GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Alexander McCaskill
Company: Lunda Construction Company	No. of Sheets: 36
E-mail:whamacher@lundaconstruction.com	Date: December 11, 2014

RE: Dynamic Testing Results – Pier 3
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On December 9, 2014, Pier 3 #1 and Pier 3 #38 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on December 10. The 75.5 foot long HP 12 x 53 H-piles were driven with an APE D25-42 hammer operated on fuel setting 3. The piles were equipped with driving shoes. The project plans indicate a required driving resistance, or ultimate capacity, of 420 kips for the piles in Pier 3, with an estimated pile length of 35 feet.

Pier 3 #1 was driven to a depth of 31.5 feet below the excavated ground surface at El. 573.5, which corresponds to a pile tip elevation of El. 542.0. The final blow count was 10 blows over ⅝ of an inch of penetration at an average hammer stroke of 7.6 feet. The blow count at the beginning of restrike of was 10 blows for 1 inch of penetration at an average hammer stroke of 9.5 feet. Pier 3 #38 was driven to a depth of 32.5 feet below the ground surface at the same elevation, which corresponds to a tip elevation of El. 541.0. The final blow count was 10 blows for 1 inch of penetration at an average hammer stroke of 8.8 feet. The blow count at the beginning of restrike was 10 blows over ¾ of an inch of penetration at an average hammer stroke of 9.4 feet.

For the 420 kip piles driven with the APE D25-42 hammer in Pier 3 of the STH 96 bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.0	18
7.5	12
8.0	9
8.5	7
9.0	6

December 11, 2014

We recommended the above blow count at the corresponding hammer stroke be maintained for two inches of driving. Driving should be terminated immediately if the blow count reaches 10 blows per inch or greater at an average hammer stroke of 8.0 feet. We anticipate that the production piles will terminate at depths very similar to those of the test piles.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Alexander McCaskill

Alexander McCaskill, E.I.

Travis Coleman, P.E.

cc: Steve Seymour – steve.seymour@omnni.com
Jeff Horsfall – jeffrey.horsfall@dot.wi.gov

Attachments:

Dynamic Test Results	-	(Pages 3 – 12)
CAPWAP Analysis Results	-	(Pages 13 – 36)

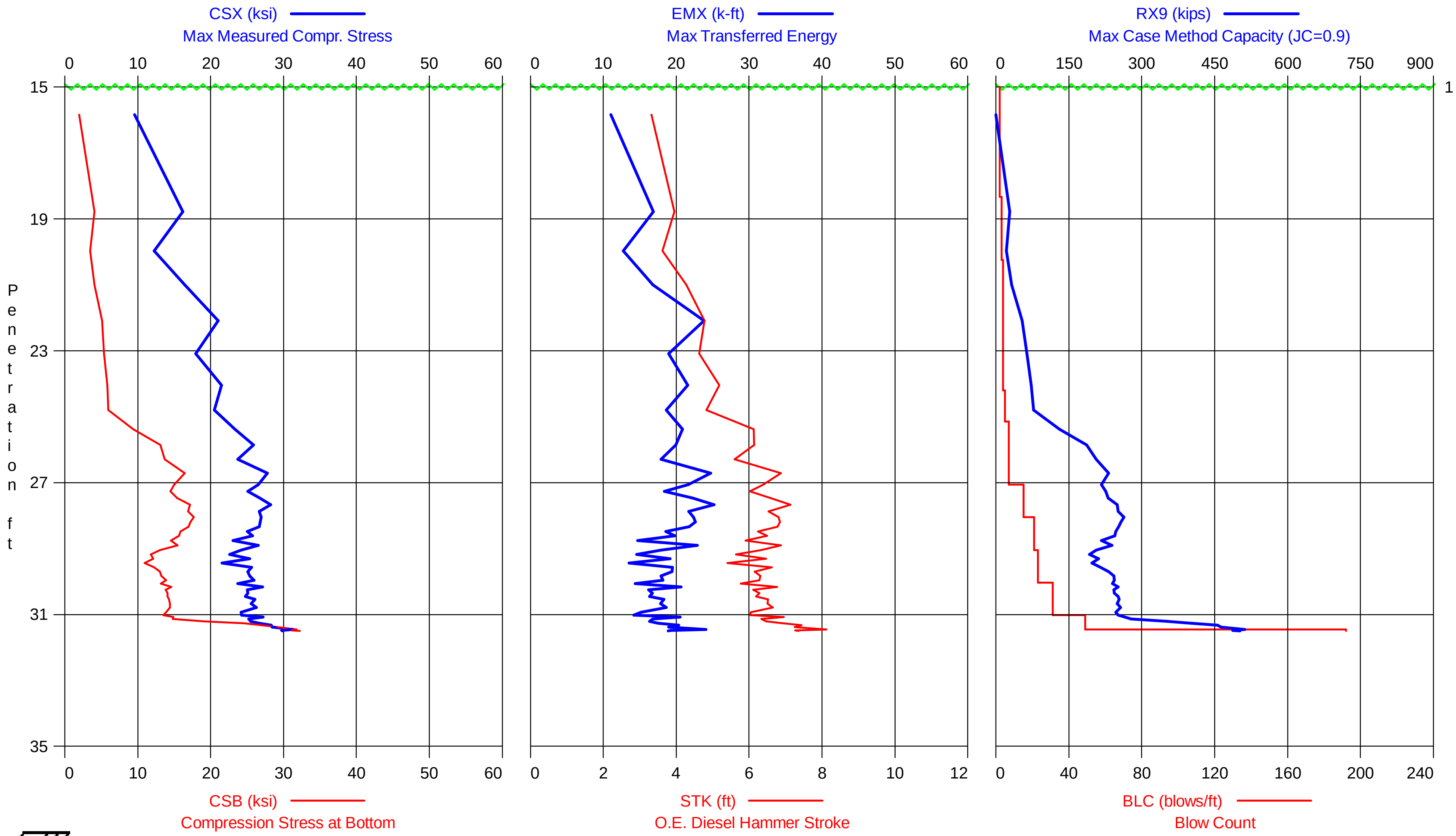
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 11-Dec-2014

Test date: 9-Dec-2014

STH 96 over Fox River (B-5-381) - Pier 3 #1 - EOID

APE D25-42, HP 12 x 53



1 - Reference Elevation EL 573.5

STH 96 over Fox River (B-5-381) - Pier 3 #1 - EOID APE D25-42, HP 12 x 53
OP: AZ Test date: 9-Dec-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.50 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# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
2	15.00	2	AV1	0.3	0.0	2.6	0	70	0
			MAX	0.3	0.0	2.6	0	70	0
			MIN	0.3	0.0	2.6	0	70	0
4	16.00	2	AV1	22.1	3.9	5.0	26	53	0
			MAX	22.1	3.9	5.0	26	53	0
			MIN	22.1	3.9	5.0	26	53	0
6	17.00	2	AV1	6.2	1.9	2.4	7	74	0
			MAX	6.2	1.9	2.4	7	74	0
			MIN	6.2	1.9	2.4	7	74	0
11	19.00	3	AV2	15.3	3.7	3.8	15	60	29
			STD	4.1	0.5	0.5	6	4	5
			MAX	19.4	4.2	4.3	21	64	34
			MIN	11.3	3.2	3.3	8	56	23
14	20.00	3	AV3	16.6	4.4	4.1	19	57	25
			STD	1.0	0.3	0.1	2	1	10
			MAX	17.8	4.7	4.3	21	59	37
			MIN	15.5	4.1	3.9	17	56	12
18	21.00	4	AV3	15.9	4.0	4.2	17	58	29
			STD	8.1	1.3	1.1	11	8	18
			MAX	23.2	5.0	5.4	28	68	54
			MIN	4.7	2.1	2.8	2	50	17
22	22.00	4	AV3	15.9	4.1	4.1	15	58	39
			STD	6.9	1.2	0.9	10	6	14
			MAX	22.0	5.0	5.0	27	67	57
			MIN	6.2	2.4	2.9	3	52	24
26	23.00	4	AV3	16.8	4.9	4.3	16	57	64
			STD	6.5	1.0	0.9	10	6	13
			MAX	21.7	5.7	4.9	28	66	75
			MIN	7.6	3.5	3.0	2	53	46
30	24.00	4	AV3	21.8	6.0	5.2	24	52	69
			STD	3.4	0.7	0.8	10	4	5
			MAX	25.3	6.9	6.0	35	57	76
			MIN	17.1	5.3	4.1	12	48	63
35	25.00	5	AV4	21.5	6.0	5.1	21	52	77
			STD	3.5	0.6	0.8	7	4	9
			MAX	24.5	6.8	6.0	28	58	90
			MIN	15.9	5.1	4.0	10	48	63
42	26.00	7	AV6	24.6	11.2	6.1	20	49	158
			STD	6.3	3.0	1.4	9	7	46
			MAX	29.9	14.1	7.8	32	63	198
			MIN	11.0	4.9	3.4	4	42	62
49	27.00	7	AV7	25.9	15.2	6.3	22	47	219
			STD	2.6	1.4	0.8	5	3	13
			MAX	29.5	16.6	7.5	27	52	235
			MIN	22.0	12.9	5.0	13	43	195
64	28.00	15	AV15	26.7	16.0	6.6	22	46	238
			STD	1.3	1.3	0.5	3	2	17
			MAX	29.0	18.3	7.7	27	48	271
			MIN	24.3	14.3	5.9	17	43	214
85	29.00	21	AV21	25.6	16.0	6.5	20	46	243
			STD	1.8	1.2	0.5	3	2	16
			MAX	27.9	17.4	7.3	26	50	270
			MIN	21.8	13.8	5.5	13	44	214
108	30.00	23	AV23	24.5	12.4	6.2	18	48	218
			STD	1.9	0.9	0.6	3	2	20
			MAX	28.5	14.3	7.6	25	52	250
			MIN	20.4	10.7	5.1	11	43	182

STH 96 over Fox River (B-5-381) - Pier 3 #1 - EOID APE D25-42, HP 12 x 53
OP: AZ Test date: 9-Dec-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
139	31.00	31	AV28	25.2	14.1	6.3	17	47	248
			STD	1.4	0.6	0.4	2	1	8
			MAX	27.9	15.3	7.2	22	50	262
			MIN	22.1	13.0	5.5	13	44	233
161	31.45	49	AV20	26.7	20.8	6.8	18	45	358
			STD	1.6	6.0	0.6	2	2	84
			MAX	29.4	29.9	7.9	23	48	478
			MIN	24.1	13.3	6.0	14	42	251
171	31.50	192	AV9	30.3	31.7	7.6	21	43	501
			STD	1.4	1.5	0.7	4	2	27
			MAX	32.5	33.9	9.2	29	45	543
			MIN	28.5	29.4	6.9	16	39	469
			Average	24.5	14.6	6.2	19	48	234
			Std. Dev.	4.9	6.8	1.1	5	5	116
			Maximum	32.5	33.9	9.2	35	74	543
			Minimum	0.3	0.0	2.4	0	39	0

Total number of blows analyzed: 153

BL#	depth (ft)	Comments
2	15.00	Reference Elevation EL 573.5

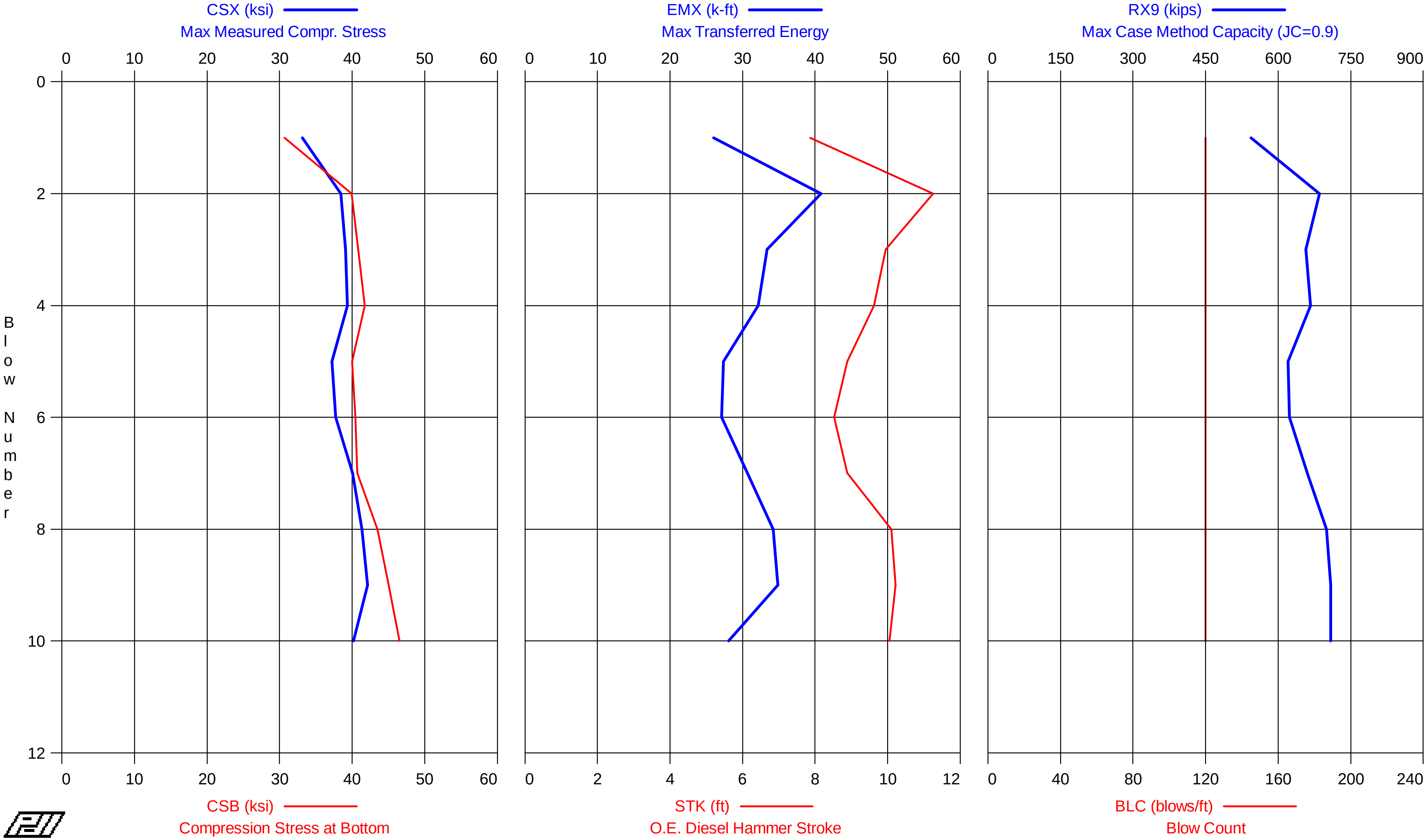
Time Summary

Drive 6 minutes 42 seconds 3:49:26 PM - 3:56:08 PM (12/9/2014) BN 1 - 171

Test date: 10-Dec-2014

STH 96 over Fox River (B-5-381) - Pier 3 #1 - BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-381) - Pier 3 #1 - BOR APE D25-42, HP 12 x 53
OP: AZ Test date: 10-Dec-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.50 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
10	31.58	120	AV10	38.9	40.9	9.5	31	39	657
			STD	2.4	4.0	0.9	4	2	48
			MAX	42.1	46.5	11.3	41	42	709
			MIN	33.1	30.7	7.9	26	35	544
			Average	38.9	40.9	9.5	31	39	657
			Std. Dev.	2.4	4.0	0.9	4	2	48
			Maximum	42.1	46.5	11.3	41	42	709
			Minimum	33.1	30.7	7.9	26	35	544

Total number of blows analyzed: 10

Time Summary

Drive 14 seconds 9:37:14 AM - 9:37:28 AM (12/10/2014) BN 1 - 10

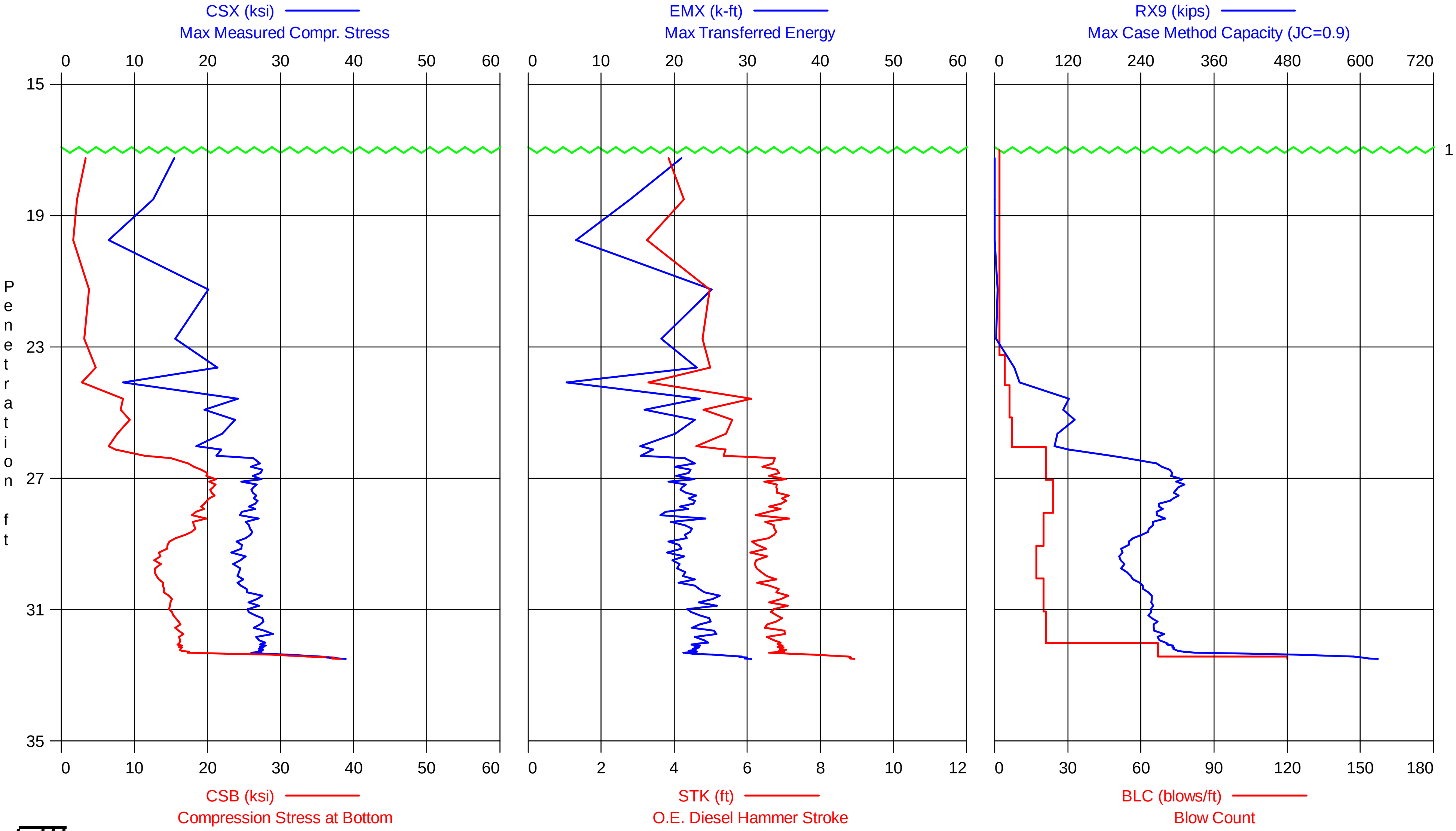
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 11-Dec-2014

Test date: 9-Dec-2014

STH 96 over Fox River (B-5-381) - Pier 3 #38 - EOID

APE D25-42, HP 12 x 53



1 - Reference Elevation EL 573.5

STH 96 over Fox River (B-5-381) - Pier 3 #38 - EOID
OP: AZ

APE D25-42, HP 12 x 53
Test date: 9-Dec-2014

AR: 15.50 in^2
LE: 72.50 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

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

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
3	16.00	2	AV1	16.2	3.2	24	4.1	57.4	0
			MAX	16.2	3.2	24	4.1	57.4	0
			MIN	16.2	3.2	24	4.1	57.4	0
3	17.00	2	AV1	14.7	3.6	18	3.6	61.0	0
			MAX	14.7	3.6	18	3.6	61.0	0
			MIN	14.7	3.6	18	3.6	61.0	0
5	18.00	2	AV1	0.9	0.2	0	2.7	69.0	0
			MAX	0.9	0.2	0	2.7	69.0	0
			MIN	0.9	0.2	0	2.7	69.0	0
7	19.00	2	AV1	24.2	4.1	28	5.8	48.8	0
			MAX	24.2	4.1	28	5.8	48.8	0
			MIN	24.2	4.1	28	5.8	48.8	0
9	20.00	2	AV2	6.5	1.6	7	3.3	63.8	0
			STD	6.5	1.6	6	0.2	1.7	0
			MAX	12.9	3.3	13	3.5	65.6	0
			MIN	0.0	0.0	0	3.1	62.1	0
11	21.00	2	AV1	23.5	4.3	34	5.8	48.6	0
			MAX	23.5	4.3	34	5.8	48.6	0
			MIN	23.5	4.3	34	5.8	48.6	0
13	22.00	2	AV1	16.7	3.3	17	4.1	57.2	9
			MAX	16.7	3.3	17	4.1	57.2	9
			MIN	16.7	3.3	17	4.1	57.2	9
15	23.00	2	AV2	15.6	3.1	18	4.8	54.3	2
			STD	8.6	1.2	14	1.1	5.8	2
			MAX	24.2	4.3	32	5.8	60.1	4
			MIN	7.0	2.0	4	3.7	48.6	0
19	24.00	4	AV3	18.6	4.5	19	4.5	56.1	42
			STD	5.3	0.6	7	1.1	6.1	15
			MAX	25.8	5.4	27	6.1	61.9	62
			MIN	13.1	4.0	10	3.5	47.7	29
25	25.00	6	AV5	18.3	7.0	16	5.0	53.5	98
			STD	7.8	2.7	9	1.2	6.8	39
			MAX	25.8	9.1	28	6.5	65.1	126
			MIN	3.7	1.6	1	3.1	46.2	19
32	26.00	7	AV5	22.1	8.1	21	5.3	50.9	112
			STD	2.2	1.1	3	0.5	2.2	16
			MAX	24.7	9.4	25	6.0	54.3	136
			MIN	18.8	6.6	17	4.6	48.0	94
53	27.00	21	AV17	25.1	15.8	20	6.3	47.3	239
			STD	3.3	4.9	4	0.8	3.4	67
			MAX	29.8	21.3	26	7.6	55.0	303
			MIN	17.5	6.3	10	4.5	42.7	103
77	28.00	24	AV24	26.2	20.2	21	6.8	45.1	291
			STD	1.0	0.8	2	0.3	0.8	15
			MAX	27.7	22.0	25	7.5	46.7	314
			MIN	23.6	18.5	18	6.3	43.1	263
97	29.00	20	AV20	25.4	17.4	21	6.6	45.9	250
			STD	1.2	1.6	2	0.4	1.3	19
			MAX	27.2	20.0	25	7.2	48.4	280
			MIN	22.8	14.3	16	5.9	44.0	216
114	30.00	17	AV17	24.4	13.4	21	6.4	46.6	212
			STD	0.9	0.7	1	0.2	0.8	8
			MAX	26.6	14.7	23	6.8	48.0	230
			MIN	22.5	12.4	18	6.0	45.2	201

STH 96 over Fox River (B-5-381) - Pier 3 #38 - EOID
OP: AZ

APE D25-42, HP 12 x 53
Test date: 9-Dec-2014

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
134	31.00	20	AV20	25.7	14.4	24	6.8	45.3	249
			STD	1.3	0.6	2	0.3	1.0	11
			MAX	28.1	15.3	27	7.3	47.4	266
			MIN	23.6	13.0	20	6.1	43.7	226
155	32.00	21	AV21	27.2	15.9	24	6.8	45.3	264
			STD	1.1	0.5	1	0.3	0.8	8
			MAX	29.6	16.8	27	7.1	47.0	283
			MIN	25.0	14.9	21	6.3	44.1	249
183	32.42	67	AV25	27.6	17.9	23	7.0	44.6	322
			STD	1.3	3.7	1	0.3	1.0	63
			MAX	31.6	29.9	26	7.9	46.4	505
			MIN	25.5	15.4	20	6.4	42.1	276
192	32.49	120	AV9	36.8	36.3	30	8.8	39.9	604
			STD	1.3	2.0	1	0.3	0.7	16
			MAX	38.9	39.4	33	9.4	41.0	629
			MIN	34.4	32.1	27	8.3	38.7	575
			Average	25.5	16.1	22	6.5	46.6	255
			Std. Dev.	5.1	6.8	5	1.0	4.6	119
			Maximum	38.9	39.4	34	9.4	69.0	629
			Minimum	0.0	0.0	0	2.7	38.7	0

Total number of blows analyzed: 176

BL#	depth (ft)	Comments
3	17.00	Reference Elevation EL 573.5

Time Summary

Drive 6 minutes 38 seconds 4:10:38 PM - 4:17:16 PM (12/9/2014) BN 1 - 193

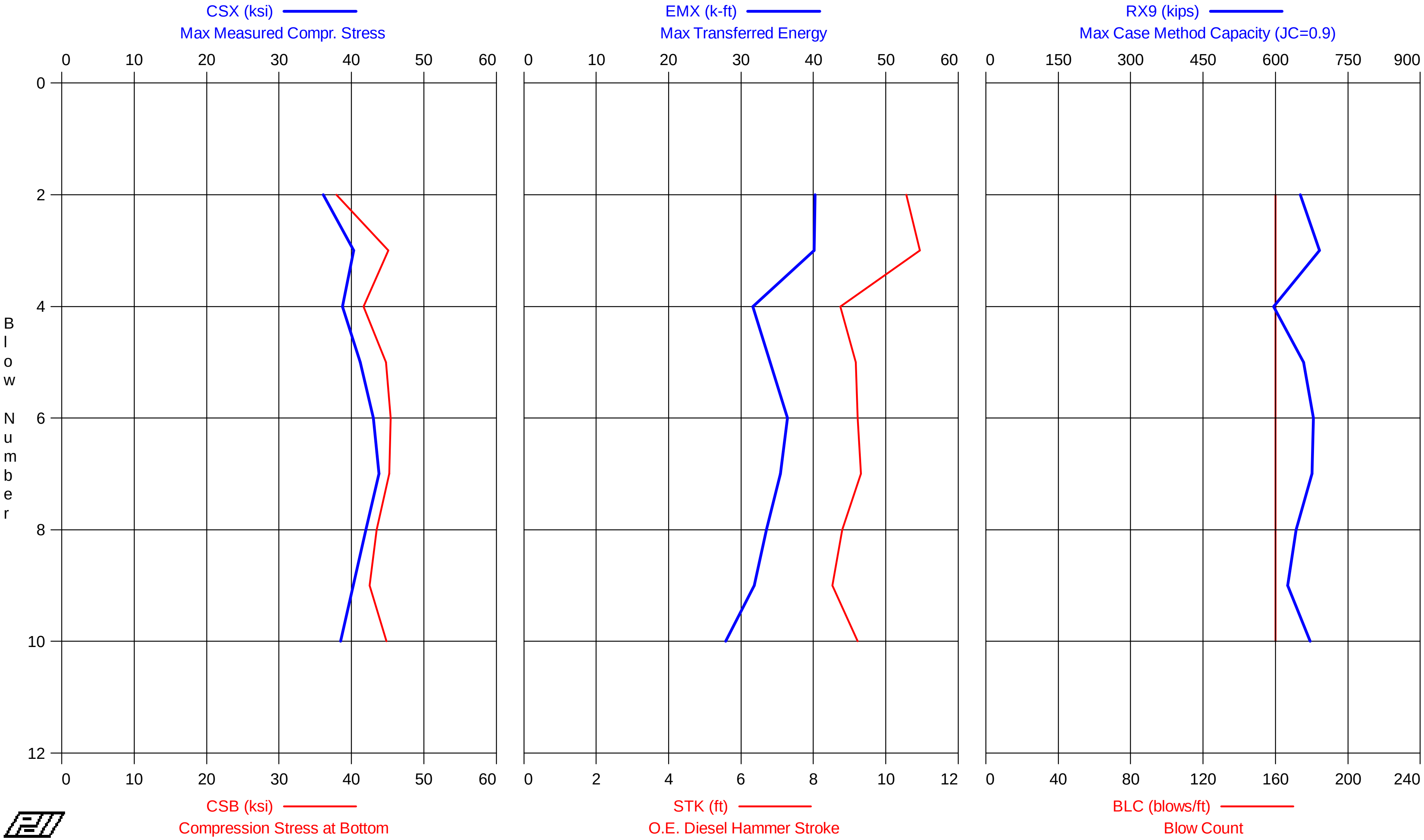
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 11-Dec-2014

Test date: 10-Dec-2014

STH 96 over Fox River (B-5-381) - Pier 3 #38 - BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-381) - Pier 3 #38 - BOR
OP: AZ

APE D25-42, HP 12 x 53
Test date: 10-Dec-2014

AR: 15.50 in^2
LE: 72.50 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke

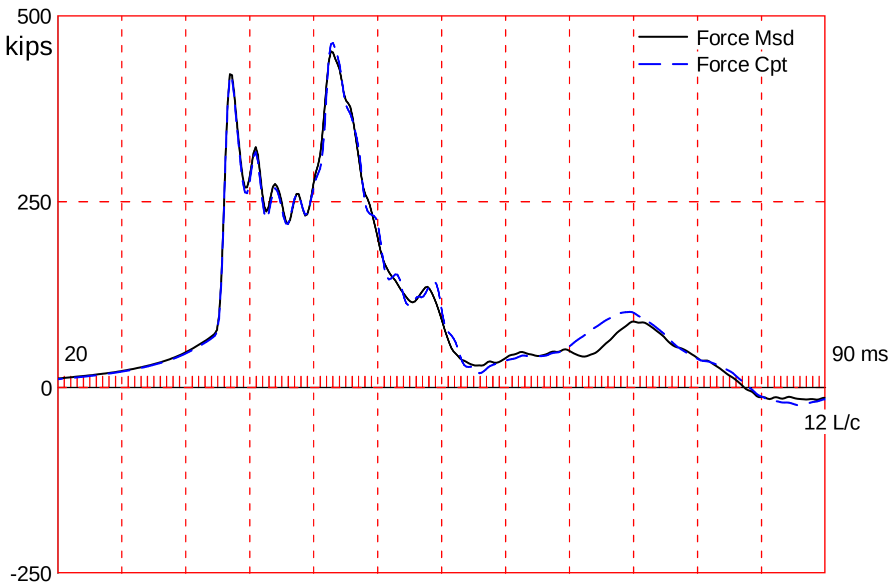
EMX: Max Transferred Energy
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

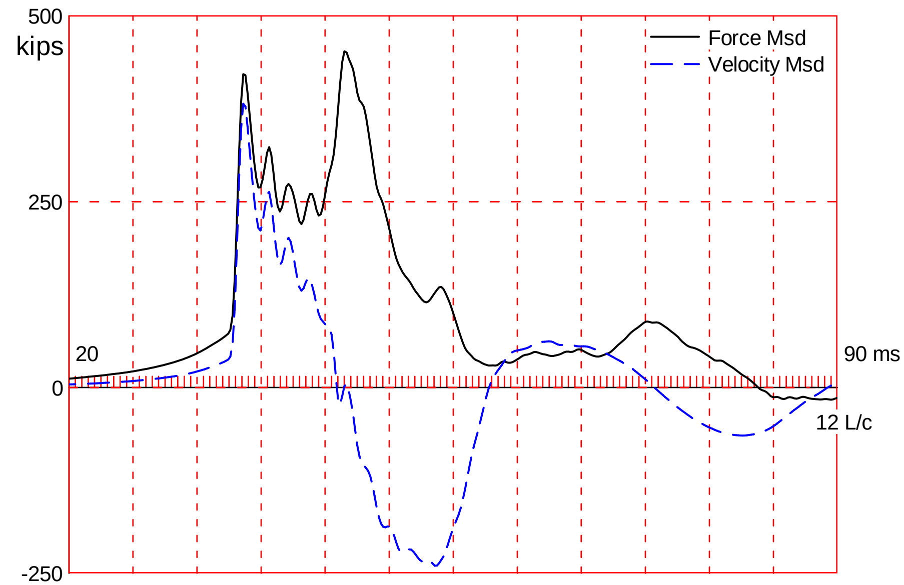
BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
10	32.56	160	AV9	40.4	43.4	9.4	35	39	655
			STD	2.3	2.3	0.8	4	1	28
			MAX	43.8	45.4	10.9	40	41	691
			MIN	36.1	37.9	8.5	28	36	597
			Average	40.4	43.4	9.4	35	39	655
			Std. Dev.	2.3	2.3	0.8	4	1	28
			Maximum	43.8	45.4	10.9	40	41	691
			Minimum	36.1	37.9	8.5	28	36	597

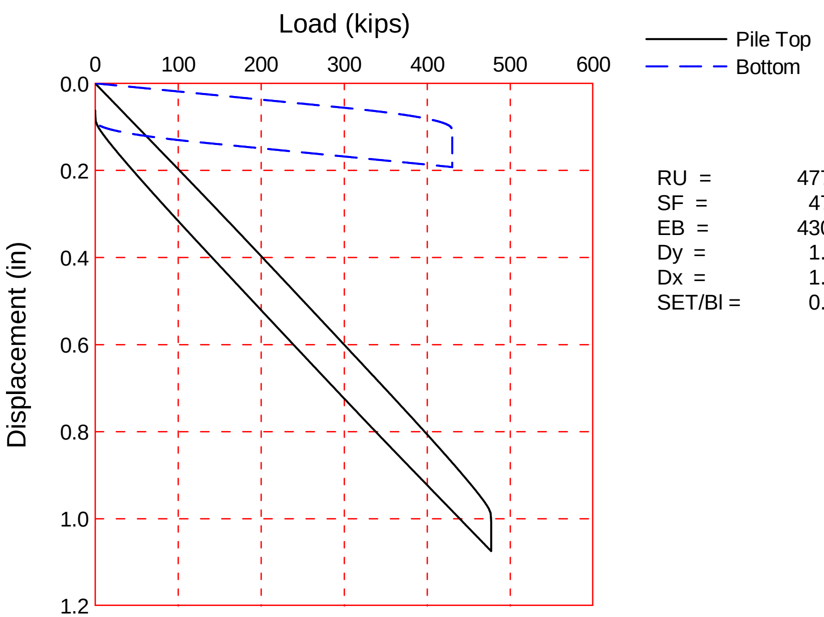
Total number of blows analyzed: 9

Time Summary

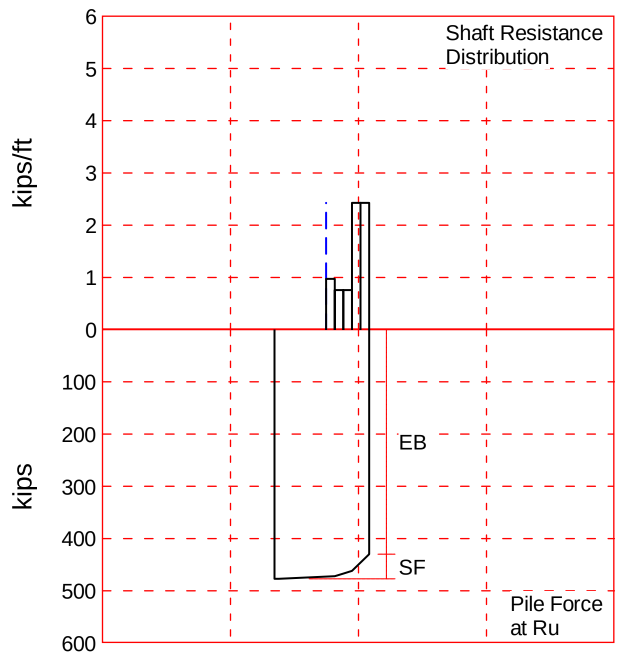
Drive 14 seconds 9:47:57 AM - 9:48:11 AM (12/10/2014) BN 1 - 10







RU =	477.0 kips
SF =	47.0 kips
EB =	430.0 kips
Dy =	1.01 in
Dx =	1.07 in
SET/Bl =	0.06 in



Length b. Sensors	72.5 ft
Embedment	31.5 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	3.27
Top Compr. Stress	30.0 ksi
Max Compr. Stress	34.7 ksi
Max Tension Stress	-3.88 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.08 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.05 s/ft

About the CAPWAP Results

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

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

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

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

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

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

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

The CAPWAP analysis software is one of many means by which the capacity of a deep foundation can be assessed. The engineer performing the analysis is responsible for proper software application and the analysis results. Pile Dynamics accepts

no liability whatsoever of any kind for the analysis solution and/or the application of the analysis result.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 477.0; along Shaft 47.0; at Toe 430.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				477.0			
1	46.1	5.1	5.0	472.0	5.0	0.97	0.25
2	52.7	11.7	5.0	467.0	10.0	0.76	0.19
3	59.3	18.3	5.0	462.0	15.0	0.76	0.19
4	65.9	24.9	16.0	446.0	31.0	2.43	0.61
5	72.5	31.5	16.0	430.0	47.0	2.43	0.61
Avg. Shaft			9.4			1.49	0.38
Toe			430.0				436.39

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.29	0.05
Quake	(in)	0.10	0.08
Case Damping Factor		0.49	0.78
Damping Type		Viscous	Viscous
Unloading Quake	(% of loading quake)	100	34
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	59	
Resistance Gap (included in Toe Quake) (in)			0.00

CAPWAP match quality = 3.27 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.06 in; Blow Count = 192 b/ft
Computed: Final Set = 0.03 in; Blow Count = 468 b/ft
Transducer F3(H083) CAL: 94.4; RF: 0.98; F4(F523) CAL: 93.8; RF: 0.98
A3(K974) CAL: 305; RF: 1.02; A4(K2214) CAL: 332; RF: 1.02

max. Top Comp. Stress = 30.0 ksi (T= 45.5 ms, max= 1.155 x Top)
max. Comp. Stress = 34.7 ksi (Z= 72.5 ft, T= 40.6 ms)
max. Tens. Stress = -3.88 ksi (Z= 46.1 ft, T= 56.1 ms)
max. Energy (EMX) = 18.8 kip-ft; max. Measured Top Displ. (DMX)= 0.86 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	465.5	-24.8	30.0	-1.60	18.8	13.9	0.87
2	6.6	466.7	-26.6	30.1	-1.72	18.3	13.8	0.84
3	9.9	462.5	-29.5	29.8	-1.91	17.8	13.8	0.81
4	13.2	459.5	-31.8	29.6	-2.05	17.4	13.7	0.78
5	16.5	458.8	-33.6	29.6	-2.17	17.0	13.7	0.75
6	19.8	460.2	-39.5	29.7	-2.55	16.5	13.6	0.72
7	23.1	451.7	-47.7	29.1	-3.08	15.9	13.5	0.68
8	26.4	437.8	-50.7	28.2	-3.27	15.4	13.5	0.65
9	29.7	439.5	-51.6	28.3	-3.33	14.9	13.4	0.62
10	33.0	442.9	-52.8	28.6	-3.40	14.4	13.3	0.59
11	36.3	442.0	-53.8	28.5	-3.47	13.8	13.2	0.55
12	39.5	466.2	-54.5	30.1	-3.52	13.1	13.1	0.51
13	42.8	472.3	-57.2	30.5	-3.69	12.3	12.8	0.47
14	46.1	473.9	-60.2	30.6	-3.88	11.7	12.6	0.44
15	49.4	471.7	-55.7	30.4	-3.59	10.5	12.3	0.40
16	52.7	484.6	-56.9	31.3	-3.67	9.7	12.0	0.36
17	56.0	508.2	-52.6	32.8	-3.40	8.5	11.8	0.32
18	59.3	511.3	-53.7	33.0	-3.46	7.8	11.4	0.28
19	62.6	506.9	-49.1	32.7	-3.17	6.7	10.9	0.24
20	65.9	509.3	-50.2	32.8	-3.24	5.9	10.3	0.20
21	69.2	490.1	-38.8	31.6	-2.50	4.8	9.4	0.17
22	72.5	537.8	-39.4	34.7	-2.54	4.4	7.1	0.14
Absolute	72.5			34.7			(T =	40.6 ms)
	46.1				-3.88		(T =	56.1 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	574.4	530.7	487.1	443.4	399.7					
RX	616.0	579.4	543.9	511.0	495.7	485.0	474.3	470.4	469.5	468.7
RU	601.3	558.6	515.9	473.3	430.6					

RAU = 440.0 (kips); RA2 = 487.0 (kips)

Current CAPWAP Ru = 477.0 (kips); Corresponding J(RP)= 0.45; J(RX) = 1.15

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
14.0	35.88	376.9	415.8	454.3	0.86	0.06	0.06	19.0	493.5	5383

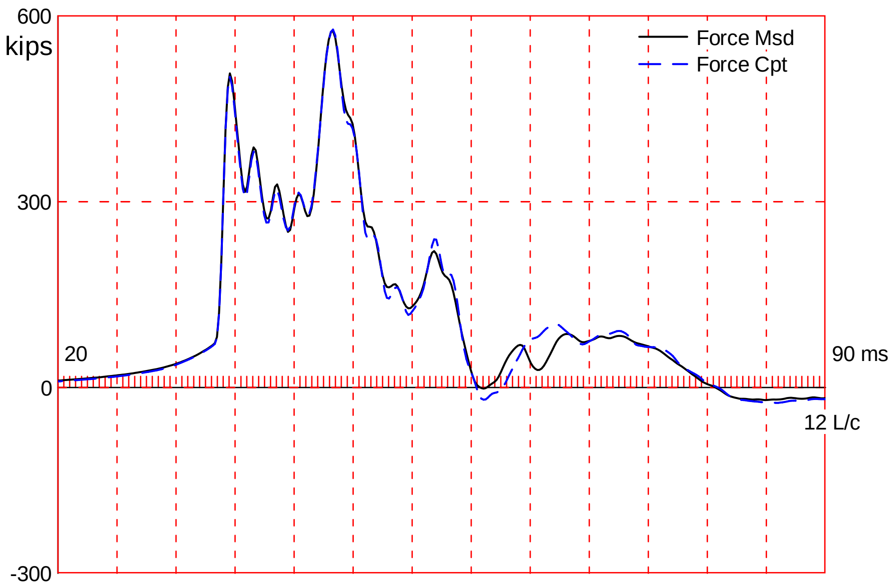
PILE PROFILE AND PILE MODEL

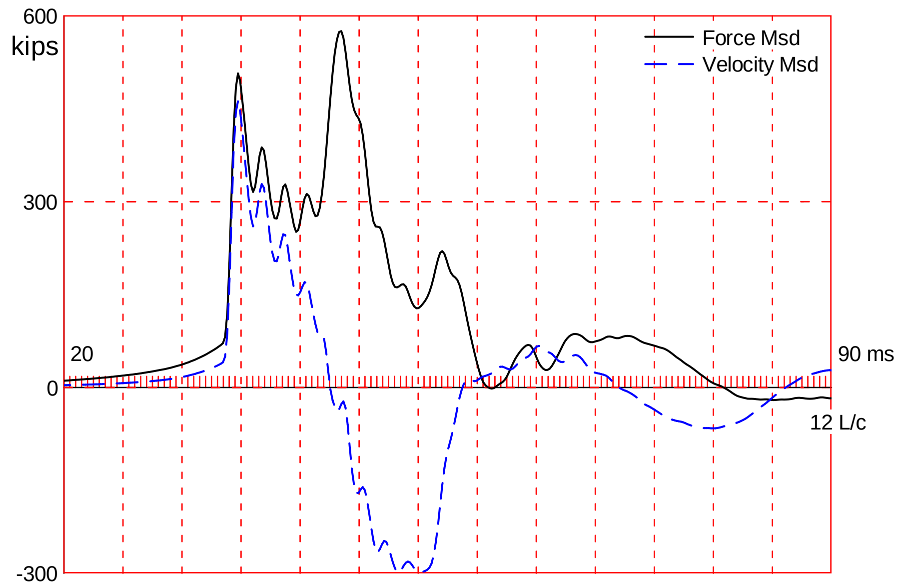
Depth	Area	E-Modulus	Spec. Weight	Perim.
ft	in²	ksi	lb/ft³	ft
0.0	15.5	29992.2	492.000	3.97
72.5	15.5	29992.2	492.000	3.97

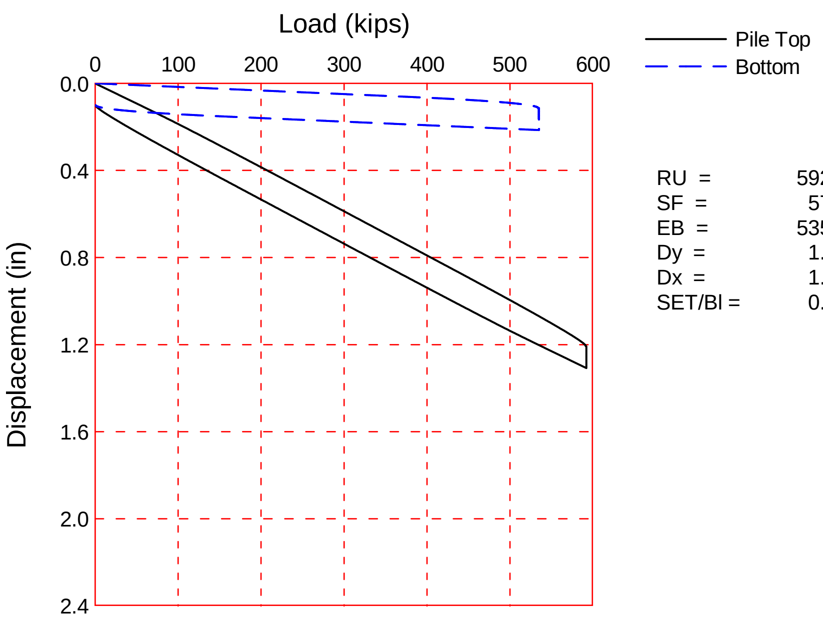
Toe Area 141.9 in²

Top Segment Length 3.30 ft, Top Impedance 28 kips/ft/s

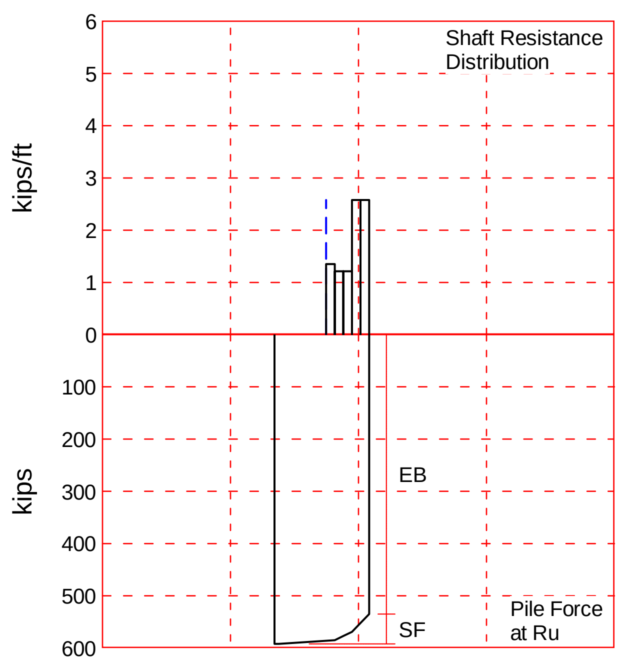
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.804 ft³; Volume ratio considering added impedance: 1.000







RU =	592.0 kips
SF =	57.0 kips
EB =	535.0 kips
Dy =	1.21 in
Dx =	1.31 in
SET/Bl =	0.10 in



Length b. Sensors	72.5 ft
Embedment	31.5 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	2.80
Top Compr. Stress	36.5 ksi
Max Compr. Stress	41.9 ksi
Max Tension Stress	-6.65 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.09 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.10 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.

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The CAPWAP analysis software is one of many means by which the capacity of a deep foundation can be assessed. The engineer performing the analysis is responsible for proper software application and the analysis results. Pile Dynamics accepts

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 592.0; along Shaft 57.0; at Toe 535.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				592.0			
1	46.1	5.2	7.0	585.0	7.0	1.35	0.34
2	52.7	11.8	8.0	577.0	15.0	1.21	0.31
3	59.3	18.4	8.0	569.0	23.0	1.21	0.31
4	65.9	25.0	17.0	552.0	40.0	2.58	0.65
5	72.5	31.5	17.0	535.0	57.0	2.58	0.65
Avg. Shaft			11.4			1.81	0.46
Toe			535.0				542.96

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.29	0.10
Quake	(in)	0.05	0.09
Case Damping Factor		0.60	1.93
Damping Type		Viscous	Viscous
Unloading Quake	(% of loading quake)	82	30
Unloading Level	(% of Ru)	73	
Resistance Gap (included in Toe Quake) (in)			0.01

CAPWAP match quality = 2.80 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.06 in; Blow Count = 207 b/ft
Transducer F3(F523) CAL: 93.8; RF: 1.00; F4(H083) CAL: 94.4; RF: 1.00
A3(K2214) CAL: 332; RF: 1.03; A4(K974) CAL: 305; RF: 1.03

max. Top Comp. Stress = 36.5 ksi (T= 45.3 ms, max= 1.147 x Top)
max. Comp. Stress = 41.9 ksi (Z= 72.5 ft, T= 40.4 ms)
max. Tens. Stress = -6.65 ksi (Z= 52.7 ft, T= 55.9 ms)
max. Energy (EMX) = 26.6 kip-ft; max. Measured Top Displ. (DMX)= 1.02 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	566.4	-27.3	36.5	-1.76	26.6	16.9	1.01
2	6.6	558.5	-30.3	36.0	-1.95	26.1	16.8	0.98
3	9.9	562.2	-33.2	36.3	-2.14	25.6	16.8	0.94
4	13.2	566.9	-35.7	36.6	-2.31	25.0	16.8	0.91
5	16.5	556.6	-38.5	35.9	-2.48	24.3	16.7	0.87
6	19.8	541.8	-41.1	34.9	-2.65	23.5	16.6	0.83
7	23.1	538.5	-43.7	34.7	-2.82	22.8	16.6	0.79
8	26.4	543.7	-46.1	35.1	-2.98	22.2	16.5	0.76
9	29.7	533.7	-48.6	34.4	-3.13	21.5	16.4	0.72
10	33.0	524.1	-50.3	33.8	-3.24	20.6	16.4	0.68
11	36.3	560.3	-62.4	36.1	-4.02	19.6	16.3	0.63
12	39.5	585.7	-70.3	37.8	-4.54	18.4	16.0	0.58
13	42.8	590.1	-86.6	38.1	-5.58	17.5	15.7	0.54
14	46.1	580.1	-100.4	37.4	-6.48	16.6	15.3	0.50
15	49.4	567.9	-98.7	36.6	-6.36	14.6	14.9	0.45
16	52.7	609.7	-103.1	39.3	-6.65	13.4	14.5	0.40
17	56.0	629.9	-96.5	40.6	-6.22	11.1	14.1	0.35
18	59.3	638.4	-97.9	41.2	-6.31	9.9	13.6	0.30
19	62.6	618.2	-90.6	39.9	-5.84	8.1	12.8	0.25
20	65.9	610.9	-94.5	39.4	-6.10	7.0	11.3	0.20
21	69.2	607.2	-79.3	39.2	-5.12	5.3	9.0	0.16
22	72.5	649.8	-80.6	41.9	-5.20	4.8	5.7	0.12
Absolute	72.5			41.9			(T =	40.4 ms)
	52.7				-6.65		(T =	55.9 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	752.7	707.6	662.6	617.5	572.5					
RX	757.2	718.0	683.4	654.7	631.2	611.2	600.0	589.2	582.9	579.8
RU	755.2	710.7	666.1	621.6	577.0					

RAU = 571.8 (kips); RA2 = 638.0 (kips)

Current CAPWAP Ru = 592.0 (kips); Corresponding J(RP)= 0.71; J(RX) = 1.35

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
16.9	35.88	466.4	511.6	577.1	1.02	0.09	0.10	27.4	587.5	6688

PILE PROFILE AND PILE MODEL

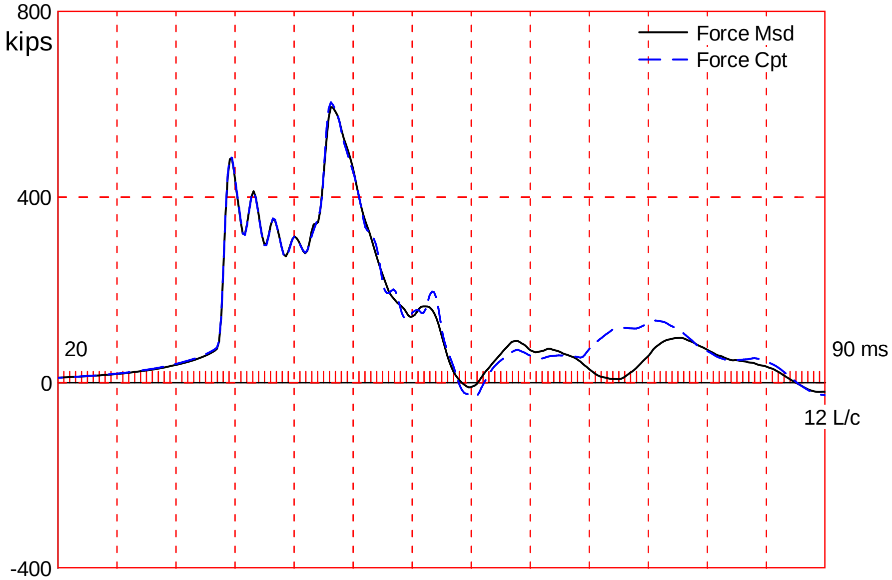
Depth	Area	E-Modulus	Spec. Weight	Perim.
ft	in^2	ksi	lb/ft^3	ft
0.0	15.5	29992.2	492.000	3.97
72.5	15.5	29992.2	492.000	3.97

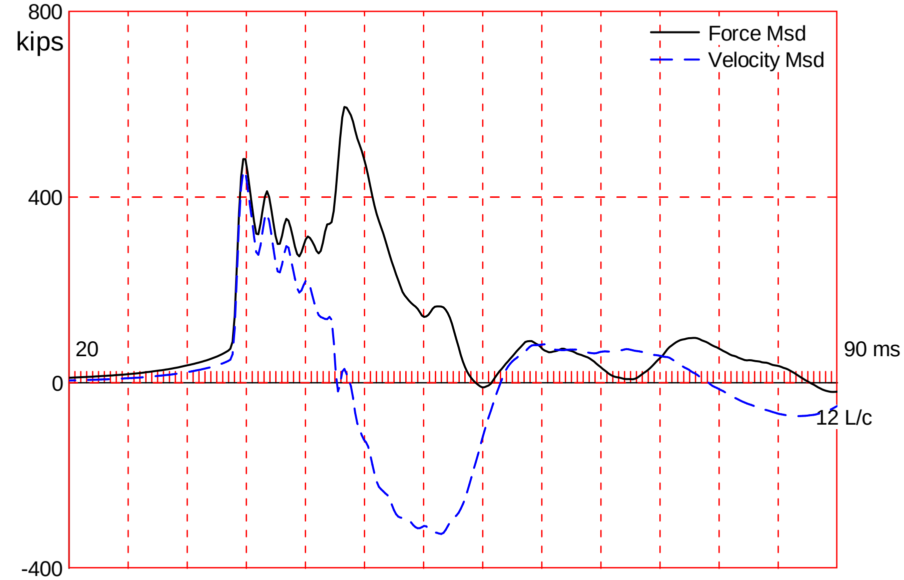
Toe Area 141.9 in^2

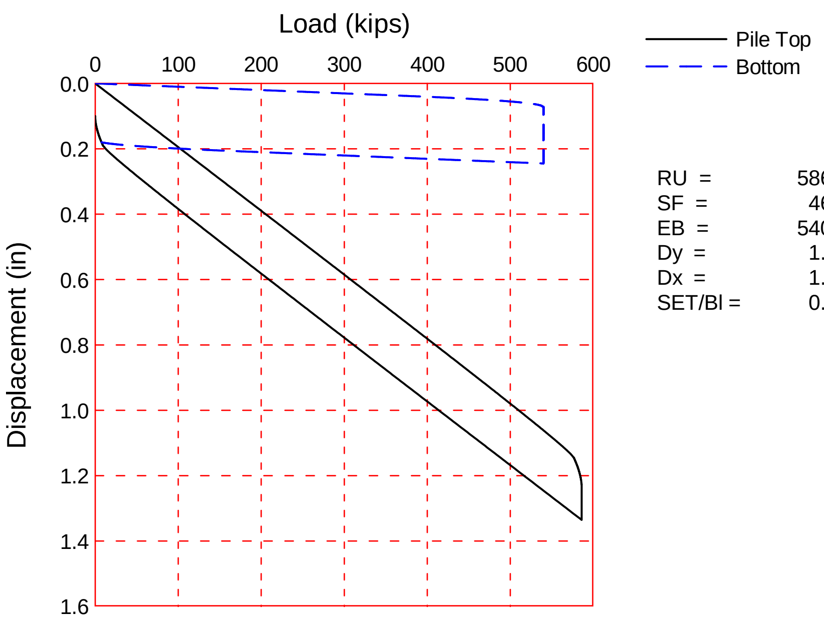
Top Segment Length 3.30 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.804 ft^3; Volume ratio considering added impedance: 1.000

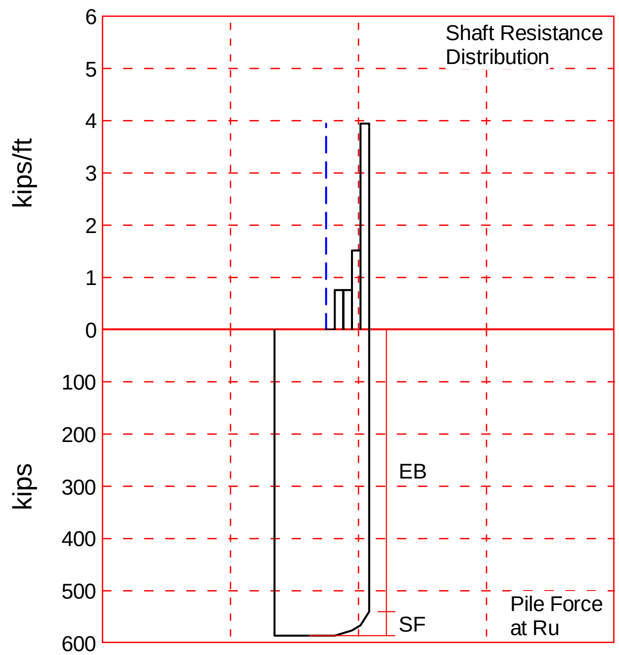
Match Quality Poor - Results May Be Unreliable!!!







RU =	586.0 kips
SF =	46.0 kips
EB =	540.0 kips
Dy =	1.24 in
Dx =	1.34 in
SET/Bl =	0.10 in



Length b. Sensors	72.5 ft
Embedment	32.5 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	5.68
Top Compr. Stress	39.0 ksi
Max Compr. Stress	45.2 ksi
Max Tension Stress	-7.94 ksi
Avg. Shaft Quake	0.13 in
Toe Quake	0.06 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.04 s/ft

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Match Quality Poor - Results May Be Unreliable!!!

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 586.0; along Shaft 46.0; at Toe 540.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft	Quake in
				586.0					
1	46.1	6.1	0.0	586.0	0.0	0.00	0.00	0.00	0.15
2	52.7	12.7	5.0	581.0	5.0	0.76	0.19	0.29	0.15
3	59.3	19.3	5.0	576.0	10.0	0.76	0.19	0.29	0.15
4	65.9	25.9	10.0	566.0	20.0	1.52	0.38	0.29	0.15
5	72.5	32.5	26.0	540.0	46.0	3.94	0.99	0.29	0.11
Avg. Shaft			9.2			1.42	0.36	0.29	0.13
Toe			540.0				548.03	0.04	0.06

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		0.48	0.78
Damping Type		Viscous	Viscous
Unloading Quake	(% of loading quake)	100	52
Unloading Level	(% of Ru)	36	
Soil Plug Weight	(kips)		0.027

CAPWAP match quality = 5.68 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.10 in; Blow Count = 119 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.98; F4(H083) CAL: 94.4; RF: 0.98
A3(K2214) CAL: 332; RF: 1.02; A4(K974) CAL: 305; RF: 1.02

max. Top Comp. Stress = 39.0 ksi (T= 45.3 ms, max= 1.157 x Top)
max. Comp. Stress = 45.2 ksi (Z= 72.5 ft, T= 40.4 ms)
max. Tens. Stress = -7.94 ksi (Z= 52.7 ft, T= 59.2 ms)
max. Energy (EMX) = 29.8 kip-ft; max. Measured Top Displ. (DMX)= 1.16 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	605.2	-47.0	39.0	-3.03	29.8	16.3	1.11
2	6.6	608.7	-63.4	39.3	-4.09	29.0	16.2	1.07
3	9.9	610.5	-77.6	39.4	-5.00	28.2	16.2	1.03
4	13.2	606.6	-89.8	39.1	-5.79	27.5	16.1	0.99
5	16.5	601.2	-100.2	38.8	-6.46	26.8	16.1	0.95
6	19.8	600.6	-106.2	38.7	-6.85	26.0	16.0	0.91
7	23.1	599.2	-108.8	38.6	-7.02	25.1	16.0	0.87
8	26.4	583.6	-110.3	37.6	-7.12	24.1	15.9	0.82
9	29.7	594.7	-112.1	38.4	-7.23	23.3	15.8	0.78
10	33.0	595.4	-113.9	38.4	-7.35	22.4	15.8	0.74
11	36.3	586.6	-115.4	37.8	-7.44	21.3	15.7	0.69
12	39.5	611.5	-117.1	39.4	-7.55	20.1	15.6	0.64
13	42.8	615.4	-118.4	39.7	-7.63	18.8	15.5	0.59
14	46.1	614.7	-120.0	39.6	-7.74	17.6	15.3	0.54
15	49.4	617.7	-121.4	39.8	-7.83	16.3	15.0	0.49
16	52.7	643.7	-123.2	41.5	-7.94	15.0	14.7	0.44
17	56.0	667.8	-118.0	43.1	-7.61	13.2	14.3	0.39
18	59.3	668.7	-119.8	43.1	-7.72	12.0	14.0	0.34
19	62.6	661.8	-114.5	42.7	-7.38	10.5	13.5	0.29
20	65.9	666.5	-115.0	43.0	-7.42	9.7	12.8	0.25
21	69.2	651.8	-102.3	42.0	-6.60	8.2	10.9	0.21
22	72.5	700.2	-102.1	45.2	-6.58	7.7	7.4	0.16
Absolute	72.5			45.2			(T =	40.4 ms)
	52.7				-7.94		(T =	59.2 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	734.8	691.4	647.9	604.5	561.0					
RX	734.8	692.9	665.1	648.1	631.1	614.7	607.1	601.9	599.1	597.5
RU	736.1	692.9	649.7	606.5	563.3					

RAU = 585.9 (kips); RA2 = 612.4 (kips)

Current CAPWAP Ru = 586.0 (kips); Corresponding J(RP)= 0.69; matches RX20 within 5%

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
16.7	35.88	462.1	489.9	596.9	1.16	0.10	0.10	30.8	589.0	9804

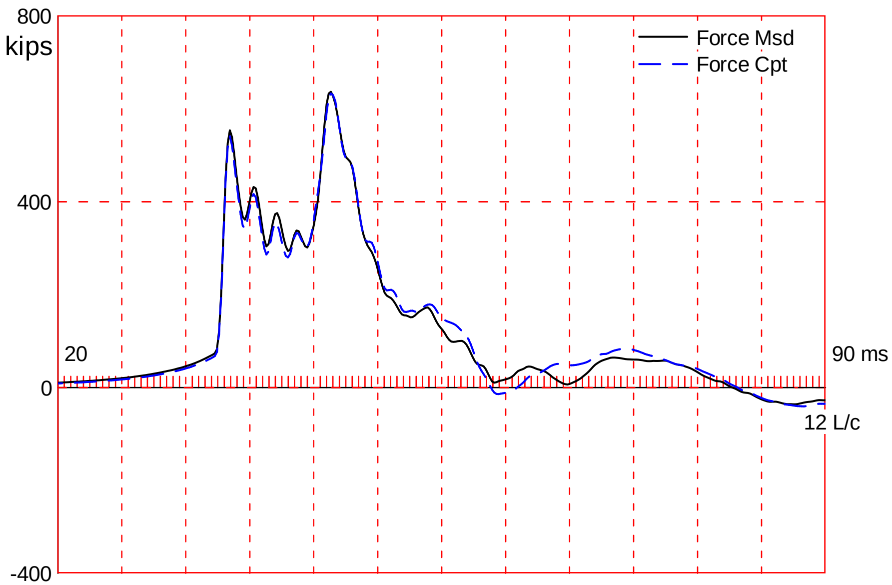
PILE PROFILE AND PILE MODEL

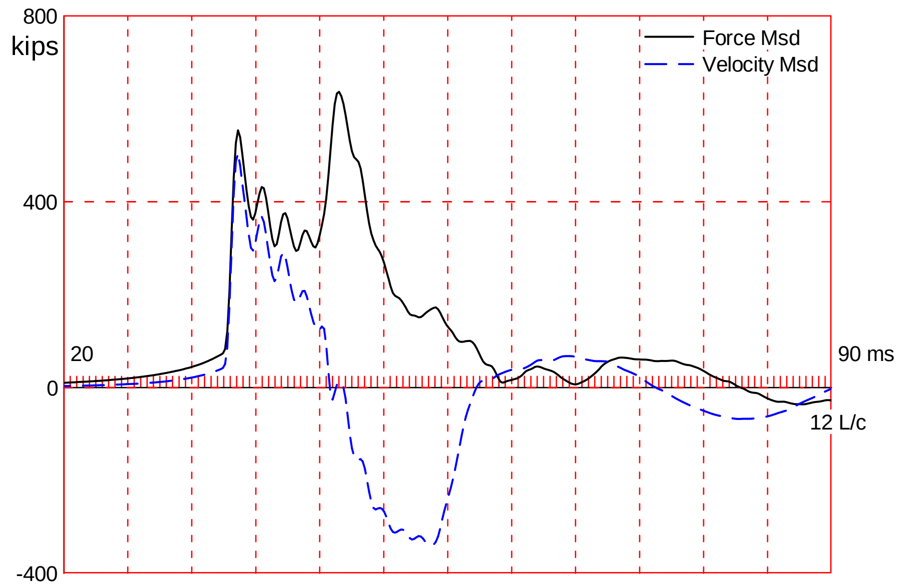
Depth	Area	E-Modulus	Spec. Weight	Perim.
ft	in^2	ksi	lb/ft^3	ft
0.0	15.5	29992.2	492.000	3.97
72.5	15.5	29992.2	492.000	3.97

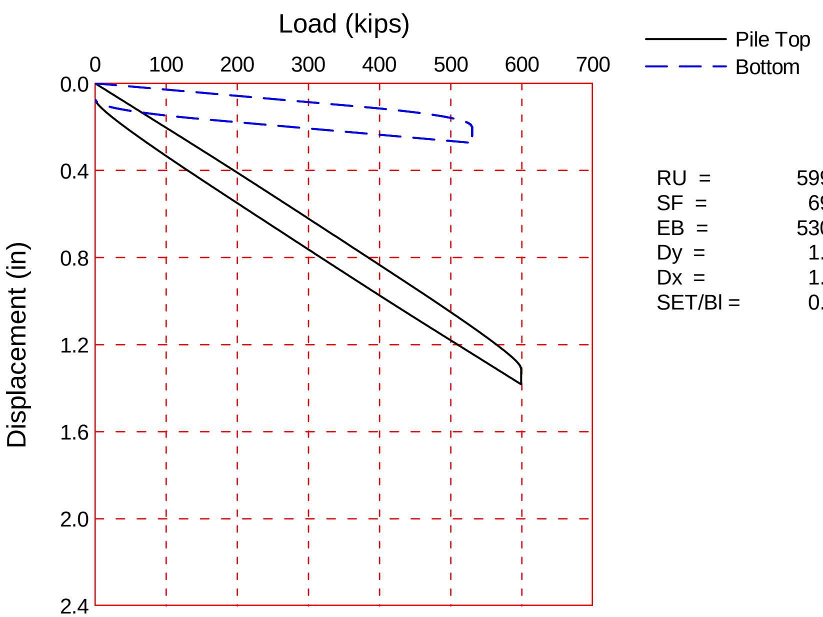
Toe Area 141.9 in^2

Top Segment Length 3.30 ft, Top Impedance 28 kips/ft/s

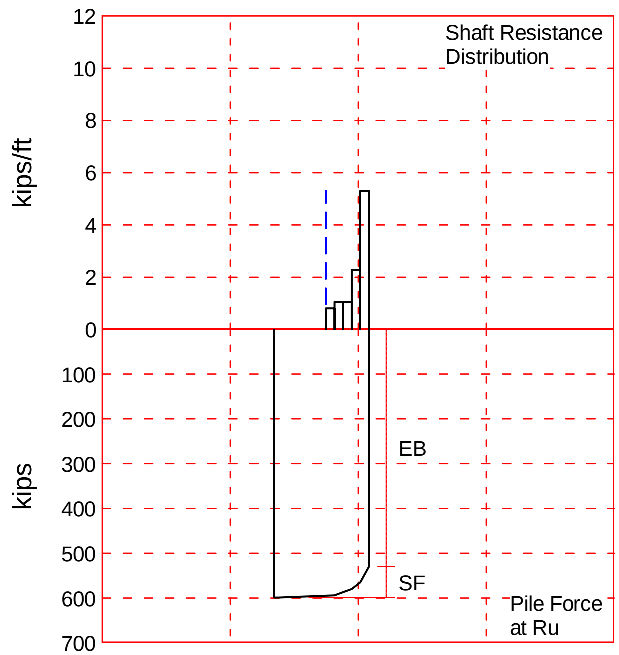
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.804 ft^3; Volume ratio considering added impedance: 1.000







RU =	599.0 kips
SF =	69.0 kips
EB =	530.0 kips
Dy =	1.31 in
Dx =	1.38 in
SET/Bl =	0.08 in



Length b. Sensors	72.5 ft
Embedment	32.5 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	3.97
Top Compr. Stress	41.0 ksi
Max Compr. Stress	44.8 ksi
Max Tension Stress	-7.23 ksi
Avg. Shaft Quake	0.13 in
Toe Quake	0.15 in
Avg. Shaft Smith Dpg.	0.32 s/ft
Toe Smith Damping	0.10 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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 599.0; along Shaft 69.0; at Toe 530.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				599.0			
1	46.1	6.2	5.0	594.0	5.0	0.81	0.20
2	52.7	12.8	7.0	587.0	12.0	1.06	0.27
3	59.3	19.3	7.0	580.0	19.0	1.06	0.27
4	65.9	25.9	15.0	565.0	34.0	2.28	0.57
5	72.5	32.5	35.0	530.0	69.0	5.31	1.34
Avg. Shaft			13.8			2.12	0.53
Toe			530.0				537.88

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.32	0.10
Quake	(in)	0.13	0.15
Case Damping Factor		0.80	1.92
Damping Type		Viscous	Viscous
Unloading Quake	(% of loading quake)	100	104
Unloading Level	(% of Ru)	60	
Resistance Gap (included in Toe Quake) (in)			0.04

CAPWAP match quality = 3.97 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.04 in; Blow Count = 287 b/ft
Transducer F3(F523) CAL: 93.8; RF: 1.00; F4(H083) CAL: 94.4; RF: 1.00
A3(K2214) CAL: 332; RF: 1.09; A4(K974) CAL: 305; RF: 1.09

max. Top Comp. Stress = 41.0 ksi (T= 45.3 ms, max= 1.094 x Top)
max. Comp. Stress = 44.8 ksi (Z= 72.5 ft, T= 40.4 ms)
max. Tens. Stress = -7.23 ksi (Z= 52.7 ft, T= 57.1 ms)
max. Energy (EMX) = 33.6 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	3.3	635.1	-43.6	41.0	-2.81	33.6	18.7	1.18
2	6.6	633.1	-46.4	40.8	-2.99	32.8	18.6	1.14
3	9.9	639.0	-48.6	41.2	-3.13	32.1	18.6	1.10
4	13.2	645.9	-51.1	41.7	-3.30	31.4	18.6	1.06
5	16.5	639.5	-53.0	41.2	-3.42	30.5	18.5	1.02
6	19.8	626.6	-54.7	40.4	-3.53	29.6	18.5	0.98
7	23.1	612.4	-56.1	39.5	-3.62	28.5	18.4	0.93
8	26.4	612.6	-57.5	39.5	-3.71	27.7	18.4	0.89
9	29.7	618.9	-59.1	39.9	-3.81	26.8	18.3	0.85
10	33.0	615.6	-60.5	39.7	-3.90	25.7	18.2	0.80
11	36.3	608.3	-67.6	39.2	-4.36	24.5	18.2	0.75
12	39.5	633.4	-78.9	40.9	-5.09	23.1	18.0	0.70
13	42.8	640.5	-89.4	41.3	-5.77	21.7	17.6	0.64
14	46.1	640.8	-98.8	41.3	-6.37	20.5	17.3	0.59
15	49.4	635.5	-103.9	41.0	-6.70	18.3	16.9	0.54
16	52.7	660.3	-112.1	42.6	-7.23	16.9	16.5	0.49
17	56.0	675.1	-109.2	43.5	-7.04	14.5	15.9	0.44
18	59.3	683.3	-111.5	44.1	-7.19	13.1	15.3	0.39
19	62.6	672.8	-105.3	43.4	-6.79	11.0	14.4	0.33
20	65.9	674.2	-106.6	43.5	-6.88	9.6	12.7	0.28
21	69.2	664.9	-92.9	42.9	-5.99	7.3	10.1	0.23
22	72.5	694.6	-93.7	44.8	-6.04	5.8	6.6	0.18
Absolute	72.5			44.8			(T =	40.4 ms)
	52.7				-7.23		(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	830.0	782.5	735.0	687.5	640.0					
RX	830.0	786.0	742.4	700.7	663.5	647.8	632.2	622.2	615.7	610.9
RU	835.6	789.2	742.8	696.4	650.0					

RAU = 571.7 (kips); RA2 = 657.1 (kips)

Current CAPWAP Ru = 599.0 (kips); Corresponding J(RP)= 0.00; matches RX20 within 5%

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
18.4	35.88	508.2	559.4	638.5	1.15	0.08	0.08	34.4	675.7	4926

PILE PROFILE AND PILE MODEL

Depth	Area	E-Modulus	Spec. Weight	Perim.
ft	in^2	ksi	lb/ft^3	ft
0.0	15.5	29992.2	492.000	3.97
72.5	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

Top Segment Length 3.30 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.804 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Mark Rawlings
Company: Lunda Construction Company	No. of Sheets: 29
E-mail: whamacher@lundaconstruction.com	Date: October 27, 2014

RE: Dynamic Testing Results – Pier 4
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On October 23, 2014, Pier 4 #7 and Pier 4 #28 at the above structure were dynamically tested during initial driving. The 75.3 foot long HP 12 x 53 H-piles were driven with an APE D25-42 hammer operated on fuel setting 3. Plans indicate the piles in Pier 4 have a required driving resistance or ultimate capacity of 410 kips, and an estimated length of 45 feet.

Pier 4 #7 was driven to a depth of 40.0 feet below the excavated ground surface at El. 580.5, which corresponds to a pile tip elevation of El. 540.5. The blow count over the final increment of driving was 5 blows for 1 inch of penetration at an average hammer stroke of 8.6 feet. Pier 4 #28 was driven to a depth of 39.8 feet below the ground surface at the same elevation, which corresponds to a tip elevation of El. 540.7. The blow count over the final increment of driving was also 5 blows for 1 inch of penetration at an average hammer stroke of 8.9 feet. Restrike testing was conducted on both piles on October 24. The blow count at the beginning of restrike of Pier 4 #7 was 5 blows for ⅝ inch of penetration at an average hammer stroke of 9.0 feet. The blow count at the beginning of restrike of Pier 4 #28 was 5 blows for ½ inch of penetration at an average hammer stroke of 9.7 feet.

For the 410 kip piles driven with the APE D25-42 hammer in Pier 4 of the STH 96 bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.0	8
7.5	6
8.0	5
8.5	4
9.0	4
9.5	4
10.0	4

We recommended the above blow count at the corresponding hammer stroke be maintained for

two inches of driving. Driving may be terminated immediately if the blow count reaches 10 blows per inch or greater at an average hammer stroke of 8.0 feet.

We anticipate the production piles will terminate at depths very similar to those of the test piles near El. 540. If a blow count of 10 blows per inch at an associated stroke of 8.0 feet is achieved above approximately El. 542 driving should be halted and we should be contacted for consultation.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Mark A. Rawlings

Mark Rawlings

Travis Coleman, P.E.

cc: Steve Seymour – steve.seymour@omnni.com
Jeff Horsfall –jeffrey.horsfall@dot.wi.gov

Attachments:

Dynamic Test Results - (Pages 3 – 14)
CAPWAP Analysis Results - (Pages 15 – 29)

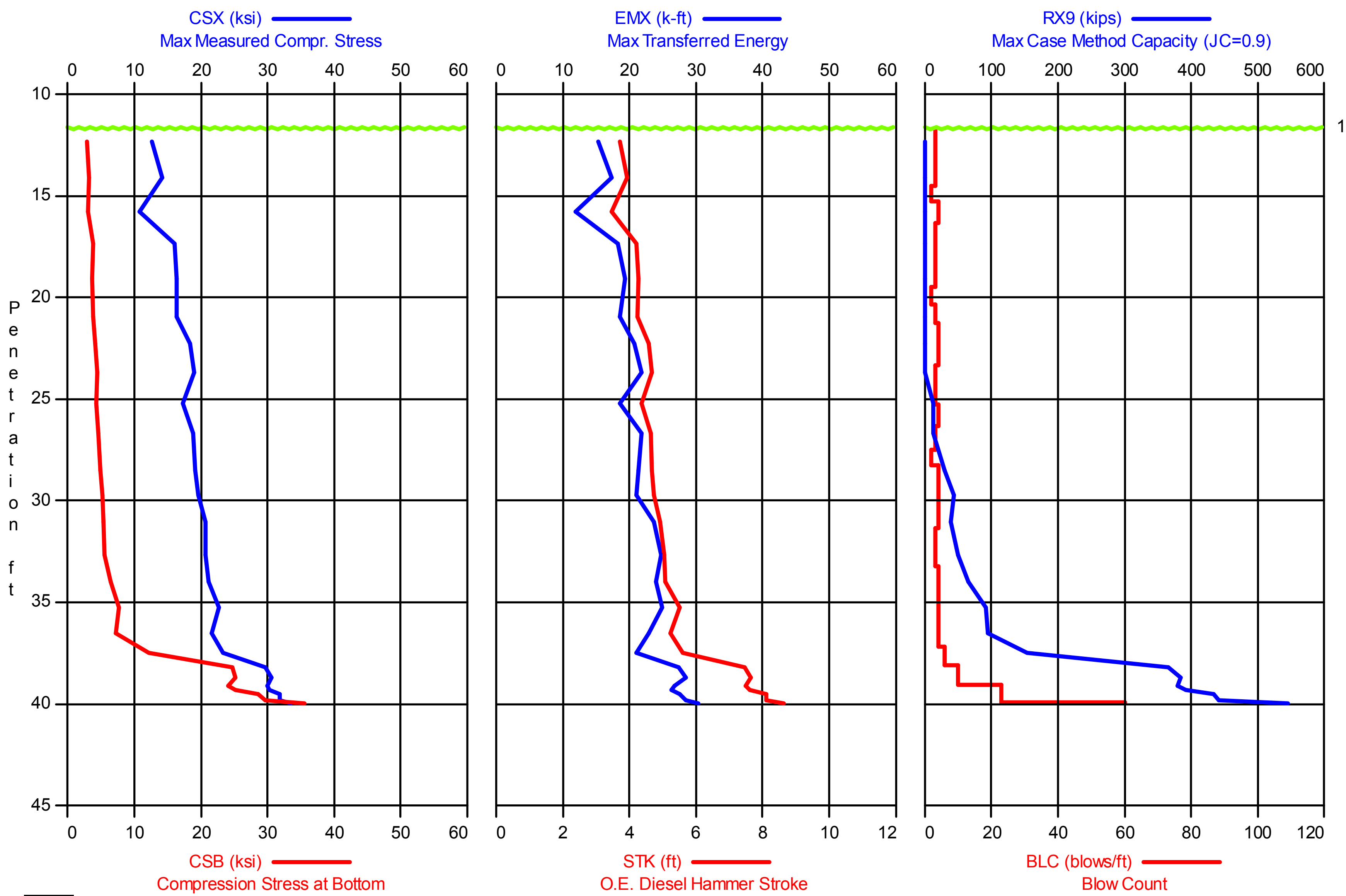
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 23-Oct-2014

Test date: 23-Oct-2014

STH 96 over Fox River - PIER 4 #7 - EOID

APE D25-42, HP 12 x 53



1 - Reported Reference EL 580.5

STH 96 over Fox River - PIER 4 #7 - EOID
OP: RF
APE D25-42, HP 12 x 53
Test date: 23-Oct-2014

AR: 15.50 in^2
LE: 72.30 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.20

CSX: Max Measured Compr. Stress
CSI: Max F1 or F2 Compr. Stress
STK: O.E. Diesel Hammer Stroke
EMX: Max Transferred Energy
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

BL#	depth	BLC	TYPE	CSX	CSI	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
3	12.00	3	AV2	13.2	13.4	3.8	17	59	0
			STD	0.6	0.5	0.0	0	0	0
			MAX	13.8	13.9	3.8	17	60	0
			MIN	12.6	12.9	3.8	17	59	0
6	13.00	3	AV3	12.2	12.4	3.6	14	61	0
			STD	0.3	0.3	0.1	0	0	0
			MAX	12.5	12.7	3.7	15	61	0
			MIN	11.7	11.9	3.6	14	60	0
9	14.00	3	AV3	13.6	13.9	3.9	16	59	0
			STD	0.5	0.5	0.1	0	1	0
			MAX	14.3	14.6	4.0	17	60	0
			MIN	13.2	13.4	3.8	16	58	0
11	15.00	2	AV2	15.1	15.5	4.1	19	58	0
			STD	0.4	0.3	0.1	1	0	0
			MAX	15.5	15.8	4.1	20	58	0
			MIN	14.7	15.2	4.0	17	57	0
15	16.00	4	AV4	10.6	10.7	3.4	11	62	0
			STD	0.4	0.4	0.1	0	1	0
			MAX	11.2	11.4	3.5	12	63	0
			MIN	10.3	10.4	3.4	11	62	0
18	17.00	3	AV3	13.9	14.2	3.9	17	59	0
			STD	1.5	1.6	0.3	2	2	0
			MAX	15.4	15.9	4.2	19	62	0
			MIN	11.8	12.0	3.5	14	57	0
21	18.00	3	AV3	16.7	17.2	4.3	19	56	0
			STD	0.2	0.3	0.0	1	0	0
			MAX	17.1	17.6	4.3	20	56	0
			MIN	16.5	16.9	4.3	18	56	0
24	19.00	3	AV3	16.9	17.4	4.4	20	56	0
			STD	1.1	1.2	0.2	1	1	0
			MAX	17.8	18.3	4.6	21	57	0
			MIN	15.4	15.7	4.1	19	55	0
26	20.00	2	AV2	15.5	15.8	4.1	19	58	0
			STD	2.6	2.8	0.4	3	2	0
			MAX	18.1	18.6	4.4	22	60	0
			MIN	13.0	13.0	3.7	16	55	0
29	21.00	3	AV3	15.5	15.8	4.2	18	57	0
			STD	2.6	2.7	0.4	2	3	0
			MAX	17.8	18.1	4.5	20	61	0
			MIN	11.9	12.0	3.6	15	55	0
33	22.00	4	AV4	17.7	18.0	4.4	20	55	0
			STD	0.3	0.3	0.0	1	0	0
			MAX	18.1	18.4	4.5	21	56	0
			MIN	17.3	17.6	4.4	19	55	0
37	23.00	4	AV4	18.8	19.2	4.7	21	54	0
			STD	0.2	0.3	0.0	1	0	0
			MAX	19.0	19.6	4.7	22	54	0
			MIN	18.6	18.8	4.6	20	54	0

STH 96 over Fox River - PIER 4 #7 - EOID APE D25-42, HP 12 x 53
OP: RF Test date: 23-Oct-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSI ksi	STK ft	EMX k-ft	BPM **	RX9 kips
40	24.00	3	AV3	19.0	19.4	4.7	22	54	0
			STD	0.5	0.6	0.1	0	0	0
			MAX	19.7	20.2	4.7	23	55	0
			MIN	18.5	18.9	4.6	22	54	0
43	25.00	3	AV3	17.1	17.3	4.3	18	56	16
			STD	1.6	1.6	0.3	3	2	11
			MAX	19.1	19.3	4.7	21	58	26
			MIN	15.1	15.4	4.0	15	54	2
47	26.00	4	AV4	18.6	18.8	4.6	20	54	14
			STD	2.1	2.1	0.4	2	2	15
			MAX	20.4	20.6	5.0	23	58	39
			MIN	15.1	15.4	4.0	16	53	4
50	27.00	3	AV3	18.0	18.1	4.5	21	55	6
			STD	2.1	2.2	0.4	4	2	6
			MAX	20.0	20.4	4.9	25	58	14
			MIN	15.1	15.1	3.9	16	53	0
52	28.00	2	AV2	19.1	19.2	4.7	24	54	10
			STD	0.7	0.8	0.1	1	1	6
			MAX	19.9	19.9	4.8	24	55	16
			MIN	18.4	18.4	4.5	23	53	4
56	29.00	4	AV4	19.2	19.4	4.7	21	54	34
			STD	0.9	0.9	0.2	0	1	9
			MAX	20.7	20.9	5.0	21	55	48
			MIN	18.1	18.5	4.5	20	52	28
60	30.00	4	AV4	19.8	20.2	4.8	21	53	43
			STD	0.4	0.6	0.1	0	0	5
			MAX	20.2	20.7	4.9	22	54	49
			MIN	19.2	19.4	4.7	21	53	34
64	31.00	4	AV4	20.2	20.5	4.9	23	53	40
			STD	1.0	1.1	0.2	1	1	3
			MAX	21.2	21.8	5.0	23	54	44
			MIN	18.5	18.7	4.6	21	52	38
67	32.00	3	AV3	20.4	20.6	4.9	24	53	42
			STD	0.2	0.2	0.1	1	0	9
			MAX	20.8	20.9	5.0	25	53	52
			MIN	20.2	20.4	4.8	23	52	30
70	33.00	3	AV3	20.5	21.2	5.0	25	52	44
			STD	1.0	1.2	0.2	2	1	7
			MAX	21.6	22.1	5.2	27	54	52
			MIN	19.1	19.4	4.7	23	51	35
74	34.00	4	AV4	21.0	21.4	5.0	23	52	61
			STD	1.1	1.1	0.2	2	1	4
			MAX	22.3	22.7	5.3	25	53	65
			MIN	19.6	19.9	4.8	22	51	55
78	35.00	4	AV4	22.2	22.5	5.4	25	51	81
			STD	0.3	0.4	0.1	1	1	11
			MAX	22.6	23.0	5.5	26	51	99
			MIN	21.7	21.9	5.2	25	50	71
82	36.00	4	AV4	22.3	22.7	5.4	24	51	94
			STD	1.0	1.1	0.3	2	1	2
			MAX	23.3	23.7	5.6	25	53	96
			MIN	20.7	20.9	4.9	21	50	91
86	37.00	4	AV4	21.9	22.3	5.3	23	51	95
			STD	0.9	0.9	0.2	1	1	3
			MAX	23.3	23.8	5.6	25	52	99
			MIN	21.0	21.4	5.1	21	50	93

STH 96 over Fox River - PIER 4 #7 - EOID
OP: RF
APE D25-42, HP 12 x 53
Test date: 23-Oct-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSI ksi	STK ft	EMX k-ft	BPM **	RX9 kips
92	38.00	6	AV6	24.0	24.5	5.8	21	49	177
			STD	2.2	2.3	0.6	1	2	74
			MAX	27.2	27.9	6.6	23	52	289
			MIN	21.0	21.5	5.0	20	46	94
102	39.00	10	AV10	30.6	31.5	7.7	29	43	384
			STD	0.6	0.7	0.2	2	1	9
			MAX	31.8	33.2	8.3	32	43	401
			MIN	29.8	30.6	7.4	26	41	371
123	39.92	23	AV17	30.9	31.3	7.8	27	42	411
			STD	1.6	1.8	0.5	3	1	31
			MAX	34.0	35.2	8.9	34	44	476
			MIN	28.4	28.8	7.0	20	40	375
127	39.98	60	AV4	33.5	34.4	8.6	30	40	546
			STD	0.8	0.8	0.2	4	1	22
			MAX	34.5	35.5	8.9	34	41	576
			MIN	32.5	33.4	8.3	25	40	518
			Average	21.6	22.0	5.4	22	51	133
			Std. Dev.	6.4	6.6	1.5	5	6	176
			Maximum	34.5	35.5	8.9	34	63	576
			Minimum	10.3	10.4	3.4	11	40	0

Total number of blows analyzed: 122

BL#	depth (ft)	Comments
2	11.67	Reported Reference EL 580.5

Time Summary

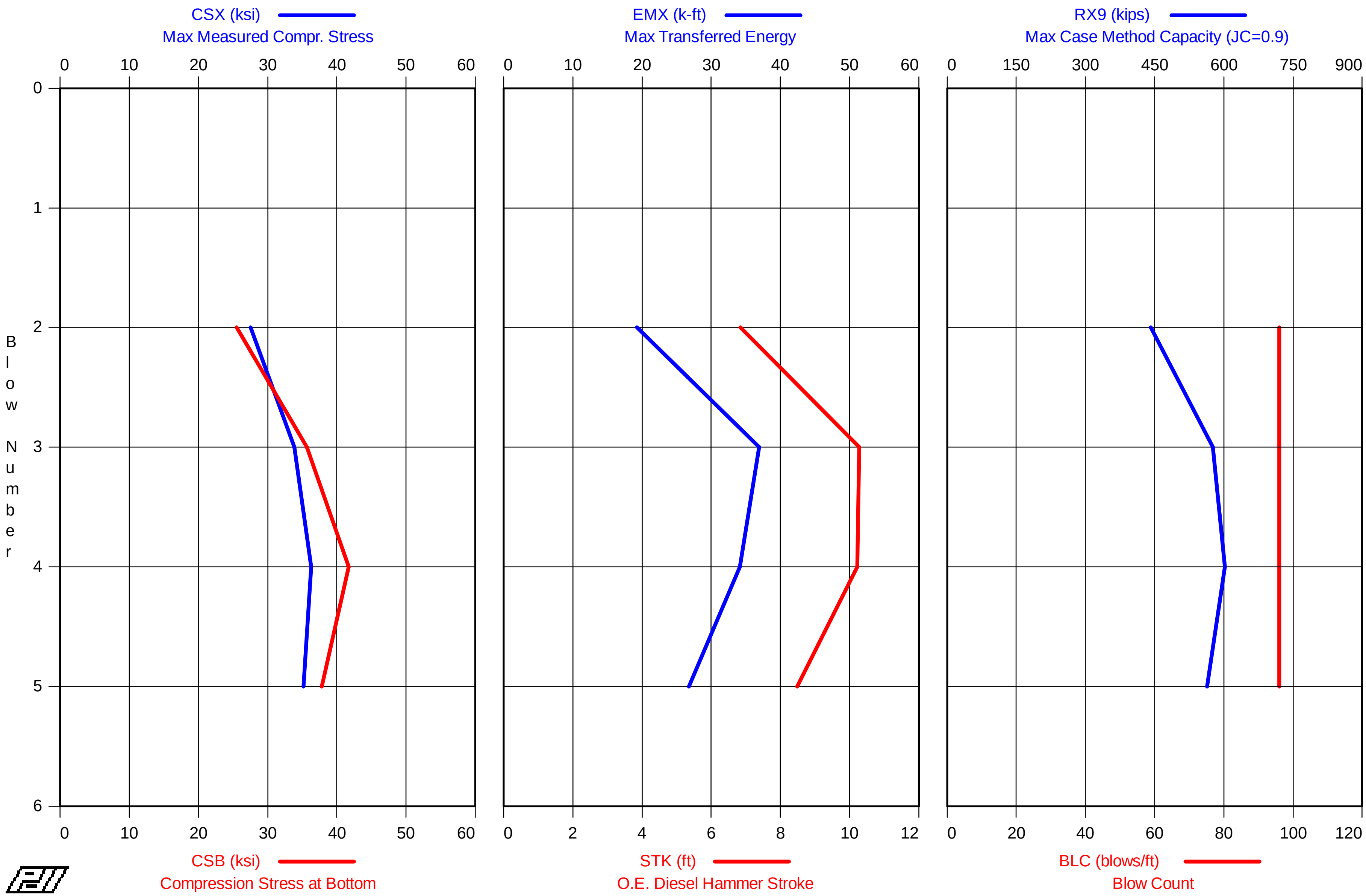
Drive 3 minutes 41 seconds 1:51:05 PM - 1:54:46 PM (10/23/2014) BN 1 - 128

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

PDIPLOT Ver. 2014.1 - Printed: 27-Oct-2014

Test date: 24-Oct-2014

STH 96 over Fox River - Pier 4 #7 Restrike
APE D25-42, HP 12 x 53



STH 96 over Fox River - Pier 4 #7 Restrike
OP: MR
APE D25-42, HP 12 x 53
Test date: 24-Oct-2014

AR: 15.50 in^2
LE: 72.30 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#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
5	40.05	96	AV4	33.2	35.2	29	9.0	39.9	546
			STD	3.4	6.0	7	1.4	3.3	62
			MAX	36.3	41.7	37	10.3	45.0	602
			MIN	27.5	25.5	19	6.9	37.0	442
			Average	33.2	35.2	29	9.0	39.9	546
			Std. Dev.	3.4	6.0	7	1.4	3.3	62
			Maximum	36.3	41.7	37	10.3	45.0	602
			Minimum	27.5	25.5	19	6.9	37.0	442

Total number of blows analyzed: 4

Time Summary

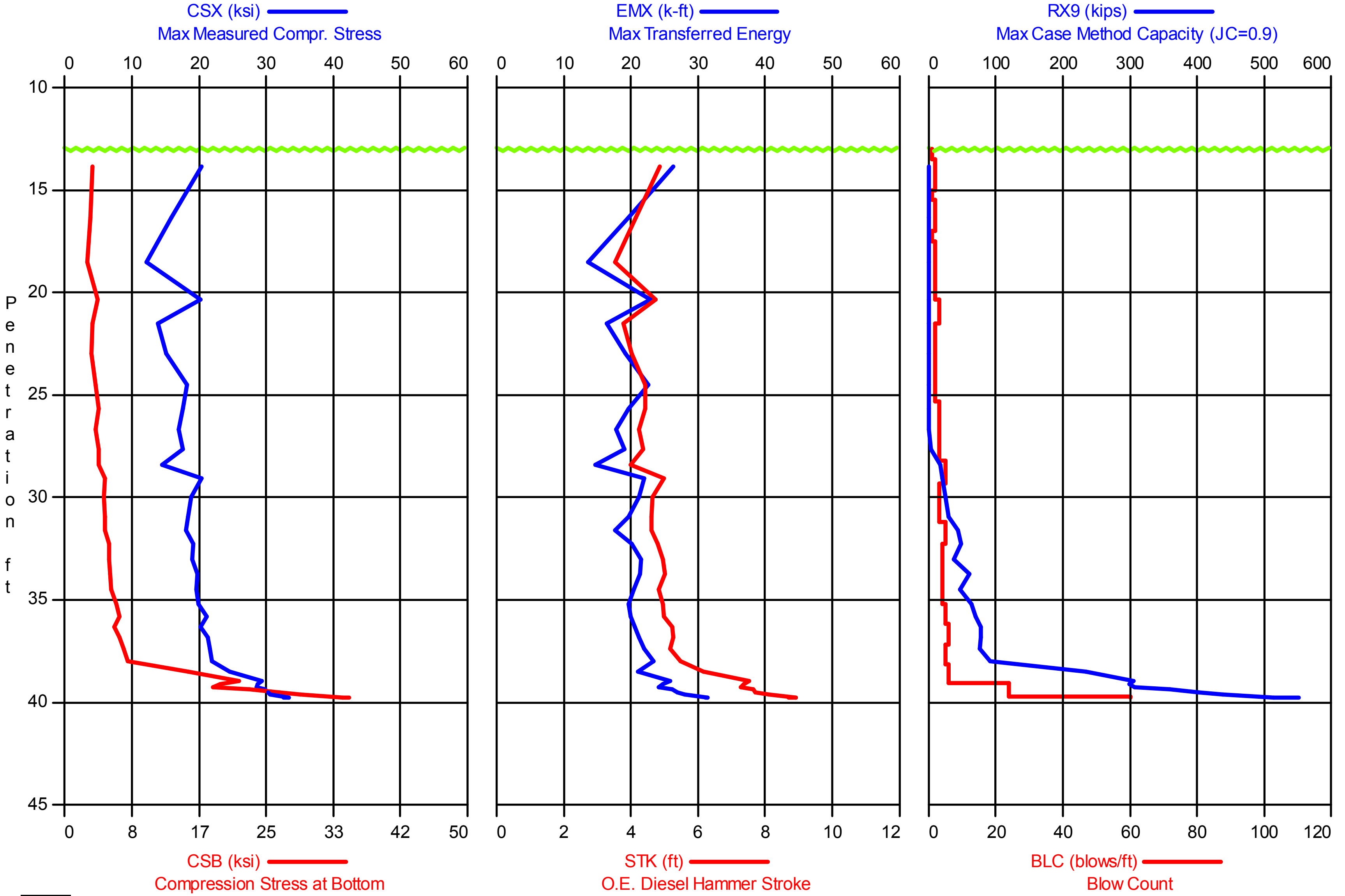
Drive 6 seconds 9:33:37 AM - 9:33:43 AM (10/24/2014) BN 1 - 5

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

PDIPLOT Ver. 2014.1 - Printed: 23-Oct-2014

Test date: 23-Oct-2014

STH 96 over Fox River - PIER 4 #28 - EOID
APE D25-42, HP 12 x 53



1 - Reported Reference EL 580.5

STH 96 over Fox River - PIER 4 #28 - EOID APE D25-42, HP 12 x 53
OP: RF Test date: 23-Oct-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.30 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.20

CSX: Max Measured Compr. Stress EMX: Max Transferred Energy
CSI: Max F1 or F2 Compr. Stress BPM: Blows per Minute
STK: O.E. Diesel Hammer Stroke RX9: Max Case Method Capacity (JC=0.9)

BL#	depth	BLC	TYPE	CSX	CSI	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
3	12.00	1	AV1	22.6	22.7	5.5	31	50	0
			MAX	22.6	22.7	5.5	31	50	0
			MIN	22.6	22.7	5.5	31	50	0
3	13.00	1	AV1	15.4	15.6	3.7	16	60	0
			MAX	15.4	15.6	3.7	16	60	0
			MIN	15.4	15.6	3.7	16	60	0
6	15.00	1	AV1	23.2	24.5	5.4	31	51	0
			MAX	23.2	24.5	5.4	31	51	0
			MIN	23.2	24.5	5.4	31	51	0
8	16.00	2	AV2	12.3	12.6	3.4	13	62	0
			STD	3.5	3.5	0.3	4	3	0
			MAX	15.8	16.1	3.7	17	65	0
			MIN	8.8	9.1	3.1	9	60	0
11	18.00	2	AV2	20.9	21.3	4.9	27	53	0
			STD	2.4	2.5	0.6	6	3	0
			MAX	23.3	23.8	5.6	33	56	0
			MIN	18.5	18.9	4.3	21	50	0
13	19.00	2	AV2	9.0	9.1	3.2	10	65	0
			STD	1.6	1.6	0.1	2	1	0
			MAX	10.6	10.7	3.3	12	66	0
			MIN	7.4	7.5	3.0	8	64	0
15	20.00	2	AV1	25.0	25.4	5.8	30	49	0
			MAX	25.0	25.4	5.8	30	49	0
			MIN	25.0	25.4	5.8	30	49	0
18	21.00	3	AV3	16.2	16.6	4.0	18	58	0
			STD	2.4	2.5	0.3	3	2	0
			MAX	18.9	19.4	4.4	22	60	0
			MIN	13.1	13.3	3.7	14	55	0
20	22.00	2	AV2	14.2	14.5	3.8	17	59	0
			STD	0.5	0.6	0.1	1	1	0
			MAX	14.7	15.1	3.9	18	60	0
			MIN	13.7	13.9	3.7	17	59	0
22	23.00	2	AV2	14.4	14.9	3.9	18	59	0
			STD	0.6	0.9	0.1	0	1	0
			MAX	15.0	15.7	4.1	18	60	0
			MIN	13.8	14.0	3.8	18	58	0
24	24.00	2	AV2	17.4	17.6	4.4	23	56	0
			STD	0.9	0.8	0.1	1	1	0
			MAX	18.3	18.4	4.5	24	56	0
			MIN	16.5	16.8	4.3	22	55	0
26	25.00	2	AV2	18.2	19.5	4.4	22	55	0
			STD	1.2	0.5	0.2	2	1	0
			MAX	19.4	20.0	4.6	24	57	0
			MIN	17.0	19.0	4.2	20	54	0
29	26.00	3	AV3	17.7	18.2	4.4	20	55	0
			STD	1.6	1.7	0.2	1	1	0
			MAX	19.3	19.8	4.6	20	57	0
			MIN	15.4	15.9	4.1	18	54	0
32	27.00	3	AV3	17.0	18.0	4.2	18	57	1
			STD	0.7	0.9	0.2	1	1	1
			MAX	17.9	19.2	4.4	19	58	3
			MIN	16.2	17.2	4.0	17	56	0

STH 96 over Fox River - PIER 4 #28 - EOID APE D25-42, HP 12 x 53
OP: RF Test date: 23-Oct-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSI ksi	STK ft	EMX k-ft	BPM **	RX9 kips
35	28.00	3	AV3	17.6	18.5	4.4	19	56	3
			STD	1.7	1.6	0.3	3	2	3
			MAX	19.6	20.6	4.6	21	58	8
			MIN	15.4	16.6	4.0	15	54	0
40	29.00	5	AV5	17.1	18.2	4.5	18	56	21
			STD	3.5	3.7	0.6	4	3	12
			MAX	21.6	22.9	5.2	23	60	35
			MIN	12.8	13.5	3.7	12	51	0
43	30.00	3	AV3	19.1	19.6	4.7	22	54	18
			STD	0.1	0.6	0.0	0	0	9
			MAX	19.2	20.4	4.7	22	54	26
			MIN	19.0	19.2	4.6	21	54	6
46	31.00	3	AV3	18.3	19.2	4.6	21	54	21
			STD	0.5	0.6	0.1	1	0	9
			MAX	18.9	19.8	4.7	22	55	29
			MIN	17.6	18.5	4.5	20	54	8
51	32.00	5	AV5	18.2	19.8	4.6	18	54	44
			STD	0.5	0.5	0.1	1	1	9
			MAX	18.9	20.4	4.8	19	55	57
			MIN	17.7	19.2	4.5	17	54	34
55	33.00	4	AV4	19.1	20.4	4.9	21	53	48
			STD	0.5	0.5	0.0	0	0	7
			MAX	19.7	20.8	4.9	21	53	58
			MIN	18.5	19.5	4.9	21	53	38
59	34.00	4	AV4	19.7	21.7	5.0	22	52	53
			STD	0.4	1.0	0.1	1	1	14
			MAX	20.5	23.0	5.2	22	53	62
			MIN	19.4	20.5	4.9	21	51	29
63	35.00	4	AV4	19.6	22.0	4.8	20	53	49
			STD	0.8	0.8	0.1	1	1	7
			MAX	20.8	23.3	5.0	23	54	57
			MIN	18.6	21.2	4.6	19	52	39
68	36.00	5	AV5	20.7	23.8	5.0	20	52	68
			STD	0.9	1.3	0.1	1	1	5
			MAX	22.4	25.7	5.1	20	53	78
			MIN	19.6	21.8	4.8	19	52	62
74	37.00	6	AV6	20.7	23.5	5.3	21	51	78
			STD	1.4	1.9	0.1	1	0	4
			MAX	22.5	26.0	5.4	22	52	85
			MIN	18.4	21.2	5.1	19	50	72
79	38.00	5	AV5	21.6	24.1	5.3	23	51	78
			STD	1.0	0.9	0.2	1	1	5
			MAX	23.4	25.5	5.6	25	53	84
			MIN	20.2	22.7	4.9	21	50	70
85	39.00	6	AV6	25.8	27.6	6.5	23	46	239
			STD	2.7	2.5	0.8	3	3	74
			MAX	29.4	30.6	7.8	28	50	316
			MIN	22.8	24.6	5.5	18	42	112
102	39.72	24	AV16	29.6	30.6	7.6	26	43	357
			STD	1.2	1.1	0.4	2	1	56
			MAX	31.8	33.0	8.6	29	45	445
			MIN	27.1	29.1	6.9	23	40	268
106	39.78	60	AV4	33.2	34.2	8.9	31	40	523
			STD	1.5	1.4	0.5	2	1	17
			MAX	35.7	36.3	9.7	35	41	552
			MIN	31.7	32.5	8.4	29	38	510
			Average	21.2	22.6	5.4	22	52	115
			Std. Dev.	5.7	5.9	1.5	5	6	154
			Maximum	35.7	36.3	9.7	35	66	552
			Minimum	7.4	7.5	3.0	8	38	0

Total number of blows analyzed: 100

BL#	depth (ft)	Comments
3	13.00	Reported Reference EL 580.5

Time Summary

Drive	3 minutes 47 seconds	2:10:34 PM - 2:14:21 PM (10/23/2014) BN 1 - 107

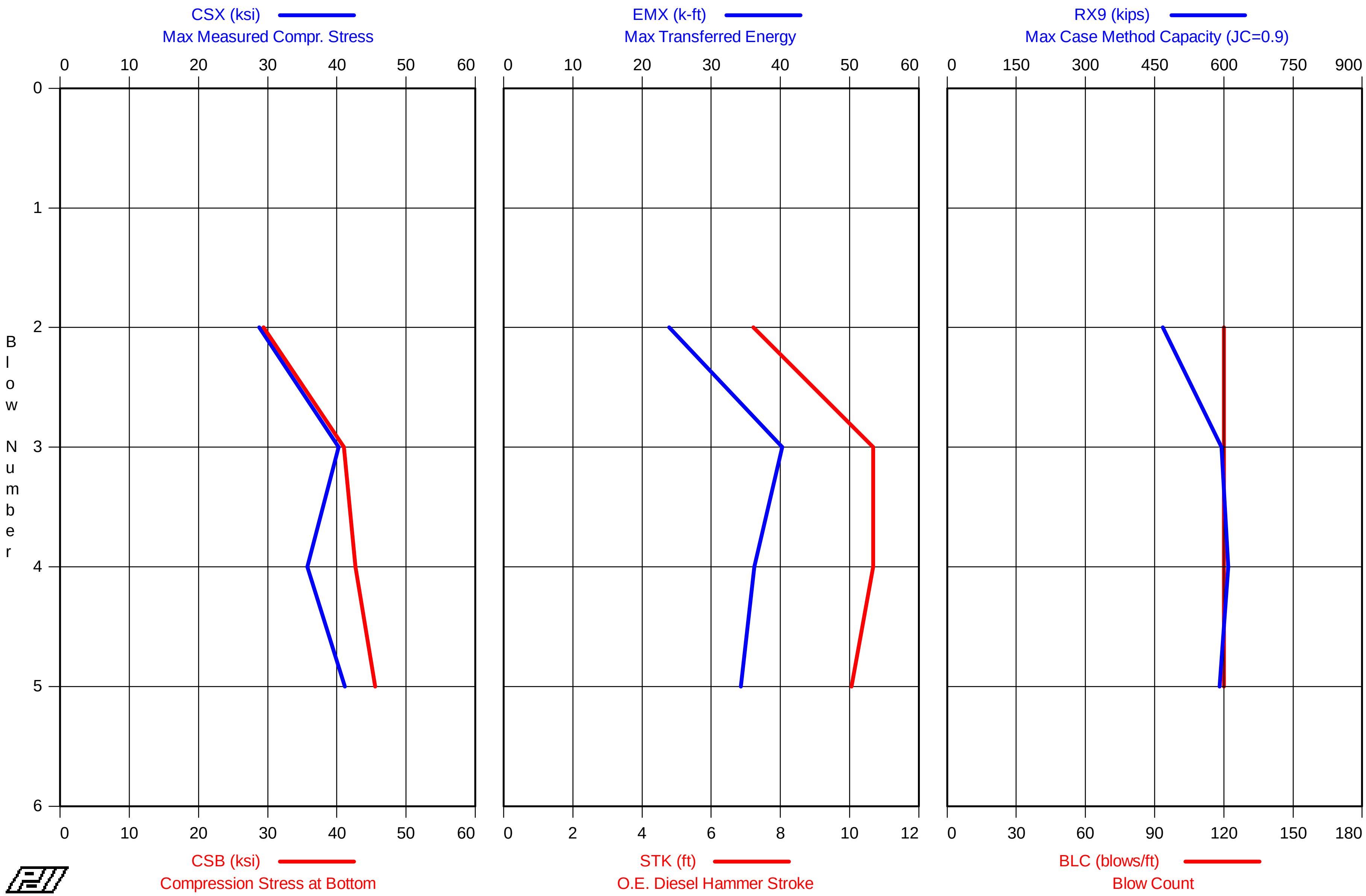
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 27-Oct-2014

Test date: 24-Oct-2014

STH 96 over Fox River - Pier 4 #28 Restrike

APE D25-42, HP 12 x 53



STH 96 over Fox River - Pier 4 #28 Restrike APE D25-42, HP 12 x 53
OP: MR Test date: 24-Oct-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.30 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.20

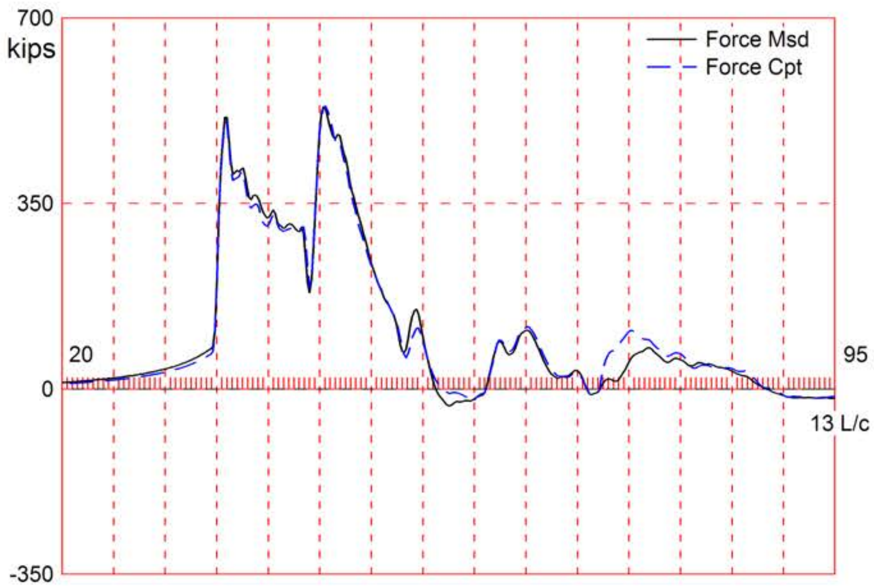
CSX: Max Measured Compr. Stress STK: O.E. Diesel Hammer Stroke
CSB: Compression Stress at Bottom BPM: Blows per Minute
EMX: Max Transferred Energy RX9: Max Case Method Capacity (JC=0.9)

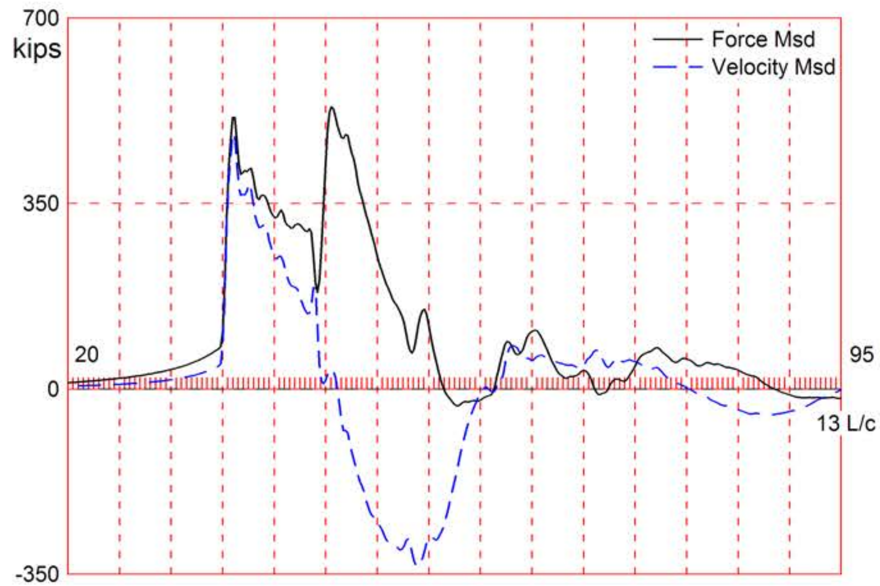
BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
5	39.88	120	AV4	36.5	39.7	34	9.7	38.5	566
			STD	4.9	6.1	6	1.4	3.2	57
			MAX	41.2	45.5	40	10.7	43.9	610
			MIN	28.8	29.4	24	7.2	36.3	468
			Average	36.5	39.7	34	9.7	38.5	566
			Std. Dev.	4.9	6.1	6	1.4	3.2	57
			Maximum	41.2	45.5	40	10.7	43.9	610
			Minimum	28.8	29.4	24	7.2	36.3	468

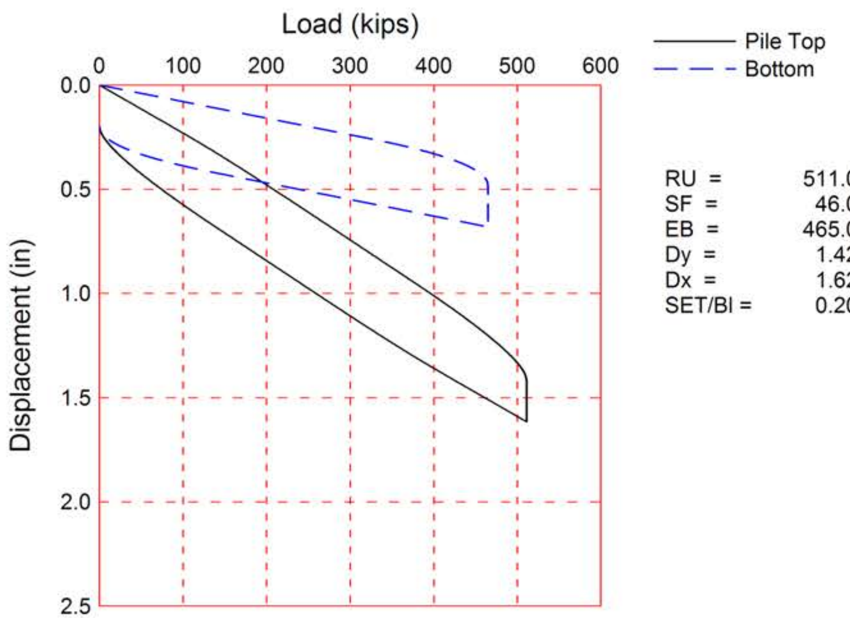
Total number of blows analyzed: 4

Time Summary

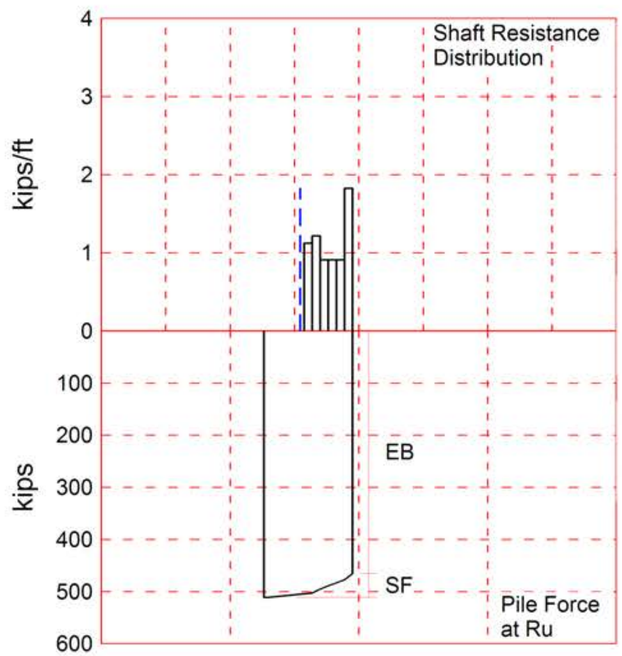
Drive 7 seconds 9:17:20 AM - 9:17:27 AM (10/24/2014) BN 1 - 5







RU =	511.0 kips
SF =	46.0 kips
EB =	465.0 kips
Dy =	1.42 in
Dx =	1.62 in
SET/Bl =	0.20 in



Length b. Sensors	72.3 ft
Embedment	40.0 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	4.17
Top Compr. Stress	35.3 ksi
Max Compr. Stress	37.8 ksi
Max Tension Stress	-9.08 ksi
Avg. Shaft Quake	0.15 in
Toe Quake	0.37 in
Avg. Shaft Smith Dpg.	0.30 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: 511.0; along Shaft 46.0; at Toe 465.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Quake in
				511.0				
1	39.4	7.1	8.0	503.0	8.0	1.13	0.28	0.15
2	46.0	13.7	8.0	495.0	16.0	1.22	0.31	0.15
3	52.6	20.2	6.0	489.0	22.0	0.91	0.23	0.15
4	59.2	26.8	6.0	483.0	28.0	0.91	0.23	0.15
5	65.7	33.4	6.0	477.0	34.0	0.91	0.23	0.15
6	72.3	40.0	12.0	465.0	46.0	1.83	0.46	0.14
Avg. Shaft			7.7			1.15	0.29	0.15
Toe			465.0				471.91	0.37

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.11
Case Damping Factor		0.50	1.85
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	53	30
Unloading Level	(% of Ru)	81	
Resistance Gap (included in Toe Quake) (in)			0.12
Soil Plug Weight	(kips)		0.008

CAPWAP match quality = 4.17 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.16 in; Blow Count = 77 b/ft
Transducer F3(F523) CAL: 93.8; RF: 1.00; F4(H083) CAL: 94.4; RF: 1.00
A3(K2214) CAL: 332; RF: 1.01; A4(K974) CAL: 305; RF: 1.01

max. Top Comp. Stress = 35.3 ksi (T= 45.9 ms, max= 1.070 x Top)
max. Comp. Stress = 37.8 ksi (Z= 72.3 ft, T= 42.0 ms)
max. Tens. Stress = -9.08 ksi (Z= 29.6 ft, T= 58.3 ms)
max. Energy (EMX) = 34.1 kip-ft; max. Measured Top Displ. (DMX)= 1.24 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	546.8	-34.6	35.3	-2.23	34.1	17.7	1.27
2	6.6	554.4	-45.1	35.8	-2.91	33.7	17.7	1.25
3	9.9	555.6	-61.7	35.8	-3.98	33.2	17.6	1.21
4	13.1	553.8	-77.8	35.7	-5.02	32.4	17.6	1.17
5	16.4	553.6	-93.5	35.7	-6.03	31.7	17.6	1.14
6	19.7	551.4	-109.8	35.6	-7.08	31.0	17.5	1.10
7	23.0	545.2	-121.2	35.2	-7.82	30.2	17.5	1.06
8	26.3	540.0	-133.0	34.8	-8.58	29.4	17.5	1.02
9	29.6	536.6	-140.8	34.6	-9.08	28.5	17.4	0.97
10	32.9	535.1	-139.9	34.5	-9.02	27.6	17.2	0.93
11	36.2	528.8	-135.8	34.1	-8.76	26.7	16.9	0.89
12	39.4	534.6	-130.1	34.5	-8.39	25.8	16.5	0.84
13	42.7	536.7	-109.4	34.6	-7.06	22.7	16.2	0.80
14	46.0	550.0	-103.9	35.5	-6.70	21.6	15.9	0.75
15	49.3	547.6	-86.6	35.3	-5.58	18.8	15.8	0.71
16	52.6	547.4	-101.0	35.3	-6.52	17.8	15.5	0.66
17	55.9	544.3	-89.7	35.1	-5.78	15.6	14.9	0.62
18	59.2	558.5	-87.7	36.0	-5.66	14.7	14.4	0.57
19	62.4	556.8	-72.0	35.9	-4.65	12.8	14.3	0.53
20	65.7	565.6	-64.2	36.5	-4.14	12.0	16.2	0.49
21	69.0	569.5	-40.6	36.7	-2.62	10.6	15.4	0.45
22	72.3	585.3	-29.7	37.8	-1.91	9.7	12.4	0.41
Absolute	72.3			37.8			(T =	42.0 ms)
	29.6				-9.08		(T =	58.3 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	659.8	588.0	516.1	444.3	372.4					
RX	666.9	629.1	601.7	591.0	580.4	569.8	559.2	548.5	537.9	528.5
RU	659.8	588.0	516.1	444.3	372.4					

RAU = 466.4 (kips); RA2 = 609.5 (kips)

Current CAPWAP Ru = 511.0 (kips); Corresponding J(RP)= 0.41; 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
17.8	35.98	493.7	525.4	533.7	1.24	0.20	0.20	35.0	582.0	1860

PILE PROFILE AND PILE MODEL

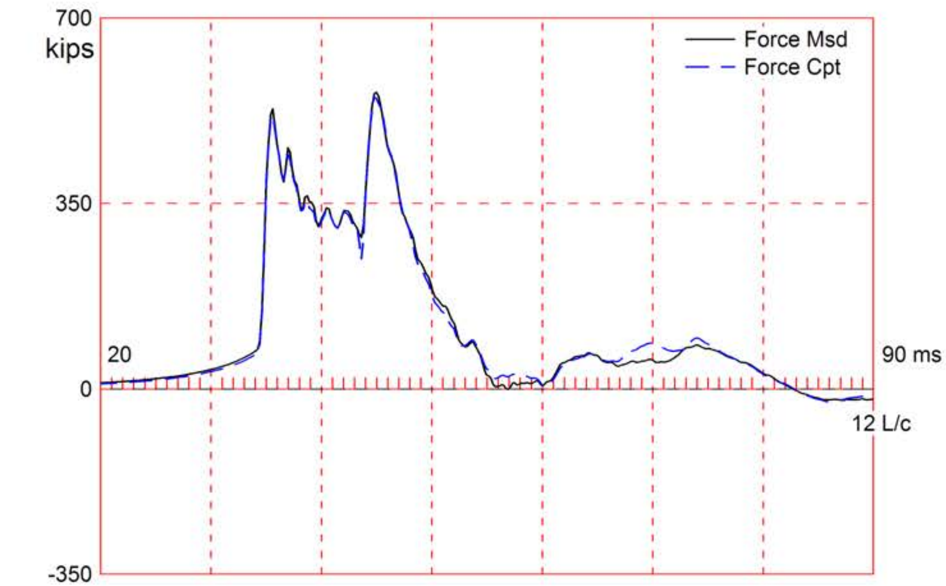
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

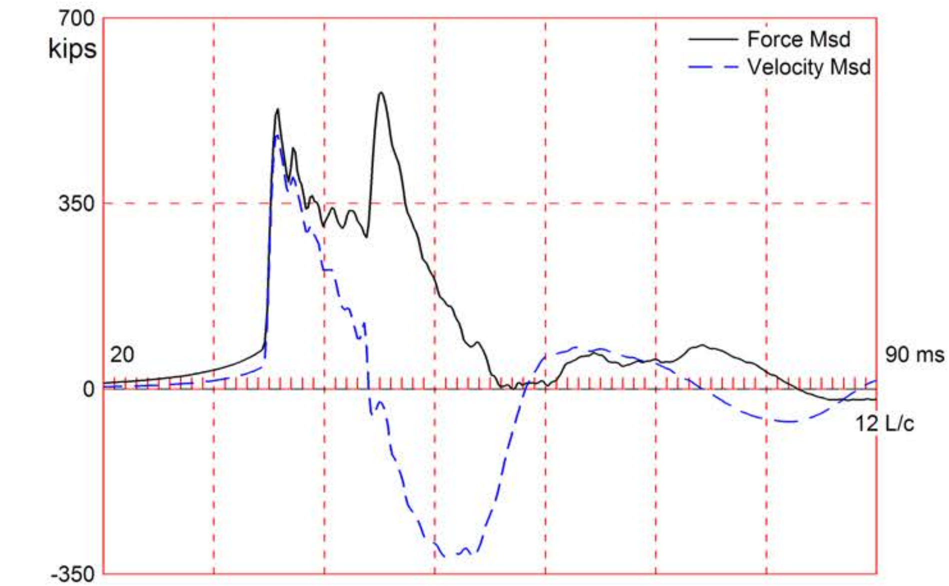
Toe Area 141.9 in^2

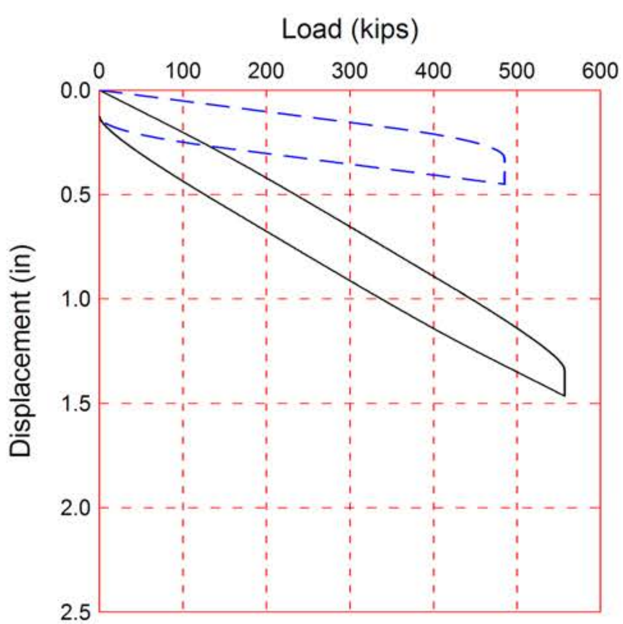
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s

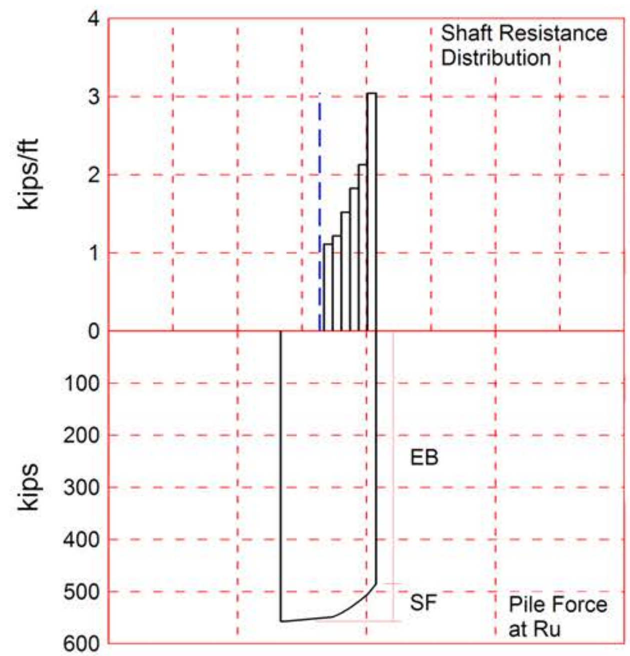
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.782 ft^3; Volume ratio considering added impedance: 1.000







RU = 557.0 kips
SF = 72.0 kips
EB = 485.0 kips
Dy = 1.34 in
Dx = 1.47 in
SET/Bl = 0.12 in



Length b. Sensors	72.3 ft
Embedment	40.0 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	3.08
Top Compr. Stress	35.9 ksi
Max Compr. Stress	39.2 ksi
Max Tension Stress	-8.11 ksi
Avg. Shaft Quake	0.11 in
Toe Quake	0.25 in
Avg. Shaft Smith Dpg.	0.33 s/ft
Toe Smith Damping	0.25 s/ft

About the CAPWAP Results

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

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

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

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

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

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

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

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 557.0; along Shaft 72.0; at Toe 485.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				557.0			
1	39.4	7.2	8.0	549.0	8.0	1.11	0.28
2	46.0	13.8	8.0	541.0	16.0	1.22	0.31
3	52.6	20.3	10.0	531.0	26.0	1.52	0.38
4	59.2	26.9	12.0	519.0	38.0	1.83	0.46
5	65.7	33.5	14.0	505.0	52.0	2.13	0.54
6	72.3	40.0	20.0	485.0	72.0	3.04	0.77
Avg. Shaft			12.0			1.80	0.45
Toe			485.0				492.21

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.33	0.25
Quake	(in)	0.11	0.25
Case Damping Factor		0.86	4.38
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	30	68
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	89	
Resistance Gap (included in Toe Quake) (in)			0.10
Soil Plug Weight	(kips)		0.018

CAPWAP match quality = 3.08 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.07 in; Blow Count = 179 b/ft

max. Top Comp. Stress = 35.9 ksi (T= 45.6 ms, max= 1.091 x Top)
max. Comp. Stress = 39.2 ksi (Z= 72.3 ft, T= 41.6 ms)
max. Tens. Stress = -8.11 ksi (Z= 39.4 ft, T= 58.1 ms)
max. Energy (EMX) = 33.9 kip-ft; max. Measured Top Displ. (DMX)= 1.16 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	557.4	-26.6	35.9	-1.71	33.9	17.8	1.18
2	6.6	566.3	-28.4	36.5	-1.83	33.3	17.7	1.14
3	9.9	559.6	-29.7	36.1	-1.92	32.7	17.7	1.11
4	13.1	556.2	-39.7	35.9	-2.56	32.0	17.7	1.07
5	16.4	542.1	-52.7	35.0	-3.40	31.2	17.6	1.03
6	19.7	545.2	-65.3	35.2	-4.21	30.4	17.6	0.99
7	23.0	538.3	-76.2	34.7	-4.92	29.6	17.5	0.95
8	26.3	533.8	-87.5	34.4	-5.64	28.8	17.5	0.91
9	29.6	542.5	-96.5	35.0	-6.23	27.8	17.4	0.87
10	32.9	557.8	-106.2	36.0	-6.85	26.8	17.1	0.82
11	36.2	567.9	-115.7	36.6	-7.46	25.6	16.7	0.77
12	39.4	566.7	-125.7	36.6	-8.11	24.6	16.3	0.72
13	42.7	576.9	-119.0	37.2	-7.67	21.5	15.9	0.68
14	46.0	582.6	-123.3	37.6	-7.95	20.4	15.5	0.63
15	49.3	581.6	-107.7	37.5	-6.94	17.6	15.1	0.58
16	52.6	592.0	-110.5	38.2	-7.13	16.4	14.6	0.53
17	55.9	587.2	-98.1	37.9	-6.33	13.5	14.1	0.48
18	59.2	596.7	-102.2	38.5	-6.59	12.3	13.7	0.43
19	62.4	597.1	-79.7	38.5	-5.14	9.7	13.8	0.39
20	65.7	603.8	-74.4	38.9	-4.80	8.6	15.1	0.34
21	69.0	589.6	-44.8	38.0	-2.89	6.3	14.6	0.30
22	72.3	608.0	-40.0	39.2	-2.58	5.0	11.1	0.25
Absolute	72.3			39.2			(T =	41.6 ms)
	39.4				-8.11		(T =	58.1 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	760.9	734.4	708.0	681.5	655.1	628.7	602.2	575.8	549.3	522.9
RX	765.7	741.0	716.8	694.6	672.3	657.2	643.3	629.4	615.6	602.1
RU	747.6	719.8	692.0	664.3	636.5	608.7	581.0	553.2	525.4	497.7

RAU = 535.0 (kips); RA2 = 614.8 (kips)

Current CAPWAP Ru = 557.0 (kips); Corresponding J(RP)= 0.77;

RMX requires higher damping; see PDA-W

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
17.6	35.78	485.7	539.5	562.7	1.16	0.12	0.12	34.2	640.4	3233

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

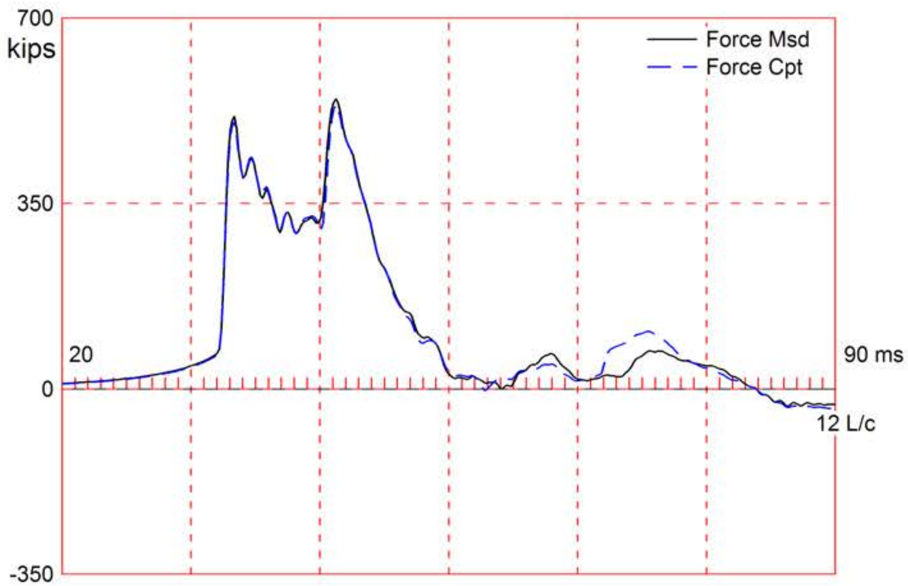
Toe Area 141.9 in^2

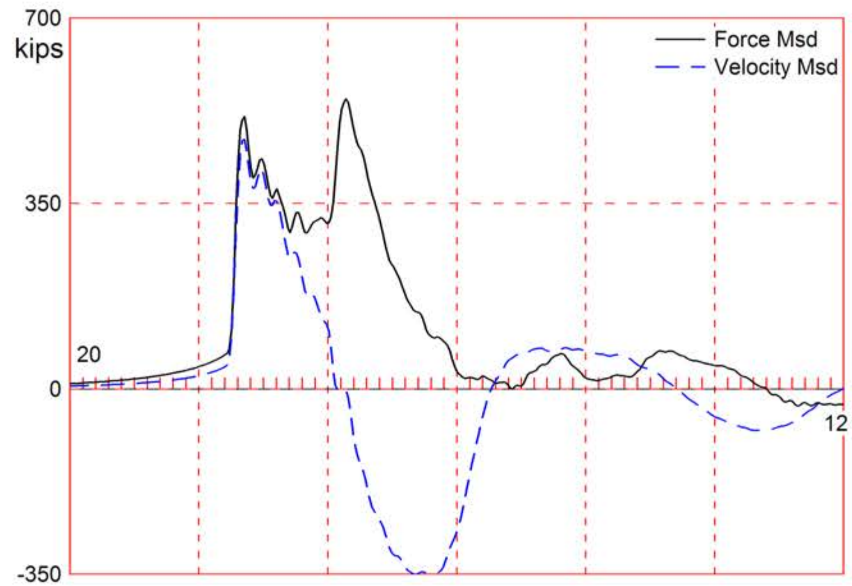
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

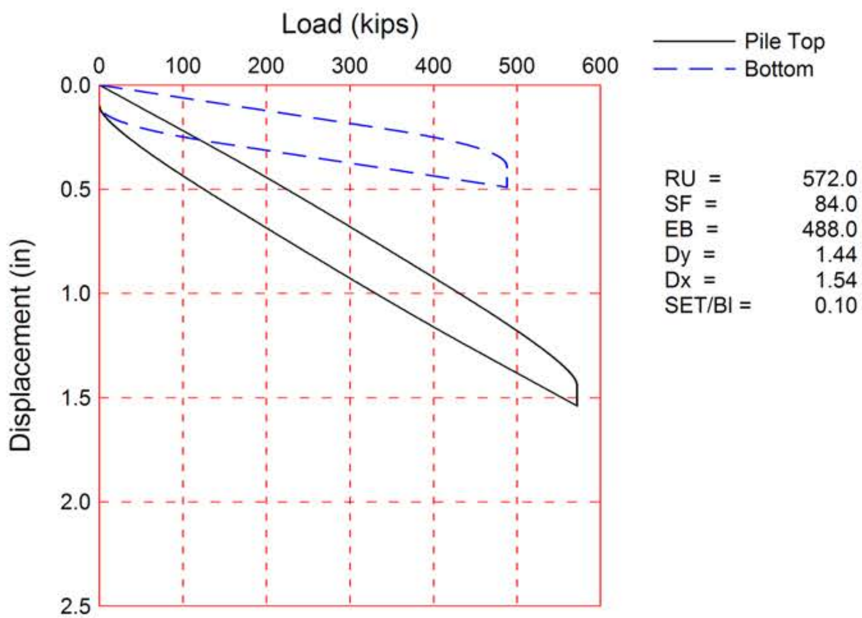
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.782 ft^3; Volume ratio considering added impedance: 1.000

STH 96 over Fox River; Pile: Pier 4 #28 Restrike; APE D25-42, HP 12 x 53; Blow: 4 (Test: 24-Oct-2014 09:17:)
GRL Engineers, Inc.

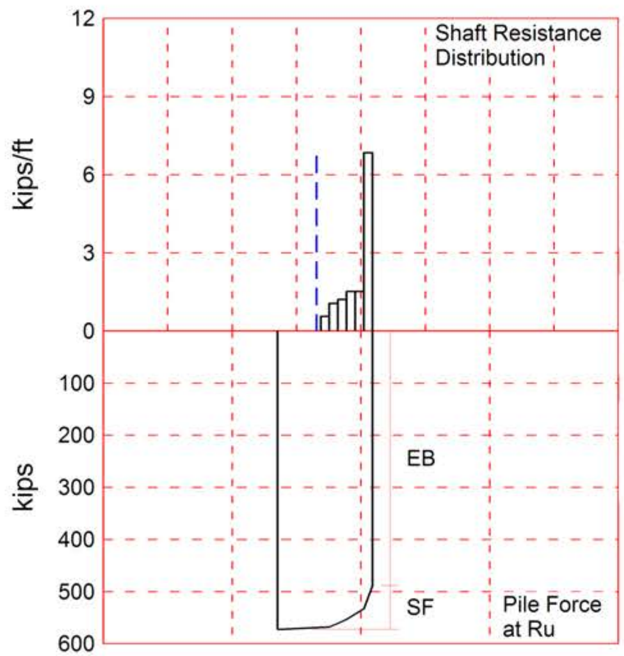
27-Oct-2014
CAPWAP(R) 2014







RU =	572.0 kips
SF =	84.0 kips
EB =	488.0 kips
Dy =	1.44 in
Dx =	1.54 in
SET/Bl =	0.10 in



Length b. Sensors	72.3 ft
Embedment	39.9 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	3.69
Top Compr. Stress	35.2 ksi
Max Compr. Stress	40.6 ksi
Max Tension Stress	-8.99 ksi
Avg. Shaft Quake	0.16 in
Toe Quake	0.30 in
Avg. Shaft Smith Dpg.	0.31 s/ft
Toe Smith Damping	0.13 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: 572.0; along Shaft 84.0; at Toe 488.0 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
				572.0			
1	39.4	7.0	4.0	568.0	4.0	0.57	0.14
2	46.0	13.6	7.0	561.0	11.0	1.07	0.27
3	52.6	20.1	8.0	553.0	19.0	1.22	0.31
4	59.2	26.7	10.0	543.0	29.0	1.52	0.38
5	65.7	33.3	10.0	533.0	39.0	1.52	0.38
6	72.3	39.9	45.0	488.0	84.0	6.85	1.72
Avg. Shaft			14.0			2.11	0.53
Toe			488.0				495.26

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.31	0.13
Quake	(in)	0.16	0.30
Case Damping Factor		0.94	2.29
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	88	35
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.07

CAPWAP match quality = 3.69 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.05 in; Blow Count = 218 b/ft

max. Top Comp. Stress = 35.2 ksi (T= 45.2 ms, max= 1.154 x Top)
max. Comp. Stress = 40.6 ksi (Z= 72.3 ft, T= 41.8 ms)
max. Tens. Stress = -8.99 ksi (Z= 39.4 ft, T= 56.1 ms)
max. Energy (EMX) = 35.6 kip-ft; max. Measured Top Displ. (DMX)= 1.25 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	545.2	-40.1	35.2	-2.58	35.6	17.4	1.24
2	6.6	560.9	-42.9	36.2	-2.76	35.1	17.4	1.20
3	9.9	569.3	-45.9	36.7	-2.96	34.4	17.4	1.17
4	13.1	567.4	-53.5	36.6	-3.45	33.7	17.3	1.13
5	16.4	563.8	-72.7	36.4	-4.69	32.9	17.3	1.09
6	19.7	569.2	-92.9	36.7	-5.99	32.1	17.3	1.05
7	23.0	566.2	-111.4	36.5	-7.19	31.3	17.2	1.01
8	26.3	558.1	-126.2	36.0	-8.14	30.5	17.2	0.96
9	29.6	546.4	-135.0	35.2	-8.71	29.6	17.1	0.92
10	32.9	545.6	-134.8	35.2	-8.69	28.7	16.9	0.88
11	36.2	553.8	-132.8	35.7	-8.57	27.6	16.7	0.83
12	39.4	562.5	-139.3	36.3	-8.99	26.6	16.4	0.79
13	42.7	575.1	-131.7	37.1	-8.49	24.4	16.0	0.74
14	46.0	585.2	-133.2	37.7	-8.59	23.2	15.7	0.69
15	49.3	590.7	-116.4	38.1	-7.51	20.6	15.3	0.64
16	52.6	605.3	-115.1	39.0	-7.42	19.4	14.8	0.59
17	55.9	603.7	-101.0	38.9	-6.51	16.8	14.2	0.54
18	59.2	620.8	-104.4	40.0	-6.73	15.6	13.7	0.49
19	62.4	616.5	-88.0	39.8	-5.67	13.1	13.4	0.45
20	65.7	615.8	-92.6	39.7	-5.98	12.0	13.4	0.40
21	69.0	615.7	-76.6	39.7	-4.94	9.9	12.3	0.35
22	72.3	628.8	-78.8	40.6	-5.08	7.0	9.4	0.30
Absolute	72.3			40.6			(T =	41.8 ms)
	39.4				-8.99		(T =	56.1 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	745.6	721.6	697.6	673.5	649.5	625.5	601.5	577.5	553.5	529.5
RX	756.7	733.1	709.4	686.0	668.4	655.5	642.6	629.9	617.6	606.4
RU	751.4	727.9	704.5	681.1	657.6	634.2	610.8	587.3	563.9	540.5

RAU = 543.3 (kips); RA2 = 602.0 (kips)

Current CAPWAP Ru = 572.0 (kips); RMX requires J > 0.9;

Check with PDA-W; RA2 may be a better Case Method

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
17.2	35.98	477.1	508.6	550.2	1.25	0.10	0.10	36.0	642.0	2122

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.782 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Al Ziai
Company: Lunda Construction Company	No. of Sheets: 34
E-mail: whamacher@lundaconstruction.com	Date: October 9, 2014

RE: Dynamic Testing Results – Pier 5
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On October 7, 2014, Pier 5 #1 and Pier 5 #34 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on October 8. The 75.4 foot long HP 12 x 53 H-piles equipped with driving shoes were driven with an APE D25-42 hammer operated on fuel setting four. Plans indicate the piles in Pier 5 have a required driving resistance or ultimate capacity of 400 kips, and an estimated length of 50 feet.

Pier 5 #1 was driven to a depth of 46.0 feet below the excavated ground surface at EL 582.5, which corresponds to a pile tip elevation of EL 536.5. The blow count over the final increment of driving was 5 blows for ⅜ inch of penetration at an average hammer stroke of 8.9 feet. The transition in driving resistance was very rapid at the end of driving as the pile was driven to bedrock. Prior to the final five blow set the blow count was 12 blows per foot at an average hammer stroke of 6.0 feet. The blow count at the beginning of restrike of Pier 5 #1 was 5 blows for ¼ inch of penetration at an average hammer stroke of 9.8 feet

Pier 5 #34 was driven to a depth of 46.0 feet below the excavated ground surface at EL 582.5, which corresponds to a pile tip elevation of EL 536.5. The blow count over the final increment of driving was 5 blows for ½ inch of penetration at an average hammer stroke of 9.8 feet. Prior to the final five blow set the blow count was 9 blows per foot at an average hammer stroke of 7.6 feet. The blow count at the beginning of restrike of Pier 5 #34 was 5 blows for ¼ inch of penetration at an average hammer stroke of 9.4 feet

Pier 5 #1 approached the maximum driving stress limit during initial driving and restrike and Pier 5 #34 slightly exceeded the driving stress limit during both driving sequences. We recommend reducing the fuel setting to three for production driving. If the stroke still exceeds 9.0 feet at the end of driving we recommend further reducing the fuel setting.

October 9, 2014

For the 400 kip piles, driven with the APE D25-42 hammer, in Pier 5 of the STH 96 bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.5	5
8.0	4
8.5	4
9.0	3

We recommended the above blow count at the corresponding hammer stroke be maintained for three consecutive inches of driving. Driving may be terminated if production piles exceed 10 blows over an increment of one inch or less at hammer strokes of 9.0 feet. After splicing or any other delays, we recommend not applying the criteria until at least two feet of driving has occurred beyond the termination depth associated with the delay.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Al Ziai

Travis Coleman, P.E.

Cc: Steve Seymour - steve.seymour@omnni.com
Jeff Horsfall - Jeffrey.Horsfall@dot.wi.gov

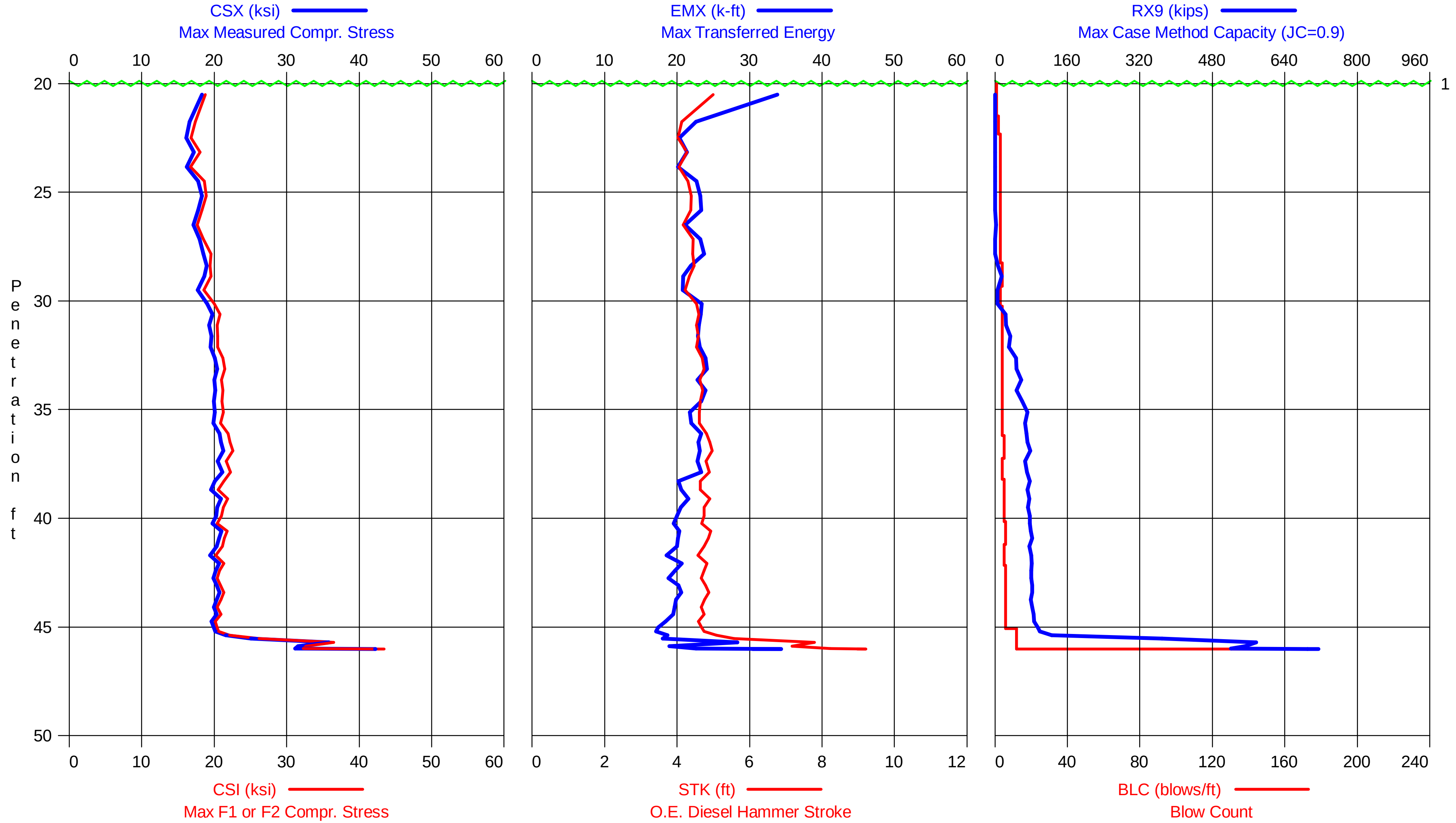
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 8-Oct-2014

Test date: 7-Oct-2014

STH 96 over Fox River - Pier 5 #1 - EOID

APE D25-42, HP 12 x 53



1 - Reported Reference EL 582.5

STH 96 over Fox River - Pier 5 #1 - EOID APE D25-42, HP 12 x 53
OP: AZ Test date: 7-Oct-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
1	20.00	1	AV1	16.1	4.3	**	34	**	0
			MAX	16.1	4.3	**	34	**	0
			MIN	16.1	4.3	**	34	**	0
2	21.00	1	AV1	20.5	4.1	5.0	34	52	0
			MAX	20.5	4.1	5.0	34	52	0
			MIN	20.5	4.1	5.0	34	52	0
4	22.00	2	AV2	16.6	3.9	4.1	23	57	0
			STD	0.1	0.0	0.0	0	0	0
			MAX	16.6	4.0	4.2	23	58	0
			MIN	16.5	3.9	4.1	22	57	0
7	23.00	3	AV3	16.1	3.9	4.1	20	58	0
			STD	1.2	0.1	0.2	1	1	0
			MAX	17.7	3.9	4.2	22	59	0
			MIN	14.6	3.8	3.8	19	57	0
10	24.00	3	AV3	16.9	4.1	4.2	21	57	0
			STD	1.0	0.2	0.2	1	1	0
			MAX	18.3	4.4	4.4	23	58	0
			MIN	16.1	4.0	4.0	19	56	0
13	25.00	3	AV3	17.8	4.3	4.3	23	56	0
			STD	0.5	0.1	0.1	1	1	0
			MAX	18.4	4.5	4.5	24	57	0
			MIN	17.2	4.2	4.2	22	55	0
16	26.00	3	AV3	18.1	4.4	4.4	23	56	0
			STD	1.2	0.2	0.2	1	1	0
			MAX	19.2	4.6	4.6	25	57	0
			MIN	16.4	4.2	4.2	22	55	0
19	27.00	3	AV3	17.3	4.2	4.3	22	56	1
			STD	1.4	0.3	0.2	2	1	2
			MAX	18.8	4.5	4.4	24	58	4
			MIN	15.5	3.8	3.9	18	55	0
22	28.00	3	AV3	18.4	4.4	4.4	24	55	0
			STD	0.4	0.1	0.1	1	0	0
			MAX	18.9	4.5	4.5	25	56	0
			MIN	18.1	4.3	4.4	23	55	0
26	29.00	4	AV4	18.8	4.6	4.4	21	55	11
			STD	0.9	0.1	0.1	1	1	6
			MAX	20.1	4.7	4.6	22	56	17
			MIN	17.8	4.5	4.3	21	54	1
29	30.00	3	AV3	18.1	4.6	4.3	22	56	4
			STD	0.8	0.2	0.2	2	1	5
			MAX	18.9	4.9	4.6	24	57	11
			MIN	17.1	4.3	4.2	21	55	0
33	31.00	4	AV4	19.5	4.8	4.6	23	55	19
			STD	0.7	0.1	0.1	1	1	7
			MAX	20.7	5.0	4.8	24	55	28
			MIN	18.7	4.8	4.4	23	53	10
37	32.00	4	AV4	19.5	4.9	4.6	23	55	36
			STD	0.2	0.1	0.0	0	0	7
			MAX	19.7	5.0	4.6	23	55	43
			MIN	19.2	4.9	4.5	23	54	27
41	33.00	4	AV4	20.0	5.0	4.7	24	54	40
			STD	0.4	0.1	0.1	0	1	12
			MAX	20.3	5.1	4.7	24	55	49
			MIN	19.4	4.9	4.5	23	54	20

STH 96 over Fox River - Pier 5 #1 - EOID
OP: AZ
APE D25-42, HP 12 x 53
Test date: 7-Oct-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
45	34.00	4	AV4	20.0	5.0	4.6	23	54	52
			STD	0.4	0.1	0.1	1	0	6
			MAX	20.5	5.1	4.7	24	55	60
			MIN	19.6	5.0	4.6	22	54	45
49	35.00	4	AV4	20.2	5.2	4.7	23	54	61
			STD	0.4	0.0	0.1	1	0	11
			MAX	20.7	5.2	4.8	24	54	72
			MIN	19.7	5.1	4.6	23	53	48
53	36.00	4	AV4	19.9	5.2	4.6	22	54	68
			STD	0.1	0.1	0.0	1	0	3
			MAX	20.0	5.3	4.7	23	55	73
			MIN	19.7	5.1	4.6	21	54	64
58	37.00	5	AV5	21.2	5.5	4.9	23	53	75
			STD	0.5	0.0	0.1	0	0	3
			MAX	21.6	5.6	5.0	23	53	80
			MIN	20.3	5.4	4.8	23	52	71
62	38.00	4	AV4	20.8	5.5	4.8	23	53	68
			STD	0.7	0.1	0.1	1	1	4
			MAX	21.5	5.6	5.0	25	54	72
			MIN	19.6	5.4	4.7	22	52	63
67	39.00	5	AV5	20.1	5.5	4.7	21	54	75
			STD	0.8	0.1	0.2	1	1	3
			MAX	21.1	5.6	5.0	22	55	79
			MIN	18.8	5.4	4.5	19	52	71
72	40.00	5	AV5	20.4	5.4	4.8	21	53	75
			STD	0.2	0.1	0.1	1	0	2
			MAX	20.7	5.6	4.8	22	54	78
			MIN	20.1	5.2	4.7	20	53	73
78	41.00	6	AV6	20.5	5.5	4.8	20	53	80
			STD	0.8	0.1	0.2	1	1	2
			MAX	21.3	5.7	5.0	21	55	83
			MIN	19.0	5.4	4.5	19	52	77
83	42.00	5	AV5	20.0	5.6	4.7	20	54	78
			STD	0.5	0.1	0.1	1	1	2
			MAX	20.5	5.8	4.8	21	55	81
			MIN	19.1	5.5	4.5	18	53	75
89	43.00	6	AV6	20.1	5.7	4.7	19	54	81
			STD	0.5	0.1	0.1	1	1	3
			MAX	20.8	5.8	4.9	20	54	85
			MIN	19.6	5.5	4.6	19	53	76
95	44.00	6	AV6	20.5	5.7	4.8	20	53	81
			STD	0.4	0.1	0.1	1	1	1
			MAX	21.0	5.8	4.9	21	54	83
			MIN	19.7	5.5	4.6	19	53	79
101	45.00	6	AV6	20.0	5.7	4.7	19	54	86
			STD	0.4	0.1	0.1	1	0	5
			MAX	20.5	5.8	4.8	21	55	93
			MIN	19.2	5.5	4.5	18	53	78
113	46.00	12	AV12	26.2	21.0	6.0	19	49	329
			STD	6.3	13.6	1.5	6	5	205
			MAX	38.5	43.2	8.9	32	54	630
			MIN	19.8	5.7	4.7	11	40	97
118	46.03	160	AV5	41.0	44.8	8.9	32	40	689
			STD	2.6	3.0	0.4	4	1	31
			MAX	43.3	46.7	9.5	36	41	715
			MIN	36.2	38.9	8.2	26	38	633

STH 96 over Fox River - Pier 5 #1 - EOID
OP: AZ

APE D25-42, HP 12 x 53
Test date: 7-Oct-2014

	CSX	CSB	STK	EMX	BPM	RX9
	ksi	ksi	ft	k-ft	**	kips
Average	21.1	8.4	4.9	22	53	104
Std. Dev.	5.3	10.1	1.1	4	4	166
Maximum	43.3	46.7	9.5	36	59	715
Minimum	14.6	3.8	3.8	11	38	0

Total number of blows analyzed: 118

BL#	depth (ft)	Comments
1	20.00	Reported Reference EL 582.5

Time Summary

Drive 3 minutes 31 seconds 2:01:07 PM - 2:04:38 PM (10/7/2014) BN 1 - 118

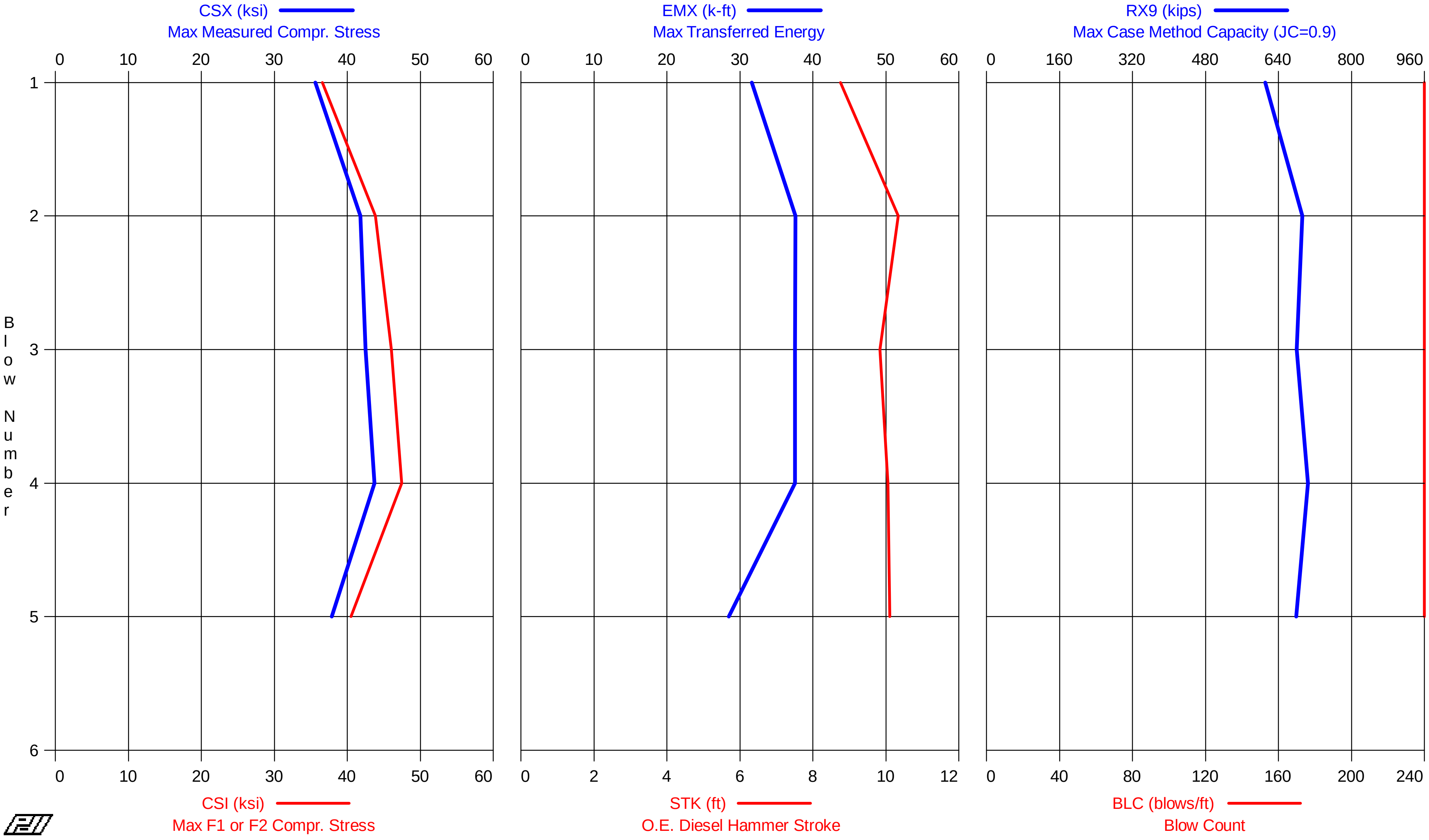
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 8-Oct-2014

Test date: 8-Oct-2014

STH 96 over Fox River - Pier 5 #1 - BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River - Pier 5 #1 - BOR APE D25-42, HP 12 x 53
OP: AZ Test date: 8-Oct-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
5	46.05	240	AV5	40.3	44.5	9.8	35	38	674
			STD	3.1	4.1	0.6	4	1	33
			MAX	43.7	47.9	10.3	38	40	705
			MIN	35.6	36.6	8.7	28	37	611
			Average	40.3	44.5	9.8	35	38	674
			Std. Dev.	3.1	4.1	0.6	4	1	33
			Maximum	43.7	47.9	10.3	38	40	705
			Minimum	35.6	36.6	8.7	28	37	611

Total number of blows analyzed: 5

Time Summary

Drive 6 seconds 10:08:15 AM - 10:08:21 AM (10/8/2014) BN 1 - 5

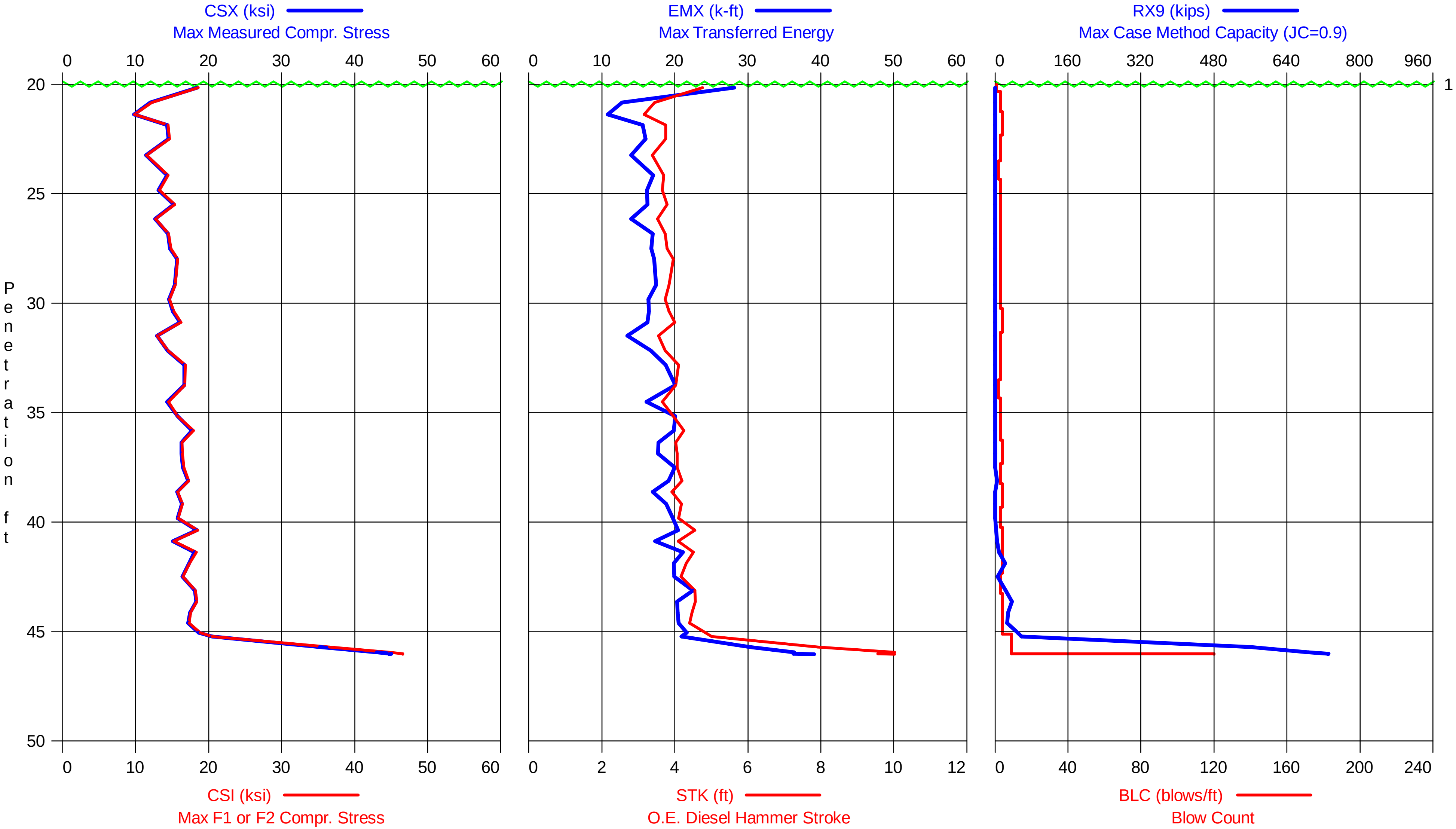
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 8-Oct-2014

Test date: 7-Oct-2014

STH 96 over Fox River - Pier 5 #34 - EOID

APE D25-42, HP 12 x 53



1 - Reported Reference EL 582.5

STH 96 over Fox River - Pier 5 #34 - EOID APE D25-42, HP 12 x 53
OP: AZ Test date: 7-Oct-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
1	20.00	1	AV1	16.8	3.6	**	31	**	0
			MAX	16.8	3.6	**	31	**	0
			MIN	16.8	3.6	**	31	**	0
4	21.00	3	AV3	14.7	3.4	3.9	17	59	0
			STD	4.2	0.5	0.7	6	4	0
			MAX	20.0	4.0	4.8	25	64	0
			MIN	9.7	2.8	3.2	10	54	0
8	22.00	4	AV4	12.0	3.2	3.5	13	62	0
			STD	2.4	0.5	0.3	2	2	0
			MAX	15.1	3.9	3.9	17	65	0
			MIN	9.3	2.7	3.2	10	59	0
11	23.00	3	AV3	13.5	3.5	3.6	15	61	0
			STD	1.4	0.3	0.2	1	1	0
			MAX	15.1	3.9	3.8	17	62	0
			MIN	11.6	3.1	3.4	13	59	0
13	24.00	2	AV2	12.6	3.2	3.5	17	62	0
			STD	1.4	0.2	0.2	2	1	0
			MAX	14.0	3.3	3.7	18	63	0
			MIN	11.2	3.0	3.4	15	60	0
16	25.00	3	AV3	13.6	3.6	3.7	16	60	0
			STD	1.9	0.3	0.2	2	2	0
			MAX	15.3	3.9	3.9	19	63	0
			MIN	11.0	3.2	3.4	14	59	0
19	26.00	3	AV3	14.8	3.5	3.8	16	60	0
			STD	1.0	0.2	0.1	1	1	0
			MAX	16.3	3.7	3.9	17	61	0
			MIN	13.9	3.3	3.6	15	59	0
22	27.00	3	AV3	13.4	3.5	3.6	16	61	0
			STD	1.6	0.4	0.2	2	2	0
			MAX	15.4	3.9	3.9	17	63	0
			MIN	11.4	3.0	3.4	13	59	0
25	28.00	3	AV3	15.0	3.7	3.8	17	59	0
			STD	0.6	0.1	0.1	0	1	0
			MAX	15.6	3.8	4.0	17	60	0
			MIN	14.3	3.6	3.7	17	58	0
28	29.00	3	AV1	15.3	3.8	3.8	17	59	0
			MAX	15.3	3.8	3.8	17	59	0
			MIN	15.3	3.8	3.8	17	59	0
31	30.00	3	AV3	14.8	3.5	3.8	17	60	0
			STD	0.8	0.3	0.1	1	1	0
			MAX	15.4	3.7	3.8	18	61	0
			MIN	13.7	3.2	3.6	16	59	0
35	31.00	4	AV4	15.6	3.9	3.9	16	59	0
			STD	0.7	0.1	0.1	1	1	0
			MAX	16.2	4.0	4.0	17	60	0
			MIN	14.3	3.8	3.7	15	58	0
38	32.00	3	AV3	13.0	3.2	3.6	14	61	0
			STD	1.3	0.1	0.2	1	1	0
			MAX	14.5	3.3	3.8	15	63	0
			MIN	11.3	3.1	3.3	12	60	0
41	33.00	3	AV3	16.3	4.0	4.0	19	58	0
			STD	0.5	0.0	0.1	0	1	0
			MAX	16.8	4.0	4.1	19	59	0
			MIN	15.6	3.9	3.9	18	57	0

STH 96 over Fox River - Pier 5 #34 - EOID
APE D25-42, HP 12 x 53
OP: AZ
Test date: 7-Oct-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
43	34.00	2	AV2	16.6	3.5	4.0	20	58	0
			STD	0.5	0.1	0.1	2	1	0
			MAX	17.2	3.6	4.1	22	59	0
			MIN	16.1	3.4	3.9	18	57	0
46	35.00	3	AV3	14.3	3.5	3.7	17	60	0
			STD	0.3	0.0	0.0	1	0	0
			MAX	14.7	3.5	3.7	18	61	0
			MIN	13.9	3.4	3.6	15	60	0
49	36.00	3	AV3	17.6	4.2	4.2	21	56	0
			STD	0.6	0.2	0.1	1	1	0
			MAX	18.4	4.4	4.4	22	57	0
			MIN	17.0	3.9	4.1	19	56	0
53	37.00	4	AV4	16.3	4.2	4.0	18	58	0
			STD	0.5	0.1	0.1	1	1	0
			MAX	17.0	4.3	4.2	19	59	0
			MIN	15.5	4.2	3.9	17	57	0
56	38.00	3	AV3	16.8	4.0	4.1	20	57	0
			STD	0.6	0.2	0.1	1	1	0
			MAX	17.4	4.2	4.2	21	58	0
			MIN	16.0	3.8	4.0	20	57	0
60	39.00	4	AV4	16.0	4.3	4.0	17	58	3
			STD	0.6	0.1	0.1	0	1	4
			MAX	17.0	4.4	4.2	18	59	10
			MIN	15.5	4.1	3.9	17	57	0
63	40.00	3	AV3	16.2	4.1	4.2	20	57	0
			STD	0.9	0.1	0.2	1	1	0
			MAX	17.1	4.3	4.3	21	59	0
			MIN	14.9	4.0	3.9	19	56	0
67	41.00	4	AV4	16.7	4.6	4.3	19	56	4
			STD	1.9	0.2	0.3	2	2	2
			MAX	19.6	5.0	4.7	21	57	7
			MIN	15.0	4.3	4.1	17	54	0
71	42.00	4	AV4	17.7	4.8	4.4	20	55	16
			STD	1.0	0.1	0.2	1	1	9
			MAX	19.4	4.9	4.7	21	56	24
			MIN	16.7	4.7	4.3	19	54	0
74	43.00	3	AV3	16.9	4.6	4.3	21	56	6
			STD	0.8	0.2	0.2	2	1	1
			MAX	17.8	4.8	4.5	23	57	7
			MIN	15.8	4.3	4.1	19	55	4
78	44.00	4	AV4	18.0	5.0	4.5	21	55	35
			STD	0.7	0.1	0.1	1	0	8
			MAX	18.5	5.1	4.6	22	56	43
			MIN	16.8	4.9	4.4	20	54	23
82	45.00	4	AV4	17.8	5.0	4.5	21	55	33
			STD	0.7	0.2	0.2	1	1	9
			MAX	18.7	5.3	4.8	22	56	44
			MIN	17.2	4.9	4.4	20	53	18
91	46.00	9	AV6	32.6	29.1	7.6	29	44	435
			STD	10.0	17.6	2.2	7	7	276
			MAX	44.8	47.3	10.2	40	53	693
			MIN	18.6	5.3	4.8	21	37	56
96	46.04	120	AV4	44.9	47.0	9.8	38	38	731
			STD	0.5	1.8	0.3	3	1	8
			MAX	45.7	49.4	10.3	41	39	738
			MIN	44.4	44.9	9.5	34	37	723

STH 96 over Fox River - Pier 5 #34 - EOID
OP: AZ
APE D25-42, HP 12 x 53
Test date: 7-Oct-2014

	CSX	CSB	STK	EMX	BPM	RX9
	ksi	ksi	ft	k-ft	**	kips
Average	18.0	7.6	4.5	20	56	66
Std. Dev.	7.9	11.5	1.6	6	6	193
Maximum	45.7	49.4	10.3	41	65	738
Minimum	9.3	2.7	3.2	10	37	0

Total number of blows analyzed: 90

BL#	depth (ft)	Comments
1	20.00	Reported Reference EL 582.5

Time Summary

Drive 2 minutes 22 seconds 2:17:53 PM - 2:20:15 PM (10/7/2014) BN 1 - 97

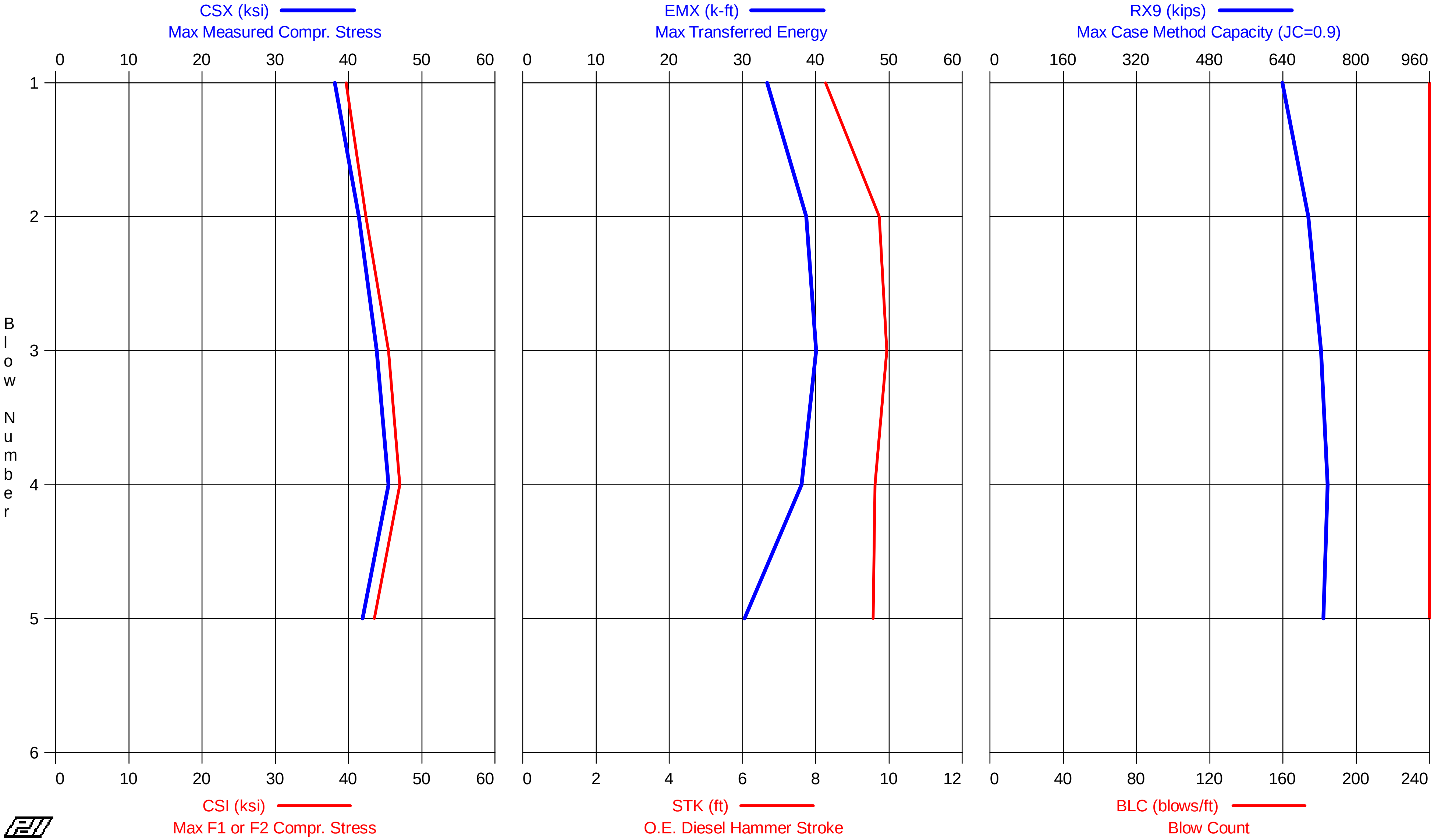
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 8-Oct-2014

Test date: 8-Oct-2014

STH 96 over Fox River - Pier 5 #34 - BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River - Pier 5 #34 - BOR APE D25-42, HP 12 x 53
OP: AZ Test date: 8-Oct-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

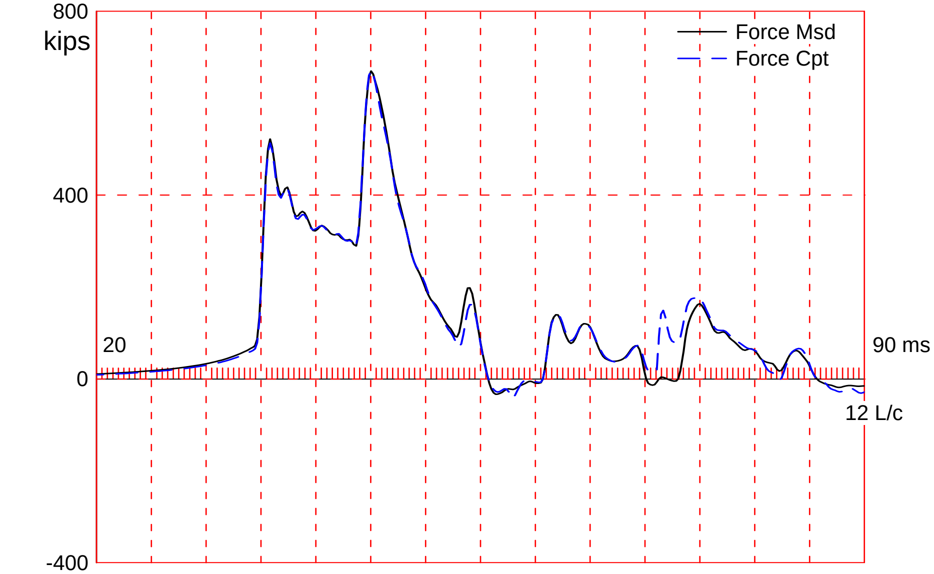
CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke
EMX: Max Transferred Energy
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

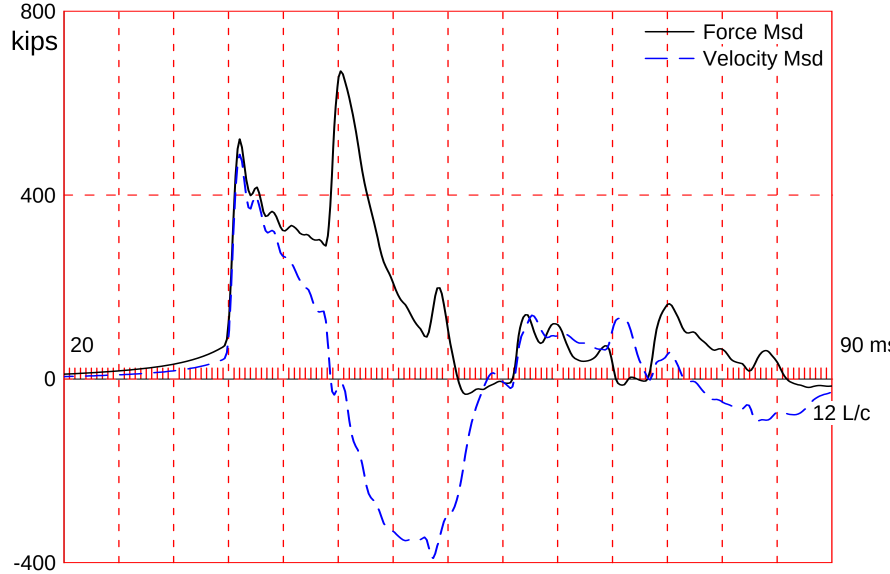
BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
5	46.06	240	AV5	42.2	44.3	9.4	36	39	704
			STD	2.5	5.1	0.6	4	1	36
			MAX	45.5	48.2	9.9	40	41	738
			MIN	38.1	34.7	8.3	30	38	638
			Average	42.2	44.3	9.4	36	39	704
			Std. Dev.	2.5	5.1	0.6	4	1	36
			Maximum	45.5	48.2	9.9	40	41	738
			Minimum	38.1	34.7	8.3	30	38	638

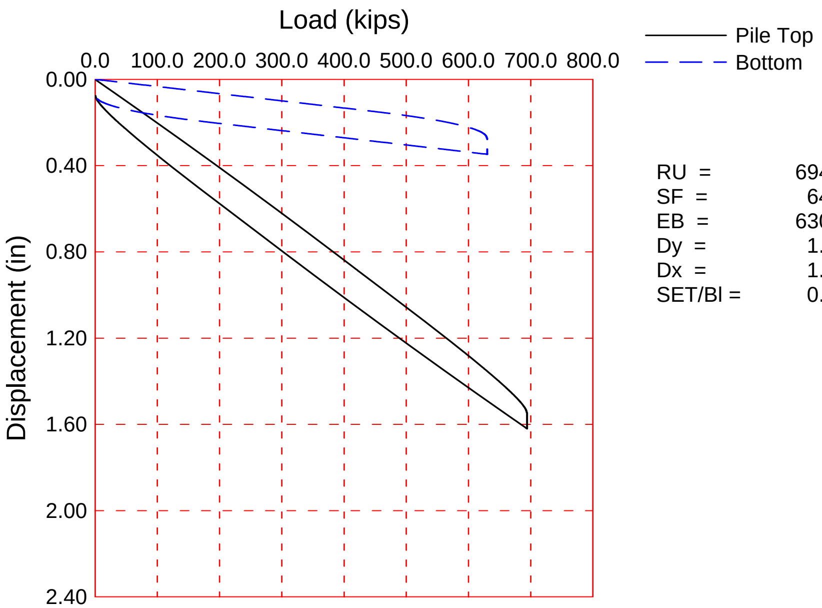
Total number of blows analyzed: 5

Time Summary

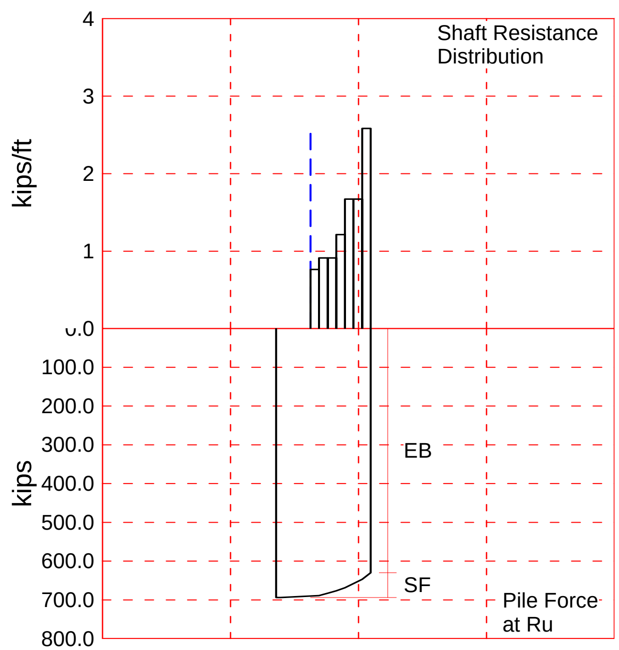
Drive 6 seconds 10:20:29 AM - 10:20:35 AM (10/8/2014) BN 1 - 5







RU =	694.0 kips
SF =	64.0 kips
EB =	630.0 kips
Dy =	1.55 in
Dx =	1.62 in
SET/Bl =	0.08 in



Length b. Sensors	72.4 ft
Embedment	46.0 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	3.17
Top Compr. Stress	42.8 ksi
Max Compr. Stress	44.4 ksi
Max Tension Stress	-9.34 ksi
Avg. Shaft Quake	0.20 in
Toe Quake	0.21 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.09 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: 694.0; along Shaft 64.0; at Toe 630.0 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
				694.0			
1	32.9	6.5	5.0	689.0	5.0	0.77	0.19
2	39.5	13.1	6.0	683.0	11.0	0.91	0.23
3	46.1	19.7	6.0	677.0	17.0	0.91	0.23
4	52.7	26.3	8.0	669.0	25.0	1.22	0.31
5	59.2	32.9	11.0	658.0	36.0	1.67	0.42
6	65.8	39.4	11.0	647.0	47.0	1.67	0.42
7	72.4	46.0	17.0	630.0	64.0	2.58	0.65
Avg. Shaft			9.1			1.39	0.35
Toe			630.0				639.37

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.28	0.09
Quake	(in)	0.20	0.21
Case Damping Factor		0.65	2.05
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	85	49
Unloading Level	(% of Ru)	88	
Resistance Gap (included in Toe Quake) (in)			0.13
Soil Plug Weight	(kips)		0.009

CAPWAP match quality = 3.17 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.04 in; Blow Count = 287 b/ft
Transducer F3(F523) CAL: 93.8; RF: 1.00; F4(H083) CAL: 94.4; RF: 1.00
A3(K974) CAL: 305; RF: 1.00; A4(K2214) CAL: 332; RF: 1.00

max. Top Comp. Stress = 42.8 ksi (T= 45.4 ms, max= 1.037 x Top)
max. Comp. Stress = 44.4 ksi (Z= 72.4 ft, T= 40.5 ms)
max. Tens. Stress = -9.34 ksi (Z= 19.7 ft, T= 57.0 ms)
max. Energy (EMX) = 34.6 kip-ft; max. Measured Top Displ. (DMX)= 1.24 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	663.5	-54.5	42.8	-3.52	34.6	17.9	1.24
2	6.6	662.8	-75.7	42.7	-4.88	33.9	17.9	1.20
3	9.9	663.0	-92.7	42.8	-5.98	33.2	17.9	1.16
4	13.2	655.6	-118.9	42.3	-7.67	32.4	17.9	1.13
5	16.5	645.0	-139.4	41.6	-8.99	31.6	17.8	1.09
6	19.7	638.1	-144.8	41.2	-9.34	30.7	17.8	1.04
7	23.0	634.4	-142.0	40.9	-9.16	29.8	17.8	1.00
8	26.3	627.2	-135.1	40.5	-8.72	28.8	17.6	0.95
9	29.6	617.9	-129.1	39.9	-8.33	27.7	17.4	0.90
10	32.9	623.3	-125.8	40.2	-8.11	26.5	17.1	0.86
11	36.2	632.1	-117.5	40.8	-7.58	23.9	16.9	0.81
12	39.5	632.0	-139.2	40.8	-8.98	22.7	16.6	0.76
13	42.8	625.8	-128.3	40.4	-8.28	20.1	16.3	0.71
14	46.1	642.7	-122.4	41.5	-7.89	18.8	16.1	0.65
15	49.4	656.3	-102.9	42.3	-6.64	16.2	15.8	0.60
16	52.7	655.9	-98.0	42.3	-6.32	14.8	15.4	0.54
17	55.9	642.6	-92.3	41.4	-5.95	12.2	15.0	0.49
18	59.2	667.2	-99.6	43.0	-6.42	10.7	14.7	0.44
19	62.5	674.1	-78.8	43.5	-5.08	7.9	14.6	0.38
20	65.8	668.9	-71.7	43.1	-4.63	6.4	14.0	0.32
21	69.1	655.2	-39.9	42.3	-2.57	4.2	11.3	0.27
22	72.4	687.8	-32.6	44.4	-2.10	3.2	6.9	0.22
Absolute	72.4			44.4			(T =	40.5 ms)
	19.7				-9.34		(T =	57.0 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	791.5	746.1	700.6	655.2	609.8					
RX	811.3	776.5	746.6	730.8	720.5	710.2	700.0	690.5	681.3	672.0
RU	787.7	741.5	695.3	649.1	602.9					

RAU = 539.9 (kips); RA2 = 698.9 (kips)

Current CAPWAP Ru = 694.0 (kips); Corresponding J(RP)= 0.43; J(RX) = 1.32

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
17.8	36.03	491.4	527.2	671.8	1.24	0.08	0.08	35.2	642.7	7875

PILE PROFILE AND PILE MODEL

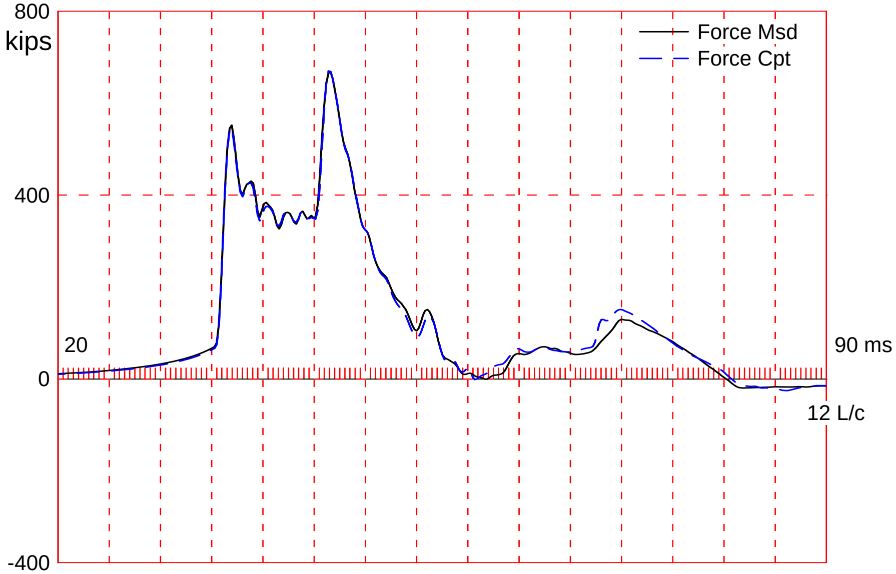
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

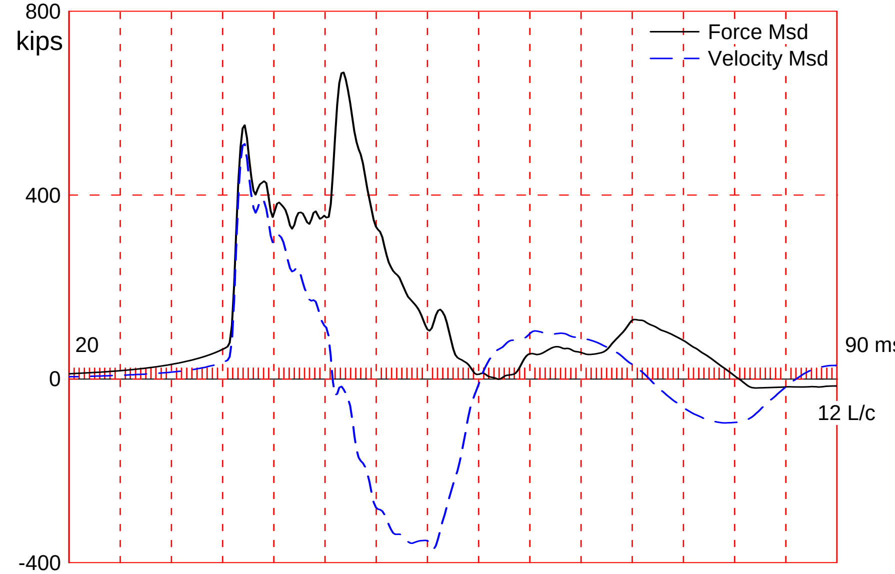
Toe Area 141.9 in^2

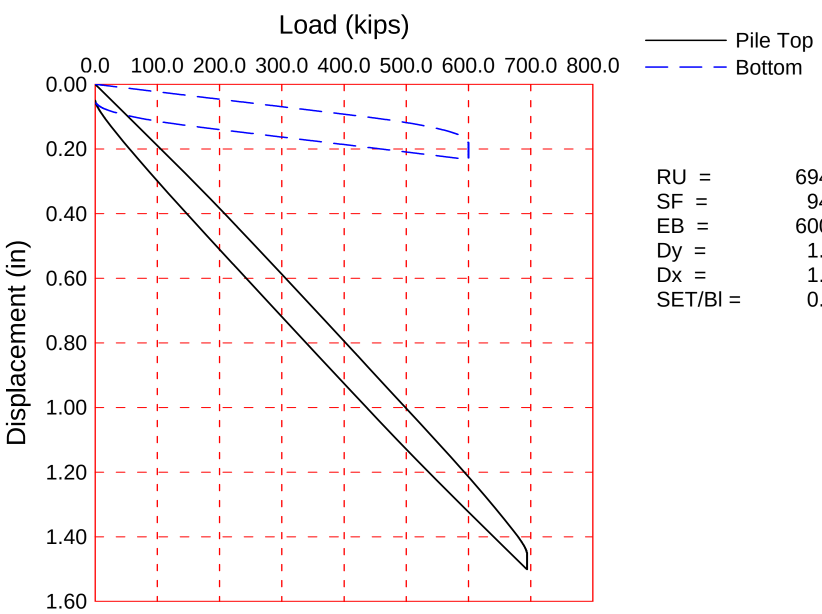
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

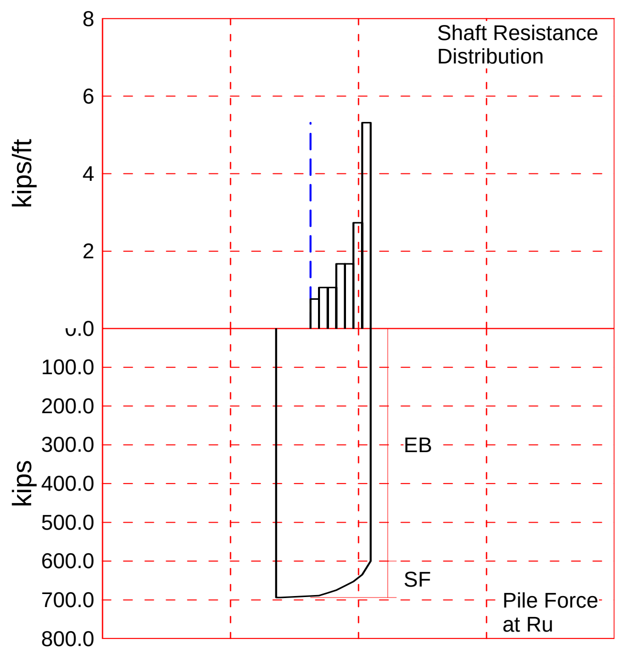
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000







RU =	694.0 kips
SF =	94.0 kips
EB =	600.0 kips
Dy =	1.45 in
Dx =	1.50 in
SET/Bl =	0.05 in



Length b. Sensors	72.4 ft
Embedment	46.0 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	2.01
Top Compr. Stress	43.0 ksi
Max Compr. Stress	44.8 ksi
Max Tension Stress	-8.22 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.14 in
Avg. Shaft Smith Dpg.	0.31 s/ft
Toe Smith Damping	0.15 s/ft

About the CAPWAP Results

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 694.0; along Shaft 94.0; at Toe 600.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				694.0			
1	32.9	6.5	5.0	689.0	5.0	0.77	0.19
2	39.5	13.1	7.0	682.0	12.0	1.06	0.27
3	46.1	19.7	7.0	675.0	19.0	1.06	0.27
4	52.7	26.3	11.0	664.0	30.0	1.67	0.42
5	59.2	32.9	11.0	653.0	41.0	1.67	0.42
6	65.8	39.4	18.0	635.0	59.0	2.73	0.69
7	72.4	46.0	35.0	600.0	94.0	5.32	1.34
Avg. Shaft			13.4			2.04	0.51
Toe			600.0				608.92

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.31	0.15
Quake	(in)	0.14	0.14
Case Damping Factor		1.05	3.25
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	78	34
Unloading Level	(% of Ru)	99	
Resistance Gap (included in Toe Quake) (in)			0.08
Soil Plug Weight	(kips)		0.052

CAPWAP match quality = 2.01 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.05 in; Blow Count = 240 b/ft
Computed: Final Set = 0.06 in; Blow Count = 196 b/ft
Transducer F3(H083) CAL: 94.4; RF: 1.00; F4(F523) CAL: 93.8; RF: 1.00
A3(K2214) CAL: 332; RF: 1.00; A4(K974) CAL: 305; RF: 1.00

max. Top Comp. Stress = 43.0 ksi (T= 45.0 ms, max= 1.041 x Top)
max. Comp. Stress = 44.8 ksi (Z= 72.4 ft, T= 40.5 ms)
max. Tens. Stress = -8.22 ksi (Z= 39.5 ft, T= 55.6 ms)
max. Energy (EMX) = 36.6 kip-ft; max. Measured Top Displ. (DMX)= 1.21 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	666.6	-28.3	43.0	-1.83	36.6	18.7	1.20
2	6.6	655.3	-31.6	42.3	-2.04	35.8	18.7	1.16
3	9.9	656.1	-36.1	42.3	-2.33	35.0	18.6	1.12
4	13.2	656.5	-51.3	42.3	-3.31	34.1	18.6	1.08
5	16.5	651.6	-62.4	42.0	-4.02	33.1	18.6	1.03
6	19.7	637.5	-83.3	41.1	-5.37	32.1	18.5	0.99
7	23.0	632.5	-99.8	40.8	-6.44	31.2	18.4	0.94
8	26.3	628.2	-105.3	40.5	-6.79	30.0	18.2	0.90
9	29.6	632.5	-105.0	40.8	-6.77	28.8	17.9	0.85
10	32.9	646.5	-103.6	41.7	-6.68	27.6	17.6	0.79
11	36.2	640.7	-105.3	41.3	-6.79	25.1	17.2	0.75
12	39.5	637.8	-127.5	41.1	-8.22	23.7	16.9	0.69
13	42.8	658.8	-125.1	42.5	-8.07	20.7	16.5	0.64
14	46.1	672.0	-126.1	43.3	-8.13	19.1	16.0	0.58
15	49.4	667.9	-110.9	43.1	-7.15	16.4	15.5	0.53
16	52.7	656.4	-108.9	42.3	-7.03	15.1	15.1	0.48
17	55.9	676.4	-84.3	43.6	-5.44	11.9	14.6	0.42
18	59.2	691.3	-85.7	44.6	-5.53	10.3	14.0	0.36
19	62.5	675.1	-65.4	43.5	-4.22	7.7	13.6	0.31
20	65.8	664.1	-67.2	42.8	-4.33	6.2	12.7	0.25
21	69.1	660.3	-34.1	42.6	-2.20	3.7	9.8	0.20
22	72.4	693.9	-34.9	44.8	-2.25	2.5	4.9	0.15
Absolute	72.4			44.8			(T =	40.5 ms)
	39.5				-8.22		(T =	55.6 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	867.7	825.7	783.8	741.8	699.9					
RX	867.7	825.7	786.3	747.4	716.0	691.1	671.6	655.0	640.9	629.1
RU	867.3	825.3	783.3	741.3	699.3					

RAU = 582.1 (kips); RA2 = 717.4 (kips)

Current CAPWAP Ru = 694.0 (kips); Corresponding J(RP)= 0.83; 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
18.7	36.03	518.0	559.4	670.4	1.21	0.05	0.05	37.2	710.1	10000

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

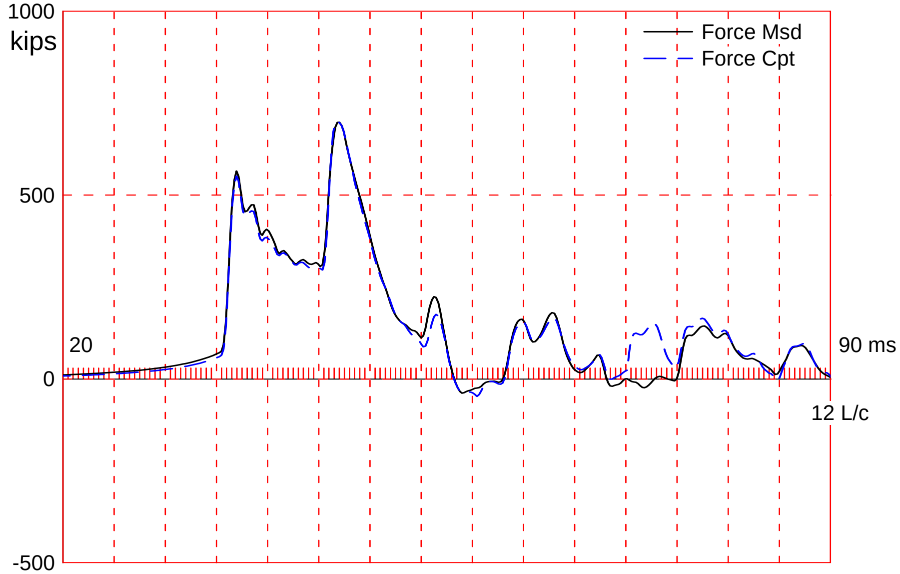
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

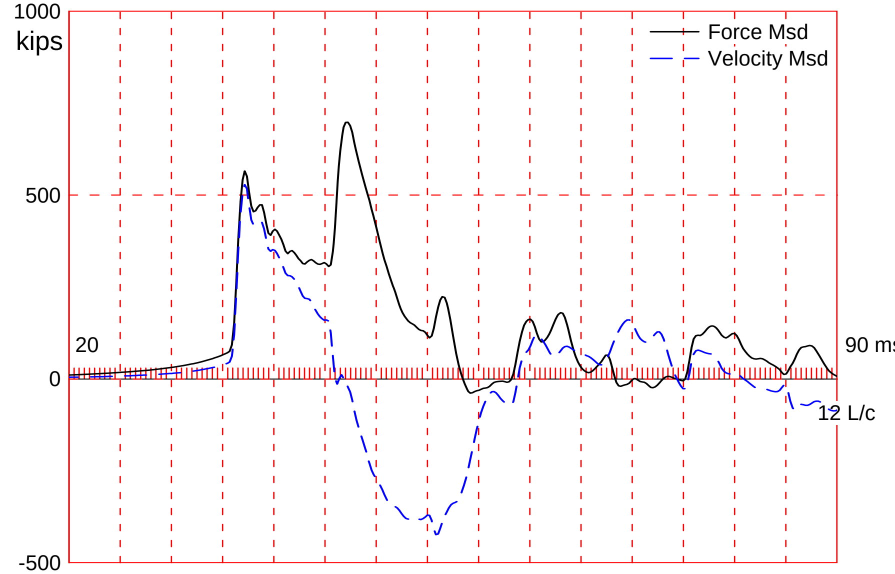
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

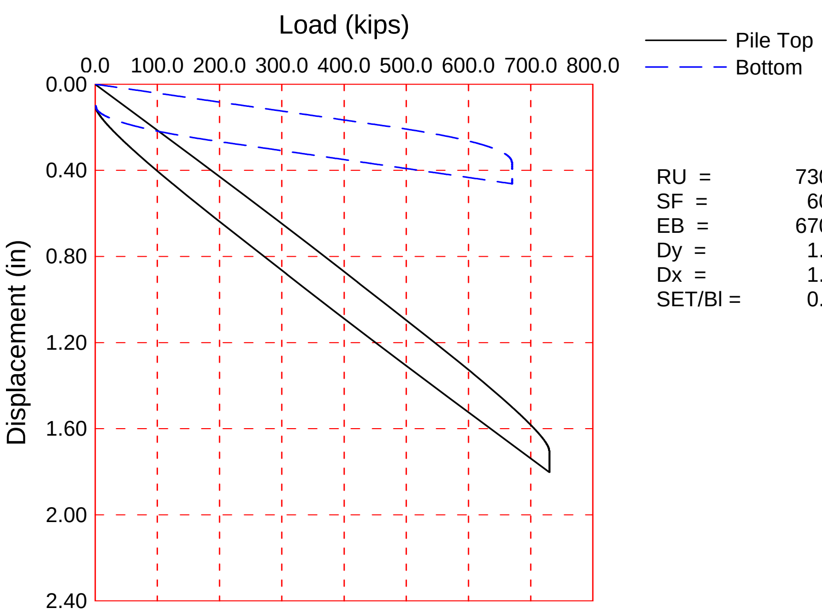
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000

STH 96 over Fox River; Pile: Pier 5 #34 - EOID; APE D25-42, HP 12 x 53; Blow: 96 (Test: 07-Oct-2014 14:20:) — 08-Oct-2014

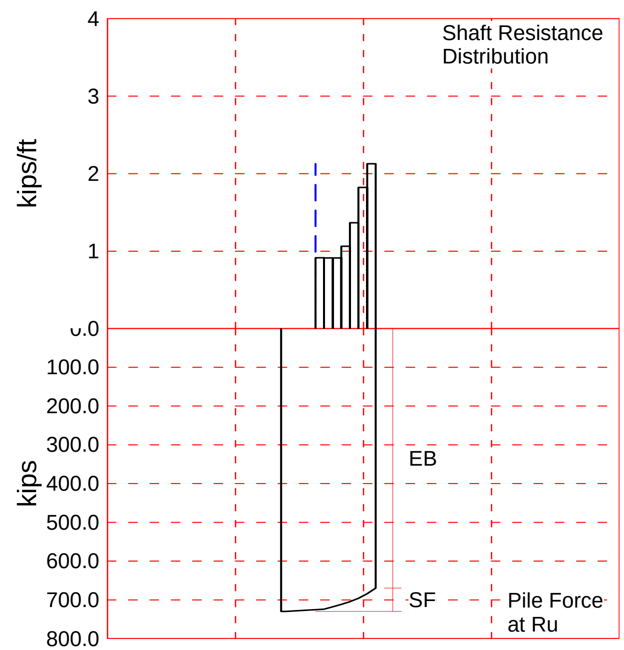
GRL Engineers, Inc. — CAPWAP(R) 2014







RU =	730.0 kips
SF =	60.0 kips
EB =	670.0 kips
Dy =	1.70 in
Dx =	1.80 in
SET/Bl =	0.10 in



Length b. Sensors	72.4 ft
Embedment	46.0 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	4.94
Top Compr. Stress	45.4 ksi
Max Compr. Stress	48.0 ksi
Max Tension Stress	-10.01 ksi
Avg. Shaft Quake	0.29 in
Toe Quake	0.28 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.10 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: 730.0; along Shaft 60.0; at Toe 670.0 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
				730.0				
1	32.9	6.6	6.0	724.0	6.0	0.92	0.23	0.30
2	39.5	13.1	6.0	718.0	12.0	0.91	0.23	0.30
3	46.1	19.7	6.0	712.0	18.0	0.91	0.23	0.30
4	52.7	26.3	7.0	705.0	25.0	1.06	0.27	0.30
5	59.2	32.9	9.0	696.0	34.0	1.37	0.34	0.30
6	65.8	39.5	12.0	684.0	46.0	1.82	0.46	0.30
7	72.4	46.0	14.0	670.0	60.0	2.13	0.54	0.28
Avg. Shaft			8.6			1.30	0.33	0.29
Toe			670.0				679.96	0.28

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.24	0.10
Case Damping Factor		0.52	2.42
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	38
Unloading Level	(% of Ru)	83	
Resistance Gap (included in Toe Quake) (in)			0.16

CAPWAP match quality = 4.94 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.01 in; Blow Count = 1042 b/ft
Transducer F3(F523) CAL: 93.8; RF: 1.00; F4(H083) CAL: 94.4; RF: 1.00
A3(K974) CAL: 305; RF: 1.00; A4(K2214) CAL: 332; RF: 1.00

max. Top Comp. Stress = 45.4 ksi (T= 45.4 ms, max= 1.057 x Top)
max. Comp. Stress = 48.0 ksi (Z= 72.4 ft, T= 40.5 ms)
max. Tens. Stress = -10.01 ksi (Z= 19.7 ft, T= 57.0 ms)
max. Energy (EMX) = 40.4 kip-ft; max. Measured Top Displ. (DMX)= 1.31 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	704.4	-66.2	45.4	-4.27	40.4	19.6	1.37
2	6.6	710.3	-92.1	45.8	-5.94	39.7	19.6	1.33
3	9.9	710.0	-120.2	45.8	-7.75	38.9	19.6	1.29
4	13.2	699.2	-144.8	45.1	-9.34	38.1	19.5	1.25
5	16.5	686.9	-154.4	44.3	-9.96	37.2	19.5	1.21
6	19.7	683.9	-155.2	44.1	-10.01	36.3	19.5	1.16
7	23.0	677.9	-148.0	43.7	-9.55	35.2	19.5	1.12
8	26.3	668.3	-136.7	43.1	-8.82	34.2	19.3	1.07
9	29.6	655.8	-126.4	42.3	-8.15	33.1	19.1	1.02
10	32.9	648.5	-124.5	41.8	-8.03	31.9	18.8	0.97
11	36.2	651.7	-110.7	42.0	-7.14	28.8	18.6	0.92
12	39.5	661.3	-129.4	42.7	-8.35	27.5	18.3	0.87
13	42.8	662.6	-115.7	42.7	-7.46	24.6	18.1	0.82
14	46.1	672.2	-106.9	43.4	-6.90	23.1	17.9	0.76
15	49.4	688.6	-93.0	44.4	-6.00	20.2	17.6	0.70
16	52.7	699.3	-104.2	45.1	-6.72	18.5	17.4	0.64
17	55.9	698.9	-101.8	45.1	-6.57	15.6	17.1	0.59
18	59.2	717.0	-105.2	46.2	-6.78	14.0	16.8	0.53
19	62.5	731.4	-84.2	47.2	-5.43	11.1	16.7	0.47
20	65.8	737.2	-75.0	47.5	-4.84	9.3	15.8	0.41
21	69.1	732.6	-39.1	47.3	-2.52	6.5	13.2	0.35
22	72.4	744.6	-26.3	48.0	-1.69	5.4	8.2	0.29
Absolute	72.4			48.0			(T =	40.5 ms)
	19.7				-10.01		(T =	57.0 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	853.9	804.2	754.4	704.7	654.9					
RX	856.4	810.6	781.9	764.9	747.9	730.9	715.8	711.4	708.9	706.3
RU	854.6	805.0	755.4	705.7	656.1					

RAU = 679.7 (kips); RA2 = 759.2 (kips)

Current CAPWAP Ru = 730.0 (kips); Corresponding J(RP)= 0.50; J(RX) = 1.01

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
19.2	36.03	532.0	570.7	700.0	1.31	0.10	0.10	40.8	694.2	5583

PILE PROFILE AND PILE MODEL

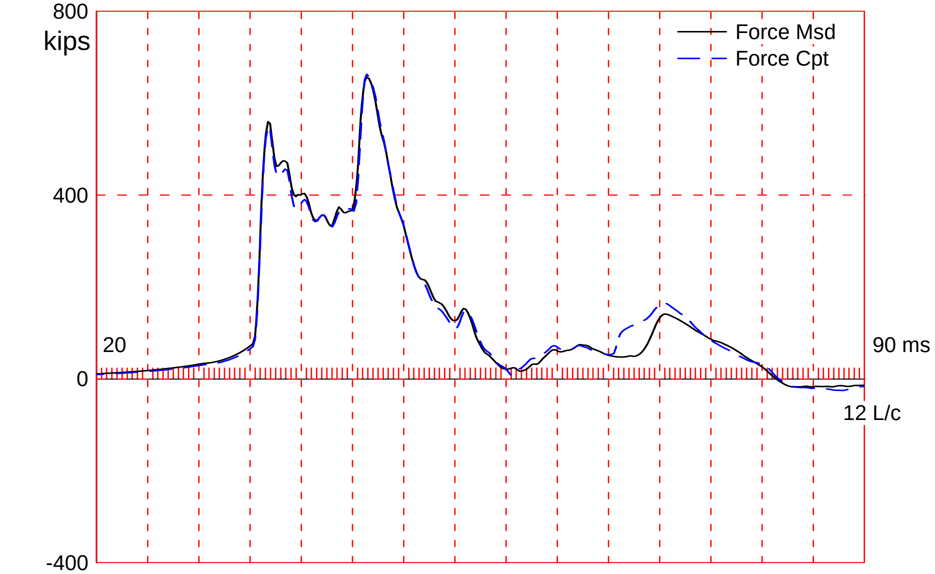
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

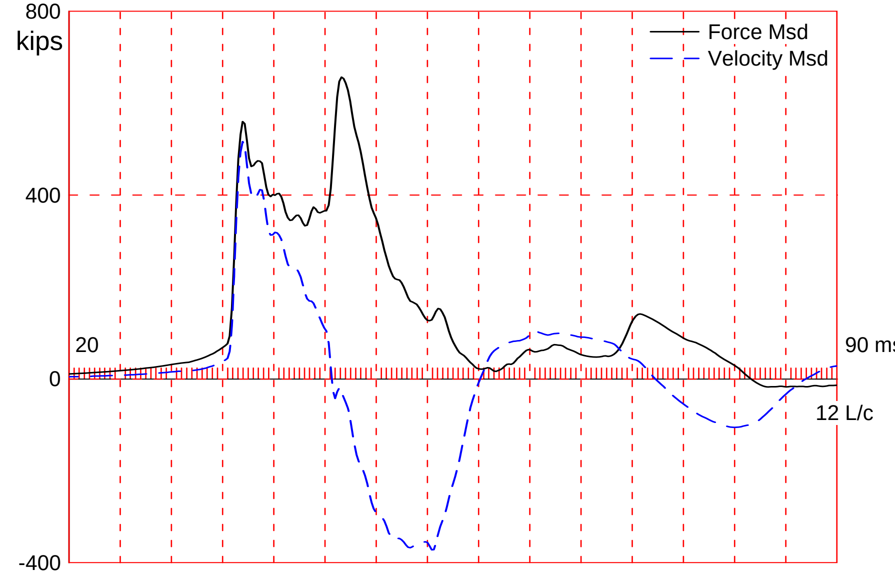
Toe Area 141.9 in^2

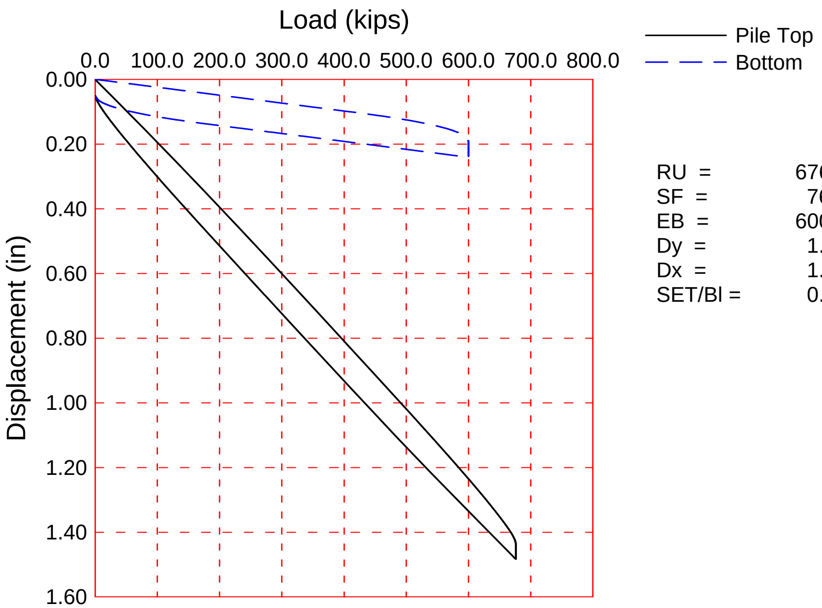
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

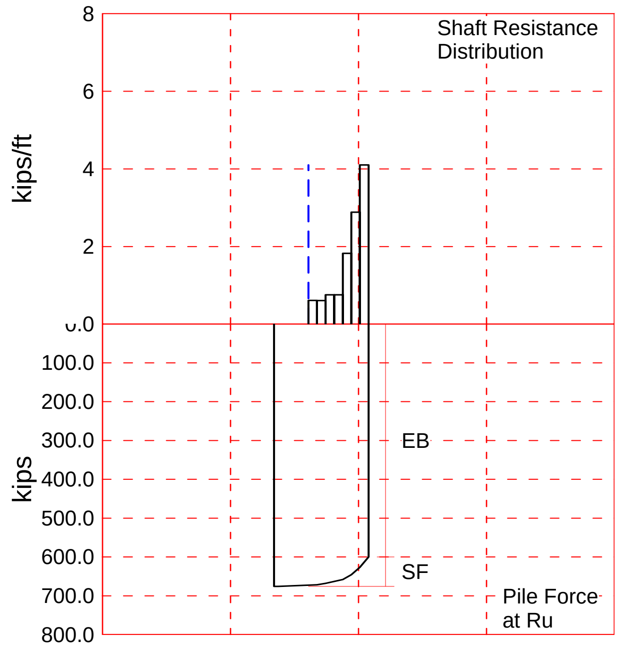
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000







RU =	676.0 kips
SF =	76.0 kips
EB =	600.0 kips
Dy =	1.43 in
Dx =	1.48 in
SET/Bl =	0.05 in



Length b. Sensors	72.4 ft
Embedment	46.0 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	3.24
Top Compr. Stress	42.9 ksi
Max Compr. Stress	47.4 ksi
Max Tension Stress	-8.21 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.15 in
Avg. Shaft Smith Dpg.	0.31 s/ft
Toe Smith Damping	0.14 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.

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

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 676.0; along Shaft 76.0; at Toe 600.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				676.0			
1	32.9	6.5	4.0	672.0	4.0	0.61	0.15
2	39.5	13.1	4.0	668.0	8.0	0.61	0.15
3	46.1	19.7	5.0	663.0	13.0	0.76	0.19
4	52.7	26.3	5.0	658.0	18.0	0.76	0.19
5	59.2	32.8	12.0	646.0	30.0	1.82	0.46
6	65.8	39.4	19.0	627.0	49.0	2.89	0.73
7	72.4	46.0	27.0	600.0	76.0	4.10	1.03
Avg. Shaft			10.9			1.65	0.42
Toe			600.0				608.92

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.31	0.14
Quake	(in)	0.14	0.15
Case Damping Factor		0.85	3.04
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	65	30
Unloading Level	(% of Ru)	88	
Resistance Gap (included in Toe Quake) (in)			0.05

CAPWAP match quality = 3.24 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.05 in; Blow Count = 240 b/ft
Computed: Final Set = 0.03 in; Blow Count = 446 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.97; F4(H083) CAL: 94.4; RF: 0.97
A3(K974) CAL: 305; RF: 1.03; A4(K2214) CAL: 332; RF: 1.03

max. Top Comp. Stress = 42.9 ksi (T= 44.8 ms, max= 1.106 x Top)
max. Comp. Stress = 47.4 ksi (Z= 65.8 ft, T= 41.5 ms)
max. Tens. Stress = -8.21 ksi (Z= 39.5 ft, T= 55.6 ms)
max. Energy (EMX) = 39.1 kip-ft; max. Measured Top Displ. (DMX)= 1.22 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	664.5	-27.9	42.9	-1.80	39.1	19.0	1.25
2	6.6	669.0	-31.3	43.2	-2.02	38.3	19.0	1.21
3	9.9	670.8	-34.6	43.3	-2.23	37.5	19.0	1.17
4	13.2	669.3	-39.4	43.2	-2.54	36.6	18.9	1.13
5	16.5	654.5	-56.0	42.2	-3.61	35.5	18.9	1.08
6	19.7	640.9	-76.1	41.3	-4.91	34.6	18.9	1.04
7	23.0	638.4	-87.5	41.2	-5.65	33.6	18.8	0.99
8	26.3	634.5	-93.5	40.9	-6.03	32.5	18.4	0.94
9	29.6	626.3	-97.3	40.4	-6.28	31.3	18.0	0.89
10	32.9	644.3	-100.0	41.6	-6.45	30.1	17.8	0.84
11	36.2	646.6	-103.9	41.7	-6.70	27.7	17.5	0.79
12	39.5	649.8	-127.3	41.9	-8.21	26.3	17.3	0.74
13	42.8	664.2	-121.9	42.8	-7.86	23.8	16.9	0.69
14	46.1	687.7	-121.6	44.4	-7.84	22.2	16.6	0.63
15	49.4	690.4	-112.1	44.5	-7.23	19.5	16.3	0.57
16	52.7	693.9	-108.8	44.8	-7.02	17.8	15.8	0.51
17	55.9	695.5	-96.0	44.9	-6.19	15.4	15.1	0.45
18	59.2	734.0	-98.9	47.3	-6.38	13.7	14.3	0.40
19	62.5	729.2	-77.3	47.0	-4.98	10.7	13.6	0.34
20	65.8	734.9	-77.7	47.4	-5.01	8.9	13.2	0.28
21	69.1	719.0	-41.4	46.4	-2.67	6.0	10.8	0.22
22	72.4	724.1	-42.7	46.7	-2.75	4.7	6.5	0.17
Absolute	65.8			47.4			(T =	41.5 ms)
	39.5				-8.21		(T =	55.6 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	870.8	826.8	782.8	738.8	694.8					
RX	873.8	831.6	789.3	747.1	716.5	695.5	681.5	670.9	661.5	653.6
RU	874.4	831.1	787.9	744.6	701.3					

RAU = 604.9 (kips); RA2 = 744.8 (kips)

Current CAPWAP Ru = 676.0 (kips); Corresponding J(RP)= 0.89; J(RX) = 1.30

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
18.9	35.83	522.1	568.6	658.0	1.22	0.05	0.05	39.5	746.9	6000

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Al Ziai
Company: Lunda Construction Company	No. of Sheets: 32
E-mail:whamacher@lundaconstruction.com	Date: October 2, 2014

RE: Dynamic Testing Results – Pier 6
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On October 1, 2014, Pier 6 #9 and Pier 6 #30 at the above structure were dynamically tested during initial driving and tested during restrike on October 2. The 75.3 foot long HP 12 x 53 H-piles equipped with driving shoes were driven with an APE D25-42 hammer operated on fuel setting four. Plans indicate the piles in Pier 6 have a required driving resistance or ultimate capacity of 350 kips, and an estimated length of 45 feet.

Pier 6 #9 was driven to a depth of 48.3 feet below the excavated ground surface at EL 582.5, which corresponds to a pile tip elevation of EL 534.2 The blow count over the final increment of driving was 10 blows for 1½ inch of penetration at an average hammer stroke of 8.8 feet. The blow count at the beginning of restrike of Pier 6 #9 was 10 blows for ¾ inch of penetration at an average hammer stroke of 9.2 feet

Pier 6 #30 was driven to a depth of 48.8 feet below the excavated ground surface at EL 582.5, which corresponds to a pile tip elevation of EL 533.8 The blow count over the final increment of driving was 10 blows per inch at an average hammer stroke of 9.5 feet. The blow count at the beginning of restrike of Pier 6 #30 was 10 blows per inch at an average hammer stroke of 10.1 feet

For the 350 kip piles, driven with the APE D25-42 hammer, in Pier 6 of the STH 96 bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.5	8
8.0	6
8.5	5
9.0	4
9.5	4

We recommended the above blow count at the corresponding hammer stroke be maintained for <u>three consecutive inches</u> of driving. Driving may be terminated if production piles exceed 10 blows over an increment of one inch or less at hammer strokes of 9.0 feet or more. After splicing or any other delays, we recommend not applying the criteria until at least two feet of driving has occurred beyond the termination depth associated with the delay.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

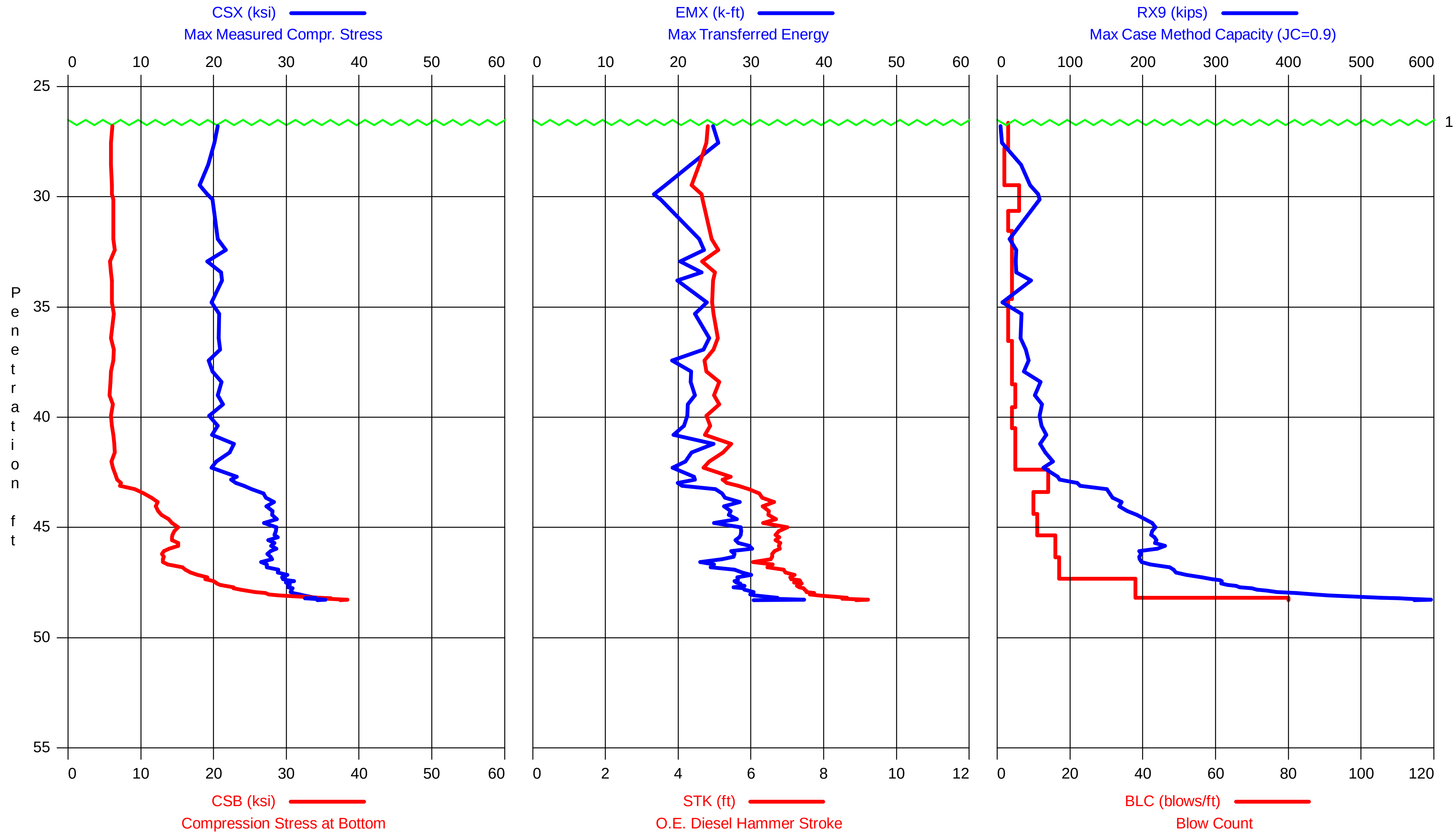
GRL Engineers, Inc.

Al Ziai

Travis Coleman, P.E.

Cc: Steve Seymour – Omnni Associates
steve.seymour@omnni.com

STH 96 over Fox River - Pier 6 #9 - EOID
APE D25-42, HP 12 x 53



1 - Surface Reference Elevation EL 582.50

STH 96 over Fox River - Pier 6 #9 - EOID APE D25-42, HP 12 x 53
OP: RF Test date: 1-Oct-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.33 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
3	26.30	3	AV1	21.2	6.7	27	4.9	52.7	9
			MAX	21.2	6.7	27	4.9	52.7	9
			MIN	21.2	6.7	27	4.9	52.7	9
5	27.30	3	AV2	20.1	5.8	24	4.8	53.3	0
			STD	0.1	0.2	2	0.1	0.4	0
			MAX	20.2	6.0	26	4.9	53.7	0
			MIN	20.0	5.6	23	4.7	53.0	0
7	28.30	2	AV2	20.2	6.0	24	4.7	53.5	19
			STD	0.2	0.2	1	0.0	0.3	6
			MAX	20.4	6.2	25	4.8	53.8	24
			MIN	20.1	5.8	23	4.7	53.3	13
9	29.30	2	AV2	18.5	6.0	20	4.4	55.3	47
			STD	0.3	0.3	0	0.1	0.4	6
			MAX	18.8	6.4	20	4.5	55.7	53
			MIN	18.2	5.7	20	4.4	55.0	41
15	30.30	6	AV4	18.9	6.0	17	4.6	54.7	52
			STD	1.2	0.3	1	0.2	1.3	9
			MAX	20.2	6.4	18	4.9	56.4	59
			MIN	17.4	5.7	16	4.3	53.0	37
22	32.30	4	AV3	20.8	6.2	23	4.9	52.6	22
			STD	0.8	0.1	0	0.1	0.5	12
			MAX	21.5	6.4	24	5.1	53.3	33
			MIN	19.7	6.1	23	4.8	52.0	6
26	33.30	4	AV4	20.4	6.0	22	4.9	52.7	23
			STD	1.4	0.3	2	0.3	1.4	5
			MAX	22.2	6.5	23	5.3	54.1	31
			MIN	18.8	5.7	20	4.6	51.0	19
30	34.30	4	AV2	21.1	6.0	22	4.9	52.6	37
			STD	0.1	0.0	2	0.0	0.1	9
			MAX	21.2	6.0	23	5.0	52.7	46
			MIN	21.0	6.0	20	4.9	52.5	28
33	35.30	3	AV3	20.1	6.1	23	4.9	52.6	16
			STD	1.1	0.5	1	0.2	0.9	13
			MAX	21.0	6.5	25	5.2	53.8	34
			MIN	18.5	5.5	22	4.7	51.5	4
36	36.30	3	AV1	19.9	5.8	25	4.9	52.7	20
			MAX	19.9	5.8	25	4.9	52.7	20
			MIN	19.9	5.8	25	4.9	52.7	20
40	37.30	4	AV4	20.9	6.2	23	5.1	52.0	40
			STD	0.6	0.1	2	0.2	0.8	5
			MAX	21.5	6.3	24	5.3	53.1	45
			MIN	20.2	6.0	20	4.8	51.0	33
44	38.30	4	AV4	19.9	6.0	21	4.8	53.2	43
			STD	1.4	0.3	2	0.4	1.9	7
			MAX	22.0	6.3	24	5.4	55.4	51
			MIN	18.2	5.7	18	4.4	50.3	34
49	39.30	5	AV4	20.8	5.9	22	5.0	52.2	56
			STD	1.9	0.2	2	0.4	2.1	7
			MAX	23.0	6.2	24	5.5	55.1	67
			MIN	18.1	5.5	19	4.5	49.9	48
53	40.30	4	AV4	20.0	6.0	21	4.8	53.2	59
			STD	1.2	0.2	2	0.3	1.5	10
			MAX	20.9	6.2	24	5.2	55.6	70
			MIN	17.9	5.8	19	4.4	51.5	46

STH 96 over Fox River - Pier 6 #9 - EOID
OP: RF

APE D25-42, HP 12 x 53
Test date: 1-Oct-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
58	41.30	5	AV5	21.2	6.2	21	5.1	52.1	64
			STD	1.5	0.2	3	0.4	1.8	7
			MAX	23.5	6.5	26	5.7	54.5	76
			MIN	19.1	5.9	18	4.6	49.3	59
63	42.30	5	AV5	21.0	6.2	21	5.0	52.4	70
			STD	1.1	0.2	1	0.3	1.2	7
			MAX	22.9	6.5	23	5.4	53.8	83
			MIN	19.7	5.9	19	4.7	50.3	63
77	43.30	14	AV10	23.6	7.4	22	5.5	49.9	109
			STD	1.1	1.0	2	0.3	1.2	25
			MAX	25.7	9.7	26	6.1	51.8	160
			MIN	21.9	6.4	19	5.1	47.6	78
87	44.30	10	AV10	27.5	11.7	27	6.4	46.5	166
			STD	0.7	0.8	2	0.2	0.6	10
			MAX	28.5	12.6	29	6.8	47.5	184
			MIN	26.5	10.3	24	6.1	45.3	154
98	45.30	11	AV11	28.3	14.2	28	6.7	45.6	208
			STD	0.8	0.9	2	0.3	0.9	9
			MAX	29.3	15.6	31	7.2	47.1	218
			MIN	26.4	12.2	25	6.2	43.8	189
114	46.30	16	AV16	28.0	14.0	28	6.7	45.5	212
			STD	0.7	0.8	2	0.2	0.6	13
			MAX	29.4	15.6	33	7.0	46.7	232
			MIN	26.7	12.9	26	6.3	44.4	190
131	47.30	17	AV17	28.3	15.5	27	6.7	45.5	232
			STD	1.2	2.2	2	0.4	1.2	29
			MAX	30.5	19.8	30	7.3	48.6	283
			MIN	25.5	12.9	21	5.8	43.7	183
164	48.18	38	AV30	30.7	23.0	29	7.4	43.3	351
			STD	0.9	3.1	1	0.2	0.7	49
			MAX	33.5	29.5	32	8.1	44.9	469
			MIN	29.1	18.4	26	6.9	41.4	293
174	48.30	80	AV10	34.0	36.4	33	8.8	40.0	563
			STD	1.3	1.5	3	0.3	0.7	26
			MAX	35.5	38.5	39	9.4	41.2	607
			MIN	32.0	34.5	27	8.2	38.6	525
			Average	26.2	14.2	26	6.3	47.5	199
			Std. Dev.	4.7	8.7	4	1.2	4.4	151
			Maximum	35.5	38.5	39	9.4	56.4	607
			Minimum	17.4	5.5	16	4.3	38.6	0

Total number of blows analyzed: 154

BL#	depth (ft)	Comments
3	26.63	Surface Reference Elevation EL 582.50

Time Summary

Drive 4 minutes 58 seconds 3:43:04 PM - 3:48:02 PM (10/1/2014) BN 1 - 174

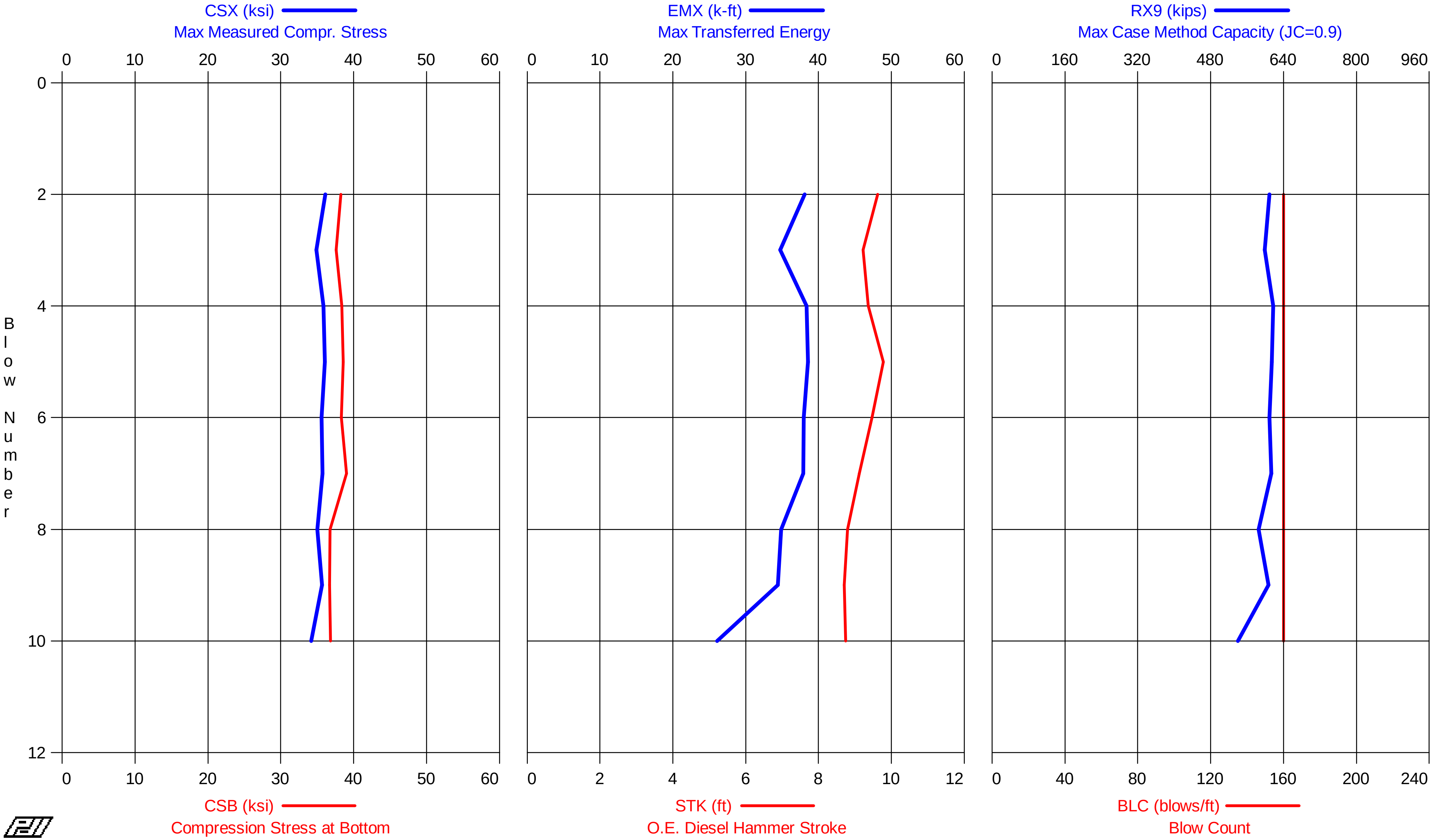
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 2-Oct-2014

Test date: 2-Oct-2014

STH 96 over Fox River - Pier 6 #9 - BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River - Pier 6 #9 - BOR
OP: AZ

APE D25-42, HP 12 x 53
Test date: 2-Oct-2014

AR: 15.50 in^2
LE: 72.33 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
10	58.06	160	AV9	35.5	37.8	9.2	36	39	599
			STD	0.6	0.8	0.4	4	1	23
			MAX	36.1	39.0	9.8	39	40	618
			MIN	34.2	36.7	8.7	26	38	540
			Average	35.5	37.8	9.2	36	39	599
			Std. Dev.	0.6	0.8	0.4	4	1	23
			Maximum	36.1	39.0	9.8	39	40	618
			Minimum	34.2	36.7	8.7	26	38	540

Total number of blows analyzed: 9

Time Summary

Drive 14 seconds 8:59:56 AM - 9:00:10 AM (10/2/2014) BN 1 - 10

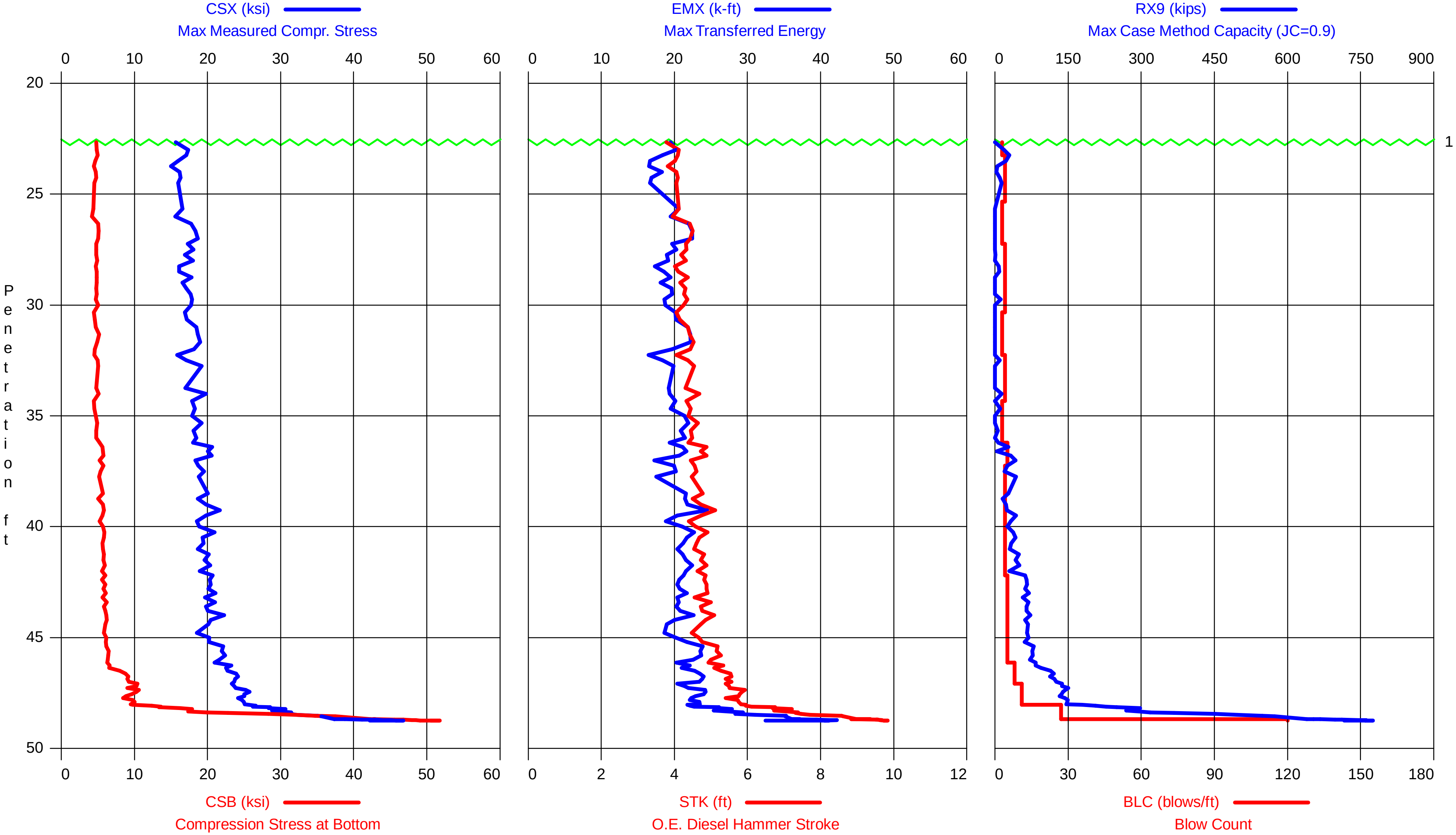
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 2-Oct-2014

Test date: 1-Oct-2014

STH 96 over Fox River - Pier 6 #30 - EOID

APE D25-42, HP 12 x 53



1 - Surface Reference Elevation EL 582.50

STH 96 over Fox River - Pier 6 #30 - EOID APE D25-42, HP 12 x 53
OP: RF Test date: 1-Oct-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.33 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
3	23.00	3	AV2	16.5	4.8	4.0	20	58	9
			STD	0.9	0.0	0.2	0	1	9
			MAX	17.4	4.8	4.1	20	60	19
			MIN	15.6	4.8	3.8	19	57	0
7	24.00	4	AV4	16.1	4.7	4.0	17	58	15
			STD	0.7	0.2	0.1	1	1	11
			MAX	17.1	5.0	4.1	18	59	29
			MIN	15.0	4.4	3.8	17	57	3
11	25.00	4	AV2	16.1	4.7	4.1	17	58	12
			STD	0.2	0.1	0.0	0	0	2
			MAX	16.3	4.8	4.1	17	58	13
			MIN	16.0	4.5	4.0	17	57	10
14	26.00	3	AV2	16.1	4.3	4.0	20	58	0
			STD	0.5	0.1	0.1	1	1	0
			MAX	16.6	4.4	4.1	21	58	0
			MIN	15.6	4.2	3.9	20	57	0
17	27.00	3	AV3	18.3	5.0	4.5	22	55	0
			STD	0.4	0.0	0.0	0	0	0
			MAX	18.7	5.1	4.5	22	55	0
			MIN	17.8	5.0	4.4	22	55	0
21	28.00	4	AV4	17.6	4.8	4.3	20	56	0
			STD	0.5	0.0	0.1	1	0	0
			MAX	18.1	4.9	4.3	20	57	1
			MIN	16.9	4.8	4.2	19	56	0
25	29.00	4	AV4	16.7	4.8	4.2	18	57	4
			STD	0.7	0.1	0.1	1	1	4
			MAX	17.8	4.9	4.4	20	58	9
			MIN	16.1	4.7	4.0	17	56	0
29	30.00	4	AV4	17.6	4.8	4.3	19	56	3
			STD	0.3	0.1	0.0	0	0	5
			MAX	17.9	5.0	4.4	20	56	12
			MIN	17.1	4.7	4.3	19	56	0
32	31.00	3	AV3	17.5	4.6	4.2	21	57	0
			STD	0.7	0.1	0.1	1	1	0
			MAX	18.4	4.7	4.4	22	58	0
			MIN	16.9	4.5	4.0	20	56	0
35	32.00	3	AV3	18.6	4.9	4.5	21	55	0
			STD	0.4	0.2	0.0	1	0	0
			MAX	19.0	5.1	4.5	22	55	0
			MIN	18.1	4.6	4.4	20	55	0
39	33.00	4	AV3	17.4	4.9	4.3	18	56	3
			STD	1.4	0.2	0.2	1	1	4
			MAX	19.2	5.0	4.5	20	58	9
			MIN	15.8	4.5	4.0	16	55	0
43	34.00	4	AV2	18.4	5.0	4.5	19	55	7
			STD	1.4	0.2	0.2	0	1	7
			MAX	19.7	5.1	4.7	19	56	13
			MIN	17.0	4.8	4.3	19	54	0
46	35.00	3	AV3	18.0	4.6	4.4	20	56	4
			STD	0.2	0.1	0.0	1	0	5
			MAX	18.3	4.7	4.5	21	56	11
			MIN	17.9	4.5	4.3	19	55	0
49	36.00	3	AV3	18.6	4.8	4.5	21	55	2
			STD	0.5	0.1	0.1	0	0	3
			MAX	19.2	4.9	4.6	22	55	6
			MIN	18.1	4.8	4.5	21	54	0

STH 96 over Fox River - Pier 6 #30 - EOID APE D25-42, HP 12 x 53
OP: RF Test date: 1-Oct-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
54	37.00	5	AV5	19.5	5.5	4.7	20	54	22
			STD	1.1	0.2	0.2	2	1	15
			MAX	20.6	5.8	4.9	22	56	42
			MIN	18.0	5.2	4.4	17	53	4
58	38.00	4	AV3	19.0	5.4	4.5	19	55	29
			STD	0.4	0.2	0.1	1	0	10
			MAX	19.5	5.8	4.6	20	55	43
			MIN	18.7	5.2	4.5	18	54	20
62	39.00	4	AV3	19.5	5.5	4.7	22	54	22
			STD	0.6	0.3	0.1	0	1	5
			MAX	20.1	5.7	4.8	22	55	27
			MIN	18.7	5.0	4.5	21	53	15
66	40.00	4	AV4	19.7	5.6	4.7	21	54	31
			STD	1.2	0.2	0.3	2	1	8
			MAX	21.7	5.8	5.1	24	56	43
			MIN	18.5	5.3	4.4	19	52	24
70	41.00	4	AV4	19.6	5.8	4.7	21	54	36
			STD	0.8	0.1	0.1	1	1	4
			MAX	21.0	5.9	4.9	23	55	42
			MIN	18.7	5.6	4.5	20	53	30
74	42.00	4	AV4	19.8	5.8	4.8	22	54	43
			STD	0.6	0.1	0.1	0	0	8
			MAX	20.4	6.0	4.9	22	54	50
			MIN	18.9	5.6	4.6	21	53	29
79	43.00	5	AV5	20.5	5.9	4.9	21	53	65
			STD	0.3	0.2	0.0	0	0	3
			MAX	21.1	6.1	4.9	22	53	69
			MIN	20.1	5.6	4.8	20	53	62
84	44.00	5	AV5	20.6	6.0	4.8	21	53	65
			STD	1.0	0.2	0.2	1	1	5
			MAX	22.3	6.2	5.1	23	55	73
			MIN	19.6	5.6	4.6	20	52	57
89	45.00	5	AV4	19.8	6.1	4.7	19	54	66
			STD	0.7	0.1	0.1	1	1	2
			MAX	20.4	6.2	4.9	20	55	68
			MIN	18.6	5.9	4.5	19	53	62
94	46.00	5	AV5	21.7	6.3	5.1	23	52	73
			STD	0.8	0.2	0.2	1	1	7
			MAX	22.4	6.5	5.3	24	54	79
			MIN	20.2	6.1	4.8	22	51	61
102	47.00	8	AV8	23.1	8.0	5.3	23	51	107
			STD	1.0	1.2	0.2	1	1	16
			MAX	24.2	9.3	5.6	24	53	125
			MIN	20.9	6.3	4.9	20	50	83
113	48.00	11	AV11	24.6	9.7	5.7	23	49	142
			STD	0.7	0.7	0.2	1	1	6
			MAX	25.7	10.6	5.9	24	50	150
			MIN	23.3	8.4	5.4	20	48	133
131	48.67	27	AV15	30.1	20.7	7.1	28	44	336
			STD	2.8	8.3	0.8	4	2	120
			MAX	35.6	37.5	8.6	35	48	574
			MIN	25.6	9.7	6.0	22	40	178
141	48.75	120	AV10	42.2	46.8	9.5	39	38	713
			STD	3.3	3.2	0.3	3	1	46
			MAX	46.8	51.8	9.8	42	40	776
			MIN	37.3	42.2	8.8	32	38	640
			Average	22.7	10.9	5.4	23	52	131
			Std. Dev.	7.1	11.9	1.5	6	6	203
			Maximum	46.8	51.8	9.8	42	60	776
			Minimum	15.0	4.2	3.8	16	38	0

Total number of blows analyzed: 128

BL#	depth (ft)	Comments
2	22.67	Surface Reference Elevation EL 582.50

Time Summary

Drive	3 minutes 20 seconds	4:04:10 PM - 4:07:30 PM (10/1/2014) BN 1 - 141

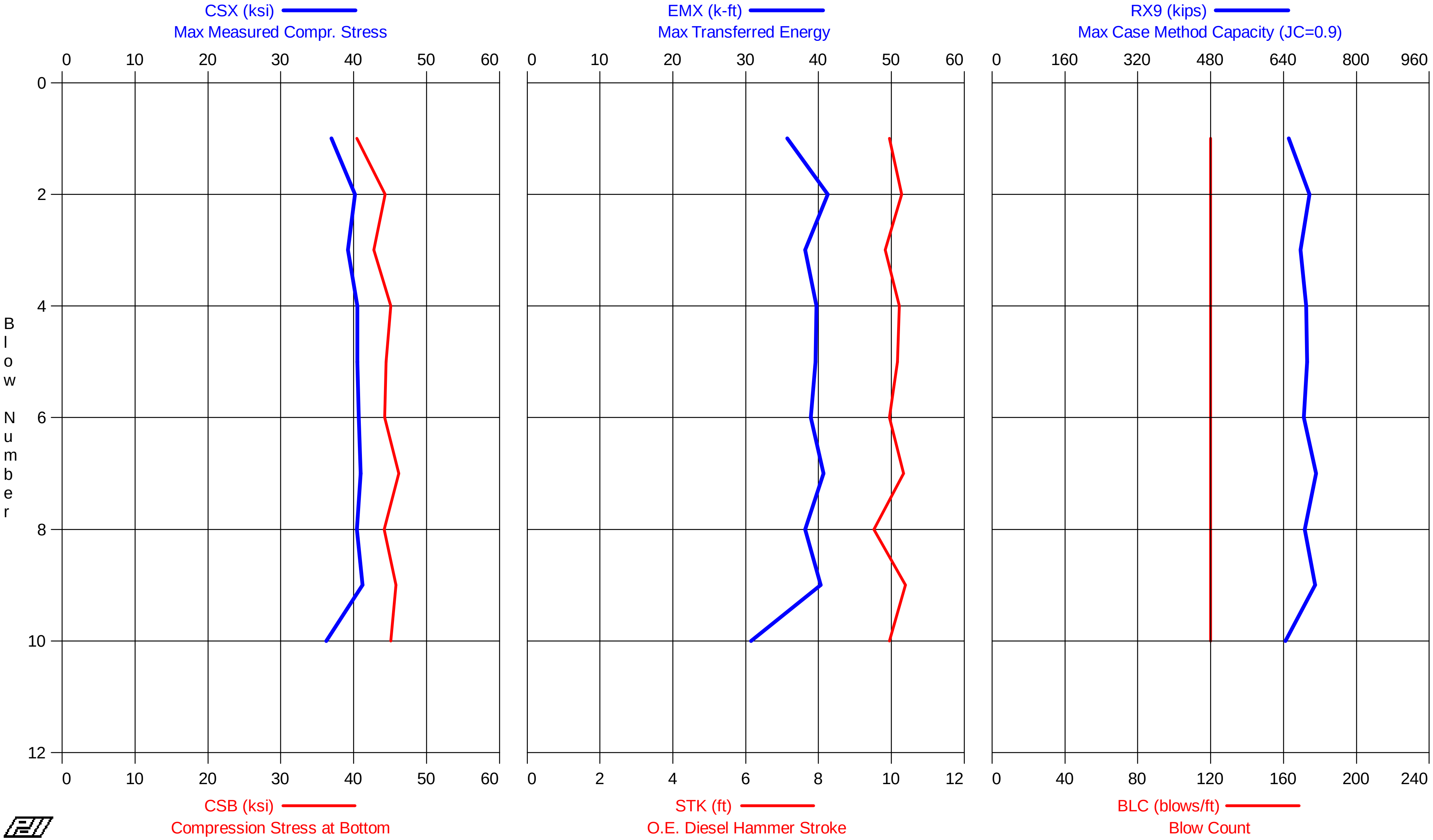
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 2-Oct-2014

Test date: 2-Oct-2014

STH 96 over Fox River - Pier 6 #30 - BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River - Pier 6 #30 - BOR
APE D25-42, HP 12 x 53
OP: AZ
Test date: 2-Oct-2014

AR: 15.50 in^2
SP: 0.492 k/ft3
LE: 72.33 ft
EM: 30,000 ksi
WS: 16,807.9 f/s
JC: 1.00

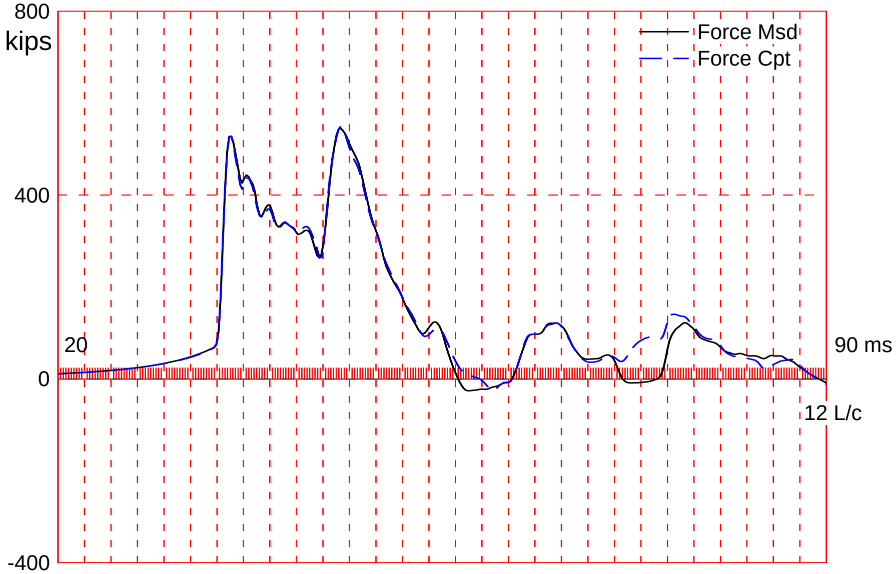
CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke
EMX: Max Transferred Energy
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9)

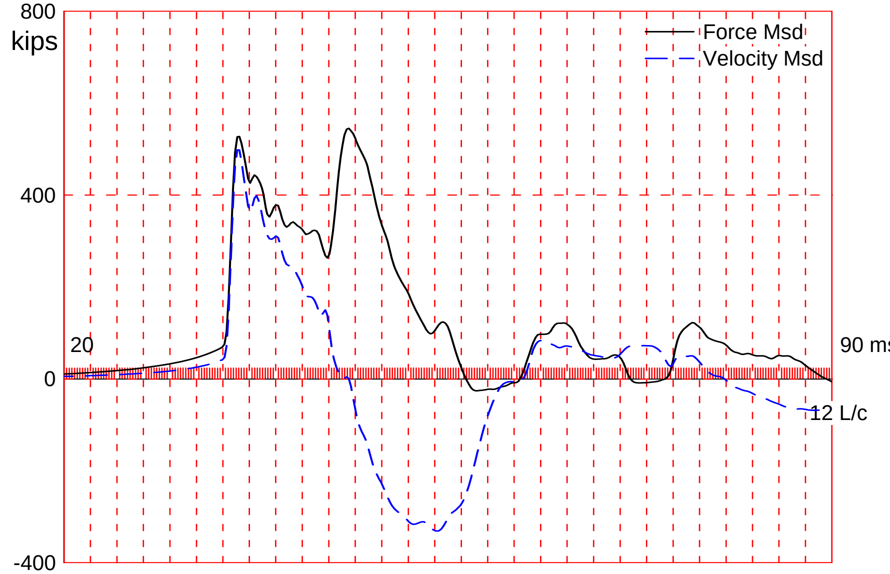
BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
10	48.83	120	AV10	39.7	44.2	10.1	38	37	684
			STD	1.6	1.6	0.3	3	0	21
			MAX	41.2	46.2	10.4	41	38	711
			MIN	36.2	40.4	9.5	31	37	644
			Average	39.7	44.2	10.1	38	37	684
			Std. Dev.	1.6	1.6	0.3	3	0	21
			Maximum	41.2	46.2	10.4	41	38	711
			Minimum	36.2	40.4	9.5	31	37	644

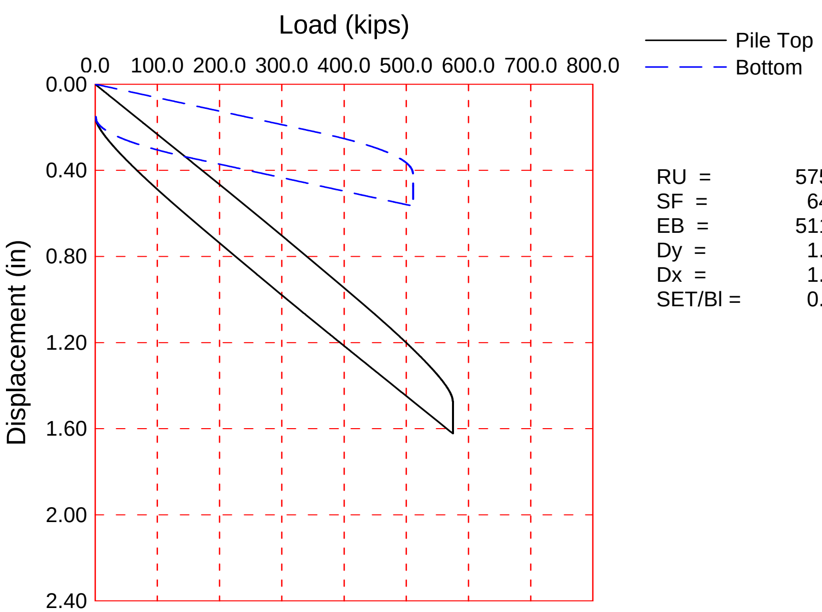
Total number of blows analyzed: 10

Time Summary

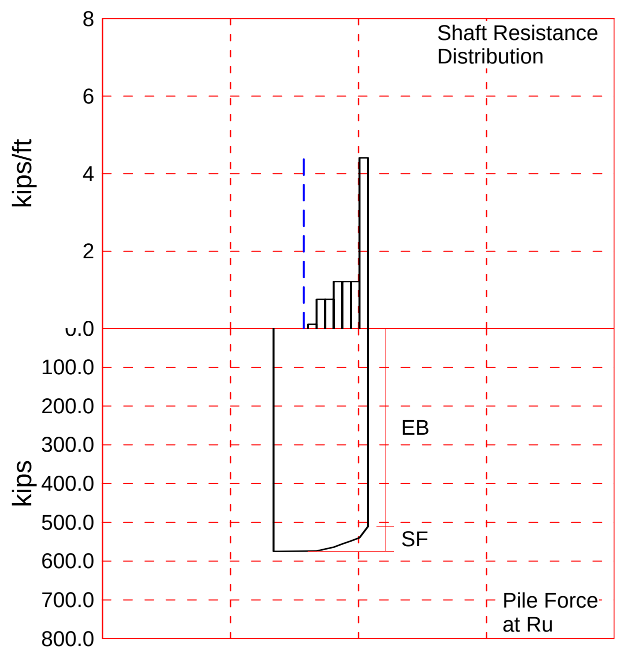
Drive 15 seconds 8:40:26 AM - 8:40:41 AM (10/2/2014) BN 1 - 10







RU =	575.0 kips
SF =	64.0 kips
EB =	511.0 kips
Dy =	1.47 in
Dx =	1.62 in
SET/Bl =	0.15 in



Length b. Sensors	72.3 ft
Embedment	48.3 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	4.48
Top Compr. Stress	36.1 ksi
Max Compr. Stress	40.2 ksi
Max Tension Stress	-8.65 ksi
Avg. Shaft Quake	0.30 in
Toe Quake	0.32 in
Avg. Shaft Smith Dpg.	0.24 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.

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: 575.0; along Shaft 64.0; at Toe 511.0 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
				575.0			
1	32.9	8.8	1.0	574.0	1.0	0.11	0.03
2	39.5	15.4	5.0	569.0	6.0	0.76	0.19
3	46.0	22.0	5.0	564.0	11.0	0.76	0.19
4	52.6	28.6	8.0	556.0	19.0	1.22	0.31
5	59.2	35.1	8.0	548.0	27.0	1.22	0.31
6	65.8	41.7	8.0	540.0	35.0	1.22	0.31
7	72.3	48.3	29.0	511.0	64.0	4.41	1.11
Avg. Shaft			9.1			1.33	0.33
Toe			511.0				518.60

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.24	0.08
Quake	(in)	0.30	0.32
Case Damping Factor		0.56	1.48
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	30	30
Unloading Level	(% of Ru)	52	
Soil Plug Weight	(kips)		0.031

```
CAPWAP match quality     =    4.48        (Wave Up Match) ; RSA = 0
Observed: Final Set      =    0.15 in;    Blow Count      =     80 b/ft
Computed: Final Set      =    0.02 in;    Blow Count      =    782 b/ft
Transducer      F3(H083)  CAL:  94.4; RF: 1.01; F4(F523)  CAL:  93.8; RF: 1.01
                A3(K2214) CAL:   332; RF: 0.99; A4(K974)  CAL:   305; RF: 0.99

max. Top Comp. Stress    =    36.1 ksi     (T=  46.2 ms, max= 1.115 x Top)
max. Comp. Stress        =    40.2 ksi     (Z=  72.3 ft, T=  42.1 ms)
max. Tens. Stress        =   -8.65 ksi     (Z=  29.6 ft, T=  58.1 ms)
max. Energy (EMX)        =    37.6 kip-ft; max. Measured Top Displ. (DMX)=  1.29 in
```

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	558.9	-34.2	36.1	-2.21	37.6	18.0	1.26
2	6.6	563.6	-45.7	36.4	-2.95	37.1	17.9	1.23
3	9.9	564.0	-59.6	36.4	-3.84	36.5	17.9	1.20
4	13.2	563.9	-76.1	36.4	-4.91	35.8	17.9	1.16
5	16.4	566.1	-95.3	36.5	-6.15	35.1	17.8	1.12
6	19.7	564.9	-113.3	36.4	-7.31	34.3	17.8	1.08
7	23.0	557.6	-126.3	36.0	-8.14	33.4	17.7	1.04
8	26.3	552.1	-133.4	35.6	-8.61	32.5	17.7	0.99
9	29.6	550.4	-134.1	35.5	-8.65	31.6	17.6	0.95
10	32.9	547.2	-130.9	35.3	-8.44	30.6	17.4	0.91
11	36.2	546.4	-124.7	35.2	-8.04	29.3	17.1	0.86
12	39.5	557.4	-123.2	35.9	-7.95	28.3	16.9	0.81
13	42.7	564.1	-113.3	36.4	-7.31	26.0	16.7	0.77
14	46.0	572.9	-108.4	37.0	-6.99	24.9	16.3	0.72
15	49.3	573.6	-102.9	37.0	-6.63	22.7	16.0	0.67
16	52.6	593.0	-105.3	38.2	-6.79	21.6	15.7	0.62
17	55.9	595.1	-90.8	38.4	-5.85	19.1	15.3	0.57
18	59.2	603.7	-91.7	38.9	-5.91	18.0	15.0	0.52
19	62.5	594.8	-78.1	38.4	-5.04	15.8	14.8	0.48
20	65.8	608.1	-74.2	39.2	-4.79	14.7	15.6	0.43
21	69.0	611.5	-55.5	39.4	-3.58	12.8	15.7	0.38
22	72.3	623.2	-51.1	40.2	-3.30	10.7	13.7	0.33
Absolute	72.3			40.2			(T =	42.1 ms)
	29.6				-8.65		(T =	58.1 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	647.6	570.1	492.6	415.1	337.6					
RX	698.5	671.9	651.8	632.6	616.5	607.2	602.4	597.6	592.8	588.1
RU	647.6	570.1	492.6	415.1	337.6					

RAU = 512.0 (kips); RA2 = 658.9 (kips)

Current CAPWAP Ru = 575.0 (kips); Corresponding J(RP)= 0.19; matches RX20 within 5%

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
18.2	35.80	503.4	531.7	547.2	1.29	0.15	0.15	38.4	640.4	1597

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

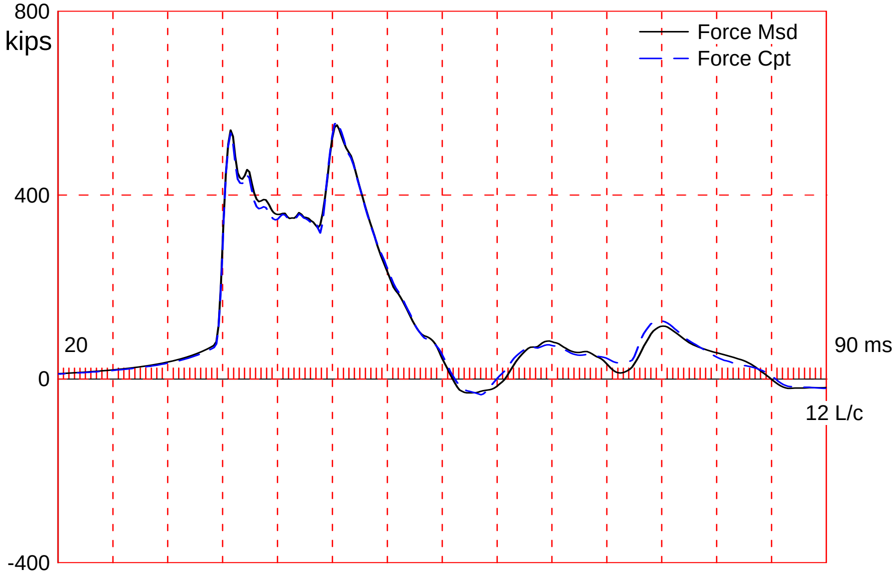
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

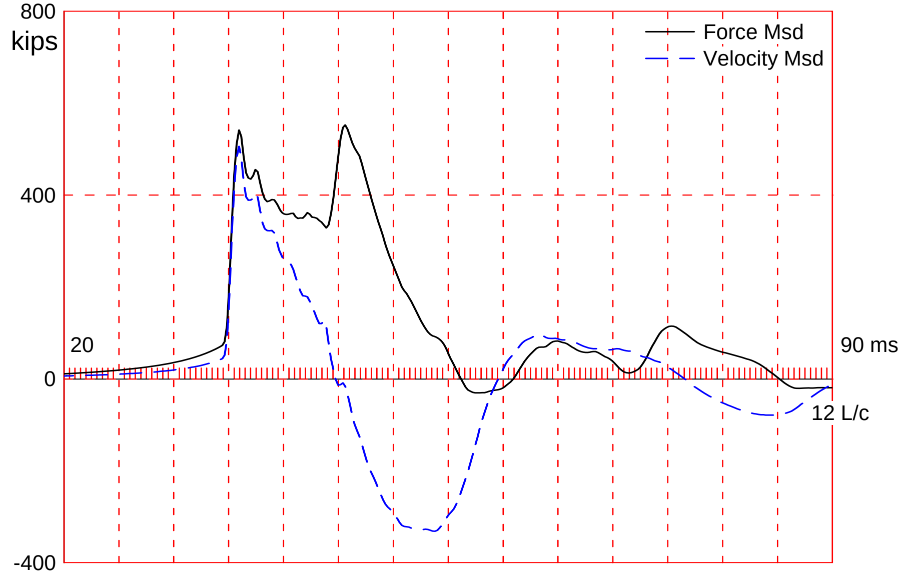
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

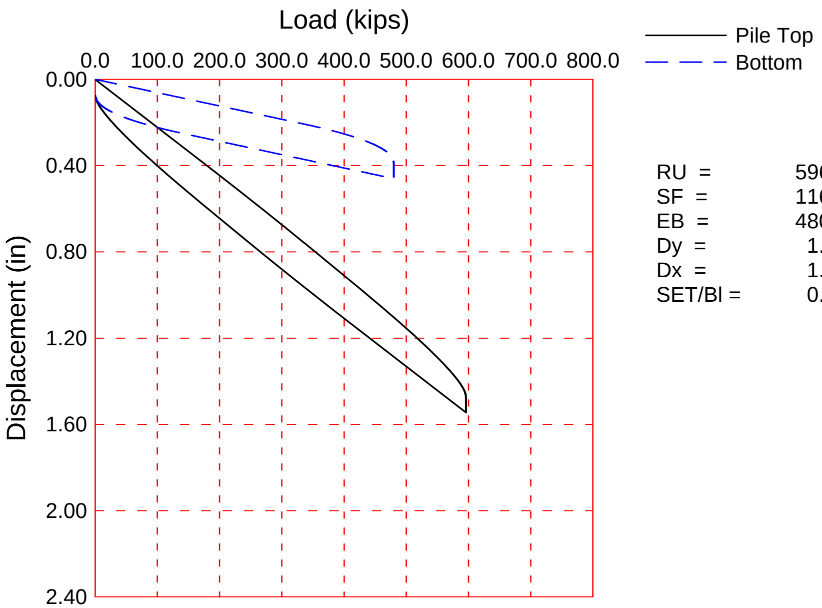
Total volume: 7.786 ft^3; Volume ratio considering added impedance: 1.000

STH 96 over Fox River; Pile: Pier 6 ; APE D25-42, HP 12 x 53; Blow: 4 (Test: 02-Oct-2014 09:00:)
GRL Engineers, Inc.

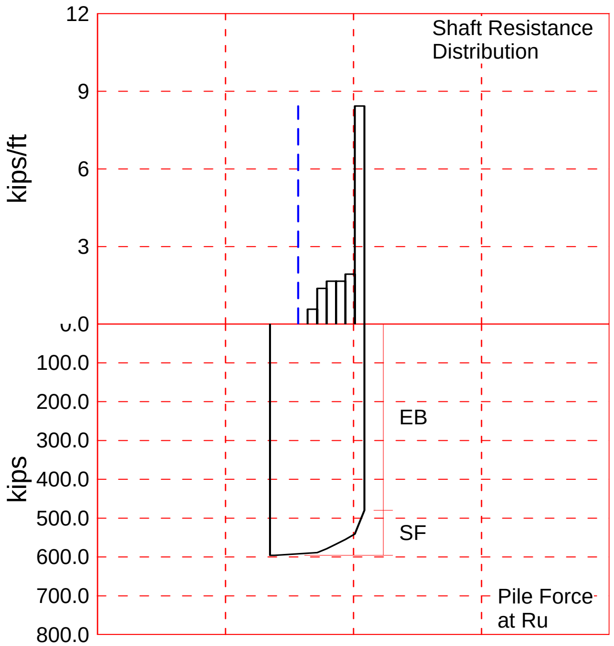
02-Oct-2014
CAPWAP(R) 2014







RU = 596.0 kips
SF = 116.0 kips
EB = 480.0 kips
Dy = 1.47 in
Dx = 1.55 in
SET/Bl = 0.08 in



Length b. Sensors	72.3 ft
Embedment	48.3 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	2.56
Top Compr. Stress	36.7 ksi
Max Compr. Stress	39.3 ksi
Max Tension Stress	-8.55 ksi
Avg. Shaft Quake	0.30 in
Toe Quake	0.30 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.10 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 596.0; along Shaft 116.0; at Toe 480.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				596.0			
1	36.2	12.1	7.0	589.0	7.0	0.58	0.15
2	43.4	19.4	10.0	579.0	17.0	1.38	0.35
3	50.6	26.6	12.0	567.0	29.0	1.66	0.42
4	57.9	33.8	12.0	555.0	41.0	1.66	0.42
5	65.1	41.1	14.0	541.0	55.0	1.94	0.49
6	72.3	48.3	61.0	480.0	116.0	8.43	2.12
Avg. Shaft			19.3			2.40	0.60
Toe			480.0				487.14

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.28	0.10
Quake	(in)	0.30	0.30
Case Damping Factor		1.17	1.74
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	79	30
Unloading Level	(% of Ru)	67	
Resistance Gap (included in Toe Quake) (in)			0.12
Soil Plug Weight	(kips)		0.091

CAPWAP match quality = 2.56 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.11 in; Blow Count = 106 b/ft
Transducer F3(H083) CAL: 94.4; RF: 0.99; F4(F523) CAL: 93.8; RF: 0.99
A3(K2214) CAL: 332; RF: 1.01; A4(K974) CAL: 305; RF: 1.01

max. Top Comp. Stress = 36.7 ksi (T= 45.8 ms, max= 1.072 x Top)
max. Comp. Stress = 39.3 ksi (Z= 72.3 ft, T= 42.0 ms)
max. Tens. Stress = -8.55 ksi (Z= 36.2 ft, T= 58.1 ms)
max. Energy (EMX) = 38.1 kip-ft; max. Measured Top Displ. (DMX)= 1.26 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	3.6	568.5	-50.6	36.7	-3.26	38.1	18.5	1.27
2	7.2	571.6	-68.5	36.9	-4.42	37.4	18.4	1.23
3	10.8	568.8	-87.8	36.7	-5.66	36.6	18.4	1.19
4	14.5	570.8	-104.8	36.8	-6.76	35.7	18.4	1.15
5	18.1	570.4	-117.2	36.8	-7.56	34.8	18.3	1.10
6	21.7	565.5	-125.3	36.5	-8.08	33.7	18.3	1.05
7	25.3	558.1	-130.4	36.0	-8.41	32.6	18.2	1.00
8	28.9	561.6	-132.5	36.2	-8.55	31.5	18.0	0.95
9	32.5	570.5	-131.8	36.8	-8.50	30.3	17.7	0.90
10	36.2	575.0	-132.6	37.1	-8.55	29.1	17.3	0.85
11	39.8	584.4	-121.3	37.7	-7.82	26.0	16.8	0.79
12	43.4	594.2	-122.2	38.3	-7.88	24.6	16.4	0.74
13	47.0	591.2	-105.9	38.1	-6.83	21.2	15.8	0.68
14	50.6	596.8	-107.5	38.5	-6.93	19.8	15.4	0.63
15	54.2	594.1	-88.3	38.3	-5.70	16.5	14.9	0.57
16	57.9	605.9	-91.4	39.1	-5.89	15.2	14.5	0.52
17	61.5	593.3	-75.1	38.3	-4.85	12.3	14.0	0.47
18	65.1	607.4	-78.2	39.2	-5.04	11.0	13.6	0.41
19	68.7	597.2	-60.0	38.5	-3.87	8.6	13.5	0.36
20	72.3	609.6	-62.0	39.3	-4.00	5.4	11.0	0.31
Absolute	72.3			39.3			(T =	42.0 ms)
	36.2				-8.55		(T =	58.1 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	723.7	655.1	586.4	517.8	449.1					
RX	731.1	701.4	673.3	646.7	621.8	612.1	602.3	592.5	582.7	573.0
RU	723.7	655.1	586.4	517.8	449.1					

RAU = 527.5 (kips); RA2 = 668.8 (kips)

Current CAPWAP Ru = 596.0 (kips); Corresponding J(RP)= 0.37; J(RX) = 1.33

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
18.6	35.93	515.4	551.6	555.5	1.26	0.08	0.08	38.6	693.1	2667

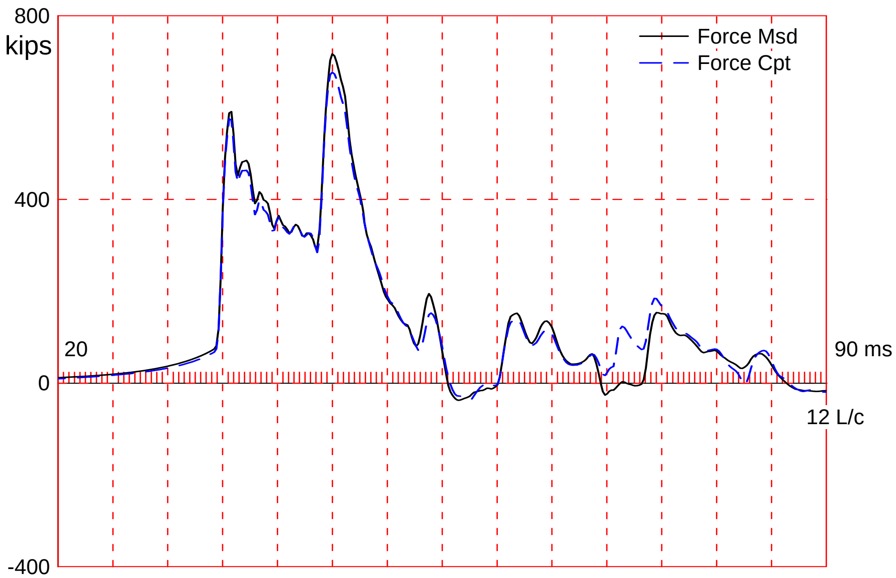
PILE PROFILE AND PILE MODEL

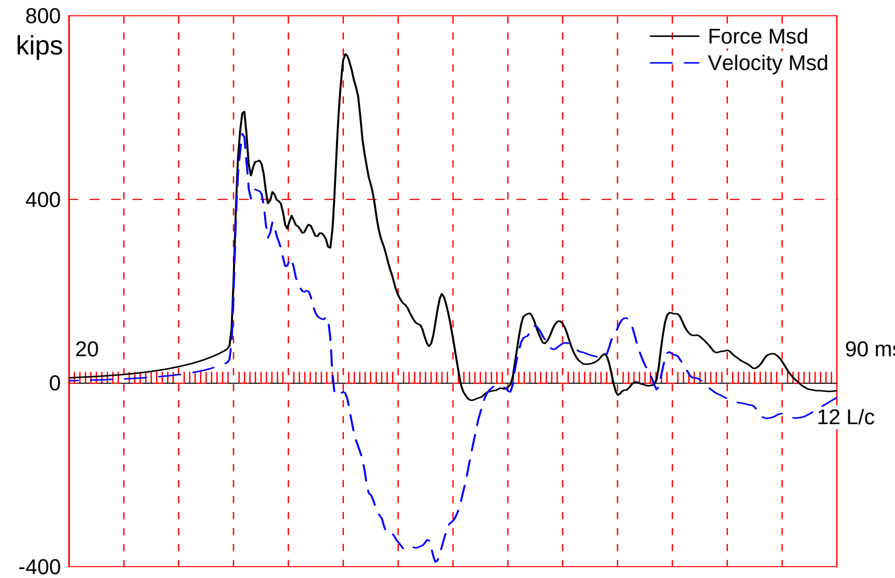
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

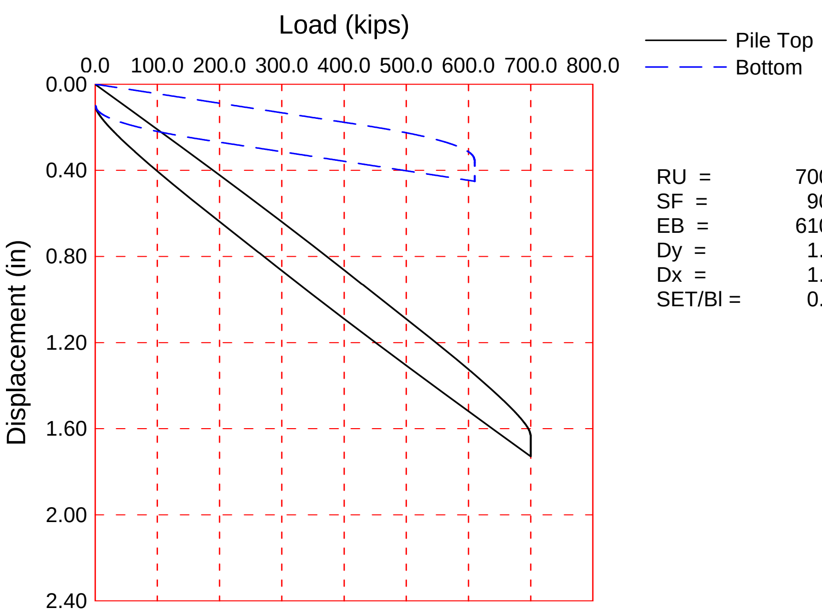
Toe Area 141.9 in^2

Top Segment Length 3.62 ft, Top Impedance 28 kips/ft/s

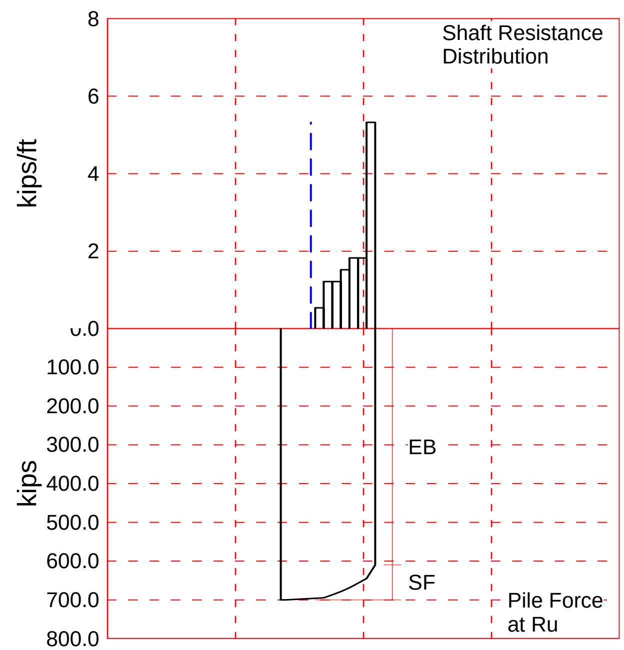
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.215 ms, 2L/c 8.6 ms
Total volume: 7.786 ft^3; Volume ratio considering added impedance: 1.000







RU =	700.0 kips
SF =	90.0 kips
EB =	610.0 kips
Dy =	1.63 in
Dx =	1.73 in
SET/Bl =	0.10 in



Length b. Sensors	72.3 ft
Embedment	48.7 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	4.33
Top Compr. Stress	44.4 ksi
Max Compr. Stress	45.2 ksi
Max Tension Stress	-8.79 ksi
Avg. Shaft Quake	0.25 in
Toe Quake	0.27 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.10 s/ft

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

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

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

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

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

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 700.0; along Shaft 90.0; at Toe 610.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Quake in
				700.0				
1	32.9	9.3	5.0	695.0	5.0	0.54	0.14	0.25
2	39.5	15.9	8.0	687.0	13.0	1.22	0.31	0.25
3	46.0	22.4	8.0	679.0	21.0	1.22	0.31	0.25
4	52.6	29.0	10.0	669.0	31.0	1.52	0.38	0.25
5	59.2	35.6	12.0	657.0	43.0	1.82	0.46	0.25
6	65.8	42.2	12.0	645.0	55.0	1.82	0.46	0.25
7	72.3	48.7	35.0	610.0	90.0	5.32	1.34	0.24
Avg. Shaft			12.9			1.85	0.47	0.25
Toe			610.0				619.07	0.27

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.24	0.10
Case Damping Factor		0.78	2.20
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	92	30
Unloading Level	(% of Ru)	63	
Resistance Gap (included in Toe Quake) (in)			0.12

CAPWAP match quality = 4.33 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.06 in; Blow Count = 198 b/ft
Transducer F3(H083) CAL: 94.4; RF: 1.00; F4(F523) CAL: 93.8; RF: 1.00
A3(K2214) CAL: 332; RF: 1.00; A4(K974) CAL: 305; RF: 1.00

max. Top Comp. Stress = 44.4 ksi (T= 45.4 ms, max= 1.017 x Top)
max. Comp. Stress = 45.2 ksi (Z= 72.3 ft, T= 41.9 ms)
max. Tens. Stress = -8.79 ksi (Z= 19.7 ft, T= 56.9 ms)
max. Energy (EMX) = 40.6 kip-ft; max. Measured Top Displ. (DMX)= 1.28 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	688.6	-56.9	44.4	-3.67	40.6	20.1	1.32
2	6.6	693.9	-81.3	44.8	-5.24	40.0	20.0	1.28
3	9.9	694.9	-101.6	44.8	-6.55	39.2	20.0	1.24
4	13.2	681.7	-119.5	44.0	-7.71	38.4	20.0	1.20
5	16.4	678.4	-133.9	43.8	-8.63	37.6	19.9	1.16
6	19.7	673.7	-136.3	43.5	-8.79	36.7	19.9	1.12
7	23.0	666.7	-130.3	43.0	-8.40	35.7	19.8	1.07
8	26.3	654.6	-125.3	42.2	-8.08	34.6	19.7	1.02
9	29.6	644.6	-123.1	41.6	-7.94	33.6	19.4	0.98
10	32.9	642.3	-123.7	41.4	-7.98	32.4	19.1	0.93
11	36.2	631.4	-120.1	40.7	-7.74	29.8	18.8	0.88
12	39.5	641.4	-134.7	41.4	-8.69	28.5	18.4	0.83
13	42.7	641.0	-118.6	41.3	-7.65	25.3	18.1	0.77
14	46.0	652.4	-112.7	42.1	-7.27	23.9	17.7	0.72
15	49.3	652.7	-94.1	42.1	-6.07	20.8	17.3	0.67
16	52.6	668.3	-96.3	43.1	-6.21	19.2	17.0	0.61
17	55.9	665.3	-93.1	42.9	-6.00	16.1	16.5	0.55
18	59.2	682.2	-98.9	44.0	-6.38	14.5	16.1	0.50
19	62.5	683.0	-82.7	44.1	-5.33	11.6	16.2	0.44
20	65.8	693.1	-77.0	44.7	-4.97	10.0	16.3	0.39
21	69.0	691.0	-51.3	44.6	-3.31	7.5	14.6	0.33
22	72.3	700.2	-48.4	45.2	-3.12	6.1	10.2	0.28
Absolute	72.3			45.2			(T =	41.9 ms)
	19.7				-8.79		(T =	56.9 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	864.4	806.8	749.2	691.6	634.0					
RX	876.3	829.3	808.8	795.2	781.5	771.1	761.6	752.0	742.5	735.3
RU	868.3	811.5	754.7	697.9	641.0					

RAU = 622.8 (kips); RA2 = 828.7 (kips)

Current CAPWAP Ru = 700.0 (kips); Corresponding J(RP)= 0.57; 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
20.0	35.99	552.2	600.3	719.3	1.28	0.10	0.10	41.0	714.0	4067

PILE PROFILE AND PILE MODEL

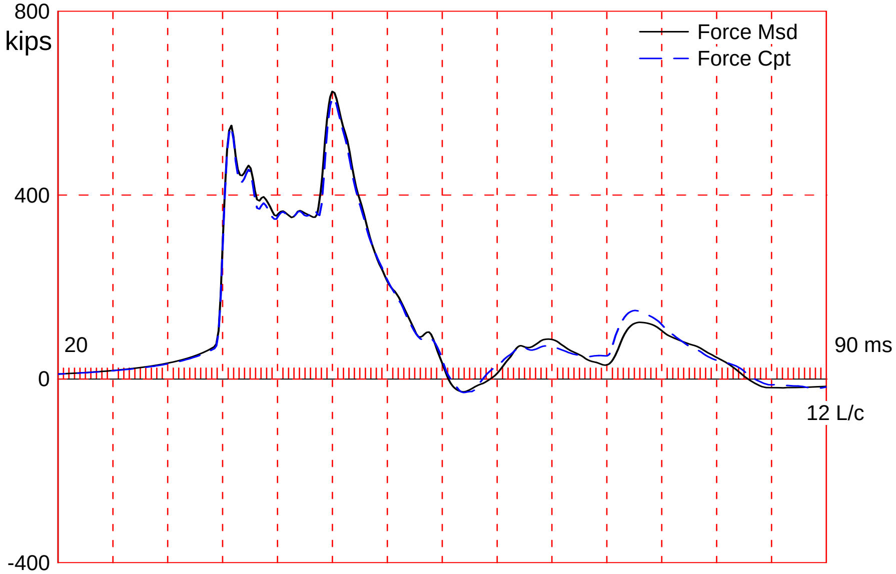
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

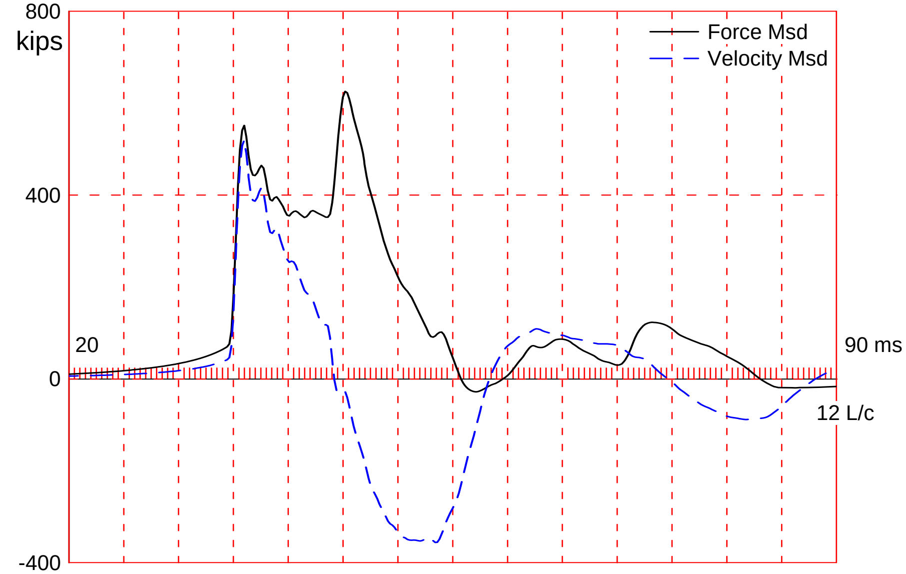
Toe Area 141.9 in^2

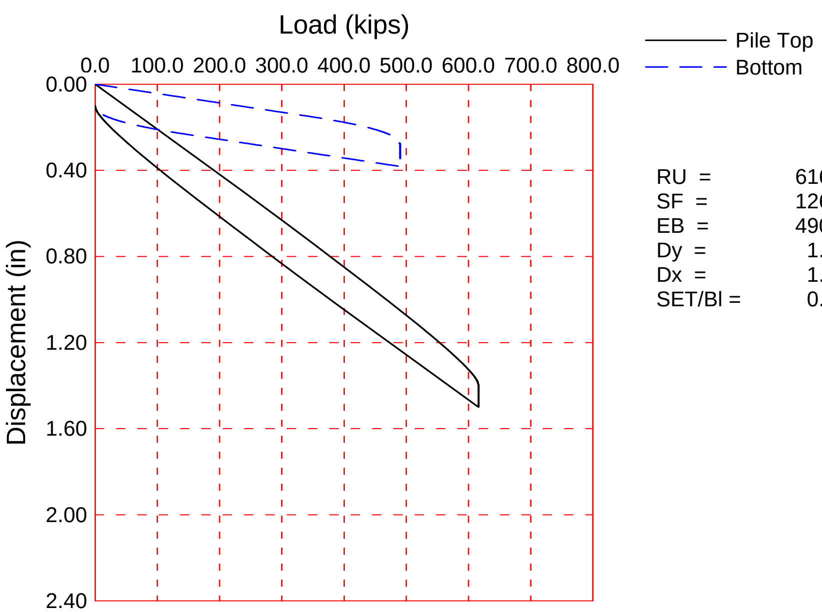
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

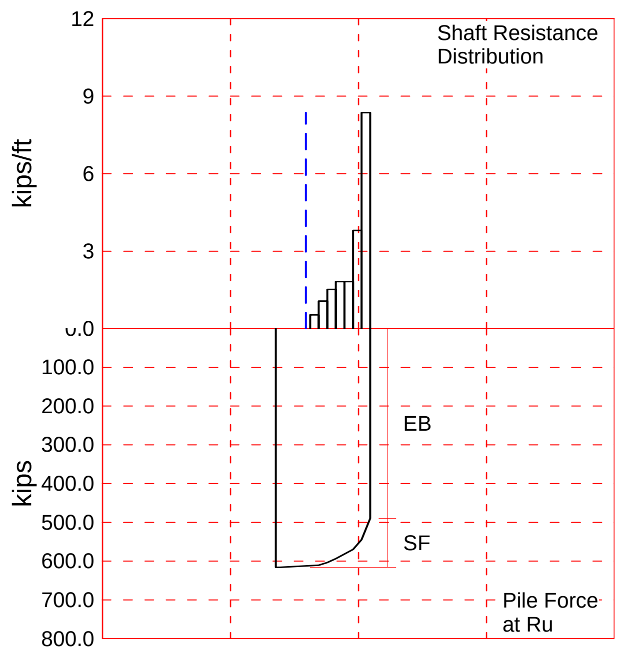
Total volume: 7.786 ft^3; Volume ratio considering added impedance: 1.000







RU =	616.0 kips
SF =	126.0 kips
EB =	490.0 kips
Dy =	1.40 in
Dx =	1.50 in
SET/Bl =	0.10 in



Length b. Sensors	72.3 ft
Embedment	48.8 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	3.09
Top Compr. Stress	40.1 ksi
Max Compr. Stress	42.5 ksi
Max Tension Stress	-8.40 ksi
Avg. Shaft Quake	0.26 in
Toe Quake	0.21 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.10 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: 616.0; along Shaft 126.0; at Toe 490.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Quake in
				616.0				
1	32.9	9.3	5.0	611.0	5.0	0.54	0.13	0.30
2	39.5	15.9	7.0	604.0	12.0	1.06	0.27	0.30
3	46.0	22.5	10.0	594.0	22.0	1.52	0.38	0.30
4	52.6	29.1	12.0	582.0	34.0	1.82	0.46	0.30
5	59.2	35.6	12.0	570.0	46.0	1.82	0.46	0.30
6	65.8	42.2	25.0	545.0	71.0	3.80	0.96	0.30
7	72.3	48.8	55.0	490.0	126.0	8.36	2.11	0.21
Avg. Shaft			18.0			2.58	0.65	0.26
Toe			490.0				497.29	0.21

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.27	0.10
Case Damping Factor		1.23	1.77
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	82	30
Unloading Level	(% of Ru)	89	
Resistance Gap (included in Toe Quake) (in)			0.09
Soil Plug Weight	(kips)		0.108

CAPWAP match quality = 3.09 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.09 in; Blow Count = 134 b/ft
Transducer F3(H083) CAL: 94.4; RF: 0.99; F4(F523) CAL: 93.8; RF: 0.99
Not Active A3(K2214) CAL: 332; RF: 1.01; A4(K974) CAL: 305; RF: 1.01

max. Top Comp. Stress = 40.1 ksi (T= 45.4 ms, max= 1.059 x Top)
max. Comp. Stress = 42.5 ksi (Z= 65.8 ft, T= 41.7 ms)
max. Tens. Stress = -8.40 ksi (Z= 32.9 ft, T= 57.5 ms)
max. Energy (EMX) = 38.6 kip-ft; max. Measured Top Displ. (DMX)= 1.24 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	621.2	-47.8	40.1	-3.08	38.6	18.9	1.25
2	6.6	624.8	-67.1	40.3	-4.32	37.9	18.9	1.21
3	9.9	622.7	-83.3	40.2	-5.37	37.1	18.8	1.17
4	13.2	613.1	-97.4	39.5	-6.28	36.3	18.8	1.13
5	16.4	607.9	-110.9	39.2	-7.15	35.4	18.8	1.09
6	19.7	607.9	-122.4	39.2	-7.90	34.5	18.7	1.04
7	23.0	600.2	-128.2	38.7	-8.27	33.4	18.6	1.00
8	26.3	595.3	-129.8	38.4	-8.37	32.4	18.4	0.95
9	29.6	594.3	-129.6	38.3	-8.36	31.3	18.2	0.90
10	32.9	597.8	-130.2	38.6	-8.40	30.1	17.9	0.85
11	36.2	607.1	-123.0	39.2	-7.94	27.5	17.5	0.80
12	39.5	620.7	-128.2	40.0	-8.27	26.2	17.1	0.75
13	42.7	620.3	-116.6	40.0	-7.52	23.4	16.7	0.70
14	46.0	624.0	-116.5	40.2	-7.52	22.1	16.2	0.65
15	49.3	622.2	-100.1	40.1	-6.46	19.0	15.7	0.60
16	52.6	637.6	-101.6	41.1	-6.55	17.6	15.3	0.54
17	55.9	631.8	-82.5	40.8	-5.32	14.5	14.8	0.49
18	59.2	637.3	-88.2	41.1	-5.69	13.1	14.1	0.44
19	62.5	644.2	-75.6	41.5	-4.88	10.6	13.4	0.38
20	65.8	658.2	-79.5	42.5	-5.13	9.3	13.1	0.33
21	69.0	633.6	-55.7	40.9	-3.59	6.6	12.1	0.29
22	72.3	637.5	-57.3	41.1	-3.70	4.6	9.3	0.24
Absolute	65.8			42.5			(T =	41.7 ms)
	32.9				-8.40		(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	833.0	783.6	734.3	685.0	635.7					
RX	834.3	789.0	743.7	713.7	692.2	672.3	656.0	639.8	625.0	618.5
RU	843.6	796.4	749.2	702.0	654.8					

RAU = 550.9 (kips); RA2 = 708.6 (kips)

Current CAPWAP Ru = 616.0 (kips); Corresponding J(RP)= 0.88; J(RX) = 1.88

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
18.9	35.99	523.6	555.9	627.6	1.24	0.10	0.10	39.0	696.4	4083

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

Total volume: 7.786 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Travis Coleman
Company: Lunda Construction Company	No. of Sheets: 36
E-mail: whamacher@lundaconstruction.com	Date: January 2, 2015

RE: Dynamic Testing Results – Pier 7
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On December 22, 2014, Pier 7 #1 and Pier 7 #30 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on December 23. The approximately 78 foot long HP 12 x 53 H-piles equipped with driving shoes were driven with an APE D25-42 hammer operated on fuel setting four. Plans indicate the piles in Pier 7 have a required driving resistance, or ultimate capacity, of 380 kips, and an estimated length of 55 feet.

Pier 7 #1 was driven to a depth of 50.0 feet below the excavated ground surface at EL 592.5, which corresponds to a pile tip elevation of EL 542.5. The blow count over the final increment of driving was 10 blows for 3 ¼ inch of penetration at an average hammer stroke of 7.7 feet. The blow count at the beginning of restrike of Pier 7 #1 was 10 blows for 1 ½ inch of penetration at an average hammer stroke of 8.0 feet

Pier 7 #30 was driven to a depth of 53.6 feet below the excavated ground surface at EL 592.5, which corresponds to a pile tip elevation of EL 538.9. The blow count over the final increment of driving was 10 blows for 2 inches of penetration at an average hammer stroke of 8.0 feet. The blow count at the beginning of restrike of Pier 7 #30 was 10 blows for ¾ inch of penetration at an average hammer stroke of 8.0 feet

For the 380 kip piles, driven with the APE D25-42 hammer, in Pier 7 of the STH 96 bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
6.5	8
7.0	6
7.5	5
8.0	5
8.5	4
9.0	4

We recommended the above blow count at the corresponding hammer stroke be maintained for three consecutive inches of driving. Driving may be terminated if production piles exceed 10 blows over an increment of one inch or less at an average hammer stroke of 9.0 feet or higher. After splicing or any other delays, we recommend not applying the criteria until at least two feet of driving has occurred beyond the termination depth associated with the delay.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Travis Coleman, P.E.

Benjamin White

Cc: Steve Seymour - steve.seymour@omnni.com
Jeff Horsfall - Jeffrey.Horsfall@dot.wi.gov

Attachments:

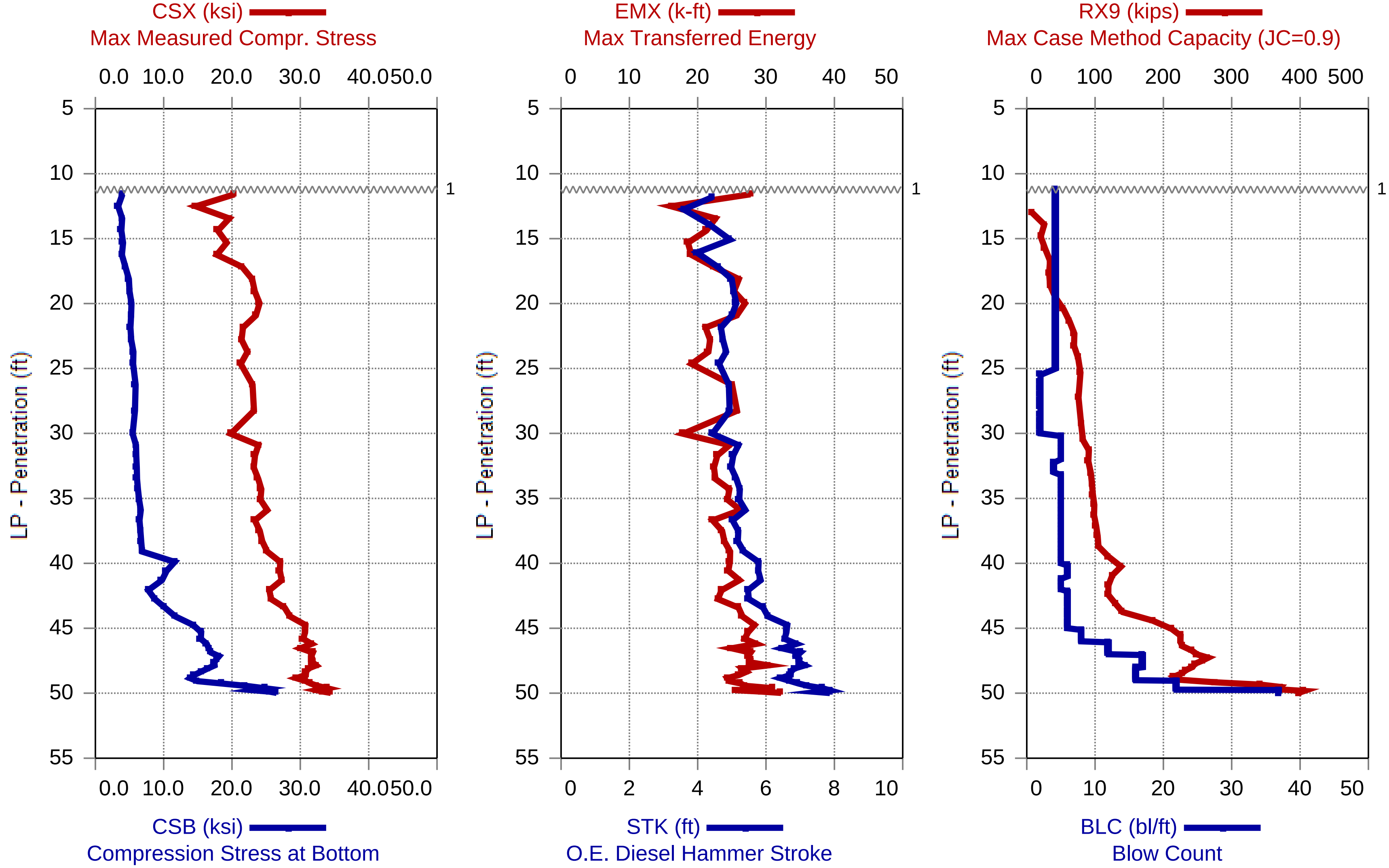
Dynamic Test Results - (Pages 3 – 16)
CAPWAP Analysis Results - (Pages 17 – 36)

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

Printed: 02-January-2015 **Test started: 22-December-2014**

STH 96 over Fox River (B-5-831) - Pier 7 #1 - EOID

APE D25-42, HP 12 x 53



1 - Pile Driven from EL 592.5

STH 96 over Fox River (B-5-831) - Pier 7 #1 - EOID APE D25-42, HP 12 x 53
OP: AZ Date: 22-December-2014

AR: 15.50 in² SP: 0.492 k/ft³
LE: 74.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
60	25.00	4	AV60	20.8	4.6	4.6	22	54.6	39
			STD	4.8	0.9	0.7	7	4.5	25
			MAX	28.4	6.6	6.2	35	68.5	79
			MIN	5.3	2.2	2.8	4	47.2	0
62	26.00	2	AV2	24.3	6.2	5.2	27	51.5	80
			STD	1.1	0.4	0.2	0	0.8	0
			MAX	25.4	6.6	5.3	28	52.2	81
			MIN	23.2	5.8	5.0	27	50.7	80
64	27.00	2	AV2	21.7	5.6	4.7	23	54.1	79
			STD	1.2	0.2	0.2	2	1.1	1
			MAX	22.9	5.7	4.9	25	55.2	79
			MIN	20.5	5.4	4.5	21	53.0	78
66	28.00	2	AV2	22.3	5.8	4.8	24	53.5	73
			STD	1.2	0.0	0.3	1	1.3	0
			MAX	23.6	5.8	5.0	25	54.8	73
			MIN	21.1	5.8	4.5	23	52.1	73
68	29.00	2	AV2	24.1	5.8	5.1	28	51.9	81
			STD	1.4	0.4	0.2	1	1.2	2
			MAX	25.5	6.2	5.3	29	53.0	82
			MIN	22.7	5.4	4.9	26	50.7	79
70	30.00	2	AV2	22.3	5.9	4.8	23	53.2	79
			STD	0.2	0.3	0.1	2	0.3	1
			MAX	22.5	6.2	4.9	24	53.5	80
			MIN	22.1	5.6	4.8	21	52.9	77
75	31.00	5	AV5	21.5	5.6	4.8	20	53.6	84
			STD	3.7	0.6	0.7	7	3.6	5
			MAX	26.3	6.4	5.7	29	58.2	91
			MIN	17.1	4.9	4.0	12	49.1	76
80	32.00	5	AV5	23.2	6.0	5.0	23	52.3	91
			STD	0.8	0.1	0.1	1	0.7	1
			MAX	24.6	6.2	5.2	25	53.0	91
			MIN	22.4	5.8	4.9	21	51.1	90
84	33.00	4	AV4	23.2	6.1	5.0	22	52.4	91
			STD	0.5	0.1	0.1	1	0.4	2
			MAX	23.9	6.2	5.1	24	52.8	94
			MIN	22.6	5.9	4.9	22	51.7	90
89	34.00	5	AV5	23.6	6.1	5.1	22	51.9	95
			STD	1.0	0.2	0.2	2	1.0	2

STH 96 over Fox River (B-5-831) - Pier 7 #1 - EOID APE D25-42, HP 12 x 53
OP: AZ Date: 22-December-2014

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
			MAX	25.4	6.5	5.4	26	53.0	98
			MIN	22.6	5.8	4.9	20	50.2	91
94	35.00	5	AV5	24.5	6.3	5.3	25	51.0	97
			STD	1.3	0.2	0.2	2	1.1	1
			MAX	26.9	6.6	5.8	27	51.9	98
			MIN	23.1	6.1	5.1	22	48.9	96
99	36.00	5	AV5	24.7	6.5	5.3	26	50.7	99
			STD	0.8	0.2	0.2	2	0.7	1
			MAX	25.4	6.7	5.5	27	52.0	100
			MIN	23.4	6.2	5.1	22	50.1	98
104	37.00	5	AV5	23.8	6.5	5.1	23	51.8	99
			STD	1.5	0.2	0.3	2	1.3	2
			MAX	25.7	6.8	5.5	25	53.8	101
			MIN	21.6	6.2	4.7	20	50.1	97
109	38.00	5	AV5	24.1	6.6	5.2	23	51.4	103
			STD	0.8	0.2	0.1	1	0.7	1
			MAX	24.7	6.8	5.3	25	52.6	104
			MIN	22.7	6.2	4.9	22	50.7	101
114	39.00	5	AV5	24.8	6.8	5.3	24	51.1	105
			STD	1.1	0.2	0.2	1	1.1	2
			MAX	26.2	7.0	5.6	26	52.9	109
			MIN	23.1	6.5	4.9	23	49.7	102
119	40.00	5	AV5	26.3	9.7	5.6	25	49.6	125
			STD	1.5	2.4	0.3	1	1.4	15
			MAX	28.4	12.6	6.1	27	52.1	142
			MIN	23.8	6.6	5.0	23	47.7	105
125	41.00	6	AV6	27.2	10.6	5.8	25	48.6	130
			STD	1.5	0.9	0.3	3	1.4	11
			MAX	28.7	11.8	6.2	29	51.3	143
			MIN	24.3	9.1	5.2	20	47.1	114
130	42.00	5	AV5	26.1	8.8	5.6	24	49.7	122
			STD	1.0	1.1	0.2	2	0.9	6
			MAX	27.6	10.0	5.9	27	50.6	133
			MIN	25.0	7.3	5.4	21	48.3	117
136	43.00	6	AV6	25.8	8.5	5.5	24	49.9	120
			STD	1.1	0.5	0.2	2	1.0	5
			MAX	27.5	9.1	5.9	27	51.2	126
			MIN	24.2	7.8	5.2	22	48.2	109
142	44.00	6	AV6	27.7	10.4	5.9	26	48.3	140
			STD	0.5	0.5	0.1	1	0.4	3
			MAX	28.5	11.1	6.1	27	48.8	145
			MIN	27.1	9.4	5.8	24	47.7	136

STH 96 over Fox River (B-5-831) - Pier 7 #1 - EOID APE D25-42, HP 12 x 53
OP: AZ Date: 22-December-2014

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
148	45.00	6	AV6	30.2	13.7	6.5	28	46.3	191
			STD	1.3	1.0	0.4	2	1.2	18
			MAX	32.4	14.8	7.0	31	47.6	208
			MIN	28.8	11.9	6.1	26	44.6	158
156	46.00	8	AV8	30.6	15.5	6.6	27	45.9	223
			STD	1.0	0.6	0.3	2	0.9	6
			MAX	32.2	16.5	7.1	31	47.5	235
			MIN	28.8	14.6	6.1	24	44.3	215
168	47.00	12	AV12	31.2	16.6	6.8	27	45.2	235
			STD	0.9	0.5	0.3	2	0.8	9
			MAX	32.1	17.5	7.1	32	46.8	248
			MIN	29.6	15.7	6.3	25	44.2	222
185	48.00	17	AV17	31.8	17.6	7.0	28	44.6	254
			STD	1.0	0.7	0.3	2	0.9	10
			MAX	33.4	18.7	7.5	32	45.8	271
			MIN	30.3	16.4	6.6	25	43.2	237
201	49.00	16	AV16	30.5	14.9	6.7	26	45.7	225
			STD	1.1	1.0	0.3	2	0.9	9
			MAX	32.3	16.8	7.1	29	48.0	244
			MIN	27.6	13.5	6.0	23	44.1	209
217	49.73	22	AV16	32.5	20.6	7.2	27	43.9	332
			STD	1.3	3.5	0.4	3	1.3	50
			MAX	34.2	25.5	8.0	33	46.0	395
			MIN	30.1	14.6	6.5	24	41.8	232
227	50.00	37	AV10	33.2	25.1	7.7	29	42.6	397
			STD	2.8	2.4	0.3	5	0.9	17
			MAX	36.2	27.4	8.4	33	44.2	416
			MIN	25.4	18.2	7.1	16	40.9	352
			Average	26.2	10.6	5.7	25	49.6	149
			Std. Dev.	5.3	6.3	1.1	5	4.8	106
			Maximum	36.2	27.4	8.4	35	68.5	416
			Minimum	5.3	2.2	2.8	4	40.9	0

Total number of blows analyzed: 227

BL# Sensors

1-227 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K2214] 332.0 (1.10); A4: [K1020] 307.0 (1.10)

BL# Comments

1 Pile Driven from EL 592.5
226 CW

STH 96 over Fox River (B-5-831) - Pier 7 #1 - EOID
OP: AZ
APE D25-42, HP 12 x 53
Date: 22-December-2014

Time Summary

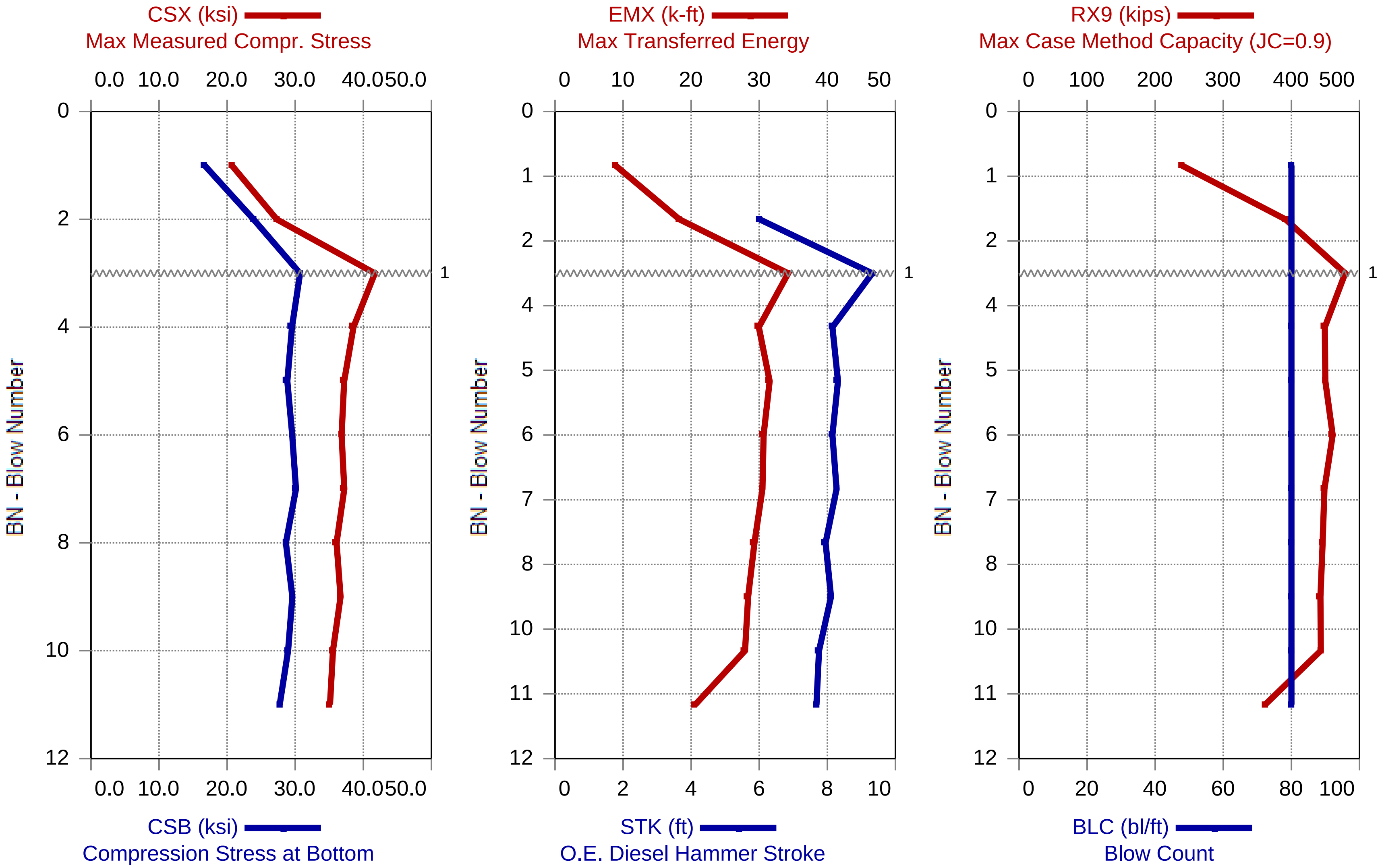
Drive 6 minutes 2 seconds 3:39 PM - 3:45 PM BN 1 - 227

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

Printed: 02-January-2015 **Test started: 23-December-2014**

STH 96 over Fox River (B-5-831) - Pier 7 #1 - BOR

APE D25-42, HP 12 x 53



1 - One strain gage slipped. Gage shut off for remainder or restrike

STH 96 over Fox River (B-5-831) - Pier 7 #1 - BOR APE D25-42, HP 12 x 53
OP: TC Date: 23-December-2014

AR: 15.50 in² SP: 0.492 k/ft³
LE: 74.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
10	50.13	80	AV10	34.8	27.6	8.0	27	41.9	425
			STD	5.8	4.1	0.8	7	2.3	65
			MAX	41.7	30.7	9.3	34	47.9	479
			MIN	20.7	16.7	6.0	9	38.8	239
11	50.14	80	AV1	35.1	27.7	7.7	21	42.6	361
			STD	0.0	0.0	0.0	0	0.0	0
			MAX	35.1	27.7	7.7	21	42.6	361
			MIN	35.1	27.7	7.7	21	42.6	361
			Average	34.8	27.7	8.0	26	42.0	419
			Std. Dev.	5.5	3.9	0.8	7	2.2	65
			Maximum	41.7	30.7	9.3	34	47.9	479
			Minimum	20.7	16.7	6.0	9	38.8	239

Total number of blows analyzed: 11

BL# Sensors

1-1 F3: [H083] 94.4 (1.00); F4: off; ; A3: [K1020] 307.0 (1.05); A4: [K2214] 332.0 (1.05)
2-2 F3: [H083] 94.4 (1.00); F4: [F523] 93.8 (1.00); A3: [K1020] 307.0 (1.06); A4: [K2214] 332.0 (1.06)
3-11 F3: [H083] 94.4 (1.00); F4: off; ; A3: [K1020] 307.0 (1.05); A4: [K2214] 332.0 (1.05)

BL# Comments

2 CW

Time Summary

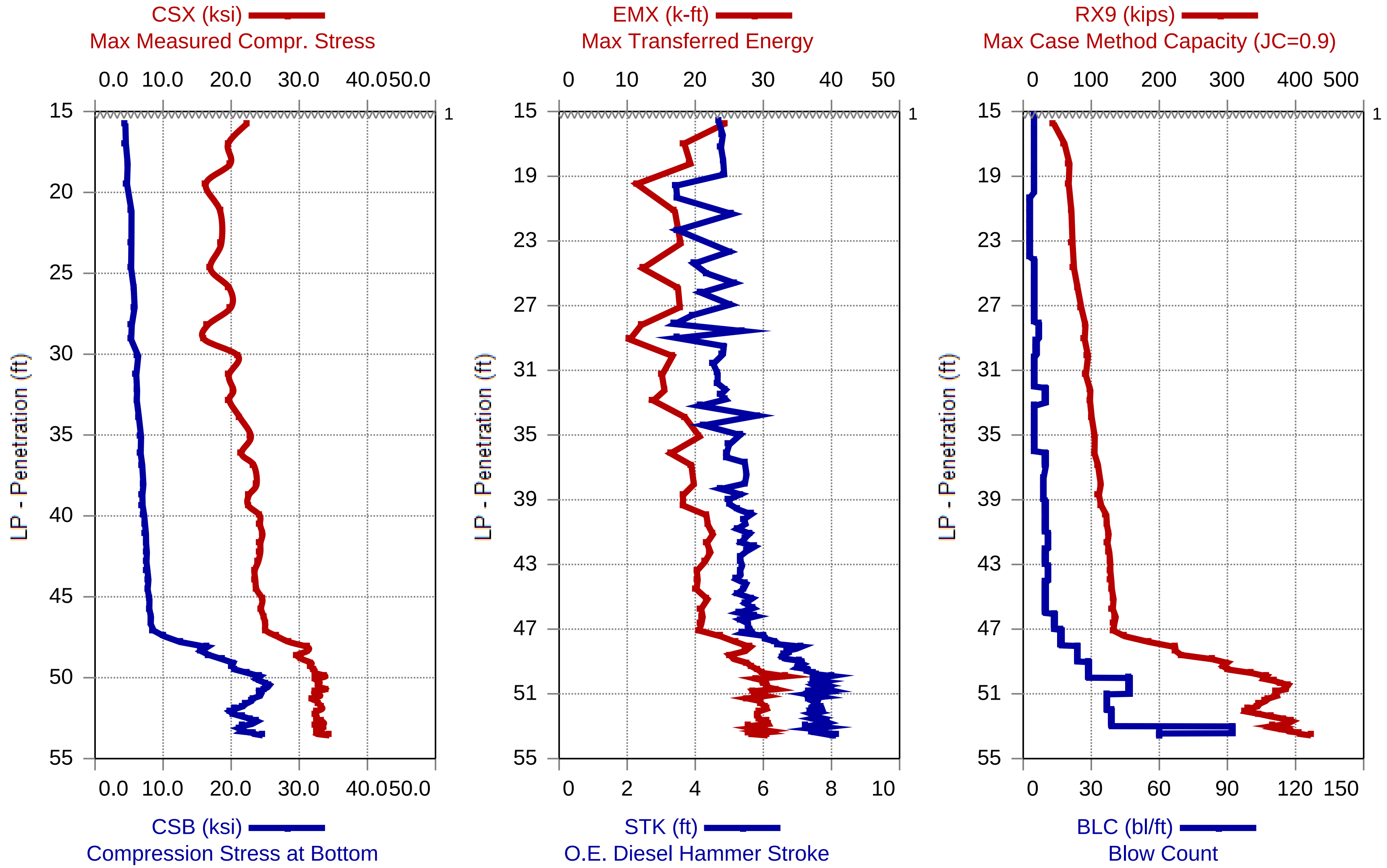
Drive 14 seconds 9:24 AM - 9:24 AM BN 1 - 11

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

Printed: 31-December-2014 **Test started: 22-December-2014**

STH 96 over Fox River (B-5-831) - Pier 7 #30 - EOID

APE D25-42, HP 12 x 53



1 - Pile Driven from EL 592.5

STH 96 over Fox River (B-5-831) - Pier 7 #30 - EOID APE D25-42, HP 12 x 53
OP: AZ Date: 22-December-2014

AR: 15.50 in² SP: 0.492 k/ft³
LE: 75.90 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
24	20.00	5	AV24	19.5	4.6	4.5	18	56.3	60
			STD	5.9	0.6	1.2	11	6.8	14
			MAX	27.2	5.8	6.4	32	65.8	83
			MIN	10.3	3.3	3.0	3	46.6	27
27	21.00	3	AV3	17.2	5.2	4.2	18	57.6	70
			STD	5.8	1.1	0.9	9	6.3	5
			MAX	23.5	6.5	5.3	28	66.1	74
			MIN	9.4	3.8	3.0	5	50.9	64
30	22.00	3	AV3	19.6	5.5	4.6	16	54.9	71
			STD	3.4	0.5	0.7	6	3.7	3
			MAX	23.5	6.2	5.4	24	59.6	75
			MIN	15.1	4.8	3.8	9	50.5	68
33	23.00	3	AV3	15.6	4.9	3.3	15	63.1	70
			STD	5.4	0.8	0.1	13	1.1	12
			MAX	23.2	6.0	3.5	33	64.2	87
			MIN	11.1	4.1	3.2	4	62.0	59
36	24.00	3	AV3	21.4	5.8	5.0	21	52.8	75
			STD	4.4	0.6	0.8	9	4.3	4
			MAX	26.2	6.4	5.9	32	58.7	80
			MIN	15.7	5.1	3.9	10	48.4	73
41	25.00	5	AV5	17.2	5.4	4.2	13	57.0	75
			STD	2.8	0.4	0.5	4	2.8	5
			MAX	20.9	5.8	4.9	18	60.5	81
			MIN	13.0	4.7	3.7	7	52.9	68
46	26.00	5	AV5	21.0	5.9	4.9	20	53.1	82
			STD	3.1	0.4	0.6	6	3.1	6
			MAX	24.1	6.3	5.5	26	58.5	88
			MIN	15.7	5.1	3.9	11	50.0	71
51	27.00	5	AV5	17.8	5.4	4.2	15	57.9	79
			STD	6.1	1.0	1.2	12	6.7	12
			MAX	26.6	6.7	6.2	29	64.4	96
			MIN	10.8	4.2	3.2	3	47.3	66
56	28.00	5	AV5	17.1	5.5	4.2	11	57.8	85
			STD	4.5	0.7	0.9	7	5.3	6
			MAX	24.6	6.6	5.7	24	63.5	95
			MIN	12.8	4.7	3.3	4	49.0	77
63	29.00	7	AV7	17.6	5.6	4.3	13	56.9	92
			STD	5.7	1.0	1.0	9	6.1	11

STH 96 over Fox River (B-5-831) - Pier 7 #30 - EOID APE D25-42, HP 12 x 53
OP: AZ Date: 22-December-2014

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
			MAX	25.1	7.1	5.7	25	65.7	109
			MIN	9.6	4.0	3.1	3	49.1	78
69	30.00	6	AV6	19.2	5.9	4.6	16	55.3	98
			STD	5.8	1.1	1.0	9	6.1	10
			MAX	25.8	7.1	5.9	27	64.3	109
			MIN	10.2	4.2	3.2	3	48.4	79
74	31.00	5	AV5	20.5	6.2	4.7	16	53.8	92
			STD	2.0	0.3	0.4	4	2.1	4
			MAX	24.0	6.8	5.5	22	55.7	99
			MIN	18.8	5.9	4.4	12	50.1	86
79	32.00	5	AV5	18.9	5.9	4.5	14	55.0	93
			STD	1.5	0.3	0.3	4	1.6	6
			MAX	21.6	6.4	5.0	22	57.3	105
			MIN	16.9	5.4	4.1	10	52.3	90
89	33.00	10	AV10	20.2	6.2	4.8	14	53.8	98
			STD	3.2	0.4	0.6	5	3.3	8
			MAX	25.2	6.7	5.9	21	58.4	113
			MIN	15.7	5.6	3.9	8	48.5	89
94	34.00	5	AV5	22.5	6.6	5.2	21	51.8	102
			STD	3.8	0.6	0.8	8	4.1	8
			MAX	27.1	7.3	6.2	30	57.6	112
			MIN	17.2	5.8	4.1	11	47.1	91
99	35.00	5	AV5	19.4	6.1	4.6	15	54.8	100
			STD	2.8	0.5	0.5	5	3.1	7
			MAX	22.2	6.6	5.2	20	59.6	107
			MIN	15.2	5.5	3.8	8	51.5	90
104	36.00	5	AV5	22.5	6.8	5.1	19	51.9	103
			STD	2.4	0.3	0.5	5	2.5	3
			MAX	25.8	7.1	5.9	27	55.4	109
			MIN	19.3	6.3	4.4	14	48.4	100
114	37.00	10	AV9	22.7	6.9	5.1	18	51.7	108
			STD	1.5	0.2	0.3	2	1.5	5
			MAX	25.9	7.3	5.9	24	53.5	115
			MIN	20.9	6.6	4.8	15	48.3	100
123	38.00	9	AV4	24.8	7.2	5.6	22	49.6	119
			STD	2.0	0.3	0.4	3	1.9	3
			MAX	26.9	7.5	6.1	26	52.6	123
			MIN	21.6	6.7	4.9	17	47.7	114
132	39.00	9	AV9	22.6	7.0	5.1	18	51.9	110
			STD	1.9	0.3	0.4	3	1.9	6
			MAX	25.5	7.5	5.7	23	56.0	120
			MIN	18.8	6.5	4.3	11	49.1	99

STH 96 over Fox River (B-5-831) - Pier 7 #30 - EOID APE D25-42, HP 12 x 53
OP: AZ Date: 22-December-2014

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
142	40.00	10	AV10	23.3	7.1	5.3	20	51.2	118
			STD	2.0	0.2	0.4	3	2.1	7
			MAX	26.0	7.4	5.9	25	56.0	127
			MIN	18.8	6.5	4.3	14	48.4	106
152	41.00	10	AV10	24.3	7.4	5.4	22	50.3	123
			STD	1.4	0.2	0.3	2	1.3	4
			MAX	26.3	7.7	5.9	25	51.9	129
			MIN	22.6	7.0	5.1	19	48.3	118
163	42.00	11	AV11	24.3	7.4	5.5	22	50.0	125
			STD	1.0	0.2	0.2	1	1.1	3
			MAX	25.6	7.8	5.9	24	51.8	129
			MIN	22.5	7.2	5.1	20	48.5	121
173	43.00	10	AV10	24.0	7.6	5.4	22	50.6	127
			STD	1.4	0.2	0.3	2	1.4	2
			MAX	25.7	7.9	5.8	25	53.6	131
			MIN	20.6	7.0	4.7	17	48.9	124
184	44.00	11	AV11	23.4	7.7	5.3	20	50.9	129
			STD	1.0	0.2	0.2	1	1.0	2
			MAX	24.7	8.0	5.6	22	53.1	131
			MIN	21.1	7.4	4.8	18	49.5	126
194	45.00	10	AV10	23.9	7.8	5.4	21	50.4	131
			STD	0.7	0.2	0.2	2	0.7	2
			MAX	25.0	8.1	5.7	23	52.2	135
			MIN	22.2	7.4	5.0	17	49.3	128
204	46.00	10	AV10	24.6	8.0	5.5	21	49.8	132
			STD	1.0	0.1	0.3	2	1.1	2
			MAX	26.0	8.1	6.0	24	52.2	136
			MIN	22.3	7.6	5.0	18	48.0	129
218	47.00	14	AV14	24.9	8.2	5.5	21	49.8	134
			STD	0.9	0.2	0.2	1	1.0	4
			MAX	26.7	8.7	6.1	23	51.5	139
			MIN	23.4	7.8	5.2	18	47.7	127
235	48.00	17	AV17	27.2	11.0	6.0	24	48.0	162
			STD	1.9	2.2	0.5	3	1.7	30
			MAX	30.3	16.3	6.8	28	50.9	222
			MIN	24.1	8.2	5.3	19	45.1	128
259	49.00	24	AV24	30.7	17.1	6.8	27	45.2	243
			STD	1.0	1.8	0.3	2	0.9	32
			MAX	32.4	22.1	7.3	30	46.8	331
			MIN	29.0	14.7	6.3	23	43.6	214
288	50.00	29	AV29	32.4	21.5	7.4	30	43.5	317
			STD	1.1	1.7	0.4	2	1.0	26
			MAX	35.5	24.4	8.4	34	45.2	362

STH 96 over Fox River (B-5-831) - Pier 7 #30 - EOID APE D25-42, HP 12 x 53
OP: AZ Date: 22-December-2014

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
			MIN	30.5	19.7	6.8	26	40.7	287
335	51.00	47	AV47	32.8	24.7	7.6	30	42.8	376
			STD	1.3	0.8	0.3	2	0.9	12
			MAX	35.5	26.9	8.4	34	44.7	395
			MIN	30.3	22.8	6.9	25	40.8	348
372	52.00	37	AV37	32.8	22.6	7.5	30	43.0	352
			STD	1.1	1.2	0.3	2	0.7	14
			MAX	35.0	24.7	8.2	33	44.3	380
			MIN	31.0	20.1	7.1	26	41.3	325
411	53.00	39	AV39	32.8	21.9	7.6	30	42.9	367
			STD	1.0	1.5	0.3	2	0.8	24
			MAX	35.2	24.4	8.4	34	44.3	401
			MIN	31.0	19.0	7.1	26	40.9	320
451	53.43	92	AV40	33.1	21.8	7.6	29	42.8	384
			STD	0.8	0.7	0.2	2	0.6	13
			MAX	34.8	23.9	8.1	32	44.0	413
			MIN	31.6	20.7	7.2	25	41.4	361
461	53.60	60	AV10	33.4	24.1	8.0	30	41.7	418
			STD	3.1	2.2	0.3	5	0.7	31
			MAX	36.2	26.4	8.5	34	42.7	442
			MIN	24.7	18.9	7.6	16	40.6	350
			Average	27.3	14.5	6.3	24	47.8	229
			Std. Dev.	6.2	7.9	1.4	7	5.7	129
			Maximum	36.2	26.9	8.5	34	66.1	442
			Minimum	9.4	3.3	3.0	3	40.6	27

Total number of blows analyzed: 455

BL# Sensors

1-461 F3: [H083] 94.4 (1.00); F4: [F523] 93.8 (1.00); A3: [K1020] 307.0 (1.09); A4: [K2214] 332.0 (1.09)

BL# Comments

1 Pile Driven from EL 592.5
458 CW

Time Summary

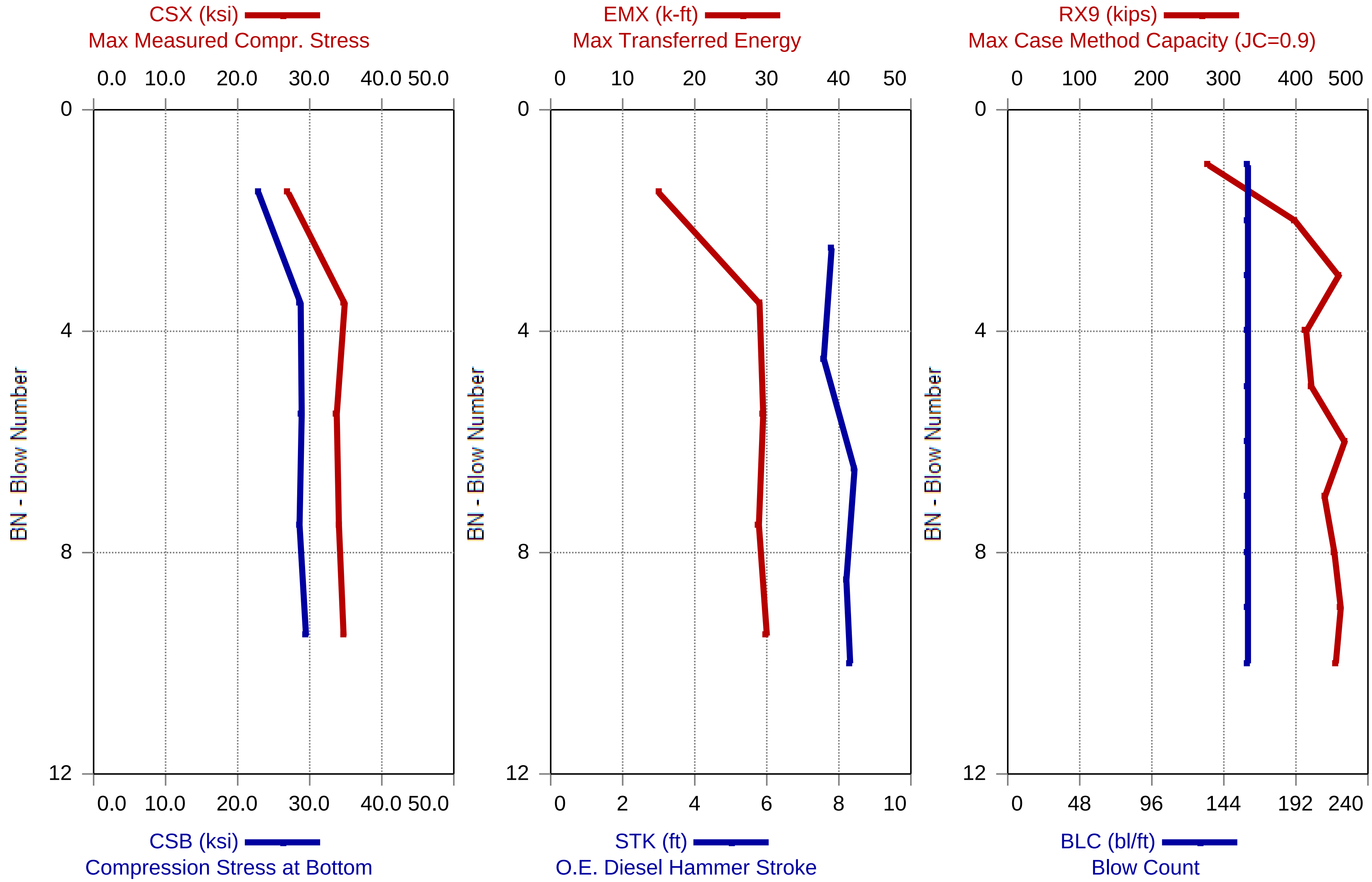
Drive 11 minutes 40 seconds 4:12 PM - 4:23 PM BN 1 - 461

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

Printed: 02-January-2015 **Test started: 23-December-2014**

STH 96 over Fox River (B-5-831) - Pier 7 #30 - BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - Pier 7 #30 - BOR APE D25-42, HP 12 x 53
OP: TC Date: 23-December-2014

AR: 15.50 in² SP: 0.492 k/ft³
LE: 75.90 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
10	53.63	160	AV10	32.9	27.7	8.0	26	41.8	425
			STD	3.4	2.8	0.7	7	1.9	53
			MAX	36.6	30.8	9.0	34	45.9	467
			MIN	24.7	20.6	6.6	11	39.4	279
			Average	32.9	27.7	8.0	26	41.8	425
			Std. Dev.	3.4	2.8	0.7	7	1.9	53
			Maximum	36.6	30.8	9.0	34	45.9	467
			Minimum	24.7	20.6	6.6	11	39.4	279

Total number of blows analyzed: 10

BL# Sensors

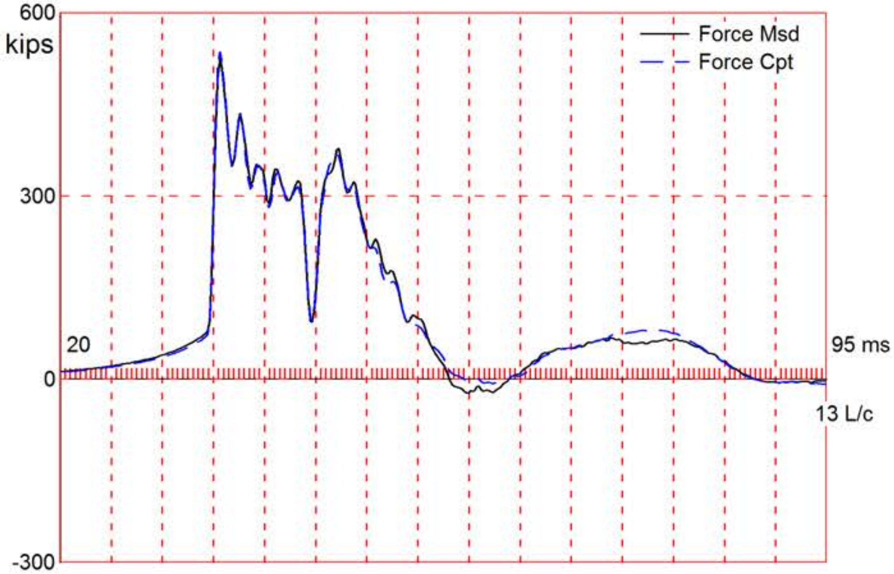
1-3 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K2214] 332.0 (1.06); A4: [K1020] 307.0 (1.06)
4-4 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K2214] 332.0 (1.06); A4: off
5-10 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K2214] 332.0 (1.06); A4: [K1020] 307.0 (1.06)

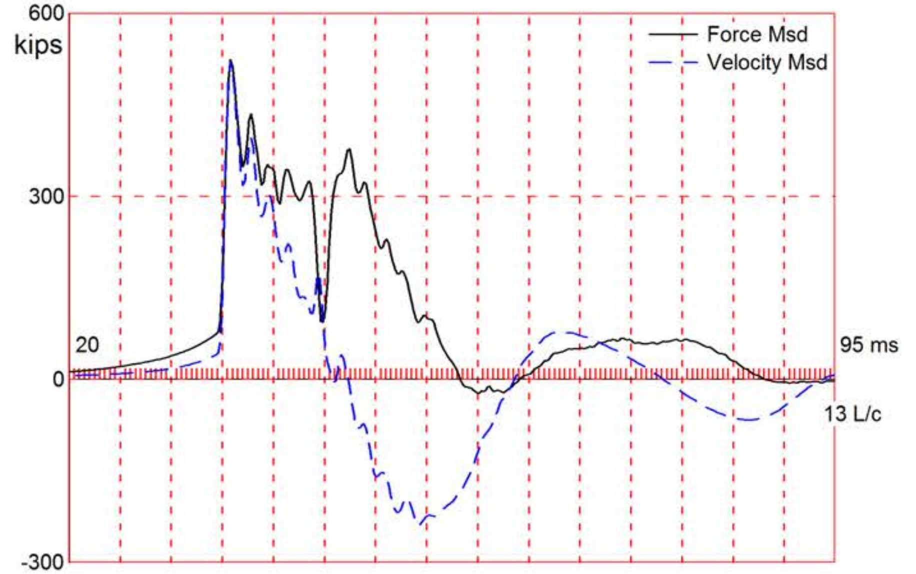
BL# Comments

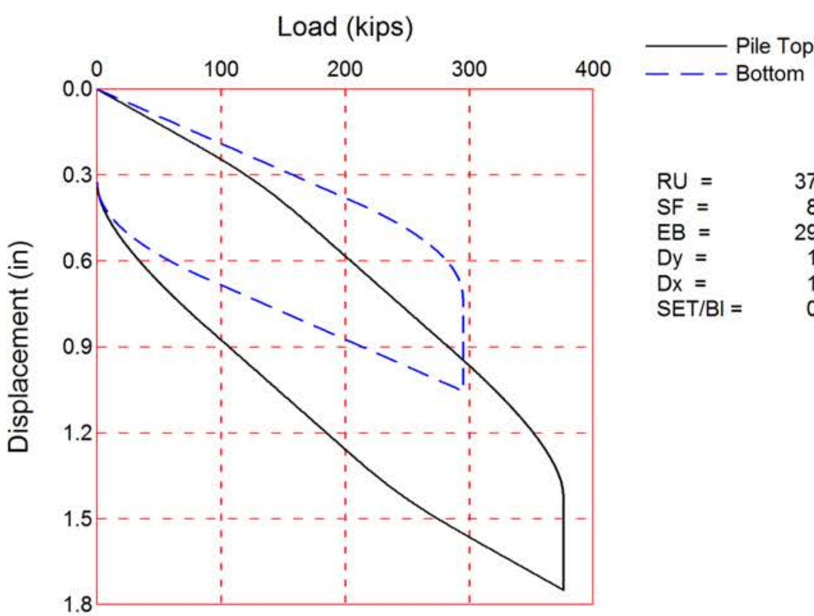
4 CW

Time Summary

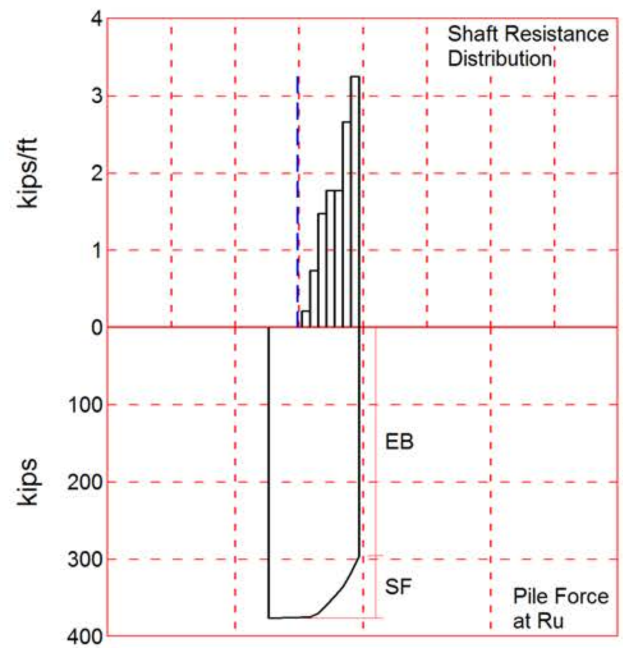
Drive 12 seconds 9:04 AM - 9:04 AM BN 1 - 10







RU =	376.0 kips
SF =	81.0 kips
EB =	295.0 kips
Dy =	1.42 in
Dx =	1.75 in
SET/Bl =	0.33 in



Length b. Sensors	74.4 ft
Embedment	50.0 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.59
Top Compr. Stress	34.6 ksi
Max Compr. Stress	35.4 ksi
Max Tension Stress	-6.29 ksi
Avg. Shaft Quake	0.13 in
Toe Quake	0.56 in
Avg. Shaft Smith Dpg.	0.23 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.

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: 376.0; along Shaft 81.0; at Toe 295.0 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
				376.0			
1	33.8	9.4	2.0	374.0	2.0	0.21	0.05
2	40.6	16.2	5.0	369.0	7.0	0.74	0.19
3	47.3	22.9	10.0	359.0	17.0	1.48	0.37
4	54.1	29.7	12.0	347.0	29.0	1.77	0.45
5	60.9	36.4	12.0	335.0	41.0	1.77	0.45
6	67.6	43.2	18.0	317.0	59.0	2.66	0.67
7	74.4	50.0	22.0	295.0	81.0	3.25	0.82
Avg. Shaft			11.6			1.62	0.41
Toe			295.0				299.39

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.23	0.08
Quake	(in)	0.13	0.56
Case Damping Factor		0.67	0.85
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	48
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	32	
Resistance Gap (included in Toe Quake) (in)			0.12
Soil Plug Weight	(kips)		0.068

CAPWAP match quality = 2.59 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.33 in; Blow Count = 37 b/ft
Computed: Final Set = 0.31 in; Blow Count = 38 b/ft
Transducer F1(F523) CAL: 93.8; RF: 1.00; F2(H083) CAL: 94.4; RF: 1.00
A1(K2214) CAL: 332; RF: 1.10; A2(K1020) CAL: 307; RF: 1.10

max. Top Comp. Stress = 34.6 ksi (T= 36.0 ms, max= 1.023 x Top)
max. Comp. Stress = 35.4 ksi (Z= 40.6 ft, T= 38.2 ms)
max. Tens. Stress = -6.29 ksi (Z= 54.1 ft, T= 62.2 ms)
max. Energy (EMX) = 35.0 kip-ft; max. Measured Top Displ. (DMX)= 1.29 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	536.7	-14.7	34.6	-0.95	35.0	18.4	1.29
2	6.8	537.1	-22.1	34.6	-1.43	34.9	18.4	1.27
3	10.1	537.5	-28.2	34.7	-1.82	34.7	18.3	1.25
4	13.5	538.0	-34.4	34.7	-2.22	34.3	18.3	1.22
5	16.9	538.6	-43.6	34.7	-2.81	34.0	18.2	1.19
6	20.3	539.1	-51.2	34.8	-3.30	33.6	18.2	1.16
7	23.7	539.8	-58.2	34.8	-3.75	33.1	18.1	1.13
8	27.1	541.1	-64.3	34.9	-4.15	32.7	18.1	1.10
9	30.4	544.0	-70.7	35.1	-4.56	32.2	17.9	1.07
10	33.8	547.2	-78.7	35.3	-5.08	31.6	17.8	1.04
11	37.2	543.1	-84.0	35.0	-5.41	30.5	17.6	1.00
12	40.6	549.0	-90.0	35.4	-5.80	29.9	17.3	0.97
13	44.0	535.1	-91.1	34.5	-5.88	28.1	16.9	0.93
14	47.3	543.5	-96.5	35.1	-6.23	27.6	16.6	0.90
15	50.7	507.8	-93.0	32.8	-6.00	24.8	16.1	0.87
16	54.1	516.7	-97.6	33.3	-6.29	24.3	15.8	0.83
17	57.5	472.7	-92.5	30.5	-5.97	21.3	15.7	0.80
18	60.9	483.3	-95.0	31.2	-6.12	20.9	15.0	0.77
19	64.3	443.6	-85.3	28.6	-5.50	18.2	14.4	0.74
20	67.6	438.7	-85.5	28.3	-5.52	17.8	16.8	0.71
21	71.0	411.2	-71.3	26.5	-4.60	14.4	18.9	0.68
22	74.4	414.0	-71.1	26.7	-4.59	11.3	19.0	0.66
Absolute	40.6			35.4			(T =	38.2 ms)
	54.1				-6.29		(T =	62.2 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	507.5	397.4	287.2	177.1	67.0					
RX	569.8	515.2	469.0	443.8	422.8	412.7	402.6	393.0	390.1	387.2
RU	507.5	397.4	287.2	177.1	67.0					

RAU = 326.8 (kips); RA2 = 465.1 (kips)

Current CAPWAP Ru = 376.0 (kips); Corresponding J(RP)= 0.24; 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
19.1	36.02	528.5	529.7	529.7	1.29	0.37	0.33	35.6	529.3	670

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
74.4	15.5	29992.2	492.000	3.97

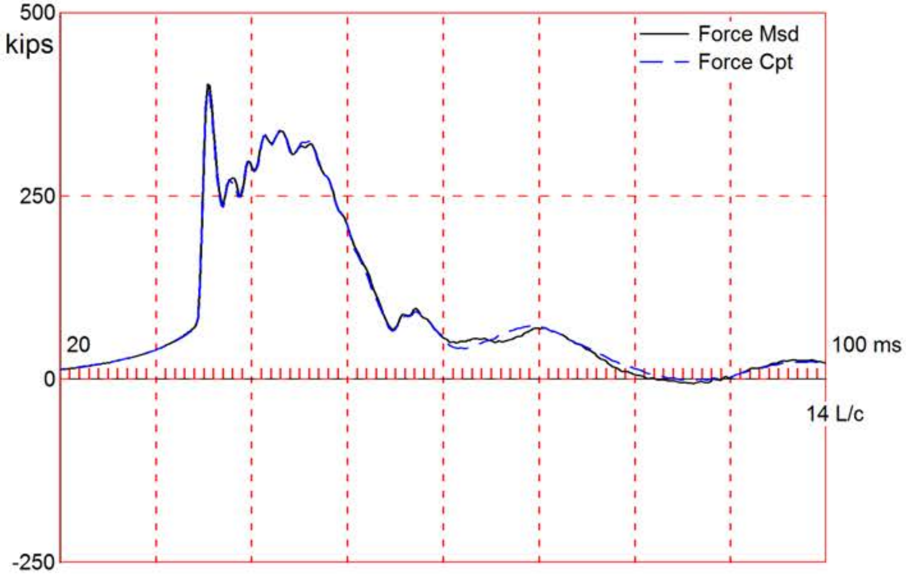
Toe Area 141.9 in^2

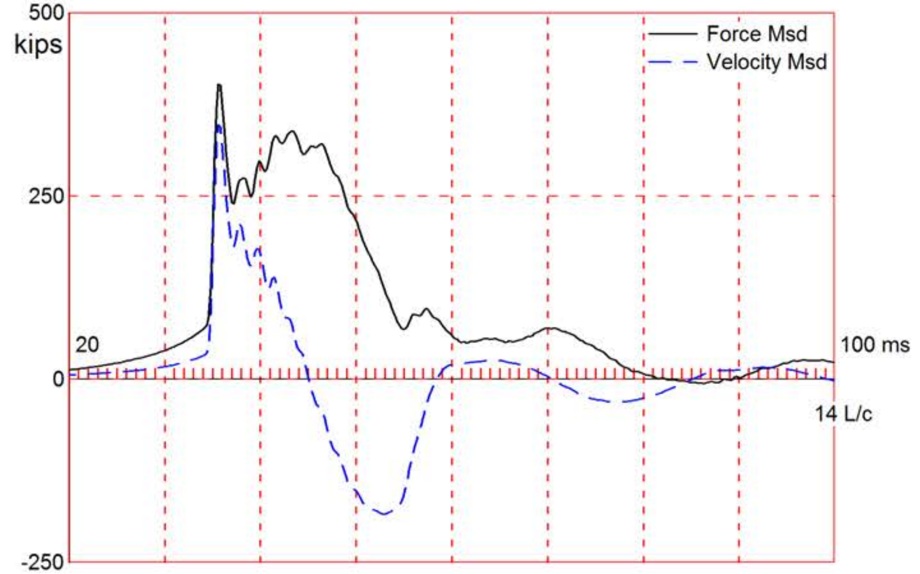
Top Segment Length 3.38 ft, Top Impedance 28 kips/ft/s

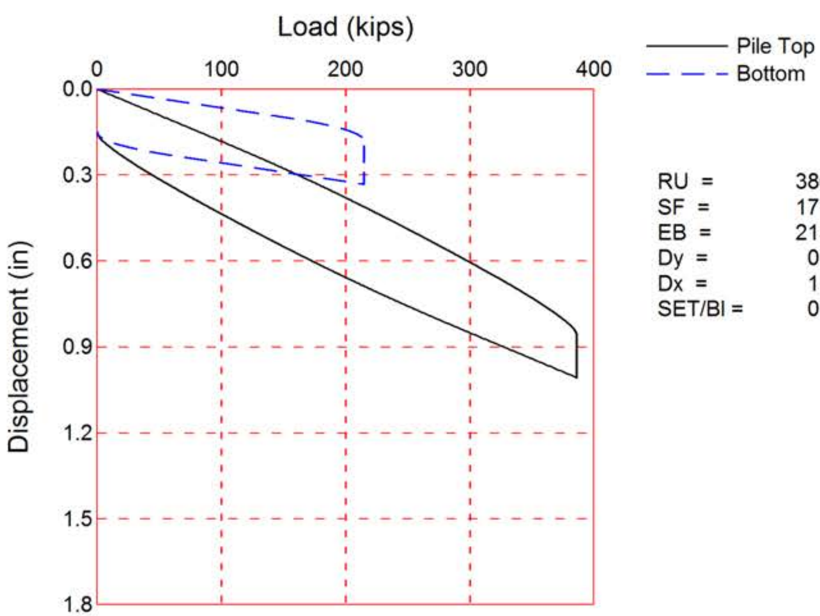
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s

Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 8.9 ms

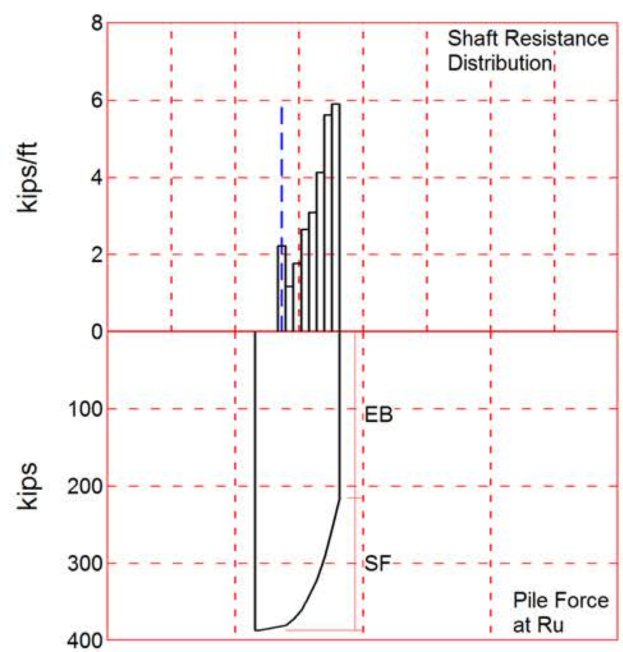
Total volume: 8.008 ft^3; Volume ratio considering added impedance: 1.000







RU =	386.0 kips
SF =	171.0 kips
EB =	215.0 kips
Dy =	0.86 in
Dx =	1.01 in
SET/Bl =	0.15 in



Length b. Sensors	74.4 ft
Embedment	50.0 ft
Top Area	15.5 in²
End Bearing Area	141.9 in²
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft³
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	1.79
Top Compr. Stress	25.5 ksi
Max Compr. Stress	27.1 ksi
Max Tension Stress	-0.51 ksi
Avg. Shaft Quake	0.13 in
Toe Quake	0.14 in
Avg. Shaft Smith Dpg.	0.28 s/ft
Toe Smith Damping	0.11 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 386.0; along Shaft 171.0; at Toe 215.0 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
				386.0			
1	27.1	2.7	6.0	380.0	6.0	2.24	0.56
2	33.8	9.4	8.0	372.0	14.0	1.18	0.30
3	40.6	16.2	12.0	360.0	26.0	1.77	0.45
4	47.3	23.0	18.0	342.0	44.0	2.66	0.67
5	54.1	29.7	21.0	321.0	65.0	3.10	0.78
6	60.9	36.5	28.0	293.0	93.0	4.14	1.04
7	67.6	43.3	38.0	255.0	131.0	5.62	1.41
8	74.4	50.0	40.0	215.0	171.0	5.91	1.49
Avg. Shaft			21.4			3.42	0.86
Toe			215.0				218.20

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.28	0.11
Quake	(in)	0.13	0.14
Case Damping Factor		1.73	0.85
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	63
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	75	
Resistance Gap (included in Toe Quake) (in)			0.02
Soil Plug Weight	(kips)		0.114

CAPWAP match quality = 1.79 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.12 in; Blow Count = 104 b/ft

max. Top Comp. Stress = 25.5 ksi (T= 35.8 ms, max= 1.061 x Top)
max. Comp. Stress = 27.1 ksi (Z= 27.1 ft, T= 37.4 ms)
max. Tens. Stress = -0.51 ksi (Z= 27.1 ft, T= 85.3 ms)
max. Energy (EMX) = 17.3 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	396.0	-4.3	25.5	-0.28	17.3	12.8	0.79
2	6.8	396.8	-4.7	25.6	-0.30	16.9	12.7	0.76
3	10.1	397.6	-5.0	25.6	-0.32	16.5	12.7	0.73
4	13.5	399.0	-5.3	25.7	-0.34	16.0	12.6	0.70
5	16.9	400.9	-5.7	25.9	-0.37	15.5	12.5	0.66
6	20.3	406.0	-6.3	26.2	-0.40	15.0	12.4	0.63
7	23.7	413.3	-7.1	26.7	-0.46	14.5	12.1	0.60
8	27.1	420.3	-7.9	27.1	-0.51	14.0	11.9	0.57
9	30.4	403.4	-4.1	26.0	-0.26	12.9	11.6	0.53
10	33.8	412.7	-5.1	26.6	-0.33	12.4	11.2	0.50
11	37.2	396.0	-0.7	25.5	-0.04	11.1	10.8	0.47
12	40.6	404.1	-7.2	26.1	-0.46	10.6	10.4	0.44
13	44.0	383.2	0.0	24.7	0.00	9.2	9.9	0.40
14	47.3	387.3	-3.6	25.0	-0.23	8.8	9.4	0.37
15	50.7	365.1	0.0	23.5	0.00	7.2	8.9	0.34
16	54.1	369.5	0.0	23.8	0.00	6.8	8.3	0.31
17	57.5	346.3	0.0	22.3	0.00	5.5	7.7	0.28
18	60.9	346.8	0.0	22.4	0.00	5.1	7.1	0.26
19	64.3	316.9	0.0	20.4	0.00	3.9	6.5	0.23
20	67.6	321.2	0.0	20.7	0.00	3.6	5.9	0.20
21	71.0	284.5	0.0	18.4	0.00	2.5	6.2	0.18
22	74.4	283.5	0.0	18.3	0.00	1.7	6.0	0.16
Absolute	27.1			27.1			(T =	37.4 ms)
	27.1				-0.51		(T =	85.3 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	518.8	494.3	469.9	445.5	421.0	396.6	372.2	347.7	323.3	298.9
RX	522.0	497.9	473.8	450.6	427.8	405.2	398.3	393.2	388.2	383.1
RU	518.8	494.3	469.9	445.5	421.0	396.6	372.2	347.7	323.3	298.9

RAU = 93.2 (kips); RA2 = 404.7 (kips)

Current CAPWAP Ru = 386.0 (kips); Corresponding J(RP)= 0.54; J(RX) = 0.84

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
12.8	35.61	354.1	409.0	410.1	0.80	0.15	0.15	17.7	445.8	1792

PILE PROFILE AND PILE MODEL

Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	15.5	29992.2	492.000	3.97
74.4	15.5	29992.2	492.000	3.97

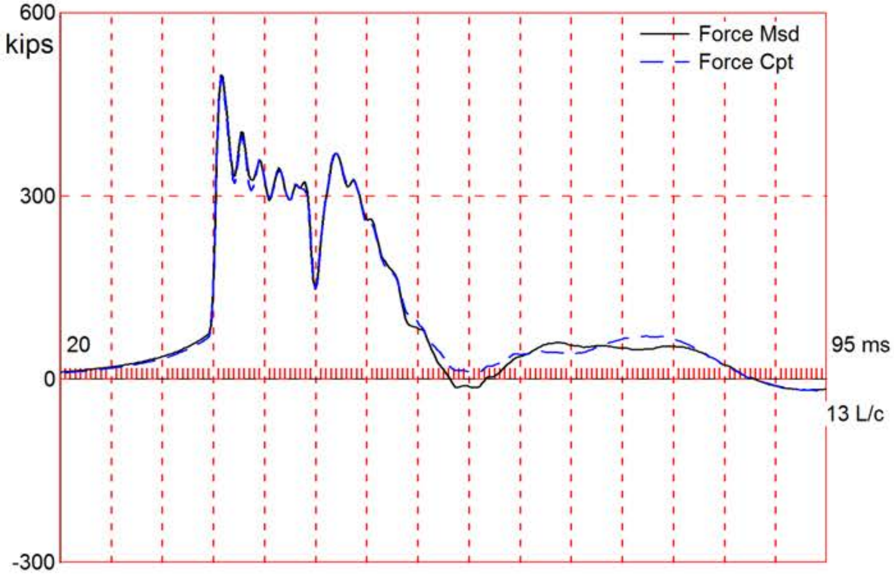
Toe Area 141.9 in²

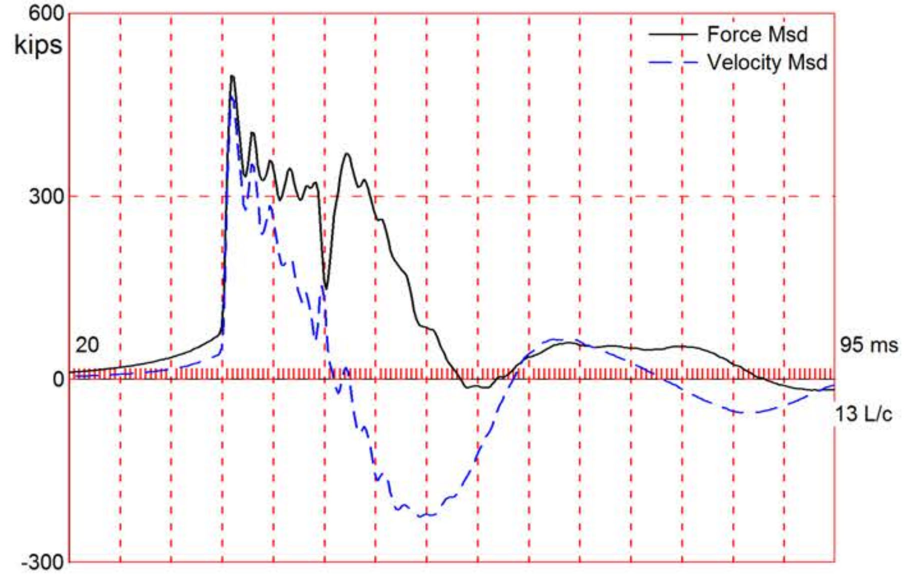
Top Segment Length 3.38 ft, Top Impedance 28 kips/ft/s

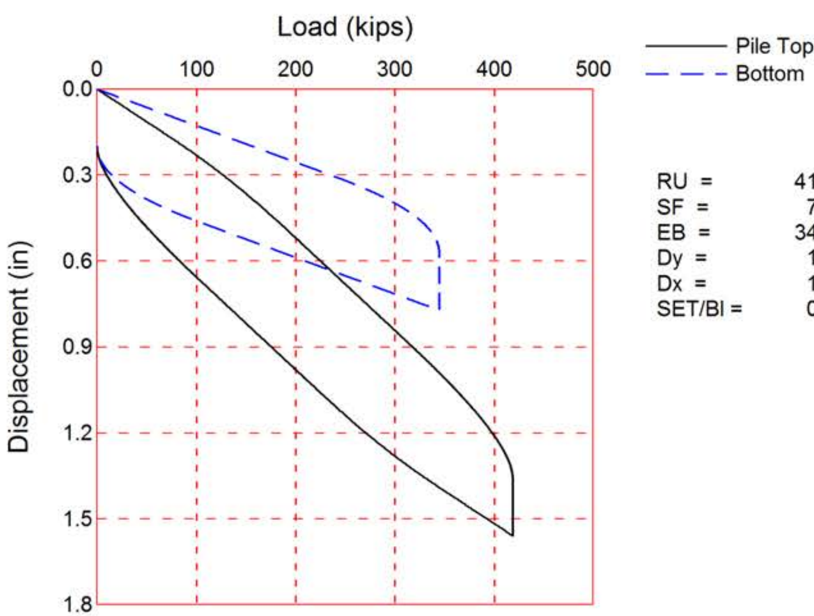
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s

Pile Damping 1.00 %, Time Incr 0.201 ms, 2L/c 8.9 ms

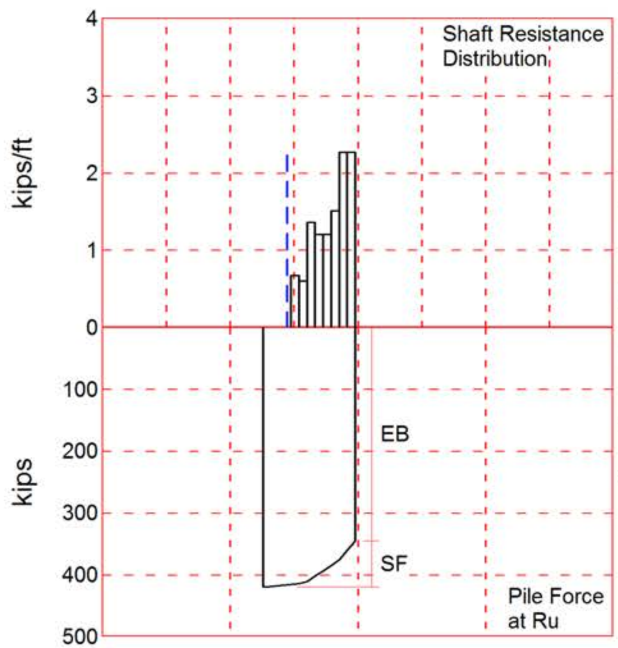
Total volume: 8.008 ft^3; Volume ratio considering added impedance: 1.000







RU =	419.0 kips
SF =	74.0 kips
EB =	345.0 kips
Dy =	1.36 in
Dx =	1.56 in
SET/Bl =	0.20 in



Length b. Sensors	75.9 ft
Embedment	53.6 ft
Top Area	15.5 in²
End Bearing Area	141.9 in²
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft³
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	3.06
Top Compr. Stress	31.9 ksi
Max Compr. Stress	33.2 ksi
Max Tension Stress	-3.67 ksi
Avg. Shaft Quake	0.13 in
Toe Quake	0.44 in
Avg. Shaft Smith Dpg.	0.25 s/ft
Toe Smith Damping	0.07 s/ft

About the CAPWAP Results

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

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

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

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

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

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

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

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 419.0; along Shaft 74.0; at Toe 345.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				419.0			
1	29.7	7.3	5.0	414.0	5.0	0.68	0.17
2	36.3	13.9	4.0	410.0	9.0	0.61	0.15
3	42.9	20.5	9.0	401.0	18.0	1.36	0.34
4	49.5	27.1	8.0	393.0	26.0	1.21	0.31
5	56.1	33.8	8.0	385.0	34.0	1.21	0.31
6	62.7	40.4	10.0	375.0	44.0	1.52	0.38
7	69.3	47.0	15.0	360.0	59.0	2.27	0.57
8	75.9	53.6	15.0	345.0	74.0	2.27	0.57
Avg. Shaft			9.3			1.38	0.35
Toe			345.0				350.13

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.25	0.07
Quake	(in)	0.13	0.44
Case Damping Factor		0.67	0.87
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	94	91
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.04
Soil Plug Weight	(kips)	0.100	

CAPWAP match quality = 3.06 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.16 in; Blow Count = 75 b/ft
Transducer F3(H083) CAL: 94.4; RF: 0.97; F4(F523) CAL: 93.8; RF: 0.97
A3(K1020) CAL: 307; RF: 1.08; A4(K2214) CAL: 332; RF: 1.08

max. Top Comp. Stress = 31.9 ksi (T= 36.1 ms, max= 1.041 x Top)
max. Comp. Stress = 33.2 ksi (Z= 29.7 ft, T= 37.9 ms)
max. Tens. Stress = -3.67 ksi (Z= 42.9 ft, T= 61.8 ms)
max. Energy (EMX) = 30.9 kip-ft; max. Measured Top Displ. (DMX)= 1.15 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	494.9	-25.0	31.9	-1.61	30.9	16.9	1.17
2	6.6	495.2	-25.4	31.9	-1.64	30.7	16.9	1.15
4	13.2	496.9	-26.4	32.1	-1.70	30.0	16.7	1.10
5	16.5	498.4	-27.3	32.1	-1.76	29.6	16.7	1.07
6	19.8	499.8	-30.7	32.2	-1.98	29.1	16.6	1.04
7	23.1	503.6	-38.6	32.5	-2.49	28.6	16.5	1.01
8	26.4	510.2	-45.4	32.9	-2.93	28.1	16.2	0.98
9	29.7	515.3	-51.6	33.2	-3.33	27.6	16.0	0.94
10	33.0	496.4	-46.8	32.0	-3.02	25.8	15.8	0.91
11	36.3	504.0	-52.0	32.5	-3.35	25.2	15.5	0.87
12	39.6	495.0	-50.8	31.9	-3.28	23.8	15.1	0.84
13	42.9	502.4	-56.9	32.4	-3.67	23.2	14.8	0.81
14	46.2	469.7	-46.7	30.3	-3.01	20.9	14.5	0.77
15	49.5	476.7	-52.0	30.7	-3.35	20.3	14.2	0.74
16	52.8	449.7	-43.4	29.0	-2.80	18.3	13.9	0.70
17	56.1	457.8	-48.0	29.5	-3.10	17.8	13.6	0.67
18	59.4	433.5	-40.0	28.0	-2.58	16.0	13.2	0.64
19	62.7	446.9	-44.1	28.8	-2.84	15.5	12.8	0.60
20	66.0	432.3	-33.2	27.9	-2.14	13.6	12.0	0.57
21	69.3	438.4	-37.2	28.3	-2.40	13.1	13.7	0.54
22	72.6	416.6	-20.2	26.9	-1.30	10.9	15.5	0.51
23	75.9	421.0	-25.2	27.2	-1.63	9.4	15.3	0.48
Absolute	29.7			33.2			(T =	37.9 ms)
	42.9				-3.67		(T =	61.8 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	501.5	405.8	310.0	214.3	118.6					
RX	557.1	515.1	479.8	455.2	436.8	429.3	421.8	414.4	406.9	400.0
RU	501.5	405.8	310.0	214.3	118.6					

RAU = 322.9 (kips); RA2 = 475.5 (kips)

Current CAPWAP Ru = 419.0 (kips); Corresponding J(RP)= 0.17; J(RX) = 1.28

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	35.93	472.9	507.2	507.2	1.15	0.20	0.20	31.0	551.2	863

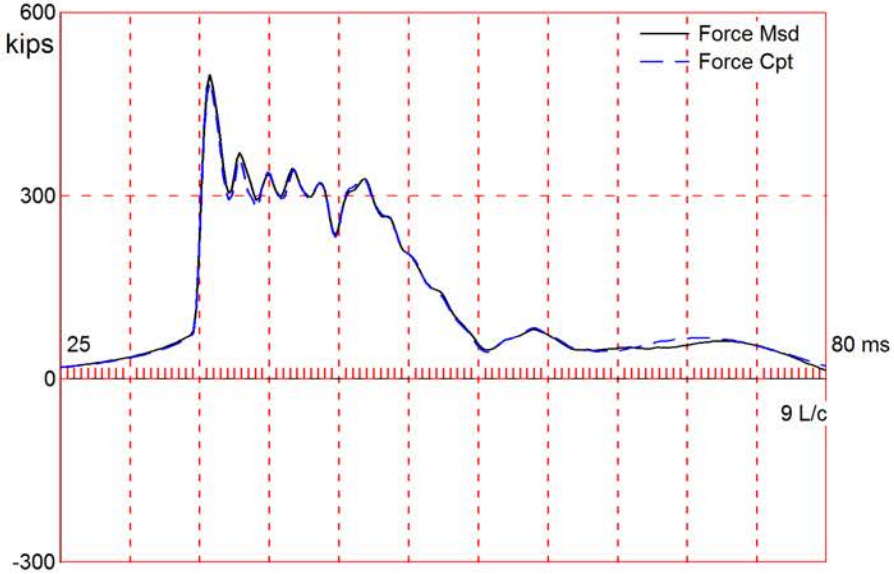
PILE PROFILE AND PILE MODEL

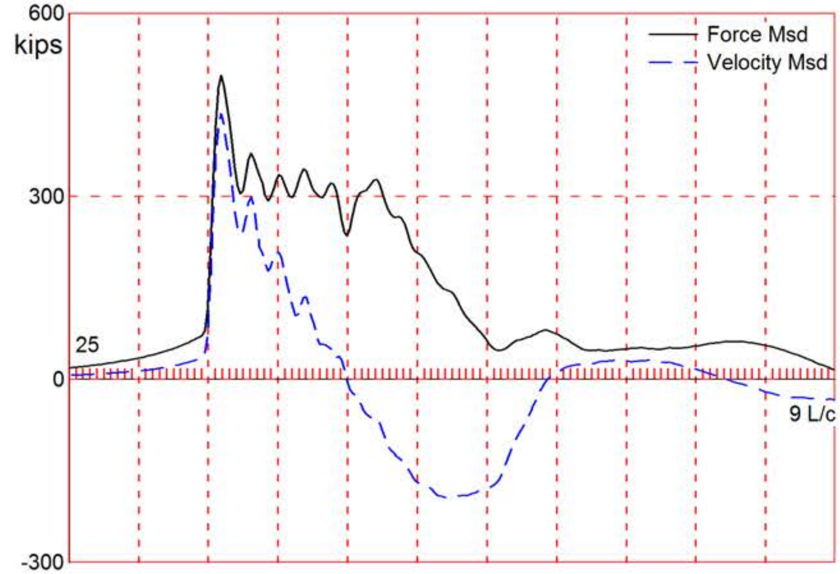
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
75.9	15.5	29992.2	492.000	3.97

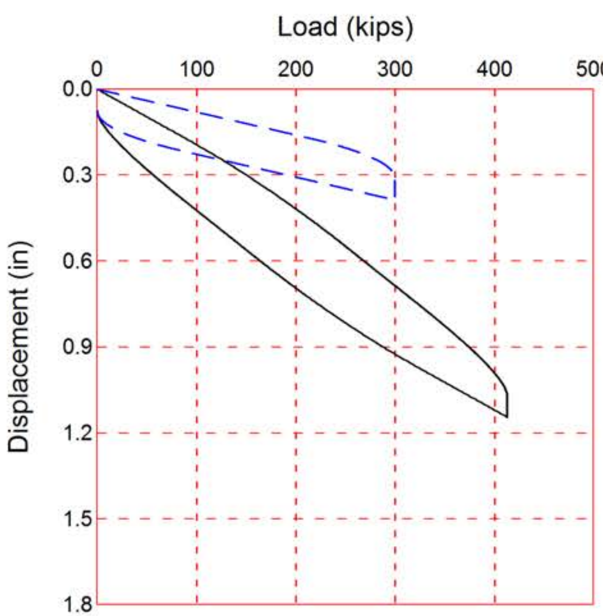
Toe Area 141.9 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000
22	72.6	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.040
23	75.9	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.060

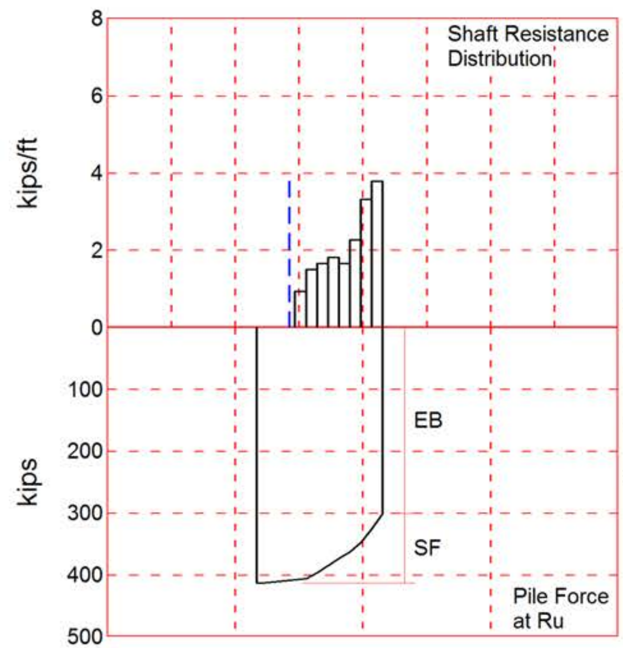
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 9.0 ms
Total volume: 8.170 ft^3; Volume ratio considering added impedance: 1.000







RU =	413.0 kips
SF =	113.0 kips
EB =	300.0 kips
Dy =	1.07 in
Dx =	1.15 in
SET/Bl =	0.08 in



Length b. Sensors	75.9 ft
Embedment	53.6 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	1.75
Top Compr. Stress	31.4 ksi
Max Compr. Stress	33.3 ksi
Max Tension Stress	-1.09 ksi
Avg. Shaft Quake	0.11 in
Toe Quake	0.24 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.

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: 413.0; along Shaft 113.0; at Toe 300.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Quake in
				413.0				
1	29.7	7.4	7.0	406.0	7.0	0.95	0.24	0.12
2	36.3	14.0	10.0	396.0	17.0	1.52	0.38	0.12
3	42.9	20.6	11.0	385.0	28.0	1.67	0.42	0.12
4	49.5	27.2	12.0	373.0	40.0	1.82	0.46	0.12
5	56.1	33.8	11.0	362.0	51.0	1.67	0.42	0.12
6	62.7	40.4	15.0	347.0	66.0	2.27	0.57	0.12
7	69.3	47.0	22.0	325.0	88.0	3.33	0.84	0.11
8	75.9	53.6	25.0	300.0	113.0	3.79	0.95	0.08
Avg. Shaft			14.1			2.11	0.53	0.11
Toe			300.0				304.46	0.24

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.08
Case Damping Factor		1.23	0.87
Damping Type		Viscous	Sm+Visc
Reloading Level	(% of Ru)	100	100
Soil Plug Weight	(kips)		0.080

CAPWAP match quality = 1.75 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.11 in; Blow Count = 106 b/ft

max. Top Comp. Stress = 31.4 ksi (T= 36.1 ms, max= 1.063 x Top)
max. Comp. Stress = 33.3 ksi (Z= 29.7 ft, T= 37.7 ms)
max. Tens. Stress = -1.09 ksi (Z= 29.7 ft, T= 57.7 ms)
max. Energy (EMX) = 24.2 kip-ft; max. Measured Top Displ. (DMX)= 0.90 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	486.3	-10.2	31.4	-0.66	24.2	16.2	0.92
2	6.6	487.2	-10.4	31.4	-0.67	23.9	16.1	0.90
4	13.2	489.3	-10.6	31.6	-0.69	23.2	16.0	0.84
5	16.5	490.5	-10.7	31.6	-0.69	22.7	16.0	0.81
6	19.8	491.9	-11.3	31.7	-0.73	22.2	15.9	0.78
7	23.1	497.3	-12.4	32.1	-0.80	21.8	15.7	0.75
8	26.4	507.2	-13.4	32.7	-0.86	21.3	15.3	0.72
9	29.7	517.0	-16.9	33.3	-1.09	20.8	15.0	0.68
10	33.0	491.5	-9.4	31.7	-0.61	19.0	14.5	0.65
11	36.3	502.9	-15.5	32.4	-1.00	18.5	14.1	0.62
12	39.6	464.3	-2.3	29.9	-0.15	16.4	13.6	0.59
13	42.9	476.3	-7.8	30.7	-0.50	15.9	13.1	0.55
14	46.2	435.8	0.0	28.1	0.00	14.0	12.6	0.52
15	49.5	447.6	-0.0	28.9	-0.00	13.5	12.2	0.49
16	52.8	404.0	0.0	26.1	0.00	11.6	11.8	0.46
17	56.1	416.2	0.0	26.8	0.00	11.1	11.3	0.43
18	59.4	383.3	0.0	24.7	0.00	9.6	10.8	0.40
19	62.7	399.9	0.0	25.8	0.00	9.2	10.2	0.36
20	66.0	371.6	0.0	24.0	0.00	7.6	9.6	0.34
21	69.3	381.9	0.0	24.6	0.00	7.2	9.6	0.30
22	72.6	353.2	0.0	22.8	0.00	5.5	10.4	0.28
23	75.9	354.0	0.0	22.8	0.00	4.2	10.0	0.25
Absolute	29.7			33.3			(T =	37.7 ms)
	29.7				-1.09		(T =	57.7 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	586.4	550.7	515.0	479.3	443.6	407.9	372.2	336.5	300.8	265.1
RX	589.0	554.1	519.2	490.3	476.0	461.8	447.6	433.3	419.1	404.9
RU	586.4	550.7	515.0	479.3	443.6	407.9	372.2	336.5	300.8	265.1

RAU = 289.8 (kips); RA2 = 489.8 (kips)

Current CAPWAP Ru = 413.0 (kips); Corresponding J(RP)= 0.49; J(RX) = 0.84

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
15.9	35.93	440.8	502.7	502.7	0.90	0.08	0.08	24.3	597.1	1250

PILE PROFILE AND PILE MODEL

Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	15.5	29992.2	492.000	3.97
75.9	15.5	29992.2	492.000	3.97

Toe Area 141.9 in²

Top Segment Length 3.30 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s

Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 9.0 ms

Total volume: 8.170 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Al Ziai
Company: Lunda Construction Company	No. of Sheets: 32
E-mail: whamacher@lundaconstruction.com	Date: January 23, 2015

RE: Dynamic Testing Results – Pier 8
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On January 21, 2015, Pier 8 #6 and Pier 8 #27 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on January 22. The 75.3 foot long HP 12 x 53 H-piles were equipped with driving shoes and were driven with an APE D25-42 hammer operated on fuel setting three. Plans indicate the piles in Pier 8 have a required driving resistance or ultimate capacity of 360 kips, and an estimated length of 60 feet.

Pier 8 #6 was driven to a depth of 56.0 feet below the excavated ground surface at EL 594.5, which corresponds to a pile tip elevation of EL 538.5. The blow count over the final increment of driving was 10 blows for 3 inches of penetration at an average hammer stroke of 7.7 feet. The blow count at the beginning of restrike of Pier 8 #6 was 10 blows for 2 inches of penetration at an average hammer stroke of 8.1 feet.

Pier 8 #27 was driven to a depth of 57.0 feet below the excavated ground surface at EL 594.5, which corresponds to a pile tip elevation of EL 537.5. The blow count over the final increment of driving was 10 blows for 3 inches of penetration at an average hammer stroke of 7.4 feet. The blow count at the beginning of restrike of Pier 8 #27 was 10 blows for 2 inches of penetration at an average hammer stroke of 8.2 feet.

For the 360 kip piles, driven with the APE D25-42 hammer, in Pier 8 of the STH 96 Bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per foot)
6.5	59
7.0	48
7.5	40
8.0	40

We recommended the above blow count at the corresponding hammer stroke be maintained for <u>two full feet</u> of driving. Driving may be terminated if production piles exceed 10 blows over an increment of one inch or less at hammer strokes of 8.0 feet. After splicing or any other delays, we recommend not applying the criteria until at least two feet of driving has occurred beyond the termination depth associated with the delay.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Al Ziai

Travis Coleman, P.E.

cc: Steve Seymour - steve.seymour@omnni.com
Jeff Horsfall - jeffrey.horsfall@dot.wi.gov

Attachments:

Dynamic Results (Pages 3 – 16)
CAPWAP Results (Pages 17 – 32)

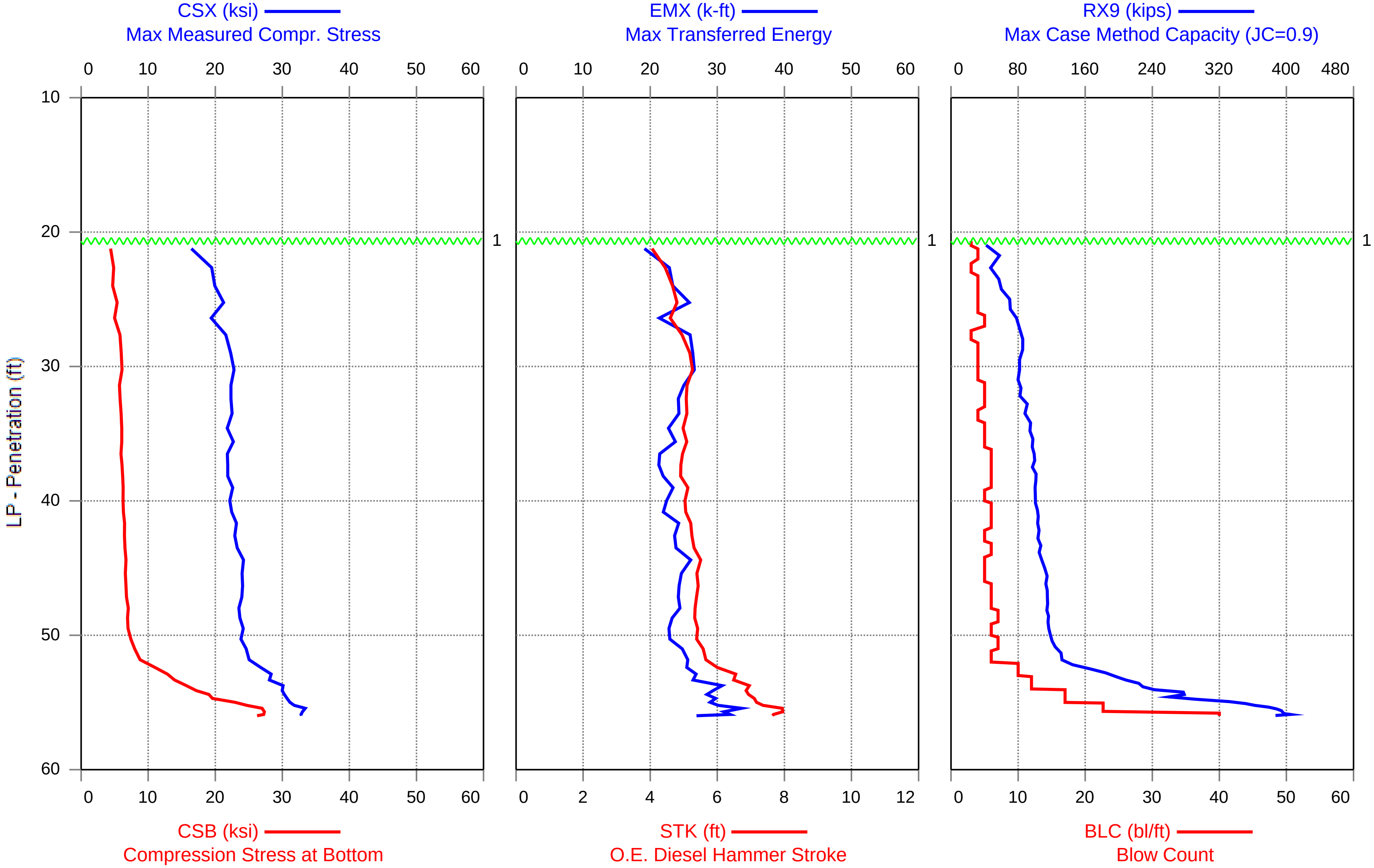
Printed: 22-January-2015

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

Test started: 21-January-2015

STH 96 over Fox River (B-5-831) - Pier 8 #6

APE D25-42, HP 12 x 53



1 - Excavated ground surface at El. 594.5

STH 96 over Fox River (B-5-831) - Pier 8 #6 APE D25-42, HP 12 x 53
OP: AM Date: 21-January-2015

AR: 15.50 in² SP: 0.492 k/ft³
LE: 72.33 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
3	21.00	3	AV2	11.8	3.8	14	3.5	62.1	33
			MAX	12.5	4.0	16	3.5	62.3	41
			MIN	11.0	3.6	12	3.4	61.9	24
7	22.00	4	AV4	19.8	4.8	23	4.5	55.1	58
			MAX	21.4	5.0	24	4.7	56.0	60
			MIN	18.5	4.6	22	4.3	53.7	57
10	23.00	3	AV3	19.4	4.8	23	4.5	55.2	47
			MAX	19.7	5.0	23	4.5	55.4	53
			MIN	19.0	4.7	22	4.4	55.0	44
14	24.00	4	AV4	19.0	4.6	22	4.5	55.2	57
			MAX	20.6	4.8	24	4.7	56.5	58
			MIN	17.3	4.5	20	4.2	53.8	57
18	25.00	4	AV4	21.6	5.1	27	4.9	52.8	66
			MAX	22.5	5.2	29	5.0	53.4	75
			MIN	20.6	4.9	25	4.8	52.1	59
22	26.00	4	AV4	20.5	5.4	24	4.7	54.0	70
			MAX	21.8	5.5	26	5.0	55.1	77
			MIN	19.4	5.1	21	4.5	52.5	65
27	27.00	5	AV5	19.9	5.1	22	4.7	54.0	80
			MAX	22.7	5.4	26	5.2	59.8	85
			MIN	13.9	4.3	13	3.7	51.4	74
30	28.00	3	AV3	22.6	6.0	28	5.1	51.6	83
			MAX	23.8	6.4	30	5.4	52.9	96
			MIN	21.3	5.6	27	4.9	50.3	76
34	29.00	4	AV4	22.0	5.8	26	5.1	52.0	85
			MAX	24.6	6.2	31	5.6	56.1	96
			MIN	18.1	5.4	21	4.3	49.5	79
38	30.00	4	AV4	20.8	6.0	23	4.9	52.8	83
			MAX	22.0	6.1	25	5.2	54.3	88
			MIN	19.7	5.9	22	4.6	51.3	79
42	31.00	4	AV4	23.5	6.1	29	5.4	50.5	79
			MAX	24.9	6.3	32	5.6	52.1	85
			MIN	21.6	5.6	26	5.0	49.4	72
47	32.00	5	AV5	22.4	5.7	24	5.1	51.9	83
			MAX	24.0	5.9	27	5.4	52.9	93
			MIN	21.2	5.7	22	4.9	50.6	78

STH 96 over Fox River (B-5-831) - Pier 8 #6 APE D25-42, HP 12 x 53
OP: AM Date: 21-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
52	33.00	5	AV5	22.8	5.9	25	5.2	51.6	88
			MAX	24.2	6.1	27	5.4	54.1	100
			MIN	19.2	5.6	21	4.6	50.4	82
56	34.00	4	AV4	22.1	6.0	24	5.0	52.2	91
			MAX	23.3	6.0	25	5.3	53.0	99
			MIN	21.3	5.8	21	4.9	50.7	80
61	35.00	5	AV5	21.8	6.1	23	5.0	52.5	94
			MAX	23.8	6.4	26	5.4	55.9	100
			MIN	17.9	5.4	17	4.3	50.5	86
66	36.00	5	AV5	22.7	6.1	24	5.1	51.8	97
			MAX	23.5	6.3	26	5.2	53.3	105
			MIN	21.5	5.8	21	4.8	51.3	87
72	37.00	6	AV6	21.7	6.0	21	4.9	52.7	99
			MAX	23.9	6.2	24	5.4	54.8	102
			MIN	19.6	5.6	19	4.5	50.5	94
78	38.00	6	AV6	22.0	6.2	22	5.0	52.6	100
			MAX	23.6	6.3	24	5.3	54.5	104
			MIN	20.2	6.0	20	4.6	50.8	93
84	39.00	6	AV6	22.0	6.2	22	5.0	52.5	101
			MAX	23.0	6.3	25	5.2	53.7	102
			MIN	21.0	6.1	20	4.7	51.2	99
89	40.00	5	AV5	22.6	6.2	23	5.1	51.8	100
			MAX	24.5	6.5	26	5.5	53.8	102
			MIN	20.6	6.1	20	4.7	49.9	99
95	41.00	6	AV6	22.5	6.3	22	5.1	51.9	102
			MAX	24.5	6.5	25	5.5	53.1	105
			MIN	21.7	6.1	19	4.8	50.1	100
101	42.00	6	AV6	23.0	6.4	24	5.2	51.5	104
			MAX	24.2	6.6	25	5.4	52.7	106
			MIN	21.9	6.3	21	4.9	50.2	102
106	43.00	5	AV5	22.9	6.5	24	5.2	51.1	104
			MAX	23.7	6.6	25	5.5	51.8	106
			MIN	22.2	6.3	22	5.1	50.1	100
112	44.00	6	AV6	23.6	6.6	25	5.4	50.6	106
			MAX	25.0	6.7	28	5.7	51.8	110
			MIN	22.3	6.4	22	5.1	49.2	99
117	45.00	5	AV5	23.8	6.6	25	5.4	50.4	110
			MAX	24.7	6.9	26	5.6	51.4	112
			MIN	22.9	6.3	24	5.2	49.5	105

STH 96 over Fox River (B-5-831) - Pier 8 #6 APE D25-42, HP 12 x 53
OP: AM Date: 21-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
122	46.00	5	AV5	24.1	6.7	24	5.4	50.4	114
			MAX	25.4	7.0	28	5.7	52.2	117
			MIN	22.4	6.3	21	5.0	49.3	112
128	47.00	6	AV6	24.1	6.7	25	5.5	50.2	114
			MAX	25.1	7.0	27	5.7	51.0	115
			MIN	23.3	6.4	22	5.3	49.3	111
134	48.00	6	AV6	23.7	6.8	24	5.3	50.7	115
			MAX	24.7	7.0	26	5.7	51.5	117
			MIN	22.8	6.6	23	5.2	49.3	113
141	49.00	7	AV7	23.6	7.1	24	5.3	50.8	116
			MAX	25.4	7.4	26	5.8	53.6	120
			MIN	21.0	6.5	19	4.7	48.9	114
147	50.00	6	AV6	24.2	7.0	23	5.4	50.4	117
			MAX	24.5	7.2	24	5.5	50.8	119
			MIN	23.5	6.8	21	5.3	49.9	115
154	51.00	7	AV7	24.1	7.7	24	5.5	50.2	122
			MAX	25.0	8.0	25	5.7	51.5	126
			MIN	22.8	7.3	22	5.2	49.3	119
160	52.00	6	AV6	25.0	8.5	26	5.7	49.3	132
			MAX	26.5	8.9	27	5.9	50.4	135
			MIN	23.8	8.1	24	5.4	48.2	129
170	53.00	10	AV10	27.3	11.5	26	6.2	47.3	168
			MAX	28.8	13.4	30	6.7	49.7	193
			MIN	25.0	9.0	24	5.6	45.6	141
182	54.00	12	AV12	29.0	14.8	28	6.7	45.6	219
			MAX	30.9	16.6	33	7.2	46.9	245
			MIN	27.1	13.0	25	6.3	43.9	197
199	55.00	17	AV17	30.5	19.4	29	7.0	44.5	282
			MAX	32.0	22.9	32	7.7	46.3	344
			MIN	28.5	15.7	26	6.5	42.6	241
216	55.75	23	AV15	32.6	25.9	31	7.7	42.7	375
			MAX	35.6	28.9	36	8.8	44.3	410
			MIN	30.5	23.0	27	7.1	39.9	341
226	56.00	40	AV9	32.7	26.9	31	7.7	42.6	396
			MAX	35.3	28.8	35	8.8	45.1	421
			MIN	29.8	25.1	23	6.8	39.9	374
			Average	24.7	10.1	25	5.7	49.8	152
			Maximum	35.6	28.9	36	8.8	62.3	421
			Minimum	11.0	3.6	12	3.4	39.9	24

Total number of blows analyzed: 222

BL# Sensors

1-226 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K1020] 307.0 (1.10); A4: [K974] 305.0 (1.10)

BL# Comments

2 Excavated ground surface at El. 594.5

Time Summary

Drive 5 minutes 14 seconds 12:44 PM - 12:49 PM BN 1 - 226

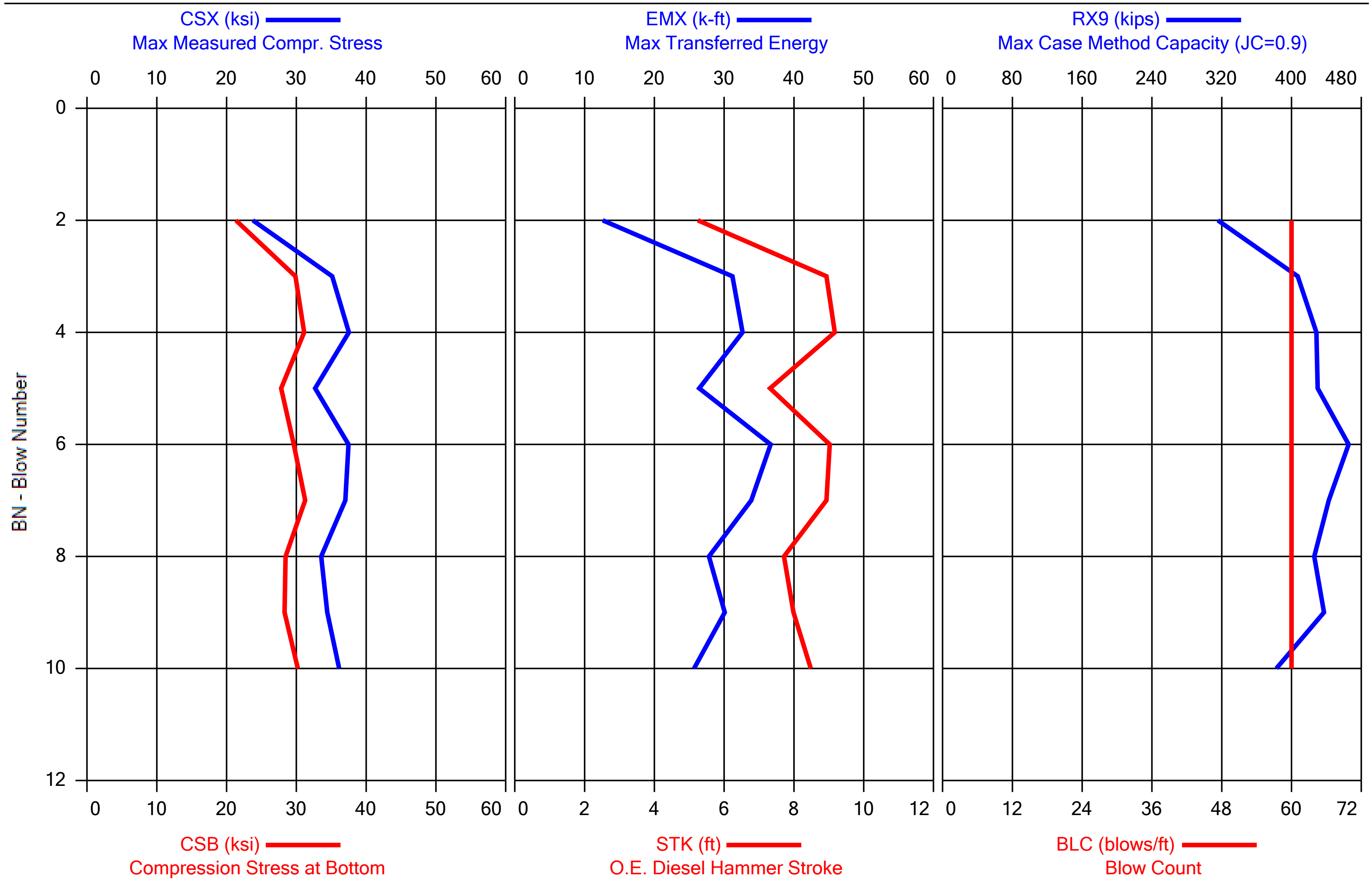
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 22-January-2015

Test started: 22-January-2015

STH 96 over Fox River (B-5-831) - Pier 8 #6 Restrike

APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - Pier 8 #6 Restrike APE D25-42, HP 12 x 53
OP: AM Date: 22-January-2015

AR:	15.50 in²	SP:	0.492 k/ft³
LE:	72.33 ft	EM:	30,000 ksi
WS:	16,807.9 f/s	JC:	1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	blows/ft		ksi	ksi	k-ft	ft	bpm	kips
10	56.17	60	AV9	34.2	28.7	29	8.1	41.9	415
			MAX	37.5	31.3	37	9.2	51.1	465
			MIN	23.8	21.3	13	5.2	39.1	316
			Average	34.2	28.7	29	8.1	41.9	415
			Maximum	37.5	31.3	37	9.2	51.1	465
			Minimum	23.8	21.3	13	5.2	39.1	316

Total number of blows analyzed: 9

BL# Sensors

1-10 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K1020] 307.0 (1.07); A4: [K974] 305.0 (1.07)

Time Summary

Drive 12 seconds 9:04 AM - 9:04 AM BN 1 - 10

GRL engineers, inc.

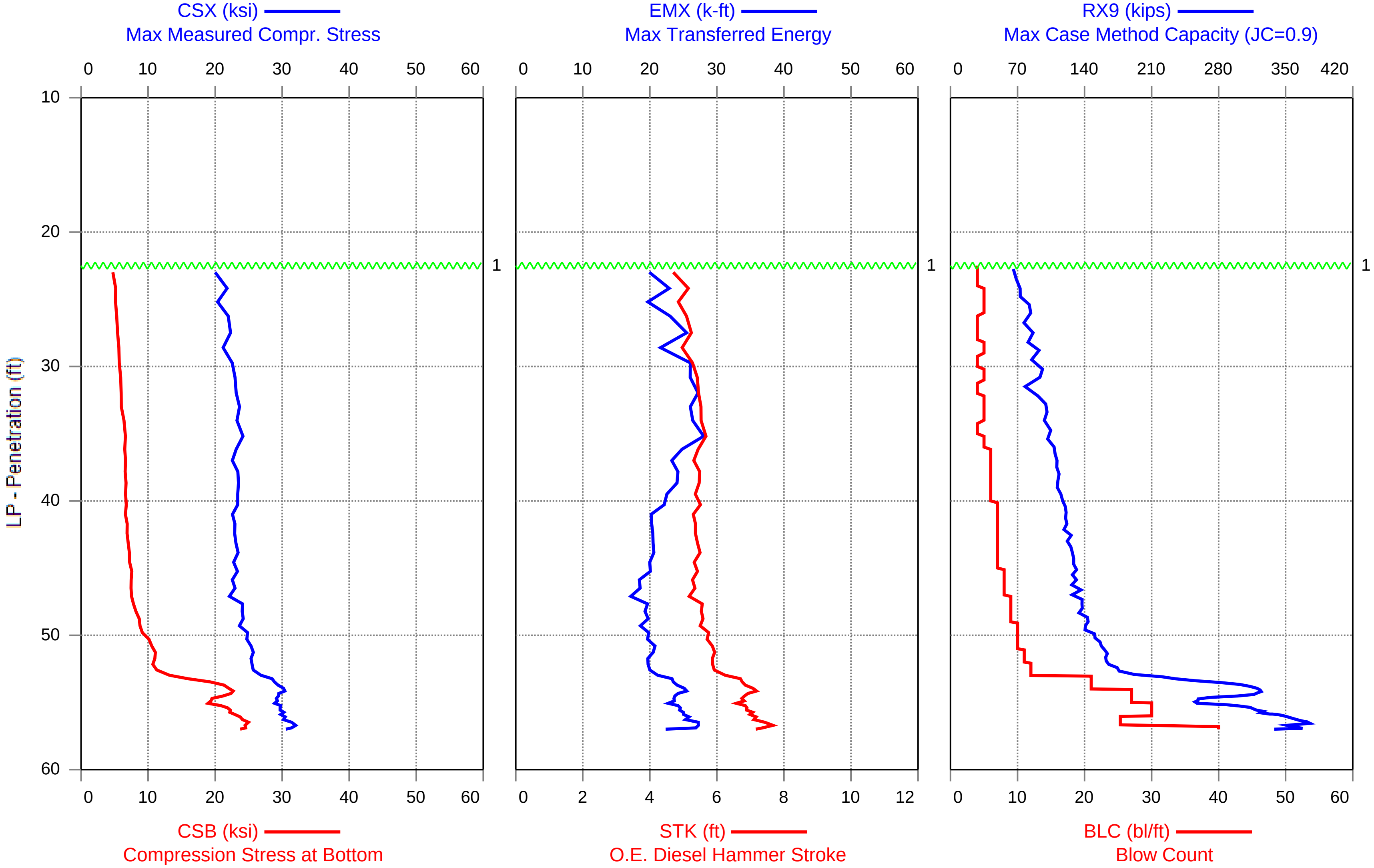
Printed: 22-January-2015

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

Test started: 21-January-2015

STH 96 over Fox River (B-5-831) - Pier 8 #27

APE D25-42, HP 12 x 53



1 - Excavated ground surface at El. 594.5

STH 96 over Fox River (B-5-831) - Pier 8 #27 APE D25-42, HP 12 x 53
OP: AM Date: 21-January-2015

AR:	15.50 in²	SP:	0.492 k/ft³
LE:	72.33 ft	EM:	30,000 ksi
WS:	16,807.9 f/s	JC:	1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
8	22.50	4	AV1	22.3	4.9	22	5.1	52.0	68
			MAX	22.3	4.9	22	5.1	52.0	68
			MIN	22.3	4.9	22	5.1	52.0	68
9	22.75	4	AV1	19.6	4.6	19	4.7	53.9	57
			MAX	19.6	4.6	19	4.7	53.9	57
			MIN	19.6	4.6	19	4.7	53.9	57
10	23.00	4	AV1	18.0	4.6	18	4.4	55.6	72
			MAX	18.0	4.6	18	4.4	55.6	72
			MIN	18.0	4.6	18	4.4	55.6	72
14	24.00	4	AV4	21.7	5.0	23	5.1	52.0	70
			MAX	24.6	5.3	27	5.8	54.6	77
			MIN	19.4	4.6	20	4.6	48.9	56
19	25.00	5	AV5	20.3	5.1	20	4.8	53.2	73
			MAX	23.0	5.7	24	5.4	56.5	75
			MIN	17.3	4.8	16	4.2	50.4	71
24	26.00	5	AV5	20.9	5.2	21	4.9	52.8	82
			MAX	21.7	5.6	22	5.1	54.1	85
			MIN	19.2	4.9	20	4.6	51.7	79
28	27.00	4	AV4	21.8	5.4	23	5.1	52.0	80
			MAX	24.6	5.5	27	5.7	54.3	88
			MIN	19.3	5.2	19	4.6	49.1	75
32	28.00	4	AV4	23.0	5.5	27	5.4	50.6	84
			MAX	25.3	5.9	31	6.0	53.6	98
			MIN	20.1	5.3	21	4.7	48.0	76
37	29.00	5	AV5	21.2	5.6	22	5.0	52.5	89
			MAX	22.4	5.9	25	5.3	55.0	95
			MIN	18.6	5.3	18	4.5	51.0	80
41	30.00	4	AV4	22.9	5.7	27	5.3	50.9	87
			MAX	25.5	6.0	29	5.8	53.2	92
			MIN	20.5	5.4	23	4.8	48.8	81
46	31.00	5	AV5	22.6	5.9	25	5.3	50.7	95
			MAX	23.2	6.1	27	5.6	51.8	104
			MIN	21.3	5.7	23	5.1	49.6	91
50	32.00	4	AV4	22.9	5.9	27	5.4	50.6	82
			MAX	23.6	6.3	28	5.6	51.8	94
			MIN	21.5	5.7	25	5.1	49.7	74

STH 96 over Fox River (B-5-831) - Pier 8 #27 APE D25-42, HP 12 x 53
OP: AM Date: 21-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
55	33.00	5	AV5	23.7	6.0	27	5.6	49.7	96
			MAX	24.9	6.3	28	5.7	50.2	103
			MIN	22.7	5.7	25	5.4	49.1	86
60	34.00	5	AV5	23.5	6.2	27	5.6	49.4	101
			MAX	24.4	6.5	28	5.8	49.8	104
			MIN	22.6	5.9	26	5.5	48.6	98
64	35.00	4	AV4	23.2	6.5	26	5.4	50.4	102
			MAX	24.8	6.6	29	5.7	52.9	107
			MIN	21.0	6.3	23	4.9	49.2	93
69	36.00	5	AV5	24.0	6.7	27	5.6	49.5	104
			MAX	25.4	6.9	28	5.9	50.4	108
			MIN	22.8	6.5	26	5.4	48.4	94
75	37.00	6	AV6	22.7	6.5	23	5.3	50.8	109
			MAX	23.7	6.8	25	5.5	52.3	112
			MIN	21.2	6.2	22	5.0	49.8	105
81	38.00	6	AV6	23.3	6.6	24	5.5	50.0	112
			MAX	24.3	6.8	25	5.7	50.7	118
			MIN	22.3	6.4	23	5.3	49.2	106
87	39.00	6	AV6	23.5	6.7	24	5.5	50.2	113
			MAX	24.5	6.9	25	5.7	51.1	117
			MIN	22.3	6.5	23	5.2	49.2	108
93	40.00	6	AV6	23.4	6.7	23	5.4	50.5	114
			MAX	24.6	7.0	25	5.6	52.4	118
			MIN	21.5	6.4	21	5.0	49.6	109
100	41.00	7	AV7	23.2	6.6	21	5.5	50.1	120
			MAX	24.1	7.0	22	5.6	50.8	122
			MIN	22.6	6.5	19	5.3	49.6	118
107	42.00	7	AV7	22.7	6.8	20	5.3	50.9	121
			MAX	24.2	7.2	21	5.6	52.1	124
			MIN	21.5	6.5	18	5.0	49.4	115
114	43.00	7	AV7	22.7	6.9	20	5.3	50.9	122
			MAX	25.3	7.2	24	5.9	54.4	130
			MIN	19.2	6.3	16	4.6	48.3	116
121	44.00	7	AV7	23.8	7.2	21	5.6	49.6	126
			MAX	25.6	7.7	24	6.1	50.9	133
			MIN	22.8	7.0	20	5.3	47.7	124
128	45.00	7	AV7	22.8	7.3	20	5.3	50.7	129
			MAX	24.1	7.7	22	5.6	52.0	133
			MIN	21.4	6.9	18	5.1	49.5	124

STH 96 over Fox River (B-5-831) - Pier 8 #27 APE D25-42, HP 12 x 53
OP: AM Date: 21-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
136	46.00	8	AV8	23.0	7.5	19	5.4	50.6	130
			MAX	24.2	7.8	21	5.7	51.4	134
			MIN	22.1	7.3	18	5.2	49.2	126
144	47.00	8	AV8	22.4	7.4	18	5.2	51.3	130
			MAX	25.0	7.7	21	5.8	52.6	141
			MIN	21.0	7.2	15	4.9	48.7	126
153	48.00	9	AV9	23.7	7.8	19	5.5	50.0	137
			MAX	25.3	8.1	21	5.8	52.3	142
			MIN	21.2	7.2	16	5.0	48.7	128
162	49.00	9	AV9	24.0	8.5	19	5.5	49.9	140
			MAX	25.6	9.4	21	5.9	51.7	148
			MIN	22.1	7.9	17	5.1	48.4	134
172	50.00	10	AV10	24.2	9.0	19	5.6	49.5	143
			MAX	26.0	9.5	22	6.0	51.4	154
			MIN	22.3	8.6	16	5.2	48.0	138
182	51.00	10	AV10	25.0	10.3	20	5.8	48.8	155
			MAX	26.1	11.0	22	6.0	50.1	160
			MIN	23.6	9.9	18	5.5	47.8	151
193	52.00	11	AV11	25.5	11.0	20	5.9	48.4	163
			MAX	26.7	11.4	22	6.2	49.2	167
			MIN	24.7	10.7	17	5.7	47.3	155
205	53.00	12	AV12	25.9	11.5	20	6.0	48.0	177
			MAX	27.8	13.4	23	6.4	49.5	198
			MIN	24.3	10.3	18	5.6	46.4	161
226	54.00	21	AV21	29.0	19.0	24	6.8	45.2	275
			MAX	31.3	22.4	27	7.3	47.6	321
			MIN	26.4	13.7	20	6.1	43.6	218
253	55.00	27	AV27	29.5	21.0	24	6.9	44.9	292
			MAX	31.7	23.1	28	7.6	46.1	327
			MIN	28.0	18.9	22	6.5	42.9	251
283	56.00	30	AV30	29.7	21.7	24	6.9	44.9	312
			MAX	32.1	24.0	27	7.5	46.7	352
			MIN	28.2	18.2	22	6.3	43.1	252
302	56.75	25	AV17	30.9	24.3	26	7.3	43.7	362
			MAX	32.6	26.0	30	7.8	45.3	378
			MIN	28.9	23.0	22	6.8	42.3	323
312	57.00	40	AV9	31.5	24.4	26	7.4	43.3	358
			MAX	33.4	25.2	32	8.2	44.1	371
			MIN	30.2	22.8	19	7.1	41.2	314
			Average	25.6	12.3	23	6.0	48.3	186
			Maximum	33.4	26.0	32	8.2	56.5	378

STH 96 over Fox River (B-5-831) - Pier 8 #27
OP: AM

APE D25-42, HP 12 x 53
Date: 21-January-2015

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	bl/ft		ksi	ksi	k-ft	ft	bpm	kips
			Minimum	17.3	4.6	15	4.2	41.2	56

Total number of blows analyzed: 302

BL# Sensors

1-312 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K1020] 307.0 (1.10); A4: [K974] 305.0 (1.10)

BL# Comments

8 Excavated ground surface at El. 594.5

Time Summary

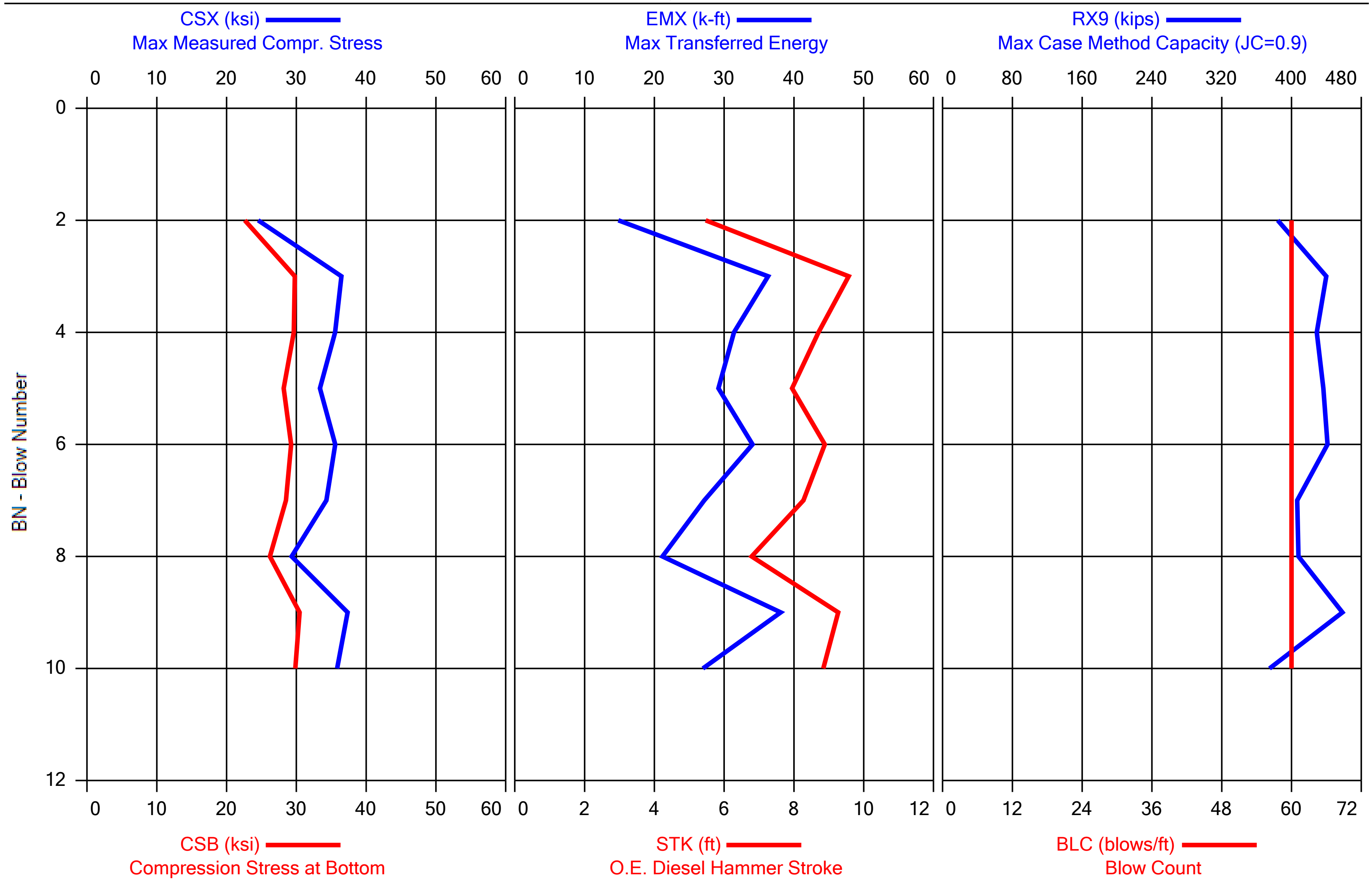
Drive 7 minutes 55 seconds 11:51 AM - 11:59 AM BN 1 - 312

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

Printed: 22-January-2015 Test started: 22-January-2015

STH 96 over Fox River (B-5-831) - Pier 8 #27 Restrike

APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - Pier 8 #27 Restrike APE D25-42, HP 12 x 53
OP: AM Date: 22-January-2015

AR:	15.50 in²	SP:	0.492 k/ft³
LE:	72.33 ft	EM:	30,000 ksi
WS:	16,807.9 f/s	JC:	1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
	ft	blows/ft		ksi	ksi	k-ft	ft	bpm	kips
10	57.17	60	AV9	33.6	28.3	29	8.2	41.7	420
			MAX	37.3	30.5	38	9.6	50.1	458
			MIN	24.5	22.6	15	5.5	38.3	375
			Average	33.6	28.3	29	8.2	41.7	420
			Maximum	37.3	30.5	38	9.6	50.1	458
			Minimum	24.5	22.6	15	5.5	38.3	375

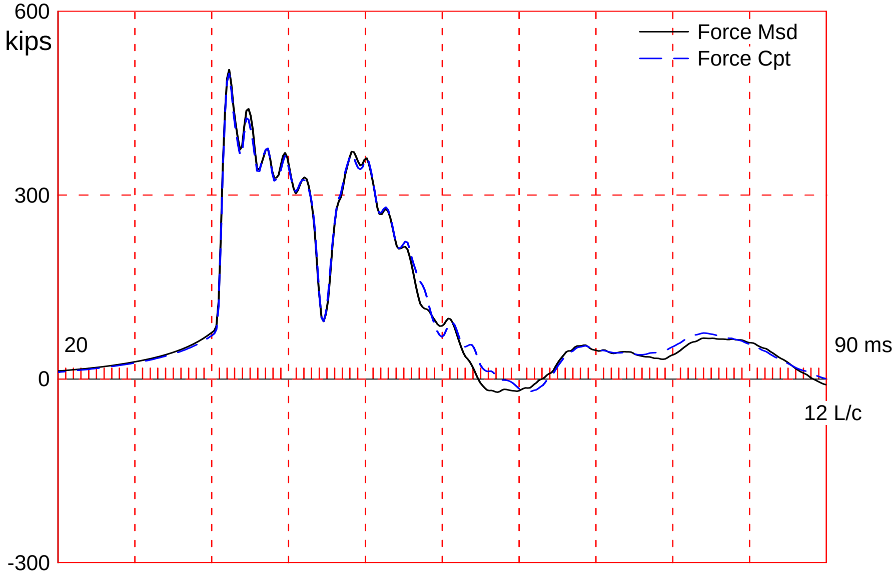
Total number of blows analyzed: 9

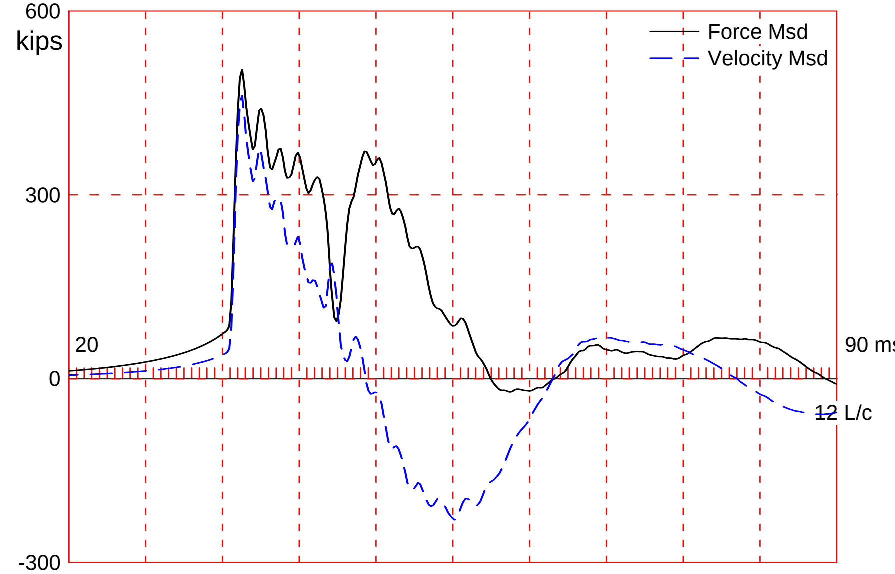
BL# Sensors

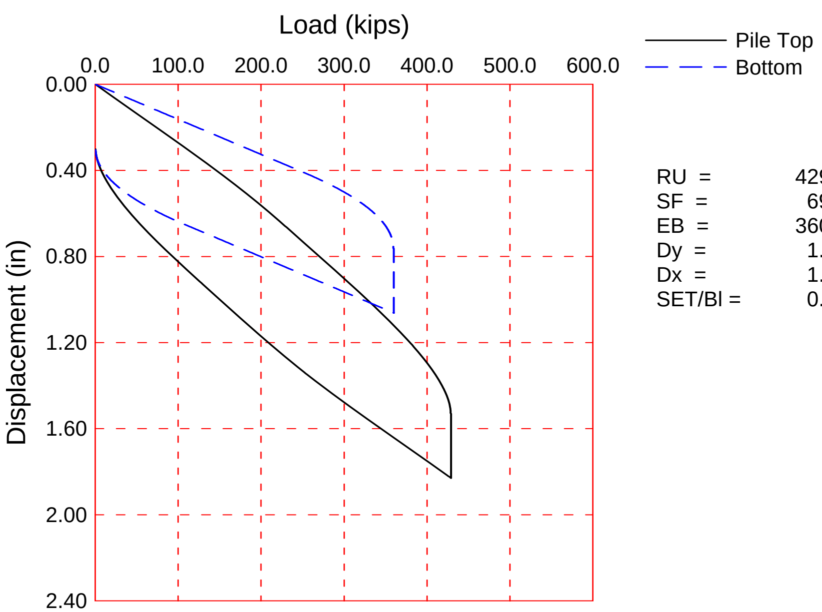
1-10 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K1020] 307.0 (1.07); A4: [K974] 305.0 (1.07)

Time Summary

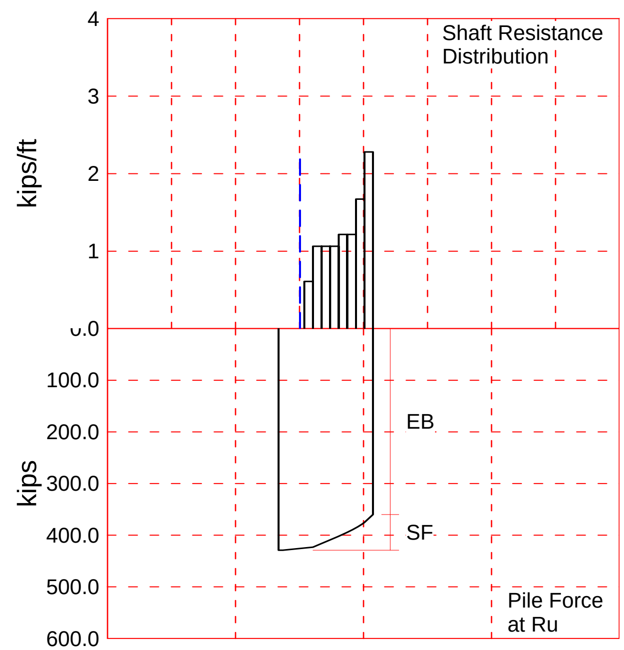
Drive 13 seconds 9:24 AM - 9:24 AM BN 1 - 10







RU =	429.0 kips
SF =	69.0 kips
EB =	360.0 kips
Dy =	1.53 in
Dx =	1.83 in
SET/Bl =	0.30 in



Length b. Sensors	72.3 ft
Embedment	55.9 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.97
Top Compr. Stress	32.2 ksi
Max Compr. Stress	33.5 ksi
Max Tension Stress	-5.16 ksi
Avg. Shaft Quake	0.28 in
Toe Quake	0.59 in
Avg. Shaft Smith Dpg.	0.22 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: 429.0; along Shaft 69.0; at Toe 360.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				429.0			
1	26.3	9.8	6.0	423.0	6.0	0.61	0.15
2	32.9	16.4	7.0	416.0	13.0	1.06	0.27
3	39.5	23.0	7.0	409.0	20.0	1.06	0.27
4	46.0	29.6	7.0	402.0	27.0	1.06	0.27
5	52.6	36.1	8.0	394.0	35.0	1.22	0.31
6	59.2	42.7	8.0	386.0	43.0	1.22	0.31
7	65.8	49.3	11.0	375.0	54.0	1.67	0.42
8	72.3	55.9	15.0	360.0	69.0	2.28	0.57
Avg. Shaft			8.6			1.23	0.31
Toe			360.0				365.35

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.22	0.03
Quake	(in)	0.28	0.59
Case Damping Factor		0.55	0.39
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	38
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	76	
Resistance Gap (included in Toe Quake) (in)			0.01

CAPWAP match quality = 2.97 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.30 in; Blow Count = 40 b/ft
Computed: Final Set = 0.34 in; Blow Count = 35 b/ft
Transducer F3(F523) CAL: 93.8; RF: 1.00; F4(H083) CAL: 94.4; RF: 1.00
A3(K1020) CAL: 307; RF: 1.12; A4(K974) CAL: 305; RF: 1.12

max. Top Comp. Stress = 32.2 ksi (T= 36.0 ms, max= 1.039 x Top)
max. Comp. Stress = 33.5 ksi (Z= 26.3 ft, T= 37.4 ms)
max. Tens. Stress = -5.16 ksi (Z= 39.5 ft, T= 61.6 ms)
max. Energy (EMX) = 33.7 kip-ft; max. Measured Top Displ. (DMX)= 1.25 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	499.4	-27.3	32.2	-1.76	33.7	16.9	1.26
2	6.6	500.1	-34.1	32.3	-2.20	33.2	16.9	1.22
3	9.9	500.8	-40.7	32.3	-2.62	32.8	16.8	1.20
4	13.2	501.6	-47.7	32.4	-3.08	32.5	16.8	1.18
5	16.4	502.6	-54.1	32.4	-3.49	32.3	16.7	1.15
6	19.7	506.4	-59.1	32.7	-3.81	32.0	16.6	1.13
7	23.0	512.6	-63.4	33.1	-4.09	31.7	16.3	1.10
8	26.3	519.0	-71.0	33.5	-4.58	31.3	16.1	1.08
9	29.6	500.0	-69.6	32.2	-4.49	29.3	15.8	1.04
10	32.9	506.5	-76.8	32.7	-4.95	28.8	15.6	1.01
11	36.2	484.0	-74.9	31.2	-4.83	26.7	15.3	0.98
12	39.5	490.2	-80.0	31.6	-5.16	26.2	15.1	0.95
13	42.7	468.5	-75.0	30.2	-4.84	24.2	14.9	0.92
14	46.0	474.9	-77.2	30.6	-4.98	23.6	14.6	0.89
15	49.3	454.6	-68.4	29.3	-4.41	21.6	14.4	0.85
16	52.6	461.1	-67.0	29.7	-4.32	21.1	15.3	0.82
17	55.9	437.8	-54.8	28.2	-3.54	19.1	16.0	0.79
18	59.2	445.0	-53.6	28.7	-3.46	18.6	15.2	0.76
19	62.5	427.1	-47.3	27.5	-3.05	16.7	15.0	0.72
20	65.8	434.0	-46.7	28.0	-3.01	16.2	16.7	0.69
21	69.0	416.6	-37.2	26.9	-2.40	14.0	18.6	0.66
22	72.3	410.8	-37.0	26.5	-2.39	12.1	18.2	0.63
Absolute	26.3			33.5			(T =	37.4 ms)
	39.5				-5.16		(T =	61.6 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	462.3	414.2	366.2	318.2	270.2	222.2	174.1	126.1	78.1	30.1
RX	526.1	506.5	492.4	478.7	465.5	452.3	439.0	426.4	418.0	410.9
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RAU = 379.9 (kips); RA2 = 482.2 (kips)

Current CAPWAP Ru = 429.0 (kips); Corresponding J(RP)= 0.14; J(RX) = 1.36

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
16.7	35.80	461.7	504.8	504.8	1.25	0.42	0.30	34.1	528.3	621

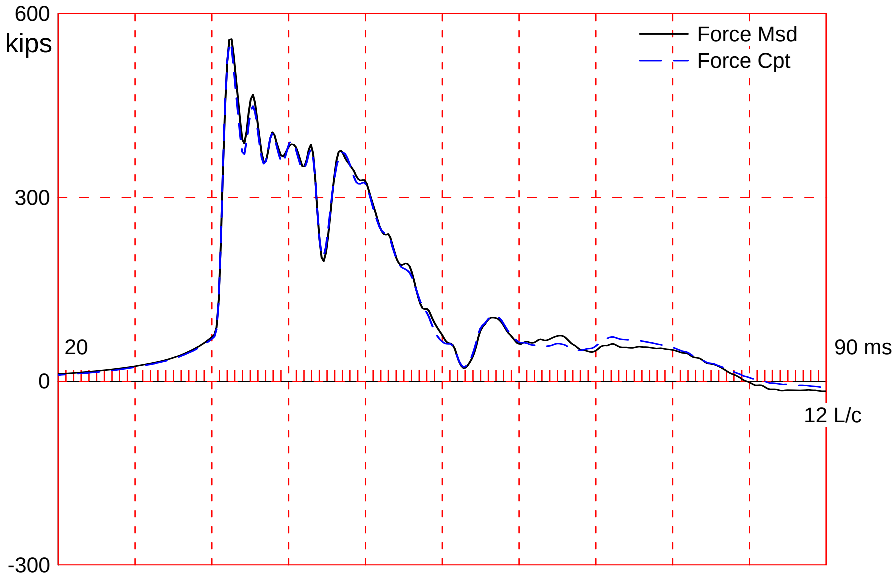
PILE PROFILE AND PILE MODEL

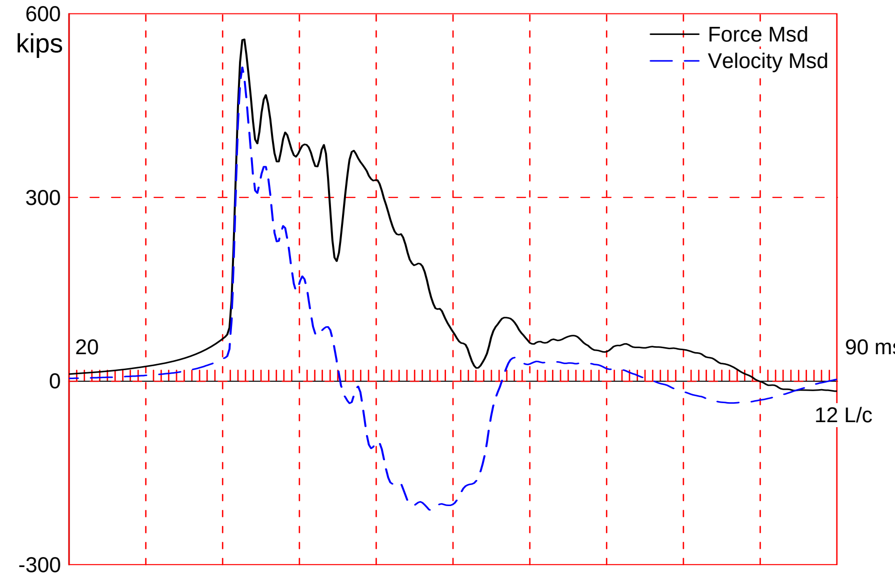
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

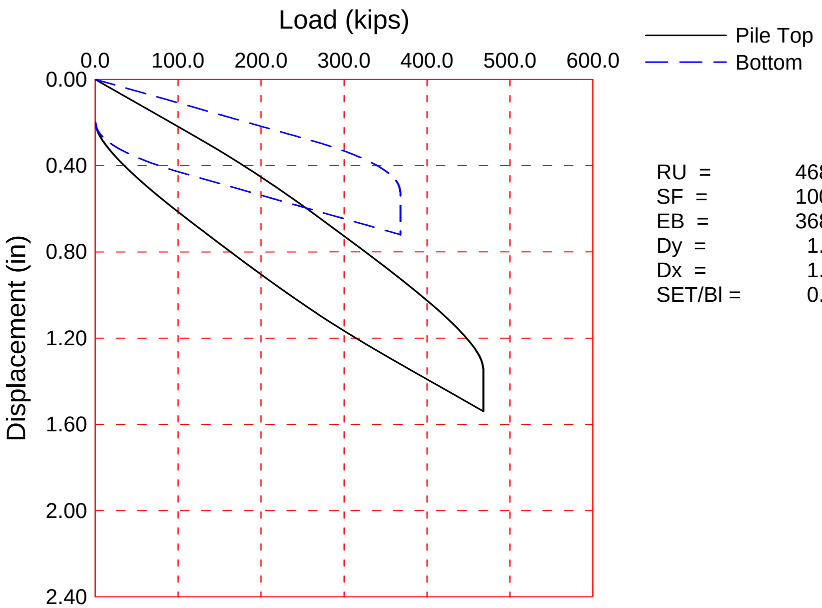
Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

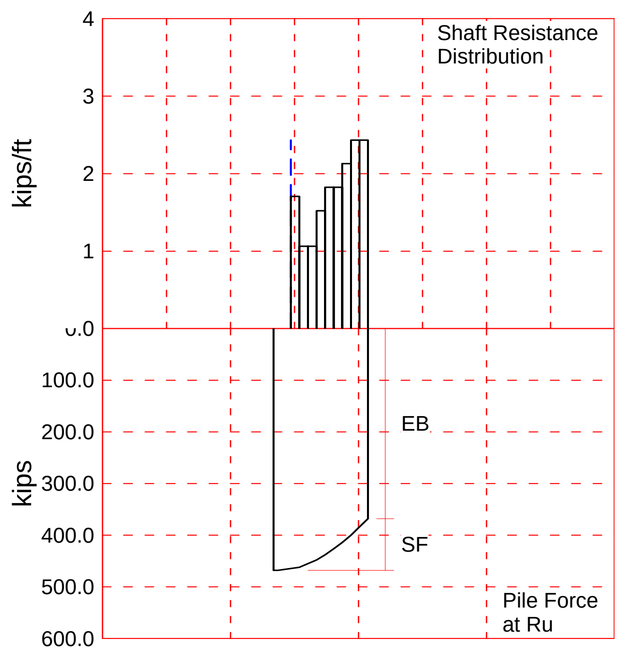
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.786 ft^3; Volume ratio considering added impedance: 1.000







RU =	468.0 kips
SF =	100.0 kips
EB =	368.0 kips
Dy =	1.34 in
Dx =	1.54 in
SET/Bl =	0.20 in



Length b. Sensors	72.3 ft
Embedment	56.1 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	2.20
Top Compr. Stress	35.7 ksi
Max Compr. Stress	37.3 ksi
Max Tension Stress	-1.43 ksi
Avg. Shaft Quake	0.23 in
Toe Quake	0.40 in
Avg. Shaft Smith Dpg.	0.30 s/ft
Toe Smith Damping	0.04 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: 468.0; along Shaft 100.0; at Toe 368.0 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
				468.0			
1	19.7	3.5	6.0	462.0	6.0	1.71	0.43
2	26.3	10.1	7.0	455.0	13.0	1.06	0.27
3	32.9	16.7	7.0	448.0	20.0	1.06	0.27
4	39.5	23.2	10.0	438.0	30.0	1.52	0.38
5	46.0	29.8	12.0	426.0	42.0	1.82	0.46
6	52.6	36.4	12.0	414.0	54.0	1.82	0.46
7	59.2	43.0	14.0	400.0	68.0	2.13	0.54
8	65.8	49.5	16.0	384.0	84.0	2.43	0.61
9	72.3	56.1	16.0	368.0	100.0	2.43	0.61
Avg. Shaft			11.1			1.78	0.45
Toe			368.0				373.47

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.04
Quake	(in)	0.23	0.40
Case Damping Factor		1.08	0.53
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	82	66
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	99	
Resistance Gap (included in Toe Quake) (in)			0.01

CAPWAP match quality = 2.20 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.24 in; Blow Count = 50 b/ft
Transducer F3(F523) CAL: 93.8; RF: 1.00; F4(H083) CAL: 94.4; RF: 1.00
A3(K1020) CAL: 307; RF: 1.10; A4(K974) CAL: 305; RF: 1.10

max. Top Comp. Stress = 35.7 ksi (T= 36.0 ms, max= 1.046 x Top)
max. Comp. Stress = 37.3 ksi (Z= 19.7 ft, T= 37.0 ms)
max. Tens. Stress = -1.43 ksi (Z= 26.3 ft, T= 58.9 ms)
max. Energy (EMX) = 34.2 kip-ft; max. Measured Top Displ. (DMX)= 1.07 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	553.5	-14.1	35.7	-0.91	34.2	18.7	1.09
2	6.6	554.4	-14.7	35.8	-0.95	33.9	18.6	1.07
3	9.9	555.6	-15.0	35.8	-0.97	33.6	18.5	1.04
4	13.2	560.7	-15.2	36.2	-0.98	33.2	18.3	1.01
5	16.4	569.5	-15.4	36.7	-1.00	32.7	18.0	0.98
6	19.7	579.0	-19.4	37.3	-1.25	32.1	17.6	0.95
7	23.0	551.7	-13.9	35.6	-0.90	29.9	17.3	0.91
8	26.3	561.6	-22.2	36.2	-1.43	29.3	16.9	0.88
9	29.6	530.4	-14.9	34.2	-0.96	26.9	16.5	0.85
10	32.9	542.8	-20.0	35.0	-1.29	26.3	16.1	0.81
11	36.2	516.2	-11.4	33.3	-0.73	24.1	15.6	0.78
12	39.5	530.1	-17.5	34.2	-1.13	23.4	15.1	0.74
13	42.7	491.1	-7.1	31.7	-0.46	20.8	14.6	0.70
14	46.0	504.5	-12.7	32.5	-0.82	20.2	14.1	0.67
15	49.3	458.8	0.0	29.6	0.00	17.5	13.7	0.64
16	52.6	472.6	-3.2	30.5	-0.21	17.0	13.2	0.60
17	55.9	431.8	0.0	27.8	0.00	14.6	12.7	0.57
18	59.2	445.8	0.0	28.8	0.00	14.0	12.1	0.53
19	62.5	413.8	0.0	26.7	0.00	11.6	12.2	0.50
20	65.8	422.0	0.0	27.2	0.00	11.1	13.9	0.47
21	69.0	398.7	0.0	25.7	0.00	8.8	14.8	0.43
22	72.3	399.0	0.0	25.7	0.00	7.3	14.0	0.40
Absolute	19.7			37.3			(T =	37.0 ms)
	26.3				-1.43		(T =	58.9 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	618.9	573.1	527.3	481.4	435.6	389.8	344.0	298.2	252.4	206.5
RX	627.4	584.3	553.7	531.6	511.0	492.2	478.5	468.1	457.7	448.5
RU	618.9	573.1	527.3	481.4	435.6	389.8	344.0	298.2	252.4	206.5

RAU = 375.0 (kips); RA2 = 553.4 (kips)

Current CAPWAP Ru = 468.0 (kips); Corresponding J(RP)= 0.33; J(RX) = 0.70

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
18.7	35.80	516.7	560.4	565.6	1.07	0.20	0.20	34.2	647.3	944

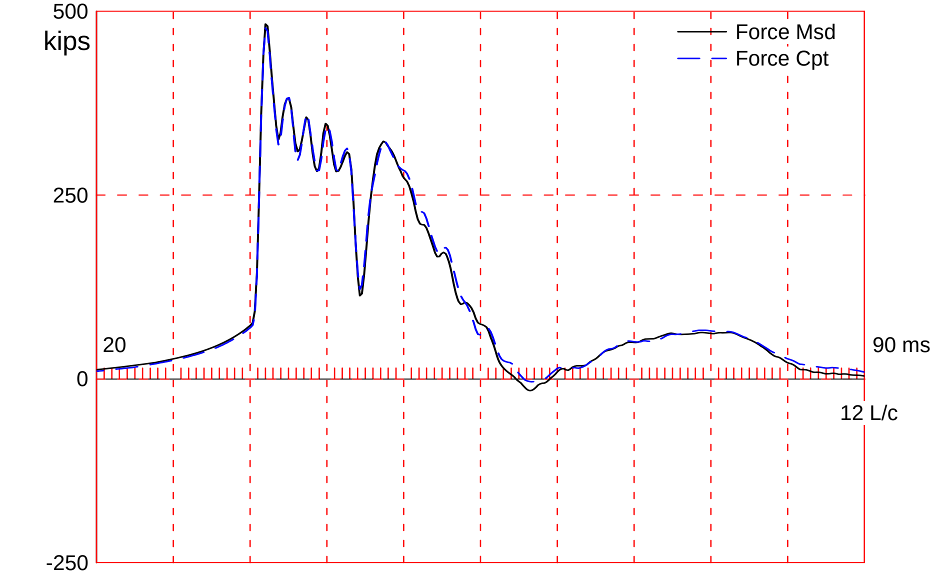
PILE PROFILE AND PILE MODEL

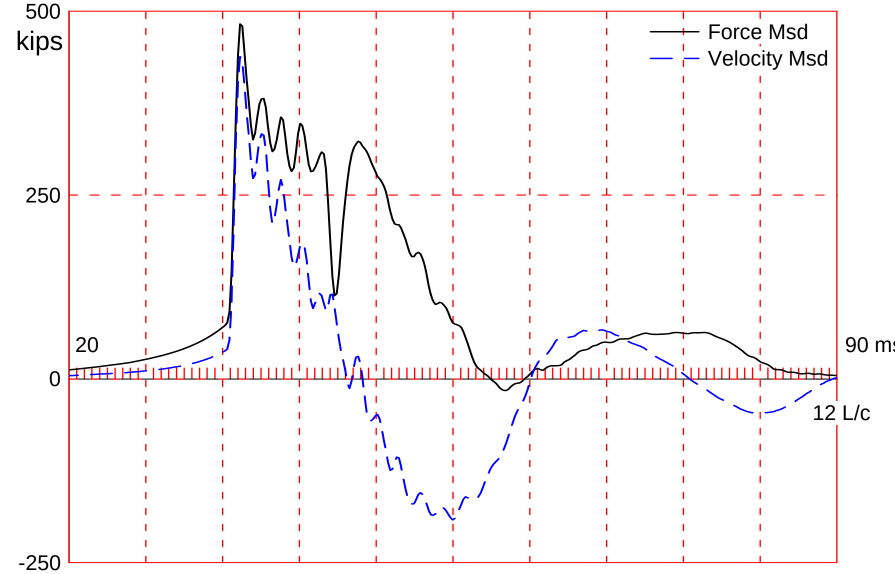
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

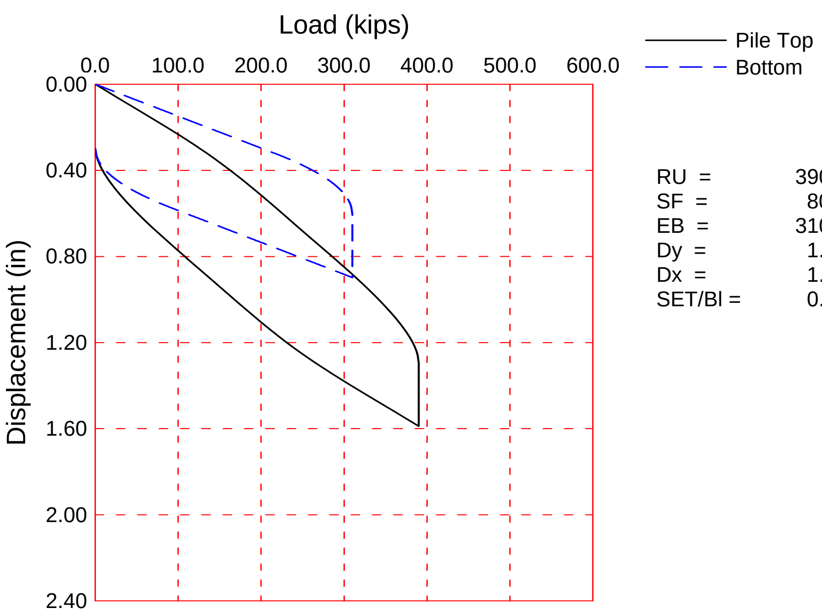
Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

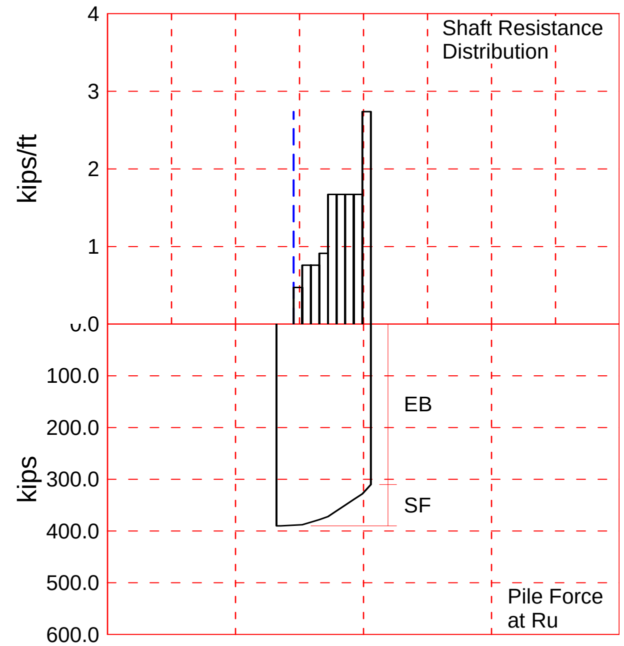
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.786 ft^3; Volume ratio considering added impedance: 1.000







RU	=	390.0 kips
SF	=	80.0 kips
EB	=	310.0 kips
Dy	=	1.29 in
Dx	=	1.59 in
SET/Bl	=	0.30 in



Length b. Sensors	72.3 ft
Embedment	56.8 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	2.20
Top Compr. Stress	30.8 ksi
Max Compr. Stress	31.5 ksi
Max Tension Stress	-4.23 ksi
Avg. Shaft Quake	0.17 in
Toe Quake	0.46 in
Avg. Shaft Smith Dpg.	0.26 s/ft
Toe Smith Damping	0.04 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: 390.0; along Shaft 80.0; at Toe 310.0 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
				390.0			
1	19.7	4.2	2.0	388.0	2.0	0.47	0.12
2	26.3	10.8	5.0	383.0	7.0	0.76	0.19
3	32.9	17.4	5.0	378.0	12.0	0.76	0.19
4	39.5	23.9	6.0	372.0	18.0	0.91	0.23
5	46.0	30.5	11.0	361.0	29.0	1.67	0.42
6	52.6	37.1	11.0	350.0	40.0	1.67	0.42
7	59.2	43.7	11.0	339.0	51.0	1.67	0.42
8	65.8	50.2	11.0	328.0	62.0	1.67	0.42
9	72.3	56.8	18.0	310.0	80.0	2.74	0.69
Avg. Shaft			8.9			1.41	0.35
Toe			310.0				314.61

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.26	0.04
Quake	(in)	0.17	0.46
Case Damping Factor		0.75	0.45
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	100	36
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	58	
Resistance Gap (included in Toe Quake) (in)			0.01
Soil Plug Weight	(kips)		0.015

CAPWAP match quality = 2.20 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.30 in; Blow Count = 40 b/ft
Computed: Final Set = 0.34 in; Blow Count = 35 b/ft
Transducer F3(F523) CAL: 93.8; RF: 1.00; F4(H083) CAL: 94.4; RF: 1.00
A3(K1020) CAL: 307; RF: 1.14; A4(K974) CAL: 305; RF: 1.14

max. Top Comp. Stress = 30.8 ksi (T= 35.8 ms, max= 1.023 x Top)
max. Comp. Stress = 31.5 ksi (Z= 26.3 ft, T= 37.4 ms)
max. Tens. Stress = -4.23 ksi (Z= 39.5 ft, T= 61.8 ms)
max. Energy (EMX) = 27.0 kip-ft; max. Measured Top Displ. (DMX)= 1.06 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	478.2	-14.5	30.8	-0.93	27.0	16.0	1.05
2	6.6	478.7	-23.9	30.9	-1.54	26.8	16.0	1.03
3	9.9	479.4	-30.9	30.9	-1.99	26.6	15.9	1.01
4	13.2	480.6	-35.7	31.0	-2.30	26.4	15.8	0.99
5	16.4	483.4	-38.4	31.2	-2.48	26.1	15.7	0.97
6	19.7	487.2	-44.5	31.4	-2.87	25.8	15.5	0.94
7	23.0	483.5	-50.3	31.2	-3.24	25.0	15.3	0.92
8	26.3	489.1	-56.8	31.5	-3.66	24.7	15.1	0.89
9	29.6	471.1	-56.4	30.4	-3.64	23.2	14.8	0.86
10	32.9	477.3	-59.9	30.8	-3.87	22.7	14.6	0.83
11	36.2	460.8	-59.9	29.7	-3.86	21.3	14.3	0.80
12	39.5	470.1	-65.5	30.3	-4.23	20.9	14.1	0.78
13	42.7	453.6	-63.1	29.3	-4.07	19.4	13.6	0.75
14	46.0	463.8	-63.7	29.9	-4.11	18.9	13.3	0.72
15	49.3	426.3	-53.5	27.5	-3.45	16.6	12.9	0.68
16	52.6	436.1	-56.0	28.1	-3.61	16.2	12.5	0.65
17	55.9	400.4	-49.3	25.8	-3.18	14.1	12.2	0.63
18	59.2	409.5	-51.1	26.4	-3.29	13.7	11.8	0.60
19	62.5	377.0	-41.0	24.3	-2.65	11.8	11.8	0.57
20	65.8	384.2	-39.9	24.8	-2.57	11.4	13.8	0.54
21	69.0	365.4	-29.9	23.6	-1.93	9.7	15.4	0.51
22	72.3	364.0	-29.4	23.5	-1.89	7.9	15.2	0.48
Absolute	26.3			31.5			(T =	37.4 ms)
	39.5				-4.23		(T =	61.8 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	476.5	430.8	385.1	339.4	293.6	247.9	202.2	156.5	110.8	65.0
RX	504.1	482.7	461.3	439.9	423.5	409.0	395.3	385.2	377.0	368.7
RU	476.5	430.8	385.1	339.4	293.6	247.9	202.2	156.5	110.8	65.0

RAU = 312.2 (kips); RA2 = 438.4 (kips)

Current CAPWAP Ru = 390.0 (kips); Corresponding J(RP)= 0.19; J(RX) = 0.65

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
16.0	35.60	442.6	491.1	491.1	1.06	0.30	0.30	27.4	485.7	689

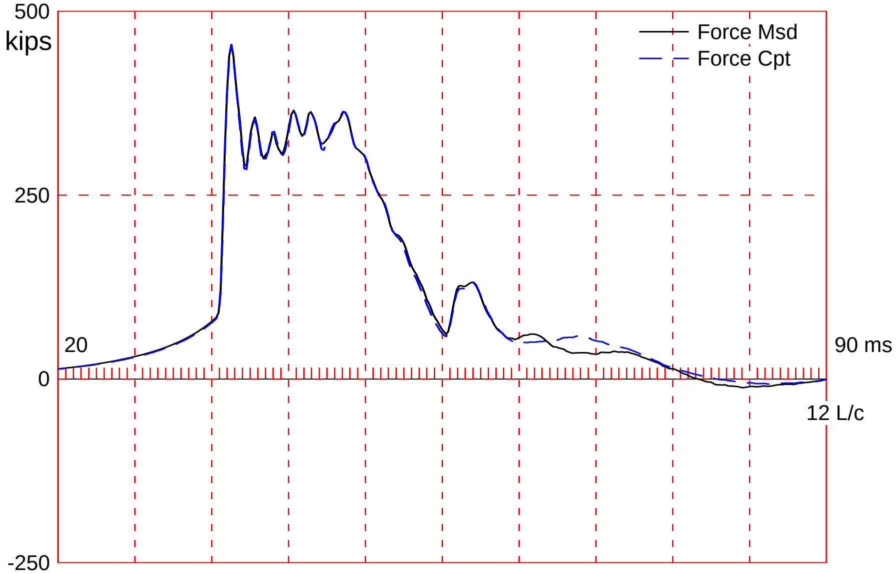
PILE PROFILE AND PILE MODEL

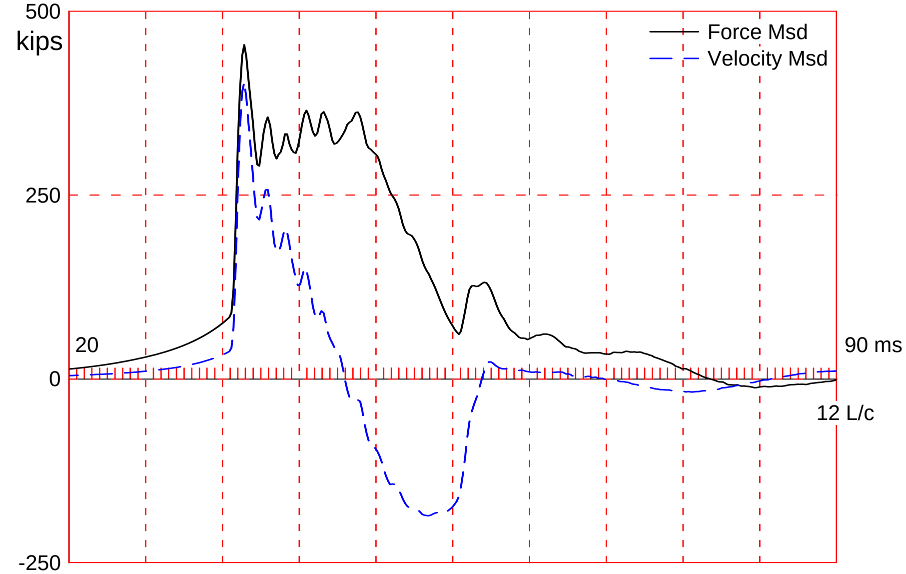
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

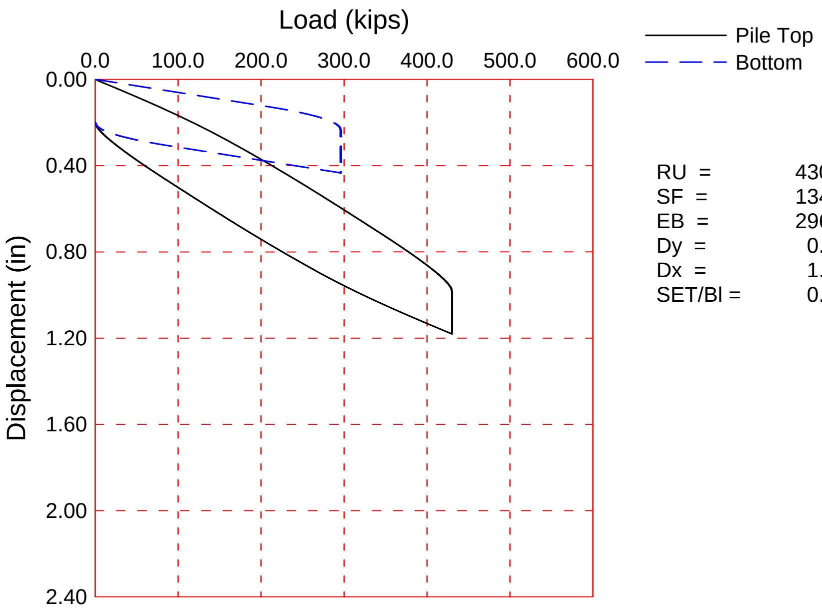
Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

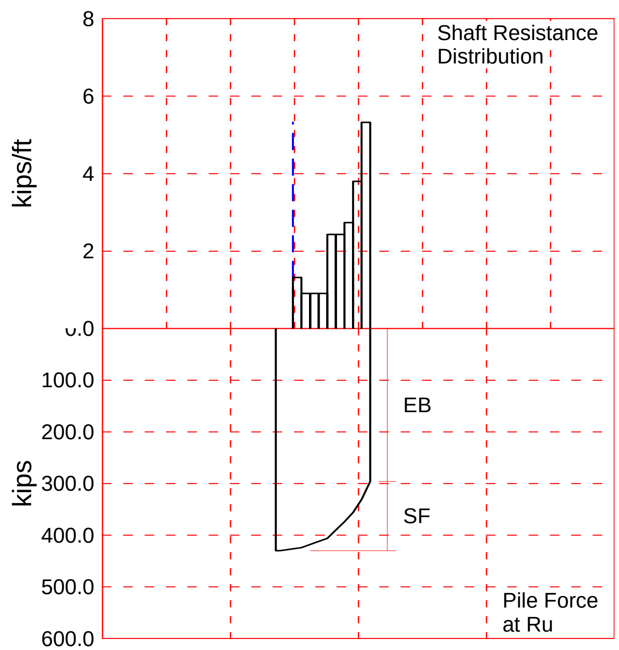
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.786 ft^3; Volume ratio considering added impedance: 1.000







RU =	430.0 kips
SF =	134.0 kips
EB =	296.0 kips
Dy =	0.98 in
Dx =	1.18 in
SET/Bl =	0.20 in



Length b. Sensors	72.3 ft
Embedment	57.1 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	1.93
Top Compr. Stress	29.4 ksi
Max Compr. Stress	30.9 ksi
Max Tension Stress	-1.54 ksi
Avg. Shaft Quake	0.09 in
Toe Quake	0.18 in
Avg. Shaft Smith Dpg.	0.32 s/ft
Toe Smith Damping	0.06 s/ft

About the CAPWAP Results

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

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

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

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

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

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

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

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 430.0; along Shaft 134.0; at Toe 296.0 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
				430.0			
1	19.7	4.5	6.0	424.0	6.0	1.32	0.33
2	26.3	11.1	6.0	418.0	12.0	0.91	0.23
3	32.9	17.7	6.0	412.0	18.0	0.91	0.23
4	39.5	24.3	6.0	406.0	24.0	0.91	0.23
5	46.0	30.8	16.0	390.0	40.0	2.43	0.61
6	52.6	37.4	16.0	374.0	56.0	2.43	0.61
7	59.2	44.0	18.0	356.0	74.0	2.74	0.69
8	65.8	50.6	25.0	331.0	99.0	3.80	0.96
9	72.3	57.1	35.0	296.0	134.0	5.32	1.34
Avg. Shaft			14.9			2.35	0.59
Toe			296.0				300.40

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.32	0.06
Quake	(in)	0.09	0.18
Case Damping Factor		1.55	0.64
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	79	30
Unloading Level	(% of Ru)	56	
Soil Plug Weight	(kips)		0.067

CAPWAP match quality = 1.93 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.16 in; Blow Count = 75 b/ft
Transducer F3(F523) CAL: 93.8; RF: 1.00; F4(H083) CAL: 94.4; RF: 1.00
A3(K1020) CAL: 307; RF: 1.10; A4(K974) CAL: 305; RF: 1.10

max. Top Comp. Stress = 29.4 ksi (T= 36.2 ms, max= 1.050 x Top)
max. Comp. Stress = 30.9 ksi (Z= 19.7 ft, T= 37.2 ms)
max. Tens. Stress = -1.54 ksi (Z= 19.7 ft, T= 204.8 ms)
max. Energy (EMX) = 21.9 kip-ft; max. Measured Top Displ. (DMX)= 0.86 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	456.2	-22.1	29.4	-1.43	21.9	14.5	0.85
2	6.6	457.5	-22.6	29.5	-1.46	21.4	14.5	0.82
3	9.9	459.2	-22.9	29.6	-1.48	21.0	14.4	0.79
4	13.2	464.2	-23.3	29.9	-1.50	20.5	14.2	0.76
5	16.4	471.8	-23.6	30.4	-1.52	20.0	13.9	0.73
6	19.7	479.0	-24.0	30.9	-1.54	19.4	13.6	0.69
7	23.0	454.5	-20.7	29.3	-1.34	17.8	13.4	0.66
8	26.3	461.5	-21.0	29.8	-1.35	17.3	13.1	0.63
9	29.6	438.2	-17.7	28.3	-1.14	15.8	12.8	0.59
10	32.9	445.0	-17.9	28.7	-1.16	15.3	12.5	0.56
11	36.2	423.1	-14.6	27.3	-0.94	13.9	12.3	0.53
12	39.5	434.2	-14.8	28.0	-0.95	13.4	11.8	0.49
13	42.7	422.0	-11.4	27.2	-0.73	12.1	11.2	0.46
14	46.0	436.1	-11.5	28.1	-0.74	11.6	10.7	0.43
15	49.3	403.5	-2.8	26.0	-0.18	9.7	10.2	0.39
16	52.6	406.6	-3.9	26.2	-0.25	9.1	9.6	0.36
17	55.9	387.0	0.0	25.0	0.00	7.5	9.1	0.33
18	59.2	387.1	-0.6	25.0	-0.04	7.0	8.5	0.30
19	62.5	369.7	0.0	23.8	0.00	5.6	7.9	0.27
20	65.8	373.6	0.0	24.1	0.00	5.2	7.6	0.24
21	69.0	347.4	0.0	22.4	0.00	3.8	8.1	0.21
22	72.3	346.8	0.0	22.4	0.00	2.6	7.5	0.18
Absolute	19.7			30.9			(T =	37.2 ms)
	19.7				-1.54		(T =	204.8 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	578.5	549.8	521.1	492.5	463.8	435.1	406.4	377.7	349.1	320.4
RX	578.5	549.8	521.1	492.9	465.4	447.9	436.7	425.4	414.2	409.1
RU	578.5	549.8	521.1	492.5	463.8	435.1	406.4	377.7	349.1	320.4

RAU = 123.3 (kips); RA2 = 449.6 (kips)

Current CAPWAP Ru = 430.0 (kips); Corresponding J(RP)= 0.52; J(RX) = 0.66

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
14.7	35.99	407.0	458.3	458.3	0.86	0.20	0.20	22.3	502.9	1644

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.3	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.786 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Mark Rawlings
Company: Lunda Construction Company	No. of Sheets: 28
E-mail:whamacher@lundaconstruction.com	Date: September 12, 2014

RE: Dynamic Testing Results – Pier 9
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On September 10, 2014, Pier 9 #1 and Pier 9 #15 at the above structure were dynamically tested during initial driving. The 75.4 foot long HP 12 x 53 H-piles were driven with an APE D25-42 hammer. Plans indicate the piles in Pier 9 have a required driving resistance or ultimate capacity of 350 kips, and an estimated length of 55 feet.

Pier 9 #1 was driven to a depth of 66.5 feet below the excavated ground surface at El. 596.5, which corresponds to a pile tip elevation of El. 530. The blow count over the final increment of driving was 5 blows for ⅝ inch of penetration at an average hammer stroke of 7.8 feet. Pier 9 #32 was driven to a depth of 66.0 feet below the ground surface at the same elevation, which corresponds to a tip elevation of El. 530.5. The blow count over the final increment of driving was 5 blows for ½ inch of penetration at an average hammer stroke of 8.8 feet. Restrike testing was conducted on both piles on September 11. The blow count at the beginning of restrike of Pier 9 #1 was 10 blows for ⅞ inch of penetration at an average hammer stroke of 9.1 feet. The blow count at the beginning of restrike of Pier 9 #32 was 10 blows for ⅝ inch of penetration at an average hammer stroke of 9.9 feet.

For the 350 kip piles driven with the APE D25-42 hammer in Pier 9 of the STH 96 bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.0	8
7.5	6
8.0	5
8.5	4
9.0	4
9.5	4
10.0	4

We recommended the above blow count at the corresponding hammer stroke be maintained for one inch of driving. Driving may be terminated if the blow count is achieved in less than a full inch

We anticipate the production piles will terminate at depths very similar to those of the test piles near El. 530. Due to the presence of cobbles, boulders or softer bedrock above this approximate elevation we recommend the piles be driven to approximately this elevation before applying the driving criteria. If a blow count of 10 blows per inch at an associated stroke of 8 feet is achieved above approximately El. 531 driving should be halted and we should be contacted for consultation.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Mark A. Rawlings

Mark Rawlings

Travis Coleman, P.E.

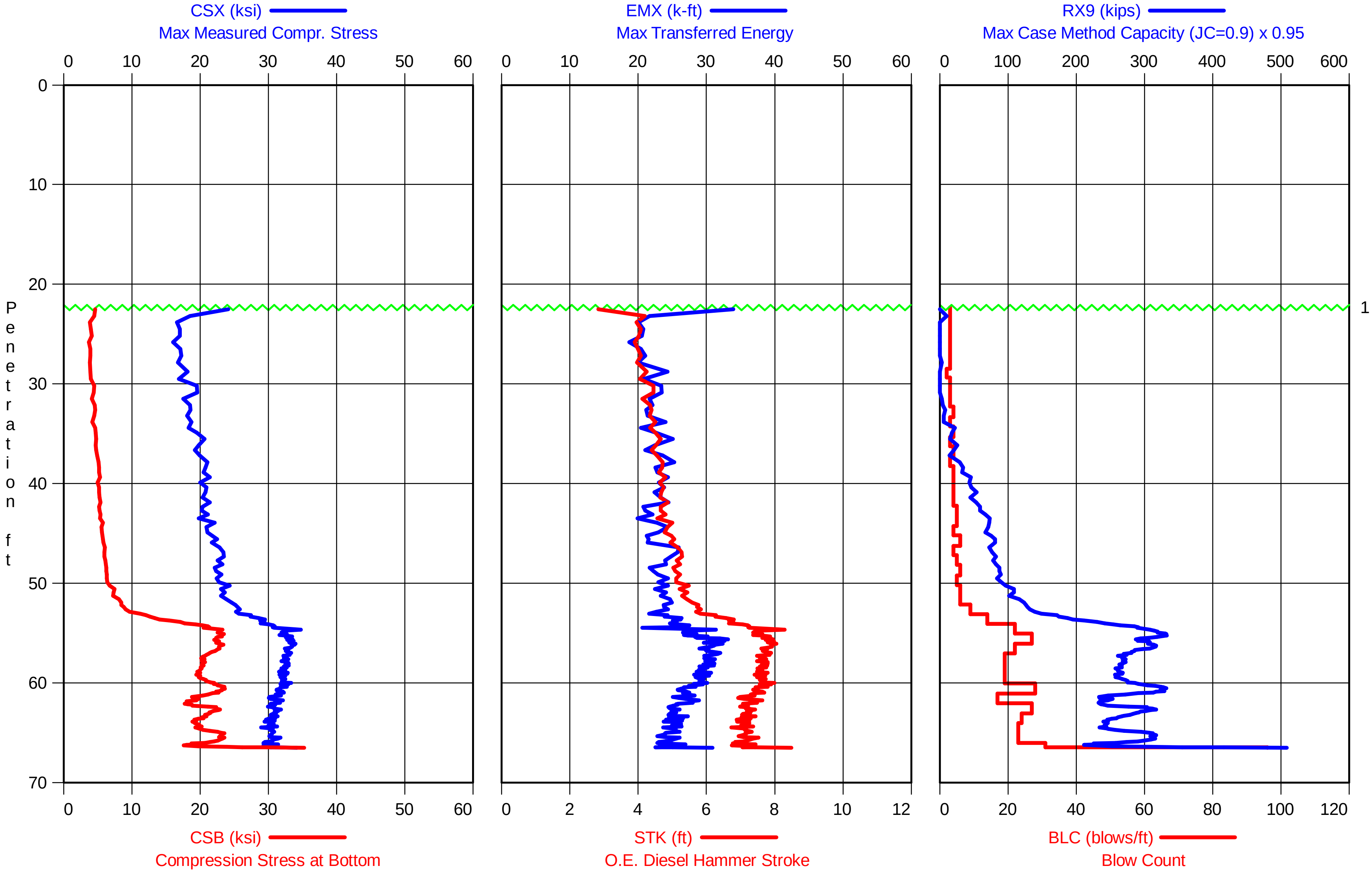
Cc: Steve Seymour – Omnni Associates
steve.seymour@omnni.com

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

PDIPLOT Ver. 2014.1 - Printed: 12-Sep-2014

Test date: 10-Sep-2014

STH 96 over Fox River - Pier 9 #1
APE D25-42, HP 12 x 53



1 - Excavated ground surface at El. 596.5

STH 96 over Fox River - Pier 9 #1
OP: MR

APE D25-42, HP 12 x 53
Test date: 10-Sep-2014

AR: 15.50 in^2
LE: 71.37 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

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

STK: O.E. Diesel Hammer Stroke
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9) x 0.95

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
3	23.00	3	AV3	22.2	4.6	30	4.9	53.0	3
			STD	2.9	0.1	6	0.7	3.8	5
			MAX	25.4	4.7	34	5.7	56.8	10
			MIN	18.5	4.4	22	4.2	49.3	0
6	24.00	3	AV3	17.2	4.1	20	4.0	57.8	4
			STD	1.0	0.3	1	0.1	0.9	5
			MAX	18.5	4.4	21	4.2	58.9	11
			MIN	16.2	3.8	20	3.9	56.7	0
9	25.00	3	AV3	17.0	4.1	21	4.1	57.6	0
			STD	0.6	0.2	0	0.1	0.6	0
			MAX	17.8	4.2	21	4.2	58.2	0
			MIN	16.2	3.8	20	4.0	56.8	0
12	26.00	3	AV3	16.3	3.8	19	3.9	58.5	0
			STD	0.7	0.2	1	0.1	0.5	0
			MAX	17.0	4.0	21	4.0	59.2	0
			MIN	15.3	3.6	18	3.8	58.0	0
15	27.00	3	AV3	16.9	3.8	20	4.0	58.1	0
			STD	0.4	0.2	0	0.1	0.5	0
			MAX	17.4	4.1	21	4.1	58.7	0
			MIN	16.5	3.6	20	3.9	57.4	0
18	28.00	3	AV3	17.1	4.0	21	4.0	57.8	2
			STD	0.6	0.2	1	0.1	0.7	3
			MAX	17.9	4.2	22	4.2	58.3	7
			MIN	16.7	3.8	19	4.0	56.8	0
20	29.00	2	AV2	18.2	3.9	24	4.2	56.4	0
			STD	0.3	0.1	0	0.1	0.7	0
			MAX	18.5	4.0	25	4.4	57.1	0
			MIN	17.9	3.9	24	4.1	55.8	0
23	30.00	3	AV3	18.0	4.1	22	4.2	56.6	0
			STD	1.7	0.2	2	0.3	1.8	0
			MAX	20.2	4.4	24	4.6	58.7	0
			MIN	16.3	3.9	20	3.9	54.4	0
26	31.00	3	AV3	19.3	4.5	23	4.4	55.5	0
			STD	0.6	0.2	0	0.1	0.4	0
			MAX	20.1	4.6	23	4.5	56.0	0
			MIN	18.8	4.3	23	4.3	54.9	0
29	32.00	3	AV3	18.0	4.2	22	4.2	56.6	2
			STD	1.0	0.2	1	0.2	1.1	3
			MAX	19.1	4.5	24	4.4	57.9	6
			MIN	16.7	3.9	21	4.0	55.3	0
33	33.00	4	AV4	18.3	4.6	21	4.3	55.9	9
			STD	0.4	0.1	1	0.1	0.3	2
			MAX	18.8	4.7	22	4.4	56.3	12
			MIN	17.9	4.4	20	4.3	55.4	6
36	34.00	3	AV3	18.6	4.2	24	4.5	55.2	4
			STD	0.7	0.1	1	0.1	0.8	6
			MAX	19.5	4.4	24	4.6	55.8	12
			MIN	18.0	4.1	23	4.4	54.1	0
40	35.00	4	AV4	18.9	4.7	21	4.4	55.4	20
			STD	0.8	0.0	1	0.1	0.6	3
			MAX	20.0	4.7	23	4.6	56.4	22
			MIN	17.8	4.6	20	4.3	54.6	16

STH 96 over Fox River - Pier 9 #1
OP: MR
APE D25-42, HP 12 x 53
Test date: 10-Sep-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
43	36.00	3	AV3	20.4	4.7	25	4.6	54.2	19
			STD	0.6	0.2	1	0.1	0.5	5
			MAX	21.2	4.9	26	4.8	54.6	26
			MIN	20.0	4.5	24	4.6	53.5	13
47	37.00	4	AV4	19.5	4.8	21	4.4	55.3	23
			STD	0.3	0.1	1	0.1	0.3	3
			MAX	20.0	4.9	22	4.5	55.6	25
			MIN	19.1	4.7	21	4.4	54.8	18
50	38.00	3	AV3	20.7	5.0	25	4.7	54.0	21
			STD	0.6	0.2	0	0.1	0.5	11
			MAX	21.3	5.3	26	4.8	54.5	30
			MIN	19.9	4.9	25	4.6	53.4	6
54	39.00	4	AV4	20.6	5.2	23	4.7	54.1	34
			STD	0.3	0.1	1	0.1	0.4	8
			MAX	21.0	5.3	24	4.7	54.6	44
			MIN	20.3	5.1	22	4.6	53.6	26
58	40.00	4	AV4	20.7	5.1	24	4.7	53.7	45
			STD	1.0	0.2	1	0.1	0.7	10
			MAX	21.6	5.4	24	4.8	55.0	56
			MIN	19.1	5.0	22	4.5	53.2	31
62	41.00	4	AV4	20.8	5.2	23	4.7	53.8	50
			STD	0.8	0.0	1	0.1	0.8	7
			MAX	21.8	5.2	24	4.9	55.0	63
			MIN	19.7	5.1	22	4.5	52.9	45
66	42.00	4	AV4	20.9	5.3	24	4.8	53.5	49
			STD	0.6	0.1	1	0.1	0.6	8
			MAX	21.8	5.4	25	4.9	54.1	63
			MIN	20.4	5.3	23	4.6	52.6	42
71	43.00	5	AV5	20.4	5.2	21	4.7	53.9	61
			STD	0.3	0.0	0	0.1	0.3	3
			MAX	20.7	5.2	22	4.8	54.3	65
			MIN	20.0	5.2	21	4.6	53.4	59
76	44.00	5	AV5	21.1	5.6	22	4.8	53.4	72
			STD	1.2	0.2	1	0.2	1.1	2
			MAX	22.2	5.8	23	5.0	55.0	76
			MIN	19.1	5.2	20	4.5	52.1	69
80	45.00	4	AV4	21.0	5.5	24	4.8	53.2	69
			STD	1.0	0.2	2	0.2	0.9	2
			MAX	22.2	5.8	26	5.1	54.1	71
			MIN	19.7	5.2	22	4.6	52.0	65
86	46.00	6	AV6	22.0	5.7	21	5.0	52.3	79
			STD	0.4	0.1	0	0.1	0.4	4
			MAX	22.7	5.8	22	5.1	53.0	86
			MIN	21.4	5.5	21	4.9	51.7	75
90	47.00	4	AV4	23.1	6.0	26	5.2	51.3	75
			STD	0.5	0.1	0	0.1	0.4	2
			MAX	23.8	6.1	27	5.4	51.8	77
			MIN	22.5	5.9	25	5.1	50.6	73
95	48.00	5	AV5	23.0	6.1	24	5.2	51.3	82
			STD	0.7	0.1	0	0.1	0.5	4
			MAX	24.3	6.3	25	5.4	51.7	86
			MIN	22.4	5.9	24	5.1	50.3	77
101	49.00	6	AV6	22.6	6.2	22	5.1	51.6	87
			STD	0.8	0.2	1	0.2	0.8	6
			MAX	23.5	6.4	24	5.3	52.7	96
			MIN	21.6	6.0	21	4.9	50.9	79

STH 96 over Fox River - Pier 9 #1 APE D25-42, HP 12 x 53
OP: MR Test date: 10-Sep-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
106	50.00	5	AV5	22.6	6.3	24	5.1	51.7	86
			STD	0.4	0.1	1	0.1	0.4	4
			MAX	23.1	6.4	25	5.2	52.3	94
			MIN	21.8	6.2	23	5.0	51.2	81
112	51.00	6	AV6	23.7	7.1	24	5.4	50.5	105
			STD	0.7	0.3	1	0.1	0.6	6
			MAX	24.6	7.6	25	5.6	51.3	111
			MIN	22.9	6.6	22	5.2	49.6	93
118	52.00	6	AV6	23.8	7.9	24	5.4	50.3	114
			STD	0.7	0.5	1	0.2	0.7	10
			MAX	25.0	8.5	25	5.7	51.0	126
			MIN	22.9	7.2	23	5.3	49.0	98
127	53.00	9	AV9	25.4	9.2	23	5.8	48.9	133
			STD	0.6	0.8	1	0.1	0.5	6
			MAX	26.3	11.0	25	6.0	49.9	141
			MIN	24.0	8.3	22	5.5	47.9	126
141	54.00	14	AV14	28.3	14.2	25	6.5	46.1	195
			STD	1.1	2.0	1	0.3	1.0	24
			MAX	30.1	17.6	27	7.0	48.4	235
			MIN	25.7	11.4	21	5.9	44.5	157
163	55.00	22	AV19	31.5	21.5	27	7.4	43.5	293
			STD	1.7	1.6	3	0.5	1.2	25
			MAX	36.8	23.9	34	8.9	45.2	323
			MIN	29.2	17.8	21	6.8	39.6	250
190	56.00	27	AV27	32.9	22.7	30	7.8	42.4	311
			STD	0.7	0.5	2	0.2	0.5	16
			MAX	34.5	23.6	34	8.2	43.5	338
			MIN	31.4	21.7	27	7.4	41.2	284
212	57.00	22	AV22	33.2	22.5	31	7.8	42.2	300
			STD	0.6	0.6	1	0.2	0.4	14
			MAX	34.0	23.6	34	8.1	43.2	321
			MIN	31.9	20.8	28	7.5	41.5	278
231	58.00	19	AV19	32.6	20.6	31	7.7	42.6	270
			STD	0.6	0.4	1	0.2	0.5	4
			MAX	34.0	21.2	33	8.1	43.3	274
			MIN	31.7	19.7	29	7.4	41.6	261
250	59.00	19	AV19	32.3	20.1	30	7.6	42.7	264
			STD	0.6	0.3	1	0.2	0.4	4
			MAX	33.2	20.6	31	7.9	43.7	271
			MIN	31.1	19.3	28	7.3	42.1	251
269	60.00	19	AV19	32.2	20.4	29	7.6	42.7	268
			STD	0.6	0.8	1	0.2	0.5	9
			MAX	33.4	22.0	32	7.9	43.4	291
			MIN	31.4	19.3	28	7.4	41.9	253
297	61.00	28	AV28	32.0	22.9	27	7.6	42.8	315
			STD	0.7	0.5	1	0.2	0.6	14
			MAX	33.4	23.6	31	8.0	43.7	333
			MIN	30.8	22.0	25	7.3	41.7	282
314	62.00	17	AV17	31.0	19.4	27	7.3	43.8	247
			STD	1.0	1.1	2	0.3	0.9	17
			MAX	33.0	21.5	31	7.9	45.2	285
			MIN	29.1	17.8	25	6.8	41.9	227
341	63.00	27	AV27	30.9	21.0	25	7.2	44.0	282
			STD	0.9	1.8	1	0.2	0.7	30
			MAX	33.0	23.3	27	7.8	45.1	319
			MIN	29.4	17.5	23	6.8	42.4	232

STH 96 over Fox River - Pier 9 #1
OP: MR

APE D25-42, HP 12 x 53
Test date: 10-Sep-2014

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
365	64.00	24	AV24	30.4	20.1	25	7.1	44.2	259
			STD	0.8	0.9	1	0.2	0.6	15
			MAX	31.8	21.4	28	7.5	45.7	286
			MIN	28.4	18.4	22	6.6	43.1	240
388	65.00	23	AV23	30.4	20.5	25	7.2	44.1	257
			STD	0.8	1.2	1	0.2	0.7	23
			MAX	32.0	23.1	27	7.6	45.8	307
			MIN	28.4	19.1	23	6.6	42.8	234
411	66.00	23	AV23	30.4	22.8	24	7.1	44.2	304
			STD	0.9	0.8	1	0.3	0.8	15
			MAX	32.1	23.7	27	7.7	45.9	318
			MIN	28.3	20.9	22	6.6	42.6	267
425	66.45	31	AV14	30.4	20.1	25	7.1	44.2	250
			STD	1.0	2.5	2	0.3	0.9	40
			MAX	32.0	25.4	28	7.7	45.6	342
			MIN	28.9	17.5	22	6.7	42.6	208
430	66.50	96	AV5	32.0	31.3	27	7.8	42.5	444
			STD	2.0	3.4	4	0.7	1.7	58
			MAX	35.2	35.8	32	8.8	44.7	525
			MIN	29.6	26.9	22	6.9	39.8	370
			Average	28.3	16.5	26	6.6	46.4	212
			Std. Dev.	5.2	7.5	3	1.3	5.0	112
			Maximum	36.8	35.8	34	8.9	59.2	525
			Minimum	15.3	3.6	18	3.8	39.6	0

Total number of blows analyzed: 427

BL#	depth (ft)	Comments
1	22.33	Excavated ground surface at El. 596.5

Time Summary

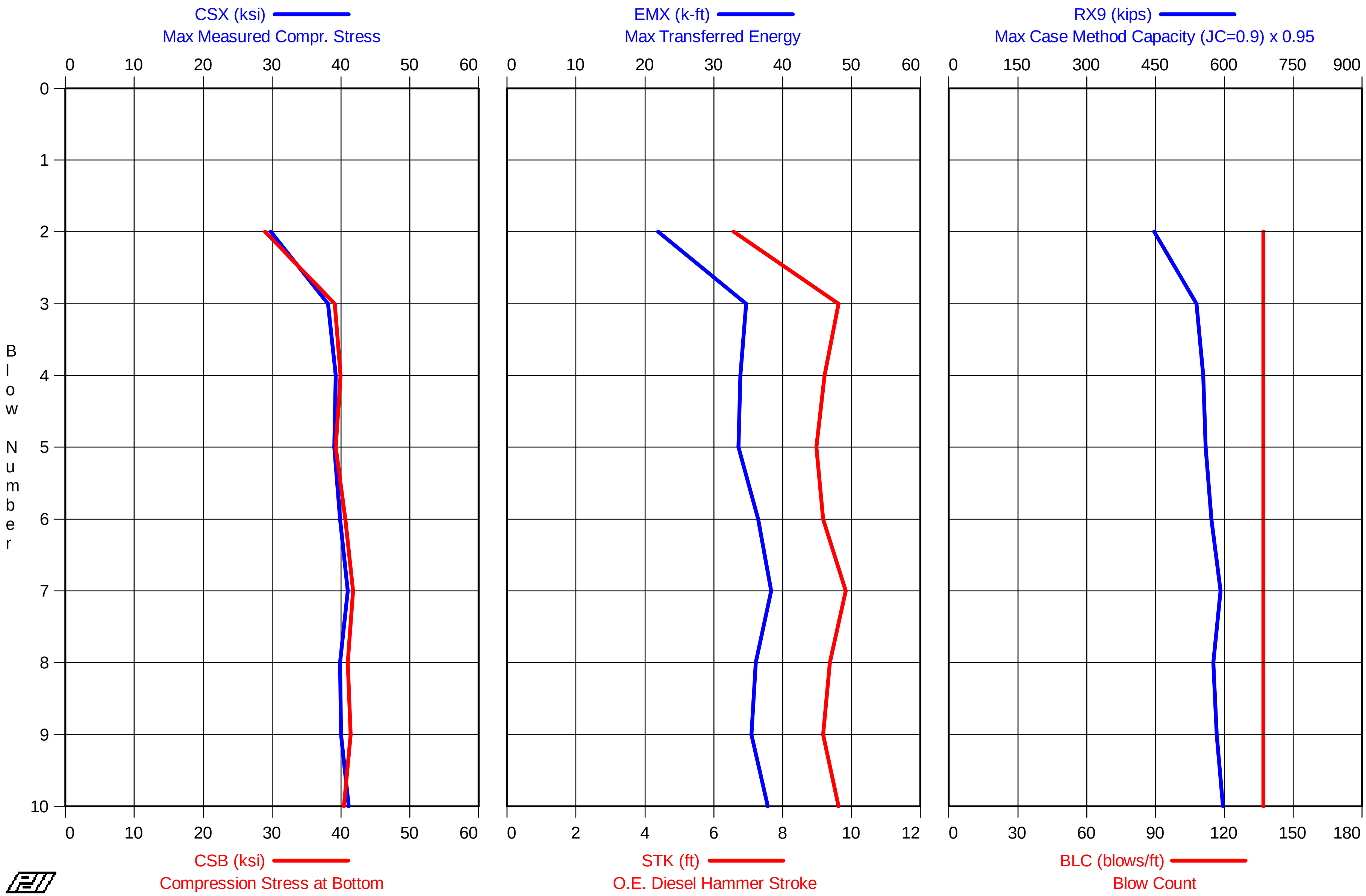
Drive 14 minutes 7 seconds 4:16:18 PM - 4:30:25 PM (9/10/2014) BN 1 - 430

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

PDIPLOT Ver. 2014.1 - Printed: 12-Sep-2014

Test date: 11-Sep-2014

STH 96 over Fox River - Pier 9 #1 Restrike
APE D25-42, HP 12 x 53



STH 96 over Fox River - Pier 9 #1 Restrike
OP: MR

APE D25-42, HP 12 x 53
Test date: 11-Sep-2014

AR: 15.50 in^2
LE: 71.37 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

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

STK: O.E. Diesel Hammer Stroke
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9) x 0.95

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
10	66.57	137	AV9	38.7	39.2	34	9.1	39.5	558
			STD	3.3	3.7	5	0.9	2.3	43
			MAX	41.1	41.8	38	9.8	45.9	597
			MIN	29.8	29.0	22	6.6	37.8	447
			Average	38.7	39.2	34	9.1	39.5	558
			Std. Dev.	3.3	3.7	5	0.9	2.3	43
			Maximum	41.1	41.8	38	9.8	45.9	597
			Minimum	29.8	29.0	22	6.6	37.8	447

Total number of blows analyzed: 9

Time Summary

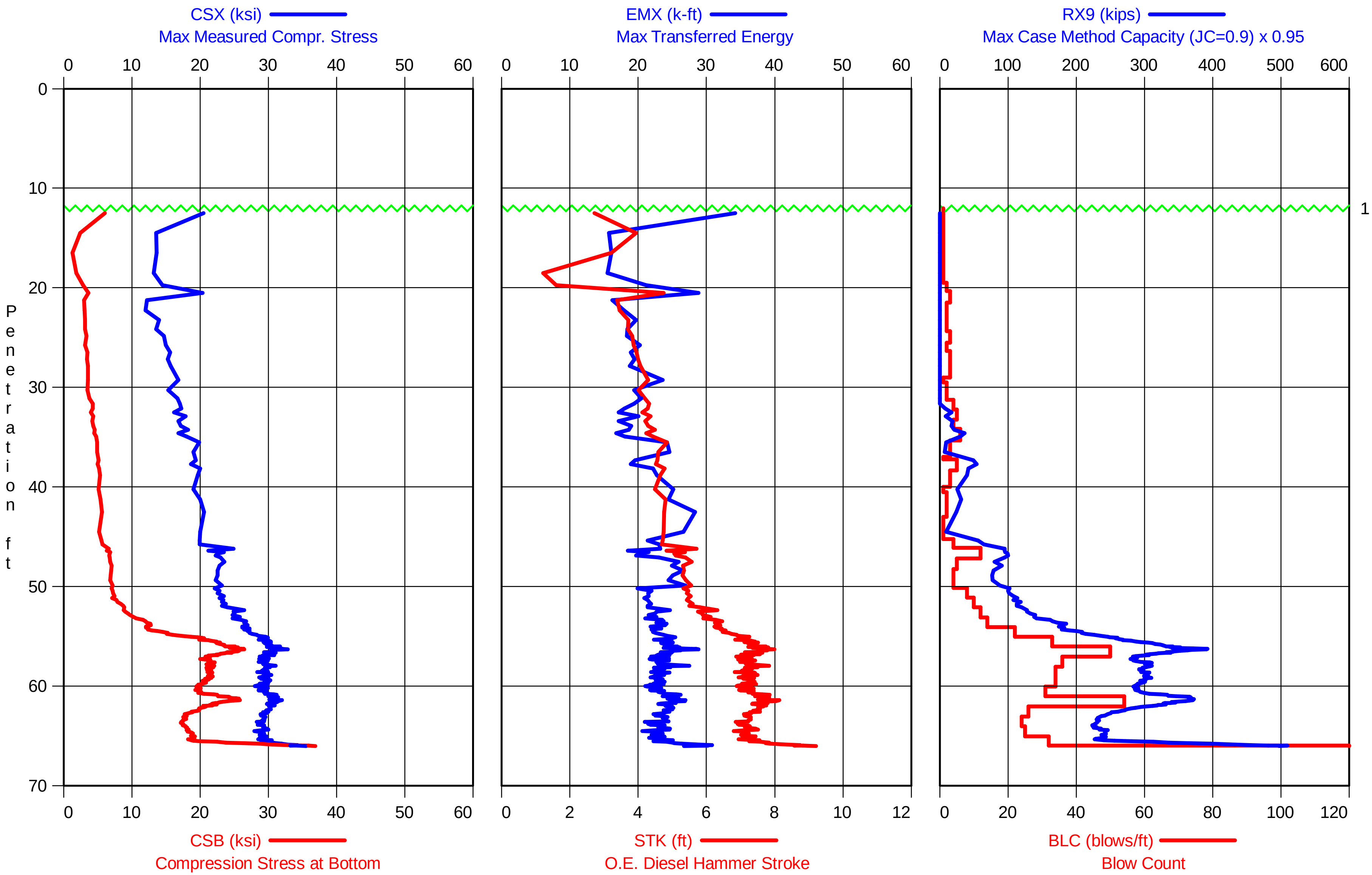
Drive 14 seconds 7:28:59 AM - 7:29:13 AM (9/11/2014) BN 1 - 10

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

PDIPLOT Ver. 2014.1 - Printed: 12-Sep-2014

Test date: 10-Sep-2014

STH 96 over Fox River - Pier 9 #32
APE D25-42, HP 12 x 53



1 - Excavated ground reference at El. 596.5

STH 96 over Fox River - Pier 9 #32 APE D25-42, HP 12 x 53
OP: MR Test date: 10-Sep-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.42 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
EMX: Max Transferred Energy
STK: O.E. Diesel Hammer Stroke
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9) x 0.95

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	EMX k-ft	STK ft	BPM **	RX9 kips
1	12.00	1	AV1	19.6	4.9	33	**	**	0
			MAX	19.6	4.9	33	**	**	0
			MIN	19.6	4.9	33	**	**	0
2	13.00	1	AV1	21.3	7.1	35	5.4	50.3	0
			MAX	21.3	7.1	35	5.4	50.3	0
			MIN	21.3	7.1	35	5.4	50.3	0
3	14.00	1	AV1	14.0	3.8	19	4.1	57.2	0
			MAX	14.0	3.8	19	4.1	57.2	0
			MIN	14.0	3.8	19	4.1	57.2	0
4	15.00	1	AV1	13.0	1.1	13	3.7	59.8	0
			MAX	13.0	1.1	13	3.7	59.8	0
			MIN	13.0	1.1	13	3.7	59.8	0
5	16.00	1	AV1	17.2	1.3	18	3.6	61.1	0
			MAX	17.2	1.3	18	3.6	61.1	0
			MIN	17.2	1.3	18	3.6	61.1	0
6	17.00	1	AV1	9.9	1.3	14	2.8	67.9	0
			MAX	9.9	1.3	14	2.8	67.9	0
			MIN	9.9	1.3	14	2.8	67.9	0
7	18.00	1	AV1	6.1	0.8	8	2.4	72.8	0
			MAX	6.1	0.8	8	2.4	72.8	0
			MIN	6.1	0.8	8	2.4	72.8	0
8	19.00	1	AV1	20.2	2.9	23	**	**	0
			MAX	20.2	2.9	23	**	**	0
			MIN	20.2	2.9	23	**	**	0
10	20.00	2	AV2	14.5	2.8	21	3.2	64.3	0
			STD	5.0	0.7	15	0.0	0.0	0
			MAX	19.5	3.6	36	3.2	64.3	0
			MIN	9.5	2.1	6	3.2	64.3	0
13	21.00	3	AV3	17.9	3.4	25	4.3	56.8	0
			STD	4.3	0.2	7	0.9	5.2	0
			MAX	23.4	3.7	34	5.5	62.4	0
			MIN	12.9	3.1	17	3.4	49.9	0
15	22.00	2	AV2	11.6	2.9	16	3.4	62.7	0
			STD	0.1	0.1	1	0.0	0.2	0
			MAX	11.7	3.0	17	3.4	62.9	0
			MIN	11.5	2.8	16	3.4	62.5	0
17	23.00	2	AV2	13.0	3.1	20	3.6	61.2	0
			STD	0.8	0.0	1	0.1	0.5	0
			MAX	13.8	3.2	20	3.6	61.7	0
			MIN	12.2	3.1	19	3.5	60.6	0
19	24.00	2	AV2	14.1	3.1	19	3.7	59.8	0
			STD	0.2	0.0	1	0.0	0.4	0
			MAX	14.2	3.1	19	3.8	60.2	0
			MIN	13.9	3.0	18	3.7	59.5	0
22	25.00	3	AV3	14.2	3.3	18	3.8	59.5	0
			STD	0.7	0.2	0	0.1	0.5	0
			MAX	14.7	3.5	19	3.9	60.2	0
			MIN	13.2	3.1	18	3.7	59.0	0
24	26.00	2	AV2	14.9	3.1	20	3.9	59.0	0
			STD	0.1	0.0	0	0.1	0.6	0
			MAX	15.1	3.2	20	3.9	59.6	0
			MIN	14.8	3.1	20	3.8	58.4	0

STH 96 over Fox River - Pier 9 #32
OP: MR
APE D25-42, HP 12 x 53
Test date: 10-Sep-2014

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
27	27.00	3	AV3	15.1	3.4	19	3.9	58.7	0
			STD	0.8	0.1	0	0.1	0.5	0
			MAX	16.0	3.6	19	4.0	59.3	0
			MIN	14.1	3.2	18	3.8	58.1	0
30	28.00	3	AV3	15.9	3.5	19	4.1	57.4	0
			STD	0.4	0.1	1	0.0	0.3	0
			MAX	16.4	3.6	21	4.2	57.7	0
			MIN	15.5	3.5	18	4.0	57.0	0
31	29.00	1	AV1	15.9	3.2	24	4.1	57.4	0
			MAX	15.9	3.2	24	4.1	57.4	0
			MIN	15.9	3.2	24	4.1	57.4	0
33	30.00	2	AV2	17.1	3.8	21	4.3	56.1	0
			STD	0.7	0.0	1	0.2	1.1	0
			MAX	17.7	3.9	23	4.5	57.2	0
			MIN	16.4	3.8	20	4.1	55.0	0
35	31.00	2	AV2	15.6	3.5	20	4.1	57.6	0
			STD	1.4	0.3	2	0.2	1.2	0
			MAX	17.0	3.8	22	4.3	58.8	0
			MIN	14.2	3.2	19	3.9	56.4	0
39	32.00	4	AV4	17.1	4.2	19	4.3	56.0	0
			STD	0.7	0.3	0	0.1	0.7	0
			MAX	18.2	4.6	20	4.5	57.1	0
			MIN	16.4	3.7	19	4.1	55.1	0
44	33.00	5	AV5	16.9	4.1	18	4.2	56.7	14
			STD	1.0	0.2	2	0.2	1.0	5
			MAX	18.6	4.3	21	4.5	57.5	17
			MIN	15.9	3.9	16	4.1	54.9	5
48	34.00	4	AV4	17.0	4.3	18	4.3	56.4	18
			STD	0.7	0.1	1	0.1	0.8	7
			MAX	17.9	4.5	20	4.4	57.4	26
			MIN	16.2	4.2	16	4.1	55.3	10
54	35.00	6	AV6	17.7	4.6	18	4.4	55.6	29
			STD	0.7	0.1	1	0.1	0.7	10
			MAX	18.3	4.7	19	4.5	56.7	47
			MIN	16.4	4.5	17	4.2	54.9	21
57	36.00	3	AV3	19.8	5.0	24	4.8	53.4	11
			STD	0.4	0.1	1	0.1	0.6	7
			MAX	20.3	5.2	25	4.9	53.9	18
			MIN	19.4	4.9	23	4.7	52.6	1
58	37.00	1	AV1	18.4	4.7	26	4.5	55.0	0
			MAX	18.4	4.7	26	4.5	55.0	0
			MIN	18.4	4.7	26	4.5	55.0	0
63	38.00	5	AV5	19.1	5.0	19	4.6	54.5	53
			STD	0.5	0.0	1	0.1	0.4	4
			MAX	19.9	5.1	20	4.7	54.9	58
			MIN	18.6	5.0	18	4.5	53.9	45
66	39.00	3	AV3	19.9	5.3	23	4.7	53.7	36
			STD	0.4	0.1	1	0.1	0.5	7
			MAX	20.4	5.4	24	4.9	54.3	40
			MIN	19.3	5.1	22	4.6	53.0	26
67	40.00	1	AV1	19.0	5.1	27	4.5	55.2	11
			MAX	19.0	5.1	27	4.5	55.2	11
			MIN	19.0	5.1	27	4.5	55.2	11
69	41.00	2	AV2	19.1	5.1	23	4.6	54.3	37
			STD	0.2	0.0	0	0.1	0.5	4
			MAX	19.4	5.1	24	4.7	54.8	40
			MIN	18.9	5.1	23	4.5	53.8	33

STH 96 over Fox River - Pier 9 #32 APE D25-42, HP 12 x 53
OP: MR Test date: 10-Sep-2014

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
71	42.00	2	AV2	20.9	5.7	26	4.9	52.9	32
			STD	0.3	0.0	0	0.0	0.1	2
			MAX	21.2	5.7	27	4.9	53.0	34
			MIN	20.6	5.7	26	4.9	52.8	29
72	43.00	1	AV1	19.9	5.5	30	4.7	54.0	15
			MAX	19.9	5.5	30	4.7	54.0	15
			MIN	19.9	5.5	30	4.7	54.0	15
73	44.00	1	AV1	20.3	4.9	25	4.8	53.1	1
			MAX	20.3	4.9	25	4.8	53.1	1
			MIN	20.3	4.9	25	4.8	53.1	1
74	45.00	1	AV1	19.6	5.5	29	4.6	54.1	19
			MAX	19.6	5.5	29	4.6	54.1	19
			MIN	19.6	5.5	29	4.6	54.1	19
78	46.00	4	AV3	19.9	5.6	22	4.7	53.8	59
			STD	0.2	0.1	1	0.0	0.1	4
			MAX	20.1	5.7	23	4.7	53.9	65
			MIN	19.8	5.4	21	4.7	53.7	55
90	47.00	12	AV11	22.8	6.6	21	5.2	51.3	97
			STD	1.4	0.2	2	0.4	1.6	6
			MAX	26.6	6.9	27	6.2	53.5	106
			MIN	20.8	6.3	18	4.8	47.1	84
95	48.00	5	AV5	23.2	6.9	25	5.5	50.1	89
			STD	0.8	0.2	1	0.2	0.9	12
			MAX	24.0	7.0	26	5.6	51.8	102
			MIN	21.7	6.6	25	5.1	49.4	71
99	49.00	4	AV4	22.6	6.9	26	5.3	50.8	78
			STD	0.5	0.2	1	0.1	0.4	4
			MAX	23.1	7.1	27	5.4	51.2	84
			MIN	22.0	6.6	24	5.2	50.2	74
103	50.00	4	AV4	22.7	7.0	26	5.5	50.1	83
			STD	0.8	0.3	2	0.1	0.6	7
			MAX	23.3	7.2	27	5.6	51.1	93
			MIN	21.4	6.5	23	5.2	49.7	72
111	51.00	8	AV8	22.7	7.2	21	5.4	50.2	103
			STD	0.8	0.2	1	0.2	0.7	3
			MAX	23.5	7.6	22	5.6	51.6	109
			MIN	21.2	7.0	20	5.1	49.5	98
121	52.00	10	AV10	23.2	7.9	21	5.5	50.0	113
			STD	0.5	0.6	1	0.1	0.4	5
			MAX	23.9	8.8	22	5.6	50.6	125
			MIN	22.3	6.9	20	5.4	49.4	104
133	53.00	12	AV10	25.2	9.3	23	6.0	48.2	131
			STD	1.1	0.5	1	0.3	1.2	8
			MAX	28.0	10.4	26	6.9	49.3	146
			MIN	24.0	8.7	21	5.7	44.9	120
147	54.00	14	AV14	26.2	11.9	23	6.3	47.0	166
			STD	0.8	0.8	1	0.2	0.7	15
			MAX	27.6	13.0	24	6.6	48.9	191
			MIN	24.2	10.1	21	5.8	45.9	140
169	55.00	22	AV22	27.3	14.2	23	6.6	45.8	204
			STD	0.9	1.9	1	0.2	0.8	21
			MAX	29.3	18.2	25	7.1	47.4	245
			MIN	25.8	11.9	20	6.1	44.3	172
202	56.00	33	AV33	29.8	21.8	24	7.3	43.8	291
			STD	0.7	1.5	1	0.2	0.7	28
			MAX	31.1	24.2	26	7.8	45.2	332
			MIN	28.3	19.0	22	6.8	42.4	248

STH 96 over Fox River - Pier 9 #32 APE D25-42, HP 12 x 53
OP: MR Test date: 10-Sep-2014

BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
252	57.00	50	AV50	30.6	24.3	25	7.5	43.2	339
			STD	1.0	1.6	2	0.3	0.8	29
			MAX	33.3	26.9	29	8.1	45.1	396
			MIN	28.2	20.4	22	6.8	41.5	285
288	58.00	36	AV34	29.5	21.3	23	7.2	43.9	295
			STD	0.8	0.6	2	0.3	0.8	11
			MAX	32.1	22.5	29	8.3	45.5	315
			MIN	28.1	19.9	21	6.7	41.0	275
322	59.00	34	AV34	29.6	21.4	23	7.3	43.8	300
			STD	0.7	0.4	1	0.2	0.7	5
			MAX	30.9	22.2	25	7.6	45.2	307
			MIN	28.2	20.5	22	6.8	42.7	286
356	60.00	34	AV34	29.3	20.7	23	7.2	44.0	297
			STD	0.9	0.7	1	0.2	0.7	7
			MAX	30.9	21.9	26	7.7	45.2	311
			MIN	27.8	19.4	21	6.8	42.6	285
387	61.00	31	AV31	29.6	20.4	23	7.3	43.6	301
			STD	0.9	1.2	1	0.3	0.8	18
			MAX	31.3	23.0	27	7.9	45.1	340
			MIN	28.0	19.1	21	6.8	42.0	284
441	62.00	54	AV54	30.7	23.4	25	7.7	42.6	349
			STD	0.7	1.5	1	0.3	0.7	20
			MAX	32.7	26.2	28	8.4	43.9	373
			MIN	29.1	20.2	23	7.2	40.9	307
467	63.00	26	AV26	29.6	19.1	24	7.4	43.4	265
			STD	0.7	1.0	1	0.2	0.6	18
			MAX	31.1	20.8	26	7.8	44.7	299
			MIN	28.3	17.7	22	6.9	42.3	237
491	64.00	24	AV24	29.1	17.5	23	7.2	44.1	230
			STD	0.5	0.4	1	0.2	0.6	4
			MAX	30.2	18.2	25	7.5	45.6	236
			MIN	27.5	16.7	20	6.7	43.2	221
516	65.00	25	AV25	29.2	18.4	23	7.2	44.0	238
			STD	0.7	0.5	1	0.2	0.7	7
			MAX	30.2	19.7	25	7.6	45.4	251
			MIN	27.3	17.7	20	6.7	42.8	224
547	65.96	32	AV28	30.4	22.6	25	7.6	42.9	304
			STD	1.6	4.8	2	0.5	1.3	77
			MAX	34.3	33.3	31	8.8	44.8	460
			MIN	28.4	18.1	21	6.9	39.8	226
552	66.00	120	AV5	34.1	35.6	29	8.8	39.9	496
			STD	1.4	1.4	2	0.4	1.0	13
			MAX	35.5	36.9	31	9.2	41.6	513
			MIN	31.6	32.9	26	8.1	39.0	476
			Average	27.3	17.2	23	6.7	46.1	235
			Std. Dev.	4.9	7.4	3	1.2	5.0	117
			Maximum	35.5	36.9	36	9.2	72.8	513
			Minimum	6.1	0.8	6	2.4	39.0	0

Total number of blows analyzed: 543

BL#	depth (ft)	Comments
1	12.00	Excavated ground reference at El. 596.5

Time Summary

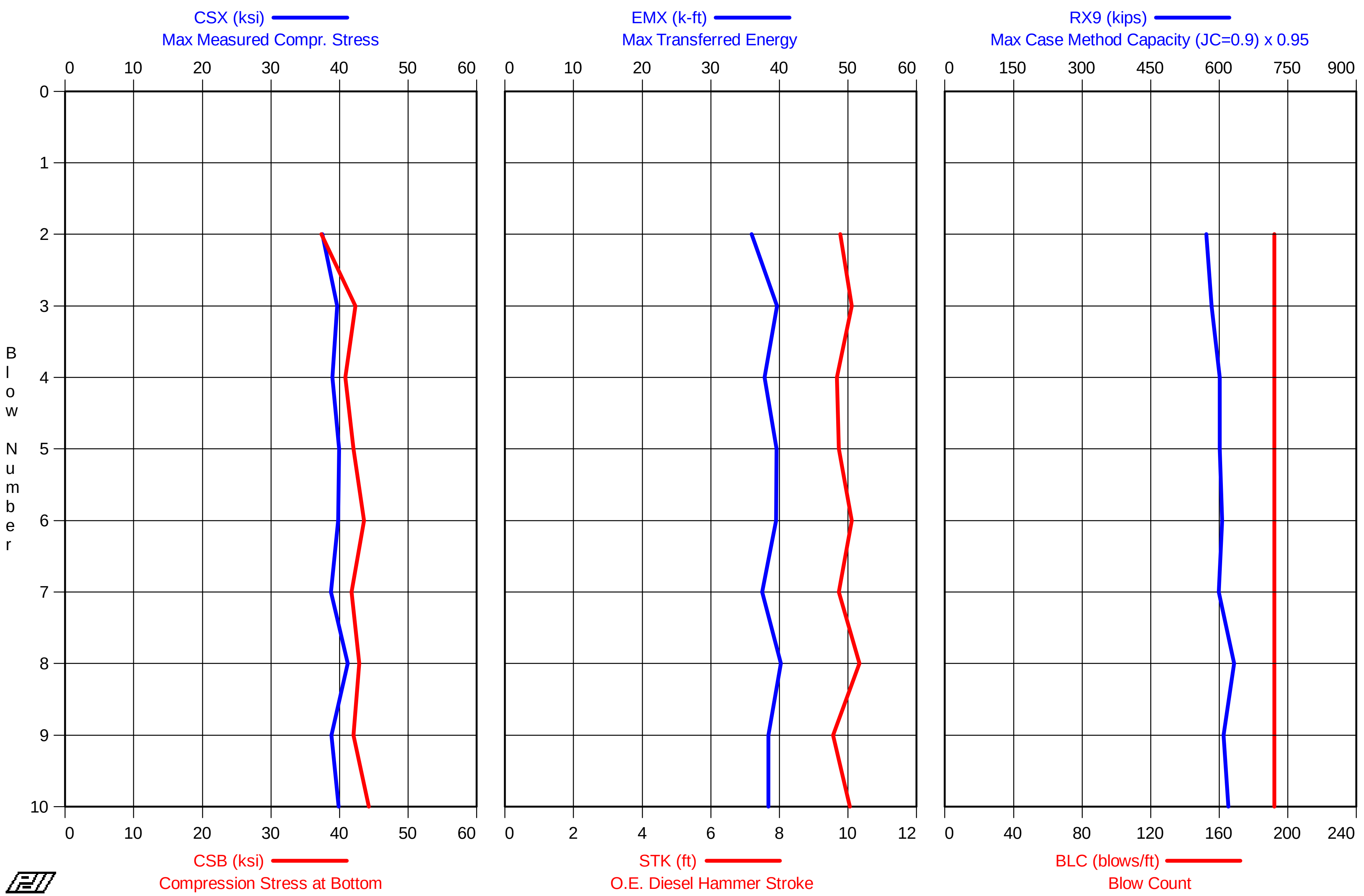
Drive 30 minutes 1 second 5:03:17 PM - 5:33:18 PM (9/10/2014) BN 1 - 552

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

PDIPLOT Ver. 2014.1 - Printed: 12-Sep-2014

Test date: 11-Sep-2014

STH 96 over Fox River - Pier 9 #32 Restrike
APE D25-42, HP 12 x 53



STH 96 over Fox River - Pier 9 #32 Restrike
OP: MR

APE D25-42, HP 12 x 53
Test date: 11-Sep-2014

AR: 15.50 in^2
LE: 72.42 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

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

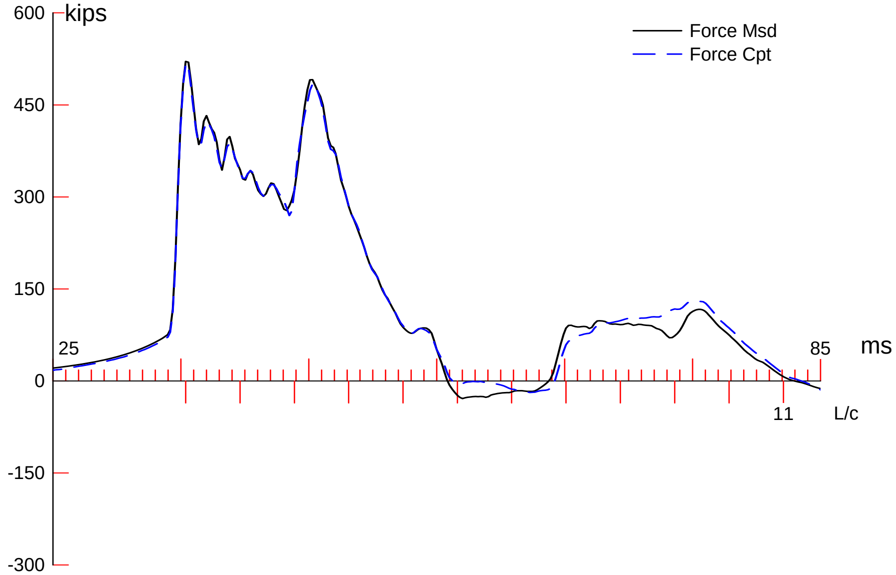
STK: O.E. Diesel Hammer Stroke
BPM: Blows per Minute
RX9: Max Case Method Capacity (JC=0.9) x 0.95

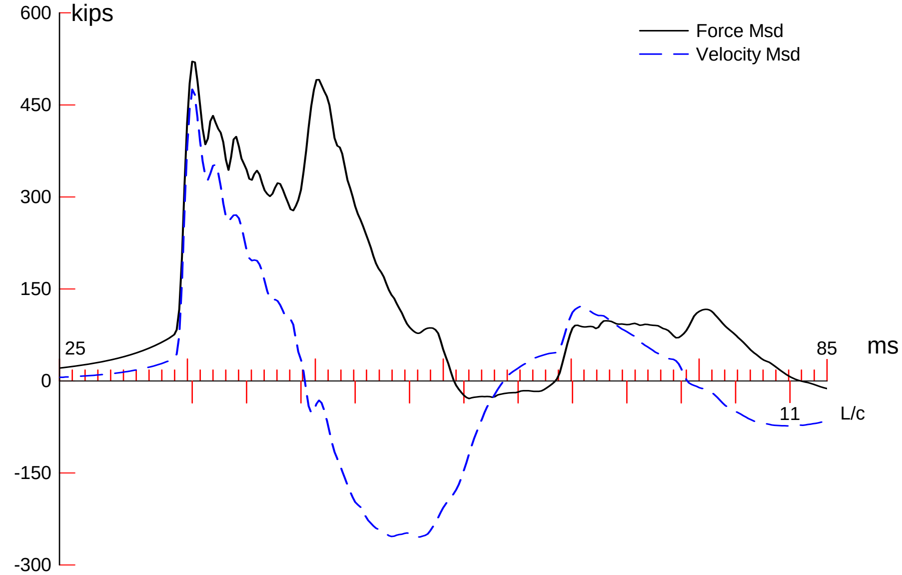
BL#	depth	BLC	TYPE	CSX	CSB	EMX	STK	BPM	RX9
end	ft	bl/ft		ksi	ksi	k-ft	ft	**	kips
10	66.05	192	AV9	39.4	41.9	39	9.9	37.7	603
			STD	1.0	1.9	1	0.2	0.4	17
			MAX	41.2	44.3	40	10.3	38.3	633
			MIN	37.5	37.4	36	9.6	36.9	571
			Average	39.4	41.9	39	9.9	37.7	603
			Std. Dev.	1.0	1.9	1	0.2	0.4	17
			Maximum	41.2	44.3	40	10.3	38.3	633
			Minimum	37.5	37.4	36	9.6	36.9	571

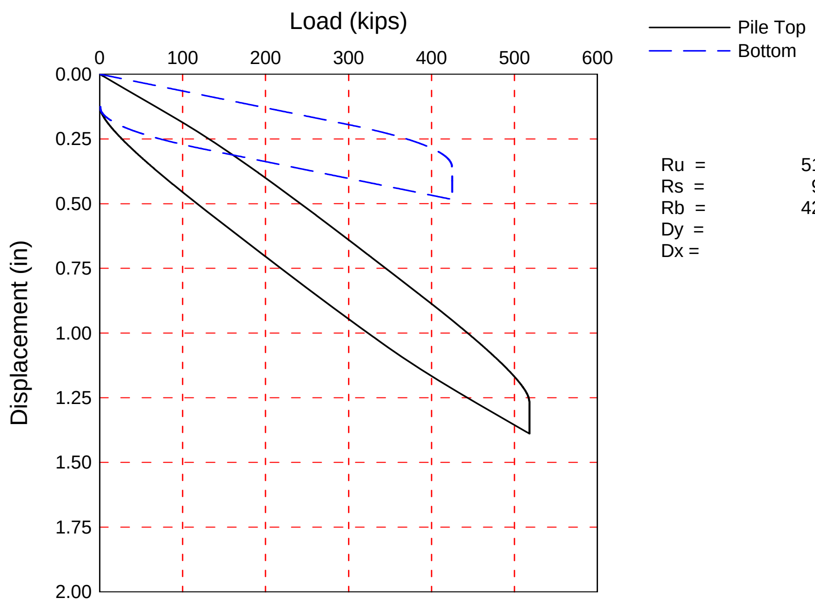
Total number of blows analyzed: 9

Time Summary

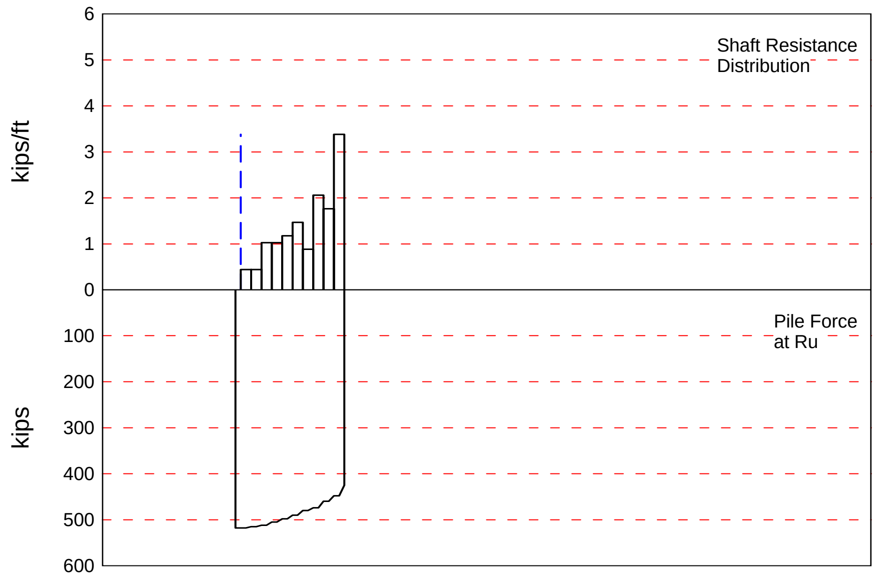
Drive 14 seconds 7:16:30 AM - 7:16:44 AM (9/11/2014) BN 1 - 10







Ru = 518.0 kips
Rs = 93.0 kips
Rb = 425.0 kips
Dy = 1.26 in
Dx = 1.39 in



CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 518.0; along Shaft 93.0; at Toe 425.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				518.0				
1	10.2	5.3	3.0	515.0	3.0	0.56	0.14	0.160
2	17.0	12.1	3.0	512.0	6.0	0.44	0.11	0.160
3	23.8	18.9	7.0	505.0	13.0	1.03	0.26	0.160
4	30.6	25.7	7.0	498.0	20.0	1.03	0.26	0.160
5	37.4	32.5	8.0	490.0	28.0	1.18	0.30	0.160
6	44.2	39.3	10.0	480.0	38.0	1.47	0.37	0.160
7	51.0	46.1	6.0	474.0	44.0	0.88	0.22	0.160
8	57.8	52.9	14.0	460.0	58.0	2.06	0.52	0.160
9	64.6	59.7	12.0	448.0	70.0	1.77	0.44	0.160
10	71.4	66.5	23.0	425.0	93.0	3.38	0.85	0.160
Avg. Shaft			9.3			1.40	0.35	0.160
Toe			425.0				431.32	0.155

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.150	0.276
Case Damping Factor		0.538	2.381
Damping Type			Smith
Unloading Quake	(% of loading quake)	73	83
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.010
Soil Plug Weight	(kips)		0.09

CAPWAP match quality = 3.46 (Wave Up Match) ; RSA = 0
Observed: final set = 0.125 in; blow count = 96 b/ft
Computed: final set = 0.086 in; blow count = 140 b/ft

max. Top Comp. Stress = 33.5 ksi (T= 35.8 ms, max= 1.028 x Top)
max. Comp. Stress = 34.4 ksi (Z= 71.4 ft, T= 41.7 ms)
max. Tens. Stress = -5.04 ksi (Z= 44.2 ft, T= 59.2 ms)
max. Energy (EMX) = 31.6 kip-ft; max. Measured Top Displ. (DMX)= 1.07 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	519.0	-32.9	33.5	-2.12	31.63	17.2	1.076
2	6.8	522.0	-36.2	33.7	-2.33	31.16	17.1	1.044
3	10.2	524.7	-39.5	33.8	-2.55	30.64	17.0	1.011
4	13.6	516.8	-42.7	33.3	-2.75	29.44	16.9	0.976
5	17.0	520.9	-51.6	33.6	-3.33	28.80	16.7	0.939
6	20.4	515.8	-56.9	33.3	-3.67	27.51	16.4	0.900
7	23.8	521.6	-65.5	33.6	-4.22	26.82	16.2	0.862
8	27.2	503.1	-63.2	32.4	-4.08	24.94	16.0	0.824
9	30.6	509.5	-71.4	32.9	-4.60	24.19	15.7	0.785
10	34.0	492.1	-69.3	31.7	-4.47	22.31	15.5	0.744
11	37.4	499.8	-76.4	32.2	-4.92	21.48	15.2	0.701
12	40.8	493.9	-72.5	31.9	-4.68	19.50	14.9	0.658
13	44.2	498.6	-78.2	32.2	-5.04	18.64	14.6	0.615
14	47.6	504.5	-69.2	32.5	-4.46	16.63	14.4	0.573
15	51.0	516.3	-73.2	33.3	-4.72	15.72	14.1	0.529
16	54.4	525.7	-68.3	33.9	-4.40	14.25	13.8	0.486
17	57.8	531.7	-71.8	34.3	-4.63	13.38	13.4	0.443
18	61.2	517.0	-60.3	33.3	-3.89	11.50	13.1	0.402
19	64.6	527.4	-65.8	34.0	-4.25	10.63	13.2	0.358
20	68.0	527.0	-56.9	34.0	-3.67	9.12	13.3	0.317
21	71.4	533.5	-59.7	34.4	-3.85	7.97	11.5	0.276
Absolute	71.4			34.4			(T =	41.7 ms)
	44.2				-5.04		(T =	59.2 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	651.8	615.2	578.6	542.0	505.4	468.8	432.2	395.6	359.0	322.5
RX	660.5	638.9	625.3	611.7	598.1	585.0	574.3	564.3	554.3	544.2
RU	651.8	615.2	578.6	542.0	505.4	468.8	432.2	395.6	359.0	322.5

RAU = 339.6 (kips); RA2 = 613.6 (kips)

Current CAPWAP Ru = 518.0 (kips); Corresponding J(RP)= 0.37; matches RX9 within 5%

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
17.57	35.59	486.1	531.5	531.5	1.068	0.121	0.125	32.1	646.6

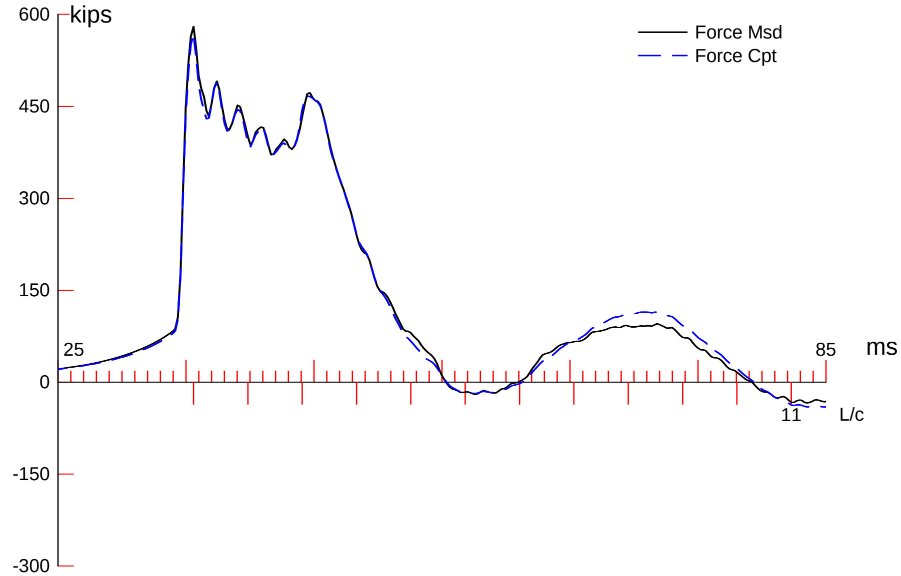
PILE PROFILE AND PILE MODEL

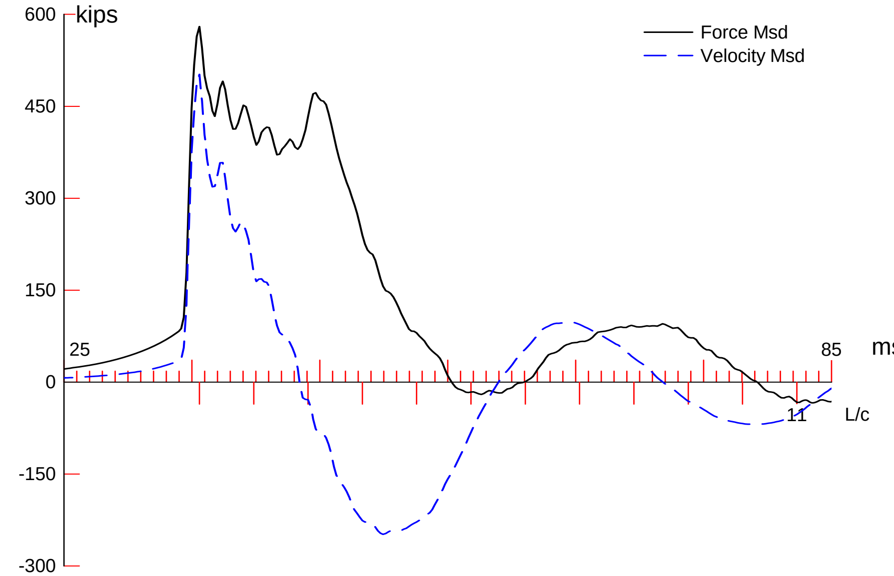
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	15.50	29992.2	492.000	3.971
71.37	15.50	29992.2	492.000	3.971

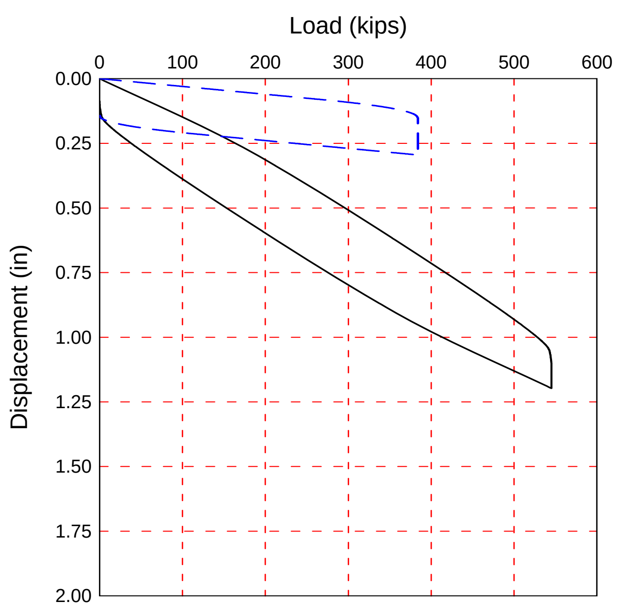
Toe Area 0.985 ft^2

Top Segment Length 3.40 ft, Top Impedance 27.67 kips/ft/s

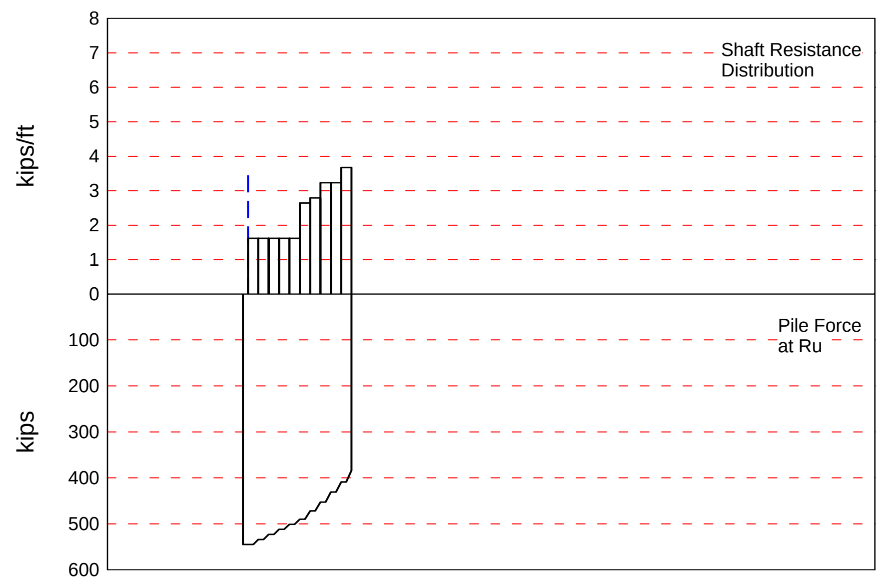
Pile Damping 1.0 %, Time Incr 0.202 ms, Wave Speed 16807.9 ft/s, 2L/c 8.5 ms







Ru = 545.0 kips
Rs = 161.0 kips
Rb = 384.0 kips
Dy = 1.11 in
Dx = 1.20 in



CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 545.0; along Shaft 161.0; at Toe 384.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				545.0				
1	10.2	5.3	11.0	534.0	11.0	2.06	0.52	0.160
2	17.0	12.1	11.0	523.0	22.0	1.62	0.41	0.160
3	23.8	18.9	11.0	512.0	33.0	1.62	0.41	0.160
4	30.6	25.7	11.0	501.0	44.0	1.62	0.41	0.160
5	37.4	32.5	11.0	490.0	55.0	1.62	0.41	0.160
6	44.2	39.3	18.0	472.0	73.0	2.65	0.67	0.160
7	51.0	46.1	19.0	453.0	92.0	2.80	0.70	0.160
8	57.8	52.9	22.0	431.0	114.0	3.24	0.82	0.160
9	64.6	59.7	22.0	409.0	136.0	3.24	0.82	0.160
10	71.4	66.5	25.0	384.0	161.0	3.68	0.93	0.160
Avg. Shaft			16.1			2.42	0.61	0.160
Toe			384.0				389.71	0.095

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.160	0.116
Case Damping Factor		0.931	1.319
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	89	
Soil Plug Weight	(kips)		0.01

CAPWAP match quality = 2.38 (Wave Up Match) ; RSA = 0
Observed: final set = 0.088 in; blow count = 137 b/ft
Computed: final set = 0.065 in; blow count = 183 b/ft

max. Top Comp. Stress = 37.1 ksi (T= 36.0 ms, max= 1.033 x Top)
max. Comp. Stress = 38.4 ksi (Z= 10.2 ft, T= 36.4 ms)
max. Tens. Stress = -3.29 ksi (Z= 10.2 ft, T= 84.3 ms)
max. Energy (EMX) = 34.2 kip-ft; max. Measured Top Displ. (DMX)= 1.00 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	575.7	-44.1	37.1	-2.84	34.18	18.3	0.995
2	6.8	584.9	-47.7	37.7	-3.08	33.51	18.0	0.957
3	10.2	594.8	-51.0	38.4	-3.29	32.76	17.6	0.918
4	13.6	562.2	-44.3	36.3	-2.86	29.96	17.2	0.878
5	17.0	572.1	-47.7	36.9	-3.08	29.22	16.9	0.839
6	20.4	540.4	-41.3	34.9	-2.66	26.69	16.6	0.800
7	23.8	550.4	-46.1	35.5	-2.98	25.88	16.2	0.758
8	27.2	519.8	-39.7	33.5	-2.56	23.37	15.9	0.716
9	30.6	529.8	-45.6	34.2	-2.94	22.41	15.5	0.670
10	34.0	516.2	-39.7	33.3	-2.56	20.05	15.2	0.625
11	37.4	514.6	-45.1	33.2	-2.91	19.14	14.7	0.581
12	40.8	511.3	-38.8	33.0	-2.51	17.09	14.2	0.538
13	44.2	532.1	-43.6	34.3	-2.82	16.15	13.7	0.493
14	47.6	526.4	-30.1	34.0	-1.94	13.73	13.2	0.450
15	51.0	529.2	-34.1	34.1	-2.20	12.82	12.7	0.406
16	54.4	509.0	-19.8	32.8	-1.28	10.73	12.2	0.364
17	57.8	517.1	-22.8	33.4	-1.47	9.92	11.7	0.322
18	61.2	506.5	-9.6	32.7	-0.62	8.16	11.2	0.283
19	64.6	515.0	-11.6	33.2	-0.75	7.45	10.3	0.244
20	68.0	488.7	-6.7	31.5	-0.43	6.16	8.7	0.208
21	71.4	493.2	-6.9	31.8	-0.45	5.52	6.9	0.171
Absolute	10.2			38.4			(T =	36.4 ms)
	10.2				-3.29		(T =	84.3 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	789.7	757.6	725.5	693.5	661.4	629.3	597.3	565.2	533.2	501.1
RX	789.7	759.3	729.0	698.7	668.5	639.3	617.0	599.3	583.2	567.2
RU	816.2	786.8	757.4	728.0	698.6	669.2	639.8	610.4	581.0	551.6

RAU = 97.4 (kips); RA2 = 678.1 (kips)

Current CAPWAP Ru = 545.0 (kips); Corresponding J(RP)= 0.76; matches RX9 within 5%

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
18.77	35.79	519.2	591.1	591.1	0.998	0.084	0.088	34.7	766.6

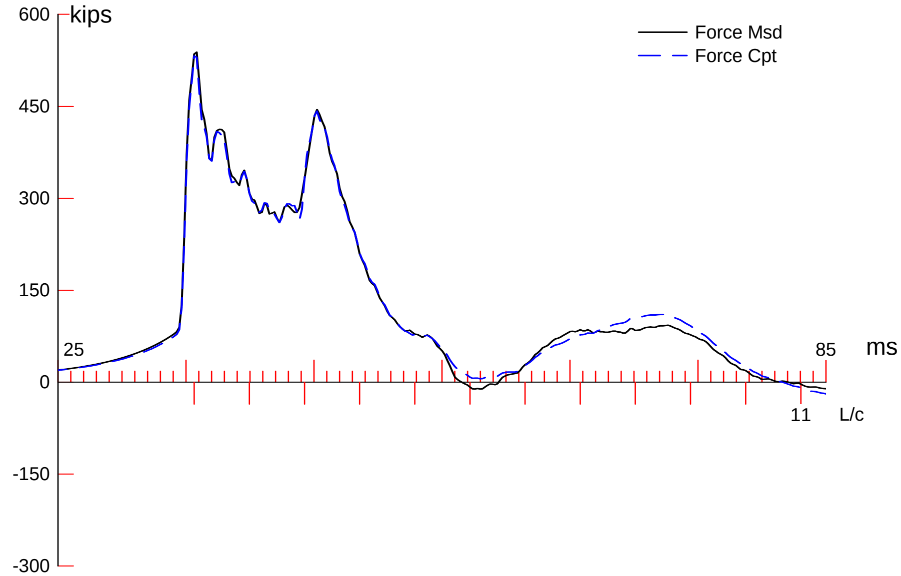
PILE PROFILE AND PILE MODEL

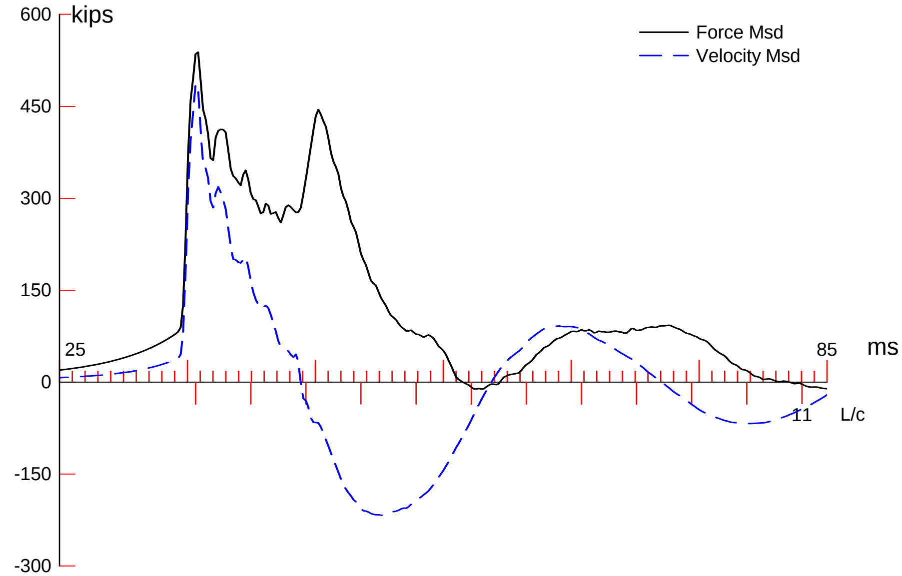
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	15.50	29992.2	492.000	3.971
71.37	15.50	29992.2	492.000	3.971

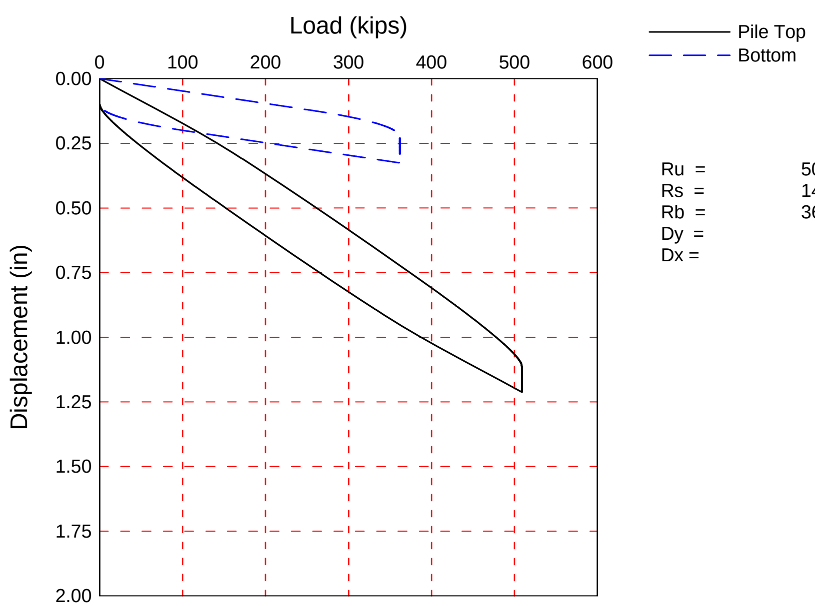
Toe Area 0.985 ft^2

Top Segment Length 3.40 ft, Top Impedance 27.67 kips/ft/s

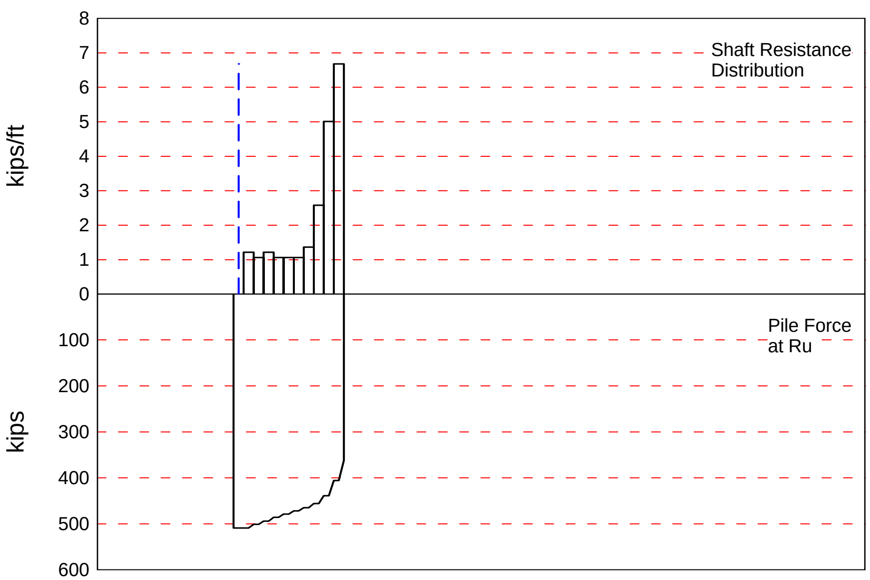
Pile Damping 1.0 %, Time Incr 0.202 ms, Wave Speed 16807.9 ft/s, 2L/c 8.5 ms







Ru = 509.0 kips
Rs = 147.0 kips
Rb = 362.0 kips
Dy = 1.11 in
Dx = 1.21 in



CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 509.0; along Shaft 147.0; at Toe 362.0 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
				509.0				
1	13.2	6.7	8.0	501.0	8.0	1.19	0.30	0.164
2	19.8	13.3	7.0	494.0	15.0	1.06	0.27	0.164
3	26.3	19.9	8.0	486.0	23.0	1.22	0.31	0.164
4	32.9	26.5	7.0	479.0	30.0	1.06	0.27	0.164
5	39.5	33.1	7.0	472.0	37.0	1.06	0.27	0.164
6	46.1	39.7	7.0	465.0	44.0	1.06	0.27	0.164
7	52.7	46.2	9.0	456.0	53.0	1.37	0.34	0.164
8	59.3	52.8	17.0	439.0	70.0	2.58	0.65	0.164
9	65.8	59.4	33.0	406.0	103.0	5.01	1.26	0.164
10	72.4	66.0	44.0	362.0	147.0	6.68	1.68	0.164
Avg. Shaft			14.7			2.23	0.56	0.164
Toe			362.0				367.38	0.123

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.159	0.174
Case Damping Factor		0.871	1.605
Damping Type			Smith
Unloading Quake	(% of loading quake)	100	101
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.005
Soil Plug Weight	(kips)		0.05

```
CAPWAP match quality     =    2.74        (Wave Up Match) ; RSA = 0
Observed: final set      =   0.100 in;    blow count     =     120 b/ft
Computed: final set      =   0.062 in;    blow count     =     195 b/ft

max. Top Comp. Stress    =    34.4 ksi     (T=  36.0 ms, max= 1.036 x Top)
max. Comp. Stress        =    35.6 ksi     (Z=  13.2 ft, T=  36.8 ms)
max. Tens. Stress        =   -1.94 ksi     (Z=  13.2 ft, T=  86.0 ms)
max. Energy (EMX)        =    26.4 kip-ft; max. Measured Top Displ. (DMX)= 0.91 in
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EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	533.4	-23.7	34.4	-1.53	26.40	17.6	0.917
2	6.6	539.3	-25.7	34.8	-1.66	26.04	17.4	0.890
3	9.9	545.5	-27.9	35.2	-1.80	25.66	17.2	0.862
4	13.2	552.5	-30.1	35.6	-1.94	25.24	16.9	0.833
5	16.5	528.5	-25.2	34.1	-1.62	23.58	16.7	0.806
6	19.8	536.0	-27.1	34.6	-1.75	23.17	16.4	0.778
7	23.0	516.6	-24.5	33.3	-1.58	21.66	16.1	0.747
8	26.3	523.8	-29.2	33.8	-1.88	21.15	15.9	0.715
9	29.6	500.8	-25.1	32.3	-1.62	19.55	15.6	0.683
10	32.9	507.9	-29.8	32.8	-1.93	19.05	15.4	0.651
11	36.2	489.0	-26.2	31.5	-1.69	17.63	15.2	0.617
12	39.5	496.3	-29.7	32.0	-1.92	17.01	14.9	0.582
13	42.8	478.2	-25.3	30.8	-1.63	15.53	14.7	0.544
14	46.1	486.8	-28.2	31.4	-1.82	14.74	14.4	0.503
15	49.4	473.1	-23.2	30.5	-1.50	13.38	14.1	0.465
16	52.7	484.2	-24.9	31.2	-1.61	12.65	13.7	0.426
17	56.0	493.6	-17.2	31.8	-1.11	11.22	13.3	0.387
18	59.3	521.5	-19.2	33.6	-1.24	10.42	12.7	0.346
19	62.5	509.0	-3.9	32.8	-0.25	8.71	12.0	0.307
20	65.8	512.9	-5.5	33.1	-0.36	7.90	12.1	0.266
21	69.1	481.6	0.0	31.1	0.00	5.93	11.8	0.229
22	72.4	500.3	0.0	32.3	0.00	4.73	9.7	0.193
Absolute	13.2			35.6			(T =	36.8 ms)
	13.2				-1.94		(T =	86.0 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	709.6	675.4	641.3	607.1	573.0	538.9	504.7	470.6	436.4	402.3
RX	715.0	682.1	649.3	617.4	589.2	575.6	562.1	548.5	535.8	523.7
RU	728.3	696.1	663.8	631.5	599.3	567.0	534.7	502.5	470.2	437.9

RAU = 323.2 (kips); RA2 = 566.7 (kips)

Current CAPWAP Ru = 509.0 (kips); Corresponding J(RP)= 0.59; matches RX9 within 5%

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
18.10	35.84	500.8	550.1	550.1	0.913	0.097	0.100	26.7	632.5

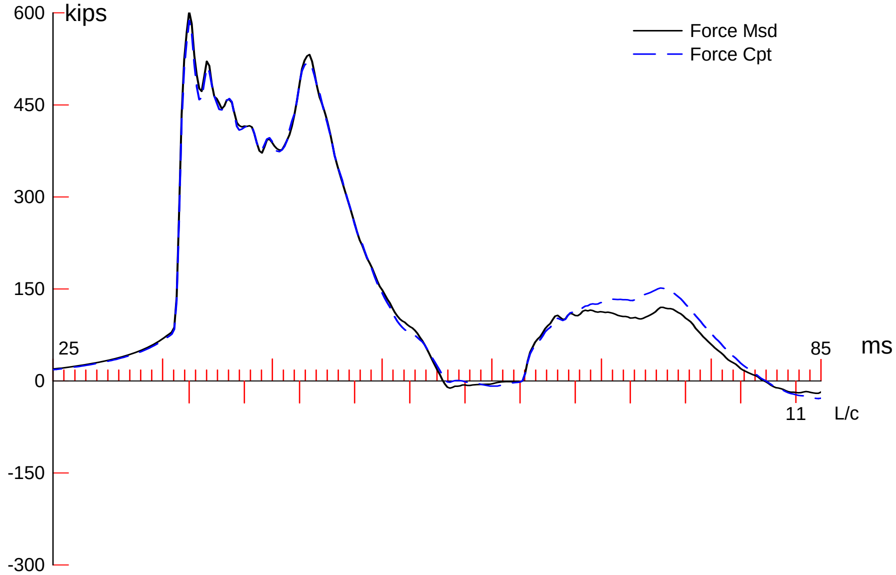
PILE PROFILE AND PILE MODEL

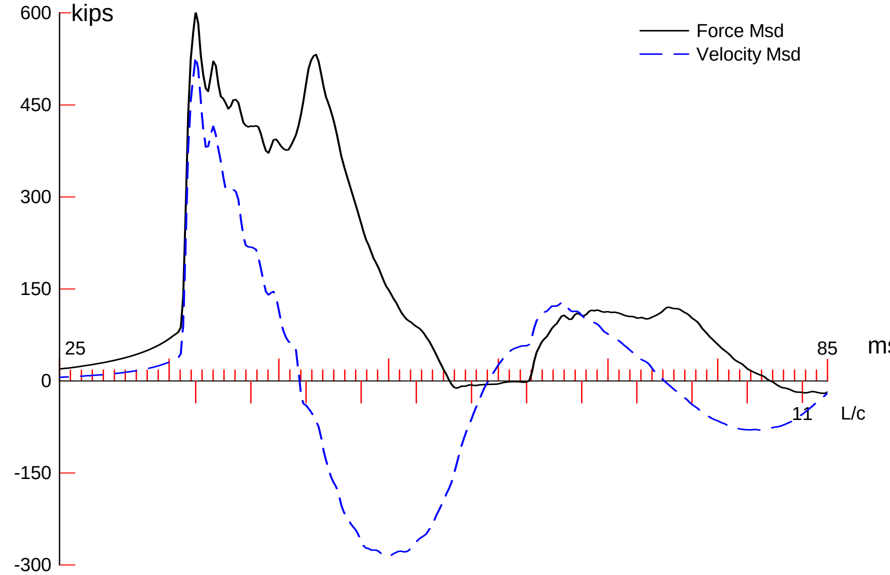
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	15.50	29992.2	492.000	3.971
72.42	15.50	29992.2	492.000	3.971

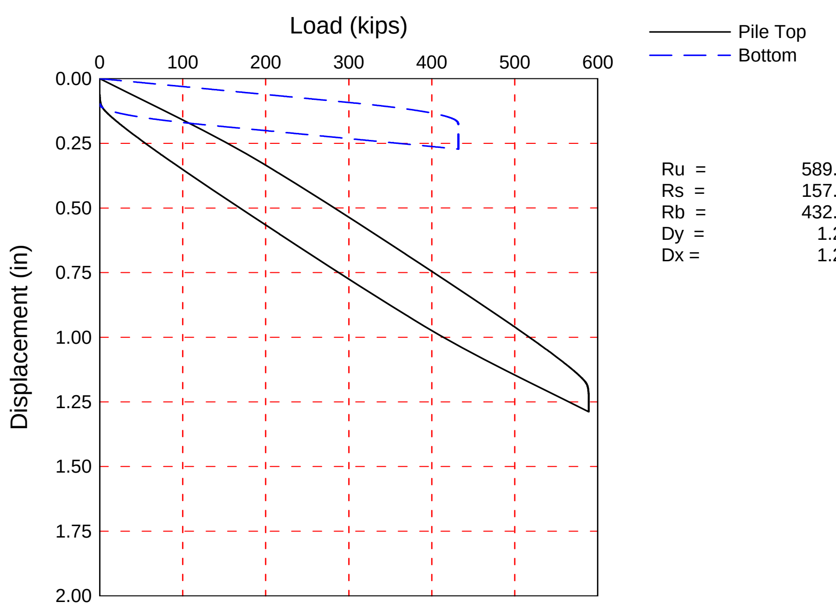
Toe Area 0.985 ft^2

Top Segment Length 3.29 ft, Top Impedance 27.67 kips/ft/s

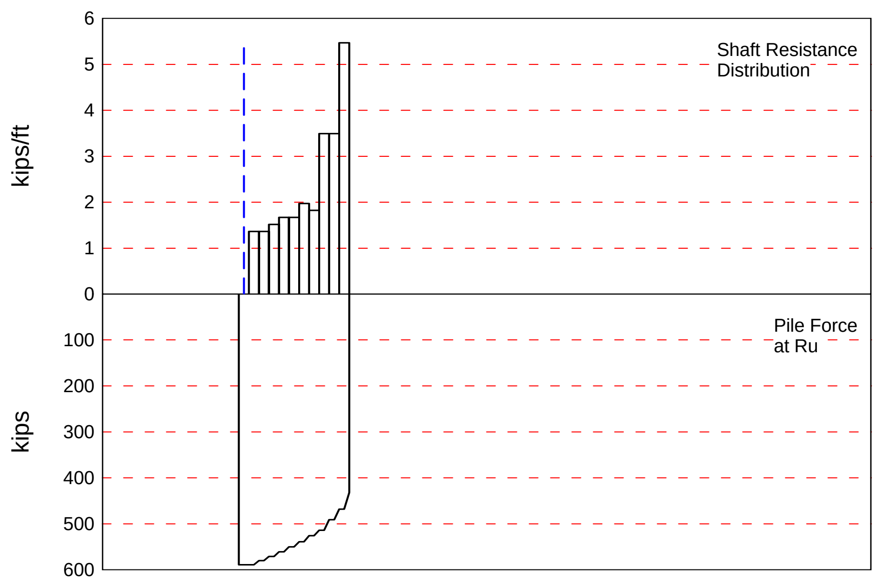
Pile Damping 1.0 %, Time Incr 0.196 ms, Wave Speed 16807.9 ft/s, 2L/c 8.6 ms







Ru = 589.0 kips
Rs = 157.0 kips
Rb = 432.0 kips
Dy = 1.23 in
Dx = 1.29 in



CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 589.0; along Shaft 157.0; at Toe 432.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				589.0				
1	13.2	6.8	9.0	580.0	9.0	1.33	0.34	0.166
2	19.8	13.3	9.0	571.0	18.0	1.37	0.34	0.166
3	26.3	19.9	10.0	561.0	28.0	1.52	0.38	0.166
4	32.9	26.5	11.0	550.0	39.0	1.67	0.42	0.166
5	39.5	33.1	11.0	539.0	50.0	1.67	0.42	0.166
6	46.1	39.7	13.0	526.0	63.0	1.97	0.50	0.166
7	52.7	46.3	12.0	514.0	75.0	1.82	0.46	0.166
8	59.3	52.8	23.0	491.0	98.0	3.49	0.88	0.166
9	65.8	59.4	23.0	468.0	121.0	3.49	0.88	0.166
10	72.4	66.0	36.0	432.0	157.0	5.47	1.38	0.166
Avg. Shaft			15.7			2.38	0.60	0.166
Toe			432.0				438.42	0.109

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.162	0.133
Case Damping Factor		0.942	1.698
Unloading Quake	(% of loading quake)	100	52
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	44	
Resistance Gap (included in Toe Quake) (in)			0.003

CAPWAP match quality = 2.70 (Wave Up Match) ; RSA = 0
Observed: final set = 0.063 in; blow count = 192 b/ft
Computed: final set = 0.023 in; blow count = 515 b/ft

max. Top Comp. Stress = 38.0 ksi (T= 36.0 ms, max= 1.039 x Top)
max. Comp. Stress = 39.5 ksi (Z= 13.2 ft, T= 36.6 ms)
max. Tens. Stress = -5.73 ksi (Z= 39.5 ft, T= 58.2 ms)
max. Energy (EMX) = 38.9 kip-ft; max. Measured Top Displ. (DMX)= 1.10 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	589.3	-32.9	38.0	-2.12	38.93	19.6	1.092
2	6.6	595.1	-36.5	38.4	-2.35	38.20	19.4	1.053
3	9.9	603.7	-42.0	38.9	-2.71	37.49	19.0	1.015
4	13.2	612.1	-54.8	39.5	-3.53	36.73	18.7	0.976
5	16.5	583.8	-57.1	37.7	-3.68	33.95	18.4	0.935
6	19.8	592.7	-68.2	38.2	-4.40	33.02	18.0	0.891
7	23.0	566.0	-69.9	36.5	-4.51	30.34	17.7	0.848
8	26.3	575.7	-79.8	37.1	-5.15	29.47	17.3	0.805
9	29.6	546.8	-80.8	35.3	-5.21	26.82	16.9	0.762
10	32.9	556.8	-88.7	35.9	-5.72	25.80	16.6	0.716
11	36.2	546.0	-86.1	35.2	-5.55	23.12	16.2	0.670
12	39.5	554.0	-88.9	35.7	-5.73	22.04	15.8	0.624
13	42.8	558.8	-83.9	36.0	-5.41	19.56	15.4	0.576
14	46.1	570.8	-85.6	36.8	-5.52	18.47	15.0	0.529
15	49.4	565.7	-78.2	36.5	-5.04	16.11	14.6	0.483
16	52.7	574.9	-79.5	37.1	-5.13	15.02	14.1	0.436
17	56.0	578.1	-73.4	37.3	-4.73	12.96	13.5	0.388
18	59.3	587.6	-74.7	37.9	-4.82	11.86	12.9	0.341
19	62.5	558.5	-61.4	36.0	-3.96	9.64	12.3	0.297
20	65.8	570.0	-62.5	36.8	-4.03	8.69	11.1	0.252
21	69.1	553.9	-52.7	35.7	-3.40	7.11	9.0	0.212
22	72.4	571.2	-53.3	36.8	-3.44	6.12	6.6	0.171
Absolute	13.2			39.5			(T =	36.6 ms)
	39.5				-5.73		(T =	58.2 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	850.0	819.7	789.3	759.0	728.6	698.3	667.9	637.6	607.3	576.9
RX	850.0	819.7	789.3	759.0	728.6	700.5	672.6	645.7	628.2	613.2
RU	861.2	832.0	802.7	773.5	744.3	715.1	685.8	656.6	627.4	598.2

RAU = 117.1 (kips); RA2 = 701.2 (kips)

Current CAPWAP Ru = 589.0 (kips); Corresponding J(RP)= 0.86; matches RX9 within 5%

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
19.49	35.84	539.2	614.2	614.2	1.098	0.060	0.063	39.7	820.2

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	15.50	29992.2	492.000	3.971
72.42	15.50	29992.2	492.000	3.971

Toe Area 0.985 ft^2

Top Segment Length 3.29 ft, Top Impedance 27.67 kips/ft/s

Pile Damping 1.0 %, Time Incr 0.196 ms, Wave Speed 16807.9 ft/s, 2L/c 8.6 ms

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Rory Flynn
Company: Lunda Construction Company	No. of Sheets: 36
E-mail: whamacher@lundaconstruction.com	Date: February 4, 2015

RE: Dynamic Testing Results – Pier 10
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On February 2, 2015, Pier 10 #8 and Pier 10 #17 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on February 3. The 12 x 53 H-piles were equipped with driving shoes and were driven with an APE D25-42 hammer operated on fuel setting three. Plans indicate the piles in Pier 10 have a required driving resistance, or ultimate capacity, of 420 kips and an estimated length of 85 feet. We understand the pier was excavated to the required 30 foot pre-boring depth and backfilled.

Pier 10 #8 was driven to a depth of 77.3 feet below the excavated ground surface at EL 614.7, which corresponds to a pile tip elevation of EL 537.4. The blow count over the final increment of driving was 10 blows for 2 1/8 inch of penetration at an average hammer stroke of 8.7 feet. The blow count at the beginning of restrike of Pier 10 #8 was 10 blows for 1¼ inch of penetration at an average hammer stroke of 9.6 feet.

Pier 10 #17 was driven to a depth of 76.3 feet below the excavated ground surface at EL 614.7, which corresponds to a pile tip elevation of EL 538.4. 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 9.0 feet. The blow count at the beginning of restrike of Pier 10 #17 was 10 blows for 1 3/4 inch of penetration at an average hammer stroke of 9.4 feet.

For the 420 kip piles, driven with the APE D25-42 hammer, in Pier 10 of the STH 96 Bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.5	10
8.0	7
8.5	6
9.0	5

We recommended the above blow count at the corresponding hammer stroke be maintained for

two consecutive inches of driving. Driving may be terminated if production piles exceed 10 blows over an increment of one inch or less at hammer strokes of 8.5 feet. After splicing or any other delays, we recommend not applying the criteria until at least two feet of driving has occurred beyond the termination depth associated with the delay.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Rory Flynn, E.I.

Travis Coleman, P.E.

cc: Steve Seymour - steve.seymour@omnni.com
Jeff Horsfall - jeffrey.horsfall@dot.wi.gov

Attachments:

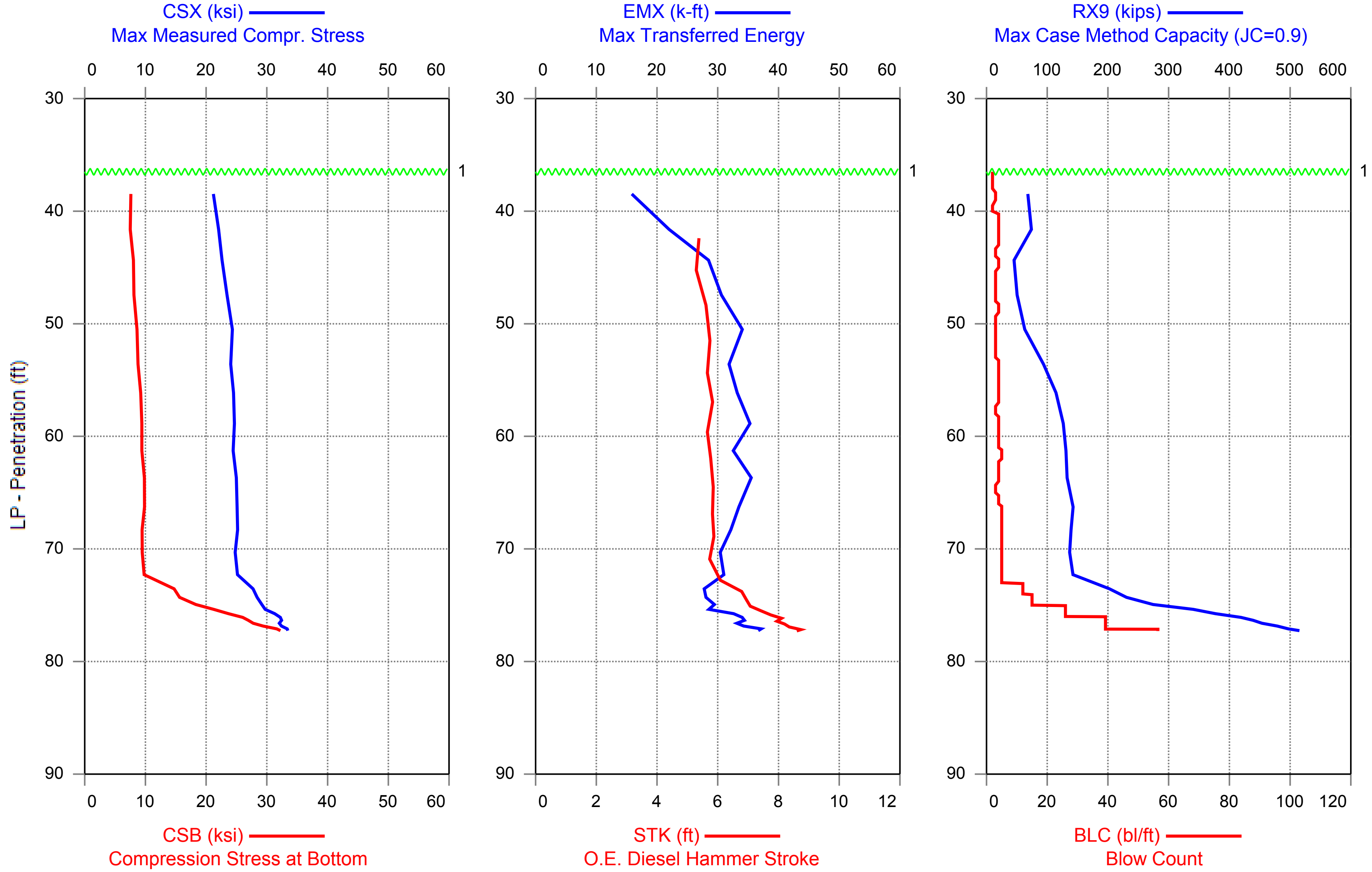
Dynamic Results	(Pages 3 – 16)
CAPWAP Results	(Pages 17 – 36)

Printed: 03-February-2015

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

Test started: 02-February-2015

STH 96 over Fox River (B-5-831) - PIER 10 #8 EOID
APE D25-42, HP 12 x 53



1 - Reported Reference EL 614.72

STH 96 over Fox River (B-5-831) - PIER 10 #8 EOID APE D25-42, HP 12 x 53
OP: RF Date: 02-February-2015

AR: 15.50 in² SP: 0.492 k/ft³
LE: 105.30 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
2	37.00	2	AV2	20.5	7.5	**	14	**	55
			MAX	21.8	8.1	**	17	**	63
			MIN	19.2	6.9	**	11	**	48
4	38.00	2	AV2	21.6	7.8	**	17	**	71
			MAX	21.7	7.9	**	17	**	72
			MIN	21.6	7.7	**	17	**	69
7	39.00	3	AV3	21.4	7.5	**	15	**	74
			MAX	22.0	7.8	**	16	**	75
			MIN	21.0	7.2	**	15	**	74
9	40.00	2	AV2	21.1	7.6	**	17	**	64
			MAX	21.1	7.7	**	18	**	70
			MIN	21.0	7.4	**	17	**	58
13	41.00	4	AV4	21.2	7.4	**	17	**	81
			MAX	21.5	7.8	**	22	**	88
			MIN	21.0	7.1	**	14	**	72
17	42.00	4	AV4	23.3	7.5	5.6	22	50.0	81
			MAX	27.8	7.9	7.2	27	56.1	103
			MIN	19.8	7.0	4.3	16	43.8	59
21	43.00	4	AV4	21.8	7.8	5.1	27	51.9	58
			MAX	23.4	8.2	5.4	28	54.1	64
			MIN	19.7	7.3	4.6	25	50.5	50
24	44.00	3	AV3	22.5	8.0	5.2	30	51.1	28
			MAX	23.5	8.5	5.5	31	52.9	41
			MIN	21.6	7.6	4.9	29	50.0	2
28	45.00	4	AV4	22.0	7.9	5.2	26	51.6	54
			MAX	24.1	8.7	5.7	28	55.6	75
			MIN	18.2	7.1	4.4	22	49.2	32
31	46.00	3	AV3	23.8	8.1	5.5	32	49.9	48
			MAX	24.5	8.7	5.7	33	50.8	56
			MIN	23.0	7.6	5.3	31	49.3	42
34	47.00	3	AV3	23.1	7.8	5.5	31	50.0	44
			MAX	24.4	8.3	5.8	34	50.7	47
			MIN	22.0	7.3	5.3	29	48.9	41
37	48.00	3	AV3	24.1	8.4	5.5	31	49.9	49
			MAX	24.6	8.5	5.7	33	50.6	56
			MIN	23.6	8.2	5.4	30	49.0	41

STH 96 over Fox River (B-5-831) - PIER 10 #8 EOID APE D25-42, HP 12 x 53
OP: RF Date: 02-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
41	49.00	4	AV4	23.1	8.2	5.5	29	49.9	65
			MAX	23.6	8.4	5.7	30	51.2	79
			MIN	21.9	8.1	5.2	27	49.2	50
44	50.00	3	AV3	24.6	8.6	5.9	34	48.5	53
			MAX	25.4	8.7	6.1	36	49.2	59
			MIN	23.9	8.5	5.7	34	47.7	46
47	51.00	3	AV3	24.1	8.8	5.8	34	48.8	63
			MAX	24.6	8.9	6.0	35	50.0	75
			MIN	23.4	8.6	5.5	33	47.9	52
50	52.00	3	AV3	24.6	8.6	5.9	36	48.4	68
			MAX	25.4	9.0	6.0	36	48.7	69
			MIN	24.1	8.4	5.8	34	47.9	66
53	53.00	3	AV3	23.9	8.6	5.5	33	49.9	72
			MAX	24.9	8.9	5.8	34	50.6	82
			MIN	23.3	8.5	5.4	32	48.8	62
57	54.00	4	AV4	24.5	8.7	5.7	32	49.1	100
			MAX	25.4	9.0	5.9	33	50.0	107
			MIN	23.4	8.3	5.5	30	48.2	91
61	55.00	4	AV4	24.0	9.1	5.6	31	49.6	110
			MAX	24.9	9.2	5.8	32	50.9	119
			MIN	23.0	8.9	5.3	30	48.8	98
65	56.00	4	AV4	24.4	9.0	5.7	32	49.3	112
			MAX	24.5	9.2	5.7	33	49.8	120
			MIN	24.1	8.8	5.5	32	49.0	102
69	57.00	4	AV4	24.6	9.4	5.9	33	48.5	118
			MAX	25.7	9.9	6.1	34	49.0	129
			MIN	24.2	8.8	5.7	33	47.5	105
72	58.00	3	AV3	25.2	9.6	5.9	39	48.5	119
			MAX	25.9	9.9	6.0	41	49.4	128
			MIN	24.2	9.5	5.6	37	48.0	106
76	59.00	4	AV4	24.8	9.4	5.8	35	48.9	131
			MAX	25.8	9.6	5.9	36	49.9	137
			MIN	23.8	9.1	5.5	32	48.4	127
80	60.00	4	AV4	24.0	9.3	5.6	33	49.7	122
			MAX	25.3	9.7	5.9	35	50.6	135
			MIN	23.2	9.0	5.4	32	48.3	112
84	61.00	4	AV4	24.3	9.2	5.7	34	49.2	128
			MAX	25.1	9.4	5.8	35	49.8	132
			MIN	23.8	8.9	5.5	33	48.6	124

STH 96 over Fox River (B-5-831) - PIER 10 #8 EOID APE D25-42, HP 12 x 53
OP: RF Date: 02-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
89	62.00	5	AV5	24.5	9.6	5.7	31	49.1	133
			MAX	25.1	9.8	5.9	32	50.0	139
			MIN	23.5	9.3	5.5	30	48.4	128
93	63.00	4	AV4	25.2	9.8	5.9	36	48.5	135
			MAX	25.7	10.5	6.0	37	49.0	141
			MIN	24.5	9.5	5.7	34	48.0	130
97	64.00	4	AV4	25.2	9.9	5.9	35	48.4	132
			MAX	26.0	10.2	6.0	36	49.0	137
			MIN	24.3	9.6	5.7	33	48.0	123
100	65.00	3	AV3	24.4	9.6	5.7	36	49.2	130
			MAX	25.7	9.9	6.0	41	50.4	139
			MIN	23.4	9.5	5.4	33	47.9	124
104	66.00	4	AV4	25.3	10.0	5.9	36	48.3	139
			MAX	26.6	10.7	6.2	38	49.2	146
			MIN	24.1	9.4	5.7	33	47.3	133
109	67.00	5	AV5	24.9	9.8	5.8	32	48.8	145
			MAX	25.8	10.2	6.0	33	50.0	151
			MIN	23.8	9.4	5.5	30	48.0	140
114	68.00	5	AV5	25.6	9.7	5.9	33	48.3	145
			MAX	26.1	9.9	6.0	34	48.7	149
			MIN	25.0	9.5	5.8	32	48.0	138
119	69.00	5	AV5	24.8	9.3	5.9	32	48.5	135
			MAX	25.4	9.5	6.0	32	49.0	144
			MIN	24.3	8.9	5.7	30	47.8	130
124	70.00	5	AV5	25.1	9.5	5.9	31	48.3	137
			MAX	25.6	9.7	6.1	33	49.1	141
			MIN	24.4	9.2	5.7	30	47.7	133
129	71.00	5	AV5	24.2	9.4	5.6	29	49.5	137
			MAX	25.6	9.8	5.9	32	50.8	139
			MIN	22.6	8.9	5.3	27	48.2	134
134	72.00	5	AV5	25.0	9.4	5.8	31	48.8	140
			MAX	26.5	9.7	6.1	33	50.3	145
			MIN	23.5	9.1	5.4	29	47.4	131
139	73.00	5	AV5	25.5	9.7	5.9	32	48.3	141
			MAX	26.6	10.4	6.1	34	49.8	151
			MIN	23.8	9.0	5.5	29	47.4	134
151	74.00	12	AV12	27.6	14.6	6.6	28	45.7	201
			MAX	29.2	16.1	7.0	31	48.2	228
			MIN	25.9	11.9	5.9	23	44.4	163
166	75.00	15	AV15	28.5	16.4	6.9	28	44.8	241

STH 96 over Fox River (B-5-831) - PIER 10 #8 EOID APE D25-42, HP 12 x 53
OP: RF Date: 02-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
			MAX	30.0	18.5	7.4	31	46.4	263
			MIN	26.5	14.9	6.4	24	43.5	221
192	76.00	26	AV26	30.6	22.2	7.5	31	43.2	354
			MAX	33.1	25.7	8.2	35	44.7	415
			MIN	28.5	18.8	6.9	26	41.2	291
236	77.12	39	AV44	32.4	28.1	8.2	34	41.4	455
			MAX	34.3	31.7	9.0	39	43.0	499
			MIN	30.7	24.7	7.5	30	39.5	415
246	77.30	56	AV10	33.5	32.3	8.7	37	40.1	514
			MAX	34.6	33.1	9.1	40	40.9	522
			MIN	32.5	31.5	8.4	34	39.3	503
			Average	27.1	15.4	6.6	31	46.2	223
			Maximum	34.6	33.1	9.1	41	56.1	522
			Minimum	18.2	6.9	4.3	11	39.3	2

Total number of blows analyzed: 246

BL# Sensors

1-246 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K974] 305.0 (1.09); A4: [K1020] 307.0 (1.09)

BL# Comments

1 Reported Reference EL 614.72

Time Summary

Drive 11 minutes 48 seconds 5:00 PM - 5:12 PM BN 1 - 246

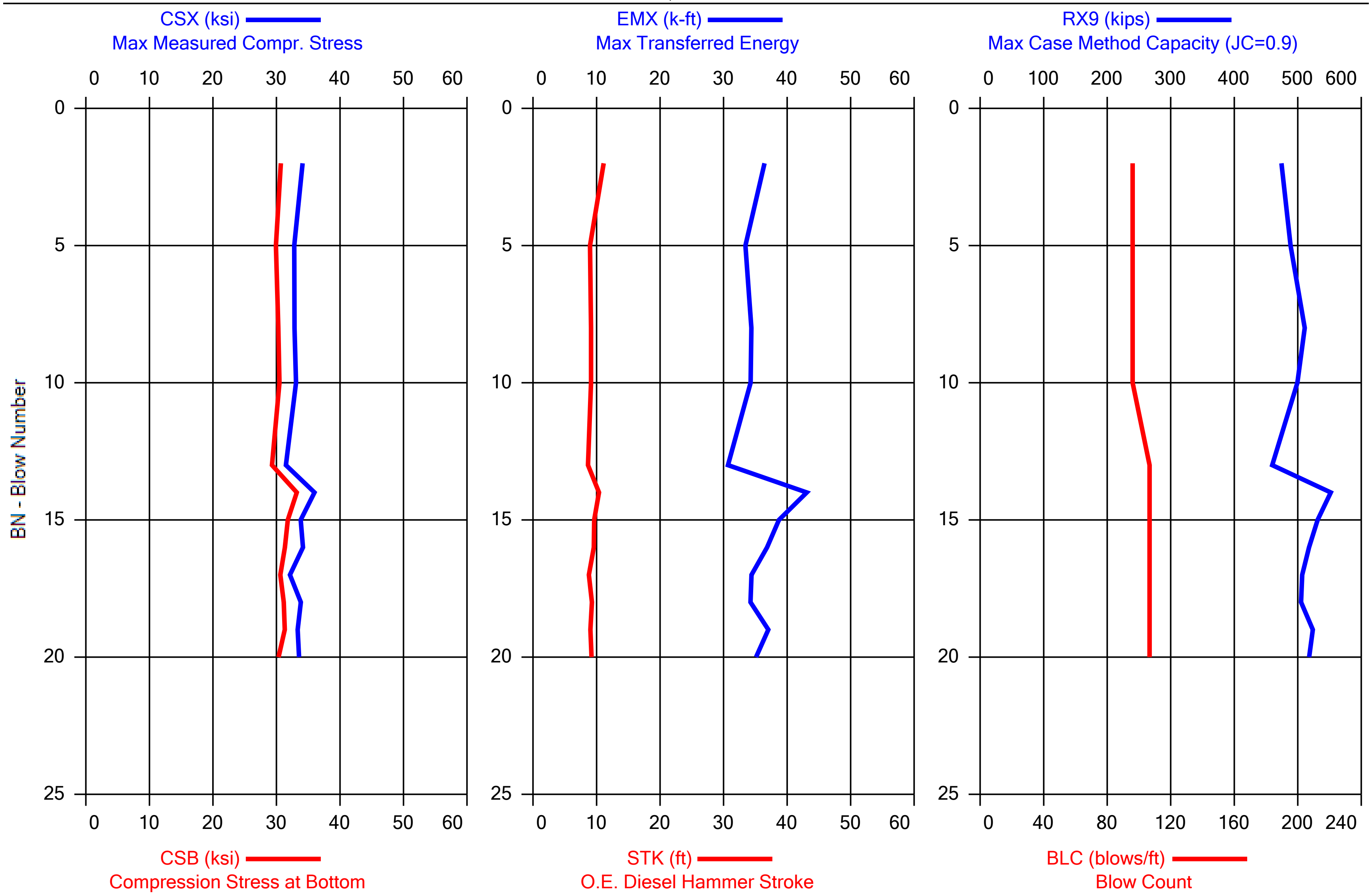
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 03-February-2015

Test started: 03-February-2015

STH 96 over Fox River (B-5-831) - PIER 10 #8 BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - PIER 10 #8 BOR APE D25-42, HP 12 x 53
OP: RF Date: 03-February-2015

AR:	15.50 in²	SP:	0.492 k/ft³
LE:	105.30 ft	EM:	30,000 ksi
WS:	16,807.9 f/s	JC:	1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
10	77.40	96	AV4	33.2	30.3	9.6	35	38.4	493
			MAX	34.1	30.7	11.1	36	39.5	511
			MIN	32.8	29.9	9.0	33	35.6	474
20	77.50	107	AV8	33.5	31.1	9.3	36	38.8	514
			MAX	36.0	33.2	10.4	43	40.2	552
			MIN	31.5	29.3	8.7	31	36.8	460
			Average	33.4	30.9	9.4	36	38.7	507
			Maximum	36.0	33.2	11.1	43	40.2	552
			Minimum	31.5	29.3	8.7	31	35.6	460

Total number of blows analyzed: 12

BL# Sensors

1-20 F3: [H083] 94.4 (0.98); F4: [F523] 93.8 (0.98); A3: [K974] 305.0 (1.09); A4: [K1020] 307.0 (1.09)

Time Summary

Drive 2 minutes 26 seconds 9:04 AM - 9:07 AM BN 1 - 20

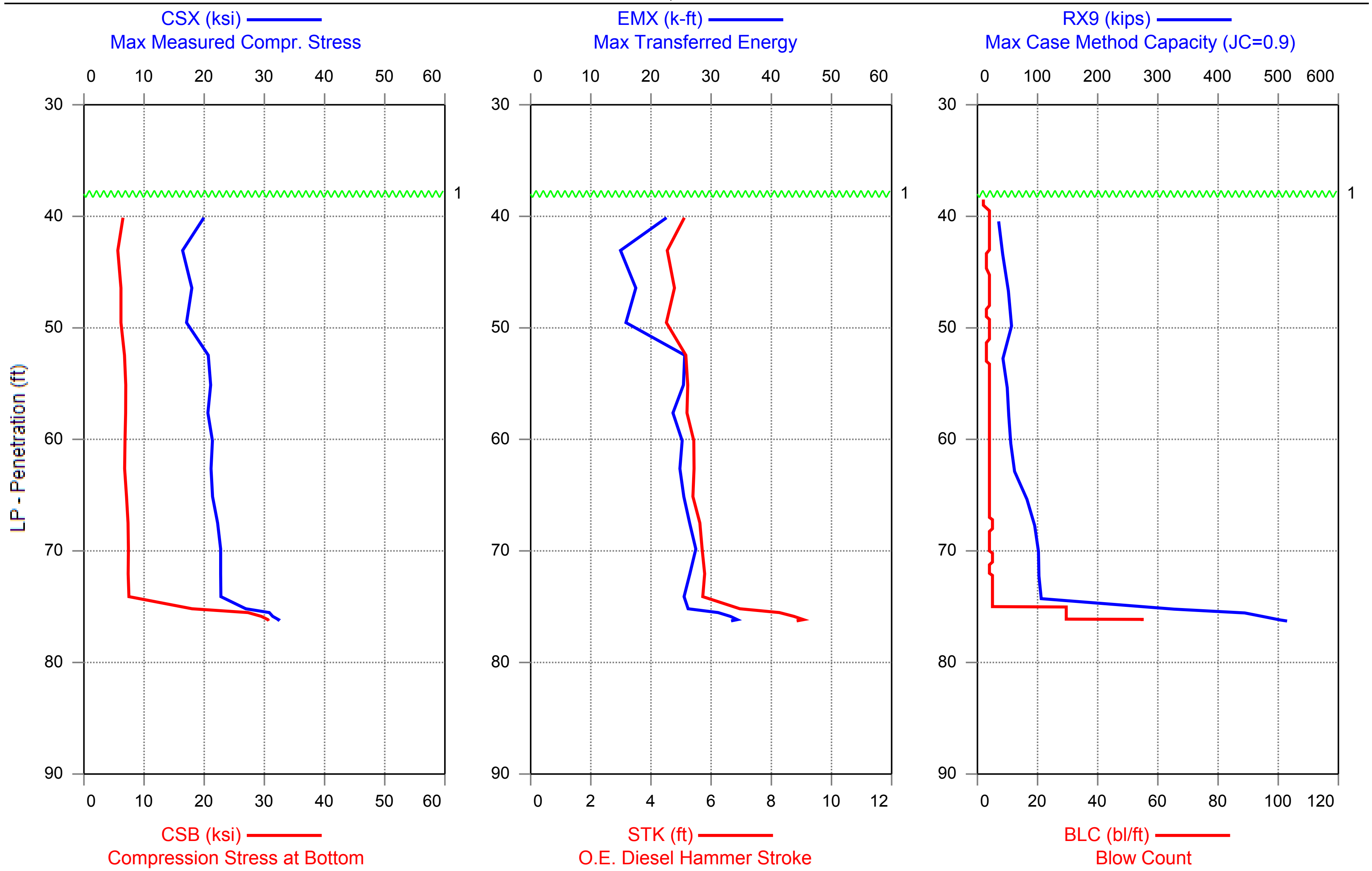
GRL Engineers, Inc. - PDIPLOT2 Ver 2014.2.48.1 - Case Method & iCAP® Results

Printed: 03-February-2015

Test started: 02-February-2015

STH 96 over Fox River (B-5-831) - PIER 10 #17 EOID

APE D25-42, HP 12 x 53



1 - Reported Reference EL 614.72

STH 96 over Fox River (B-5-831) - PIER 10 #17 EOID APE D25-42, HP 12 x 53
OP: RF Date: 02-February-2015

AR: 15.50 in² SP: 0.492 k/ft³
LE: 104.20 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
2	38.50	2	AV1	19.8	6.6	5.2	32	51.5	0
			MAX	19.8	6.6	5.2	32	51.5	0
			MIN	19.8	6.6	5.2	32	51.5	0
3	39.00	2	AV1	22.9	6.5	5.8	22	48.7	64
			MAX	22.9	6.5	5.8	22	48.7	64
			MIN	22.9	6.5	5.8	22	48.7	64
7	40.00	4	AV3	19.7	6.6	5.1	23	52.1	25
			MAX	21.1	6.8	5.4	26	54.5	39
			MIN	17.6	6.3	4.6	22	50.6	10
11	41.00	4	AV3	18.5	6.3	4.8	17	53.4	49
			MAX	21.1	6.6	5.4	23	58.4	63
			MIN	14.2	5.6	3.9	10	50.5	25
15	42.00	4	AV4	20.5	6.6	5.1	24	51.7	18
			MAX	21.3	6.9	5.4	26	52.1	23
			MIN	19.8	6.2	5.0	22	50.5	4
19	43.00	4	AV4	16.7	5.9	4.5	15	55.3	46
			MAX	20.6	6.6	5.3	22	60.5	67
			MIN	11.6	5.0	3.7	8	51.0	20
22	44.00	3	AV2	17.2	5.3	5.1	14	54.4	46
			MAX	25.9	6.8	6.8	24	63.7	58
			MIN	8.5	3.8	3.3	4	45.0	35
25	45.00	3	AV2	11.4	4.6	3.6	8	61.3	52
			MAX	15.9	6.0	4.0	12	64.8	69
			MIN	6.9	3.3	3.1	3	57.7	34
29	46.00	4	AV4	18.5	6.2	4.9	20	53.2	34
			MAX	21.2	6.7	5.4	24	58.3	61
			MIN	14.0	5.7	4.0	15	50.5	17
33	47.00	4	AV4	15.0	5.8	4.2	12	57.5	54
			MAX	20.9	6.6	5.2	21	62.0	64
			MIN	10.2	4.5	3.5	6	51.2	42
37	48.00	4	AV3	19.7	6.6	5.2	18	52.3	68
			MAX	26.1	7.1	7.0	24	59.0	72
			MIN	13.8	5.9	3.9	9	44.5	65
40	49.00	3	AV2	18.6	6.1	5.1	18	54.2	60
			MAX	27.1	7.8	6.9	30	63.6	74
			MIN	10.2	4.5	3.3	6	44.8	45

STH 96 over Fox River (B-5-831) - PIER 10 #17 EOID APE D25-42, HP 12 x 53
OP: RF Date: 02-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
44	50.00	4	AV4	15.2	5.9	4.1	12	57.7	64
			MAX	19.2	6.5	4.7	18	60.5	76
			MIN	12.4	5.3	3.7	9	53.7	54
48	51.00	4	AV4	19.0	6.5	4.8	20	53.4	48
			MAX	21.0	7.0	5.3	24	55.3	61
			MIN	17.2	6.1	4.4	17	50.9	32
51	52.00	3	AV3	19.7	6.4	4.9	25	52.7	35
			MAX	22.3	6.8	5.4	28	54.4	45
			MIN	17.5	6.0	4.6	22	50.2	29
54	53.00	3	AV3	21.8	7.0	5.4	29	50.3	38
			MAX	22.6	7.4	5.7	30	51.0	47
			MIN	21.3	6.8	5.3	28	49.3	25
58	54.00	4	AV4	20.9	6.9	5.2	25	51.5	51
			MAX	22.2	7.3	5.4	27	54.3	67
			MIN	18.5	6.6	4.6	21	50.3	37
62	55.00	4	AV4	21.5	7.3	5.3	27	50.8	51
			MAX	23.1	7.8	5.7	28	51.8	61
			MIN	20.5	6.8	5.1	24	49.3	37
66	56.00	4	AV4	21.4	6.8	5.3	25	50.8	55
			MAX	22.3	7.1	5.5	27	52.0	62
			MIN	20.1	6.2	5.1	23	49.9	45
70	57.00	4	AV4	20.1	6.8	5.0	22	52.2	48
			MAX	21.7	7.3	5.4	24	55.3	62
			MIN	17.1	6.3	4.4	16	50.4	34
74	58.00	4	AV4	21.2	7.0	5.3	25	50.8	49
			MAX	22.1	7.3	5.6	26	51.7	60
			MIN	20.1	6.8	5.1	24	49.7	40
78	59.00	4	AV4	20.7	7.0	5.2	24	51.1	52
			MAX	21.8	7.5	5.4	26	52.5	67
			MIN	19.3	6.7	5.0	22	50.2	34
82	60.00	4	AV4	21.2	6.8	5.3	25	50.7	57
			MAX	21.6	7.0	5.4	25	51.2	62
			MIN	20.8	6.4	5.2	23	50.2	43
86	61.00	4	AV4	22.0	6.8	5.6	27	49.6	58
			MAX	23.0	7.1	5.8	29	50.5	60
			MIN	21.2	6.5	5.4	25	48.7	55
90	62.00	4	AV4	20.8	6.8	5.3	24	50.7	56
			MAX	21.5	6.9	5.5	25	51.8	70
			MIN	19.9	6.6	5.1	22	49.8	49

STH 96 over Fox River (B-5-831) - PIER 10 #17 EOID APE D25-42, HP 12 x 53
OP: RF Date: 02-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
94	63.00	4	AV4	21.2	6.7	5.5	25	50.2	60
			MAX	22.9	7.0	5.9	28	52.8	67
			MIN	18.6	6.3	4.9	21	48.5	46
98	64.00	4	AV4	20.9	6.8	5.3	24	50.7	63
			MAX	22.5	7.0	5.7	28	52.5	77
			MIN	19.1	6.6	5.0	22	49.0	50
102	65.00	4	AV4	20.6	6.8	5.3	24	50.9	67
			MAX	22.1	6.9	5.6	26	51.8	81
			MIN	19.7	6.7	5.1	22	49.4	56
106	66.00	4	AV4	22.3	7.4	5.5	27	50.0	94
			MAX	23.1	8.0	5.6	30	50.5	110
			MIN	21.7	6.8	5.4	25	49.4	76
110	67.00	4	AV4	22.1	7.3	5.6	27	49.7	89
			MAX	23.1	7.4	5.9	28	50.7	98
			MIN	21.0	7.3	5.3	24	48.5	78
115	68.00	5	AV5	21.9	7.3	5.6	26	49.7	93
			MAX	22.3	7.5	5.7	27	50.9	97
			MIN	21.1	7.1	5.3	24	49.2	84
119	69.00	4	AV4	22.9	7.5	5.8	28	48.9	103
			MAX	23.8	7.5	6.0	28	49.6	104
			MIN	22.2	7.4	5.6	28	47.9	102
123	70.00	4	AV4	22.6	7.3	5.7	27	49.3	98
			MAX	23.2	7.6	5.9	29	51.1	107
			MIN	20.9	7.0	5.2	25	48.5	89
128	71.00	5	AV5	23.0	7.5	5.8	27	48.8	104
			MAX	24.5	8.0	6.2	31	50.5	112
			MIN	21.2	7.0	5.4	24	47.3	90
132	72.00	4	AV4	22.1	7.1	5.6	25	49.5	101
			MAX	22.6	7.2	5.7	26	49.8	107
			MIN	21.7	7.1	5.5	24	49.0	97
137	73.00	5	AV5	23.1	7.5	5.9	28	48.4	102
			MAX	23.8	7.8	6.1	29	49.8	115
			MIN	21.9	7.2	5.5	26	47.6	92
142	74.00	5	AV5	22.7	7.5	5.7	26	49.1	104
			MAX	23.8	7.7	6.1	27	49.9	108
			MIN	21.4	7.2	5.5	25	47.7	96
147	75.00	5	AV5	22.8	7.4	5.7	25	49.0	108
			MAX	24.3	7.7	6.1	27	50.5	111
			MIN	21.6	7.2	5.4	23	47.7	102
180	76.12	30	AV33	29.9	25.4	8.1	31	41.7	412

STH 96 over Fox River (B-5-831) - PIER 10 #17 EOID APE D25-42, HP 12 x 53
OP: RF Date: 02-February-2015

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	bl/ft		ksi	ksi	ft	k-ft	bpm	kips
			MAX	33.2	31.4	9.5	36	48.7	505
			MIN	23.3	7.7	5.8	22	38.4	112
190	76.30	55	AV9	32.2	30.6	9.0	34	39.6	505
			MAX	33.7	31.3	9.9	36	40.7	520
			MIN	30.5	29.8	8.4	32	37.7	490
			Average	22.8	11.4	6.0	25	49.0	150
			Maximum	33.7	31.4	9.9	36	64.8	520
			Minimum	6.9	3.3	3.1	3	37.7	0

Total number of blows analyzed: 182

BL# Sensors

1-190 F3: [F523] 93.8 (1.00); F4: [H083] 94.4 (1.00); A3: [K974] 305.0 (1.06); A4: [K1020] 307.0 (1.06)

BL# Comments

1 Reported Reference EL 614.72

Time Summary

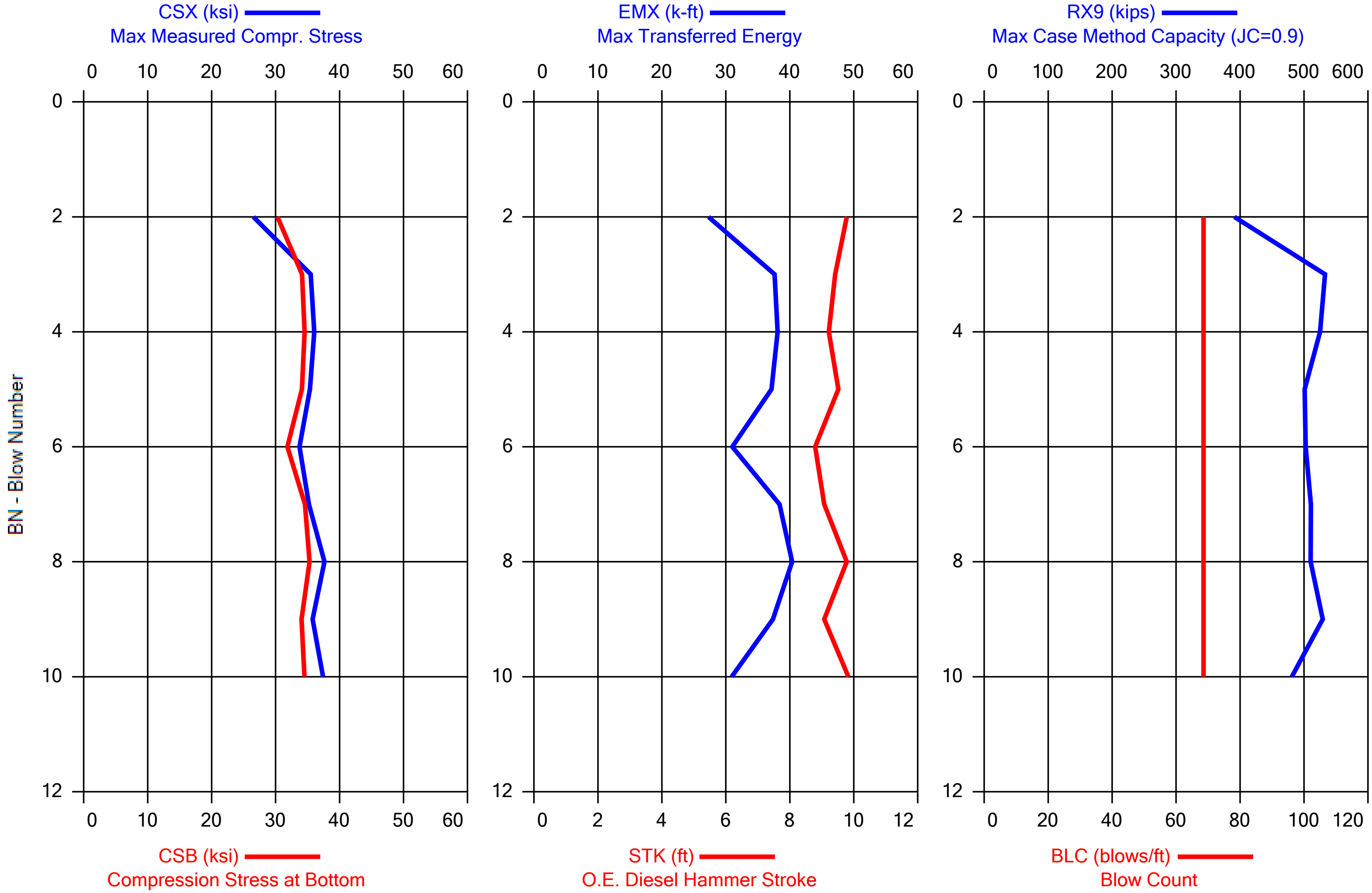
Drive 6 minutes 10 seconds 6:01 PM - 6:07 PM BN 1 - 190

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

Printed: 03-February-2015

Test started: 03-February-2015

STH 96 over Fox River (B-5-831) - PIER 10 #17 BOR
APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - PIER 10 #17 BOR APE D25-42, HP 12 x 53
OP: RF Date: 03-February-2015

AR:	15.50 in²	SP:	0.492 k/ft³
LE:	104.20 ft	EM:	30,000 ksi
WS:	16,807.9 f/s	JC:	1.00 []

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
	ft	blows/ft		ksi	ksi	ft	k-ft	bpm	kips
10	76.45	69	AV9	34.8	33.7	9.4	35	38.7	498
			MAX	37.6	35.3	9.8	40	39.9	533
			MIN	26.5	30.3	8.8	27	37.8	391
			Average	34.8	33.7	9.4	35	38.7	498
			Maximum	37.6	35.3	9.8	40	39.9	533
			Minimum	26.5	30.3	8.8	27	37.8	391

Total number of blows analyzed: 9

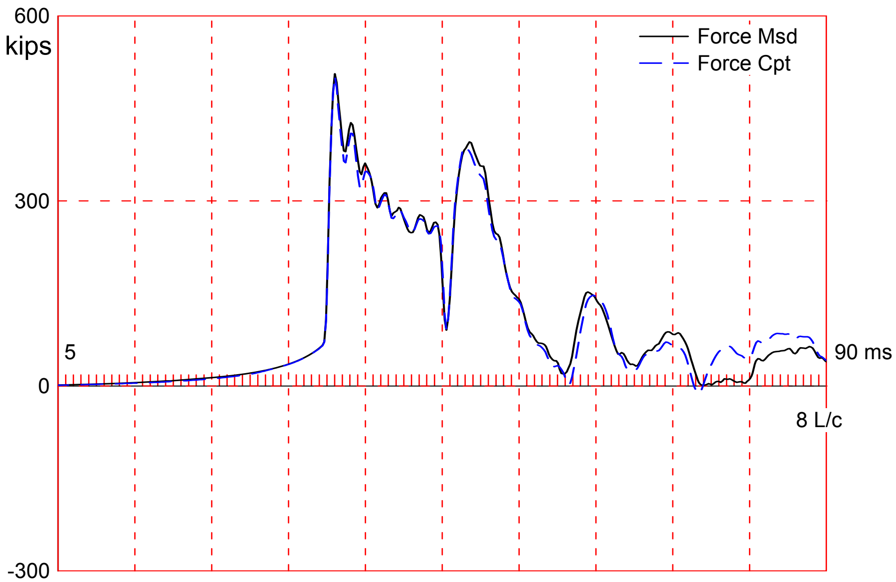
BL# Sensors

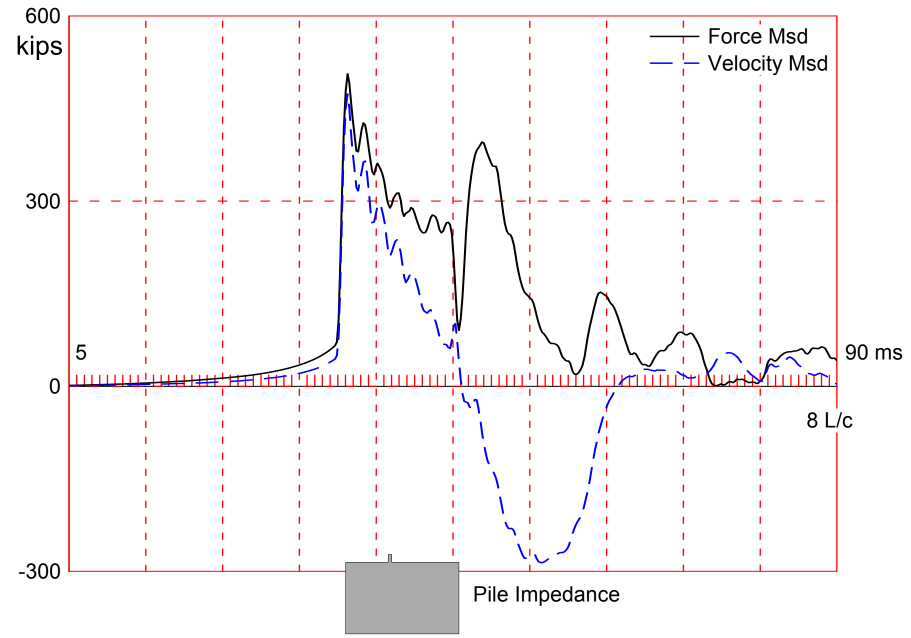
1-10 F3: [H083] 94.4 (1.00); F4: [F523] 93.8 (1.00); A3: [K974] 305.0 (1.09); A4: [K1020] 307.0 (1.09)

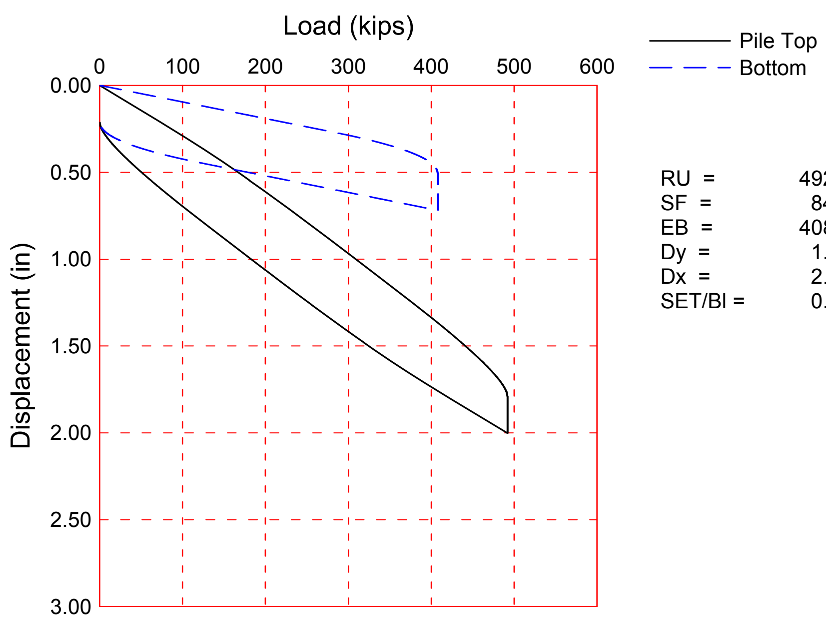
Time Summary

Drive 15 seconds 9:25 AM - 9:26 AM BN 1 - 10

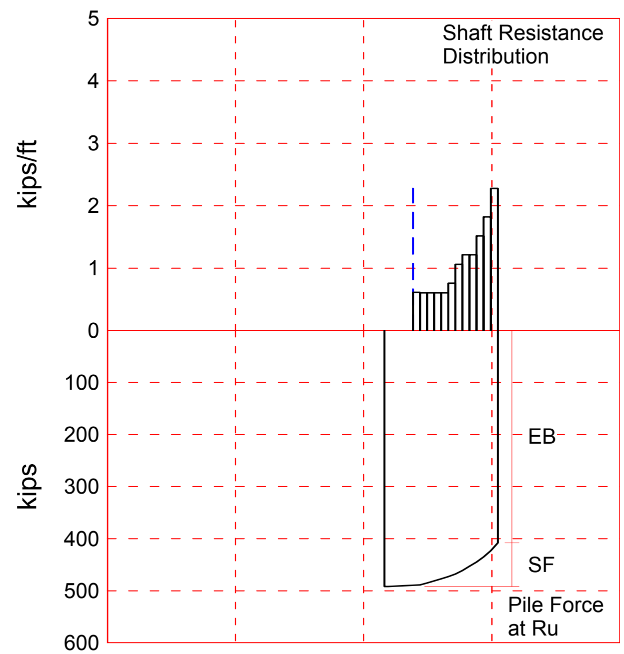
Match Quality Poor - Results May Be Unreliable!!!







RU	=	492.0 kips
SF	=	84.0 kips
EB	=	408.0 kips
Dy	=	1.79 in
Dx	=	2.00 in
SET/Bl	=	0.21 in



Length b. Sensors	105.3 ft
Embedment	77.3 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	5.33
Top Compr. Stress	32.4 ksi
Max Compr. Stress	33.4 ksi
Max Tension Stress	-5.86 ksi
Avg. Shaft Quake	0.20 in
Toe Quake	0.39 in
Avg. Shaft Smith Dpg.	0.18 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.

Match Quality Poor - Results May Be Unreliable!!!

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 492.0; along Shaft 84.0; at Toe 408.0 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
				492.0			
1	32.9	4.9	3.0	489.0	3.0	0.61	0.15
2	39.5	11.5	4.0	485.0	7.0	0.61	0.15
3	46.1	18.1	4.0	481.0	11.0	0.61	0.15
4	52.7	24.6	4.0	477.0	15.0	0.61	0.15
5	59.2	31.2	4.0	473.0	19.0	0.61	0.15
6	65.8	37.8	5.0	468.0	24.0	0.76	0.19
7	72.4	44.4	7.0	461.0	31.0	1.06	0.27
8	79.0	51.0	8.0	453.0	39.0	1.22	0.31
9	85.6	57.5	8.0	445.0	47.0	1.22	0.31
10	92.1	64.1	10.0	435.0	57.0	1.52	0.38
11	98.7	70.7	12.0	423.0	69.0	1.82	0.46
12	105.3	77.3	15.0	408.0	84.0	2.28	0.57
Avg. Shaft			7.0			1.09	0.27
Toe			408.0				414.07

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.18	0.07
Quake	(in)	0.20	0.39
Case Damping Factor		0.55	1.03
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	0
Unloading Level	(% of Ru)	81	
Resistance Gap (included in Toe Quake) (in)			0.01
Soil Plug Weight	(kips)		0.017

CAPWAP match quality = 5.33 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.21 in; Blow Count = 56 b/ft
Computed: Final Set = 0.17 in; Blow Count = 69 b/ft

max. Top Comp. Stress = 32.4 ksi (T= 36.0 ms, max= 1.032 x Top)
max. Comp. Stress = 33.4 ksi (Z= 32.9 ft, T= 37.8 ms)
max. Tens. Stress = -5.86 ksi (Z= 59.2 ft, T= 64.6 ms)
max. Energy (EMX) = 36.5 kip-ft; max. Measured Top Displ. (DMX)= 1.38 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	502.2	-21.4	32.4	-1.38	36.5	17.3	1.41
2	6.6	502.5	-21.6	32.4	-1.39	36.4	17.2	1.39
4	13.2	503.3	-21.6	32.5	-1.39	35.9	17.2	1.35
6	19.7	504.3	-26.7	32.5	-1.72	35.1	17.1	1.29
8	26.3	506.6	-23.8	32.7	-1.53	34.3	17.0	1.23
10	32.9	518.4	-21.9	33.4	-1.41	33.4	16.5	1.17
12	39.5	512.6	-46.4	33.1	-2.99	31.6	16.2	1.11
14	46.1	499.6	-66.6	32.2	-4.30	29.7	16.1	1.05
16	52.7	491.4	-81.9	31.7	-5.29	27.8	15.8	0.98
18	59.2	484.0	-90.9	31.2	-5.86	25.7	15.5	0.91
20	65.8	478.5	-90.0	30.9	-5.80	23.7	15.1	0.84
22	72.4	472.2	-86.4	30.5	-5.57	21.6	14.6	0.76
23	75.7	454.2	-76.5	29.3	-4.93	19.8	14.4	0.73
24	79.0	460.4	-73.3	29.7	-4.73	19.1	14.1	0.69
25	82.3	454.3	-56.1	29.3	-3.62	17.4	13.9	0.65
26	85.6	457.9	-55.2	29.5	-3.56	16.7	13.7	0.61
27	88.8	452.0	-43.2	29.2	-2.78	15.0	13.4	0.58
28	92.1	461.0	-41.6	29.7	-2.69	14.3	13.1	0.54
29	95.4	458.8	-29.7	29.6	-1.91	12.6	13.2	0.50
30	98.7	466.1	-30.1	30.1	-1.94	12.0	15.1	0.46
31	102.0	456.6	-15.3	29.5	-0.99	10.3	16.2	0.43
32	105.3	469.6	-15.3	30.3	-0.99	9.3	14.8	0.39
Absolute	32.9			33.4			(T =	37.8 ms)
	59.2				-5.86		(T =	64.6 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	535.5	444.6	353.7	262.8	171.9					
RX	603.7	566.2	543.4	528.1	517.6	507.7	498.5	491.1	490.3	489.4
RU	535.5	444.6	353.7	262.8	171.9					

RAU = 409.2 (kips); RA2 = 565.4 (kips)

Current CAPWAP Ru = 492.0 (kips); Corresponding J(RP)= 0.10; J(RX) = 1.37

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
17.3	35.83	479.3	510.7	510.7	1.38	0.20	0.21	36.5	551.5	1074

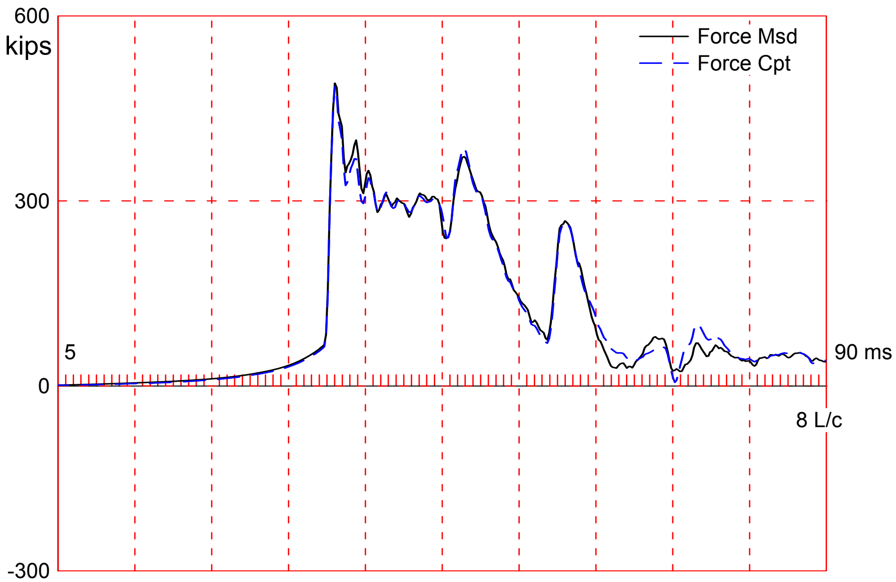
PILE PROFILE AND PILE MODEL

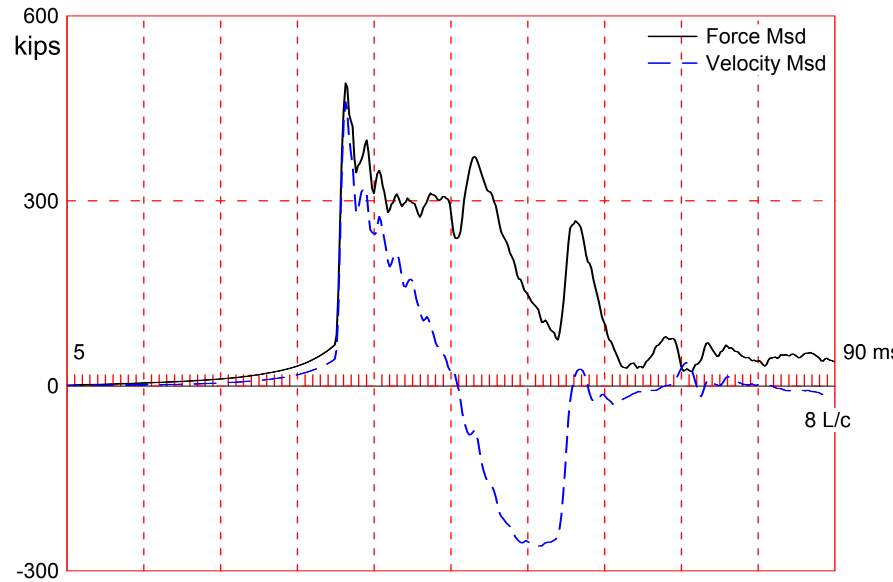
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
0.0	15.5	29992.2	492.000	3.97
105.3	15.5	29992.2	492.000	3.97

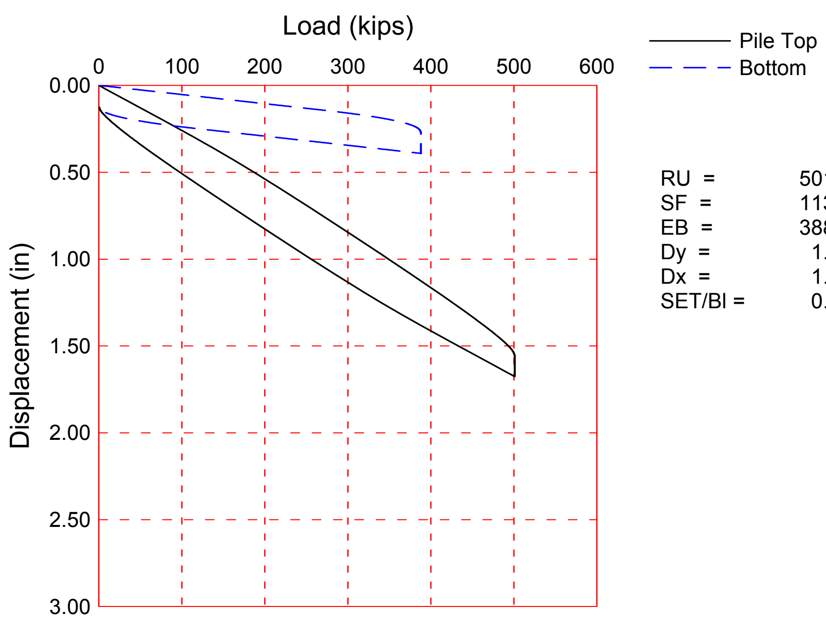
Toe Area 141.9 in²

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s
1	3.3	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9
13	42.8	30.67	10.84	0.00	0.000	-0.00	0.000	3.97	16807.9
14	46.1	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9
32	105.3	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9

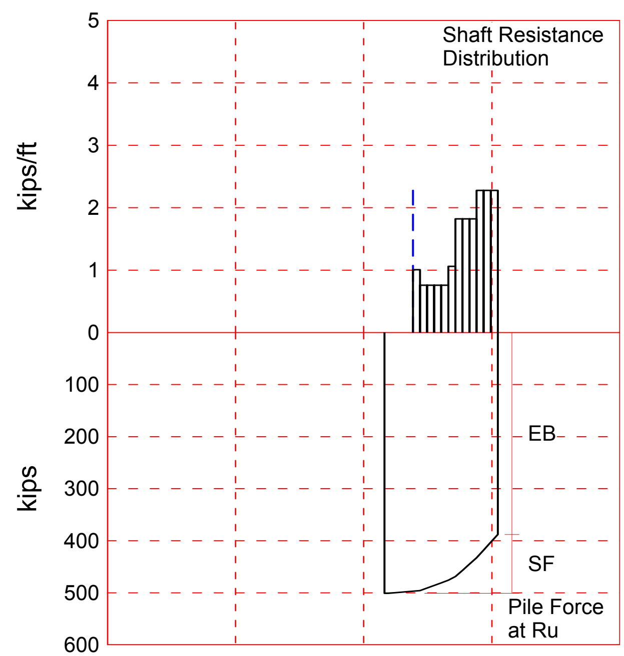
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 12.5 ms
Total volume: 11.373 ft^3; Volume ratio considering added impedance: 1.003







RU =	501.0 kips
SF =	113.0 kips
EB =	388.0 kips
Dy =	1.55 in
Dx =	1.68 in
SET/Bl =	0.13 in



Length b. Sensors	105.3 ft
Embedment	77.4 ft
Top Area	15.5 in²
End Bearing Area	141.9 in²
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft³
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	3.46
Top Compr. Stress	31.3 ksi
Max Compr. Stress	32.3 ksi
Max Tension Stress	-1.35 ksi
Avg. Shaft Quake	0.20 in
Toe Quake	0.21 in
Avg. Shaft Smith Dpg.	0.24 s/ft
Toe Smith Damping	0.09 s/ft

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

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 113.0; at Toe 388.0 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
				501.0			
1	32.9	5.0	5.0	496.0	5.0	1.01	0.25
2	39.5	11.5	5.0	491.0	10.0	0.76	0.19
3	46.1	18.1	5.0	486.0	15.0	0.76	0.19
4	52.7	24.7	5.0	481.0	20.0	0.76	0.19
5	59.2	31.3	5.0	476.0	25.0	0.76	0.19
6	65.8	37.9	7.0	469.0	32.0	1.06	0.27
7	72.4	44.4	12.0	457.0	44.0	1.82	0.46
8	79.0	51.0	12.0	445.0	56.0	1.82	0.46
9	85.6	57.6	12.0	433.0	68.0	1.82	0.46
10	92.1	64.2	15.0	418.0	83.0	2.28	0.57
11	98.7	70.8	15.0	403.0	98.0	2.28	0.57
12	105.3	77.4	15.0	388.0	113.0	2.28	0.57
Avg. Shaft			9.4			1.46	0.37
Toe			388.0				393.77

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.24	0.09
Quake	(in)	0.20	0.21
Case Damping Factor		0.98	1.26
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	113
Reloading Level	(% of Ru)	-100	100
Unloading Level	(% of Ru)	67	
Resistance Gap (included in Toe Quake) (in)			0.03
Soil Plug Weight	(kips)		0.147

```
CAPWAP match quality    =    3.46        (Wave Up Match) ; RSA = 0
Observed: Final Set     =    0.13 in;    Blow Count      =      96 b/ft
Computed: Final Set     =    0.09 in;    Blow Count      =     139 b/ft
Transducer       F3(H083)  CAL:  94.4; RF: 0.96; F4(F523)  CAL:  93.8; RF: 0.96
                 A3(K974)  CAL:   305; RF: 1.09; A4(K1020) CAL:   307; RF: 1.09

max. Top Comp. Stress   =    31.3 ksi     (T=  36.0 ms, max= 1.032 x Top)
max. Comp. Stress       =    32.3 ksi     (Z=  32.9 ft, T=  37.8 ms)
max. Tens. Stress       =   -1.35 ksi     (Z=  59.2 ft, T=  69.9 ms)
max. Energy (EMX)       =    32.7 kip-ft;  max. Measured Top Displ. (DMX)=  1.23 in
```

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	485.8	0.0	31.3	0.00	32.7	16.8	1.26
2	6.6	485.9	0.0	31.3	0.00	32.4	16.8	1.24
4	13.2	486.4	0.0	31.4	0.00	31.7	16.7	1.18
6	19.7	487.1	0.0	31.4	0.00	30.9	16.6	1.12
8	26.3	489.6	0.0	31.6	0.00	29.9	16.5	1.06
10	32.9	501.2	-8.4	32.3	-0.54	28.8	16.0	0.99
12	39.5	489.9	-15.8	31.6	-1.02	26.4	15.5	0.93
14	46.1	478.1	-14.2	30.8	-0.91	24.2	15.0	0.86
16	52.7	466.3	-17.8	30.1	-1.15	22.0	14.6	0.79
18	59.2	455.7	-20.9	29.4	-1.35	19.7	14.2	0.71
20	65.8	451.5	-13.5	29.1	-0.87	17.6	13.6	0.64
22	72.4	455.5	-16.0	29.4	-1.03	15.2	12.8	0.56
23	75.7	443.7	-6.3	28.6	-0.41	13.2	12.4	0.52
24	79.0	441.5	-14.6	28.5	-0.94	12.6	12.0	0.49
25	82.3	437.3	-5.8	28.2	-0.38	10.8	11.6	0.45
26	85.6	453.2	-12.5	29.2	-0.81	10.1	11.3	0.42
27	88.8	440.2	-5.3	28.4	-0.34	8.6	10.9	0.38
28	92.1	442.1	-10.8	28.5	-0.70	8.0	10.5	0.34
29	95.4	422.5	-2.2	27.2	-0.14	6.5	10.0	0.31
30	98.7	440.7	-9.0	28.4	-0.58	5.9	9.7	0.27
31	102.0	421.7	-4.0	27.2	-0.26	4.6	10.5	0.24
32	105.3	425.3	-5.6	27.4	-0.36	4.0	10.1	0.21
Absolute	32.9			32.3			(T =	37.8 ms)
	59.2				-1.35		(T =	69.9 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	607.2	571.4	535.5	499.7	463.9	428.1	392.2	356.4	320.6	284.8
RX	607.2	576.9	563.4	550.0	537.3	524.6	511.8	499.1	489.0	481.6
RU	612.8	577.5	542.2	507.0	471.7	436.4	401.2	365.9	330.6	295.4

RAU = 392.2 (kips); RA2 = 559.5 (kips)

Current CAPWAP Ru = 501.0 (kips); Corresponding J(RP)= 0.30; J(RX) = 0.69

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
16.9	35.83	467.5	498.0	498.0	1.23	0.13	0.13	32.8	582.8	2153

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
105.3	15.5	29992.2	492.000	3.97

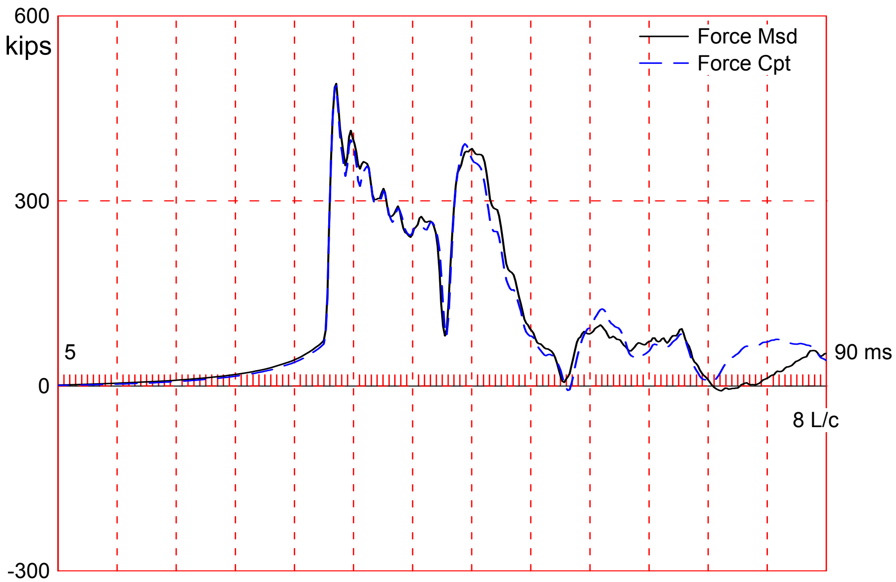
Toe Area 141.9 in^2

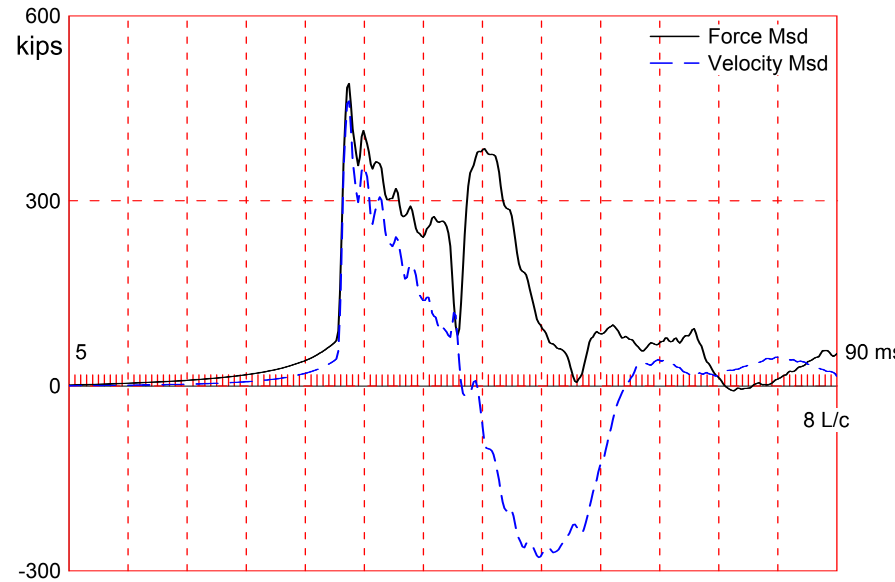
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

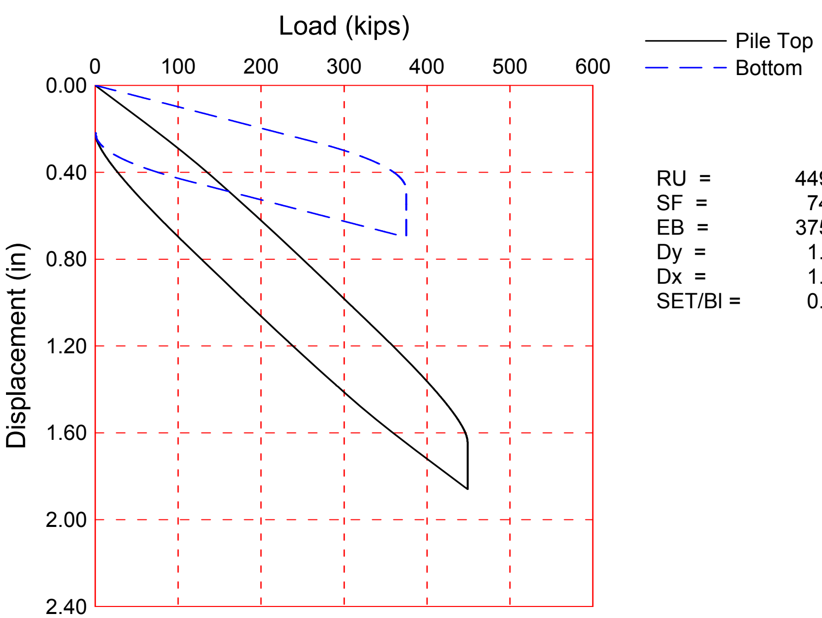
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s

Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 12.5 ms
Total volume: 11.334 ft^3; Volume ratio considering added impedance: 1.000

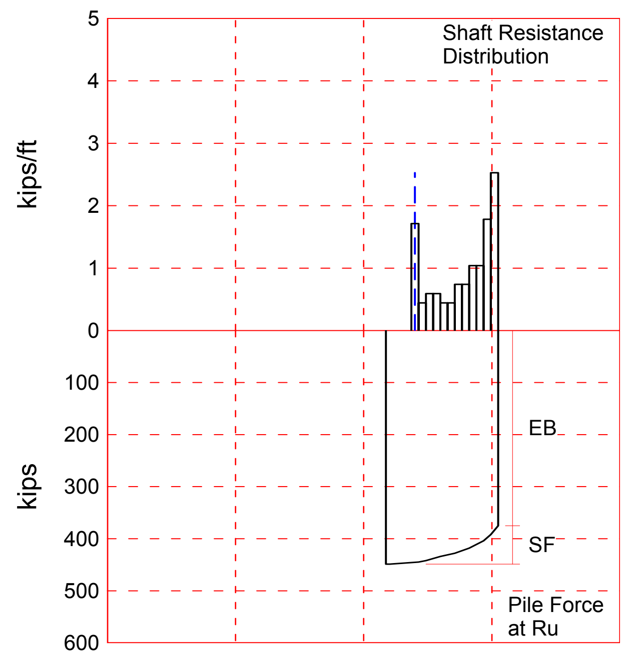
Match Quality Poor - Results May Be Unreliable!!!







RU =	449.0 kips
SF =	74.0 kips
EB =	375.0 kips
Dy =	1.64 in
Dx =	1.86 in
SET/Bl =	0.22 in



Length b. Sensors	104.2 ft
Embedment	76.3 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	6.95
Top Compr. Stress	31.5 ksi
Max Compr. Stress	32.3 ksi
Max Tension Stress	-6.23 ksi
Avg. Shaft Quake	0.18 in
Toe Quake	0.37 in
Avg. Shaft Smith Dpg.	0.16 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.

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

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Match Quality Poor - Results May Be Unreliable!!!

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 449.0; along Shaft 74.0; at Toe 375.0 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
				449.0			
1	30.3	2.3	4.0	445.0	4.0	1.71	0.43
2	37.0	9.1	3.0	442.0	7.0	0.45	0.11
3	43.7	15.8	4.0	438.0	11.0	0.60	0.15
4	50.4	22.5	4.0	434.0	15.0	0.60	0.15
5	57.1	29.2	3.0	431.0	18.0	0.45	0.11
6	63.9	35.9	3.0	428.0	21.0	0.45	0.11
7	70.6	42.7	5.0	423.0	26.0	0.74	0.19
8	77.3	49.4	5.0	418.0	31.0	0.74	0.19
9	84.0	56.1	7.0	411.0	38.0	1.04	0.26
10	90.8	62.8	7.0	404.0	45.0	1.04	0.26
11	97.5	69.6	12.0	392.0	57.0	1.79	0.45
12	104.2	76.3	17.0	375.0	74.0	2.53	0.64
Avg. Shaft			6.2			0.97	0.24
Toe			375.0				380.58

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.16	0.08
Quake	(in)	0.18	0.37
Case Damping Factor		0.43	1.08
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	30	32
Reloading Level	(% of Ru)	0	0
Unloading Level	(% of Ru)	73	
Soil Plug Weight	(kips)	0.070	

CAPWAP match quality = 6.95 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.22 in; Blow Count = 55 b/ft
Computed: Final Set = 0.18 in; Blow Count = 66 b/ft

max. Top Comp. Stress = 31.5 ksi (T= 36.2 ms, max= 1.026 x Top)
max. Comp. Stress = 32.3 ksi (Z= 30.3 ft, T= 37.8 ms)
max. Tens. Stress = -6.23 ksi (Z= 63.9 ft, T= 65.4 ms)
max. Energy (EMX) = 35.8 kip-ft; max. Measured Top Displ. (DMX)= 1.37 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	487.9	-22.3	31.5	-1.44	35.8	16.8	1.41
2	6.7	488.5	-22.4	31.5	-1.44	35.7	16.8	1.40
4	13.4	489.8	-22.7	31.6	-1.47	35.2	16.7	1.36
6	20.2	491.3	-24.3	31.7	-1.57	34.5	16.6	1.30
8	26.9	497.4	-25.3	32.1	-1.63	33.6	16.4	1.24
10	33.6	488.8	-23.5	31.5	-1.51	31.7	16.2	1.17
12	40.3	484.8	-38.9	31.3	-2.51	29.9	15.9	1.11
14	47.1	477.5	-48.5	30.8	-3.13	28.0	15.7	1.04
16	53.8	469.4	-78.3	30.3	-5.05	26.2	15.4	0.98
18	60.5	465.0	-91.4	30.0	-5.89	24.5	15.2	0.90
20	67.2	462.9	-93.5	29.9	-6.03	22.6	14.9	0.83
21	70.6	467.4	-91.4	30.1	-5.89	21.9	14.7	0.79
22	73.9	454.7	-84.2	29.3	-5.43	20.5	14.6	0.75
23	77.3	460.0	-81.8	29.7	-5.28	19.9	14.4	0.72
24	80.7	456.5	-70.7	29.4	-4.56	18.5	14.1	0.68
25	84.0	463.1	-67.9	29.9	-4.38	17.8	13.7	0.64
26	87.4	462.9	-60.7	29.9	-3.91	16.3	13.4	0.61
27	90.8	476.1	-60.8	30.7	-3.92	15.7	13.1	0.57
28	94.1	478.2	-50.7	30.8	-3.27	14.4	13.0	0.53
29	97.5	489.1	-48.2	31.5	-3.11	13.8	15.1	0.50
30	100.8	476.1	-29.1	30.7	-1.88	12.2	16.4	0.46
31	104.2	482.8	-24.2	31.1	-1.56	11.2	14.9	0.43
Absolute	30.3			32.3			(T =	37.8 ms)
	63.9				-6.23		(T =	65.4 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	530.0	441.8	353.6	265.4	177.2					
RX	574.8	556.3	537.8	520.0	508.3	501.1	496.6	492.5	488.7	485.2
RU	530.0	441.8	353.6	265.4	177.2					

RAU = 462.1 (kips); RA2 = 539.8 (kips)

Current CAPWAP Ru = 449.0 (kips); Corresponding J(RP)= 0.18;

RMX requires higher damping; see PDA-W

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
17.1	36.00	472.2	498.9	498.9	1.37	0.21	0.22	35.7	540.4	1014

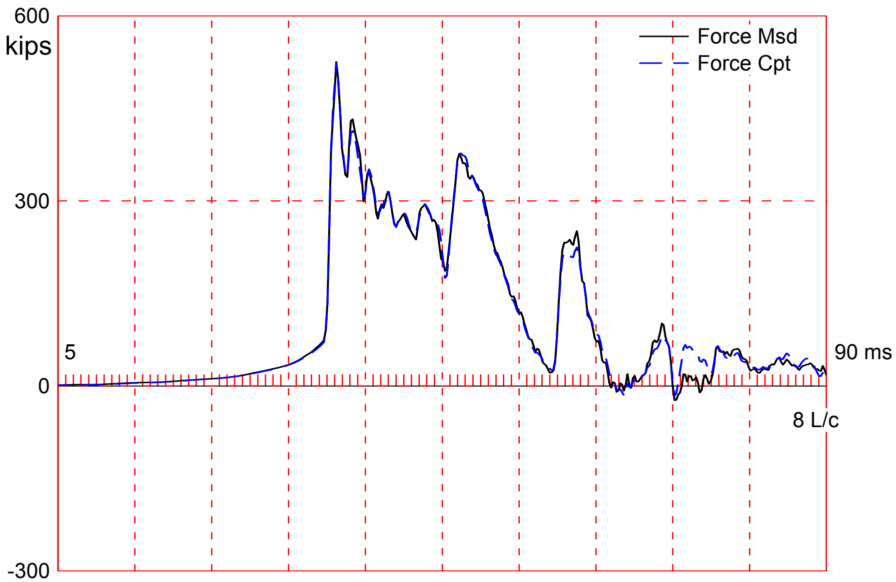
PILE PROFILE AND PILE MODEL

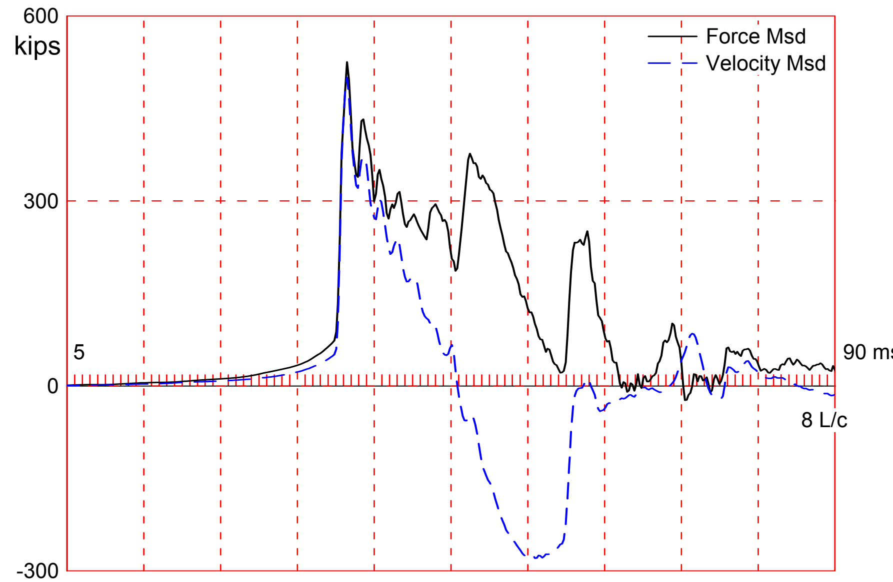
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
104.2	15.5	29992.2	492.000	3.97

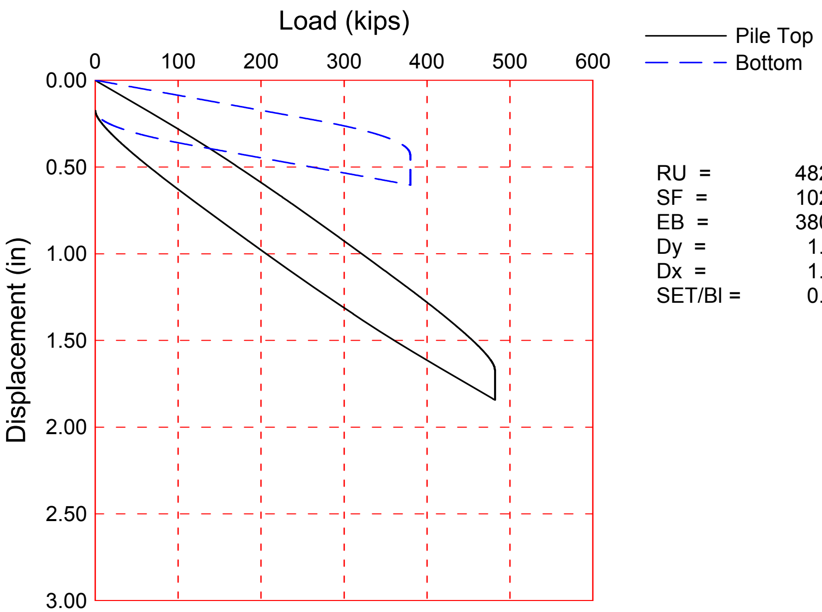
Toe Area 141.9 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.4	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000
27	90.8	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.010
28	94.1	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.020
29	97.5	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.010
31	104.2	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.020

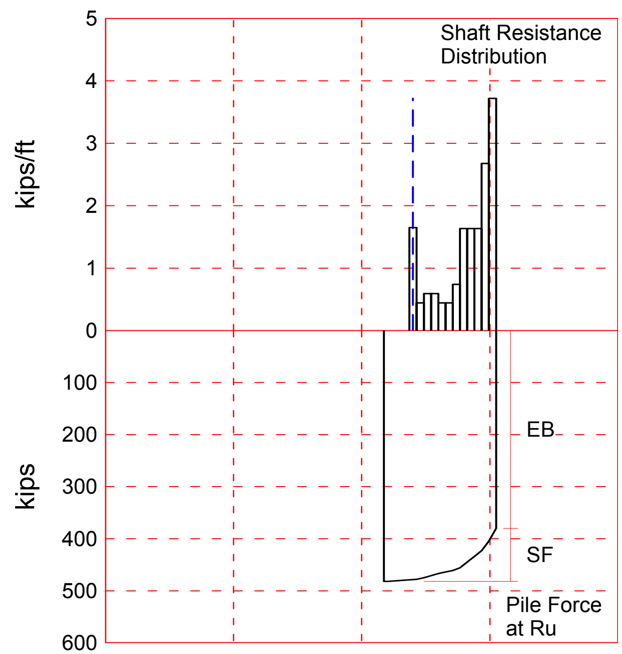
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 12.4 ms
Total volume: 11.216 ft^3; Volume ratio considering added impedance: 1.000







RU	=	482.0 kips
SF	=	102.0 kips
EB	=	380.0 kips
Dy	=	1.67 in
Dx	=	1.84 in
SET/Bl	=	0.18 in



Length b. Sensors	104.2 ft
Embedment	76.4 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	3.36
Top Compr. Stress	33.7 ksi
Max Compr. Stress	34.5 ksi
Max Tension Stress	-6.41 ksi
Avg. Shaft Quake	0.20 in
Toe Quake	0.33 in
Avg. Shaft Smith Dpg.	0.22 s/ft
Toe Smith Damping	0.08 s/ft

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

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: 482.0; along Shaft 102.0; at Toe 380.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				482.0			
1	30.3	2.4	4.0	478.0	4.0	1.65	0.42
2	37.0	9.1	3.0	475.0	7.0	0.45	0.11
3	43.7	15.9	4.0	471.0	11.0	0.60	0.15
4	50.4	22.6	4.0	467.0	15.0	0.60	0.15
5	57.1	29.3	3.0	464.0	18.0	0.45	0.11
6	63.9	36.0	3.0	461.0	21.0	0.45	0.11
7	70.6	42.8	5.0	456.0	26.0	0.74	0.19
8	77.3	49.5	11.0	445.0	37.0	1.64	0.41
9	84.0	56.2	11.0	434.0	48.0	1.64	0.41
10	90.8	62.9	11.0	423.0	59.0	1.64	0.41
11	97.5	69.7	18.0	405.0	77.0	2.68	0.67
12	104.2	76.4	25.0	380.0	102.0	3.72	0.94
Avg. Shaft			8.5			1.34	0.34
Toe			380.0				385.65

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.22	0.08
Quake	(in)	0.20	0.33
Case Damping Factor		0.81	1.10
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	100	30
Unloading Level	(% of Ru)	80	
Resistance Gap (included in Toe Quake) (in)			0.05
Soil Plug Weight	(kips)	0.045	

CAPWAP match quality = 3.36 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.18 in; Blow Count = 69 b/ft
Computed: Final Set = 0.17 in; Blow Count = 71 b/ft

max. Top Comp. Stress = 33.7 ksi (T= 36.2 ms, max= 1.023 x Top)
max. Comp. Stress = 34.5 ksi (Z= 30.3 ft, T= 37.8 ms)
max. Tens. Stress = -6.41 ksi (Z= 63.9 ft, T= 63.6 ms)
max. Energy (EMX) = 36.3 kip-ft; max. Measured Top Displ. (DMX)= 1.40 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	523.1	-34.9	33.7	-2.25	36.3	18.1	1.38
2	6.7	523.3	-34.8	33.8	-2.24	36.1	18.1	1.36
4	13.4	523.9	-34.5	33.8	-2.22	35.5	18.0	1.31
6	20.2	524.7	-33.5	33.8	-2.16	34.8	18.0	1.25
8	26.9	531.4	-34.4	34.3	-2.22	33.8	17.7	1.19
10	33.6	518.9	-31.9	33.5	-2.06	31.6	17.4	1.12
12	40.3	512.3	-38.9	33.0	-2.51	29.9	17.0	1.06
14	47.1	501.6	-51.7	32.4	-3.33	27.8	16.7	0.99
16	53.8	489.8	-72.8	31.6	-4.70	25.6	16.4	0.92
18	60.5	485.2	-90.9	31.3	-5.86	23.7	16.0	0.85
20	67.2	484.2	-98.1	31.2	-6.33	21.9	15.5	0.77
21	70.6	493.2	-97.4	31.8	-6.28	21.1	15.2	0.73
22	73.9	481.9	-88.0	31.1	-5.68	19.6	14.8	0.70
23	77.3	494.0	-88.6	31.9	-5.72	18.8	14.3	0.66
24	80.7	466.1	-70.6	30.1	-4.56	16.5	13.7	0.62
25	84.0	479.2	-68.6	30.9	-4.42	15.8	13.2	0.58
26	87.4	465.8	-51.1	30.0	-3.30	13.8	12.9	0.54
27	90.8	478.3	-52.5	30.8	-3.38	13.0	12.7	0.50
28	94.1	471.2	-38.8	30.4	-2.50	11.3	12.4	0.46
29	97.5	484.9	-38.7	31.3	-2.50	10.6	14.2	0.42
30	100.8	463.1	-19.5	29.9	-1.26	8.6	14.3	0.39
31	104.2	476.9	-21.2	30.8	-1.37	7.1	12.0	0.35
Absolute	30.3			34.5			(T =	37.8 ms)
	63.9				-6.41		(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	627.0	589.1	551.2	513.3	475.3	437.4	399.5	361.6	323.6	285.7
RX	627.0	594.9	577.0	559.0	542.0	525.2	516.5	509.3	502.1	495.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RAU = 427.1 (kips); RA2 = 522.6 (kips)

Current CAPWAP Ru = 482.0 (kips); Corresponding J(RP)= 0.76; matches RX20 within 5%

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
18.1	36.00	499.9	525.3	525.3	1.40	0.18	0.18	36.6	558.6	1357

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
104.2	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.4	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000
26	87.4	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.015
29	97.5	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000
31	104.2	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.200 ms, 2L/c 12.4 ms
Total volume: 11.216 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Al Ziai
Company: Lunda Construction Company	No. of Sheets: 32
E-mail: whamacher@lundaconstruction.com	Date: November 19, 2014

RE: Dynamic Testing Results – Pier 11
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On November 17, 2014, Pier 11 #1 and Pier 11 #32 at the above structure were dynamically tested during initial driving.   The piles were tested during restrike on November 18.   The 75.4 foot long HP 12 x 53 H-piles were equipped with driving shoes and were driven with an APE D25-42 hammer operated on fuel setting three. Plans indicate the piles in Pier 11 have a required driving resistance, or ultimate capacity, of 380 kips and an estimated length of 50 feet.

Pier 11 #1 was driven to a depth of 54.6 feet below the excavated ground surface at EL 590.5, which corresponds to a pile tip elevation of EL 535.9.   The blow count over the final increment of driving was 10 blows for ¾ inch of penetration at an average hammer stroke of 9.1 feet.   The blow count at the beginning of restrike of Pier 11 #1 was 10 blows for ½ inch of penetration at an average hammer stroke of 9.3 feet.

Pier 11 #32 was driven to a depth of 54.6 feet below the excavated ground surface at EL 590.5, which corresponds to a pile tip elevation of EL 535.9.   The blow count over the final increment of driving was 10 blows for 1¼ inch of penetration at an average hammer stroke of 8.9 feet.   The blow count at the beginning of restrike of Pier 11 #32 was 10 blows for ½ inch of penetration at an average hammer stroke of 8.9 feet.

For the 380 kip piles, driven with the APE D25-42 hammer, in Pier 11 of the STH 96 Bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.5	11
8.0	8
8.5	6
9.0	5

We recommended the above blow count at the corresponding hammer stroke be maintained for

November 19, 2014

two consecutive inches of driving. Driving may be terminated if production piles exceed 10 blows over an increment of one inch or less at hammer strokes of 8.5 feet. After splicing or any other delays, we recommend not applying the criteria until at least two feet of driving has occurred beyond the termination depth associated with the delay.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Al Ziai

Al Ziai

Travis Coleman, P.E.

cc: Steve Seymour - steve.seymour@omnni.com
Jeff Horsfall - jeffrey.horsfall@dot.wi.gov

Attachments:

Dynamic Results (Pages 3 – 12)
CAPWAP Results (Pages 13 – 32)

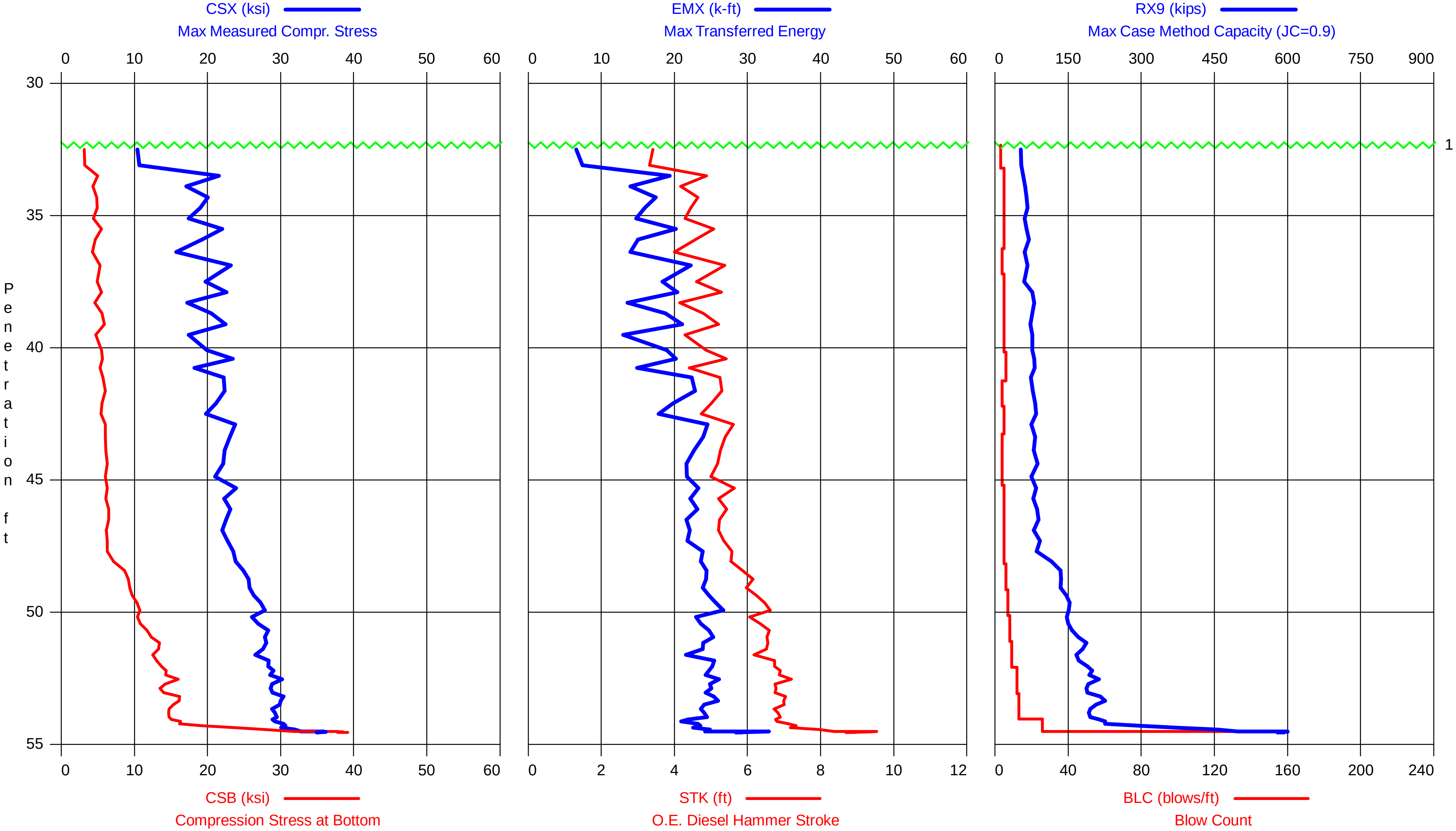
GRL Engineers, Inc. - Case Method & iCAP® Results

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

Test date: 17-Nov-2014

STH 96 over Fox River (B-5-831) - Pier 11 #1 - EOID

APE D25-42, HP 12 x 53



1 - Reference Elevation EL 590.5

STH 96 over Fox River (B-5-831) - Pier 11 #1 - EOID
APE D25-42, HP 12 x 53
OP: RF
Test date: 17-Nov-2014

AR: 15.50 in^2
LE: 72.40 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
40	19.00	3	AV1	12.0	3.5	3.6	8	61	60
			MAX	12.0	3.5	3.6	8	61	60
			MIN	12.0	3.5	3.6	8	61	60
40	20.00	3	AV1	8.8	2.8	3.2	5	64	45
			MAX	8.8	2.8	3.2	5	64	45
			MIN	8.8	2.8	3.2	5	64	45
40	21.00	3	AV1	8.8	2.7	3.2	5	65	46
			MAX	8.8	2.7	3.2	5	65	46
			MIN	8.8	2.7	3.2	5	65	46
40	22.00	3	AV1	12.5	3.7	3.5	10	62	60
			MAX	12.5	3.7	3.5	10	62	60
			MIN	12.5	3.7	3.5	10	62	60
40	23.00	3	AV1	21.1	4.9	4.8	21	53	46
			MAX	21.1	4.9	4.8	21	53	46
			MIN	21.1	4.9	4.8	21	53	46
40	24.00	3	AV1	22.0	5.1	4.9	18	53	70
			MAX	22.0	5.1	4.9	18	53	70
			MIN	22.0	5.1	4.9	18	53	70
40	25.00	3	AV1	18.0	4.6	4.3	14	56	69
			MAX	18.0	4.6	4.3	14	56	69
			MIN	18.0	4.6	4.3	14	56	69
40	26.00	3	AV1	16.2	4.0	4.0	14	58	54
			MAX	16.2	4.0	4.0	14	58	54
			MIN	16.2	4.0	4.0	14	58	54
40	27.00	3	AV1	18.9	4.3	4.4	17	55	61
			MAX	18.9	4.3	4.4	17	55	61
			MIN	18.9	4.3	4.4	17	55	61
40	28.00	3	AV1	21.2	5.4	4.9	18	53	68
			MAX	21.2	5.4	4.9	18	53	68
			MIN	21.2	5.4	4.9	18	53	68
40	29.00	3	AV1	19.6	5.2	4.6	17	54	69
			MAX	19.6	5.2	4.6	17	54	69
			MIN	19.6	5.2	4.6	17	54	69
40	30.00	3	AV1	18.4	4.6	4.3	15	56	65
			MAX	18.4	4.6	4.3	15	56	65
			MIN	18.4	4.6	4.3	15	56	65
40	31.00	3	AV1	18.1	4.5	4.3	14	56	65
			MAX	18.1	4.5	4.4	14	56	65
			MIN	18.1	4.5	4.4	14	56	65
40	32.00	3	AV1	16.8	4.2	4.2	15	57	57
			MAX	16.8	4.2	4.2	15	57	57
			MIN	16.8	4.2	4.2	15	57	57
42	33.00	3	AV1	21.7	4.9	5.1	20	52	62
			MAX	21.7	4.9	5.1	20	52	62
			MIN	21.7	4.9	5.1	20	52	62
47	34.00	5	AV1	22.3	6.1	5.1	21	52	68
			MAX	22.3	6.1	5.1	21	52	68
			MIN	22.3	6.1	5.1	21	52	68
52	35.00	5	AV1	21.6	5.0	5.0	18	52	68
			MAX	21.6	5.0	5.0	18	52	68
			MIN	21.6	5.0	5.0	18	52	68
57	36.00	5	AV1	17.0	4.4	4.2	12	57	71
			MAX	17.0	4.4	4.2	12	57	71
			MIN	17.0	4.4	4.2	12	57	71

STH 96 over Fox River (B-5-831) - Pier 11 #1 - EOID
OP: RF

APE D25-42, HP 12 x 53
Test date: 17-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
61	37.00	4	AV4	19.5	4.8	4.7	18	54	64
			STD	4.4	0.7	0.8	6	4	6
			MAX	24.0	5.6	5.5	24	61	68
			MIN	12.6	3.7	3.6	9	50	53
66	38.00	5	AV4	21.2	5.2	4.9	19	53	68
			STD	2.2	0.5	0.5	3	2	9
			MAX	23.5	5.8	5.5	23	57	77
			MIN	17.6	4.4	4.2	15	50	56
71	39.00	5	AV5	19.5	5.3	4.6	17	55	77
			STD	2.3	0.7	0.4	3	2	4
			MAX	22.2	6.4	5.1	22	59	82
			MIN	15.6	4.4	3.9	12	52	72
76	40.00	5	AV4	18.3	4.9	4.5	15	55	76
			STD	2.9	0.4	0.5	3	3	3
			MAX	22.7	5.4	5.3	21	58	79
			MIN	15.6	4.5	4.0	11	51	72
82	41.00	6	AV6	21.3	5.6	5.0	19	52	79
			STD	2.7	0.4	0.6	3	3	4
			MAX	24.7	6.4	5.8	24	56	85
			MIN	17.5	4.9	4.3	15	49	75
86	42.00	4	AV4	22.6	6.0	5.3	23	51	76
			STD	1.2	0.1	0.3	2	1	4
			MAX	24.5	6.2	5.7	26	52	82
			MIN	21.3	5.8	5.0	21	49	71
91	43.00	5	AV5	21.6	5.7	5.1	21	52	81
			STD	1.9	0.3	0.4	3	2	6
			MAX	24.3	6.2	5.8	25	54	87
			MIN	19.1	5.4	4.6	17	49	72
95	44.00	4	AV4	22.7	6.1	5.3	23	51	81
			STD	0.7	0.1	0.2	1	1	2
			MAX	23.9	6.2	5.6	25	52	84
			MIN	22.1	5.9	5.2	22	50	79
99	45.00	4	AV4	21.6	6.2	5.1	22	52	81
			STD	0.8	0.3	0.2	2	1	8
			MAX	22.3	6.6	5.2	24	53	89
			MIN	20.2	5.7	4.8	20	51	69
104	46.00	5	AV5	23.1	6.2	5.4	23	50	81
			STD	0.8	0.2	0.2	1	1	3
			MAX	24.3	6.4	5.8	24	51	86
			MIN	22.3	5.8	5.2	22	49	78
109	47.00	5	AV5	22.5	6.4	5.3	22	51	85
			STD	0.7	0.2	0.2	1	1	5
			MAX	23.4	6.6	5.5	23	52	92
			MIN	21.4	6.0	5.1	21	50	77
114	48.00	5	AV5	23.1	6.4	5.5	23	50	92
			STD	0.8	0.2	0.2	1	1	9
			MAX	24.6	6.7	5.8	24	51	108
			MIN	22.2	6.1	5.2	21	49	82
120	49.00	6	AV6	25.3	8.8	5.9	24	48	132
			STD	1.2	0.7	0.3	1	1	6
			MAX	27.0	9.7	6.5	25	50	140
			MIN	23.6	7.6	5.6	23	46	123
127	50.00	7	AV7	26.9	10.1	6.4	25	47	148
			STD	1.0	0.7	0.3	1	1	7
			MAX	28.9	11.3	6.9	27	48	157
			MIN	25.6	9.1	6.0	23	45	137
135	51.00	8	AV8	27.3	11.3	6.4	24	47	156
			STD	1.5	0.8	0.4	1	1	9
			MAX	29.5	12.8	6.9	27	48	171
			MIN	25.4	10.2	5.9	22	45	142

STH 96 over Fox River (B-5-831) - Pier 11 #1 - EOID
OP: RF

APE D25-42, HP 12 x 53
Test date: 17-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
144	52.00	9	AV9	27.6	13.1	6.5	24	46	177
			STD	1.0	0.4	0.3	2	1	9
			MAX	29.5	13.7	7.0	27	48	189
			MIN	25.8	12.2	6.0	20	45	164
156	53.00	12	AV12	29.0	14.4	6.9	25	45	196
			STD	1.5	0.9	0.4	2	1	9
			MAX	31.9	16.3	7.8	28	47	215
			MIN	26.9	12.8	6.3	22	42	183
169	54.00	13	AV13	29.6	15.2	6.9	25	45	204
			STD	0.9	0.8	0.2	2	1	13
			MAX	31.4	16.3	7.5	27	46	227
			MIN	28.4	13.9	6.5	21	43	191
182	54.50	26	AV13	30.3	20.6	7.2	23	44	309
			STD	1.3	5.3	0.5	2	1	95
			MAX	32.2	30.2	8.0	25	46	480
			MIN	27.9	14.5	6.5	19	42	205
191	54.56	160	AV9	35.4	37.8	9.1	30	39	588
			STD	0.8	1.7	0.4	2	1	14
			MAX	37.0	39.4	9.9	34	41	606
			MIN	34.1	33.6	8.4	28	38	560
			Average	25.0	11.4	6.0	22	49	163
			Std. Dev.	5.4	8.5	1.3	5	5	133
			Maximum	37.0	39.4	9.9	34	65	606
			Minimum	8.8	2.7	3.2	5	38	45

Total number of blows analyzed: 150

BL#	depth (ft)	Comments
40	32.33	Reference Elevation EL 590.5

Time Summary

Drive 6 minutes 31 seconds 4:24:31 PM - 4:31:02 PM (11/17/2014) BN 1 - 192

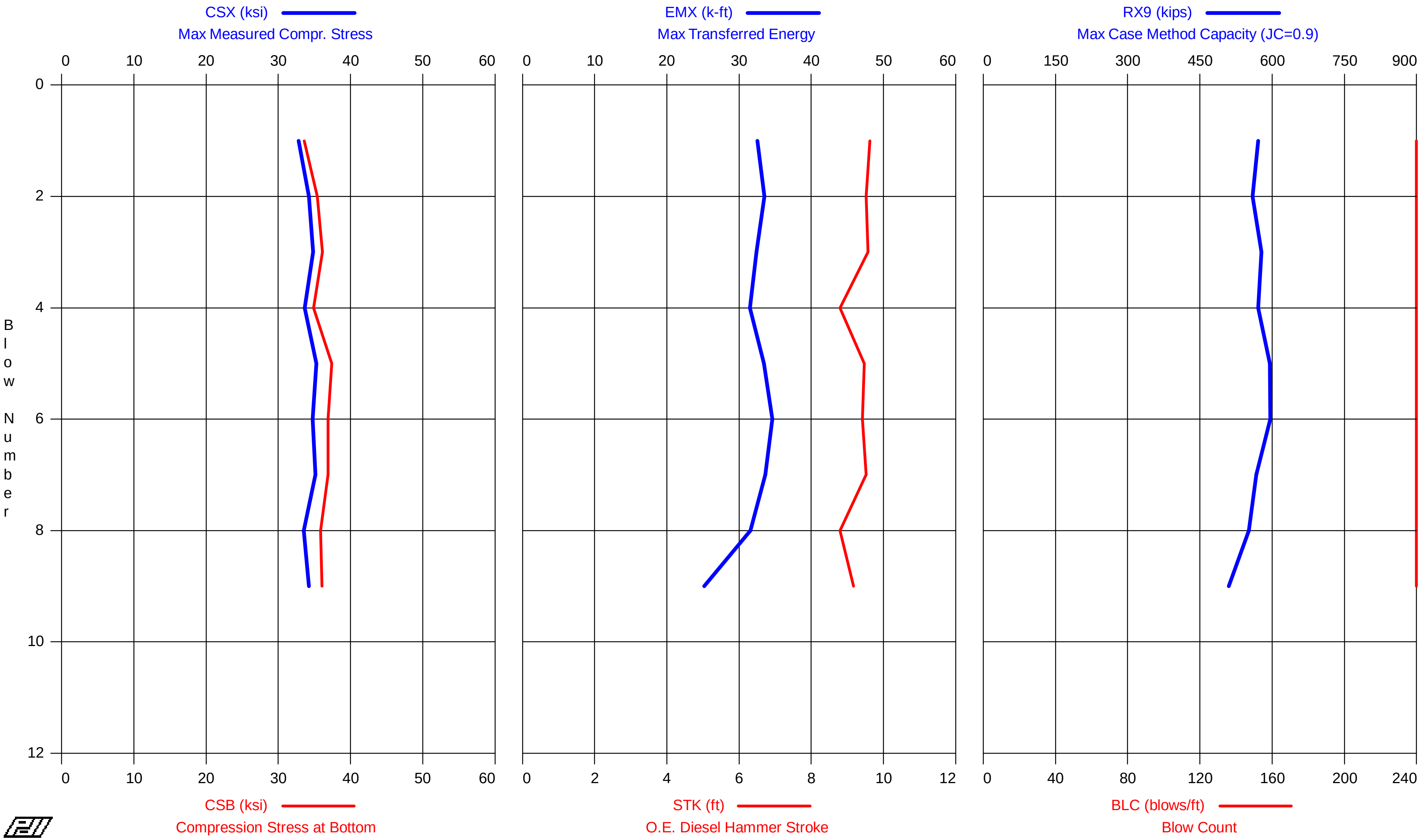
GRL Engineers, Inc. - Case Method & iCAP® Results

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

Test date: 18-Nov-2014

STH 96 over Fox River (B-5-831) - PIER 11 #1 - BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - PIER 11 #1 - BOR APE D25-42, HP 12 x 53
OP: AZ Test date: 18-Nov-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
9	54.60	240	AV9	34.3	35.9	9.3	32	39	566
			STD	0.8	1.1	0.3	3	1	24
			MAX	35.3	37.4	9.6	35	40	596
			MIN	32.8	33.6	8.8	25	38	510
			Average	34.3	35.9	9.3	32	39	566
			Std. Dev.	0.8	1.1	0.3	3	1	24
			Maximum	35.3	37.4	9.6	35	40	596
			Minimum	32.8	33.6	8.8	25	38	510

Total number of blows analyzed: 9

Time Summary

Drive 14 seconds 4:12:53 PM - 4:13:07 PM (11/18/2014) BN 1 - 10

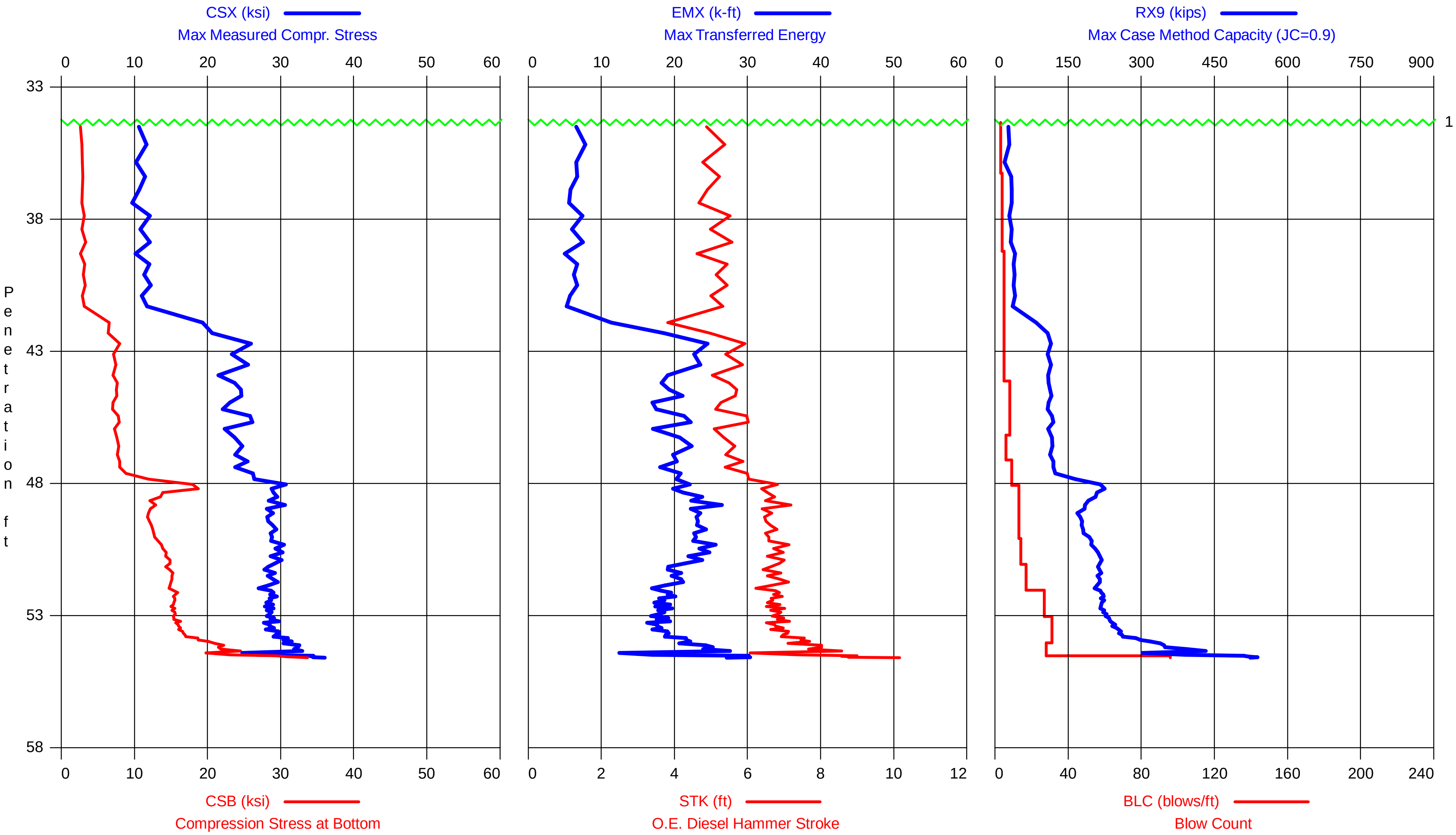
GRL Engineers, Inc. - Case Method & iCAP® Results

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

Test date: 17-Nov-2014

STH 96 over Fox River (B-5-831) - Pier 11 #32 - EOID

APE D25-42, HP 12 x 53



1 - Reference Elevation EL 590.5

STH 96 over Fox River (B-5-831) - Pier 11 #32 - EOID APE D25-42, HP 12 x 53
OP: RF Test date: 17-Nov-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
3	35.00	3	AV3	10.8	2.7	5.0	7	52	26
			STD	0.2	0.1	0.1	1	1	2
			MAX	11.1	2.7	5.1	8	53	28
			MIN	10.6	2.6	4.9	6	52	23
6	36.00	3	AV3	10.9	2.9	5.1	7	52	24
			STD	1.0	0.1	0.4	1	2	8
			MAX	12.3	3.0	5.6	8	54	35
			MIN	10.2	2.8	4.7	6	49	17
10	37.00	4	AV4	11.1	2.9	5.1	6	52	33
			STD	0.5	0.1	0.2	1	1	1
			MAX	11.8	3.0	5.3	7	53	34
			MIN	10.6	2.8	4.9	6	51	31
14	38.00	4	AV4	10.9	3.0	5.1	7	52	32
			STD	1.4	0.3	0.5	1	2	4
			MAX	12.6	3.2	5.7	8	56	38
			MIN	9.0	2.5	4.4	5	49	27
18	39.00	4	AV4	11.5	3.1	5.3	7	51	33
			STD	1.0	0.3	0.4	1	2	1
			MAX	13.2	3.3	6.0	8	53	35
			MIN	10.7	2.7	4.9	6	48	31
23	40.00	5	AV5	11.2	2.9	5.1	6	52	40
			STD	1.0	0.3	0.4	1	2	3
			MAX	12.4	3.2	5.7	7	56	42
			MIN	9.4	2.5	4.4	5	49	34
28	41.00	5	AV5	11.5	3.1	5.2	6	51	40
			STD	0.6	0.2	0.2	0	1	3
			MAX	12.5	3.3	5.6	7	53	44
			MIN	10.9	2.9	5.0	6	50	36
33	42.00	5	AV4	15.5	4.9	4.8	8	54	60
			STD	4.9	1.9	0.7	4	4	24
			MAX	23.7	7.7	5.5	16	59	86
			MIN	11.3	2.9	3.8	4	50	35
38	43.00	5	AV5	22.9	7.1	5.4	21	51	111
			STD	4.4	1.0	0.9	5	4	7
			MAX	26.3	8.2	6.1	26	59	118
			MIN	14.9	5.4	3.8	11	48	98
43	44.00	5	AV5	23.8	7.3	5.5	22	50	111
			STD	1.9	0.2	0.4	3	2	4
			MAX	25.9	7.5	6.0	26	52	118
			MIN	21.2	6.9	5.0	18	48	106
51	45.00	8	AV8	24.0	7.5	5.5	19	50	112
			STD	1.7	0.3	0.4	2	2	3
			MAX	26.4	8.0	6.1	22	53	116
			MIN	21.5	7.1	4.9	17	48	108
59	46.00	8	AV8	24.1	7.5	5.6	20	50	113
			STD	2.2	0.4	0.5	2	2	5
			MAX	27.5	8.1	6.4	22	53	121
			MIN	20.7	6.8	4.9	17	46	107
65	47.00	6	AV6	24.1	7.7	5.5	21	50	116
			STD	1.8	0.3	0.4	3	2	5
			MAX	26.9	8.2	6.1	25	52	124
			MIN	21.7	7.3	5.0	17	48	110
74	48.00	9	AV9	26.0	10.3	5.9	20	48	141
			STD	2.3	3.6	0.5	2	2	32
			MAX	29.9	18.9	6.7	22	52	213
			MIN	22.6	7.7	5.1	17	45	117

STH 96 over Fox River (B-5-831) - Pier 11 #32 - EOID
OP: RF

APE D25-42, HP 12 x 53
Test date: 17-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
87	49.00	13	AV13	29.3	14.1	6.7	23	46	201
			STD	1.5	2.3	0.4	2	1	17
			MAX	31.6	19.3	7.5	28	48	236
			MIN	26.6	11.5	6.0	19	43	177
100	50.00	13	AV13	28.8	12.3	6.6	23	46	178
			STD	1.0	0.5	0.3	1	1	6
			MAX	30.7	13.3	7.2	25	48	191
			MIN	27.1	11.6	6.1	21	44	169
114	51.00	14	AV14	29.4	14.0	6.8	23	45	207
			STD	1.1	0.7	0.3	2	1	9
			MAX	30.9	15.1	7.2	26	48	219
			MIN	27.3	12.2	6.1	21	44	194
131	52.00	17	AV17	28.5	14.9	6.7	20	46	212
			STD	1.3	0.6	0.4	2	1	6
			MAX	30.9	16.1	7.5	22	48	222
			MIN	26.2	14.1	6.0	17	43	201
158	53.00	27	AV27	28.6	15.4	6.8	19	45	221
			STD	1.1	0.4	0.3	2	1	4
			MAX	30.9	16.3	7.6	22	47	229
			MIN	26.6	14.8	6.1	16	43	215
189	54.00	31	AV31	29.3	16.8	7.0	19	45	257
			STD	1.4	1.4	0.4	2	1	24
			MAX	32.1	20.8	7.9	22	47	323
			MIN	26.5	14.9	6.2	15	42	228
203	54.50	28	AV14	30.3	22.0	7.6	22	43	365
			STD	4.4	3.1	1.1	6	4	56
			MAX	33.4	26.4	8.6	28	57	448
			MIN	16.9	13.2	4.1	5	40	220
212	54.59	96	AV9	34.6	31.1	8.9	29	40	522
			STD	0.8	1.5	0.5	2	1	15
			MAX	36.0	33.7	10.2	32	41	561
			MIN	33.4	28.6	8.4	27	37	508
			Average	25.8	13.0	6.5	19	47	195
			Std. Dev.	6.7	6.7	1.0	6	4	112
			Maximum	36.0	33.7	10.2	32	59	561
			Minimum	9.0	2.5	3.8	4	37	17

Total number of blows analyzed: 211

BL#	depth (ft)	Comments
1	34.33	Reference Elevation EL 590.5

Time Summary

Drive	33 seconds	3:21:44 PM - 3:22:17 PM (11/17/2014) BN 1 - 30
Stop	12 minutes 13 seconds	3:22:17 PM - 3:34:30 PM
Drive	4 minutes 37 seconds	3:34:30 PM - 3:39:07 PM BN 32 - 213

Total time [0:17:23] = (Driving [0:05:10] + Stop [0:12:13])

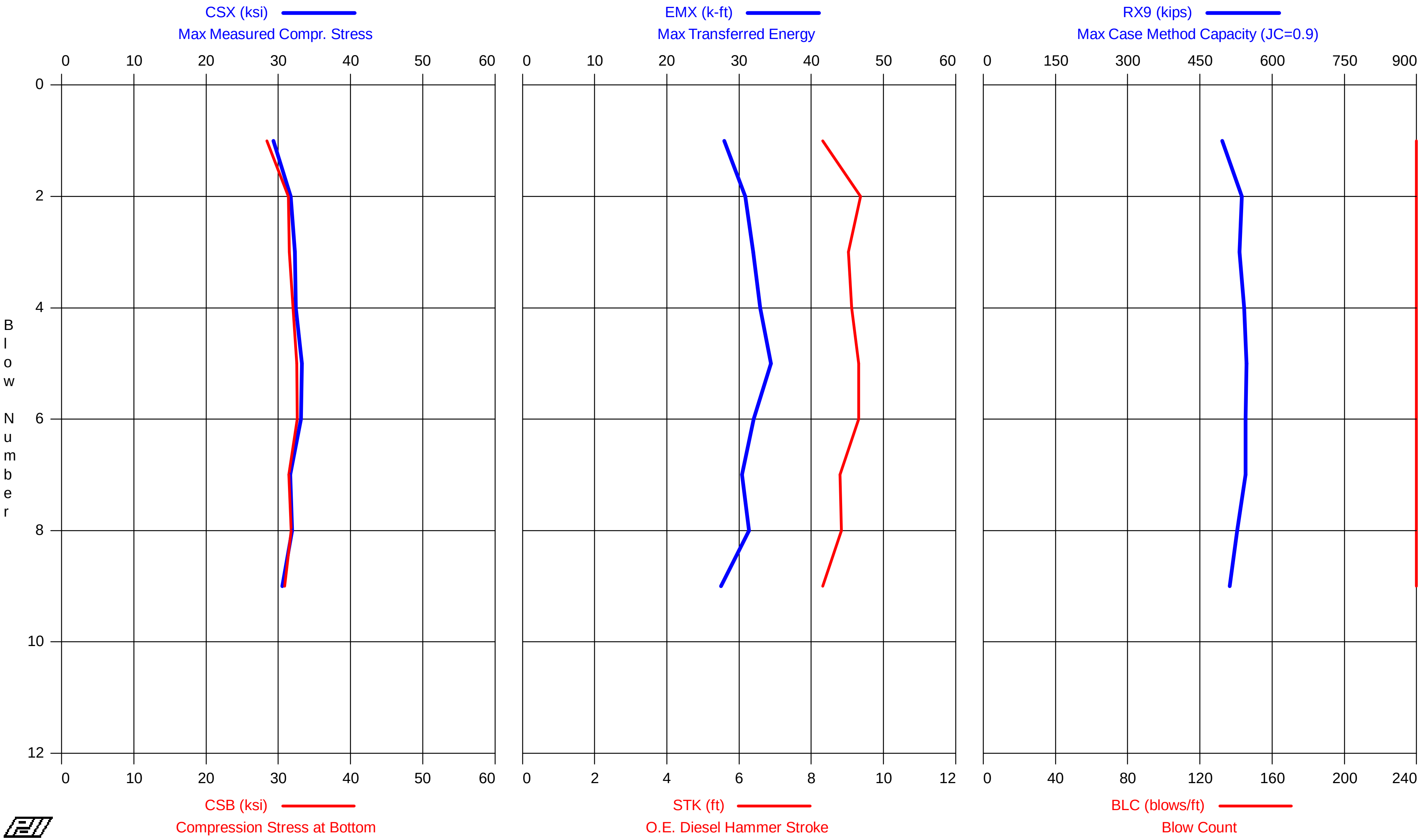
GRL Engineers, Inc. - Case Method & iCAP® Results

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

Test date: 18-Nov-2014

STH 96 over Fox River (B-5-831) - PIER 11 #32 - BOR

APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - PIER 11 #32 - BOR APE D25-42, HP 12 x 53
OP: AZ Test date: 18-Nov-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

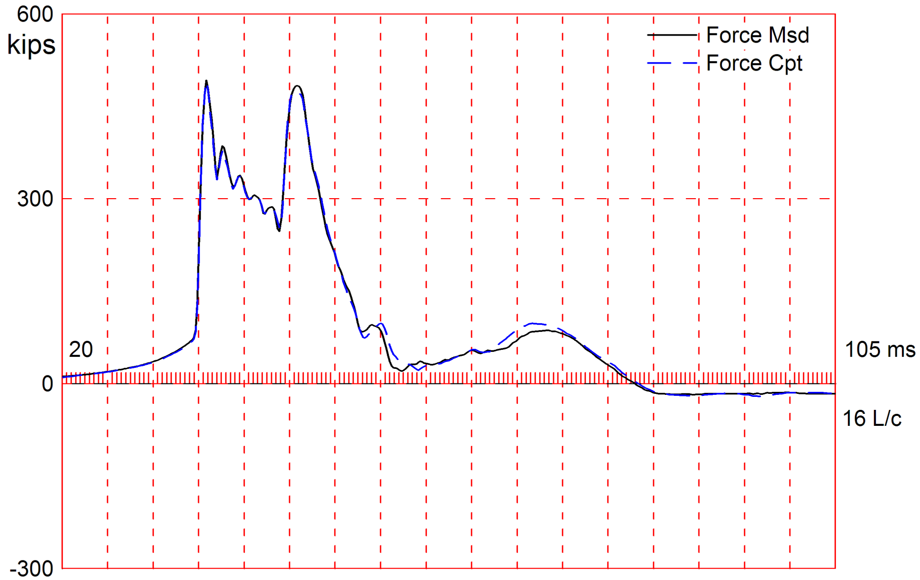
CSX: Max Measured Compr. Stress EMX: Max Transferred Energy
CSB: Compression Stress at Bottom BPM: Blows per Minute
STK: O.E. Diesel Hammer Stroke RX9: Max Case Method Capacity (JC=0.9)

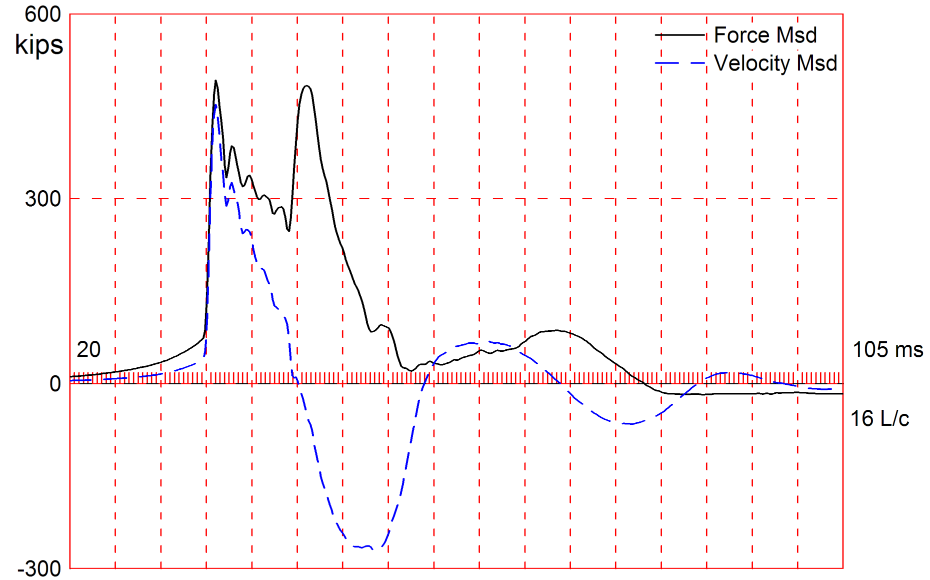
BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
9	54.64	240	AV9	31.8	31.4	8.9	31	40	531
			STD	1.2	1.2	0.4	2	1	16
			MAX	33.3	32.6	9.4	34	41	547
			MIN	29.3	28.4	8.3	28	39	496
			Average	31.8	31.4	8.9	31	40	531
			Std. Dev.	1.2	1.2	0.4	2	1	16
			Maximum	33.3	32.6	9.4	34	41	547
			Minimum	29.3	28.4	8.3	28	39	496

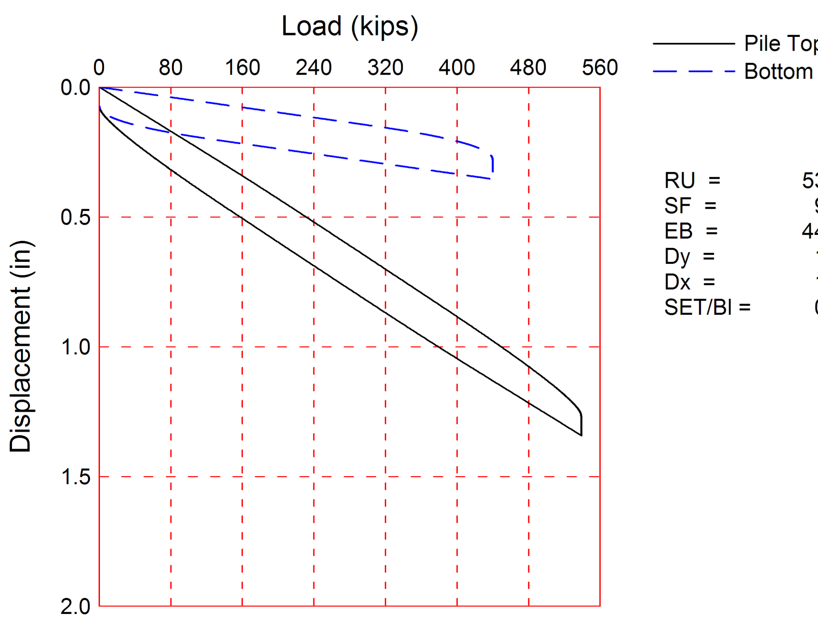
Total number of blows analyzed: 9

Time Summary

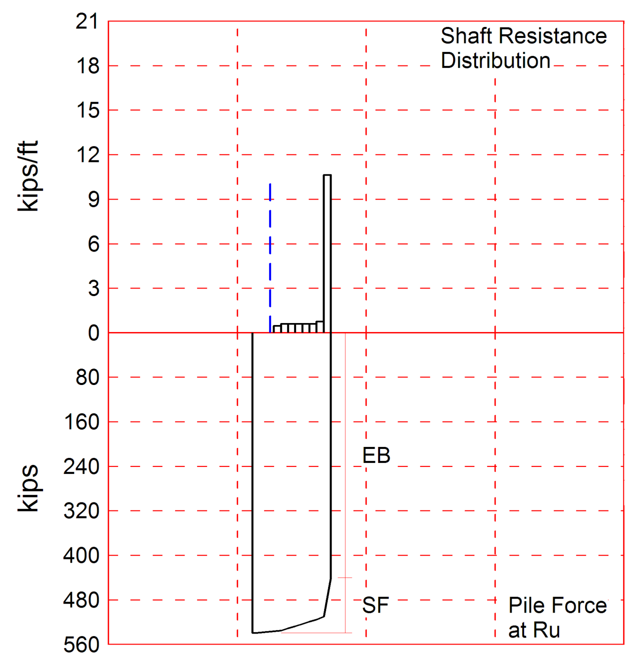
Drive 13 seconds 3:54:25 PM - 3:54:38 PM (11/18/2014) BN 1 - 10







RU	=	539.0 kips
SF	=	99.0 kips
EB	=	440.0 kips
Dy	=	1.27 in
Dx	=	1.34 in
SET/Bl	=	0.08 in



Length b. Sensors	72.4 ft
Embedment	54.5 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.12
Top Compr. Stress	31.6 ksi
Max Compr. Stress	36.6 ksi
Max Tension Stress	-5.04 ksi
Avg. Shaft Quake	0.21 in
Toe Quake	0.21 in
Avg. Shaft Smith Dpg.	0.29 s/ft
Toe Smith Damping	0.06 s/ft

About the CAPWAP Results

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

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

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

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

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

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

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

The CAPWAP analysis software is one of many means by which the capacity of a deep foundation can be assessed. The engineer performing the analysis is responsible for proper software application and the analysis results. Pile Dynamics accepts

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 539.0; along Shaft 99.0; at Toe 440.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				539.0			
1	26.3	8.5	4.0	535.0	4.0	0.47	0.12
2	32.9	15.0	4.0	531.0	8.0	0.61	0.15
3	39.5	21.6	4.0	527.0	12.0	0.61	0.15
4	46.1	28.2	4.0	523.0	16.0	0.61	0.15
5	52.7	34.8	4.0	519.0	20.0	0.61	0.15
6	59.2	41.4	4.0	515.0	24.0	0.61	0.15
7	65.8	48.0	5.0	510.0	29.0	0.76	0.19
8	72.4	54.5	70.0	440.0	99.0	10.64	2.68
Avg. Shaft			12.4			1.82	0.46
Toe			440.0				446.54

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.29	0.06
Quake	(in)	0.21	0.21
Case Damping Factor		1.04	0.95
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	38	30
Unloading Level	(% of Ru)	36	
Resistance Gap (included in Toe Quake) (in)			0.00
Soil Plug Weight	(kips)		0.009

CAPWAP match quality = 2.12 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.08 in; Blow Count = 160 b/ft
Computed: Final Set = 0.07 in; Blow Count = 183 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.94; F4(H083) CAL: 94.4; RF: 0.94
A3(K2214) CAL: 332; RF: 1.06; A4(K974) CAL: 305; RF: 1.06

max. Top Comp. Stress = 31.6 ksi (T= 36.2 ms, max= 1.158 x Top)
max. Comp. Stress = 36.6 ksi (Z= 72.4 ft, T= 40.7 ms)
max. Tens. Stress = -5.04 ksi (Z= 26.3 ft, T= 57.8 ms)
max. Energy (EMX) = 28.0 kip-ft; max. Measured Top Displ. (DMX)= 1.06 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	490.3	-22.3	31.6	-1.44	28.0	16.4	1.05
2	6.6	491.1	-23.7	31.7	-1.53	27.6	16.4	1.02
3	9.9	493.5	-26.1	31.8	-1.68	27.1	16.3	0.99
4	13.2	493.9	-31.7	31.9	-2.05	26.5	16.3	0.96
5	16.5	493.9	-45.7	31.9	-2.95	26.0	16.2	0.92
6	19.7	497.6	-58.8	32.1	-3.79	25.4	16.1	0.89
7	23.0	503.1	-70.8	32.5	-4.56	24.8	15.9	0.85
8	26.3	508.8	-78.2	32.8	-5.04	24.1	15.7	0.82
9	29.6	492.4	-75.6	31.8	-4.88	22.4	15.4	0.78
10	32.9	498.0	-76.8	32.1	-4.95	21.6	15.2	0.74
11	36.2	485.4	-74.4	31.3	-4.80	19.9	15.0	0.70
12	39.5	494.2	-76.4	31.9	-4.93	19.1	14.8	0.66
13	42.8	499.0	-74.5	32.2	-4.81	17.6	14.6	0.61
14	46.1	509.4	-77.9	32.9	-5.02	16.7	14.3	0.57
15	49.4	513.2	-77.3	33.1	-4.99	15.2	14.1	0.53
16	52.7	522.5	-77.4	33.7	-4.99	14.3	13.9	0.49
17	55.9	527.9	-73.9	34.0	-4.77	12.8	13.7	0.44
18	59.2	532.9	-74.2	34.4	-4.78	11.8	13.4	0.40
19	62.5	540.9	-73.3	34.9	-4.73	10.4	13.2	0.35
20	65.8	547.8	-75.1	35.3	-4.84	9.5	13.0	0.31
21	69.1	552.5	-73.0	35.6	-4.71	8.2	12.0	0.26
22	72.4	567.8	-73.7	36.6	-4.75	5.1	9.9	0.22
Absolute	72.4			36.6			(T =	40.7 ms)
	26.3				-5.04		(T =	57.8 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	652.3	592.3	532.2	472.2	412.2					
RX	652.3	613.2	596.1	579.0	561.9	544.8	531.1	518.5	506.4	496.7
RU	652.3	592.3	532.2	472.2	412.2					

RAU = 442.0 (kips); RA2 = 574.0 (kips)

Current CAPWAP Ru = 539.0 (kips); Corresponding J(RP)= 0.38; J(RX) = 1.08

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
16.5	36.03	456.4	496.1	496.4	1.06	0.08	0.08	28.4	599.7	2095

PILE PROFILE AND PILE MODEL

Depth	Area	E-Modulus	Spec. Weight	Perim.
ft	in^2	ksi	lb/ft^3	ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

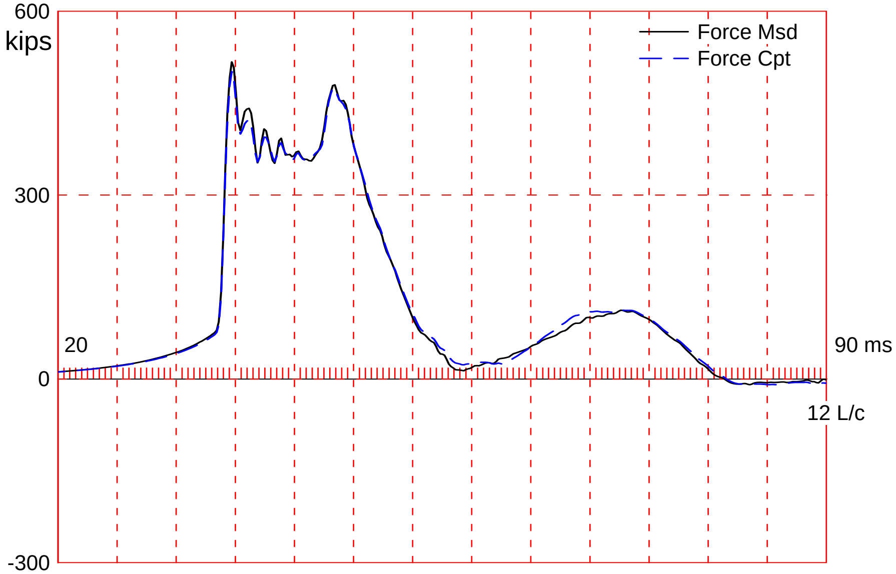
Toe Area 141.9 in^2

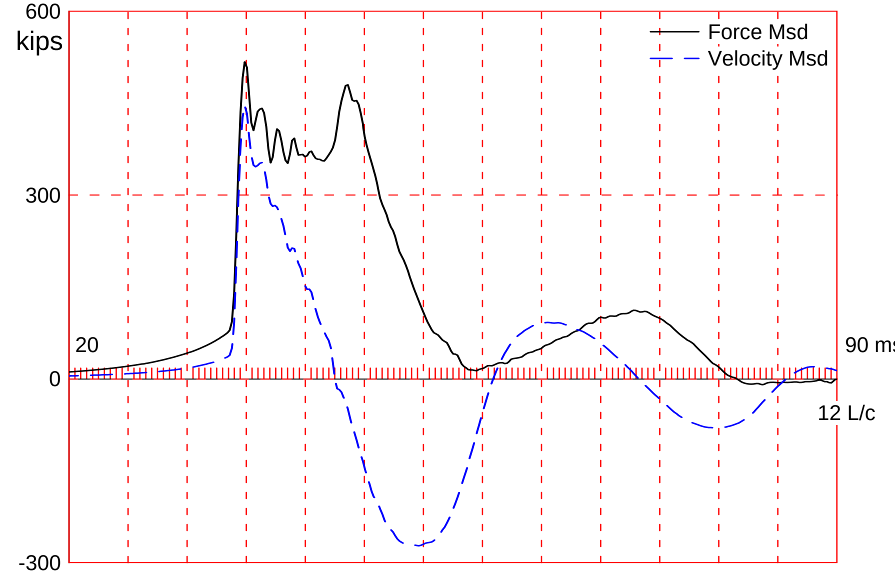
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

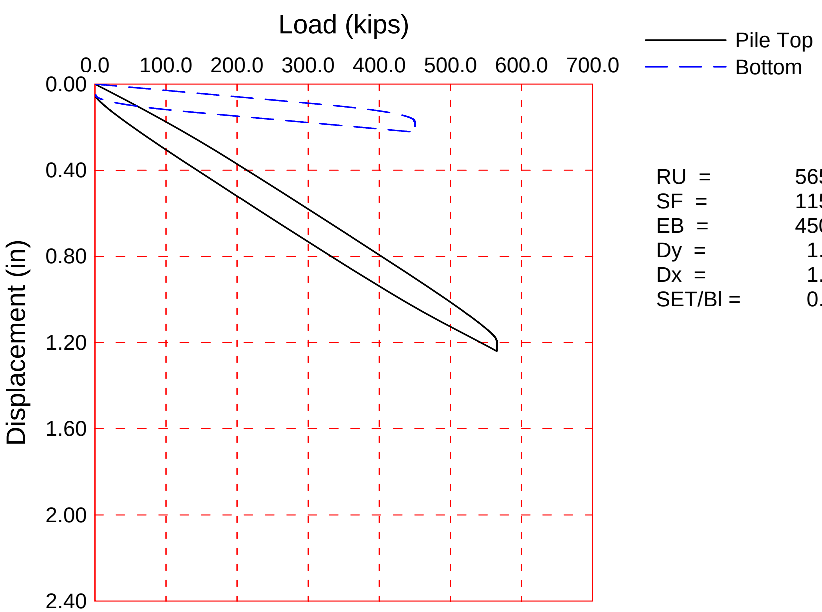
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000

STH 96 over Fox River (B-5-831); Pile: PIER 11 #1 - BOR; APE D25-42, HP 12 x 53; Blow: 4 (Test: 18-Nov-2014 16:12:)
GRL Engineers, Inc.

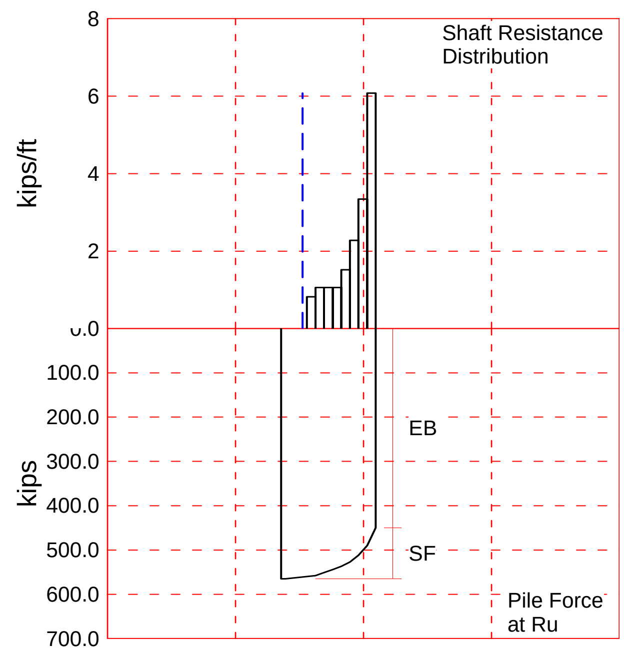
18-Nov-2014
CAPWAP(R) 2014







RU =	565.0 kips
SF =	115.0 kips
EB =	450.0 kips
Dy =	1.19 in
Dx =	1.24 in
SET/Bl =	0.05 in



Length b. Sensors	72.4 ft
Embedment	54.6 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	1.83
Top Compr. Stress	32.4 ksi
Max Compr. Stress	35.1 ksi
Max Tension Stress	-5.64 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.13 in
Avg. Shaft Smith Dpg.	0.38 s/ft
Toe Smith Damping	0.06 s/ft

About the CAPWAP Results

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

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

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

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

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

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

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

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 565.0; along Shaft 115.0; at Toe 450.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				565.0			
1	26.3	8.5	7.0	558.0	7.0	0.82	0.21
2	32.9	15.1	7.0	551.0	14.0	1.06	0.27
3	39.5	21.7	7.0	544.0	21.0	1.06	0.27
4	46.1	28.2	7.0	537.0	28.0	1.06	0.27
5	52.7	34.8	10.0	527.0	38.0	1.52	0.38
6	59.2	41.4	15.0	512.0	53.0	2.28	0.57
7	65.8	48.0	22.0	490.0	75.0	3.34	0.84
8	72.4	54.6	40.0	450.0	115.0	6.08	1.53
Avg. Shaft			14.4			2.11	0.53
Toe			450.0				456.69

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.38	0.06
Quake	(in)	0.10	0.13
Case Damping Factor		1.58	0.98
Damping Type		Viscous	Viscous
Unloading Quake	(% of loading quake)	100	72
Unloading Level	(% of Ru)	30	
Resistance Gap (included in Toe Quake) (in)			0.04

CAPWAP match quality = 1.83 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.05 in; Blow Count = 240 b/ft
Computed: Final Set = 0.04 in; Blow Count = 333 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.95; F4(H083) CAL: 94.4; RF: 0.95
A3(K974) CAL: 305; RF: 1.05; A4(K2214) CAL: 332; RF: 1.05

max. Top Comp. Stress = 32.4 ksi (T= 36.2 ms, max= 1.083 x Top)
max. Comp. Stress = 35.1 ksi (Z= 52.7 ft, T= 43.7 ms)
max. Tens. Stress = -5.64 ksi (Z= 52.7 ft, T= 58.2 ms)
max. Energy (EMX) = 31.0 kip-ft; max. Measured Top Displ. (DMX)= 1.03 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	502.9	-13.5	32.4	-0.87	31.0	16.6	1.03
2	6.6	503.9	-17.5	32.5	-1.13	30.4	16.6	1.00
3	9.9	505.0	-21.4	32.6	-1.38	29.7	16.5	0.96
4	13.2	506.3	-26.0	32.7	-1.68	29.0	16.5	0.92
5	16.5	508.1	-36.9	32.8	-2.38	28.3	16.4	0.88
6	19.7	515.3	-47.8	33.2	-3.08	27.5	16.1	0.84
7	23.0	526.2	-57.7	33.9	-3.72	26.7	15.7	0.80
8	26.3	536.4	-66.9	34.6	-4.32	25.8	15.3	0.76
9	29.6	513.7	-67.8	33.1	-4.37	23.0	14.9	0.72
10	32.9	521.6	-76.1	33.6	-4.91	22.1	14.5	0.67
11	36.2	522.2	-78.2	33.7	-5.05	19.5	14.1	0.63
12	39.5	531.5	-85.7	34.3	-5.52	18.6	13.8	0.59
13	42.8	533.0	-83.6	34.4	-5.39	16.2	13.4	0.54
14	46.1	541.9	-87.0	35.0	-5.61	15.2	13.0	0.50
15	49.4	541.3	-84.9	34.9	-5.48	13.1	12.5	0.45
16	52.7	544.4	-87.5	35.1	-5.64	12.1	12.0	0.40
17	55.9	534.0	-80.7	34.4	-5.21	10.0	11.3	0.36
18	59.2	542.7	-82.5	35.0	-5.32	9.0	10.6	0.31
19	62.5	534.0	-71.3	34.4	-4.60	6.8	9.9	0.27
20	65.8	533.6	-72.6	34.4	-4.68	5.9	9.0	0.23
21	69.1	510.3	-56.5	32.9	-3.65	4.0	7.4	0.18
22	72.4	517.9	-57.7	33.4	-3.72	2.7	5.3	0.14
Absolute	52.7			35.1			(T =	43.7 ms)
	52.7				-5.64		(T =	58.2 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	715.9	664.8	613.6	562.5	511.4					
RX	715.9	665.5	628.8	605.6	583.2	561.2	540.2	527.5	516.8	506.9
RU	710.9	658.7	606.6	554.4	502.3					

RAU = 167.8 (kips); RA2 = 628.1 (kips)

Current CAPWAP Ru = 565.0 (kips); Corresponding J(RP)= 0.59; 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
16.2	36.03	449.4	522.2	522.2	1.03	0.05	0.05	31.4	696.9	5000

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

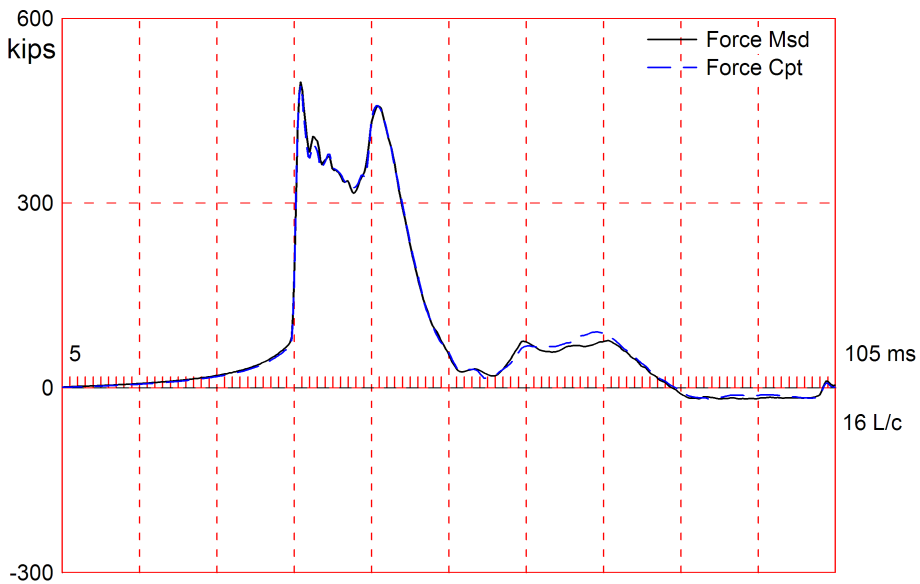
Toe Area 141.9 in^2

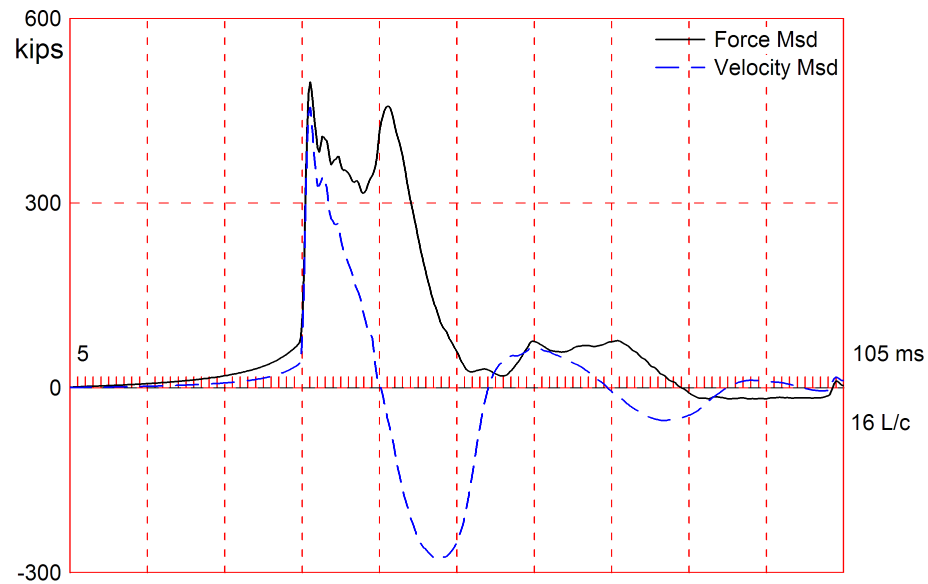
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

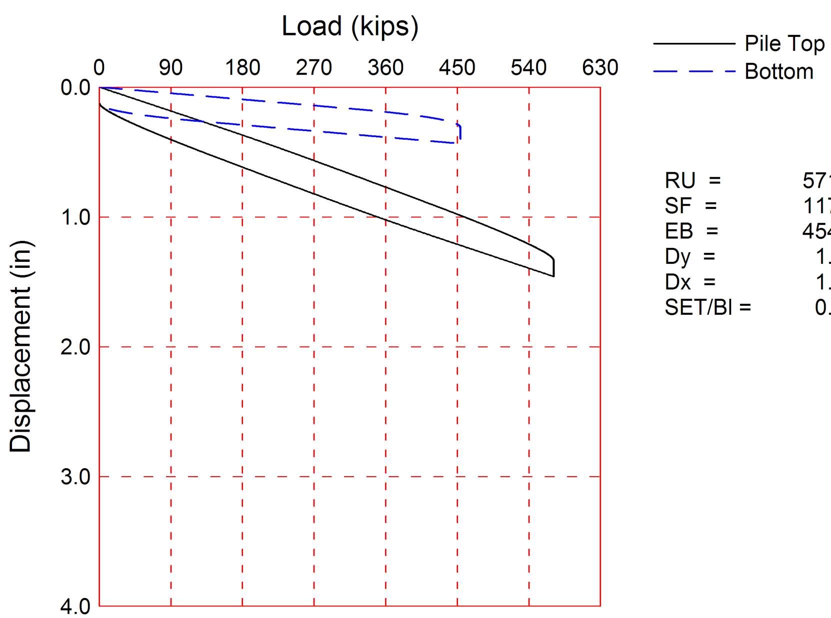
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000

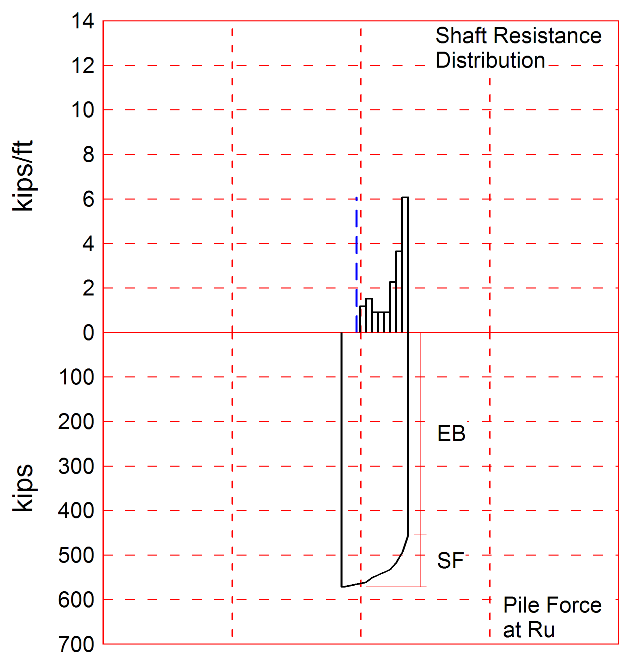
STH 96 over Fox River (B-5-831); Pile: PIER 11 #32; APE D25-42, HP 12 x 53; Blow: 211 (Test: 17-Nov-2014 15:39:) 18-Nov-2014
GRL Engineers, Inc. CAPWAP(R) 2014







RU	=	571.0 kips
SF	=	117.0 kips
EB	=	454.0 kips
Dy	=	1.33 in
Dx	=	1.46 in
SET/Bl	=	0.13 in



Length b. Sensors	72.4 ft
Embedment	54.6 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.02
Top Compr. Stress	31.7 ksi
Max Compr. Stress	33.9 ksi
Max Tension Stress	-5.70 ksi
Avg. Shaft Quake	0.24 in
Toe Quake	0.24 in
Avg. Shaft Smith Dpg.	0.27 s/ft
Toe Smith Damping	0.04 s/ft

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CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 571.0; along Shaft 117.0; at Toe 454.0 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
				571.0				
1	26.3	8.5	10.0	561.0	10.0	1.18	0.30	0.25
2	32.9	15.1	10.0	551.0	20.0	1.52	0.38	0.25
3	39.5	21.7	6.0	545.0	26.0	0.91	0.23	0.25
4	46.1	28.3	6.0	539.0	32.0	0.91	0.23	0.25
5	52.7	34.8	6.0	533.0	38.0	0.91	0.23	0.25
6	59.2	41.4	15.0	518.0	53.0	2.28	0.57	0.25
7	65.8	48.0	24.0	494.0	77.0	3.65	0.92	0.25
8	72.4	54.6	40.0	454.0	117.0	6.08	1.53	0.23
Avg. Shaft			14.6			2.14	0.54	0.24
Toe			454.0				460.75	0.24

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.27	0.04
Case Damping Factor		1.14	0.66
Damping Type		Viscous	Viscous
Unloading Quake	(% of loading quake)	82	30
Unloading Level	(% of Ru)	27	
Resistance Gap (included in Toe Quake) (in)			0.09
Soil Plug Weight	(kips)		0.031

CAPWAP match quality = 2.02 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.13 in; Blow Count = 96 b/ft
Computed: Final Set = 0.09 in; Blow Count = 139 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.95; F4(H083) CAL: 94.4; RF: 0.95
A3(K2214) CAL: 332; RF: 1.05; A4(K974) CAL: 305; RF: 1.05

max. Top Comp. Stress = 31.7 ksi (T= 36.2 ms, max= 1.070 x Top)
max. Comp. Stress = 33.9 ksi (Z= 59.2 ft, T= 43.3 ms)
max. Tens. Stress = -5.70 ksi (Z= 32.9 ft, T= 57.8 ms)
max. Energy (EMX) = 31.3 kip-ft; max. Measured Top Displ. (DMX)= 1.10 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	491.6	-19.2	31.7	-1.24	31.3	16.6	1.10
2	6.6	492.3	-21.8	31.8	-1.41	30.7	16.6	1.06
3	9.9	493.1	-24.3	31.8	-1.57	30.1	16.6	1.03
4	13.2	494.1	-31.8	31.9	-2.05	29.4	16.5	0.99
5	16.5	495.4	-45.1	32.0	-2.91	28.8	16.5	0.95
6	19.7	501.8	-57.6	32.4	-3.72	28.1	16.2	0.92
7	23.0	513.5	-69.8	33.1	-4.50	27.4	15.8	0.88
8	26.3	523.8	-81.2	33.8	-5.24	26.6	15.4	0.84
9	29.6	485.4	-81.8	31.3	-5.27	23.6	15.0	0.80
10	32.9	493.9	-88.3	31.9	-5.70	22.7	14.7	0.75
11	36.2	490.9	-81.7	31.7	-5.27	19.9	14.4	0.71
12	39.5	498.9	-83.9	32.2	-5.41	19.1	14.2	0.67
13	42.8	499.7	-80.0	32.2	-5.16	17.2	14.0	0.63
14	46.1	505.1	-82.3	32.6	-5.31	16.3	13.7	0.58
15	49.4	506.1	-78.3	32.6	-5.05	14.6	13.5	0.54
16	52.7	517.6	-80.2	33.4	-5.17	13.7	13.1	0.50
17	55.9	516.4	-76.0	33.3	-4.90	12.1	12.6	0.45
18	59.2	525.9	-77.8	33.9	-5.02	11.1	12.1	0.41
19	62.5	516.5	-65.7	33.3	-4.24	9.0	11.4	0.37
20	65.8	520.9	-67.3	33.6	-4.34	8.0	10.8	0.32
21	69.1	497.7	-51.9	32.1	-3.35	5.9	10.4	0.28
22	72.4	499.9	-53.0	32.2	-3.42	4.3	9.1	0.24
Absolute	59.2			33.9			(T =	43.3 ms)
	32.9				-5.70		(T =	57.8 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	654.2	623.7	593.1	562.5	531.9	501.4	470.8	440.2	409.6	379.1
RX	658.8	629.6	614.1	602.7	591.6	580.5	569.4	558.3	552.1	547.4
RU	654.2	623.7	593.1	562.5	531.9	501.4	470.8	440.2	409.6	379.1

RAU = 164.3 (kips); RA2 = 607.4 (kips)

Current CAPWAP Ru = 571.0 (kips); Corresponding J(RP)= 0.27; 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
16.6	36.03	459.9	500.1	500.1	1.10	0.13	0.13	31.9	626.3	3027

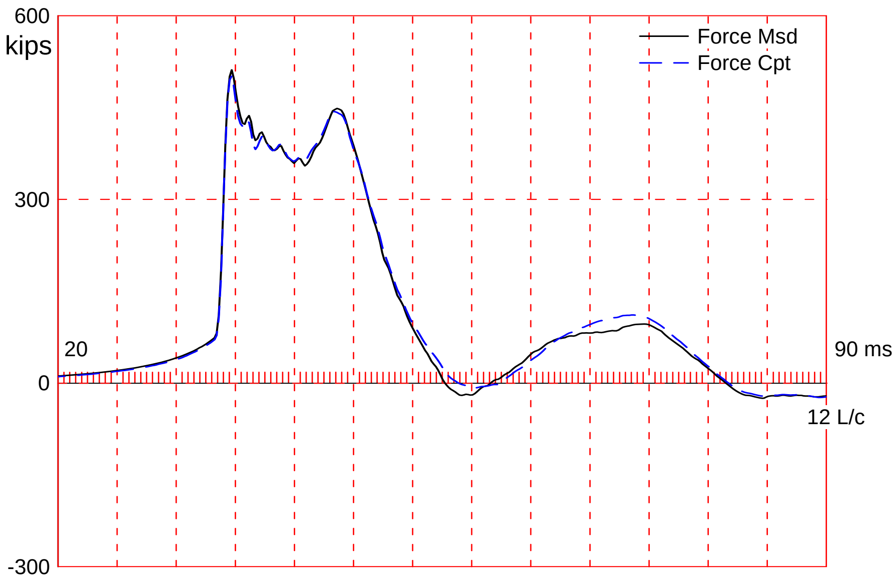
PILE PROFILE AND PILE MODEL

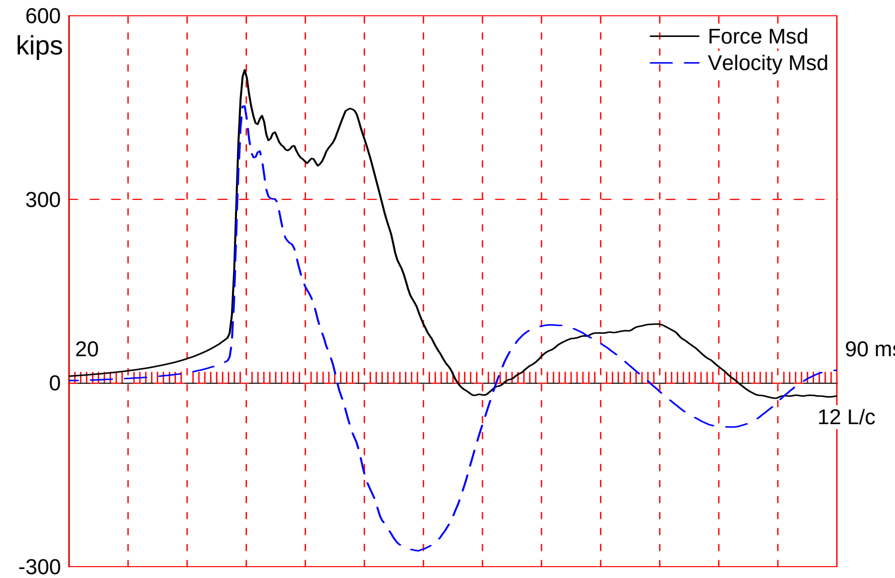
Depth	Area	E-Modulus	Spec. Weight	Perim.
ft	in^2	ksi	lb/ft^3	ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

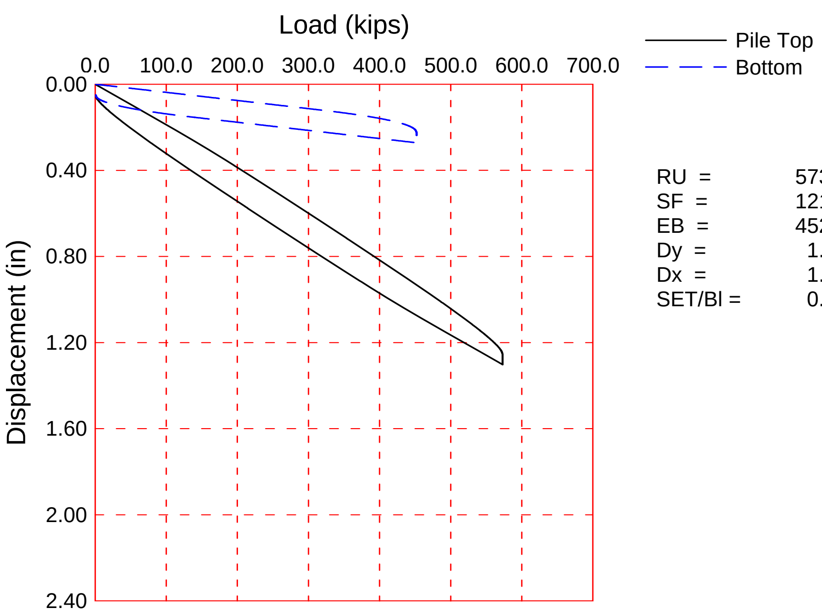
Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

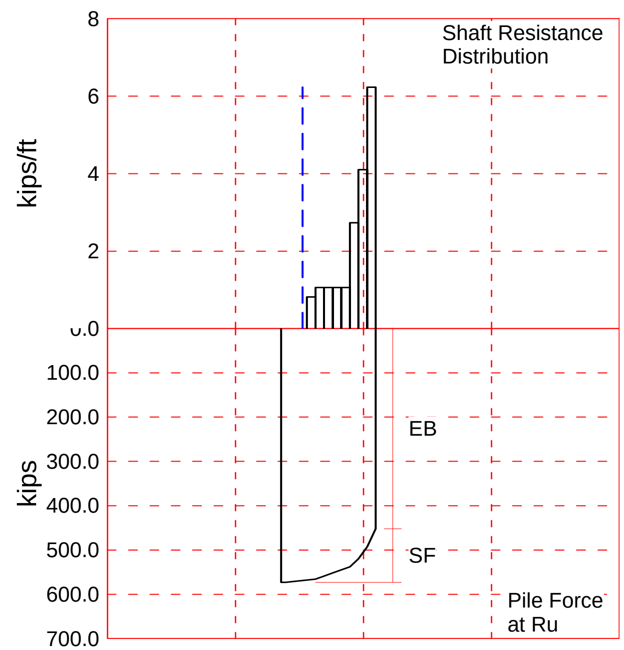
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000







RU =	573.0 kips
SF =	121.0 kips
EB =	452.0 kips
Dy =	1.25 in
Dx =	1.30 in
SET/Bl =	0.05 in



Length b. Sensors	72.4 ft
Embedment	54.6 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	2.65
Top Compr. Stress	32.4 ksi
Max Compr. Stress	34.8 ksi
Max Tension Stress	-7.33 ksi
Avg. Shaft Quake	0.15 in
Toe Quake	0.17 in
Avg. Shaft Smith Dpg.	0.36 s/ft
Toe Smith Damping	0.05 s/ft

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 573.0; along Shaft 121.0; at Toe 452.0 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
				573.0			
1	26.3	8.5	7.0	566.0	7.0	0.82	0.21
2	32.9	15.1	7.0	559.0	14.0	1.06	0.27
3	39.5	21.7	7.0	552.0	21.0	1.06	0.27
4	46.1	28.3	7.0	545.0	28.0	1.06	0.27
5	52.7	34.9	7.0	538.0	35.0	1.06	0.27
6	59.2	41.5	18.0	520.0	53.0	2.73	0.69
7	65.8	48.0	27.0	493.0	80.0	4.10	1.03
8	72.4	54.6	41.0	452.0	121.0	6.23	1.57
Avg. Shaft			15.1			2.22	0.56
Toe			452.0				458.72

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.36	0.05
Quake	(in)	0.15	0.17
Case Damping Factor		1.57	0.82
Damping Type		Viscous	Viscous
Unloading Quake	(% of loading quake)	45	30
Unloading Level	(% of Ru)	39	
Resistance Gap (included in Toe Quake) (in)			0.01

CAPWAP match quality = 2.65 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.05 in; Blow Count = 240 b/ft
Computed: Final Set = 0.07 in; Blow Count = 171 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.97; F4(H083) CAL: 94.4; RF: 0.97
A3(K974) CAL: 305; RF: 1.03; A4(K2214) CAL: 332; RF: 1.03

max. Top Comp. Stress = 32.4 ksi (T= 36.2 ms, max= 1.074 x Top)
max. Comp. Stress = 34.8 ksi (Z= 26.3 ft, T= 37.6 ms)
max. Tens. Stress = -7.33 ksi (Z= 39.5 ft, T= 58.0 ms)
max. Energy (EMX) = 32.7 kip-ft; max. Measured Top Displ. (DMX)= 1.07 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	502.7	-24.9	32.4	-1.60	32.7	16.7	1.06
2	6.6	503.8	-32.5	32.5	-2.10	32.0	16.6	1.02
3	9.9	505.1	-43.9	32.6	-2.83	31.4	16.6	0.99
4	13.2	506.5	-55.5	32.7	-3.58	30.7	16.5	0.95
5	16.5	509.3	-67.3	32.8	-4.34	29.9	16.4	0.91
6	19.7	518.1	-78.1	33.4	-5.04	29.2	16.1	0.87
7	23.0	529.3	-88.0	34.1	-5.68	28.4	15.7	0.83
8	26.3	539.7	-97.8	34.8	-6.30	27.5	15.3	0.79
9	29.6	505.2	-99.3	32.6	-6.40	24.7	14.9	0.74
10	32.9	515.5	-108.3	33.3	-6.98	23.8	14.5	0.70
11	36.2	509.4	-108.1	32.9	-6.97	21.3	14.2	0.66
12	39.5	523.0	-113.7	33.7	-7.33	20.4	13.8	0.61
13	42.8	524.7	-109.0	33.8	-7.03	18.1	13.4	0.57
14	46.1	533.9	-111.7	34.4	-7.21	17.1	13.0	0.53
15	49.4	533.6	-106.9	34.4	-6.89	15.1	12.6	0.48
16	52.7	538.3	-109.0	34.7	-7.03	14.1	12.0	0.44
17	55.9	533.6	-104.2	34.4	-6.72	12.2	11.3	0.39
18	59.2	539.7	-106.1	34.8	-6.84	11.2	10.5	0.35
19	62.5	523.5	-91.3	33.8	-5.89	8.8	9.6	0.30
20	65.8	530.1	-92.8	34.2	-5.99	7.9	8.8	0.26
21	69.1	502.3	-71.0	32.4	-4.58	5.7	7.7	0.22
22	72.4	507.8	-71.1	32.8	-4.59	4.1	6.2	0.17
Absolute	26.3			34.8			(T =	37.6 ms)
	39.5				-7.33		(T =	58.0 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	691.3	663.6	635.9	608.2	580.5	552.8	525.1	497.5	469.8	442.1
RX	698.5	672.2	647.3	633.5	619.7	605.9	592.1	578.3	564.5	556.1
RU	691.3	663.6	635.9	608.2	580.5	552.8	525.1	497.5	469.8	442.1

RAU = 85.9 (kips); RA2 = 621.9 (kips)

Current CAPWAP Ru = 573.0 (kips); Corresponding J(RP)= 0.43; J(RX) = 0.74

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
16.6	36.03	459.0	509.2	515.4	1.07	0.05	0.05	33.5	717.4	2825

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Travis Coleman
Company: Lunda Construction Company	No. of Sheets: 32
E-mail: whamacher@lundaconstruction.com	Date: November 13, 2014

RE: Dynamic Testing Results – Pier 12
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On November 12, 2014, Pier 12 #7 and Pier 12 #26 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on November 13. The 75.4 foot long HP 12 x 53 H-piles were equipped with driving shoes and were driven with an APE D25-42 hammer operated on fuel setting three. Plans indicate the piles in Pier 12 have a required driving resistance or ultimate capacity of 390 kips, and an estimated length of 45 feet.

Pier 12 #7 was driven to a depth of 52.7 feet below the excavated ground surface at EL 590.5, which corresponds to a pile tip elevation of EL 537.8. The blow count over the final increment of driving was 5 blows for ⅝ inch of penetration at an average hammer stroke of 8.0 feet. The blow count at the beginning of restrike of Pier 12 #7 was 10 blows for 1.75 inches of penetration at an average hammer stroke of 8.3 feet.

Pier 12 #26 was driven to a depth of 52.9 feet below the excavated ground surface at EL 590.5, which corresponds to a pile tip elevation of EL 537.6. The blow count over the final increment of driving was 5 blows for ½ inch of penetration at an average hammer stroke of 8.5 feet. The blow count at the beginning of restrike of Pier 12 #26 was 10 blows for 1 inch of penetration at an average hammer stroke of 9.0 feet.

For the 390 kip piles, driven with the APE D25-42 hammer, in Pier 12 of the STH 96 Bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.5	8
8.0	7
8.5	6
9.0	5

We recommended the above blow count at the corresponding hammer stroke be maintained for

November 13, 2014

two consecutive inches of driving. Driving may be terminated if production piles exceed 10 blows over an increment of one inch or less at hammer strokes of 8.5 feet. After splicing or any other delays, we recommend not applying the criteria until at least two feet of driving has occurred beyond the termination depth associated with the delay.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Rory Flynn, E.I.

Travis Coleman, P.E.

cc: Steve Seymour - steve.seymour@omnni.com
Jeff Horsfall - jeffrey.horsfall@dot.wi.gov

Attachments:

Dynamic Results	(Pages 3 – 12)
CAPWAP Results	(Pages 13 – 32)

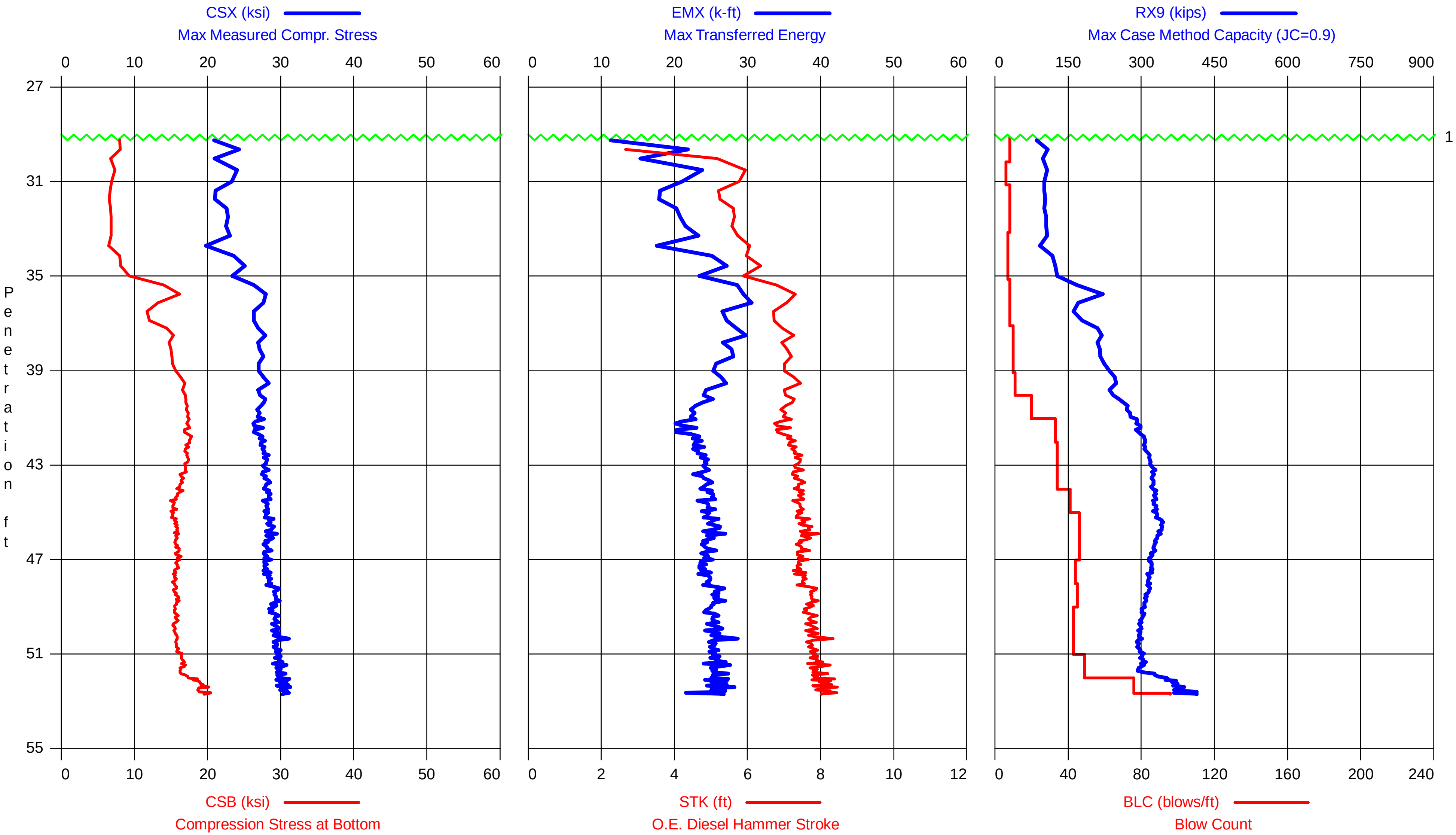
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 12-Nov-2014

Test date: 12-Nov-2014

STH 96 over Fox River (B-5-831) - Pier 12 #7 - EOID

APE D25-42, HP 12 x 53



1 - Reported reference EL 590.5

STH 96 over Fox River (B-5-831) - Pier 12 #7 - EOID
OP: AZ

APE D25-42, HP 12 x 53
Test date: 12-Nov-2014

AR: 15.50 in^2
LE: 72.40 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
8	30.00	8	AV8	22.5	7.7	6.3	16	48	97
			STD	3.3	0.6	1.4	8	5	14
			MAX	29.9	8.6	8.0	34	54	127
			MIN	18.7	6.6	4.6	11	42	79
14	31.00	6	AV6	22.8	7.0	5.6	21	50	103
			STD	2.2	0.4	0.5	3	2	4
			MAX	25.2	7.4	6.2	24	54	107
			MIN	18.7	6.4	4.6	14	47	97
22	32.00	8	AV8	22.1	6.7	5.5	19	50	103
			STD	3.4	0.5	0.8	5	4	7
			MAX	26.2	7.3	6.6	27	56	113
			MIN	16.8	5.9	4.3	13	46	93
30	33.00	8	AV8	22.2	6.7	5.5	20	50	103
			STD	2.1	0.3	0.5	3	2	4
			MAX	24.4	7.2	6.1	24	56	109
			MIN	17.6	6.1	4.4	14	48	93
37	34.00	7	AV7	21.5	6.8	5.8	21	50	102
			STD	4.0	1.3	1.7	6	7	18
			MAX	24.1	7.9	9.3	26	65	113
			MIN	11.9	3.9	3.1	7	39	58
44	35.00	7	AV7	24.4	8.1	6.2	26	47	121
			STD	1.0	0.3	0.3	2	1	4
			MAX	25.2	8.7	6.5	28	50	127
			MIN	22.2	7.7	5.6	22	46	115
52	36.00	8	AV8	26.8	14.7	6.9	28	45	187
			STD	2.0	1.6	0.6	4	2	29
			MAX	29.1	16.6	7.6	33	49	233
			MIN	23.4	11.8	5.9	22	43	147
60	37.00	8	AV8	26.6	12.0	6.8	28	45	169
			STD	0.8	0.6	0.2	2	1	9
			MAX	28.0	13.0	7.1	31	46	190
			MIN	25.5	11.3	6.5	25	44	160
70	38.00	10	AV10	27.3	14.8	7.1	28	44	213
			STD	0.6	0.5	0.2	1	1	5
			MAX	28.5	15.9	7.5	31	45	223
			MIN	26.4	14.1	6.8	26	43	206
80	39.00	10	AV10	27.1	15.3	7.1	27	44	222
			STD	0.9	0.4	0.3	2	1	8
			MAX	28.6	16.0	7.5	31	46	237
			MIN	25.3	14.5	6.6	24	43	212
91	40.00	11	AV11	27.6	16.5	7.2	26	44	242
			STD	0.8	0.7	0.2	2	1	7
			MAX	28.7	17.9	7.6	27	45	252
			MIN	26.2	15.2	6.8	23	43	231
111	41.00	20	AV20	27.3	17.1	7.1	23	44	267
			STD	0.6	0.3	0.2	1	1	11
			MAX	28.3	17.7	7.4	26	46	280
			MIN	25.7	16.3	6.6	21	43	246
144	42.00	33	AV33	27.0	17.4	7.0	22	45	297
			STD	1.0	0.5	0.3	2	1	7
			MAX	28.3	18.2	7.4	25	47	312
			MIN	24.3	16.1	6.2	17	43	285
178	43.00	34	AV34	27.8	17.2	7.3	24	44	313
			STD	0.6	0.4	0.2	1	1	6
			MAX	28.9	18.2	7.7	26	45	323
			MIN	26.3	16.4	6.9	21	43	301

STH 96 over Fox River (B-5-831) - Pier 12 #7 - EOID
OP: AZ

APE D25-42, HP 12 x 53
Test date: 12-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
212	44.00	34	AV34	27.9	16.6	7.4	24	43	324
			STD	0.7	0.5	0.2	1	1	4
			MAX	29.5	17.4	7.9	27	45	331
			MIN	26.5	15.6	6.9	22	42	313
253	45.00	41	AV41	28.2	15.6	7.4	25	43	328
			STD	0.6	0.6	0.2	1	0	4
			MAX	29.2	16.8	7.8	27	45	335
			MIN	26.4	14.7	6.9	21	42	319
299	46.00	46	AV44	28.4	15.6	7.5	25	43	338
			STD	0.7	0.4	0.2	1	1	6
			MAX	30.8	16.3	8.3	29	44	350
			MIN	26.8	14.5	7.0	23	41	326
345	47.00	46	AV44	28.2	15.8	7.5	24	43	326
			STD	0.7	0.4	0.2	1	1	5
			MAX	29.7	16.9	7.9	26	44	337
			MIN	26.8	15.3	7.1	22	42	314
389	48.00	44	AV44	28.1	15.6	7.5	24	43	318
			STD	0.7	0.3	0.2	1	1	5
			MAX	29.6	16.7	7.9	27	45	329
			MIN	26.2	15.0	6.9	22	42	308
434	49.00	45	AV45	29.2	15.7	7.7	26	42	311
			STD	0.7	0.3	0.2	1	1	5
			MAX	31.0	16.4	8.3	29	44	322
			MIN	27.4	14.8	7.1	23	41	297
477	50.00	43	AV43	29.2	15.6	7.7	25	42	301
			STD	0.7	0.4	0.2	1	1	5
			MAX	30.6	16.4	8.1	27	44	309
			MIN	27.5	14.7	7.3	23	41	292
520	51.00	43	AV43	29.5	15.8	7.8	26	42	296
			STD	0.7	0.4	0.2	1	1	5
			MAX	31.6	16.7	8.5	29	44	307
			MIN	27.9	15.0	7.3	22	41	285
569	52.00	49	AV49	29.8	16.6	7.9	26	42	307
			STD	0.8	0.5	0.3	2	1	14
			MAX	31.4	17.7	8.4	29	44	347
			MIN	27.7	15.6	7.2	22	41	285
618	52.65	76	AV48	30.4	18.9	8.1	26	42	372
			STD	0.7	0.7	0.3	2	1	16
			MAX	31.8	20.6	8.6	29	43	421
			MIN	28.8	17.3	7.5	22	40	338
623	52.70	96	AV4	30.3	19.9	8.0	26	42	413
			STD	0.2	0.9	0.1	1	0	4
			MAX	30.7	21.3	8.1	27	42	420
			MIN	30.1	19.3	7.9	26	41	409
			Average	28.1	15.6	7.4	25	43	295
			Std. Dev.	2.1	2.7	0.6	3	2	65
			Maximum	31.8	21.3	9.3	34	65	421
			Minimum	11.9	3.9	3.1	7	39	58

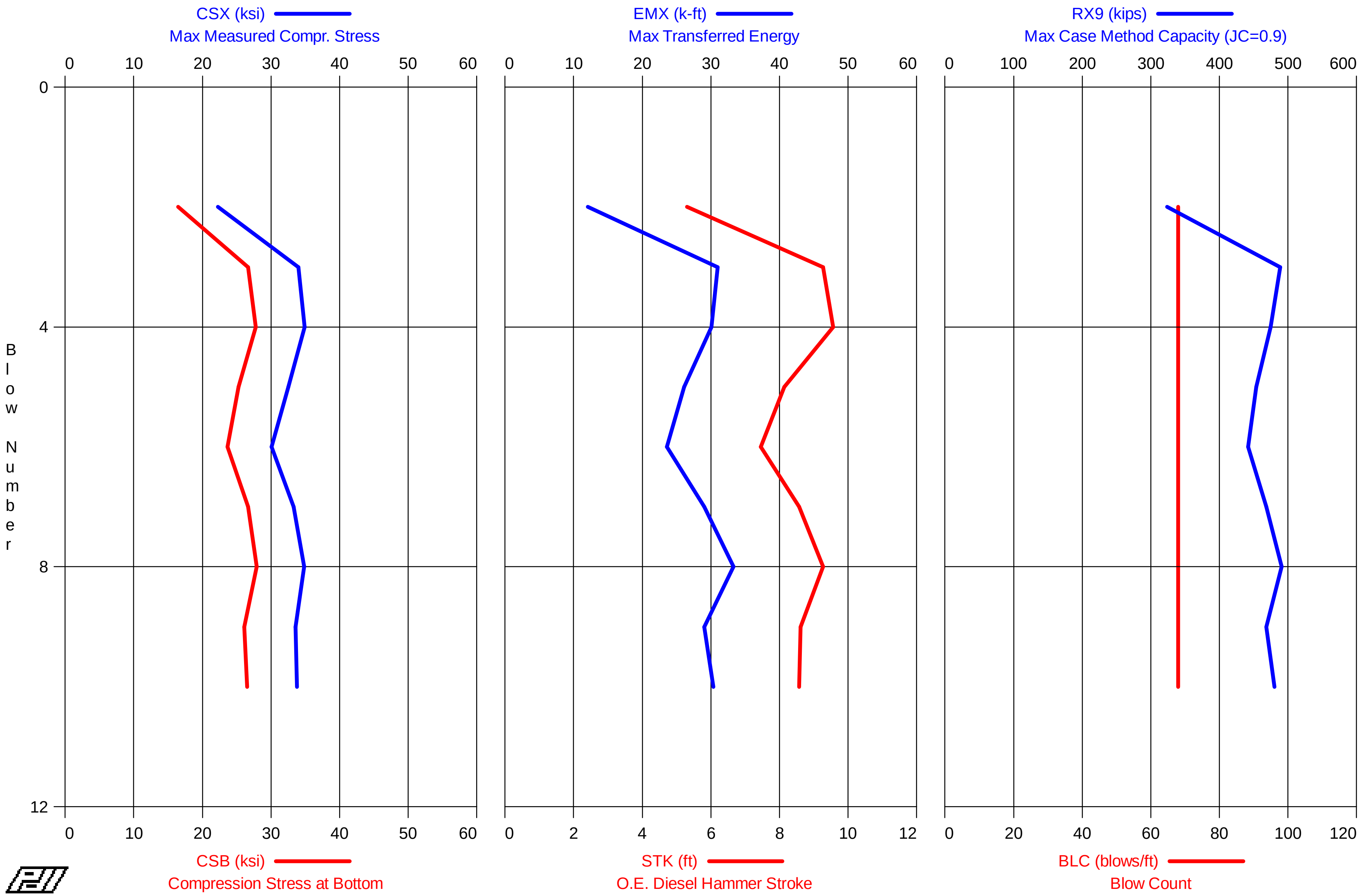
Total number of blows analyzed: 617

BL#	depth (ft)	Comments
1	29.13	Reported reference EL 590.5

Time Summary

Drive 16 minutes 49 seconds 9:25:36 AM - 9:42:25 AM (11/12/2014) BN 1 - 623

STH 96 over Fox River (B-5-831) - Pier 12 #7 - BOR
APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - Pier 12 #7 - BOR
OP: TC

APE D25-42, HP 12 x 53
Test date: 13-Nov-2014

AR: 15.50 in^2
LE: 72.40 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
10	52.85	68	AV9	32.1	25	8.3	27	41.4	454
			STD	3.7	3	1.2	6	3.6	49
			MAX	34.9	28	9.6	33	50.8	491
			MIN	22.3	16	5.3	12	38.3	324
			Average	32.1	25	8.3	27	41.4	454
			Std. Dev.	3.7	3	1.2	6	3.6	49
			Maximum	34.9	28	9.6	33	50.8	491
			Minimum	22.3	16	5.3	12	38.3	324

Total number of blows analyzed: 9

BL#	depth (ft)	Comments
5	52.77	CW

Time Summary

Drive 13 seconds 9:44:57 AM - 9:45:10 AM (11/13/2014) BN 1 - 10

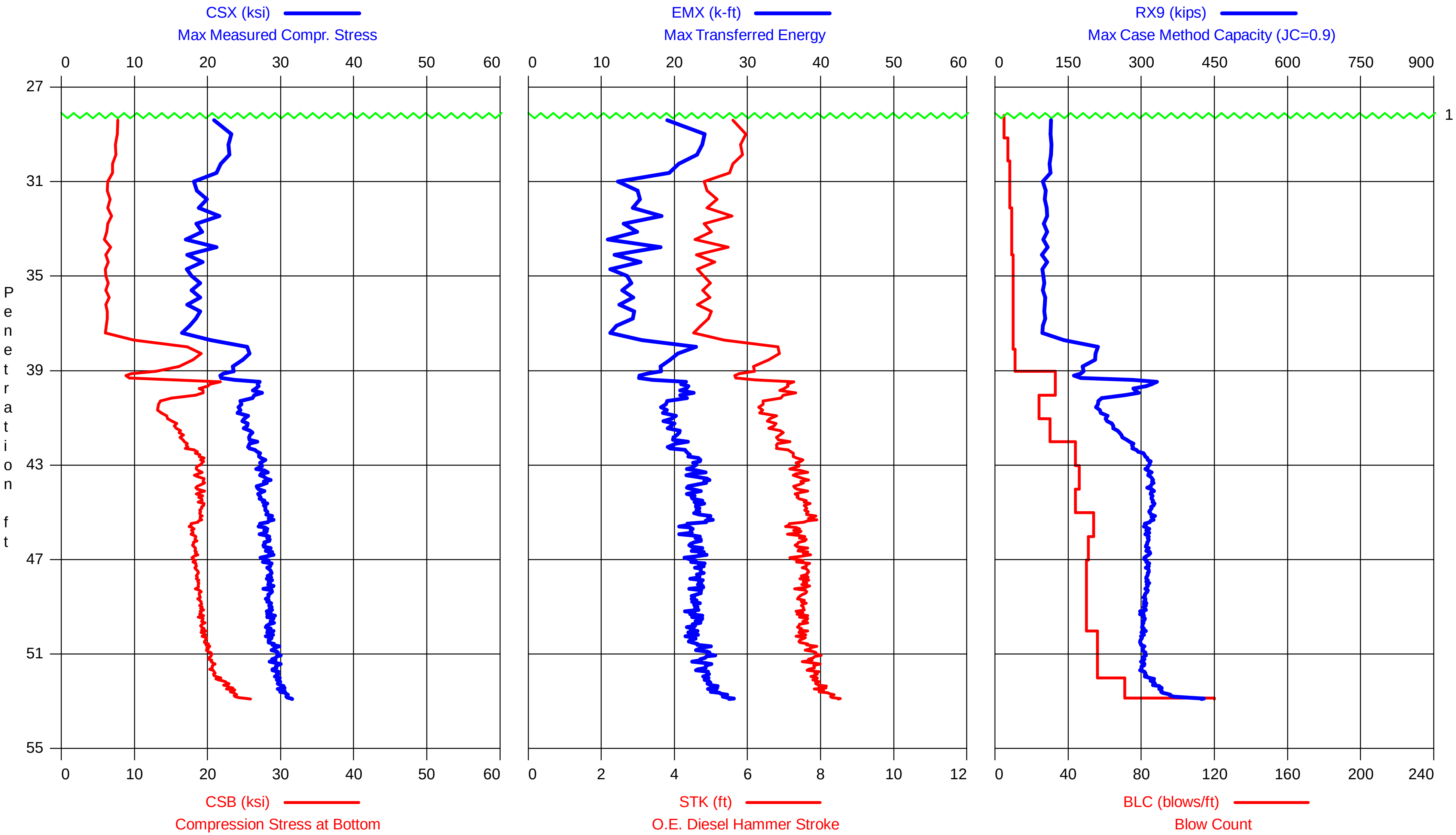
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 12-Nov-2014

Test date: 12-Nov-2014

STH 96 over Fox River (B-5-831) - Pier 12 #26 - EOID

APE D25-42, HP 12 x 53



1 - Reported reference EL 590.5

STH 96 over Fox River (B-5-831) - Pier 12 #26 - EOID
OP: AZ

APE D25-42, HP 12 x 53
Test date: 12-Nov-2014

AR: 15.50 in^2
LE: 72.40 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
5	29.00	5	AV5	21.8	7.7	5.8	21	49	114
			STD	2.4	0.3	0.6	6	3	6
			MAX	24.4	8.1	6.4	30	53	122
			MIN	18.4	7.3	4.8	13	47	106
12	30.00	7	AV7	23.0	7.5	5.9	24	49	115
			STD	0.3	0.2	0.1	1	0	3
			MAX	23.4	7.7	6.0	25	49	120
			MIN	22.4	7.3	5.7	23	48	110
20	31.00	8	AV8	21.0	6.9	5.4	18	50	109
			STD	1.2	0.3	0.3	3	1	6
			MAX	22.1	7.2	5.6	21	54	116
			MIN	17.9	6.3	4.7	12	49	97
28	32.00	8	AV8	18.6	6.4	4.9	14	53	102
			STD	2.6	0.5	0.6	4	3	7
			MAX	22.5	7.2	5.9	21	57	113
			MIN	14.7	5.6	4.1	8	49	92
37	33.00	9	AV9	19.6	6.5	5.1	15	52	104
			STD	1.7	0.3	0.4	3	2	4
			MAX	23.0	7.1	5.9	20	54	109
			MIN	17.6	5.9	4.6	12	49	98
46	34.00	9	AV9	19.3	6.3	5.0	15	52	104
			STD	2.0	0.3	0.4	3	2	6
			MAX	22.3	6.9	5.7	19	57	112
			MIN	15.3	5.7	4.2	8	49	94
56	35.00	10	AV10	17.5	6.1	4.7	12	54	99
			STD	1.8	0.3	0.4	3	2	7
			MAX	21.7	6.6	5.6	18	56	114
			MIN	15.1	5.7	4.3	9	50	90
66	36.00	10	AV10	18.8	6.4	5.0	14	53	101
			STD	1.7	0.3	0.4	3	2	6
			MAX	20.9	6.8	5.5	18	55	108
			MIN	16.3	5.8	4.4	9	50	91
76	37.00	10	AV10	18.4	6.3	4.9	14	53	102
			STD	1.2	0.2	0.2	1	1	3
			MAX	20.2	6.5	5.2	16	56	107
			MIN	15.6	5.9	4.3	10	51	97
86	38.00	10	AV10	19.2	9.1	5.1	14	52	132
			STD	3.3	3.9	0.8	5	4	45
			MAX	24.8	17.0	6.7	24	57	232
			MIN	14.3	5.6	4.1	7	46	92
97	39.00	11	AV11	25.0	17.7	6.6	20	46	198
			STD	1.5	1.9	0.5	3	1	15
			MAX	28.5	20.8	7.8	27	48	224
			MIN	23.2	14.4	6.1	18	42	176
130	40.00	33	AV33	25.0	16.2	6.6	19	46	258
			STD	2.4	4.9	0.7	3	2	63
			MAX	28.4	22.1	7.7	23	51	336
			MIN	20.4	8.5	5.3	13	43	158
154	41.00	24	AV24	24.9	14.1	6.6	19	46	220
			STD	1.0	1.3	0.3	2	1	14
			MAX	27.3	18.3	7.3	23	48	274
			MIN	23.2	12.8	6.0	17	44	202
184	42.00	30	AV30	25.6	16.0	6.8	20	45	249
			STD	0.9	0.7	0.3	1	1	14
			MAX	27.2	17.0	7.3	23	47	272
			MIN	24.0	14.2	6.3	17	44	220

STH 96 over Fox River (B-5-831) - Pier 12 #26 - EOID
OP: AZ

APE D25-42, HP 12 x 53
Test date: 12-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
228	43.00	44	AV44	26.8	18.3	7.2	22	44	300
			STD	1.0	1.0	0.3	2	1	15
			MAX	29.0	19.7	7.8	26	46	323
			MIN	24.9	16.6	6.5	18	42	274
274	44.00	46	AV46	27.5	18.9	7.4	23	43	317
			STD	0.9	0.6	0.3	2	1	6
			MAX	29.4	20.0	7.9	26	45	329
			MIN	25.5	16.9	6.9	19	42	306
318	45.00	44	AV44	27.6	19.1	7.5	23	43	322
			STD	0.6	0.4	0.2	1	1	4
			MAX	28.7	20.2	8.0	26	44	335
			MIN	26.3	18.2	7.1	21	42	315
372	46.00	54	AV54	28.0	18.4	7.5	23	43	316
			STD	0.7	0.6	0.3	2	1	7
			MAX	29.5	19.5	8.0	26	45	330
			MIN	26.1	17.4	6.8	20	42	303
423	47.00	51	AV51	28.1	18.3	7.5	23	43	313
			STD	0.6	0.3	0.2	1	1	5
			MAX	29.4	18.9	7.9	25	45	323
			MIN	26.6	17.5	7.0	21	42	300
473	48.00	50	AV50	28.5	18.5	7.6	23	43	313
			STD	0.6	0.3	0.2	1	1	4
			MAX	29.9	19.1	7.9	25	45	320
			MIN	26.6	17.6	7.0	21	42	302
523	49.00	50	AV50	28.5	18.9	7.5	23	43	309
			STD	0.5	0.3	0.1	1	0	4
			MAX	29.7	19.7	7.9	25	44	320
			MIN	27.4	18.2	7.2	22	42	302
573	50.00	50	AV50	28.5	19.2	7.5	23	43	304
			STD	0.5	0.3	0.1	1	0	4
			MAX	29.6	19.9	7.8	25	44	312
			MIN	27.5	18.7	7.2	21	42	291
629	51.00	56	AV56	28.9	19.8	7.6	23	43	303
			STD	0.6	0.5	0.2	1	1	5
			MAX	30.4	20.9	8.1	26	44	316
			MIN	27.7	18.9	7.2	21	42	292
685	52.00	56	AV56	29.4	20.7	7.8	24	42	305
			STD	0.6	0.4	0.2	1	0	5
			MAX	30.6	21.7	8.2	27	43	317
			MIN	28.1	19.6	7.4	22	41	295
746	52.86	71	AV61	30.2	22.9	8.0	25	42	339
			STD	0.6	0.9	0.2	1	1	17
			MAX	31.8	24.7	8.7	29	43	400
			MIN	29.0	20.9	7.6	23	40	314
751	52.90	120	AV5	31.4	25.3	8.5	28	41	423
			STD	0.7	0.6	0.2	1	1	10
			MAX	32.2	25.9	8.8	30	42	434
			MIN	30.3	24.5	8.1	26	40	406
			Average	27.0	17.6	7.2	22	44	281
			Std. Dev.	3.3	4.5	0.9	3	3	71
			Maximum	32.2	25.9	8.8	30	57	434
			Minimum	14.3	5.6	4.1	7	40	90

Total number of blows analyzed: 751

BL#	depth (ft)	Comments
1	28.20	Reported reference EL 590.5

Time Summary

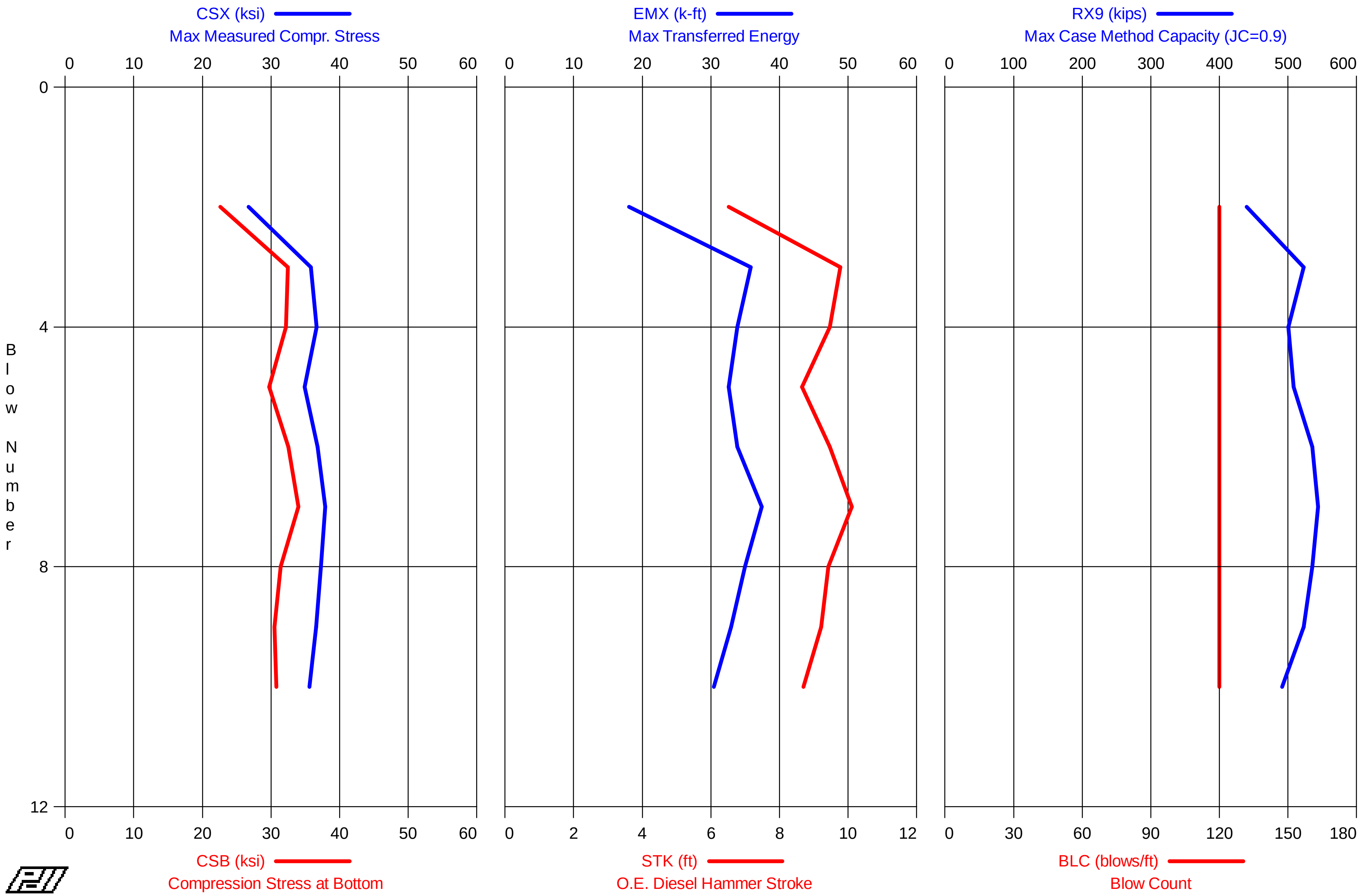
Drive 17 minutes 49 seconds 10:14:26 AM - 10:32:15 AM (11/12/2014) BN 1 - 751

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

PDIPLOT Ver. 2014.1 - Printed: 13-Nov-2014

Test date: 13-Nov-2014

STH 96 over Fox River (B-5-831) - Pier 12 #26 - BOR
APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - Pier 12 #26 - BOR
OP: TC

APE D25-42, HP 12 x 53
Test date: 13-Nov-2014

AR: 15.50 in^2
LE: 72.40 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
10	52.98	120	AV9	35.4	31	9.0	32	39.6	511
			STD	3.2	3	1.0	5	2.5	30
			MAX	37.9	34	10.1	37	46.1	544
			MIN	26.7	23	6.5	18	37.3	440
			Average	35.4	31	9.0	32	39.6	511
			Std. Dev.	3.2	3	1.0	5	2.5	30
			Maximum	37.9	34	10.1	37	46.1	544
			Minimum	26.7	23	6.5	18	37.3	440

Total number of blows analyzed: 9

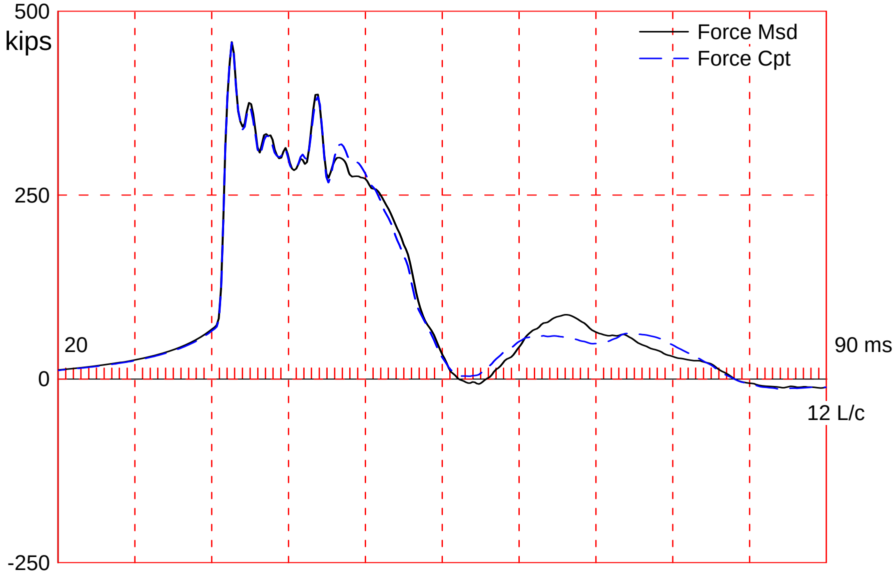
BL#	depth (ft)	Comments
5	52.94	CW

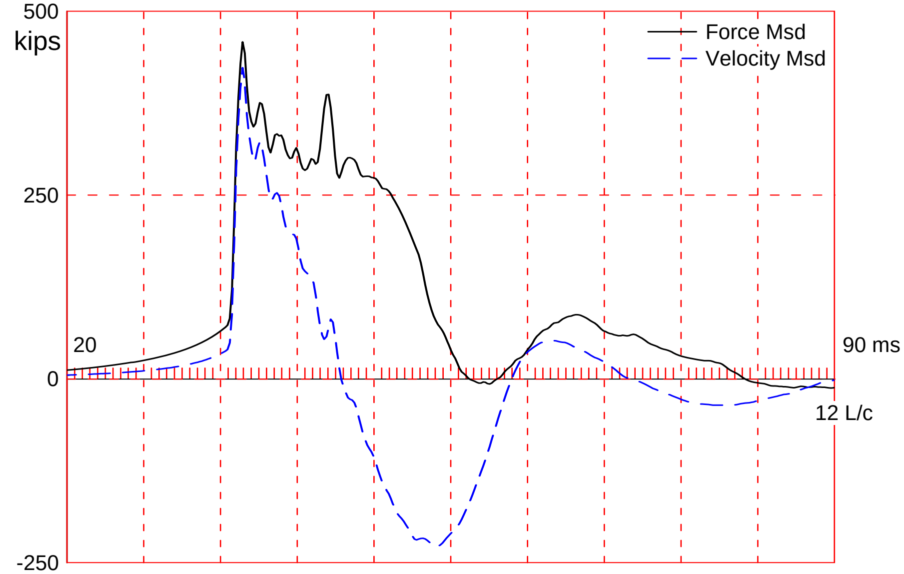
Time Summary

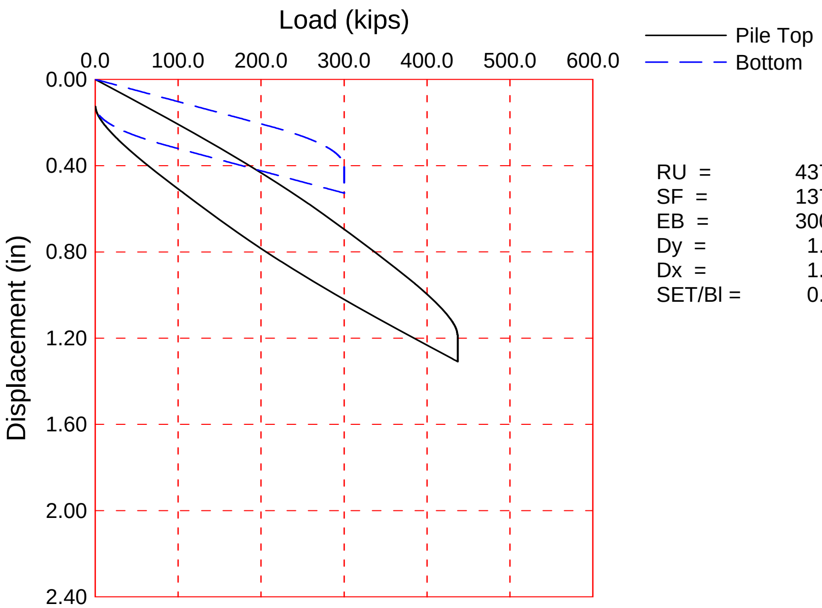
Drive 14 seconds 10:01:33 AM - 10:01:47 AM (11/13/2014) BN 1 - 10

STH 96 over Fox River (B-5-831); Pile: Pier 12 #7 - EOID; APE D25-42, HP 12 x 53; Blow: 620 (Test: 12-Nov-2014 09:42:)
GRL Engineers, Inc.

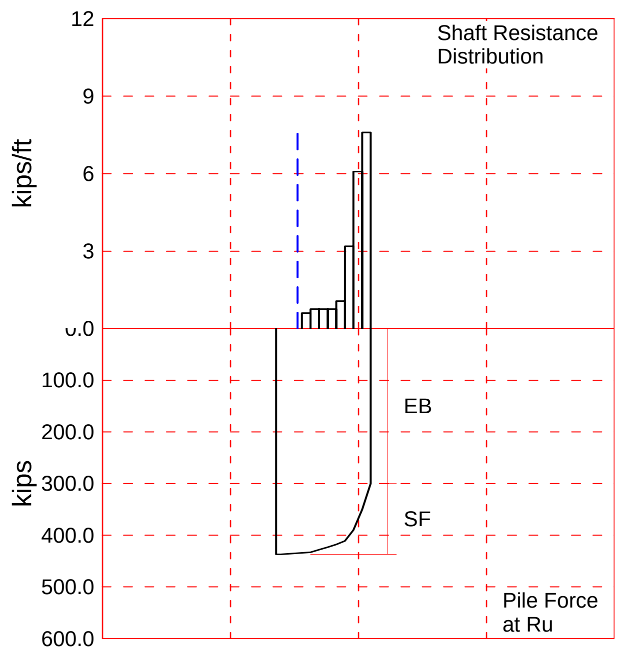
12-Nov-2014
CAPWAP(R) 2014







RU =	437.0 kips
SF =	137.0 kips
EB =	300.0 kips
Dy =	1.18 in
Dx =	1.31 in
SET/Bl =	0.12 in



Length b. Sensors	72.4 ft
Embedment	52.7 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	3.64
Top Compr. Stress	29.6 ksi
Max Compr. Stress	30.7 ksi
Max Tension Stress	-3.48 ksi
Avg. Shaft Quake	0.14 in
Toe Quake	0.31 in
Avg. Shaft Smith Dpg.	0.31 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: 437.0; along Shaft 137.0; at Toe 300.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				437.0			
1	26.3	6.6	4.0	433.0	4.0	0.61	0.15
2	32.9	13.2	5.0	428.0	9.0	0.76	0.19
3	39.5	19.8	5.0	423.0	14.0	0.76	0.19
4	46.1	26.3	5.0	418.0	19.0	0.76	0.19
5	52.7	32.9	7.0	411.0	26.0	1.06	0.27
6	59.2	39.5	21.0	390.0	47.0	3.19	0.80
7	65.8	46.1	40.0	350.0	87.0	6.08	1.53
8	72.4	52.7	50.0	300.0	137.0	7.60	1.91
Avg. Shaft			17.1			2.60	0.66
Toe			300.0				304.46

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.31	0.03
Quake	(in)	0.14	0.31
Case Damping Factor		1.54	0.33
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	32	116
Unloading Level	(% of Ru)	70	
Resistance Gap (included in Toe Quake) (in)			0.06
Soil Plug Weight	(kips)	0.100	0.062

CAPWAP match quality = 3.64 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.12 in; Blow Count = 96 b/ft
Computed: Final Set = 0.10 in; Blow Count = 124 b/ft
Transducer F3(H083) CAL: 94.4; RF: 0.96; F4(F523) CAL: 93.8; RF: 0.96
A3(K974) CAL: 305; RF: 1.04; A4(K2214) CAL: 332; RF: 1.04

max. Top Comp. Stress = 29.6 ksi (T= 36.2 ms, max= 1.039 x Top)
max. Comp. Stress = 30.7 ksi (Z= 26.3 ft, T= 37.6 ms)
max. Tens. Stress = -3.48 ksi (Z= 39.5 ft, T= 58.9 ms)
max. Energy (EMX) = 25.4 kip-ft; max. Measured Top Displ. (DMX)= 1.00 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	458.4	-14.8	29.6	-0.96	25.4	15.3	1.00
2	6.6	459.0	-15.8	29.6	-1.02	25.1	15.2	0.97
3	9.9	459.8	-18.1	29.7	-1.17	24.6	15.2	0.94
4	13.2	460.6	-24.6	29.7	-1.58	24.2	15.1	0.91
5	16.5	461.6	-31.4	29.8	-2.02	23.7	15.1	0.88
6	19.7	465.2	-38.2	30.0	-2.46	23.2	14.9	0.85
7	23.0	470.4	-44.8	30.3	-2.89	22.7	14.7	0.81
8	26.3	476.2	-50.8	30.7	-3.28	22.1	14.5	0.78
9	29.6	460.5	-48.5	29.7	-3.13	20.6	14.3	0.74
10	32.9	466.7	-53.7	30.1	-3.47	20.1	14.0	0.71
11	36.2	446.2	-49.7	28.8	-3.21	18.6	13.8	0.68
12	39.5	452.5	-54.0	29.2	-3.48	18.0	13.5	0.64
13	42.8	432.7	-48.6	27.9	-3.13	16.5	13.3	0.61
14	46.1	440.1	-51.8	28.4	-3.34	16.0	13.0	0.57
15	49.4	443.2	-48.0	28.6	-3.10	14.7	12.7	0.54
16	52.7	443.7	-53.0	28.6	-3.42	14.1	12.1	0.50
17	55.9	424.9	-47.0	27.4	-3.03	12.8	11.5	0.47
18	59.2	464.1	-51.2	29.9	-3.30	12.2	10.4	0.44
19	62.5	416.4	-25.8	26.9	-1.66	9.9	8.8	0.40
20	65.8	421.3	-29.5	27.2	-1.90	9.4	8.6	0.37
21	69.1	361.4	0.0	23.3	0.00	6.4	9.8	0.34
22	72.4	365.6	-1.4	23.6	-0.09	3.5	9.2	0.31
Absolute	26.3			30.7			(T =	37.6 ms)
	39.5				-3.48		(T =	58.9 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	569.6	537.0	504.3	471.7	439.0	406.4	373.7	341.1	308.5	275.8
RX	569.6	537.0	504.3	471.7	442.2	437.4	432.5	427.7	423.3	420.4
RU	569.6	537.0	504.3	471.7	439.0	406.4	373.7	341.1	308.5	275.8

RAU = 405.8 (kips); RA2 = 477.6 (kips)

Current CAPWAP Ru = 437.0 (kips); Corresponding J(RP)= 0.41; J(RX) = 0.51

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
15.5	36.03	429.7	466.3	466.3	1.00	0.13	0.12	25.7	546.5	1200

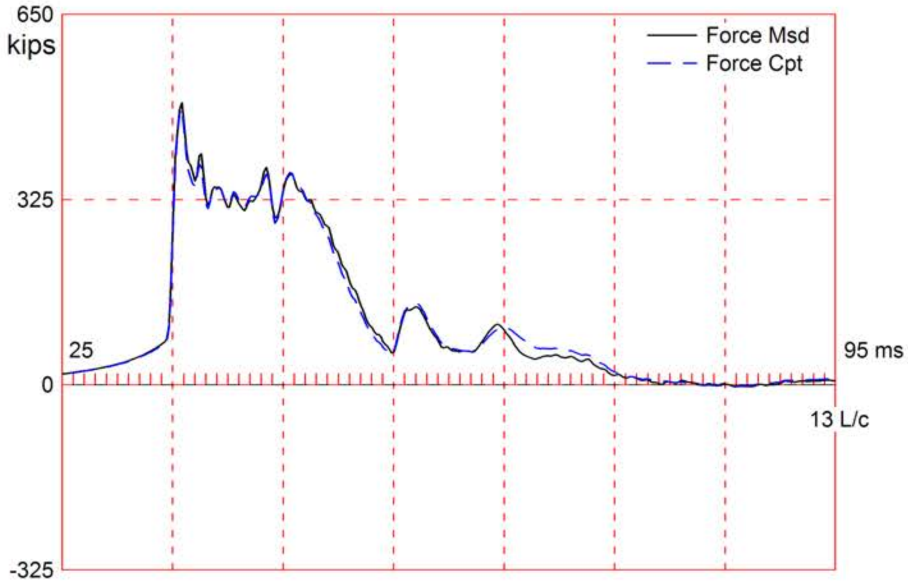
PILE PROFILE AND PILE MODEL

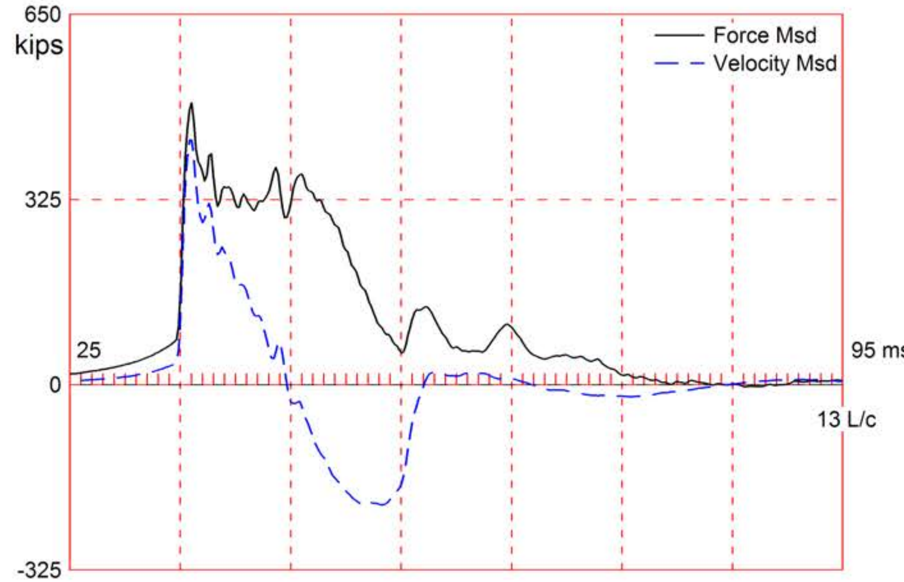
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

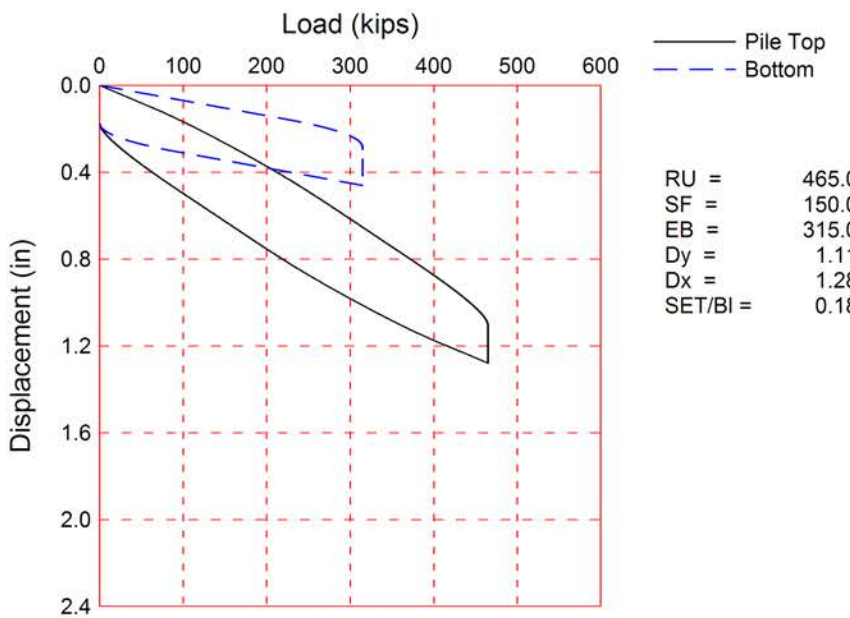
Toe Area 141.9 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000
21	69.1	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.100
22	72.4	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000

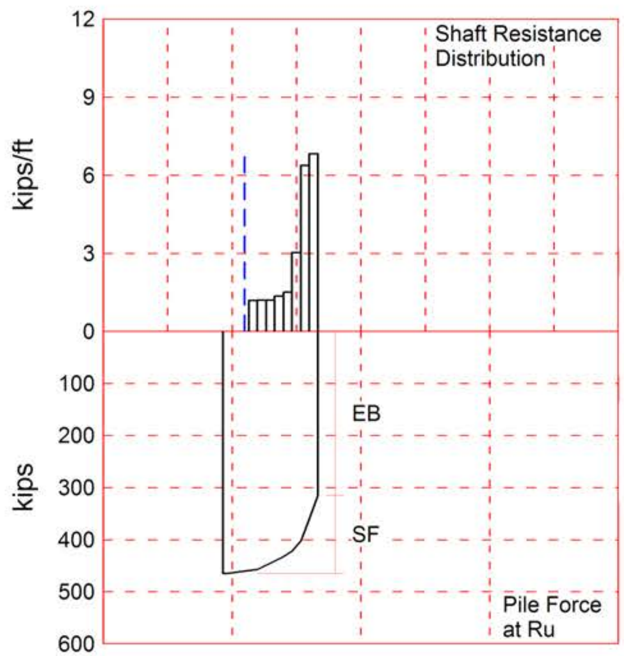
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000







RU =	465.0 kips
SF =	150.0 kips
EB =	315.0 kips
Dy =	1.11 in
Dx =	1.28 in
SET/Bl =	0.18 in



Length b. Sensors	72.4 ft
Embedment	52.8 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	31.2 ksi
Max Compr. Stress	33.5 ksi
Max Tension Stress	-1.24 ksi
Avg. Shaft Quake	0.07 in
Toe Quake	0.22 in
Avg. Shaft Smith Dpg.	0.31 s/ft
Toe Smith Damping	0.06 s/ft

About the CAPWAP Results

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

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

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

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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: 465.0; along Shaft 150.0; at Toe 315.0 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
				465.0			
1	26.3	6.7	8.0	457.0	8.0	1.19	0.30
2	32.9	13.3	8.0	449.0	16.0	1.22	0.31
3	39.5	19.9	8.0	441.0	24.0	1.22	0.31
4	46.1	26.4	9.0	432.0	33.0	1.37	0.34
5	52.7	33.0	10.0	422.0	43.0	1.52	0.38
6	59.2	39.6	20.0	402.0	63.0	3.04	0.77
7	65.8	46.2	42.0	360.0	105.0	6.38	1.61
8	72.4	52.8	45.0	315.0	150.0	6.84	1.72
Avg. Shaft			18.7			2.84	0.72
Toe			315.0				319.68

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.31	0.06
Quake	(in)	0.07	0.22
Case Damping Factor		1.68	0.68
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	55	104
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.07
Soil Plug Weight	(kips)		0.021

CAPWAP match quality = 2.60 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.18 in; Blow Count = 68 b/ft
Computed: Final Set = 0.14 in; Blow Count = 83 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.97; F4(H083) CAL: 94.4; RF: 0.97
A3(K2214) CAL: 332; RF: 1.03; A4(K974) CAL: 305; RF: 1.03

max. Top Comp. Stress = 31.2 ksi (T= 36.2 ms, max= 1.074 x Top)
max. Comp. Stress = 33.5 ksi (Z= 26.3 ft, T= 37.6 ms)
max. Tens. Stress = -1.24 ksi (Z= 26.3 ft, T= 177.8 ms)
max. Energy (EMX) = 25.8 kip-ft; max. Measured Top Displ. (DMX)= 0.94 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	484.1	-19.2	31.2	-1.24	25.8	15.9	0.94
2	6.6	485.4	-19.2	31.3	-1.24	25.4	15.9	0.91
3	9.9	486.8	-19.2	31.4	-1.24	24.9	15.8	0.88
4	13.2	488.4	-19.2	31.5	-1.24	24.4	15.7	0.84
5	16.5	490.9	-19.2	31.7	-1.24	23.8	15.7	0.81
6	19.7	500.2	-19.2	32.3	-1.24	23.2	15.3	0.77
7	23.0	509.1	-19.3	32.8	-1.24	22.5	15.0	0.74
8	26.3	519.7	-19.3	33.5	-1.24	21.9	14.6	0.70
9	29.6	484.4	-11.6	31.2	-0.75	19.7	14.3	0.66
10	32.9	494.7	-11.7	31.9	-0.75	19.1	13.9	0.63
11	36.2	461.1	-4.0	29.7	-0.26	17.1	13.6	0.59
12	39.5	471.7	-4.9	30.4	-0.32	16.5	13.2	0.56
13	42.8	440.8	0.0	28.4	0.00	14.7	12.8	0.52
14	46.1	451.7	-3.7	29.1	-0.24	14.1	12.4	0.49
15	49.4	420.3	0.0	27.1	0.00	12.4	12.0	0.45
16	52.7	436.1	-1.3	28.1	-0.08	11.8	11.4	0.42
17	55.9	417.6	0.0	26.9	0.00	10.2	10.8	0.38
18	59.2	435.8	0.0	28.1	0.00	9.6	10.0	0.35
19	62.5	404.5	0.0	26.1	0.00	7.6	9.0	0.32
20	65.8	413.4	0.0	26.7	0.00	7.0	9.3	0.28
21	69.1	367.2	0.0	23.7	0.00	4.3	10.1	0.25
22	72.4	370.9	0.0	23.9	0.00	2.3	9.3	0.22
Absolute	26.3			33.5			(T =	37.6 ms)
	26.3				-1.24		(T =	177.8 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	603.6	570.3	537.1	503.9	470.7	437.4	404.2	371.0	337.8	304.5
RX	613.8	581.0	548.2	522.3	506.6	491.0	475.3	466.0	459.8	453.7
RU	603.6	570.3	537.1	503.9	470.7	437.4	404.2	371.0	337.8	304.5

RAU = 311.1 (kips); RA2 = 491.2 (kips)

Current CAPWAP Ru = 465.0 (kips); Corresponding J(RP)= 0.42; J(RX) = 0.72

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
15.9	36.03	438.8	497.0	504.1	0.94	0.18	0.18	26.1	562.9	2100

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

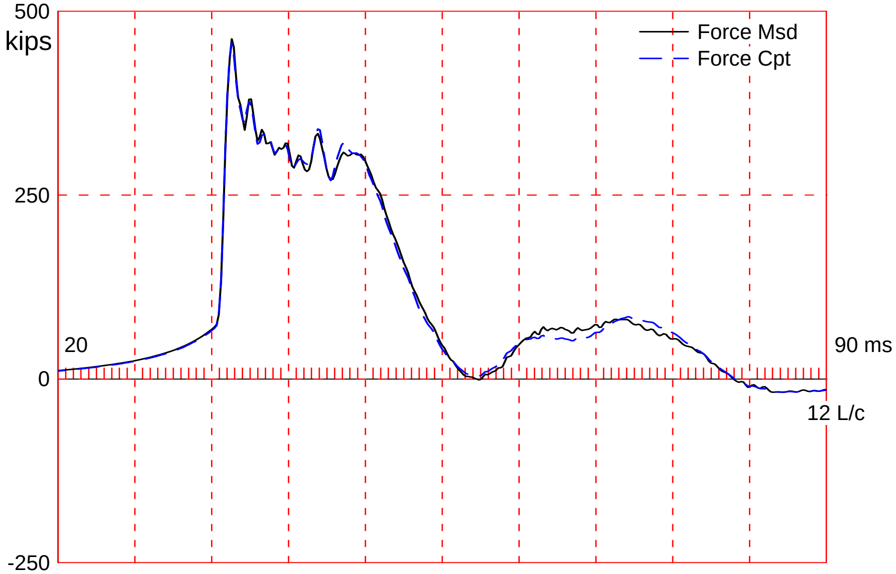
Toe Area 141.9 in^2

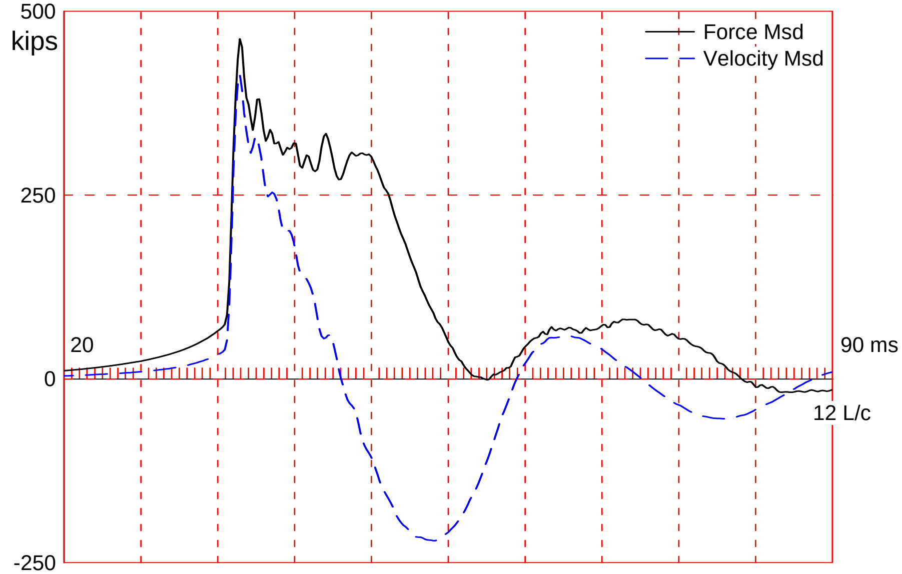
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

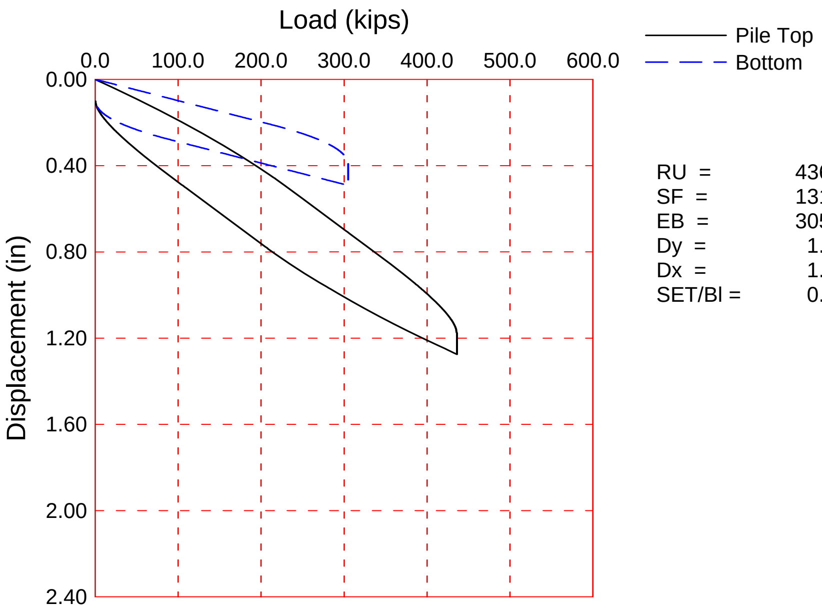
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s

Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000

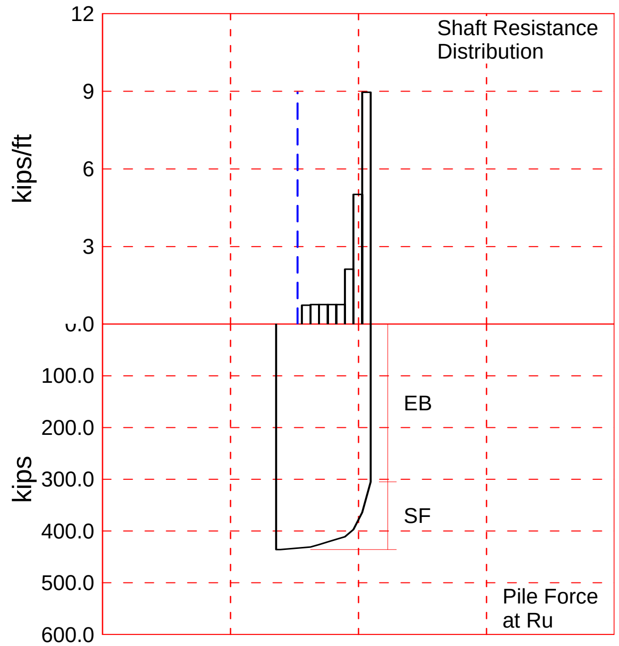
STH 96 over Fox River (B-5-831); Pile: Pier 12 #26 - EOID; APE D25-42, HP 12 x 53; Blow: 748 (Test: 12-Nov-2014 10:32:) 12-Nov-2014
GRL Engineers, Inc. CAPWAP(R) 2014







RU =	436.0 kips
SF =	131.0 kips
EB =	305.0 kips
Dy =	1.18 in
Dx =	1.28 in
SET/Bl =	0.10 in



Length b. Sensors	72.4 ft
Embedment	52.9 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	2.14
Top Compr. Stress	29.5 ksi
Max Compr. Stress	30.9 ksi
Max Tension Stress	-3.12 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.30 in
Avg. Shaft Smith Dpg.	0.33 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: 436.0; along Shaft 131.0; at Toe 305.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf
				436.0			
1	26.3	6.8	5.0	431.0	5.0	0.74	0.19
2	32.9	13.4	5.0	426.0	10.0	0.76	0.19
3	39.5	20.0	5.0	421.0	15.0	0.76	0.19
4	46.1	26.5	5.0	416.0	20.0	0.76	0.19
5	52.7	33.1	5.0	411.0	25.0	0.76	0.19
6	59.2	39.7	14.0	397.0	39.0	2.13	0.54
7	65.8	46.3	33.0	364.0	72.0	5.01	1.26
8	72.4	52.9	59.0	305.0	131.0	8.96	2.26
Avg. Shaft			16.4			2.48	0.62
Toe			305.0				309.54

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.33	0.03
Quake	(in)	0.08	0.30
Case Damping Factor		1.56	0.33
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	59	124
Unloading Level	(% of Ru)	66	
Resistance Gap (included in Toe Quake) (in)			0.06
Soil Plug Weight	(kips)		0.170

CAPWAP match quality = 2.14 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.06 in; Blow Count = 200 b/ft
Transducer F3(H083) CAL: 94.4; RF: 0.95; F4(F523) CAL: 93.8; RF: 0.95
A3(K974) CAL: 305; RF: 1.05; A4(K2214) CAL: 332; RF: 1.05

max. Top Comp. Stress = 29.5 ksi (T= 36.2 ms, max= 1.048 x Top)
max. Comp. Stress = 30.9 ksi (Z= 26.3 ft, T= 37.6 ms)
max. Tens. Stress = -3.12 ksi (Z= 59.2 ft, T= 60.9 ms)
max. Energy (EMX) = 25.4 kip-ft; max. Measured Top Displ. (DMX)= 0.99 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	457.7	-19.6	29.5	-1.26	25.4	15.1	0.97
2	6.6	458.6	-21.4	29.6	-1.38	25.1	15.1	0.95
3	9.9	459.6	-23.0	29.6	-1.48	24.7	15.0	0.92
4	13.2	460.6	-24.8	29.7	-1.60	24.2	15.0	0.89
5	16.5	462.0	-31.2	29.8	-2.01	23.7	14.9	0.86
6	19.7	466.6	-37.4	30.1	-2.41	23.2	14.7	0.83
7	23.0	473.1	-42.6	30.5	-2.75	22.7	14.5	0.79
8	26.3	479.5	-46.8	30.9	-3.02	22.2	14.2	0.76
9	29.6	457.4	-41.6	29.5	-2.68	20.6	14.0	0.73
10	32.9	463.9	-45.8	29.9	-2.96	20.1	13.7	0.70
11	36.2	442.5	-41.6	28.5	-2.68	18.6	13.5	0.66
12	39.5	448.8	-45.9	28.9	-2.96	18.1	13.2	0.63
13	42.8	428.4	-42.3	27.6	-2.73	16.6	13.0	0.60
14	46.1	434.6	-46.5	28.0	-3.00	16.1	12.8	0.56
15	49.4	420.1	-43.8	27.1	-2.82	14.8	12.5	0.53
16	52.7	432.5	-47.9	27.9	-3.09	14.2	12.1	0.50
17	55.9	419.1	-44.6	27.0	-2.87	13.0	11.5	0.46
18	59.2	441.4	-48.4	28.5	-3.12	12.4	10.8	0.43
19	62.5	411.1	-34.1	26.5	-2.20	10.5	9.8	0.40
20	65.8	428.5	-37.7	27.6	-2.43	10.0	8.8	0.36
21	69.1	377.4	-7.8	24.3	-0.50	7.1	9.4	0.33
22	72.4	378.8	-11.4	24.4	-0.73	3.4	9.5	0.30
Absolute	26.3			30.9			(T =	37.6 ms)
	59.2				-3.12		(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	563.7	531.8	499.8	467.9	436.0	404.1	372.2	340.3	308.4	276.5
RX	563.7	531.8	499.8	473.2	457.1	448.2	440.3	432.4	426.0	420.9
RU	563.7	531.8	499.8	467.9	436.0	404.1	372.2	340.3	308.4	276.5

RAU = 367.6 (kips); RA2 = 487.2 (kips)

Current CAPWAP Ru = 436.0 (kips); Corresponding J(RP)= 0.40; J(RX) = 0.65

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
15.1	36.03	418.2	464.5	469.0	0.99	0.10	0.10	25.8	568.6	1271

PILE PROFILE AND PILE MODEL

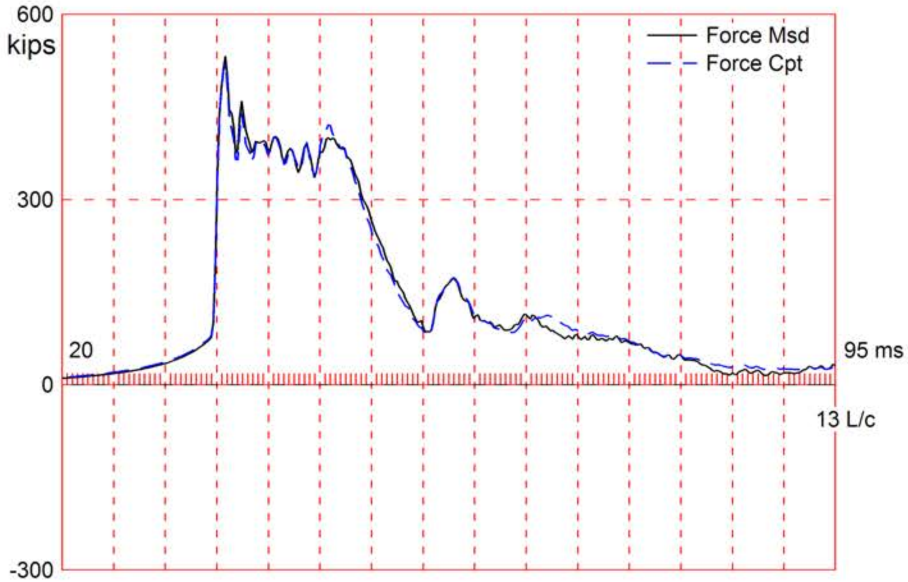
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

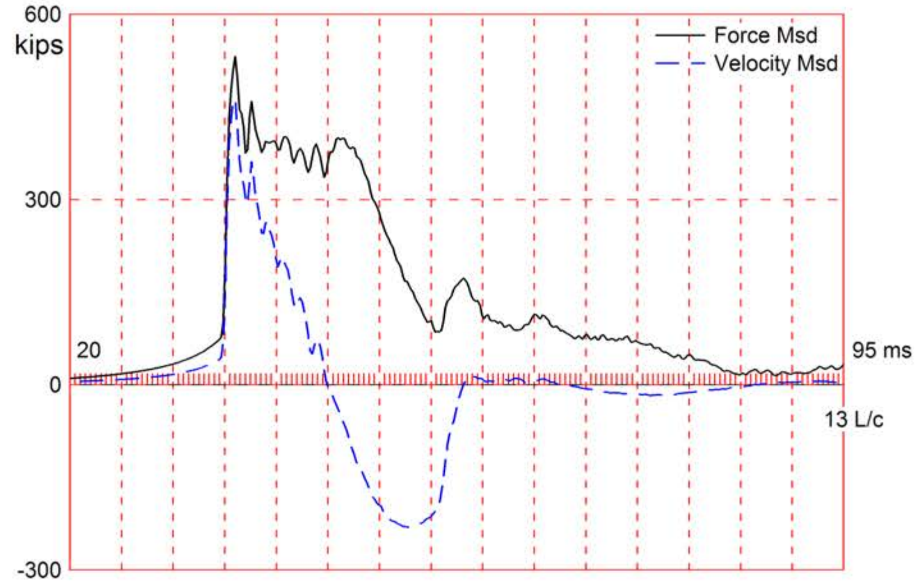
Toe Area 141.9 in^2

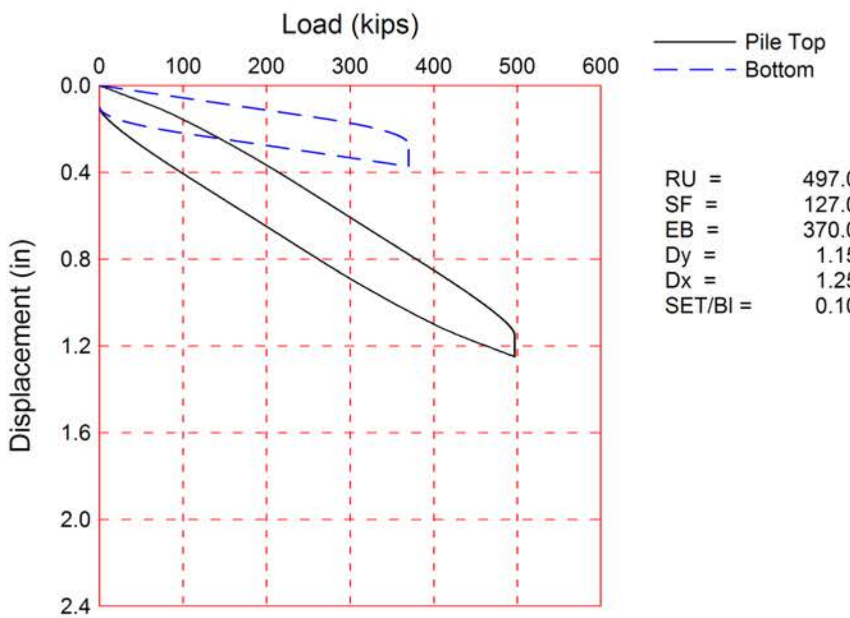
Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms

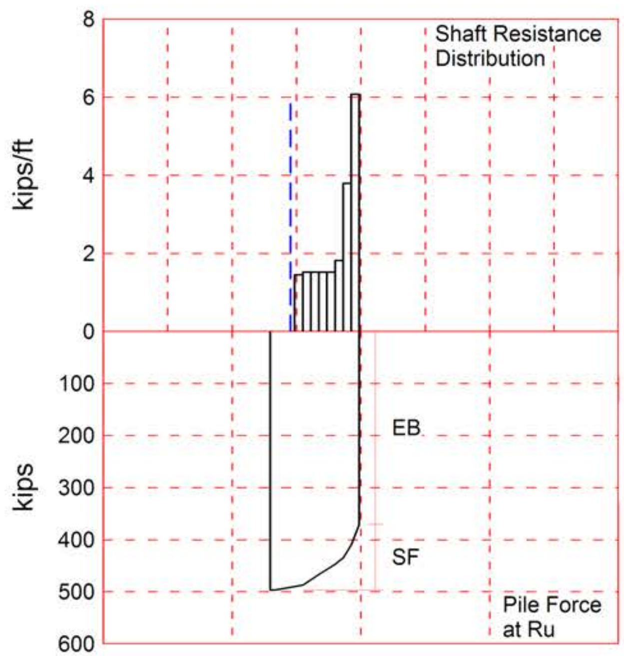
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000







RU =	497.0 kips
SF =	127.0 kips
EB =	370.0 kips
Dy =	1.15 in
Dx =	1.25 in
SET/Bl =	0.10 in



Length b. Sensors	72.4 ft
Embedment	52.9 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	4.20
Top Compr. Stress	33.6 ksi
Max Compr. Stress	36.4 ksi
Max Tension Stress	-0.77 ksi
Avg. Shaft Quake	0.05 in
Toe Quake	0.21 in
Avg. Shaft Smith Dpg.	0.31 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.

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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: 497.0; along Shaft 127.0; at Toe 370.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Quake in
				497.0				
1	26.3	6.9	10.0	487.0	10.0	1.46	0.37	0.05
2	32.9	13.5	10.0	477.0	20.0	1.52	0.38	0.05
3	39.5	20.0	10.0	467.0	30.0	1.52	0.38	0.05
4	46.1	26.6	10.0	457.0	40.0	1.52	0.38	0.05
5	52.7	33.2	10.0	447.0	50.0	1.52	0.38	0.05
6	59.2	39.8	12.0	435.0	62.0	1.82	0.46	0.05
7	65.8	46.4	25.0	410.0	87.0	3.80	0.96	0.05
8	72.4	52.9	40.0	370.0	127.0	6.08	1.53	0.05
Avg. Shaft			15.9			2.40	0.60	0.05
Toe			370.0				375.50	0.21

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.31	0.07
Case Damping Factor		1.42	0.94
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	93	76
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	0	
Resistance Gap (included in Toe Quake) (in)			0.02
Soil Plug Weight	(kips)		0.174

CAPWAP match quality = 4.20 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.10 in; Blow Count = 120 b/ft
Computed: Final Set = 0.00 in; Blow Count = 3048 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.94; F4(H083) CAL: 94.4; RF: 0.94
A3(K2214) CAL: 332; RF: 1.06; A4(K974) CAL: 305; RF: 1.06

max. Top Comp. Stress = 33.6 ksi (T= 36.2 ms, max= 1.084 x Top)
max. Comp. Stress = 36.4 ksi (Z= 26.3 ft, T= 37.6 ms)
max. Tens. Stress = -0.77 ksi (Z= 72.4 ft, T= 59.9 ms)
max. Energy (EMX) = 32.2 kip-ft; max. Measured Top Displ. (DMX)= 1.06 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	520.8	-9.3	33.6	-0.60	32.2	17.0	1.04
2	6.6	522.1	-9.3	33.7	-0.60	31.7	17.0	1.00
3	9.9	523.3	-9.3	33.8	-0.60	31.1	16.9	0.97
4	13.2	524.8	-9.3	33.8	-0.60	30.3	16.9	0.93
5	16.5	527.5	-9.2	34.0	-0.60	29.6	16.8	0.89
6	19.7	540.6	-9.2	34.9	-0.60	29.0	16.3	0.85
7	23.0	550.8	-9.3	35.5	-0.60	28.3	15.9	0.82
8	26.3	564.7	-9.3	36.4	-0.60	27.5	15.4	0.78
9	29.6	517.6	-8.6	33.4	-0.55	24.4	15.0	0.74
10	32.9	530.8	-8.6	34.2	-0.55	23.6	14.5	0.70
11	36.2	485.7	-7.8	31.3	-0.51	20.8	14.2	0.66
12	39.5	498.6	-7.8	32.2	-0.51	20.0	13.7	0.62
13	42.8	494.1	-7.2	31.9	-0.46	17.5	13.4	0.57
14	46.1	500.3	-7.2	32.3	-0.46	16.7	12.9	0.53
15	49.4	479.0	-6.4	30.9	-0.41	14.5	12.6	0.50
16	52.7	485.5	-6.4	31.3	-0.41	13.7	12.1	0.45
17	55.9	483.3	-5.7	31.2	-0.37	11.7	11.7	0.42
18	59.2	486.1	-5.7	31.4	-0.37	11.0	10.9	0.38
19	62.5	467.0	-5.5	30.1	-0.35	9.2	10.1	0.34
20	65.8	470.8	-11.5	30.4	-0.74	8.6	9.3	0.30
21	69.1	444.1	-10.2	28.6	-0.66	6.4	10.1	0.27
22	72.4	456.9	-11.9	29.5	-0.77	4.4	9.2	0.23
Absolute	26.3			36.4			(T =	37.6 ms)
	72.4				-0.77		(T =	59.9 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	646.7	577.9	509.1	440.4	371.6					
RX	656.2	599.9	560.9	532.6	516.3	501.1	489.9	482.3	474.6	467.0
RU	646.7	577.9	509.1	440.4	371.6					

RAU = 423.1 (kips); RA2 = 573.6 (kips)

Current CAPWAP Ru = 497.0 (kips); Corresponding J(RP)= 0.44; J(RX) = 1.06

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
17.0	36.42	471.4	519.1	540.8	1.06	0.13	0.10	32.6	676.3	1947

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

Top Segment Length 3.29 ft, Top Impedance 28 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s

Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000

GRL Engineers, Inc.

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

TRANSMITTAL

To: Mr. Wade Hamacher	From: Travis Coleman
Company: Lunda Construction Company	No. of Sheets: 32
E-mail: whamacher@lundaconstruction.com	Date: November 14, 2014

RE: Dynamic Testing Results – Pier 13
WisDOT Contract B-5-381 – STH 96 over Fox River
Wrightstown, Wisconsin

On November 12, 2014, Pier 13 #1 and Pier 13 #34 at the above structure were dynamically tested during initial driving. The piles were tested during restrike on November 13. The 75.4 foot long HP 12 x 53 H-piles were equipped with driving shoes and were driven with an APE D25-42 hammer operated on fuel setting three. Plans indicate the piles in Pier 13 have a required driving resistance or ultimate capacity of 370 kips, and an estimated length of 40 feet.

Pier 13 #1 was driven to a depth of 49.7 feet below the excavated ground surface at EL 592.5, which corresponds to a pile tip elevation of EL 542.8. The blow count over the final increment of driving was 5 blows for ⅝ inch of penetration at an average hammer stroke of 8.1 feet. The blow count at the beginning of restrike of Pier 13 #1 was 10 blows for 2 inches of penetration at an average hammer stroke of 8.7 feet.

Pier 13 #34 was driven to a depth of 49.7 feet below the excavated ground surface at EL 592.5, which corresponds to a pile tip elevation of EL 542.8. The blow count over the final increment of driving was 5 blows for ¾ inch of penetration at an average hammer stroke of 8.2 feet. The blow count at the beginning of restrike of Pier 13 #34 was 10 blows for ½ inch of penetration at an average hammer stroke of 8.3 feet.

For the 370 kip piles, driven with the APE D25-42 hammer, in Pier 13 of the STH 96 Bridge over the Fox River we recommend using the following criteria:

Field Observed Hammer Stroke (feet)	Recommended Minimum Blow Count (blows per inch)
7.5	10
8.0	8
8.5	7
9.0	6

We recommended the above blow count at the corresponding hammer stroke be maintained for

two consecutive inches of driving. Driving may be terminated if production piles exceed 10 blows over an increment of one inch or less at hammer strokes of 8.5 feet. After splicing or any other delays, we recommend not applying the criteria until at least two feet of driving has occurred beyond the termination depth associated with the delay.

Please contact us if there are any problems meeting the recommended criterion or if you have any questions on these recommendations.

GRL Engineers, Inc.

Travis Coleman, P.E.

Al Ziai

cc: Steve Seymour - steve.seymour@omnni.com
Jeff Horsfall - jeffrey.horsfall@dot.wi.gov

Attachments:

Dynamic Results	(Pages 3 – 12)
CAPWAP Results	(Pages 13 – 32)

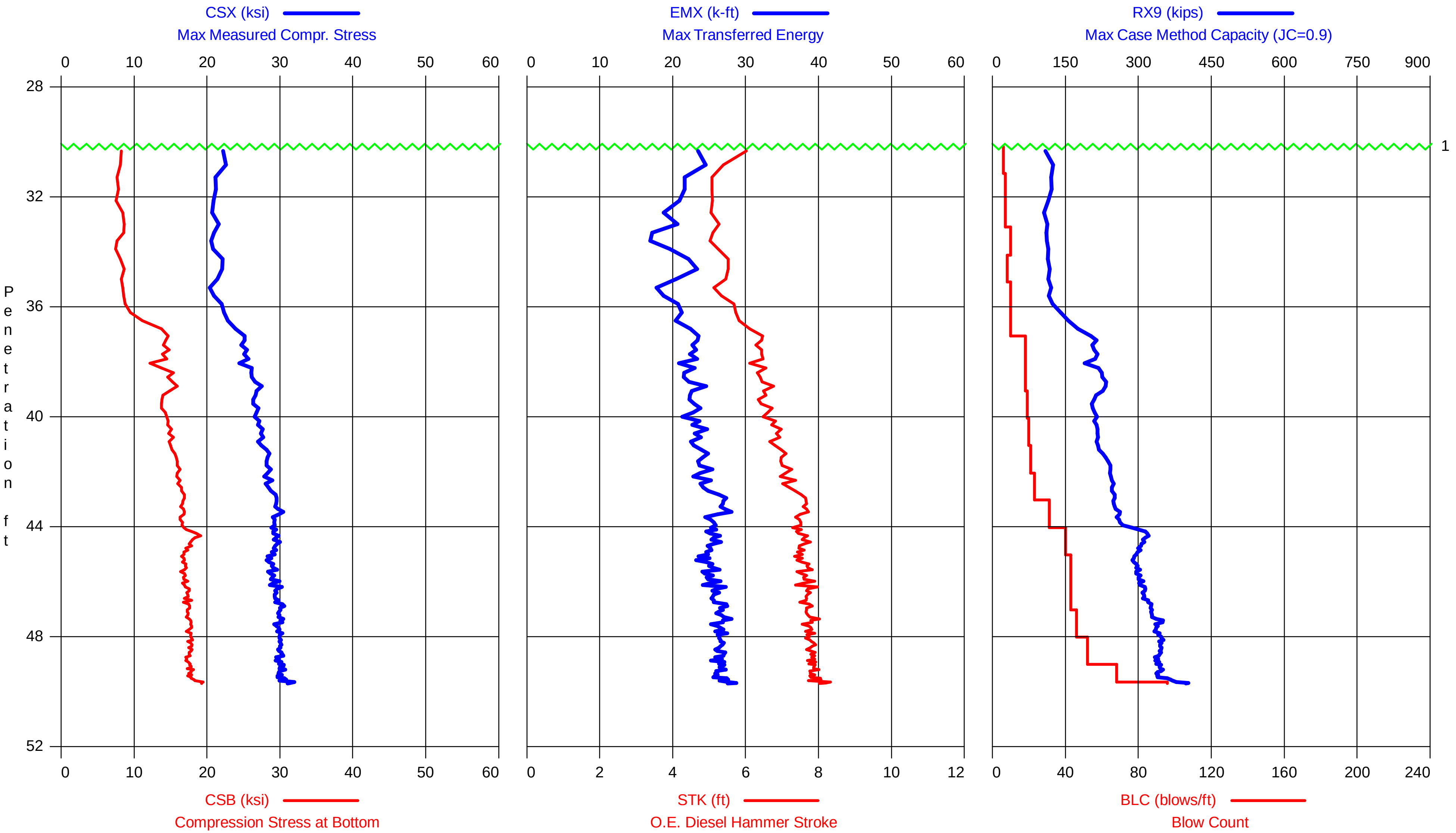
GRL Engineers, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2014.1 - Printed: 12-Nov-2014

Test date: 12-Nov-2014

STH 96 over Fox River (B-5-831) - Pier 13 #1 - EOID

APE D25-42, HP 12 x 53



1 - Reported reference EL 592.5

STH 96 over Fox River (B-5-831) - Pier 13 #1 - EOID
OP: AZ

APE D25-42, HP 12 x 53
Test date: 12-Nov-2014

AR: 15.50 in^2
LE: 72.40 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
6	31.00	6	AV6	22.4	8.2	5.6	24	49	117
			STD	1.3	0.2	0.4	3	2	14
			MAX	24.2	8.6	6.4	28	52	132
			MIN	20.1	7.9	5.2	19	46	91
13	32.00	7	AV7	21.2	7.7	5.1	22	52	121
			STD	1.0	0.2	0.3	2	1	9
			MAX	23.1	8.1	5.6	26	54	138
			MIN	20.0	7.5	4.7	18	49	111
20	33.00	7	AV7	21.0	8.3	5.1	20	52	110
			STD	0.6	0.5	0.1	1	1	4
			MAX	21.7	9.0	5.3	22	53	114
			MIN	20.1	7.4	4.9	18	51	101
30	34.00	10	AV10	20.9	8.0	5.1	18	52	112
			STD	1.5	0.5	0.4	3	2	3
			MAX	22.9	8.8	5.9	22	56	119
			MIN	17.4	7.2	4.3	14	49	108
38	35.00	8	AV8	21.9	8.4	5.5	22	50	116
			STD	0.7	0.2	0.2	2	1	6
			MAX	22.9	8.8	5.8	24	51	125
			MIN	20.8	8.0	5.2	20	49	104
48	36.00	10	AV10	21.2	8.6	5.4	19	50	120
			STD	0.7	0.2	0.2	1	1	5
			MAX	22.3	8.9	5.7	21	53	131
			MIN	19.8	8.3	4.9	17	49	111
58	37.00	10	AV10	23.3	11.8	5.9	22	48	160
			STD	0.9	2.0	0.2	1	1	18
			MAX	25.1	14.5	6.4	24	49	187
			MIN	22.0	9.5	5.6	19	46	132
76	38.00	18	AV18	25.2	14.3	6.4	23	46	210
			STD	0.5	0.6	0.1	1	1	7
			MAX	26.2	15.3	6.7	24	47	220
			MIN	24.1	13.2	6.1	21	46	192
94	39.00	18	AV18	26.2	14.6	6.5	22	46	223
			STD	1.2	1.5	0.3	2	1	15
			MAX	28.3	16.3	7.0	26	49	237
			MIN	23.0	11.0	5.8	19	44	182
113	40.00	19	AV19	26.6	14.0	6.5	23	46	211
			STD	0.4	0.4	0.2	1	1	7
			MAX	27.7	15.1	6.9	25	47	229
			MIN	26.0	13.3	6.3	21	45	198
133	41.00	20	AV20	27.2	14.9	6.8	23	45	214
			STD	0.6	0.4	0.2	1	1	4
			MAX	28.4	15.7	7.0	26	46	221
			MIN	26.3	14.4	6.5	21	44	208
154	42.00	21	AV21	28.3	15.7	7.0	24	44	233
			STD	0.6	0.5	0.2	1	1	9
			MAX	29.6	16.5	7.4	26	45	246
			MIN	27.2	14.8	6.8	22	43	218
177	43.00	23	AV23	28.7	16.4	7.3	25	44	247
			STD	0.6	0.4	0.2	1	1	4
			MAX	29.7	17.2	7.7	28	45	257
			MIN	27.7	15.5	6.9	22	43	241
208	44.00	31	AV31	29.5	16.6	7.6	26	43	258
			STD	0.5	0.3	0.2	1	0	8
			MAX	30.9	17.2	7.9	29	44	281
			MIN	28.2	16.0	7.1	24	42	243

STH 96 over Fox River (B-5-831) - Pier 13 #1 - EOID
OP: AZ
APE D25-42, HP 12 x 53
Test date: 12-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
248	45.00	40	AV40	29.4	17.7	7.5	25	43	307
			STD	0.6	0.7	0.2	1	1	9
			MAX	30.4	19.3	7.9	27	44	324
			MIN	28.0	16.5	7.0	23	42	288
291	46.00	43	AV43	28.9	16.9	7.6	25	43	297
			STD	0.6	0.4	0.2	1	1	7
			MAX	30.2	17.8	8.0	27	44	312
			MIN	27.2	15.8	7.1	23	42	280
334	47.00	43	AV43	29.6	17.3	7.7	26	43	315
			STD	0.7	0.5	0.2	1	1	9
			MAX	31.1	18.0	8.1	28	44	332
			MIN	28.2	16.3	7.2	23	42	297
380	48.00	46	AV46	29.9	17.6	7.8	27	42	337
			STD	0.5	0.4	0.2	1	0	9
			MAX	30.8	18.3	8.1	29	44	359
			MIN	28.5	16.4	7.3	24	41	321
432	49.00	52	AV52	30.0	17.6	7.8	27	42	344
			STD	0.5	0.4	0.2	1	0	5
			MAX	31.4	18.4	8.1	28	43	354
			MIN	28.8	16.9	7.4	24	41	330
476	49.65	68	AV44	30.3	17.9	7.9	27	42	350
			STD	0.8	0.6	0.2	1	1	14
			MAX	33.0	20.1	8.5	30	43	396
			MIN	28.7	16.9	7.4	24	41	332
481	49.70	96	AV5	31.4	19.2	8.1	28	41	391
			STD	0.3	0.2	0.2	2	0	21
			MAX	31.8	19.6	8.4	29	42	407
			MIN	30.9	18.9	8.0	24	41	351
			Average	28.1	15.8	7.2	25	44	273
			Std. Dev.	2.8	2.9	0.8	2	3	73
			Maximum	33.0	20.1	8.5	30	56	407
			Minimum	17.4	7.2	4.3	14	41	91

Total number of blows analyzed: 481

BL#	depth (ft)	Comments
1	30.17	Reported reference EL 592.5

Time Summary

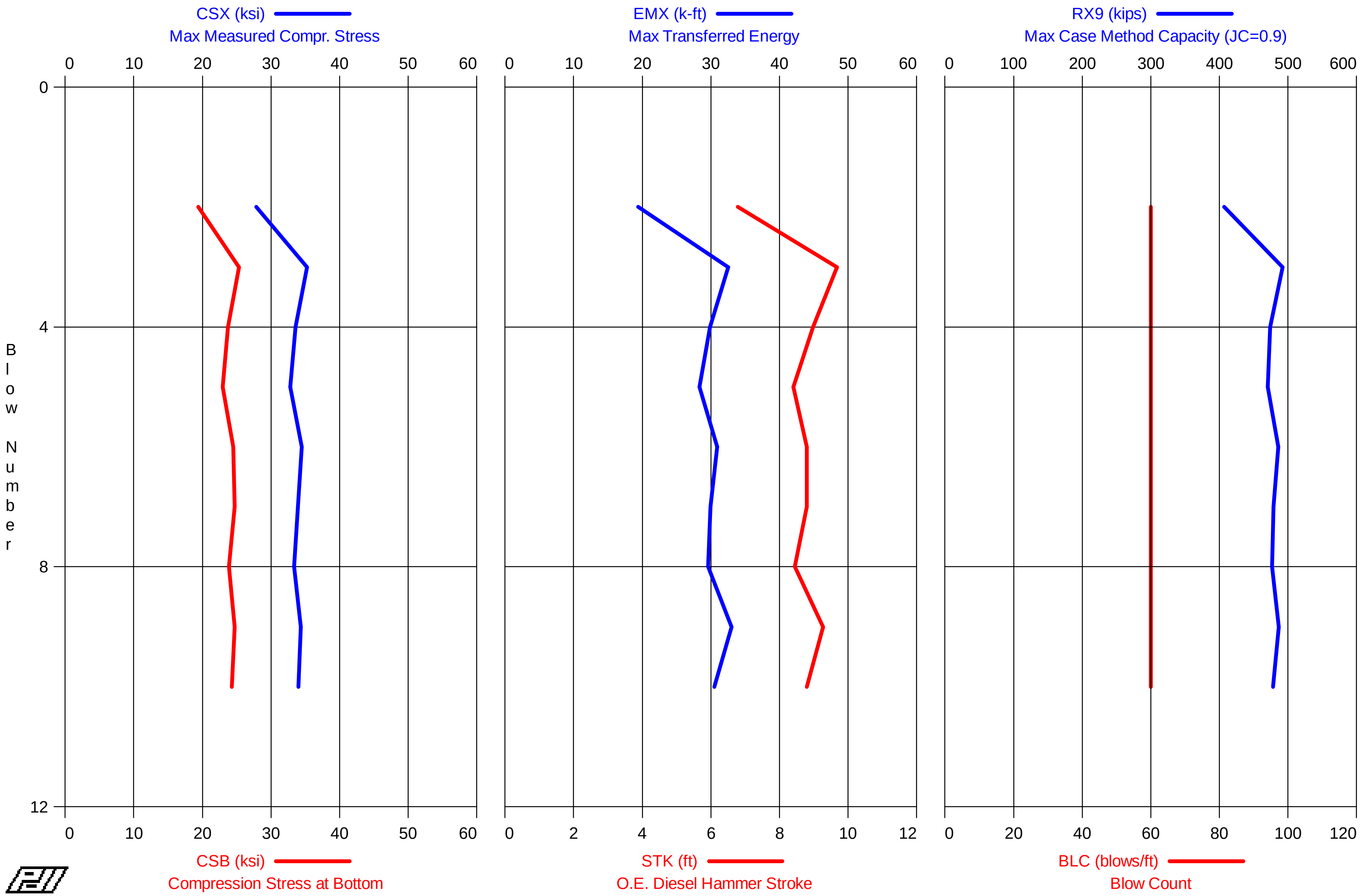
Drive 11 minutes 38 seconds 12:13:27 PM - 12:25:05 PM (11/12/2014) BN 1 - 481

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

PDIPLOT Ver. 2014.1 - Printed: 14-Nov-2014

Test date: 13-Nov-2014

STH 96 over Fox River (B-5-831) - Pier 13 #1 - BOR
APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - Pier 13 #1 - BOR
OP: AZ

APE D25-42, HP 12 x 53
Test date: 13-Nov-2014

AR: 15.50 in^2
LE: 72.40 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke

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

BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
10	49.85	60	AV9	33.3	23.7	8.7	29	40.3	472
			STD	2.0	1.7	0.8	4	1.9	24
			MAX	35.2	25.3	9.7	33	45.2	492
			MIN	27.9	19.4	6.8	19	38.1	407
			Average	33.3	23.7	8.7	29	40.3	472
			Std. Dev.	2.0	1.7	0.8	4	1.9	24
			Maximum	35.2	25.3	9.7	33	45.2	492
			Minimum	27.9	19.4	6.8	19	38.1	407

Total number of blows analyzed: 9

BL#	depth (ft)	Comments
4	49.75	CW

Time Summary

Drive 14 seconds 8:44:28 AM - 8:44:42 AM (11/13/2014) BN 1 - 11

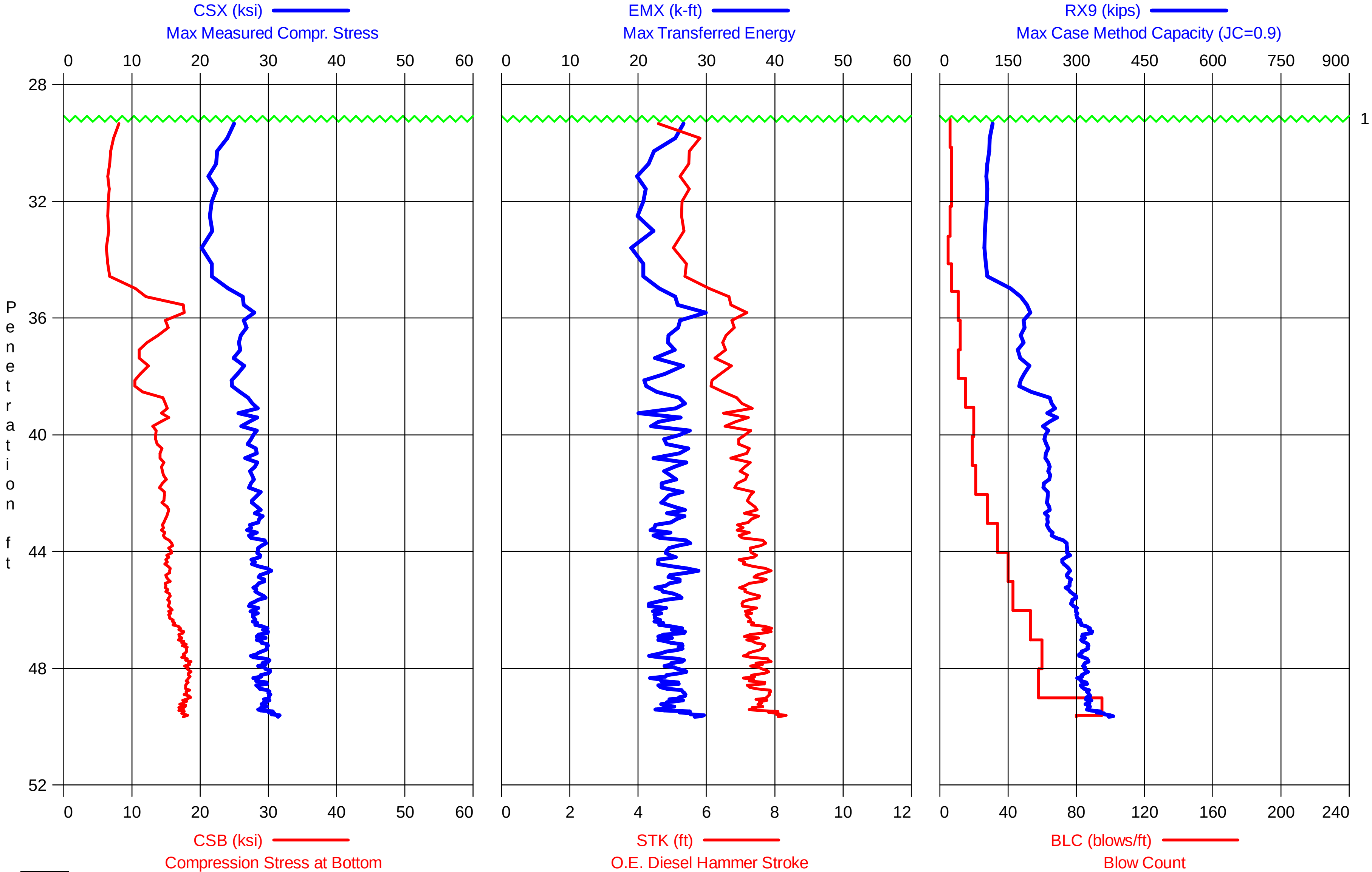
PDIPLOT Ver. 2014.1 - Printed: 14-Nov-2014

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

Test date: 12-Nov-2014

STH 96 over Fox River (B-5-831) - Pier 13 #34 - EOID

APE D25-42, HP 12 x 53



1 - Reported reference EL 592.5

STH 96 over Fox River (B-5-831) - Pier 13 #34 - EOID APE D25-42, HP 12 x 53
OP: AZ Test date: 12-Nov-2014

AR: 15.50 in^2 SP: 0.492 k/ft3
LE: 72.40 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 1.00

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

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
6	30.00	6	AV6	24.5	7.7	6.2	26	47	113
			STD	2.5	0.6	0.6	4	2	7
			MAX	28.1	8.8	7.2	34	51	128
			MIN	20.7	7.0	5.4	19	44	107
13	31.00	7	AV7	22.6	6.8	5.5	22	50	107
			STD	1.0	0.2	0.2	1	1	3
			MAX	23.5	7.1	5.7	24	52	110
			MIN	20.4	6.5	5.1	19	49	102
20	32.00	7	AV7	21.6	6.5	5.3	20	51	103
			STD	1.5	0.2	0.3	2	1	4
			MAX	24.2	6.9	5.9	23	52	108
			MIN	20.0	6.3	5.0	18	48	99
26	33.00	6	AV6	21.3	6.4	5.2	21	51	100
			STD	1.4	0.2	0.3	2	1	3
			MAX	23.3	6.7	5.7	24	53	104
			MIN	19.6	6.3	4.8	17	49	94
31	34.00	5	AV5	21.0	6.4	5.2	20	51	99
			STD	1.6	0.2	0.3	3	2	1
			MAX	23.2	6.7	5.7	24	54	101
			MIN	18.6	6.1	4.7	17	49	97
38	35.00	7	AV7	22.1	7.6	5.5	21	50	115
			STD	1.1	1.6	0.3	2	1	17
			MAX	24.3	10.3	6.1	25	51	143
			MIN	20.6	6.4	5.2	18	48	99
49	36.00	11	AV11	26.8	15.4	6.9	27	45	188
			STD	1.2	2.8	0.3	2	1	12
			MAX	28.7	18.7	7.4	31	47	210
			MIN	25.0	10.4	6.3	24	43	159
61	37.00	12	AV12	25.9	13.7	6.6	25	46	183
			STD	0.9	1.5	0.3	1	1	5
			MAX	27.9	16.1	7.1	29	47	193
			MIN	24.4	11.5	6.2	23	44	175
72	38.00	11	AV11	25.8	11.4	6.5	25	46	183
			STD	1.0	0.9	0.3	2	1	13
			MAX	27.0	12.9	6.9	28	48	201
			MIN	23.7	9.9	5.9	21	45	157
87	39.00	15	AV15	26.0	12.4	6.5	24	46	208
			STD	1.5	2.1	0.4	3	1	31
			MAX	28.3	15.5	7.3	28	49	251
			MIN	23.3	10.0	5.8	20	44	173
107	40.00	20	AV20	27.4	14.2	7.0	24	45	242
			STD	1.4	0.9	0.4	3	1	11
			MAX	30.5	15.9	8.0	30	47	262
			MIN	24.8	12.9	6.2	19	42	222
126	41.00	19	AV19	27.6	14.0	7.1	25	44	234
			STD	0.9	0.5	0.3	2	1	5
			MAX	29.2	15.3	7.5	28	46	240
			MIN	25.9	13.0	6.6	22	43	224
147	42.00	21	AV21	27.7	14.5	7.1	25	44	237
			STD	1.0	0.5	0.3	2	1	7
			MAX	29.4	15.4	7.6	27	46	250
			MIN	26.0	13.5	6.4	21	43	221

STH 96 over Fox River (B-5-831) - Pier 13 #34 - EOID
OP: AZ

APE D25-42, HP 12 x 53
Test date: 12-Nov-2014

BL# end	depth ft	BLC bl/ft	TYPE	CSX ksi	CSB ksi	STK ft	EMX k-ft	BPM **	RX9 kips
175	43.00	28	AV24	28.4	15.0	7.3	25	44	237
			STD	0.9	0.5	0.3	2	1	4
			MAX	30.0	15.7	7.9	28	46	246
			MIN	26.1	13.9	6.7	21	42	228
209	44.00	34	AV34	28.2	15.1	7.3	24	44	259
			STD	1.1	0.6	0.4	2	1	18
			MAX	29.9	16.5	7.8	28	46	285
			MIN	25.6	14.1	6.5	20	42	234
249	45.00	40	AV40	28.8	15.3	7.4	25	43	280
			STD	0.9	0.4	0.3	2	1	6
			MAX	31.3	16.1	8.2	30	45	291
			MIN	27.0	14.4	6.8	22	41	266
292	46.00	43	AV43	28.3	15.3	7.2	24	44	291
			STD	0.9	0.4	0.3	2	1	7
			MAX	30.2	16.1	7.8	27	46	303
			MIN	26.4	14.4	6.7	21	42	275
345	47.00	53	AV53	28.5	16.4	7.4	24	43	314
			STD	1.0	0.8	0.3	2	1	13
			MAX	30.4	17.9	8.1	28	46	343
			MIN	26.8	15.0	6.7	21	42	292
405	48.00	60	AV60	29.1	17.8	7.5	25	43	319
			STD	1.0	0.5	0.3	2	1	8
			MAX	31.5	19.2	8.3	29	45	333
			MIN	26.8	16.6	6.9	21	41	300
463	49.00	58	AV58	29.3	18.2	7.6	25	43	319
			STD	1.0	0.5	0.3	2	1	9
			MAX	31.0	19.4	8.1	28	45	337
			MIN	27.0	17.2	6.9	21	42	297
520	49.60	95	AV57	29.7	17.6	7.7	25	43	334
			STD	0.9	0.5	0.3	2	1	16
			MAX	31.9	18.7	8.5	30	44	378
			MIN	28.0	16.6	7.1	22	41	316
525	49.66	80	AV5	31.4	17.8	8.2	29	41	377
			STD	0.8	0.5	0.2	1	1	6
			MAX	32.5	18.5	8.4	30	42	385
			MIN	29.9	17.1	7.8	27	41	370
			Average	28.0	15.3	7.2	25	44	271
			Std. Dev.	2.2	3.0	0.7	2	2	65
			Maximum	32.5	19.4	8.5	34	54	385
			Minimum	18.6	6.1	4.7	17	41	94

Total number of blows analyzed: 521

BL#	depth (ft)	Comments
1	29.17	Reported reference EL 592.5

Time Summary

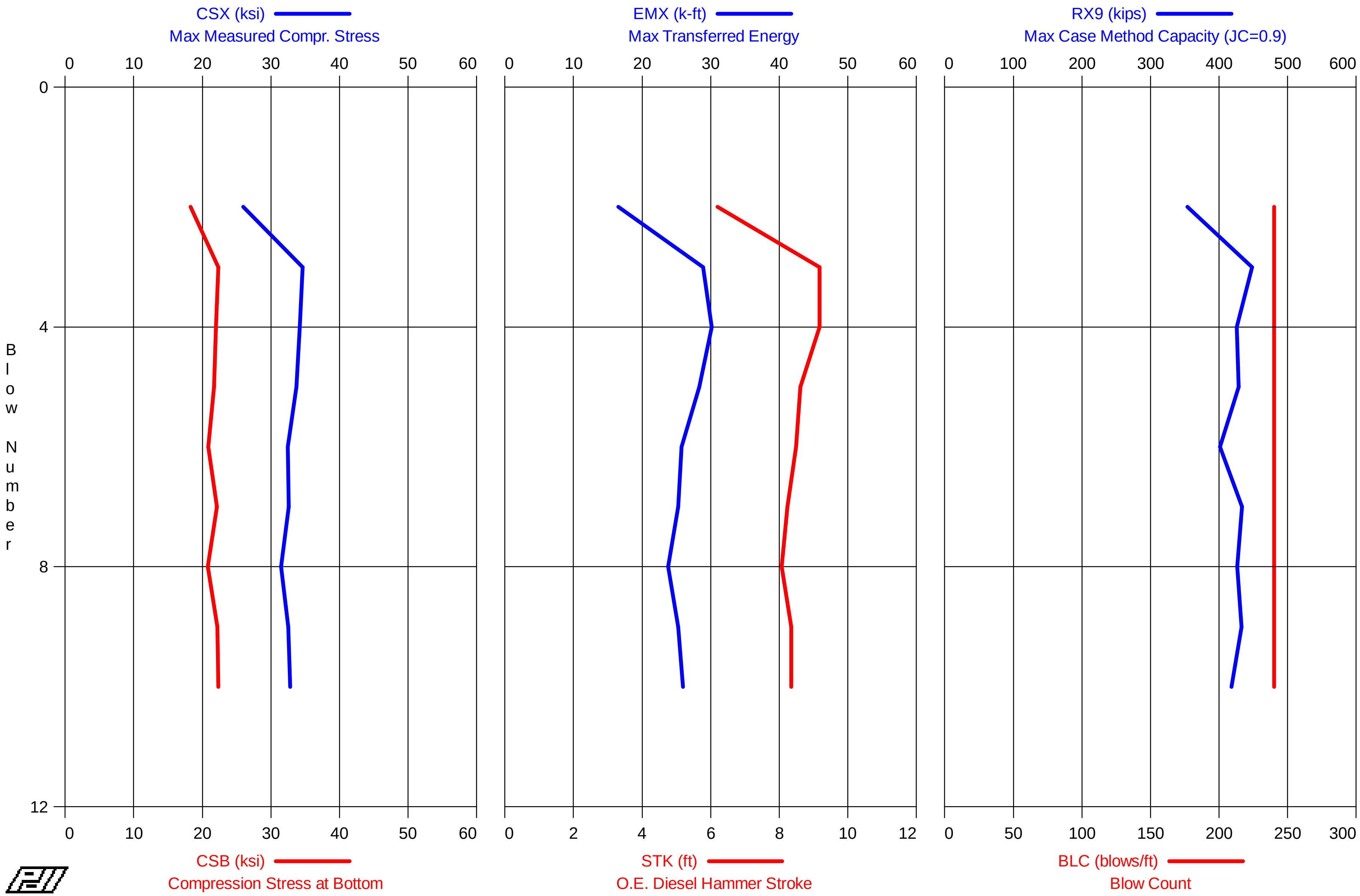
Drive 12 minutes 34 seconds 11:37:01 AM - 11:49:35 AM (11/12/2014) BN 1 - 525

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

PDIPLOT Ver. 2014.1 - Printed: 14-Nov-2014

Test date: 13-Nov-2014

STH 96 over Fox River (B-5-831) - Pier 13 #34 - BOR
APE D25-42, HP 12 x 53



STH 96 over Fox River (B-5-831) - Pier 13 #34 - BOR
OP: TC

APE D25-42, HP 12 x 53
Test date: 13-Nov-2014

AR: 15.50 in^2
LE: 72.40 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
STK: O.E. Diesel Hammer Stroke

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

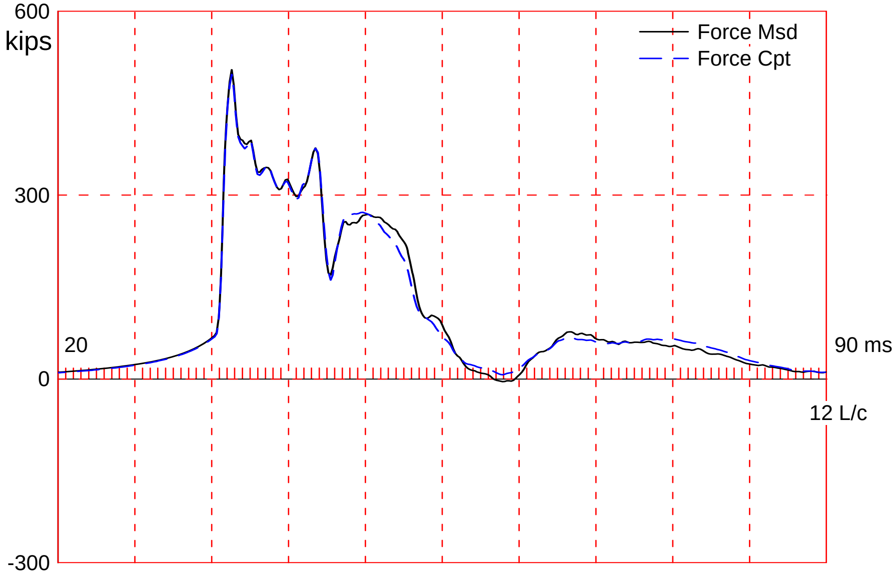
BL#	depth	BLC	TYPE	CSX	CSB	STK	EMX	BPM	RX9
end	ft	bl/ft		ksi	ksi	ft	k-ft	**	kips
10	49.74	240	AV9	32.3	21.4	8.3	26	41.2	419
			STD	2.4	1.2	0.8	4	2.3	26
			MAX	34.6	22.3	9.2	30	47.2	448
			MIN	26.0	18.3	6.2	17	39.1	354
			Average	32.3	21.4	8.3	26	41.2	419
			Std. Dev.	2.4	1.2	0.8	4	2.3	26
			Maximum	34.6	22.3	9.2	30	47.2	448
			Minimum	26.0	18.3	6.2	17	39.1	354

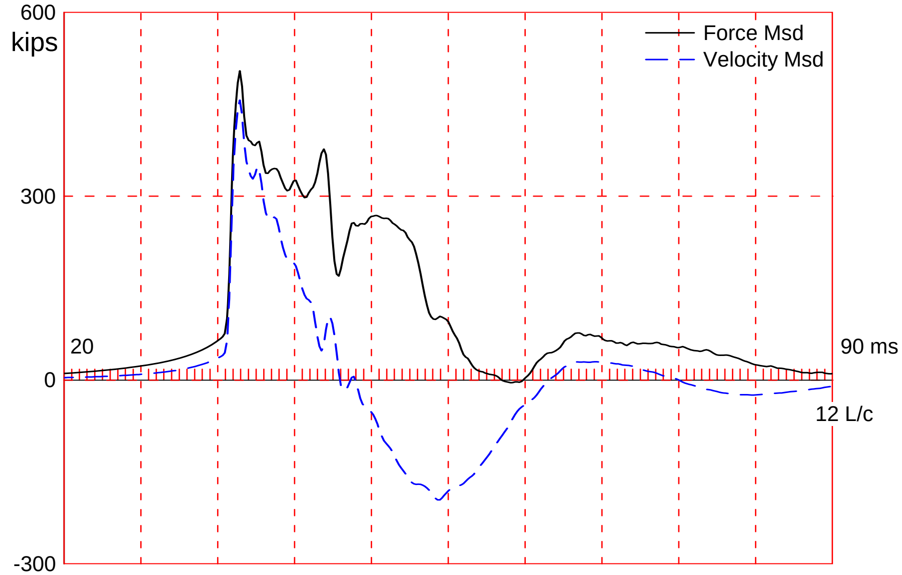
Total number of blows analyzed: 9

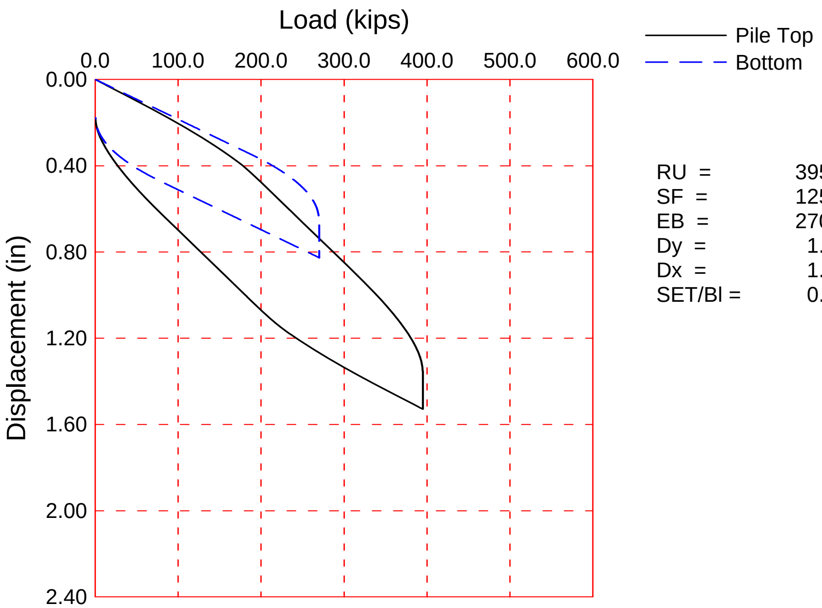
BL#	depth (ft)	Comments
4	49.72	CW
5	49.72	CW

Time Summary

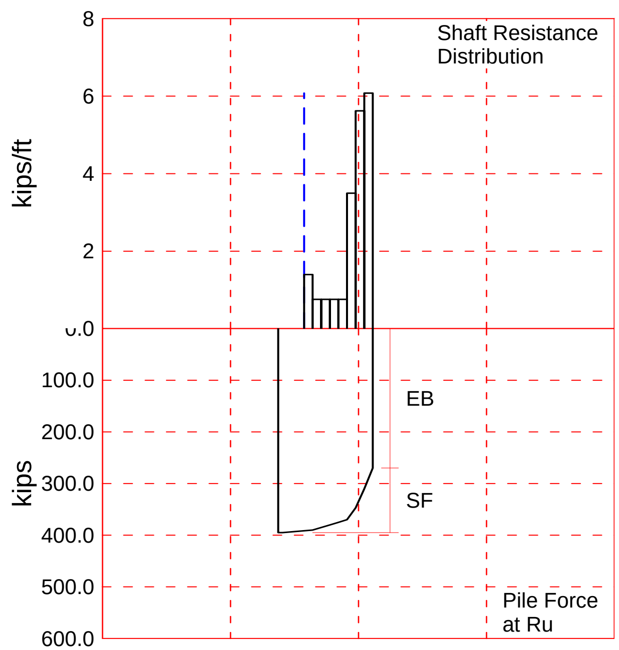
Drive 14 seconds 9:03:47 AM - 9:04:01 AM (11/13/2014) BN 1 - 10







RU =	395.0 kips
SF =	125.0 kips
EB =	270.0 kips
Dy =	1.35 in
Dx =	1.53 in
SET/Bl =	0.18 in



Length b. Sensors	72.4 ft
Embedment	49.6 ft
Top Area	15.5 in²
End Bearing Area	141.9 in²
Top Perimeter	3.97 ft
Top E-Modulus	29992 ksi
Top Spec. Weight	492.0 lb/ft³
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	2.60
Top Compr. Stress	32.1 ksi
Max Compr. Stress	33.6 ksi
Max Tension Stress	-1.55 ksi
Avg. Shaft Quake	0.10 in
Toe Quake	0.50 in
Avg. Shaft Smith Dpg.	0.30 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: 395.0; along Shaft 125.0; at Toe 270.0 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
				395.0			
1	26.3	3.6	5.0	390.0	5.0	1.40	0.35
2	32.9	10.2	5.0	385.0	10.0	0.76	0.19
3	39.5	16.7	5.0	380.0	15.0	0.76	0.19
4	46.1	23.3	5.0	375.0	20.0	0.76	0.19
5	52.7	29.9	5.0	370.0	25.0	0.76	0.19
6	59.2	36.5	23.0	347.0	48.0	3.49	0.88
7	65.8	43.1	37.0	310.0	85.0	5.62	1.42
8	72.4	49.6	40.0	270.0	125.0	6.08	1.53
Avg. Shaft			15.6			2.52	0.63
Toe			270.0				274.01

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.03
Quake	(in)	0.10	0.50
Case Damping Factor		1.36	0.29
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	57	174
Unloading Level	(% of Ru)	83	
Resistance Gap (included in Toe Quake) (in)			0.19

CAPWAP match quality = 2.60 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.18 in; Blow Count = 68 b/ft
Computed: Final Set = 0.18 in; Blow Count = 68 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.95; F4(H083) CAL: 94.4; RF: 0.95
A3(K2214) CAL: 332; RF: 1.05; A4(K974) CAL: 305; RF: 1.05

max. Top Comp. Stress = 32.1 ksi (T= 36.2 ms, max= 1.047 x Top)
max. Comp. Stress = 33.6 ksi (Z= 26.3 ft, T= 37.6 ms)
max. Tens. Stress = -1.55 ksi (Z= 26.3 ft, T= 59.5 ms)
max. Energy (EMX) = 29.4 kip-ft; max. Measured Top Displ. (DMX)= 1.07 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	497.9	0.0	32.1	0.00	29.4	16.7	1.07
2	6.6	498.8	-3.1	32.2	-0.20	29.3	16.7	1.05
3	9.9	499.7	-6.7	32.2	-0.43	29.1	16.7	1.03
4	13.2	500.8	-9.6	32.3	-0.62	28.8	16.6	1.01
5	16.5	502.5	-12.8	32.4	-0.83	28.6	16.5	0.98
6	19.7	508.4	-17.3	32.8	-1.11	28.3	16.3	0.96
7	23.0	514.4	-20.8	33.2	-1.34	27.9	16.1	0.93
8	26.3	521.4	-24.0	33.6	-1.55	27.5	15.8	0.90
9	29.6	498.9	-17.8	32.2	-1.14	25.8	15.6	0.88
10	32.9	505.8	-20.6	32.6	-1.33	25.5	15.3	0.85
11	36.2	484.2	-13.4	31.2	-0.86	23.9	15.1	0.82
12	39.5	490.9	-14.6	31.7	-0.94	23.4	14.8	0.79
13	42.8	470.2	-8.9	30.3	-0.58	21.9	14.6	0.76
14	46.1	476.9	-11.8	30.8	-0.76	21.5	14.3	0.73
15	49.4	465.2	-6.5	30.0	-0.42	20.1	14.0	0.70
16	52.7	476.7	-9.2	30.7	-0.59	19.6	13.3	0.67
17	55.9	473.7	-3.3	30.6	-0.21	18.3	12.5	0.64
18	59.2	514.9	-4.9	33.2	-0.32	17.9	11.3	0.61
19	62.5	454.2	0.0	29.3	0.00	14.1	10.4	0.58
20	65.8	433.6	0.0	28.0	0.00	13.7	11.1	0.55
21	69.1	325.3	0.0	21.0	0.00	8.8	12.8	0.53
22	72.4	324.3	-0.0	20.9	-0.00	3.9	13.2	0.50
Absolute	26.3			33.6			(T =	37.6 ms)
	26.3				-1.55		(T =	59.5 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	546.1	460.8	375.5	290.2	204.9					
RX	546.1	460.8	415.4	403.0	398.6	394.2	390.9	389.0	387.1	385.2
RU	546.1	460.8	375.5	290.2	204.9					

RAU = 285.0 (kips); RA2 = 441.3 (kips)

Current CAPWAP Ru = 395.0 (kips); Corresponding J(RP)= 0.35; J(RX) = 0.96

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
16.7	36.22	461.6	511.0	511.0	1.07	0.18	0.18	29.6	572.3	871

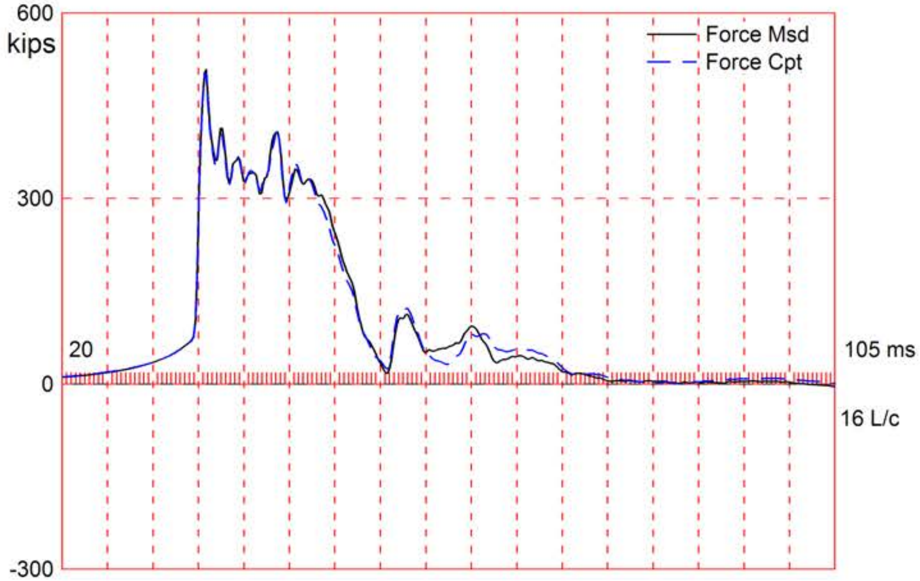
PILE PROFILE AND PILE MODEL

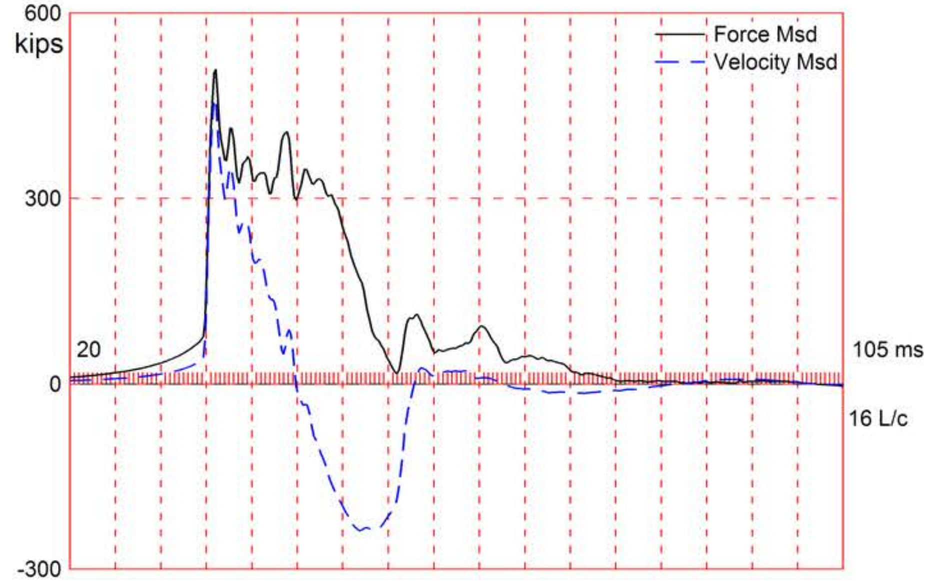
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

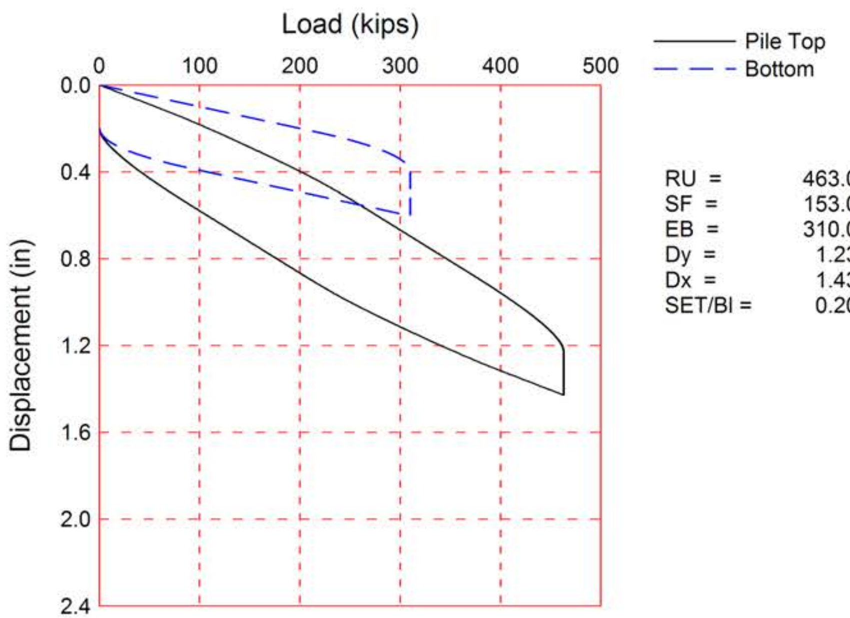
Toe Area 141.9 in^2

Segmnt Number	Dist. B.G.	Impedance	Imped. Change	Tension Slack	Tension Eff.	Compression Slack	Compression Eff.	Perim.	Wave Speed	Soil Plug
	ft	kips/ft/s	%	in		in		ft	ft/s	kips
1	3.3	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000
21	69.1	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.100
22	72.4	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000

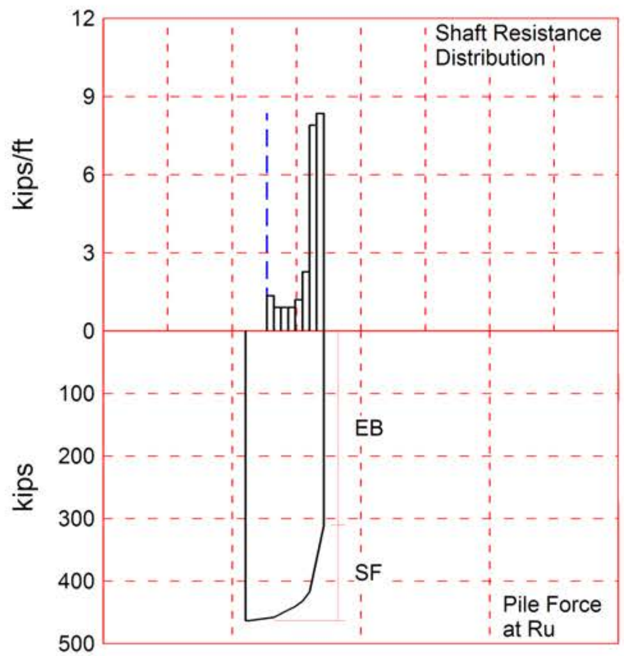
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000







RU	=	463.0 kips
SF	=	153.0 kips
EB	=	310.0 kips
Dy	=	1.23 in
Dx	=	1.43 in
SET/Bl	=	0.20 in



Length b. Sensors	72.4 ft
Embedment	49.8 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	2.92
Top Compr. Stress	32.4 ksi
Max Compr. Stress	34.2 ksi
Max Tension Stress	-5.85 ksi
Avg. Shaft Quake	0.08 in
Toe Quake	0.31 in
Avg. Shaft Smith Dpg.	0.32 s/ft
Toe Smith Damping	0.05 s/ft

About the CAPWAP Results

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

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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.

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

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 463.0; along Shaft 153.0; at Toe 310.0 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
				463.0			
1	26.3	3.7	5.0	458.0	5.0	1.36	0.34
2	32.9	10.3	6.0	452.0	11.0	0.91	0.23
3	39.5	16.8	6.0	446.0	17.0	0.91	0.23
4	46.1	23.4	6.0	440.0	23.0	0.91	0.23
5	52.7	30.0	8.0	432.0	31.0	1.22	0.31
6	59.2	36.6	15.0	417.0	46.0	2.28	0.57
7	65.8	43.2	52.0	365.0	98.0	7.90	1.99
8	72.4	49.8	55.0	310.0	153.0	8.36	2.10
Avg. Shaft			19.1			3.08	0.77
Toe			310.0				314.61

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.32	0.05
Quake	(in)	0.08	0.31
Case Damping Factor		1.77	0.50
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	30	35
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	18	
Resistance Gap (included in Toe Quake) (in)			0.08
Soil Plug Weight	(kips)	0.080	0.008

CAPWAP match quality = 2.92 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.20 in; Blow Count = 60 b/ft
Computed: Final Set = 0.16 in; Blow Count = 75 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.96; F4(H083) CAL: 94.4; RF: 0.96
A3(K2214) CAL: 332; RF: 1.04; A4(K974) CAL: 305; RF: 1.04

max. Top Comp. Stress = 32.4 ksi (T= 36.2 ms, max= 1.056 x Top)
max. Comp. Stress = 34.2 ksi (Z= 26.3 ft, T= 37.6 ms)
max. Tens. Stress = -5.85 ksi (Z= 59.2 ft, T= 59.1 ms)
max. Energy (EMX) = 29.9 kip-ft; max. Measured Top Displ. (DMX)= 1.06 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	502.6	-23.3	32.4	-1.50	29.9	16.7	1.04
2	6.6	503.8	-23.2	32.5	-1.50	29.5	16.7	1.01
3	9.9	505.0	-23.1	32.6	-1.49	29.0	16.6	0.98
4	13.2	506.4	-23.2	32.7	-1.50	28.4	16.6	0.95
5	16.5	508.6	-23.3	32.8	-1.50	27.8	16.5	0.91
6	19.7	515.3	-29.4	33.2	-1.90	27.3	16.3	0.88
7	23.0	522.0	-39.1	33.7	-2.52	26.7	16.0	0.84
8	26.3	530.9	-47.4	34.2	-3.06	26.0	15.7	0.81
9	29.6	508.3	-47.3	32.8	-3.05	24.1	15.4	0.77
10	32.9	517.2	-55.7	33.4	-3.59	23.4	15.1	0.73
11	36.2	489.8	-56.2	31.6	-3.63	21.5	14.8	0.70
12	39.5	498.5	-66.4	32.2	-4.28	20.8	14.5	0.66
13	42.8	472.6	-69.2	30.5	-4.46	19.0	14.2	0.62
14	46.1	482.7	-77.4	31.1	-4.99	18.4	13.8	0.59
15	49.4	476.3	-78.6	30.7	-5.07	16.8	13.5	0.55
16	52.7	476.0	-86.7	30.7	-5.59	16.2	13.0	0.51
17	55.9	453.5	-88.6	29.3	-5.72	14.5	12.4	0.48
18	59.2	491.9	-90.7	31.7	-5.85	13.9	11.4	0.44
19	62.5	465.4	-79.8	30.0	-5.14	11.8	9.7	0.41
20	65.8	469.1	-79.4	30.3	-5.12	11.2	9.3	0.37
21	69.1	377.4	-42.6	24.3	-2.75	7.0	10.4	0.34
22	72.4	381.0	-42.0	24.6	-2.71	3.5	9.9	0.31
Absolute	26.3			34.2			(T =	37.6 ms)
	59.2				-5.85		(T =	59.1 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	628.8	556.0	483.2	410.4	337.6					
RX	629.7	557.9	500.0	483.0	475.5	469.8	464.7	459.6	454.5	449.4
RU	628.8	556.0	483.2	410.4	337.6					

RAU = 440.3 (kips); RA2 = 495.2 (kips)

Current CAPWAP Ru = 463.0 (kips); Corresponding J(RP)= 0.46; J(RX) = 1.27

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	35.83	474.2	518.6	520.6	1.06	0.18	0.20	30.2	575.8	1319

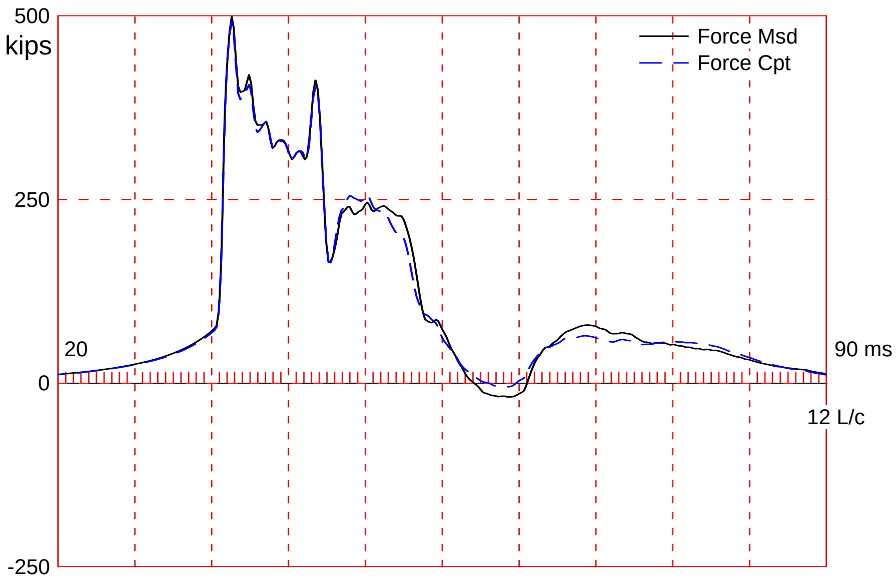
PILE PROFILE AND PILE MODEL

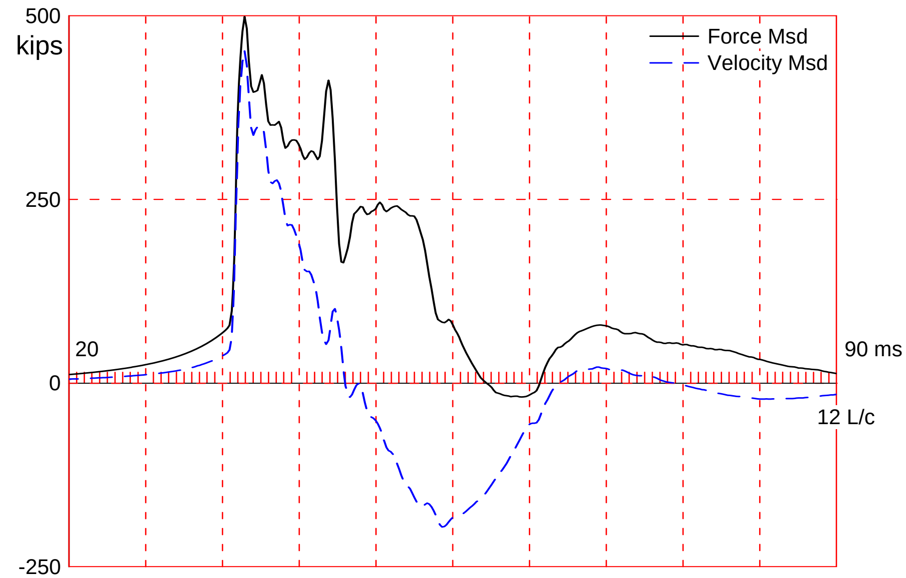
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

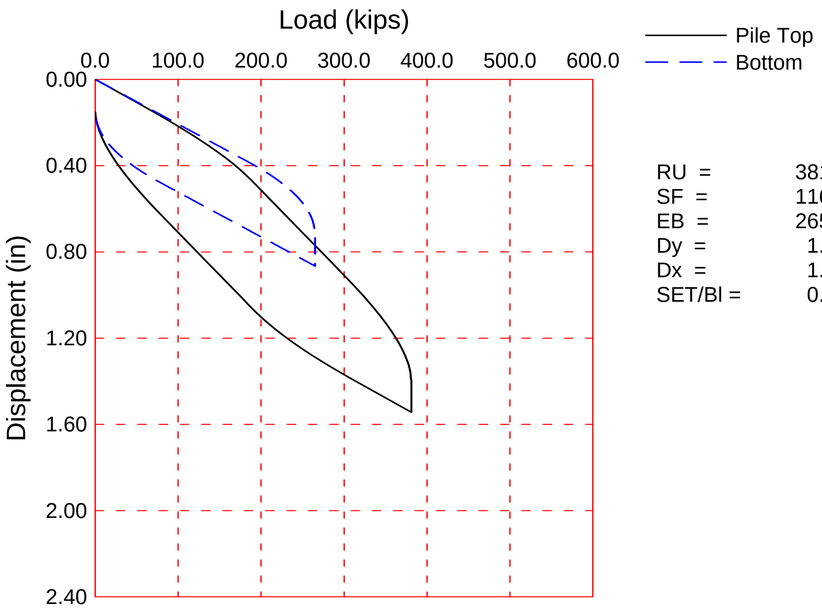
Toe Area 141.9 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000
21	69.1	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.040
22	72.4	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.040

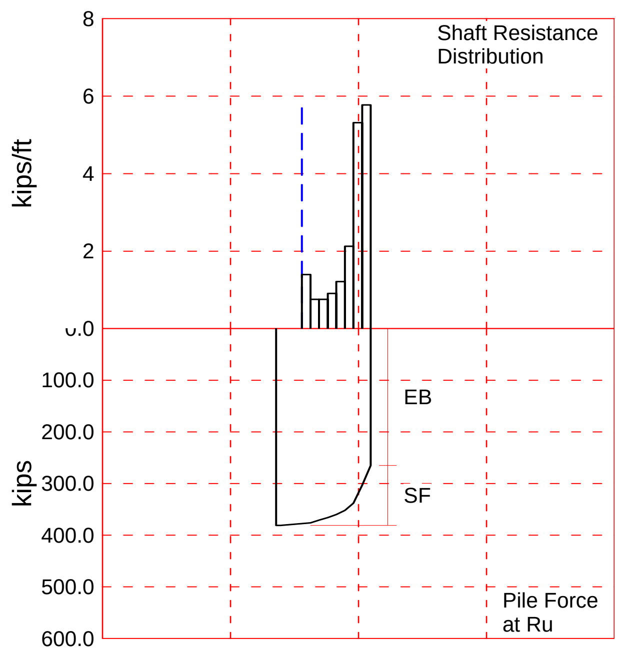
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000







RU =	381.0 kips
SF =	116.0 kips
EB =	265.0 kips
Dy =	1.39 in
Dx =	1.54 in
SET/Bl =	0.15 in



Length b. Sensors	72.4 ft
Embedment	49.7 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	2.87
Top Compr. Stress	31.8 ksi
Max Compr. Stress	33.3 ksi
Max Tension Stress	-2.28 ksi
Avg. Shaft Quake	0.12 in
Toe Quake	0.55 in
Avg. Shaft Smith Dpg.	0.30 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: 381.0; along Shaft 116.0; at Toe 265.0 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
				381.0			
1	26.3	3.6	5.0	376.0	5.0	1.40	0.35
2	32.9	10.2	5.0	371.0	10.0	0.76	0.19
3	39.5	16.7	5.0	366.0	15.0	0.76	0.19
4	46.1	23.3	6.0	360.0	21.0	0.91	0.23
5	52.7	29.9	8.0	352.0	29.0	1.22	0.31
6	59.2	36.5	14.0	338.0	43.0	2.13	0.54
7	65.8	43.1	35.0	303.0	78.0	5.32	1.34
8	72.4	49.7	38.0	265.0	116.0	5.77	1.45
Avg. Shaft			14.5			2.34	0.59
Toe			265.0				268.94

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.30	0.03
Quake	(in)	0.12	0.55
Case Damping Factor		1.26	0.29
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	64	135
Unloading Level	(% of Ru)	58	
Resistance Gap (included in Toe Quake) (in)			0.12
Soil Plug Weight	(kips)	0.150	0.026

CAPWAP match quality = 2.87 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.15 in; Blow Count = 80 b/ft
Computed: Final Set = 0.13 in; Blow Count = 92 b/ft
Transducer F3(H083) CAL: 94.4; RF: 0.95; F4(F523) CAL: 93.8; RF: 0.95
A3(K974) CAL: 305; RF: 1.05; A4(K2214) CAL: 332; RF: 1.05

max. Top Comp. Stress = 31.8 ksi (T= 36.2 ms, max= 1.046 x Top)
max. Comp. Stress = 33.3 ksi (Z= 26.3 ft, T= 37.6 ms)
max. Tens. Stress = -2.28 ksi (Z= 26.3 ft, T= 60.1 ms)
max. Energy (EMX) = 30.3 kip-ft; max. Measured Top Displ. (DMX)= 1.09 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	493.6	-10.1	31.8	-0.65	30.3	16.5	1.10
2	6.6	494.5	-15.2	31.9	-0.98	30.2	16.5	1.08
3	9.9	495.4	-20.4	32.0	-1.31	30.0	16.4	1.06
4	13.2	496.4	-25.2	32.0	-1.62	29.7	16.4	1.04
5	16.5	498.0	-28.8	32.1	-1.86	29.5	16.3	1.02
6	19.7	503.7	-31.7	32.5	-2.04	29.2	16.1	0.99
7	23.0	509.8	-34.4	32.9	-2.22	28.9	15.9	0.97
8	26.3	516.5	-35.3	33.3	-2.28	28.5	15.6	0.94
9	29.6	494.5	-28.2	31.9	-1.82	26.8	15.4	0.91
10	32.9	501.0	-29.1	32.3	-1.88	26.5	15.1	0.88
11	36.2	479.8	-23.0	30.9	-1.48	24.9	14.9	0.86
12	39.5	486.9	-25.6	31.4	-1.65	24.5	14.6	0.83
13	42.8	467.5	-20.2	30.2	-1.30	23.0	14.3	0.80
14	46.1	476.1	-22.5	30.7	-1.45	22.6	14.0	0.77
15	49.4	482.1	-15.7	31.1	-1.02	21.0	13.7	0.74
16	52.7	478.5	-18.0	30.9	-1.16	20.6	13.2	0.71
17	55.9	445.9	-8.5	28.8	-0.55	18.7	12.6	0.69
18	59.2	495.8	-10.7	32.0	-0.69	18.3	11.6	0.66
19	62.5	472.5	0.0	30.5	0.00	15.7	11.4	0.63
20	65.8	458.5	0.0	29.6	0.00	15.3	11.4	0.60
21	69.1	331.3	0.0	21.4	0.00	10.4	13.4	0.58
22	72.4	327.2	-0.0	21.1	-0.00	5.4	13.1	0.55
Absolute	26.3			33.3			(T =	37.6 ms)
	26.3				-2.28		(T =	60.1 ms)

CASE METHOD

J =	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
RP	538.0	454.0	370.1	286.1	202.1					
RX	538.0	454.0	398.9	389.7	385.2	383.8	382.8	381.8	380.7	379.7
RU	538.0	454.0	370.1	286.1	202.1					

RAU = 281.3 (kips); RA2 = 433.5 (kips)

Current CAPWAP Ru = 381.0 (kips); Corresponding J(RP)= 0.37; J(RX) = 1.54

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
16.5	36.03	455.5	502.4	503.0	1.09	0.15	0.15	30.4	588.1	616

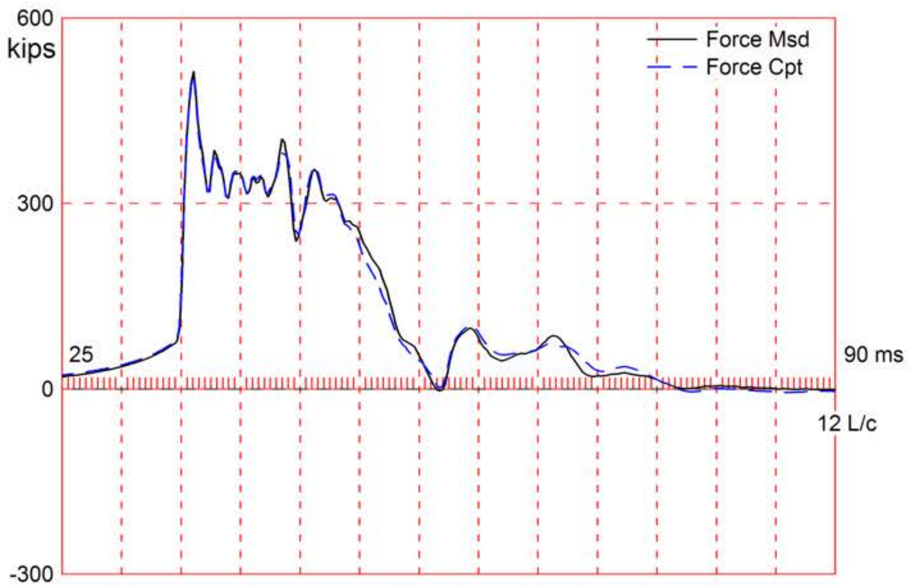
PILE PROFILE AND PILE MODEL

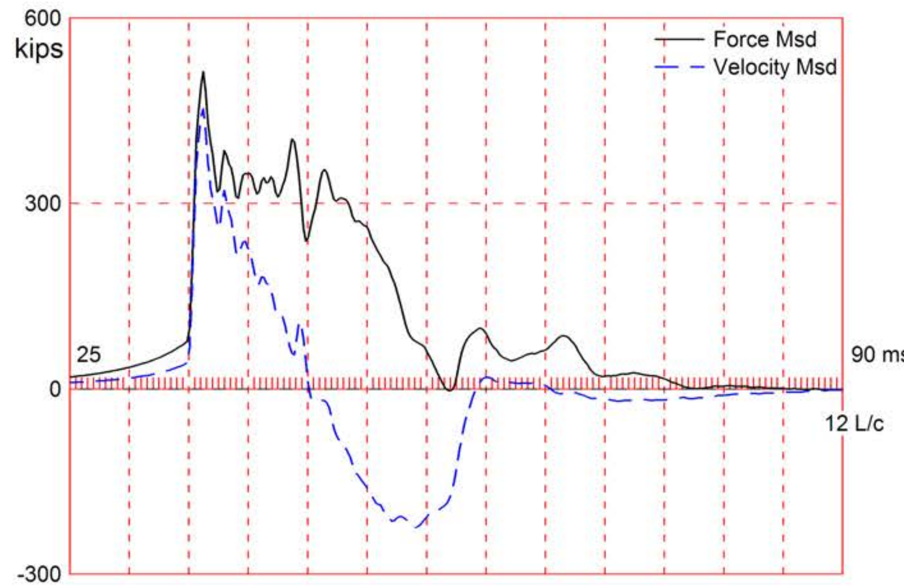
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

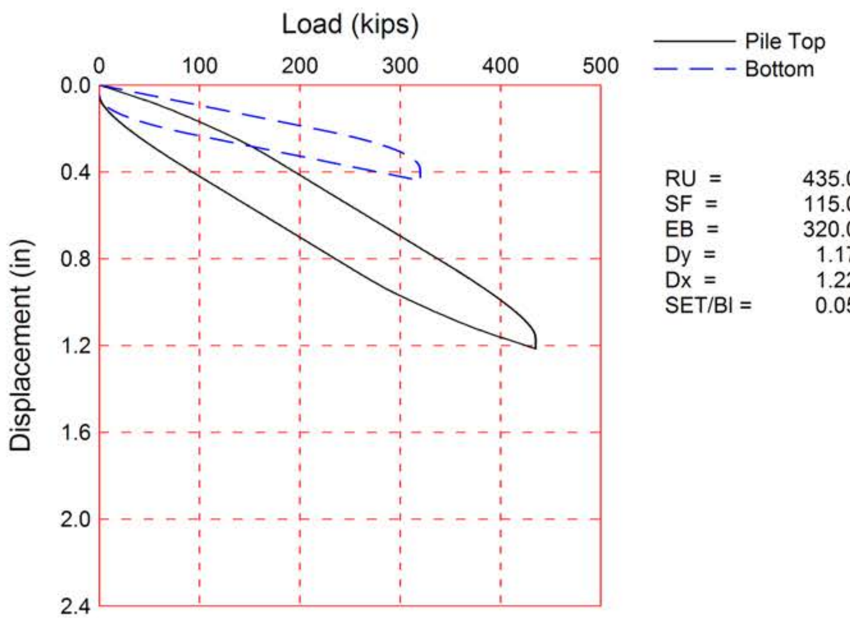
Toe Area 141.9 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000
21	69.1	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.150
22	72.4	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000

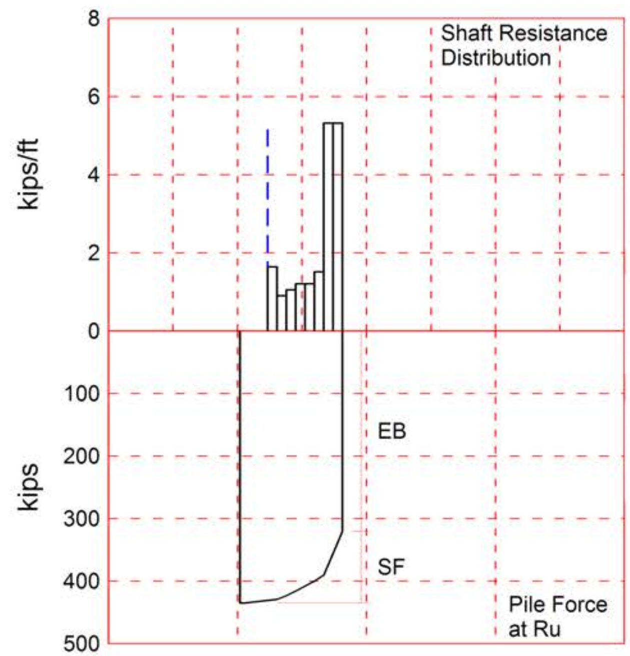
Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000







RU =	435.0 kips
SF =	115.0 kips
EB =	320.0 kips
Dy =	1.17 in
Dx =	1.22 in
SET/Bl =	0.05 in



Length b. Sensors	72.4 ft
Embedment	49.7 ft
Top Area	15.5 in^2
End Bearing Area	141.9 in^2
Top Perimeter	3.97 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	32.8 ksi
Max Compr. Stress	34.6 ksi
Max Tension Stress	-3.19 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.30 in
Avg. Shaft Smith Dpg.	0.33 s/ft
Toe Smith Damping	0.05 s/ft

About the CAPWAP Results

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

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

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

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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: 435.0; along Shaft 115.0; at Toe 320.0 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
				435.0				
1	26.3	3.6	6.0	429.0	6.0	1.64	0.41	0.04
2	32.9	10.2	6.0	423.0	12.0	0.91	0.23	0.04
3	39.5	16.8	7.0	416.0	19.0	1.06	0.27	0.04
4	46.1	23.4	8.0	408.0	27.0	1.22	0.31	0.04
5	52.7	30.0	8.0	400.0	35.0	1.22	0.31	0.04
6	59.2	36.6	10.0	390.0	45.0	1.52	0.38	0.04
7	65.8	43.1	35.0	355.0	80.0	5.32	1.34	0.04
8	72.4	49.7	35.0	320.0	115.0	5.32	1.34	0.04
Avg. Shaft			14.4			2.31	0.58	0.04
Toe			320.0				324.76	0.30

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.33	0.05
Case Damping Factor		1.37	0.58
Damping Type		Viscous	Smith
Unloading Quake	(% of loading quake)	40	108
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.01
Soil Plug Weight	(kips)	0.090	0.042

CAPWAP match quality = 2.88 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.05 in; Blow Count = 240 b/ft
Computed: Final Set = 0.09 in; Blow Count = 129 b/ft
Transducer F3(F523) CAL: 93.8; RF: 0.97; F4(H083) CAL: 94.4; RF: 0.97
A3(K2214) CAL: 332; RF: 1.03; A4(K974) CAL: 305; RF: 1.03

max. Top Comp. Stress = 32.8 ksi (T= 36.4 ms, max= 1.058 x Top)
max. Comp. Stress = 34.6 ksi (Z= 26.3 ft, T= 37.8 ms)
max. Tens. Stress = -3.19 ksi (Z= 26.3 ft, T= 58.3 ms)
max. Energy (EMX) = 28.0 kip-ft; max. Measured Top Displ. (DMX)= 1.04 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.3	507.8	-16.6	32.8	-1.07	28.0	16.6	0.99
2	6.6	508.7	-16.7	32.8	-1.07	27.7	16.6	0.97
3	9.9	509.7	-18.2	32.9	-1.17	27.2	16.5	0.94
4	13.2	510.8	-26.8	32.9	-1.73	26.8	16.5	0.91
5	16.5	512.7	-33.7	33.1	-2.17	26.3	16.4	0.88
6	19.7	520.7	-40.6	33.6	-2.62	25.7	16.1	0.84
7	23.0	527.7	-45.0	34.0	-2.90	25.2	15.8	0.81
8	26.3	537.2	-49.5	34.6	-3.19	24.6	15.4	0.78
9	29.6	507.8	-38.4	32.8	-2.47	22.7	15.2	0.74
10	32.9	517.9	-43.4	33.4	-2.80	22.0	14.8	0.71
11	36.2	490.4	-33.7	31.6	-2.17	20.2	14.5	0.67
12	39.5	501.5	-39.3	32.3	-2.54	19.7	14.1	0.64
13	42.8	470.5	-27.4	30.3	-1.77	17.8	13.8	0.60
14	46.1	481.4	-30.7	31.1	-1.98	17.2	13.4	0.57
15	49.4	446.8	-16.4	28.8	-1.06	15.4	13.1	0.54
16	52.7	459.4	-21.7	29.6	-1.40	14.8	12.6	0.50
17	55.9	431.0	-11.8	27.8	-0.76	13.2	12.1	0.47
18	59.2	464.2	-17.4	29.9	-1.12	12.7	11.0	0.43
19	62.5	449.7	-3.4	29.0	-0.22	11.1	9.8	0.40
20	65.8	446.4	-7.4	28.8	-0.48	10.6	10.0	0.37
21	69.1	369.9	-0.0	23.9	-0.00	7.3	11.2	0.34
22	72.4	374.3	-0.0	24.1	-0.00	4.8	10.4	0.31
Absolute	26.3			34.6			(T =	37.8 ms)
	26.3				-3.19		(T =	58.3 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	595.7	556.8	517.9	479.0	440.1	401.2	362.3	323.4	284.5	245.6
RX	595.7	558.7	522.2	491.1	473.5	456.0	444.0	438.9	433.7	428.6
RU	595.7	556.8	517.9	479.0	440.1	401.2	362.3	323.4	284.5	245.6

RAU = 296.6 (kips); RA2 = 468.3 (kips)

Current CAPWAP Ru = 435.0 (kips); Corresponding J(RP)= 0.41; J(RX) = 0.78

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
16.7	36.22	461.7	523.1	523.1	1.04	0.05	0.05	28.3	624.1	1103

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	15.5	29992.2	492.000	3.97
72.4	15.5	29992.2	492.000	3.97

Toe Area 141.9 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s	Soil Plug kips
1	3.3	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.000
20	65.8	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.010
21	69.1	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.040
22	72.4	27.67	0.00	0.00	0.000	-0.00	0.000	3.97	16807.9	0.040

Wave Speed: Pile Top 16807.9, Elastic 16807.9, Overall 16807.9 ft/s
Pile Damping 1.00 %, Time Incr 0.196 ms, 2L/c 8.6 ms
Total volume: 7.793 ft^3; Volume ratio considering added impedance: 1.000