

Forest Lakes Bridges

Report Date: Jul 22, 2021

Work Order No.: 21-8536.PileDynamicAnalysis.0001; ver:

Work Order Date: Jul 22, 2021

Reviewed by:

Pile Dynamic Load Testing

General Contractor: Structures, Inc.

Performed by: Kelsey Van Bommel

Pile Driving Contractor: Structures, Inc.

Representative Notified: Mark Workman

Hammer Used: APE D19

Number of Test Piles: 1

PDA Equipment: PAX

Placement Location: ITEM 503: Abutment #1, East Pile line, 7th Pile from South, TP-1

Design Requirements

PDA Test Pile ID #	Date of Drive	Pile Location	Pile Type and Size	Est. Tip Elevation (ft.)	Min. Tip Elevation (ft.)	Design Load (kips)	PDA Factor	PDA Test Load (kips)
TP-1	7/22/21	Abutment 1, East Pile Line, 7th Pile from south	12x53	7031.5	7031.5	215	0.65	331

Pile Measurements

PDA Test Pile ID #	Yield Stress (ksi)	Fuel Setting	Predrill Depth (ft.)	Predrill Dia. (in.)	Installed Length (ft.)	Batter	Ground Elev. (ft.)	Tip Elev. (ft.)	Pile Toe Attachments	Pile Head Cond. After Driving
TP-1	45	4	N/A	N/A	17.0	N/a	7053.0	7036.0	Yes	Not deformed

PDA Results

PDA Test Pile ID #	Average CASE Capacity at Refusal (kips)	Restrike Age	Average CASE Capacity at Restrike (kips)	Additional Soil Setup at Restrike	Refusal Criteria	Minimum Depth Specified (ft.)
TP-1	368	N/A	N/A	N/A	12 Blows/3 inches	N/A

Plans reference a minimum of 10 feet of bedrock penetration, estimated to be at 7031.5. Structures drove the test pile to an elevation of approximately 7036. The test pile was driven to a blow count of 56 blows per 3 inches in an attempt to achieve minimum tip elevation.

Hammer Performance

An APE D 19 diesel fired hammer was used to drive the HP 12 X 53 piles as referenced previously. During the end of driving, the efficiency of the hammer ranged from approximately 59 to 63 percent (based on stroke). This efficiency is considered good for open-ended diesel hammers.

Conclusions

The capacity analysis was performed by PDA using the Case Method during initial drive. The initial test piles were driven at fuel setting #4 of the hammer. Based on the measurements obtained on the test piles, the production piles for Abutment 1 should be driven to a minimum of 12 blows per 3 inches at Fuel Setting #4 to achieve the required capacity of 331 kips.

It should be noted that records of the PDA measurements were edited to remove data that was generally the result of pile hammer stops, calibration testing, or other inconsequential causes.

Closure

The design team should review this report and the data presented herein. Any recommendations provided by our office were based on the data obtained from the piles tested, at the depths achieved during which the testing was performed, and for the subsurface conditions present at the tested pile locations. This report may not be sufficient for adjacent piles if the subsurface geology, piling, hammer settings, or any other portion of the pile driving is modified or otherwise differs from the conditions encountered during the testing. Our office should be contacted immediately if subsequent pile driving operations on this project appear to differ with respect to the conditions or observations presented herein, including, but not limited to, bedrock elevation, design loads, piling type, hammer type or condition, etc. In no case should the information in this report be used to terminate pile driving operations prior to achieving any minimum tip elevations, bedrock penetration or any other requirement contained in project plans or other project documents without the written consent of the structural engineer of record.

Results apply only to the specific items and locations referenced and at the time of testing, observations or special inspections. This report should not be reproduced, except in full, without the written permission of GROUND Engineering Consultants, Inc.

Forest Lakes Bridges

Report Date: Jul 22, 2021

Work Order No.: 21-8536.PileDynamicAnalysis.0001; ver:

Work Order Date: Jul 22, 2021

Reviewed by:

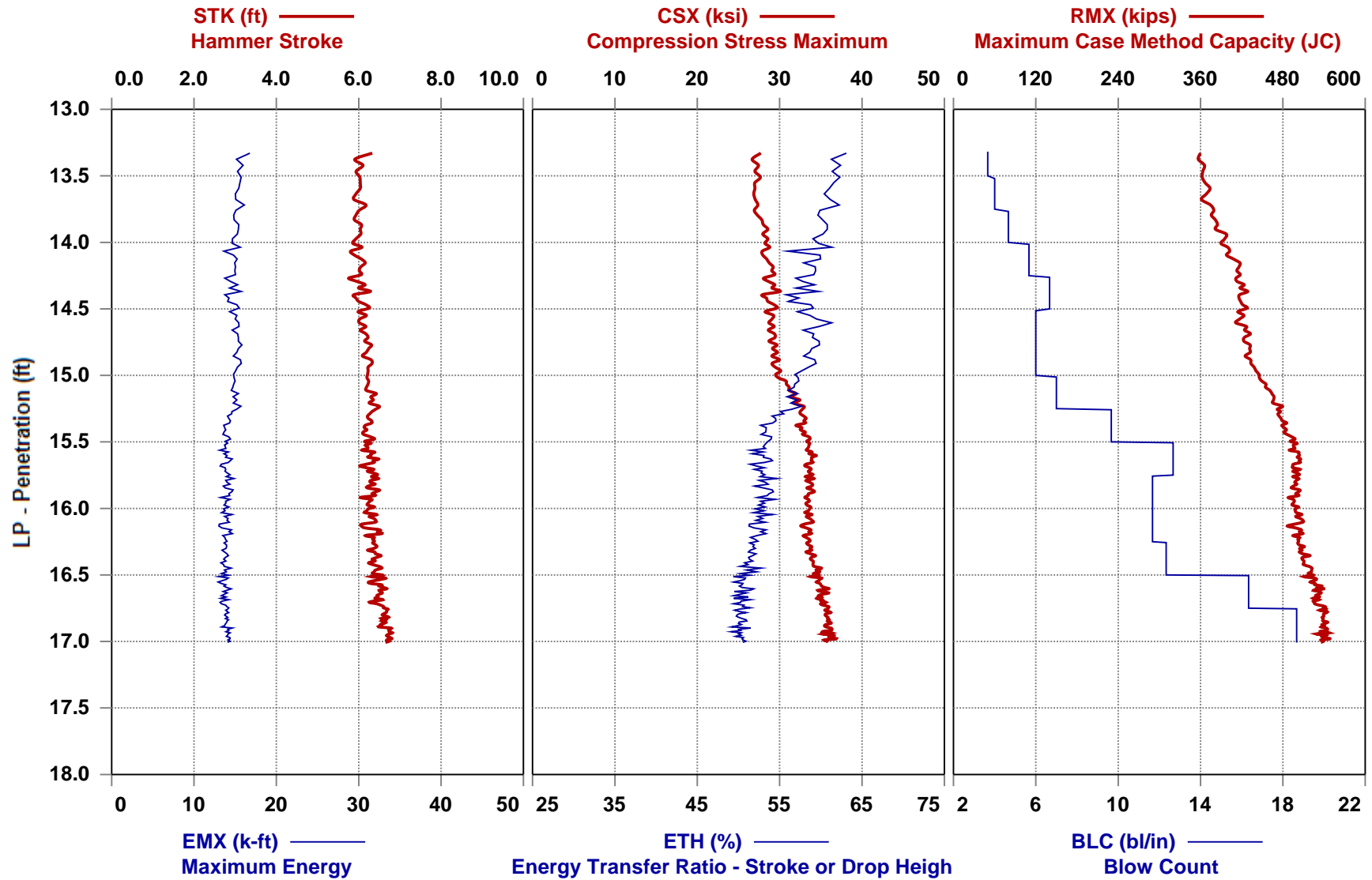
Pile Dynamic Load Testing

Photos



TP-1, Abutment 1, 7th pile from south



21-8536.FORESTLAKEBRIDGES - TP-1.ABUT1.7TH PILE FROMSOUTH
12X53

Case Method & iCAP® Results

21-8536.FORESTLAKEBRIDGES - TP-1.ABUT1.7TH PILE FROMSOUTH

12X53

OP: KVB

Date: 22-July-2021

AR: 15.50 in²

SP: 0.492 k/ft³

LE: 19.00 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.69

STK: Hammer Stroke

ETH: Energy Transfer Ratio - Stroke or Drop Height

EMX: Maximum Energy

RMX: Maximum Case Method Capacity (JC)

CSX: Compression Stress Maximum

BL#	Depth ft	BLC bl/in	STK ft	EMX k-ft	CSX ksi	ETH (%)	RMX kips
12	13.52	4.000	5.91	15.3	27.7	61.8	362.0
13	13.54	4.000	6.04	15.4	27.0	60.9	362.1
14	13.56	4.000	6.04	15.7	27.0	62.2	371.4
15	13.58	4.000	6.09	15.5	26.9	60.9	382.3
16	13.60	4.000	5.98	15.3	27.1	61.2	365.3
17	13.63	4.000	6.09	15.7	27.8	61.5	373.2
18	13.65	4.000	5.78	14.4	25.9	59.3	363.9
19	13.67	4.000	5.88	15.3	27.4	61.9	360.2
20	13.69	4.000	5.88	14.9	26.6	60.3	362.4
21	13.71	4.000	6.01	15.4	26.5	61.0	367.3
22	13.73	4.000	6.34	16.8	28.2	63.4	381.7
23	13.75	4.000	6.06	15.1	26.6	59.5	375.3
Average			6.01	15.4	27.1	61.2	368.9
Std. Dev.			0.14	0.6	0.6	1.1	7.4
Maximum			6.34	16.8	28.2	63.4	382.3
Minimum			5.78	14.4	25.9	59.3	360.2

Total number of blows analyzed: 12

BL# Sensors

3-412 F3: [K014] 95.9 (1.00); F4: [K025] 95.0 (1.00); A3: [K11353] 396.0 (1.00);
 A4: [K4437] 382.0 (1.00)

Time Summary

Drive 9 minutes 27 seconds 9:39 AM - 9:48 AM BN 1 - 414

Case Method & iCAP® Results

21-8536.FORESTLAKEBRIDGES - TP-1.ABUT1.7TH PILE FROMSOUTH

12X53

OP: KVB

Date: 22-July-2021

AR: 15.50 in²

SP: 0.492 k/ft³

LE: 19.00 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.69

STK: Hammer Stroke

ETH: Energy Transfer Ratio - Stroke or Drop Height

EMX: Maximum Energy

RMX: Maximum Case Method Capacity (JC)

CSX: Compression Stress Maximum

BL#	Depth ft	BLC bl/in	STK ft	EMX k-ft	CSX ksi	ETH (%)	RMX kips
402	16.96	18.667	6.79	14.5	37.0	51.0	548.2
403	16.97	18.667	6.85	14.6	36.7	51.0	539.1
404	16.97	18.667	6.69	14.1	35.4	50.2	541.3
405	16.98	18.667	6.72	14.0	36.2	49.8	545.2
406	16.98	18.667	6.88	14.7	37.5	51.1	551.9
407	16.99	18.667	6.69	14.3	35.5	50.9	534.9
408	16.99	18.667	6.66	14.0	35.4	50.1	535.9
409	17.00	18.667	6.85	14.7	35.8	51.2	541.8
410	17.00	18.667	6.63	14.1	35.7	50.6	536.6
411	17.00	18.667	6.76	14.4	36.3	50.8	534.4
		Average	6.75	14.3	36.1	50.7	540.9
		Std. Dev.	0.08	0.3	0.7	0.5	5.6
		Maximum	6.88	14.7	37.5	51.2	551.9
		Minimum	6.63	14.0	35.4	49.8	534.4

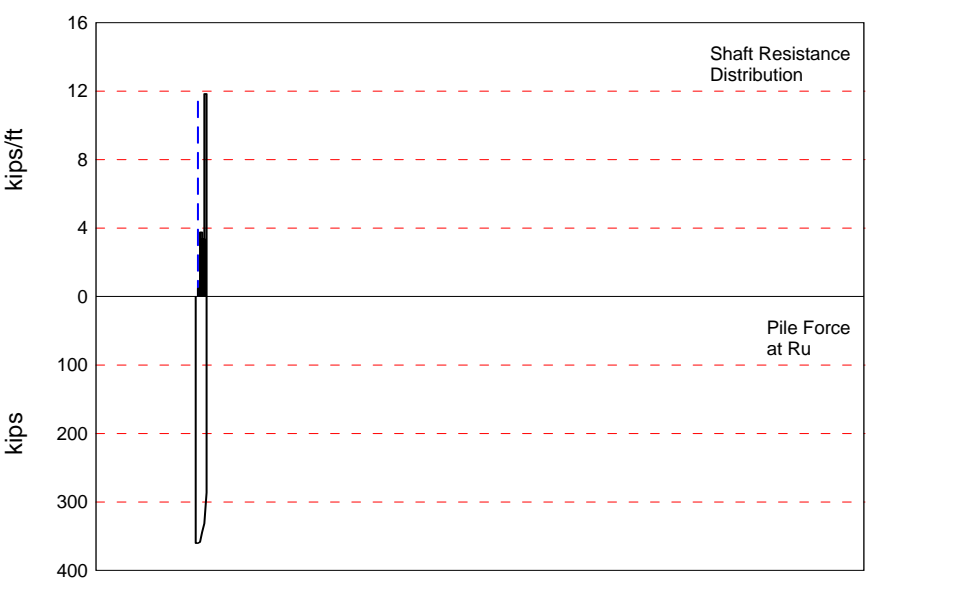
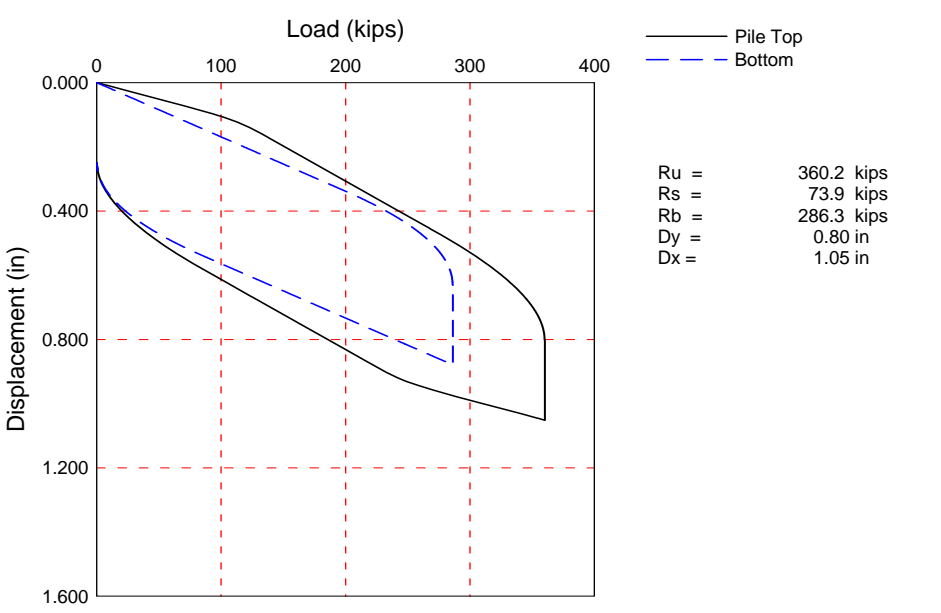
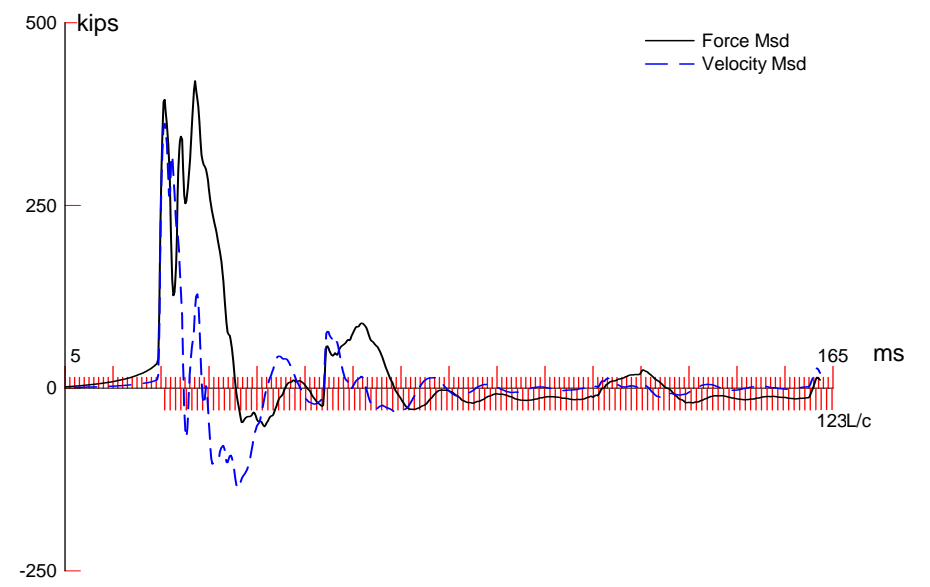
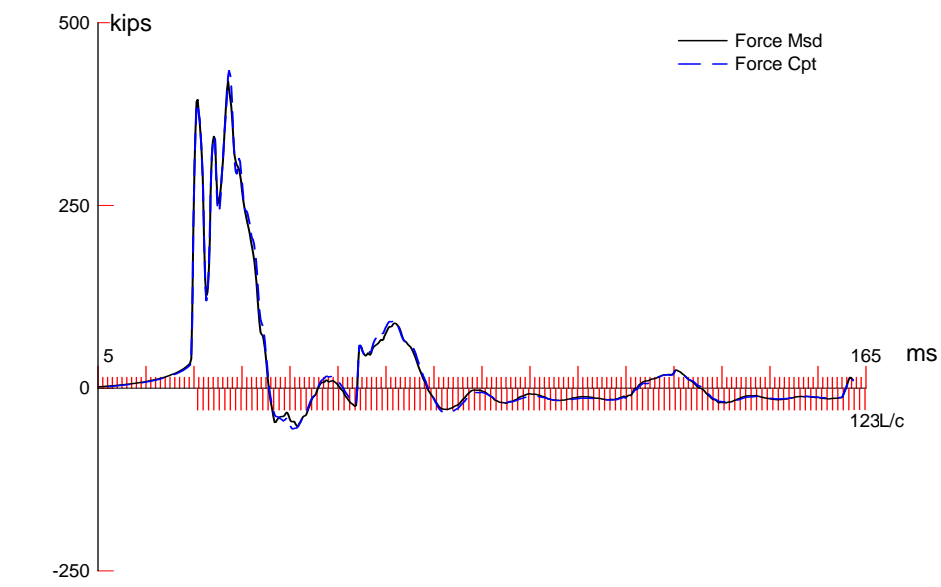
Total number of blows analyzed: 10

BL# Sensors

3-412 F3: [K014] 95.9 (1.00); F4: [K025] 95.0 (1.00); A3: [K11353] 396.0 (1.00);
A4: [K4437] 382.0 (1.00)

Time Summary

Drive 9 minutes 27 seconds 9:39 AM - 9:48 AM BN 1 - 414



21-8536.FORESTLAKEBRIDGES; Pile: TP-1.ABUT1.7TH PILE FROMSOUTH Test: 22-Jul-2021 09:40:
 12X53; Blow: 19 CAPWAP(R) 2006-3
 Ground Engineering Consultants OP: KVB

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 360.2; along Shaft 73.9; at Toe 286.3 kips

Soil Sgmt 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
				360.2				
1	7.6	2.0	1.8	358.4	1.8	0.89	0.22	0.086
2	11.4	5.8	14.3	344.1	16.1	3.76	0.95	0.086
3	15.2	9.6	12.8	331.3	28.9	3.37	0.85	0.086
4	19.0	13.4	45.0	286.3	73.9	11.84	2.98	0.086
Avg. Shaft			18.5			5.51	1.39	0.086
Toe			286.3				290.56	0.072

Soil Model Parameters/Extensions			Shaft	Toe
Quake	(in)		0.072	0.485
Case Damping Factor			0.228	0.749
Damping Type				Smith
Unloading Quake	(% of loading quake)		77	72
Reloading Level	(% of Ru)		100	100
Resistance Gap (included in Toe Quake) (in)				0.034
Soil Plug Weight	(kips)			0.04

CAPWAP match quality = 2.69 (Wave Up Match) ; RSA = 0
 Observed: final set = 0.250 in; blow count = 48 b/ft
 Computed: final set = 0.210 in; blow count = 57 b/ft

21-8536.FORESTLAKEBRIDGES; Pile: TP-1.ABUT1.7TH PILE FROMSOUTH Test: 22-Jul-2021 09:40:
 12X53; Blow: 19 CAPWAP(R) 2006-3
 Ground Engineering Consultants OP: KVB

	CASE METHOD									
J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	320.9	275.5	230.0	184.6	139.1	93.7	48.3	2.8	0.0	0.0
RX	424.6	414.8	405.0	395.1	385.3	375.5	365.7	359.7	354.7	349.8
RU	320.9	275.5	230.0	184.6	139.1	93.7	48.3	2.8	0.0	0.0

RAU = 322.6 (kips); RA2 = 404.1 (kips)

Current CAPWAP Ru = 360.2 (kips); Corresponding J(RP)= 0.00; J(RX) = 0.69

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips
13.43	26.00	371.5	403.8	425.2	0.645	0.244	0.250	15.3	409.0