INFRASTRUCTURE
CONSULTING & ENGINEERING

March 17, 2023

Mr. Billy Hardwick
Senior Project Manager
Archer-United Joint Venture
billy.hardwick@uig.net

Re: **Report of Dynamic Pile Testing and Recommended Production Pile Driving Criteria**
Carolina Crossroads Phase 1 (CCR1)
Load Transfer Platform – Test Piles 1 Through 3
SCDOT Project ID No.: P039718
Lexington and Richland Counties, South Carolina

Dear Mr. Hardwick:

The attached results of dynamic pile testing for the subject piles and project includes measurements and analysis performed by Infrastructure Consulting & Engineering in accordance with ASTM D4945. Measurements were made with the Pile Dynamics, Inc. Model 8G and signal matching analysis was performed with CAPWAP version 2014. For further information on the test method please refer to the ASTM.

Thank you for the opportunity to provide these services.

Sincerely,
Infrastructure Consulting & Engineering (ICE), PLLC

Michael J. Simpson 2023.03.17 14:53:20 -04'00'

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 35396 MICHAEL JOEL SIMPSON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

Michael J. Simpson, P.E.
Geotechnical Testing Manager
Certified PDA Signatory "Advanced"
South Carolina Registration Number: 35396

Gerzan E. Nunez, E.I.
Staff Geotechnical Professional
Certified PDA Tester "Advanced"

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Summary of Provided Project and Pile Driving Information

Project Description	Carolina Crossroads Phase 1 – Load Transfer Platform Lexington and Richland Counties, South Carolina
Pile Driving Contractor	Untied Infrastructure Group (UIG)
SCDOT Project ID	P039718
ICE Field Personnel	Gerzan E. Nunez, E.I.
ICE Responsible Engineer	Michael J. Simpson, P.E.

Structure	**Station**	**Pile Type**	**Pile Batter**	**Hammer Used**	**Pile Cushion Type and Thickness**
Load Transfer Platform	7390+51.26 7391+52.26	Timber Pile	Plumb	ICE I-19v2	N/A

Pile Number	**Total Pile Length (feet)**	**Pile Length Below Gages (feet)**	**Initial Drive Test Date**	**Restrike Test Date**
Test Pile 1 (TP-1)	25.0	21.0	03/15/2023	N/A
Test Pile 2 (TP-2)	25.0	21.0	03/15/2023	N/A
Test Pile 3 (TP-3)	25.0	21.0	03/15/2023	N/A

Required Bearing Capacity of Pile (kips)	**Minimum Tip Elevation of Piles (feet)**
80	+152.0

Installation Records Provided to ICE	No
Project Information and Soil Borings Provided to ICE	Yes, Attached in Appendix E
Pile Driving Equipment Data Form Provided to ICE	ICE I-19v2 Data Hammer Sheets Attached in Appendix F
Strain and Accelerometer Calibrations Attached	Yes, Attached in Appendix G
Timber Acceptable Compression Driving Stress Limit (ksi)*	3.6
Timber Acceptable Tension Driving Stress Limit (ksi)*	3.6

*For timber piles based on SCDOT 2007 Standard Specifications Section 711.4.2.3 with σ_a of 1200 psi (allowable unit working stress compression for Southern Pine). Allowable Driving Stress = 3 *$\sigma_{a\,(1,200\,psi)}$ = 3, 600 psi (3.6 ksi)

Pile Number	**TP-1**	**TP-2**	**TP-3**
Approximate Reference Elevation (feet)*	+170.0	+170.0	+170.0
Approximate Ground/Mudline Elevation (feet)*	+170.0	+170.0	+170.0
Approximate Final Pile Penetration Below Reference after Initial Drive (feet)	19.0	19.0	20.0
Approximate Final Pile Tip Elevation after Initial Drive (feet)	+151.0	+151.0	+150.0
Approximate Final Pile Penetration Below Reference after Restrike (feet)	N/A	N/A	N/A
Approximate Final Pile Tip Elevation after Restrike (feet)	N/A	N/A	N/A

*Reference/Ground elevation based on information provided to ICE while on-site.

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Additional Notes on Pile Installation
- All three test piles were dynamically monitored for the entire initial drive. -For additional detailed information on the hammer driving system, bridge plans, and soils information please refer to the project documents. -The blows per foot of penetration for each pile was kept by the PDA operator on the PDA.

Summary of Results

Dynamic Pile Testing Results (Detailed Results in Appendix A and B)

Pile / Location*	Case Method	Capacity (kips)	Max. CSX Stress (ksi)	Avg. CSX Stress (ksi)	Max. CSB Stress (ksi)	Avg. CSB Stress (ksi)	Max. TSX (ksi)	Avg. TSX (ksi)	Avg. Energy EMX (k-ft)	Avg. Stroke (feet)
TP-1 / EOD	RMX (Jc=0.8)	307	3.2	2.4	2.8	2.1	0.4	0.2	21.6	5.7
TP-2 / EOD	RMX (Jc=0.8)	340	2.4	1.8	2.4	1.5	0.7	0.1	13.8	5.4
TP-3 / EOD	RMX (Jc=0.8)	172	3.8	2.0	2.5	1.5	0.8	0.2	14.3	4.9

Signal Matching Analyses Results (Detailed Result in Appendix A and B)

Pile / Location*	R_{ult} (kips)	R_{side} / R_{end} (kips)	Equiv. BPF*	Stroke (ft)	EMX (k-ft)	Qs (in)	Qt (in)	Ss (sec/ft)	St (sec/ft)	MQN*
TP-1 / EOD Blow 169	305	85 / 220	30	6.1	19.9	0.04	0.16	0.10	0.03	2.84
TP-2 / EOD Blow 309	337	117 / 220	45	6.0	13.7	0.04	0.15	0.05	0.03	4.41
TP-3 / EOD Blow 123	167	92 / 75	30	5.5	11.1	0.04	0.38	0.13	0.02	2.56

*EOD – End of Drive; BPF – Blows per foot; MQN – Match Quality Number

Dynamic Pile Testing Interpretation and Commentary

The capacities listed in the Summary of Dynamic Pile Testing Results are based on the RMX Method (Maximum Case Method Capacity with Jc=0.8) solution for the maximum value of the last increment of initial drive. The summary plot and table attached for the dynamic pile testing results are based on the same capacity solutions.

Signal matching analysis was performed for a blow near the end of initial drive for each test pile. The piles were modeled as a non-uniform pile in the signal matching software. The signal matching analyses indicates the ultimate capacities at the end of drive for all test piles were above the required bearing capacity of 80 kips.

Tension pile driving stresses were below the acceptable limit for the piles tested during the entire drive. Compression pile driving stresses were below the acceptable limit for the piles tested during the instrumented portion of the initial drive, except for one blow (Blow Number 51) during driving of Test Pile 3. This spike in the stress measurement occurred during easy driving conditions and was due to an initial blow with an atypical high stroke (7.6 feet) during efforts for the hammer to continuously drive the test pile. The compression pile driving stresses were steadily below the allowable limits prior and after Blow Number 51 for Test Pile 3.

Beta Integrity values (BTA) less than 100 percent were observed during driving of the test piles. However, the intermittent beta values less than 100 percent were due to the non-uniformity of the timber piles, easy driving (free end condition) and not due to a pile integrity issue. Therefore, the piles tested did not show any signs of integrity problems below the gage locations based on the test results.

Recommended Production Pile Driving Criteria – Load Transfer Platform

The recommended drive criteria for the up to 25.0 feet long timber piles with a minimum butt diameter of 12 inches is based on the wave equation analysis and the dynamic testing results. Please see the attached wave equation outputs for additional information.

The driving criteria also only apply to piles driven with the ICE I-19v2 hammer driving system. A hammer helmet weight of 2.3 kips and a hammer cushion of 2.0 total inches of nylon, based on the pile installation document submitted, was used to develop the production pile driving criteria. A change in the hammer driving system, installation procedures, and/or pile type would require re-analysis and likely would warrant modifications to the driving criteria. ICE should be notified immediately should any changes occur. To minimize driving stresses ***only Fuel Setting 1 should be used to drive the piles.*** If Fuel Setting 2 is required to start the hammer, the fuel setting should be immediately lowered to Fuel Setting 1 once the hammer is operating.

Load Transfer Platform Timber Piles

The up to 25-foot timber piles may be stopped if one of the following conditions is met, provided pile rebound is less than ¼ inch per blow and the minimum tip elevation or minimum penetration requirements in the project plans and/or specifications are met.

1. Practical refusal (20 blows per one inch or ½ inch in 10 blows with at least a stroke of 4.5 feet) is reached during driving.
2. The following minimum blows per foot (maximum set per 10 blows) is not exceeded for the respective stroke during driving:

Stroke (feet)	Maximum Set in inches per 10 blows	Minimum Blows Per Foot
5.0	11	11
5.5	12	10
6.0 or greater	13-1/4	9

Piles not meeting the above requirements should be brought to the Engineer's attention and may require additional testing and/or driving to meet the requirements.

Limitations

This report presents test measurement made by ICE. Interpretations were made based upon the measurements made by ICE with the latest techniques available and currently accepted standards of care recognized by Geotechnical Engineering professionals. The Geotechnical Engineer of Record should ultimately make final recommendations for foundation design and construction.

Appendix A

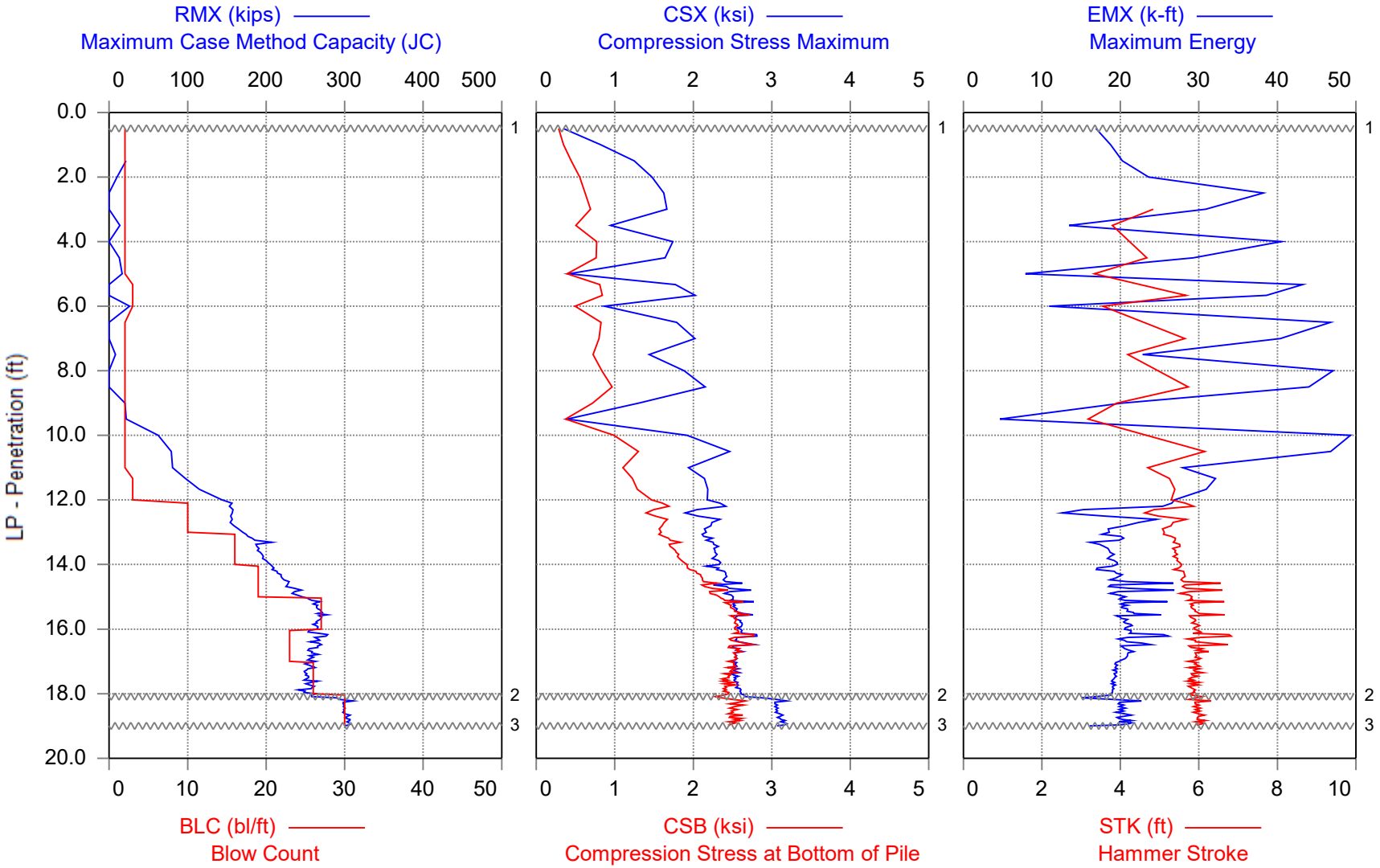
Dynamic Pile Testing, Signal Matching Results, and Calibration WEAP

Test Pile 1

Pile Dynamics, Inc. - PDIPLOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

Printed: 16-March-2023 Test started: 15-March-2023

CCR Phase 1 - Load Transfer Platform - Test Pile 1



1 - REF = GSE = +170.0' / Hammer fuel setting 1

2 - Stopped to remove anchor bolt

3 - Last set in 10 blows at EOD was four inches

CCR Phase 1 - Load Transfer Platform - Test Pile 1 Timber Pile 14" x 25'
OP: ICE - GEN Date: 15-March-2023

AR: 125.74 in² SP: 0.060 k/ft³
LE: 21.00 ft EM: 2,630 ksi
WS: 14,250.0 f/s JC: 0.80

RX9: Maximum Case Method Capacity (JC=0.9)
RMX: Maximum Case Method Capacity (JC)
CSX: Compression Stress Maximum
CSB: Compression Stress at Bottom of Pile
TSX: Tension Stress Maximum - Full Record Search
EMX: Maximum Energy
STK: Hammer Stroke
FVP: Force/Velocity Proportionality
BTA: Integrity Factor (1)

BL#	Depth	BLC	TYPE	RX9	RMX	CSX	CSB	TSX	EMX	STK	FVP	BTA
	ft	bl/ft		kips	kips	ksi	ksi	ksi	k-ft	ft		(%)
2	1.0	2	AV2	0	0	0.6	0.3	0.1	17.8	**	0.2	100.0
			STD	0	0	0.2	0.0	0.1	0.9	**	0.1	0.0
			MAX	0	0	0.8	0.3	0.2	18.7	**	0.2	100.0
			@BL	1	1	2	2	2	2	**	2	1
4	2.0	2	AV2	12	16	1.4	0.5	0.2	21.9	**	0.7	89.5
			STD	7	6	0.1	0.1	0.0	1.7	**	0.0	10.5
			MAX	19	21	1.5	0.6	0.2	23.6	**	0.8	100.0
			@BL	3	3	4	4	3	4	**	4	4
6	3.0	2	AV2	0	0	1.6	0.7	0.1	34.5	4.84	0.8	88.5
			STD	0	0	0.0	0.0	0.0	3.7	0.00	0.0	11.5
			MAX	0	0	1.7	0.7	0.2	38.2	4.84	0.8	100.0
			@BL	5	5	6	6	6	5	6	6	5
8	4.0	2	AV2	6	7	1.3	0.6	0.2	27.0	3.79	0.8	79.5
			STD	6	7	0.4	0.1	0.0	13.5	0.00	0.0	0.5
			MAX	12	14	1.7	0.8	0.2	40.5	3.79	0.8	80.0
			@BL	7	7	8	8	7	8	7	8	7
10	5.0	2	AV2	11	15	1.0	0.6	0.1	18.6	4.00	0.6	100.0
			STD	3	2	0.6	0.2	0.1	10.7	0.67	0.1	0.0
			MAX	14	17	1.6	0.8	0.2	29.3	4.67	0.8	100.0
			@BL	10	10	9	9	9	9	9	9	9
13	6.0	3	AV3	8	9	1.6	0.7	0.2	30.9	4.61	0.8	100.0
			STD	12	12	0.5	0.2	0.0	14.2	1.06	0.0	0.0
			MAX	25	26	2.0	0.8	0.2	43.2	5.67	0.8	100.0
			@BL	13	13	12	12	11	11	12	11	11
15	7.0	2	AV2	0	0	1.9	0.8	0.2	43.6	5.64	0.8	100.0
			STD	0	0	0.1	0.0	0.0	3.2	0.00	0.0	0.0
			MAX	0	0	2.0	0.8	0.2	46.8	5.64	0.8	100.0
			@BL	14	14	15	14	15	14	15	14	14
17	8.0	2	AV2	1	4	1.7	0.8	0.2	35.0	4.19	0.8	100.0
			STD	1	4	0.2	0.1	0.0	12.1	0.00	0.0	0.0
			MAX	3	8	1.9	0.8	0.2	47.1	4.19	0.8	100.0
			@BL	16	16	17	17	17	17	16	17	16
19	9.0	2	AV2	9	10	1.7	0.8	0.1	32.1	4.82	0.8	100.0
			STD	9	10	0.4	0.1	0.0	11.9	0.91	0.0	0.0
			MAX	17	20	2.2	1.0	0.1	44.0	5.73	0.8	100.0
			@BL	19	19	18	18	18	18	18	18	18

CCR Phase 1 - Load Transfer Platform - Test Pile 1 Timber Pile 14" x 25'
OP: ICE - GEN Date: 15-March-2023

BL#	Depth ft	BLC bl/ft	TYPE	RX9 kips	RMX kips	CSX ksi	CSB ksi	TSX ksi	EMX k-ft	STK ft	FVP	BTA (%)
21	10.0	2	AV2	40	42	1.2	0.7	0.1	27.0	3.18	0.8	100.0
			STD	19	20	0.8	0.3	0.1	22.3	0.00	0.1	0.0
			MAX	59	63	1.9	1.0	0.2	49.3	3.18	0.8	100.0
			@BL	21	21	21	21	21	21	20	21	20
23	11.0	2	AV2	77	80	2.2	1.2	0.1	37.4	5.42	0.8	100.0
			STD	1	1	0.3	0.1	0.0	9.4	0.72	0.0	0.0
			MAX	78	81	2.5	1.3	0.2	46.8	6.15	0.8	100.0
			@BL	23	23	22	22	22	22	22	23	22
26	12.0	3	AV3	117	119	2.2	1.3	0.1	30.0	5.31	0.8	100.0
			STD	20	19	0.0	0.1	0.0	2.2	0.06	0.0	0.0
			MAX	142	144	2.2	1.5	0.2	32.1	5.39	0.8	100.0
			@BL	26	26	25	26	24	24	25	25	24
36	13.0	10	AV10	156	158	2.2	1.6	0.2	20.2	5.25	0.8	100.0
			STD	5	5	0.1	0.1	0.0	4.3	0.38	0.0	0.0
			MAX	167	170	2.4	1.7	0.2	26.5	5.86	0.9	100.0
			@BL	36	36	28	28	30	27	28	29	27
52	14.0	16	AV16	189	192	2.3	1.8	0.2	18.7	5.40	0.8	100.0
			STD	9	9	0.1	0.1	0.1	1.1	0.11	0.0	0.0
			MAX	205	207	2.3	1.9	0.4	20.4	5.56	0.8	100.0
			@BL	41	41	51	52	42	39	52	47	37
71	15.0	19	AV19	224	225	2.4	2.1	0.1	20.1	5.71	0.8	100.0
			STD	11	12	0.1	0.1	0.0	2.5	0.31	0.0	0.0
			MAX	243	246	2.7	2.4	0.3	26.9	6.60	0.9	100.0
			@BL	71	71	67	67	63	67	67	55	53
98	16.0	27	AV27	263	265	2.6	2.5	0.1	21.0	5.93	0.8	100.0
			STD	5	5	0.1	0.1	0.0	1.4	0.22	0.0	0.0
			MAX	276	278	2.8	2.7	0.2	26.0	6.65	0.8	100.0
			@BL	86	86	75	86	86	75	86	91	72
121	17.0	23	AV23	261	262	2.6	2.6	0.2	21.4	6.05	0.8	100.0
			STD	6	7	0.1	0.1	0.0	1.6	0.31	0.0	0.0
			MAX	276	278	2.8	2.8	0.2	26.1	6.82	0.8	100.0
			@BL	102	102	103	102	109	103	103	105	99
147	18.0	26	AV26	253	254	2.6	2.5	0.2	19.2	5.88	0.8	100.0
			STD	5	5	0.0	0.1	0.0	0.2	0.10	0.0	0.0
			MAX	262	266	2.6	2.6	0.3	19.6	6.10	0.8	100.0
			@BL	137	137	146	130	147	124	130	124	122
162	18.7	30	AV15	292	294	3.0	2.5	0.2	19.7	5.97	0.8	100.0
			STD	15	15	0.2	0.1	0.1	1.7	0.14	0.0	0.0
			MAX	308	311	3.2	2.7	0.4	22.7	6.30	0.8	100.0
			@BL	152	152	152	152	149	152	152	157	148
172	19.0	30	AV10	302	304	3.1	2.5	0.3	20.0	6.01	0.8	100.0
			STD	4	3	0.0	0.1	0.0	1.4	0.07	0.0	0.0
			MAX	306	307	3.2	2.6	0.4	21.4	6.16	0.8	100.0

CCR Phase 1 - Load Transfer Platform - Test Pile 1 Timber Pile 14" x 25'
OP: ICE - GEN Date: 15-March-2023

BL#	Depth ft	BLC bl/ft	TYPE	RX9 kips	RMX kips	CSX ksi	CSB ksi	TSX ksi	EMX k-ft	STK ft	FVP	BTA (%)
			@BL	170	170	170	165	172	169	167	164	163
			Average	213	215	2.4	2.1	0.2	21.6	5.71	0.8	99.5
			Std. Dev.	88	88	0.5	0.6	0.1	6.4	0.54	0.1	3.2
			Maximum	308	311	3.2	2.8	0.4	49.3	6.82	0.9	100.0
			@ Blow#	152	152	170	102	42	21	103	29	1

Total number of blows analyzed: 172

BL# Sensors

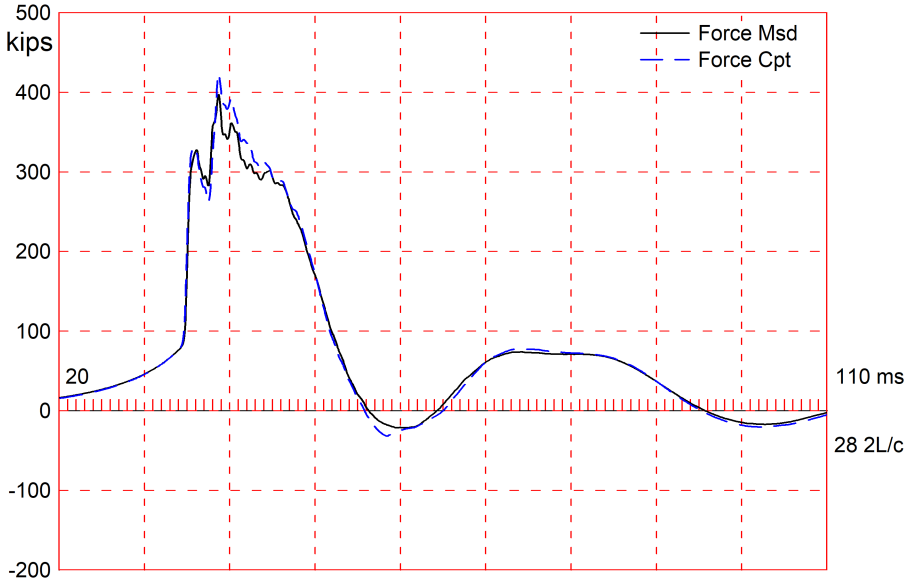
1-172 F1: [P815] 146.1 (1.00); F3: [S048] 94.3 (1.00); A2: [K11186] 443.2 (1.00); A4: [K11187] 433.6 (1.00)

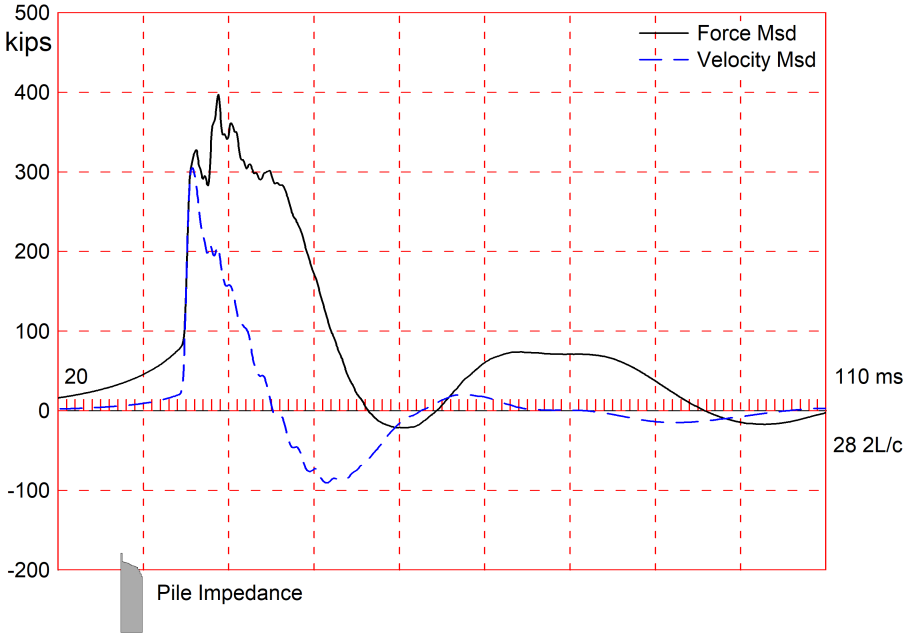
BL# Comments

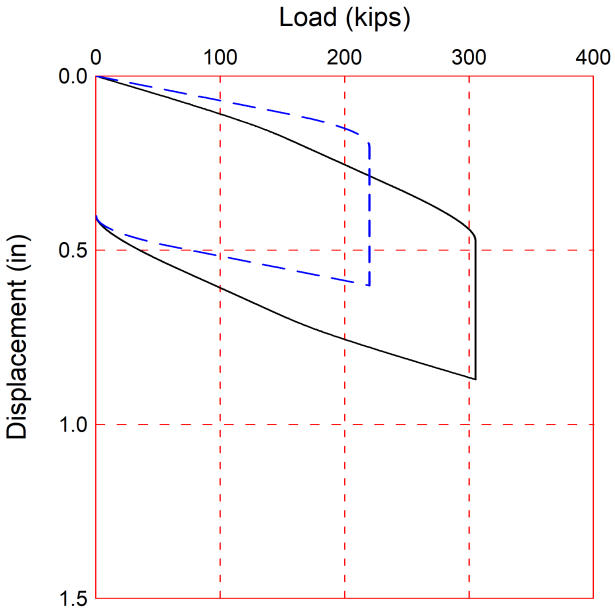
1 REF = GSE = +170.0' / Hammer fuel setting 1
149 Stopped to remove anchor bolt
172 Last set in 10 blows at EOD was four inches

Time Summary

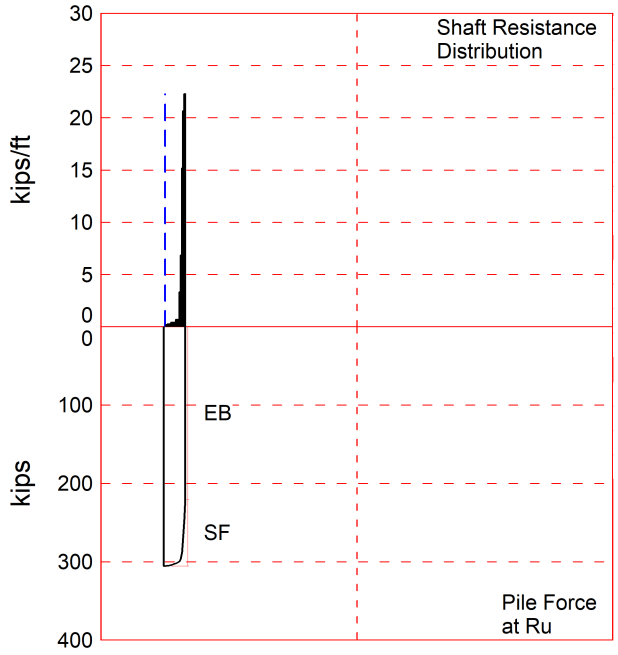
Drive 15 minutes 14 seconds 2:23 PM - 2:38 PM BN 1 - 172







RU =	305.3 kips
SF =	85.3 kips
EB =	220.0 kips
Dy =	0.47 in
Dx =	0.87 in
SET/Bl =	0.40 in



Length b. Sensors	21.0 ft
Embedment	18.9 ft
Top Area	125.7 in^2
End Bearing Area	86.6 in^2
Top Perimeter	3.31 ft
Top E-Modulus	2630 ksi
Top Spec. Weight	60.0 lb/ft^3
Top Wave Spd.	14250 ft/s
Overall W.S.	14250 ft/s
Match Quality	2.84
Top Compr. Stress	3.4 ksi
Max Compr. Stress	4.1 ksi
Max Tension Stress	-0.33 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.16 in
Avg. Shaft Smith Dpg.	0.10 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: 305.3; along Shaft 85.3; at Toe 220.0 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
				305.3			
1	3.5	1.4	0.3	305.0	0.3	0.21	0.07
2	4.7	2.6	0.3	304.7	0.6	0.26	0.08
3	5.8	3.7	0.3	304.4	0.9	0.26	0.08
4	7.0	4.9	0.3	304.1	1.2	0.26	0.08
5	8.2	6.1	0.5	303.6	1.7	0.43	0.14
6	9.3	7.2	0.5	303.1	2.2	0.43	0.14
7	10.5	8.4	0.5	302.6	2.7	0.43	0.14
8	11.7	9.6	0.5	302.1	3.2	0.43	0.14
9	12.8	10.7	0.8	301.3	4.0	0.69	0.23
10	14.0	11.9	0.8	300.5	4.8	0.69	0.23
11	15.2	13.1	0.8	299.7	5.6	0.69	0.23
12	16.3	14.2	3.9	295.8	9.5	3.34	1.11
13	17.5	15.4	8.0	287.8	17.5	6.86	2.32
14	18.7	16.6	17.7	270.1	35.2	15.17	5.24
15	19.8	17.7	24.1	246.0	59.3	20.66	7.28
16	21.0	18.9	26.0	220.0	85.3	22.29	8.02
Avg. Shaft			5.3			4.51	1.50
Toe			220.0				365.86

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.10	0.03
Quake	(in)	0.04	0.16
Case Damping Factor		0.37	0.28
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	86	84
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	25	

CAPWAP match quality = 2.84 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.40 in; Blow Count = 30 b/ft
Computed: Final Set = 0.40 in; Blow Count = 30 b/ft
Transducer F1 (P815) CAL: 146.1; RF: 1.00; F3 (S048) CAL: 94.3; RF: 1.00
A2 (K11186) CAL: 443; RF: 1.00; A4 (K11187) CAL: 434; RF: 1.00

max. Top Comp. Stress = 3.4 ksi (T= 38.9 ms, max= 1.211 x Top)
max. Comp. Stress = 4.1 ksi (Z= 18.7 ft, T= 39.9 ms)
max. Tens. Stress = -0.33 ksi (Z= 11.7 ft, T= 57.8 ms)
max. Energy (EMX) = 19.9 kip-ft; max. Measured Top Displ. (DMX)= 0.87 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	1.2	422.9	-32.5	3.4	-0.26	19.9	12.6	0.80
2	2.3	424.1	-33.0	3.8	-0.30	19.7	12.6	0.79
3	3.5	425.1	-33.6	3.8	-0.30	19.6	12.6	0.77
4	4.7	425.6	-34.0	3.8	-0.31	19.4	12.6	0.76
5	5.8	425.8	-34.4	3.8	-0.31	19.2	12.6	0.75
6	7.0	425.2	-34.7	3.9	-0.32	19.0	12.5	0.74
7	8.2	424.6	-35.0	3.9	-0.32	18.9	12.5	0.72
8	9.3	424.6	-35.0	3.9	-0.32	18.6	12.5	0.71
9	10.5	424.8	-34.8	4.0	-0.33	18.4	12.4	0.70
10	11.7	424.2	-34.6	4.0	-0.33	18.2	12.5	0.69
11	12.8	422.3	-34.3	4.0	-0.33	18.0	12.7	0.67
12	14.0	418.6	-34.0	4.0	-0.32	17.8	12.8	0.66
13	15.2	415.0	-33.7	4.0	-0.32	17.6	12.8	0.65
14	16.3	413.6	-33.4	4.0	-0.32	17.3	12.8	0.63
15	17.5	406.7	-32.1	4.1	-0.32	16.8	12.6	0.62
16	18.7	391.8	-29.3	4.1	-0.30	16.0	12.3	0.61
17	19.8	360.0	-23.4	3.9	-0.25	14.5	11.7	0.59
18	21.0	318.0	-15.5	3.6	-0.18	10.8	10.8	0.58
Absolute	18.7			4.1			(T =	39.9 ms)
	11.7				-0.33		(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	405.6	384.2	362.9	341.6	320.3	299.0	277.7	256.3	235.0	213.7
RX	409.2	387.9	366.8	347.0	328.4	319.3	313.6	307.8	305.3	303.3
RU	405.6	384.2	362.9	341.6	320.3	299.0	277.7	256.3	235.0	213.7

RAU = 279.7 (kips); RA2 = 391.7 (kips)

Current CAPWAP Ru = 305.3 (kips); Corresponding J(RP)= 0.47; J(RX) = 0.80

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
13.2	27.45	305.4	313.4	398.3	0.87	0.40	0.40	21.4	404.9	1419

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	125.7	2629.7	60.000	3.31
1.0	111.9	2629.7	60.000	3.13
6.0	110.4	2629.7	60.000	3.10

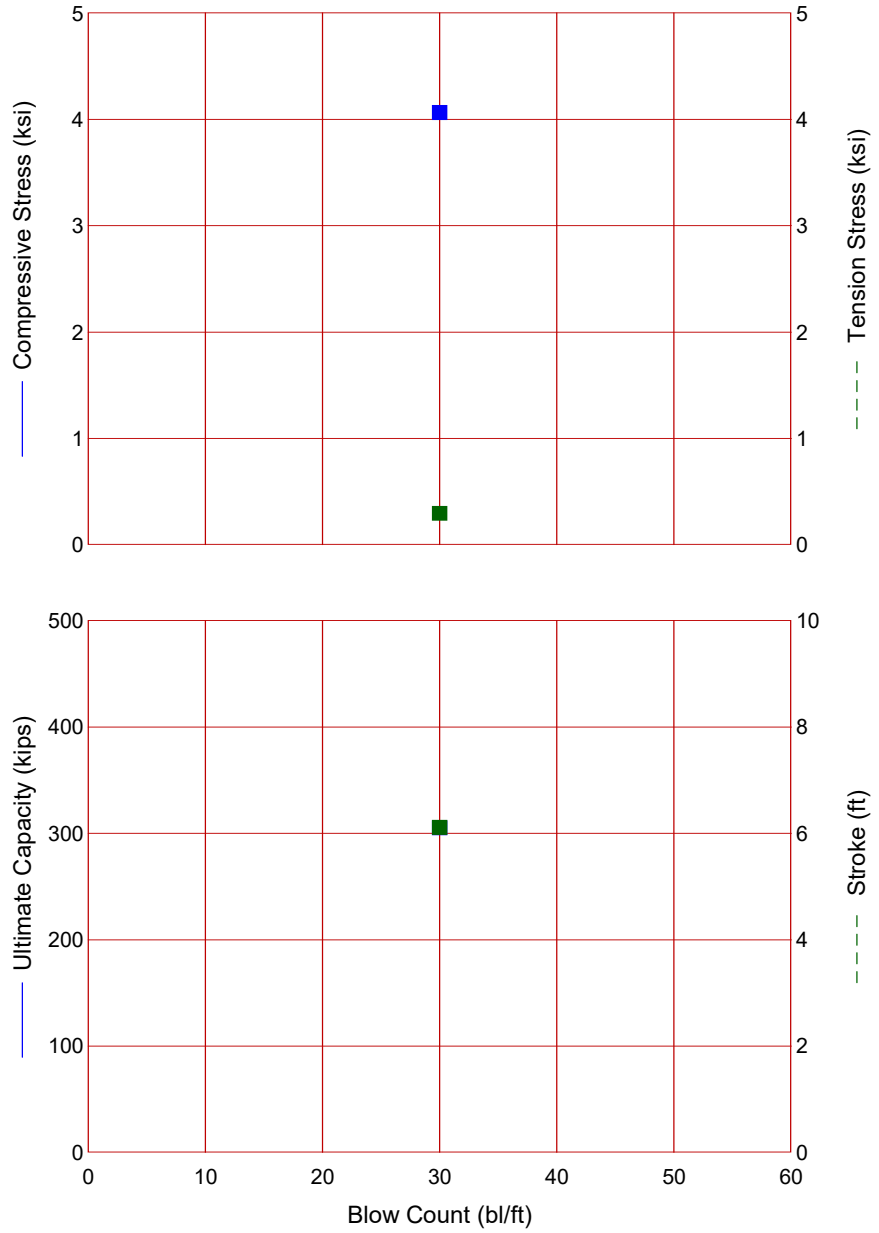
PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
11.0	106.0	2629.7	60.000	3.04
16.0	103.1	2629.7	60.000	3.00
21.0	86.6	2629.7	60.000	2.75

Toe Area 86.6 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s
1	1.2	23.20	0.00	0.00	0.000	-0.00	0.000	3.31	14250.0
2	2.3	20.61	0.00	0.00	0.000	-0.00	0.000	3.12	14250.0
3	3.5	20.55	0.00	0.00	0.000	-0.00	0.000	3.12	14250.0
4	4.7	20.48	0.00	0.00	0.000	-0.00	0.000	3.11	14250.0
5	5.8	20.42	0.00	0.00	0.000	-0.00	0.000	3.11	14250.0
6	7.0	20.31	0.00	0.00	0.000	-0.00	0.000	3.10	14250.0
7	8.2	20.12	0.00	0.00	0.000	-0.00	0.000	3.08	14250.0
8	9.3	19.93	0.00	0.00	0.000	-0.00	0.000	3.07	14250.0
9	10.5	19.74	0.00	0.00	0.000	-0.00	0.000	3.06	14250.0
10	11.7	19.56	0.00	0.00	0.000	-0.00	0.000	3.04	14250.0
11	12.8	19.43	0.00	0.00	0.000	-0.00	0.000	3.03	14250.0
12	14.0	19.31	0.00	0.00	0.000	-0.00	0.000	3.02	14250.0
13	15.2	19.18	0.00	0.00	0.000	-0.00	0.000	3.01	14250.0
14	16.3	19.03	0.00	0.00	0.000	-0.00	0.000	3.00	14250.0
15	17.5	18.47	0.00	0.00	0.000	-0.00	0.000	2.95	14250.0
16	18.7	17.76	0.00	0.00	0.000	-0.00	0.000	2.90	14250.0
17	19.8	17.05	0.00	0.00	0.000	-0.00	0.000	2.84	14250.0
18	21.0	16.34	0.00	0.00	0.000	-0.00	0.000	2.78	14250.0

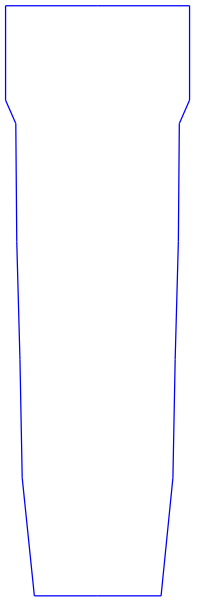
Wave Speed: Pile Top 14250.0, Elastic 14249.9, Overall 14250.0 ft/s
Pile Damping 2.00 %
Total volume: 15.432 ft^3; Volume ratio considering added impedance: 1.000
Time (ms) 0.0
Time Incr 0.070



ICE I-19v2

Ram Weight	4.01	kips
Efficiency	0.990	
Pressure	1876 (118%)	psi
Helmet Weight	2.31	kips
Hammer Cushion	34825	kips/in
COR of H.C.	0.900	
Skin Quake	0.040	in
Toe Quake	0.155	in
Skin Damping	0.100	s/ft
Toe Damping	0.030	s/ft
Pile Length	25.00	ft
Pile Penetration	18.90	ft
Pile Top Area	125.73	in2

Pile Model



Skin Friction Distribution

Res. Shaft = 28 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
305.0	4.06	0.29	30.0	6.11	18.82

Appendix B

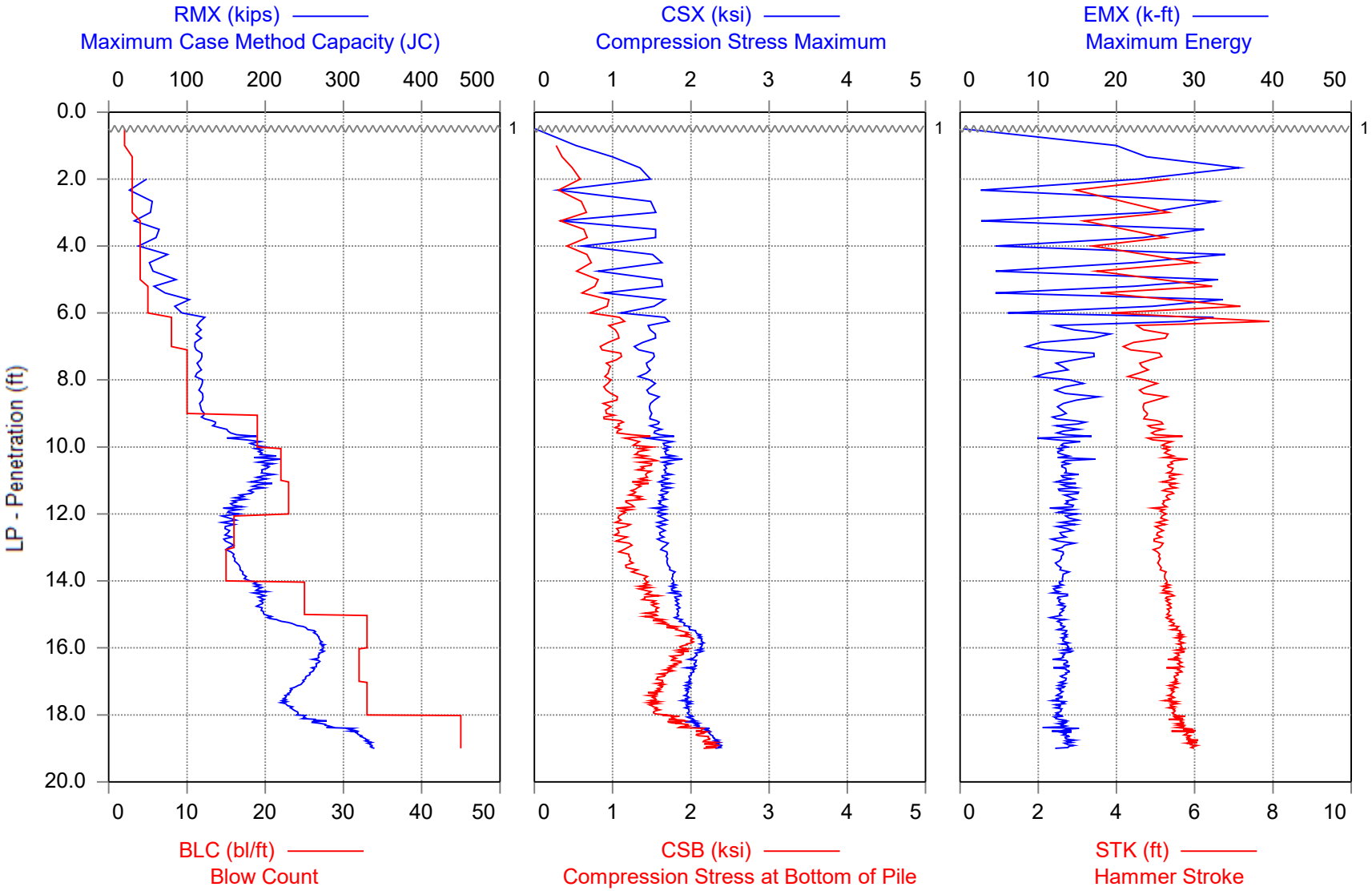
Dynamic Pile Testing, Signal Matching Results, and Calibration WEAP

Test Pile 2

Pile Dynamics, Inc. - PDIPLOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

Printed: 16-March-2023 Test started: 15-March-2023

CCR Phase 1 - Load Transfer Platform - Test Pile 2



1 - REF = GSE = +170.0' / Hammer fuel setting 1

CCR Phase 1 - Load Transfer Platform - Test Pile 2 Timber Pile 14" x 25'
OP: ICE - GEN Date: 15-March-2023

AR: 150.58 in² SP: 0.060 k/ft³
LE: 21.00 ft EM: 2,630 ksi
WS: 14,250.0 f/s JC: 0.80

RX9: Maximum Case Method Capacity (JC=0.9)
RMX: Maximum Case Method Capacity (JC)
CSX: Compression Stress Maximum
CSB: Compression Stress at Bottom of Pile
TSX: Tension Stress Maximum - Full Record Search
EMX: Maximum Energy
STK: Hammer Stroke
FVP: Force/Velocity Proportionality
BTA: Integrity Factor (1)

BL#	Depth	BLC	TYPE	RX9	RMX	CSX	CSB	TSX	EMX	STK	FVP	BTA
	ft	bl/ft		kips	kips	ksi	ksi	ksi	k-ft	ft		(%)
2	1.0	2	AV2	0	0	0.3	0.1	0.0	10.2	**	0.1	100.0
			STD	0	0	0.3	0.1	0.0	9.8	**	0.1	0.0
			MAX	0	0	0.5	0.3	0.1	20.0	**	0.2	100.0
			@BL	1	1	2	2	2	2	**	2	1
5	2.0	3	AV3	16	16	1.3	0.5	0.2	27.5	5.35	0.6	100.0
			STD	23	23	0.2	0.1	0.0	5.8	0.00	0.0	0.0
			MAX	48	48	1.5	0.6	0.2	35.7	5.35	0.7	100.0
			@BL	5	5	5	5	5	4	5	4	3
8	3.0	3	AV3	44	45	1.1	0.5	0.1	19.8	4.15	1.0	77.7
			STD	13	13	0.6	0.2	0.1	12.6	1.19	0.5	18.8
			MAX	53	55	1.6	0.7	0.2	32.7	5.33	1.6	100.0
			@BL	8	7	8	8	8	7	8	6	7
12	4.0	4	AV4	49	49	1.0	0.5	0.1	15.5	3.94	0.9	93.0
			STD	14	14	0.6	0.1	0.1	12.2	0.94	0.4	12.1
			MAX	65	65	1.5	0.7	0.2	31.2	5.25	1.6	100.0
			@BL	10	10	11	11	11	10	11	9	10
16	5.0	4	AV4	67	67	1.4	0.7	0.2	23.4	4.77	0.7	100.0
			STD	14	14	0.3	0.1	0.2	11.8	1.27	0.1	0.0
			MAX	86	86	1.6	0.8	0.5	33.9	6.04	0.7	100.0
			@BL	16	16	14	16	14	13	14	15	13
21	6.0	5	AV5	82	82	1.4	0.8	0.3	18.2	5.27	0.6	95.0
			STD	16	16	0.3	0.1	0.3	11.2	1.56	0.1	10.0
			MAX	103	103	1.7	1.0	0.7	33.6	7.16	0.7	100.0
			@BL	19	19	19	19	20	19	20	21	17
29	7.0	8	AV8	114	115	1.5	1.0	0.2	17.9	5.19	0.6	97.5
			STD	5	4	0.1	0.1	0.2	8.0	1.17	0.1	6.6
			MAX	123	123	1.7	1.2	0.7	32.4	7.90	0.7	100.0
			@BL	22	22	23	23	23	22	23	24	22
49	9.0	10	AV20	117	117	1.5	1.0	0.1	13.7	4.77	0.6	100.0
			STD	3	3	0.1	0.1	0.0	2.1	0.25	0.0	0.0
			MAX	122	122	1.6	1.1	0.1	17.7	5.29	0.7	100.0
			@BL	49	49	44	32	31	44	44	38	30
68	10.0	19	AV19	154	155	1.6	1.2	0.1	13.5	5.05	0.6	97.9
			STD	26	26	0.1	0.2	0.0	1.6	0.26	0.0	6.1
			MAX	200	200	1.8	1.5	0.2	16.8	5.69	0.6	100.0
			@BL	68	68	62	68	63	62	62	52	50

CCR Phase 1 - Load Transfer Platform - Test Pile 2 Timber Pile 14" x 25'
OP: ICE - GEN Date: 15-March-2023

BL#	Depth ft	BLC bl/ft	TYPE	RX9 kips	RMX kips	CSX ksi	CSB ksi	TSX ksi	EMX k-ft	STK ft	FVP	BTA (%)
90	11.0	22	AV22	197	199	1.7	1.4	0.1	13.5	5.39	0.6	99.1
			STD	9	9	0.1	0.1	0.0	1.0	0.13	0.0	4.2
			MAX	219	220	1.9	1.6	0.2	17.3	5.81	0.6	100.0
			@BL	76	76	76	77	75	76	76	85	70
113	12.0	23	AV23	171	172	1.6	1.3	0.1	13.8	5.28	0.6	100.0
			STD	16	15	0.1	0.1	0.0	1.0	0.13	0.0	0.0
			MAX	208	209	1.7	1.5	0.2	15.2	5.53	0.6	100.0
			@BL	92	92	95	92	109	98	95	92	91
129	13.0	16	AV16	151	153	1.6	1.1	0.1	13.5	5.11	0.6	100.0
			STD	5	5	0.0	0.1	0.0	0.9	0.10	0.0	0.0
			MAX	160	163	1.7	1.2	0.2	15.1	5.28	0.6	100.0
			@BL	116	116	127	128	114	116	116	127	114
144	14.0	15	AV15	164	166	1.7	1.3	0.1	12.9	5.14	0.6	100.0
			STD	7	8	0.0	0.1	0.0	0.4	0.09	0.0	0.0
			MAX	176	180	1.8	1.4	0.1	13.9	5.28	0.6	100.0
			@BL	144	144	140	142	130	140	144	141	130
169	15.0	25	AV25	190	194	1.8	1.5	0.1	12.8	5.31	0.6	100.0
			STD	5	4	0.0	0.1	0.0	0.5	0.07	0.0	0.0
			MAX	199	202	1.9	1.6	0.1	13.7	5.47	0.6	100.0
			@BL	152	152	155	155	153	154	155	160	145
202	16.0	33	AV33	247	250	2.0	1.8	0.1	13.1	5.54	0.7	100.0
			STD	24	24	0.1	0.2	0.0	0.5	0.13	0.0	0.0
			MAX	273	276	2.2	2.0	0.1	13.9	5.72	0.7	100.0
			@BL	199	199	197	196	201	197	197	198	170
234	17.0	32	AV32	260	263	2.0	1.8	0.1	13.4	5.57	0.7	100.0
			STD	8	7	0.0	0.1	0.0	0.5	0.10	0.0	0.0
			MAX	272	275	2.2	2.0	0.2	14.3	5.73	0.7	100.0
			@BL	205	205	205	205	203	205	203	221	203
267	18.0	33	AV33	229	233	2.0	1.6	0.1	12.8	5.44	0.7	100.0
			STD	8	7	0.0	0.1	0.0	0.4	0.07	0.0	0.0
			MAX	244	248	2.0	1.7	0.1	13.5	5.58	0.7	100.0
			@BL	235	235	256	267	267	236	236	238	235
312	19.0	45	AV45	297	303	2.2	2.1	0.2	13.4	5.77	0.7	100.0
			STD	30	31	0.1	0.2	0.1	0.8	0.18	0.0	0.0
			MAX	337	340	2.4	2.4	0.3	15.2	6.09	0.7	100.0
			@BL	312	312	308	308	312	285	301	273	268
			Average	200	203	1.8	1.5	0.1	13.8	5.35	0.6	99.4
			Std. Dev.	70	72	0.3	0.4	0.1	3.9	0.47	0.1	4.2
			Maximum	337	340	2.4	2.4	0.7	35.7	7.90	1.6	100.0
			@ Blow#	312	312	308	308	23	4	23	6	1

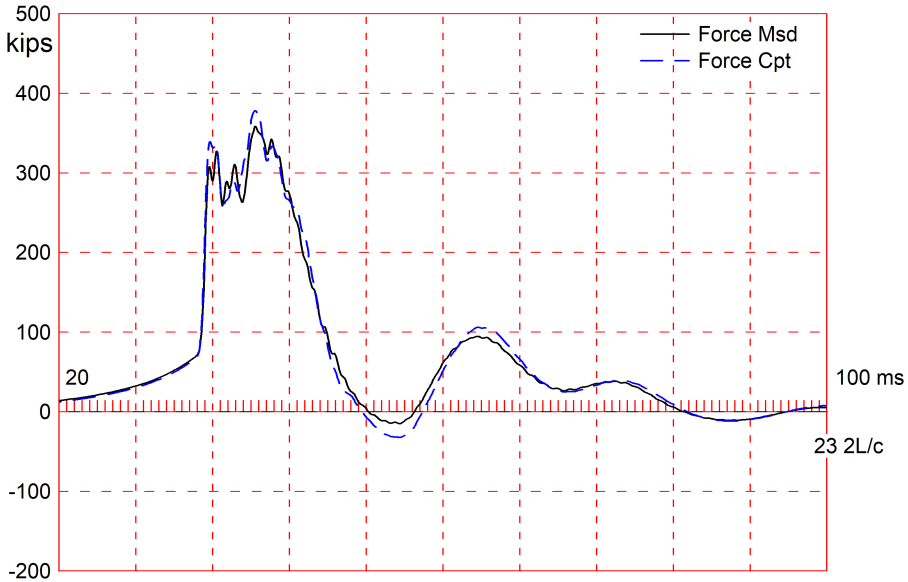
Total number of blows analyzed: 312

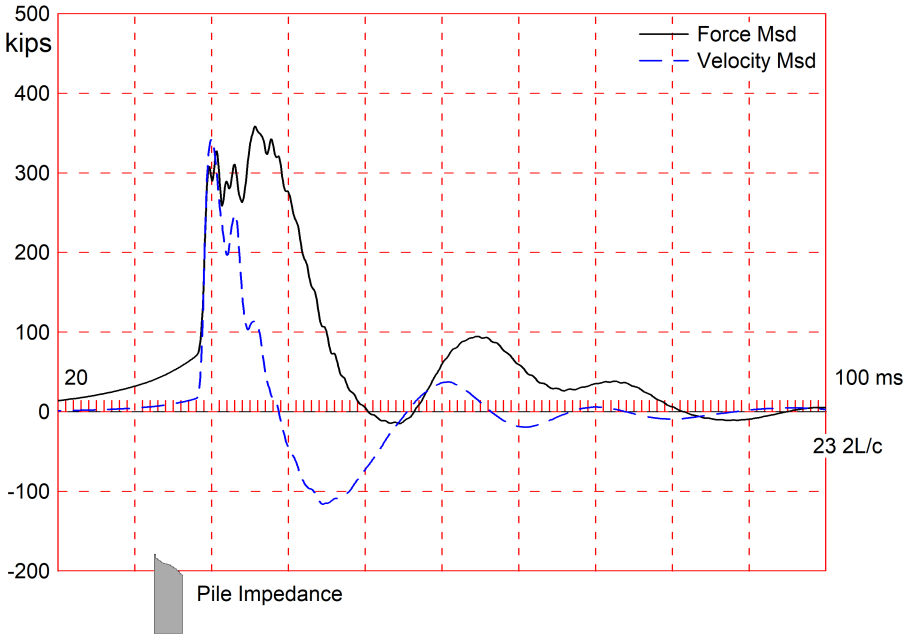
BL#	Sensors
1-312	F1: [P815] 146.1 (1.00); F3: [S048] 94.3 (1.00); A2: [K11186] 443.2 (1.00); A4: [K11187] 433.6 (1.00)

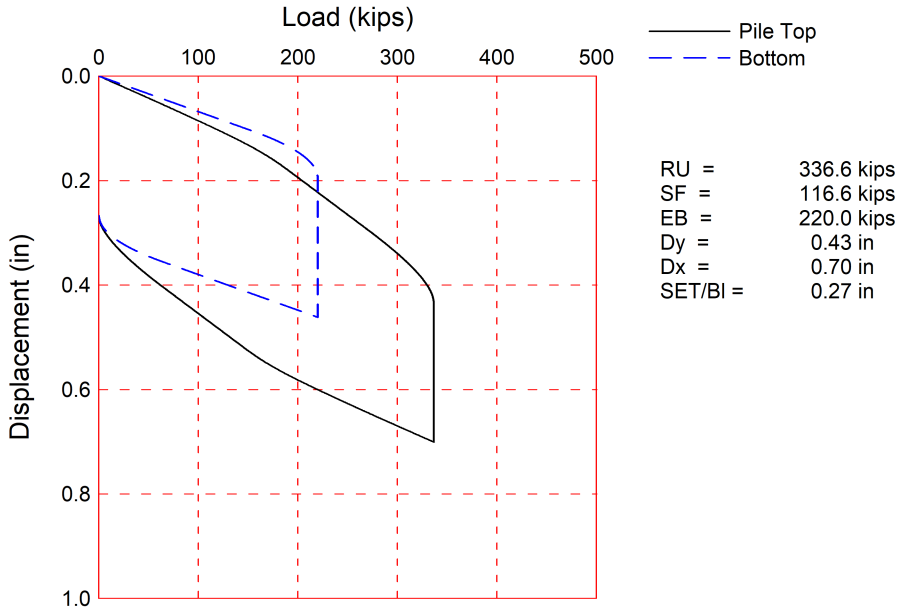
BL#	Comments
1	REF = GSE = +170.0' / Hammer fuel setting 1

Time Summary

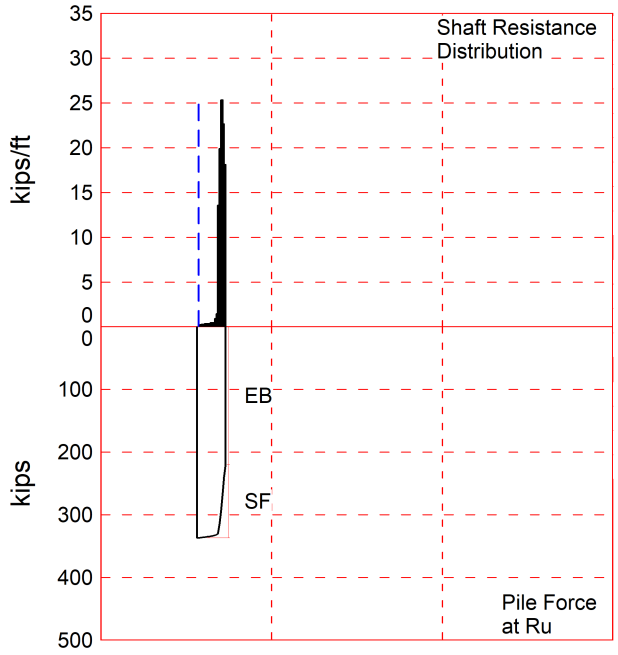
Drive 13 minutes 39 seconds 3:33 PM - 3:47 PM BN 1 - 312







RU =	336.6 kips
SF =	116.6 kips
EB =	220.0 kips
Dy =	0.43 in
Dx =	0.70 in
SET/Bl =	0.27 in



Length b. Sensors	21.0 ft
Embedment	18.9 ft
Top Area	150.6 in^2
End Bearing Area	109.9 in^2
Top Perimeter	3.63 ft
Top E-Modulus	2630 ksi
Top Spec. Weight	60.0 lb/ft^3
Top Wave Spd.	14250 ft/s
Overall W.S.	14250 ft/s
Match Quality	4.41
Top Compr. Stress	2.5 ksi
Max Compr. Stress	3.3 ksi
Max Tension Stress	-0.34 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.15 in
Avg. Shaft Smith Dpg.	0.05 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: 336.6; along Shaft 116.6; at Toe 220.0 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
				336.6			
1	3.3	1.2	0.3	336.3	0.3	0.24	0.07
2	4.4	2.4	0.3	336.0	0.6	0.27	0.08
3	5.5	3.5	0.3	335.7	0.9	0.27	0.08
4	6.6	4.6	0.4	335.3	1.3	0.36	0.11
5	7.7	5.7	0.4	334.9	1.7	0.36	0.11
6	8.8	6.8	0.4	334.5	2.1	0.36	0.11
7	9.9	7.9	0.4	334.1	2.5	0.36	0.11
8	11.1	9.0	0.5	333.6	3.0	0.45	0.13
9	12.2	10.1	0.5	333.1	3.5	0.45	0.13
10	13.3	11.2	0.5	332.6	4.0	0.45	0.14
11	14.4	12.3	1.0	331.6	5.0	0.90	0.27
12	15.5	13.4	1.6	330.0	6.6	1.45	0.44
13	16.6	14.5	15.0	315.0	21.6	13.57	4.15
14	17.7	15.6	22.0	293.0	43.6	19.90	6.16
15	18.8	16.7	28.0	265.0	71.6	25.33	7.93
16	19.9	17.8	25.0	240.0	96.6	22.62	7.17
17	21.0	18.9	20.0	220.0	116.6	18.10	5.81
Avg. Shaft			6.9			6.16	1.85
Toe			220.0				288.22

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.05	0.03
Quake	(in)	0.04	0.15
Case Damping Factor		0.21	0.24
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	99
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	80	
Soil Plug Weight	(kips)		0.034

CAPWAP match quality = 4.41 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.27 in; Blow Count = 45 b/ft
Computed: Final Set = 0.26 in; Blow Count = 46 b/ft
Transducer F1 (P815) CAL: 146.1; RF: 1.00; F3 (S048) CAL: 94.3; RF: 1.00
A2 (K11186) CAL: 443; RF: 1.00; A4 (K11187) CAL: 434; RF: 1.00

max. Top Comp. Stress = 2.5 ksi (T= 40.6 ms, max= 1.310 x Top)
max. Comp. Stress = 3.3 ksi (Z= 16.6 ft, T= 39.6 ms)
max. Tens. Stress = -0.34 ksi (Z= 16.6 ft, T= 54.8 ms)
max. Energy (EMX) = 13.7 kip-ft; max. Measured Top Displ. (DMX)= 0.61 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	1.1	378.6	-33.2	2.5	-0.22	13.7	11.0	0.59
2	2.2	379.5	-34.5	2.7	-0.24	13.5	11.0	0.58
3	3.3	378.8	-35.7	2.7	-0.25	13.4	11.0	0.57
4	4.4	375.9	-36.6	2.7	-0.26	13.2	11.0	0.56
5	5.5	383.1	-37.2	2.8	-0.27	13.1	11.0	0.55
6	6.6	389.7	-37.9	2.9	-0.28	12.9	11.0	0.54
7	7.7	390.1	-38.5	2.9	-0.29	12.7	11.0	0.52
8	8.8	390.5	-39.3	3.0	-0.30	12.6	11.0	0.51
9	9.9	396.7	-40.2	3.0	-0.31	12.4	11.0	0.50
10	11.1	402.8	-40.8	3.1	-0.31	12.2	11.0	0.49
11	12.2	406.4	-41.3	3.1	-0.32	12.0	11.0	0.48
12	13.3	406.7	-41.7	3.2	-0.33	11.8	11.3	0.46
13	14.4	405.7	-42.3	3.2	-0.34	11.6	11.4	0.45
14	15.5	404.2	-42.5	3.3	-0.34	11.4	11.4	0.44
15	16.6	403.2	-42.1	3.3	-0.34	11.1	11.3	0.42
16	17.7	384.8	-30.8	3.2	-0.26	10.3	11.5	0.41
17	18.8	355.4	-14.0	3.0	-0.12	9.2	11.6	0.40
18	19.9	319.0	0.0	2.8	0.00	8.0	11.4	0.39
19	21.0	290.2	0.0	2.6	0.00	6.3	10.9	0.37
Absolute	16.6			3.3			(T =	39.6 ms)
	16.6				-0.34		(T =	54.8 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	357.9	329.9	301.9	273.9	245.9	217.9	189.9	161.9	133.9	105.9
RX	419.2	405.2	391.2	377.3	363.3	356.4	349.8	343.2	336.6	330.0
RU	357.9	329.9	301.9	273.9	245.9	217.9	189.9	161.9	133.9	105.9

RAU = 249.7 (kips); RA2 = 372.2 (kips)

Current CAPWAP Ru = 336.6 (kips); Corresponding J(RP)= 0.08; J(RX) = 0.80

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS	KEB
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips	kips/in
12.3	30.09	342.3	295.6	359.3	0.61	0.30	0.27	14.1	384.8	1467

PILE PROFILE AND PILE MODEL

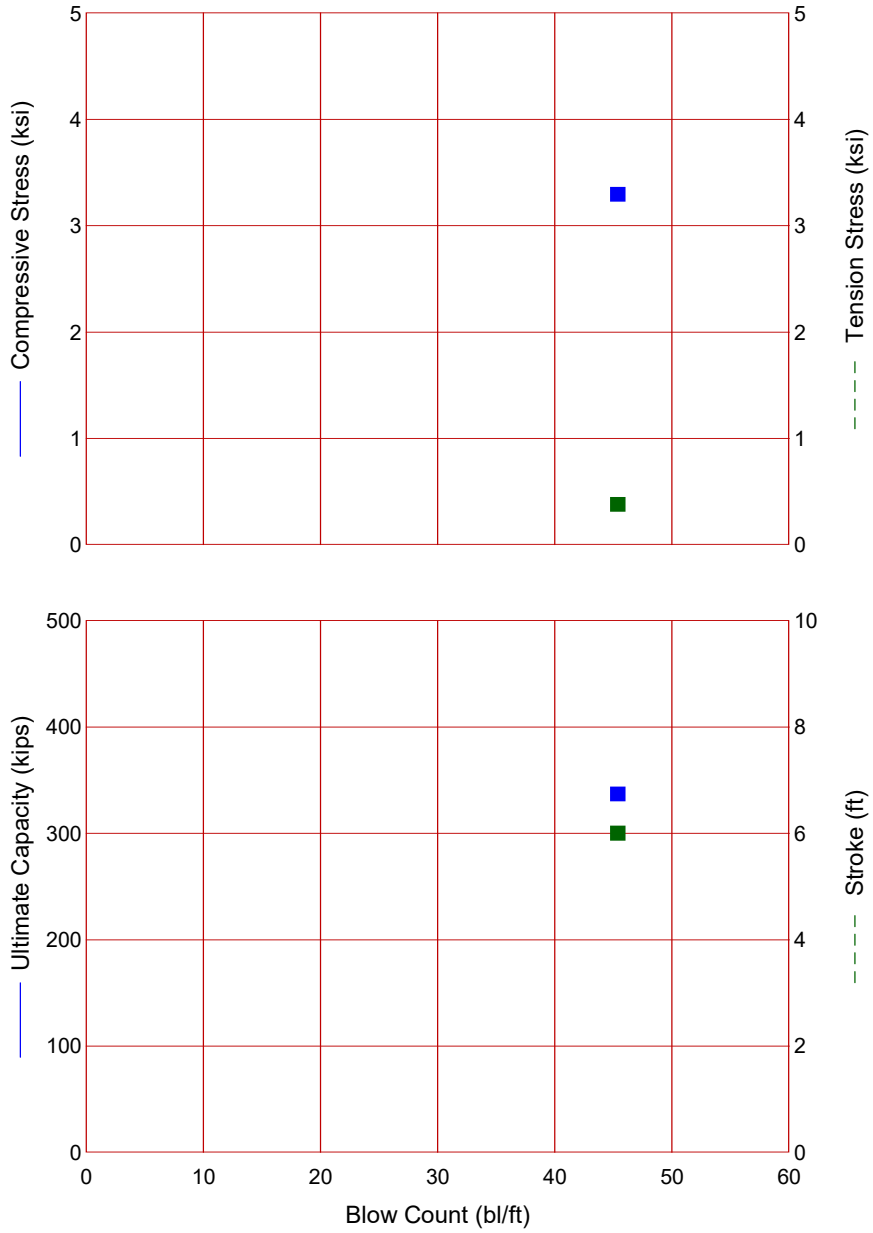
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	150.6	2629.7	60.000	3.63
1.0	143.7	2629.7	60.000	3.54
6.0	133.8	2629.7	60.000	3.42
11.0	130.5	2629.7	60.000	3.38
16.0	122.6	2629.7	60.000	3.27
21.0	109.9	2629.7	60.000	3.10

Toe Area 109.9 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
1	1.1	27.79	0.00	0.00	0.000	-0.00	0.000	3.63	14250.0
2	2.2	26.28	0.00	0.00	0.000	-0.00	0.000	3.53	14250.0
3	3.3	25.88	0.00	0.00	0.000	-0.00	0.000	3.50	14250.0
4	4.4	25.47	0.00	0.00	0.000	-0.00	0.000	3.47	14250.0
5	5.5	25.06	0.00	0.00	0.000	-0.00	0.000	3.44	14250.0
6	6.6	24.70	0.00	0.00	0.000	-0.00	0.000	3.42	14250.0
7	7.7	24.54	0.00	0.00	0.000	-0.00	0.000	3.41	14250.0
8	8.8	24.41	0.00	0.00	0.000	-0.00	0.000	3.40	14250.0
9	9.9	24.28	0.00	0.00	0.000	-0.00	0.000	3.39	14250.0
10	11.1	24.15	0.00	0.00	0.000	-0.00	0.000	3.38	14250.0
11	12.2	23.91	0.00	0.00	0.000	-0.00	0.000	3.36	14250.0
12	13.3	23.59	0.00	0.00	0.000	-0.00	0.000	3.34	14250.0
13	14.4	23.26	0.00	0.00	0.000	-0.00	0.000	3.32	14250.0
14	15.5	22.94	0.00	0.00	0.000	-0.00	0.000	3.29	14250.0
15	16.6	22.59	0.00	0.00	0.000	-0.00	0.000	3.27	14250.0
16	17.7	22.09	0.00	0.00	0.000	-0.00	0.000	3.23	14250.0
17	18.8	21.58	0.00	0.00	0.000	-0.00	0.000	3.19	14250.0
18	19.9	21.06	0.00	0.00	0.000	-0.00	0.000	3.15	14250.0
19	21.0	20.54	0.00	0.00	0.000	-0.00	0.000	3.12	14250.0

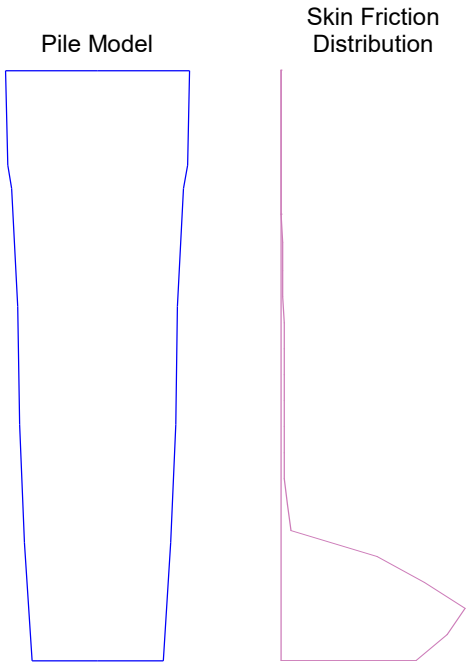
Wave Speed: Pile Top 14250.0, Elastic 14249.9, Overall 14250.0 ft/s

Pile Damping 2.00 %, Time Incr 0.078 ms, 2L/c 2.9 ms
Total volume: 18.888 ft^3; Volume ratio considering added impedance: 1.000



ICE I-19v2

Ram Weight	4.01	kips
Efficiency	0.840	
Pressure	1590 (100%)	psi
Helmet Weight	2.31	kips
Hammer Cushion	34825	kips/in
COR of H.C.	0.900	
Skin Quake	0.040	in
Toe Quake	0.150	in
Skin Damping	0.050	s/ft
Toe Damping	0.030	s/ft
Pile Length	25.00	ft
Pile Penetration	18.90	ft
Pile Top Area	153.94	in2



Res. Shaft = 35 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
337.0	3.29	0.38	45.4	6.00	13.77

Appendix C

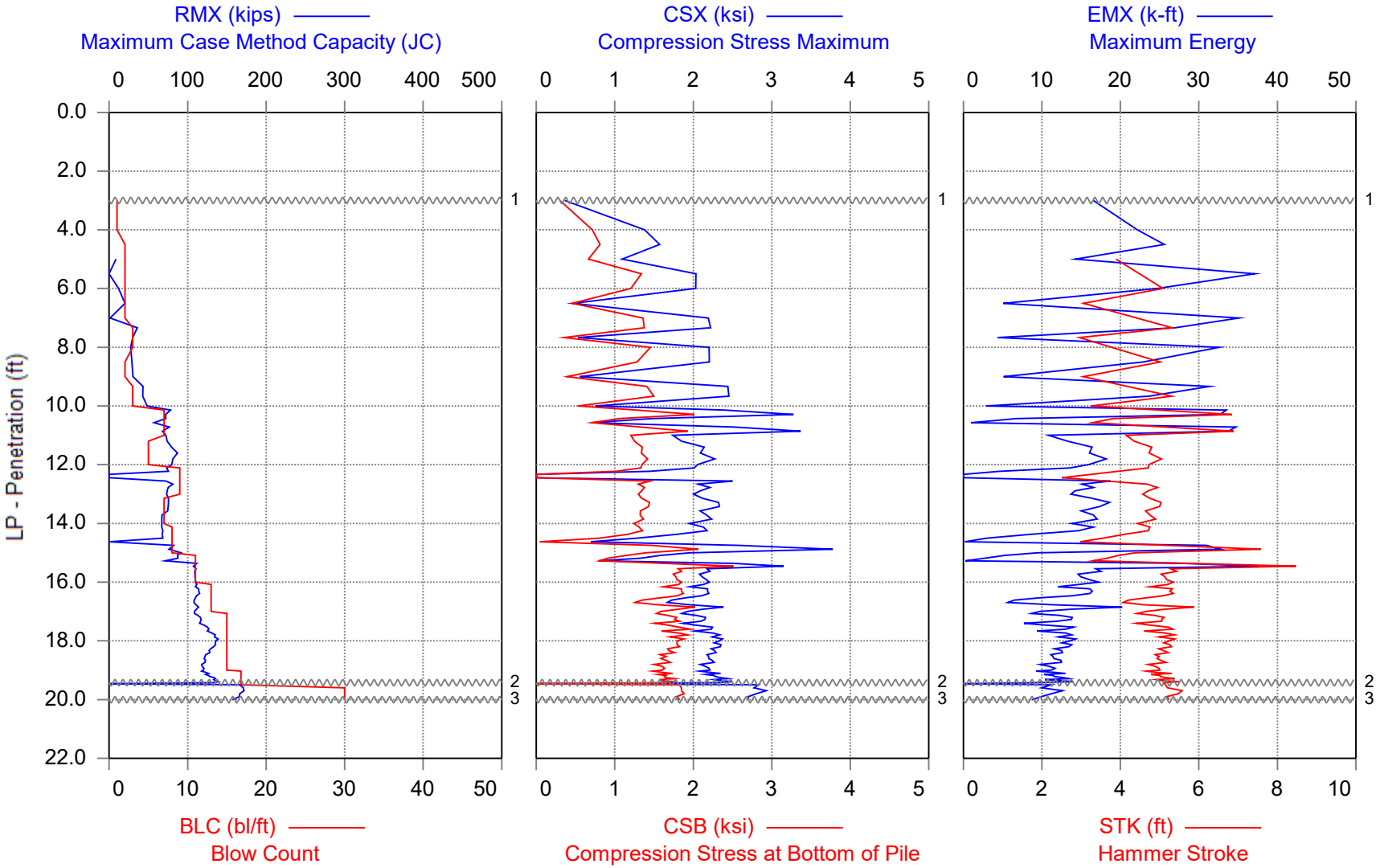
Dynamic Pile Testing, Signal Matching Results, and Calibration WEAP

Test Pile 3

Pile Dynamics, Inc. - PDIPLOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

Printed: 16-March-2023 Test started: 15-March-2023

CCR Phase 1 - Load Transfer Platform - Test Pile 3



1 - REF = GSE = +170.0' / Hammer fuel setting 1

2 - Stopped to remove anchor bolt

3 - Last set in 5 blows at EOD was two inches

CCR Phase 1 - Load Transfer Platform - Test Pile 3 Timber Pile 11" x 25'
OP: ICE - GEN Date: 15-March-2023

AR: 89.31 in² SP: 0.060 k/ft³
LE: 21.00 ft EM: 2,630 ksi
WS: 14,250.0 f/s JC: 0.80

RX9: Maximum Case Method Capacity (JC=0.9) EMX: Maximum Energy
RMX: Maximum Case Method Capacity (JC) STK: Hammer Stroke
CSX: Compression Stress Maximum FVP: Force/Velocity Proportionality
CSB: Compression Stress at Bottom of Pile BTA: Integrity Factor (1)
TSX: Tension Stress Maximum - Full Record Search

BL#	Depth	BLC	TYPE	RX9	RMX	CSX	CSB	TSX	EMX	STK	FVP	BTA
	ft	bl/ft		kips	kips	ksi	ksi	ksi	k-ft	ft		(%)
2	4.0	1	AV2	0	0	0.9	0.5	0.2	19.3	**	0.2	81.5
			STD	0	0	0.5	0.2	0.2	2.8	**	0.3	18.5
			MAX	0	0	1.4	0.7	0.4	22.2	**	0.5	100.0
			@BL	1	1	2	2	2	2	**	2	1
4	5.0	2	AV2	3	4	1.3	0.7	0.3	19.9	3.89	0.6	66.5
			STD	3	4	0.2	0.1	0.1	5.6	0.00	0.0	2.5
			MAX	6	9	1.6	0.8	0.5	25.6	3.89	0.6	69.0
			@BL	4	4	3	3	3	3	4	3	4
6	6.0	2	AV2	4	6	2.0	1.3	0.5	30.9	5.08	0.7	56.0
			STD	4	6	0.0	0.1	0.0	6.2	0.00	0.0	4.0
			MAX	8	12	2.0	1.3	0.5	37.1	5.08	0.8	60.0
			@BL	6	6	5	5	5	5	6	6	6
8	7.0	2	AV2	9	11	1.3	0.9	0.3	20.1	3.06	0.8	78.0
			STD	9	9	0.9	0.5	0.3	15.0	0.00	0.0	22.0
			MAX	19	20	2.2	1.4	0.5	35.1	3.06	0.8	100.0
			@BL	7	7	8	8	8	8	7	8	7
11	8.0	3	AV3	29	31	1.7	1.1	0.3	21.3	4.14	0.8	44.7
			STD	4	3	0.8	0.5	0.2	12.2	1.18	0.1	20.3
			MAX	34	36	2.2	1.5	0.5	32.6	5.32	0.9	59.0
			@BL	9	9	9	11	9	11	9	10	9
13	9.0	2	AV2	29	30	1.4	0.8	0.2	14.0	4.04	0.9	38.0
			STD	1	1	0.8	0.4	0.2	8.9	0.98	0.0	21.0
			MAX	29	30	2.2	1.3	0.5	22.9	5.01	0.9	59.0
			@BL	13	13	12	12	12	12	12	13	12
16	10.0	3	AV3	44	45	1.9	1.1	0.3	19.3	4.28	0.8	55.3
			STD	3	3	0.8	0.4	0.2	12.0	1.03	0.0	7.7
			MAX	48	48	2.5	1.5	0.5	31.4	5.31	0.8	66.0
			@BL	16	16	15	15	14	14	15	15	16
23	11.0	7	AV7	71	71	2.2	1.4	0.3	21.9	5.00	1.3	58.3
			STD	6	6	0.9	0.4	0.2	13.9	1.55	1.1	17.5
			MAX	78	78	3.4	2.0	0.6	34.7	6.89	4.1	100.0
			@BL	17	17	22	18	22	21	22	20	20
28	12.0	5	AV5	80	80	2.1	1.3	0.4	16.0	4.73	0.9	57.2
			STD	4	4	0.1	0.1	0.2	1.6	0.22	0.0	1.0
			MAX	87	87	2.3	1.4	0.8	18.2	5.05	0.9	59.0
			@BL	26	26	27	27	28	27	27	27	28

CCR Phase 1 - Load Transfer Platform - Test Pile 3 Timber Pile 11" x 25'
OP: ICE - GEN Date: 15-March-2023

BL#	Depth ft	BLC bl/ft	TYPE	RX9 kips	RMX kips	CSX ksi	CSB ksi	TSX ksi	EMX k-ft	STK ft	FVP	BTA (%)
37	13.0	9	AV9	58	58	1.6	1.0	0.2	10.7	4.30	0.8	57.9
			STD	31	31	0.9	0.6	0.1	6.8	0.78	0.4	17.8
			MAX	81	81	2.5	1.4	0.3	18.7	4.94	0.9	100.0
			@BL	34	34	33	33	33	33	35	34	32
44	14.0	7	AV7	71	72	2.2	1.4	0.2	16.4	4.79	0.9	56.1
			STD	4	4	0.1	0.1	0.0	1.5	0.19	0.0	0.8
			MAX	75	76	2.3	1.4	0.2	18.6	5.03	0.9	57.0
			@BL	38	38	40	39	40	39	39	40	38
52	15.0	8	AV8	64	65	2.0	1.2	0.2	14.5	4.58	0.7	58.5
			STD	26	26	0.9	0.5	0.1	11.2	1.36	0.6	16.6
			MAX	91	92	3.8	2.1	0.6	32.8	7.58	1.0	100.0
			@BL	52	52	51	51	51	51	51	51	49
63	16.0	11	AV11	101	102	2.0	1.6	0.2	15.6	5.08	1.7	81.8
			STD	13	13	0.6	0.5	0.0	10.3	1.35	2.7	16.6
			MAX	111	112	3.1	2.5	0.3	37.6	8.47	10.2	100.0
			@BL	56	56	57	57	55	57	57	55	55
76	17.0	13	AV13	110	111	2.0	1.7	0.1	12.8	4.94	0.8	87.5
			STD	3	2	0.2	0.2	0.0	4.0	0.49	0.0	9.9
			MAX	114	115	2.4	2.0	0.2	20.2	5.88	0.8	100.0
			@BL	68	68	74	74	70	74	74	72	66
91	18.0	15	AV15	122	124	2.1	1.8	0.1	12.1	5.00	0.8	87.8
			STD	9	9	0.2	0.1	0.0	2.0	0.31	0.0	11.4
			MAX	136	139	2.4	2.0	0.2	14.3	5.38	0.8	100.0
			@BL	90	90	90	85	77	90	90	82	77
106	19.0	15	AV15	123	125	2.2	1.7	0.1	11.9	5.04	0.8	78.6
			STD	6	6	0.1	0.1	0.0	1.0	0.15	0.0	0.6
			MAX	133	136	2.4	1.8	0.2	13.8	5.30	0.8	79.0
			@BL	92	93	93	94	103	93	94	103	95
120	19.5	17	AV14	121	123	2.2	1.5	0.1	10.7	5.06	0.9	90.0
			STD	35	36	0.6	0.4	0.0	3.3	0.23	0.1	25.9
			MAX	162	166	2.8	1.8	0.2	14.0	5.49	1.3	100.0
			@BL	120	120	120	120	118	117	117	119	108
125	20.0	30	AV5	163	166	2.8	1.8	0.2	10.5	5.33	0.9	96.0
			STD	6	5	0.1	0.0	0.0	1.3	0.16	0.0	8.0
			MAX	170	172	2.9	1.9	0.2	12.6	5.57	0.9	100.0
			@BL	122	122	122	123	125	122	122	124	121
			Average	92	93	2.0	1.5	0.2	14.3	4.86	0.9	74.3
			Std. Dev.	42	42	0.6	0.5	0.1	8.0	0.82	0.9	21.2
			Maximum	170	172	3.8	2.5	0.8	37.6	8.47	10.2	100.0
			@ Blow#	122	122	51	57	28	57	57	55	1

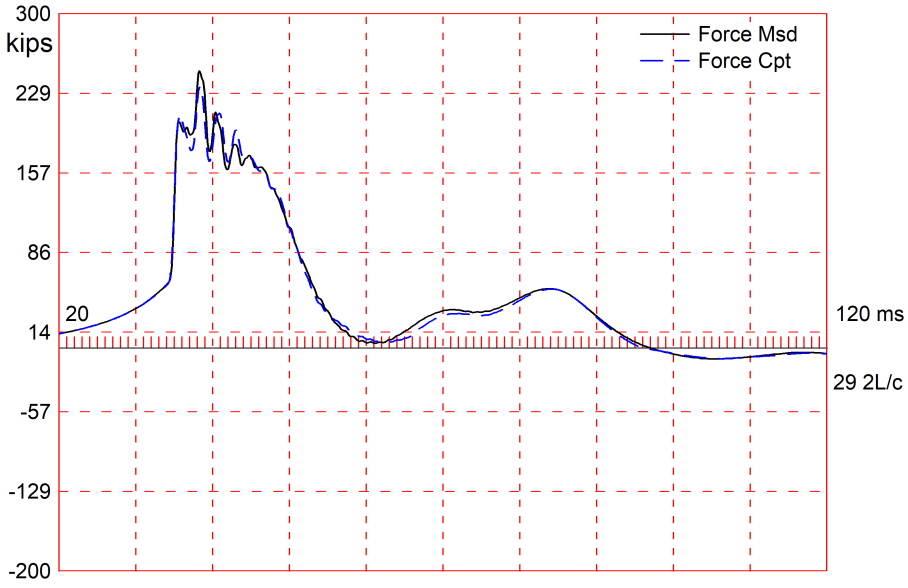
Total number of blows analyzed: 125

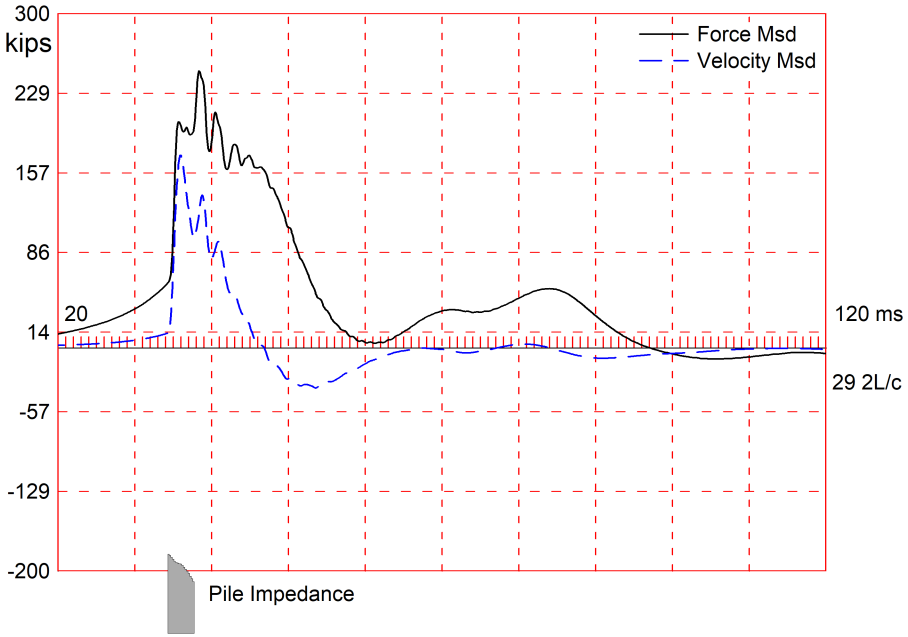
BL#	Sensors
1-125	F1: [P815] 146.1 (1.00); F3: [S048] 94.3 (1.00); A2: [K11186] 443.2 (1.00); A4: [K11187] 433.6 (1.00)

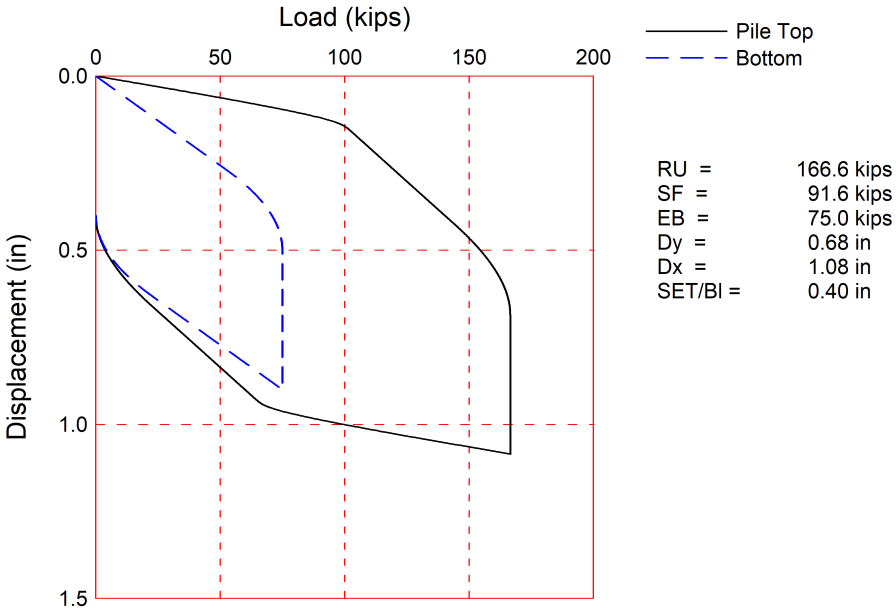
BL#	Comments
1	REF = GSE = +170.0' / Hammer fuel setting 1
118	Stopped to remove anchor bolt
125	Last set in 5 blows at EOD was two inches

Time Summary

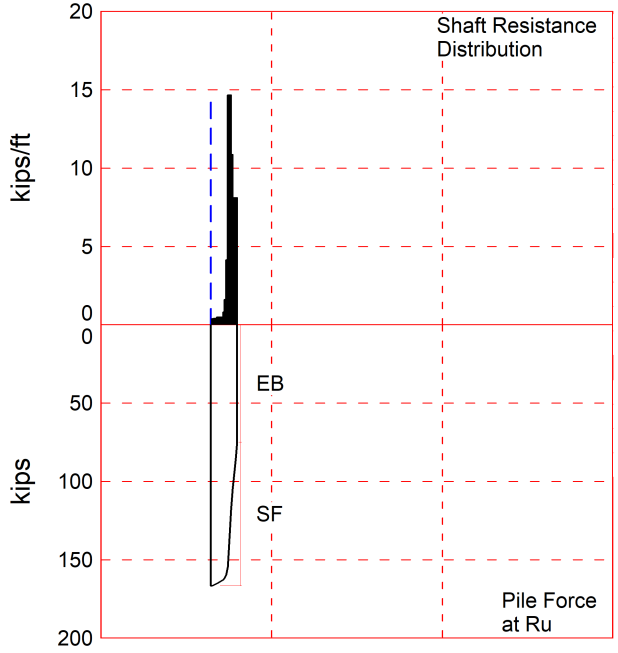
Drive 15 minutes 11 seconds 4:41 PM - 4:56 PM BN 1 - 125







RU =	166.6 kips
SF =	91.6 kips
EB =	75.0 kips
Dy =	0.68 in
Dx =	1.08 in
SET/Bl =	0.40 in



Length b. Sensors	21.0 ft
Embedment	19.8 ft
Top Area	89.3 in^2
End Bearing Area	56.7 in^2
Top Perimeter	2.79 ft
Top E-Modulus	2630 ksi
Top Spec. Weight	60.0 lb/ft^3
Top Wave Spd.	14250 ft/s
Overall W.S.	14250 ft/s
Match Quality	2.56
Top Compr. Stress	2.6 ksi
Max Compr. Stress	3.2 ksi
Max Tension Stress	-0.12 ksi
Avg. Shaft Quake	0.04 in
Toe Quake	0.38 in
Avg. Shaft Smith Dpg.	0.13 s/ft
Toe Smith Damping	0.02 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: 166.6; along Shaft 91.6; at Toe 75.0 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
				166.6			
1	2.5	1.3	0.5	166.1	0.5	0.39	0.14
2	3.7	2.5	0.5	165.6	1.0	0.40	0.15
3	4.9	3.7	0.5	165.1	1.5	0.40	0.15
4	6.2	5.0	0.6	164.5	2.1	0.49	0.18
5	7.4	6.2	0.6	163.9	2.7	0.49	0.18
6	8.6	7.4	0.6	163.3	3.3	0.49	0.18
7	9.9	8.7	0.6	162.7	3.9	0.49	0.19
8	11.1	9.9	1.0	161.7	4.9	0.81	0.31
9	12.4	11.2	2.0	159.7	6.9	1.62	0.63
10	13.6	12.4	5.1	154.6	12.0	4.13	1.62
11	14.8	13.6	18.1	136.5	30.1	14.65	5.84
12	16.1	14.9	18.1	118.4	48.2	14.65	5.92
13	17.3	16.1	13.4	105.0	61.6	10.85	4.47
14	18.5	17.3	10.0	95.0	71.6	8.10	3.42
15	19.8	18.6	10.0	85.0	81.6	8.10	3.50
16	21.0	19.8	10.0	75.0	91.6	8.10	3.59
Avg. Shaft			5.7			4.63	1.81
Toe			75.0				190.33

Soil Model Parameters/Extensions		Shaft	Toe
Smith Damping Factor		0.13	0.02
Quake	(in)	0.04	0.38
Case Damping Factor		0.72	0.11
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	30	35
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	9	
Resistance Gap (included in Toe Quake)	(in)		0.01

CAPWAP match quality = 2.56 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.40 in; Blow Count = 30 b/ft
Computed: Final Set = 0.40 in; Blow Count = 30 b/ft
Transducer F1 (P815) CAL: 146.1; RF: 1.00; F3 (S048) CAL: 94.3; RF: 1.00
A2 (K11186) CAL: 443; RF: 1.00; A4 (K11187) CAL: 434; RF: 1.00

max. Top Comp. Stress = 2.6 ksi (T= 38.4 ms, max= 1.235 x Top)
max. Comp. Stress = 3.2 ksi (Z= 13.6 ft, T= 40.0 ms)
max. Tens. Stress = -0.12 ksi (Z= 13.6 ft, T= 131.7 ms)
max. Energy (EMX) = 11.1 kip-ft; max. Measured Top Displ. (DMX)= 0.76 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	1.2	228.8	-10.0	2.6	-0.11	11.1	10.1	0.76
2	2.5	221.8	-10.0	2.5	-0.11	11.1	10.1	0.75
3	3.7	218.2	-9.9	2.6	-0.12	10.9	10.1	0.73
4	4.9	221.2	-9.8	2.7	-0.12	10.8	10.0	0.72
5	6.2	224.1	-9.8	2.8	-0.12	10.6	10.0	0.71
6	7.4	226.0	-9.7	2.8	-0.12	10.5	9.9	0.69
7	8.6	228.1	-9.7	2.9	-0.12	10.3	9.8	0.68
8	9.9	231.1	-9.6	2.9	-0.12	10.2	9.6	0.67
9	11.1	234.3	-9.5	3.0	-0.12	10.0	9.2	0.65
10	12.4	236.3	-9.4	3.1	-0.12	9.8	8.7	0.64
11	13.6	235.3	-9.2	3.2	-0.12	9.6	8.5	0.62
12	14.8	226.8	-8.6	3.1	-0.12	9.0	8.8	0.61
13	16.1	192.4	-6.8	2.7	-0.10	7.5	9.2	0.60
14	17.3	156.9	-4.9	2.3	-0.07	6.0	9.6	0.59
15	18.5	134.7	-3.5	2.1	-0.05	4.8	9.8	0.57
16	19.8	116.9	-2.5	1.9	-0.04	4.0	9.9	0.56
17	21.0	99.7	-1.4	1.7	-0.02	2.5	9.8	0.55
Absolute	13.6			3.2			(T =	40.0 ms)
	13.6				-0.12		(T =	131.7 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	239.3	225.8	212.2	198.6	185.1	171.5	157.9	144.4	130.8	117.3
RX	239.3	225.8	212.2	198.6	185.4	177.1	173.1	169.6	166.3	163.0
RU	239.3	225.8	212.2	198.6	185.1	171.5	157.9	144.4	130.8	117.3

RAU = 109.5 (kips); RA2 = 211.8 (kips)

Current CAPWAP Ru = 166.6 (kips); Corresponding J(RP)= 0.54; J(RX) = 0.79

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips	KEB kips/in
10.5	34.36	173.5	201.5	250.1	0.76	0.40	0.40	11.2	232.7	200

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	89.3	2629.7	60.000	2.79
1.0	89.3	2629.7	60.000	2.79
6.0	80.2	2629.7	60.000	2.65
11.0	77.7	2629.7	60.000	2.60

PILE PROFILE AND PILE MODEL

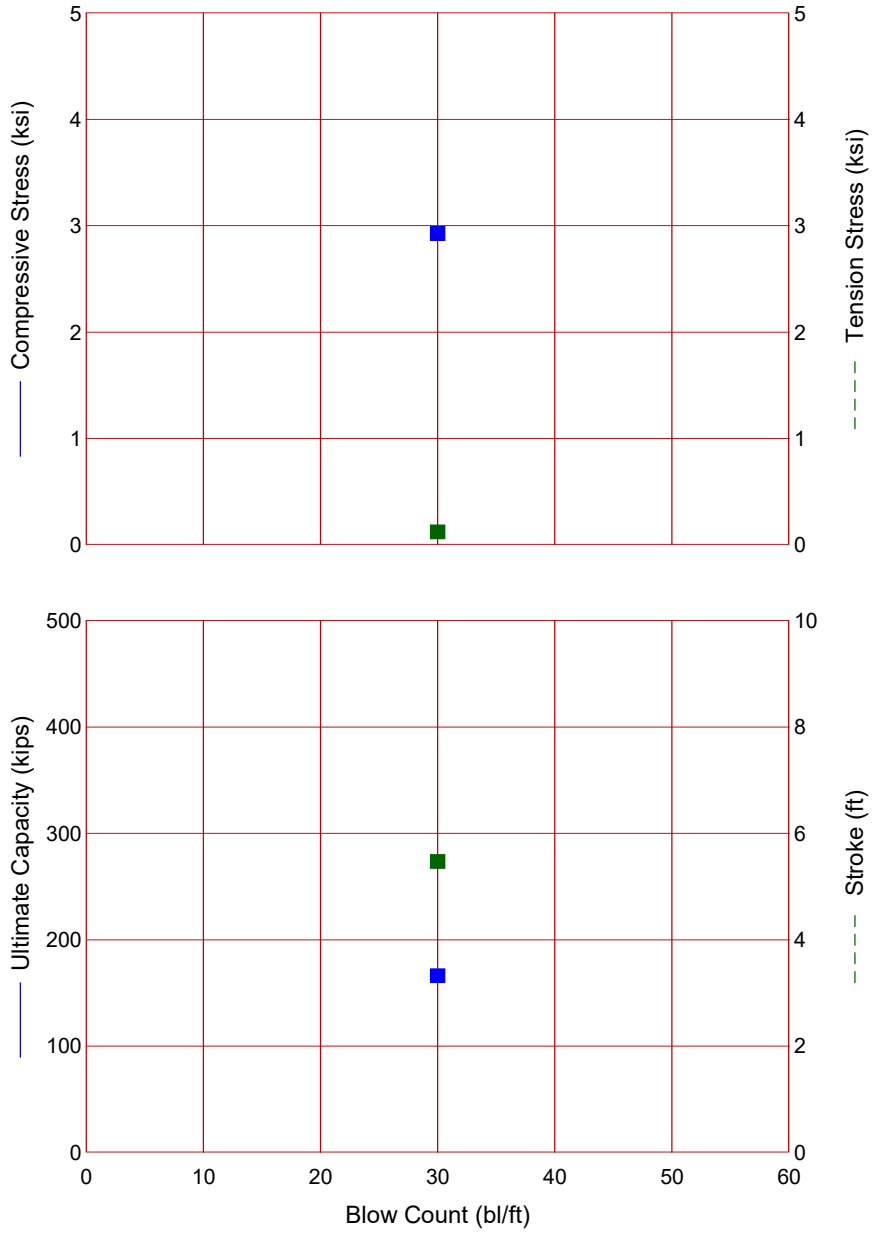
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
16.0	69.3	2629.7	60.000	2.46
21.0	56.8	2629.7	60.000	2.23

Toe Area 56.7 in^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Wave Speed ft/s
1	1.2	16.48	0.00	0.00	0.000	-0.00	0.000	2.79	14250.0
2	2.5	16.20	0.00	0.00	0.000	-0.00	0.000	2.77	14250.0
3	3.7	15.78	0.00	0.00	0.000	-0.00	0.000	2.73	14250.0
4	4.9	15.37	0.00	0.00	0.000	-0.00	0.000	2.69	14250.0
5	6.2	14.96	0.00	0.00	0.000	-0.00	0.000	2.66	14250.0
6	7.4	14.73	0.00	0.00	0.000	-0.00	0.000	2.64	14250.0
7	8.6	14.62	0.00	0.00	0.000	-0.00	0.000	2.63	14250.0
8	9.9	14.50	0.00	0.00	0.000	-0.00	0.000	2.62	14250.0
9	11.1	14.39	0.00	0.00	0.000	-0.00	0.000	2.61	14250.0
10	12.4	14.11	0.00	0.00	0.000	-0.00	0.000	2.58	14250.0
11	13.6	13.73	0.00	0.00	0.000	-0.00	0.000	2.55	14250.0
12	14.8	13.34	0.00	0.00	0.000	-0.00	0.000	2.51	14250.0
13	16.1	12.95	0.00	0.00	0.000	-0.00	0.000	2.47	14250.0
14	17.3	12.47	0.00	0.00	0.000	-0.00	0.000	2.43	14250.0
15	18.5	11.90	0.00	0.00	0.000	-0.00	0.000	2.37	14250.0
16	19.8	11.33	0.00	0.00	0.000	-0.00	0.000	2.31	14250.0
17	21.0	10.76	0.00	0.00	0.000	-0.00	0.000	2.25	14250.0

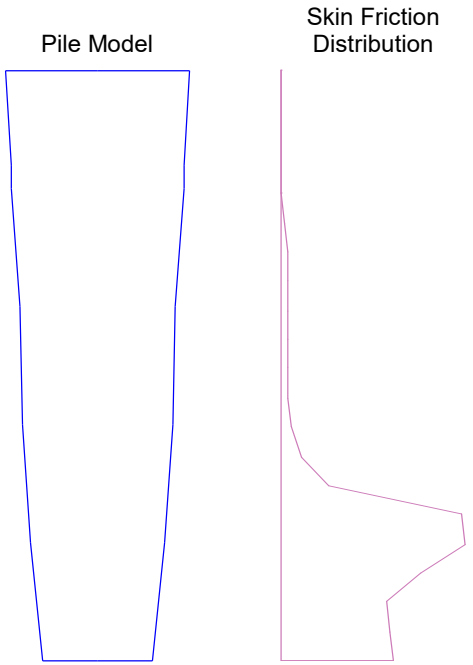
Wave Speed: Pile Top 14250.0, Elastic 14249.9, Overall 14250.0 ft/s
Pile Damping 2.00 %
Total volume: 11.045 ft^3; Volume ratio considering added impedance: 1.000

Time (ms)	0.0	45.0
Time Incr	0.102	0.080



ICE I-19v2

Ram Weight	4.01	kips
Efficiency	0.460	
Pressure	1590 (100%)	psi
Helmet Weight	2.31	kips
Hammer Cushion	34825	kips/in
COR of H.C.	0.900	
Skin Quake	0.040	in
Toe Quake	0.375	in
Skin Damping	0.130	s/ft
Toe Damping	0.024	s/ft
Pile Length	25.00	ft
Pile Penetration	19.80	ft
Pile Top Area	95.03	in2



Res. Shaft = 55 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
166.0	2.92	0.12	30.0	5.47	11.10

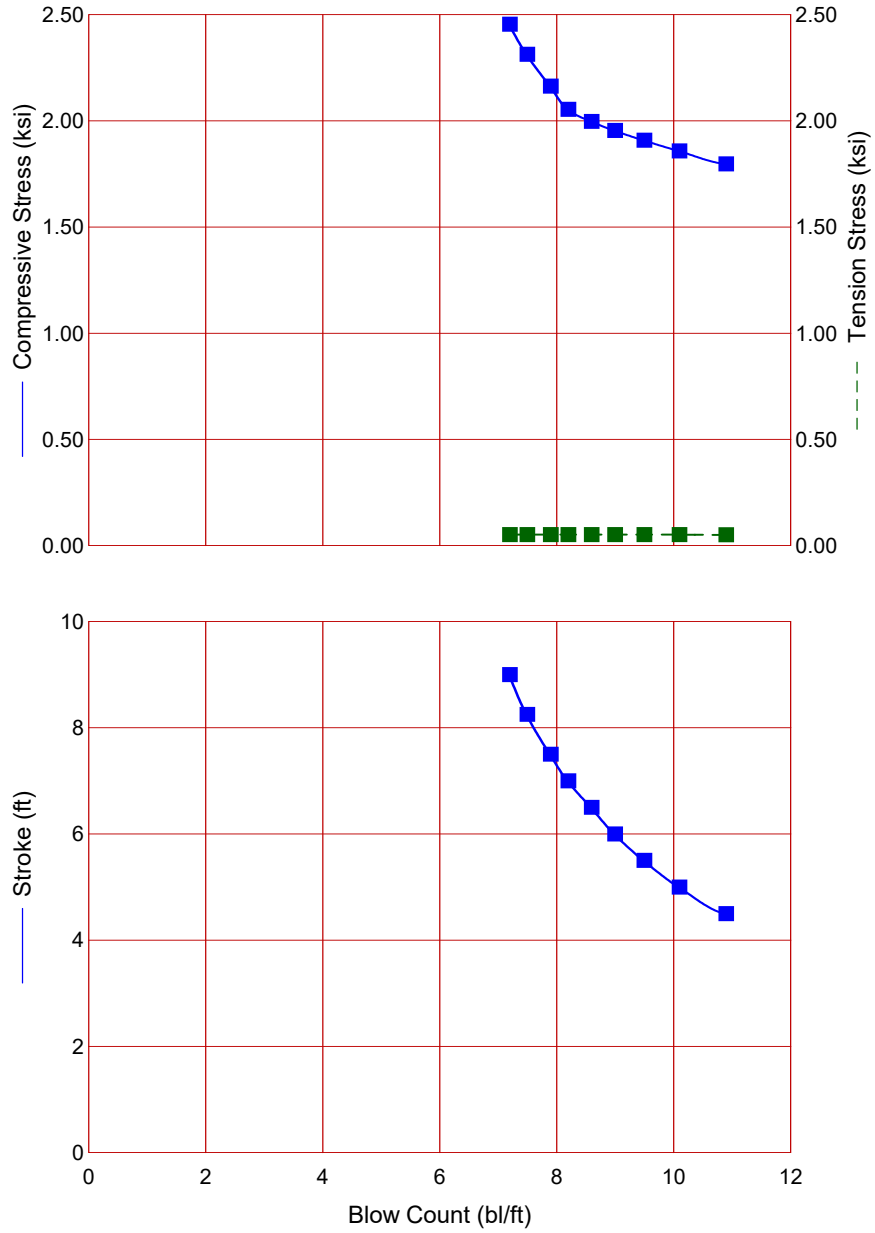
Appendix D

Production Driving Criteria

Bridge 35 – Load Transfer Platform

ICE of Carolinas, PLLC
CCR1_Load Transfer Platform Criteria

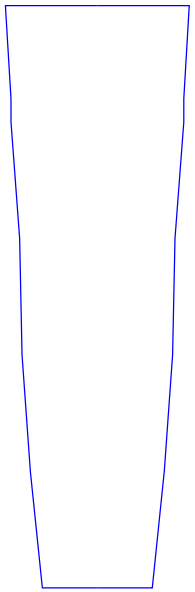
16-Mar-2023
GRLWEAP Version 2010



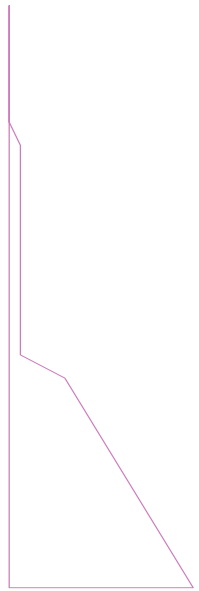
ICE I-19v2

Capacity	80.0	kips
Ram Weight	4.01	kips
Efficiency	0.350	
Pressure	1590 (100%)	psi
Helmet Weight	2.31	kips
Hammer Cushion	34825	kips/in
COR of H.C.	0.900	
Skin Quake	0.050	in
Toe Quake	0.380	in
Skin Damping	0.150	s/ft
Toe Damping	0.050	s/ft
Pile Length	25.00	ft
Pile Penetration	20.00	ft
Pile Top Area	95.03	in2

Pile Model



Skin Friction Distribution



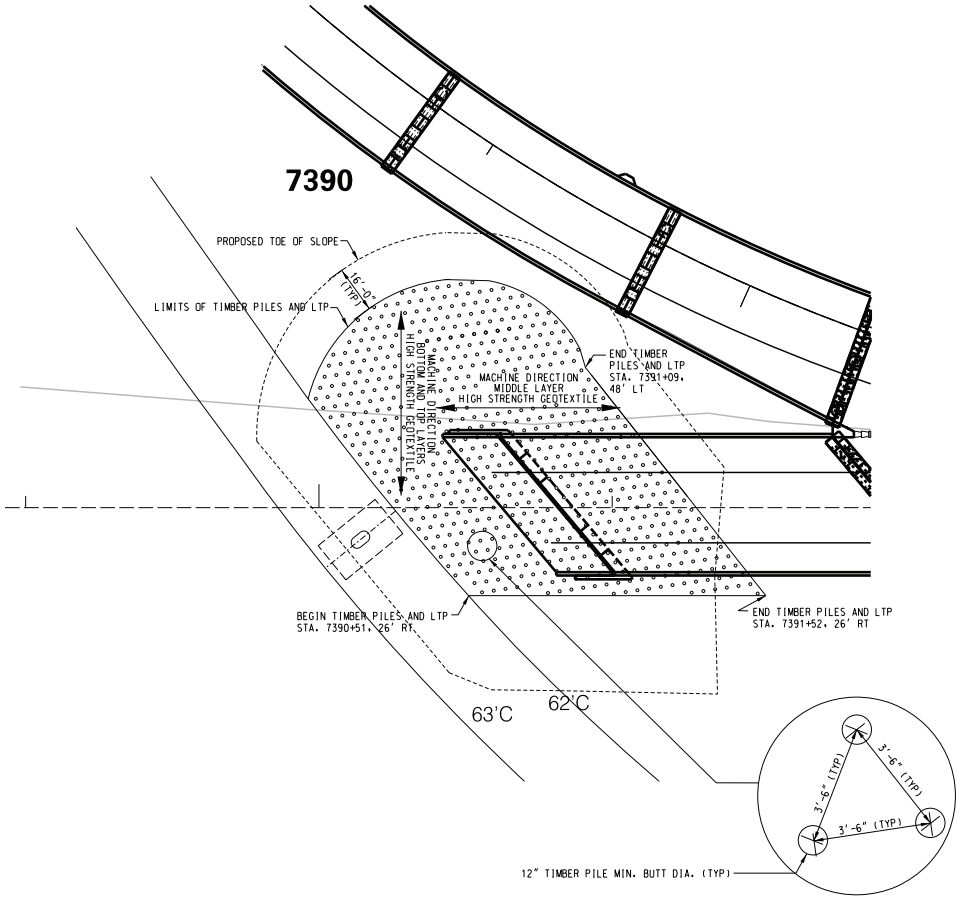
Res. Shaft = 55 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
80.0	1.80	0.05	10.9	4.50	12.22
80.0	1.86	0.05	10.1	5.00	13.52
80.0	1.91	0.05	9.5	5.50	14.71
80.0	1.95	0.05	9.0	6.00	15.84
80.0	2.00	0.05	8.6	6.50	16.88
80.0	2.05	0.05	8.2	7.00	17.91
80.0	2.16	0.05	7.9	7.50	18.89
80.0	2.27	0.05	7.6	8.00	19.84
80.0	2.36	0.05	7.4	8.50	20.75
80.0	2.45	0.05	7.2	9.00	21.67

Appendix E

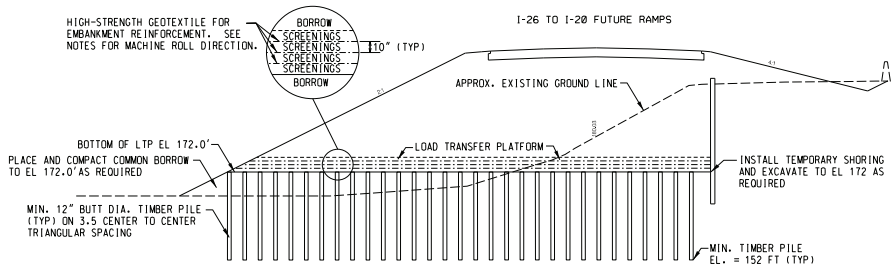
Project Information and Nearby Soil Borings

FED. ROAD DOC. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	LEXINGTON	P039718	I-26	G2



TIMBER PILE AND LOAD TRANSFER PLATFORM PLAN

NOTES:
1. WITHIN LIMITS OF TIMBER PILE GROUP AND LOAD TRANSFER PLATFORM (LTP), EXCAVATE EXISTING EMBANKMENT AND PLACE FILL AS NEEDED TO BRING GROUND TO BOTTOM OF LTP ELEVATION OF EL 172.0 FT.
2. DRIVE TIMBER PILES ON A 3.5-FT TRIANGULAR SPACING TO A REQUIRED BEARING CAPACITY OF 80 KIPS EACH AND TO A TIP ELEVATION NO HIGHER THAN EL. 152.0.
3. PERFORM DYNAMIC LOAD TESTING ON A MINIMUM OF 3 TIMBER PILES TO VERIFY PILE DRIVING STRESSES AND AXIAL CAPACITY.
4. TOP OF TIMBER PILE ELEVATION = 172.0
5. AFTER INSTALLING TIMBER PILES, PLACE AND COMPACT 10" SCREENINGS OVER LTP LIMITS.
6. INSTALL LOWER, MIDDLE, AND UPPER HIGH-STRENGTH GEOTEXTILE WITH MACHINE DIRECTIONS AS SHOWN ON THE PLANS, SEPARATED BY 10" OF COMPACTED SCREENINGS.
7. HIGH-STRENGTH GEOTEXTILE MUST BE CONTINUOUS IN THE MACHINE DIRECTION FROM BEGIN TO END OF THE LTP. NO SPLICES OR OVERLAPS ARE PERMITTED IN THE MACHINE DIRECTION
8. ADJACENT HIGH-STRENGTH GEOTEXTILE SHEETS MUST BE SEWN THE ENTIRE LENGTH OF THE JOINT PARALLEL TO THE MACHINE DIRECTION.
9. PLACE AND COMPACT 10" SCREENINGS ABOVE UPPER HIGH-STRENGTH GEOTEXTILE PRIOR TO PLACING COMMON BORROW.
10. SEE HIGH-STRENGTH GEOTEXTILE FOR EMBANKMENT REINFORCEMENT SPECIAL PROVISION.
11. HIGH-STRENGTH GEOTEXTILE PROPERTIES SHALL BE IN ACCORDANCE WITH TABLE 1 OF THE SPECIAL PROVISION. LONG-TERM DESIGN STRENGTH, Tal, IN THE MACHINE DIRECTION SHALL BE NO LESS THAN 22,800 LB/FT



TIMBER PILE AND LOAD TRANSFER TYPICAL SECTION

ARCHER UNITED JOINT VENTURE

INFRASTRUCTURE CONSULTING & ENGINEERING

NO.	BY	CHK'D.	DATE	DESCRIPTION OF REVISION
4				
3				
2				
1				
0	MDV	SGT	6-2-22	RELEASED FOR CONSTRUCTION

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

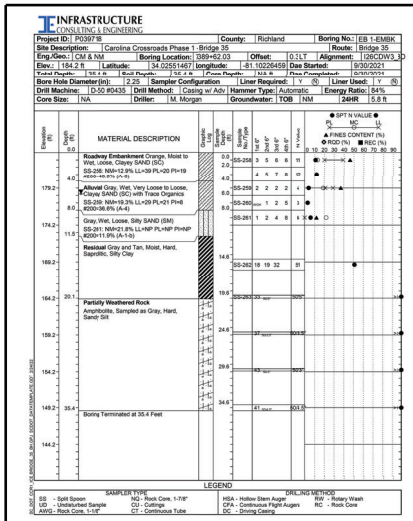
CAROLINA CROSSROADS PHASE 1

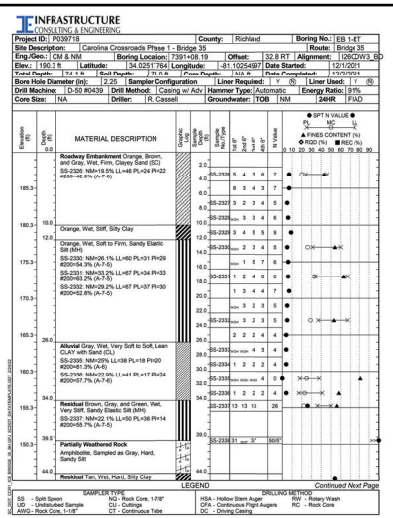
SEGMENT 2
GEOTECHNICAL DETAILS

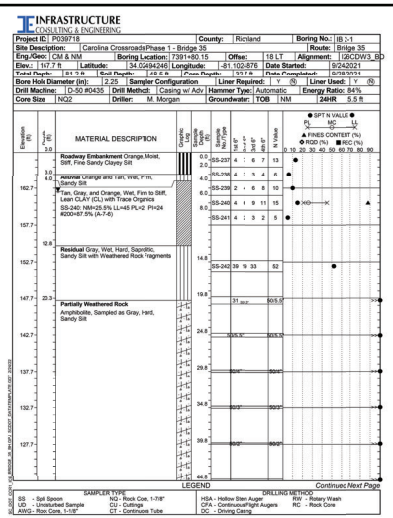
Z:\Projects\20-6\CR Ph 1\Roadway\PLANS\SEGMENT 2\40_002_S2_P039718_GeotechnicalDetails.dgn

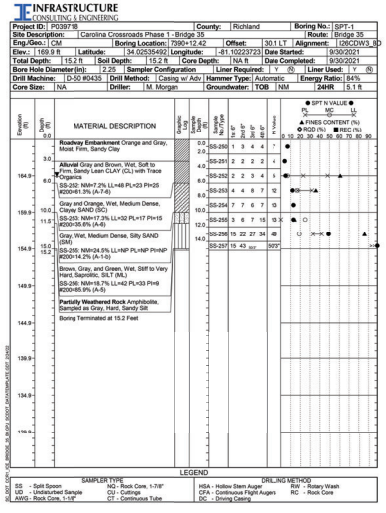
6/27/2022

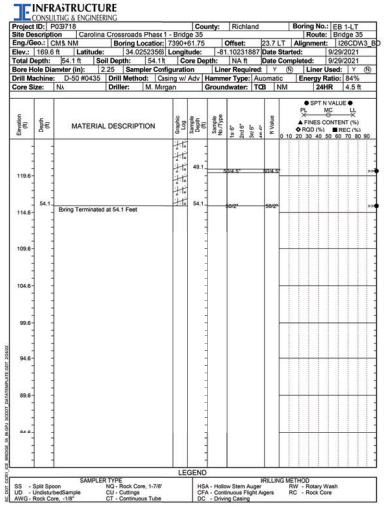
BRIDGE PLANS ID	SHEET NO.
P039718-B35	31

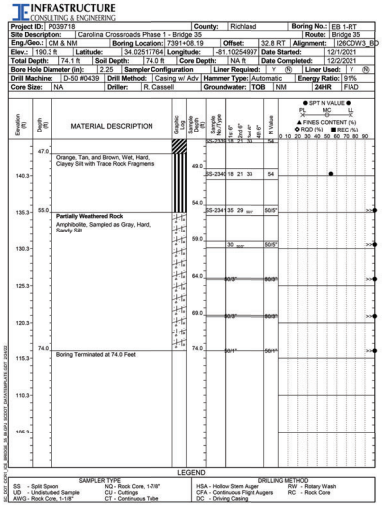


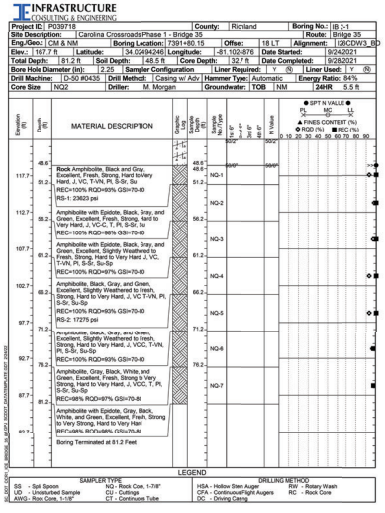












FOR INFORMATION ONLY

REV.	DKY	06-20-22
	RFC PLANS	
REV.		
REV.		
REVIEWED	J. FELKEL	
QUAN.		
DR.	BFS	DKY 01-22
DES.	DKY	CSB 01-22
	BY	CHK. DATE

ARCHER UNITED
JOINT VENTURE
UNITED INFRASTRUCTURE GROUP

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

BORING LOGS (4)

I-26 TO I-20 FUTURE RAMPS AND RAMP I-26 WB TO I-126 EB BRIDGE OVER SALUDA RIVER AND CSX R.R.

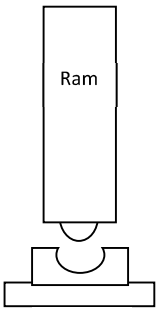
COUNTY: LEXINGTON/RICHLAND
ROUTE: I-26

Z:\Projects\20-6\CCR Ph 1\Structures\01_New Bridges\Bridge 35\04_Final Plans\3j_BRIDGE 35_BORING LOGS (4).dgn
6/20/2022
8:41:30 AM

Appendix F

Pile Driving Hammer Information

County:	Lexington/Richland	Bridge Plans ID:	P039718
Route:	I-26 and I-126		
Description:	Carolina Crossroads Phase 1 Bridge 35 Timber Piles		
Contractor:	Archer United		



Hammer

Manufacturer:	ICE			Model:	I-19
Type:	Single Act Diesel			Serial No.	TBD
Rated Energy (k-ft)	46.17	at	11.5	Length of stroke (ft)	
Lead Size (in):	26				
Modifications :	None				

Note: Attach any hammer modification specifications. Manufacturer's Specifications may be required if hammer is not found in Wave Equation database.

Date of Last Maintenance:	TBD
Type of Maintenance:	TBD
Performed By:	TBD

Striker Plate

Weight (kips):	.46		
Diameter (in):	22.5	Thickness (in):	4

Hammer Cushion

Description:

	Material Description	No. of Layers	Modulus of Elasticity (ksi)	Thickness (in)
1	MC-904 Blue Nylon	1	175	2
2				

Area (sq. in):	398	Total Thickness (in)	2.5
Coefficient of Restitution:	.90		

Pile Cap (Helmet)

Dimension:	DCB-1 Drive Cap & DCH-1 Cap Insert
Pile Cap Weight (kips):	1.065
Inserts Weight (kips):	.78

Pile Cushion

Material:	N/A		
Thickness (in.)	N/A	Area (sq. in):	N/A
Modulus of Elasticity (ksi):	N/A		
Coefficient of Restitution:	N/A		

Pile

Pile Type/Size & Pile Point:	12"X20' and 12"X25' Timber Pile		
Total Pile & Point Length (ft):	BR35 Timber Pile 20' & 25'	Exposed Pile Point Length (ft):	N/A
Pile Cross-Sectional Area (sq.in):	N/A		
Pipe Pile Wall Thickness (in):	N/A		
Pile Tip Description:	N/A		
Splice Description:	N/A		
Splice Location From Pile Top (ft):	N/A		
Concrete Pile Strength, f'_c (psi):	N/A		

		Steel Pile Yield Strength, F_y (ksi):	50		
Note: Within 30 calendar days after award of contract or no later than 30 days before driving the first pile, submit form and Pile Installation Plan to the Geotechnical Design Engineer, with copy to the Bridge Construction Engineer and RCE.					
SCDOT – Design-Build Section Geotechnical Design Engineer P.O. Box 191 Columbia, SC 29202-0191 Telephone (803) 737-0766 FAX (803) 737-9868		Submitted By:	Josh Bennett		
		Title:	Project Engineer		
		Telephone No.	(803)374-9108	Date:	8/5/2022

Appendix G

Instrumentation Calibrations

Certificate of Calibration

Transducer Model: PDI Transducer

Pile Dynamics, Inc.

Serial Number: P815

PDI Gage Factor: 146.1 me/V

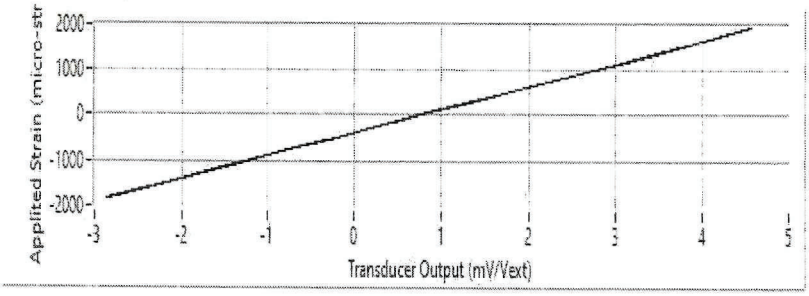
General Gage Factor: 507.4 **me**/mV/V$_{ext}$

Initial Offset Voltage: 0.223 mV/V$_{ext}$

Table 1) Representative Calibration Data

Applied Strain (micro-strain)	Transducer Output (mV/Vext)	Applied Strain (micro-strain)	Transducer Output (mV/Vext)
-102.255	0.562	197.647	1.019
-206.923	0.343	445.587	1.634
-462.060	-0.599	795.802	2.237
-767.929	-0.759	1064.547	2.849
-1015.226	-1.238	1381.545	3.467
-1266.127	-1.735	1726.783	4.100
-1522.264	-2.253	1955.471	4.571
-1766.147	-2.732	1900.222	4.470
-1830.597	-2.864	1570.884	3.849
-1697.751	-2.629	1246.030	3.209
-1425.978	-2.067	927.536	2.581
-1152.569	-1.545	612.288	1.952
-887.343	-1.008	299.578	1.344
-635.457	-0.513	5.658	0.772
-445.443	-0.129	-135.549	0.554
-167.625	0.416	-134.193	0.597

Calibration Curve



Mean Linear Correlation Coefficient (LCC): 0.999979

LCC Standard Deviation: 1.577618E-7

Calibrated By: DJC

Signature: _____

Date and Time: 12/1/2021 7:14 AM

Temperature (Degrees C): 24.3

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on 26Oct2022

Serial No:	K11186	**Temperature:**	72.9 °F
Model:	PR	**Humidity:**	42%
Calibrated on:	Channel 3 on 8G 5161 LE		

Ref Acc 1:	72505! 1035 g's/volt	**Cal on:**	24Mar2022
Ref Acc 2:	72517! 1049 g's/volt	**Cal on:**	24Mar2022

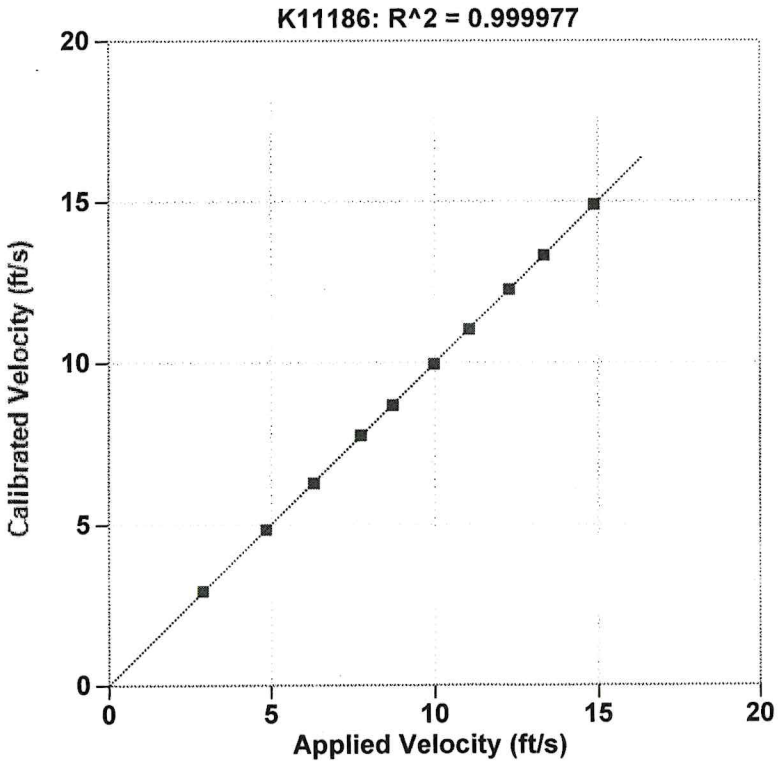
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

443.2 mv/5000g
(88.6 µv/g)
R^2: 0.999977 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K11186 Velocity
ft/s	ft/s
2.904	2.926
4.849	4.853
6.314	6.291
7.736	7.761
8.706	8.687
9.964	9.955
11.051	11.028
12.256	12.266
13.330	13.332
14.880	14.896

Maximum Acceleration: 1024 g's

Pile Dynamics, Inc.

Certificate of Calibration

Transducer Model: PDI Transducer

Serial Number: S048

PDI Gage Factor: 94.3 me/V

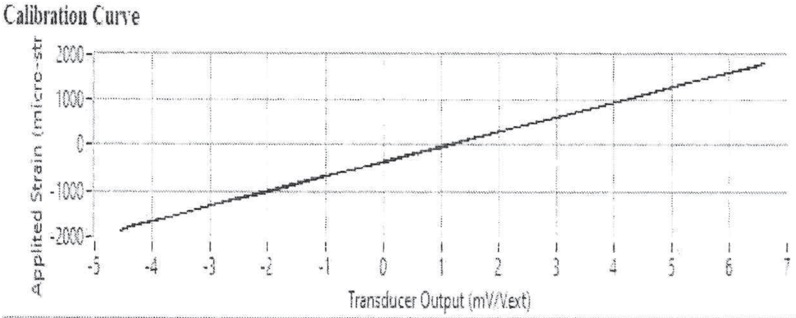
General Gage Factor: 327.6 **me**/mV/V_{ext}

Initial Offset Voltage: 0.214 mV/V_{ext}

Table 1: Representative Calibration Data

Applied Strain (micro-strain)	Transducer Output (mV/Vext)	Applied Strain (micro-strain)	Transducer Output (mV/Vext)
-160.072	0.596	1.605	1.096
-329.423	0.161	305.411	2.033
-595.730	-0.710	621.319	2.989
-867.723	-1.553	935.466	3.932
-1093.559	-2.246	1249.944	4.857
-1329.467	-2.979	1566.367	5.839
-1563.417	-3.691	1825.661	6.607
-1787.425	-4.365	1760.022	6.423
-1850.024	-4.549	1427.945	5.433
-1755.169	-4.315	1104.159	4.450
-1509.236	-3.576	792.700	3.508
-1241.518	-2.753	485.242	2.575
-975.923	-1.949	188.106	1.674
-725.466	-1.188	-56.216	0.928
-461.236	-0.398	-172.009	0.581
-257.944	0.291	-172.693	0.583

Calibration Curve



Mean Linear Correlation Coefficient (LCC): 0.999970

LCC Standard Deviation: 7.332388E-7

Calibrated By: Paul Hartman

Signature: Paul Hartman

Date and Time: 9/19/2022 7:36 AM

Temperature (Degrees C): 23.8

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on 15Jul2022

Serial No:	K11187	**Temperature:**	77.1 °F
Model:	PR	**Humidity:**	45%
Calibrated on:	Channel 3 on 8G 5161 LE		

Ref Acc 1:	72505! 1035 g's/volt	**Cal on:**	24Mar2022
Ref Acc 2:	72517! 1049 g's/volt	**Cal on:**	24Mar2022

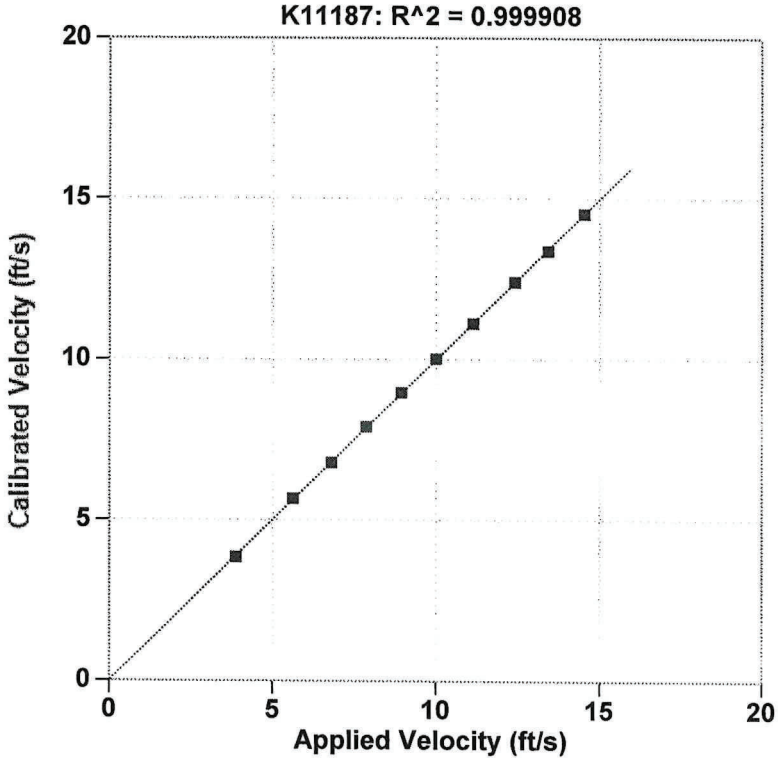
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

433.6 mv/5000g
(86.7 µv/g)
R^2: 0.999908 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K11187 Velocity
ft/s	ft/s
3.885	3.852
5.622	5.667
6.805	6.788
7.870	7.905
8.939	8.969
9.995	10.015
11.129	11.116
12.398	12.409
13.428	13.367
14.526	14.531

Maximum Acceleration: 984 g's

Appendix H

PDA Proficiency Certifications

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Pile Dynamics, Inc.

This documents that

Michael Simpson
ICE of Carolinas

has on October 13, 2017 achieved the rank of

ADVANCED

on the **Dynamic Measurement and Analysis Proficiency Test.**

The individual identified on this document demonstrated to the degree granted above an understanding of theory, data quality evaluation, interpretation and signal matching for high strain dynamic testing of deep foundations. ***It is recommended*** **that Individuals at the Advanced level seek Master or Expert levels through additional study within six years of the date of this document.**

The ability of the individual named to provide appropriate knowledge and advice on a specific project is not implied or warranted by the Pile Driving Contractors Association or Pile Dynamics, Inc. **This certificate can be verified at www.PDAproficiencytest.com.** The Pile Driving Contractors Association or Pile Dynamics, Inc. assumes no liability for foundation testing and analysis work performed by the bearer of this certificate.

Steven A. Hall, Executive Director
Pile Driving Contractors Association

SEAL

Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 2362

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Pile Dynamics, Inc.

This documents that

Gerzan Nunez
Infrastructure Consulting & Engineering

has on April 13, 2018 achieved the rank of

ADVANCED

on the Dynamic Measurement and Analysis Proficiency Test.

The individual identified on this document demonstrated to the degree granted above an understanding of theory, data quality evaluation, interpretation and signal matching for high strain dynamic testing of deep foundations. ***It is recommended*** **that Individuals at the Advanced level seek Master or Expert levels through additional study within six years of the date of this document.**

The ability of the individual named to provide appropriate knowledge and advice on a specific project is not implied or warranted by the Pile Driving Contractors Association or Pile Dynamics, Inc. **This certificate can be verified at www.PDAproficiencytest.com.** The Pile Driving Contractors Association or Pile Dynamics, Inc. assumes no liability for foundation testing and analysis work performed by the bearer of this certificate.

Frank T. Peters, Executive Director
Pile Driving Contractors Association

PILE DRIVING CONTRACTORS INC. CORPORATE SEAL 1972 OHIO

Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 2490