362.0 (1.00)

Time Summary

Drive 47 seconds 6:50 AM - 6:50 AM BN 1 - 35

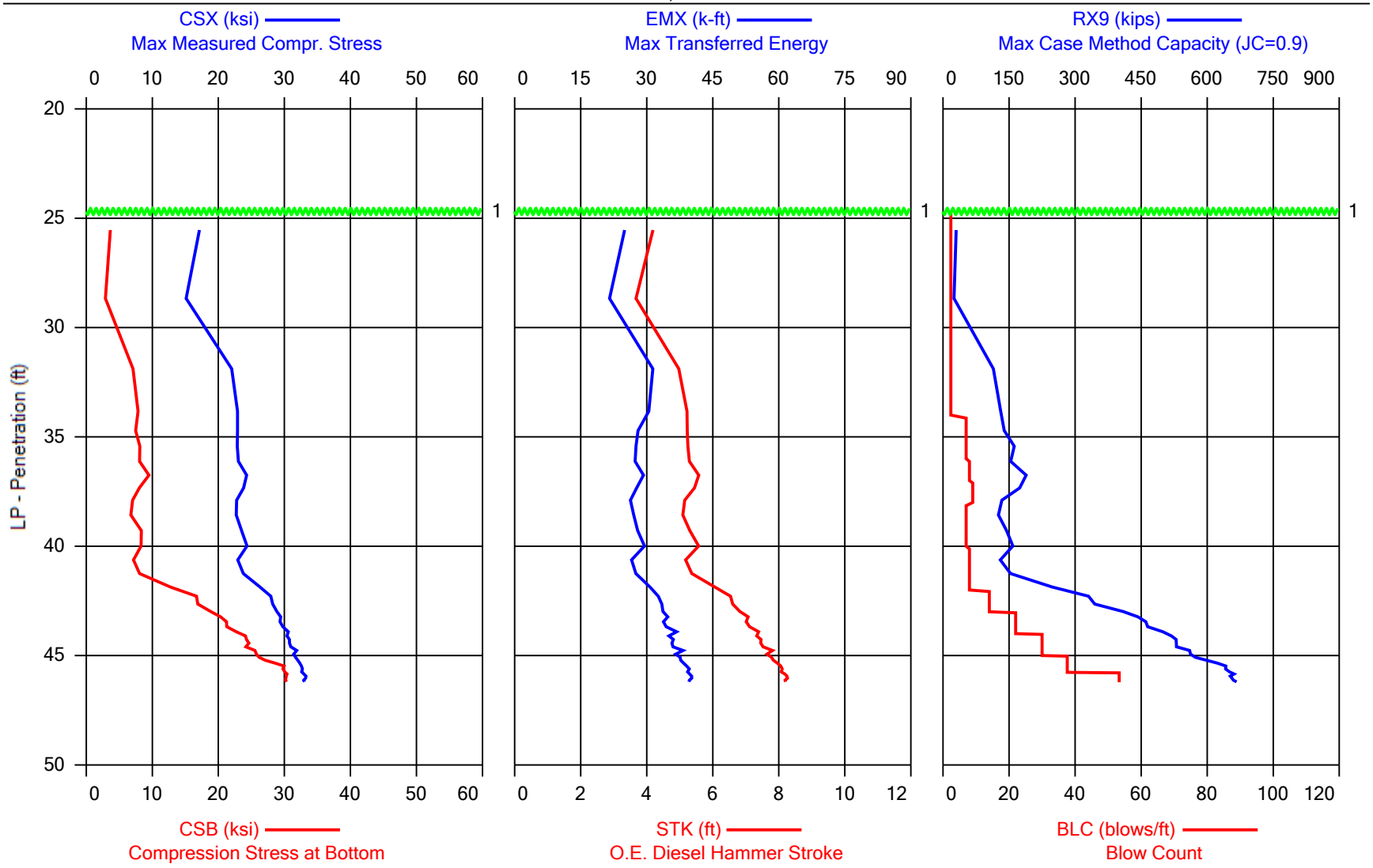
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 17-June-2015

Test started: 15-June-2015

USH 10 over LLBDM - PIER 20 #36

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.9 - Mudline EL 720.1

USH 10 over LLBDM - PIER 20 #36 APE D30-42, HP 14 x 73
OP: TC Date: 15-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
26	34.00	2	AV18	18.9	5.1	4.4	27	56.1	67
			MAX	23.4	8.3	5.3	36	73.5	125
			MIN	3.2	0.4	2.4	4	50.9	0
33	35.00	7	AV7	22.9	7.6	5.2	28	51.1	140
			MAX	23.5	8.1	5.4	30	51.8	152
			MIN	22.4	7.3	5.1	27	50.2	132
40	36.00	7	AV7	22.9	7.9	5.3	28	51.1	154
			MAX	23.6	8.5	5.4	30	51.4	180
			MIN	22.6	7.3	5.2	27	50.3	132
48	37.00	8	AV8	23.8	9.1	5.5	28	50.1	180
			MAX	24.8	10.0	5.8	31	52.3	196
			MIN	21.8	7.9	5.0	25	48.8	139
57	38.00	9	AV9	23.4	7.6	5.3	27	50.7	156
			MAX	24.3	8.5	5.5	28	52.1	183
			MIN	22.1	6.7	5.0	25	49.8	128
64	39.00	7	AV7	22.8	6.9	5.1	27	51.7	129
			MAX	23.5	7.5	5.3	29	52.2	138
			MIN	22.4	6.6	5.0	26	50.9	118
71	40.00	7	AV7	24.0	8.6	5.5	29	50.2	157
			MAX	24.7	10.3	5.7	31	52.2	177
			MIN	22.3	7.6	5.0	26	49.1	127
79	41.00	8	AV8	23.3	7.4	5.3	27	51.0	133
			MAX	25.2	7.9	5.8	30	51.8	140
			MIN	22.5	6.7	5.1	26	48.9	121
87	42.00	8	AV8	24.9	10.0	5.7	29	49.3	197
			MAX	27.5	13.6	6.5	33	50.9	286
			MIN	23.4	7.3	5.3	26	46.2	139
101	43.00	14	AV14	28.3	17.1	6.6	33	45.7	348
			MAX	30.2	18.9	7.1	36	46.6	403
			MIN	27.5	15.1	6.4	31	44.1	294
123	44.00	22	AV22	29.7	21.2	7.1	35	44.2	463
			MAX	31.5	23.1	7.7	39	45.5	506
			MIN	28.3	18.9	6.7	32	42.5	418
153	45.00	30	AV30	31.0	24.7	7.5	36	43.0	538
			MAX	32.8	26.2	8.1	40	43.8	576
			MIN	30.0	23.4	7.2	35	41.4	509

USH 10 over LLBDM - PIER 20 #36 APE D30-42, HP 14 x 73
OP: TC Date: 15-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
182	45.77	38	AV29	32.3	28.5	8.0	39	41.9	620
			MAX	33.7	30.8	8.4	41	43.1	656
			MIN	31.0	25.6	7.5	36	40.8	560
192	45.96	53	AV10	33.0	30.3	8.2	40	41.3	657
			MAX	33.3	30.8	8.3	41	41.6	666
			MIN	32.5	30.0	8.1	39	41.0	646
202	46.15	53	AV10	33.1	30.3	8.3	40	41.2	657
			MAX	33.7	30.8	8.4	41	41.7	668
			MIN	32.4	29.7	8.0	39	40.8	649
206	46.22	53	AV4	33.0	30.2	8.2	40	41.3	665
			MAX	33.3	30.8	8.4	40	41.6	679
			MIN	32.7	29.9	8.1	39	40.9	652
			Average	27.7	18.1	6.6	33	46.5	383
			Maximum	33.7	30.8	8.4	41	73.5	679
			Minimum	3.2	0.4	2.4	4	40.8	0

Total number of blows analyzed: 198

BL# Sensors

1-206 F1: [K769] 91.9 (1.00); F2: [D815] 93.0 (1.00); A1: [K3658] 362.0 (1.00); A2: [K3550] 360.0 (1.00)

BL# Comments

4 Reported Reference EL 740.9 - Mudline EL 720.1
203 CW

Time Summary

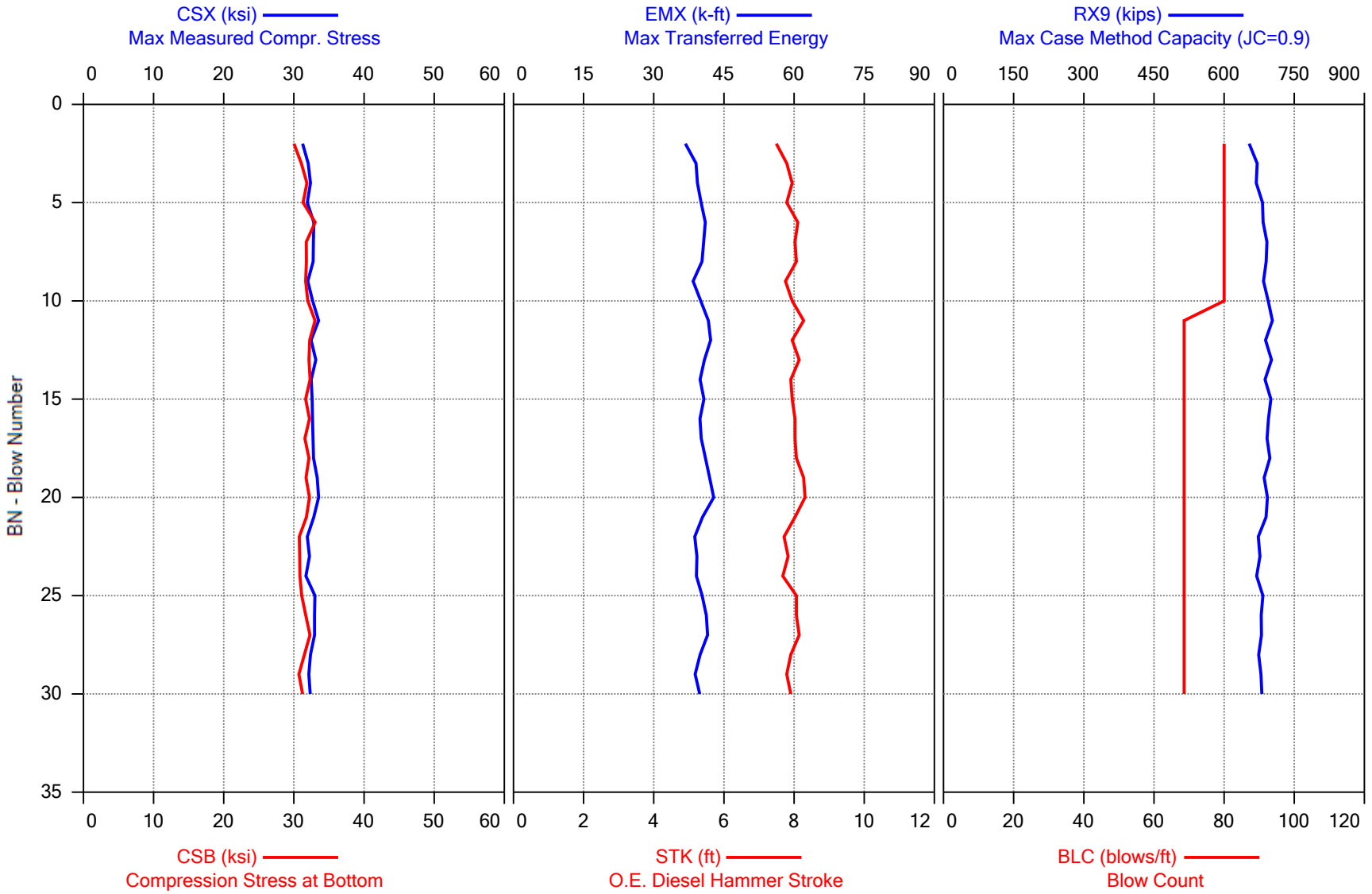
Drive 5 minutes 20 seconds 12:42 PM - 12:48 PM BN 1 - 206

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

Printed: 17-June-2015

Test started: 16-June-2015

USH 10 over LLBDM - PIER 20 #36 RESTRIKE
APE D30-42, HP 14 x 73



USH 10 over LLBDM - PIER 20 #36 RESTRIKE APE D30-42, HP 14 x 73
OP: RF Date: 16-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	46.46	80	AV9	32.3	31.6	7.9	40	42.1	680
			MAX	32.8	33.0	8.1	41	43.1	694
			MIN	31.2	30.0	7.5	37	41.5	653
20	46.60	69	AV10	32.9	32.1	8.1	41	41.5	694
			MAX	33.5	33.0	8.3	43	42.0	703
			MIN	32.5	31.6	7.9	40	41.0	685
31	46.76	69	AV10	32.4	31.3	7.9	40	42.0	678
			MAX	33.0	32.3	8.1	42	42.6	690
			MIN	31.7	30.7	7.7	39	41.4	669
			Average	32.6	31.7	8.0	40	41.9	684
			Maximum	33.5	33.0	8.3	43	43.1	703
			Minimum	31.2	30.0	7.5	37	41.0	653

Total number of blows analyzed: 29

BL# Sensors

1-31 F1: [D815] 93.0 (1.00); F2: [K769] 91.9 (1.00); A1: [K3550] 360.0 (1.00); A2: [K3658] 362.0 (1.00)

Time Summary

Drive 42 seconds 7:01 AM - 7:01 AM BN 1 - 31

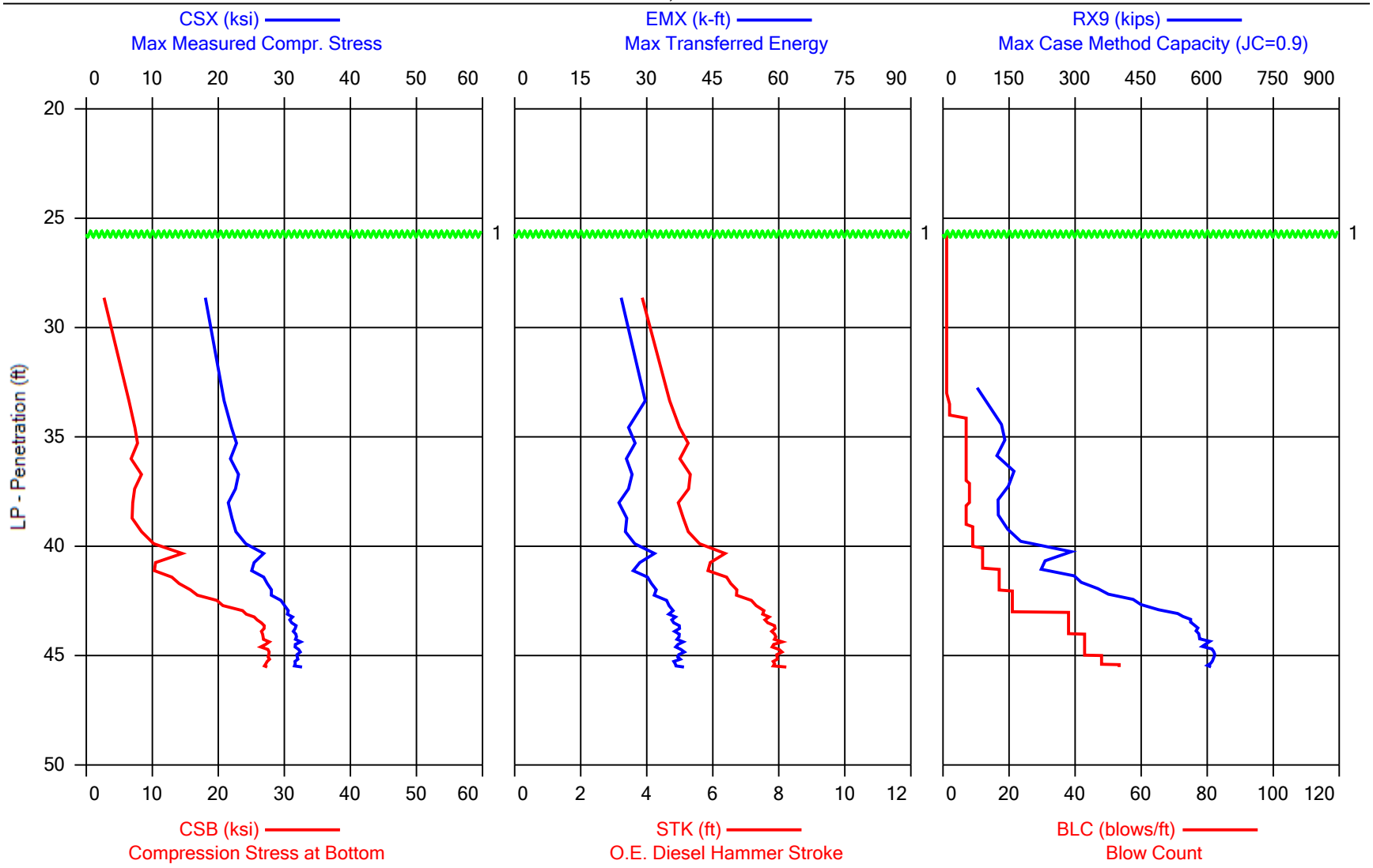
GRL Engineers, Inc. - PDIPLOT2 Ver 2015.1.50.1 - Case Method & iCAP® Results

Printed: 17-June-2015

Test started: 15-June-2015

USH 10 over LLBDM - PIER 20 #44

APE D30-42, HP 14 x 73



1 - Reported Reference EL 740.1 - Mudline EL 720.1

USH 10 over LLBDM - PIER 20 #44 APE D30-42, HP 14 x 73
OP: TC Date: 15-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
11	33.00	1	AV7	18.5	3.6	4.0	26	58.4	29
			MAX	22.8	6.3	4.8	38	66.6	80
			MIN	11.6	1.4	3.0	14	53.1	0
13	34.00	2	AV2	22.0	6.7	4.9	31	52.6	93
			MAX	22.1	6.9	5.0	31	52.8	97
			MIN	21.9	6.5	4.9	31	52.3	88
20	35.00	7	AV7	21.9	7.4	5.0	26	52.3	135
			MAX	22.5	8.1	5.1	27	53.5	143
			MIN	21.1	6.7	4.8	24	51.8	126
27	36.00	7	AV7	22.4	7.2	5.1	27	51.6	129
			MAX	23.3	8.0	5.4	29	53.6	146
			MIN	20.7	6.3	4.7	24	50.5	112
34	37.00	7	AV7	22.8	8.0	5.3	27	51.0	156
			MAX	23.5	8.7	5.4	28	51.9	181
			MIN	21.9	6.5	5.1	25	50.4	128
42	38.00	8	AV8	22.0	7.0	5.1	25	51.8	133
			MAX	23.9	7.9	5.5	28	53.2	157
			MIN	20.9	5.9	4.8	23	50.0	111
49	39.00	7	AV7	22.2	7.2	5.1	25	51.7	127
			MAX	23.1	8.1	5.4	27	53.7	150
			MIN	20.4	6.1	4.7	23	50.6	101
58	40.00	9	AV9	23.3	8.9	5.4	26	50.4	167
			MAX	24.4	10.9	5.8	28	52.7	182
			MIN	21.2	6.4	4.9	23	48.9	121
70	41.00	12	AV12	25.9	12.3	6.1	30	47.7	253
			MAX	27.8	15.6	6.7	35	49.5	315
			MIN	24.4	9.3	5.6	26	45.6	201
87	42.00	17	AV17	26.7	13.1	6.4	30	46.7	302
			MAX	28.0	15.7	6.8	32	49.3	364
			MIN	24.4	9.2	5.7	25	45.3	216
108	43.00	21	AV21	29.3	19.6	7.1	34	44.2	434
			MAX	30.6	25.6	7.5	37	45.7	533
			MIN	27.8	16.0	6.6	32	43.0	362
146	44.00	38	AV38	31.2	26.1	7.7	36	42.5	562
			MAX	32.3	28.0	8.1	39	43.6	586
			MIN	30.0	23.3	7.3	34	41.4	516

USH 10 over LLBDM - PIER 20 #44 APE D30-42, HP 14 x 73
OP: TC Date: 15-June-2015

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
188	44.98	43	AV42	32.0	27.2	7.9	37	41.9	599
			MAX	32.8	28.3	8.2	39	42.8	628
			MIN	31.0	26.2	7.6	35	41.2	576
198	45.19	48	AV10	31.9	27.6	7.9	37	42.0	615
			MAX	32.3	28.1	8.0	38	42.6	621
			MIN	31.4	27.2	7.7	36	41.7	606
208	45.40	48	AV10	31.7	27.4	7.9	37	42.1	610
			MAX	32.9	28.4	8.2	39	42.9	620
			MIN	30.8	26.7	7.6	35	41.2	602
216	45.55	53	AV7	31.7	27.1	7.9	37	42.0	603
			MAX	32.7	27.4	8.2	38	42.5	610
			MIN	31.0	26.9	7.7	36	41.2	596
			Average	28.2	19.1	6.8	33	45.6	413
			Maximum	32.9	28.4	8.2	39	66.6	628
			Minimum	11.6	1.4	3.0	14	41.2	0

Total number of blows analyzed: 211

BL# Sensors

1-216 F1: [K769] 91.9 (1.00); F2: [D815] 93.0 (1.00); A1: [K3658] 362.0 (1.00); A2: [K3550] 360.0 (1.00)

BL# Comments

3 Reported Reference EL 740.1 - Mudline EL 720.1
213 CW

Time Summary

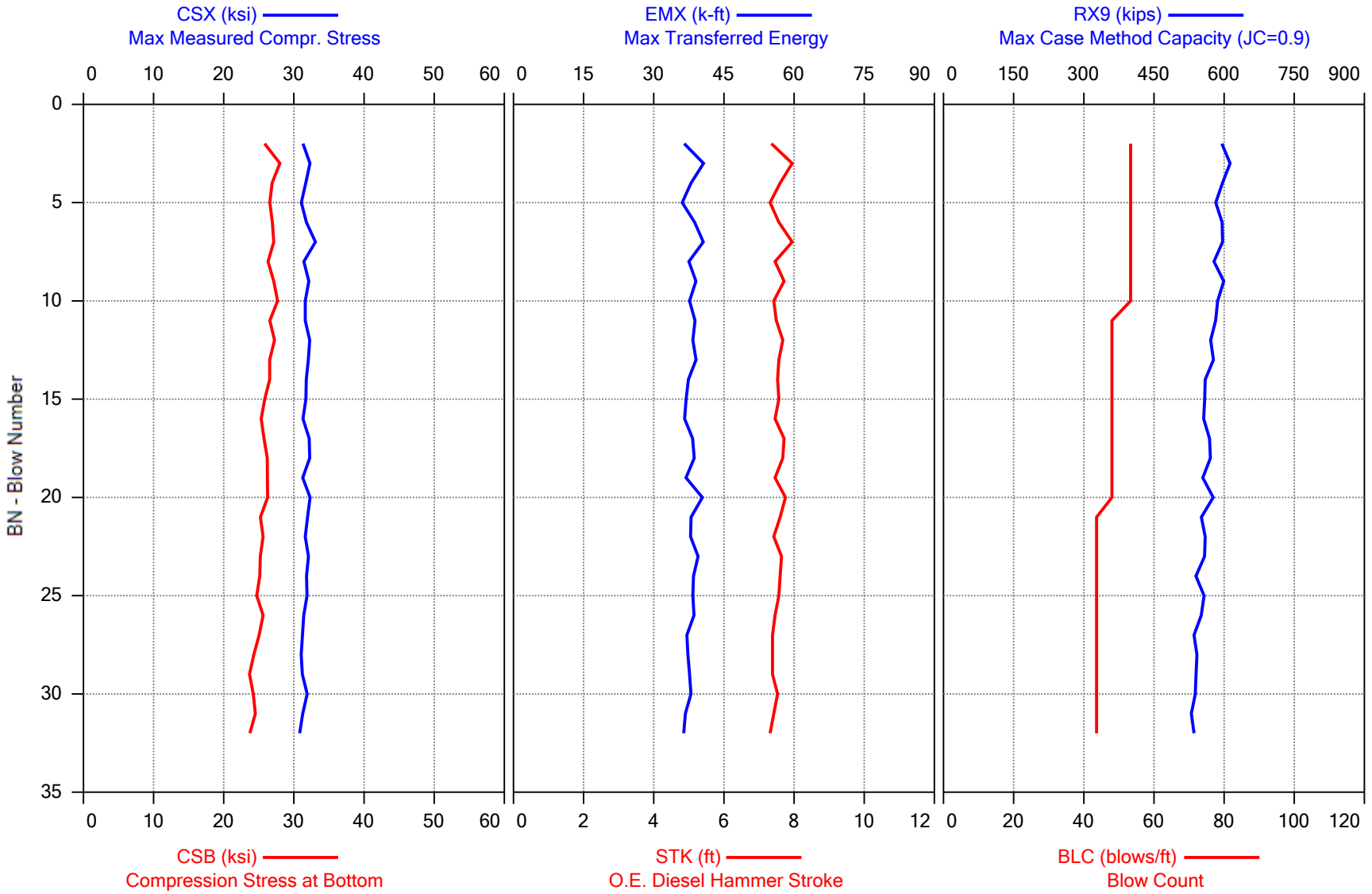
Drive 5 minutes 33 seconds 12:58 PM - 1:04 PM BN 1 - 216

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

Printed: 17-June-2015

Test started: 16-June-2015

USH 10 over LLBDM - PIER 20 #44 RESTRIKE
APE D30-42, HP 14 x 73



USH 10 over LLBDM - PIER 20 #44 RESTRIKE APE D30-42, HP 14 x 73
OP: RF Date: 16-June-2015

AR: 21.40 in² SP: 0.492 k/ft³
LE: 77.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	Depth ft	BLC blows/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM bpm	RX9 kips
10	45.77	53	AV9	31.8	26.9	7.6	38	42.8	594
			MAX	33.1	28.0	7.9	41	43.6	613
			MIN	31.1	25.8	7.3	36	41.9	578
20	45.98	48	AV10	31.9	26.3	7.6	38	42.8	567
			MAX	32.3	27.2	7.8	40	43.2	582
			MIN	31.3	25.3	7.5	37	42.4	554
32	46.25	44	AV12	31.5	24.8	7.5	38	43.2	545
			MAX	32.1	25.6	7.6	39	43.6	559
			MIN	30.8	23.7	7.3	36	42.7	530
			Average	31.7	25.9	7.5	38	43.0	566
			Maximum	33.1	28.0	7.9	41	43.6	613
			Minimum	30.8	23.7	7.3	36	41.9	530

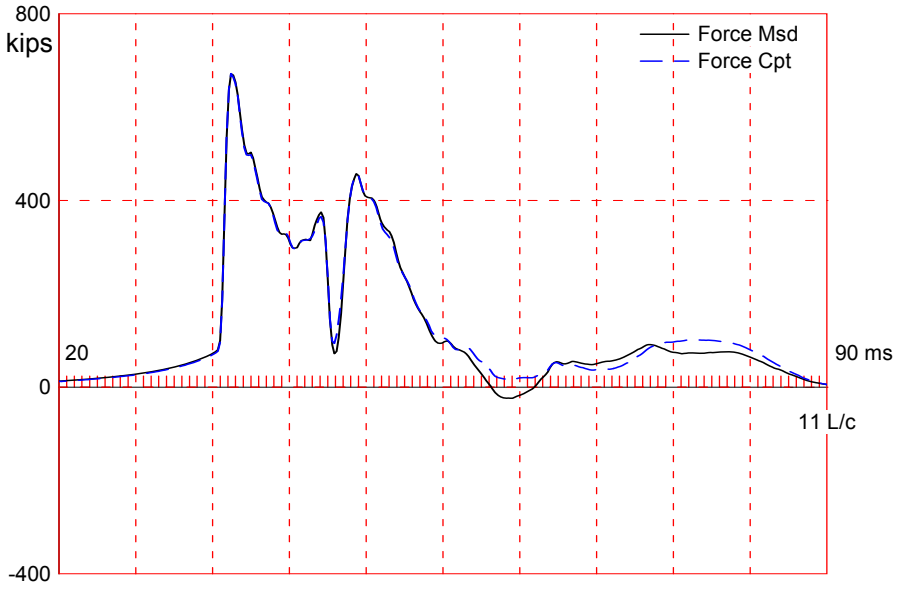
Total number of blows analyzed: 31

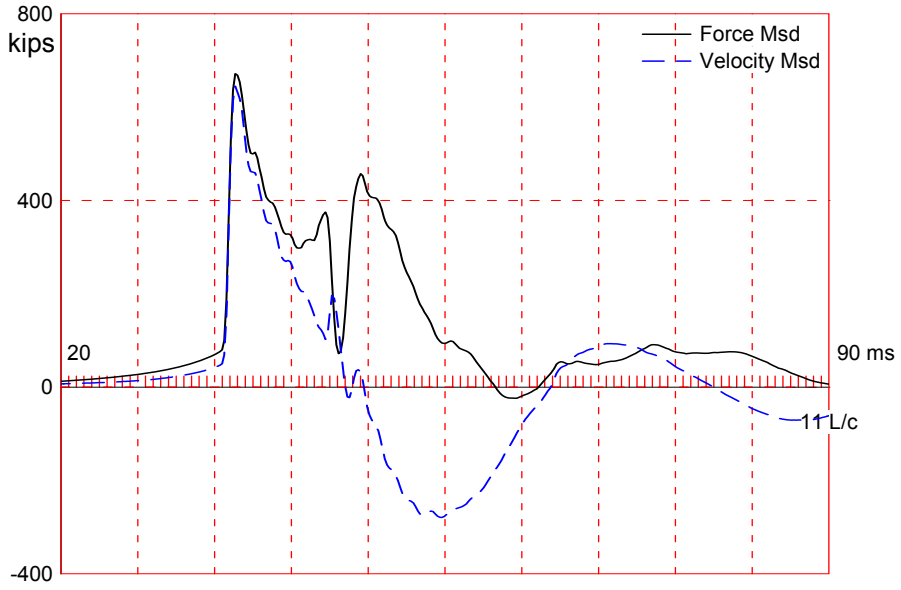
BL# Sensors

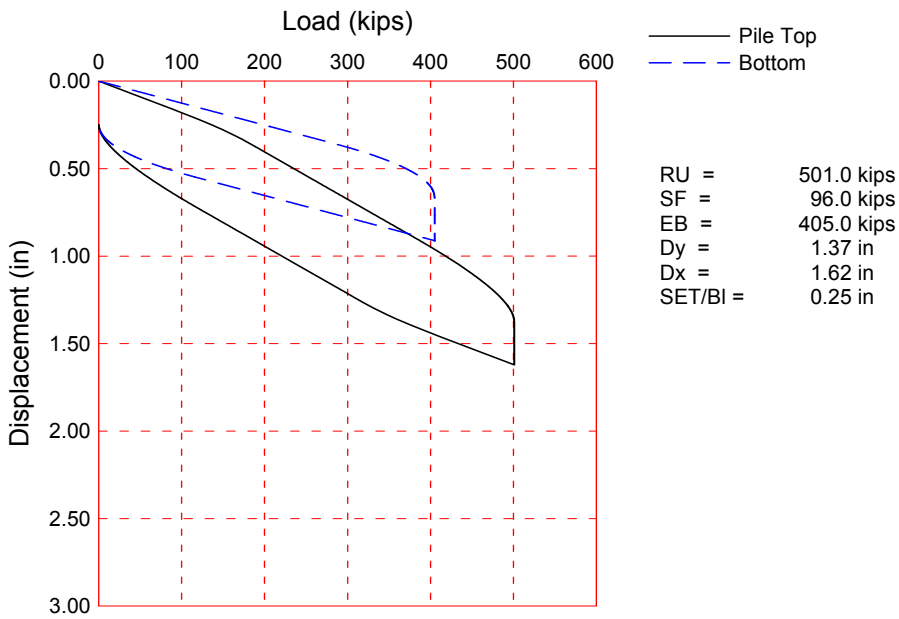
1-32 F1: [K769] 91.9 (1.00); F2: [D815] 93.0 (1.00); A1: [K3658] 362.0 (1.00); A2: [K3550] 360.0 (1.00)

Time Summary

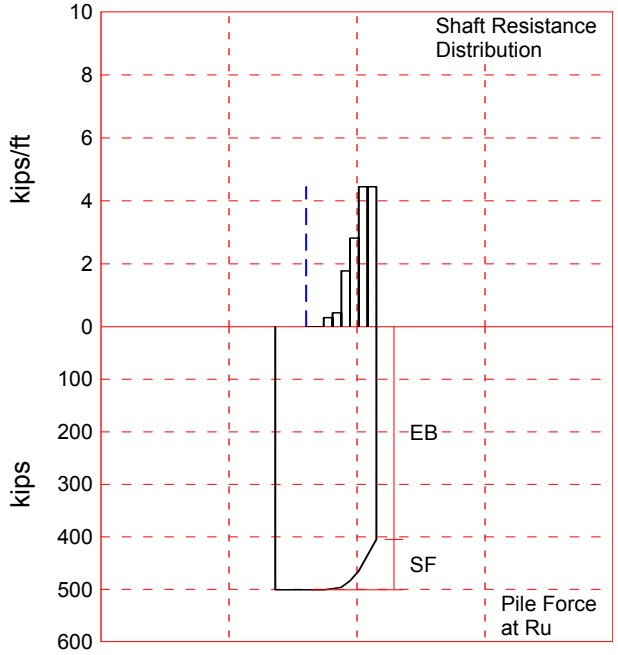
Drive 43 seconds 7:11 AM - 7:12 AM BN 1 - 32







RU =	501.0 kips
SF =	96.0 kips
EB =	405.0 kips
Dy =	1.37 in
Dx =	1.62 in
SET/Bl =	0.25 in



Length b. Sensors	77.5 ft
Embedment	51.9 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	3.32
Top Compr. Stress	31.4 ksi
Max Compr. Stress	33.0 ksi
Max Tension Stress	-4.40 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.51 in
Avg. Shaft Smith Dpg.	0.22 s/ft
Toe Smith Damping	0.07 s/ft

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About the CAPWAP Results

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

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

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

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

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

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

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

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 501.0; along Shaft 96.0; at Toe 405.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				501.0				
1	30.3	4.8	0.0	501.0	0.0	0.00	0.00	0.00
2	37.1	11.5	0.0	501.0	0.0	0.00	0.00	0.00
3	43.8	18.2	2.0	499.0	2.0	0.30	0.06	0.22
4	50.5	25.0	3.0	496.0	5.0	0.45	0.09	0.22
5	57.3	31.7	12.0	484.0	17.0	1.78	0.38	0.22
6	64.0	38.5	19.0	465.0	36.0	2.82	0.60	0.22
7	70.8	45.2	30.0	435.0	66.0	4.45	0.95	0.22
8	77.5	51.9	30.0	405.0	96.0	4.45	0.95	0.22
Avg. Shaft			12.0			1.85	0.39	0.22
Toe			405.0				293.80	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.09	0.51
Case Damping Factor		0.55	0.74
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	55	69
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	86	
Resistance Gap (included in Toe Quake)	(in)		0.03
Soil Plug Weight	(kips)	0.035	0.045

CAPWAP match quality = 3.32 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.25 in; Blow Count = 48 b/ft
Computed: Final Set = 0.22 in; Blow Count = 55 b/ft

Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(K769) CAL: 91.9; RF: 1.00
A3(K3550) CAL: 360; RF: 0.98; A4(K3658) CAL: 362; RF: 0.98

max. Top Comp. Stress = 31.4 ksi (T= 36.1 ms, max= 1.052 x Top)
max. Comp. Stress = 33.0 ksi (Z= 57.3 ft, T= 39.5 ms)
max. Tens. Stress = -4.40 ksi (Z= 57.3 ft, T= 63.6 ms)
max. Energy (EMX) = 38.3 kip-ft; max. Measured Top Displ. (DMX)= 1.14 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	672.6	-15.8	31.4	-0.74	38.3	16.9	1.14
2	6.7	672.9	-16.5	31.4	-0.77	38.2	16.8	1.13
4	13.5	673.6	-19.7	31.5	-0.92	37.7	16.8	1.09
5	16.8	674.4	-23.5	31.5	-1.10	37.4	16.7	1.06
6	20.2	675.6	-31.3	31.6	-1.46	36.9	16.7	1.04
7	23.6	676.9	-38.6	31.6	-1.80	36.4	16.6	1.01
8	27.0	678.0	-44.9	31.7	-2.10	35.9	16.6	0.98
9	30.3	679.2	-52.2	31.7	-2.44	35.3	16.5	0.95
10	33.7	680.5	-60.0	31.8	-2.80	34.7	16.5	0.92
11	37.1	682.2	-67.2	31.9	-3.14	34.1	16.4	0.89
12	40.4	685.5	-73.6	32.0	-3.44	33.5	16.3	0.86
13	43.8	688.5	-79.2	32.2	-3.70	32.9	16.2	0.83
14	47.2	683.8	-82.2	31.9	-3.84	31.9	16.1	0.80
15	50.5	693.7	-87.7	32.4	-4.10	31.2	15.9	0.77
16	53.9	692.8	-89.2	32.4	-4.17	30.0	15.5	0.74
17	57.3	707.4	-94.2	33.0	-4.40	29.4	15.2	0.71
18	60.7	674.3	-83.7	31.5	-3.91	26.6	14.7	0.68
19	64.0	698.4	-87.9	32.6	-4.11	26.0	14.3	0.65
20	67.4	644.2	-70.4	30.1	-3.29	22.4	14.9	0.62
21	70.8	629.5	-74.5	29.4	-3.48	21.9	16.8	0.59
22	74.1	501.4	-46.2	23.4	-2.16	17.0	17.7	0.56
23	77.5	521.9	-50.1	24.4	-2.34	13.4	17.6	0.54
Absolute	57.3			33.0			(T =	39.5 ms)
	57.3				-4.40		(T =	63.6 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	629.6	488.7	347.8	206.8	65.9					
RX	682.3	624.6	568.4	536.7	523.6	515.8	511.5	509.4	508.6	507.8
RU	629.6	488.7	347.8	206.8	65.9					

RAU = 504.4 (kips); RA2 = 563.9 (kips)

Current CAPWAP Ru = 501.0 (kips); Corresponding J(RP)= 0.18; matches RX20 within 5%

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
17.1	36.09	654.1	680.1	680.1	1.14	0.25	0.25	38.8	667.2	844

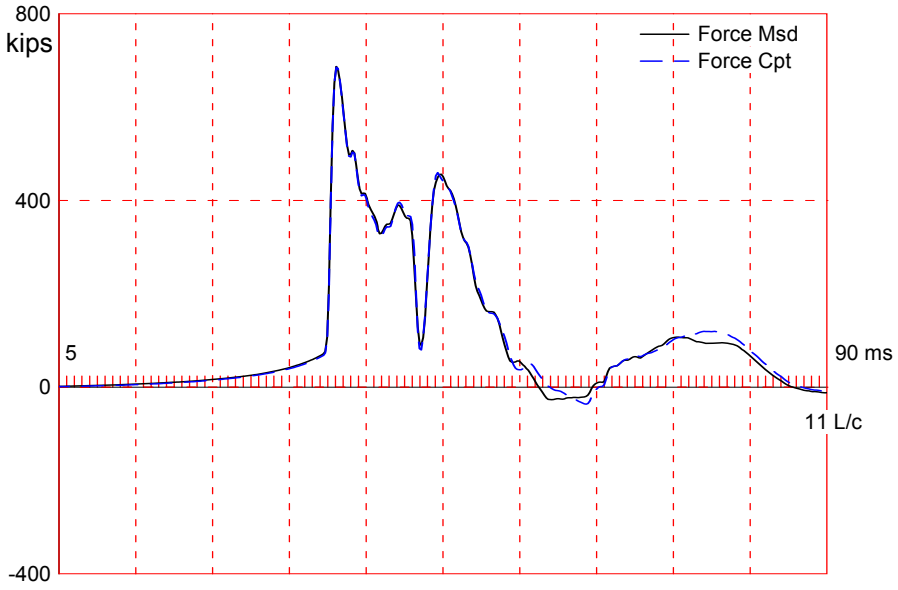
PILE PROFILE AND PILE MODEL

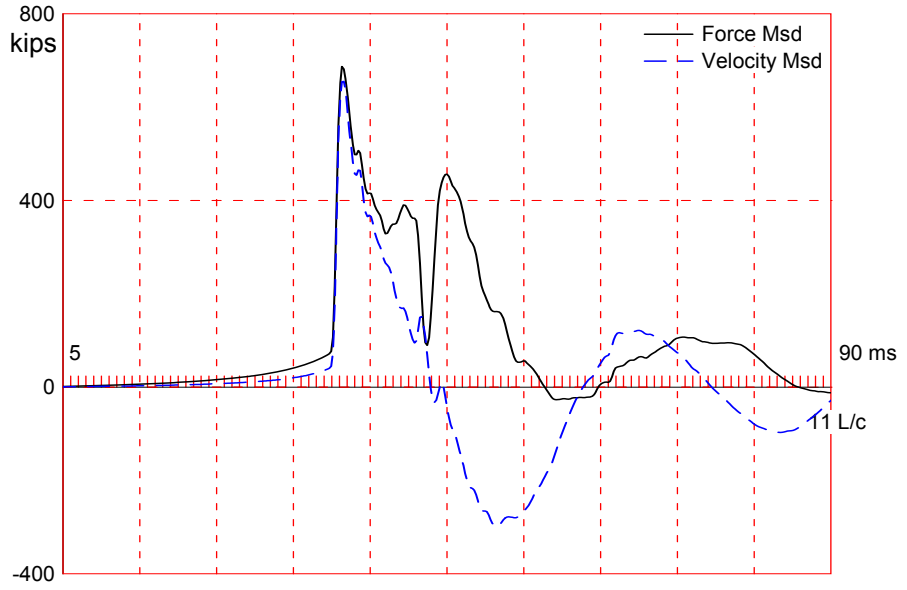
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

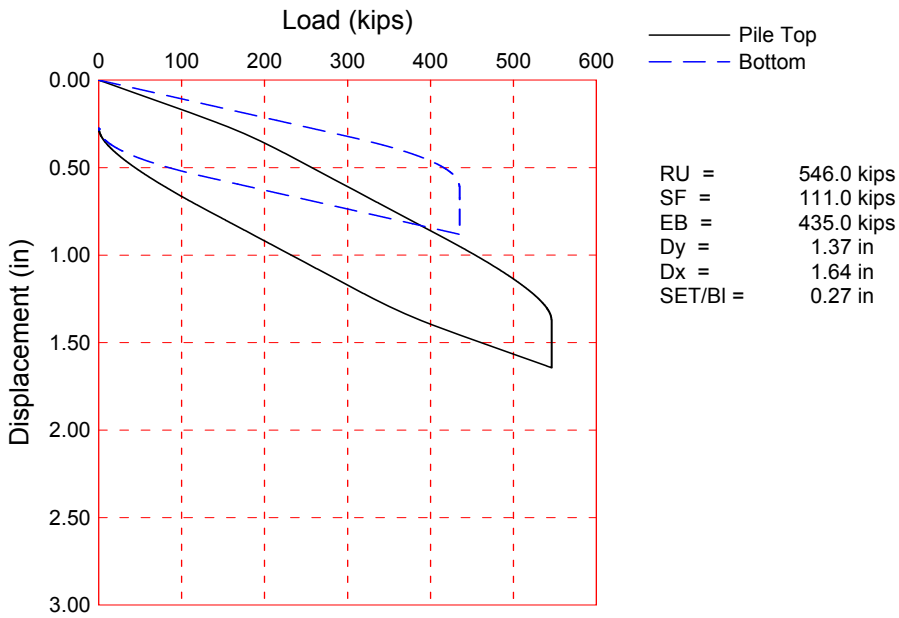
Toe Area 198.5 in²

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.4	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.000
22	74.1	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.010
23	77.5	38.20	0.00	0.00	0.000	-0.00	0.000	4.70	16807.9	0.025

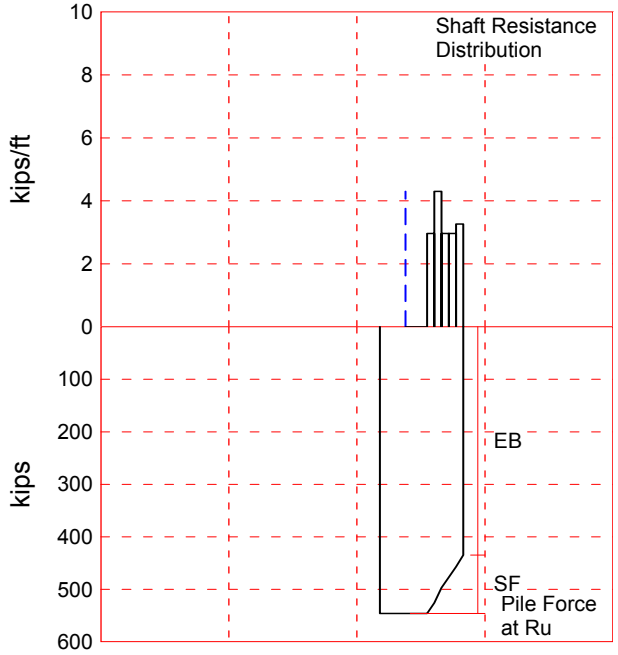
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 9.2 ms
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	546.0 kips
SF =	111.0 kips
EB =	435.0 kips
Dy =	1.37 in
Dx =	1.64 in
SET/Bl =	0.27 in



Length b. Sensors	77.5 ft
Embedment	52.1 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.54
Top Compr. Stress	32.0 ksi
Max Compr. Stress	35.4 ksi
Max Tension Stress	-6.40 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.47 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.06 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 546.0; along Shaft 111.0; at Toe 435.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				546.0				
1	30.3	4.9	0.0	546.0	0.0	0.00	0.00	0.00
2	37.1	11.7	0.0	546.0	0.0	0.00	0.00	0.00
3	43.8	18.4	0.0	546.0	0.0	0.00	0.00	0.00
4	50.5	25.1	20.0	526.0	20.0	2.97	0.63	0.24
5	57.3	31.9	29.0	497.0	49.0	4.30	0.92	0.24
6	64.0	38.6	20.0	477.0	69.0	2.97	0.63	0.24
7	70.8	45.4	20.0	457.0	89.0	2.97	0.63	0.24
8	77.5	52.1	22.0	435.0	111.0	3.26	0.69	0.24
Avg. Shaft			13.9			2.13	0.45	0.24
Toe			435.0				315.56	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.10	0.47
Case Damping Factor		0.69	0.68
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	31
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	56	
Resistance Gap (included in Toe Quake)	(in)		0.08
Soil Plug Weight	(kips)		0.135

CAPWAP match quality = 2.54 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.27 in; Blow Count = 44 b/ft
Computed: Final Set = 0.26 in; Blow Count = 46 b/ft
Transducer F3(D815) CAL: 93.0; RF: 0.99; F4(K769) CAL: 91.9; RF: 0.99
A3(K3550) CAL: 360; RF: 1.01; A4(K3658) CAL: 362; RF: 1.01

max. Top Comp. Stress = 32.0 ksi (T= 36.1 ms, max= 1.104 x Top)
max. Comp. Stress = 35.4 ksi (Z= 50.5 ft, T= 39.1 ms)
max. Tens. Stress = -6.40 ksi (Z= 50.5 ft, T= 60.9 ms)
max. Energy (EMX) = 39.4 kip-ft; max. Measured Top Displ. (DMX)= 1.11 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	685.9	-40.5	32.0	-1.89	39.4	17.2	1.12
2	6.7	686.2	-46.0	32.1	-2.15	39.3	17.1	1.11
4	13.5	687.0	-62.2	32.1	-2.91	38.8	17.1	1.07
5	16.8	687.5	-72.2	32.1	-3.37	38.4	17.1	1.04
6	20.2	688.0	-83.7	32.1	-3.91	37.9	17.0	1.02
7	23.6	688.9	-95.0	32.2	-4.44	37.3	17.0	0.99
8	27.0	690.0	-105.8	32.2	-4.94	36.8	16.9	0.96
9	30.3	691.1	-115.6	32.3	-5.40	36.2	16.9	0.93
10	33.7	692.3	-123.6	32.3	-5.77	35.6	16.9	0.90
11	37.1	693.6	-130.1	32.4	-6.08	34.9	16.8	0.87
12	40.4	696.5	-133.2	32.5	-6.22	34.3	16.8	0.84
13	43.8	713.6	-134.6	33.3	-6.29	33.5	16.5	0.80
14	47.2	734.3	-136.6	34.3	-6.38	32.8	15.9	0.77
15	50.5	757.3	-137.1	35.4	-6.40	32.0	15.4	0.73
16	53.9	692.9	-118.7	32.4	-5.55	27.6	14.7	0.70
17	57.3	709.2	-120.6	33.1	-5.63	26.9	14.2	0.67
18	60.7	603.8	-96.8	28.2	-4.52	21.4	13.7	0.64
19	64.0	617.8	-96.8	28.9	-4.52	20.7	13.5	0.61
20	67.4	548.1	-81.0	25.6	-3.78	17.1	14.9	0.58
21	70.8	528.5	-81.8	24.7	-3.82	16.5	16.5	0.55
22	74.1	495.7	-62.3	23.2	-2.91	13.1	17.7	0.52
23	77.5	506.7	-60.9	23.7	-2.84	10.7	17.6	0.49
Absolute	50.5			35.4			(T =	39.1 ms)
	50.5				-6.40		(T =	60.9 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	662.8	525.3	387.8	250.3	112.8					
RX	710.6	655.5	605.0	575.3	558.3	543.5	529.8	520.2	513.4	506.6
RU	671.0	533.0	394.9	256.9	118.9					

RAU = 461.6 (kips); RA2 = 609.1 (kips)

Current CAPWAP Ru = 546.0 (kips); Corresponding J(RP)= 0.17; J(RX) = 0.97

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
17.4	36.09	658.6	691.7	697.6	1.11	0.28	0.27	39.7	687.5	1130

PILE PROFILE AND PILE MODEL

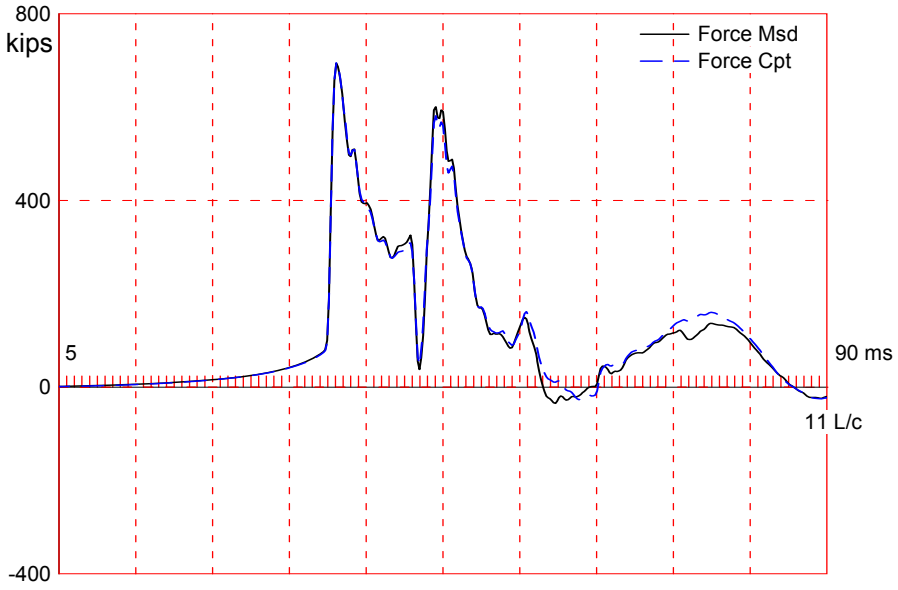
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

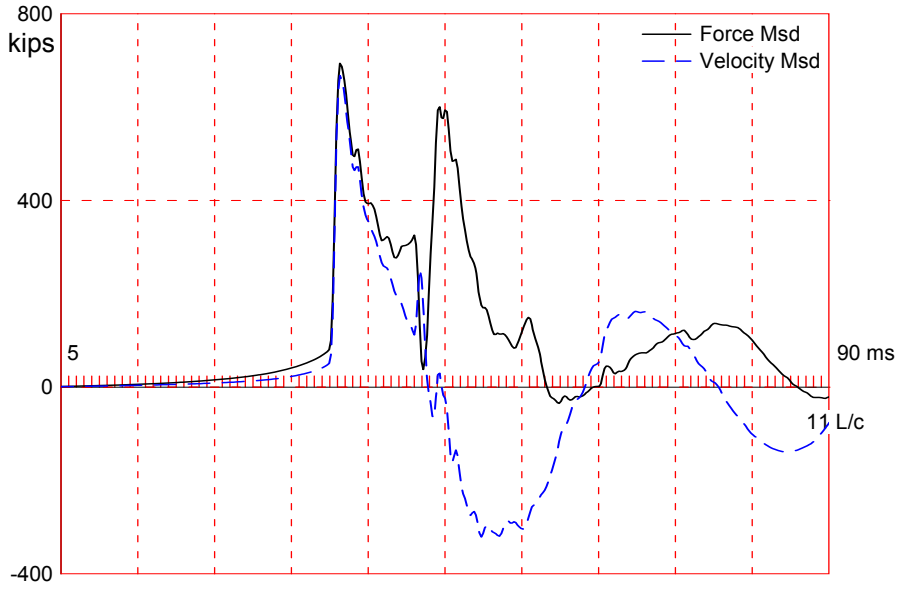
Toe Area 198.5 in^2

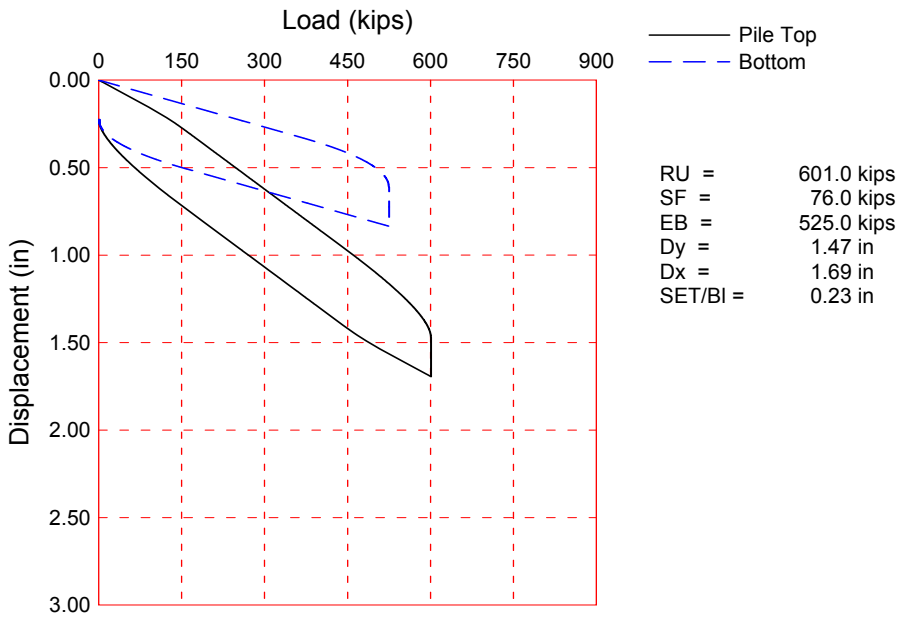
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

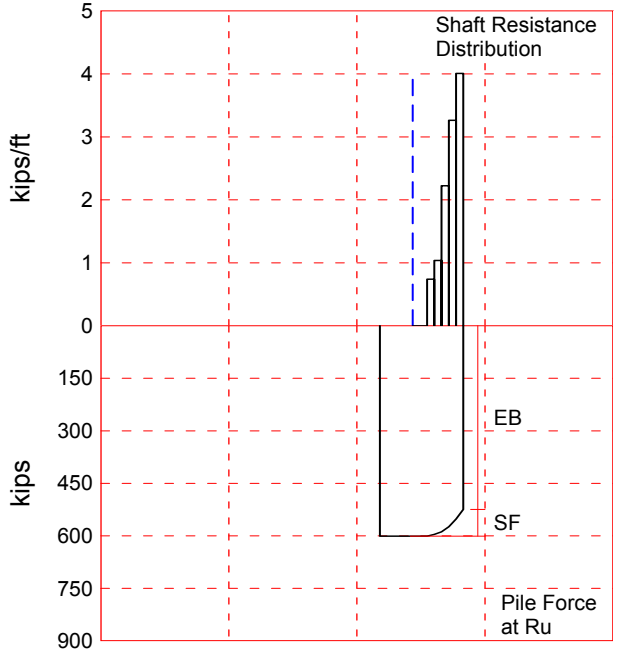
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	601.0 kips
SF =	76.0 kips
EB =	525.0 kips
Dy =	1.47 in
Dx =	1.69 in
SET/Bl =	0.23 in



Length b. Sensors	77.5 ft
Embedment	46.3 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	3.51
Top Compr. Stress	32.5 ksi
Max Compr. Stress	33.3 ksi
Max Tension Stress	-6.98 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.47 in
Avg. Shaft Smith Dpg.	0.20 s/ft
Toe Smith Damping	0.07 s/ft

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About the CAPWAP Results

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

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

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

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

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

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

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

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 601.0; along Shaft 76.0; at Toe 525.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				601.0				
1	37.1	5.8	0.0	601.0	0.0	0.00	0.00	0.00
2	43.8	12.6	0.0	601.0	0.0	0.00	0.00	0.00
3	50.5	19.3	5.0	596.0	5.0	0.74	0.16	0.20
4	57.3	26.0	7.0	589.0	12.0	1.04	0.22	0.20
5	64.0	32.8	15.0	574.0	27.0	2.23	0.47	0.20
6	70.8	39.5	22.0	552.0	49.0	3.26	0.69	0.20
7	77.5	46.3	27.0	525.0	76.0	4.01	0.85	0.20
Avg. Shaft			10.9			1.64	0.35	0.20
Toe			525.0				380.85	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.06	0.47
Case Damping Factor		0.40	0.96
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	35	47
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake)	(in)		0.05
Soil Plug Weight	(kips)		0.045

CAPWAP match quality = 3.51 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.19 in; Blow Count = 65 b/ft

Transducer F3(K769) CAL: 91.9; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K3658) CAL: 362; RF: 1.00; A4(K3550) CAL: 360; RF: 1.00

max. Top Comp. Stress = 32.5 ksi (T= 36.1 ms, max= 1.024 x Top)
max. Comp. Stress = 33.3 ksi (Z= 50.5 ft, T= 39.1 ms)
max. Tens. Stress = -6.98 ksi (Z= 47.2 ft, T= 61.7 ms)
max. Energy (EMX) = 39.3 kip-ft; max. Measured Top Displ. (DMX)= 1.17 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	695.8	-40.8	32.5	-1.91	39.3	17.4	1.17
2	6.7	696.1	-47.3	32.5	-2.21	39.1	17.4	1.15
4	13.5	696.8	-62.9	32.6	-2.94	38.4	17.3	1.11
5	16.8	697.2	-70.9	32.6	-3.31	37.9	17.3	1.08
6	20.2	697.6	-83.4	32.6	-3.89	37.4	17.3	1.05
7	23.6	698.0	-96.4	32.6	-4.51	36.9	17.3	1.02
8	27.0	698.6	-108.1	32.6	-5.05	36.3	17.2	0.99
9	30.3	699.0	-118.8	32.7	-5.55	35.8	17.2	0.96
10	33.7	699.5	-129.2	32.7	-6.04	35.1	17.2	0.93
11	37.1	700.1	-138.0	32.7	-6.45	34.5	17.1	0.90
12	40.4	700.7	-145.4	32.7	-6.79	33.9	17.1	0.87
13	43.8	702.4	-149.2	32.8	-6.97	33.2	17.0	0.84
14	47.2	707.5	-149.5	33.1	-6.98	32.4	16.8	0.81
15	50.5	712.9	-148.8	33.3	-6.95	31.6	16.7	0.77
16	53.9	697.9	-141.8	32.6	-6.62	29.8	16.5	0.74
17	57.3	709.8	-141.7	33.2	-6.62	28.9	16.3	0.70
18	60.7	694.9	-133.8	32.5	-6.25	26.8	15.9	0.66
19	64.0	710.1	-135.3	33.2	-6.32	25.9	15.5	0.63
20	67.4	661.0	-116.6	30.9	-5.45	22.6	17.2	0.59
21	70.8	653.5	-117.6	30.5	-5.49	21.7	18.9	0.55
22	74.1	642.6	-90.8	30.0	-4.24	17.8	19.9	0.52
23	77.5	663.0	-90.4	31.0	-4.22	14.9	18.8	0.48
Absolute	50.5			33.3			(T =	39.1 ms)
	47.2				-6.98		(T =	61.7 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	606.6	451.9	297.1	142.4	0.0					
RX	786.6	743.2	699.8	676.0	665.8	655.5	645.3	635.6	626.1	616.7
RU	606.6	451.9	297.1	142.4	0.0					

RAU = 578.9 (kips); RA2 = 675.4 (kips)

Current CAPWAP Ru = 601.0 (kips); Corresponding J(RP)= 0.01; matches RX20 within 5%

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
17.7	36.09	675.6	704.8	704.8	1.17	0.22	0.23	39.4	679.7	1250

PILE PROFILE AND PILE MODEL

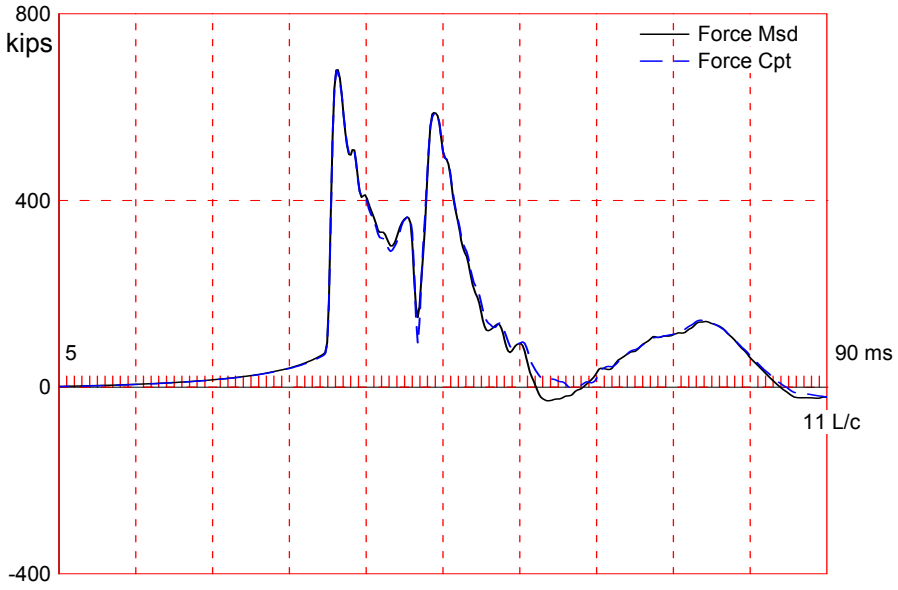
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

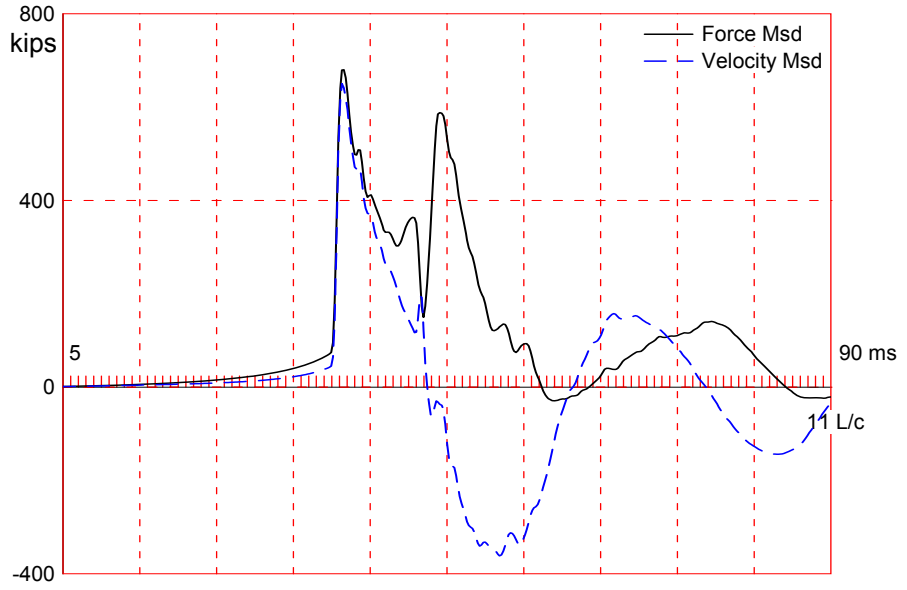
Toe Area 198.5 in^2

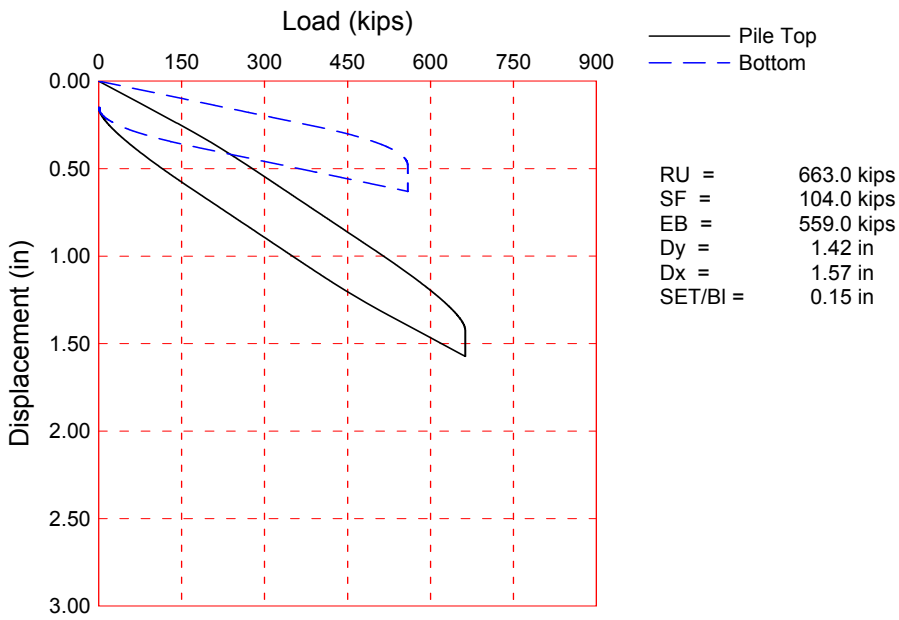
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

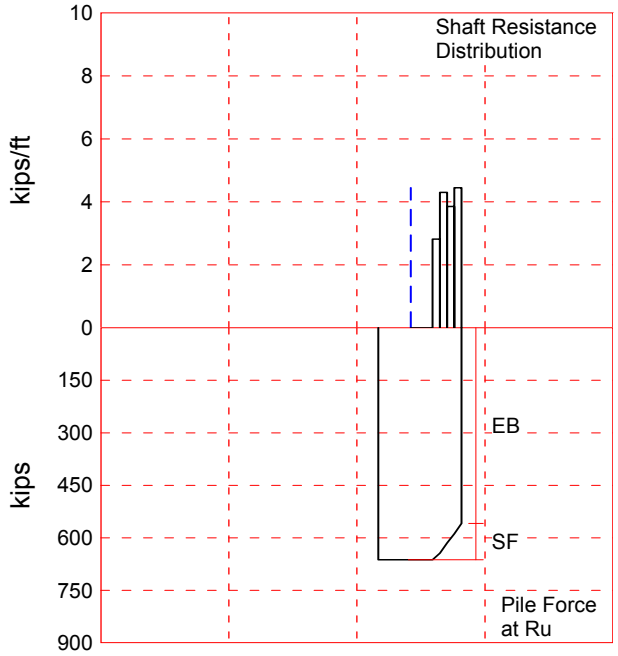
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	663.0 kips
SF =	104.0 kips
EB =	559.0 kips
Dy =	1.42 in
Dx =	1.57 in
SET/Bl =	0.15 in



Length b. Sensors	77.5 ft
Embedment	46.4 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.60
Top Compr. Stress	31.7 ksi
Max Compr. Stress	34.8 ksi
Max Tension Stress	-7.93 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.37 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.07 s/ft

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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: 663.0; along Shaft 104.0; at Toe 559.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				663.0				
1	37.1	5.9	0.0	663.0	0.0	0.00	0.00	0.00
2	43.8	12.7	0.0	663.0	0.0	0.00	0.00	0.00
3	50.5	19.4	0.0	663.0	0.0	0.00	0.00	0.00
4	57.3	26.2	19.0	644.0	19.0	2.82	0.60	0.24
5	64.0	32.9	29.0	615.0	48.0	4.30	0.92	0.24
6	70.8	39.6	26.0	589.0	74.0	3.86	0.82	0.24
7	77.5	46.4	30.0	559.0	104.0	4.45	0.95	0.24
Avg. Shaft			14.9			2.24	0.48	0.24
Toe			559.0				405.52	0.07

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.10	0.37
Case Damping Factor		0.65	1.10
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	90
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	72	
Resistance Gap (included in Toe Quake)	(in)		0.10

CAPWAP match quality = 2.60 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.11 in; Blow Count = 108 b/ft

Transducer F3(D815) CAL: 93.0; RF: 1.00; F4(K769) CAL: 91.9; RF: 1.00
A3(K3550) CAL: 360; RF: 1.00; A4(K3658) CAL: 362; RF: 1.00

max. Top Comp. Stress = 31.7 ksi (T= 36.1 ms, max= 1.097 x Top)
max. Comp. Stress = 34.8 ksi (Z= 57.3 ft, T= 39.5 ms)
max. Tens. Stress = -7.93 ksi (Z= 57.3 ft, T= 61.1 ms)
max. Energy (EMX) = 39.1 kip-ft; max. Measured Top Displ. (DMX)= 1.13 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	679.1	-35.6	31.7	-1.66	39.1	17.0	1.14
2	6.7	679.4	-39.6	31.7	-1.85	38.8	17.0	1.12
4	13.5	679.9	-49.5	31.8	-2.31	37.8	17.0	1.07
5	16.8	680.2	-62.1	31.8	-2.90	37.2	16.9	1.04
6	20.2	680.5	-75.5	31.8	-3.53	36.6	16.9	1.01
7	23.6	681.0	-89.2	31.8	-4.17	35.9	16.9	0.97
8	27.0	681.4	-101.6	31.8	-4.75	35.2	16.8	0.94
9	30.3	681.9	-113.2	31.9	-5.29	34.6	16.8	0.91
10	33.7	682.7	-123.8	31.9	-5.78	33.9	16.8	0.88
11	37.1	683.8	-132.7	31.9	-6.20	33.1	16.7	0.84
12	40.4	685.0	-140.4	32.0	-6.56	32.3	16.7	0.81
13	43.8	686.2	-146.8	32.1	-6.86	31.4	16.6	0.77
14	47.2	688.5	-153.6	32.2	-7.18	30.4	16.6	0.73
15	50.5	703.3	-160.4	32.9	-7.49	29.5	16.4	0.70
16	53.9	723.5	-166.3	33.8	-7.77	28.5	15.8	0.66
17	57.3	744.9	-169.7	34.8	-7.93	27.4	15.4	0.62
18	60.7	685.3	-150.4	32.0	-7.03	23.1	14.6	0.58
19	64.0	703.8	-149.9	32.9	-7.00	22.0	14.8	0.53
20	67.4	648.2	-120.1	30.3	-5.61	16.9	16.7	0.50
21	70.8	671.0	-120.4	31.3	-5.62	15.9	18.3	0.46
22	74.1	646.1	-99.5	30.2	-4.65	11.8	18.8	0.42
23	77.5	664.1	-101.3	31.0	-4.73	9.3	17.4	0.38
Absolute	57.3			34.8			(T =	39.5 ms)
	57.3				-7.93		(T =	61.1 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	748.0	627.3	506.7	386.1	265.5					
RX	817.5	775.0	738.1	701.2	673.4	661.5	650.2	639.0	627.8	616.6
RU	748.0	627.3	506.7	386.1	265.5					

RAU = 601.6 (kips); RA2 = 684.6 (kips)

Current CAPWAP Ru = 663.0 (kips); Corresponding J(RP)= 0.14; J(RX) = 0.97

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
17.3	35.89	661.8	689.3	689.3	1.13	0.15	0.15	39.3	735.8	2098

PILE PROFILE AND PILE MODEL

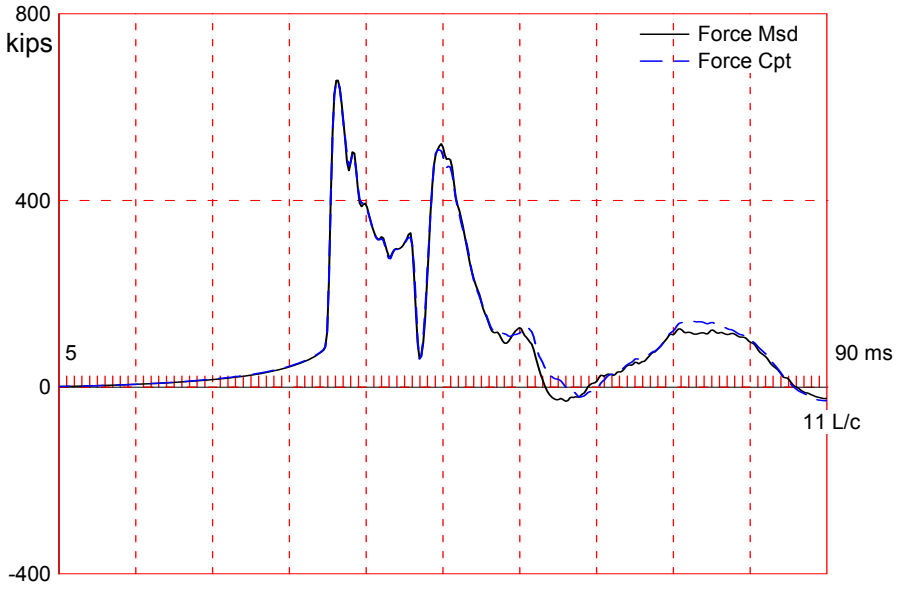
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

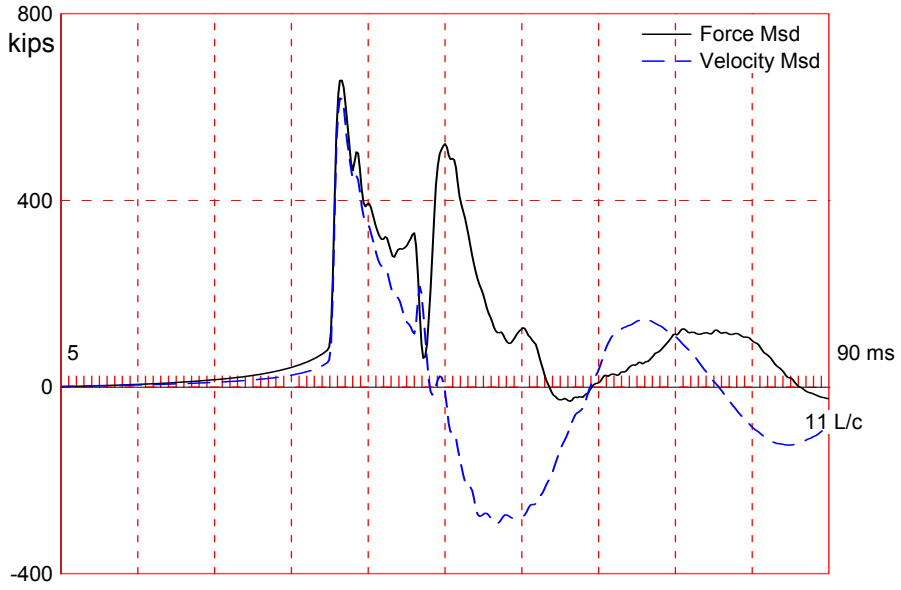
Toe Area 198.5 in^2

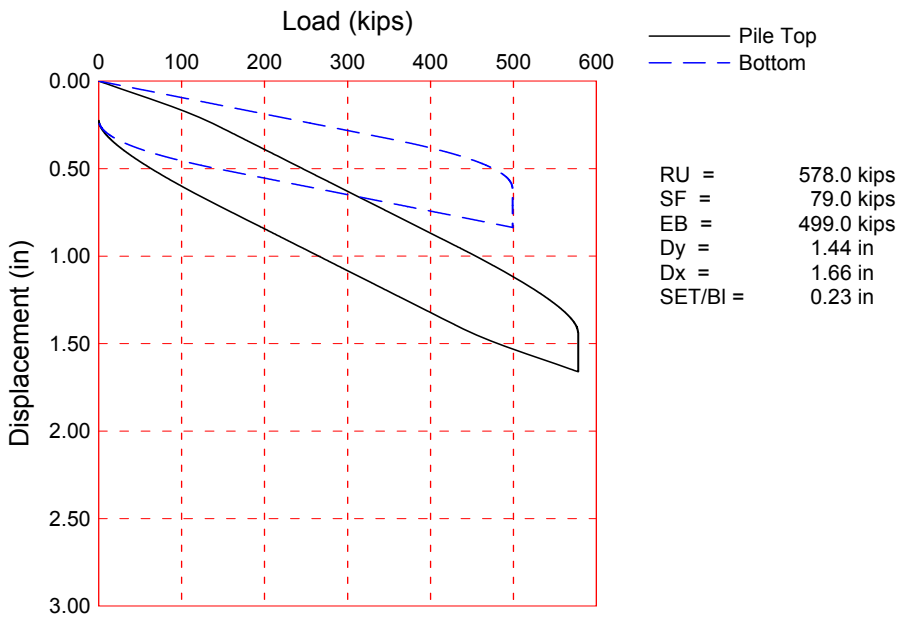
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

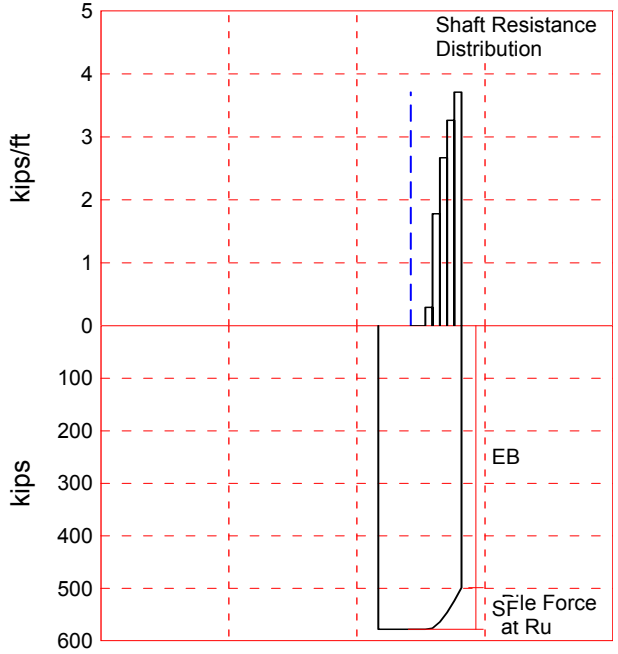
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	578.0 kips
SF =	79.0 kips
EB =	499.0 kips
Dy =	1.44 in
Dx =	1.66 in
SET/Bl =	0.23 in



Length b. Sensors	77.5 ft
Embedment	45.5 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.93
Top Compr. Stress	30.6 ksi
Max Compr. Stress	32.7 ksi
Max Tension Stress	-6.63 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.47 in
Avg. Shaft Smith Dpg.	0.21 s/ft
Toe Smith Damping	0.06 s/ft

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About the CAPWAP Results

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

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

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

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

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

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

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

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 578.0; along Shaft 79.0; at Toe 499.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				578.0				
1	37.1	5.1	0.0	578.0	0.0	0.00	0.00	0.00
2	43.8	11.8	0.0	578.0	0.0	0.00	0.00	0.00
3	50.5	18.6	2.0	576.0	2.0	0.30	0.06	0.21
4	57.3	25.3	12.0	564.0	14.0	1.78	0.38	0.21
5	64.0	32.0	18.0	546.0	32.0	2.67	0.57	0.21
6	70.8	38.8	22.0	524.0	54.0	3.26	0.69	0.21
7	77.5	45.5	25.0	499.0	79.0	3.71	0.79	0.21
Avg. Shaft			11.3			1.74	0.37	0.21
Toe			499.0				361.99	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.05	0.47
Case Damping Factor		0.43	0.78
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	34	47
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.04
Soil Plug Weight	(kips)		0.121

CAPWAP match quality = 2.93 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.19 in; Blow Count = 65 b/ft

Transducer F3(K769) CAL: 91.9; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K3658) CAL: 362; RF: 1.00; A4(K3550) CAL: 360; RF: 1.00

max. Top Comp. Stress = 30.6 ksi (T= 36.1 ms, max= 1.066 x Top)
max. Comp. Stress = 32.7 ksi (Z= 57.3 ft, T= 39.5 ms)
max. Tens. Stress = -6.63 ksi (Z= 50.5 ft, T= 62.3 ms)
max. Energy (EMX) = 36.3 kip-ft; max. Measured Top Displ. (DMX)= 1.14 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	656.0	-37.8	30.6	-1.77	36.3	16.3	1.12
2	6.7	656.5	-45.0	30.7	-2.10	36.1	16.2	1.11
4	13.5	658.1	-61.0	30.7	-2.85	35.6	16.2	1.07
5	16.8	659.1	-68.7	30.8	-3.21	35.2	16.1	1.04
6	20.2	660.0	-75.0	30.8	-3.51	34.7	16.1	1.01
7	23.6	661.1	-83.3	30.9	-3.89	34.1	16.1	0.98
8	27.0	662.1	-91.1	30.9	-4.25	33.6	16.0	0.96
9	30.3	663.3	-100.3	31.0	-4.69	33.1	16.0	0.93
10	33.7	664.3	-108.7	31.0	-5.08	32.5	16.0	0.90
11	37.1	665.3	-117.0	31.1	-5.47	31.9	16.0	0.87
12	40.4	666.7	-124.6	31.1	-5.82	31.3	15.9	0.84
13	43.8	669.2	-132.4	31.3	-6.18	30.7	15.9	0.81
14	47.2	672.3	-138.9	31.4	-6.49	30.0	15.8	0.78
15	50.5	682.4	-142.0	31.9	-6.63	29.4	15.6	0.74
16	53.9	685.3	-140.1	32.0	-6.55	28.3	15.2	0.71
17	57.3	699.4	-140.2	32.7	-6.55	27.5	14.9	0.68
18	60.7	664.2	-126.3	31.0	-5.90	24.7	14.5	0.64
19	64.0	679.0	-126.5	31.7	-5.91	23.9	14.2	0.61
20	67.4	617.2	-104.0	28.8	-4.86	20.4	15.1	0.58
21	70.8	595.5	-103.6	27.8	-4.84	19.7	16.9	0.54
22	74.1	580.2	-75.8	27.1	-3.54	15.9	18.1	0.51
23	77.5	596.9	-75.7	27.9	-3.53	13.2	17.8	0.47
Absolute	57.3			32.7			(T =	39.5 ms)
	50.5				-6.63		(T =	62.3 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	586.3	446.3	306.2	166.1	26.0					
RX	724.7	675.4	635.1	619.3	603.5	587.7	572.9	567.3	566.9	566.6
RU	586.3	446.3	306.2	166.1	26.0					

RAU = 501.7 (kips); RA2 = 638.1 (kips)

Current CAPWAP Ru = 578.0 (kips); Corresponding J(RP)= 0.01; J(RX) = 1.13

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
16.3	35.89	624.4	662.4	662.4	1.14	0.23	0.23	36.6	643.8	1160

PILE PROFILE AND PILE MODEL

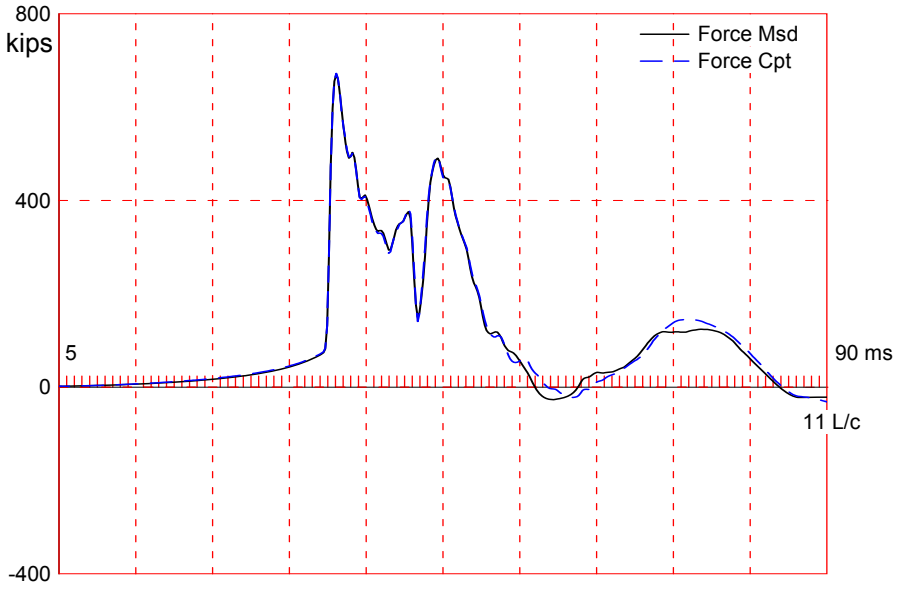
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	21.4	29992.2	492.000	4.70
77.5	21.4	29992.2	492.000	4.70

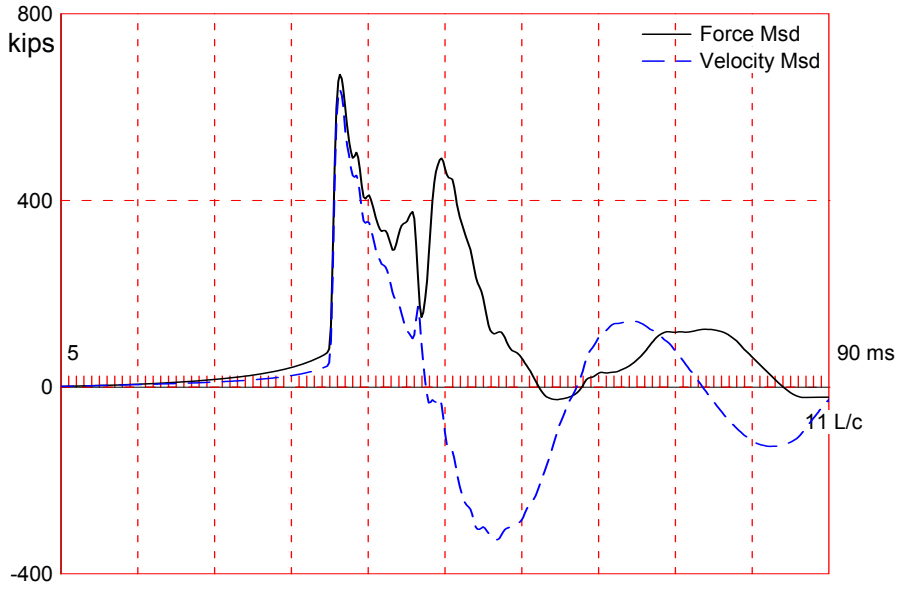
Toe Area 198.5 in²

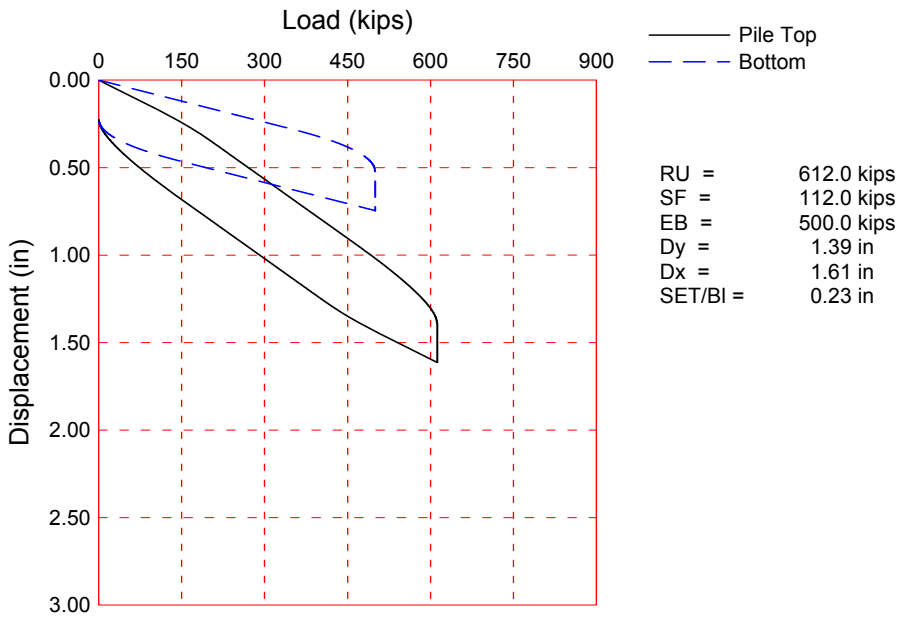
Top Segment Length 3.37 ft, Top Impedance 38 kips/ft/s

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

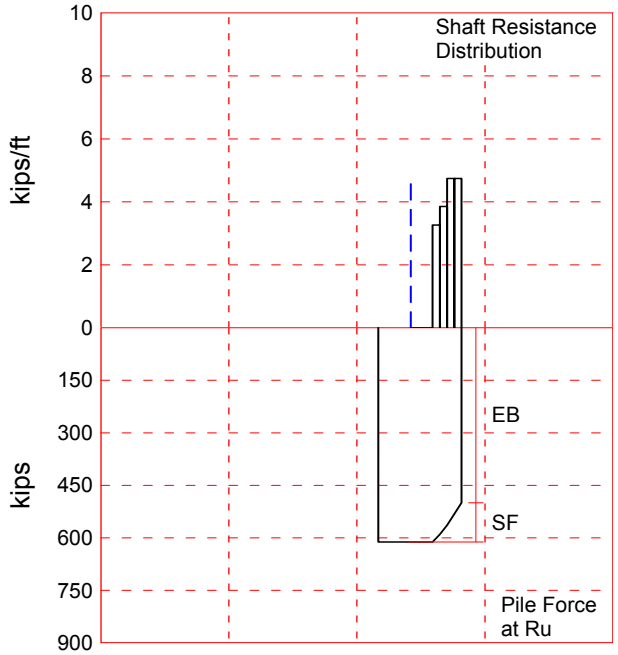
Total volume: 11.517 ft^3; Volume ratio considering added impedance: 1.000







RU =	612.0 kips
SF =	112.0 kips
EB =	500.0 kips
Dy =	1.39 in
Dx =	1.61 in
SET/Bl =	0.23 in



Length b. Sensors	77.5 ft
Embedment	45.7 ft
Top Area	21.4 in^2
End Bearing Area	198.5 in^2
Top Perimeter	4.70 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.88
Top Compr. Stress	31.4 ksi
Max Compr. Stress	35.0 ksi
Max Tension Stress	-8.00 ksi
Avg. Shaft Quake	0.06 in
Toe Quake	0.40 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.05 s/ft

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

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: 612.0; along Shaft 112.0; at Toe 500.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft	Quake in
				612.0					
1	37.1	5.2	0.0	612.0	0.0	0.00	0.00	0.00	0.06
2	43.8	12.0	0.0	612.0	0.0	0.00	0.00	0.00	0.06
3	50.5	18.7	0.0	612.0	0.0	0.00	0.00	0.00	0.06
4	57.3	25.4	22.0	590.0	22.0	3.26	0.69	0.25	0.06
5	64.0	32.2	26.0	564.0	48.0	3.86	0.82	0.25	0.06
6	70.8	38.9	32.0	532.0	80.0	4.75	1.01	0.25	0.06
7	77.5	45.7	32.0	500.0	112.0	4.75	1.01	0.25	0.06
Avg. Shaft			16.0			2.45	0.52	0.25	0.06
Toe			500.0				362.72	0.05	0.40

Soil Model Parameters/Extensions	Shaft	Toe
Case Damping Factor	0.73	0.65
Damping Type	Viscous	Sm+Visc
Unloading Quake (% of loading quake)	81	44
Reloading Level (% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)		0.05
Soil Plug Weight (kips)		0.018

CAPWAP match quality = 2.88 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.23 in; Blow Count = 53 b/ft
Computed: Final Set = 0.19 in; Blow Count = 65 b/ft

Transducer F3(K769) CAL: 91.9; RF: 1.00; F4(D815) CAL: 93.0; RF: 1.00
A3(K3658) CAL: 362; RF: 1.00; A4(K3550) CAL: 360; RF: 1.00

max. Top Comp. Stress = 31.4 ksi (T= 36.1 ms, max= 1.113 x Top)
max. Comp. Stress = 35.0 ksi (Z= 57.3 ft, T= 39.5 ms)
max. Tens. Stress = -8.00 ksi (Z= 57.3 ft, T= 60.9 ms)
max. Energy (EMX) = 37.7 kip-ft; max. Measured Top Displ. (DMX)= 1.11 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	672.9	-40.2	31.4	-1.88	37.7	16.6	1.09
2	6.7	673.5	-46.7	31.5	-2.18	37.5	16.6	1.07
4	13.5	675.0	-66.0	31.5	-3.08	36.7	16.5	1.03
5	16.8	675.8	-75.7	31.6	-3.53	36.2	16.5	1.00
6	20.2	676.6	-86.4	31.6	-4.04	35.6	16.5	0.97
7	23.6	677.5	-98.1	31.7	-4.58	35.0	16.4	0.94
8	27.0	678.5	-110.3	31.7	-5.15	34.3	16.4	0.91
9	30.3	679.6	-121.5	31.7	-5.68	33.7	16.4	0.88
10	33.7	680.8	-132.2	31.8	-6.18	33.0	16.3	0.84
11	37.1	682.0	-141.6	31.9	-6.61	32.4	16.3	0.81
12	40.4	683.4	-149.4	31.9	-6.98	31.7	16.2	0.78
13	43.8	684.8	-156.2	32.0	-7.30	31.0	16.2	0.75
14	47.2	686.8	-162.1	32.1	-7.57	30.3	16.1	0.72
15	50.5	706.1	-167.2	33.0	-7.81	29.5	15.8	0.68
16	53.9	724.3	-170.2	33.8	-7.95	28.7	15.2	0.65
17	57.3	748.9	-171.2	35.0	-8.00	27.8	14.7	0.61
18	60.7	670.1	-143.9	31.3	-6.72	23.4	14.0	0.57
19	64.0	696.2	-143.8	32.5	-6.72	22.5	13.4	0.54
20	67.4	601.4	-111.8	28.1	-5.22	18.0	14.1	0.50
21	70.8	592.6	-112.1	27.7	-5.23	17.2	15.9	0.47
22	74.1	558.3	-73.4	26.1	-3.43	12.6	16.7	0.44
23	77.5	565.0	-73.3	26.4	-3.42	9.5	15.7	0.40
Absolute	57.3			35.0			(T =	39.5 ms)
	57.3				-8.00		(T =	60.9 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	703.9	642.1	580.3	518.5	456.7	394.9	333.1	271.3	209.5	147.7
RX	739.3	716.0	693.2	670.6	648.9	630.7	620.5	611.2	602.5	594.4
RU	703.9	642.1	580.3	518.5	456.7	394.9	333.1	271.3	209.5	147.7

RAU = 546.3 (kips); RA2 = 643.3 (kips)

Current CAPWAP Ru = 612.0 (kips); Corresponding J(RP)= 0.15; J(RX) = 0.69

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
16.9	35.89	647.3	674.8	674.8	1.11	0.23	0.23	38.0	680.6	1423

PILE PROFILE AND PILE MODEL

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

Toe Area 198.5 in²

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

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

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