INFRASTRUCTURE
CONSULTING & ENGINEERING

June 18, 2023

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

Re: **Report of Dynamic Pile Testing**
Bent 2 Pile 30
Bridge 36 - Colonial Life Blvd. Ramp B Bridge over I-126, I-126 Ramp & S-287 (Arrowwood Road)
Project ID: P039718
Richland County, South Carolina

Dear Mr. Hardwick:

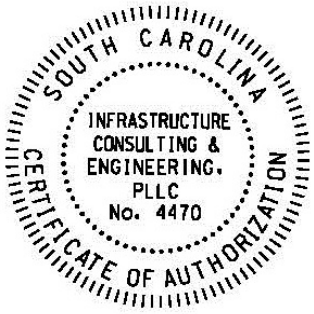
The attached results of dynamic pile testing for the subject pile and project includes measurements and analysis performed by Infrastructure Consulting & Engineering in accordance with ASTM D4945. Measurements were made with the Pile Dynamics, Inc. Model 8G and signal matching analysis was performed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

Also included are the production pile driving recommendations for Bent 2 of the subject project. The Geotechnical Engineer of Record should ultimately make final recommendations for foundation design and construction.

Thank you for the opportunity to provide these services.

Sincerely,
Infrastructure Consulting & Engineering (ICE), PLLC

Michael J Simpson, P.E.
Digitally signed by Michael J Simpson, P.E.
Date: 2023.06.18 14:45:32-04'00'



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

Sally G. Thomson, P.E.
Geotechnical Designer
Certified PDA Signatory "Advanced"

Appendix A

Dynamic Pile Testing, Signal Matching Results, and Calibration WEAP

Bridge 36, Bent 2, Pile 30

INFRASTRUCTURE CONSULTING & ENGINEERING

Summary of Provided Project and Pile Driving Information

Project Description	Colonial Life Blvd. Ramp B Bridge over I-126, I-126 Ramp & S-287 (Arrowwood Road) Richland County, South Carolina
Pile Driving Contractor	Archer United Joint Venture
Project ID	P039718
ICE Field Personnel	Sally G. Thomson, P.E.
ICE Responsible Engineer	Michael J. Simpson, P.E.

Bent Number	**Station**	**Pile Type**	**Pile Batter**	**Hammer Used**	**Pile Cushion Type and Thickness**
Bent 2	32+47.51	HP14x89 with Pile Tip	Plumb	ICE I-19v2	N/A

Pile Number	**Total Pile Length (feet)**	**Pile Length Below Gages (feet)**	**Pile Splice Location(s) above Pile Tip (feet)**	**Initial Drive Test Date**	**Restrike Test Date**
30	35.0	32.7	N/A	6/14/23	N/A

Factored Design Load (kips)	**Geotechnical Resistance Factor**	**Nominal Resistance of Pile (kips)**	**Required Driving Resistance of Pile (kips)**	**Minimum Tip Elevation of Pile (feet)**
360	0.65	554	554	+156.0

Installation Records Provided to ICE	Please Refer to SCDOT Pile Driving Logs
Project Information and Soil Borings Provided to ICE	Yes, Attached in Appendix C
Pile Driving Equipment Data Form Provided to ICE	ICE I-19v2 Data Hammer Sheet Attached in Appendix D
Strain and Accelerometer Calibrations Attached	Yes, Attached in Appendix E

Steel Acceptable Compression Driving Stress Limit (ksi)*	45
Steel Acceptable Tension Driving Stress Limit (ksi)*	45

*For steel piles based on Section 711.4.2.2 and a steel yield strength (Fy) of 50 ksi.

Approximate Reference Elevation (feet)	+183.0
Approximate Ground/Mudline Elevation (feet)	+181.7
Approximate Final Pile Penetration Below Reference at End of Initial Drive (feet)	24.9
Approximate Final Pile Tip Elevation at End of Initial Drive (feet)	+158.1
Approximate Final Pile Penetration Below Reference at End of Restrike (feet)	N/A
Approximate Final Pile Tip Elevation at End of Restrike (feet)	N/A

Additional Notes on Pile Installation
-Pile 30 was monitored with instrumentation 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 the pile was kept by the PDA operator on the PDA during the initial drive. A pile driving log was also maintained by a SCDOT representative.

Summary of Results

Dynamic Pile Testing Results (Detailed Results in Appendix A)

Location*	Capacity (kips)	Case Method	Max. Comp. Stress (ksi)	Avg. Comp. Stress (ksi)	Max. Comp. Stress at Pile Bottom (ksi)	Avg. Comp. Stress at Pile Bottom (ksi)	Avg. Transferred Energy (k-ft)	Avg. Stroke (feet)
EOD	711	RAU	26.3	16.4	34.3	8.8	12.0	6.4

Signal Matching Analyses Results (Detailed Result in Appendix A)

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*
EOD (Blow 283)	714	149 / 565	500	9.3	16.5	0.15	0.14	0.05	0.10	4.82

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

Dynamic Pile Testing Interpretation and Commentary

The capacity listed in the Summary of Dynamic Pile Testing Results is based on the RAU (Auto Capacity End Bearing Piles) solution for the average for the last increment of the initial drive. The summary plot and table attached for the dynamic pile testing results are based on the same capacity solution.

Signal matching analysis was performed for a blow (Blow 283) near the end of the initial drive. The signal matching mobilized capacity near the end of initial drive was above the required driving resistance of 554 kips for Bent 2.

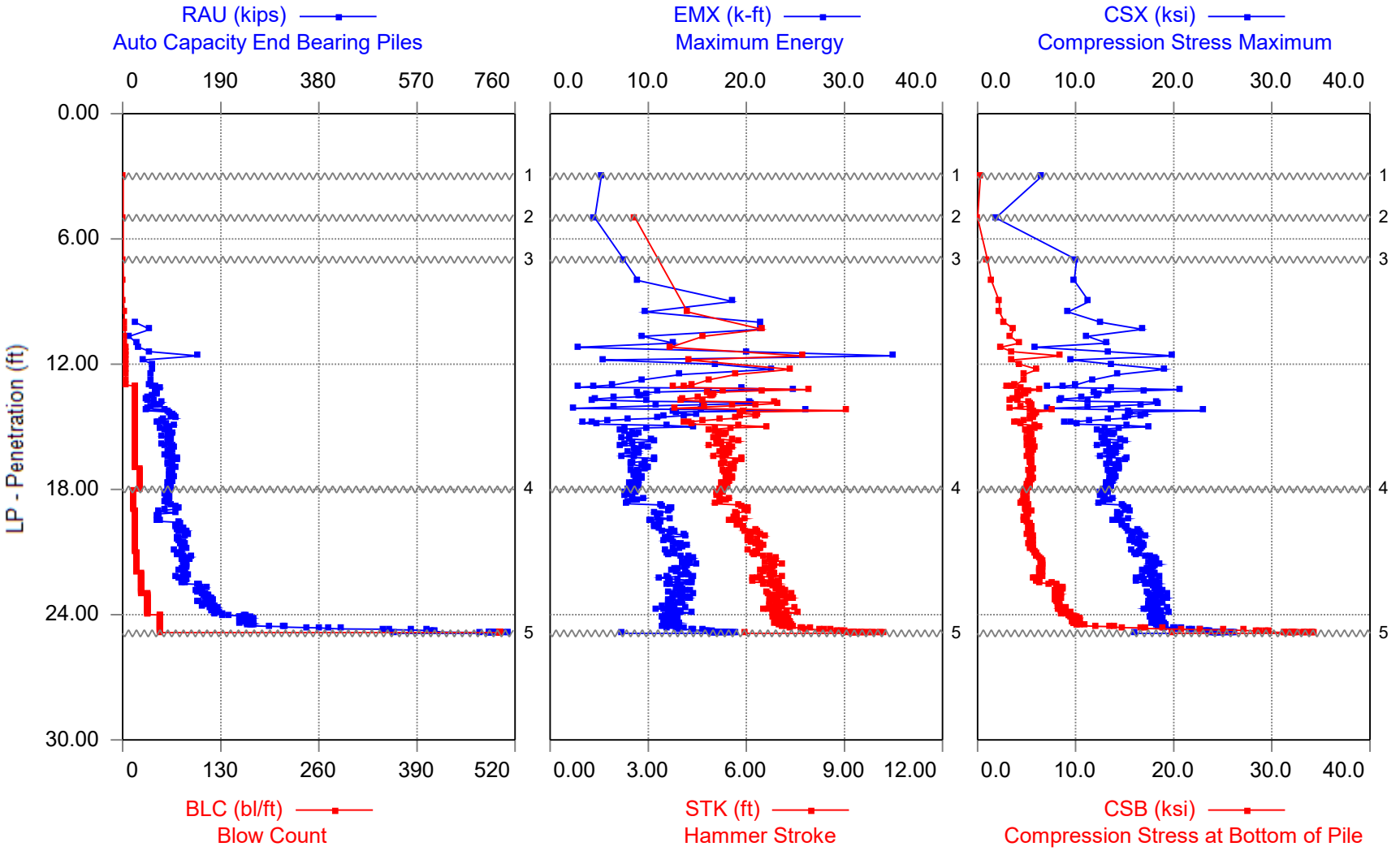
Compression and tension pile driving stresses were below the acceptable limit for the pile tested during the initial drive. The pile tested did not show any signs of integrity problems below the gage locations based on the test results.

Pile Dynamics, Inc. - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results

Printed: 18-June-2023

Test started: 14-June-2023

CCRP1 Bridge 36 Bent 2 Ftg 4 - Pile 30



1 - Reference Template Elevation +183.08

2 - Ground Elevation +181.70

3 - Fuel Setting 2

4 - Fuel Setting 3

5 - Approximately 1/4" set in 10 blows

CCRP1 Bridge 36 Bent 2 Ftg 4 - Pile 30 HP 14x89 w tips
OP: ICE Date: 14-June-2023

AR: 26.10 in² SP: 0.492 k/ft³
LE: 32.67 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.90

RAU: Auto Capacity End Bearing Piles
EMX: Maximum Energy
STK: Hammer Stroke
CSX: Compression Stress Maximum
CSB: Compression Stress at Bottom of Pile
TSX: Tension Stress Maximum - Full Record Search
DMX: Maximum Displacement
DFN: Final Displacement
BTA: Integrity Factor (1)

BL#	Depth	BLC	TYPE	RAU	EMX	STK	CSX	CSB	TSX	DMX	DFN	BTA
	ft	bl/ft		kips	k-ft	ft	ksi	ksi	ksi	in	in	(%)
3	7.00	1	AV3	0	5.8	2.60	6.2	0.4	2.7	24.01	24.01	100.0
			STD	0	1.3	0.00	3.4	0.4	2.2	0.00	0.00	0.0
			MAX	0	7.5	2.60	10.1	1.0	5.5	24.02	24.02	100.0
			@BL	1	3	2	3	3	3	2	2	1
4	8.00	1	AV1	0	9.0	**	9.9	1.4	5.5	12.00	12.00	100.0
			STD	0	0.0	**	0.0	0.0	0.0	0.00	0.00	0.0
			MAX	0	9.0	**	9.9	1.4	5.5	12.00	12.00	100.0
			@BL	4	4	**	4	4	4	4	4	4
5	9.00	1	AV1	0	18.6	**	11.4	2.2	5.4	12.00	12.00	100.0
			STD	0	0.0	**	0.0	0.0	0.0	0.00	0.00	0.0
			MAX	0	18.6	**	11.4	2.2	5.4	12.00	12.00	100.0
			@BL	5	5	**	5	5	5	5	5	5
7	10.00	2	AV2	12	15.6	4.21	10.9	2.5	4.4	6.00	6.00	100.0
			STD	12	5.9	0.00	1.7	0.3	0.5	0.00	0.00	0.0
			MAX	24	21.4	4.21	12.6	2.7	4.9	6.00	6.00	100.0
			@BL	7	7	6	7	7	7	6	6	6
10	11.00	3	AV3	31	14.5	5.59	13.7	3.8	6.6	4.11	4.00	100.0
			STD	17	5.1	0.90	2.3	0.4	1.5	0.15	0.00	0.0
			MAX	53	21.5	6.49	16.8	4.3	8.6	4.33	4.00	100.0
			@BL	8	8	8	8	10	8	8	9	8
15	12.00	5	AV5	65	16.1	5.21	12.5	4.4	4.6	2.83	2.40	100.0
			STD	41	11.5	1.79	4.7	2.1	2.9	0.50	0.00	0.0
			MAX	146	35.0	7.72	19.9	8.5	9.9	3.48	2.40	100.0
			@BL	13	13	13	13	13	13	12	11	11
19	13.00	4	AV4	55	12.9	5.56	13.8	4.9	5.0	3.03	3.00	100.0
			STD	3	6.1	1.14	3.4	0.8	2.2	0.05	0.00	0.0
			MAX	58	22.6	7.36	19.1	6.1	8.4	3.11	3.00	100.0
			@BL	16	16	16	16	16	16	16	19	16
37	14.00	18	AV18	63	11.6	5.32	13.2	4.6	4.2	1.54	0.67	100.0
			STD	8	6.3	1.17	3.7	0.9	2.0	0.71	0.00	0.0
			MAX	77	24.9	7.94	20.8	6.4	8.2	3.09	0.67	100.0
			@BL	34	23	23	23	23	23	23	31	20
88	17.00	17	AV51	89	9.4	5.42	13.8	5.4	3.2	0.90	0.71	100.0
			STD	13	3.5	0.74	2.3	0.6	1.2	0.28	0.00	0.0
			MAX	107	26.2	9.09	23.1	7.7	9.2	2.28	0.71	100.0
			@BL	81	41	41	41	41	41	41	51	38

CCRP1 Bridge 36 Bent 2 Ftg 4 - Pile 30 HP 14x89 w tips
OP: ICE Date: 14-June-2023

BL#	Depth ft	BLC bl/ft	TYPE	RAU kips	EMX k-ft	STK ft	CSX ksi	CSB ksi	TSX ksi	DMX in	DFN in	BTA (%)
111	18.00	23	AV23	94	8.8	5.41	13.6	5.4	2.7	0.78	0.52	100.0
			STD	3	0.4	0.10	0.4	0.2	0.2	0.03	0.00	0.0
			MAX	100	9.8	5.65	14.4	5.7	3.2	0.85	0.52	100.0
			@BL	97	89	89	89	99	89	89	97	89
127	19.00	16	AV16	92	9.5	5.46	13.7	4.9	3.0	0.90	0.75	100.0
			STD	8	1.8	0.34	1.0	0.2	0.5	0.15	0.00	0.0
			MAX	109	12.4	6.05	15.4	5.3	4.0	1.16	0.75	100.0
			@BL	125	125	126	125	123	126	127	114	112
144	20.00	17	AV17	91	11.2	5.83	14.9	5.2	3.8	1.04	0.71	100.0
			STD	21	0.6	0.18	0.6	0.2	0.3	0.08	0.00	0.0
			MAX	125	12.4	6.29	16.4	5.7	4.4	1.20	0.71	100.0
			@BL	144	143	143	143	141	134	134	144	128
161	21.00	17	AV17	116	12.8	6.31	16.4	5.5	3.9	1.03	0.71	100.0
			STD	7	0.7	0.17	0.5	0.2	0.3	0.05	0.00	0.0
			MAX	127	14.0	6.59	17.2	5.8	4.3	1.11	0.71	100.0
			@BL	147	156	148	148	161	156	156	155	145
181	22.00	20	AV20	120	13.5	6.68	17.5	6.4	3.6	0.91	0.60	100.0
			STD	7	0.8	0.24	0.7	0.2	0.3	0.06	0.00	0.0
			MAX	135	15.0	7.12	18.7	6.8	4.1	1.03	0.60	100.0
			@BL	166	173	173	173	173	167	167	171	162
206	23.00	25	AV25	134	13.2	6.79	17.8	7.3	2.6	0.80	0.48	100.0
			STD	18	1.0	0.28	0.7	1.0	0.9	0.10	0.00	0.0
			MAX	163	14.7	7.20	18.9	8.8	4.1	0.98	0.48	100.0
			@BL	199	185	203	203	199	191	191	201	182
239	24.00	33	AV33	171	12.9	7.01	18.3	8.5	1.6	0.66	0.36	100.0
			STD	11	0.9	0.26	0.7	0.3	0.4	0.04	0.00	0.0
			MAX	194	14.6	7.60	19.6	9.5	2.3	0.75	0.36	100.0
			@BL	239	207	236	236	236	207	207	230	207
282	24.86	50	AV43	330	13.1	7.51	19.5	14.5	1.5	0.52	0.24	100.0
			STD	141	1.5	0.68	1.9	7.0	1.1	0.05	0.00	0.0
			MAX	693	17.6	9.48	24.8	31.4	4.2	0.63	0.25	100.0
			@BL	282	282	282	282	282	282	240	280	240
292	24.88	500	AV10	713	16.9	9.30	24.3	32.0	5.0	0.48	0.02	100.0
			STD	2	0.3	0.10	0.3	0.3	0.3	0.01	0.00	0.0
			MAX	718	17.5	9.53	25.0	32.4	5.2	0.49	0.02	100.0
			@BL	292	284	284	284	288	288	284	285	283
302	24.90	500	AV10	711	17.0	9.43	24.5	32.3	4.9	0.48	0.02	100.0
			STD	62	3.3	1.18	2.9	4.2	0.8	0.06	0.00	0.0
			MAX	748	19.0	10.21	26.3	34.3	5.4	0.51	0.03	100.0
			@BL	298	297	301	301	301	300	297	302	293
			Average	176	12.0	6.44	16.4	8.8	3.1	1.26	0.95	100.0
			Std. Dev.	175	3.8	1.30	3.8	7.6	1.5	2.55	2.58	0.0
			Maximum	748	35.0	10.21	26.3	34.3	9.9	24.02	24.02	100.0
			@ Blow#	298	13	301	301	301	13	2	2	1

CCRP1 Bridge 36 Bent 2 Ftg 4 - Pile 30 HP 14x89 w tips
OP: ICE Date: 14-June-2023

BL#	Depth ft	BLC bl/ft	TYPE	RAU kips	EMX k-ft	STK ft	CSX ksi	CSB ksi	TSX ksi	DMX in	DFN in	BTA (%)

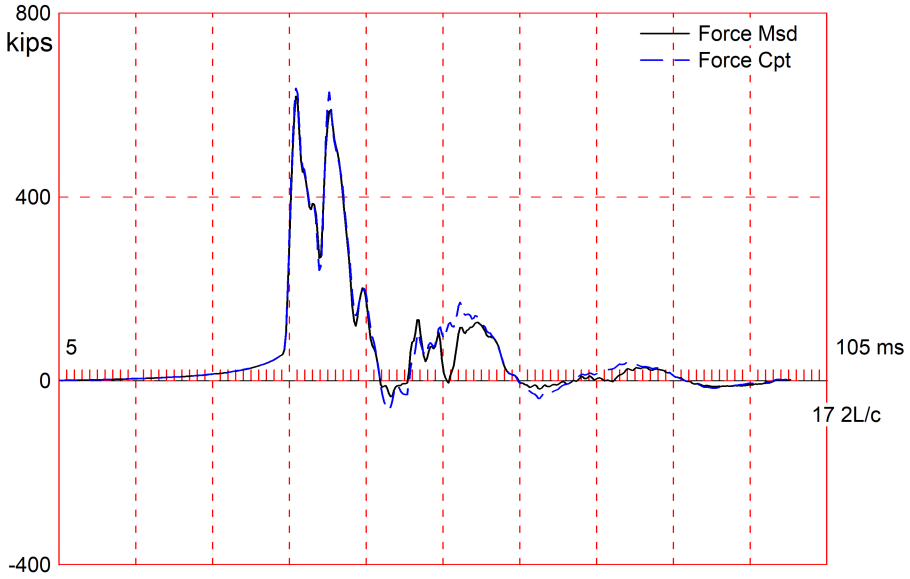
Total number of blows analyzed: 302

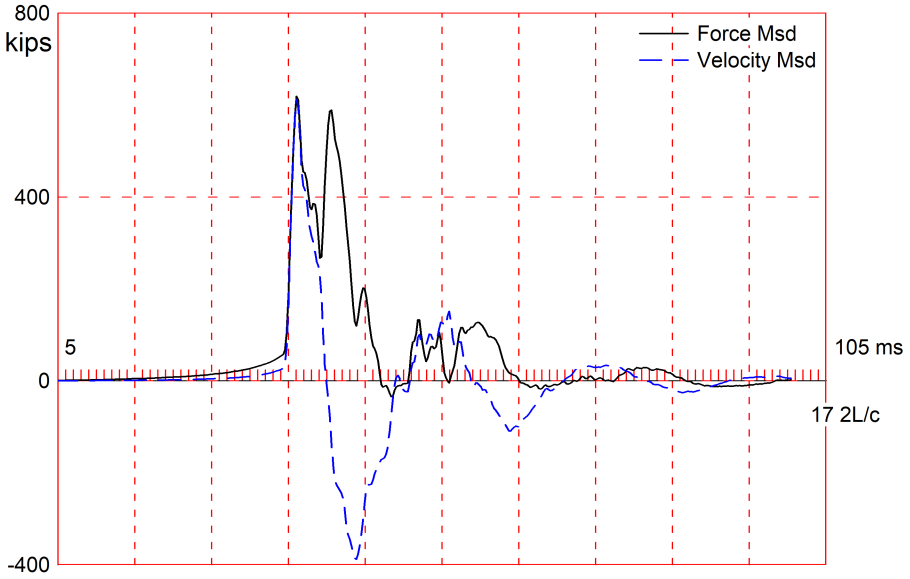
BL#	Sensors
1-302	F7: [P821] 145.1 (1.00); F8: [W877] 94.7 (1.00); A5: [K12389] 483.1 (1.00); A6: [K12388] 451.0 (1.00)

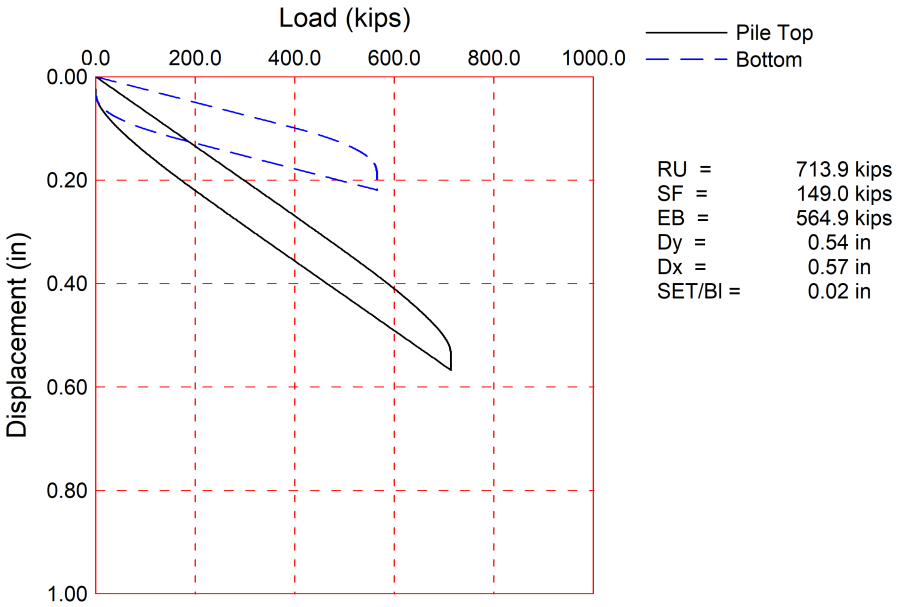
BL#	Comments
1	Reference Template Elevation +183.08
2	Ground Elevation +181.70
3	Fuel Setting 2
111	Fuel Setting 3
302	Approximately 1/4" set in 10 blows

Time Summary

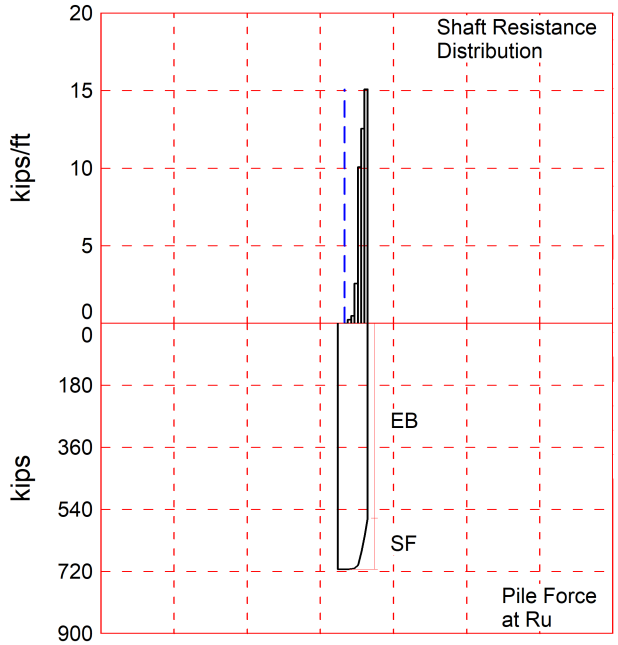
Drive 14 minutes 25 seconds 11:58 PM - 12:12 AM BN 1 - 302







RU =	713.9 kips
SF =	149.0 kips
EB =	564.9 kips
Dy =	0.54 in
Dx =	0.57 in
SET/Bl =	0.02 in



Length b. Sensors	32.7 ft
Embedment	23.5 ft
Top Area	26.1 in^2
End Bearing Area	203.2 in^2
Top Perimeter	4.75 ft
Top E-Modulus	30000 ksi
Top Spec. Weight	492.0 lb/ft^3
Top Wave Spd.	16808 ft/s
Overall W.S.	16808 ft/s
Match Quality	4.82
Top Compr. Stress	24.5 ksi
Max Compr. Stress	31.6 ksi
Max Tension Stress	-4.05 ksi
Avg. Shaft Quake	0.15 in
Toe Quake	0.14 in
Avg. Shaft Smith Dpg.	0.05 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: 713.9; along Shaft 149.0; at Toe 564.9 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
				713.9				
1	10.9	1.7	0.0	713.9	0.0	0.00	0.00	0.00
2	14.5	5.3	0.9	713.0	0.9	0.25	0.05	0.05
3	18.2	9.0	1.8	711.2	2.7	0.50	0.10	0.05
4	21.8	12.6	9.3	701.9	12.0	2.56	0.54	0.05
5	25.4	16.2	36.6	665.3	48.6	10.08	2.12	0.05
6	29.0	19.9	45.6	619.7	94.2	12.56	2.64	0.05
7	32.7	23.5	54.8	564.9	149.0	15.10	3.18	0.05
Avg. Shaft			21.3			6.35	1.33	0.05
Toe			564.9				400.26	0.10

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.15	0.14
Case Damping Factor		0.16	1.21
Damping Type		Viscous	Sm+Visc
Unloading Quake	(% of loading quake)	61	100
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	6	

CAPWAP match quality = 4.82 (Wave Up Match) ; RSA = 0
Observed: Final Set = 0.02 in; Blow Count = 500 b/ft
Computed: Final Set = 0.03 in; Blow Count = 398 b/ft

max. Top Comp. Stress = 24.5 ksi (T= 36.3 ms, max= 1.294 x Top)
max. Comp. Stress = 31.6 ksi (Z= 32.7 ft, T= 38.2 ms)
max. Tens. Stress = -4.05 ksi (Z= 21.8 ft, T= 48.6 ms)
max. Energy (EMX) = 16.5 kip-ft; max. Measured Top Displ. (DMX)= 0.49 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	638.3	-81.0	24.5	-3.10	16.5	12.7	0.46
2	7.3	639.8	-93.3	24.5	-3.57	15.9	12.7	0.43
3	10.9	641.9	-100.0	24.6	-3.83	15.2	12.6	0.40
4	14.5	685.5	-100.8	26.3	-3.86	14.2	12.5	0.36
5	18.2	717.4	-103.5	27.5	-3.97	13.1	12.3	0.33
6	21.8	728.2	-105.6	27.9	-4.05	11.9	12.8	0.29
7	25.4	777.8	-104.5	29.8	-4.01	10.4	13.4	0.25
8	29.0	763.9	-101.3	29.3	-3.88	8.5	11.8	0.21
9	32.7	825.8	-96.4	31.6	-3.69	7.1	8.7	0.17
Absolute	32.7			31.6			(T =	38.2 ms)
	21.8				-4.05		(T =	48.6 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	909.6	839.3	769.1	698.8	628.5					
RX	912.3	848.2	791.8	776.7	764.5	752.3	740.1	727.9	721.6	720.4
RU	914.1	844.7	775.3	705.9	636.5					

RAU = 713.9 (kips); RA2 = 764.8 (kips)

Current CAPWAP Ru = 713.9 (kips); Corresponding J(RP)= 0.56; 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
13.4	36.07	624.4	636.6	636.6	0.49	0.01	0.02	17.0	797.9	4035

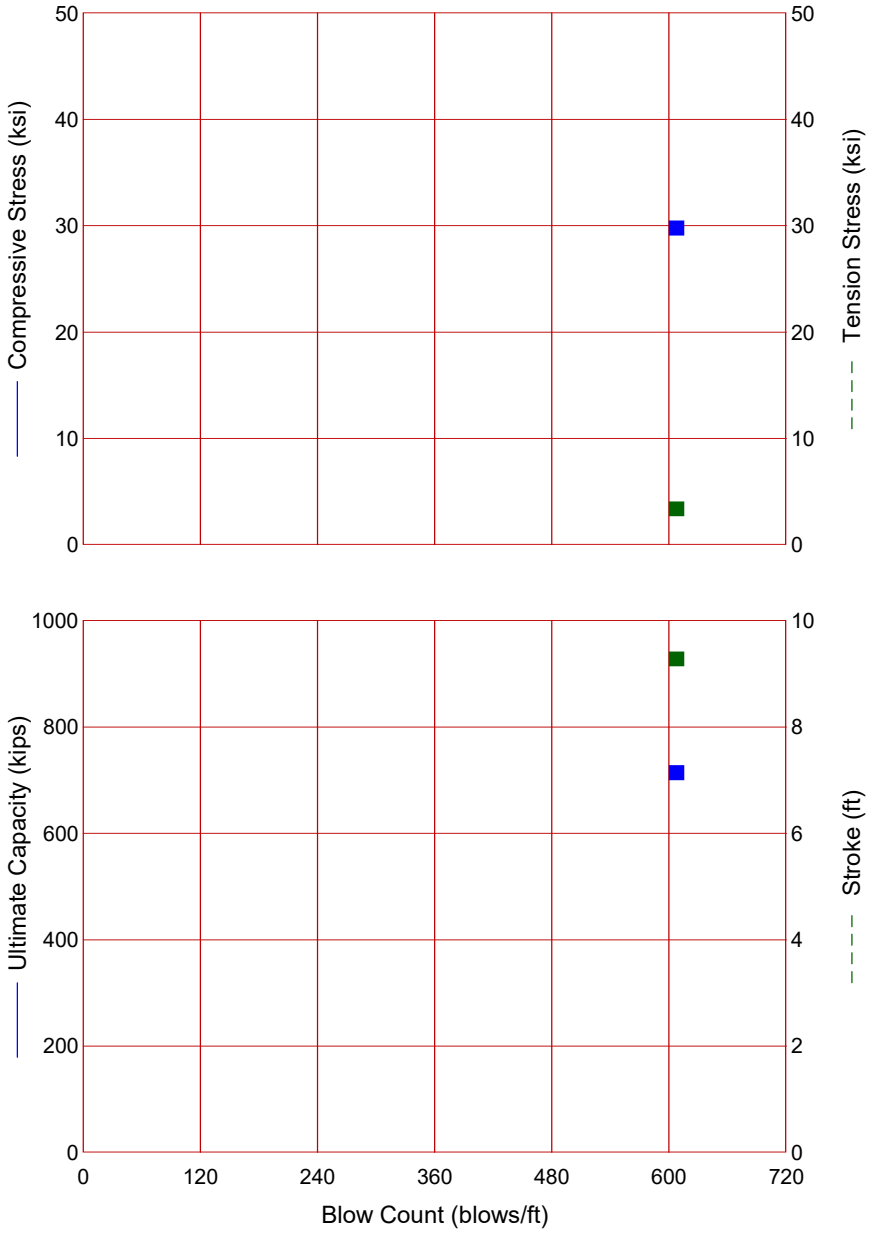
PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.0	26.1	30000.0	492.000	4.75
32.7	26.1	30000.0	492.000	4.75

Toe Area 203.2 in^2

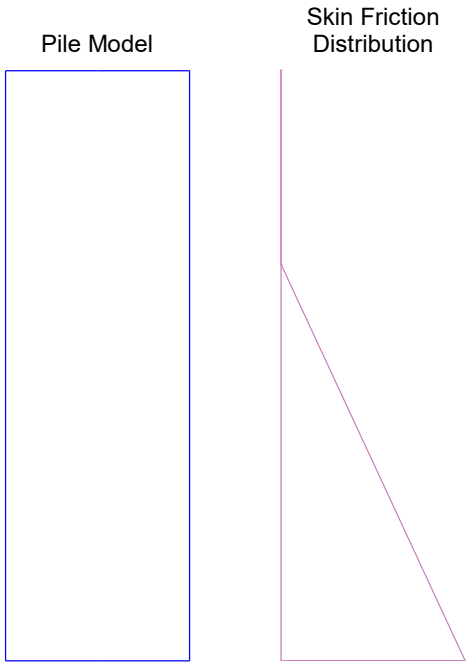
Top Segment Length 3.63 ft, Top Impedance 47 kips/ft/s

Wave Speed: Pile Top 16807.9, Elastic 16807.8, Overall 16807.8 ft/s
Pile Damping 1.00 %, Time Incr 0.216 ms, 2L/c 3.9 ms
Total volume: 5.921 ft^3; Volume ratio considering added impedance: 1.000



ICE I-19v2

Ram Weight	4.01	kips
Efficiency	0.715	
Pressure	1590 (100%)	psi
Helmet Weight	2.31	kips
Hammer Cushion	34825	kips/in
COR of H.C.	0.900	
Skin Quake	0.150	in
Toe Quake	0.140	in
Skin Damping	0.050	s/ft
Toe Damping	0.100	s/ft
Pile Length	35.00	ft
Pile Penetration	23.50	ft
Pile Top Area	26.10	in2



Res. Shaft = 21 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count blows/ft	Stroke ft	Energy kips-ft
714.0	29.77	3.37	608.1	9.28	16.52

Appendix B

Pile Driving Criteria

Bent 2

Recommended Production Pile Driving Criteria

The recommended drive criteria for the up to 35.0 feet long HP 14x89 steel piles with pile points in Bent 2 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 project pile installation plan, 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.

Bent 2

The up to 35-foot HP 14x89 steel piles with pile points at Bent 2 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 while driving on Fuel Setting 3 or 4.

1. Practical refusal (20 blows per one inch or ½ inch in 10 blows with at least a stroke of 8.5 feet) is reached during driving.
2. The following 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
9.0	5/8	172
9.5	7/8	134
10.0 or greater	1	120

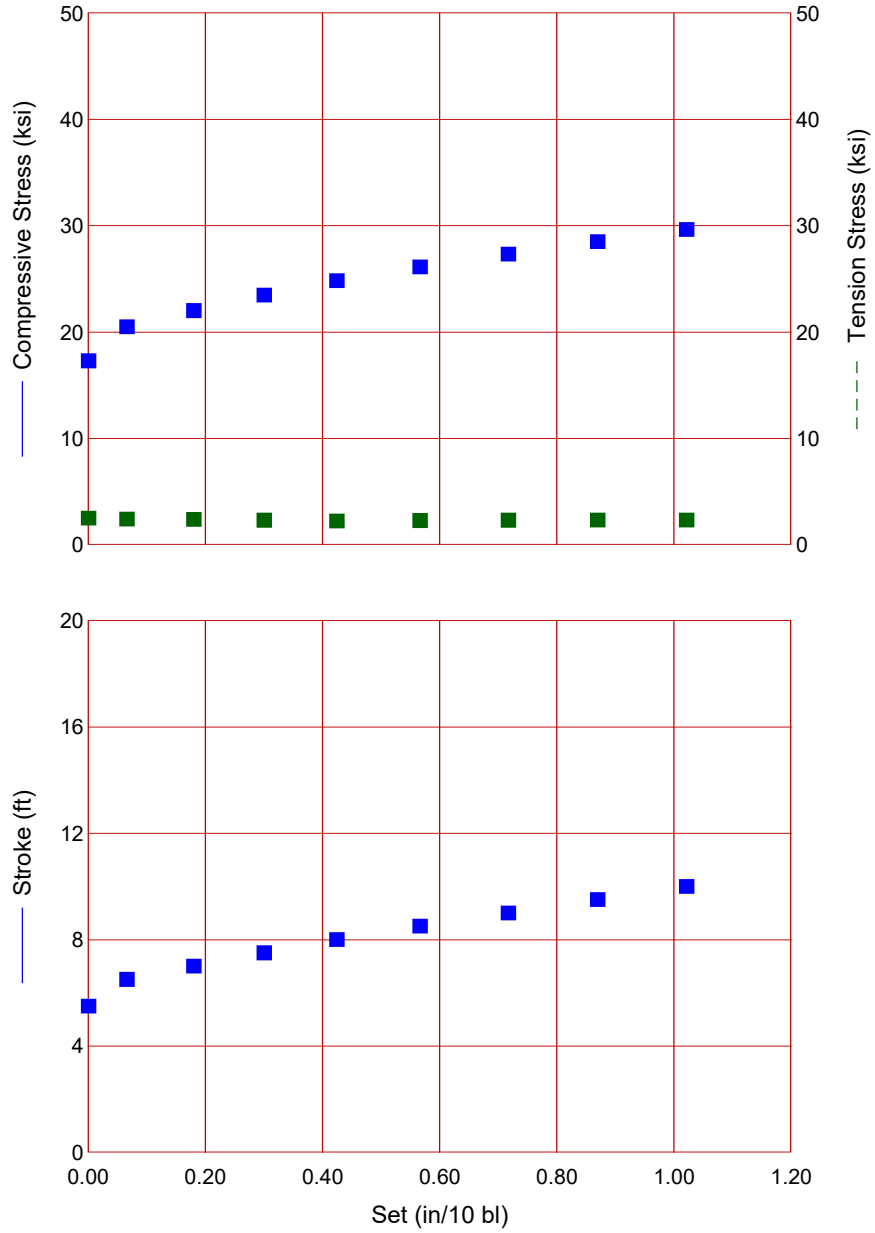
Piles not meeting the above requirements or minimum tip elevation should be brought to the Engineer's attention and may require additional testing and/or driving to meet the requirements.

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.

ICE of Carolinas, PLLC
CCR 1 Bridge 36 BT2 Criteria

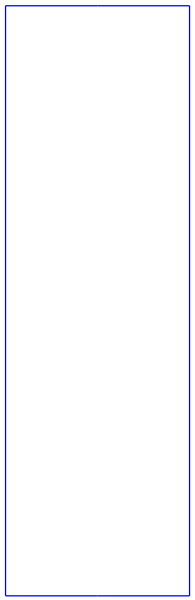
18-Jun-2023
GRLWEAP Version 2010



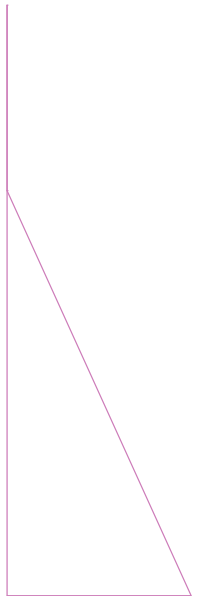
ICE I-19v2

Capacity	554.0	kips
Ram Weight	4.01	kips
Efficiency	0.700	
Pressure	1590 (100%)	psi
Helmet Weight	2.31	kips
Hammer Cushion	34825	kips/in
COR of H.C.	0.900	
Skin Quake	0.150	in
Toe Quake	0.140	in
Skin Damping	0.050	s/ft
Toe Damping	0.100	s/ft
Pile Length	35.00	ft
Pile Penetration	24.00	ft
Pile Top Area	26.10	in2

Pile Model



Skin Friction Distribution



Res. Shaft = 21 %
(Proportional)

ICE of Carolinas, PLLC
CCR 1 Bridge 36 BT2 Criteria

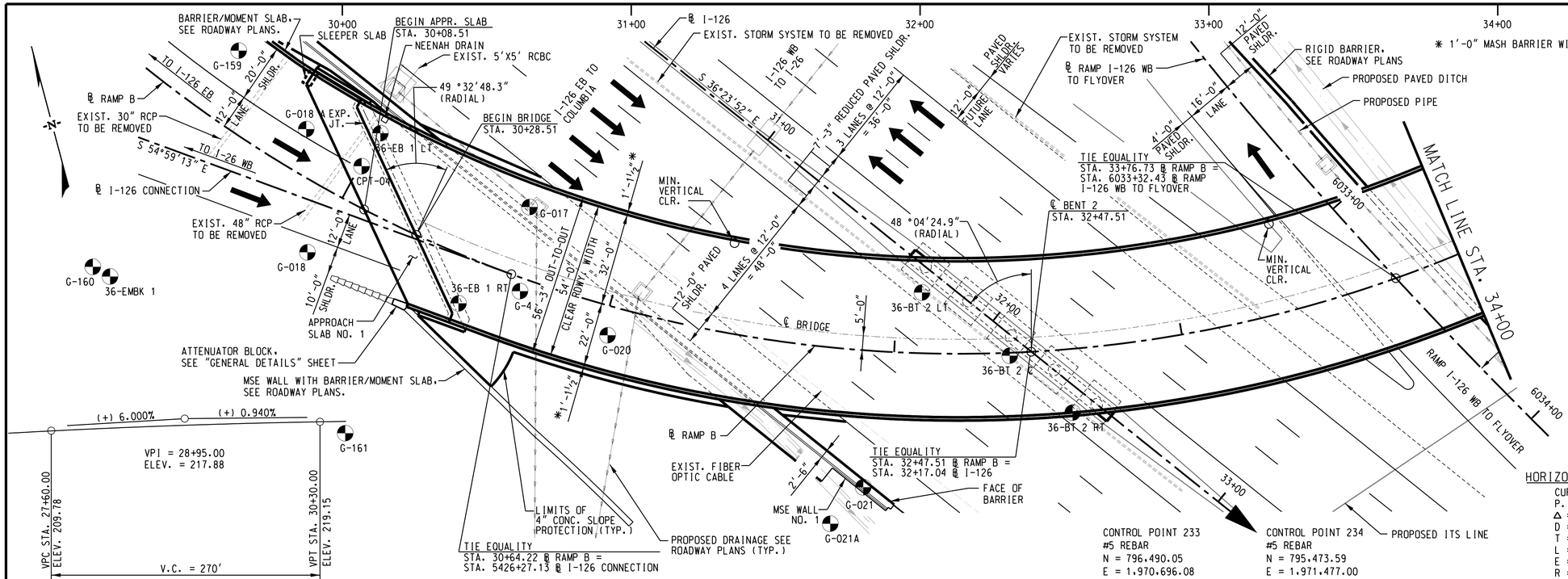
18-Jun-2023
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Set in/10 bl	Stroke ft	Energy kips-ft
554.0	17.29	2.50	0.0	5.50	6.71
554.0	18.95	2.46	0.0	6.00	7.99
554.0	20.49	2.41	0.1	6.50	9.24
554.0	22.00	2.38	0.2	7.00	10.52
554.0	23.46	2.30	0.3	7.50	11.83
554.0	24.82	2.23	0.4	8.00	13.12
554.0	26.10	2.27	0.6	8.50	14.45
554.0	27.32	2.29	0.7	9.00	15.79
554.0	28.50	2.31	0.9	9.50	17.13
554.0	29.63	2.30	1.0	10.00	18.49

Appendix C

Project Information and Nearby Soil Borings

BRIDGE PLANS ID	SHEET NO.
P039718-B36	16



PLAN

NOTES:

DECK DRAINS AS NOTED.

SKEW ANGLE AT END BENT 1 IS MEASURED AT BEGIN BRIDGE.

TEST BORING LOCATIONS

BORING	STATION	OFFSET
G-4	30+69.00	4.5' RT
G-015	29+01.86	45.2' LT
G-017	30+62.00	24.0' LT
G-018	29+98.34	22.3' RT
G-018 A	29+76.91	14.5' LT
G-020	31+02.00	10.0' RT
G-021	31+92.44	47.3' RT
G-021 A	31+83.14	60.8' RT
G-159	29+40.84	24.2' LT
G-160	29+43.37	66.0' RT
G-161	30+34.03	72.7' RT
36-EMBK 1	29+49.32	65.3' RT
36-EB 1 LT	30+01.00	26.0' LT
36-EB 1 RT	30+51.00	16.0' LT
36-BT 2 LT	32+09.00	21.0' LT
36-BT 2 RT	32+60.00	22.0' RT
36-BT 2 C	32+40.00	1.0' RT
CPT-04	30+00.66	12.9' LT

SOME TEST BORING LOCATIONS FALL OUTSIDE OF BRIDGE PLAN VIEW.

STATIONS AND OFFSETS ARE REFERENCED TO PROPOSED ℄ RAMP B.

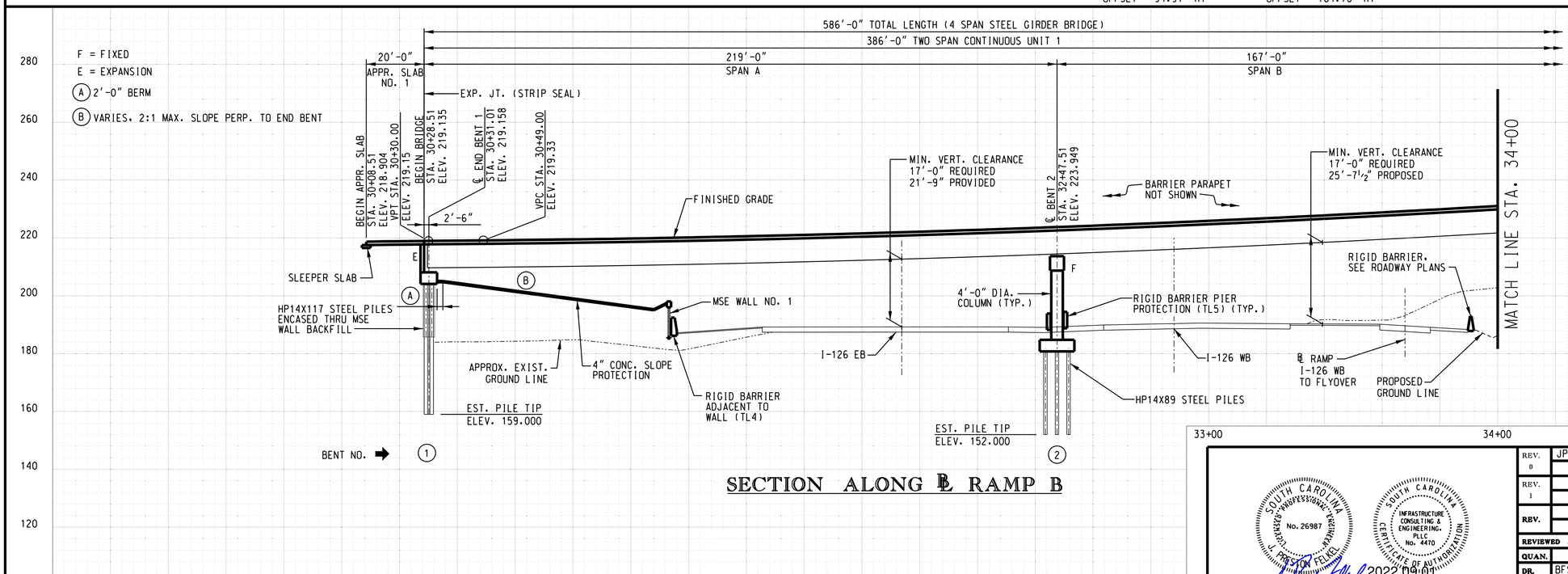
VERTICAL GRADE DATA

CONTROL POINT 233
#5 REBAR
N = 796,490.05
E = 1,970,696.08
ELEV. = 180.74
STA. = 26+31.82 (I-126)
OFFSET = 94.91' RT

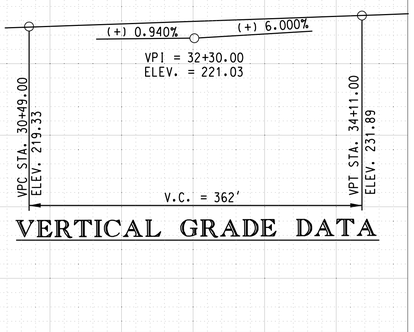
CONTROL POINT 234
#5 REBAR
N = 795,473.59
E = 1,971,477.00
ELEV. = 202.62
STA. = 39+00.89 (I-126)
OFFSET = 104.76' RT

HORIZONTAL CURVE DATA

CURVE COLRB-3
P.I. = 33+13.04
Δ = 82° 31' 32.14" (LT)
D = 12° 43' 56.62"
T = 394.82'
L = 648.15'
E = 148.65'
R = 450.00'
D.S. = 40 MPH
eMAX = 8.0%
e = 8.0%



SECTION ALONG ℄ RAMP B



VERTICAL GRADE DATA

ARCHER UNITED JOINT VENTURE — UNITED INFRASTRUCTURE GROUP

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

BRIDGE PLAN AND PROFILE (1)

COLONIAL LIFE BLVD. RAMP B BRIDGE OVER I-126, I-126 RAMP & S-287 (ARROWWOOD ROAD)

COUNTY	ROUTE
RICHLAND	RAMP B

REV.	BY	CHK.	DATE
0	JPF		09-01-22
	RFC PLANS		
1			
REV.			
REVIEWED	J. FELKEL		
QUAN.			
DR.	BFS	DKY	04-22
DES.	CSB	DKY	04-22

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26987 J. PRESTON FELKEL

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

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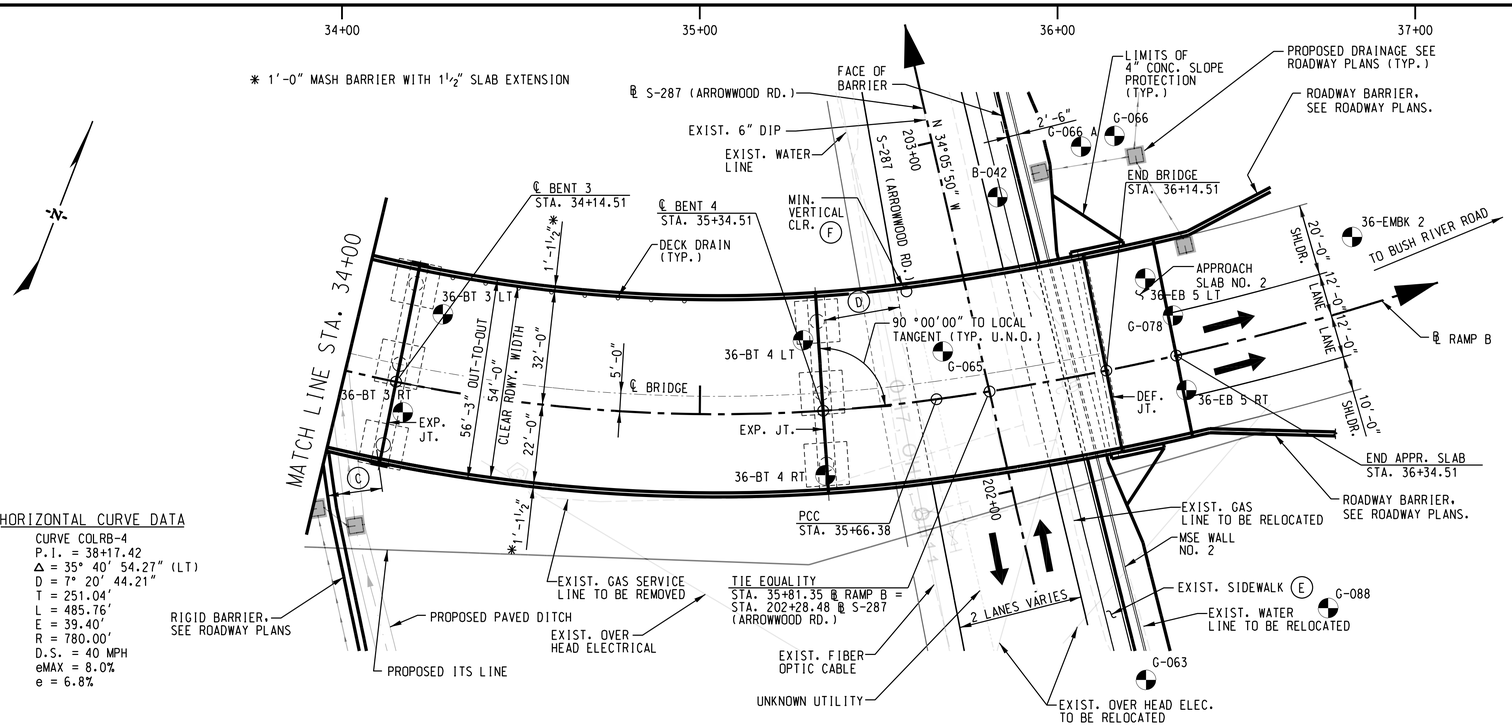


HORIZONTAL CURVE DATA

CURVE COLRB-4
P.I. = 38+17.42
Δ = 35° 40' 54.27" (LT)
D = 7° 20' 44.21"
T = 251.04'
L = 485.76'
E = 39.40'
R = 780.00'
D.S. = 40 MPH
eMAX = 8.0%
e = 6.8%

PLAN

NOTES:

U.N.O. = UNLESS NOTED OTHERWISE.

DECK DRAINS AS NOTED.

SKEW ANGLE AT END BENT 5 IS MEASURED AT END BRIDGE.

(C) 27'-4½" MIN. HORIZONTAL CLEARANCE

(D) 21'-4 13/16" MIN. HORIZONTAL CLEARANCE

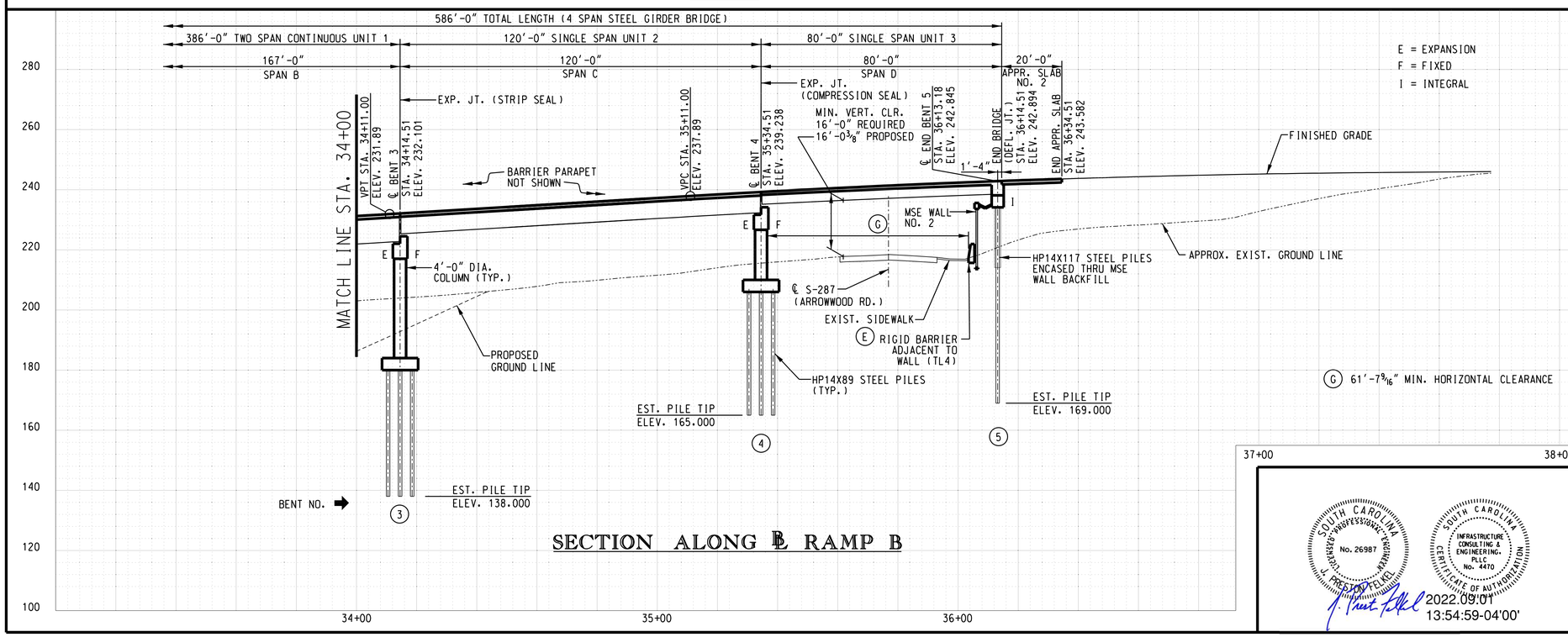
(E) EXISTING SIDEWALK TO REMAIN OR BE RECONSTRUCTED. SEE ROADWAY PLANS.

(F) STA. 35+61.83, OFFSET = 30' LT. (℄ RAMP B) EXISTING ARROWWOOD PAVEMENT ELEV. 218.657

TEST BORING LOCATIONS

BORING	STATION	OFFSET
B-042	35+92.76	53.3' LT.
G-078	36+36.11	11.1' LT.
G-088	36+57.90	78.6' RT.
G-063	36+09.00	87.0' RT.
G-065	35+70.00	13.0' LT.
G-066	36+31.02	63.7' LT.
G-066 A	36+20.39	62.7' LT.
36-BT 3 LT	34+24.00	21.0' LT.
36-BT 3 RT	34+18.00	8.0' RT.
36-BT 4 LT	35+30.00	20.0' LT.
36-BT 4 RT	35+34.00	18.0' RT.
36-EB 5 LT	36+30.73	23.0' LT.
36-EB 5 RT	36+35.14	10.0' RT.
36-EMBK 2	36+91.29	19.4' LT.

STATIONS AND OFFSETS ARE REFERENCED TO PROPOSED ℄ RAMP B.



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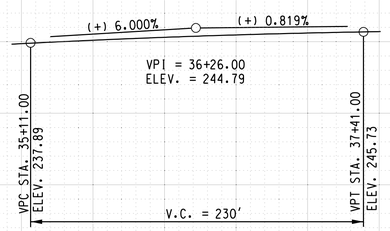

VERTICAL GRADE DATA

ARCHER UNITED JOINT VENTURE — UNITED INFRASTRUCTURE GROUP

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

BRIDGE PLAN AND PROFILE (2)

COLONIAL LIFE BLVD. RAMP B BRIDGE OVER I-126, I-126 RAMP & S-287 (ARROWWOOD ROAD)

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26987 J. PRESTON FELKEL

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

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REV.			
REVIEWED	J. FELKEL		
QUAN.			
DR.	BFS	DKY	04-22
DES.	CSB	DKY	04-22
	BY	CHK.	DATE

COUNTY: RICHLAND

ROUTE: RAMP B

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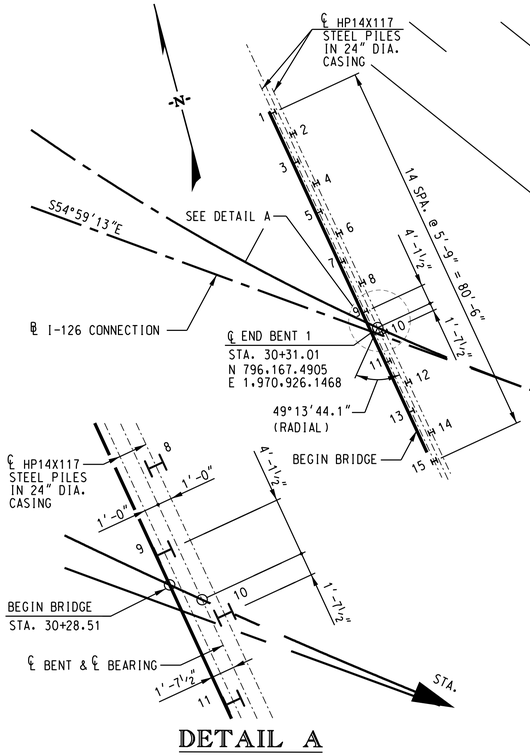
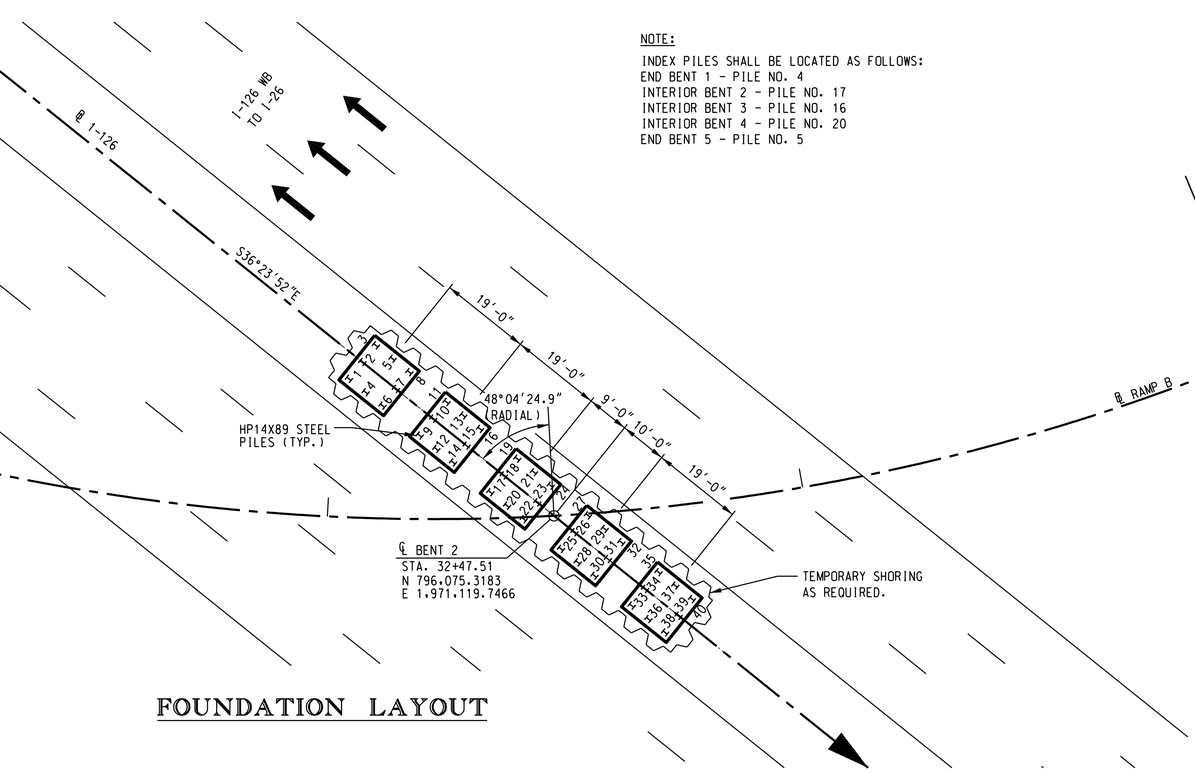


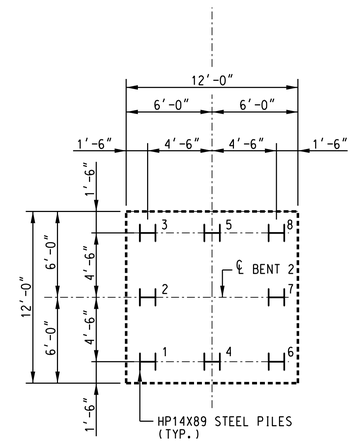
DETAIL A



FOUNDATION LAYOUT

NOTE:

INDEX PILES SHALL BE LOCATED AS FOLLOWS:
END BENT 1 - PILE NO. 4
INTERIOR BENT 2 - PILE NO. 17
INTERIOR BENT 3 - PILE NO. 16
INTERIOR BENT 4 - PILE NO. 20
END BENT 5 - PILE NO. 5



TYPICAL PILE LAYOUT AT BENT 2

FOOTING NO. 1 SHOWN.
FOOTING NO. 2 THRU 5 SIMILAR

GENERAL NOTES - PILE BEARING:

BENT I.D.	END BENT 1	INT. BENT 2	INT. BENT 3	INT. BENT 4	END BENT 5
PILE SECTION	HP14X117	HP14X89	HP14X89	HP14X89	HP14X117
CONTROL LIMIT STATE	STRENGTH	STRENGTH	STRENGTH	STRENGTH	STRENGTH
FACTORED DESIGN LOAD (KIPS)	477	360	345	273	338
GEOTECHNICAL RESISTANCE FACTOR	0.65	0.65	0.65	0.65	0.65
NOMINAL RESISTANCE (KIPS)	734	554	531	420	520
LIQUEFACTION INDUCED DOWNDRAG (KIPS)	0	0	0	0	0
SETTLEMENT INDUCED UNFACTORED DOWNDRAG (KIPS)	0	0	0	0	0
SETTLEMENT INDUCED FACTORED DOWNDRAG (KIPS)	0	0	0	0	0
REQUIRED DRIVING RESISTANCE (KIPS)	734	554	531	420	520
REQUIRED MINIMUM TIP ELEVATION TO ACHIEVE LATERAL STABILITY (FEET MSL)	164	156	163	187	202
ESTIMATED PILE TIP ELEVATION (FEET MSL)	159	152	138	165	169

Initially drive End Bent 1 and End Bent 5 piles to at least the required minimum tip elevation and no deeper than tip elevation 164 at End Bent 1 and 185 at End Bent 5 before MSE wall and bridge embankment construction.

Method of controlling installation of piles and verifying their resistance: Resistance and stresses will be verified by Pile Driving Analyzer (PDA) and CAPWAP analysis of index piles during driving. A Pile Installation Chart developed from the analysis will be used to verify the resistance of production piles.

Perform Pile Driving Analyzer (PDA) testing on one (1) index pile per Bent. An index pile shall be the first pile driven at each required bent location. Include an additional two feet of (HP14x117 or HP14x89) length to accommodate the initial PDA testing. If a CAPWAP analysis determines that capacity has not been achieved, restrike one of the production piles. Perform the restrike on the production pile exhibiting the least blows per foot. On initial drive, piles shall be stopped at the highest allowable finished grade on the plans to accommodate a restrike while remaining within an allowable plan finished grade elevation. Perform PDA testing during the restrike. The Geotechnical Engineer of Record will determine the time between initial driving and any required restrikes.

PDA testing is only required during final driving at End Bent 1 and End Bent 5.

Reinforced pile tips are required to penetrate partially weathered rock at all bents. Install the reinforced pile tips in accordance with the manufacturer's installation recommendations.

The top of partially weathered rock elevation may vary across each bent and result in varying pile lengths. Practical refusal of a pile is defined as 20 blows per inch.

If required minimum tip elevation cannot be achieved by driving alone, predrill pile locations at End Bent 1 to an elevation no lower than 164 feet with equipment that will result in a maximum predrilling diameter of 20". For predrilling for piles, see section 711.4.5.2 of the Standard Specifications.

Drive piles at End Bent 1 and 5 to a minimum pile movement of 0.5 inches during final driving to negate any induced downdrag loads from prior MSE wall settlement.

Reference the Standard Specifications for Highway Construction for Driven Pile Foundations, Section 711. Notes included in these plans are in addition to the requirements of the Standard Specifications.

The following estimated parameters were used for performing a drivability analysis for End Bent 1, Interior Bents 2 thru 4, & End Bent 5:

DRIVABILITY ANALYSIS

BENT I.D.	END BENT 1	INT. BENT 2	INT. BENT 3	INT. BENT 4	END BENT 5
SKIN QUAKE (QS)	0.10 in	0.10 in	0.10 in	0.10 in	0.10 in
TOE QUAKE (QT)	0.10 in	0.10 in	0.10 in	0.10 in	0.10 in
SKIN DAMPING (SD)	0.20 s/ft	0.20 s/ft	0.20 s/ft	0.20 s/ft	0.20 s/ft
TOE DAMPING (TD)	0.15 s/ft	0.15 s/ft	0.15 s/ft	0.15 s/ft	0.15 s/ft
% SKIN FRICTION	3%	15%	20%	40%	18%
DISTRIBUTION SHAPE NO.	0	0	0	0	0
PILE INSTALLATION CHART	PROPORTIONAL	PROPORTIONAL	PROPORTIONAL	PROPORTIONAL	PROPORTIONAL
PILE PENETRATION	26%	83%	86%	85%	58%
HAMMER ENERGY RANGE	60 to 90 kip-ft	40 to 80 kip-ft	40 to 80 kip-ft	40 to 80 kip-ft	40 to 80 kip-ft

Note: GRLWEAP 2010-7 was used to perform the wave equation analysis.

A pile hammer having the rated energy as indicated above is considered suitable for driven pile installation. However, final hammer approval is based on a wave equation analysis that accurately reflects the Contractor's proposed driving system.

The Contractor shall retain a geotechnical engineering firm to perform the pre-construction condition assessment and Earth-borne Vibration Monitoring in accordance with the RFP.

SCDOT Supplemental Technical Specification SC-M-713 (01/19) shall apply to the project except as modified herein.

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26987 J. FRANK FELKEL
SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION
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REV.			
0	JPF	09-01-22	
	RFC PLANS		
REV. 1			
REV.			
REVIEWED	J. FELKEL		
QUAN.			
DR.	BFS	DKY	05-22
DES.	VD	DVW	05-22
	BY	CHK.	DATE

ARCHER UNITED JOINT VENTURE UNITED INFRASTRUCTURE GROUP
INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

FOUNDATION LAYOUT (1)

COLONIAL LIFE BLVD. RAMP B BRIDGE OVER I-126, I-126 RAMP & S-287 (ARROWWOOD ROAD)

COUNTY RICHLAND | ROUTE RAMP B

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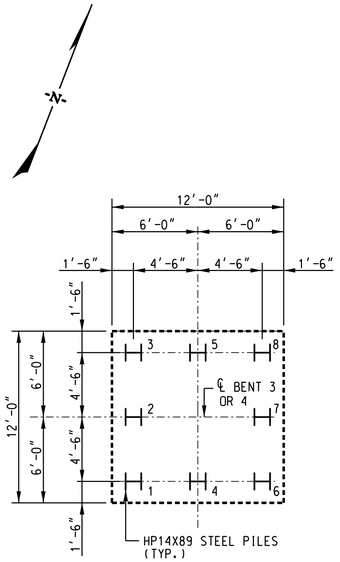
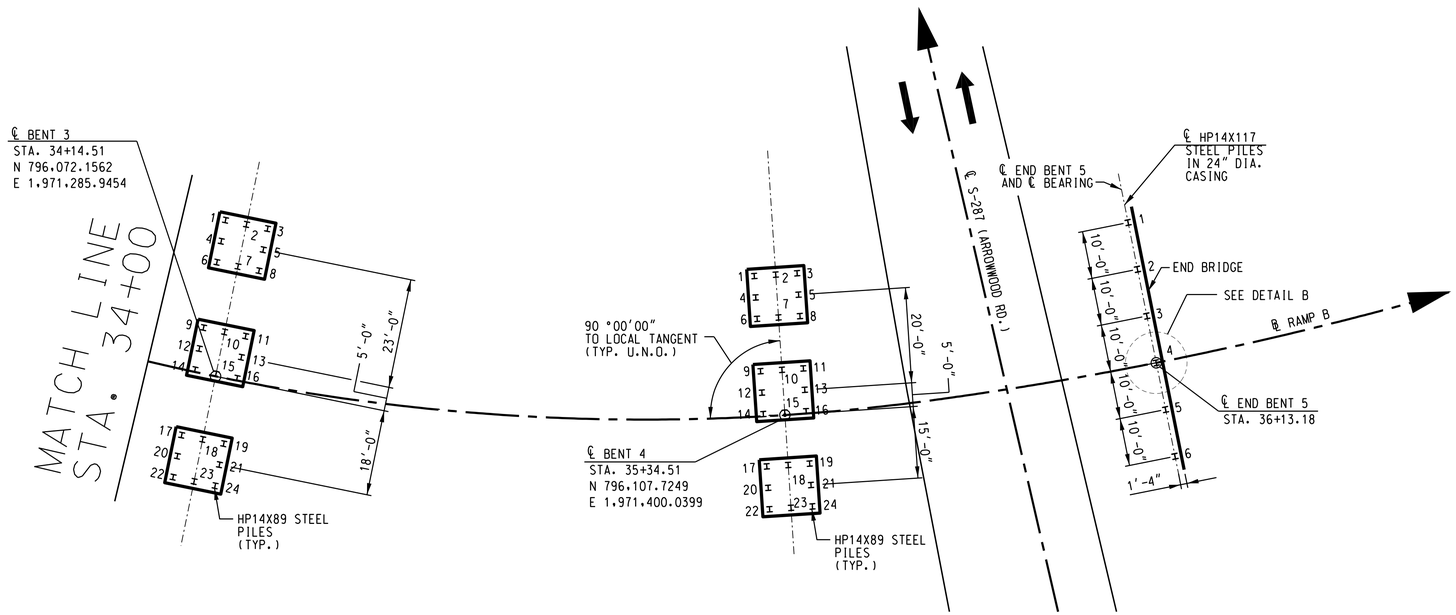
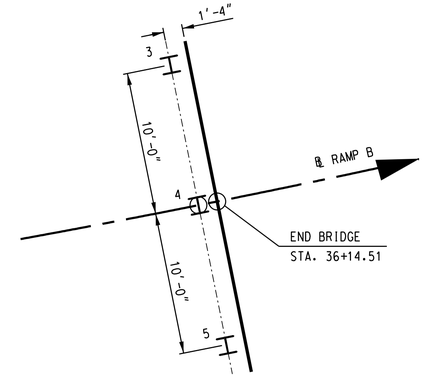


TYPICAL PILE LAYOUT AT BENT 3 AND 4

FOOTING NO. 1 SHOWN.
FOOTING NO. 2 AND NO.3 SIMILAR



FOUNDATION LAYOUT



DETAIL B

Temporary Shoring Notes:

Designer shall determine appropriate water level and consider all unbalanced water forces in design. Design shall accommodate live loading. Use the following soil strength parameters for determining earth pressure coefficients.

Temporary Shoring Wall Soil Design Parameters

	Elevation Top/Bottom	Stress State	Internal Friction, φ (deg)	Cohesion, c (psf)
Roadway Embankment/ Alluvial	189	Total	0	500
	176	Effective	32	0
Coastal Plain	176	Total	18	700
	159	Effective	34	100
Residual	159	Total	0	1800
	156	Effective	30	0

ARCHER UNITED JOINT VENTURE — UNITED INFRASTRUCTURE GROUP

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26987 J. TRENT FELKEL

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

J. Trent Felkel 2022.09.07 13:57:32-04'00'

REV. 0	JPF	09-01-22	RFC PLANS	
REV. 1				
REV.				
REVIEWED	J. FELKEL			
QUAN.				
DR.	BFS	DKY	05-22	
DES.	VD	DVW	05-22	
	BY	CHK.	DATE	

FOUNDATION LAYOUT (2)

COLONIAL LIFE BLVD. RAMP B BRIDGE OVER I-126, I-126 RAMP & S-287 (ARROWWOOD ROAD)

COUNTY RICHLAND

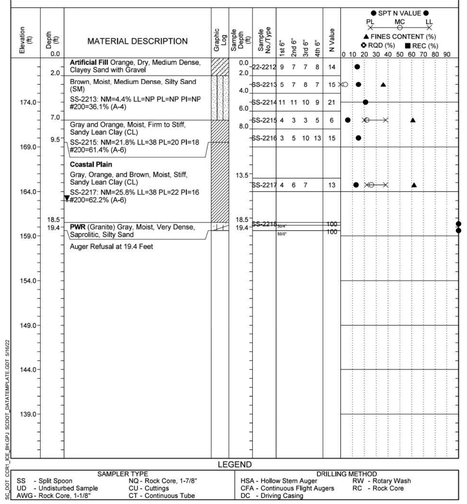
ROUTE RAMP B

T:\Projects\20-61CCR Phase I\Structures\BR_36\FinalPlans\28_BRIDGE 36_FOUNDATION LAYOUT (2).dgn
9/1/2022
10:03:47 AM

BRIDGE PLANS ID	SHEET NO.
P039718-B36	20

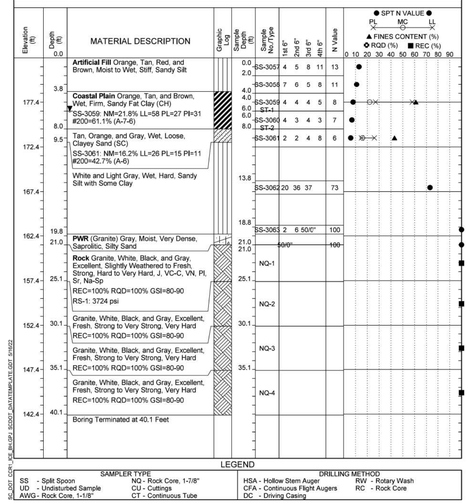
INFRASTRUCTURE CONSULTING & ENGINEERING

Project ID:	P039718	**County:**	Richland	**Boring No.:**	36-Embk-1		
Site Description:	Carolina Crossroads Phase 1 - Bridge 36			**Route:**	Bridge 36		
Eng./Geo.:	MS	**Boring Location:**	29+49	**Offset:**	65 RT	**Alignment:**	COLRB
Elev.:	179.0 ft	**Latitude:**	34.02168711	**Longitude:**	-81.09389358	**Date Started:**	11/10/2021
Total Depth:	19.4 ft	**Soil Depth:**	19.4 ft	**Core Depth:**	NA ft	**Date Completed:**	11/10/2021
Bore Hole Diameter (in):	2.25	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	D-50 #0439	**Drill Method:**	HSA	**Hammer Type:**	Automatic	**Energy Ratio:**	91%
Core Size:	NA	**Driller:**	R. Cassell	**Groundwater:**	TOB 16.1 ft	**24HR**	16.0 ft



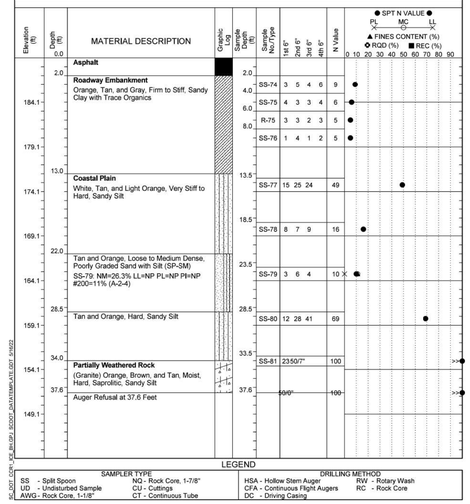
INFRASTRUCTURE CONSULTING & ENGINEERING

Project ID:	P039718	**County:**	Richland	**Boring No.:**	36-End Bent 1 RT		
Site Description:	Carolina Crossroads Phase 1 - Bridge 36			**Route:**	Bridge 36		
Eng./Geo.:	CM & NM	**Boring Location:**	30+51	**Offset:**	16 RT	**Alignment:**	COLRB
Elev.:	182.4 ft	**Latitude:**	34.02151348	**Longitude:**	-81.09593049	**Date Started:**	11/15/2021
Total Depth:	40.1 ft	**Soil Depth:**	21.0 ft	**Core Depth:**	19.1 ft	**Date Completed:**	11/16/2021
Bore Hole Diameter (in):	2.25	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	D-50 #0435	**Drill Method:**	Casing w/ Adv	**Hammer Type:**	Automatic	**Energy Ratio:**	84%
Core Size:	NQ2	**Driller:**	M. Morgan	**Groundwater:**	TOB NM	**24HR**	6.0 ft



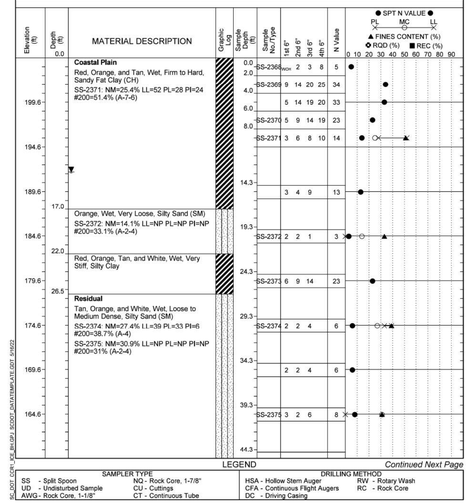
INFRASTRUCTURE CONSULTING & ENGINEERING

Project ID:	P039718	**County:**	Richland	**Boring No.:**	36-Bent 2 C		
Site Description:	Carolina Crossroads Phase 1 - Bridge 36			**Route:**	Bridge 36		
Eng./Geo.:	CM	**Boring Location:**	32+40	**Offset:**	1 RT	**Alignment:**	COLRB
Elev.:	189.1 ft	**Latitude:**	34.02132833	**Longitude:**	-81.09533669	**Date Started:**	2/3/2022
Total Depth:	37.6 ft	**Soil Depth:**	37.6 ft	**Core Depth:**	NA ft	**Date Completed:**	2/3/2022
Bore Hole Diameter (in):	2.25	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	D-50 #0435	**Drill Method:**	HSA	**Hammer Type:**	Automatic	**Energy Ratio:**	84%
Core Size:	NA	**Driller:**	M. Morgan	**Groundwater:**	TOB 14.5 ft	**24HR**	FIAD



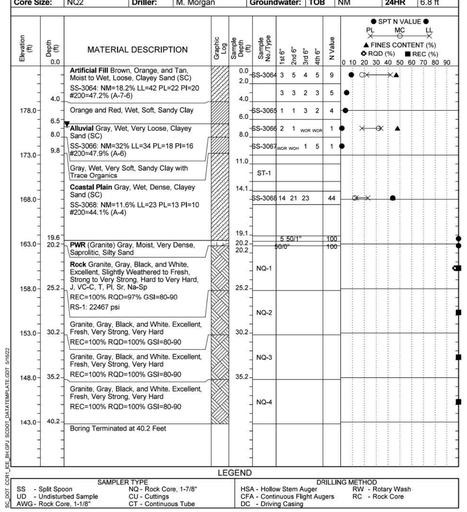
INFRASTRUCTURE CONSULTING & ENGINEERING

Project ID:	P039718	**County:**	Richland	**Boring No.:**	36-Bent 3 LT		
Site Description:	Carolina Crossroads Phase 1 - Bridge 36			**Route:**	Bridge 36		
Eng./Geo.:	CM & NM	**Boring Location:**	34+24	**Offset:**	21 LT	**Alignment:**	COLRB
Elev.:	204.6 ft	**Latitude:**	34.02138011	**Longitude:**	-81.09474598	**Date Started:**	12/8/2021
Total Depth:	85.4 ft	**Soil Depth:**	64.3 ft	**Core Depth:**	20.4 ft	**Date Completed:**	12/9/2021
Bore Hole Diameter (in):	2.25	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	D-50 #0439	**Drill Method:**	Casing w/ Adv	**Hammer Type:**	Automatic	**Energy Ratio:**	91%
Core Size:	NQ2	**Driller:**	R. Cassell	**Groundwater:**	TOB NM	**24HR**	12.8 ft



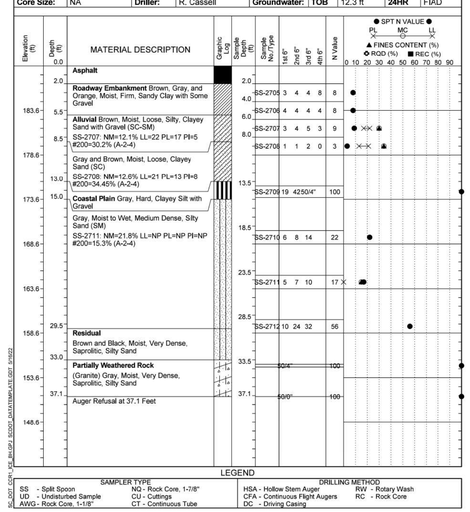
INFRASTRUCTURE CONSULTING & ENGINEERING

Project ID:	P039718	**County:**	Richland	**Boring No.:**	36-Bent 1 LT		
Site Description:	Carolina Crossroads Phase 1 - Bridge 36			**Route:**	Bridge 36		
Eng./Geo.:	CM & NM	**Boring Location:**	30+01	**Offset:**	26 LT	**Alignment:**	COLRB
Elev.:	183.0 ft	**Latitude:**	34.02168598	**Longitude:**	-81.09596711	**Date Started:**	11/16/2021
Total Depth:	40.2 ft	**Soil Depth:**	20.2 ft	**Core Depth:**	20 ft	**Date Completed:**	11/16/2021
Bore Hole Diameter (in):	2.25	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	D-50 #0435	**Drill Method:**	Casing w/ Adv	**Hammer Type:**	Automatic	**Energy Ratio:**	84%
Core Size:	NQ2	**Driller:**	M. Morgan	**Groundwater:**	TOB NM	**24HR**	6.8 ft



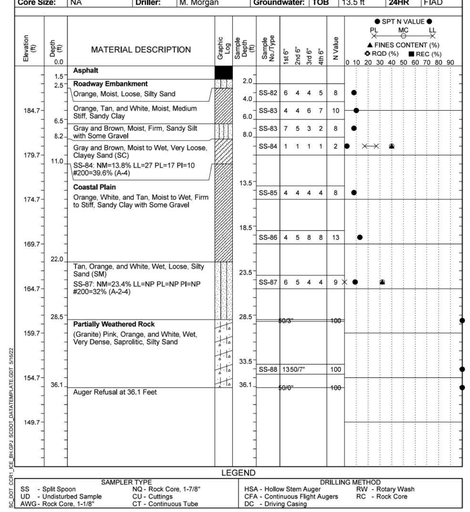
INFRASTRUCTURE CONSULTING & ENGINEERING

Project ID:	P039718	**County:**	Richland	**Boring No.:**	36-Bent 2 LT		
Site Description:	Carolina Crossroads Phase 1 - Bridge 36			**Route:**	Bridge 36		
Eng./Geo.:	MS	**Boring Location:**	32+09	**Offset:**	21 LT	**Alignment:**	COLRB
Elev.:	188.6 ft	**Latitude:**	34.02140775	**Longitude:**	-81.09541527	**Date Started:**	2/3/2022
Total Depth:	37.1 ft	**Soil Depth:**	37.1 ft	**Core Depth:**	NA ft	**Date Completed:**	2/3/2022
Bore Hole Diameter (in):	2.25	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	D-50 #0439	**Drill Method:**	HSA	**Hammer Type:**	Automatic	**Energy Ratio:**	91%
Core Size:	NA	**Driller:**	R. Cassell	**Groundwater:**	TOB 12.3 ft	**24HR**	FIAD



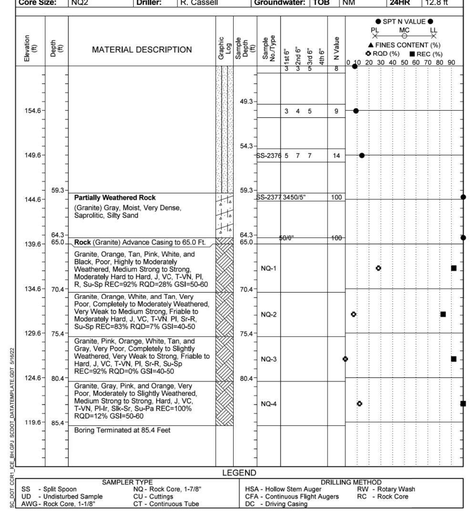
INFRASTRUCTURE CONSULTING & ENGINEERING

Project ID:	P039718	**County:**	Richland	**Boring No.:**	36-Bent 2 RT		
Site Description:	Carolina Crossroads Phase 1 - Bridge 36			**Route:**	Bridge 36		
Eng./Geo.:	CM	**Boring Location:**	32+60	**Offset:**	22 RT	**Alignment:**	COLRB
Elev.:	189.7 ft	**Latitude:**	34.0212607	**Longitude:**	-81.09528389	**Date Started:**	2/3/2022
Total Depth:	36.1 ft	**Soil Depth:**	36.1 ft	**Core Depth:**	NA ft	**Date Completed:**	2/3/2022
Bore Hole Diameter (in):	2.25	**Sampler Configuration**		**Liner Required:**	Y N	**Liner Used:**	Y N
Drill Machine:	D-50 #0435	**Drill Method:**	HSA	**Hammer Type:**	Automatic	**Energy Ratio:**	84%
Core Size:	NA	**Driller:**	M. Morgan	**Groundwater:**	TOB 13.5 ft	**24HR**	FIAD



INFRASTRUCTURE CONSULTING & ENGINEERING

Project ID:	P039718	**County:**	Richland	**Boring No.:**	36-Bent 3 LT		
Site Description:	Carolina Crossroads Phase 1 - Bridge 36			**Route:**	Bridge 36		
Eng./Geo.:	CM & NM	**Boring Location:**	34+24	**Offset:**	21 LT	**Alignment:**	COLRB
Elev.:	204.6 ft	**Latitude:**	34.02138011	**Longitude:**	-81.09474598	**Date Started:**	12/8/2021
Total Depth:	85.4 ft	**Soil Depth:**	64.3 ft	**Core Depth:**	20.4 ft	**Date Completed:**	12/9/2021
Bore Hole Diameter (in):	2.25	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	D-50 #0439	**Drill Method:**	Casing w/ Adv	**Hammer Type:**	Automatic	**Energy Ratio:**	91%
Core Size:	NQ2	**Driller:**	R. Cassell	**Groundwater:**	TOB NM	**24HR**	12.8 ft



FOR INFORMATION ONLY

REV.			
0	JPF	09-01-22	RFC PLANS
1			
REV.			
REVIEWED	J. FELKEL		
QUAN.			
DR.	BFS	DKY	05-22
DES.	DKY	CSB	05-22
	BY	CHK.	DATE

ARCHER UNITED JOINT VENTURE — UNITED INFRASTRUCTURE GROUP

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

BORING LOGS (3)

COLONIAL LIFE BLVD. RAMP B BRIDGE OVER I-126, I-126 RAMP & S-287 (ARROWWOOD ROAD)

COUNTY	ROUTE
RICHLAND	RAMP B

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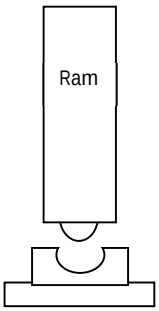
Appendix D

Pile Driving Hammer Information

County:	Lexington/Richland	Bridge Plans ID:	P039718
Route:	I- S-2963 Road Colonial Life Blvd. Ramp B Bridge		
Description:	Carolina Crossroads Phase 1 Bridge 36		
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)		2.0
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:	HP 14X89 and HP14X117 14X89 & 14X117 Reinf. Pile Tips		
Total Pile & Point Length (ft):	BR36 IB2 – 31 IB3 – 43.5 IB4 – 44 EB5 - 67	Exposed Pile Point Length (ft):	N/A
Pile Cross-Sectional Area (sq.in):	26.1		
Pipe Pile Wall Thickness (in):	N/A		
Pile Tip Description:	Welded Reinf. Tip		
Splice Description:	Bevel butt weld per SCDOT Specs		
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:	9/12/2022

Appendix E

Instrumentation Calibrations

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on OCT 2 2 2021

Serial No:	K12388	**Temperature:**	22.6 °C
Model:	PR	**Humidity:**	44%
Calibrated on:	Channel 3 on 8G 5161 LE		

Ref Acc 1:	69132! 960 g's/volt	**Cal on:**	09Feb2021
Ref Acc 2:	69096! 978 g's/volt	**Cal on:**	27Jan2021

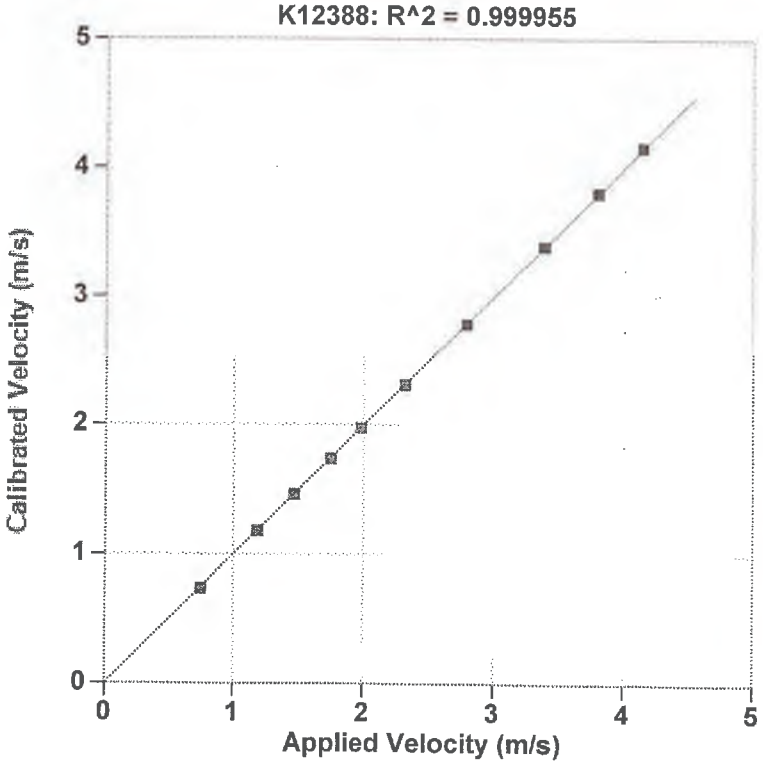
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

451.0 mv/5000g
(90.2 µv/g)
R^2: 0.999955 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K12388 Velocity
m/s	m/s
0.741	0.734
1.184	1.178
1.464	1.459
1.744	1.739
1.980	1.976
2.319	2.306
2.790	2.783
3.384	3.388
3.798	3.805
4.147	4.158

Maximum Acceleration: 919 g's

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on OCT 2 2 2021

Serial No:	K12389	**Temperature:**	22.8 °C
Model:	PR	**Humidity:**	44%
Calibrated on:	Channel 3 on 8G 5161 LE		

Ref Acc 1:	69132! 960 g's/volt	**Cal on:**	09Feb2021
Ref Acc 2:	69096! 978 g's/volt	**Cal on:**	27Jan2021

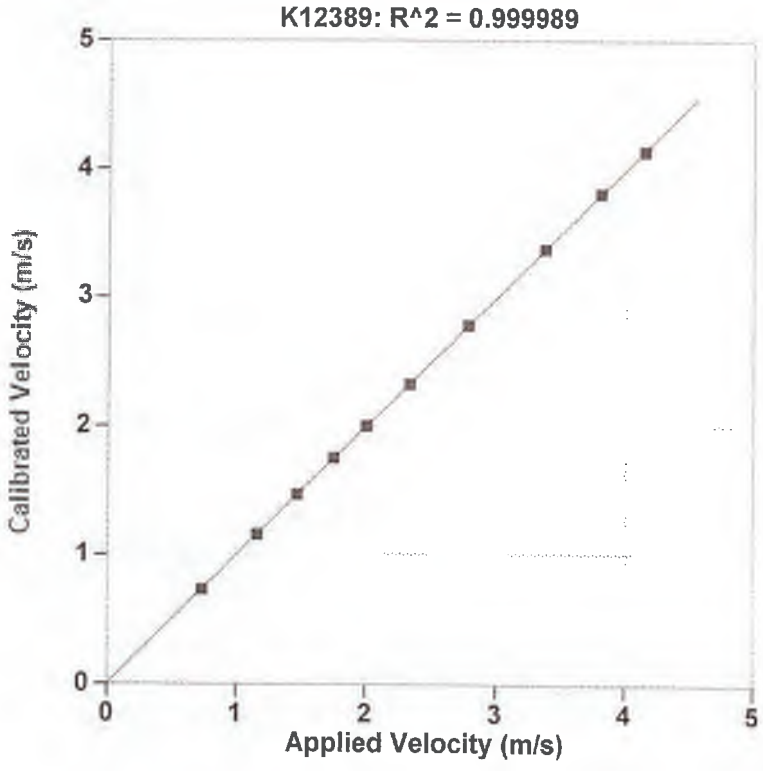
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

483.2 mv/5000g
(96.6 µv/g)
R^2: 0.999989 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K12389 Velocity
m/s	m/s
0.730	0.728
1.158	1.158
1.470	1.471
1.748	1.755
2.001	2.004
2.330	2.326
2.780	2.782
3.372	3.373
3.803	3.807
4.144	4.137

Maximum Acceleration: 914 g's

Pile Dynamics, Inc.

Certificate of Calibration

Transducer Model: PDI Transducer

Serial Number: P821

PDI Gage Factor: 145.1 me/V

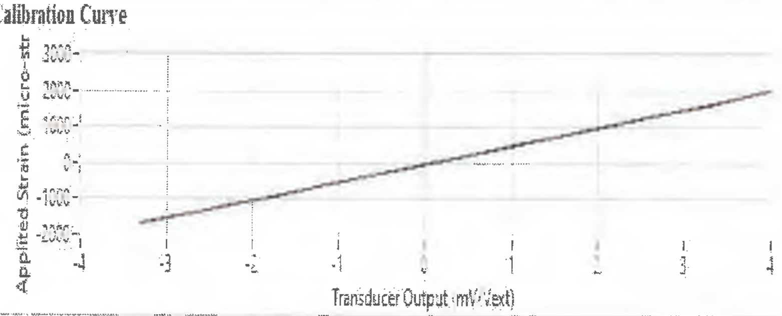
General Gage Factor: 503.9 **me**/mV/Vext

Initial Offset Voltage 0.006 mV/Vext

Table 1: Representative Calibration Data

Applied Strain (micro-strain)	Transducer Output (mV/Vext)	Applied Strain (micro-strain)	Transducer Output (mV/Vext)
-41.039	0.142	223.401	0.442
-101.915	-0.145	525.711	1.034
-591.374	-0.705	810.046	1.645
-558.231	-1.099	1103.380	2.252
-903.922	-1.740	1489.817	2.953
-1151.002	-2.242	1751.421	3.563
-1421.526	-2.788	2007.084	3.896
-1625.524	-3.172	1986.858	3.919
-1597.421	-3.311	1628.651	3.234
-1565.939	-3.135	1358.004	2.646
-1332.929	-2.655	990.022	2.023
-1054.845	-2.092	581.979	1.420
-795.582	-1.555	419.391	0.835
-526.002	-1.035	189.592	0.354
-274.157	-0.511	41.451	0.145
-55.234	-0.099	42.033	0.143

Calibration Curve



Mean Linear Correlation Coefficient (LCC): 0.999973

LCC Standard Deviation: 1.354270E-6

Calibrated By: DJC

Signature:

Date and Time: 9/9/2021 8:53 AM

Temperature (Degrees C): 24.2

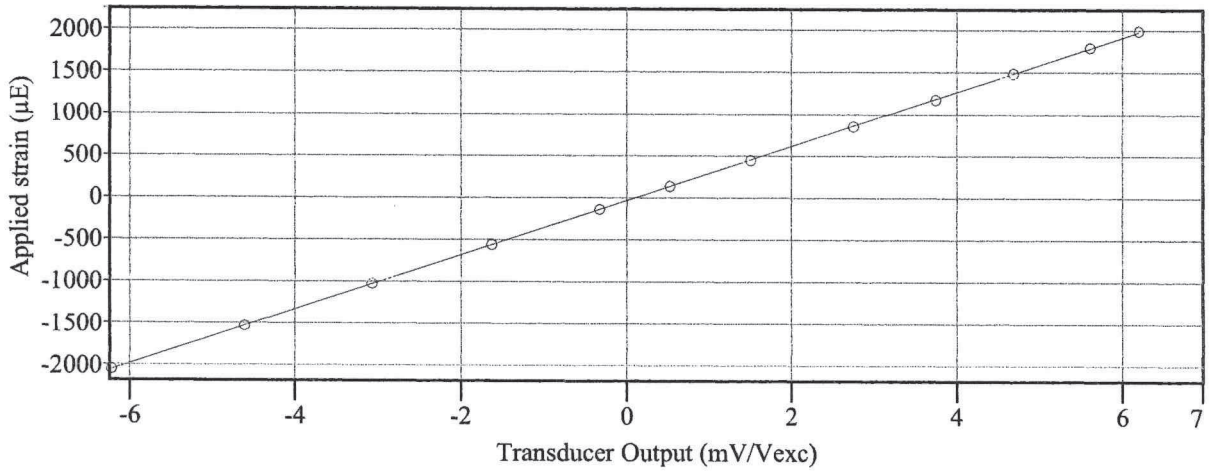
Certificate of Calibration

Pile Dynamics, Inc.
Transducer Model: PDI Strain Transducer
Serial Number: W877
PDI Gage Factor: 94.7
Mean Linear Correlation Coefficient: 0.999972

Table 1: Representative Calibration Data

Applied strain (μE)	Gage Output (mV/Vexc)	Applied strain (μE)	Gage Output (mV/Vexc)
-2047.2	-6.223	446.2	1.502
-1528.9	-4.613	853.0	2.750
-1023.6	-3.071	1174.5	3.746
-557.7	-1.629	1489.5	4.680
-137.8	-0.335	1797.9	5.608
137.8	0.521	1994.8	6.205

Calibration Curve



PDI Strain Transducer Calibration System (PDI STCS)

PDI STCS Serial Number:	1000HA
Firmware version number:	0.8.0.0
Transducer Gage Length:	3 inches (76.2mm)
Excitation Voltage for Calibration:	5.0 VDC

PDI certifies the above STCS instrument meets or exceeds published specifications and has been verified using standards and instruments whose accuracies are traceable to the National Institute of Standards and Technology (NIST), an accepted value of a natural physical constant or a ratio calibration technique.

Calibrated By: Kay Tol

Signature: Kay Tol

PDI Gage: W877

Calibration Date: JUN 0 8 2022

Pile Dynamics, Inc.

Appendix F

PDA Proficiency Certifications

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Pile Dynamics, Inc.

This documents that

Sally Thomson
Infrastructure Consulting Engineering

has on August 11, 2021 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

SEAL
OHIO

Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 3139

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Pile Dynamics, Inc.

This documents that

Michael Simpson
Infrastructure Consulting & Engineering

has on August 25, 2021 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

SEAL
1972
OHIO

Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 3149