

SUPPORT DOCUMENTS FOR:

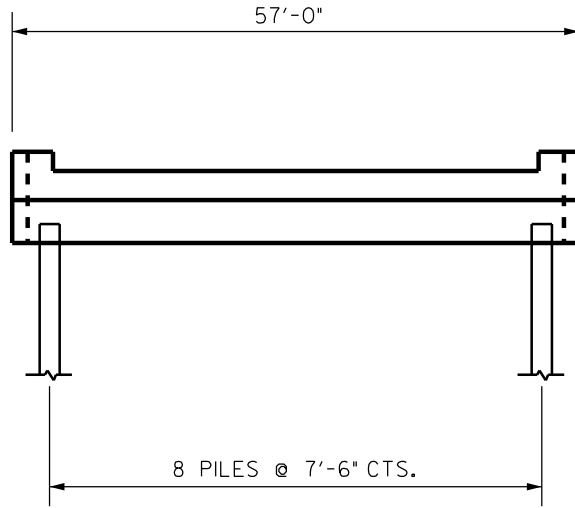
SF-910216

BRIDGE 216

**END BENT
NO. 1**

END BENT #1
SINGLE ROW OF PILES
0 BATTERED PILES
PILE TYPE : HP 12x53

AVG BOC ELEV = 275.57 FT
FACTORED AXIAL PILE LOAD = 150 KIPS

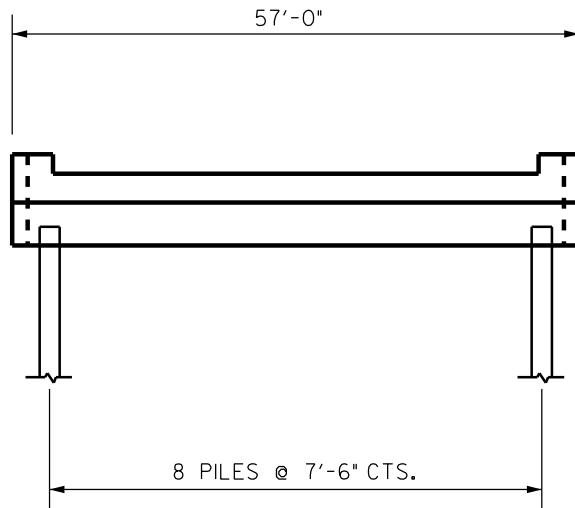


END BENT SKETCH

NO SCALE

END BENT #2
SINGLE ROW OF PILES
0 BATTERED PILES
PILE TYPE : HP 12x53

AVG BOC ELEV = 275.05 FT
FACTORED AXIAL PILE LOAD = 120 KIPS



END BENT SKETCH

NO SCALE

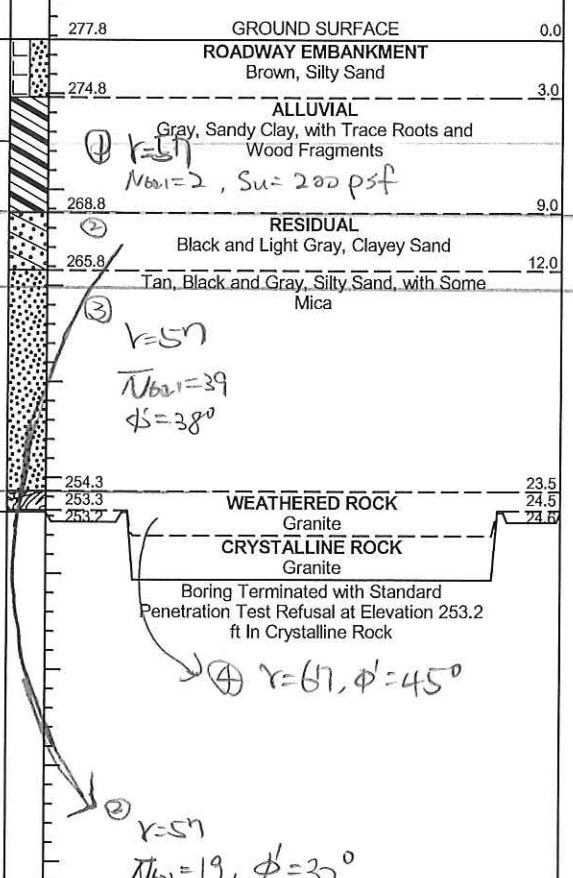
GEOTECHNICAL BORING REPORT

BORE LOG

WBS 17BP.5.R.79	TIP SF-910216	COUNTY WAKE	GEOLOGIST C.T. TANG
SITE DESCRIPTION Bridge No. 216 on SR 2366 (Old Battle Bridge Road) over Buffalo Creek			GROUND WTR (ft)
BORING NO. EB1-A	STATION 11+43 11+50	OFFSET 44 FT LT 26 FT LT	ALIGNMENT -L-
COLLAR ELEV. 277.8 ft	TOTAL DEPTH 24.6 ft	NORTHING 746,234	EASTING 2,176,511
DRILL RIG/HAMMER EFF./DATE BRI9103 BK-51 82% 02/23/2017			DRILL METHOD Mud Rotary
DRILLER G. EISTER			HAMMER TYPE Automatic
START DATE 11/15/07		COMP. DATE 11/15/07	
SURFACE WATER DEPTH N/A			

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100						
280																
	277.3	0.5	1	6	7										277.8	0.0
	274.3	3.5	1	WOH	1										274.8	3.0
	269.3	8.5	1		4	7									268.8	9.0
	264.3	13.5	12	11	10										265.8	12.0
	259.3	18.5	34	15	14										254.3	23.5
	253.3	24.5	39	61/0.3											253.3	24.5
			60/0.1												253.2	24.6

BDC
11-15-07
HP
12x53



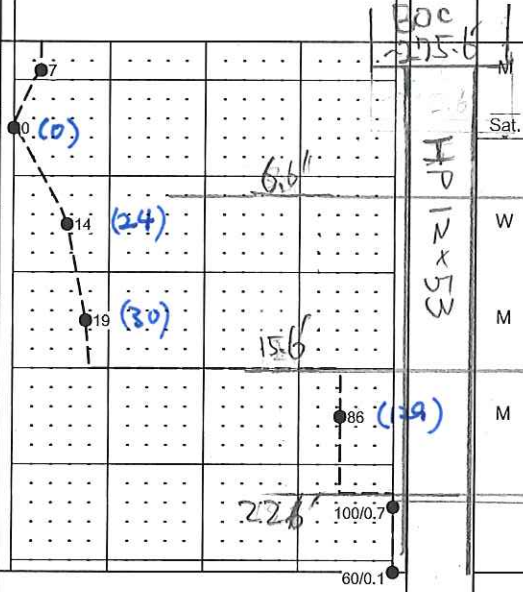
NCDOT BORE SINGLE 910216_GEO_BRDG0216_BH.GPJ NC_DOT.GDT 11/21/17

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 17BP.5.R.79		TIP SF-910216		COUNTY WAKE		GEOLOGIST C.T. TANG										
SITE DESCRIPTION Bridge No. 216 on SR 2366 (Old Battle Bridge Road) over Buffalo Creek							GROUND WTR (ft)									
BORING NO. EB1-Bc		STATION 11+45 11+52		OFFSET 41 ft RT 4' LT		ALIGNMENT -L-										
COLLAR ELEV. 277.0 ft		TOTAL DEPTH 27.6 ft		NORTHING 746,214		EASTING 2,176,521										
DRILL RIG/HAMMER EFF./DATE BRI9103 BK-51 82% 02/23/2017				DRILL METHOD Mud Rotary		HAMMER TYPE Automatic										
DRILLER G. EISTER		START DATE 11/15/07		COMP. DATE 11/15/07		SURFACE WATER DEPTH N/A										
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100						
280																
	276.5	0.5	4	3	4										277.0	GROUND SURFACE
275															274.0	ROADWAY EMBANKMENT Brown, Silty Sand
	273.5	3.5	WOH	WOH	WOH										270.0	ALLUVIAL Gray, Silty Sand
270															270.0	RESIDUAL Black, Tan, and Light Gray, Silty Sand, with Some Mica
	268.5	8.5	3	5	9											
265																
	263.5	13.5	5	8	11											
260																
	258.5	18.5	21	33	53											
255																
	253.5	23.5	37	63/0.2											253.0	WEATHERED ROCK Tan and Gray, Granite
250															249.5	CRYSTALLINE ROCK Granite
	249.5	27.5	60/0.1												249.4	Boring Terminated with Standard Penetration Test Refusal at Elevation 249.4 ft In Crystalline Rock
															27.5	
															27.6	

NCDOT BORE SINGLE 910216_GEO_BRD0216_BH.GPJ NC_DOT.GDT 11/21/17



① $r=57$
 $N_{601}=0$
 $\phi=27^\circ$ *

② $r=57$
 $N_{601}=2.7$, $\phi=35^\circ$

③ $r=57$
 $\phi=42^\circ$

④

$r=67$, $\phi=45^\circ$

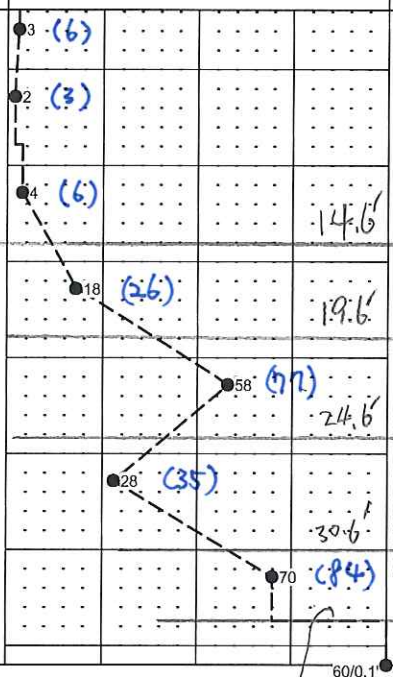
GEOTECHNICAL BORING REPORT BORE LOG

WBS 17BP.5.R.79	TIP SF-910216	COUNTY WAKE	GEOLOGIST S. Woods
SITE DESCRIPTION Bridge No. 216 on SR 2366 (Old Battle Bridge Road) over Buffalo Creek			GROUND WTR (ft)
BORING NO. EB1-B	STATION 11+51	OFFSET 15 ft RT	ALIGNMENT -L-
COLLAR ELEV. 273.1 ft	TOTAL DEPTH 34.1 ft	NORTHING 746,201	EASTING 2,176,535
DRILL RIG/HAMMER EFF./DATE F&R5785 CME-55 73% 03/01/2019		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER S. DAVIS	START DATE 09/23/19	COMP. DATE 09/23/19	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION		
			0.5ft	0.5ft	0.5ft	0	25	50	75	100				ELEV. (ft)	DEPTH (ft)	
275																
	273.1	0.0	1	2	1									273.1	GROUND SURFACE	0.0
270	269.6	3.5	1	1	1									271.1	ALLUVIAL Brown, Silty Sand, with Trace Roots Gray, Clayey Sand, with Trace Roots, Wood Fragments and Organics	2.0
265	264.6	8.5	1	2	2									266.1	RESIDUAL Gray-Tan, Clayey Sandy Silt, with Trace Mica	7.0
260	259.6	13.5	5	8	10											
255	254.6	18.5	17	22	36											
250	249.6	23.5	10	13	15											
245	244.6	28.5	16	27	43											
240	239.1	34.0												241.3	WEATHERED ROCK Granite	31.8
														239.1	CRYSTALLINE ROCK Granite	34.0
														239.0	Granite	34.1

BOC
275.6'

HP 12x57



- ① $r=57, N_{60.1}=5, \phi'=28.5^\circ$
- ② $r=57, N_{60.1}=26, \phi'=34.8^\circ$
- ③ $r=57, \phi'=40^\circ$
- ④ $r=57, N_{60.1}=35, \phi'=37.5^\circ$
- ⑤ $r=57, \phi'=40^\circ$
- ⑥ $r=67, \phi'=45^\circ$

Boring Terminated with Standard Penetration Test Refusal at Elevation 239.0 ft in Crystalline Rock



STEWART

FACTORED PILE RESISTANCE

STATE ID: SF-910216
 FEDERAL ID: 17BP.5.R.79
 COUNTY: Wake

	INITIAL	DATE
PERFORMED BY:	CTT	10/11/19
CHECKED BY:	db	

DESCRIPTION: Bridge No. 216 on SR 2633 over Buffalo Creek

BRIDGE TYPE: 21-in Cored Slab
 BRIDGE WIDTH : 57 feet
 # OF SPANS: 1
 SPAN LENGTH: 50 feet
 PILE TYPE: HP 12X53

BENT NO: EB1

Boring No.: EB1-A
 BOC El.: 275.6±

STANDARD STRUCTURAL LOADING (PER PILE)

FINAL

NO. OF PILES : 8 (SINGLE ROW, ALL PLUMB)
 MAX. FACTORED STRUCTURAL LOAD: 150 KIPS STANDARD LOAD
MAX. FACTORED STRUCTURAL LOAD (ROUNDED): 75 TONS

REQUIRED STATIC NOMINAL RESISTANCE (PER PILE)

FINAL

HP PILE IN COASTAL PLAIN?: NO
 PREDOMINANT SOIL TYPE: SAND
 STATIC RF: 0.45
 DOWNDRAW RESISTANCE: 0.0 KIPS
 FACTORED DOWNDRAW LOAD²: 0.0 KIPS
 REQ'D STATIC NOMINAL RESISTANCE (R_n) : 333.3 KIPS 340 KIPS [ROUNDED UP]

	LT	RT
EST. PILE TIP DEPTH [BELOW BOC]	22 FEET	32 FEET
UNSUPPORTED PILE LENGTH	0 FEET	0 FEET
TOTAL ESTIMATED PILE LENGTH [ROUNDED]	25 FEET	35 FEET

If delta b/t LT and RT is greater than 5 ft, report seperately.

REQUIRED DRIVING RESISTANCE (PER PILE)

FINAL

PDA REQ'D?: NO
 DYNAMIC MONITORING RF: 0.6
 FACTORED LOAD: 150.0 KIPS
 FACTORED DOWNDRAW LOAD²: 0.0 KIPS
 DOWNDRAW RESISTANCE: 0.0 KIPS
 RESISTANCE LOST TO SCOUR³: 0.0 KIPS
 TOTAL REQ'D DRIVING RESISTANCE: 250.0 KIPS 250 KIPS [ROUNDED UP]
TOTAL REQ'D DRIVING RESISTANCE: 125 TONS

COMMENTS:

- ¹FROM NCDOT CHART "NOMINAL COMPRESSIVE RESISTANCE FOR STEEL PILES"
- ²BASED ON APILE RESULTS
- ³SCOUR RF=1.0 APPLIED
- ⁴USED TO ESTIMATE PILE LENGTH WITH APILE OUTPUT
- ⁵NCDOT LOAD FACTOR = 1.25 APPLIED

APILE for Windows, Version 2015.7.6

Serial Number : 154813345

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

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This program is licensed to :

Stewart Engineering, Inc
Raleigh, North Carolina

Path to file locations : F:\Projects\GEO\2017\Other\B17006.00_17BP.5.R.79_Wake_216\04 - Calculations\EB1\
Name of input data file : EB1-A side APILE.ap7d
Name of output file : EB1-A side APILE.ap7o
Name of plot output file : EB1-A side APILE.ap7p

Time and Date of Analysis

Date: October 11, 2019 Time: 10:16:46

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* INPUT INFORMATION *

Bridge 216, EB1-A

DESIGNER : C.T. TANG

JOB NUMBER : SF-910216

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
 - CROSS SECTION AREA = 15.50 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 25.00 FT.
 - PILE STICKUP LENGTH, PSL = 0.00 FT.
 - ZERO FRICTION LENGTH, ZFL = 1.00 FT.
 - PERIMETER OF PILE = 48.00 IN.
 - TIP AREA OF PILE = 144.00 IN2
 - INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.00	57.00	0.00	0.00
6.60	CLAY	0.00	57.00	0.00	0.00
6.60	SAND	0.00	57.00	32.00	0.00
10.60	SAND	0.00	57.00	32.00	0.00
10.60	SAND	0.00	57.00	38.00	0.00
21.30	SAND	0.00	57.00	38.00	0.00
21.30	SAND	0.00	67.00	45.00	0.00
30.00	SAND	0.00	67.00	45.00	0.00

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.20	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.20	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
6.60	1.000	1.000
6.60	1.000	1.000
10.60	1.000	1.000

10.60 1.000 1.000
 21.30 1.000 1.000
 21.30 1.000 1.000
 30.00 1.000 1.000

1

 * COMPUTATION RESULT *

 * FED. HWY. METHOD *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.9	0.9
1.00	0.0	0.9	0.9
2.00	0.3	1.8	2.1
3.00	0.8	1.8	2.6
4.00	1.3	1.8	3.1
5.00	1.8	1.8	3.6
6.00	2.3	3.9	6.2
7.00	2.8	6.6	9.4
8.00	3.7	9.7	13.4
9.00	5.1	13.0	18.0
10.00	6.6	22.9	29.5
11.00	8.3	34.4	42.7
12.00	11.3	46.7	58.0
13.00	15.6	59.1	74.6
14.00	20.2	63.6	83.8
15.00	25.1	68.2	93.3
16.00	30.4	72.7	103.1
17.00	36.1	77.2	113.3
18.00	42.0	81.8	123.8
19.00	48.3	86.3	134.7
20.00	55.0	90.9	145.9
21.00	62.0	187.4	249.4
22.00	69.3	298.2	367.6
23.00	78.5	414.5	493.1
24.00	89.7	527.4	617.1
25.00	101.3	552.9	654.2

REQ'D STATIC NOMINAL RESISTANCE = 340 KIPS
 SKIN FRICTION = 19%

NOTES:

- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

 * COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
 * CURVES FOR AXIAL LOADING *

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		

EB1-A side APILE.ap7o

			0.0000E+00	0.0000E+00
			0.1307E+00	0.2445E-01
			0.2179E+00	0.4736E-01
			0.3269E+00	0.8709E-01
			0.3922E+00	0.1222E+00
			0.4358E+00	0.1528E+00
			0.3922E+00	0.3056E+00
			0.3922E+00	0.4584E+00
			0.3922E+00	0.7639E+00
			0.3922E+00	0.3056E+01
2	10	0.3325E+01		
			0.0000E+00	0.0000E+00
			0.2615E+00	0.2445E-01
			0.4358E+00	0.4736E-01
			0.6537E+00	0.8709E-01
			0.7845E+00	0.1222E+00
			0.8717E+00	0.1528E+00
			0.7845E+00	0.3056E+00
			0.7845E+00	0.4584E+00
			0.7845E+00	0.7639E+00
			0.7845E+00	0.3056E+01
3	10	0.6558E+01		
			0.0000E+00	0.0000E+00
			0.3678E+00	0.2445E-01
			0.6131E+00	0.4736E-01
			0.9196E+00	0.8709E-01
			0.1104E+01	0.1222E+00
			0.1226E+01	0.1528E+00
			0.1104E+01	0.3056E+00
			0.1104E+01	0.4584E+00
			0.1104E+01	0.7639E+00
			0.1104E+01	0.3056E+01
4	10	0.6600E+01		
			0.0000E+00	0.0000E+00
			0.1226E+00	0.1000E-01
			0.2452E+00	0.2000E-01
			0.4904E+00	0.4000E-01
			0.7357E+00	0.6000E-01
			0.9809E+00	0.8000E-01
			0.1104E+01	0.9000E-01
			0.1226E+01	0.1000E+00
			0.1226E+01	0.5000E+00
			0.1226E+01	0.2000E+01
5	10	0.8625E+01		
			0.0000E+00	0.0000E+00
			0.2559E+00	0.1000E-01
			0.5118E+00	0.2000E-01
			0.1024E+01	0.4000E-01
			0.1535E+01	0.6000E-01
			0.2047E+01	0.8000E-01
			0.2303E+01	0.9000E-01
			0.2559E+01	0.1000E+00
			0.2559E+01	0.5000E+00
			0.2559E+01	0.2000E+01
6	10	0.1056E+02		
			0.0000E+00	0.0000E+00
			0.4053E+00	0.1000E-01
			0.8106E+00	0.2000E-01
			0.1621E+01	0.4000E-01
			0.2432E+01	0.6000E-01
			0.3243E+01	0.8000E-01
			0.3648E+01	0.9000E-01
			0.4053E+01	0.1000E+00
			0.4053E+01	0.5000E+00
			0.4053E+01	0.2000E+01
7	10	0.1060E+02		

EB1-A side APILE.ap7o

			0.0000E+00	0.0000E+00
			0.4053E+00	0.1000E-01
			0.8106E+00	0.2000E-01
			0.1621E+01	0.4000E-01
			0.2432E+01	0.6000E-01
			0.3243E+01	0.8000E-01
			0.3648E+01	0.9000E-01
			0.4053E+01	0.1000E+00
			0.4053E+01	0.5000E+00
			0.4053E+01	0.2000E+01
8	10	0.1598E+02		
			0.0000E+00	0.0000E+00
			0.9486E+00	0.1000E-01
			0.1897E+01	0.2000E-01
			0.3794E+01	0.4000E-01
			0.5691E+01	0.6000E-01
			0.7589E+01	0.8000E-01
			0.8537E+01	0.9000E-01
			0.9486E+01	0.1000E+00
			0.9486E+01	0.5000E+00
			0.9486E+01	0.2000E+01
9	10	0.2126E+02		
			0.0000E+00	0.0000E+00
			0.1435E+01	0.1000E-01
			0.2869E+01	0.2000E-01
			0.5738E+01	0.4000E-01
			0.8607E+01	0.6000E-01
			0.1148E+02	0.8000E-01
			0.1291E+02	0.9000E-01
			0.1435E+02	0.1000E+00
			0.1435E+02	0.5000E+00
			0.1435E+02	0.2000E+01
10	10	0.2130E+02		
			0.0000E+00	0.0000E+00
			0.1435E+01	0.1000E-01
			0.2869E+01	0.2000E-01
			0.5738E+01	0.4000E-01
			0.8607E+01	0.6000E-01
			0.1148E+02	0.8000E-01
			0.1291E+02	0.9000E-01
			0.1435E+02	0.1000E+00
			0.1435E+02	0.5000E+00
			0.1435E+02	0.2000E+01
11	10	0.2568E+02		
			0.0000E+00	0.0000E+00
			0.2028E+01	0.1000E-01
			0.4056E+01	0.2000E-01
			0.8112E+01	0.4000E-01
			0.1217E+02	0.6000E-01
			0.1622E+02	0.8000E-01
			0.1825E+02	0.9000E-01
			0.2028E+02	0.1000E+00
			0.2028E+02	0.5000E+00
			0.2028E+02	0.2000E+01
12	10	0.2996E+02		
			0.0000E+00	0.0000E+00
			0.2028E+01	0.1000E-01
			0.4056E+01	0.2000E-01
			0.8112E+01	0.4000E-01
			0.1217E+02	0.6000E-01
			0.1622E+02	0.8000E-01
			0.1825E+02	0.9000E-01
			0.2028E+02	0.1000E+00
			0.2028E+02	0.5000E+00
			0.2028E+02	0.2000E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.3456E+02	0.7639E-02
0.6911E+02	0.1528E-01
0.1382E+03	0.3056E-01
0.2765E+03	0.1986E+00
0.4147E+03	0.6417E+00
0.4976E+03	0.1115E+01
0.5529E+03	0.1528E+01
0.5529E+03	0.2292E+01
0.5529E+03	0.3056E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.6460E+00	0.4844E-03	0.4523E+00	0.1000E-03
0.6460E+01	0.4844E-02	0.4523E+01	0.1000E-02
0.3267E+02	0.2439E-01	0.2262E+02	0.5000E-02
0.6514E+02	0.4877E-01	0.4523E+02	0.1000E-01
0.2336E+03	0.1893E+00	0.1542E+03	0.5000E-01
0.2978E+03	0.2804E+00	0.1953E+03	0.1000E+00
0.4728E+03	0.7973E+00	0.3705E+03	0.5000E+00
0.5798E+03	0.1369E+01	0.4774E+03	0.1000E+01
0.6553E+03	0.2419E+01	0.5529E+03	0.2000E+01

=====

APILE for Windows, Version 2015.7.6

Serial Number : 154813345

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

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This program is licensed to :

Stewart Engineering, Inc
Raleigh, North Carolina

Path to file locations : F:\Projects\GEO\2017\Other\B17006.00_17BP.5.R.79_Wake_216\04 - Calculations\EB1\
Name of input data file : EB1-B side APILE.ap7d
Name of output file : EB1-B side APILE.ap7o
Name of plot output file : EB1-B side APILE.ap7p

Time and Date of Analysis

Date: October 11, 2019 Time: 10:16:01

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* INPUT INFORMATION *

Bridge 216, EB1-B

DESIGNER : C.T. TANG

JOB NUMBER : SF-910216

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
 - CROSS SECTION AREA = 15.50 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 35.00 FT.
 - PILE STICKUP LENGTH, PSL = 0.00 FT.
 - ZERO FRICTION LENGTH, ZFL = 1.00 FT.
 - PERIMETER OF PILE = 48.00 IN.
 - TIP AREA OF PILE = 144.00 IN2
 - INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	SAND	0.00	57.00	28.50	0.00
14.60	SAND	0.00	57.00	28.50	0.00
14.60	SAND	0.00	57.00	34.80	0.00
19.60	SAND	0.00	57.00	34.80	0.00
19.60	SAND	0.00	57.00	40.00	0.00
24.60	SAND	0.00	57.00	40.00	0.00
24.60	SAND	0.00	57.00	37.50	0.00
30.60	SAND	0.00	57.00	37.50	0.00
30.60	SAND	0.00	57.00	40.00	0.00
34.30	SAND	0.00	57.00	40.00	0.00
34.30	SAND	0.00	67.00	45.00	0.00
40.00	SAND	0.00	67.00	45.00	0.00

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT FRICTION KSF	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
14.60	1.000	1.000
14.60	1.000	1.000
19.60	1.000	1.000
19.60	1.000	1.000
24.60	1.000	1.000
24.60	1.000	1.000
30.60	1.000	1.000
30.60	1.000	1.000
34.30	1.000	1.000
34.30	1.000	1.000
40.00	1.000	1.000

1

 * COMPUTATION RESULT *

 * FED. HWY. METHOD *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.4	0.4
1.00	0.1	0.7	0.8
2.00	0.2	1.5	1.8
3.00	0.5	2.3	2.8
4.00	0.9	3.1	4.0
5.00	1.4	3.8	5.2
6.00	2.0	4.6	6.6
7.00	2.8	5.4	8.1
8.00	3.6	6.1	9.7
9.00	4.6	6.9	11.5
10.00	5.6	7.7	13.3
11.00	6.8	8.4	15.2
12.00	8.1	9.2	17.3
13.00	9.5	10.0	19.5
14.00	11.0	16.8	27.8
15.00	12.7	24.6	37.2
16.00	15.3	32.8	48.0
17.00	18.9	40.9	59.7
18.00	22.7	43.3	66.0
19.00	26.7	67.3	94.0
20.00	31.0	94.6	125.6
21.00	37.7	123.0	160.7
22.00	46.9	150.5	197.4
23.00	56.5	157.3	213.8
24.00	66.5	146.9	213.4
25.00	77.0	134.1	211.1
26.00	86.5	120.5	207.0
27.00	95.0	107.8	202.9
28.00	103.8	111.8	215.7
29.00	113.0	115.8	228.8
30.00	122.4	141.1	263.6
31.00	132.2	169.3	301.5
32.00	144.0	198.2	342.2

REQ'D STATIC NOMINAL
 RESISTANCE = 340 KIPS

33.00	157.9	225.7	383.7
34.00	172.2	350.5	522.7
35.00	187.0	485.2	672.2

NOTES:

- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

 * COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
 * CURVES FOR AXIAL LOADING *

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00	0.0000E+00	0.0000E+00
			0.2931E-01	0.1000E-01
			0.5863E-01	0.2000E-01
			0.1173E+00	0.4000E-01
			0.1759E+00	0.6000E-01
			0.2345E+00	0.8000E-01
			0.2638E+00	0.9000E-01
			0.2931E+00	0.1000E+00
			0.2931E+00	0.5000E+00
2	10	0.7325E+01	0.2931E+00	0.2000E+01
			0.0000E+00	0.0000E+00
			0.1563E+00	0.1000E-01
			0.3127E+00	0.2000E-01
			0.6254E+00	0.4000E-01
			0.9380E+00	0.6000E-01
			0.1251E+01	0.8000E-01
			0.1407E+01	0.9000E-01
			0.1563E+01	0.1000E+00
3	10	0.1456E+02	0.1563E+01	0.5000E+00
			0.0000E+00	0.0000E+00
			0.3669E+00	0.1000E-01
			0.7338E+00	0.2000E-01
			0.1468E+01	0.4000E-01
			0.2201E+01	0.6000E-01
			0.2935E+01	0.8000E-01
			0.3302E+01	0.9000E-01
			0.3669E+01	0.1000E+00
4	10	0.1460E+02	0.3669E+01	0.5000E+00
			0.0000E+00	0.0000E+00
			0.3669E+00	0.1000E-01
			0.7338E+00	0.2000E-01
			0.1468E+01	0.4000E-01
			0.2201E+01	0.6000E-01
			0.2935E+01	0.8000E-01
			0.3302E+01	0.9000E-01
			0.3669E+01	0.1000E+00
5	10	0.1713E+02	0.3669E+01	0.5000E+00
			0.0000E+00	0.0000E+00
			0.3669E+00	0.1000E-01
			0.7338E+00	0.2000E-01
			0.1468E+01	0.4000E-01

EB1-B side APILE.ap7o

			0.0000E+00	0.0000E+00
			0.6837E+00	0.1000E-01
			0.1367E+01	0.2000E-01
			0.2735E+01	0.4000E-01
			0.4102E+01	0.6000E-01
			0.5470E+01	0.8000E-01
			0.6154E+01	0.9000E-01
			0.6837E+01	0.1000E+00
			0.6837E+01	0.5000E+00
			0.6837E+01	0.2000E+01
6	10	0.1956E+02		
			0.0000E+00	0.0000E+00
			0.9498E+00	0.1000E-01
			0.1900E+01	0.2000E-01
			0.3799E+01	0.4000E-01
			0.5699E+01	0.6000E-01
			0.7598E+01	0.8000E-01
			0.8548E+01	0.9000E-01
			0.9498E+01	0.1000E+00
			0.9498E+01	0.5000E+00
			0.9498E+01	0.2000E+01
7	10	0.1960E+02		
			0.0000E+00	0.0000E+00
			0.9498E+00	0.1000E-01
			0.1900E+01	0.2000E-01
			0.3799E+01	0.4000E-01
			0.5699E+01	0.6000E-01
			0.7598E+01	0.8000E-01
			0.8548E+01	0.9000E-01
			0.9498E+01	0.1000E+00
			0.9498E+01	0.5000E+00
			0.9498E+01	0.2000E+01
8	10	0.2213E+02		
			0.0000E+00	0.0000E+00
			0.1706E+01	0.1000E-01
			0.3413E+01	0.2000E-01
			0.6825E+01	0.4000E-01
			0.1024E+02	0.6000E-01
			0.1365E+02	0.8000E-01
			0.1536E+02	0.9000E-01
			0.1706E+02	0.1000E+00
			0.1706E+02	0.5000E+00
			0.1706E+02	0.2000E+01
9	10	0.2456E+02		
			0.0000E+00	0.0000E+00
			0.1735E+01	0.1000E-01
			0.3469E+01	0.2000E-01
			0.6938E+01	0.4000E-01
			0.1041E+02	0.6000E-01
			0.1388E+02	0.8000E-01
			0.1561E+02	0.9000E-01
			0.1735E+02	0.1000E+00
			0.1735E+02	0.5000E+00
			0.1735E+02	0.2000E+01
10	10	0.2460E+02		
			0.0000E+00	0.0000E+00
			0.1735E+01	0.1000E-01
			0.3469E+01	0.2000E-01
			0.6938E+01	0.4000E-01
			0.1041E+02	0.6000E-01
			0.1388E+02	0.8000E-01
			0.1561E+02	0.9000E-01
			0.1735E+02	0.1000E+00
			0.1735E+02	0.5000E+00
			0.1735E+02	0.2000E+01
11	10	0.2763E+02		

EB1-B side APILE.ap7o

			0.0000E+00	0.0000E+00
			0.1560E+01	0.1000E-01
			0.3119E+01	0.2000E-01
			0.6238E+01	0.4000E-01
			0.9358E+01	0.6000E-01
			0.1248E+02	0.8000E-01
			0.1404E+02	0.9000E-01
			0.1560E+02	0.1000E+00
			0.1560E+02	0.5000E+00
			0.1560E+02	0.2000E+01
12	10	0.3056E+02		
			0.0000E+00	0.0000E+00
			0.1875E+01	0.1000E-01
			0.3749E+01	0.2000E-01
			0.7498E+01	0.4000E-01
			0.1125E+02	0.6000E-01
			0.1500E+02	0.8000E-01
			0.1687E+02	0.9000E-01
			0.1875E+02	0.1000E+00
			0.1875E+02	0.5000E+00
			0.1875E+02	0.2000E+01
13	10	0.3060E+02		
			0.0000E+00	0.0000E+00
			0.1875E+01	0.1000E-01
			0.3749E+01	0.2000E-01
			0.7498E+01	0.4000E-01
			0.1125E+02	0.6000E-01
			0.1500E+02	0.8000E-01
			0.1687E+02	0.9000E-01
			0.1875E+02	0.1000E+00
			0.1875E+02	0.5000E+00
			0.1875E+02	0.2000E+01
14	10	0.3248E+02		
			0.0000E+00	0.0000E+00
			0.2448E+01	0.1000E-01
			0.4897E+01	0.2000E-01
			0.9793E+01	0.4000E-01
			0.1469E+02	0.6000E-01
			0.1959E+02	0.8000E-01
			0.2203E+02	0.9000E-01
			0.2448E+02	0.1000E+00
			0.2448E+02	0.5000E+00
			0.2448E+02	0.2000E+01
15	10	0.3426E+02		
			0.0000E+00	0.0000E+00
			0.2560E+01	0.1000E-01
			0.5119E+01	0.2000E-01
			0.1024E+02	0.4000E-01
			0.1536E+02	0.6000E-01
			0.2048E+02	0.8000E-01
			0.2304E+02	0.9000E-01
			0.2560E+02	0.1000E+00
			0.2560E+02	0.5000E+00
			0.2560E+02	0.2000E+01
16	10	0.3430E+02		
			0.0000E+00	0.0000E+00
			0.2560E+01	0.1000E-01
			0.5119E+01	0.2000E-01
			0.1024E+02	0.4000E-01
			0.1536E+02	0.6000E-01
			0.2048E+02	0.8000E-01
			0.2304E+02	0.9000E-01
			0.2560E+02	0.1000E+00
			0.2560E+02	0.5000E+00
			0.2560E+02	0.2000E+01
17	10	0.3718E+02		

EB1-B side APILE.ap7o

			0.0000E+00	0.0000E+00
			0.2560E+01	0.1000E-01
			0.5119E+01	0.2000E-01
			0.1024E+02	0.4000E-01
			0.1536E+02	0.6000E-01
			0.2048E+02	0.8000E-01
			0.2304E+02	0.9000E-01
			0.2560E+02	0.1000E+00
			0.2560E+02	0.5000E+00
18	10	0.3996E+02	0.2560E+02	0.2000E+01
			0.0000E+00	0.0000E+00
			0.2560E+01	0.1000E-01
			0.5119E+01	0.2000E-01
			0.1024E+02	0.4000E-01
			0.1536E+02	0.6000E-01
			0.2048E+02	0.8000E-01
			0.2304E+02	0.9000E-01
			0.2560E+02	0.1000E+00
			0.2560E+02	0.5000E+00
			0.2560E+02	0.2000E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.3033E+02	0.7639E-02
0.6065E+02	0.1528E-01
0.1213E+03	0.3056E-01
0.2426E+03	0.1986E+00
0.3639E+03	0.6417E+00
0.4367E+03	0.1115E+01
0.4852E+03	0.1528E+01
0.4852E+03	0.2292E+01
0.4852E+03	0.3056E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.8333E+00	0.7289E-03	0.3970E+00	0.1000E-03
0.8344E+01	0.7291E-02	0.3970E+01	0.1000E-02
0.4250E+02	0.3696E-01	0.1985E+02	0.5000E-02
0.8499E+02	0.7391E-01	0.3970E+02	0.1000E-01
0.2963E+03	0.2811E+00	0.1353E+03	0.5000E-01
0.3676E+03	0.3947E+00	0.1714E+03	0.1000E+00
0.5213E+03	0.9383E+00	0.3251E+03	0.5000E+00
0.6152E+03	0.1526E+01	0.4190E+03	0.1000E+01
0.6814E+03	0.2588E+01	0.4852E+03	0.2000E+01

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
250.0	35.19	0.43	33.7	8.11	17.37

Bridge 216, EB1-A

Hammer Information
 Select from following list [10/17/2016-2003]: ID: **41**

ID	Name	Type	Ram Wt/Ecc. M.	Energy/Power
40	DELMAG D 19-32	OED	4.000	42.440
41	DELMAG D 19-42	OED	4.000	43.240
42	DELMAG D200-42	OED	44.090	492.044

Hammer parameters
 Efficiency: **0.8**
 Pressure: **1600** psi Fixed **100** %
 Stroke: **10.81** ft Variable

Pile material
 Concrete Steel Timber

Cushion Information

	Hammer	Pile	Units
Area	227.	0.	in ²
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	25. ft	Auto	Segments
Penetration	25. ft	Auto.	S-Length
Section Area	15.5 in ²	Auto.	S-St. Wt
Elast Modulus	29000. ksi	0	Splices
Spec Weight	492.0 lb/ft ³		
Toe Area	15.5 in ²		Pile Type:
Perimeter	3.97 ft		H Pile
Pile Size	12.04 in		

Ultimate Capacities (up to 10) kips

1	250.0	6	0.0
2	0.0	7	0.0
3	0.0	8	0.0
4	0.0	9	0.0
5	0.0	10	0.0

Incr. **0** Action >>

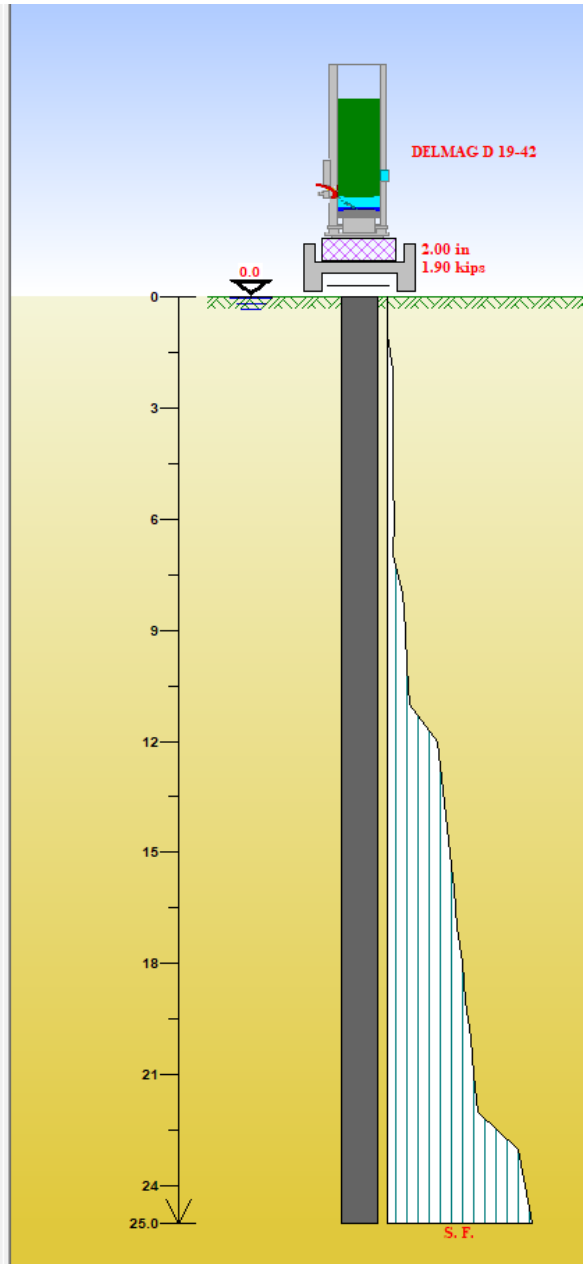
Soil Parameters **2nd Toe - No**

Quake
 Shaft **0.1** in Const
 Toe **0.1** in

Damping
 Shaft **0.05** s/ft Const
 Toe **0.15** s/ft Smith

Shaft Resistance Percentage **19** %
 Dist. Shape Num **0.0**

Residual Stress Analysis: **No**



Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
250.0	29.42	0.68	30.4	8.00	18.08

Bridge 216, EB1-B

Hammer Information
 Select from following list [10/17/2016-2003]: ID: **41**

ID	Name	Type	Ram Wt/Ecc. M.	Energy/Power
40	DELMAG D 19-32	OED	4.000	42.440
41	DELMAG D 19-42	OED	4.000	43.240
42	DELMAG D200-42	OED	44.090	492.044

Hammer parameters
 Efficiency: **0.8**
 Pressure: **1600** psi Fixed **100** %
 Stroke: **10.81** ft Variable

Pile material
 Concrete Steel Timber

Cushion Information

	Hammer	Pile
Area	227.	0 in ²
Elastic Modulus	530.	0 ksi
Thickness	2.	0 in
C.O.R.	0.8	0
Stiffness	0.	0 kips/in
Helmet Weight	1.9	0 kips

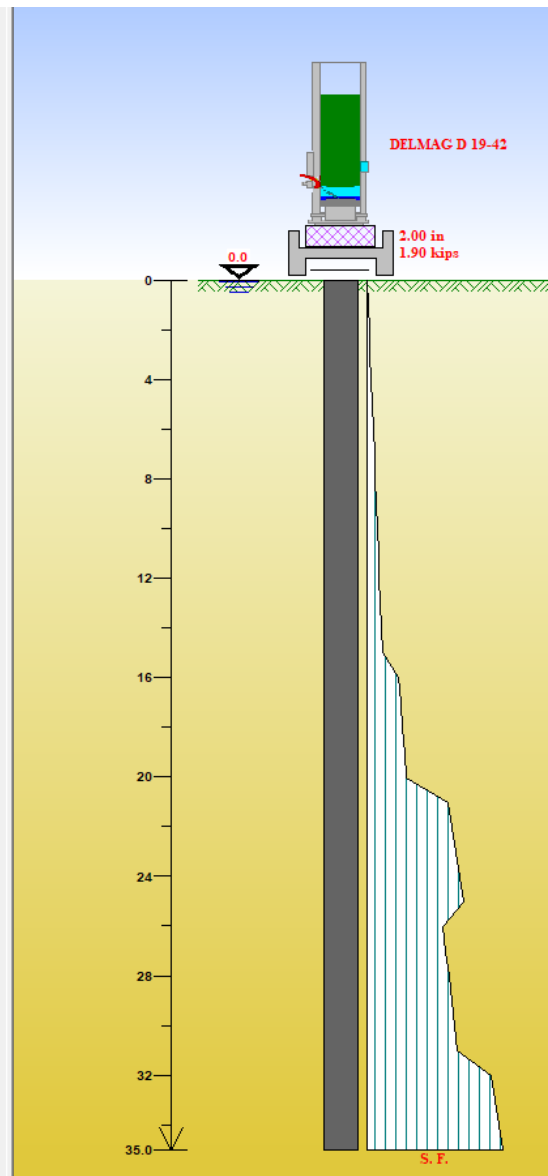
Ultimate Capacities (up to 10)
 kips

1	250.0	6	0.0
2	0.0	7	0.0
3	0.0	8	0.0
4	0.0	9	0.0
5	0.0	10	0.0

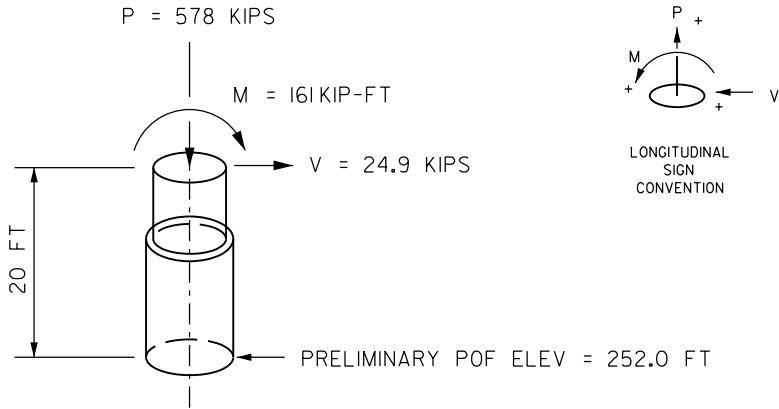
Incr. **0** Action >>

Soil Parameters
 2nd Toe - No
 Quake
 Shaft **0.1** in Const
 Toe **0.1** in
 Damping
 Shaft **0.05** s/ft Const
 Toe **0.15** s/ft Smith
 Shaft Resistance Percentage **42** %
 Dist. Shape Num **0.0**
 Residual Stress Analysis: No

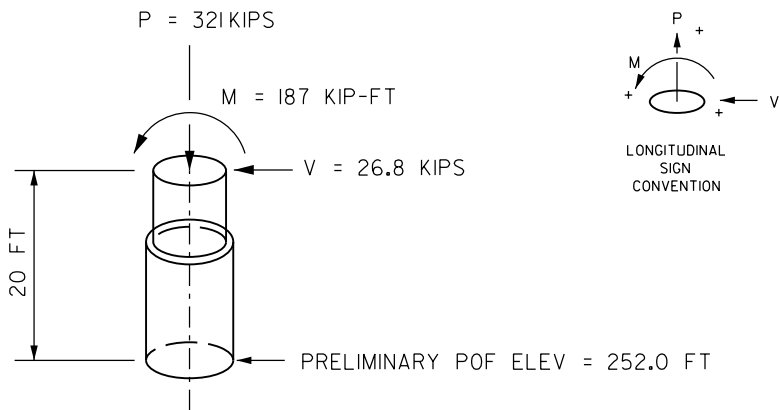
Pile Information
 Length **35.** ft Auto Segments
 Penetration **35.** ft Auto S-Length
 Section Area **15.5** in² Auto S-St, Wt
 Elast Modulus **29000.** ksi 0 Splices
 Spec Weight **492.0** lb/ft³
 Toe Area **15.5** in² Pile Type:
 Perimeter **3.97** ft H Pile
 Pile Size **12.04** in



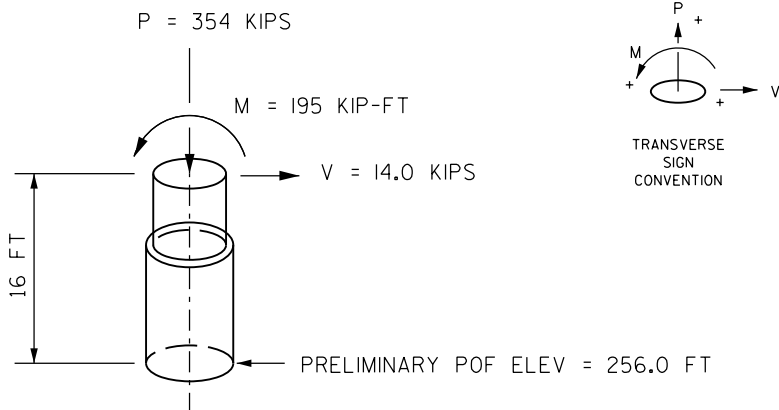
BENT
NO. 1



MAXIMUM AXIAL LOAD WITH
 LONGITUDINAL SHEAR & MOMENT



MAXIMUM LONGITUDINAL SHEAR WITH
 AXIAL LOAD & LONGITUDINAL MOMENT

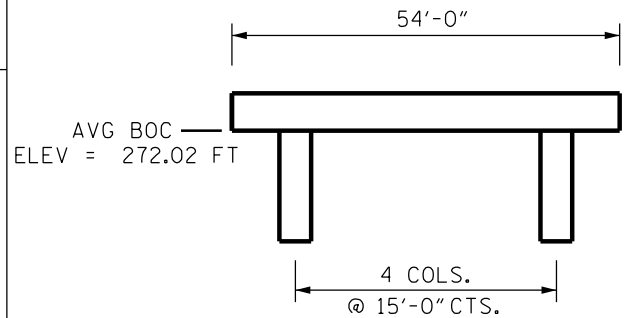


MAXIMUM TRANSVERSE SHEAR WITH
 AXIAL LOAD & TRANSVERSE MOMENT

LEFT

BENT #1

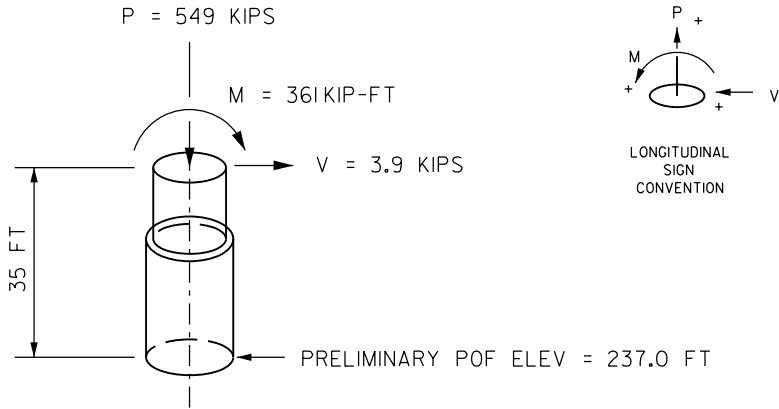
COLUMN Ø = 3.0 FT
 DRILLED SHAFT Ø = 3.0 FT



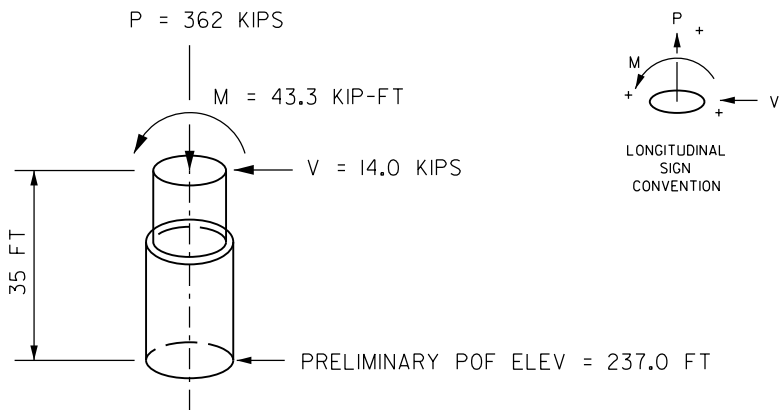
NOTES:

ADJUST ARROWHEADS TO SHOW
 TRUE DIRECTION OF LOADS AND
 MAKE ALL THE LOADS POSITIVE

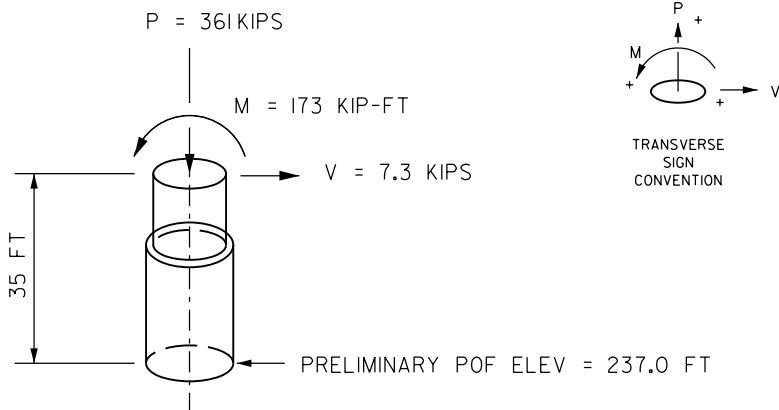
ARROWHEADS FOR SIGN
 CONVENTION REFLECT
 RC PIER GLOBAL AXES.



MAXIMUM AXIAL LOAD WITH
 LONGITUDINAL SHEAR & MOMENT



MAXIMUM LONGITUDINAL SHEAR WITH
 AXIAL LOAD & LONGITUDINAL MOMENT

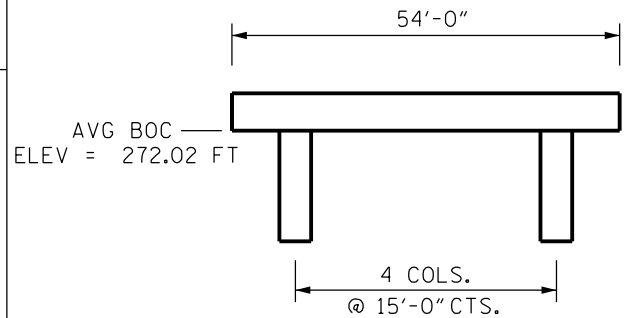


MAXIMUM TRANSVERSE SHEAR WITH
 AXIAL LOAD & TRANSVERSE MOMENT

RIGHT

BENT #1

COLUMN Ø = 3.0 FT
 DRILLED SHAFT Ø = 3.0 FT



NOTES:

ADJUST ARROWHEADS TO SHOW
 TRUE DIRECTION OF LOADS AND
 MAKE ALL THE LOADS POSITIVE

ARROWHEADS FOR SIGN
 CONVENTION REFLECT
 RC PIER GLOBAL AXES.



Elevations

Bottom of Cap (BOC) Elevation =	272.02	ft
Top of Pier/Bottom of Column Elevation =	272.02	ft
Natural Ground / Finished Grade Elevation =	266.00	ft
Groundwater Table (GWT) Elevation =	271.00	ft
Design Scour (DSE) Elevation =	254.00	ft
Amount of Contraction Scour (from BSR) =	9.00	ft
Is Permanent Casing Required? <input checked="" type="radio"/> Yes / Maybe <input type="radio"/> No		
Bottom of Permanent Casing Elevation =	257.00	ft
Drilled Pier Tip Elevation =	246.00	ft

Drilled Pier Information

Maximum Factored Axial Load (P_r) =	580.0	kips
Number of Drilled Piers per Bent =	4	
Diameter of Column (d_{Column}) =	36	in
Diameter of Drilled Pier (d_{DP}) =	36	in
Unit Weight of Concrete (γ_c) =	0.150	kcf
Compressive Strength of Concrete (f'_c) =	4.500	ksi

Subsurface Information and Soil/Rock Layer Properties

internally calculate N_{160} values at midpoint of each layer

Subsurface Boring Name / ID No. =	EB2-C
SPT Hammer Energy Efficiency Rating (ER) =	82 %
Top of Boring (Collar) Elevation =	276.20 ft
Depth to Groundwater Table (for actual boring) =	5.00 ft

BENT 1 - LT

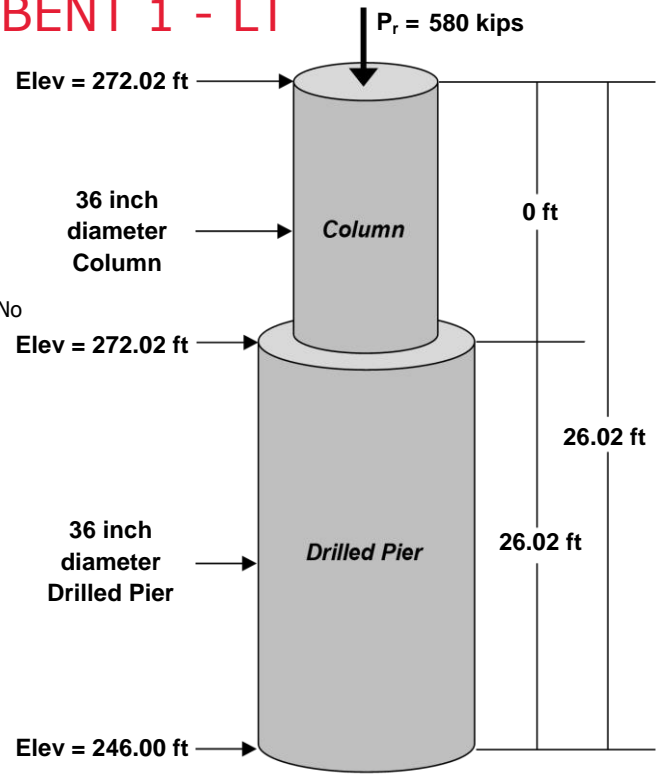


Figure shows typical drilled pier

Calculate GSI using RQD values :
(Use if GSI is not shown on boring)

Layer No.	Material Description	Layer Elevations		Total γ (kcf)	N (bpf)	N_{60} (bpf)	N_{160} (bpf)	RQD (%)	⁽²⁾ GSI	q_u (ksf)	E_i (ksi)	ν
		Top ⁽¹⁾ (ft)	Bottom (ft)									
1	Weathered Rock	254.00	252.70	0.140	100	137	147				X	
2	Hard Rock	252.70	246.00	0.156			N/A	11	22	800		
3												
4												
5												
6												
7												
8												
TIP ⁽³⁾	Hard Rock	246.00	240.00	0.156			N/A	11	22	800	6,000	0.150

Notes

- Resistance from subsurface layers above the Bottom of Column Elevation, Drilled Pier Design Scour Elevation, and Permanent Casing Elevation will be ignored.
- Hard rock layers with poor or very poor quality rock mass ($GSI < 30$) will be modeled as weathered rock.
- Input the subsurface information for the soil / rock at the base of the drilled pier to a distance of 2 pier diameters below the base of the drilled pier.

DISCLAIMER: The application of this spreadsheet is the responsibility of the user. It is imperative that the user understands the potential accuracy limitations and examines the reasonableness of the results with engineering knowledge and experience. There are no expressed or implied warranties.



Correcting SPT Values for Hammer Efficiency and Overburden Pressure

SPT-N Value Corrected for Hammer Efficiency, (N_{60})

$N_{60} = (ER/60\%)(N)$ AASHTO Eqn. 10.4.6.2.4-2

N_{60} = SPT blow count corrected for hammer efficiency (blows/ft)

ER = hammer efficiency expressed as percent of theoretical free fall energy delivered by the hammer system actually used. If ER is not known, use 80% for automatic hammers and 60% for drop hammers.

N = uncorrected SPT blow count (blows/ft)

SPT-N Value Corrected for Overburden Pressure, (N_1)

$N_1 = (C_N)(N)$ AASHTO Eqn. 10.4.6.2.4-1

N_1 = SPT blow count corrected for overburden pressure (blows/ft)

C_N = correction factor = $[0.77 \log_{10}(40/\sigma'_v)] < 2.0$

$\sigma'_v = \sigma_v - \mu$ = effective vertical stress at the depth of the SPT-N value (ksf)

σ_v = total vertical stress at the depth of the SPT-N value (ksf)

μ = total pore water pressure at the depth of the SPT-N value (ksf)

N = uncorrected SPT blow count (blows/ft)

SPT-N Value Corrected for both Overburden Pressure and Hammer Efficiency, (N_{160})

$N_{160} = (C_N)(N)$ AASHTO Eqn. 10.4.6.2.4-3

Summary of Corrected N Values for Boring

Top of Boring (Collar) Elevation = 276.2 ft

Depth to Groundwater Table = 5.0 ft

Hammer Efficiency (ER) = 82 %

Unit Weight of Water = 0.0624 kcf

Layer No.	Layer Elevations		σ_v at top (ksf)	Δz (ft)	Total γ (kcf)	σ_v at bottom (ksf)	σ_v at midpoint (ksf)	z_{water} (ft)	μ at midpoint (ksf)	σ'_{vo} at midpoint (ksf)	N (bpf)	N_{60} (bpf)	C_N	N_{160} (bpf)
	Top (ft)	Bottom (ft)												
1	254.00	252.70	2.664	1.30	0.140	2.846	2.755	17.85	1.114	1.641	100	137	1.07	147
2	252.70	246.00	2.846	6.70	0.156	3.891	3.369	21.85	1.363	2.005	N/A			N/A
3														
4														
5														
6														
7														
8														
TIP	246.00	240.00	3.891	6.00	0.156	4.827	4.359	28.20	1.760	2.6	N/A			N/A



Side Resistance in Weathered and Hard Rock

$R_s = (A_s)(q_s)$ AASHTO Eqn. 10.8.3.5-3

q_s = unit side resistance for weathered or hard rock layer (ksf)

For weathered rock layers or hard rock layers with a GSI < 30

= 8 ksf

NCDOT Policy

For drilled piers socketed into hard rock

$$= \left(C \sqrt{\frac{q_u}{p_a}} \right) p_a$$
 AASHTO Eqn. 10.8.3.5.4b-1

C = regression coefficient taken as 1.0 for normal rock sockets (see AASHTO C10.8.3.5.4b-1 for details)

For fractured rock that caves and cannot be drilled without artificial support

$$= \left(0.65 \alpha_E \sqrt{\frac{q_u}{p_a}} \right) p_a$$
 AASHTO Eqn. 10.8.3.5.4b-2

α_E = reduction factor to account for jointing in rock (from AASHTO Table 10.8.3.5.4b-1)

RQD (%)	Joint Modification Factor, α_E	
	Closed Joints	Open or Gouge-Filled Joints
100	1.00	0.85
70	0.85	0.55
50	0.60	0.55
30	0.50	0.50
20	0.45	0.45

q_u = Uniaxial Compressive Strength of Intact Rock (ksf) $\leq f'_c$

f'_c = 28 day Compressive Strength of Concrete (4.5 ksi = 648 ksf)

p_a = atmospheric pressure (2.12 ksf)

A_s = area of drilled pier side resistance (ft²)

= $(\pi)(B)(\Delta z)$

B = diameter of drilled pier (subtract 2 inches to account for possible reduction of drilled pier in rock)

= (36 inches - 2 inches) / 12 inches per ft = 2.83 ft

Δz = effective thickness of the soil layer (ft)

Layer No.	Rock Type	Layer Elevations		AASHTO Equation and Rock Joint Condition to use	RQD (%)	α_E	q_u (ksf)	q_s (ksf)	Δz (ft)	A_s (ft ²)	R_s (kips)
		Top (ft)	Bottom (ft)								
1	Weathered Rock	254.00	252.70	N/A	N/A	N/A	N/A	8.000	1.30	11.57	93
2	Hard Rock*	252.70	246.00	N/A	N/A	N/A	N/A	8.000	6.70	59.64	477

Total Side Resistance in Weathered and Hard Rock = 570

Note: * Indicates a hard rock layer with a GSI < 30. The layer will be modeled as weatherd rock with a qs vlaue = 8 ksf.



Note: Hard Rock Layers with a poor surface quality ($GSI < 30$) will be modeled as weathered rock with an $N_{60} = 600$ blows/ft

Tip Resistance in Weathered Rock

$R_p = (q_p)(A_p)$ AASHTO Eqn. 10.8.3.5-2

$q_p = \text{unit tip resistance (ksf)}$
 $= (N_c)(S_u)$ AASHTO Eqn. 10.8.3.5.1c-1

$N_c = \text{cohesion bearing capacity factor}$ $N_c = 9$ for Weathered Rock per NCDOT Policy

$S_u = \text{undrained shear strength of material below drilled pier tip (ksf)}$
 $= 0.23(OCR)^{0.8}(\sigma'_{vo})$ Mayne and Harris, 1993 (after Jamiolkowski, et al., 1985)

$OCR = (\sigma'_p)/(\sigma'_{vo})$
 $\sigma'_p = 0.47(N_{60})^{0.8}(\rho_a)$ AASHTO Eqn. 10.8.3.5.2b-4

$N_{60} = \text{SPT-N value corrected for hammer efficiency}$ N_{60} limited to 600 blows/ft

$\rho_a = \text{atmospheric pressure (2.12 ksf)}$

$\sigma'_{vo} = \text{effective vertical stress at drilled pier tip as defined in FHWA GEC 010 pages 13-46}$

$A_p = \text{area of drilled pier tip resistance (ft}^2\text{)}$
 $= (\pi)(B^2)/4$

$B = \text{diameter of drilled pier (subtract 2 inches to account for possible reduction of drilled pier in rock)}$
 $(36 \text{ inches} - 2 \text{ inches}) / 12 \text{ inches per ft} = 2.83 \text{ ft}$

Tip Elevation (ft)	N_c	N_{60}	σ'_p (ksf)	σ'_{vo} (ksf)	OCR	S_u (ksf)	q_p (ksf)	A_p (ft ²)	R_p (kips)
246.00	9	600	166	0.901	184.640	13.472	121.248	6.31	765

Summary of Nominal and Factored Side Resistance

Material Type	Nominal Side Resistance (kips)	Resistance Factor from AASHTO Table 10.5.5.2.4-1	Factored Side Resistance (kips)	Percentage of Side Resistance produced by Material Type
Cohesive Soil	0	0.45	0	0.0%
Cohesionless Soil	0	0.55	0	0.0%
Cohesive/GM	0	0.60	0	0.0%
Weathered Rock	570	0.60	342	100.0%
Hard Rock	0	0.55	0	0.0%
Total	570		342	100%

Summary of Total Nominal and Factored Tip Resistance

Total Nominal Tip Resistance = 765 kips
 Tip Resistance Factor = 0.55
 Total Factored Tip Resistance = 421 kips

the drilled pier is bearing on Weathered Rock for Weathered Rock (use IGM), see AASHTO Table 10.5.5.2.4-1.





Required Factored Resistance

R_req = P_r + gamma_DC(W_Column + W_Pier) - gamma_WA W_Water - gamma_DC W_Soil/Rock >= P_r Required Factored Resistance

P_r = 580 kips Maximum Factored Axial Load Reported by Structure Design

gamma_DC = 1.25 Factor for Permanent Dead Loads, from AASHTO Table 3.4.1-2

gamma_WA = 1.00 Factor for Water Loads, from AASHTO Table 3.4.1-1

W_Column = (A_Column)(L_Column)(gamma_c) Unfactored Weight of Column

A_Column = 7.07 ft^2 Area of Column

L_Column = 0 ft Length of Column

gamma_c = 0.150 kcf Unit Weight of Concrete

= 0 kips

W_Pier = (A_Pier)(L_Pier)(gamma_c) Unfactored Weight of Drilled Pier

A_Pier = 7.07 ft^2 Area of Drilled Pier

L_Pier = 26.02 ft Length of Drilled Pier

gamma_c = 0.150 kcf Unit Weight of Concrete

= 28 kips

W_Water = (A_Pier)(Z_w)(gamma_w) Unfactored Weight of Water Displaced by Drilled Pier

A_Pier = 7.07 ft^2 Area of Drilled Pier

Z_w = 25 ft Depth from water surface to the drilled pier tip

gamma_w = 0.0624 kcf Unit Weight of Water

= 11 kips

W_Soil/Rock = (A_Pier)(sigma'_vo) Unfactored Effective Weight of Soil / Rock that will be displaced

A_Pier = 7.07 ft^2 Area of Drilled Pier

sigma'_vo = 0.901 ksf effective vertical stress at drilled pier tip as defined in FHWA GEC 010 pages 13-46

W_Soil/Rock = 6 kips

R_req = 580 kips + 1.25(0 kips + 28 kips) - 1.00(11 kips) - 1.25(6 kips) = 597 kips

Load Transfer of Side and Tip Resistance

The majority of the side resistance is produced by Weathered Rock, which is treated as a cohesive material for Load transfer. Use AASHTO Figure 10.8.2.2.1 to predict the normalized load transfer for side resistance.

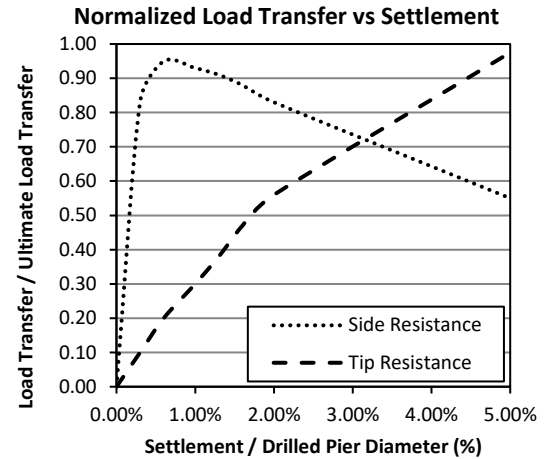
The drilled pier tip is bearing on Weathered Rock, which is treated as a cohesive material for load transfer. Use AASHTO Figure 10.8.2.2.2 to predict the normalized load transfer for tip resistance.





Load Transfer of Side and Tip Resistance (continued)

$\Delta z / D$ (%)	Normalized Side Transfer R_{sd} / R_s AASHTO Figure 10.8.2.2.2.1	Normalized Tip Transfer R_{pd} / R_p AASHTO Figure 10.8.2.2.2.2
0.0	0.00	0.00
0.3	0.83	0.10
0.6	0.95	0.20
1.0	0.93	0.30
1.3	0.91	0.38
1.6	0.88	0.47
2.0	0.83	0.56
5.0	0.55	0.98



$\Delta z / D$ = total settlement / drilled pier diameter
 R_{sd} / R_s = developed side resistance / total nominal side resistance
 R_{pd} / R_p = developed tip resistance / total nominal tip resistance

Developed Factored Resistance, (R_{rd})

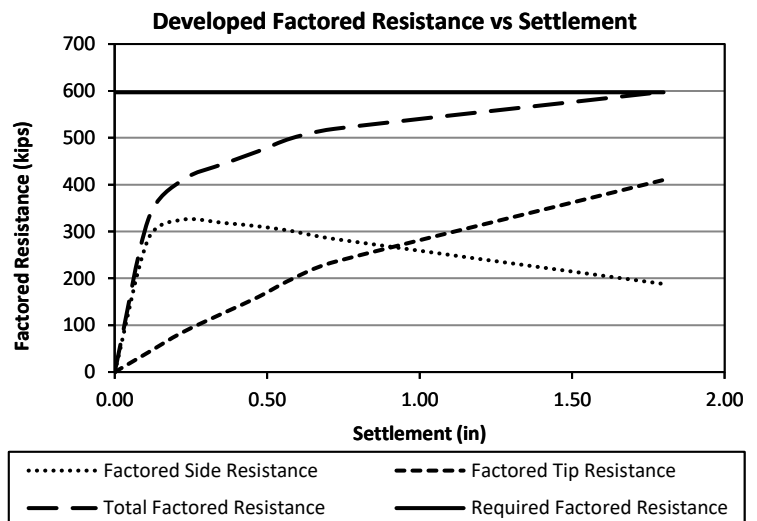
Use the normalized load transfer values along with the total factored side and tip resistance values to calculate the developed side and tip resistance at different vertical displacements. The developed factored resistance must be greater than or equal to the required axial resistance, ($R_{rd} \geq R_{req}$).

$\frac{\Delta z}{D}$	D (in)	Δz (in)	$\phi_{qs}R_s$ (kips)	$\frac{R_{sd}}{R_s}$	$\phi_{qs}R_{sd}$ (kips)	$\phi_{qp}R_p$ (kips)	$\frac{R_{pd}}{R_p}$	$\phi_{qp}R_{pd}$ (kips)	R_{rd} (kips)	R_{req} (kips)	Axial Resistance Requirement Satisfied
0.3%	36	0.11	342	0.83	284	421	0.10	42	326	597	NO
0.6%	36	0.22	342	0.95	325	421	0.20	84	409	597	NO
1.0%	36	0.36	342	0.93	318	421	0.30	127	445	597	NO
1.3%	36	0.47	342	0.91	311	421	0.38	160	471	597	NO
1.6%	36	0.58	342	0.88	301	421	0.47	198	499	597	NO
2.0%	36	0.72	342	0.83	284	421	0.56	235	519	597	NO
5.0%	36	1.80	342	0.55	188	421	0.98	410	598	597	YES

$\phi_{qs}R_s$ = total factored side resistance
 $\phi_{qp}R_p$ = total factored tip resistance
 $\phi_{qs}R_{sd}$ = developed factored side resistance
 = $(R_{sd}/R_s)(\phi_{qs}R_s)$
 $\phi_{qp}R_{pd}$ = developed factored tip resistance
 = $(R_{pd}/R_p)(\phi_{qp}R_p)$

The axial resistance requirement is satisfied at an estimated vertical displacement of 1.8 inches.

Developed Factored Side Resistance = 188 kips
 Developed Factored Tip Resistance = 410 kips
 Developed Factored Total Resistance = 598 kips





Required Tip Resistance

q_{req} = required tip resistance (rounded up to the nearest 10 ksf or 5 tsf)

$$= \frac{R_{req} - \phi_{qs}R_{sd}}{A_T} \leq q_p$$

NCDOT policy

R_r = required factored geotechnical resistance (kips)

$\phi_{qs}R_{sd}$ = factored developed side resistance (kips)

A_T = area of drilled pier tip (ft²)

ϕ_{qp} = tip resistance factor

q_p = unit tip resistance (ksf)

R_{req} (kips)	$\phi_{qs}R_{sd}$ (kips)	A_{Tip} (ft ²)	ϕ_{qp}	q_p (ksf)	q_{req} (ksf)
597	188	6.31	0.55	121	120



BENT 1 - RT

Elevations

Bottom of Cap (BOC) Elevation =	272.02	ft
Top of Pier/Bottom of Column Elevation =	272.02	ft
Natural Ground / Finished Grade Elevation =	266.00	ft
Groundwater Table (GWT) Elevation =	271.00	ft
Design Scour (DSE) Elevation =	254.00	ft
Amount of Contraction Scour (from BSR) =	9.00	ft
Is Permanent Casing Required?	<input checked="" type="radio"/> Yes / Maybe <input type="radio"/> No	
Bottom of Permanent Casing Elevation =	238.00	ft
Drilled Pier Tip Elevation =	226.00	ft

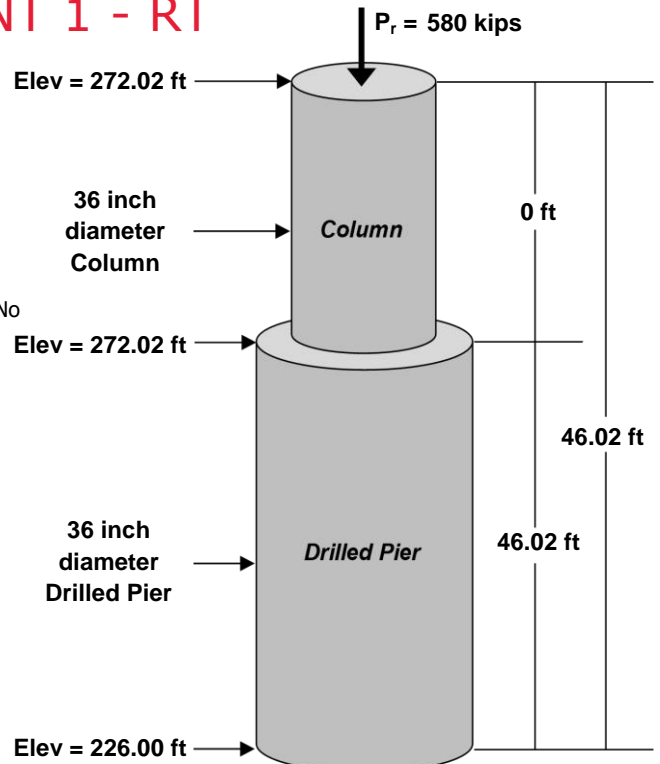


Figure shows typical drilled pier

Drilled Pier Information

Maximum Factored Axial Load (P_r) =	580.0	kips
Number of Drilled Piers per Bent =	4	
Diameter of Column (d_{Column}) =	36	in
Diameter of Drilled Pier (d_{DP}) =	36	in
Unit Weight of Concrete (γ_c) =	0.150	kcf
Compressive Strength of Concrete (f'_c) =	4.500	ksi

Subsurface Information and Soil/Rock Layer Properties

internally calculate N_{160} values at midpoint of each layer

Subsurface Boring Name / ID No. =	EB2-B
SPT Hammer Energy Efficiency Rating (ER) =	73 %
Top of Boring (Collar) Elevation =	272.10 ft
Depth to Groundwater Table (for actual boring) =	1.00 ft

Calculate GSI using RQD values :
(Use if GSI is not shown on boring)

Layer No.	Material Description	Layer Elevations		Total γ (kcf)	N (bpf)	N_{60} (bpf)	N_{160} (bpf)	RQD (%)	⁽²⁾ GSI	q_u (ksf)	E_i (ksi)	ν
		Top ⁽¹⁾ (ft)	Bottom (ft)									
1	Weathered Rock	238.00	229.00	0.140	100	122	115				X	
2	Hard Rock	229.00	226.00	0.156			N/A	11	22	800		
3												
4												
5												
6												
7												
8												
TIP ⁽³⁾	Hard Rock	226.00	220.00	0.156			N/A	11	22	800	6,000	0.150

Notes

- Resistance from subsurface layers above the Bottom of Column Elevation, Drilled Pier Design Scour Elevation, and Permanent Casing Elevation will be ignored.
- Hard rock layers with poor or very poor quality rock mass ($GSI < 30$) will be modeled as weathered rock.
- Input the subsurface information for the soil / rock at the base of the drilled pier to a distance of 2 pier diameters below the base of the drilled pier.

DISCLAIMER: The application of this spreadsheet is the responsibility of the user. It is imperative that the user understands the potential accuracy limitations and examines the reasonableness of the results with engineering knowledge and experience. There are no expressed or implied warranties.



Correcting SPT Values for Hammer Efficiency and Overburden Pressure

SPT-N Value Corrected for Hammer Efficiency, (N_{60})

$N_{60} = (ER/60\%)(N)$ AASHTO Eqn. 10.4.6.2.4-2

N_{60} = SPT blow count corrected for hammer efficiency (blows/ft)

ER = hammer efficiency expressed as percent of theoretical free fall energy delivered by the hammer system actually used. If ER is not known, use 80% for automatic hammers and 60% for drop hammers.

N = uncorrected SPT blow count (blows/ft)

SPT-N Value Corrected for Overburden Pressure, (N_1)

$N_1 = (C_N)(N)$ AASHTO Eqn. 10.4.6.2.4-1

N_1 = SPT blow count corrected for overburden pressure (blows/ft)

C_N = correction factor = $[0.77 \log_{10}(40/\sigma'_v)] < 2.0$

$\sigma'_v = \sigma_v - \mu$ = effective vertical stress at the depth of the SPT-N value (ksf)

σ_v = total vertical stress at the depth of the SPT-N value (ksf)

μ = total pore water pressure at the depth of the SPT-N value (ksf)

N = uncorrected SPT blow count (blows/ft)

SPT-N Value Corrected for both Overburden Pressure and Hammer Efficiency, (N_{160})

$N_{160} = (C_N)(N)$ AASHTO Eqn. 10.4.6.2.4-3

Summary of Corrected N Values for Boring

Top of Boring (Collar) Elevation = 272.1 ft

Depth to Groundwater Table = 1.0 ft

Hammer Efficiency (ER) = 73 %

Unit Weight of Water = 0.0624 kcf

Layer No.	Layer Elevations		σ_v at top (ksf)	Δz (ft)	Total γ (kcf)	σ_v at bottom (ksf)	σ_v at midpoint (ksf)	z_{water} (ft)	μ at midpoint (ksf)	σ'_{vo} at midpoint (ksf)	N (bpf)	N_{60} (bpf)	C_N	N_{160} (bpf)
	Top (ft)	Bottom (ft)												
1	238.00	229.00	4.092	9.00	0.140	5.352	4.722	37.60	2.346	2.376	100	122	0.94	115
2	229.00	226.00	5.352	3.00	0.156	5.820	5.586	43.60	2.721	2.865	N/A			N/A
3														
4														
5														
6														
7														
8														
TIP	226.00	220.00	5.820	6.00	0.156	6.756	6.288	48.10	3.001	3.287	N/A			N/A



Side Resistance in Weathered and Hard Rock

$R_s = (A_s)(q_s)$ AASHTO Eqn. 10.8.3.5-3

q_s = unit side resistance for weathered or hard rock layer (ksf)

For weathered rock layers or hard rock layers with a GSI < 30

= 8 ksf

NCDOT Policy

For drilled piers socketed into hard rock

$$= \left(C \sqrt{\frac{q_u}{p_a}} \right) p_a$$

AASHTO Eqn. 10.8.3.5.4b-1

C = regression coefficient taken as 1.0 for normal rock sockets (see AASHTO C10.8.3.5.4b-1 for details)

For fractured rock that caves and cannot be drilled without artificial support

$$= \left(0.65 \alpha_E \sqrt{\frac{q_u}{p_a}} \right) p_a$$

AASHTO Eqn. 10.8.3.5.4b-2

α_E = reduction factor to account for jointing in rock (from AASHTO Table 10.8.3.5.4b-1)

RQD (%)	Joint Modification Factor, α_E	
	Closed Joints	Open or Gouge-Filled Joints
100	1.00	0.85
70	0.85	0.55
50	0.60	0.55
30	0.50	0.50
20	0.45	0.45

q_u = Uniaxial Compressive Strength of Intact Rock (ksf) $\leq f'_c$

f'_c = 28 day Compressive Strength of Concrete (4.5 ksi = 648 ksf)

p_a = atmospheric pressure (2.12 ksf)

A_s = area of drilled pier side resistance (ft²)

= $(\pi)(B)(\Delta z)$

B = diameter of drilled pier (subtract 2 inches to account for possible reduction of drilled pier in rock)

= (36 inches - 2 inches) / 12 inches per ft = 2.83 ft

Δz = effective thickness of the soil layer (ft)

Layer No.	Rock Type	Layer Elevations		AASHTO Equation and Rock Joint Condition to use	RQD (%)	α_E	q_u (ksf)	q_s (ksf)	Δz (ft)	A_s (ft ²)	R_s (kips)
		Top (ft)	Bottom (ft)								
1	Weathered Rock	238.00	229.00	N/A	N/A	N/A	N/A	8.000	9.00	80.11	641
2	Hard Rock*	229.00	226.00	N/A	N/A	N/A	N/A	8.000	3.00	26.70	214

Total Side Resistance in Weathered and Hard Rock = 855

Note: * Indicates a hard rock layer with a GSI < 30. The layer will be modeled as weatherd rock with a qs vlaue = 8 ksf.



Note: Hard Rock Layers with a poor surface quality ($GSI < 30$) will be modeled as weathered rock with an $N_{60} = 600$ blows/ft

Tip Resistance in Weathered Rock

$R_p = (q_p)(A_p)$ AASHTO Eqn. 10.8.3.5-2

$q_p = \text{unit tip resistance (ksf)}$
 $= (N_c)(S_u)$ AASHTO Eqn. 10.8.3.5.1c-1

$N_c = \text{cohesion bearing capacity factor}$ $N_c = 9$ for Weathered Rock per NCDOT Policy

$S_u = \text{undrained shear strength of material below drilled pier tip (ksf)}$
 $= 0.23(OCR)^{0.8}(\sigma'_{vo})$ Mayne and Harris, 1993 (after Jamiolkowski, et al., 1985)

$OCR = (\sigma'_p)/(\sigma'_{vo})$
 $\sigma'_p = 0.47(N_{60})^{0.8}(\rho_a)$ AASHTO Eqn. 10.8.3.5.2b-4

$N_{60} = \text{SPT-N value corrected for hammer efficiency}$ N_{60} limited to 600 blows/ft

$\rho_a = \text{atmospheric pressure (2.12 ksf)}$

$\sigma'_{vo} = \text{effective vertical stress at drilled pier tip as defined in FHWA GEC 010 pages 13-46}$

$A_p = \text{area of drilled pier tip resistance (ft}^2\text{)}$
 $= (\pi)(B^2)/4$

$B = \text{diameter of drilled pier (subtract 2 inches to account for possible reduction of drilled pier in rock)}$
 $(36 \text{ inches} - 2 \text{ inches}) / 12 \text{ inches per ft} = 2.83 \text{ ft}$

Tip Elevation (ft)	N_c	N_{60}	σ'_p (ksf)	σ'_{vo} (ksf)	OCR	S_u (ksf)	q_p (ksf)	A_p (ft ²)	R_p (kips)
226.00	9	600	166	2.394	69.487	16.38	147.42	6.31	930

Summary of Nominal and Factored Side Resistance

Material Type	Nominal Side Resistance (kips)	Resistance Factor from AASHTO Table 10.5.5.2.4-1	Factored Side Resistance (kips)	Percentage of Side Resistance produced by Material Type
Cohesive Soil	0	0.45	0	0.0%
Cohesionless Soil	0	0.55	0	0.0%
Cohesive/GM	0	0.60	0	0.0%
Weathered Rock	855	0.60	513	100.0%
Hard Rock	0	0.55	0	0.0%
Total	855		513	100%

Summary of Total Nominal and Factored Tip Resistance

Total Nominal Tip Resistance = 930 kips
 Tip Resistance Factor = 0.55
 Total Factored Tip Resistance = 512 kips

the drilled pier is bearing on Weathered Rock for Weathered Rock (use IGM), see AASHTO Table 10.5.5.2.4-1.





Required Factored Resistance

R_req = P_r + gamma_DC(W_Column + W_Pier) - gamma_WA W_Water - gamma_DC W_Soil/Rock >= P_r Required Factored Resistance

P_r = 580 kips

Maximum Factored Axial Load Reported by Structure Design

gamma_DC = 1.25

Factor for Permanent Dead Loads, from AASHTO Table 3.4.1-2

gamma_WA = 1.00

Factor for Water Loads, from AASHTO Table 3.4.1-1

W_Column = (A_Column)(L_Column)(gamma_c) Unfactored Weight of Column

A_Column = 7.07 ft^2

Area of Column

L_Column = 0 ft

Length of Column

gamma_c = 0.150 kcf

Unit Weight of Concrete

= 0 kips

W_Pier = (A_Pier)(L_Pier)(gamma_c) Unfactored Weight of Drilled Pier

A_Pier = 7.07 ft^2

Area of Drilled Pier

L_Pier = 46.02 ft

Length of Drilled Pier

gamma_c = 0.150 kcf

Unit Weight of Concrete

= 49 kips

W_Water = (A_Pier)(Z_w)(gamma_w) Unfactored Weight of Water Displaced by Drilled Pier

A_Pier = 7.07 ft^2

Area of Drilled Pier

Z_w = 45 ft

Depth from water surface to the drilled pier tip

gamma_w = 0.0624 kcf

Unit Weight of Water

= 20 kips

W_Soil/Rock = (A_Pier)(sigma'_vo) Unfactored Effective Weight of Soil / Rock that will be displaced

A_Pier = 7.07 ft^2

Area of Drilled Pier

sigma'_vo = 2.394 ksf

Effective vertical stress at drilled pier tip as defined in FHWA GEC 010 pages 13-46

W_Soil/Rock = 17 kips

R_req = 580 kips + 1.25(0 kips + 49 kips) - 1.00(20 kips) - 1.25(17 kips) = 600 kips

Load Transfer of Side and Tip Resistance

The majority of the side resistance is produced by Weathered Rock, which is treated as a cohesive material for Load transfer. Use AASHTO Figure 10.8.2.2.1 to predict the normalized load transfer for side resistance.

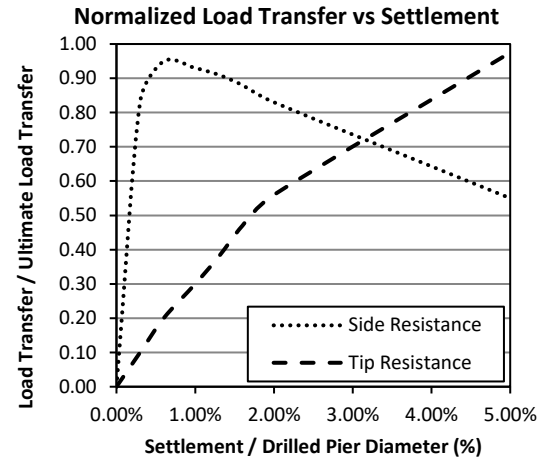
The drilled pier tip is bearing on Weathered Rock, which is treated as a cohesive material for load transfer. Use AASHTO Figure 10.8.2.2.2 to predict the normalized load transfer for tip resistance.





Load Transfer of Side and Tip Resistance (continued)

$\Delta z / D$ (%)	Normalized Side Transfer R_{sd} / R_s AASHTO Figure 10.8.2.2.2.1	Normalized Tip Transfer R_{pd} / R_p AASHTO Figure 10.8.2.2.2.2
0.0	0.00	0.00
0.3	0.83	0.10
0.6	0.95	0.20
1.0	0.93	0.30
1.3	0.91	0.38
1.6	0.88	0.47
2.0	0.83	0.56
5.0	0.55	0.98



$\Delta z / D$ = total settlement / drilled pier diameter
 R_{sd} / R_s = developed side resistance / total nominal side resistance
 R_{pd} / R_p = developed tip resistance / total nominal tip resistance

Developed Factored Resistance, (R_{rd})

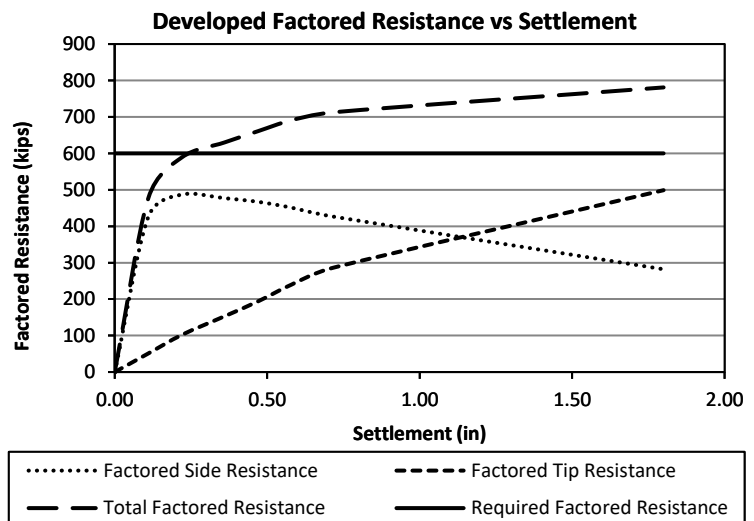
Use the normalized load transfer values along with the total factored side and tip resistance values to calculate the developed side and tip resistance at different vertical displacements. The developed factored resistance must be greater than or equal to the required axial resistance, ($R_{rd} \geq R_{req}$).

$\frac{\Delta z}{D}$	D (in)	Δz (in)	$\phi_{qs}R_s$ (kips)	$\frac{R_{sd}}{R_s}$	$\phi_{qs}R_{sd}$ (kips)	$\phi_{qp}R_p$ (kips)	$\frac{R_{pd}}{R_p}$	$\phi_{qp}R_{pd}$ (kips)	R_{rd} (kips)	R_{req} (kips)	Axial Resistance Requirement Satisfied
0.3%	36	0.11	513	0.83	426	512	0.10	51	477	600	NO
0.6%	36	0.22	513	0.95	487	512	0.20	102	589	600	NO
1.0%	36	0.36	513	0.93	477	512	0.30	153	630	600	YES
1.3%	36	0.47	513	0.91	467	512	0.38	194	661	600	YES
1.6%	36	0.58	513	0.88	451	512	0.47	240	691	600	YES
2.0%	36	0.72	513	0.83	426	512	0.56	287	713	600	YES
5.0%	36	1.80	513	0.55	282	512	0.98	499	781	600	YES

$\phi_{qs}R_s$ = total factored side resistance
 $\phi_{qp}R_p$ = total factored tip resistance
 $\phi_{qs}R_{sd}$ = developed factored side resistance
 = $(R_{sd}/R_s)(\phi_{qs}R_s)$
 $\phi_{qp}R_{pd}$ = developed factored tip resistance
 = $(R_{pd}/R_p)(\phi_{qp}R_p)$

The axial resistance requirement is satisfied at an estimated vertical displacement of 0.36 inches.

Developed Factored Side Resistance = 477 kips
 Developed Factored Tip Resistance = 153 kips
 Developed Factored Total Resistance = 630 kips





Required Tip Resistance

q_{req} = required tip resistance (rounded up to the nearest 10 ksf or 5 tsf)

$$= \frac{R_{req} - \phi_{qs}R_{sd}}{A_T} \leq q_p$$

NCDOT policy

R_r = required factored geotechnical resistance (kips)

$\phi_{qs}R_{sd}$ = factored developed side resistance (kips)

A_T = area of drilled pier tip (ft²)

ϕ_{qp} = tip resistance factor

q_p = unit tip resistance (ksf)

R_{req} (kips)	$\phi_{qs}R_{sd}$ (kips)	A_{Tip} (ft ²)	ϕ_{qp}	q_p (ksf)	q_{req} (ksf)
600	477	6.31	0.55	147	40

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LPile for Windows, Version 2019-11.003

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method
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Files Used for Analysis

Path to file locations:

\Projects\GEO\2019\Other\T19014.00 Wake 216 (Alignment Shift)\06 - Calculations\Structures\B1\

Name of input data file:

L-pile B-1A.lp11d

Name of output report file:

L-pile B-1A.lp11o

Name of plot output file:

L-pile B-1A.lp11p

Name of runtime message file:

L-pile B-1A.lp11r

Date and Time of Analysis

Date: December 5, 2019

Time: 9:57:07

Problem Title

Project Name: Bridge 216 (Wake)

Job Number: 17BP.5.R.79 (SF-910216)

Client: NCDOT

Engineer: C.T. Tang

Description: Bent 1

Program Options and Settings

Computational Options:

- Conventional Analysis

Engineering Units Used for Data Input and Computations:

- US Customary System Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 7.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:

- Static loading specified
- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

- Number of pile sections defined = 1
- Total length of pile = 27.000 ft
- Depth of ground surface below top of pile = 18.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
-----	-----	-----

1	0.000	36.0000
2	27.000	36.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is an elastic pile

Cross-sectional Shape	=	Circular Pile
Length of section	=	27.000000 ft
Width of top of section	=	36.000000 in
Width of bottom of section	=	36.000000 in
Top Area	=	1018. sq. in
Bottom Area	=	1018. sq. in
Moment of Inertia at Top	=	82448. in^4
Moment of Inertia at Bottom	=	82448. in^4
Elastic Modulus	=	3800000. psi

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	18.000000 ft
Distance from top of pile to bottom of layer	=	19.000000 ft
Effective unit weight at top of layer	=	67.000000 pcf
Effective unit weight at bottom of layer	=	67.000000 pcf
Friction angle at top of layer	=	45.000000 deg.
Friction angle at bottom of layer	=	45.000000 deg.
Subgrade k at top of layer	=	0.0000 pci
Subgrade k at bottom of layer	=	0.0000 pci

NOTE: Default values for subgrade k will be computed for this layer.

Layer 2 is weak rock, p-y criteria by Reese, 1997

Distance from top of pile to top of layer	=	19.000000 ft
Distance from top of pile to bottom of layer	=	50.000000 ft
Effective unit weight at top of layer	=	156.000000 pcf
Effective unit weight at bottom of layer	=	156.000000 pcf
Uniaxial compressive strength at top of layer	=	5700. psi
Uniaxial compressive strength at bottom of layer	=	5700. psi
Initial modulus of rock at top of layer	=	8000. psi
Initial modulus of rock at bottom of layer	=	8000. psi
RQD of rock at top of layer	=	11.000000 %
RQD of rock at bottom of layer	=	11.000000 %
k _{rm} of rock at top of layer	=	0.0005000

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 = 0.0005000

k r m of rock at bottom of layer

(Depth of the lowest soil layer extends 23.000 ft below the pile tip)

**** Warning - Possible Input Data Error ****

Values entered for effective unit weight of rock were outside the limits of 50 pcf to 150 pcf.

The maximum input value, in layer 1, for effective unit weight = 156.00 pcf

This data may be erroneous. Please check your data.

 Summary of Input Soil Properties

Layer	Soil Type	Layer	Effective	Angle of	Uniaxial		E50	
Layer	Rock Mass	Depth	Unit Wt.	Friction	qu	RQD %	or	kpy
Num.	Name (p-y Curve Type)	ft	pcf	deg.	psi		krm	pci
	Modulus psi							
1	Sand	18.0000	67.0000	45.0000	--	--	--	
default	--							
	(Reese, et al.)	19.0000	67.0000	45.0000	--	--	--	
default	--							
2	Weak	19.0000	156.0000	--	5700.	11.0000	5.00E-04	--
	8000.							
	Rock	50.0000	156.0000	--	5700.	11.0000	5.00E-04	--
	8000.							

 Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

 Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 24900. lbs	M = 1932000. in-lbs	578000.	No	Yes
2	1	V = 26800. lbs	M = 2244000. in-lbs	321000.	No	Yes
3	2	V = 1800. lbs	S = 0.0000 in/in	354000.	No	Yes

V = shear force applied normal to pile axis

M = bending moment applied to pile head

y = lateral deflection normal to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Values of top y vs. pile lengths can be computed only for load types with

specified shear loading (Load Types 1, 2, and 3).
 Thrust force is assumed to be acting axially for all pile batter angles.

 Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

 Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	18.0000	0.00	N.A.	No	0.00	1952.
2	19.0000	1.0000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

 Computed Values of Pile Loading and Deflection
 for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 24900.0 lbs
 Applied moment at pile head = 1932000.0 in-lbs
 Axial thrust load on pile head = 578000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.7184	1932000.	24900.	-0.00454	989.6425	3.13E+11	0.00	0.00	0.00
0.2700	0.7037	2021151.	24900.	-0.00452	1009.	3.13E+11	0.00	0.00	0.00
0.5400	0.6891	2110264.	24900.	-0.00449	1029.	3.13E+11	0.00	0.00	0.00
0.8100	0.6746	2199335.	24900.	-0.00447	1048.	3.13E+11	0.00	0.00	0.00
1.0800	0.6601	2288364.	24900.	-0.00445	1067.	3.13E+11	0.00	0.00	0.00
1.3500	0.6458	2377348.	24900.	-0.00442	1087.	3.13E+11	0.00	0.00	0.00
1.6200	0.6315	2466286.	24900.	-0.00440	1106.	3.13E+11	0.00	0.00	0.00
1.8900	0.6172	2555177.	24900.	-0.00437	1126.	3.13E+11	0.00	0.00	0.00
2.1600	0.6031	2644018.	24900.	-0.00435	1145.	3.13E+11	0.00	0.00	0.00
2.4300	0.5891	2732808.	24900.	-0.00432	1164.	3.13E+11	0.00	0.00	0.00

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2.7000	0.5751	2821545.	24900.	-0.00429	1184.	3.13E+11	0.00	0.00	0.00
2.9700	0.5613	2910227.	24900.	-0.00426	1203.	3.13E+11	0.00	0.00	0.00
3.2400	0.5475	2998853.	24900.	-0.00423	1223.	3.13E+11	0.00	0.00	0.00
3.5100	0.5339	3087421.	24900.	-0.00420	1242.	3.13E+11	0.00	0.00	0.00
3.7800	0.5203	3175929.	24900.	-0.00417	1261.	3.13E+11	0.00	0.00	0.00
4.0500	0.5069	3264376.	24900.	-0.00413	1281.	3.13E+11	0.00	0.00	0.00
4.3200	0.4935	3352759.	24900.	-0.00410	1300.	3.13E+11	0.00	0.00	0.00
4.5900	0.4803	3441078.	24900.	-0.00406	1319.	3.13E+11	0.00	0.00	0.00
4.8600	0.4672	3529329.	24900.	-0.00403	1338.	3.13E+11	0.00	0.00	0.00
5.1300	0.4542	3617513.	24900.	-0.00399	1358.	3.13E+11	0.00	0.00	0.00
5.4000	0.4414	3705626.	24900.	-0.00395	1377.	3.13E+11	0.00	0.00	0.00
5.6700	0.4286	3793668.	24900.	-0.00391	1396.	3.13E+11	0.00	0.00	0.00
5.9400	0.4160	3881636.	24900.	-0.00387	1415.	3.13E+11	0.00	0.00	0.00
6.2100	0.4035	3969529.	24900.	-0.00383	1434.	3.13E+11	0.00	0.00	0.00
6.4800	0.3912	4057345.	24900.	-0.00379	1454.	3.13E+11	0.00	0.00	0.00
6.7500	0.3789	4145083.	24900.	-0.00375	1473.	3.13E+11	0.00	0.00	0.00
7.0200	0.3669	4232740.	24900.	-0.00371	1492.	3.13E+11	0.00	0.00	0.00
7.2900	0.3549	4320315.	24900.	-0.00366	1511.	3.13E+11	0.00	0.00	0.00
7.5600	0.3431	4407807.	24900.	-0.00362	1530.	3.13E+11	0.00	0.00	0.00
7.8300	0.3315	4495213.	24900.	-0.00357	1549.	3.13E+11	0.00	0.00	0.00
8.1000	0.3200	4582532.	24900.	-0.00352	1568.	3.13E+11	0.00	0.00	0.00
8.3700	0.3087	4669763.	24900.	-0.00348	1587.	3.13E+11	0.00	0.00	0.00
8.6400	0.2975	4756903.	24900.	-0.00343	1606.	3.13E+11	0.00	0.00	0.00
8.9100	0.2865	4843950.	24900.	-0.00338	1625.	3.13E+11	0.00	0.00	0.00
9.1800	0.2756	4930905.	24900.	-0.00333	1644.	3.13E+11	0.00	0.00	0.00
9.4500	0.2649	5017763.	24900.	-0.00328	1663.	3.13E+11	0.00	0.00	0.00
9.7200	0.2544	5104524.	24900.	-0.00322	1682.	3.13E+11	0.00	0.00	0.00
9.9900	0.2440	5191187.	24900.	-0.00317	1701.	3.13E+11	0.00	0.00	0.00
10.2600	0.2338	5277749.	24900.	-0.00312	1720.	3.13E+11	0.00	0.00	0.00
10.5300	0.2238	5364209.	24900.	-0.00306	1739.	3.13E+11	0.00	0.00	0.00
10.8000	0.2140	5450565.	24900.	-0.00300	1758.	3.13E+11	0.00	0.00	0.00
11.0700	0.2044	5536815.	24900.	-0.00295	1777.	3.13E+11	0.00	0.00	0.00
11.3400	0.1949	5622958.	24900.	-0.00289	1795.	3.13E+11	0.00	0.00	0.00
11.6100	0.1856	5708992.	24900.	-0.00283	1814.	3.13E+11	0.00	0.00	0.00
11.8800	0.1765	5794916.	24900.	-0.00277	1833.	3.13E+11	0.00	0.00	0.00
12.1500	0.1677	5880727.	24900.	-0.00271	1852.	3.13E+11	0.00	0.00	0.00
12.4200	0.1590	5966425.	24900.	-0.00265	1870.	3.13E+11	0.00	0.00	0.00
12.6900	0.1505	6052007.	24900.	-0.00259	1889.	3.13E+11	0.00	0.00	0.00
12.9600	0.1422	6137472.	24900.	-0.00253	1908.	3.13E+11	0.00	0.00	0.00
13.2300	0.1341	6222818.	24900.	-0.00246	1926.	3.13E+11	0.00	0.00	0.00
13.5000	0.1262	6308043.	24900.	-0.00240	1945.	3.13E+11	0.00	0.00	0.00
13.7700	0.1186	6393146.	24900.	-0.00233	1964.	3.13E+11	0.00	0.00	0.00
14.0400	0.1111	6478126.	24900.	-0.00226	1982.	3.13E+11	0.00	0.00	0.00
14.3100	0.1039	6562980.	24900.	-0.00220	2001.	3.13E+11	0.00	0.00	0.00
14.5800	0.09691	6647706.	24900.	-0.00213	2019.	3.13E+11	0.00	0.00	0.00
14.8500	0.09012	6732305.	24900.	-0.00206	2038.	3.13E+11	0.00	0.00	0.00
15.1200	0.08356	6816772.	24900.	-0.00199	2056.	3.13E+11	0.00	0.00	0.00
15.3900	0.07723	6901108.	24900.	-0.00192	2074.	3.13E+11	0.00	0.00	0.00
15.6600	0.07113	6985310.	24900.	-0.00185	2093.	3.13E+11	0.00	0.00	0.00
15.9300	0.06526	7069377.	24900.	-0.00177	2111.	3.13E+11	0.00	0.00	0.00
16.2000	0.05963	7153307.	24900.	-0.00170	2130.	3.13E+11	0.00	0.00	0.00
16.4700	0.05424	7237098.	24900.	-0.00163	2148.	3.13E+11	0.00	0.00	0.00
16.7400	0.04909	7320749.	24900.	-0.00155	2166.	3.13E+11	0.00	0.00	0.00
17.0100	0.04419	7404259.	24900.	-0.00147	2184.	3.13E+11	0.00	0.00	0.00
17.2800	0.03954	7487625.	24900.	-0.00140	2203.	3.13E+11	0.00	0.00	0.00
17.5500	0.03514	7570846.	24900.	-0.00132	2221.	3.13E+11	0.00	0.00	0.00
17.8200	0.03099	7653920.	24900.	-0.00124	2239.	3.13E+11	0.00	0.00	0.00
18.0900	0.02709	7736846.	24889.	-0.00116	2257.	3.13E+11	-6.6938	800.4970	0.00
18.3600	0.02346	7819552.	24841.	-0.00108	2275.	3.13E+11	-23.1840	3202.	0.00
18.6300	0.02009	7901863.	24747.	-1.00E-03	2293.	3.13E+11	-34.7408	5603.	0.00
18.9000	0.01698	7983657.	24623.	-9.18E-04	2311.	3.13E+11	-41.9534	8005.	0.00
19.1700	0.01414	8064855.	4843.	-8.35E-04	2329.	3.13E+11	-12168.	2787840.	0.00
19.4400	0.01157	8018167.	-32798.	-7.52E-04	2318.	3.13E+11	-11068.	3098880.	0.00
19.7100	0.00927	7855137.	-66535.	-6.69E-04	2283.	3.13E+11	-9758.	3409920.	0.00
19.9800	0.00723	7589525.	-95801.	-5.90E-04	2225.	3.13E+11	-8308.	3720960.	0.00
20.2500	0.00545	7236554.	-120248.	-5.13E-04	2148.	3.13E+11	-6783.	4032000.	0.00

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20.5200	0.00391	6812236.	-139728.	-4.40E-04	2055.	3.13E+11	-5241.	4343040.	0.00
20.7900	0.00260	6332764.	-154264.	-3.72E-04	1950.	3.13E+11	-3732.	4654080.	0.00
21.0600	0.00150	5813997.	-164028.	-3.09E-04	1837.	3.13E+11	-2295.	4965120.	0.00
21.3300	5.92E-04	5271024.	-169308.	-2.52E-04	1719.	3.13E+11	-964.4710	5276160.	0.00
21.6000	-1.36E-04	4717825.	-170489.	-2.01E-04	1598.	3.13E+11	235.3785	5587200.	0.00
21.8700	-7.07E-04	4167005.	-168022.	-1.55E-04	1478.	3.13E+11	1287.	5898240.	0.00
22.1400	-0.00114	3629619.	-162403.	-1.14E-04	1360.	3.13E+11	2181.	6209280.	0.00
22.4100	-0.00145	3115062.	-154149.	-7.94E-05	1248.	3.13E+11	2913.	6520320.	0.00
22.6800	-0.00165	2631028.	-143784.	-4.97E-05	1142.	3.13E+11	3485.	6831360.	0.00
22.9500	-0.00177	2183525.	-131819.	-2.48E-05	1045.	3.13E+11	3901.	7142400.	0.00
23.2200	-0.00181	1776932.	-118741.	-4.32E-06	955.7881	3.13E+11	4172.	7453440.	0.00
23.4900	-0.00180	1414098.	-105004.	1.22E-05	876.5742	3.13E+11	4308.	7764480.	0.00
23.7600	-0.00173	1096459.	-91022.	2.52E-05	807.2276	3.13E+11	4323.	8075520.	0.00
24.0300	-0.00163	824182.	-77164.	3.51E-05	747.7842	3.13E+11	4231.	8386560.	0.00
24.3000	-0.00151	596305.	-63756.	4.24E-05	698.0341	3.13E+11	4046.	8697600.	0.00
24.5700	-0.00136	410885.	-51078.	4.76E-05	657.5534	3.13E+11	3780.	9008640.	0.00
24.8400	-0.00120	265141.	-39370.	5.11E-05	625.7346	3.13E+11	3447.	9319680.	0.00
25.1100	-0.00103	155575.	-28835.	5.33E-05	601.8143	3.13E+11	3056.	9630720.	0.00
25.3800	-8.53E-04	78089.	-19645.	5.45E-05	584.8974	3.13E+11	2617.	9941760.	0.00
25.6500	-6.75E-04	28070.	-11947.	5.51E-05	573.9774	3.13E+11	2135.	1.03E+07	0.00
25.9200	-4.96E-04	468.1624	-5868.	5.52E-05	567.9513	3.13E+11	1617.	1.06E+07	0.00
26.1900	-3.17E-04	-10161.	-1525.	5.52E-05	570.0675	3.13E+11	1064.	1.09E+07	0.00
26.4600	-1.38E-04	-9622.	972.1393	5.51E-05	569.9498	3.13E+11	477.7142	1.12E+07	0.00
26.7300	3.99E-05	-4068.	1517.	5.50E-05	568.7372	3.13E+11	-141.5886	1.15E+07	0.00
27.0000	2.18E-04	0.00	0.00	5.50E-05	567.8491	3.13E+11	-794.6228	5904000.	0.00

POF

MIN TIP

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.71836308 inches
Computed slope at pile head	=	-0.00453566 radians
Maximum bending moment	=	8064855. inch-lbs
Maximum shear force	=	-170489. lbs
Depth of maximum bending moment	=	19.17000000 feet below pile head
Depth of maximum shear force	=	21.60000000 feet below pile head
Number of iterations	=	6
Number of zero deflection points	=	2

 Computed Values of Pile Loading and Deflection
 for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head	=	26800.0 lbs
Applied moment at pile head	=	2244000.0 in-lbs
Axial thrust load on pile head	=	321000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.7736	2244000.	26800.	-0.00491	805.2716	3.13E+11	0.00	0.00	0.00
0.2700	0.7577	2335930.	26800.	-0.00489	825.3418	3.13E+11	0.00	0.00	0.00
0.5400	0.7419	2427835.	26800.	-0.00487	845.4065	3.13E+11	0.00	0.00	0.00
0.8100	0.7262	2519715.	26800.	-0.00484	865.4655	3.13E+11	0.00	0.00	0.00
1.0800	0.7106	2611567.	26800.	-0.00481	885.5186	3.13E+11	0.00	0.00	0.00
1.3500	0.6950	2703390.	26800.	-0.00479	905.5655	3.13E+11	0.00	0.00	0.00
1.6200	0.6795	2795185.	26800.	-0.00476	925.6061	3.13E+11	0.00	0.00	0.00
1.8900	0.6642	2886950.	26800.	-0.00473	945.6402	3.13E+11	0.00	0.00	0.00
2.1600	0.6489	2978684.	26800.	-0.00470	965.6674	3.13E+11	0.00	0.00	0.00

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2.4300	0.6337	3070385.	26800.	-0.00467	985.6877	3.13E+11	0.00	0.00	0.00
2.7000	0.6187	3162054.	26800.	-0.00463	1006.	3.13E+11	0.00	0.00	0.00
2.9700	0.6037	3253689.	26800.	-0.00460	1026.	3.13E+11	0.00	0.00	0.00
3.2400	0.5889	3345288.	26800.	-0.00457	1046.	3.13E+11	0.00	0.00	0.00
3.5100	0.5741	3436852.	26800.	-0.00453	1066.	3.13E+11	0.00	0.00	0.00
3.7800	0.5595	3528378.	26800.	-0.00450	1086.	3.13E+11	0.00	0.00	0.00
4.0500	0.5450	3619867.	26800.	-0.00446	1106.	3.13E+11	0.00	0.00	0.00
4.3200	0.5306	3711317.	26800.	-0.00442	1126.	3.13E+11	0.00	0.00	0.00
4.5900	0.5163	3802727.	26800.	-0.00438	1146.	3.13E+11	0.00	0.00	0.00
4.8600	0.5022	3894096.	26800.	-0.00434	1166.	3.13E+11	0.00	0.00	0.00
5.1300	0.4882	3985423.	26800.	-0.00430	1185.	3.13E+11	0.00	0.00	0.00
5.4000	0.4743	4076707.	26800.	-0.00426	1205.	3.13E+11	0.00	0.00	0.00
5.6700	0.4606	4167948.	26800.	-0.00422	1225.	3.13E+11	0.00	0.00	0.00
5.9400	0.4470	4259143.	26800.	-0.00417	1245.	3.13E+11	0.00	0.00	0.00
6.2100	0.4336	4350293.	26800.	-0.00413	1265.	3.13E+11	0.00	0.00	0.00
6.4800	0.4203	4441396.	26800.	-0.00408	1285.	3.13E+11	0.00	0.00	0.00
6.7500	0.4071	4532451.	26800.	-0.00404	1305.	3.13E+11	0.00	0.00	0.00
7.0200	0.3941	4623457.	26800.	-0.00399	1325.	3.13E+11	0.00	0.00	0.00
7.2900	0.3812	4714414.	26800.	-0.00394	1345.	3.13E+11	0.00	0.00	0.00
7.5600	0.3685	4805320.	26800.	-0.00389	1364.	3.13E+11	0.00	0.00	0.00
7.8300	0.3560	4896174.	26800.	-0.00384	1384.	3.13E+11	0.00	0.00	0.00
8.1000	0.3437	4986976.	26800.	-0.00379	1404.	3.13E+11	0.00	0.00	0.00
8.3700	0.3315	5077724.	26800.	-0.00374	1424.	3.13E+11	0.00	0.00	0.00
8.6400	0.3194	5168418.	26800.	-0.00369	1444.	3.13E+11	0.00	0.00	0.00
8.9100	0.3076	5259055.	26800.	-0.00363	1464.	3.13E+11	0.00	0.00	0.00
9.1800	0.2959	5349637.	26800.	-0.00358	1483.	3.13E+11	0.00	0.00	0.00
9.4500	0.2844	5440160.	26800.	-0.00352	1503.	3.13E+11	0.00	0.00	0.00
9.7200	0.2731	5530626.	26800.	-0.00346	1523.	3.13E+11	0.00	0.00	0.00
9.9900	0.2619	5621031.	26800.	-0.00341	1543.	3.13E+11	0.00	0.00	0.00
10.2600	0.2510	5711377.	26800.	-0.00335	1562.	3.13E+11	0.00	0.00	0.00
10.5300	0.2402	5801660.	26800.	-0.00329	1582.	3.13E+11	0.00	0.00	0.00
10.8000	0.2297	5891882.	26800.	-0.00323	1602.	3.13E+11	0.00	0.00	0.00
11.0700	0.2193	5982040.	26800.	-0.00317	1621.	3.13E+11	0.00	0.00	0.00
11.3400	0.2092	6072134.	26800.	-0.00310	1641.	3.13E+11	0.00	0.00	0.00
11.6100	0.1992	6162162.	26800.	-0.00304	1661.	3.13E+11	0.00	0.00	0.00
11.8800	0.1894	6252124.	26800.	-0.00298	1680.	3.13E+11	0.00	0.00	0.00
12.1500	0.1799	6342019.	26800.	-0.00291	1700.	3.13E+11	0.00	0.00	0.00
12.4200	0.1706	6431846.	26800.	-0.00285	1720.	3.13E+11	0.00	0.00	0.00
12.6900	0.1615	6521603.	26800.	-0.00278	1739.	3.13E+11	0.00	0.00	0.00
12.9600	0.1526	6611291.	26800.	-0.00271	1759.	3.13E+11	0.00	0.00	0.00
13.2300	0.1439	6700907.	26800.	-0.00264	1778.	3.13E+11	0.00	0.00	0.00
13.5000	0.1354	6790451.	26800.	-0.00257	1798.	3.13E+11	0.00	0.00	0.00
13.7700	0.1272	6879922.	26800.	-0.00250	1817.	3.13E+11	0.00	0.00	0.00
14.0400	0.1192	6969319.	26800.	-0.00243	1837.	3.13E+11	0.00	0.00	0.00
14.3100	0.1115	7058641.	26800.	-0.00236	1856.	3.13E+11	0.00	0.00	0.00
14.5800	0.1040	7147888.	26800.	-0.00228	1876.	3.13E+11	0.00	0.00	0.00
14.8500	0.09667	7237057.	26800.	-0.00221	1895.	3.13E+11	0.00	0.00	0.00
15.1200	0.08963	7326149.	26800.	-0.00213	1915.	3.13E+11	0.00	0.00	0.00
15.3900	0.08284	7415161.	26800.	-0.00206	1934.	3.13E+11	0.00	0.00	0.00
15.6600	0.07629	7504094.	26800.	-0.00198	1954.	3.13E+11	0.00	0.00	0.00
15.9300	0.07000	7592947.	26800.	-0.00190	1973.	3.13E+11	0.00	0.00	0.00
16.2000	0.06396	7681717.	26800.	-0.00182	1992.	3.13E+11	0.00	0.00	0.00
16.4700	0.05818	7770405.	26800.	-0.00174	2012.	3.13E+11	0.00	0.00	0.00
16.7400	0.05266	7859010.	26800.	-0.00166	2031.	3.13E+11	0.00	0.00	0.00
17.0100	0.04740	7947530.	26800.	-0.00158	2050.	3.13E+11	0.00	0.00	0.00
17.2800	0.04241	8035964.	26800.	-0.00150	2070.	3.13E+11	0.00	0.00	0.00
17.5500	0.03768	8124312.	26800.	-0.00142	2089.	3.13E+11	0.00	0.00	0.00
17.8200	0.03323	8212573.	26800.	-0.00133	2108.	3.13E+11	0.00	0.00	0.00
18.0900	0.02906	8300745.	26788.	-0.00125	2128.	3.13E+11	-7.1790	800.4970	0.00
18.3600	0.02516	8388753.	26736.	-0.00116	2147.	3.13E+11	-24.8645	3202.	0.00
18.6300	0.02154	8476409.	26636.	-0.00107	2166.	3.13E+11	-37.2589	5603.	0.00
18.9000	0.01821	8563583.	26503.	-9.84E-04	2185.	3.13E+11	-44.9944	8005.	0.00
19.1700	0.01517	8650193.	5289.	-8.95E-04	2204.	3.13E+11	-13050.	2787840.	0.00
19.4400	0.01241	8599719.	-35081.	-8.06E-04	2193.	3.13E+11	-11870.	3098880.	0.00
19.7100	0.00994	8424542.	-71265.	-7.18E-04	2155.	3.13E+11	-10465.	3409920.	0.00
19.9800	0.00776	8139415.	-102654.	-6.32E-04	2092.	3.13E+11	-8911.	3720960.	0.00

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20.2500	0.00585	7760660.	-128876.	-5.50E-04	2010.	3.13E+11	-7276.	4032000.	0.00	
20.5200	0.00419	7305444.	-149771.	-4.72E-04	1910.	3.13E+11	-5622.	4343040.	0.00	
20.7900	0.00279	6791127.	-165365.	-3.99E-04	1798.	3.13E+11	-4003.	4654080.	0.00	
21.0600	0.00161	6234710.	-175841.	-3.32E-04	1677.	3.13E+11	-2463.	4965120.	0.00	
21.3300	6.36E-04	5652371.	-181509.	-2.70E-04	1549.	3.13E+11	-1036.	5276160.	0.00	
21.6000	-1.45E-04	5059093.	-182782.	-2.15E-04	1420.	3.13E+11	250.4639	5587200.	0.00	
21.8700	-7.57E-04	4468390.	-180143.	-1.66E-04	1291.	3.13E+11	1379.	5898240.	0.00	
22.1400	-0.00122	3892110.	-174123.	-1.23E-04	1165.	3.13E+11	2337.	6209280.	0.00	
22.4100	-0.00155	3340325.	-165279.	-8.52E-05	1045.	3.13E+11	3122.	6520320.	0.00	
22.6800	-0.00177	2821281.	-154170.	-5.33E-05	931.3033	3.13E+11	3735.	6831360.	0.00	
22.9500	-0.00190	2341415.	-141345.	-2.66E-05	826.5393	3.13E+11	4182.	7142400.	0.00	
23.2200	-0.00194	1905422.	-127326.	-4.65E-06	731.3534	3.13E+11	4472.	7453440.	0.00	POF
23.4900	-0.00193	1516353.	-112600.	1.30E-05	646.4120	3.13E+11	4618.	7764480.	0.00	
23.7600	-0.00186	1175747.	-97611.	2.70E-05	572.0511	3.13E+11	4635.	8075520.	0.00	
24.0300	-0.00175	883780.	-82754.	3.76E-05	508.3090	3.13E+11	4536.	8386560.	0.00	
24.3000	-0.00162	639420.	-68380.	4.55E-05	454.9605	3.13E+11	4337.	8697600.	0.00	
24.5700	-0.00146	440586.	-54787.	5.11E-05	411.5510	3.13E+11	4053.	9008640.	0.00	
24.8400	-0.00128	284292.	-42235.	5.48E-05	377.4291	3.13E+11	3696.	9319680.	0.00	
25.1100	-0.00110	166791.	-30939.	5.71E-05	351.7764	3.13E+11	3277.	9630720.	0.00	
25.3800	-9.14E-04	83689.	-21085.	5.84E-05	333.6335	3.13E+11	2806.	9941760.	0.00	
25.6500	-7.24E-04	30042.	-12829.	5.90E-05	321.9213	3.13E+11	2290.	1.03E+07	0.00	
25.9200	-5.32E-04	435.6340	-6309.	5.92E-05	315.4577	3.13E+11	1734.	1.06E+07	0.00	
26.1900	-3.40E-04	-10964.	-1650.	5.91E-05	317.7562	3.13E+11	1142.	1.09E+07	0.00	
26.4600	-1.49E-04	-10378.	1032.	5.90E-05	317.6282	3.13E+11	513.5290	1.12E+07	0.00	
26.7300	4.23E-05	-4400.	1620.	5.89E-05	316.3233	3.13E+11	-150.1906	1.15E+07	0.00	
27.0000	2.33E-04	0.00	0.00	5.89E-05	315.3626	3.13E+11	-850.0582	5904000.	0.00	

MIN TIP

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

Pile-head deflection	=	0.77360814 inches
Computed slope at pile head	=	-0.00491363 radians
Maximum bending moment	=	8650193. inch-lbs
Maximum shear force	=	-182782. lbs
Depth of maximum bending moment	=	19.17000000 feet below pile head
Depth of maximum shear force	=	21.60000000 feet below pile head
Number of iterations	=	6
Number of zero deflection points	=	2

 Computed Values of Pile Loading and Deflection
 for Lateral Loading for Load Case Number 3

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head	=	1800.0 lbs
Rotation of pile head	=	0.000E+00 radians
Axial load at pile head	=	354000.0 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.00863	-236491.	1800.	0.00	399.4136	3.13E+11	0.00	0.00	0.00
0.2700	0.00863	-230657.	1800.	-2.42E-06	398.1401	3.13E+11	0.00	0.00	0.00
0.5400	0.00862	-224821.	1800.	-4.77E-06	396.8659	3.13E+11	0.00	0.00	0.00
0.8100	0.00860	-218983.	1800.	-7.07E-06	395.5912	3.13E+11	0.00	0.00	0.00
1.0800	0.00857	-213141.	1800.	-9.30E-06	394.3159	3.13E+11	0.00	0.00	0.00
1.3500	0.00854	-207297.	1800.	-1.15E-05	393.0401	3.13E+11	0.00	0.00	0.00

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1.6200	0.00850	-201451.	1800.	-1.36E-05	391.7637	3.13E+11	0.00	0.00	0.00
1.8900	0.00845	-195602.	1800.	-1.56E-05	390.4868	3.13E+11	0.00	0.00	0.00
2.1600	0.00839	-189751.	1800.	-1.76E-05	389.2094	3.13E+11	0.00	0.00	0.00
2.4300	0.00833	-183898.	1800.	-1.96E-05	387.9315	3.13E+11	0.00	0.00	0.00
2.7000	0.00827	-178042.	1800.	-2.14E-05	386.6531	3.13E+11	0.00	0.00	0.00
2.9700	0.00820	-172184.	1800.	-2.32E-05	385.3742	3.13E+11	0.00	0.00	0.00
3.2400	0.00812	-166325.	1800.	-2.50E-05	384.0950	3.13E+11	0.00	0.00	0.00
3.5100	0.00803	-160463.	1800.	-2.67E-05	382.8152	3.13E+11	0.00	0.00	0.00
3.7800	0.00794	-154600.	1800.	-2.83E-05	381.5351	3.13E+11	0.00	0.00	0.00
4.0500	0.00785	-148734.	1800.	-2.99E-05	380.2546	3.13E+11	0.00	0.00	0.00
4.3200	0.00775	-142867.	1800.	-3.14E-05	378.9737	3.13E+11	0.00	0.00	0.00
4.5900	0.00765	-136998.	1800.	-3.28E-05	377.6924	3.13E+11	0.00	0.00	0.00
4.8600	0.00754	-131128.	1800.	-3.42E-05	376.4107	3.13E+11	0.00	0.00	0.00
5.1300	0.00742	-125256.	1800.	-3.56E-05	375.1288	3.13E+11	0.00	0.00	0.00
5.4000	0.00731	-119382.	1800.	-3.68E-05	373.8465	3.13E+11	0.00	0.00	0.00
5.6700	0.00719	-113507.	1800.	-3.80E-05	372.5639	3.13E+11	0.00	0.00	0.00
5.9400	0.00706	-107631.	1800.	-3.92E-05	371.2809	3.13E+11	0.00	0.00	0.00
6.2100	0.00693	-101753.	1800.	-4.02E-05	369.9978	3.13E+11	0.00	0.00	0.00
6.4800	0.00680	-95875.	1800.	-4.13E-05	368.7143	3.13E+11	0.00	0.00	0.00
6.7500	0.00667	-89995.	1800.	-4.22E-05	367.4306	3.13E+11	0.00	0.00	0.00
7.0200	0.00653	-84114.	1800.	-4.31E-05	366.1467	3.13E+11	0.00	0.00	0.00
7.2900	0.00639	-78232.	1800.	-4.40E-05	364.8625	3.13E+11	0.00	0.00	0.00
7.5600	0.00624	-72349.	1800.	-4.47E-05	363.5782	3.13E+11	0.00	0.00	0.00
7.8300	0.00610	-66465.	1800.	-4.55E-05	362.2936	3.13E+11	0.00	0.00	0.00
8.1000	0.00595	-60581.	1800.	-4.61E-05	361.0089	3.13E+11	0.00	0.00	0.00
8.3700	0.00580	-54695.	1800.	-4.67E-05	359.7241	3.13E+11	0.00	0.00	0.00
8.6400	0.00564	-48809.	1800.	-4.73E-05	358.4391	3.13E+11	0.00	0.00	0.00
8.9100	0.00549	-42923.	1800.	-4.77E-05	357.1539	3.13E+11	0.00	0.00	0.00
9.1800	0.00534	-37036.	1800.	-4.81E-05	355.8687	3.13E+11	0.00	0.00	0.00
9.4500	0.00518	-31148.	1800.	-4.85E-05	354.5833	3.13E+11	0.00	0.00	0.00
9.7200	0.00502	-25261.	1800.	-4.88E-05	353.2979	3.13E+11	0.00	0.00	0.00
9.9900	0.00486	-19372.	1800.	-4.90E-05	352.0124	3.13E+11	0.00	0.00	0.00
10.2600	0.00470	-13484.	1800.	-4.92E-05	350.7269	3.13E+11	0.00	0.00	0.00
10.5300	0.00454	-7596.	1800.	-4.93E-05	349.4413	3.13E+11	0.00	0.00	0.00
10.8000	0.00438	-1707.	1800.	-4.93E-05	348.1557	3.13E+11	0.00	0.00	0.00
11.0700	0.00422	4182.	1800.	-4.93E-05	348.6959	3.13E+11	0.00	0.00	0.00
11.3400	0.00406	10070.	1800.	-4.93E-05	349.9815	3.13E+11	0.00	0.00	0.00
11.6100	0.00390	15959.	1800.	-4.91E-05	351.2671	3.13E+11	0.00	0.00	0.00
11.8800	0.00375	21847.	1800.	-4.89E-05	352.5526	3.13E+11	0.00	0.00	0.00
12.1500	0.00359	27735.	1800.	-4.87E-05	353.8381	3.13E+11	0.00	0.00	0.00
12.4200	0.00343	33622.	1800.	-4.84E-05	355.1235	3.13E+11	0.00	0.00	0.00
12.6900	0.00327	39510.	1800.	-4.80E-05	356.4088	3.13E+11	0.00	0.00	0.00
12.9600	0.00312	45396.	1800.	-4.75E-05	357.6940	3.13E+11	0.00	0.00	0.00
13.2300	0.00297	51283.	1800.	-4.70E-05	358.9790	3.13E+11	0.00	0.00	0.00
13.5000	0.00281	57168.	1800.	-4.65E-05	360.2640	3.13E+11	0.00	0.00	0.00
13.7700	0.00267	63053.	1800.	-4.59E-05	361.5488	3.13E+11	0.00	0.00	0.00
14.0400	0.00252	68938.	1800.	-4.52E-05	362.8334	3.13E+11	0.00	0.00	0.00
14.3100	0.00237	74821.	1800.	-4.44E-05	364.1179	3.13E+11	0.00	0.00	0.00
14.5800	0.00223	80703.	1800.	-4.36E-05	365.4022	3.13E+11	0.00	0.00	0.00
14.8500	0.00209	86585.	1800.	-4.28E-05	366.6862	3.13E+11	0.00	0.00	0.00
15.1200	0.00195	92466.	1800.	-4.18E-05	367.9701	3.13E+11	0.00	0.00	0.00
15.3900	0.00182	98345.	1800.	-4.08E-05	369.2537	3.13E+11	0.00	0.00	0.00
15.6600	0.00169	104223.	1800.	-3.98E-05	370.5370	3.13E+11	0.00	0.00	0.00
15.9300	0.00156	110100.	1800.	-3.87E-05	371.8201	3.13E+11	0.00	0.00	0.00
16.2000	0.00144	115976.	1800.	-3.75E-05	373.1029	3.13E+11	0.00	0.00	0.00
16.4700	0.00132	121850.	1800.	-3.63E-05	374.3853	3.13E+11	0.00	0.00	0.00
16.7400	0.00120	127723.	1800.	-3.50E-05	375.6675	3.13E+11	0.00	0.00	0.00
17.0100	0.00109	133595.	1800.	-3.37E-05	376.9493	3.13E+11	0.00	0.00	0.00
17.2800	9.84E-04	139464.	1800.	-3.22E-05	378.2308	3.13E+11	0.00	0.00	0.00
17.5500	8.82E-04	145333.	1800.	-3.08E-05	379.5120	3.13E+11	0.00	0.00	0.00
17.8200	7.85E-04	151199.	1800.	-2.92E-05	380.7927	3.13E+11	0.00	0.00	0.00
18.0900	6.92E-04	157064.	1800.	-2.76E-05	382.0731	3.13E+11	-0.1711	800.4970	0.00
18.3600	6.06E-04	162925.	1798.	-2.60E-05	383.3527	3.13E+11	-0.5984	3202.	0.00
18.6300	5.24E-04	168777.	1796.	-2.43E-05	384.6304	3.13E+11	-0.9063	5603.	0.00
18.9000	4.48E-04	174619.	1793.	-2.25E-05	385.9057	3.13E+11	-1.1074	8005.	0.00
19.1700	3.78E-04	180446.	1264.	-2.07E-05	387.1780	3.13E+11	-325.4897	2787840.	0.00

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19.4400	3.14E-04	182855.	249.2959	-1.88E-05	387.7038	3.13E+11	-300.6790	3098880.	0.00
19.7100	2.57E-04	182105.	-675.2783	-1.69E-05	387.5400	3.13E+11	-270.0458	3409920.	0.00
19.9800	2.05E-04	178518.	-1494.	-1.50E-05	386.7569	3.13E+11	-235.3258	3720960.	0.00
20.2500	1.59E-04	172458.	-2196.	-1.32E-05	385.4340	3.13E+11	-198.1267	4032000.	0.00
20.5200	1.19E-04	164317.	-2776.	-1.15E-05	383.6566	3.13E+11	-159.8990	4343040.	0.00
20.7900	8.49E-05	154495.	-3233.	-9.82E-06	381.5123	3.13E+11	-121.9150	4654080.	0.00
21.0600	5.56E-05	143391.	-3568.	-8.28E-06	379.0882	3.13E+11	-85.2561	4965120.	0.00
21.3300	3.12E-05	131391.	-3789.	-6.86E-06	376.4683	3.13E+11	-50.8072	5276160.	0.00
21.6000	1.12E-05	118856.	-3902.	-5.57E-06	373.7316	3.13E+11	-19.2587	5587200.	0.00
21.8700	-4.88E-06	106117.	-3919.	-4.40E-06	370.9505	3.13E+11	8.8861	5898240.	0.00
22.1400	-1.74E-05	93471.	-3851.	-3.37E-06	368.1895	3.13E+11	33.2982	6209280.	0.00
22.4100	-2.67E-05	81172.	-3710.	-2.47E-06	365.5045	3.13E+11	53.8066	6520320.	0.00
22.6800	-3.34E-05	69438.	-3508.	-1.69E-06	362.9427	3.13E+11	70.3778	6831360.	0.00
22.9500	-3.77E-05	58441.	-3260.	-1.03E-06	360.5419	3.13E+11	83.0955	7142400.	0.00
23.2200	-4.01E-05	48317.	-2976.	-4.78E-07	358.3315	3.13E+11	92.1372	7453440.	0.00
23.4900	-4.08E-05	39159.	-2668.	-2.54E-08	356.3321	3.13E+11	97.7518	7764480.	0.00
23.7600	-4.02E-05	31026.	-2348.	3.37E-07	354.5566	3.13E+11	100.2379	8075520.	0.00
24.0300	-3.86E-05	23945.	-2023.	6.22E-07	353.0108	3.13E+11	99.9231	8386560.	0.00
24.3000	-3.62E-05	17914.	-1704.	8.38E-07	351.6939	3.13E+11	97.1447	8697600.	0.00
24.5700	-3.32E-05	12901.	-1397.	9.97E-07	350.5996	3.13E+11	92.2337	9008640.	0.00
24.8400	-2.97E-05	8857.	-1109.	1.11E-06	349.7167	3.13E+11	85.5003	9319680.	0.00
25.1100	-2.60E-05	5710.	-845.7258	1.19E-06	349.0297	3.13E+11	77.2227	9630720.	0.00
25.3800	-2.20E-05	3374.	-611.0499	1.23E-06	348.5196	3.13E+11	67.6390	9941760.	0.00
25.6500	-1.80E-05	1748.	-409.2288	1.26E-06	348.1646	3.13E+11	56.9419	1.03E+07	0.00
25.9200	-1.39E-05	719.3062	-243.6352	1.27E-06	347.9401	3.13E+11	45.2764	1.06E+07	0.00
26.1900	-9.75E-06	166.1121	-117.2466	1.28E-06	347.8193	3.13E+11	32.7413	1.09E+07	0.00
26.4600	-5.62E-06	-43.3789	-32.7879	1.28E-06	347.7925	3.13E+11	19.3937	1.12E+07	0.00
26.7300	-1.48E-06	-49.2820	7.1461	1.28E-06	347.7938	3.13E+11	5.2569	1.15E+07	0.00
27.0000	2.65E-06	0.00	0.00	1.28E-06	347.7830	3.13E+11	-9.6680	5904000.	0.00

POF

MIN TIP

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 3:

Pile-head deflection = 0.00863185 inches
 Computed slope at pile head = 0.000000 radians
 Maximum bending moment = -236491. inch-lbs
 Maximum shear force = -3919. lbs
 Depth of maximum bending moment = 0.000000 feet below pile head
 Depth of maximum shear force = 21.87000000 feet below pile head
 Number of iterations = 6
 Number of zero deflection points = 2

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
 Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
 Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
 Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
 Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Load Type 2	Load Type 3	Load Type 4	Load Type 5	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	24900.	M, in-lb	1932000.	578000.	0.7184	-0.00454	-170489.	8064855.	
2	V, lb	26800.	M, in-lb	2244000.	321000.	0.7736	-0.00491	-182782.	8650193.	
3	V, lb	1800.	S, rad	0.00	354000.	0.00863	0.00	-3919.	-236491.	

Maximum pile-head deflection = 0.7736081354 inches

Maximum pile-head rotation = -0.0049136318 radians = -0.281530 deg.

Summary of Warning Messages

The following warning was reported 24 times

**** Warning ****

The input value for friction angle is either smaller than 29 degrees or higher than 41 degrees and no value of k has been specified for a soil layer defined using the sand criteria. Program will assume an internal default value, for k, but the friction angle is outside the range of data available. Please check your input data for correctness.

The following warning was reported 180 times

**** Warning ****

An unreasonable input value for unconfined compressive strength has been specified for a soil defined using the weak rock criteria. The input value is greater than 500 psi. Please check your input data for correctness.

The analysis ended normally.

=====
LPile for Windows, Version 2019-11.003

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method
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Files Used for Analysis

Path to file locations:

\Projects\GEO\2019\Other\T19014.00 Wake 216 (Alignment Shift)\06 - Calculations\Structures\B1\

Name of input data file:

L-pile B-1B.lp11d

Name of output report file:

L-pile B-1B.lp11o

Name of plot output file:

L-pile B-1B.lp11p

Name of runtime message file:

L-pile B-1B.lp11r

Date and Time of Analysis

Date: December 5, 2019

Time: 10:32:56

Problem Title

Project Name: Bridge 216 (Wake)

Job Number: 17BP.5.R.79 (SF-910216)

Client: NCDOT

Engineer: C.T. Tang

Description: Bent 1

 Program Options and Settings

Computational Options:

- Conventional Analysis

Engineering Units Used for Data Input and Computations:

- US Customary System Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 7.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:

- Static loading specified
- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

 Pile Structural Properties and Geometry

- Number of pile sections defined = 1
- Total length of pile = 45.000 ft
- Depth of ground surface below top of pile = 18.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
-----	-----	-----

1	0.000	36.0000
2	45.000	36.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is an elastic pile

Cross-sectional Shape	=	Circular Pile
Length of section	=	45.000000 ft
Width of top of section	=	36.000000 in
Width of bottom of section	=	36.000000 in
Top Area	=	1018. sq. in
Bottom Area	=	1018. sq. in
Moment of Inertia at Top	=	82448. in^4
Moment of Inertia at Bottom	=	82448. in^4
Elastic Modulus	=	3800000. psi

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	18.000000 ft
Distance from top of pile to bottom of layer	=	27.000000 ft
Effective unit weight at top of layer	=	57.000000 pcf
Effective unit weight at bottom of layer	=	57.000000 pcf
Friction angle at top of layer	=	36.600000 deg.
Friction angle at bottom of layer	=	36.600000 deg.
Subgrade k at top of layer	=	0.0000 pci
Subgrade k at bottom of layer	=	0.0000 pci

NOTE: Default values for subgrade k will be computed for this layer.

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	27.000000 ft
Distance from top of pile to bottom of layer	=	33.900000 ft
Effective unit weight at top of layer	=	57.000000 pcf
Effective unit weight at bottom of layer	=	57.000000 pcf
Friction angle at top of layer	=	40.000000 deg.
Friction angle at bottom of layer	=	40.000000 deg.
Subgrade k at top of layer	=	0.0000 pci
Subgrade k at bottom of layer	=	0.0000 pci

NOTE: Default values for subgrade k will be computed for this layer.

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 33.900000 ft
 Distance from top of pile to bottom of layer = 42.800000 ft
 Effective unit weight at top of layer = 67.000000 pcf
 Effective unit weight at bottom of layer = 67.000000 pcf
 Friction angle at top of layer = 45.000000 deg.
 Friction angle at bottom of layer = 45.000000 deg.
 Subgrade k at top of layer = 0.0000 pci
 Subgrade k at bottom of layer = 0.0000 pci

NOTE: Default values for subgrade k will be computed for this layer.

Layer 4 is weak rock, p-y criteria by Reese, 1997

Distance from top of pile to top of layer = 42.800000 ft
 Distance from top of pile to bottom of layer = 50.000000 ft
 Effective unit weight at top of layer = 156.000000 pcf
 Effective unit weight at bottom of layer = 156.000000 pcf
 Uniaxial compressive strength at top of layer = 5700. psi
 Uniaxial compressive strength at bottom of layer = 5700. psi
 Initial modulus of rock at top of layer = 6000. psi
 Initial modulus of rock at bottom of layer = 6000. psi
 RQD of rock at top of layer = 11.000000 %
 RQD of rock at bottom of layer = 11.000000 %
 k_{rm} of rock at top of layer = 0.0005000
 k_{rm} of rock at bottom of layer = 0.0005000

(Depth of the lowest soil layer extends 5.000 ft below the pile tip)

**** Warning - Possible Input Data Error ****

Values entered for effective unit weight of rock were outside the limits of 50 pcf to 150 pcf.

The maximum input value, in layer 1, for effective unit weight = 156.00 pcf

This data may be erroneous. Please check your data.

 Summary of Input Soil Properties

Layer	Soil Type	Layer	Effective	Angle of	Uniaxial	E50		
Layer	Rock Mass	Depth	Unit Wt.	Friction	qu	RQD %	or	kpy
Num.	Name	ft	pcf	deg.	psi		krm	pci
	(p-y Curve Type)							
	Modulus							
	psi							
1	Sand	18.0000	57.0000	36.6000	--	--	--	
default	--							
	(Reese, et al.)	27.0000	57.0000	36.6000	--	--	--	
default	--							
2	Sand	27.0000	57.0000	40.0000	--	--	--	
default	--							
	(Reese, et al.)	33.9000	57.0000	40.0000	--	--	--	
default	--							
3	Sand	33.9000	67.0000	45.0000	--	--	--	
default	--							
	(Reese, et al.)	42.8000	67.0000	45.0000	--	--	--	

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default	--							
4	Weak	42.8000	156.0000	--	5700.	11.0000	5.00E-04	--
	6000.							
	Rock	50.0000	156.0000	--	5700.	11.0000	5.00E-04	--
	6000.							

 Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

 Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 3900. lbs	M = 4332000. in-lbs	549000.	No	Yes
2	1	V = 14000. lbs	M = 952600. in-lbs	362000.	No	Yes
3	2	V = 2360. lbs	S = 0.0000 in/in	361000.	No	Yes

V = shear force applied normal to pile axis

M = bending moment applied to pile head

y = lateral deflection normal to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Values of top y vs. pile lengths can be computed only for load types with specified shear loading (Load Types 1, 2, and 3).

Thrust force is assumed to be acting axially for all pile batter angles.

 Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

 Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	18.0000	0.00	N.A.	No	0.00	103826.
2	27.0000	7.9299	Yes	No	103826.	277496.
3	33.9000	12.4001	Yes	No	381321.	1115861.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

 Computed Values of Pile Loading and Deflection
 for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 3900.0 lbs
 Applied moment at pile head = 4332000.0 in-lbs
 Axial thrust load on pile head = 549000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.2384	4332000.	3900.	-0.00634	1485.	3.13E+11	0.00	0.00	0.00
0.4500	1.2044	4371758.	3900.	-0.00627	1494.	3.13E+11	0.00	0.00	0.00
0.9000	1.1707	4411292.	3900.	-0.00619	1502.	3.13E+11	0.00	0.00	0.00
1.3500	1.1375	4450601.	3900.	-0.00612	1511.	3.13E+11	0.00	0.00	0.00
1.8000	1.1046	4489683.	3900.	-0.00604	1520.	3.13E+11	0.00	0.00	0.00
2.2500	1.0722	4528535.	3900.	-0.00596	1528.	3.13E+11	0.00	0.00	0.00
2.7000	1.0402	4567155.	3900.	-0.00588	1536.	3.13E+11	0.00	0.00	0.00
3.1500	1.0087	4605543.	3900.	-0.00581	1545.	3.13E+11	0.00	0.00	0.00
3.6000	0.9776	4643695.	3900.	-0.00573	1553.	3.13E+11	0.00	0.00	0.00
4.0500	0.9468	4681610.	3900.	-0.00564	1561.	3.13E+11	0.00	0.00	0.00
4.5000	0.9166	4719285.	3900.	-0.00556	1570.	3.13E+11	0.00	0.00	0.00
4.9500	0.8868	4756720.	3900.	-0.00548	1578.	3.13E+11	0.00	0.00	0.00
5.4000	0.8574	4793911.	3900.	-0.00540	1586.	3.13E+11	0.00	0.00	0.00
5.8500	0.8284	4830857.	3900.	-0.00532	1594.	3.13E+11	0.00	0.00	0.00
6.3000	0.8000	4867557.	3900.	-0.00523	1602.	3.13E+11	0.00	0.00	0.00
6.7500	0.7719	4904008.	3900.	-0.00515	1610.	3.13E+11	0.00	0.00	0.00
7.2000	0.7443	4940208.	3900.	-0.00506	1618.	3.13E+11	0.00	0.00	0.00
7.6500	0.7172	4976156.	3900.	-0.00498	1626.	3.13E+11	0.00	0.00	0.00
8.1000	0.6906	5011849.	3900.	-0.00489	1634.	3.13E+11	0.00	0.00	0.00
8.5500	0.6644	5047287.	3900.	-0.00481	1641.	3.13E+11	0.00	0.00	0.00
9.0000	0.6387	5082466.	3900.	-0.00472	1649.	3.13E+11	0.00	0.00	0.00
9.4500	0.6134	5117386.	3900.	-0.00463	1657.	3.13E+11	0.00	0.00	0.00
9.9000	0.5886	5152045.	3900.	-0.00454	1664.	3.13E+11	0.00	0.00	0.00
10.3500	0.5644	5186440.	3900.	-0.00445	1672.	3.13E+11	0.00	0.00	0.00
10.8000	0.5405	5220570.	3900.	-0.00436	1679.	3.13E+11	0.00	0.00	0.00
11.2500	0.5172	5254433.	3900.	-0.00427	1687.	3.13E+11	0.00	0.00	0.00
11.7000	0.4944	5288028.	3900.	-0.00418	1694.	3.13E+11	0.00	0.00	0.00
12.1500	0.4721	5321353.	3900.	-0.00409	1701.	3.13E+11	0.00	0.00	0.00
12.6000	0.4502	5354406.	3900.	-0.00400	1708.	3.13E+11	0.00	0.00	0.00
13.0500	0.4289	5387185.	3900.	-0.00391	1715.	3.13E+11	0.00	0.00	0.00
13.5000	0.4080	5419689.	3900.	-0.00381	1723.	3.13E+11	0.00	0.00	0.00
13.9500	0.3877	5451916.	3900.	-0.00372	1730.	3.13E+11	0.00	0.00	0.00
14.4000	0.3678	5483864.	3900.	-0.00363	1737.	3.13E+11	0.00	0.00	0.00
14.8500	0.3485	5515532.	3900.	-0.00353	1744.	3.13E+11	0.00	0.00	0.00
15.3000	0.3297	5546918.	3900.	-0.00344	1750.	3.13E+11	0.00	0.00	0.00
15.7500	0.3114	5578021.	3900.	-0.00334	1757.	3.13E+11	0.00	0.00	0.00
16.2000	0.2936	5608839.	3900.	-0.00324	1764.	3.13E+11	0.00	0.00	0.00
16.6500	0.2764	5639371.	3900.	-0.00315	1771.	3.13E+11	0.00	0.00	0.00
17.1000	0.2597	5669614.	3900.	-0.00305	1777.	3.13E+11	0.00	0.00	0.00
17.5500	0.2435	5699567.	3900.	-0.00295	1784.	3.13E+11	0.00	0.00	0.00

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18.0000	0.2278	5729229.	3900.	-0.00285	1790.	3.13E+11	0.00	0.00	0.00
18.4500	0.2127	5758599.	3787.	-0.00275	1797.	3.13E+11	-42.0155	1067.	0.00
18.9000	0.1981	5786449.	3437.	-0.00265	1803.	3.13E+11	-87.5497	2387.	0.00
19.3500	0.1840	5811450.	2837.	-0.00255	1808.	3.13E+11	-134.5402	3948.	0.00
19.8000	0.1705	5832232.	1981.	-0.00245	1813.	3.13E+11	-182.3793	5777.	0.00
20.2500	0.1575	5847397.	868.5735	-0.00235	1816.	3.13E+11	-229.7809	7878.	0.00
20.7000	0.1451	5855563.	-493.7572	-0.00225	1818.	3.13E+11	-274.7860	10228.	0.00
21.1500	0.1332	5855417.	-2091.	-0.00215	1818.	3.13E+11	-316.6035	12837.	0.00
21.6000	0.1218	5845739.	-3904.	-0.00205	1816.	3.13E+11	-355.0569	15736.	0.00
22.0500	0.1110	5825410.	-5910.	-0.00195	1811.	3.13E+11	-388.0665	18872.	0.00
22.5000	0.1008	5793466.	-8078.	-0.00185	1804.	3.13E+11	-414.6356	22216.	0.00
22.9500	0.09107	5749136.	-10383.	-0.00175	1795.	3.13E+11	-439.2928	26049.	0.00
23.4000	0.08188	5691703.	-12804.	-0.00165	1782.	3.13E+11	-457.0960	30145.	0.00
23.8500	0.07323	5620649.	-15300.	-0.00155	1766.	3.13E+11	-467.4105	34467.	0.00
24.3000	0.06510	5535679.	-17843.	-0.00146	1748.	3.13E+11	-474.6018	39368.	0.00
24.7500	0.05749	5436587.	-20413.	-0.00136	1726.	3.13E+11	-477.0233	44810.	0.00
25.2000	0.05038	5323306.	-22915.	-0.00127	1702.	3.13E+11	-449.9406	48230.	0.00
25.6500	0.04376	5196634.	-25252.	-0.00118	1674.	3.13E+11	-415.3061	51244.	0.00
26.1000	0.03763	5057585.	-27394.	-0.00109	1644.	3.13E+11	-378.1484	54259.	0.00
26.5500	0.03198	4907252.	-29331.	-0.00101	1611.	3.13E+11	-339.1402	57273.	0.00
27.0000	0.02677	4746778.	-31212.	-9.22E-04	1576.	3.13E+11	-357.8771	72180.	0.00
27.4500	0.02201	4575626.	-33164.	-8.42E-04	1538.	3.13E+11	-364.9854	89531.	0.00
27.9000	0.01768	4393597.	-34979.	-7.65E-04	1499.	3.13E+11	-307.0824	93794.	0.00
28.3500	0.01375	4202389.	-36482.	-6.91E-04	1457.	3.13E+11	-249.7610	98058.	0.00
28.8000	0.01022	4003684.	-37679.	-6.20E-04	1413.	3.13E+11	-193.6526	102321.	0.00
29.2500	0.00706	3799127.	-38579.	-5.53E-04	1369.	3.13E+11	-139.3186	106585.	0.00
29.7000	0.00425	3590313.	-39190.	-4.89E-04	1323.	3.13E+11	-87.2508	110848.	0.00
30.1500	0.00178	3378772.	-39528.	-4.29E-04	1277.	3.13E+11	-37.8724	115111.	0.00
30.6000	-3.83E-04	3165954.	-39607.	-3.73E-04	1231.	3.13E+11	8.4604	119375.	0.00
31.0500	-0.00225	2953220.	-39446.	-3.20E-04	1184.	3.13E+11	51.4562	123638.	0.00
31.5000	-0.00384	2741836.	-39061.	-2.71E-04	1138.	3.13E+11	90.8861	127901.	0.00
31.9500	-0.00517	2532963.	-38474.	-2.25E-04	1092.	3.13E+11	126.5806	132165.	0.00
32.4000	-0.00627	2327651.	-37705.	-1.83E-04	1048.	3.13E+11	158.4264	136428.	0.00
32.8500	-0.00715	2126839.	-36774.	-1.45E-04	1004.	3.13E+11	186.3630	140692.	0.00
33.3000	-0.00784	1931354.	-35716.	-1.10E-04	961.0106	3.13E+11	205.2785	141441.	0.00
33.7500	-0.00834	1741755.	-34578.	-7.84E-05	919.6176	3.13E+11	216.3257	140037.	0.00
34.2000	-0.00868	1558376.	-33155.	-5.00E-05	879.5823	3.13E+11	310.6229	193152.	0.00
34.6500	-0.00888	1383975.	-31441.	-2.46E-05	841.5071	3.13E+11	324.1199	197066.	0.00
35.1000	-0.00895	1218954.	-29663.	-2.19E-06	805.4799	3.13E+11	334.4372	201781.	0.00
35.5500	-0.00891	1063624.	-27838.	1.75E-05	771.5682	3.13E+11	341.5908	207136.	0.00
36.0000	-0.00876	918199.	-25983.	3.46E-05	739.8193	3.13E+11	345.6086	213014.	0.00
36.4500	-0.00853	782806.	-24114.	4.92E-05	710.2603	3.13E+11	346.5372	219327.	0.00
36.9000	-0.00823	657478.	-22212.	6.16E-05	682.8987	3.13E+11	357.8935	234833.	0.00
37.3500	-0.00787	542552.	-20250.	7.20E-05	657.8082	3.13E+11	368.6983	253098.	0.00
37.8000	-0.00745	438350.	-18236.	8.04E-05	635.0589	3.13E+11	377.1852	273304.	0.00
38.2500	-0.00700	345125.	-16183.	8.72E-05	614.7059	3.13E+11	383.2105	295712.	0.00
38.7000	-0.00651	263056.	-14149.	9.24E-05	596.7886	3.13E+11	369.9904	306857.	0.00
39.1500	-0.00600	191762.	-12210.	9.63E-05	581.2238	3.13E+11	348.3474	313528.	0.00
39.6000	-0.00547	130617.	-10394.	9.91E-05	567.8746	3.13E+11	324.3829	320199.	0.00
40.0500	-0.00493	78924.	-8712.	1.01E-04	556.5890	3.13E+11	298.3751	326870.	0.00
40.5000	-0.00438	35927.	-7176.	1.02E-04	547.2020	3.13E+11	270.5763	333540.	0.00
40.9500	-0.00383	818.6246	-5794.	1.02E-04	539.5371	3.13E+11	241.2113	340211.	0.00
41.4000	-0.00328	-27256.	-4575.	1.02E-04	545.3090	3.13E+11	210.4776	346882.	0.00
41.8500	-0.00273	-49192.	-3524.	1.01E-04	550.0980	3.13E+11	178.5460	353553.	0.00
42.3000	-0.00218	-65919.	-2649.	1.00E-04	553.7498	3.13E+11	145.5621	360224.	0.00
42.7500	-0.00164	-78398.	-1955.	9.91E-05	556.4742	3.13E+11	111.6487	366894.	0.00
43.2000	-0.00111	-87617.	467.9739	9.77E-05	558.4869	3.13E+11	785.6298	3816000.	0.00
43.6500	-5.88E-04	-73923.	3902.	9.63E-05	555.4972	3.13E+11	486.3904	4464000.	0.00
44.1000	-7.19E-05	-46042.	5399.	9.52E-05	549.4102	3.13E+11	68.0567	5112000.	0.00
44.5500	4.40E-04	-16173.	4315.	9.47E-05	542.8894	3.13E+11	-469.6623	5760000.	0.00
45.0000	9.51E-04	0.00	0.00	9.46E-05	539.3584	3.13E+11	-1129.	3204000.	0.00

POF

MIN TIP

* The above values of total stress are combined axial and bending stresses.

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Pile-head deflection = 1.23841584 inches
 Computed slope at pile head = -0.00634434 radians
 Maximum bending moment = 5855563. inch-lbs
 Maximum shear force = -39607. lbs
 Depth of maximum bending moment = 20.70000000 feet below pile head
 Depth of maximum shear force = 30.60000000 feet below pile head
 Number of iterations = 9
 Number of zero deflection points = 2

 Computed Values of Pile Loading and Deflection
 for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 14000.0 lbs
 Applied moment at pile head = 952600.0 in-lbs
 Axial thrust load on pile head = 362000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in ²	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.9963	952600.	14000.	-0.00432	563.6137	3.13E+11	0.00	0.00	0.00
0.4500	0.9730	1036629.	14000.	-0.00430	581.9589	3.13E+11	0.00	0.00	0.00
0.9000	0.9498	1120623.	14000.	-0.00428	600.2965	3.13E+11	0.00	0.00	0.00
1.3500	0.9267	1204580.	14000.	-0.00426	618.6259	3.13E+11	0.00	0.00	0.00
1.8000	0.9037	1288496.	14000.	-0.00424	636.9463	3.13E+11	0.00	0.00	0.00
2.2500	0.8809	1372368.	14000.	-0.00422	655.2574	3.13E+11	0.00	0.00	0.00
2.7000	0.8582	1456195.	14000.	-0.00420	673.5583	3.13E+11	0.00	0.00	0.00
3.1500	0.8356	1539972.	14000.	-0.00417	691.8485	3.13E+11	0.00	0.00	0.00
3.6000	0.8131	1623697.	14000.	-0.00414	710.1273	3.13E+11	0.00	0.00	0.00
4.0500	0.7908	1707368.	14000.	-0.00411	728.3943	3.13E+11	0.00	0.00	0.00
4.5000	0.7687	1790981.	14000.	-0.00408	746.6486	3.13E+11	0.00	0.00	0.00
4.9500	0.7467	1874534.	14000.	-0.00405	764.8898	3.13E+11	0.00	0.00	0.00
5.4000	0.7249	1958023.	14000.	-0.00402	783.1172	3.13E+11	0.00	0.00	0.00
5.8500	0.7033	2041447.	14000.	-0.00398	801.3302	3.13E+11	0.00	0.00	0.00
6.3000	0.6819	2124802.	14000.	-0.00395	819.5282	3.13E+11	0.00	0.00	0.00
6.7500	0.6607	2208085.	14000.	-0.00391	837.7106	3.13E+11	0.00	0.00	0.00
7.2000	0.6397	2291294.	14000.	-0.00387	855.8767	3.13E+11	0.00	0.00	0.00
7.6500	0.6188	2374425.	14000.	-0.00383	874.0260	3.13E+11	0.00	0.00	0.00
8.1000	0.5983	2457477.	14000.	-0.00379	892.1578	3.13E+11	0.00	0.00	0.00
8.5500	0.5779	2540446.	14000.	-0.00375	910.2715	3.13E+11	0.00	0.00	0.00
9.0000	0.5578	2623329.	14000.	-0.00370	928.3665	3.13E+11	0.00	0.00	0.00
9.4500	0.5379	2706124.	14000.	-0.00366	946.4423	3.13E+11	0.00	0.00	0.00
9.9000	0.5183	2788828.	14000.	-0.00361	964.4981	3.13E+11	0.00	0.00	0.00
10.3500	0.4989	2871437.	14000.	-0.00356	982.5334	3.13E+11	0.00	0.00	0.00
10.8000	0.4798	2953950.	14000.	-0.00351	1001.	3.13E+11	0.00	0.00	0.00
11.2500	0.4610	3036364.	14000.	-0.00346	1019.	3.13E+11	0.00	0.00	0.00
11.7000	0.4425	3118675.	14000.	-0.00341	1037.	3.13E+11	0.00	0.00	0.00
12.1500	0.4242	3200881.	14000.	-0.00335	1054.	3.13E+11	0.00	0.00	0.00
12.6000	0.4063	3282979.	14000.	-0.00330	1072.	3.13E+11	0.00	0.00	0.00
13.0500	0.3886	3364967.	14000.	-0.00324	1090.	3.13E+11	0.00	0.00	0.00
13.5000	0.3713	3446841.	14000.	-0.00318	1108.	3.13E+11	0.00	0.00	0.00
13.9500	0.3543	3528599.	14000.	-0.00312	1126.	3.13E+11	0.00	0.00	0.00
14.4000	0.3376	3610239.	14000.	-0.00306	1144.	3.13E+11	0.00	0.00	0.00
14.8500	0.3212	3691756.	14000.	-0.00300	1162.	3.13E+11	0.00	0.00	0.00
15.3000	0.3052	3773149.	14000.	-0.00293	1179.	3.13E+11	0.00	0.00	0.00
15.7500	0.2896	3854415.	14000.	-0.00287	1197.	3.13E+11	0.00	0.00	0.00
16.2000	0.2743	3935552.	14000.	-0.00280	1215.	3.13E+11	0.00	0.00	0.00
16.6500	0.2594	4016555.	14000.	-0.00273	1233.	3.13E+11	0.00	0.00	0.00
17.1000	0.2448	4097424.	14000.	-0.00266	1250.	3.13E+11	0.00	0.00	0.00

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17.5500	0.2306	4178154.	14000.	-0.00259	1268.	3.13E+11	0.00	0.00	0.00
18.0000	0.2169	4258743.	14000.	-0.00252	1285.	3.13E+11	0.00	0.00	0.00
18.4500	0.2035	4339189.	13888.	-0.00244	1303.	3.13E+11	-41.5269	1102.	0.00
18.9000	0.1905	4418278.	13542.	-0.00237	1320.	3.13E+11	-86.6247	2456.	0.00
19.3500	0.1779	4494692.	12948.	-0.00229	1337.	3.13E+11	-133.2757	4045.	0.00
19.8000	0.1658	4567068.	12100.	-0.00221	1353.	3.13E+11	-180.9224	5894.	0.00
20.2500	0.1540	4634015.	10995.	-0.00213	1367.	3.13E+11	-228.3067	8003.	0.00
20.7000	0.1427	4694148.	9640.	-0.00205	1380.	3.13E+11	-273.4862	10346.	0.00
21.1500	0.1319	4746148.	8049.	-0.00197	1392.	3.13E+11	-315.6837	12926.	0.00
21.6000	0.1215	4788783.	6239.	-0.00189	1401.	3.13E+11	-354.7300	15770.	0.00
22.0500	0.1115	4820913.	4232.	-0.00181	1408.	3.13E+11	-388.5483	18819.	0.00
22.5000	0.1020	4841550.	2060.	-0.00172	1413.	3.13E+11	-416.1363	22038.	0.00
22.9500	0.09290	4849889.	-257.4200	-0.00164	1414.	3.13E+11	-442.0439	25696.	0.00
23.4000	0.08427	4845175.	-2696.	-0.00155	1413.	3.13E+11	-461.3152	29560.	0.00
23.8500	0.07610	4826846.	-5220.	-0.00147	1409.	3.13E+11	-473.3008	33584.	0.00
24.3000	0.06838	4794553.	-7800.	-0.00139	1402.	3.13E+11	-482.3769	38093.	0.00
24.7500	0.06111	4748032.	-10417.	-0.00131	1392.	3.13E+11	-486.8865	43027.	0.00
25.2000	0.05427	4687154.	-13040.	-0.00123	1379.	3.13E+11	-484.3221	48190.	0.00
25.6500	0.04787	4611994.	-15574.	-0.00114	1363.	3.13E+11	-454.3153	51244.	0.00
26.1000	0.04191	4523432.	-17937.	-0.00107	1343.	3.13E+11	-421.0742	54259.	0.00
26.5500	0.03636	4422439.	-20116.	-9.89E-04	1321.	3.13E+11	-385.6354	57273.	0.00
27.0000	0.03122	4310051.	-22284.	-9.14E-04	1297.	3.13E+11	-417.3637	72180.	0.00
27.4500	0.02649	4185348.	-24596.	-8.41E-04	1269.	3.13E+11	-439.2020	89531.	0.00
27.9000	0.02215	4047697.	-26821.	-7.70E-04	1239.	3.13E+11	-384.6525	93794.	0.00
28.3500	0.01818	3898693.	-28751.	-7.01E-04	1207.	3.13E+11	-330.0836	98058.	0.00
28.8000	0.01457	3739932.	-30387.	-6.35E-04	1172.	3.13E+11	-276.1249	102321.	0.00
29.2500	0.01132	3572994.	-31736.	-5.72E-04	1136.	3.13E+11	-223.3442	106585.	0.00
29.7000	0.00839	3399422.	-32804.	-5.12E-04	1098.	3.13E+11	-172.2470	110848.	0.00
30.1500	0.00578	3220713.	-33602.	-4.55E-04	1059.	3.13E+11	-123.2766	115111.	0.00
30.6000	0.00347	3038301.	-34142.	-4.01E-04	1019.	3.13E+11	-76.8147	119375.	0.00
31.0500	0.00145	2853547.	-34439.	-3.50E-04	978.6276	3.13E+11	-33.1825	123638.	0.00
31.5000	-3.11E-04	2667729.	-34509.	-3.03E-04	938.0599	3.13E+11	7.3574	127901.	0.00
31.9500	-0.00182	2482035.	-34369.	-2.59E-04	897.5193	3.13E+11	44.5992	132165.	0.00
32.4000	-0.00310	2297559.	-34037.	-2.17E-04	857.2445	3.13E+11	78.3916	136428.	0.00
32.8500	-0.00417	2115291.	-33532.	-1.79E-04	817.4518	3.13E+11	108.6346	140692.	0.00
33.3000	-0.00504	1936119.	-32873.	-1.44E-04	778.3352	3.13E+11	135.2773	144955.	0.00
33.7500	-0.00573	1760827.	-32080.	-1.13E-04	740.0655	3.13E+11	158.3140	149218.	0.00
34.2000	-0.00625	1590092.	-30957.	-8.37E-05	702.7907	3.13E+11	257.6737	222454.	0.00
34.6500	-0.00663	1426817.	-29522.	-5.77E-05	667.1446	3.13E+11	273.8861	222982.	0.00
35.1000	-0.00688	1271481.	-28008.	-3.44E-05	633.2317	3.13E+11	286.7441	225134.	0.00
35.5500	-0.00700	1124463.	-26434.	-1.38E-05	601.1348	3.13E+11	296.3523	228470.	0.00
36.0000	-0.00703	986049.	-24816.	4.42E-06	570.9164	3.13E+11	302.7929	232705.	0.00
36.4500	-0.00696	856432.	-23172.	2.03E-05	542.6183	3.13E+11	306.1455	237641.	0.00
36.9000	-0.00681	735712.	-21484.	3.40E-05	516.2629	3.13E+11	318.8903	252969.	0.00
37.3500	-0.00659	624267.	-19730.	4.57E-05	491.9322	3.13E+11	331.0478	271300.	0.00
37.8000	-0.00631	522454.	-17915.	5.56E-05	469.7044	3.13E+11	340.9929	291670.	0.00
38.2500	-0.00599	430567.	-16096.	6.38E-05	449.6436	3.13E+11	332.9002	300186.	0.00
38.7000	-0.00562	348372.	-14334.	7.06E-05	431.6990	3.13E+11	319.5705	306857.	0.00
39.1500	-0.00523	275485.	-12652.	7.59E-05	415.7862	3.13E+11	303.4570	313528.	0.00
39.6000	-0.00480	211437.	-11063.	8.01E-05	401.8033	3.13E+11	284.8418	320199.	0.00
40.0500	-0.00436	155688.	-9581.	8.33E-05	389.6322	3.13E+11	263.9908	326870.	0.00
40.5000	-0.00390	107631.	-8218.	8.56E-05	379.1405	3.13E+11	241.1515	333540.	0.00
40.9500	-0.00344	66603.	-6982.	8.71E-05	370.1833	3.13E+11	216.5520	340211.	0.00
41.4000	-0.00296	31888.	-5883.	8.79E-05	362.6042	3.13E+11	190.4004	346882.	0.00
41.8500	-0.00249	2723.	-4929.	8.82E-05	356.2370	3.13E+11	162.8854	353553.	0.00
42.3000	-0.00201	-21692.	-4127.	8.80E-05	360.3783	3.13E+11	134.1770	360224.	0.00
42.7500	-0.00154	-42194.	-3483.	8.75E-05	364.8542	3.13E+11	104.4287	366894.	0.00
43.2000	-0.00107	-59649.	-1166.	8.66E-05	368.6650	3.13E+11	753.6681	3816000.	0.00
43.6500	-6.02E-04	-55125.	2212.	8.56E-05	367.6773	3.13E+11	497.3059	4464000.	0.00
44.1000	-1.42E-04	-36098.	3917.	8.48E-05	363.5233	3.13E+11	134.2171	5112000.	0.00
44.5500	3.15E-04	-13155.	3373.	8.44E-05	358.5146	3.13E+11	-335.6403	5760000.	0.00
45.0000	7.70E-04	0.00	0.00	8.43E-05	355.6425	3.13E+11	-913.5907	3204000.	0.00

POF

MIN TIP

* The above values of total stress are combined axial and bending stresses.

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Output Summary for Load Case No. 2:

Pile-head deflection = 0.99626383 inches
 Computed slope at pile head = -0.00432025 radians
 Maximum bending moment = 4849889. inch-lbs
 Maximum shear force = -34509. lbs
 Depth of maximum bending moment = 22.95000000 feet below pile head
 Depth of maximum shear force = 31.50000000 feet below pile head
 Number of iterations = 9
 Number of zero deflection points = 2

 Computed Values of Pile Loading and Deflection
 for Lateral Loading for Load Case Number 3

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head = 2360.0 lbs
 Rotation of pile head = 0.000E+00 radians
 Axial load at pile head = 361000.0 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.03061	-425208.	2360.	0.00	447.4912	3.13E+11	0.00	0.00	0.00
0.4500	0.03059	-412457.	2360.	-7.22E-06	444.7074	3.13E+11	0.00	0.00	0.00
0.9000	0.03053	-399692.	2360.	-1.42E-05	441.9206	3.13E+11	0.00	0.00	0.00
1.3500	0.03044	-386913.	2360.	-2.10E-05	439.1308	3.13E+11	0.00	0.00	0.00
1.8000	0.03031	-374122.	2360.	-2.76E-05	436.3382	3.13E+11	0.00	0.00	0.00
2.2500	0.03014	-361318.	2360.	-3.39E-05	433.5428	3.13E+11	0.00	0.00	0.00
2.7000	0.02994	-348502.	2360.	-4.00E-05	430.7448	3.13E+11	0.00	0.00	0.00
3.1500	0.02971	-335674.	2360.	-4.59E-05	427.9442	3.13E+11	0.00	0.00	0.00
3.6000	0.02944	-322835.	2360.	-5.16E-05	425.1412	3.13E+11	0.00	0.00	0.00
4.0500	0.02915	-309985.	2360.	-5.70E-05	422.3358	3.13E+11	0.00	0.00	0.00
4.5000	0.02883	-297124.	2360.	-6.23E-05	419.5281	3.13E+11	0.00	0.00	0.00
4.9500	0.02848	-284254.	2360.	-6.73E-05	416.7183	3.13E+11	0.00	0.00	0.00
5.4000	0.02810	-271374.	2360.	-7.21E-05	413.9063	3.13E+11	0.00	0.00	0.00
5.8500	0.02770	-258485.	2360.	-7.66E-05	411.0924	3.13E+11	0.00	0.00	0.00
6.3000	0.02727	-245587.	2360.	-8.10E-05	408.2766	3.13E+11	0.00	0.00	0.00
6.7500	0.02683	-232681.	2360.	-8.51E-05	405.4589	3.13E+11	0.00	0.00	0.00
7.2000	0.02635	-219767.	2360.	-8.90E-05	402.6396	3.13E+11	0.00	0.00	0.00
7.6500	0.02586	-206846.	2360.	-9.27E-05	399.8187	3.13E+11	0.00	0.00	0.00
8.1000	0.02535	-193918.	2360.	-9.61E-05	396.9962	3.13E+11	0.00	0.00	0.00
8.5500	0.02483	-180983.	2360.	-9.94E-05	394.1723	3.13E+11	0.00	0.00	0.00
9.0000	0.02428	-168043.	2360.	-1.02E-04	391.3471	3.13E+11	0.00	0.00	0.00
9.4500	0.02372	-155096.	2360.	-1.05E-04	388.5206	3.13E+11	0.00	0.00	0.00
9.9000	0.02315	-142145.	2360.	-1.08E-04	385.6931	3.13E+11	0.00	0.00	0.00
10.3500	0.02256	-129188.	2360.	-1.10E-04	382.8644	3.13E+11	0.00	0.00	0.00
10.8000	0.02196	-116228.	2360.	-1.12E-04	380.0349	3.13E+11	0.00	0.00	0.00
11.2500	0.02135	-103263.	2360.	-1.14E-04	377.2044	3.13E+11	0.00	0.00	0.00
11.7000	0.02073	-90295.	2360.	-1.16E-04	374.3733	3.13E+11	0.00	0.00	0.00
12.1500	0.02010	-77324.	2360.	-1.17E-04	371.5414	3.13E+11	0.00	0.00	0.00
12.6000	0.01946	-64350.	2360.	-1.18E-04	368.7090	3.13E+11	0.00	0.00	0.00
13.0500	0.01882	-51374.	2360.	-1.19E-04	365.8761	3.13E+11	0.00	0.00	0.00
13.5000	0.01817	-38397.	2360.	-1.20E-04	363.0428	3.13E+11	0.00	0.00	0.00
13.9500	0.01752	-25418.	2360.	-1.21E-04	360.2093	3.13E+11	0.00	0.00	0.00
14.4000	0.01687	-12438.	2360.	-1.21E-04	357.3756	3.13E+11	0.00	0.00	0.00
14.8500	0.01621	542.0760	2360.	-1.21E-04	354.7784	3.13E+11	0.00	0.00	0.00
15.3000	0.01556	13522.	2360.	-1.21E-04	357.6123	3.13E+11	0.00	0.00	0.00
15.7500	0.01491	26502.	2360.	-1.21E-04	360.4460	3.13E+11	0.00	0.00	0.00

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16.2000	0.01425	39481.	2360.	-1.20E-04	363.2795	3.13E+11	0.00	0.00	0.00
16.6500	0.01361	52458.	2360.	-1.19E-04	366.1127	3.13E+11	0.00	0.00	0.00
17.1000	0.01297	65434.	2360.	-1.18E-04	368.9456	3.13E+11	0.00	0.00	0.00
17.5500	0.01233	78407.	2360.	-1.17E-04	371.7780	3.13E+11	0.00	0.00	0.00
18.0000	0.01170	91378.	2360.	-1.16E-04	374.6097	3.13E+11	0.00	0.00	0.00
18.4500	0.01108	104346.	2343.	-1.14E-04	377.4409	3.13E+11	-6.1863	3014.	0.00
18.9000	0.01047	117130.	2295.	-1.12E-04	380.2319	3.13E+11	-11.6913	6029.	0.00
19.3500	0.00987	129569.	2219.	-1.10E-04	382.9475	3.13E+11	-16.5332	9043.	0.00
19.8000	0.00929	141522.	2118.	-1.08E-04	385.5570	3.13E+11	-20.7330	12057.	0.00
20.2500	0.00871	152865.	1997.	-1.05E-04	388.0335	3.13E+11	-24.3138	15072.	0.00
20.7000	0.00815	163494.	1857.	-1.02E-04	390.3540	3.13E+11	-27.3014	18086.	0.00
21.1500	0.00761	173322.	1703.	-9.94E-05	392.4996	3.13E+11	-29.7233	21101.	0.00
21.6000	0.00708	182277.	1538.	-9.63E-05	394.4546	3.13E+11	-31.6092	24115.	0.00
22.0500	0.00657	190304.	1363.	-9.31E-05	396.2071	3.13E+11	-32.9902	27129.	0.00
22.5000	0.00607	197362.	1183.	-8.98E-05	397.7482	3.13E+11	-33.8990	30144.	0.00
22.9500	0.00560	203426.	998.3078	-8.63E-05	399.0720	3.13E+11	-34.3692	33158.	0.00
23.4000	0.00514	208481.	812.5352	-8.28E-05	400.1755	3.13E+11	-34.4354	36172.	0.00
23.8500	0.00470	212524.	627.4011	-7.91E-05	401.0582	3.13E+11	-34.1327	39187.	0.00
24.3000	0.00429	215565.	444.8020	-7.54E-05	401.7221	3.13E+11	-33.4966	42201.	0.00
24.7500	0.00389	217622.	266.4428	-7.17E-05	402.1712	3.13E+11	-32.5624	45216.	0.00
25.2000	0.00351	218722.	93.8371	-6.79E-05	402.4114	3.13E+11	-31.3656	48230.	0.00
25.6500	0.00316	218900.	-71.6909	-6.42E-05	402.4503	3.13E+11	-29.9410	51244.	0.00
26.1000	0.00282	218198.	-229.0036	-6.04E-05	402.2970	3.13E+11	-28.3230	54259.	0.00
26.5500	0.00250	216663.	-377.1465	-5.67E-05	401.9618	3.13E+11	-26.5448	57273.	0.00
27.0000	0.00221	214346.	-528.4652	-5.29E-05	401.4560	3.13E+11	-29.4992	72180.	0.00
27.4500	0.00193	211162.	-694.5567	-4.93E-05	400.7608	3.13E+11	-32.0162	89531.	0.00
27.9000	0.00167	207037.	-859.5433	-4.57E-05	399.8602	3.13E+11	-29.0900	93794.	0.00
28.3500	0.00144	202057.	-1009.	-4.21E-05	398.7730	3.13E+11	-26.1090	98058.	0.00
28.8000	0.00122	196308.	-1141.	-3.87E-05	397.5180	3.13E+11	-23.1103	102321.	0.00
29.2500	0.00102	189880.	-1258.	-3.54E-05	396.1145	3.13E+11	-20.1276	106585.	0.00
29.7000	8.38E-04	182858.	-1359.	-3.22E-05	394.5815	3.13E+11	-17.1921	110848.	0.00
30.1500	6.72E-04	175328.	-1444.	-2.91E-05	392.9376	3.13E+11	-14.3317	115111.	0.00
30.6000	5.23E-04	167375.	-1514.	-2.61E-05	391.2013	3.13E+11	-11.5711	119375.	0.00
31.0500	3.90E-04	159078.	-1569.	-2.33E-05	389.3900	3.13E+11	-8.9321	123638.	0.00
31.5000	2.72E-04	150516.	-1611.	-2.06E-05	387.5207	3.13E+11	-6.4333	127901.	0.00
31.9500	1.67E-04	141761.	-1639.	-1.81E-05	385.6094	3.13E+11	-4.0902	132165.	0.00
32.4000	7.58E-05	132883.	-1656.	-1.58E-05	383.6709	3.13E+11	-1.9155	136428.	0.00
32.8500	-3.12E-06	123943.	-1660.	-1.35E-05	381.7194	3.13E+11	0.08118	140692.	0.00
33.3000	-7.05E-05	115002.	-1655.	-1.15E-05	379.7674	3.13E+11	1.8928	144955.	0.00
33.7500	-1.27E-04	106113.	-1641.	-9.58E-06	377.8266	3.13E+11	3.5151	149218.	0.00
34.2000	-1.74E-04	97322.	-1610.	-7.83E-06	375.9074	3.13E+11	7.7392	240149.	0.00
34.6500	-2.12E-04	88754.	-1563.	-6.23E-06	374.0368	3.13E+11	9.6801	246820.	0.00
35.1000	-2.41E-04	80465.	-1506.	-4.77E-06	372.2271	3.13E+11	11.3265	253491.	0.00
35.5500	-2.63E-04	72503.	-1442.	-3.45E-06	370.4890	3.13E+11	12.6849	260162.	0.00
36.0000	-2.79E-04	64909.	-1370.	-2.27E-06	368.8311	3.13E+11	13.7643	266832.	0.00
36.4500	-2.88E-04	57715.	-1294.	-1.21E-06	367.2603	3.13E+11	14.5754	273503.	0.00
36.9000	-2.92E-04	50943.	-1213.	-2.74E-07	365.7819	3.13E+11	15.1306	280174.	0.00
37.3500	-2.91E-04	44611.	-1131.	5.50E-07	364.3995	3.13E+11	15.4434	286845.	0.00
37.8000	-2.86E-04	38727.	-1047.	1.27E-06	363.1150	3.13E+11	15.5283	293516.	0.00
38.2500	-2.77E-04	33296.	-963.7423	1.89E-06	361.9292	3.13E+11	15.4004	300186.	0.00
38.7000	-2.65E-04	28312.	-881.4586	2.42E-06	360.8411	3.13E+11	15.0750	306857.	0.00
39.1500	-2.51E-04	23766.	-801.4234	2.87E-06	359.8488	3.13E+11	14.5676	313528.	0.00
39.6000	-2.34E-04	19645.	-724.5783	3.24E-06	358.9490	3.13E+11	13.8935	320199.	0.00
40.0500	-2.16E-04	15928.	-651.7827	3.55E-06	358.1375	3.13E+11	13.0678	326870.	0.00
40.5000	-1.96E-04	12592.	-583.8165	3.79E-06	357.4092	3.13E+11	12.1049	333540.	0.00
40.9500	-1.75E-04	9608.	-521.3818	3.99E-06	356.7578	3.13E+11	11.0190	340211.	0.00
41.4000	-1.53E-04	6946.	-465.1067	4.13E-06	356.1764	3.13E+11	9.8236	346882.	0.00
41.8500	-1.30E-04	4569.	-415.5475	4.23E-06	355.6576	3.13E+11	8.5316	353553.	0.00
42.3000	-1.07E-04	2441.	-373.1927	4.29E-06	355.1930	3.13E+11	7.1554	360224.	0.00
42.7500	-8.40E-05	521.8170	-338.4651	4.31E-06	354.7740	3.13E+11	5.7067	366894.	0.00
43.2000	-6.07E-05	-1231.	-207.2946	4.31E-06	354.9289	3.13E+11	42.8750	3816000.	0.00
43.6500	-3.75E-05	-1734.	-7.9066	4.28E-06	355.0386	3.13E+11	30.9724	4464000.	0.00
44.1000	-1.44E-05	-1333.	112.5832	4.26E-06	354.9512	3.13E+11	13.6534	5112000.	0.00
44.5500	8.50E-06	-534.4550	124.9747	4.24E-06	354.7768	3.13E+11	-9.0639	5760000.	0.00
45.0000	3.14E-05	0.00	0.00	4.24E-06	354.6601	3.13E+11	-37.2230	3204000.	0.00

POF

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 3:

Pile-head deflection = 0.03061078 inches
 Computed slope at pile head = 0.000000 radians
 Maximum bending moment = -425208. inch-lbs
 Maximum shear force = 2360. lbs
 Depth of maximum bending moment = 0.000000 feet below pile head
 Depth of maximum shear force = 9.45000000 feet below pile head
 Number of iterations = 6
 Number of zero deflection points = 2

 Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
 Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
 Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
 Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
 Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	3900.	M, in-lb	4332000.	549000.	1.2384	-0.00634	-39607.	5855563.
2	V, lb	14000.	M, in-lb	952600.	362000.	0.9963	-0.00432	-34509.	4849889.
3	V, lb	2360.	S, rad	0.00	361000.	0.03061	0.00	2360.	-425208.

Maximum pile-head deflection = 1.2384158351 inches
 Maximum pile-head rotation = -0.0063443375 radians = -0.363504 deg.

 Summary of Warning Messages

The following warning was reported 120 times

**** Warning ****

The input value for friction angle is either smaller than 29 degrees or higher than 41 degrees and no value of k has been specified for a soil layer defined using the sand criteria. Program will assume an internal default value, for k, but the friction angle is outside the range of data available. Please check your input data for correctness.

The following warning was reported 30 times

**** Warning ****

An unreasonable input value for unconfined compressive strength has been specified for a soil defined using the weak rock criteria. The input value is greater than 500 psi. Please check your input data for correctness.

The analysis ended normally.

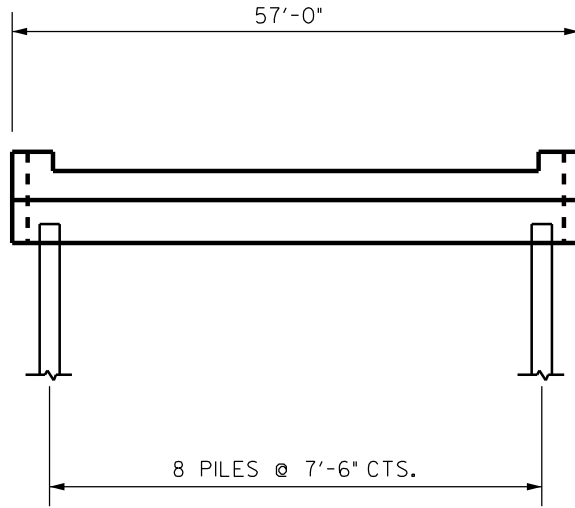
**END BENT
NO. 2**

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
HIGHWAY BUILDING
P. O. BOX 25201
RALEIGH, NORTH CAROLINA 27611

SUBJECT FACTORED GEOTECH LOADS PROJECT 17BP.5.R.79
WAKE 216 WAKE COUNTY
PREPARED BY ECP DATE 10/19 STATION STA. 11+90.50 -L-
CHECKED BY VC DATE 10/19 STR NO 1 SHEET 1 OF 2

END BENT #1
SINGLE ROW OF PILES
0 BATTERED PILES
PILE TYPE : HP 12x53

AVG BOC ELEV = 275.57 FT
FACTORED AXIAL PILE LOAD = 150 KIPS

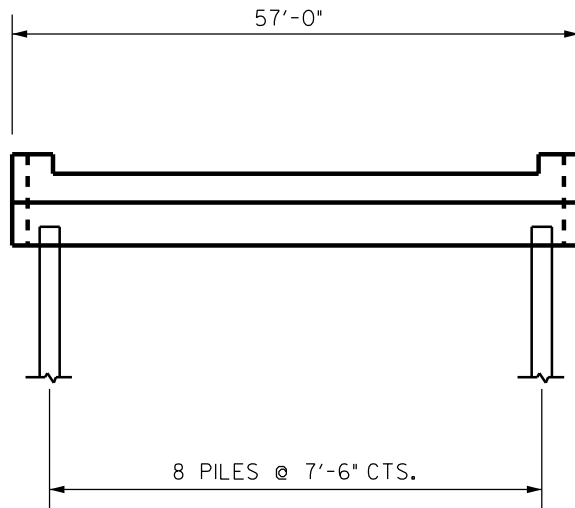


END BENT SKETCH

NO SCALE

END BENT #2
SINGLE ROW OF PILES
0 BATTERED PILES
PILE TYPE : HP 12x53

AVG BOC ELEV = 275.05 FT
FACTORED AXIAL PILE LOAD = 120 KIPS



END BENT SKETCH

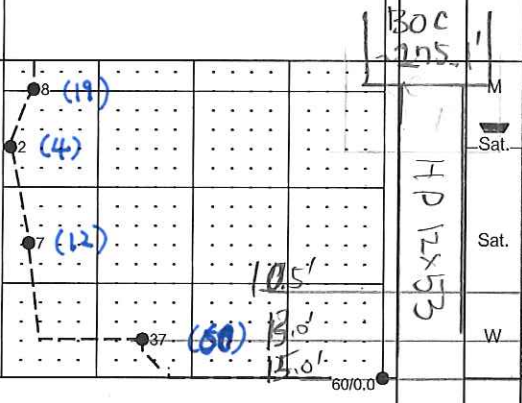
NO SCALE

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 17BP.5.R.79	TIP SF-910216	COUNTY WAKE	GEOLOGIST C.T. TANG
SITE DESCRIPTION Bridge No. 216 on SR 2366 (Old Battle Bridge Road) over Buffalo Creek			GROUND WTR (ft)
BORING NO. EB2-A	STATION 12+28 12+35	OFFSET 41 ft LT 26' LT	ALIGNMENT -L-
COLLAR ELEV. 276.6 ft	TOTAL DEPTH 16.5 ft	NORTHING 746,284	EASTING 2,176,579
DRILL RIG/HAMMER EFF./DATE BR19103 BK-51 82% 02/23/2017		DRILL METHOD Mud Rotary	HAMMER TYPE Automatic
DRILLER G. EISTER	START DATE 11/16/17	COMP. DATE 11/16/17	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION			
			0.5ft	0.5ft	0.5ft	0	25	50	75	100				ELEV. (ft)	DEPTH (ft)		
280																	
275	276.1	0.5	3	4	4									276.6	GROUND SURFACE	0.0	
270	273.1	3.5	1	1	1									273.6	ROADWAY EMBANKMENT Brown, Silty Sand	3.0	
265	268.1	8.5	2	3	4										ALLUVIAL Gray, Sandy Clay, with Trace Wood Fragments		
	263.1	13.5	3	5	32									264.6	Gray, Coarse Silty Sand	12.0	
	260.6	16.0	44	60/0.0										262.1	RESIDUAL Black, White and Gray, Silty Sand	14.5	
														260.1	Boring Terminated with Standard Penetration Test Refusal at Elevation 260.1 ft In Crystalline Rock	16.5	



① $r=57$
 $N_{60,1} = 8, S_u = 800 \text{ psf}$

② $r=57$
 $N_{60,1} = 12, \phi' = 30^\circ$

③ $r=57, N_{60,1} = 60, \phi' = 42^\circ$

④ $r=67, \phi' = 45^\circ$

GEOTECHNICAL BORING REPORT BORE LOG

WBS 17BP.5.R.79		TIP SF-910216		COUNTY WAKE		GEOLOGIST C.T. TANG										
SITE DESCRIPTION Bridge No. 216 on SR 2366 (Old Battle Bridge Road) over Buffalo Creek							GROUND WTR (ft)									
BORING NO. EB2-B _C		STATION 12+28 12+35		OFFSET 11 ft RT 4' LT		ALIGNMENT -L-										
COLLAR ELEV. 276.2 ft		TOTAL DEPTH 23.5 ft		NORTHING 746,266		EASTING 2,176,592										
DRILL RIG/HAMMER EFF./DATE BRI9103 BK-51 82% 02/23/2017				DRILL METHOD Mud Rotary		HAMMER TYPE Automatic										
DRILLER G. EISTER		START DATE 11/15/07		COMP. DATE 11/15/07		SURFACE WATER DEPTH N/A										
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100						
280																
275	275.7	0.5	1	3	6										276.2	0.0
270	272.7	3.5	1	WOH	1										274.2	2.0
	269.2	7.0													272.2	4.0
265	267.7	8.5	WOH	1	4										269.2	7.0
	264.2	12.0													264.2	12.0
260	262.7	13.5	2	2	7											
	257.7	18.5	56	44/0.4											257.7	18.5
255	252.7	23.5	60/0.0												252.7	23.5

① $v=57$
 $N_{60,1}=2, S_u=200 \text{ pcf}$

GROUND SURFACE 0.0

ROADWAY EMBANKMENT
Brown, Sandy Clay 2.0

ROADWAY EMBANKMENT
Brown, Silty Sand 4.0

ALLUVIAL
Gray, Silty Clay 7.0

Gray, Clayey Sand, with Trace Wood
Fragments

② $v=57, N_{60,1}=9, \phi=29^\circ$

Light Gray, Coarse Silty Sand 12.0

WEATHERED ROCK
Orange and Tan, Granite 18.5

③ $v=67, \phi=45^\circ$

Boring Terminated with Standard
Penetration Test Refusal at Elevation 252.7
ft In Crystalline Rock

NCDOT BORE SINGLE_910216_GEO_BRDG0216_BH.GPJ NC_DOT.GDT 11/21/17

GEOTECHNICAL BORING REPORT BORE LOG

WBS 17BP.5.R.79	TIP SF-910216	COUNTY WAKE	GEOLOGIST S. Woods
SITE DESCRIPTION Bridge No. 216 on SR 2366 (Old Battle Bridge Road) over Buffalo Creek			GROUND WTR (ft)
BORING NO. EB2-B	STATION 12+55	OFFSET 15 ft RT	ALIGNMENT -L-
COLLAR ELEV. 272.1 ft	TOTAL DEPTH 56.9 ft	NORTHING 746,262	EASTING 2,176,619
DRILL RIG/HAMMER EFF./DATE F&R5785 CME-55 73% 03/01/2019		DRILL METHOD H.S. Augers / Core	HAMMER TYPE Automatic
DRILLER S. DAVIS	START DATE 09/23/19	COMP. DATE 09/24/19	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION		
			0.5ft	0.5ft	0.5ft	0	25	50	75	100				ELEV. (ft)	DEPTH (ft)	
275																
272.1	272.1	0.0													272.1	GROUND SURFACE
270	268.6	3.5	1	1	1	2	(4)							W	268.6	ALLUVIAL Gray-Brown, Sandy Silt, with Trace Roots, Organics and Wood Fragments $r=57, \bar{N}_{60,1}=4, \phi'=28^\circ$
265	263.6	8.5	4	4	5					10.0'				Sat.	265.1	Gray, Silty Fine-Coarse Sand $r=57, \bar{N}_{60,1}=15, \phi'=31.5^\circ$
260	258.6	13.5	6	8	10					15.0'				Sat.	260.1	RESIDUAL Tan-Brown, Sandy Silt, with Trace Mica
255	253.6	18.5	8	13	17									W	255.1	Tan-Brown, Sandy Silt, with Trace Mica
250	248.6	23.5	17	10	12									Sat.	250.1	Gray-Pink, Silty Sand $r=57, \bar{N}_{60,1}=32, \phi'=36.6^\circ$
245	243.6	28.5	25	40	45					30.0'				W	243.6	Tan-Pink, Sandy Silt, with Trace Mica
240	238.6	33.5	39	60	40/0.4'									M	238.6	$r=57, \phi'=40^\circ$
235	233.6	38.5	100/0.4							100/0.9					238.1	WEATHERED ROCK Granite $r=67, \phi'=45^\circ$
230	229.2	42.9	60/0.1'							100/0.4					233.6	
225															229.2	CRYSTALLINE ROCK Light Tan, Moderately Weathered, Moderately Hard, Granite with Very Close Fracture Spacing [GSI = 17-22]
220	215.6	56.5	100/0.4							60/0.1'					215.6	
										100/0.4					215.2	WEATHERED ROCK Granite Boring Terminated at Elevation 215.2 ft In Weathered Rock

NCDOT BORE SINGLE 910216_GEO_BRDG0216_BH.GPJ_NC_DOT.GDT 10/1/19



STEWART

FACTORED PILE RESISTANCE

STATE ID: SF-910216
 FEDERAL ID: 17BP.5.R.79
 COUNTY: Wake

	INITIAL	DATE
PERFORMED BY:	CTT	10/11/19
CHECKED BY:	db	

DESCRIPTION: Bridge No. 216 on SR 2633 over Buffalo Creek

BRIDGE TYPE: 21-in Cored Slab
 BRIDGE WIDTH : 57 feet
 # OF SPANS: 1
 SPAN LENGTH: 35 feet
 PILE TYPE: HP 12X53

BENT NO: EB2

Boring No.: EB2-A
 BOC El.: 275.1±

STANDARD STRUCTURAL LOADING (PER PILE)

FINAL

NO. OF PILES : 8 (SINGLE ROW, ALL PLUMB)
 MAX. FACTORED STRUCTURAL LOAD: 120 KIPS STANDARD LOAD
MAX. FACTORED STRUCTURAL LOAD (ROUNDED): 60 TONS

REQUIRED STATIC NOMINAL RESISTANCE (PER PILE)

FINAL

HP PILE IN COASTAL PLAIN?: NO
 PREDOMINANT SOIL TYPE: SAND
 STATIC RF: 0.45
 DOWNDRAW RESISTANCE: 0.0 KIPS
 FACTORED DOWNDRAW LOAD²: 0.0 KIPS
 REQ'D STATIC NOMINAL RESISTANCE (R_n) : 266.7 KIPS 270 KIPS [ROUNDED UP]

	LT	RT
EST. PILE TIP DEPTH [BELOW BOC]	15 FEET	31 FEET
UNSUPPORTED PILE LENGTH	0 FEET	0 FEET
TOTAL ESTIMATED PILE LENGTH [ROUNDED]	20 FEET	35 FEET

If delta b/t LT and RT is greater than 5 ft, report seperately.

REQUIRED DRIVING RESISTANCE (PER PILE)

FINAL

PDA REQ'D?: NO
 DYNAMIC MONITORING RF: 0.6
 FACTORED LOAD: 120.0 KIPS
 FACTORED DOWNDRAW LOAD²: 0.0 KIPS
 DOWNDRAW RESISTANCE: 0.0 KIPS
 RESISTANCE LOST TO SCOUR³: 0.0 KIPS
 TOTAL REQ'D DRIVING RESISTANCE: 200.0 KIPS 200 KIPS [ROUNDED UP]
TOTAL REQ'D DRIVING RESISTANCE: 100 TONS

COMMENTS:

- ¹FROM NCDOT CHART "NOMINAL COMPRESSIVE RESISTANCE FOR STEEL PILES"
- ²BASED ON APILE RESULTS
- ³SCOUR RF=1.0 APPLIED
- ⁴USED TO ESTIMATE PILE LENGTH WITH APILE OUTPUT
- ⁵NCDOT LOAD FACTOR = 1.25 APPLIED

=====

APILE for Windows, Version 2015.7.6

Serial Number : 154813345

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

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This program is licensed to :

Stewart Engineering, Inc
Raleigh, North Carolina

Path to file locations : F:\Projects\GEO\2017\Other\B17006.00_17BP.5.R.79_Wake_216\04 - Calculations\EB2\
Name of input data file : EB2-A APILE.ap7d
Name of output file : EB2-A APILE.ap7o
Name of plot output file : EB2-A APILE.ap7p

Time and Date of Analysis

Date: October 14, 2019 Time: 08:20:43

1

* INPUT INFORMATION *

Bridge 216, EB2-A

DESIGNER : C.T. TANG

JOB NUMBER : SF-910216

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
 - CROSS SECTION AREA = 15.50 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 20.00 FT.
 - PILE STICKUP LENGTH, PSL = 0.00 FT.
 - ZERO FRICTION LENGTH, ZFL = 0.00 FT.
 - PERIMETER OF PILE = 48.00 IN.
 - TIP AREA OF PILE = 144.00 IN2
 - INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.00	57.00	0.00	0.00
10.50	CLAY	0.00	57.00	0.00	0.00
10.50	SAND	0.00	57.00	30.00	0.00
13.00	SAND	0.00	57.00	30.00	0.00
13.00	SAND	0.00	57.00	42.00	0.00
15.00	SAND	0.00	57.00	42.00	0.00
15.00	SAND	0.00	67.00	45.00	0.00
25.00	SAND	0.00	67.00	45.00	0.00

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.80	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.80	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
10.50	1.000	1.000
10.50	1.000	1.000
13.00	1.000	1.000


13.00 1.000 1.000
 15.00 1.000 1.000
 15.00 1.000 1.000
 25.00 1.000 1.000

1

 * COMPUTATION RESULT *

 * FED. HWY. METHOD *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	3.6	3.6
1.00	0.0	3.6	3.6
2.00	0.7	7.2	7.9
3.00	2.1	7.2	9.3
4.00	3.6	7.2	10.8
5.00	5.0	7.2	12.2
6.00	6.4	7.2	13.6
7.00	7.9	7.2	15.1
8.00	9.3	7.2	16.5
9.00	10.7	7.2	17.9
10.00	12.5	8.2	20.7
11.00	14.3	9.5	23.8
12.00	15.8	42.4	58.2
13.00	17.4	81.1	98.5
14.00	21.3	162.0	183.3
15.00	27.8	250.2	278.0
16.00	34.9	313.0	347.9
17.00	42.7	375.8	418.6
18.00	51.1	401.3	452.4
19.00	60.1	426.7	486.8
20.00	69.6	452.2	521.8

REQ'D STATIC NOMINAL RESISTANCE = 270 KIPS

 SKIN FRICTION = 10%

NOTES:

- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

 * COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
 * CURVES FOR AXIAL LOADING *

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00	0.0000E+00	0.0000E+00
			0.3720E+00	0.2445E-01
			0.6200E+00	0.4736E-01
			0.9300E+00	0.8709E-01
			0.1116E+01	0.1222E+00

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			0.1240E+01	0.1528E+00
			0.1116E+01	0.3056E+00
			0.1116E+01	0.4584E+00
			0.1116E+01	0.7639E+00
			0.1116E+01	0.3056E+01
2	10	0.5275E+01	0.0000E+00	0.0000E+00
			0.7440E+00	0.2445E-01
			0.1240E+01	0.4736E-01
			0.1860E+01	0.8709E-01
			0.2232E+01	0.1222E+00
			0.2480E+01	0.1528E+00
			0.2232E+01	0.3056E+00
			0.2232E+01	0.4584E+00
			0.2232E+01	0.7639E+00
			0.2232E+01	0.3056E+01
3	10	0.1046E+02	0.0000E+00	0.0000E+00
			0.8550E+00	0.2445E-01
			0.1425E+01	0.4736E-01
			0.2138E+01	0.8709E-01
			0.2565E+01	0.1222E+00
			0.2850E+01	0.1528E+00
			0.2565E+01	0.3056E+00
			0.2565E+01	0.4584E+00
			0.2565E+01	0.7639E+00
			0.2565E+01	0.3056E+01
4	10	0.1050E+02	0.0000E+00	0.0000E+00
			0.2850E+00	0.1000E-01
			0.5700E+00	0.2000E-01
			0.1140E+01	0.4000E-01
			0.1710E+01	0.6000E-01
			0.2280E+01	0.8000E-01
			0.2565E+01	0.9000E-01
			0.2850E+01	0.1000E+00
			0.2850E+01	0.5000E+00
			0.2850E+01	0.2000E+01
5	10	0.1178E+02	0.0000E+00	0.0000E+00
			0.2684E+00	0.1000E-01
			0.5369E+00	0.2000E-01
			0.1074E+01	0.4000E-01
			0.1611E+01	0.6000E-01
			0.2148E+01	0.8000E-01
			0.2416E+01	0.9000E-01
			0.2684E+01	0.1000E+00
			0.2684E+01	0.5000E+00
			0.2684E+01	0.2000E+01
6	10	0.1296E+02	0.0000E+00	0.0000E+00
			0.4810E+00	0.1000E-01
			0.9620E+00	0.2000E-01
			0.1924E+01	0.4000E-01
			0.2886E+01	0.6000E-01
			0.3848E+01	0.8000E-01
			0.4329E+01	0.9000E-01
			0.4810E+01	0.1000E+00
			0.4810E+01	0.5000E+00
			0.4810E+01	0.2000E+01
7	10	0.1300E+02	0.0000E+00	0.0000E+00
			0.9015E+00	0.1000E-01
			0.1803E+01	0.2000E-01
			0.3606E+01	0.4000E-01
			0.5409E+01	0.6000E-01

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			0.7212E+01	0.8000E-01
			0.8113E+01	0.9000E-01
			0.9015E+01	0.1000E+00
			0.9015E+01	0.5000E+00
			0.9015E+01	0.2000E+01
8	10	0.1403E+02		
			0.0000E+00	0.0000E+00
			0.1177E+01	0.1000E-01
			0.2355E+01	0.2000E-01
			0.4710E+01	0.4000E-01
			0.7064E+01	0.6000E-01
			0.9419E+01	0.8000E-01
			0.1060E+02	0.9000E-01
			0.1177E+02	0.1000E+00
			0.1177E+02	0.5000E+00
			0.1177E+02	0.2000E+01
9	10	0.1496E+02		
			0.0000E+00	0.0000E+00
			0.1177E+01	0.1000E-01
			0.2355E+01	0.2000E-01
			0.4710E+01	0.4000E-01
			0.7064E+01	0.6000E-01
			0.9419E+01	0.8000E-01
			0.1060E+02	0.9000E-01
			0.1177E+02	0.1000E+00
			0.1177E+02	0.5000E+00
			0.1177E+02	0.2000E+01
10	10	0.1500E+02		
			0.0000E+00	0.0000E+00
			0.1300E+01	0.1000E-01
			0.2599E+01	0.2000E-01
			0.5199E+01	0.4000E-01
			0.7798E+01	0.6000E-01
			0.1040E+02	0.8000E-01
			0.1170E+02	0.9000E-01
			0.1300E+02	0.1000E+00
			0.1300E+02	0.5000E+00
			0.1300E+02	0.2000E+01
11	10	0.2003E+02		
			0.0000E+00	0.0000E+00
			0.1650E+01	0.1000E-01
			0.3300E+01	0.2000E-01
			0.6600E+01	0.4000E-01
			0.9899E+01	0.6000E-01
			0.1320E+02	0.8000E-01
			0.1485E+02	0.9000E-01
			0.1650E+02	0.1000E+00
			0.1650E+02	0.5000E+00
			0.1650E+02	0.2000E+01
12	10	0.2496E+02		
			0.0000E+00	0.0000E+00
			0.1650E+01	0.1000E-01
			0.3300E+01	0.2000E-01
			0.6600E+01	0.4000E-01
			0.9899E+01	0.6000E-01
			0.1320E+02	0.8000E-01
			0.1485E+02	0.9000E-01
			0.1650E+02	0.1000E+00
			0.1650E+02	0.5000E+00
			0.1650E+02	0.2000E+01

TIP LOAD
KIP

TIP MOVEMENT
IN.

0.0000E+00	0.0000E+00
0.2826E+02	0.7639E-02
0.5653E+02	0.1528E-01
0.1131E+03	0.3056E-01
0.2261E+03	0.1986E+00
0.3392E+03	0.6417E+00
0.4070E+03	0.1115E+01
0.4522E+03	0.1528E+01
0.4522E+03	0.2292E+01
0.4522E+03	0.3056E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.4910E+00	0.3371E-03	0.3700E+00	0.1000E-03
0.4910E+01	0.3371E-02	0.3700E+01	0.1000E-02
0.2476E+02	0.1693E-01	0.1850E+02	0.5000E-02
0.4939E+02	0.3385E-01	0.3700E+02	0.1000E-01
0.1748E+03	0.1351E+00	0.1261E+03	0.5000E-01
0.2321E+03	0.2133E+00	0.1598E+03	0.1000E+00
0.3742E+03	0.6895E+00	0.3030E+03	0.5000E+00
0.4617E+03	0.1236E+01	0.3905E+03	0.1000E+01
0.5234E+03	0.2269E+01	0.4522E+03	0.2000E+01

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APILE for Windows, Version 2015.7.6

Serial Number : 154813345

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

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This program is licensed to :

Stewart Engineering, Inc
Raleigh, North Carolina

Path to file locations : F:\Projects\GEO\2017\Other\B17006.00_17BP.5.R.79_Wake_216\04 - Calculations\EB2\
Name of input data file : EB2-B APILE.ap7d
Name of output file : EB2-B APILE.ap7o
Name of plot output file : EB2-B APILE.ap7p

Time and Date of Analysis

Date: October 14, 2019 Time: 08:29:52

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* INPUT INFORMATION *

Bridge 216, EB2-B

DESIGNER : C.T. TANG

JOB NUMBER : SF-910216

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
 - CROSS SECTION AREA = 15.50 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 35.00 FT.
 - PILE STICKUP LENGTH, PSL = 0.00 FT.
 - ZERO FRICTION LENGTH, ZFL = 1.00 FT.
 - PERIMETER OF PILE = 48.00 IN.
 - TIP AREA OF PILE = 144.00 IN2
 - INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	SAND	0.00	57.00	28.00	0.00
10.00	SAND	0.00	57.00	28.00	0.00
10.00	SAND	0.00	57.00	31.50	0.00
15.00	SAND	0.00	57.00	31.50	0.00
15.00	SAND	0.00	57.00	36.60	0.00
30.00	SAND	0.00	57.00	36.60	0.00
30.00	SAND	0.00	57.00	40.00	0.00
37.00	SAND	0.00	57.00	40.00	0.00
37.00	SAND	0.00	67.00	45.00	0.00
45.00	SAND	0.00	67.00	45.00	0.00

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING

0.00	1.000	1.000
10.00	1.000	1.000
10.00	1.000	1.000
15.00	1.000	1.000
15.00	1.000	1.000
30.00	1.000	1.000
30.00	1.000	1.000
37.00	1.000	1.000
37.00	1.000	1.000
45.00	1.000	1.000

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 * COMPUTATION RESULT *

 * FED. HWY. METHOD *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.3	0.3
1.00	0.1	0.7	0.7
2.00	0.2	1.4	1.6
3.00	0.5	2.1	2.6
4.00	0.9	2.8	3.6
5.00	1.3	3.5	4.8
6.00	1.9	4.2	6.1
7.00	2.6	4.9	7.5
8.00	3.4	5.6	9.0
9.00	4.4	7.8	12.2
10.00	5.4	10.4	15.8
11.00	6.8	13.1	19.9
12.00	8.5	15.9	24.4
13.00	10.5	17.2	27.7
14.00	12.6	26.3	38.8
15.00	14.8	36.6	51.5
16.00	18.2	47.6	65.8
17.00	22.9	58.3	81.2
18.00	27.9	61.7	89.6
19.00	33.2	65.2	98.3
20.00	38.7	68.6	107.3
21.00	44.6	72.0	116.6
22.00	50.7	75.4	126.1
23.00	57.1	78.9	136.0
24.00	63.8	82.3	146.1
25.00	70.7	85.7	156.5
26.00	78.0	89.2	167.2
27.00	85.5	92.6	178.1
28.00	93.4	96.0	189.4
29.00	101.5	124.2	225.7
30.00	109.9	155.7	265.5
31.00	120.8	188.0	308.8
32.00	134.2	218.9	353.1
33.00	148.1	225.7	373.8
34.00	162.4	232.6	395.0
35.00	177.2	239.4	416.6

REQ'D STATIC NOMINAL RESISTANCE = 270 KIPS
 SKIN FRICTION = 39%

NOTES:

- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING *

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00	0.0000E+00	0.0000E+00
			0.2803E-01	0.1000E-01
			0.5605E-01	0.2000E-01
			0.1121E+00	0.4000E-01
			0.1682E+00	0.6000E-01
			0.2242E+00	0.8000E-01
			0.2522E+00	0.9000E-01
			0.2803E+00	0.1000E+00
			0.2803E+00	0.5000E+00
			0.2803E+00	0.2000E+01
2	10	0.5025E+01	0.0000E+00	0.0000E+00
			0.1121E+00	0.1000E-01
			0.2242E+00	0.2000E-01
			0.4484E+00	0.4000E-01
			0.6726E+00	0.6000E-01
			0.8969E+00	0.8000E-01
			0.1009E+01	0.9000E-01
			0.1121E+01	0.1000E+00
			0.1121E+01	0.5000E+00
			0.1121E+01	0.2000E+01
3	10	0.9958E+01	0.0000E+00	0.0000E+00
			0.2092E+00	0.1000E-01
			0.4185E+00	0.2000E-01
			0.8370E+00	0.4000E-01
			0.1255E+01	0.6000E-01
			0.1674E+01	0.8000E-01
			0.1883E+01	0.9000E-01
			0.2092E+01	0.1000E+00
			0.2092E+01	0.5000E+00
			0.2092E+01	0.2000E+01
4	10	0.1000E+02	0.0000E+00	0.0000E+00
			0.2748E+00	0.1000E-01
			0.5495E+00	0.2000E-01
			0.1099E+01	0.4000E-01
			0.1649E+01	0.6000E-01
			0.2198E+01	0.8000E-01
			0.2473E+01	0.9000E-01
			0.2748E+01	0.1000E+00
			0.2748E+01	0.5000E+00
			0.2748E+01	0.2000E+01
5	10	0.1253E+02	0.0000E+00	0.0000E+00
			0.3488E+00	0.1000E-01
			0.6976E+00	0.2000E-01
			0.1395E+01	0.4000E-01
			0.2093E+01	0.6000E-01
			0.2790E+01	0.8000E-01

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			0.3139E+01	0.9000E-01
			0.3488E+01	0.1000E+00
			0.3488E+01	0.5000E+00
			0.3488E+01	0.2000E+01
6	10	0.1496E+02		
			0.0000E+00	0.0000E+00
			0.4927E+00	0.1000E-01
			0.9855E+00	0.2000E-01
			0.1971E+01	0.4000E-01
			0.2956E+01	0.6000E-01
			0.3942E+01	0.8000E-01
			0.4435E+01	0.9000E-01
			0.4927E+01	0.1000E+00
			0.4927E+01	0.5000E+00
			0.4927E+01	0.2000E+01
7	10	0.1500E+02		
			0.0000E+00	0.0000E+00
			0.7058E+00	0.1000E-01
			0.1412E+01	0.2000E-01
			0.2823E+01	0.4000E-01
			0.4235E+01	0.6000E-01
			0.5646E+01	0.8000E-01
			0.6352E+01	0.9000E-01
			0.7058E+01	0.1000E+00
			0.7058E+01	0.5000E+00
			0.7058E+01	0.2000E+01
8	10	0.2253E+02		
			0.0000E+00	0.0000E+00
			0.1136E+01	0.1000E-01
			0.2272E+01	0.2000E-01
			0.4545E+01	0.4000E-01
			0.6817E+01	0.6000E-01
			0.9090E+01	0.8000E-01
			0.1023E+02	0.9000E-01
			0.1136E+02	0.1000E+00
			0.1136E+02	0.5000E+00
			0.1136E+02	0.2000E+01
9	10	0.2996E+02		
			0.0000E+00	0.0000E+00
			0.1674E+01	0.1000E-01
			0.3348E+01	0.2000E-01
			0.6697E+01	0.4000E-01
			0.1004E+02	0.6000E-01
			0.1339E+02	0.8000E-01
			0.1507E+02	0.9000E-01
			0.1674E+02	0.1000E+00
			0.1674E+02	0.5000E+00
			0.1674E+02	0.2000E+01
10	10	0.3000E+02		
			0.0000E+00	0.0000E+00
			0.2114E+01	0.1000E-01
			0.4228E+01	0.2000E-01
			0.8456E+01	0.4000E-01
			0.1268E+02	0.6000E-01
			0.1691E+02	0.8000E-01
			0.1903E+02	0.9000E-01
			0.2114E+02	0.1000E+00
			0.2114E+02	0.5000E+00
			0.2114E+02	0.2000E+01
11	10	0.3353E+02		
			0.0000E+00	0.0000E+00
			0.2522E+01	0.1000E-01
			0.5045E+01	0.2000E-01
			0.1009E+02	0.4000E-01
			0.1513E+02	0.6000E-01
			0.2018E+02	0.8000E-01

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			0.2270E+02	0.9000E-01
			0.2522E+02	0.1000E+00
			0.2522E+02	0.5000E+00
			0.2522E+02	0.2000E+01
12	10	0.3696E+02		
			0.0000E+00	0.0000E+00
			0.2560E+01	0.1000E-01
			0.5119E+01	0.2000E-01
			0.1024E+02	0.4000E-01
			0.1536E+02	0.6000E-01
			0.2048E+02	0.8000E-01
			0.2304E+02	0.9000E-01
			0.2560E+02	0.1000E+00
			0.2560E+02	0.5000E+00
			0.2560E+02	0.2000E+01
13	10	0.3700E+02		
			0.0000E+00	0.0000E+00
			0.2560E+01	0.1000E-01
			0.5119E+01	0.2000E-01
			0.1024E+02	0.4000E-01
			0.1536E+02	0.6000E-01
			0.2048E+02	0.8000E-01
			0.2304E+02	0.9000E-01
			0.2560E+02	0.1000E+00
			0.2560E+02	0.5000E+00
			0.2560E+02	0.2000E+01
14	10	0.4103E+02		
			0.0000E+00	0.0000E+00
			0.2560E+01	0.1000E-01
			0.5119E+01	0.2000E-01
			0.1024E+02	0.4000E-01
			0.1536E+02	0.6000E-01
			0.2048E+02	0.8000E-01
			0.2304E+02	0.9000E-01
			0.2560E+02	0.1000E+00
			0.2560E+02	0.5000E+00
			0.2560E+02	0.2000E+01
15	10	0.4496E+02		
			0.0000E+00	0.0000E+00
			0.2560E+01	0.1000E-01
			0.5119E+01	0.2000E-01
			0.1024E+02	0.4000E-01
			0.1536E+02	0.6000E-01
			0.2048E+02	0.8000E-01
			0.2304E+02	0.9000E-01
			0.2560E+02	0.1000E+00
			0.2560E+02	0.5000E+00
			0.2560E+02	0.2000E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.1496E+02	0.7639E-02
0.2993E+02	0.1528E-01
0.5985E+02	0.3056E-01
0.1197E+03	0.1986E+00
0.1796E+03	0.6417E+00
0.2155E+03	0.1115E+01
0.2394E+03	0.1528E+01
0.2394E+03	0.2292E+01
0.2394E+03	0.3056E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.5150E+00	0.4756E-03	0.1959E+00	0.1000E-03
0.5150E+01	0.4756E-02	0.1959E+01	0.1000E-02
0.2620E+02	0.2405E-01	0.9793E+01	0.5000E-02
0.5240E+02	0.4811E-01	0.1959E+02	0.1000E-01
0.2047E+03	0.2003E+00	0.6677E+02	0.5000E-01
0.2711E+03	0.3065E+00	0.8458E+02	0.1000E+00
0.3470E+03	0.7774E+00	0.1604E+03	0.5000E+00
0.3933E+03	0.1321E+01	0.2067E+03	0.1000E+01
0.4260E+03	0.2351E+01	0.2394E+03	0.2000E+01

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
200.0	31.70	0.00	31.0	7.15	14.78

REDUCE FUEL SETTING (-1) TO INCREASE BLOW COUNT/FT TO >30 BPF

Bridge 216, EB2-A

Hammer Information
 Select from following list [10/17/2016-2003]: ID: **41**

ID	Name	Type	Ham Wt/Ecc. M.	Energy/Power
40	DELMAG D 19-32	OED	4.000	42.440
41	DELMAG D 19-42	OED	4.000	43.240
42	DELMAG D200-42	OED	44.090	492.044

Hammer parameters
 Efficiency: **0.8**
 Pressure: **1440** psi Fixed **90** %
 Stroke: **10.81** ft Variable

Ultimate Capacities (up to 10)
 kips

1	2	3	4	5	6	7	8	9	10
200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Soil Parameters
 Quake: 2nd Toe - No
 Shaft: **0.1** in Const
 Toe: **0.1** in
 Damping: Shaft **0.05** s/ft Const, Toe **0.15** s/ft Smith
 Shaft Resistance Percentage: **10** %
 Dist. Shape Num: **0.0**

Soil Profile (S.F.):
 0.0 ft (Surface)
 2.00 in (1.90 kips)
 0 to 20.0 ft depth

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
200.0	24.61	0.52	31.8	6.31	13.08

REDUCE FUEL SETTING (-2) TO INCREASE BLOW COUNT/FT TO >30 BPF

Bridge 216, EB2-B

Hammer Information
 Select from following list [10/17/2016-2003]: ID: 41

ID	Name	Type	Ram Wt/Ecc. M.	Energy/Power
40	DELMAG D 19-32	OED	4.000	42.440
41	DELMAG D 19-42	OED	4.000	43.240
42	DELMAG D200-42	OED	44.090	492.044

Hammer parameters:

Efficiency: 0.8
 Pressure: 1295 psi Fixed 81 %
 Stroke: 10.81 ft Variable

Ultimate Capacities (up to 10) kips

1	2	3	4	5	6	7	8	9	10
200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Incr: 0 Action >>

Soil Parameters: 2nd Toe - No

Quake: Shaft 0.1 in Const, Toe 0.1 in

Damping: Shaft 0.05 s/ft Const, Toe 0.15 s/ft Smith

Shaft Resistance: Percentage 39 %

Dist. Shape Num 0.0

Residual Stress Analysis: No

