

ARKANSAS DEPARTMENT OF TRANSPORTATION



SUBSURFACE INVESTIGATION

STATE JOB NO. 061473

FEDERAL AID PROJECT NO. 9040

HWY. 165 STR. & APPRS. (LONOKE CO.) (S)

STATE HIGHWAY 165 SECTION 8

IN LONOKE COUNTY

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BAYOU METO CANAL 1000
HWY 165 BRIDGE
Geotechnical Design Report

2018 ADDENDUM

Prepared By:
US Army Corps of Engineers - Memphis District
Geotechnical Branch



November 2018

TABLE OF CONTENTS

1. Addendum Background.....	1
2. Subsurface Investigation.....	1
2.1. General Subsurface Conditions.....	1
2.2. Water Table.....	1
2.3. Laboratory Testing.....	2
3. Geotechnical Re-analysis.....	2
3.1. Liquefaction Potential & Residual Shear Strengths.....	2
3.2. Theoretical Axial Pile Capacity.....	2
3.3. Lateral Resistance.....	3
3.4. Slope Stability.....	3

TABLES

Table 1 – Liquefaction Zones & Residual Shear Strengths for Design.....	2
Table 2- General Theoretical Pile Capacity Information for Compression.....	3
Table 3 – Slope Stability Results Summary.....	3



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1. **ADDENDUM BACKGROUND.** The original HWY 165 Bridge analysis and design was completed in December 2015. Subsurface lithology variations found during subsequent Bayou Meto Basin construction adjacent to the proposed bridge location suggested that the HWY 165 borings may also be affected. USACE Memphis authorized a re-drill at the three original boring locations to verify subsurface conditions and to address any design impacts resulting from the new borings.
 2. **SUBSURFACE INVESTIGATION.** Borings 22-BMG-14, 23-BMU-14, and 24-BMU-14 were re-drilled by McCray Drilling, LLC. along the proposed centerline of the HWY 165 Bridge at positions directly adjacent to the original 2014 borings. USACE Memphis provided quality assurance (QA) personnel on-site to monitor drilling operations and to assist in sample field classifications. An "R" has been added to the end of each boring name (22-BMG-14R for example) to denote the 2017 re-drill. The re-drill boring logs and boring profile in relation to the bridge and canal are presented in the [Appendix](#).
 - 2.1. General Subsurface Conditions. Boring 22-BMG-14R was drilled to a 117.5-foot depth and borings 23 and 24-BMU-14R were drilled to 90 feet. The borings included disturbed (1.4-in I.D. split spoon) and/or undisturbed (5-in Shelby tube) sampling techniques. The upper 11 to 18 feet of material consists of Lean clays (CL) with interbedded fat clays (CH), transitioning into silty clays (CL-ML) and silts (ML) until 23 feet in depth. The above fine grained top blanket materials were generally underlain by medium dense to very dense poorly graded sands (SP) including interbedded layers containing a larger percentage of silty fines (SP-SM, and SM) and transitioning to layers containing various percentages of fine gravel starting at a depth of approximately 62 feet, including 5 to 20-foot pockets of poorly graded gravel with silt and sand (GP-GM). In general, the re-drilled borings contained a similar top blanket depth, a significant increase in the overall presence of gravels and fines within the underlying sands, and an increase in the average relative density within the coarse grained materials when compared to the original borings. The re-drilled boring 22-BMG-14R also noted tertiary below a depth of 112 ft (Approximate El. 129 ft), which was not picked up in the original 150-foot deep Boring 22-BMG-14.
 - 2.2. Water Table. At the time of drilling, the water table was measured between NAVD88 elevations 222.9 feet and 235.7 feet. To be conservative for design, the ground water table was assumed at elevation 240 feet compared to a natural ground elevation of approximately 240 to 245 feet.



- 2.3. Laboratory Testing. McCray Drilling, LLC. performed laboratory testing of the bridge boring samples. Generally, unconfined compression tests were performed on Shelby tube samples from the top 5-15 feet of fine-grained material and mechanical sieve analyses were performed on the remaining coarse-grained samples. Atterberg limits, moisture contents, dry unit weights, and fines content were also performed on Shelby tube samples. The condensed laboratory testing values are included in the boring logs.
3. **GEOTECHNICAL RE-ANALYSIS.** The following paragraphs will only highlight the findings of the re-analysis. Details on the methodologies used are further discussed in the December 2015 Bayou Meto Canal 1000 Hwy 165 Geotechnical Design Report. The original geotechnical report will be considered valid for anything not directly addressed below.
- 3.1. Liquefaction Potential & Residual Shear Strengths. The proposed bridge site class definition and design earthquake remain unchanged from the original report. However; liquefaction potential was re-evaluated due to the changes in lithology and relative densities related to the recorded standard penetration test (SPT) blow counts. Based on a global analysis and resulting Safety Factors <1, liquefaction may be induced within two layers or zones between elevations 228 and 218 feet. The resulting design residual shear strengths associated with the liquefied zones are summarized in Table 1 below. The calculations for liquefaction and S_r can be found in the [Appendix](#).

Table 1 – Liquefaction Zones & Residual Shear Strengths for Design

Range of Residual Shear Strength, S_r (psf)	
Zone 1 (EL 228 to 220.5 ft)	32 to 77
Zone 2 (EL 220.5 to 218 ft)	66 to 275

- 3.2. Theoretical Axial Pile Capacity. General Design information for HWY 165 Bridge can be seen in Table 2. The minimum tip elevations listed in Table 2 combine the max factored axial structural loading per pile and the effects of a downdrag load for the compressive case only. Downdrag will only occur above the bottom of Zone 2. Ultimate pile capacity curves can be found in the [Appendix](#).



Table 2- General Theoretical Pile Capacity Information for Compression

Bent Type	Pile Diameter (in)	Loading Condition	Max Factored Axial Loading (Kips)	Downdrag Working Load (Kips)	Approx. Minimum Tip Elevation (ft)
Abutments	18	Static	174	0	186
Abutments	18	Extreme	104	29	214
Bents	24	Static	268	0	176
Bents	24	Extreme	158	4.5	210

3.3. Lateral Resistance. Changes to lateral resistance were considered negligible from the original calculations.

3.4. Slope Stability. All slope stability F.S. met the minimum required F.S. for each scenario. A summary of the channel slope stability results are included in Table 3. Local instabilities in the channel slopes are expected during a seismic event; however, seismic cases for the channel were not re-evaluated as they were not analyzed for adjacent Bayou Meto Canal 1000 slopes nor HWY 161.

Table 3 – Slope Stability Results Summary

Analysis	Target Min. F.S.	Spencer Critical F.S.
AC	1.30	2.09
LT	1.25	1.75
FPQ	1.30	2.50
FPS	1.25	1.55
RD	1.20	1.64
SIPHON EXCAVATION	1.30	1.58
TEMPORARY CUT	1.30	2.79

It is recommended that any temporary excavation slopes adjacent to the detour shall be no steeper than 1V:3H. All other temporary slopes including excavation and excavated material embankments (EME) should be no steeper than 1V:2.5H with a minimum of 35 feet between the top bank of the temporary cut and any EME stockpile.

APPENDIX

Boring Designation 22-BMU-14(R)

DRILLING LOG		DIVISION Mississippi Valley Division (MVD)		INSTALLATION Memphis District (CEMVM)		SHEET 1 OF 4 SHEETS														
1. PROJECT Bayou Meto Canal 1000 Re-Drill				8. COORDINATE SYSTEM HORIZONTAL		VERTICAL														
2. HOLE NUMBER 22-BMU-14(R)				10. MANUFACTURER'S DESIGNATION OF DRILL CME 750x, automatic hammer		9. DRILLING METHOD: RM														
3. DRILLING AGENCY McCray Drilling				11. TOTAL SAMPLES 30		DISTURBED 30														
4. NAME OF DRILLER D. Dunn				12. DATE BORING 6/21/17		COMPLETED 6/22/17														
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED				13. ELEVATION WATER TABLE (ft)		AT DRILLING 226.12														
6. TOTAL DEPTH OF BORING 117.5				13. ELEVATION WATER TABLE (ft)		AFTER 24 HRS 227.12														
7. ELEVATION TOP OF BORING 241.12																				
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _t	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory										REMARKS	
									% Gravel	% Sand	% Fines	D10	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torvane (tsf)	C (psf)	
			8	12		Lean clay (CL) - Brown, Stiff, Silt Strata or Lenses	100	S-1					32	16	18.5					
			7																	
			5																	
			1	4		Medium Stiff	100	S-2					26	11	22.0					
235.62	5.5		2																	
			1	6		Fat clay (CH) - Brown, Medium Stiff, Oxidized, Rootlets	100	S-3					60	40	27.2					
233.12	8		3																	
			2	4		Lean clay (CL) - Brown, Medium Stiff, Oxidized	100	S-4					27	11	22.8					
			1																	
			3	8			100	S-5					25	10	23.5					
228.12	13		5																	
			3	4		Silty clay (CL-ML) - Brown, Medium Stiff	100	S-6					24	5	28.1					
			3																	
			1																	
			0	0		Soft	100	S-7					24	7	26.8					
223.12	18		0																	
			0	0																
			0	0		Silt (ML) - Brown, Soft, Clay Strata or Lenses	100	S-8					23	13	27.3					
			1	2																
			1			Sandy	100	S-9			87				26.9					
218.12	23		1																	
			4	9		Silty sand (SM) - Brown, Clay Strata or Lenses	100	S-10			30									
215.62	25.5		5																	
			10	39		Poorly graded sand with silt (SP-SM) - Brown, Fine Few Gravel	100	S-11	9	80	10									
			15																	
			24																	
			10	32			100	S-12	0	93	7	0.115								
			15																	

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DRILLING LOG (Cont Sheet)										INSTALLATION Memphis District (CEMVM)		SHEET 3 OF 4 SHEETS											
PROJECT Bayou Meto Canal 1000 Re-Drill										COORDINATE SYSTEM		HORIZONTAL VERTICAL											
LOCATION COORDINATES N 2047120.47 E 1285870.92										ELEVATION TOP OF BORING 241.12													
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _r	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory										REMARKS				
									% Gravel	% Sand	% Fines	D ₁₀	LL	PI	MC	DUW (pcf)	PPR (sf)	Torvane (sf)		C (psf)			
						Poorly graded sand with silt (SP-SM) - Gray, Fine (continued)																	
			18 16 17	33		Poorly graded sand with silt and gravel (SP-SM) - Fine to Medium	100	S-20	17	77	7	0.143											70
			23 12 10	22		Fine to Medium	100	S-21	12	80	7	0.136											75
			27 31 30	61			100	S-22	0	89	11												80
159.12	82					Silty sand (SM) - Light Gray, Fine																	
			24 34 30	64		Silty sand with gravel (SM)	100	S-23	16	68	16												85
			31 30 31	61			100	S-24	0	77	23												90
149.12	92					Clayey sand (SC) - Light Gray, Clay Strata or Lenses																	
			40 22 21	43			100	S-25			37												95
144.12	97					Silty sand (SM) - Gray																	
			31 40 36	76			100	S-26															100

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DRILLING LOG (Cont Sheet)										INSTALLATION Memphis District (CEMVM)		SHEET 4 OF 4 SHEETS										
PROJECT Bayou Meto Canal 1000 Re-Drill										COORDINATE SYSTEM		HORIZONTAL VERTICAL										
LOCATION COORDINATES N 2047120.47 E 1285870.92										ELEVATION TOP OF BORING 241.12												
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _r	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory											REMARKS		
									% Gravel	% Sand	% Fines	D ₁₀	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torvane (tsf)	C (psf)			
139.12	102					Silty sand (SM) - Gray <i>(continued)</i>																
			26 34 41	75		Clayey sand (SC) - Gray, Clay Strata or Lenses	100	S-27														
134.12	107					(Silty sand) - Gray																
			81 90	90 /			100	S-28				16										
129.12	112					Fat clay (CH) - Gray, Very Stiff																
			9 10 13	23			100	S-29					53	39	20.7							
			12 16 18	34			100	S-30							21.3							
123.62	117.5																					

Boring Designation 23-BMU-14(R)

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DRILLING LOG (Cont Sheet)										INSTALLATION Memphis District (CEMVM)		SHEET 3 OF 3 SHEETS											
PROJECT Bayou Meto Canal 1000 Re-Drill										COORDINATE SYSTEM		HORIZONTAL VERTICAL											
LOCATION COORDINATES N 2047082.97 E 1285896.57										ELEVATION TOP OF BORING 241.09													
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _r	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory										REMARKS				
									% Gravel	% Sand	% Fines	D ₁₀	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torvane (tsf)		C (psf)			
						Poorly graded gravel with silt and sand (GP-GM) - Gray, Fine <i>(continued)</i>																	
			14 21 17	38			100	S-18															70
			16 15 13	28			100	S-19	58	37	5	0.281											75
			10 29 29	58			100	S-20															80
159.09	82					Clayey sand (SC) - Gray																	
			20 22 50	72			100	S-21			40		20	5	23.7								85
151.09	90		21 16 20	36		Traces of Gravel	100	S-22	2	73	26												90
-Water Level was not encountered -Water Level was not encountered																							

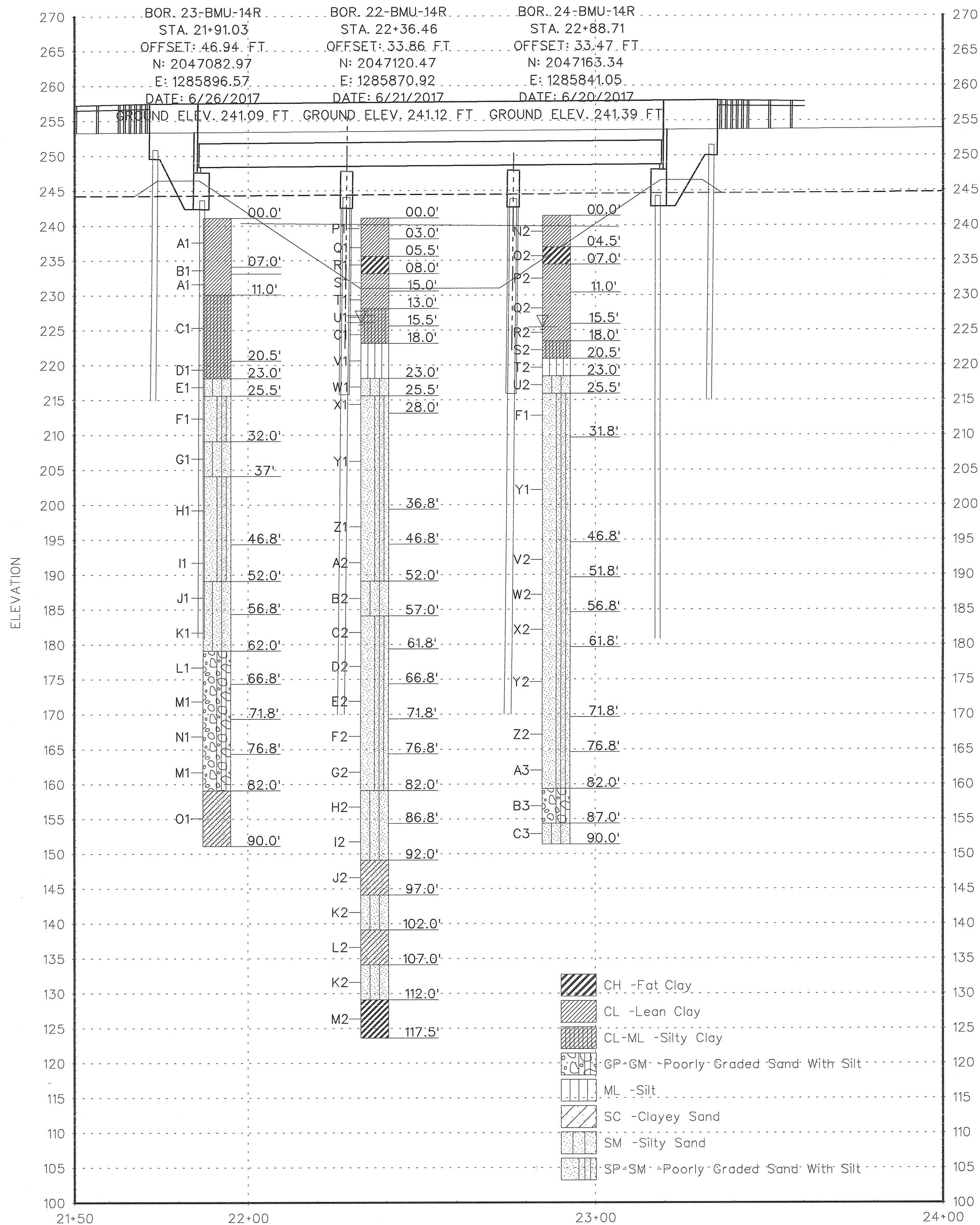
Boring Designation 24-BMU-14(R)

DRILLING LOG						DIVISION Mississippi Valley Division (MVD)	INSTALLATION Memphis District (CEMVM)								SHEET 1 OF 3 SHEETS						
1. PROJECT Bayou Meto Canal 1000 Re-Drill							8. COORDINATE SYSTEM		HORIZONTAL				VERTICAL								
							9. DRILLING METHOD: RM														
2. HOLE NUMBER 24-BMU-14(R)							LOCATION COORDINATES N 2047163.34 E 1285841.05							10. MANUFACTURER'S DESIGNATION OF DRILL CME 750x, automatic hammer							
3. DRILLING AGENCY McCray Drilling							11. TOTAL SAMPLES 22		DISTURBED 18				UNDISTURBED 4								
4. NAME OF DRILLER D. Dunn							12. DATE BORING		STARTED 6/20/17				COMPLETED 6/21/17								
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED							DEG FROM VERTICAL		BEARING ---				13. ELEVATION WATER TABLE (ft) 225.39		AT DRILLING AFTER 24 HRS						
6. TOTAL DEPTH OF BORING 90																					
7. ELEVATION TOP OF BORING 241.39																					
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _t	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory											REMARKS	
									% Gravel	% Sand	% Fines	D ₁₀	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torsion (tsf)	C (psf)		
236.89	4.5					Lean clay (CL) - Brown, Stiff, Rootlets, Debris	100	ST-1					31	18	17.1	103	4.00	0.40	1641		
										32	15	24.3	112	2.50	0.30	1064					
234.39	7					Fat clay (CH) - Brown, Stiff, Rootlets, Oxidized	100	ST-2					77	55	38.1	83	1.25	0.70	1773		
223.39	18		0 0 0	0		Lean clay (CL) - Brown, Stiff, Oxidized	100	ST-3					34	21	22.8	103	1.75	0.50	1316		
220.89	20.5		3 2 2	4		Silty clay with sand (CL-ML) - Brown	100	S-6			77		22	4	29.5						
218.39	23		3 2 4	6		Silt (ML) - Brown	100	S-7					21	1	28.0						
215.89	25.5		3 5 8	13		Silty sand (SM) - Brown	100	S-8			36				22.1						
			8 10 14	24		Poorly graded sand with silt (SP-SM) - Brown, Fine Fine to Medium, Traces of Gravel	100	S-9	1	94	5	0.156									
			11 14	25		Traces of Gravel	100	S-10	1	92	7	0.14									

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DRILLING LOG (Cont Sheet)										INSTALLATION Memphis District (CEMVM)		SHEET 3 OF 3 SHEETS											
PROJECT Bayou Meto Canal 1000 Re-Drill										COORDINATE SYSTEM		HORIZONTAL VERTICAL											
LOCATION COORDINATES N 2047163.34 E 1285841.05										ELEVATION TOP OF BORING 241.39													
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _r	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory										REMARKS				
									% Gravel	% Sand	% Fines	D ₁₀	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torvane (tsf)		C (psf)			
						Poorly graded sand with silt (SP-SM) - Brown, Fine (continued)																	
		18	18	32		Gray, Fine to Coarse, With Gravel	100	S-18	42	52	6	0.189											70
		22	19	31		Gray, Few Gravel	100	S-19	14	80	6	0.125											75
		15	10	16		Gray, Fine to Medium, With Gravel	100	S-20	32	64	5	0.178											80
159.39	82																						
		90		90		Poorly graded gravel with silt and sand (GP-GM) - Gray, Fine to Coarse Sand	100	S-21	46	44	10	0.079											85
154.39	87																						
		35	57	102		Silty sand (SM) - Gray, Traces of Clay, Traces of Organic Matter	100	S-22	0	85	15												90
151.39	90		45																				
-Water Level was not encountered																							

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PROFILE - HWY 165 BORINGS

"N60" VALUES

23-BMU-14

16.0'-17.5', N=2
18.5'-20.0', N=0
21.0'-22.5', N=7
23.5'-25.0', N=46
26.0'-27.5', N=46
28.5'-30.0', N=40
33.5'-35.0', N=50
38.5'-40.0', N=60
43.5'-45.0', N=54
48.5'-50.0', N=35
53.5'-55.0', N=14
58.5'-60.0', N=75
63.5'-65.0', N=28
68.5'-70.0', N=53
73.5'-75.0', N=39
78.5'-80.0', N=81
83.5'-85.0', N=100+
88.5'-90.0', N=50

22-BMG-14

1.0'-2.5', N=16
3.5'-5.0', N=5
6.0'-7.5', N=8
8.5'-10.0', N=5
11.0'-12.5', N=11
13.5'-15.0', N=5
16.0'-17.5', N=0
18.5'-20.0', N=0
21.0'-22.5', N=2
23.5'-25.0', N=12
26.0'-27.5', N=54
28.5'-30.0', N=44
33.5'-35.0', N=37
38.5'-40.0', N=46
43.5'-45.0', N=46
48.5'-50.0', N=30
53.5'-55.0', N=29
58.5'-60.0', N=28
63.5'-65.0', N=44
68.5'-70.0', N=46
73.5'-75.0', N=30
78.5'-80.0', N=85
83.5'-85.0', N=89
88.5'-90.0', N=85
93.5'-95.0', N=60
98.5'-100.0', N=100+
103.5'-105.0', N=100+
108.5'-110.0', N=100+
113.5'-115.0', N=32
116.0'-117.5', N=47

24-BMU-14

16.0'-17.5', N=0
18.5'-20.0', N=5
21.0'-22.5', N=8
23.5'-25.0', N=18
26.0'-27.5', N=33
28.5'-30.0', N=35
33.5'-35.0', N=33
38.5'-40.0', N=49
43.5'-45.0', N=37
48.5'-50.0', N=26
53.5'-55.0', N=36
58.5'-60.0', N=25
63.5'-65.0', N=33
68.5'-70.0', N=44
73.5'-75.0', N=43
78.5'-80.0', N=22
83.5'-85.0', N=100+
88.5'-90.0', N=100+

NOTE: "N60" values were found by taking the observed field "N" values and multiplying by an energy correction factor of 1.4

BORING LOGS

A1-Medium stiff, brown lean CLAY (CL), rootlets, traces of organic matter
B1-Stiff, brown lean CLAY (CL), rootlets, traces of organic matter
C1-Soft, brown, silty CLAY (CL-ML)
D1-Medium stiff, brown silty CLAY (CL-ML)
E1-Dense, brown silty SAND (SM)
F1-Dense, brown, fine, poorly graded SAND with silt (SP-SM), traces of gravel
G1-Dense, tan, fine, silty SAND (SM)
H1-Very Dense, tan, fine, poorly graded SAND with silt (SP-SM)
I1-Dense, tan, fine, poorly graded SAND with silt (SP-SM)
J1-Medium dense, gray, fine to coarse, silty SAND (SM) with gravel, clay strata or lenses
K1-Very dense, gray, fine to coarse, silty SAND (SM) with gravel, clay strata or lenses
L1-Medium dense, gray, fine, poorly graded GRAVEL with silt (GP-GM) and sand
M1-Very dense, gray, fine, poorly graded GRAVEL with silt (GP-GM) and sand
N1-Dense, gray, fine, poorly graded GRAVEL with silt (GP-GM) and sand
O1-Very dense, gray, clayey SAND (SC), traces of gravel
P1-Very stiff, brown, lean CLAY (CL), silt strata or lenses
Q1-Medium stiff, brown, lean CLAY (CL), silt strata or lenses
R1-Medium stiff, brown, fat CLAY (CH), oxidized, rootlets
S1-Medium stiff, brown, lean CLAY (CL), oxidized
T1-Stiff, brown, lean CLAY (CL), oxidized
U1-Medium stiff, brown, silty CLAY (CL-ML)
V1-Soft, brown, SILT (ML), clay strata or lenses
W1-Medium dense, brown, silty SAND (SM), clay strata or lenses
X1-Very dense, brown, fine, poorly graded SAND with silt (SP-SM), few gravel
Y1-Dense, brown, fine, poorly graded SAND with silt (SP-SM)
Z1-Dense, brown, fine, poorly graded SAND with silt (SP-SM), traces of gravel
A2-Medium Dense, brown, fine, poorly graded SAND with silt (SP-SM), traces of gravel
B2-Medium Dense, gray, fine to medium, silty SAND (SM), clay strata or lenses, few gravel
C2-Medium dense, gray, fine, poorly graded SAND with silt (SP-SM), few gravel
D2-Dense, gray, fine to medium, poorly graded SAND with silt (SP-SM), traces of gravel
E2-Dense, gray, fine, poorly graded SAND with silt (SP-SM) and gravel
F2-Medium dense, gray, fine to medium, poorly graded SAND with silt (SP-SM), few gravel
G2-Very dense, gray, fine, poorly graded SAND with silt (SP-SM)
H2-Very dense, light gray, fine, silty SAND (SM) with gravel
I2-Very dense, light gray, fine, silty SAND (SM)
J2-Very dense, light gray, clayey SAND (SC), clay strata or lenses
K2-Very dense, gray, silty SAND (SM)
L2-Very dense, gray, clayey SAND (SC), clay strata or lenses
M2-Hard, gray, fat CLAY (CH)
N2-Stiff, brown, lean CLAY (CL), rootlets, debris
O2-Stiff, brown, fat CLAY (CH), rootlets, oxidized
P2-Stiff, brown, lean CLAY (CL), oxidized
Q2-Medium stiff, brown, lean CLAY (CL), oxidized
R2-Very soft, brown, lean CLAY (CL), oxidized
S2-Medium stiff, brown, silty CLAY (CL-ML) with sand
T2-Medium stiff, brown, SILT (ML)
U2-Medium dense, brown, silty SAND (SM)
V2-Medium dense, brown, fine to medium, poorly graded SAND with silt (SP-SM), few gravel
W2-Dense, gray, fine to medium, poorly graded SAND with silt (SP-SM), few gravel
X2-Medium dense, gray, fine to coarse, poorly graded SAND with silt (SP-SM) and gravel
Y2-Dense, gray, fine to coarse, poorly graded SAND with silt (SP-SM) and gravel
Z2-Dense, gray, fine, poorly graded SAND with silt (SP-SM), few gravel
A3-Medium dense, gray, fine to medium, poorly graded SAND with silt (SP-SM) and gravel
B3-Very dense, gray, fine, poorly graded GRAVEL with silt (GP-GM) and sand, fine to coarse sand
C3-Very dense, gray, silty SAND (SM), traces of clay and organic matter



SHEET 2 OF 3
LAYOUT OF BRIDGE
HIGHWAY 165 OVER CANAL 1000
LONOKE COUNTIES
ROUTE 165 SEC. 8
ARKANSAS STATE HIGHWAY COMMISSION
LITTLE ROCK, ARK.

DRAWN BY: MJH DATE: NOV 2015 FILENAME: b061473_b1.dgn
CHECKED BY: NEM DATE: DEC 2015 SCALE: NO SCALE
DESIGNED BY: RL DATE: NOV 2015
BRIDGE NO. 07387 DRAWING NO. 58604

2017 - REDONE BORINGS

Sample Depth (ft)	N-Value				Material Type				Fines Content				Dry Unit Weight				Plastic Limit				Liquid Limit				Water Content				Shear Strength			
	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg
1	12			12.0	CL	CL	CL	CL				92					16			16.0	32			32	18.5			19				
3						CL	CL	CL				92			103	103.0		15		13	14		29	31	30.0		19.2	17.1	18.2	1641	1641.0	
3.5	4			4.0	CL	CL	CL	CL				92			112	112	15			17	16.0	26		32	29.0	22		24.3	23.2		1064	1064.0
5						CL	CH	CH				92																				
6	6			6.0	CH	CL	CH	CH				92		111	83	97	20	18	22	20.0	60	28	77	55.0	27.2	25.4	38.1	30.2		761	1773	1267.0
7						CL	CL	CL				77		105		105		13		13.0		38		38.0		21.9		21.9	1499		1499.0	
8.5	4			4.0	CL	CL	CL	CL				77		100	103	102	16			13	14.5	27		34	30.5	22.8	18	22.8	21.2	644	1316	980.0
9						CL	CL	CL				77																				
11	8			8.0	CL	CL-ML	CL	CL				77					15			15.0	25			25.0	23.5			23.5				
13.5	4			4.0	CL-ML	CL-ML	CL	CL-ML				77					19			19.0	24			24.0	28.1			28.1				
16	0	2	0	0.7	CL-ML	CL-ML	CL	CL-ML				77			110	110	17			16	16.5	24		26	25.0	26.8		30	28.4		712	712
18.5	0	0	4	1.3	ML	CL-ML	CL-ML	CL-ML				77					10	16	18	14.7	23	23	22	22.7	27.3	30.5	29.5	29.1				
21	2	5	6	4.3	ML	CL-ML	ML	ML	87			87						18	20	19.0			23	21	22.0	26.9	31.5	28	28.8			
23.5	9	33	13	18.3	SM	SM	SM	SM	30	29	36	32																				
26	39	33	24	32.0	SP-SM	SP-SM	SP-SM	SP-SM	10	9	5	8																				
28.5	32	29	25	28.7	SP-SM	SP-SM	SP-SM	SP-SM	7	11	7	8																				
33.5	27	36	24	29.0	SP-SM	SM	SP-SM	SP-SM	6	15		11																				
38.5	33	43	35	37.0	SP-SM	SP-SM	SP-SM	SP-SM	9	8	6	8																				
43.5	33	39	27	33.0	SP-SM	SP-SM	SP-SM	SP-SM	8	6	6	7																				
48.5	22	25	19	22.0	SP-SM	SP-SM	SP-SM	SP-SM	9	6	6	7																				
53.5	21	10	26	19.0	SM	SM	SP-SM	SM	18	23	8	16																				
58.5	20	54	18	30.7	SP-SM	SM	SP-SM	SP-SM	8		5	7																				
63.5	32	20	24	25.3	SP-SM	GP-GM	SP-SM	SP-SM	7	8		8																				
68.5	33	38	32	34.3	SP-SM	GP-GM	SP-SM	SP-SM	7		6	7																				
73.5	22	28	31	27.0	SP-SM	GP-GM	SP-SM	SP-SM	7	5	6	6																				
78.5	61	58	16	45.0	SP-SM	GP-GM	SP-SM	SP-SM	11		5	8																				
83.5	64	72	90	75.3	SM	SC	GP-GM	SM	16	40	10	22					15			15		20		20		23.7		23.7				
88.5	61	36	102	66.3	SM	SC	SM		23	26	15	21																				
93.5	43			43.0	SC			SM	37			37																				
98.5	76			76.0	SM			SM				20																				
103.5	75			75.0	SC			SM				20																				
108.5	90			90.0	SM			SM	16			16																				
113.5	23			23.0	CH			CH				80					14			14	53		53	20.7			20.7					
116	34			34.0	CH			CH				80												21.3			21.3					

2017 - REDONE BORINGS STEPPED LIQUEFACTION FACTOR OF SAFETY

Grade		229		230		231		232		233		234		235		236		237		238		239		240		241.12		251.8		Ground Surface		Under Abutment w/ fill		
Wt ELE		-11		-10		-9		-8		-7		-6		-5		-4		-3		-2		-1		0		1.12		11.8						
Sample	Elevation	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	
1	240.12																														Unsat	NO	Unsat	Unsat
2	238.12																					2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
3	236.12																	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
4	232.62									0.34	Likely!	1.08	Unlikely	1.68	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
5	230.12					0.43	Likely!	0.85	Likely!	1.20	Unlikely	1.50	Unlikely	1.77	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
6	227.62	0.29	Likely!	0.46	Likely!	0.58	Likely!	0.69	Likely!	0.78	Likely!	0.87	Likely!	0.94	Likely!	1.02	Unlikely	1.08	Unlikely	1.15	Unlikely	1.20	Unlikely	1.25	Unlikely	1.34	Unlikely	1.41	Unlikely	1.48	Unlikely	1.55	Unlikely	
7	225.12	0.49	Likely!	0.58	Likely!	0.65	Likely!	0.71	Likely!	0.76	Likely!	0.81	Likely!	0.86	Likely!	0.91	Likely!	0.95	Likely!	0.99	Likely!	1.02	Unlikely	1.06	Unlikely	1.13	Unlikely	1.20	Unlikely	1.27	Unlikely	1.34	Unlikely	
8	222.62	0.53	Likely!	0.58	Likely!	0.62	Likely!	0.66	Likely!	0.70	Likely!	0.73	Likely!	0.76	Likely!	0.79	Likely!	0.82	Likely!	0.85	Likely!	0.87	Likely!	0.89	Likely!	0.94	Likely!	0.99	Likely!	1.04	Likely!	1.09	Unlikely	
9	220.12	0.36	Likely!	0.39	Likely!	0.41	Likely!	0.43	Likely!	0.45	Likely!	0.46	Likely!	0.48	Likely!	0.49	Likely!	0.51	Likely!	0.52	Likely!	0.54	Likely!	0.55	Likely!	0.58	Likely!	0.61	Likely!	0.64	Likely!	0.67	Likely!	
10	217.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
11	215.12	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
12	212.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
13	207.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
14	202.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
15	197.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
16	192.62	1.23	Unlikely	1.25	Unlikely	1.29	Unlikely	1.31	Unlikely	1.35	Unlikely	1.37	Unlikely	1.42	Unlikely	1.43	Unlikely	1.48	Unlikely	1.50	Unlikely	1.55	Unlikely	1.57	Unlikely	1.64	Unlikely	1.71	Unlikely	1.78	Unlikely	1.85	Unlikely	
17	187.62	1.22	Unlikely	1.27	Unlikely	1.29	Unlikely	1.33	Unlikely	1.35	Unlikely	1.40	Unlikely	1.41	Unlikely	1.46	Unlikely	1.48	Unlikely	1.53	Unlikely	1.55	Unlikely	1.60	Unlikely	1.63	Unlikely	1.68	Unlikely	1.73	Unlikely	1.78	Unlikely	
18	182.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
19	177.62	1.52	Unlikely	1.58	Unlikely	1.60	Unlikely	1.66	Unlikely	1.67	Unlikely	1.73	Unlikely	1.75	Unlikely	1.81	Unlikely	1.82	Unlikely	1.89	Unlikely	1.90	Unlikely	1.96	Unlikely	1.99	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
20	172.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
21	167.62	1.70	Unlikely	1.76	Unlikely	1.77	Unlikely	1.83	Unlikely	1.84	Unlikely	1.90	Unlikely	1.91	Unlikely	1.96	Unlikely	1.98	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
22	162.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
23	157.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
24	152.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
25	147.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
26	142.62	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
WITH CYCLIC SOFTENING																																		

2017 - REDONE BORINGS RESIDUAL SHEAR STRENGTHS

1 atm = 2116 psf

In-Situ Data									Design Grade EL = 229'									
MATERIAL	EL _{top}	(N ₁) ₆₀ req'd	finer	PL	LL	PI	WC	S _u	Design Stress	Mitchell and Soga (2005)				Idriss & Boulanger (2008)				
TYPE		bpf	%				%	psf	σ _{vd}	σ _{vd}	Liquidity	S ₁	S ₂	Δ(N ₁) ₆₀ to (SEED-HARDER)	(N ₁) ₆₀ to	S ₁ /σ _{vd} (seed values, significant)	S ₂	
										atm	Index	(From Figure)			bpf		psf	
CL	232.62																	
CL	230.12																	
CL-ML	227.62	6.3	77	19	24	5	28	700	107	0.05	1.80	19.0	37					
CL-ML	225.12	1.6	77	17	25	8	29	700	304	0.14	1.50	12.0	58					
CL-ML	222.62	1.5	77	15	23	8	29	700	503	0.24	1.75	22.0	32					
ML	220.12	5.8	87	19	22	3			659	0.31				5	10.8	0.1	66	

In-Situ Data									Design Grade EL =231'									
MATERIAL	EL _{top}	(N ₁) ₆₀ req'd	finer	PI	LL	PI	WC	S _u	σ' _{vd}	σ' _{vd}	Liquidity	S ₁	S ₂	Δ(N ₁) ₆₀ to (SEED-HARDER)	(N ₁) ₆₀ to	S ₁ /σ' _{vd} (seed values, significant)	S ₂	
TYPE	R	bpf	%				%	psf	psf	atm	Index	(From Figure)	psf	bpf	bpf	%	psf	
CL	232.62																	
CL	230.12	13.6	77	15	25	10	23	1250	54	0.03	0.80	2.0	625					
CL-ML	227.62	6.3	77	19	24	5	28	700	248	0.12	1.80	19.0	37					
CL-ML	225.12	1.6	77	17	25	8	29	700	445	0.21	1.50	12.0	58					
CL-ML	222.62	1.5	77	15	23	8	29	700	644	0.30	1.75	22.0	32					
ML	220.12	5.8	87	19	22	3			800	0.38				5	10.8	0.1	80	

In-Situ Data										Design Grade EL = 233'									
Design Stress					Mitchell and Soga (2005)					Idriss & Boulanger (2008)									
MATERIAL TYPE	EL _{top} ft	(N ₁) ₆₀ test bpf	finer %	PI	LL	PI	WC %		S _u psf	σ' _{vd} psf	σ' _{vd} atm	Liquidity Index	S ₁ psf (From Figure)	S ₂ psf	N ₆₀ (Seed-Harder) bpf	(N ₁) ₆₀ to bpf	S ₁ /σ' _{vd} (seed values, significant) %	S ₂ psf	
CL	232.62	7.0	77	14	34	20	28		1250	23	0.01	0.70	1.0	1250					
CL	230.12					0			1250	177	0.08								
CL-ML	227.62	6.3	77	19	24	5	28		1000	371	0.18	1.80	22.0	45					
CL-ML	225.12	1.6	77	17	25	8	29		1000	568	0.27	1.50	13.0	77					
CL-ML	222.62	1.5	77	15	23	8	29		970	767	0.36	1.75	24.0	40					
ML	220.12	5.8	87	19	22	3			970	923	0.44				5	10.8	0.1	92	

In-Situ Data										Design Grade EL =235'									
MATERIAL TYPE	El _{top} ft	(N ₁) _{60 req'd} bpf	finer %	PL	LL	PI	WC %	S _u psf	Design Stress		Mitchell and Soga (2005)				Idriss & Boulanger (2008)				
									σ' _{vd} psf	σ' _{vd} atm	Liquidity Index	S ₁ (From Figure)	S ₂ psf	N ₆₀ (Seed- Harder) bpf	(N ₁) _{60 to} bpf	S ₁ /σ' _{vd} (seed values, significant)	S ₂ psf		
CL	232.62					0													
CL	230.12					0													
CL-ML	227.62	6.3	77	19	24	5	28	1000	495	0.23	1.80	24.0	42						
CL-ML	225.12	1.6	77	17	25	8	29	1000	691	0.33	1.50	15.0	67						
CL-ML	222.62	1.5	77	15	23	8	29	970	890	0.42	1.75	25.0	39						
ML	220.12	5.8	87	19	22	3		970	1047	0.49				5	10.8	0.1		105	

In-Situ Data										Design Grade EL =238'									
MATERIAL TYPE	EL _{top} ft	(N ₁) ₆₀ req'd bpf	finer %	PL	LL	PI	WC %	S _u psf	σ' _{vd} psf	σ' _{vd} atm	Liquidity Index	S ₁ (From Figure)	S ₂ psf	N ₆₀ (Seed-Harder) bpf	(N ₁) ₆₀ to bpf	S ₁ /σ' _{vd} (seed values, significant) %	S ₂ psf		
CL	232.62					0													
CL	230.12					0													
CL-ML	227.62	6.3	77	19	24	5	28	1000	683	0.32	1.80	26.0	38						
CL-ML	225.12	1.6	77	17	25	8	29	1000	880	0.42	1.50	18.0	56						
CL-ML	222.62	1.5	77	15	23	8	29	970	1079	0.51	1.75	28.0	35						
ML	220.12	5.8	87	19	22	3		970	1235	0.58				5	10.8	0.1	124		

In-Situ Data									Design Grade EL =241.12'									
MATERIAL TYPE	El _{top} ft	(N ₁) ₆₀ test bpf	finer %	PL	LL	PI	WC %	S _u psf	Design Stress			Mitchell and Soga (2005)			Idriss & Boulanger (2008)			
									σ' _{vd} psf	σ' _{vd} atm	Liquidity Index	S ₁ (From Figure)	S ₂ psf	N ₆₀ (Seed-Harder) bpf	(N ₁) ₆₀ to bpf	S ₁ /σ' _{vd} (seed values, significant)	S ₂ psf	
CL	232.62					0												
CL	230.12					0												
CL-ML	227.62					0												
CL-ML	225.12	1.6	77	17	25	8	29	1000	1133		1.50	20.0	50					
CL-ML	222.62	1.5	77	15	23	8	29	970	1332		1.75	29.0	33					
ML	220.12	5.8	87	19	22	3		970	1488		0.70			5	10.8	0.1	149	

In-Situ Data									Design Grade EL =Full Overburden											
MATERIAL TYPE	E _{top} ft	(N ₁) ₆₀ req'd bpf	finer %	PL	LL	PI	WC %	S _u psf	Design Stress				Mitchell and Soga (2005)				Idriss & Boulanger (2008)			
									σ' _{vs} psf	σ' _{vs} atm	Liquidity Index	S ₁ (From Figure)	S ₂ psf	N ₆₀ (Seed-Header) bpf	(N ₁) ₆₀ to bpf	S ₁ /σ' _{vs} (seed values, significant)	S ₂ psf			
CL	232.62					0														
CL	230.12					0														
CL-ML	227.62					0														
CL-ML	225.12					0														
CL-ML	222.62					0														
ML	220.12	5.8	87	19	22	3		970	2749	1.30				5	10.8	0.1		275		

Zone	MATERIAL	EL _{top}	GRADE EL. S, PROFILE						
#	TYPE		EL=229'	EL=231'	EL=233'	EL=235'	EL=238'	EL=241.12'	EL=Overburden Max
1	CL	232.62			1250				
	CL	230.12		625					
	CL-ML	227.62	37	37	45	42	38		
2	CL-ML	225.12	58	58	77	67	56	50	
	CL-ML	222.62	32	32	40	40	35	33	
	ML	220.12	66	80	92	105	124	149	275

2017- Redone Settlement & Downdrag Potential Due to Liquefaction/Cyclic Softening

In-Situ Data				Tokimatsu-Seed (1987)										FHWA Criteria			
MATERIAL TYPE	EL _{top} ft	(N ₁) ₆₀ Youd bpf	fines %	CSR _{7.16} Bent Youd	CSR _{7.16} Abut Youd	CSR _{7.16} /CSR _{7.5} * Correction Factor	CSR _{7.5} Bent	CSR _{7.5} Abut	ε _v * Bent (%)	ε _v * Abut (%)	Specimen H ft	ΔH Bent ft	ΔH Abut ft	ΔH Bent Zone (in)	≥.5 (in)	ΔH Abut Zone (in)	≥.5 (in)
CL	232.62	7.0	77		0.17	1.06		0.16		2.90	2.0		0.058	0.000	No	1.176	Yes
CL	230.12	13.6	77		0.17	1.06		0.16		2.00	2.0		0.040				
CL-ML	227.62	6.3	77	0.14	0.18	1.06	0.13	0.17	10.00	3.10	2.6	0.260	0.081	6.120	Yes	3.967	Yes
CL-ML	225.12	1.6	77	0.09	0.18	1.06	0.08	0.17	10.00	10.00	2.5	0.250	0.250				
CL-ML	222.62	1.5	77	0.09	0.18	1.06	0.08	0.17	10.00	10.00	2.9	0.290	0.290				
ML	220.12	5.8	87	0.13	0.19	1.06	0.12	0.18	4.00	4.00	3	0.120	0.120	1.440	Yes	1.440	Yes

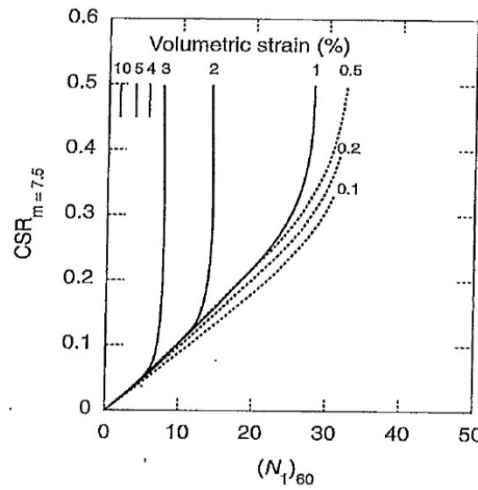
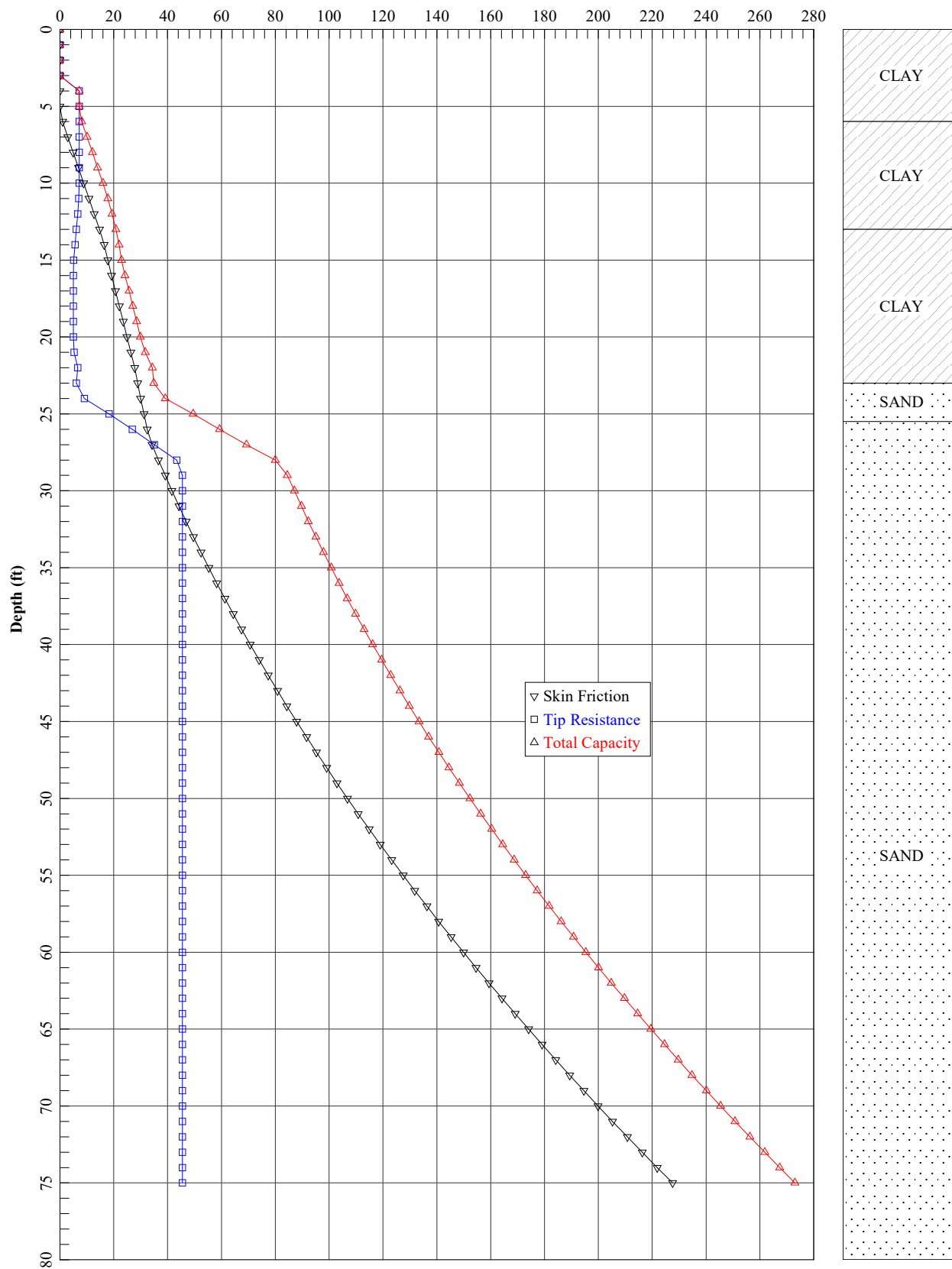


Figure 9.53 Chart for estimation of volumetric strain in saturated sands from cyclic stress ratio and standard penetration resistance. (After Tokimatsu and Seed, 1987. Evaluation of settlements in sand due to earthquake shaking, *Journal of Geotechnical Engineering*, Vol. 113, No. 8. Reprinted by permission of ASCE.)

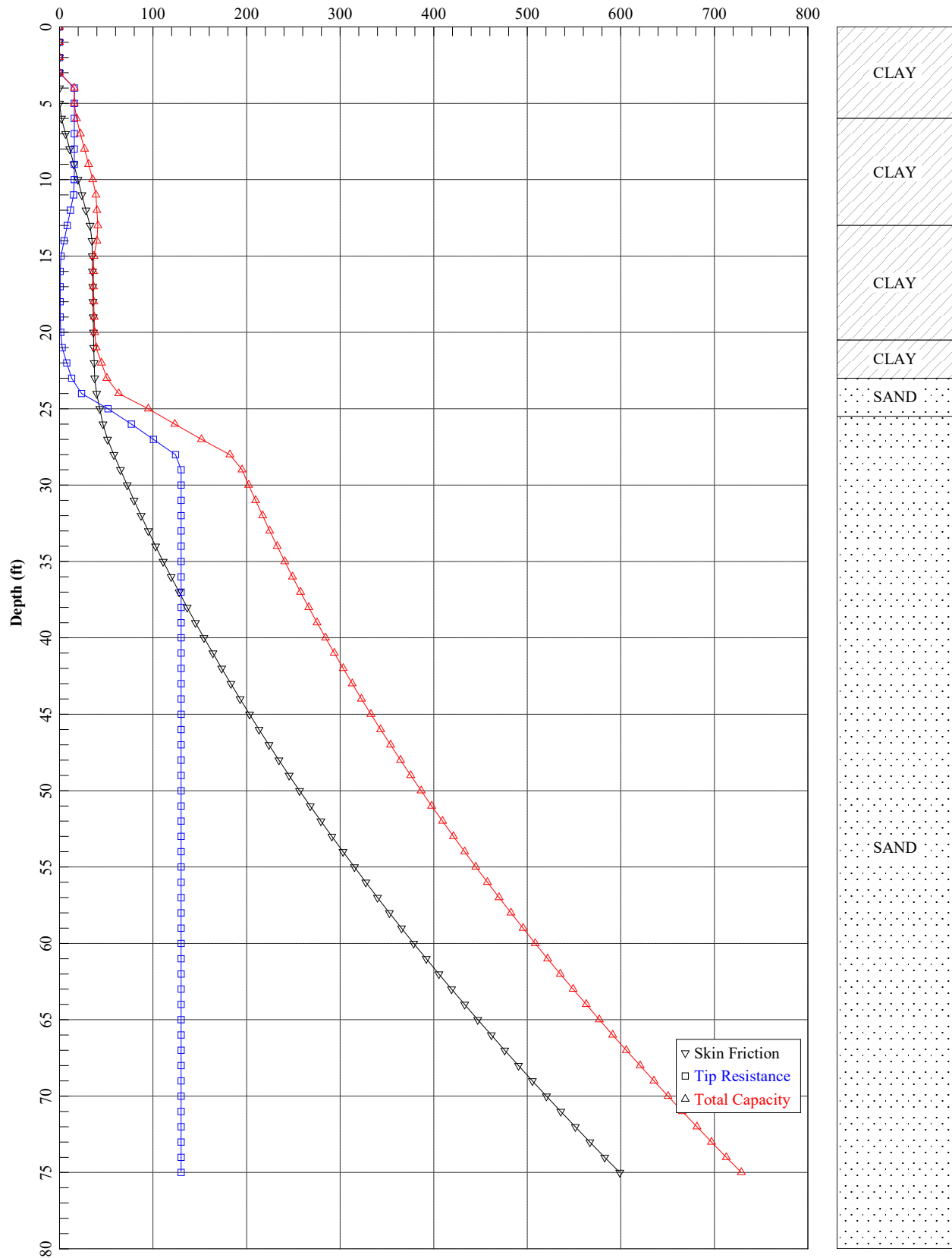
Table 9-2 Magnitude Correction Factors for Cyclic Stress Approach

Magnitude, <i>M</i>	CSR _{<i>M</i>} /CSR _{<i>M</i>=7.5}
5 ¹ / ₄	1.50
6	1.32
6 ³ / ₄	1.13
7 ¹ / ₂	1.00
8 ¹ / ₂	0.89

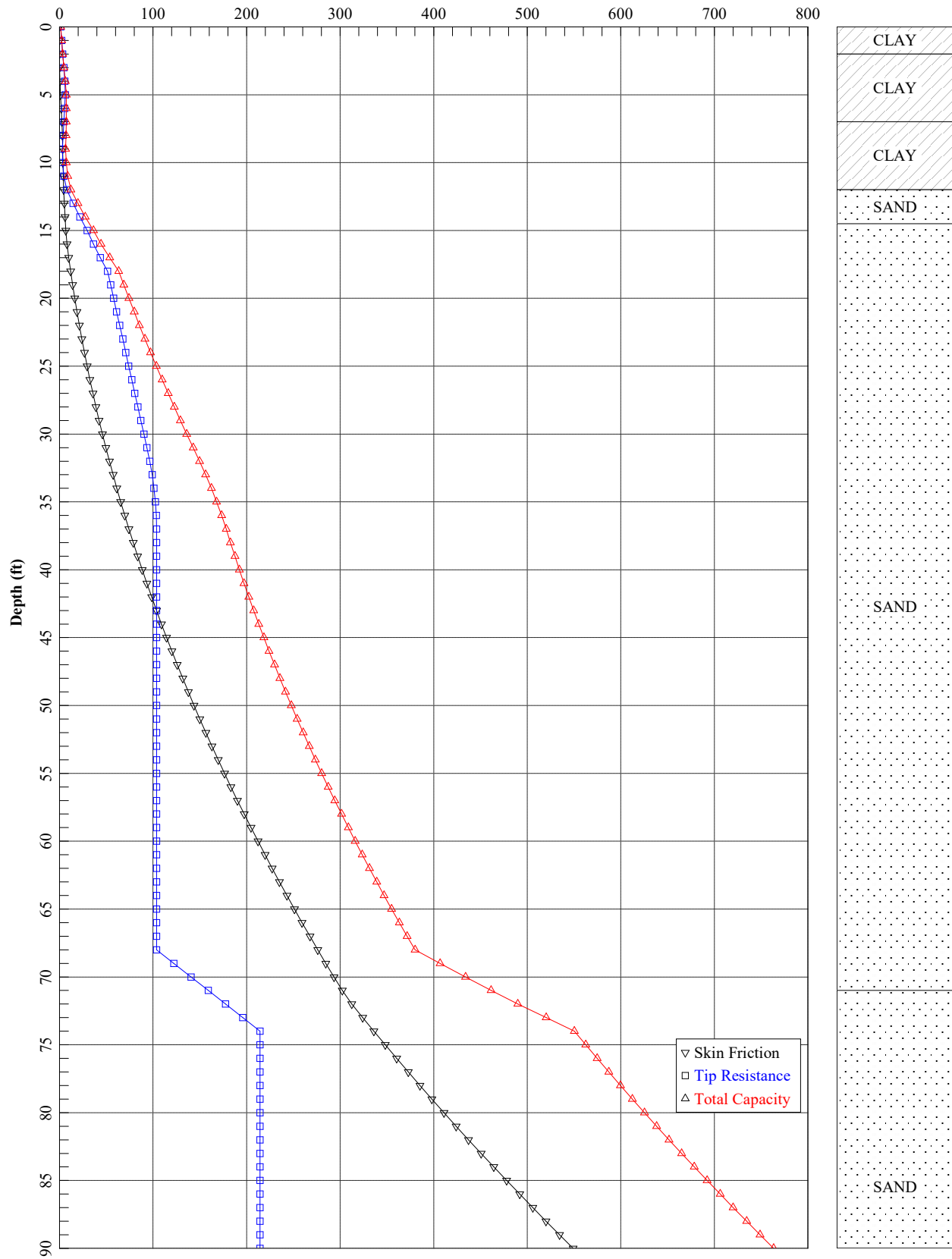
HWY 165 - 18in Diameter Abutment Static
Axial Capacity (kips)



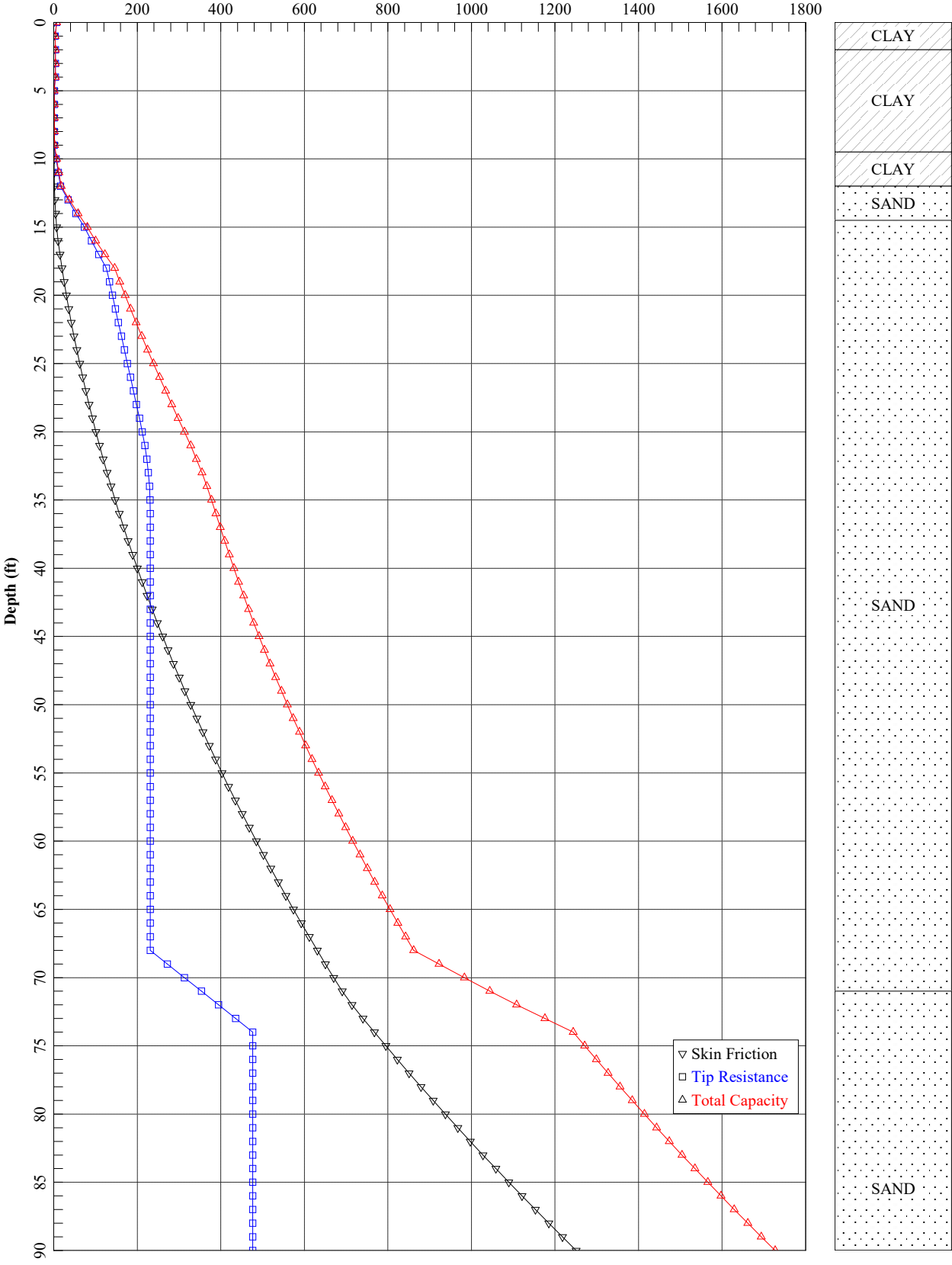
HWY 165 - 18in Diameter Abutment Extreme
Axial Capacity (kips)



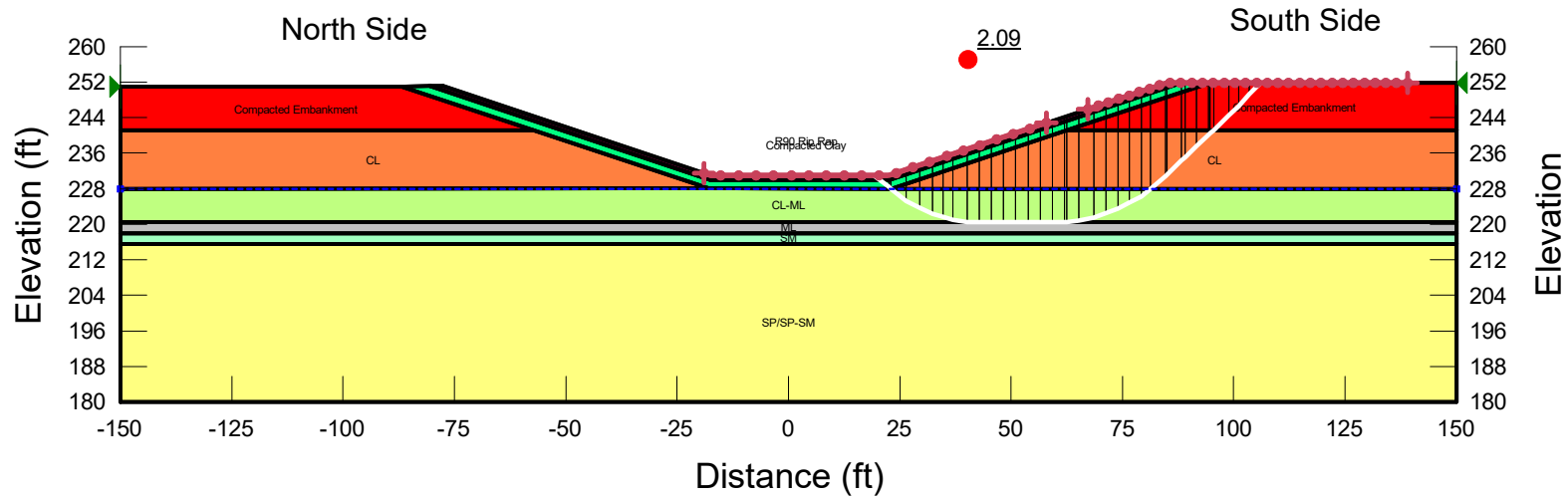
HWY 165 - 24in Diameter Bents Static
Axial Capacity (kips)



HWY 165 - 24in Bent Extreme
Axial Capacity (kips)



Name: HWY 165 - AC
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



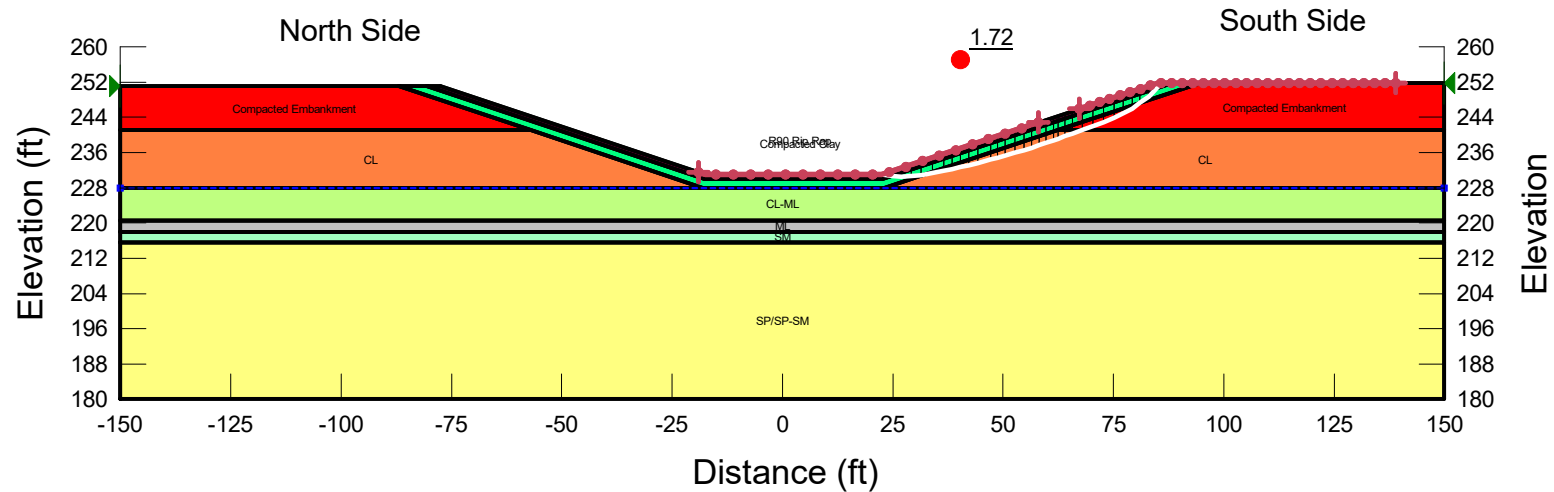
Name: R90 Rip Rap Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 750 psf Phi': 0 ° Piezometric Line: 1
Name: CL Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 1,000 psf Phi': 0 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 250 psf Phi': 20 ° Piezometric Line: 1
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 750 psf Phi': 0 ° Piezometric Line: 1
Name: CL-ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 700 psf Phi': 0 ° Piezometric Line: 1
Name: SM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - LT
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



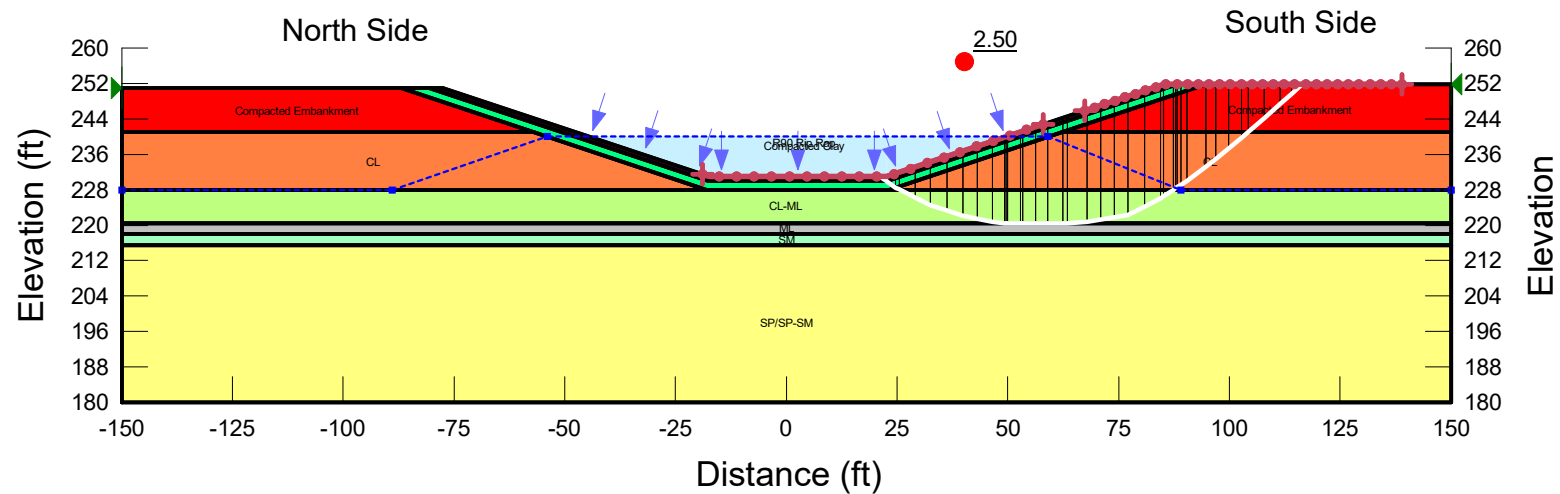
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Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 50 psf Phi': 23 ° Piezometric Line: 1
Name: CL Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 50 psf Phi': 23 ° Piezometric Line: 1
Name: CL-ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1
Name: SM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - FPQ
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



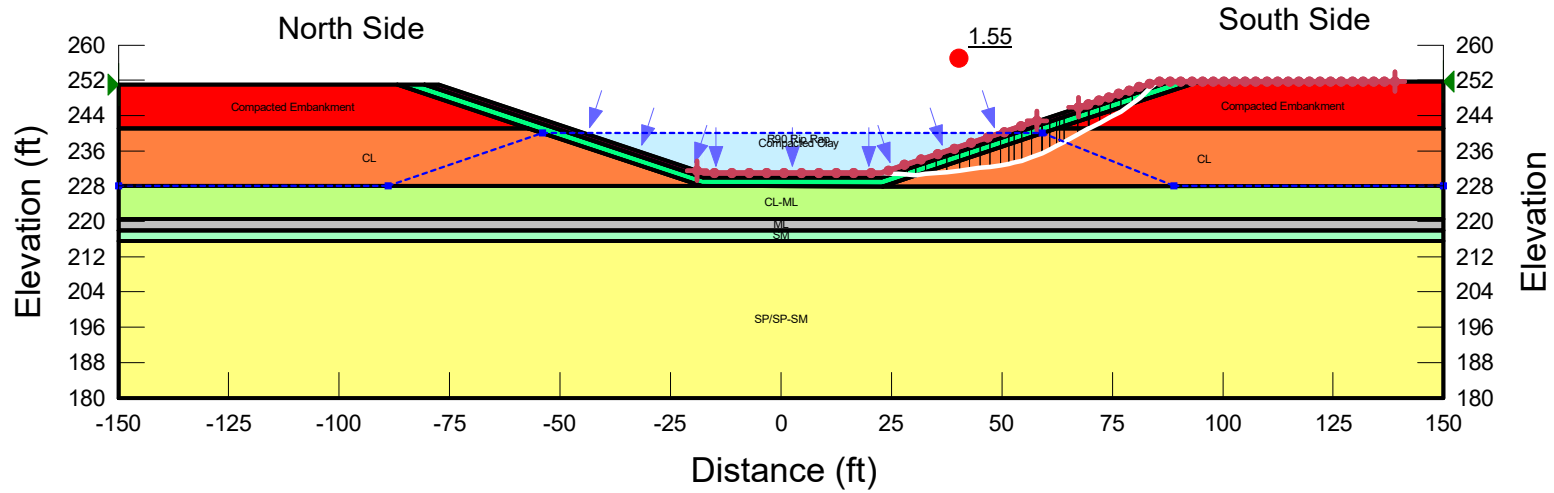
Name: R90 Rip Rap Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 750 psf Phi': 0 ° Piezometric Line: 1
Name: CL Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 1,000 psf Phi': 0 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 250 psf Phi': 20 ° Piezometric Line: 1
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 750 psf Phi': 0 ° Piezometric Line: 1
Name: CL-ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 700 psf Phi': 0 ° Piezometric Line: 1
Name: SM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - FPS
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



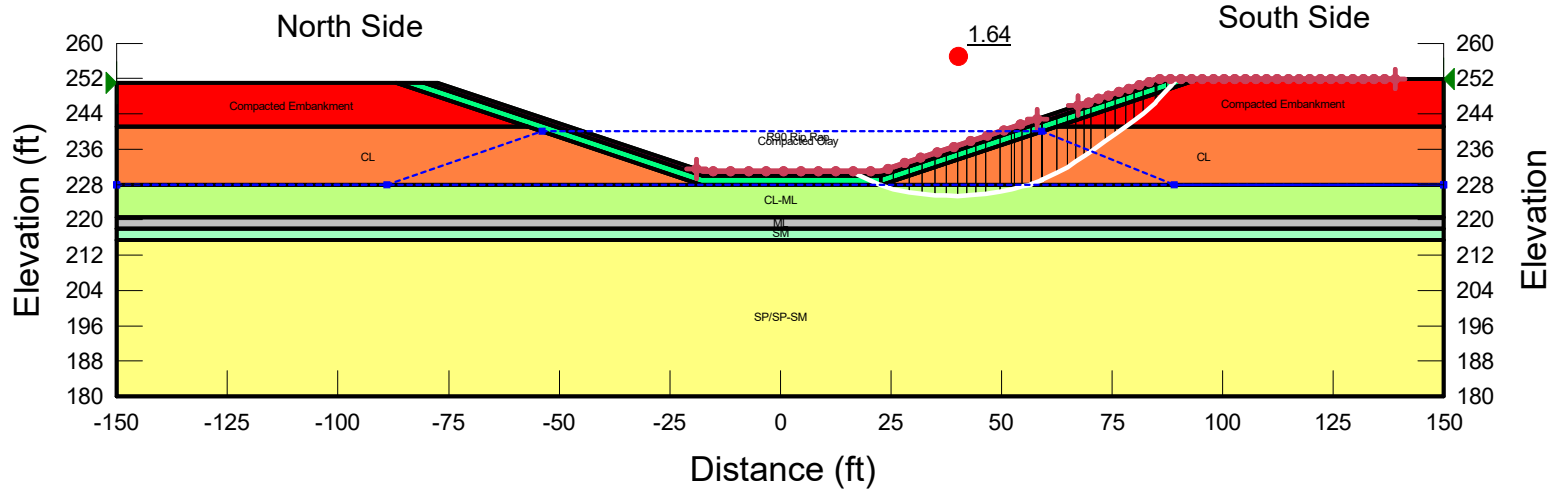
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Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 50 psf Phi': 23 ° Piezometric Line: 1
Name: CL Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 50 psf Phi': 23 ° Piezometric Line: 1
Name: CL-ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1
Name: SM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - RD
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



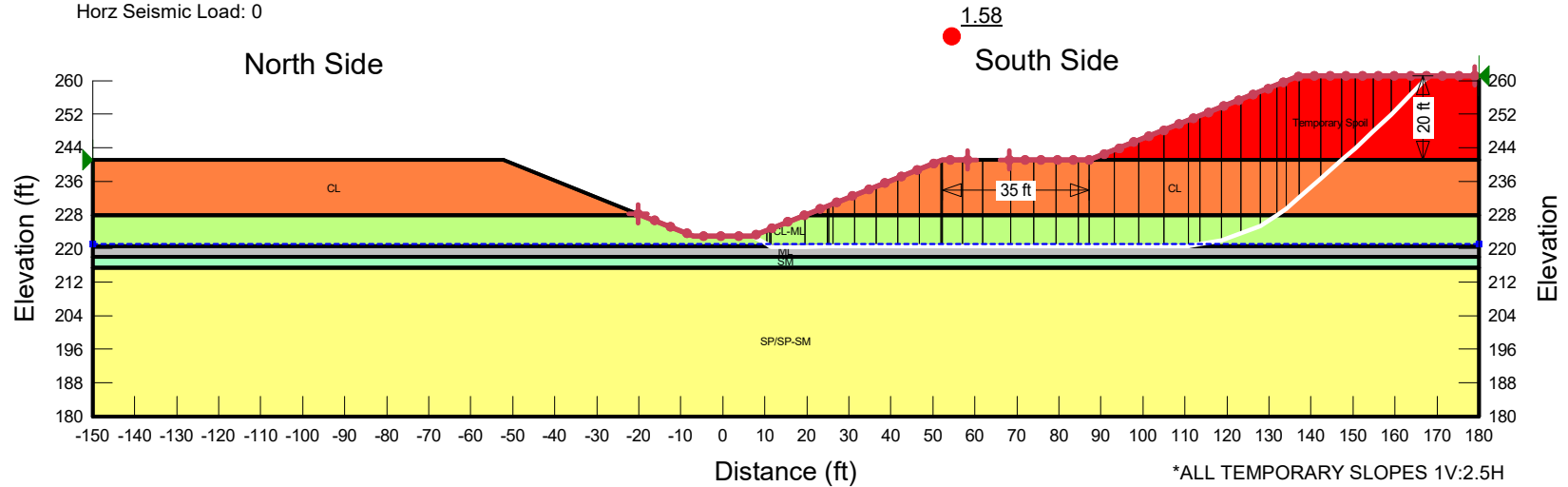
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Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 50 psf Phi': 23 ° Cohesion R: 350 psf Phi R: 11 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: CL Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 0 psf Phi': 28 ° Cohesion R: 500 psf Phi R: 14 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Cohesion R: 0 psf Phi R: 30 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 0 psf Phi': 28 ° Cohesion R: 250 psf Phi R: 20 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 50 psf Phi': 23 ° Cohesion R: 350 psf Phi R: 11 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: CL-ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 0 psf Phi': 28 ° Cohesion R: 350 psf Phi R: 14 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: SM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 28 ° Cohesion R: 0 psf Phi R: 28 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - AC
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



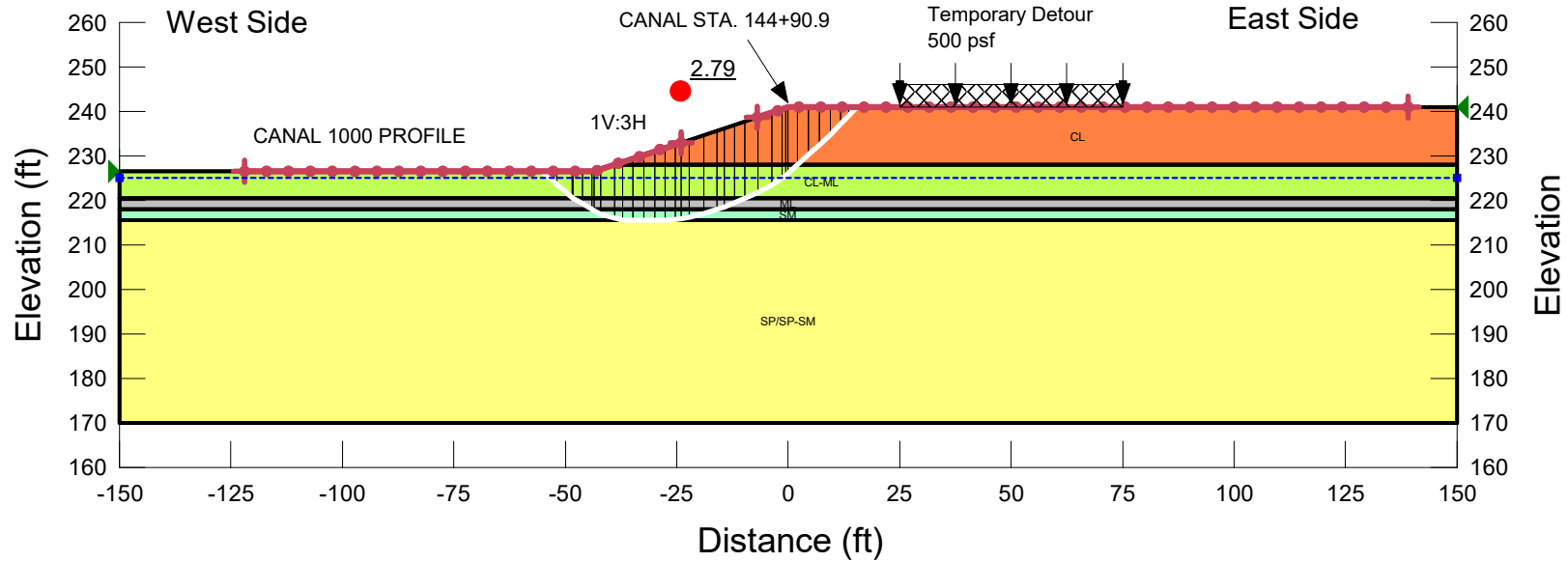
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Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 250 psf Phi': 20 ° Piezometric Line: 1
Name: Temporary Spoil Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion': 500 psf Phi': 0 ° Piezometric Line: 1
Name: CL-ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 700 psf Phi': 0 ° Piezometric Line: 1
Name: SM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - Temporary Cut
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line



Name: CL Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 1,000 psf Phi': 0 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 250 psf Phi': 20 ° Piezometric Line: 1
Name: SM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 28 ° Piezometric Line: 1
Name: CL-ML Model: Mohr-Coulomb Unit Weight: 126 pcf Cohesion': 700 psf Phi': 0 ° Piezometric Line: 1
Surcharge Load: 1 Surcharge (Unit Weight): 100 pcf

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
HWY 165 CL STATION 22+52.53
PULASKI COUNTY, ARKANSAS

BAYOU METO CANAL 1000

HWY 165 BRIDGE

Geotechnical Design Report

Prepared By:

US Army Corps of Engineers - Memphis District

Geotechnical Branch



December 2015

TABLE OF CONTENTS

1.	Introduction.....	1
2.	Project Background.....	1
3.	Geology.....	2
3.1.	Subsurface Investigation.....	4
3.1.1.	General Subsurface Conditions.....	4
3.1.2.	Water Table.....	4
3.1.3.	Laboratory Testing.....	5
4.	Geotechnical Analysis.....	5
4.1.	Site Class Determination.....	5
4.1.1.	Method B (N Method).....	6
4.2.	Liquefaction Potential.....	6
4.2.1.	Design Earthquake.....	7
4.2.2.	Liquefaction and Cyclic Softening.....	8
4.2.3.	Residual Shear Strengths.....	9
4.3.	Pile Design.....	10
4.3.1.	Theoretical Axial Pile Capacity.....	10
4.3.2.	Vertical Settlement.....	11
4.3.3.	Lateral Resistance.....	12
4.3.4.	Pile Drivability.....	13
4.3.5.	Pile Spacing.....	14
4.3.6.	Pile Vibration.....	14
4.4.	Approach Embankment Settlement.....	14
4.5.	Abutment Earth Pressures.....	14
4.6.	Channel Slope Stability.....	15
4.7.	Channel Settlement.....	16
4.8.	Clay Liner Determination.....	16
4.9.	Groundwater Control.....	17
4.10.	Siphon Analysis.....	17
4.10.1.	Temporary Excavations.....	17
4.10.2.	Settlement.....	17
4.11.	Pavement Design.....	18

TABLES

Table 1 – Site Class Summary.....	6
Table 2 - HWY 161 Liquefaction/Cyclic Softening Summary	8
Table 3 - Residual Shear Strengths for Design	9
Table 4- General Theoretical Pile Capacity Information for Compression	11
Table 5 - L-Pile Analysis Summary.....	13
Table 6 – Slope Stability Results Summary	16
Table 7 - Pavement Design Alternatives Summary.....	18

FIGURES

Figure 1 - Plan View of HWY 161 Bridge Location	2
Figure 2 - Geologic Map of Bridge Area	3



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HWY 165 BRIDGE
GEOTECHNICAL DESIGN REPORT

11/01/2015

-
- 1. INTRODUCTION.** This report provides information pertaining to the soils investigation, testing, and foundation design for the proposed Bayou Meto Canal 1000 – HWY 165 Bridge regionally located east of Little Rock, Arkansas and east of the USACE Bayou Meto Canal 1000 control structure in Pulaski County, Arkansas. The following sections provide details of the analyses performed in the geotechnical design of the proposed bridge structure.
 - 2. PROJECT BACKGROUND.** The proposed HWY 165 Bridge is located in the Bayou Meto Basin in the vicinity of Scott, Arkansas. The bridge structure is part of a larger basin project, Bayou Meto Canal 1000, which consists of a large water distribution system meant to provide supplemental agricultural water supply to the depleted areas of the Bayou Meto Basin while preserving the groundwater resource. The entire irrigation project area includes portions of Prairie, Arkansas, Lonoke, Jefferson, and Pulaski counties in eastern Arkansas. The general area begins about 10 miles east of Little Rock, Arkansas and extends approximately 60 miles to the southeast.

The plan of improvement for the Bayou Meto area consists of a major pumping station located at the Arkansas River, 3 other pumping stations, a network of new canals, existing channels, pipelines, and associated channel structures including multiple bridges to accomplish interbasin transfer of surface water to the water depleted areas.

The proposed bridge will run North/South replacing an existing portion of Arkansas Highway 165. An approximate plan view of the proposed bridge location is presented in Figure 1. The bridge will be designed to traverse a future section of Canal 1000 heading east from the control structure and reservoir location seen in Figure 1. The bridge is a steel and concrete structure approximately 136 feet long and 43 feet wide. The bridge will include 4 pile bents (2 abutments and 2 intermediate piers) and 10 feet or less of embankment fill leading to natural grade on either side of the bridge. The proposed Canal 1000 beneath the structure will be approximately 15 feet deep with 11 feet existing below existing ground. The canal will have a 40-foot bottom width, 1V:3H side slopes, a minimum 2-foot clay liner, and rip rap scour protection in the bridge vicinity.



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GEOTECHNICAL DESIGN REPORT

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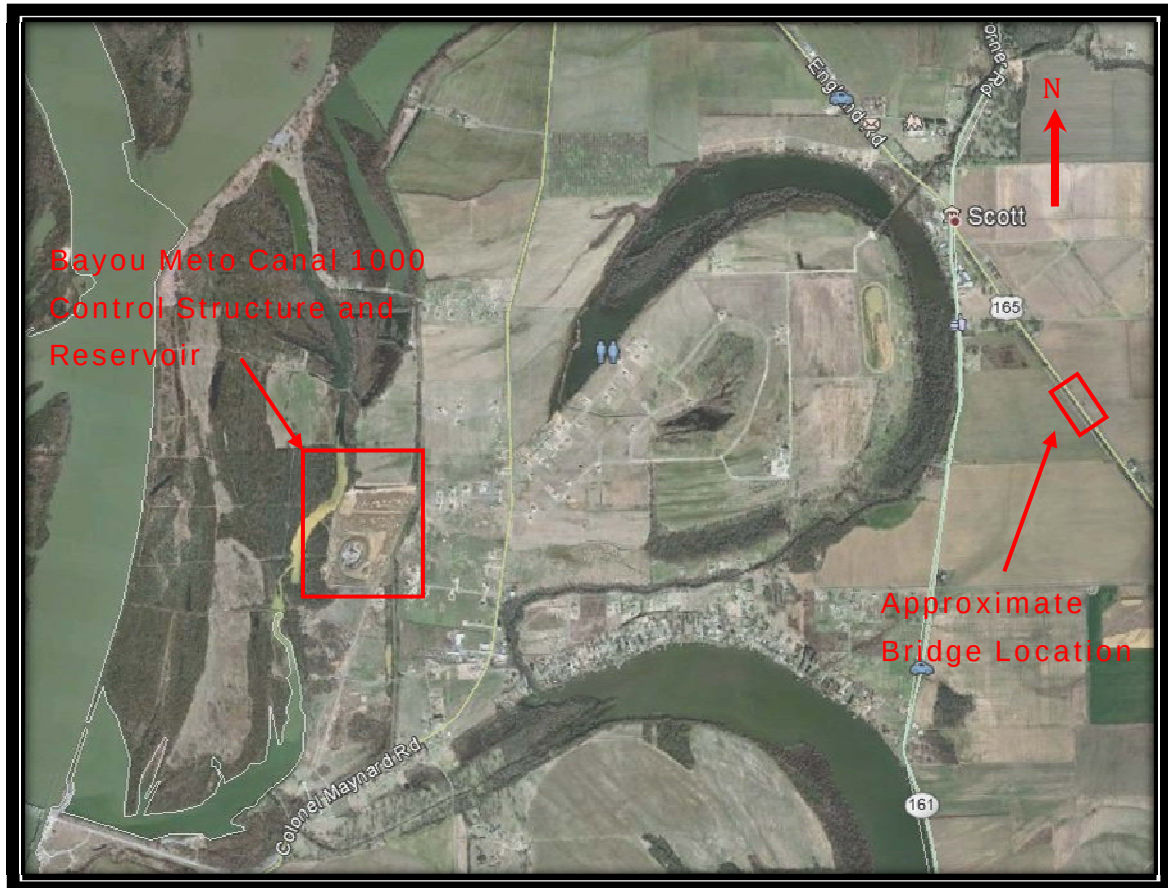


Figure 1 - Plan View of HWY 165 Bridge Location

3. **GEOLOGY.** This project consists of two distinctive geological areas located within the entire Bayou Meto Basin project boundaries. The first geological area encompasses the alluvial floodplain of the Arkansas River where the majority of the irrigation project and the HWY 165 Bridge are located. The other geological area is the Grand Prairie region located in the uplands northeast of the town of Lonoke. Only the first geological area is described in detail in the following paragraphs. A more in depth description of Basin geography can be found in a Bayou Meto comprehensive report¹.

¹ USACE. 2007. *Bayou Meto Basin, Arkansas, General Reevaluation Report, Volume 4, Appendix B, Engineering Investigations and Analyses, Agricultural Water Supply Component, Section II – Geology and Soils*. US Army Corps of Engineers – Memphis District, Memphis, Tennessee.



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HWY 165 BRIDGE
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Based on a review of geological maps seen in Figure 2, the bridge is located on point bar deposits of the Arkansas River within the Mississippi-Ohio River complex. The alluvial deposits resulting from the meandering process tend to be highly variable in short distances

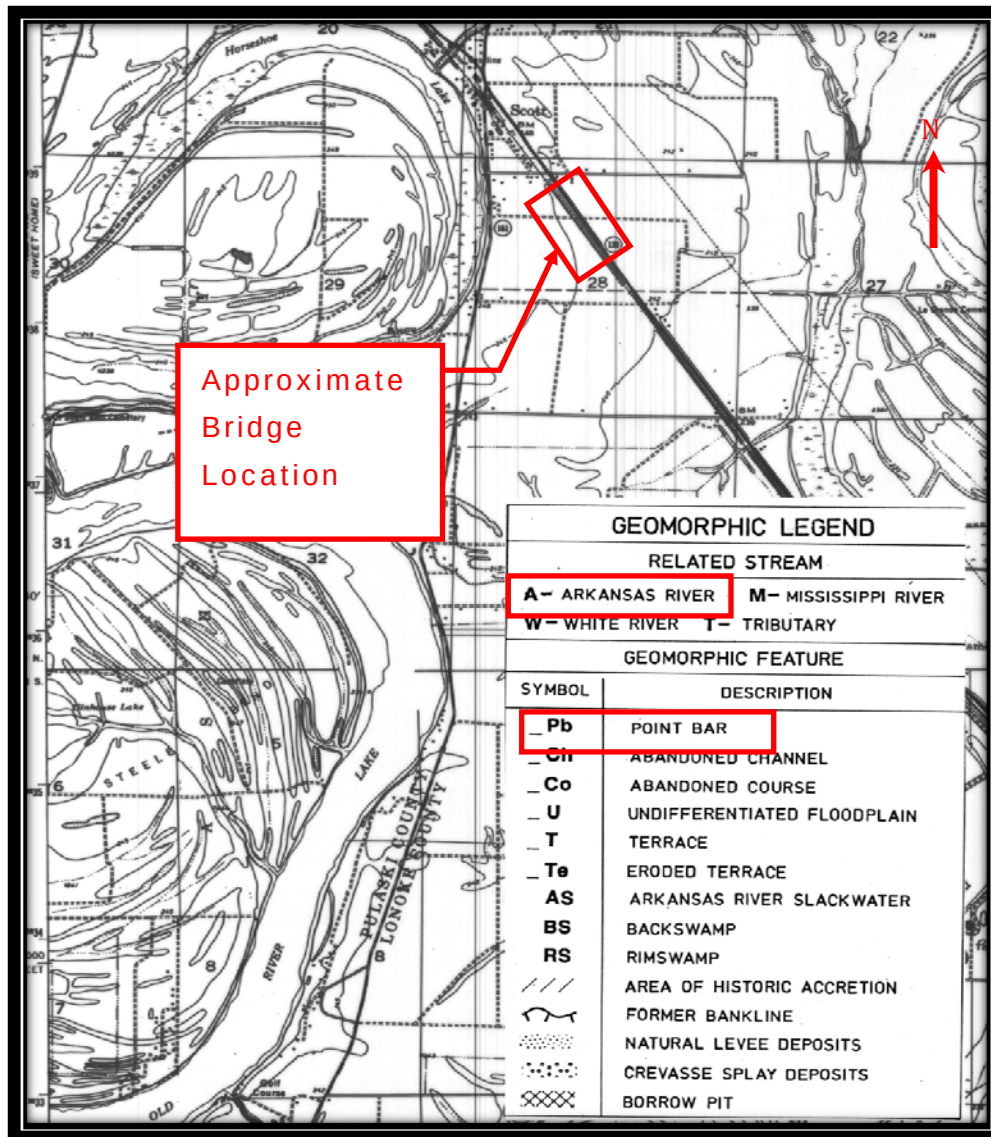


Figure 2 - Geologic Map of Bridge Area

in both areal extent and with depth. The more predominate forms of deposition within the Bayou Meto Basin study area are point bar, back swamp and abandoned channels. Point



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HWY 165 BRIDGE
GEOTECHNICAL DESIGN REPORT

11/01/2015

bar deposits tend to consist of alternating sand, silt, and clay, whereas the back swamp deposits formed by the frequent inundation of the area during several periods are generally composed of finer grained materials. The abandoned channels are old river courses and are generally composed of highly plastic clays that can extend to a depth of 100 feet. Also, the point bar deposits frequently contain clay swales, which are similar in composition to the abandoned channel deposits. However, two primary differences between the deposits are that the swales tend to be less plastic due to the presence of more silty and sandy clays and they do not extend to a depth of the abandoned channel deposits. The surface deposits are underlain by substratum sands which range from a fine to a gravelly sand. The Undifferentiated Tertiary deposits underlie the substratum sands.

3.1. Subsurface Investigation. Borings at the approximate bridge site were made based on the alignment of Canal 1000 in relation to HWY 165. The borings were evaluated to define soil stratification and engineering properties relevant to the geotechnical design of the bridge and canal structures. Borings 01-H165G-14 and 02-H165G-14 were drilled by Professional Service Industries (PSI), Inc. and borings 22-BMG-14, 23-BMU-14, and 24-BMU-14 were drilled by McCray Drilling, LLC. along the proposed centerline of the HWY 165 Bridge. The individual boring logs and profile of this centerline in relation to the bridge and canal are presented in [Appendix A](#).

3.1.1. General Subsurface Conditions. Both borings drilled by PSI were shallow 5-foot general samples (i.e. SPT split spoon samples) including 6-inch diameter core samples of the existing asphalt pavement and grab sampling of the immediate in-situ material directly underneath the pavement. Two of the McCray borings noted above were drilled to 90 feet and the final boring, 22-BMG-14, was drilled to a 150-foot depth. The borings included disturbed (1.4-in I.D. split spoon) and/or undisturbed (5-in Shelby tube) sampling techniques. The first 23 feet of material included interbedded layers of silts (ML), lean clays (CL), silty clays (CL-ML), and higher plasticity fat clays (CH). The top 23 feet of finer materials were generally underlain by a poorly graded sand (SP) including interbedded layers containing a larger percentage of fines (SP-SM, SM) and transitioning to layers containing various percentages of fine gravel starting at a depth of approximately 60 feet. Two 10 to 15-foot pockets of clayey sand (SC) were also noted past a depth of 53.5 feet in boring 23-BMU-14.

3.1.2. Water Table. At the time of drilling, the water table was measured at NAVD88 elevation 222.7 feet. Water table readings are not available for the bridge site over an extended length of time. The water table in the area to the west of HWY 161 is influenced by the Arkansas River and the David D. Terry Lock and Dam which typically maintains 231 feet as a constant pool elevation. The HWY 165 bridge site appears to be outside of the influence of the river



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based on recent USACE Bayou Meto projects in the area and most likely is around elevation 222 feet +/- seasonal variations.

3.1.3. Laboratory Testing. McCray Drilling, LLC. performed laboratory testing of the bridge boring samples. Generally, unconfined compression tests were to be performed on Shelby tube samples from the top 20 feet of fines and mechanical sieve analyses were performed on the remaining coarse-grained samples. McCray Drilling had issues obtaining sample recovery on the Shelby tube samples; thus not enough material was recovered to run the unconfined compression tests at certain sampling intervals. Atterberg limits, moisture contents, dry unit weights, and fines content were also performed on Shelby tube samples. The condensed laboratory testing schedule can be seen in [Appendix A](#). The laboratory test results were utilized in determining the geotechnical foundation design parameters for this project.

PSI performed laboratory testing of the bridge pavement boring samples. Atterberg limits, moisture contents, and fines content were performed on grab samples taken from beneath the pavement. Standard Proctor and California bearing ratio (CBR) tests were also performed on the grab samples. The CBR tests were performed using a saturated specimen, mimicking worst case conditions. The condensed laboratory testing schedule can be seen in [Appendix A](#). The laboratory test results were utilized in determining the geotechnical pavement design parameters for this project.

3.1.4. Design Profile. Borings 22-BMG-14, 23-BMU-14, and 24-BMU-14 are separated by less than 100 feet total and contain similar lithology and engineering properties. Because of this, the borings were combined into a global profile for use in the geotechnical analysis.

4. GEOTECHNICAL ANALYSIS

4.1. Site Class Determination. The site class definition quantifies the soil's propensity to amplify, or in some cases decrease, surface ground motion propagating from underlying rock. The site class definition is required in order to develop the seismic performance zone and other parameters needed for design including the liquefaction analysis. The site class analysis was performed in accordance with methods described in the required bridge specifications² (AASHTO will be used hereafter). Sites are classified A through F in accordance with site class definitions in Article C3.10.3.1. Amplification intensity generally increases (Site stability degrades) as the site class definitions move from A to F.

² AASHTO. (2012). "AASHTO LRFD Bridge Design Specifications." *American Association of State Highway and Transportation Officials*, Washington, DC.



Three methods based on average shear wave velocity (Method A), average Standard Penetration Test blow counts (Method B), or average undrained shear strength (Method C) can be used to determine the stiffness of the site's soils within the top 100 feet and the associated site class definitions. The site investigation did not include a measurement of shear wave velocities. Only Method B will be discussed further.

- 4.1.1. Method B ($\bar{N}$ Method). This method simultaneously evaluates geotechnical parameters for cohesive and cohesionless soils using SPT blow counts (N) for each substratum layer within the upper 100 feet. Article C3.10.3.1 makes the distinction that any soil with a plasticity index of 20 or less is considered cohesionless which would include some soils that would be considered cohesive in other geotechnical analyses. Typically, low blow counts in conjunction within larger layer thicknesses drive down the reported method blows per foot and ultimately the Site Class Definition.

The design profile was used to develop the $\bar{N}$ value. Average blow counts were used for design values at increment depths since the sample spacing was typically constant within each boring. The Method B calculations are summarized in [Table 1](#) and found in [Appendix B](#). HWY 165 qualified as site class D according to the definition presented for blow counts between $15 < \bar{N} < 50$ blows/ft.

Table 1 – Site Class Summary

$\bar{N}$ Method Value	Site Class Definition
15.1	D

It should be noted that two borings, 123 & 124, were not drilled to a depth of 100 feet as required by Article C3.10.3.1. The AASHTO specifications do not provide guidance on using a boring length less than 100 feet. Both borings extend to a depth of 90 feet below the ground surface, but the calculations contained in [Appendix B](#) are analyzed for 100 feet. The extra 10 feet required for these calculations was assumed similar in composition and blow counts to boring 122-BMG-14.

- 4.2. Liquefaction Potential. The proposed bridge site is located within the New-Madrid Seismic zone. 2012 *AASHTO LRFD Bridge Design Specifications* assign a seismic performance zone to the bridge based upon the horizontal spectral response coefficients. A table correlating an acceleration coefficient to the seismic zone can be found in Article 3.10.6. AASHTO Article 10.5.4.2 does not require a liquefaction study for zone 1 and only



for zone 2 when loose to very loose saturated sands may have an impact on structure stability. A liquefaction assessment shall be conducted for seismic zones 3 and 4 if:

- the ground water level is anticipated to be within 50 feet of the existing or final ground surface .
- low plasticity silts and sands are present within the upper 75 and have corrected blow counts, $(N_1)_{60}$, less than or equal to 25 blows/ft within these layers.

The proposed HWY 165 bridge location is within zone 2 with a majority of the substratum sands being characterized as medium or dense based on the blow counts. However, subsurface data displays pockets of loose sands and display the characteristics noted above for seismic zones 3 and 4. Because of this, liquefaction potential was analyzed. AASHTO does not define a specific methodology for assessing the potential for liquefaction, but gives commentary on multiple commonly used techniques and consensus publications regarding the use of simplified methods.

Liquefaction potential for HWY 165 was analyzed using empirical methods based on standard penetration test (SPT) blow counts from the design profile. A spreadsheet, used in this analysis, developed by the University of Arkansas compares three commonly used methods, Youd (2001), Cetin (2004), and Idriss and Boulanger (2008). The spreadsheet was developed for use by Arkansas State Highway and Transportation Department (AHTD) and is AHTD's current liquefaction assessment practice. Spreadsheet documentation and a comparison of these empirical methods can be found in a report for AHTD by Griffiths³. The Youd method was chosen for this analysis.

It should be noted that the spreadsheet was altered to account for application of additional stresses due to proposed embankments and also changed to include cyclic softening in materials with a plasticity index (PI) > 3.5.

4.2.1. Design Earthquake. The magnitude and response for the design earthquake must be found when conducting liquefaction assessments using the Youd Method. AASHTO Article C10.5.4.2 currently recommends the liquefaction analysis be performed for a seismic event that has a 7% probability of being exceeded in 75 years (1000 year event). Using the above standards in coordination with the global seismic site class, as described in Section 4.1, a design response spectrum and earthquake magnitude can be customized to the potential bridge location. The design data is currently available through US Geologic Survey (USGS)

³ Griffiths, Shawn C. (2011). "Practical Recommendations for Evaluation and Mitigation of Deep Soil Liquefaction." PhD Dissertation, University of Arkansas, Fayetteville, Arkansas.



national seismic hazard website. The detailed design data report for HWY 165 Bridge can be found in [Appendix B](#).

4.2.2. Liquefaction and Cyclic Softening. The cyclic loading imposed by an earthquake shaking may induce liquefaction and/or cyclic (strain) softening within the soil column beneath HWY 165 resulting in a loss of bearing, or inducing excessive settlements. Liquefaction is used to reference the strength loss and deformation in saturated, cohesionless materials during an earthquake. Similar to liquefaction, cyclic softening applies to clays and plastic silts. Two methods described by Youd⁴ and Idriss and Boulanger⁵, for liquefaction and cyclic-softening respectively, use a simplified approach to compute the stress induced on the soil from earthquake forces. The dynamic stress imparted by the earthquake is the cyclic stress ratio (CSR) and the dynamic stress the soil can withstand before liquefying or strain softening is the cyclic resistance ratio (CRR). The CSR of the soil is based on empirical relationships between the earthquake acceleration and in-situ design stresses. The CRR of the soil is primarily based on empirical relations to the SPT and in-situ engineering and index properties of the soil at the time of the drilling. A factor of safety is derived from dividing the CRR by the CSR.

A factor of safety (F.S.) less than 1.0 suggests that the soil is susceptible to initiation of liquefaction or cyclic softening, whereas a F.S. greater than 1.0 suggests that initiation will not occur. It must be noted that this F.S. delineation is not definite as liquefaction or cyclic softening may be induced at marginal safety factors above 1.0.

Table 2 - HWY 165 Liquefaction/Cyclic Softening Summary

Elevations (ft)	Liquefaction/Cyclic Softening Potential	Approx. +/- Lateral Extent Past Canal Centerline (ft)
Ground - 233	No	-
233 - 228	Yes (Zone 1)	36
228 - 224	Yes (Zone 2)	36
224 - 219	Yes (Zone 3)	44
219-207.5	Yes (Zone 4)	83
207.5 - 188	No	-
188 - 177	Yes (Zone 5)	36
177 - Below	No	-

⁴ Youd, T.L., and Idriss, I.M. (2001). "Liquefaction Resistance of Soils: Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils." *J. of Geotech. and Geoenviron. Engrg.*, ASCE, Vol. 127, No. 4, 297-313.

⁵ Idriss, I.M., and Boulanger, R.W., (2008). "Soil Liquefaction During Earthquakes." *MNO-12, Earthquake Engr. Research Institute*, Oakland, California, 185-207.



Table 2 list a summary of the liquefaction/cyclic softening potential for each layer within the design profile. The potential for strength loss and deformation in the soil column is also spatially dependent on relative position along the canal design surface and water table. This is due to the CSR taking into account design in-situ stresses relative to the position of the canal cut or fills. For a soil at a given elevation beneath the canal bottom, the soils underneath the deepest cut are more prone to liquefaction/cyclic softening. As the position moves laterally underneath the increasing slope of the canal towards the original ground line typically the CSR decreases due to increased overburden stresses and increases the resulting F.S. Table 2 Summarizes the lateral extent of the liquefied/cyclic softening layers and [Appendix B](#) contains a table summarizing the change in F.S. compared to relative position along the design surface.

4.2.3. Residual Shear Strengths. During liquefaction/cyclic softening pore pressures may build up resulting in a loss of strength and then settlement as excessive pore pressures are alleviated. The loss of strength and settlement will result in a need to analyze extreme limit state cases for ultimate axial pile capacities, lateral pile capacities, vertical ground settlement, and slope stability or lateral spreading.

Residual shear strengths (S_r) are used to replace the static shear strengths in the liquefied layers displayed in Table 2. The design S_r values for this project were calculated using residual shear strength ratio approaches; Mitchell and Soga (2005) for cyclic softening or Idriss and Boulanger (2008) for liquefaction. These approaches found in Idriss and Boulanger or Kramer's⁶ text estimate S_r based on sensitivity of a soil with respect to overburden pressure or empirically estimates a S_r correlated to clean sand SPT blow counts that have been corrected for fines and effective vertical confining pressures. The design residual shear strength ranges are summarized in Table 3 below. The calculations for S_r can be found in more detail in [Appendix B](#).

Table 3 - Residual Shear Strengths for Design

Range of Residual Shear Strength, S_r (psf)	
Zone 1	900 to 1000
Zone 2	500 to 667
Zone 3	54 to 69
Zone 4	120 to 538
Zone 5	456 to 536

⁶ Kramer, Steven L. 1996. "Geotechnical Earthquake Engineering." Prentice-Hall, Inc., Saddle River, NJ.



The residual strengths found in Table 3 are the lowest at each zones upper boundary relative to the bottom grade of the canal and increase in strength as the depth increases or relative position laterally to overburden increases. The maximum values typically occur at each zones lower boundary and furthest lateral extent into the canal slopes.

- 4.3. Pile Design. The HWY 161 Bridge will consist of two abutments supported by driven 18-in diameter, concrete filled steel pipe piles and two bents supported by driven 24-in diameter, concrete filled steel pipe piles. The steel pipe piles will be driven as open-ended and then backfilled with concrete. Steel H-piles and pre-cast concrete piles were also considered for design, but depth of embedment and effects of earthquake loadings along with commentary from AASHTO discourage the use of these piles for this project.

2012 AASHTO LRFD Bridge Specifications currently require two designs including a static strength case and one extreme event case that incorporates shear strength reductions due to the effects of liquefaction after an earthquake event.

- 4.3.1. Theoretical Axial Pile Capacity. The ultimate axial compressive capacities of the piles used for this design were determined using the computer program APILE Plus 5.0 based on design methodologies required by AASHTO LRFD Bridge Specifications. AASHTO recommends multiple methodologies for static analysis of axial pile capacities. The FHWA method was used in this static analysis. The FHWA method, based on total or effective stresses, is a combination of the methods and equations presented by Nordlund (1963, 1979), Thurman (1964), Meyerhof (1976), Tomlinson (1980), and Hannigan, et al. (1997, 2006). More information on the FHWA methodology can be found in the APILE Plus 5.0 technical manual⁷ or in AASHTO Articles 10.7.3.8.6b – *α-Method* and 10.7.3.8.6f – *Nordlund/Thurman Method in Cohesionless Soils*.

AASHTO utilizes Load Resistance Factored Design (LRFD) methodologies and states that the static analysis shall be factored at the strength limit state by resistance factors in AASHTO Table 10.5.5.2.3-1, which correlate to the design method used in the analysis. The nominal resistance factor of a single pile applied to static limit state analysis methods for side resistance or end bearing in compression is 0.35 and 0.45 for the α -method and Nordlund/Thurman Method, respectively. It is assumed that the piles will not be loaded in tension.

The extreme limit state described in Article 10.7.4 is based on an “After Earthquake” scenario where soil layers in or above any liquefied layers do not contribute to bearing resistance. The ultimate axial pile capacity calculations follow the same methodology as the

⁷ Reese, L. et al. 2007. *COMPUTER PROGRAM APILE Plus Version 5.0, A Program for the Analysis of the Axial Capacity of Driven Piles*. Ensoft, Inc., Austin, Texas.



static condition. The nominal resistance factor recommended by AASHTO Table 10.5.5.2.3-1 is 1.0 for the extreme limit case.

Table 4- General Theoretical Pile Capacity Information for Compression

Bent Type	Pile Diameter (in)	Loading Condition	Max Factored Axial Loading (Kips)	Downdrag Working Load (Kips)	Approx. Minimum Tip Elevation (ft)
Abutments	18	Static	174	0	177
Abutments	18	Extreme	104	0	198
Bents	24	Static	268	0	160
Bents	24	Extreme	158	96.1	159

The sum of the maximum factored resistances of the individual piles will control for group resistance. General Design information for the HWY 165 Bridge can be seen in Table 4. The minimum tip elevations listed in Table 4 combine the max factored axial structural loading per pile and the effects of a downdrag load for the compressive case only. Downdrag is discussed in greater detail in Section 4.3.2. Ultimate pile capacity curves can be found in [Appendix C](#).

Ultimate (or nominal) capacity curves should be used for sustained loadings including the effects of the downdrag working load. Any transient-type loadings in excess of the loadings listed in Table 4 should be taken into account when using the ultimate pile capacity curves in [Appendix C](#). The static nominal capacity curves neglecting the downdrag working load can be used in calculating transient-type loading conditions based on the premise that downdrag will not be present at the same time as the transient loading or that the downward movement of the pile caused by the additional transient loads will reengage positive skin friction in the negative skin friction zone, thus allowing the entire pile to resist the structural loading.

4.3.2. Vertical Settlement. For the static limit state, each pile group will be founded in dense granular soils and will not be subjected to a downdrag loading. An equivalent footing analogy is recommended by Article 10.7.2.3.1 for purposes of calculating the piles settlement. Settlements are expected to be minimal on the order of less than 0.5 inches for the service limit state design in the static case based on similar Bridge Designs for Colonel Maynard and HWY 161 both just west of HWY 165.

The extreme limit state includes the effects of liquefied/cyclic softening layers within the analysis. Each pile group will still be founded in a dense granular soil limiting the amount of



axial pile settlement for service limit state considerations, but the settlement of the liquefied/cyclic-softening layers after excessive pore water dissipation occurs may induce additional downdrag loading that should be taken into consideration for the ultimate axial pile capacity during the extreme limit state conditions.

Downdrag will occur at and above the lowest liquefied/cyclic-softening layer within the length of each pile which can produce enough relative settlement between soil and pile. The Federal Highway Administration (FHWA) suggests that 0.4 to 0.5 inches of relative movement is needed to fully mobilize downdrag forces. The design profile was analyzed to determine the lowest depth for fully mobilizing downdrag. The bridge abutments were found to only pass through Zone 4 while the bents will pass through all 5 liquefied zones. Empirical correlations after Tokimatsu and Seed (1987) were used to compare blow counts, corrected for overburden and efficiency effects, and the CSR, corrected to a standardized moment magnitude of 7.5, to volumetric strains. The analysis suggests that all liquefaction zones will fully mobilize downdrag forces for the bridge bents. The abutments will not feel downdrag. Calculations can be found in [Appendix E](#).

The liquefied and softened zone elevations listed in Table 2 were assumed constant across all abutments and bents. Article C10.7.2.5 suggests that full downdrag is equal to the mobilized skin friction calculated for static axial ultimate loading that occurs between the pile butt and the bottom elevation of the lowest liquefied or cyclic softened layer above the pile tip. These downdrag loads, seen in Table 4, are added to the max factored axial loading to produce the ultimate axial load compared against the ultimate load curves to produce the minimum tip elevations seen in [Appendix C](#). Settlements are expected to be minimal on the order of less than 0.5 inches for the service limit state design in the extreme case.

- 4.3.3. Lateral Resistance. Lateral pile loadings and response was developed in tandem with a USACE Memphis structural engineer using the commercial programs LPILE 5.0 and RISA-3D. An initial loading condition at the top of each abutment and at the ground line for each pile was estimated by the structural for use in LPILE to calculate an initial stiffness. Once calculated, the structural engineer developed a solution for the superstructure. Revised values of shear, moment, and deflection were iterated until compatibility was achieved for the entire system for a given set of loadings. Final shear, moment, and deflection values in two orthogonal directions were recorded at the pile head for abutments and at the ground line for pile bents. The loading directions were perpendicular to Canal 1000 into sloping ground and parallel to the Canal 1000. The directions were named Longitudinal and Transverse, respectively.



LPILE parameter values were assigned based on soil boring test data, total stress strengths for clays, and the LPILEplus v5.0 manual⁸ recommendations for strain and modulus values. All LPILE runs were analyzed based on a nonlinear soil and an elastic pile response. Both static and extreme events were analyzed. Liquefiable layers in the extreme event case were modeled as soft clays with residual shear strengths. P-multipliers were assigned to account for group reduction factors. Guidance on P-multipliers was taken from AASHTO Article 10.7.2.4. A summary of the final results are included in Table 5 below. The final output files from LPILE can be found in [Appendix D](#) of this report. Structural calculations and iterations for the pile curves including axial, flexure, shear, and deflection can be found in Appendix D of the *HWY 165 Design Documentation Report Bayou Meto Basin, Arkansas* dated December 2015.

Table 5 - L-Pile Analysis Summary

Bent #	Pile Diam. (in)	Load Case Description	Groundline Deflection (in)	Max Bending Moment (ft-kips)	Max Shear Force (kips)
Abut 1	18	Static, Longitudinal	-0.10	-44.3	-11.5
Abut 1	18	Static, Transverse	0.25	80.0	-11.3
Abut 1	18	Extreme, Longitudinal	-0.18	-69.0	-12.0
Abut 1	18	Extreme, Transverse	0.27	84.0	-11.7
Abut 2	18	Static, Longitudinal	-0.13	-41.8	6.4
Abut 2	18	Extreme, Longitudinal	-0.19	54.3	8.0
Bents	24	Static, Longitudinal, Row 1	0.05	57.6	-6.1
Bents	24	Static, Transverse, Row 1	0.02	22.7	-2.6
Bents	24	Static, Transverse, Row 2	0.02	22.7	-2.4
Bents	24	Static, Transverse, Row 3,4,5	0.02	22.8	-2.3
Bents	24	Extreme, Longitudinal, Row 1	0.06	46.7	-3.9
Bents	24	Extreme, Transverse, Row 1	0.02	18.6	-1.9
Bents	24	Extreme, Transverse, Row 2	0.02	18.6	-1.7
Bents	24	Extreme, Transverse, Row 3,4,5	0.03	18.7	-1.6

4.3.4. Pile Drivability. Drivability and heave may be of concern with pipe piles. A Wave Equation Analysis should be performed by the contractor to verify the driving equipment will advance the pile to the maximum tip elevation of 159 feet NAVD88. It is recommended that a minimum wall thickness of ½-inch be used for drivability.

⁸ Reese, L. et al. (2004). "COMPUTER PROGRAM LPILE Plus Version 5.0 User's Guide." *A Program for the Analysis of Piles and Drilled Shafts Under Lateral Loads*. Ensoft, Inc., Austin, Texas.



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BAYOU METO CANAL 1000
HWY 165 BRIDGE
GEOTECHNICAL DESIGN REPORT

11/01/2015

- 4.3.5. **Pile Spacing.** The pile center-to-center spacing of no less than three pile diameters is met for this project. Based on current layout of the site, constructability issues based on pile spacing are not anticipated.
- 4.3.6. **Pile Vibration.** Pile driving may cause vibrations that could result in soil densification and settlement or direct damage to a structure due to the vibrations alone. HWY 165 bridge will be located within proximity to residential housing. Residential properties are located a minimum of 1,000 feet from the construction zone. It is believed that proximity of the structures to the construction site will not require direct vibration monitoring, but it is recommended, that at a minimum, if structures are present within a 700-ft radius of the bridge that a pre-driving condition survey be provided by the licensed surveyor after excavating and dewatering/unwatering are in place. A post-driving condition survey should also take place after all piles have been driven.
- 4.4. **Approach Embankment Settlement.** The compacted earthen embankment for the bridge approaches will be approximately 12 feet tall at the highest point. It is recommended that the embankment be placed before other bridge construction phasing. It is anticipated that most of the settlement will occur during the bridge construction given an anticipated bridge construction time of at least one year, partial in-situ overburden stress relief due to the site excavation, and a stratigraphy consisting of mostly low plasticity index clays, silts, and sands conducive to more immediate settlement.
- 4.5. **Abutment Earth Pressures.** Both abutments for HWY 165 will be expansion joint abutments and are roughly 7 feet tall with a 3.8-foot surcharge load of 125 pcf due to traffic. An expansion joint is provided, between the end bent wall and end of beam, to allow movement of the end of beam due to temperature expansion. For the static condition, it is assumed the abutments will not mobilize active or passive resistance. A coefficient of earth pressure at-rest (K_0) equal to 0.5 for the coarse-grained soil wedge behind the abutment can be estimated by Jaky's empirical relationship. This coefficient may be unconservative if the granular fill is over compacted. It is recommended a K_0 of 0.75 be used instead. Lateral earth pressure calculations can be found in [Appendix D](#).

For the extreme condition it is assumed that full active and passive conditions will be mobilized. Active (K_A) and passive (K_P) earth pressure coefficients of 0.30 and 1.65, respectively, were estimated based on Coulomb's lateral earth pressure theory. AASHTO Article A11.3 recommends the Mononabe-Okabe Method to calculate the seismic active (K_{AE}) and passive (K_{PE}) earth pressure coefficients. A K_{AE} of approximately 0.52 is expected for the active condition and a K_{PE} of approximately 4.92 is expected for the passive case. It should be noted that different authors suggest different locations along the back wall for the



active and passive resultants to occur. Article A11.3 suggests a reasonable approach is that the static/seismic resultant should be located at the same location as the static resultant but no less than $h/3$. Calculations for the seismic earth pressures can also be found in [Appendix D](#).

- 4.6. Channel Slope Stability. Slope stability analyses were performed in accordance with EM 1110-2-1902 and DIVR 1110-1-400 to determine the F.S. for the canal at the bridge location. Channel slope stability was analyzed for static cases using Spencer's Method in the computer program Slope/W. Seismic Stability and Residual Strength stability for the channel were also evaluated.

The section of Canal 1000 immediately at the bridge location will be partially above and below existing grade. The channel is approximately 15 feet deep with 1V:3H side slopes, a 40-foot bottom width, a bottom elevation of approximately 230 feet, and includes a uniform surcharge modeling 12 feet of 115 pcf clay approach embankment. The following scenarios were evaluated when appropriate for the proposed canal slopes; after construction (AC), long-term (LT), full pool Q-case (FPQ), full pool S-case (FPS), rapid drawdown (RD), Seismic (S), and Residual Shear (RS). Groundwater was assumed to be at elevation 224 feet before the canal is filled. Once the channel is filled to full pool, it is assumed that the pool elevation will stay constant around elevation 240 feet.

The unconsolidated-undrained (Q) shear strength (S_u) for clay soils were assigned based on empirical correlations to N_{60} blow counts. The consolidated-undrained (R) shear strengths for silts were selected based on guidance in DIVR 1110-1-400. The R shear strengths for clays (used in staged rapid drawdown) were approximated by assuming a total cohesion (c_T) of half of the undrained shear strength and a total friction angle (ϕ_T) of half of the drained friction angle. The internal angle of friction (ϕ') for the consolidated-drained (S) shear strengths were selected based on correlations with the soil plasticity index versus the drained friction angle that is contained in DIVR 1110-1-40. Natural, in-situ soil was considered to have zero effective cohesion (c'). The c' for compacted fill was conservatively selected to be 50 psf. The ϕ' for the S shear strength for sand was selected to be 30 degrees which is typical for the condition of the coarse-grained soils influencing the stability calculations. The S_r for Zones 1-5 were inputted as spatial functions and based on Table 3. The seismic loading was ignored in the vertical direction and approximated as half of the design peak horizontal ground acceleration (A_s) in the horizontal direction. All SLOPE/W critical factors of safety and graphical results can be found in [Appendix F](#). All slope stability F.S. met the minimum required F.S. for each scenario. A summary of the channel slope stability results are included in Table 6.



Table 6 – Slope Stability Results Summary

Analysis	Target Min. F.S.	Spencer Critical F.S.
AC	1.30	2.42
LT	1.25	1.74
FPQ	1.30	2.81
FPS	1.25	1.57
RD	1.20	1.72
S	1.10	1.81
RS	1.10	1.46

4.7. Channel Settlement. The compacted earthen embankment for Canal 1000 will be less than 5 feet above natural grade. The canal embankments will be built to gross grade without considering the effects of settlement. It is anticipated that settlement will be negligible and occur during the embankment construction given an anticipated bridge construction time of at least one year, partial in-situ overburden stress relief due to the site excavation, and a stratigraphy consisting of mostly low plasticity index clays, silts, and sands conducive to more immediate settlement.

4.8. Clay Liner Determination. The proposed Bayou Meto Basin project contains a system of canal and ditches which will carry water from the reservoir to several hundred locations within the basin. The pumps for the main reservoir were designed to supply a constant head of water to every turnout location taking into account seasonal farming demands and losses from evaporation and seepage. Criteria for the tolerable seepage losses and clay liner requirements are based on the analysis and information provided in the geotechnical report⁹ for Canal 1000 Phase 1. Based on these criteria, the “clay liner” shall be a minimum thickness of 2 feet and consist of earth materials that are classified as CL or CH in accordance with ASTM D 2487 provided that the materials have a plasticity index greater than 8 and a liquid limit between 25 and 60. Earth materials classified in accordance with ASTM D 2487 as ML or MH may also be used provided that the material plots within 3 percentage points of the A-Line, has a plasticity index greater than 8, and has a liquid limit between 30 and 60.

Undercutting will be required in order to construct the clay liner for the section of canal within the HWY 165 Bridge construction limits. New canal embankment shall have a minimum clay

⁹ USACE. (2014). “Bayou Meto Canal 1000 Phase 1 & Drainage Fix Geotechnical Design Report.” US Army Corps of Engineers – Memphis District Geotechnical Branch, Memphis, Tennessee.



liner thickness of 2 feet. Fill materials used to construct the clay liner shall have a maximum particle size of 3 inches and be free from masses of organic matter, sticks, branches, roots and other debris. In order to ensure proper compaction and reduce the permeability rate of the clay blanket it is also recommended that the loose lift thickness shall be limited to a maximum of 8 inches, compacted to 92% of standard Proctor, water content is placed as - 1/+3 percent of optimum, the blanket is compacted in layers running transverse to the direction of the canal length, and any in-situ soils are scarified prior to placement of a subsequent lift.

- 4.9. Groundwater Control. Based on the water depths encountered in the borings and the proposed construction, groundwater control will be required. Groundwater control including unwatering or dewatering will be dependent on the groundwater conditions at the time of construction. The areas and construction sequences where groundwater control is of particular concern are during the undercutting, installation of the siphon, and compaction required for a clay liner.
- 4.10. Siphon Analysis. The HWY 165 project requires a siphon to be constructed at station 142+96. The siphon will be made of twin 36-inch diameter reinforced concrete pressure pipes approximately 180 feet in length with pre-cast inlet and outlet structures.
- 4.10.1. Temporary Excavations. Temporary excavations for the siphon construction may be needed. The maximum excavation depth is approximately 19 feet below the existing ground surface. The design profile and undisturbed boring in the area were used as the basis for assigning the design engineering properties for the stability analysis. Due to the assumed depth of the groundwater at elevation 222.5 feet, the excavation was assumed to be unwatered. Methodologies similar to paragraph 4.6 were used to determine the FS for the temporary siphon excavations and associated stockpiles. Slope stability was analyzed for static cases using a circular failure arc to Spencer's Method with an optimized solution in the computer program SLOPE/W. Generalized cross-sections were evaluated to provide recommendations in order to meet the target minimum FS of 1.30 for the After Construction scenario. All SLOPE/W critical factors of safety and graphical results, including the siphon recommendations for slopes, minimum berm widths, and temporary EME heights can be found in [Appendix F](#).
- 4.10.2. Settlement. Approximately 3 feet of fill will be placed over the siphons after construction is complete. Excessive differential settlement and pipe rotation is not anticipated. Less than 2/10-inch long-term settlement is expected under the middle of the canal embankment. An analysis of the settlement can be found in [Appendix E](#).



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HWY 165 BRIDGE
GEOTECHNICAL DESIGN REPORT

11/01/2015

- 4.11. Pavement Design. Approximately 1,383 feet of new flexible pavement will exist within the HWY 165 Bridge construction limits not including an approximate 1,704-foot temporary detour route. The pavement was assumed to be at natural grade and underlain by an AASHTO Group A-4 silt/clay for purposes of design. The flexible pavement design was analyzed according to *1993 AASHTO Guide for Design of Pavement Structures* methodologies. Equivalent single axle load application (ESAL) data, additional pavement design criteria, and local cost data were provided by AHTD. Three pavement designs and one detour alternative, including preliminary cost estimates, were submitted to AHTD for review. A summary of the alternatives can be seen in Table 7 below.

Table 7 - Pavement Design Alternatives Summary

Description	Alt. 1	Alt. 2	Alt. 3	Detour
ACHM Surface Course (1/2")	2	2	-	4
ACHM Surface Course (1/2")	2	2	-	-
ACHM Binder Course (1")	3	6	2	-
ACHM Base Course (1 1/2")	4	-	6	-
Aggregate Base Course (Class 7)	6	6	12	8
Total Thickness (inches)	17	16	20	12
Calculated Structural No.	5.36	5.24	5.20	-
Required Structural no.	5.18	5.18	5.18	-
Estimated Cost (Project)	\$478,987	\$446,955	\$467,347	-

Alternative #2 and the Detour were approved as the design pavement sections by AHTD. Please note that all asphalt concrete hot mix sections (ACHM) in the table above assume performance grade binder PG 64-22 and include tack coat applications. Pavement designs for the submitted alternatives and the AHTD memo of approval can be found in [Appendix G](#).

APPENDIX

APPENDIX A – Subsurface Data

APPENDIX B – Site Class and Liquefaction Data

APPENDIX C – Theoretical Axial Pile Capacity Analysis

APPENDIX D – Lateral Pile Resistance and Lateral Earth Pressure Analysis

APPENDIX E – Settlement Analysis

APPENDIX F – Slope Stability Analysis

APPENDIX G – Pavement Analysis

APPENDIX A

Subsurface Data

Boring Designation 22-BMG-14

DRILLING LOG		DIVISION Mississippi Valley Division (MVD)		INSTALLATION Memphis District (CEMVM)		SHEET 1 OF 4 SHEETS														
1. PROJECT Bayou Meto Bridge Design - HWY #161 & HWY #165				8. COORDINATE SYSTEM		HORIZONTAL AR State Plane														
				9. DRILLING METHOD: RM		VERTICAL N.A.V.D 88														
2. HOLE NUMBER 22-BMG-14		LOCATION COORDINATES N 2047120.47 E 1285870.92		10. MANUFACTURER'S DESIGNATION OF DRILL CME 750x, automatic hammer																
3. DRILLING AGENCY McCray Drilling, LLC				11. TOTAL SAMPLES 36		DISTURBED 36														
						UNDISTURBED 0														
4. NAME OF DRILLER J. Kinas				12. DATE BORING 4/16/14		STARTED 4/17/14														
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED				DEG FROM VERTICAL ---		BEARING														
				13. ELEVATION WATER TABLE (ft)		AT DRILLING AFTER 24 HRS														
6. TOTAL DEPTH OF BORING 150																				
7. ELEVATION TOP OF BORING 241.12																				
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _t	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory										REMARKS	
% Gravel	% Sand	% Fines	D10	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torvane (tsf)	C (psf)										
Stiff, brown SILT (ML), rootlets																				
238.12	3	X	2	6			100	SP-1					NP	NP	18.9					
		X	3	8		Stiff, brown, silty CLAY (CL-ML), rootlets, trace sand	100	SP-2					22	4	22.4					
233.62	7.5	X	3	6			100	SP-3					24	6	21.5					
		X	4	9		Stiff, brown, lean CLAY (CL), concretions	100	SP-4					28	11	22.3					
		X	3	9		Trace of sand	100	SP-5					30	12	22.6					
		X	4	11			100	SP-6					30	13	22.5		No water table measurement, hole caved at 14'.			
223.12	18	X	5	4		Medium stiff	100	SP-7					30	12	23.0					
		X	2	4		Medium stiff, brown, silty CLAY (CL-ML), concretions	100	SP-8					25	7	22.7					
218.12	23	X	2	7		Stiff, trace sand	100	SP-9					25	7	29.5					
		X	6	15		Medium dense, tan, poorly-graded, medium to fine SAND (SP)	100	SP-10	0	96	4	0.171								
		X	7	18		Some gravel	100	SP-11	14	84	3	0.184								
		X	6	18		Trace gravel	100	SP-12	2	95	3	0.176								
207.62	33.5	X	7	17			100	SP-13	3	89	8	0.155								

GENERAL/UNDISTURBED - GINT STD US LAB.GDT - 11/1/15 17:37 - G:\GOSH-TO-BE_GOSH\BAYOU_METO_HWY165_BRIDGE_DESIGN\07 BORING_DATA\FINAL BORING_DATA\FINAL_GINT\HWY165.GPJ

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DRILLING LOG (Cont Sheet)					INSTALLATION		SHEET 3 OF 4 SHEETS												
PROJECT					Memphis District (CEMVM)														
Bayou Meto Bridge Design - HWY #161 & HWY #165					COORDINATE SYSTEM		HORIZONTAL VERTICAL												
LOCATION COORDINATES					ELEVATION TOP OF BORING		AR State Plane N.A.V.D 88												
N 2047120.47 E 1285870.92					241.12														
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _r	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory										REMARKS
									% Gravel	% Sand	% Fines	D ₁₀	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torvane (tsf)	
						Medium dense, tan, poorly-graded, medium to fine SAND (SP) (continued)													
		8	12	26		Dense, gray, coarse to fine, with gravel	100	SP-22	19	76	4	0.271							
		9	9	21		Gray, coarse to fine, trace gravel	100	SP-23	4	94	2	0.229							
		10	11	27		Dense, gray, coarse to fine, trace gravel	100	SP-24	8	89	3	0.187							
		5	10	20		Gray, coarse to fine, with gravel	100	SP-25	17	79	4	0.236							
		8	11	25		Dense, gray, coarse to fine, trace gravel	100	SP-26	5	93	2	0.213							
		10	13	30		Dense, gray, coarse to fine, trace gravel	100	SP-27											
		13	15	31		Dense, gray, coarse to fine, with gravel	100	SP-28	20	77	3	0.226							
		15	18	36		Dense, gray, coarse to fine, with gravel	100	SP-29											

Boring Designation 23-BMU-14

[illegible]

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DRILLING LOG (Cont Sheet)						INSTALLATION Memphis District (CEMVM)		SHEET 3 OF 3 SHEETS												
PROJECT Bayou Meto Bridge Design - HWY #161 & HWY #165						COORDINATE SYSTEM		HORIZONTAL AR State Plane												
LOCATION COORDINATES N 2047082.97 E 1285896.57						ELEVATION TOP OF BORING 241.09		VERTICAL N.A.V.D 88												
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _r	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory										REMARKS	
									% Gravel	% Sand	% Fines	D ₁₀	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torvane (tsf)		C (psf)
151.09	90	X	9 9 9	18	[Hatched Box]	Medium dense, gray, medium to fine, clayey SAND (SC), trace gravel (<i>continued</i>)														
						Dense, with gravel	100	SP-18												
		X	9 14 15	29	[Hatched Box]	Dense, with gravel			14	71	15									
							100	SP-19												
		X	11 15 14	29	[Hatched Box]	Dense, with gravel														
							100	SP-20												

Note: The SPT N-value is a field value and uncorrected. Autohammer correction values should be verified by the drilling contractor before use.

Boring Designation 24-BMU-14

DRILLING LOG		DIVISION Mississippi Valley Division (MVD)		INSTALLATION Memphis District (CEMVM)		SHEET 1 OF 3 SHEETS														
1. PROJECT Bayou Meto Bridge Design - HWY #161 & HWY #165				8. COORDINATE SYSTEM HORIZONTAL AR State Plane		VERTICAL N.A.V.D 88														
2. HOLE NUMBER 24-BMU-14				LOCATION COORDINATES N 2047163.34 E 1285841.05		9. DRILLING METHOD: RM														
3. DRILLING AGENCY McCray Drilling, LLC				11. TOTAL SAMPLES 25		DISTURBED 20														
4. NAME OF DRILLER J. Kinas				12. DATE BORING 4/16/14		COMPLETED 4/16/14														
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED		DEG FROM VERTICAL ---		BEARING		13. ELEVATION WATER TABLE (ft) 222.69														
6. TOTAL DEPTH OF BORING 90																				
7. ELEVATION TOP OF BORING 241.39																				
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _t	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory										REMARKS	
% Gravel	% Sand	% Fines	D10	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torvane (tsf)	C (psf)										
						Medium stiff, brown, silty CLAY (CL-ML), rootlets, trace gravel	100	ST-1					25	7	23.0	109			797	
						Stiff, brown SILT (ML)	100	ST-2					NP	NP	21.3	107			1144	
						Brown, fat CLAY (CH)	100	ST-3					61	41						Sample Broken, could not run UC
						Medium stiff, brown SILT (ML)	100	ST-4					NP	NP	23.0	112			909	
						Stiff, brown, lean CLAY (CL), trace sand	0	ST-5												
			4				100	SP-1					88	31	14	15.1				
			3				100	SP-2						35	19	30.7				
			4				100	SP-3						33	19	24.0				
			3				100	SP-4					89	24	3	28.4				
			4				100	SP-5					15	NP	NP	27.8				
			4				100	SP-6	5	91	5	0.171								
			9				100	SP-7	3	93	4	0.159								
			8				100	SP-8	1	95	4	0.166								
			9				100	SP-9	0	96	4	0.18								

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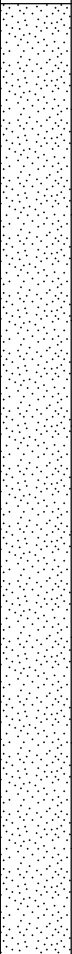
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DRILLING LOG (Cont Sheet)										INSTALLATION Memphis District (CEMVM)		SHEET 3 OF 3 SHEETS								
PROJECT Bayou Meto Bridge Design - HWY #161 & HWY #165										COORDINATE SYSTEM		HORIZONTAL AR State Plane		VERTICAL N.A.V.D 88						
LOCATION COORDINATES N 2047163.34 E 1285841.05										ELEVATION TOP OF BORING 241.39										
ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _r	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory										REMARKS	
									% Gravel	% Sand	% Fines	D ₁₀	LL	PI	MC	DUW (pcf)	PPR (tsf)	Torvane (tsf)		C (psf)
151.39	90		9	18		Medium dense, gray, poorly-graded, medium to fine SAND (SP), trace gravel (continued)	100	SP-18	11	84	4	0.17								
			8																	
			10																	
			10	23		Dense, some gravel	100	SP-19												
			11																	
			12																	
			13	25		Dense, some gravel	100	SP-20	16	81	3	0.206								
			13																	
			12																	

Note: The SPT N-value is a field value and uncorrected. Autohammer correction values should be verified by the drilling contractor before use.

CONDENSED SOIL DATA SHEET																				HOLE NUMBER: 22-BMG-14							
PROJECT: Bayou Meto Bridge Design - HWY #161 & HWY #165										LOCATION COORD: N 2047120.47 E 1285870.92					COORDINATE SYSTEM					VERTICAL: N.A.V.D 88				HORIZONTAL: AR State Plane			
DATE OF BORING:			DATE CLASSIFIED: 4/17/2014			DRILL METHOD: RM			DRILLER NAME: J. Kinas			BORING TYPE: G			TOTAL SAMPLES			GROUNDWATER DEPTH									
START: 4/16/14 END: 4/17/14			DRILLING CO.: McCray Drilling, LLC			MANUFACTURER DRILL DESIGNATION: CME 750x, automatic hammer			ELEV OF TOP: 241.12			DIST: 36			UNDIST: 0			AD: 24 HRS:									
ABBREVIATIONS:										W = WATER CONTENT (AS % OF DRY WEIGHT)					c = COHESION (LB/FT ²)					TV = TORVANE SHEAR (TONS/FT ²)							
										LL = LIQUID LIMIT PL = PLASTIC LIMIT					Phi = FRICTION ANGLE (DEG)					PPR = POCKET PENETROMETER (TONS/FT ²)							
US STANDARD SIEVE				3"				3/4"				#4				#10				#40				#200			
COBBLES								GRAVEL								SAND								FINES			
				Coarse				Fine				Coarse				Medium				Fine				(Clay or Silt)			
				3"				3/4"				4.76 mm				2.0 mm				0.42 mm				0.074 mm			
Sample No	Depth (ft)		Laboratory Classification	Blow Count		Strata	Classification Data										D ₁₀	Dry Density (lb/ft ³)	Strength Data								
	From	To		Blows/0.5 ft	N _f		w (%)	LL	PL	PI	% Gravel	% Sand	% Fines	% Pass		TV (ton/ft ²)			PPR (ton/ft ²)	c (lb/ft ²)	Phi (deg)						
														#10	#40												
SP-1	1	2.5	Stiff, brown SILT (ML), rootlets	2 2 4	6		18.9	NP	NP																		
SP-2	3.5	5	Stiff, brown, silty CLAY (CL-ML), rootlets, trace sand	3 5 3	8		22.4	22	18	4				91.8													
SP-3	6	7.5	Stiff, brown, silty CLAY (CL-ML), rootlets, trace sand	3 3 3	6		21.5	24	18	6																	
SP-4	8.5	10	Stiff, brown, lean CLAY (CL), concretions	4 4 5	9		22.3	28	17	11																	
SP-5	11	12.5	Trace of sand	3 5 4	9		22.6	30	18	12				94.9													
SP-6	13.5	15	Stiff, brown, lean CLAY (CL), concretions	4 4 7	11		22.5	30	17	13																	
SP-7	16	17.5	Medium stiff	5 2 2	4		23.0	30	18	12																	
SP-8	18.5	20	Medium stiff, brown, silty CLAY (CL-ML), concretions	2 2 2	4		22.7	25	18	7																	
SP-9	21	22.5	Stiff, trace sand	2 4 3	7		29.5	25	18	7				88.5													
SP-10	23.5	25	Medium dense, tan, poorly-graded, medium to fine SAND (SP)	6 7 8	15						0.0	96.0	4.0	99.7	58.1	0.171											

CONDENSED SOIL DATA SHEET															HOLE NUMBER: 22-BMG-14									
PROJECT: Bayou Meto Bridge Design - HWY #161 & HWY #165					LOCATION COORD: N 2047120.47 E 1285870.92					COORDINATE SYSTEM					VERTICAL: N.A.V.D 88					HORIZONTAL: AR State Plane				
DATE OF BORING:			DATE CLASSIFIED: 4/17/2014			DRILL METHOD: RM			DRILLER NAME: J. Kinas			BORING TYPE: G			TOTAL SAMPLES			GROUNDWATER DEPTH						
START: 4/16/14 END: 4/17/14			DRILLING CO.: McCray Drilling, LLC			MANUFACTURER DRILL DESIGNATION: CME 750x, automatic hammer			ELEV OF TOP: 241.12			DIST: 36			UNDIST: 0			AD: 24 HRS:						
ABBREVIATIONS:					W = WATER CONTENT (AS % OF DRY WEIGHT)					c = COHESION (LB/FT ²)					TV = TORVANE SHEAR (TONS/FT ²)									
					LL = LIQUID LIMIT PL = PLASTIC LIMIT					Phi = FRICTION ANGLE (DEG)					PPR = POCKET PENETROMETER (TONS/FT ²)									
US STANDARD SIEVE					3"		3/4"		#4		#10		#40		#200									
COBBLES					GRAVEL					SAND					FINES									
					Coarse		Fine		Coarse		Medium		Fine		(Clay or Silt)									
					3"		3/4"		4.76 mm		2.0 mm		0.42 mm		0.074 mm									
Sample No	Depth (ft)		Laboratory Classification	Blow Count		Strata	Classification Data										Dry Density (lb/ft ³)	Strength Data						
	From	To		Blows/ 0.5 ft	N _f		w (%)	LL	PL	PI	% Gravel	% Sand	% Fines	% Pass		D ₁₀		TV (ton/ft ²)	PPR (ton/ft ²)	c (lb/ft ²)	Phi (deg)			
														#10	#40									
SP-11	26	27.5	Some gravel	7 7 11	18						13.5	83.6	2.9	86.2	53.5	0.184								
SP-12	28.5	30	Trace gravel	6 8 10	18						1.8	95.4	2.8	97.9	54.4	0.176								
SP-13	33.5	35	Medium dense, tan, poorly-graded, medium to fine SAND with silt (SP-SM), trace gravel	7 8 9	17						3.0	89.4	7.6	96.7	64.1	0.155								
SP-14	38.5	40	Medium dense, tan, poorly-graded, medium to fine SAND (SP)	9 9 11	20						0.0	95.8	4.2		67.9	0.166								
SP-15	43.5	45	Trace gravel	9 9 9	18						4.6	92.9	2.4	95.3	75.8	0.177								
SP-16	48.5	50	Dense, trace gravel	8 11 13	24						2.0	94.9	3.0	97.7	60.9	0.179								
SP-17	53.5	55	Gray, trace gravel	3 9 12	21						7.6	89.8	2.6	89.6	10.6	0.407								
SP-18	58.5	60	Gray, trace gravel	4 10 10	20						4.2	93.4	2.4	92.1	14.5	0.314								
SP-19	63.5	65	Gray, trace gravel	5 6 12	18						11.7	84.2	4.1	84.1	22.5	0.201								
SP-20	68.5	70	Gray, trace gravel	7 8 11	19						1.6	94.9	3.6	97.3	39.6	0.176								

CONDENSED SOIL DATA SHEET															HOLE NUMBER: 22-BMG-14									
PROJECT: Bayou Meto Bridge Design - HWY #161 & HWY #165					LOCATION COORD: N 2047120.47 E 1285870.92					COORDINATE SYSTEM					VERTICAL: N.A.V.D 88					HORIZONTAL: AR State Plane				
DATE OF BORING:			DATE CLASSIFIED: 4/17/2014			DRILL METHOD: RM			DRILLER NAME: J. Kinas			BORING TYPE: G			TOTAL SAMPLES			GROUNDWATER DEPTH						
START: 4/16/14 END: 4/17/14			DRILLING CO.: McCray Drilling, LLC			MANUFACTURER DRILL DESIGNATION: CME 750x, automatic hammer			ELEV OF TOP: 241.12			DIST: 36			UNDIST: 0			AD: 24 HRS:						
ABBREVIATIONS:					W = WATER CONTENT (AS % OF DRY WEIGHT)					c = COHESION (LB/FT ²)					TV = TORVANE SHEAR (TONS/FT ²)									
					LL = LIQUID LIMIT PL = PLASTIC LIMIT					Phi = FRICTION ANGLE (DEG)					PPR = POCKET PENETROMETER (TONS/FT ²)									
US STANDARD SIEVE					3"		3/4"		#4		#10		#40		#200									
COBBLES					GRAVEL					SAND					FINES									
					Coarse		Fine		Coarse		Medium		Fine		(Clay or Silt)									
					3"		3/4"		4.76 mm		2.0 mm		0.42 mm		0.074 mm									
Sample No	Depth (ft)		Laboratory Classification	Blow Count		Strata	Classification Data										Dry Density (lb/ft ³)	Strength Data						
	From	To		Blows/ 0.5 ft	N _f		w (%)	LL	PL	PI	% Gravel	% Sand	% Fines	% Pass		D ₁₀		TV (ton/ft ²)	PPR (ton/ft ²)	c (lb/ft ²)	Phi (deg)			
														#10	#40									
SP-21	73.5	75	Dense, gray, coarse to fine, with gravel	8 12 15	27						18.1	78.5	3.4	73.7	25.8	0.201								
SP-22	78.5	80	Dense, gray, coarse to fine, with gravel	8 12 14	26						19.4	76.4	4.2	72.9	19.5	0.271								
SP-23	83.5	85	Gray, coarse to fine, trace gravel	9 9 12	21						4.1	94.0	1.9	87.7	29.2	0.229								
SP-24	88.5	90	Dense, gray, coarse to fine, trace gravel	10 11 16	27						7.9	89.5	2.6	83.5	37.1	0.187								
SP-25	93.5	95	Gray, coarse to fine, with gravel	5 10 10	20						17.4	78.9	3.6	72.9	20.6	0.236								
SP-26	98.5	100	Dense, gray, coarse to fine, trace gravel	8 11 14	25						4.7	93.3	2.1	88.0	31.8	0.213								
SP-28	108.5	110	Dense, gray, coarse to fine, with gravel	13 15 16	31						20.4	77.0	2.5	69.3	24.3	0.226								
SP-30	118.5	120	Very dense, gray, coarse to fine, with gravel	19 19 19	38						24.1	72.2	3.7	67.6	32.5	0.184								
SP-32	128.5	130	Very dense, gray, coarse to fine, with gravel	18 21 23	44						19.9	76.5	3.7	69.2	35.3	0.185								
SP-34	138.5	140	Very dense, gray, coarse to fine, with gravel	7 21 23	44					47.9	48.7	3.4	51.5	22.8	0.244									

HOLE NUMBER: 22-BMG-14

[illegible]

CONDENSED SOIL DATA SHEET																				HOLE NUMBER: 23-BMU-14														
PROJECT: Bayou Meto Bridge Design - HWY #161 & HWY #165										LOCATION COORD: N 2047082.97 E 1285896.57					COORDINATE SYSTEM					VERTICAL: N.A.V.D 88					HORIZONTAL: AR State Plane									
DATE OF BORING:			DATE CLASSIFIED: 4/17/2014			DRILL METHOD: RM			DRILLER NAME: J. Kinas			BORING TYPE: G			TOTAL SAMPLES			GROUNDWATER DEPTH																
START: 4/17/14 END: 4/17/14			DRILLING CO.: McCray Drilling, LLC			MANUFACTURER DRILL DESIGNATION: CME 750x, automatic hammer			ELEV OF TOP: 241.09			DIST: 20			UNDIST: 3			AD: 24 HRS:																
ABBREVIATIONS:										W = WATER CONTENT (AS % OF DRY WEIGHT)					c = COHESION (LB/FT ²)					TV = TORVANE SHEAR (TONS/FT ²)														
										LL = LIQUID LIMIT PL = PLASTIC LIMIT					Phi = FRICTION ANGLE (DEG)					PPR = POCKET PENETROMETER (TONS/FT ²)														
US STANDARD SIEVE					3"					3/4"					#4					#10					#40					#200				
COBBLES					GRAVEL					SAND					FINES																			
					Coarse					Fine					Coarse					Medium					Fine					(Clay or Silt)				
3"					3/4"					4.76 mm					2.0 mm					0.42 mm					0.074 mm									
Sample No	Depth (ft)		Laboratory Classification	Blow Count		Strata	Classification Data										Dry Density (lb/ft ³)	Strength Data																
	From	To		Blows/0.5 ft	N _f		w (%)	LL	PL	PI	% Gravel	% Sand	% Fines	% Pass		D ₁₀		TV (ton/ft ²)	PPR (ton/ft ²)	c (lb/ft ²)	Phi (deg)													
														#10	#40																			
ST-1	1	3	Rootlets				24.0	27	22	5								107			908													
ST-2	3	5	Stiff, organic matter				20.9	23	20	3								114			1088													
SP-1	11	12.5	Medium stiff, brown lean CLAY (CL)	3 3 3	6		22.3	28	19	9																								
SP-2	13.5	15	Stiff, brown SILT (ML), trace sand	4 5 5	10		29.4	NP	NP				90.4																					
SP-3	16	17.5	Soft	2 2 1	3		26.3	22	19	3																								
SP-4	18.5	20	With sand	3 4 3	7		29.8	NP	NP				75.4																					
SP-5	21	22.5	Medium dense, brown silty SAND (SM), saturated	4 7 9	16						0.0	54.1	45.9	100.0	93.3																			
SP-6	23.5	25	Medium dense, brown, poorly-graded, fine SAND (SP)	6 6 8	14						0.0	96.7	3.3	100.0	62.5	0.168																		
SP-7	26	27.5	Medium dense, brown, poorly-graded, fine SAND (SP)	7 8 9	17						0.0	95.9	4.1	100.0	80.5	0.169																		
SP-8	28.5	30	Medium dense, brown, poorly-graded, fine SAND (SP)	6 9 9	18						0.0	96.5	3.5		76.7	0.175																		

CONDENSED SOIL DATA SHEET

HOLE NUMBER: **23-BMU-14**

PROJECT: Bayou Meto Bridge Design - HWY #161 & HWY #163				LOCATION COORD: N 2047082.97 E 1285896.57		COORDINATE SYSTEM		VERTICAL: N.A.V.D 88		HORIZONTAL: AR State Plane			
DATE OF BORING:		DATE CLASSIFIED: 4/17/2014		DRILL METHOD: RM		DRILLER NAME: J. Kinas		BORING TYPE: G		TOTAL SAMPLES		GROUNDWATER DEPTH	
START: 4/17/14 END: 4/17/14		DRILLING CO.: McCray Drilling, LLC		MANUFACTURER DRILL DESIGNATION: CME 750x, automatic hammer		ELEV OF TOP: 241.09		DIST: 20		UNDIST: 3		AD: 24 HRS:	
ABBREVIATIONS:		W = WATER CONTENT (AS % OF DRY WEIGHT)				c = COHESION (LB/FT ²)		TV = TORVANE SHEAR (TONS/FT ²)		PPR = POCKET PENETROMETER (TONS/FT ²)			
		LL = LIQUID LIMIT PL = PLASTIC LIMIT				Phi = FRICTION ANGLE (DEG)							

US STANDARD SIEVE		3"	3/4"	#4	#10	#40	#200
COBBLES		GRAVEL		SAND			FINES
		Coarse	Fine	Coarse	Medium	Fine	(Clay or Silt)
		3"	3/4"	4.76 mm	2.0 mm	0.42 mm	0.074 mm

Sample No	Depth (ft)		Laboratory Classification	Blow Count		Strata	Classification Data										Dry Density (lb/ft ³)	Strength Data			
	From	To		Blows/0.5 ft	N _f		w (%)	LL	PL	PI	% Gravel	% Sand	% Fines	% Pass		D ₁₀		TV (ton/ft ²)	PPR (ton/ft ²)	c (lb/ft ²)	Phi (deg)
														#10	#40						
SP-9	33.5	35	Medium dense, brown, poorly-graded, fine SAND (SP)	8 9 11	20						0.0	96.8	3.2		87.2	0.177					
SP-10	38.5	40	Medium dense, brown, fine SAND with silt (SP-SM)	7 9 13	22							0.0	95.4	4.6		90.1	0.165				
SP-11	43.5	45	Medium dense, brown, poorly-graded, fine SAND (SP)	9 9 9	18								0.0	96.6	3.4		70.3	0.175			
SP-12	48.5	50	Dense	8 12 16	28								0.0	95.8	4.2		66.5	0.167			
SP-13	53.5	55	Medium dense, gray, fine, clayey SAND (SC)	7 9 11	20							0.0	80.1	19.9		84.3					
SP-14	58.5	60	Medium dense, gray, fine, clayey SAND (SC)	10 7 14	21				25.9	32	16	16			44.6						
SP-15	63.5	65	Medium dense, gray, poorly-graded, fine SAND with clay (SP-SC), trace gravel	3 5 12	17										6.2						
SP-16	68.5	70	Medium dense, gray, poorly-graded, medium to fine SAND with gravel (SP)	5 10 11	21							14.9	82.6	2.4	76.4	50.3	0.182				
SP-17	73.5	75	Medium dense, gray, medium to fine, clayey SAND (SC), trace gravel	6 9 13	22								0.0	80.7	19.3	99.0	72.6				
SP-19	83.5	85	Dense, with gravel	9 14 15	29								14.0	70.7	15.4	79.9	47.8				

HOLE NUMBER: 24-BMU-14

US STANDARD SIEVE	3"	3/4"	#4	#10	#40	#200
COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	(Clay or Silt)
	3"	3/4"	4.76 mm	2.0 mm	0.42 mm	0.074 mm

Sample No	Depth (ft)		Laboratory Classification	Blow Count		Strata	Classification Data										Dry Density (lb/ft³)	Strength Data			
	From	To		Blows/ 0.5 ft	N _f		w (%)	LL	PL	PI	% Gravel	% Sand	% Fines	% Pass		D ₁₀		TV (ton/ft²)	PPR (ton/ft²)	c (lb/ft²)	Phi (deg)
ST-1	1	3	Medium stiff, brown, silty CLAY (CL-ML), rootlets, trace gravel				23.0	25	18	7							109			797	
ST-2	3	5	Stiff, brown SILT (ML)				21.3	NP	NP								107			1144	
ST-3	5	6	Stiff, brown SILT (ML)				23.3	NP	NP												
ST-3	6	7	Brown, fat CLAY (CH)					61	20	41											
ST-4	7	9	Medium stiff, brown SILT (ML)				23.0	NP	NP								112			909	
SP-1	11	12.5	Stiff, brown, lean CLAY (CL), trace sand	4 4 4	8		15.1	31	17	14			88.2								
SP-2	13.5	15	Stiff, brown, lean CLAY (CL), trace sand	3 4 5	9		30.7	35	16	19											
SP-3	16	17.5	Stiff, brown, lean CLAY (CL), trace sand	4 5 6	11		24.0	33	14	19											
SP-4	18.5	20	Stiff, brown SILT (ML), trace sand	3 6 3	9		28.4	24	21	3			89.4								
SP-5	21	22.5	Medium dense, brown, fine silty SAND (SM)	4 9 5	14		27.8	NP	NP				15.5								

CONDENSED SOIL DATA SHEET																	HOLE NUMBER: 24-BMU-14							
PROJECT: Bayou Meto Bridge Design - HWY #161 & HWY #165					LOCATION COORD: N 2047163.34 E 1285841.05					COORDINATE SYSTEM					VERTICAL: N.A.V.D 88					HORIZONTAL: AR State Plane				
DATE OF BORING:			DATE CLASSIFIED: 4/16/2014			DRILL METHOD: RM			DRILLER NAME: J. Kinas			BORING TYPE: G			TOTAL SAMPLES			GROUNDWATER DEPTH						
START: 4/16/14 END: 4/16/14			DRILLING CO.: McCray Drilling, LLC			MANUFACTURER DRILL DESIGNATION: CME 750x, automatic hammer			ELEV OF TOP: 241.39			DIST: 20			UNDIST: 5			AD: 24 HRS: 18.7						
ABBREVIATIONS:					W = WATER CONTENT (AS % OF DRY WEIGHT)					c = COHESION (LB/FT ²)					TV = TORVANE SHEAR (TONS/FT ²)									
					LL = LIQUID LIMIT PL = PLASTIC LIMIT					Phi = FRICTION ANGLE (DEG)					PPR = POCKET PENETROMETER (TONS/FT ²)									
US STANDARD SIEVE					3"		3/4"		#4		#10		#40		#200									
COBBLES					GRAVEL					SAND					FINES									
					Coarse		Fine		Coarse		Medium		Fine		(Clay or Silt)									
					3"		3/4"		4.76 mm		2.0 mm		0.42 mm		0.074 mm									
Sample No	Depth (ft)		Laboratory Classification	Blow Count		Strata	Classification Data										Dry Density (lb/ft ³)	Strength Data						
	From	To		Blows/ 0.5 ft	N _f		w (%)	LL	PL	PI	% Gravel	% Sand	% Fines	% Pass		D ₁₀		TV (ton/ft ²)	PPR (ton/ft ²)	c (lb/ft ²)	Phi (deg)			
														#10	#40									
SP-6	23.5	25	Medium dense, brown, poorly-graded, medium to fine SAND with silt (SP-SM), trace gravel	4 8 4	12						4.8	90.6	4.6	94.9	61.6	0.171								
SP-7	26	27.5	Dense, tan, poorly-graded, medium to fine SAND (SP), trace gravel	9 11 12	23						2.7	93.1	4.2	97.3	90.3	0.159								
SP-8	28.5	30	Medium dense, fine	8 5 8	13						0.8	95.4	3.8	99.0	86.7	0.166								
SP-9	33.5	35	Medium dense, fine	9 9 9	18						0.0	96.3	3.7		66.3	0.18								
SP-10	38.5	40	Dense, tan, poorly-graded, medium to fine SAND (SP), trace gravel	8 10 15	25						0.0	96.8	3.2	100.0	84.3	0.163								
SP-11	43.5	45	Fine	7 11 13	24						0.5	95.8	3.7	99.2	71.6	0.18								
SP-12	48.5	50	Fine	10 11 12	23						1.9	94.3	3.8	97.8	81.0	0.183								
SP-13	53.5	55	Medium dense, gray, poorly-graded, fine SAND with silt (SP-SM) and gravel	4 5 8	13						24.3	70.6	5.0	65.6	22.2	0.192								
SP-14	58.5	60	Medium dense, gray, poorly-graded, coarse to fine SAND (SP), trace gravel	3 8 6	14						11.7	85.4	2.9	82.2	13.2	0.35								
SP-15	63.5	65	Medium dense, gray, poorly-graded, coarse to fine, gravelly SAND with silt (SP-SM)	3 6 9	15						33.0	58.4	8.6	55.5	15.8	0.152								

HOLE NUMBER: 24-BMU-14

US STANDARD SIEVE	3"	3/4"	#4	#10	#40	#200
COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	(Clay or Silt)
	3"	3/4"	4.76 mm	2.0 mm	0.42 mm	0.074 mm

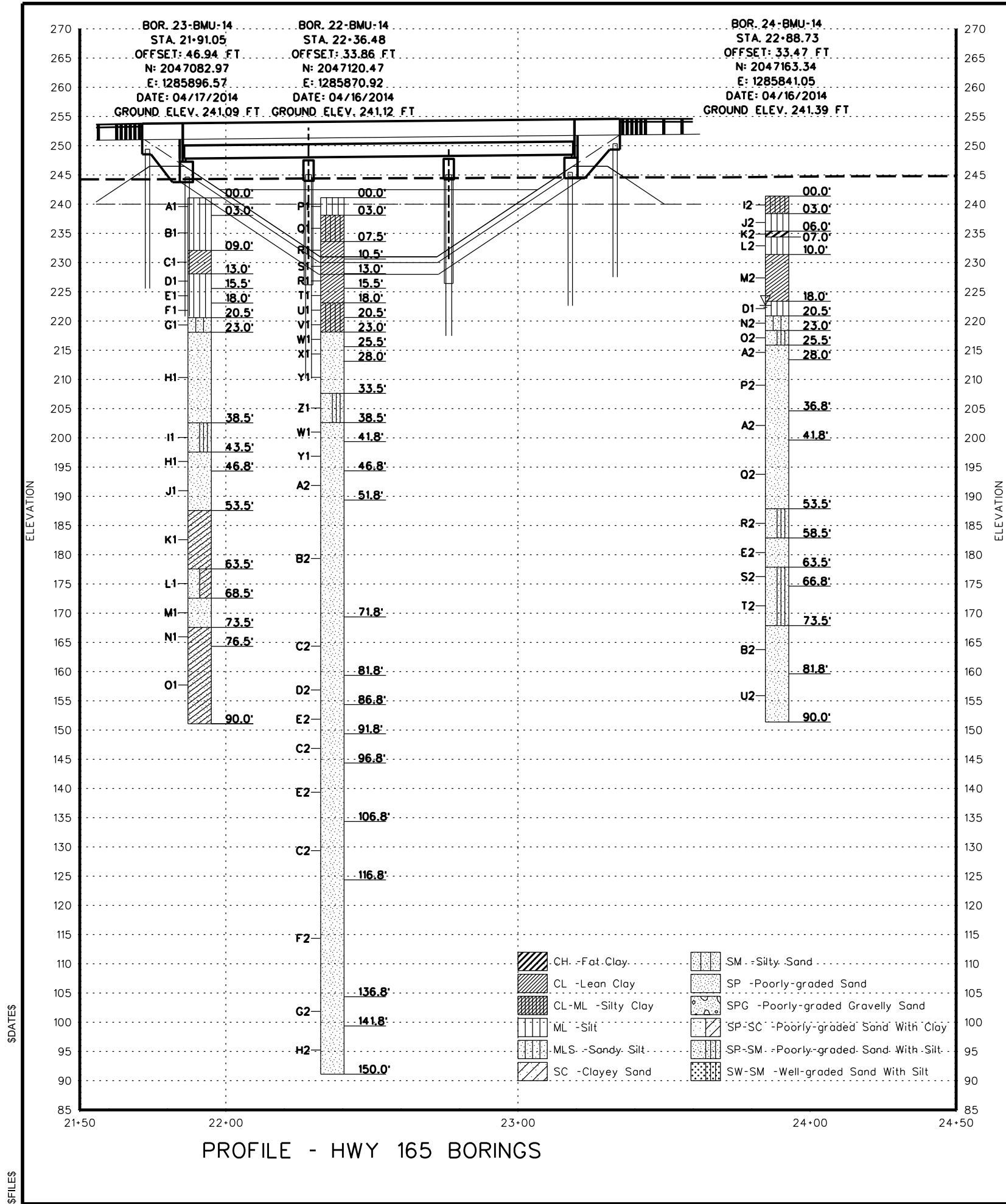
[illegible]

DRILLING LOG		DIVISION		INSTALLATION		SHEET 1 OF 1 SHEETS	
1. PROJECT Highway 161 and 165 Bridge Pavement Investigations				8. COORDINATE SYSTEM		HORIZONTAL VERTICAL	
2. HOLE NUMBER 02-H161G-14				LOCATION COORDINATES N 2044879.706 E 1282875.151		9. DRILLING METHOD: HSA	
3. DRILLING AGENCY PSI				11. TOTAL SAMPLES 2		DISTURBED 2 UNDISTURBED 0	
4. NAME OF DRILLER R. Strunk				12. DATE BORING		STARTED 10/16/14 COMPLETED 10/16/14	
5. DIRECTION OF BORING		DEG FROM VERTICAL		BEARING		13. ELEVATION WATER TABLE (ft)	
☒ VERTICAL ☐ INCLINED		---				AT DRILLING AFTER 24 HRS	
6. TOTAL DEPTH OF BORING 5							
7. ELEVATION TOP OF BORING 246							

ELEV	DEPTH	SAMPLE	Blows/ 0.5 ft	N _r	LEGEND	LAB CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory												REMARKS
									% Gravel	% Sand	% Fines	D10	LL	PI	MC	DJW (pcf)	PPR (tsf)	Torvane (tsf)	C (psf)		
245.79	0.21					Asphalt, ACHM Surface Course															
						Asphalt, Concrete Base															
245.17	0.83																				
245	1					Asphalt, Aggregate Base															
				18		Silt with sand (ML) - Brown, Very Stiff	100	1			74				17.7						Classifies as AASHTO A-4 (1). A CBR test was performed on a bucket grab sample. The bearing ratio was recorded as 4.96 @ 0.1 inch and 6.59 @ 0.2 inch penetration.
			6																		
				9																	
				9																	
243	3																				
						Lean clay (CL) - Brown, Soft															Classifies as AASHTO A-4 (4). Assumes 74% Fines.
			2	4										26	8	27.8					
							100	2													
241	5																				

Note: The SPT N-value is a field value and uncorrected. Autohammer correction values should be verified by the drilling contractor before use.

0.0
2.5
5.0



DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
				6	ARK.			
				JOB NO.				

1 BORINGS - PROFILE

"N60" VALUES

23-BMU-14

22-BMG-14

24-BMU-14

NOTE: "N60" values are field N-values only corrected for a CME Auto Hammer using an energy correction factor of 1.4 and rounding down to the nearest N-value.

BORING LEGEND

A1-Medium stiff, brown SILT (ML), rootlets
B1-Stiff, brown SILT (ML), organic matter
C1-Medium stiff, brown, lean CLAY (CL)
D1-Stiff, brown SILT (ML), trace sand
E1-Soft, brown SILT (ML), trace sand
F1-Stiff, brown SILT (ML) with sand
G1-Medium dense, brown, silty SAND (SM), saturated
H1-Medium dense, brown, poorly-graded, fine SAND (SP)
I1-Medium dense, brown, poorly-graded, fine SAND with silt (SP-SM)
J1-Dense, brown, poorly-graded, fine SAND (SP)
K1-Medium dense, gray, fine, clayey SAND (SC)
L1-Medium dense, gray, poorly-graded, fine SAND with clay (SP-SC), trace gravel
M1-Medium dense, gray, poorly-graded, medium to fine SAND (SP) with gravel
N1-Medium dense, gray, medium to fine, clayey SAND (SC), trace gravel
O1-Dense, gray, medium to fine, clayey SAND (SC) with gravel
P1-Stiff, brown, SILT (ML), rootlets
Q1-Stiff, brown, silty CLAY (CL-ML), rootlets, trace sand
R1-Stiff, brown, lean CLAY (CL), concretions
S1-Stiff, brown, lean CLAY (CL), concretions, trace sand
T1-Medium stiff, brown, lean CLAY (CL), concretions
U1-Medium stiff, brown, silty CLAY (CL-ML), concretions
V1-Stiff, brown, silty CLAY (CL-ML), concretions, trace sand
W1-Medium dense, tan, poorly-graded, medium to fine SAND (SP)
X1-Medium dense, tan, poorly-graded, medium to fine SAND (SP), some gravel
Y1-Medium dense, tan, poorly-graded, medium to fine SAND (SP), trace gravel
Z1-Medium dense, tan, poorly-graded, medium to fine SAND with silt (SP-SM), trace gravel
A2-Dense, tan, poorly-graded, medium to fine SAND (SP), trace gravel
B2-Dense, gray, poorly-graded, medium to fine SAND (SP), trace gravel
C2-Dense, gray, poorly-graded, coarse to fine SAND (SP) with gravel
D2-Medium dense, gray, poorly-graded, coarse to fine SAND (SP), trace gravel
E2-Dense, gray, poorly-graded, coarse to fine SAND (SP), trace gravel
F2-Very dense, gray, poorly-graded, coarse to fine SAND (SP), with gravel
G2-Very dense, gray, poorly-graded, coarse to fine, gravelly SAND (SP)
H2-Very dense, gray, poorly-graded, medium to fine SAND (SP) with gravel
I2-Medium stiff, brown, silty CLAY (CL-ML), rootlets, trace gravel
J2-Stiff, brown, SILT (ML)
K2-Brown, fat CLAY (CH)
L2-Medium stiff, brown SILT (ML)
M2-Stiff, brown, lean CLAY (CL), trace sand
N2-Medium dense, brown, fine, silty SAND (SM)
O2-Medium dense, brown, poorly-graded, medium to fine SAND with silt (SP-SM), trace gravel
P2-Medium dense, tan, poorly-graded, fine SAND (SP), trace gravel
Q2-Dense, tan, poorly-graded, fine SAND (SP), trace gravel
R2-Medium dense, gray, poorly-graded, fine SAND with silt (SP-SM) and gravel
S2-Medium dense, gray, poorly-graded, coarse to fine, gravelly SAND with silt (SP-SM)
T2-Medium dense, gray, poorly-graded, coarse to fine SAND with silt (SP-SM), trace gravel
U2-Dense, gray, poorly-graded, medium to fine SAND (SP), some gravel

PRELIMINARY
NOT FOR
CONSTRUCTION

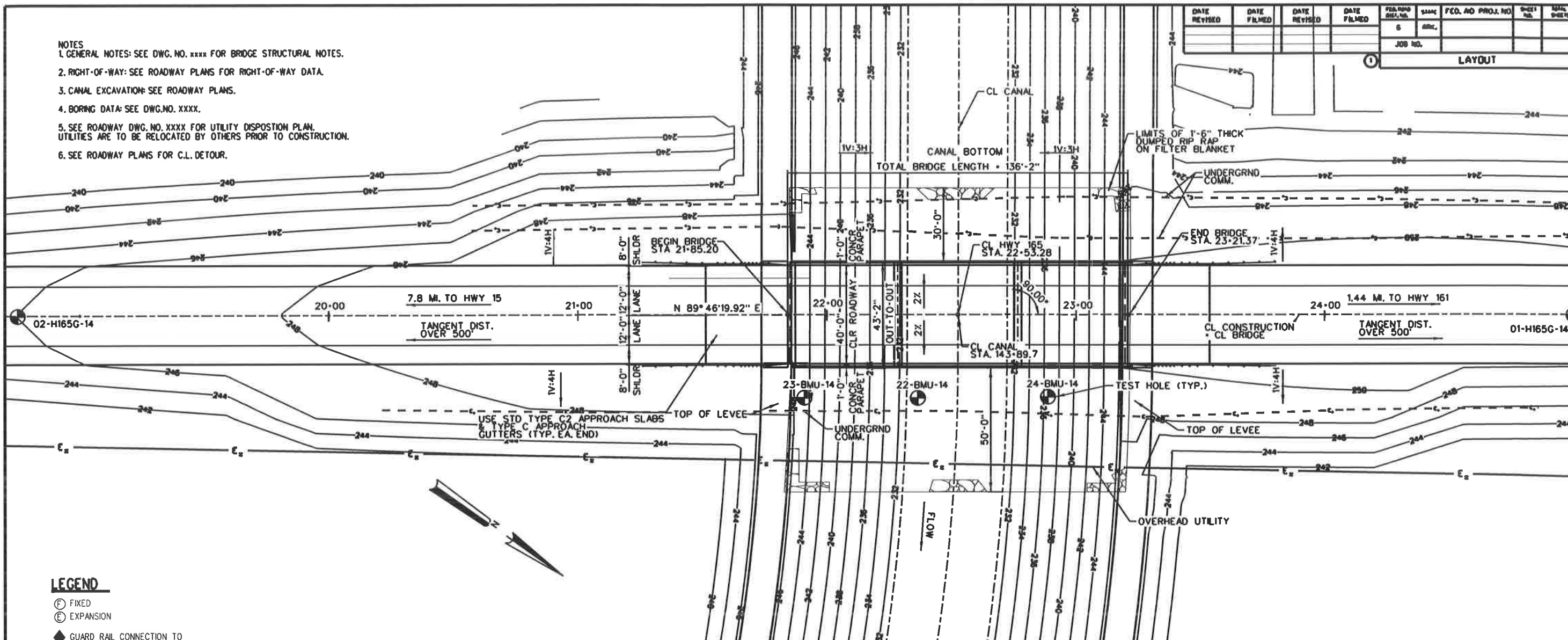
BRIDGE ENGINEER

HIGHWAY 165 OVER CANAL 1000
LONOKE COUNTIES
ROUTE 165 SEC. 6
ARKANSAS STATE HIGHWAY COMMISSION
LITTLE ROCK, ARK.

DRAWN BY: _____ DATE: _____ FILENAME: FILENAME
CHECKED BY: _____ DATE: _____ SCALE: _____
DESIGNED BY: _____ DATE: _____
BRIDGE NO. XXXXX DRAWING NO.

- NOTES
1. GENERAL NOTES: SEE DWG. NO. XXXX FOR BRIDGE STRUCTURAL NOTES.
 2. RIGHT-OF-WAY: SEE ROADWAY PLANS FOR RIGHT-OF-WAY DATA.
 3. CANAL EXCAVATION: SEE ROADWAY PLANS.
 4. BORING DATA: SEE DWG. NO. XXXX.
 5. SEE ROADWAY DWG. NO. XXXX FOR UTILITY DISPOSITION PLAN. UTILITIES ARE TO BE RELOCATED BY OTHERS PRIOR TO CONSTRUCTION.
 6. SEE ROADWAY PLANS FOR C.L. DETOUR.

DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	FILING NO.	DATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
				6	APR. 2015			
				JOB NO.	LAYOUT			

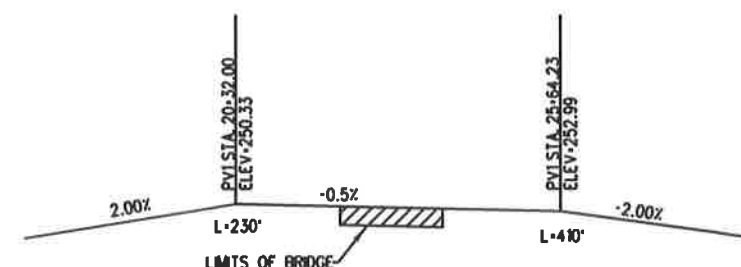
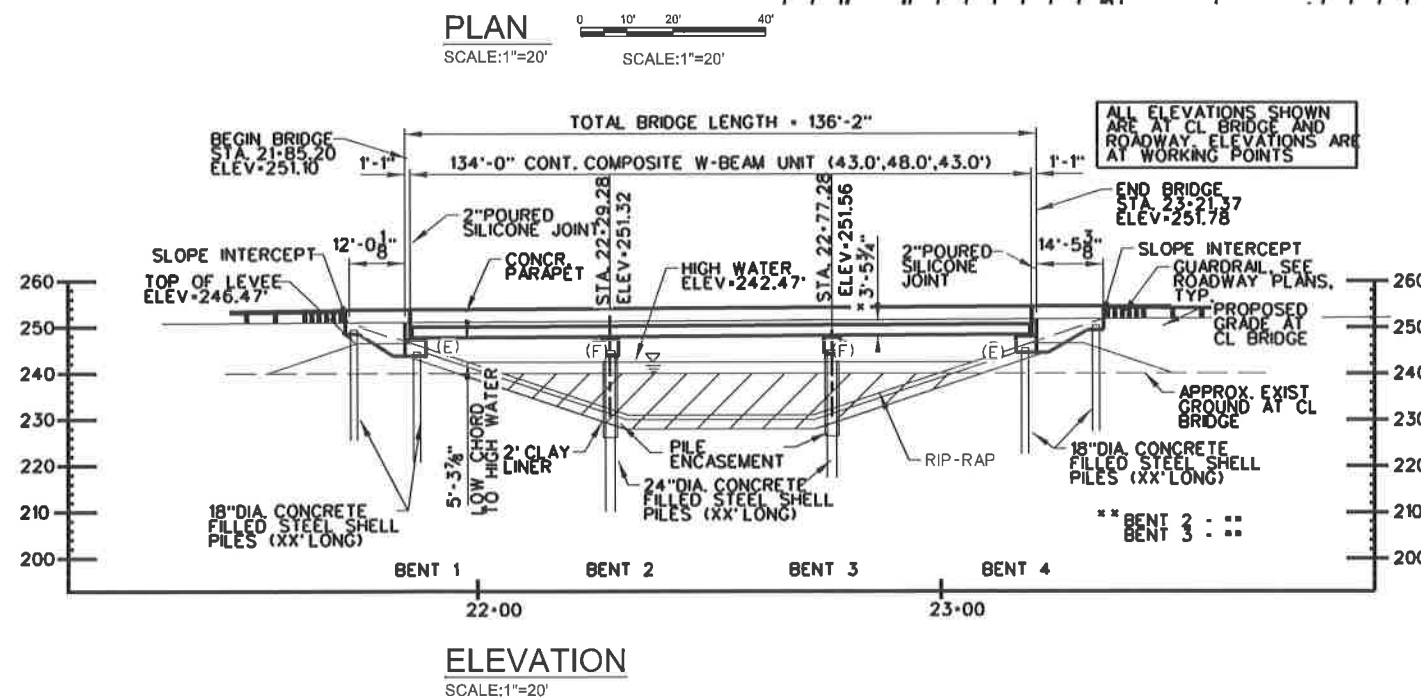


LEGEND

- ⊙ FIXED
- ⊕ EXPANSION
- ◆ GUARD RAIL CONNECTION TO PARAPET TRANSITION
- + CL DECK TO LOW STEEL
- + + CL DECK TO LOW SEAT
- ▨ EXCAVATION LIMITS, SEE ROADWAY FOR QUANTITIES
- ⊙ TEST HOLE

HYDRAULIC DATA

DRAINAGE AREA • 0.07 SQ. MI.
MAIN CANAL LENGTH FOR CANAL 1000 • 7.95 MI.
CANAL FREEBOARD • 5'-3 1/2"
HISTORIC HIGHWATER ELEVATION • N/A
MAXIMUM PUMPED DISCHARGE • 1750 CFS.
FREQUENCY DISCHARGE • N/A
HECRAS STATION • 144+00



VERTICAL CURVE DATA

GRADE LINE AT CL BRIDGE

PRELIMINARY
NOT FOR
CONSTRUCTION

SHEET 1 OF ?
LAYOUT OF BRIDGE
HIGHWAY 165 OVER CANAL 1000
LONOKE COUNTIES

ROUTE 165 SEC. 8
ARKANSAS STATE HIGHWAY COMMISSION
LITTLE ROCK, ARK.

DESIGN BY: MJH DATE: APR. 2015
CHECKED BY: DR DATE: APR. 2015
DESIGNED BY: TLW DATE: APR. 2015
BRIDGE NO. XXXXX DRAWING NO. 6XXXXX00_11

APPENDIX B

Site Class and Liquefaction Data

Design Maps Summary Report

User-Specified Input

Report Title HWY 165

Mon July 20, 2015 21:19:53 UTC

Building Code Reference Document 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design
(which utilizes USGS hazard data available in 2002)

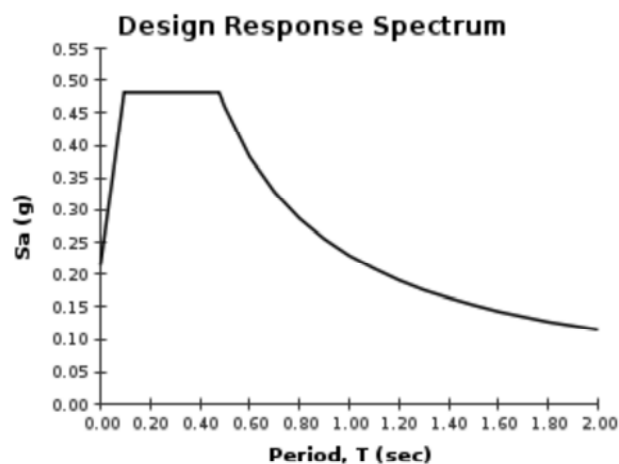
Site Coordinates 34.68586°N, 92.08797°W

Site Soil Classification Site Class D – “Stiff Soil”



USGS-Provided Output

PGA =	0.141 g	A_s =	0.214 g
S_s =	0.310 g	S_{DS} =	0.481 g
S₁ =	0.096 g	S_{D1} =	0.229 g



Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

 Design Maps Detailed Report

2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design (34.68586°N, 92.08797°W)

Site Class D – “Stiff Soil”

Article 3.4.1 — Design Spectra Based on General Procedure

Note: Maps in the 2009 AASHTO Specifications are provided by AASHTO for Site Class B. Adjustments for other Site Classes are made, as needed, in Article 3.4.2.3.

From [Figure 3.4.1-2](#) ^[1]

PGA = 0.141 g

From [Figure 3.4.1-3](#) ^[2]

S_s = 0.310 g

From [Figure 3.4.1-4](#) ^[3]

S_1 = 0.096 g

Article 3.4.2.1 — Site Class Definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Article 3.4.2.

Table 3.4.2.1–1 Site Class Definitions

SITE CLASS	SOIL PROFILE NAME	Soil shear wave velocity, $\bar{v}_s$, (ft/s)	Standard penetration resistance, $\bar{N}$	Soil undrained shear strength, $\bar{s}_u$, (psf)
A	Hard rock	$\bar{v}_s > 5,000$	N/A	N/A
B	Rock	$2,500 < \bar{v}_s \leq 5,000$	N/A	N/A
C	Very dense soil and soft rock	$1,200 < \bar{v}_s \leq 2,500$	$\bar{N} > 50$	$> 2,000$ psf
D	Stiff soil profile	$600 \leq \bar{v}_s < 1,200$	$15 \leq \bar{N} \leq 50$	1,000 to 2,000 psf
E	Stiff soil profile	$\bar{v}_s < 600$	$\bar{N} < 15$	$< 1,000$ psf
E	—	Any profile with more than 10 ft of soil having the characteristics: 1. Plasticity index $PI > 20$, 2. Moisture content $w \geq 40\%$, and 3. Undrained shear strength $\bar{s}_u < 500$ psf		
F	—	Any profile containing soils having one or more of the following characteristics: 1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays ($H > 10$ feet of peat and/or highly organic clay where H = thickness of soil) 3. Very high plasticity clays ($H > 25$ feet with plasticity index $PI > 75$) 4. Very thick soft/medium stiff clays ($H > 120$ feet)		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Article 3.4.2.3 — Site Coefficients

Table 3.4.2.3-1 (for F_{pga})—Values of F_{pga} as a Function of Site Class and Mapped Peak Ground Acceleration Coefficient

Site Class	Mapped Peak Ground Acceleration				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				
Note: Use straight-line interpolation for intermediate values of PGA					

For Site Class = D and PGA = 0.141 g, $F_{PGA} = 1.519$

Table 3.4.2.3-1 (for F_a)—Values of F_a as a Function of Site Class and Mapped Short-Period Spectral Acceleration Coefficient

Site Class	Spectral Response Acceleration Parameter at Short Periods				
	$S_s \leq 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				
Note: Use straight-line interpolation for intermediate values of S_s					

For Site Class = D and $S_s = 0.310$ g, $F_a = 1.552$

Table 3.4.2.3-2—Values of F_v as a Function of Site Class and Mapped 1-sec Period Spectral Acceleration Coefficient

Site Class	Mapped Spectral Response Acceleration Coefficient at 1-sec Periods				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See AASHTO Article 3.4.3				

Note: Use straight-line interpolation for intermediate values of S_1

For Site Class = D and $S_1 = 0.096$ g, $F_v = 2.400$

Equation (3.4.1-1):

$$A_s = F_{PGA} \text{ PGA} = 1.519 \times 0.141 = 0.214 \text{ g}$$

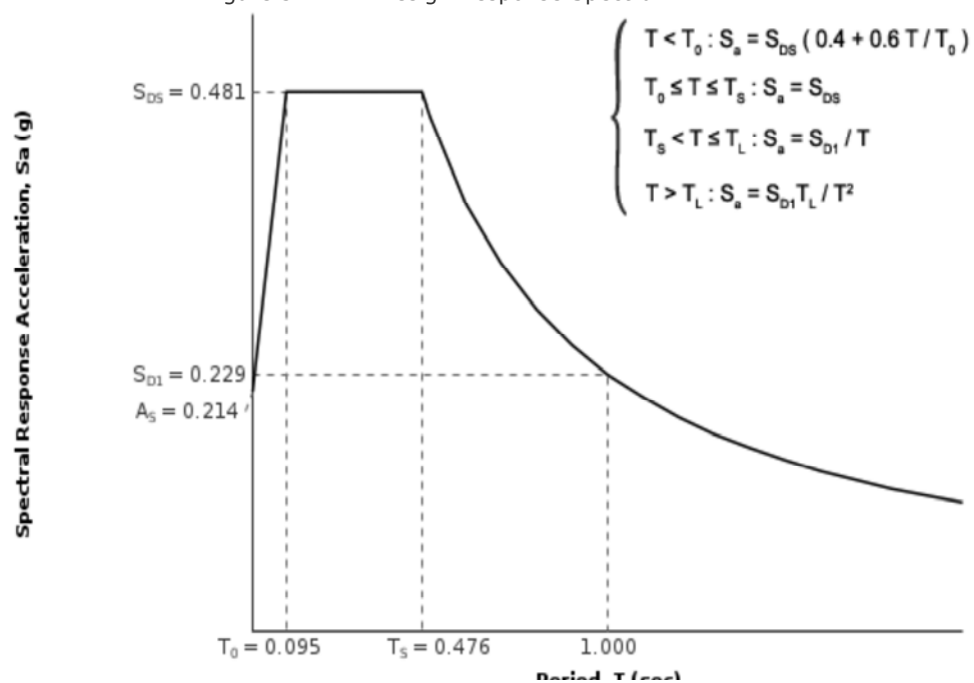
Equation (3.4.1-2):

$$S_{DS} = F_a S_s = 1.552 \times 0.310 = 0.481 \text{ g}$$

Equation (3.4.1-3):

$$S_{D1} = F_v S_1 = 2.400 \times 0.096 = 0.229 \text{ g}$$

Figure 3.4.1-1: Design Response Spectrum



PERIOD, T (SEC)

Article 3.5 - Selection of Seismic Design Category (SDC)

Table 3.5-1—Partitions for Seismic Design Categories A, B, C, and D

VALUE OF S_{D1}	SDC
$S_{D1} < 0.15g$	A
$0.15g \leq S_{D1} < 0.30g$	B
$0.30g \leq S_{D1} < 0.50g$	C
$0.50g \leq S_{D1}$	D

For $S_{D1} = 0.229 g$, Seismic Design Category = B

Seismic Design Category $\equiv$ "the design category in accordance with Table 3.5-1" = B

References

1. *Figure 3.4.1-2*: <http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-2.pdf>
2. *Figure 3.4.1-3*: <http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-3.pdf>
3. *Figure 3.4.1-4*: <http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-4.pdf>

PSH Deaggregation on NEHRP BC rock

HWY_165 92.088° W, 34.686 N.

Peak Horiz. Ground Accel. ≥ 0.12571 g

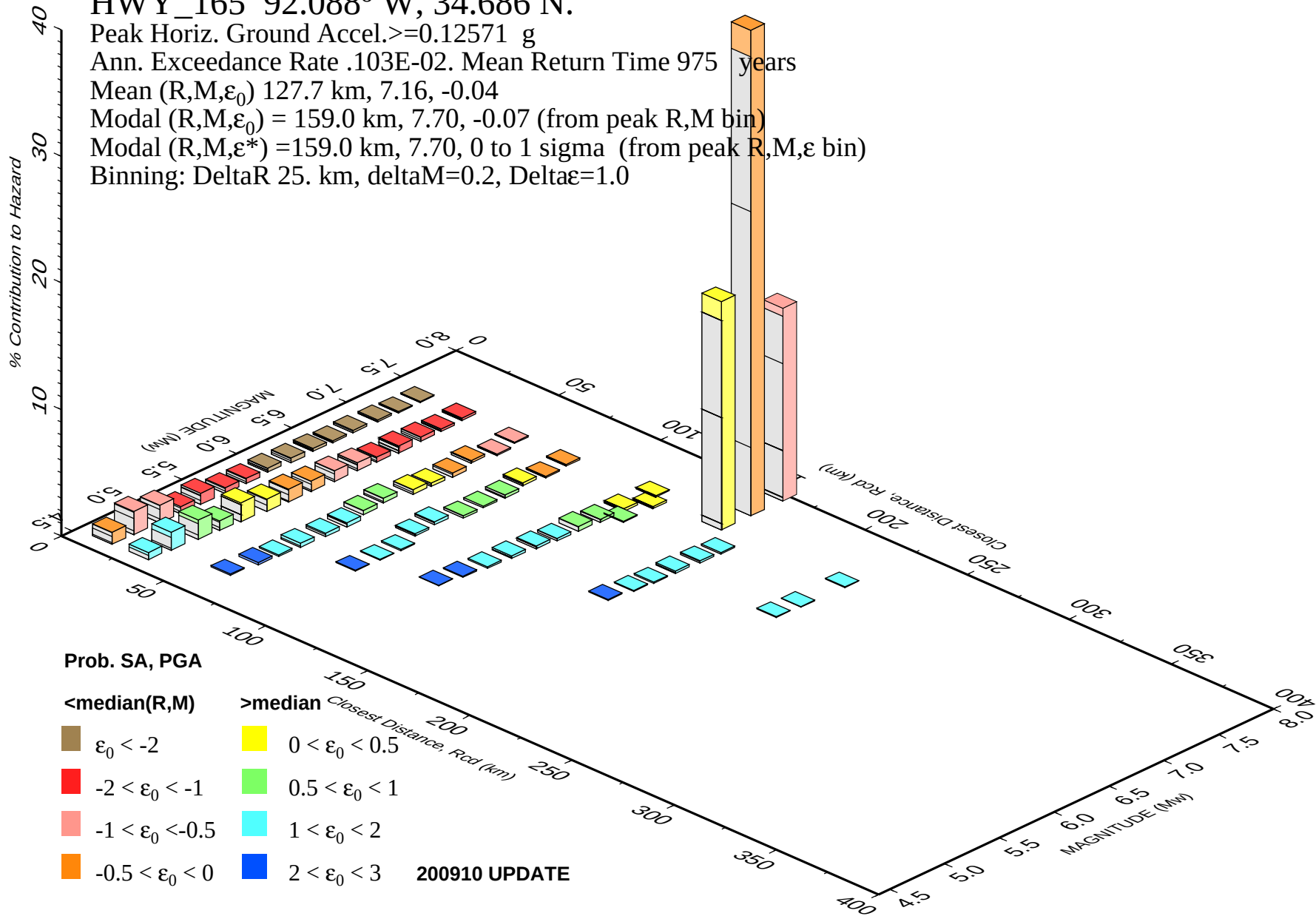
Ann. Exceedance Rate .103E-02. Mean Return Time 975 years

Mean (R,M, ϵ_0) 127.7 km, 7.16, -0.04

Modal (R,M, ϵ_0) = 159.0 km, 7.70, -0.07 (from peak R,M bin)

Modal (R,M, ϵ^*) = 159.0 km, 7.70, 0 to 1 sigma (from peak R,M, ϵ bin)

Binning: DeltaR 25. km, deltaM=0.2, Delta ϵ =1.0



Sample Depth (ft)	N60				Material Type				Fines Content				Unit Weight				Plastic Limit				Liquid Limit				Water Content				Shear Strength			
	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg	22	23	24	Avg
1	6			6.0	ML	ML	CL-ML	ML				92		132	134.1	133.1	0	22	18	20.0	0	27	25	26.0	18.9	24	23	22.0		908	797	852.5
3						ML		ML				92		138	129.8	133.9		20		20.0		23		23.0		20.9	21.3	21.1		1088	1144	1116.0
3.5	8			8.0	CL-ML			ML	92			92					18			18.0	22			22.0	22.4							
5						ML		CH	ML			92							20	20.0			61	61.0								
6	6			6.0	CL-ML			ML	92			92					18			18.0	24			24.0	21.5				21.5			
7							ML	ML				92			110.8	110.8											23			909	909.0	
8.5	9			9.0	CL			CL	95			95					14			14.0	28			28.0	22.3				22.3			
9							ML	CL				95																				
11	9	6	8	7.7	CL	CL	CL	CL	95		88	92					18	19	17	18.0	30	28	31	29.7	22.6	22.3	15.1	20.0				
13.5	11	10	9	10.0	CL	ML	CL	CL	95	90		93					17		16	16.5	30		35	32.5	22.5	29.4	30.7	27.5				
16	4	3	11	6.0	CL	ML	CL	CL	95			95					18	19	14	17.0	30	22	33	28.3	23	26.3	24	24.4				
18.5	4	7	9	6.7	CL-ML	ML	ML	ML	88	75	89	84					18		21	19.5	25		24	24.5	22.7	29.8	28.4	27.0				
21	7	16	14	12.3	CL-ML	SM	SM	ML	88	46	15	50					18			18.0	25			25.0	29.5			29.5				
23.5	15	14	12	13.7	SP		SP	SP-SM	SP	4	3	5	4																			
26	18	17	23	19.3	SP	SP	SP	SP	3	4	4	4																				
28.5	18	18	13	16.3	SP	SP	SP	SP	3	3	4	3																				
33.5	17	20	18	18.3	SP-SM		SP	SP	3	3	4	3																				
38.5	20	22	25	22.3	SP	SP-SM	SP	SP	4	5	3	4																				
43.5	18	18	24	20.0	SP	SP	SP	SP	2	3	4	3																				
48.5	24	28	23	25.0	SP	SP	SP	SP	3	4	4	4																				
53.5	21	20	13	18.0	SP	SC	SP-SM	SP	3	20	5	4																				
58.5	20	21	14	18.3	SP	SC	SP	SP	2	45	3	3													25.9							
63.5	18	17	15	16.7	SP	SP-SC	SP-SM	SP	4	6	9	6					16					32										
68.5	19	21	18	19.3	SP	SP	SP-SM	SP	4	2	8	5																				
73.5	27	22	16	21.7	SP	SC	SP	SP	3	19		3																				
78.5	26	18	18	20.7	SP	SC	SP	SP	4		4	4																				
83.5	21	29	23	24.3	SP	SC	SP	SP	2	15	3	3																				
88.5	27	29	25	27.0	SP	SC	SP	SP	3			3																				
93.5	20			20.0	SP			SP	4			4																				
98.5	25			25.0	SP			SP	2			2																				
103.5	30			30.0	SP			SP				2																				
108.5	31			31.0	SP			SP	3			3																				
113.5	36			36.0	SP			SP				3																				
118.5	38			38.0	SP			SP	4			4																				
123.5	37			37.0	SP			SP				4																				
128.5	44			44.0	SP			SP	4			4																				
133.5	42			42.0	SP			SP				3																				
138.5	44			44.0	SP			SP	3			3																				
143.5	47			47.0	SP			SP				2																				
148.5	48			48.0	SP			SP	2			2																				

Ignore in averages and re-evaluate to see impact of layers.

WITH CYCLIC SOFTENING

																							Ground Surface		Under Abutment w/ fill						
Grade	229		230		231		232		233		234		235		236		237		238		239		240		241.12		251.8				
Wt ELE	240	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0.0	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12			
	Sample	Elevation	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	F.S.	Occurance	
ML	1	237.62																													
ML	2	234.12												0.88	Likely!	1.62	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely
CL	3	232.12								0.45	Likely!	0.87	Likely!	1.30	Unlikely	1.66	Unlikely	1.97	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely
CL	4	230.12				0.30	Likely!	0.60	Likely!	0.86	Likely!	1.08	Unlikely	1.32	Unlikely	1.53	Unlikely	1.72	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely
CL	5	227.62	0.31	Likely!	0.50	Likely!	0.67	Likely!	0.83	Likely!	0.96	Likely!	1.09	Unlikely	1.23	Unlikely	1.36	Unlikely	1.47	Unlikely	2.00	Unlikely	1.97	Unlikely	1.92	Unlikely	1.92	Unlikely	2.00	Unlikely	
CL	6	225.12	0.55	Likely!	0.66	Likely!	0.77	Likely!	0.86	Likely!	0.95	Likely!	1.03	Unlikely	1.12	Unlikely	1.21	Unlikely	1.29	Unlikely	1.69	Unlikely	1.65	Unlikely	1.61	Unlikely	1.62	Unlikely	2.00	Unlikely	
ML	7	222.62	0.64	Likely!	0.70	Likely!	0.77	Likely!	0.82	Likely!	0.88	Likely!	0.93	Likely!	0.99	Likely!	1.04	Unlikely	1.10	Unlikely	1.37	Unlikely	1.34	Unlikely	1.31	Unlikely	1.32	Unlikely	1.72	Unlikely	
ML	8	220.12	0.68	Likely!	0.73	Likely!	0.77	Likely!	0.81	Likely!	0.85	Likely!	0.89	Likely!	0.93	Likely!	0.97	Likely!	1.01	Unlikely	1.22	Unlikely	1.20	Unlikely	1.18	Unlikely	1.19	Unlikely	1.52	Unlikely	
	9	217.62	0.55	Likely!	0.58	Likely!	0.61	Likely!	0.63	Likely!	0.66	Likely!	0.68	Likely!	0.71	Likely!	0.74	Likely!	0.76	Likely!	0.90	Likely!	0.89	Likely!	0.88	Likely!	0.88	Likely!	1.13	Unlikely	
	10	215.12	0.89	Likely!	0.93	Likely!	0.96	Likely!	1.00	Likely!	1.03	Unlikely	1.06	Unlikely	1.10	Unlikely	1.14	Unlikely	1.17	Unlikely	1.37	Unlikely	1.35	Unlikely	1.34	Unlikely	1.35	Unlikely	1.71	Unlikely	
	11	212.62	0.68	Likely!	0.70	Likely!	0.73	Likely!	0.75	Likely!	0.77	Likely!	0.79	Likely!	0.82	Likely!	0.84	Likely!	0.87	Likely!	0.99	Likely!	0.99	Likely!	0.97	Likely!	0.98	Likely!	1.24	Unlikely	
	12	207.62	0.96	Likely!	0.99	Likely!	1.01	Unlikely	1.04	Unlikely	1.06	Unlikely	1.09	Unlikely	1.11	Unlikely	1.15	Unlikely	1.17	Unlikely	1.33	Unlikely	1.31	Unlikely	1.31	Unlikely	1.31	Unlikely	1.69	Unlikely	
	13	202.62	1.37	Unlikely	1.40	Unlikely	1.43	Unlikely	1.46	Unlikely	1.50	Unlikely	1.52	Unlikely	1.57	Unlikely	1.60	Unlikely	1.65	Unlikely	1.83	Unlikely	1.83	Unlikely	1.81	Unlikely	1.85	Unlikely	2.00	Unlikely	
	14	197.62	1.04	Unlikely	1.07	Unlikely	1.09	Unlikely	1.12	Unlikely	1.13	Unlikely	1.17	Unlikely	1.18	Unlikely	1.23	Unlikely	1.24	Unlikely	1.39	Unlikely	1.37	Unlikely	1.39	Unlikely	1.39	Unlikely	1.82	Unlikely	
	15	192.62	1.61	Unlikely	1.63	Unlikely	1.68	Unlikely	1.70	Unlikely	1.76	Unlikely	1.78	Unlikely	1.84	Unlikely	1.87	Unlikely	1.94	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	
	16	187.62	0.90	Likely!	0.93	Likely!	0.94	Likely!	0.97	Likely!	0.98	Likely!	1.02	Unlikely	1.03	Unlikely	1.07	Unlikely	1.09	Unlikely	1.20	Unlikely	1.19	Unlikely	1.21	Unlikely	1.21	Unlikely	1.56	Unlikely	
	17	182.62	0.95	Likely!	0.96	Likely!	0.99	Likely!	1.00	Unlikely	1.04	Unlikely	1.05	Unlikely	1.09	Unlikely	1.10	Unlikely	1.15	Unlikely	1.23	Unlikely	1.25	Unlikely	1.24	Unlikely	1.27	Unlikely	1.56	Unlikely	
	18	177.62	0.88	Likely!	0.92	Likely!	0.92	Likely!	0.96	Likely!	0.97	Likely!	1.00	Unlikely	1.01	Unlikely	1.05	Unlikely	1.06	Unlikely	1.15	Unlikely	1.15	Unlikely	1.17	Unlikely	1.17	Unlikely	1.43	Unlikely	
	19	172.62	1.07	Unlikely	1.08	Unlikely	1.12	Unlikely	1.13	Unlikely	1.16	Unlikely	1.17	Unlikely	1.21	Unlikely	1.23	Unlikely	1.26	Unlikely	1.34	Unlikely	1.36	Unlikely	1.35	Unlikely	1.38	Unlikely	1.63	Unlikely	
	20	167.62	1.24	Unlikely	1.28	Unlikely	1.29	Unlikely	1.33	Unlikely	1.34	Unlikely	1.38	Unlikely	1.39	Unlikely	1.43	Unlikely	1.44	Unlikely	1.55	Unlikely	1.54	Unlikely	1.56	Unlikely	1.56	Unlikely	1.84	Unlikely	
	21	162.62	1.22	Unlikely	1.23	Unlikely	1.26	Unlikely	1.27	Unlikely	1.30	Unlikely	1.31	Unlikely	1.34	Unlikely	1.35	Unlikely	1.39	Unlikely	1.46	Unlikely	1.47	Unlikely	1.46	Unlikely	1.48	Unlikely	1.70	Unlikely	
	22	157.62	1.47	Unlikely	1.50	Unlikely	1.51	Unlikely	1.55	Unlikely	1.56	Unlikely	1.59	Unlikely	1.60	Unlikely	1.64	Unlikely	1.65	Unlikely	1.75	Unlikely	1.74	Unlikely	1.76	Unlikely	1.76	Unlikely	2.00	Unlikely	
	23	152.62	1.70	Unlikely	1.71	Unlikely	1.74	Unlikely	1.75	Unlikely	1.79	Unlikely	1.80	Unlikely	1.83	Unlikely	1.85	Unlikely	1.88	Unlikely	1.97	Unlikely	1.98	Unlikely	1.97	Unlikely	1.99	Unlikely	2.00	Unlikely	
	24	147.62	1.20	Unlikely	1.22	Unlikely	1.23	Unlikely	1.25	Unlikely	1.26	Unlikely	1.28	Unlikely	1.29	Unlikely	1.31	Unlikely	1.32	Unlikely	1.39	Unlikely	1.38	Unlikely	1.39	Unlikely	1.39	Unlikely	1.55	Unlikely	
	25	142.62	1.53	Unlikely	1.54	Unlikely	1.56	Unlikely	1.57	Unlikely	1.59	Unlikely	1.60	Unlikely	1.62	Unlikely	1.63	Unlikely	1.66	Unlikely	1.72	Unlikely	1.73	Unlikely	1.72	Unlikely	1.74	Unlikely	1.92	Unlikely	
	26	142.62	1.93	Unlikely	1.94	Unlikely	1.97	Unlikely	1.98	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	2.00	Unlikely	

1 atm =2116 psf

In-Situ Data									Design Grade EL =229'									
									Design Stress		Mitchell and Soga (2005)				Idriss & Boulanger (2008)			
MATERIAL TYPE	EL _{top} ft	(N ₁) ₆₀ Youd bpf	finest %	PL	LL	PI	WC %	S _u psf	σ' _{v0} psf	σ' _{v0} atm	Liquidity Index	S _r (From Figure)	S _r psf	N _{corr} (Seed-Harder) bpf	(N ₁) _{60CS-Sr} bpf	S _r /σ' _{v0} (void redist. significant)	S _r psf	
CL	232.12							1000										
CL	230.12							1000										
CL	227.62	15.7	93	16.5	32.5	16	27.5	1000	77	0.04	0.69	1.5	667					
CL	225.12	9.8	95	17	28.3	11.3	24.4	1000	216	0.10	0.65	1.5	667					
ML	222.62	10.2	84	19.5	24.5	5	27	970	395	0.19	1.50	14.0	69					
ML	220.12	18.0	50	18	25	7	29.5	970	574	0.27	1.64	18.0	54					
SP	217.62	19.5	4						730	0.35				0	19.5	0.165	120	
SP	215.12	26.7	4						887	0.42				0	26.7	0.28	248	
SP	212.62	21.9	3						1043	0.49				0	21.9	0.19	198	
SP	207.62	24.5	3						1356	0.64				0	24.5	0.243	330	
SP	187.62	19.8	4						2608	1.23				0	19.8	0.175	456	
SP	182.62	19.3	3						2921	1.38				0	19.3	0.17	497	
SP	177.62	16.9	6						3234	1.53				1	17.9	0.155	501	

In-Situ Data									Design Grade EL =233'									
									Design Stress		Mitchell and Soga (2005)				Idriss & Boulanger (2008)			
MATERIAL TYPE	EL _{top} ft	(N ₁) ₆₀ Youd bpf	finest %	PL	LL	PI	WC %	S _u psf	σ' _{v0} psf	σ' _{v0} atm	Liquidity Index	S _r (From Figure)	S _r psf	N _{corr} (Seed-Harder) bpf	(N ₁) _{60CS-Sr} bpf	S _r /σ' _{v0} (void redist. significant)	S _r psf	
CL	232.12	16.1	95	14	28	14	22.3	1000	49	0.02	0.59	1.1	909					
CL	230.12	13.0	92	18	29.7	11.7	20	1000	160	0.08	0.17	1.0	1000					
CL	227.62	15.7	93	16.5	32.5	16	27.5	1000	299	0.14	0.69	1.8	556					
CL	225.12	9.8	95	17	28.3	11.3	24.4	1000	438	0.21	0.65	2.0	500					
ML	222.62	10.2	84	19.5	24.5	5	27	970	617	0.29	1.50	15.0	65					
ML	220.12	18.0	50	18	25	7	29.5	970	796	0.38	1.64	20.0	49					
SP	217.62	19.5	4						953	0.45				0	19.5	0.165	157	
SP	215.12	26.7	4						1109	0.52				0	26.7	0.28	311	
SP	212.62	21.9	3						1266	0.60				0	21.9	0.19	240	
SP	207.62	24.5	3						1579	0.75				0	24.5	0.243	384	
SP	187.62	19.8	4						2831	1.34				0	19.8	0.175	495	
SP	182.62	19.3	3						3144	1.49				0	19.3	0.17	534	
SP	177.62	16.9	6						3457	1.63				1	17.9	0.155	536	

In-Situ Data									Design Grade EL =235'									
									Design Stress		Mitchell and Soga (2005)				Idriss & Boulanger (2008)			
MATERIAL TYPE	EL _{top} ft	(N ₁) ₆₀ Youd bpf	finest %	PL	LL	PI	WC %	S _u psf	σ' _{vo} psf	σ' _{vo} atm	Liquidity Index	S _r (From Figure)	S _r psf	N _{corr} (Seed-Harder) bpf	(N ₁) _{60CS-Sr} bpf	S _r /σ' _{vo} (void redist. significant)	S _r psf	
CL	232.12	16.1	95	14	28	14	22.3	1000	174	0.08	0.59	1.1	909					
CL	230.12	13.0	92	18	29.7	11.7	20	1000	285	0.13	0.17	1.0	1000					
CL	227.62	15.7	93	16.5	32.5	16	27.5	1000	424	0.20	0.69	2.0	500					
CL	225.12	9.8	95	17	28.3	11.3	24.4	1000	563	0.27	0.65	2.0	500					
ML	222.62	10.2	84	19.5	24.5	5	27	970	742	0.35	1.50	15.0	65					
ML	220.12	18.0	50	18	25	7	29.5	970	921	0.44	1.64	21.0	46					
SP	217.62	19.5	4						1078	0.51				0	19.5	0.165	178	
SP	215.12	26.7	4						1234	0.58				0	26.7	0.28	346	
SP	212.62	21.9	3						1391	0.66				0	21.9	0.19	264	
SP	207.62	24.5	3						1704	0.81				0	24.5	0.243	414	
SP	187.62	19.8	4						2956	1.40				0	19.8	0.175	517	
SP	182.62	19.3	3						3269	1.54				0	19.3	0.17	556	
SP	177.62	16.9	6						3582	1.69				1	17.9	0.155	555	

In-Situ Data									Design Grade EL =241.12'									
									Design Stress		Mitchell and Soga (2005)				Idriss & Boulanger (2008)			
MATERIAL TYPE	EL _{top} ft	(N ₁) ₆₀ Youd bpf	finest %	PL	LL	PI	WC %	S _u psf	σ' _{vo} psf	σ' _{vo} atm	Liquidity Index	S _r (From Figure)	S _r psf	N _{corr} (Seed-Harder) bpf	(N ₁) _{60CS-Sr} bpf	S _r /σ' _{vo} (void redist. significant)	S _r psf	
CL	232.12	16.1	95	14	28	14	22.3	1000	682	0.32	0.59	3.0	333					
CL	230.12	13.0	92	18	29.7	11.7	20	1000	793	0.37	0.17	1.0	1000					
CL	227.62	15.7	93	16.5	32.5	16	27.5	1000	932	0.44	0.69	3.0	333					
CL	225.12	9.8	95	17	28.3	11.3	24.4	1000	1071	0.51	0.65	3.8	263					
ML	222.62	10.2	84	19.5	24.5	5	27	970	1250	0.59	1.50	19.0	51					
ML	220.12	18.0	50	18	25	7	29.5	970	1429	0.68	1.64	24.0	40					
SP	217.62	19.5	4						1586	0.75				0	19.5	0.165	262	
SP	215.12	26.7	4						1742	0.82				0	26.7	0.28	488	
SP	212.62	21.9	3						1899	0.90				0	21.9	0.19	361	
SP	207.62	24.5	3						2212	1.05				0	24.5	0.243	538	
SP	187.62	19.8	4						3464	1.64				0	19.8	0.175	606	
SP	182.62	19.3	3						3777	1.78				0	19.3	0.17	642	
SP	177.62	16.9	6						4090	1.93				1	17.9	0.155	634	

Zone	MATERIAL	EL _{top}	GRADE EL. S _u PROFILE			
#	TYPE	ft	EL=229'	EL=233'	EL=236'	EL=to Overburden Max
1	CL	232.12		909		
	CL	230.12		1000		
2	CL	227.62	667	556		
	CL	225.12	667	500		
3	ML	222.62	69	65	65	
	ML	220.12	54	49	46	
4	SP	217.62	120	157	178	262
	SP	215.12	248	311	346	488
	SP	212.62	198	240	264	361
	SP	207.62	330	384	414	538
5	SP	187.62	456	495		
	SP	182.62	497	534		
	SP	177.62	501	536		

Settlement & Downdrag Potential Due to Liquefaction/Cyclic Softening

In-Situ Data				Tokimatsu-Seed (1987)										FHWA Criteria			
MATERIAL TYPE	EL _{top} ft	(N ₁) ₆₀ Youd bpf	fines %	CSR _{7.16} Bent Youd	CSR _{7.16} Abut Youd	CSR _{7.16} /CSR _{7.5} * Correction Factor	CSR _{7.5} Bent	CSR _{7.5} Abut	ε _v * Bent (%)	ε _v * Abut (%)	Specimen H ft	ΔH Bent ft	ΔH Abut ft	ΔH Bent Zone (in)	≥.5 (in)	ΔH Abut Zone (in)	≥.5 (in)
CL	232.12					1.06					2.0			0.000	No	0.000	No
CL	230.12					1.06					2.0						
CL	227.62	15.7	93	1.54		1.06	1.45		1.90		2.0	0.038		0.960	Yes	0.000	No
CL	225.12	9.8	95	0.74		1.06	0.69		2.80		1.5	0.042					
ML	222.62	10.2	84	0.51		1.06	0.49		2.80		1.5	0.042		0.504	Yes	0.000	No
ML	220.12	18.0	50	0.43		1.06	0.41		1.70		1.5	0.026					
SP	217.62	19.5	4	0.40	0.19	1.06	0.37	0.18	1.60	1.10	1.5	0.024	0.017	0.936	Yes	0.243	No
SP	215.12	26.7	4	0.37	0.19	1.06	0.35	0.18	1.10	0.00	1.5	0.017	0.000				
SP	212.62	21.9	3	0.35	0.19	1.06	0.33	0.18	1.40	0.15	1.5	0.021	0.002				
SP	207.62	24.5	3	0.33	0.19	1.06	0.31	0.18	1.10	0.10	1.5	0.017	0.002				
SP	187.62	19.8	4	0.27		1.06	0.25		1.10		1.5	0.017		0.594	Yes	0.000	No
SP	182.62	19.3	3	0.25		1.06	0.23		1.10		1.5	0.017					
SP	177.62	16.9	6	0.23		1.06	0.22		1.10		1.5	0.017					

*From Table 9-2 or Fig. 9.53

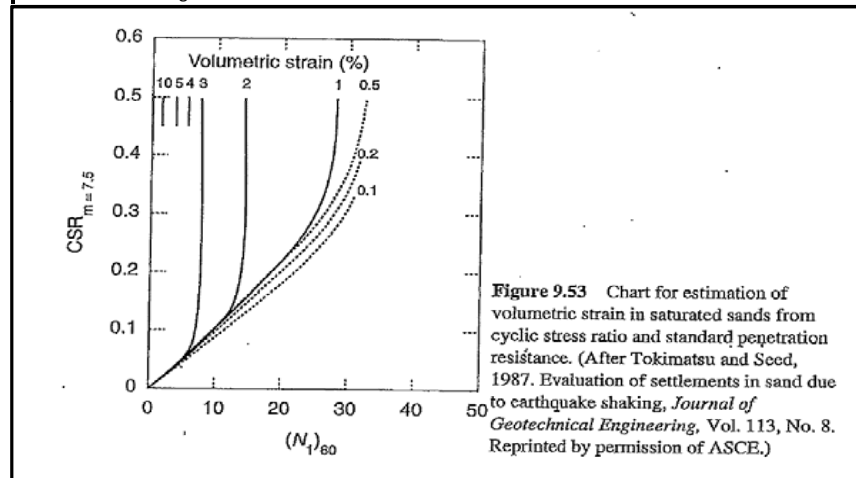
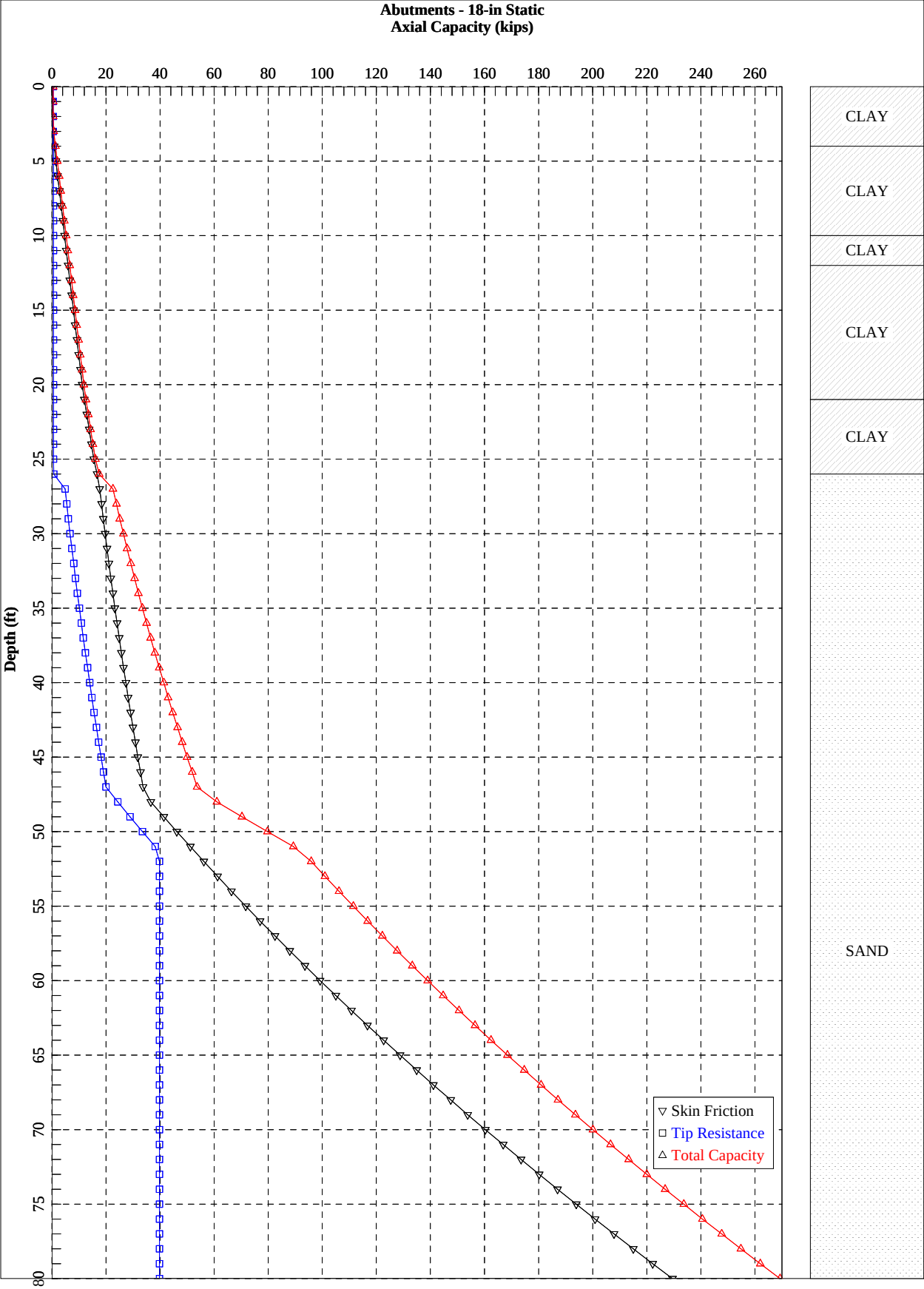


Table 9-2 Magnitude Correction Factors for Cyclic Stress Approach	
Magnitude, <i>M</i>	CSR _{<i>M</i>} /CSR _{<i>M</i>=7.5}
5 1/4	1.50
6	1.32
6 3/4	1.13
7 1/2	1.00
8 1/2	0.89

APPENDIX C

Theoretical Axial Pile Capacity Analysis



HWY165_18in_Abut_Static_Vert.ap6o

APILE for Windows, Version 2014.6.8

Serial Number : 158111698

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.
(c) Copyright ENSOFT, Inc., 1987-2014
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This program is licensed to :

U.S. Army Corps of Engineers
Memphis, Tennessee / USA

Path to file locations :
G:\GOSH\~To Be_GOSHed\BAYOU_METO_HWY165_BRIDGE_DESIGN\05_DESIGN_DOCUMENTS\04_DESIGN_
CALCULATIONS\Vertical Pile Capacity\Abutments\
Name of input data file : HWY165_18in_Abut_Static_Vert.ap6d
Name of output file : HWY165_18in_Abut_Static_Vert.ap6o
Name of plot output file : HWY165_18in_Abut_Static_Vert.ap6p

Time and Date of Analysis

Date: November 01, 2015 Time: 16:14:08

1

* INPUT INFORMATION *

Bayou Meto HWY 165 Lower Abutment vertical capacities. 18-in diameter.

DESIGNER : Randy Lord

JOB NUMBER :

METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.303E+08 PSI
 - CROSS SECTION AREA = 254.00 IN²

CIRCULAR PILE PROPERTIES :

- OUTSIDE DIAMETER, OD = 18.00 IN.
 - INTERNAL DIAMETER, ID = 17.00 IN.
 - TOTAL PILE LENGTH, TL = 80.00 FT.
 - PILE STICKUP LENGTH, PSL = 0.00 FT.
 - ZERO FRICTION LENGTH, ZFL = 3.00 FT.
 - INCREMENT OF PILE LENGTH
 USED IN COMPUTATION = 1.00 FT.
 - LENGTH OF ENHANCED
 END SECTION = 80.00 FT.
 - INTERNAL DIAMETER OF
 ENHANCED END SECTION = 17.00 IN.

PLUGGED/UNPLUGGED CONDITIONS :

Internal Pile Plug Calculated by Program

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	115.00	0.00	0.00
4.00	CLAY	0.00	115.00	0.00	0.00
4.00	CLAY	0.00	134.00	0.00	0.00
10.00	CLAY	0.00	134.00	0.00	0.00
10.00	CLAY	0.00	71.00	0.00	0.00
12.00	CLAY	0.00	71.00	0.00	0.00
12.00	CLAY	0.00	55.00	0.00	0.00
21.00	CLAY	0.00	55.00	0.00	0.00
21.00	CLAY	0.00	71.00	0.00	0.00
26.00	CLAY	0.00	71.00	0.00	0.00
26.00	SAND	0.80	62.00	33.00	20.00
90.00	SAND	0.80	62.00	33.00	20.00

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*	0.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.75	0.00	0.00	0.00	0.00

HWY165_18in_Abut_Static_Vert.ap60

0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	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	0.350	0.350
4.00	0.350	0.350
4.00	0.350	0.350
10.00	0.350	0.350
10.00	0.350	0.350
12.00	0.350	0.350
12.00	0.350	0.350
21.00	0.350	0.350
21.00	0.350	0.350
26.00	0.350	0.350
26.00	0.450	0.450
90.00	0.450	0.450

1

* COMPUTATION RESULT *

* FED. HWY. METHOD *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.5*	0.5
1.00	0.0	0.5*	0.5
2.00	0.0	0.5*	0.5
3.00	0.3	0.5*	0.7
4.00	0.9	0.5*	1.3
5.00	1.5	0.6*	2.0
6.00	2.1	0.6*	2.7
7.00	2.8	0.6*	3.3
8.00	3.4	0.6*	4.0
9.00	4.1	0.6*	4.6
10.00	4.7	0.6*	5.3
11.00	5.3	0.6*	5.9
12.00	6.0	0.6*	6.6

HWY165_18in_Abut_Static_Vert.ap60

13.00	6.6	0.6*	7.3
14.00	7.3	0.6*	7.9
15.00	8.0	0.6*	8.6
16.00	8.6	0.6*	9.2
17.00	9.3	0.6*	9.9
18.00	9.9	0.6*	10.5
19.00	10.6	0.6*	11.2
20.00	11.2	0.6*	11.8
21.00	12.0	0.6*	12.6
22.00	12.9	0.6*	13.5
23.00	13.8	0.6*	14.3
24.00	14.6	0.6*	15.2
25.00	15.5	0.6*	16.1
26.00	16.7	0.7*	17.5
27.00	17.7	4.9*	22.6
28.00	18.4	5.5*	23.9
29.00	19.0	6.1*	25.1
30.00	19.7	6.7*	26.5
31.00	20.4	7.4*	27.8
32.00	21.1	8.1*	29.2
33.00	21.8	8.7*	30.6
34.00	22.6	9.4*	32.0
35.00	23.3	10.2*	33.5
36.00	24.1	10.9*	35.0
37.00	24.9	11.6*	36.5
38.00	25.7	12.4*	38.1
39.00	26.5	13.2*	39.7
40.00	27.4	14.0*	41.4
41.00	28.2	14.8*	43.0
42.00	29.1	15.6*	44.7
43.00	30.0	16.5*	46.5
44.00	30.9	17.3*	48.2
45.00	31.8	18.2*	50.0
46.00	32.8	19.1*	51.9
47.00	33.7	20.0*	53.7
48.00	36.6	24.4*	61.0
49.00	41.4	28.9*	70.3
50.00	46.2	33.5*	79.7
51.00	51.2	38.2*	89.3
52.00	56.2	39.8	95.9
53.00	61.3	39.8	101.0
54.00	66.4	39.8	106.2
55.00	71.7	39.8	111.5
56.00	77.0	39.8	116.8
57.00	82.5	39.8	122.2
58.00	88.0	39.8	127.7
59.00	93.6	39.8	133.3
60.00	99.2	39.8	139.0
61.00	105.0	39.8	144.7
62.00	110.8	39.8	150.6
63.00	116.7	39.8	156.5
64.00	122.7	39.8	162.4
65.00	128.8	39.8	168.5
66.00	134.9	39.8	174.7
67.00	141.1	39.8	180.9
68.00	147.5	39.8	187.2
69.00	153.8	39.8	193.6
70.00	160.3	39.8	200.1
71.00	166.9	39.8	206.6
72.00	173.5	39.8	213.3
73.00	180.2	39.8	220.0
74.00	187.0	39.8	226.8
75.00	193.9	39.8	233.7

HWY165_18in_Abut_Static_Vert.ap60

76.00	200.9	39.8	240.6
77.00	207.9	39.8	247.7
78.00	215.0	39.8	254.8
79.00	222.2	39.8	262.0
80.00	229.5	39.8	269.3

 * API RP-2A (1994) *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.5*	0.5
1.00	0.0	0.5*	0.5
2.00	0.0	0.5*	0.5
3.00	0.3	0.5*	0.7
4.00	0.8	0.5*	1.2
5.00	1.4	0.6*	2.0
6.00	2.1	0.6*	2.7
7.00	2.9	0.6*	3.5
8.00	3.7	0.6*	4.3
9.00	4.5	0.6*	5.1
10.00	5.4	0.6*	6.0
11.00	6.3	0.6*	6.9
12.00	7.3	0.6*	7.9
13.00	8.3	0.6*	8.9
14.00	9.3	0.6*	9.9
15.00	10.3	0.6*	10.9
16.00	11.3	0.6*	11.9
17.00	12.4	0.6*	13.0
18.00	13.5	0.6*	14.1
19.00	14.6	0.6*	15.2
20.00	15.7	0.6*	16.3
21.00	16.8	0.6*	17.4
22.00	18.0	0.6*	18.5
23.00	19.1	0.6*	19.7
24.00	20.3	0.6*	20.9
25.00	21.5	0.6*	22.1
26.00	23.0	0.7*	23.8
27.00	24.9	5.9*	30.8
28.00	27.0	8.0*	35.0
29.00	29.2	10.2*	39.3
30.00	31.4	12.4*	43.8
31.00	33.7	14.7*	48.3
32.00	36.0	17.0*	53.0
33.00	38.4	19.4*	57.8
34.00	40.9	21.8*	62.7
35.00	43.4	24.3*	67.6
36.00	45.9	26.8*	72.7
37.00	48.6	29.4*	77.9
38.00	51.2	32.0*	83.3
39.00	54.0	34.7*	88.7
40.00	56.8	37.5*	94.2
41.00	59.6	40.2*	99.9
42.00	62.5	43.1*	105.6
43.00	65.5	46.0*	111.5
44.00	68.5	48.9*	117.4
45.00	71.6	51.9*	123.5
46.00	74.7	55.0*	129.7
47.00	77.9	56.6	134.4

HWY165_18in_Abut_Static_Vert.ap60

48.00	81.1	57.6	138.7
49.00	84.4	58.6	142.9
50.00	87.7	59.5	147.3
51.00	91.1	60.5	151.7
52.00	94.6	61.5	156.1
53.00	98.1	62.5	160.6
54.00	101.7	63.5	165.2
55.00	105.3	64.5	169.8
56.00	109.0	65.5	174.5
57.00	112.7	66.4	179.2
58.00	116.5	67.4	184.0
59.00	120.4	68.4	188.8
60.00	124.3	69.4	193.7
61.00	128.3	70.4	198.7
62.00	132.3	71.4	203.7
63.00	136.4	72.4	208.7
64.00	140.5	73.4	213.9
65.00	144.7	74.3	219.0
66.00	148.9	75.3	224.3
67.00	153.2	76.3	229.5
68.00	157.6	77.3	234.9
69.00	162.0	78.3	240.3
70.00	166.5	79.3	245.7
71.00	171.0	80.3	251.2
72.00	175.6	81.2	256.8
73.00	180.2	82.2	262.4
74.00	184.9	83.2	268.1
75.00	189.6	84.2	273.8
76.00	194.4	85.2	279.6
77.00	199.3	86.2	285.5
78.00	204.2	87.2	291.4
79.00	209.2	88.1	297.3
80.00	214.2	89.1	303.3

AN ASTERISK WILL BE 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
			0.0000E+00	0.2880E-01
			0.0000E+00	0.5580E-01
			0.0000E+00	0.1026E+00
			0.0000E+00	0.1440E+00
			0.0000E+00	0.1800E+00
			0.0000E+00	0.3600E+00
			0.0000E+00	0.5400E+00
			0.0000E+00	0.9000E+00
			0.0000E+00	0.3600E+01
2	10	0.2025E+01	0.0000E+00	0.0000E+00

HWY165_18in_Abut_Static_Vert.ap6o

			0.2507E+00	0.2880E-01
			0.4179E+00	0.5580E-01
			0.6269E+00	0.1026E+00
			0.7522E+00	0.1440E+00
			0.8358E+00	0.1800E+00
			0.7522E+00	0.3600E+00
			0.7522E+00	0.5400E+00
			0.7522E+00	0.9000E+00
			0.7522E+00	0.3600E+01
3	10	0.3958E+01	0.0000E+00	0.0000E+00
			0.2597E+00	0.2880E-01
			0.4329E+00	0.5580E-01
			0.6493E+00	0.1026E+00
			0.7791E+00	0.1440E+00
			0.8657E+00	0.1800E+00
			0.7791E+00	0.3600E+00
			0.7791E+00	0.5400E+00
			0.7791E+00	0.9000E+00
			0.7791E+00	0.3600E+01
4	10	0.4000E+01	0.0000E+00	0.0000E+00
			0.2777E+00	0.2880E-01
			0.4628E+00	0.5580E-01
			0.6942E+00	0.1026E+00
			0.8330E+00	0.1440E+00
			0.9255E+00	0.1800E+00
			0.8330E+00	0.3600E+00
			0.8330E+00	0.5400E+00
			0.8330E+00	0.9000E+00
			0.8330E+00	0.3600E+01
5	10	0.7025E+01	0.0000E+00	0.0000E+00
			0.2866E+00	0.2880E-01
			0.4777E+00	0.5580E-01
			0.7166E+00	0.1026E+00
			0.8599E+00	0.1440E+00
			0.9555E+00	0.1800E+00
			0.8599E+00	0.3600E+00
			0.8599E+00	0.5400E+00
			0.8599E+00	0.9000E+00
			0.8599E+00	0.3600E+01
6	10	0.9958E+01	0.0000E+00	0.0000E+00
			0.2866E+00	0.2880E-01
			0.4777E+00	0.5580E-01
			0.7166E+00	0.1026E+00
			0.8599E+00	0.1440E+00
			0.9555E+00	0.1800E+00
			0.8599E+00	0.3600E+00
			0.8599E+00	0.5400E+00
			0.8599E+00	0.9000E+00
			0.8599E+00	0.3600E+01
7	10	0.1000E+02	0.0000E+00	0.0000E+00
			0.2866E+00	0.2880E-01
			0.4777E+00	0.5580E-01
			0.7166E+00	0.1026E+00
			0.8599E+00	0.1440E+00
			0.9555E+00	0.1800E+00
			0.8599E+00	0.3600E+00
			0.8599E+00	0.5400E+00
			0.8599E+00	0.9000E+00

HWY165_18in_Abut_Static_Vert.ap60

8	10	0.1103E+02	0.8599E+00	0.3600E+01
			0.0000E+00	0.0000E+00
			0.2875E+00	0.2880E-01
			0.4792E+00	0.5580E-01
			0.7188E+00	0.1026E+00
			0.8626E+00	0.1440E+00
			0.9584E+00	0.1800E+00
			0.8626E+00	0.3600E+00
			0.8626E+00	0.5400E+00
			0.8626E+00	0.9000E+00
9	10	0.1196E+02	0.8626E+00	0.3600E+01
			0.0000E+00	0.0000E+00
			0.2875E+00	0.2880E-01
			0.4792E+00	0.5580E-01
			0.7188E+00	0.1026E+00
			0.8626E+00	0.1440E+00
			0.9584E+00	0.1800E+00
			0.8626E+00	0.3600E+00
			0.8626E+00	0.5400E+00
			0.8626E+00	0.9000E+00
10	10	0.1200E+02	0.8626E+00	0.3600E+01
			0.0000E+00	0.0000E+00
			0.2893E+00	0.2880E-01
			0.4822E+00	0.5580E-01
			0.7233E+00	0.1026E+00
			0.8679E+00	0.1440E+00
			0.9644E+00	0.1800E+00
			0.8679E+00	0.3600E+00
			0.8679E+00	0.5400E+00
			0.8679E+00	0.9000E+00
11	10	0.1653E+02	0.8679E+00	0.3600E+01
			0.0000E+00	0.0000E+00
			0.2902E+00	0.2880E-01
			0.4837E+00	0.5580E-01
			0.7255E+00	0.1026E+00
			0.8706E+00	0.1440E+00
			0.9674E+00	0.1800E+00
			0.8706E+00	0.3600E+00
			0.8706E+00	0.5400E+00
			0.8706E+00	0.9000E+00
12	10	0.2096E+02	0.8706E+00	0.3600E+01
			0.0000E+00	0.0000E+00
			0.3646E+00	0.2880E-01
			0.6076E+00	0.5580E-01
			0.9114E+00	0.1026E+00
			0.1094E+01	0.1440E+00
			0.1215E+01	0.1800E+00
			0.1094E+01	0.3600E+00
			0.1094E+01	0.5400E+00
			0.1094E+01	0.9000E+00
13	10	0.2100E+02	0.1094E+01	0.3600E+01
			0.0000E+00	0.0000E+00
			0.3864E+00	0.2880E-01
			0.6440E+00	0.5580E-01
			0.9660E+00	0.1026E+00
			0.1159E+01	0.1440E+00
			0.1288E+01	0.1800E+00

HWY165_18in_Abut_Static_Vert.ap60

14	10	0.2353E+02	0.1159E+01	0.3600E+00
			0.1159E+01	0.5400E+00
			0.1159E+01	0.9000E+00
			0.1159E+01	0.3600E+01
			0.0000E+00	0.0000E+00
			0.3846E+00	0.2880E-01
			0.6411E+00	0.5580E-01
			0.9616E+00	0.1026E+00
			0.1154E+01	0.1440E+00
			0.1282E+01	0.1800E+00
15	10	0.2596E+02	0.1154E+01	0.3600E+00
			0.1154E+01	0.5400E+00
			0.1154E+01	0.9000E+00
			0.1154E+01	0.3600E+01
			0.0000E+00	0.0000E+00
			0.4932E+00	0.2880E-01
			0.8220E+00	0.5580E-01
			0.1233E+01	0.1026E+00
			0.1480E+01	0.1440E+00
			0.1644E+01	0.1800E+00
16	10	0.2600E+02	0.1480E+01	0.3600E+00
			0.1480E+01	0.5400E+00
			0.1480E+01	0.9000E+00
			0.1480E+01	0.3600E+01
			0.0000E+00	0.0000E+00
			0.1204E+00	0.1000E-01
			0.2408E+00	0.2000E-01
			0.4815E+00	0.4000E-01
			0.7223E+00	0.6000E-01
			0.9631E+00	0.8000E-01
17	10	0.5803E+02	0.1083E+01	0.9000E-01
			0.1204E+01	0.1000E+00
			0.1204E+01	0.5000E+00
			0.1204E+01	0.2000E+01
			0.0000E+00	0.0000E+00
			0.8288E+00	0.1000E-01
			0.1658E+01	0.2000E-01
			0.3315E+01	0.4000E-01
			0.4973E+01	0.6000E-01
			0.6630E+01	0.8000E-01
18	10	0.8996E+02	0.7459E+01	0.9000E-01
			0.8288E+01	0.1000E+00
			0.8288E+01	0.5000E+00
			0.8288E+01	0.2000E+01
			0.0000E+00	0.0000E+00
			0.1074E+01	0.1000E-01
			0.2147E+01	0.2000E-01
			0.4294E+01	0.4000E-01
			0.6442E+01	0.6000E-01
			0.8589E+01	0.8000E-01
			0.9662E+01	0.9000E-01
			0.1074E+02	0.1000E+00
			0.1074E+02	0.5000E+00
			0.1074E+02	0.2000E+01

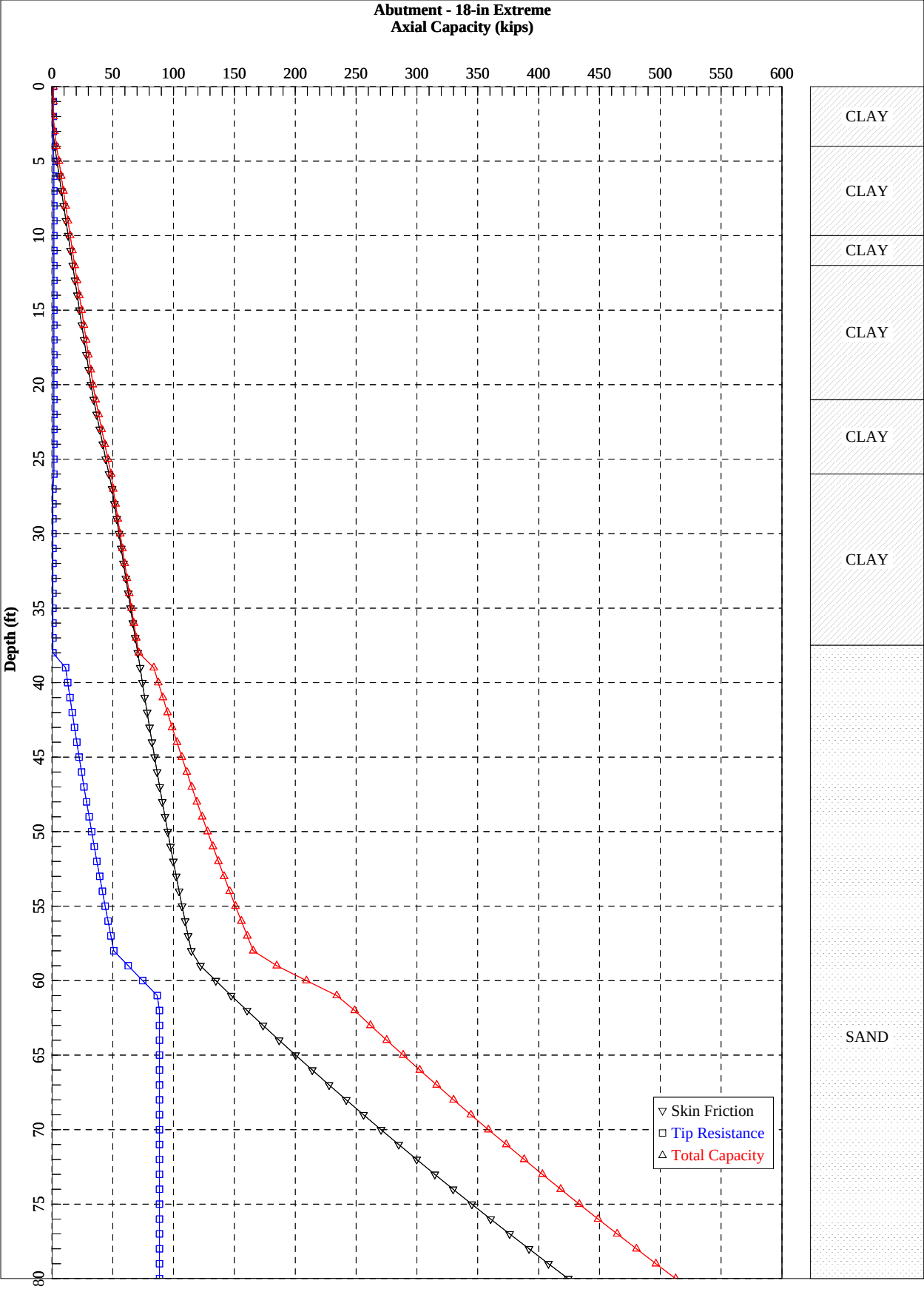
TIP LOAD

TIP MOVEMENT

	HWY165_18in_Abut_Static_Vert.ap60
KIP	IN.
0.0000E+00	0.0000E+00
0.5522E+01	0.9000E-02
0.1104E+02	0.1800E-01
0.2209E+02	0.3600E-01
0.4418E+02	0.2340E+00
0.6627E+02	0.7560E+00
0.7952E+02	0.1314E+01
0.8836E+02	0.1800E+01
0.8836E+02	0.2700E+01
0.8836E+02	0.3600E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.3349E+00	0.1311E-03	0.6136E-01	0.1000E-03
0.3349E+01	0.1311E-02	0.6136E+00	0.1000E-02
0.1675E+02	0.6555E-02	0.3068E+01	0.5000E-02
0.3349E+02	0.1311E-01	0.6136E+01	0.1000E-01
0.1579E+03	0.6459E-01	0.2365E+02	0.5000E-01
0.2830E+03	0.1261E+00	0.2923E+02	0.1000E+00
0.3107E+03	0.5294E+00	0.5543E+02	0.5000E+00
0.3273E+03	0.1031E+01	0.7206E+02	0.1000E+01
0.3436E+03	0.2033E+01	0.8836E+02	0.2000E+01



HWY165_18in_Abut_Extreme_Vert.ap6o

APILE for Windows, Version 2014.6.8

Serial Number : 158111698

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 :

U.S. Army Corps of Engineers
Memphis, Tennessee / USA

Path to file locations :
G:\GOSH\~To_Be_GOSHed\BAYOU_METO_HWY165_BRIDGE_DESIGN\05_DESIGN_DOCUMENTS\04_DESIGN_CALCULATIONS\Vertical Pile Capacity\Abutments\
Name of input data file : HWY165_18in_Abut_Extreme_Vert.ap6d
Name of output file : HWY165_18in_Abut_Extreme_Vert.ap6o
Name of plot output file : HWY165_18in_Abut_Extreme_Vert.ap6p

Time and Date of Analysis

Date: November 01, 2015 Time: 16:19:40

1

* INPUT INFORMATION *

Bayou Meto HWY 165 Abutment Vertical Extreme Capacities. 18-in diameter

DESIGNER : Randy Lord

JOB NUMBER :

METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.303E+08 PSI
 - CROSS SECTION AREA = 254.00 IN2

CIRCULAR PILE PROPERTIES :

- OUTSIDE DIAMETER, OD = 18.00 IN.
 - INTERNAL DIAMETER, ID = 17.00 IN.
 - TOTAL PILE LENGTH, TL = 80.00 FT.
 - PILE STICKUP LENGTH, PSL = 0.00 FT.
 - ZERO FRICTION LENGTH, ZFL = 3.00 FT.
 - INCREMENT OF PILE LENGTH
 USED IN COMPUTATION = 1.00 FT.
 - LENGTH OF ENHANCED
 END SECTION = 80.00 FT.
 - INTERNAL DIAMETER OF
 ENHANCED END SECTION = 17.00 IN.

PLUGGED/UNPLUGGED CONDITIONS :

Internal Pile Plug Calculated by Program

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	115.00	0.00	0.00
4.00	CLAY	0.00	115.00	0.00	0.00
4.00	CLAY	0.00	134.00	0.00	0.00
10.00	CLAY	0.00	134.00	0.00	0.00
10.00	CLAY	0.00	71.00	0.00	0.00
12.00	CLAY	0.00	71.00	0.00	0.00
12.00	CLAY	0.00	55.00	0.00	0.00
21.00	CLAY	0.00	55.00	0.00	0.00
21.00	CLAY	0.00	71.00	0.00	0.00
26.00	CLAY	0.00	71.00	0.00	0.00
26.00	CLAY	0.00	62.00	0.00	0.00
37.50	CLAY	0.00	62.00	0.00	0.00
37.50	SAND	0.80	62.00	33.00	20.00
90.00	SAND	0.80	62.00	33.00	20.00

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

HWY165_18in_Abut_Extreme_Vert.ap60

0.10E+08*	0.10E+08*	0.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.54	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.54	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
4.00	1.000	1.000
4.00	1.000	1.000
10.00	1.000	1.000
10.00	1.000	1.000
12.00	1.000	1.000
12.00	1.000	1.000
21.00	1.000	1.000
21.00	1.000	1.000
26.00	1.000	1.000
26.00	1.000	1.000
37.50	1.000	1.000
37.50	1.000	1.000
90.00	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	1.3*	1.3
1.00	0.0	1.3*	1.3
2.00	0.0	1.3*	1.3
3.00	0.8	1.3*	2.1
4.00	2.4	1.3*	3.7
5.00	4.2	1.7*	5.8
6.00	6.0	1.7*	7.7

HWY165_18in_Abut_Extreme_Vert.ap60

7.00	7.9	1.7*	9.5
8.00	9.7	1.7*	11.4
9.00	11.6	1.7*	13.2
10.00	13.4	1.7*	15.1
11.00	15.3	1.7*	16.9
12.00	17.1	1.7*	18.8
13.00	19.0	1.7*	20.7
14.00	20.9	1.7*	22.6
15.00	22.7	1.7*	24.5
16.00	24.6	1.7*	26.3
17.00	26.5	1.7*	28.2
18.00	28.4	1.7*	30.1
19.00	30.3	1.7*	32.0
20.00	32.1	1.7*	33.8
21.00	34.3	1.7*	36.0
22.00	36.8	1.7*	38.5
23.00	39.3	1.7*	41.0
24.00	41.8	1.7*	43.5
25.00	44.3	1.7*	46.0
26.00	47.0	1.7*	48.7
27.00	49.5	0.9*	50.4
28.00	51.4	0.9*	52.3
29.00	53.3	0.9*	54.2
30.00	55.2	0.9*	56.1
31.00	57.0	0.9*	58.0
32.00	58.9	0.9*	59.9
33.00	60.8	0.9*	61.7
34.00	62.7	0.9*	63.6
35.00	64.6	0.9*	65.5
36.00	66.5	0.9*	67.4
37.00	68.5	0.9*	69.4
38.00	70.6	0.9*	71.5
39.00	72.6	11.3*	83.8
40.00	74.4	13.0*	87.5
41.00	76.3	14.9*	91.2
42.00	78.3	16.7*	95.0
43.00	80.3	18.6*	98.8
44.00	82.3	20.5*	102.8
45.00	84.4	22.4*	106.8
46.00	86.5	24.4*	110.9
47.00	88.6	26.4*	115.0
48.00	90.8	28.5*	119.2
49.00	93.0	30.6*	123.5
50.00	95.2	32.7*	127.9
51.00	97.5	34.8*	132.4
52.00	99.8	37.0*	136.9
53.00	102.2	39.3*	141.5
54.00	104.6	41.5*	146.1
55.00	107.0	43.8*	150.9
56.00	109.5	46.2*	155.7
57.00	112.0	48.5*	160.6
58.00	114.6	50.9*	165.5
59.00	122.1	62.7*	184.8
60.00	134.7	74.6*	209.2
61.00	147.4	86.6*	234.1
62.00	160.4	88.4	248.8
63.00	173.5	88.4	261.9
64.00	186.8	88.4	275.2
65.00	200.3	88.4	288.7
66.00	214.0	88.4	302.3
67.00	227.8	88.4	316.2
68.00	241.9	88.4	330.2
69.00	256.1	88.4	344.4

HWY165_18in_Abut_Extreme_Vert.ap60

70.00	270.5	88.4	358.8
71.00	285.0	88.4	373.4
72.00	299.8	88.4	388.1
73.00	314.7	88.4	403.1
74.00	329.8	88.4	418.2
75.00	345.1	88.4	433.5
76.00	360.6	88.4	448.9
77.00	376.2	88.4	464.6
78.00	392.1	88.4	480.4
79.00	408.1	88.4	496.4
80.00	424.3	88.4	512.6

 * API RP-2A (1994) *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	1.3*	1.3
1.00	0.0	1.3*	1.3
2.00	0.0	1.3*	1.3
3.00	0.7	1.3*	2.0
4.00	2.2	1.3*	3.5
5.00	4.0	1.7*	5.7
6.00	6.1	1.7*	7.8
7.00	8.3	1.7*	9.9
8.00	10.5	1.7*	12.2
9.00	12.9	1.7*	14.6
10.00	15.5	1.7*	17.1
11.00	18.1	1.7*	19.8
12.00	20.8	1.7*	22.5
13.00	23.6	1.7*	25.4
14.00	26.5	1.7*	28.2
15.00	29.4	1.7*	31.2
16.00	32.4	1.7*	34.1
17.00	35.4	1.7*	37.2
18.00	38.5	1.7*	40.2
19.00	41.7	1.7*	43.4
20.00	44.8	1.7*	46.5
21.00	48.1	1.7*	49.8
22.00	51.3	1.7*	53.0
23.00	54.6	1.7*	56.3
24.00	57.9	1.7*	59.6
25.00	61.3	1.7*	63.0
26.00	64.8	1.7*	66.5
27.00	67.8	0.9*	68.7
28.00	70.3	0.9*	71.3
29.00	72.9	0.9*	73.8
30.00	75.4	0.9*	76.3
31.00	77.9	0.9*	78.8
32.00	80.4	0.9*	81.4
33.00	83.0	0.9*	83.9
34.00	85.5	0.9*	86.4
35.00	88.0	0.9*	88.9
36.00	90.5	0.9*	91.5
37.00	93.1	0.9*	94.0
38.00	95.6	0.9*	96.5
39.00	99.9	17.4*	117.4
40.00	106.1	23.5*	129.6
41.00	112.4	29.7*	142.2

HWY165_18in_Abut_Extreme_Vert.ap60

42.00	118.9	36.1*	155.0
43.00	125.5	42.5*	168.0
44.00	132.2	49.1*	181.2
45.00	139.0	55.7*	194.7
46.00	145.9	62.5*	208.5
47.00	153.0	69.5*	222.5
48.00	160.2	76.5*	236.7
49.00	167.5	83.6*	251.1
50.00	175.0	90.9*	265.9
51.00	182.5	98.3*	280.8
52.00	190.2	105.8*	296.0
53.00	198.0	113.4*	311.4
54.00	206.0	121.1*	327.1
55.00	214.0	129.0*	343.0
56.00	222.2	137.0*	359.2
57.00	230.5	145.0*	375.6
58.00	239.0	149.9	388.8
59.00	247.5	152.0	399.6
60.00	256.2	154.2	410.5
61.00	265.0	156.4	421.5
62.00	274.0	158.6	432.6
63.00	283.0	160.8	443.8
64.00	292.2	163.0	455.2
65.00	301.5	165.2	466.7
66.00	310.9	167.4	478.3
67.00	320.5	169.6	490.1
68.00	330.2	171.8	501.9
69.00	340.0	174.0	513.9
70.00	349.9	176.1	526.1
71.00	360.0	178.3	538.3
72.00	370.1	180.5	550.7
73.00	380.4	182.7	563.2
74.00	390.9	184.9	575.8
75.00	401.4	187.1	588.5
76.00	412.1	189.3	601.4
77.00	422.9	191.5	614.4
78.00	433.8	193.7	627.5
79.00	444.9	195.9	640.7
80.00	456.0	198.1	654.1

AN ASTERISK WILL BE 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
			0.0000E+00	0.2880E-01
			0.0000E+00	0.5580E-01
			0.0000E+00	0.1026E+00
			0.0000E+00	0.1440E+00
			0.0000E+00	0.1800E+00

HWY165_18in_Abut_Extreme_Vert.ap6o

			0.0000E+00	0.3600E+00
			0.0000E+00	0.5400E+00
			0.0000E+00	0.9000E+00
			0.0000E+00	0.3600E+01
2	10	0.2025E+01	0.0000E+00	0.0000E+00
			0.7164E+00	0.2880E-01
			0.1194E+01	0.5580E-01
			0.1791E+01	0.1026E+00
			0.2149E+01	0.1440E+00
			0.2388E+01	0.1800E+00
			0.2149E+01	0.3600E+00
			0.2149E+01	0.5400E+00
			0.2149E+01	0.9000E+00
			0.2149E+01	0.3600E+01
3	10	0.3958E+01	0.0000E+00	0.0000E+00
			0.7420E+00	0.2880E-01
			0.1237E+01	0.5580E-01
			0.1855E+01	0.1026E+00
			0.2226E+01	0.1440E+00
			0.2473E+01	0.1800E+00
			0.2226E+01	0.3600E+00
			0.2226E+01	0.5400E+00
			0.2226E+01	0.9000E+00
			0.2226E+01	0.3600E+01
4	10	0.4000E+01	0.0000E+00	0.0000E+00
			0.7933E+00	0.2880E-01
			0.1322E+01	0.5580E-01
			0.1983E+01	0.1026E+00
			0.2380E+01	0.1440E+00
			0.2644E+01	0.1800E+00
			0.2380E+01	0.3600E+00
			0.2380E+01	0.5400E+00
			0.2380E+01	0.9000E+00
			0.2380E+01	0.3600E+01
5	10	0.7025E+01	0.0000E+00	0.0000E+00
			0.8190E+00	0.2880E-01
			0.1365E+01	0.5580E-01
			0.2047E+01	0.1026E+00
			0.2457E+01	0.1440E+00
			0.2730E+01	0.1800E+00
			0.2457E+01	0.3600E+00
			0.2457E+01	0.5400E+00
			0.2457E+01	0.9000E+00
			0.2457E+01	0.3600E+01
6	10	0.9958E+01	0.0000E+00	0.0000E+00
			0.8190E+00	0.2880E-01
			0.1365E+01	0.5580E-01
			0.2047E+01	0.1026E+00
			0.2457E+01	0.1440E+00
			0.2730E+01	0.1800E+00
			0.2457E+01	0.3600E+00
			0.2457E+01	0.5400E+00
			0.2457E+01	0.9000E+00
			0.2457E+01	0.3600E+01
7	10	0.1000E+02	0.0000E+00	0.0000E+00
			0.8190E+00	0.2880E-01
			0.1365E+01	0.5580E-01

HWY165_18in_Abut_Extreme_Vert.ap6o

8	10	0.1103E+02	0.2047E+01	0.1026E+00
			0.2457E+01	0.1440E+00
			0.2730E+01	0.1800E+00
			0.2457E+01	0.3600E+00
			0.2457E+01	0.5400E+00
			0.2457E+01	0.9000E+00
			0.2457E+01	0.3600E+01
9	10	0.1196E+02	0.0000E+00	0.0000E+00
			0.8215E+00	0.2880E-01
			0.1369E+01	0.5580E-01
			0.2054E+01	0.1026E+00
			0.2465E+01	0.1440E+00
			0.2738E+01	0.1800E+00
			0.2465E+01	0.3600E+00
10	10	0.1200E+02	0.2465E+01	0.5400E+00
			0.2465E+01	0.9000E+00
			0.2465E+01	0.3600E+01
			0.0000E+00	0.0000E+00
			0.8215E+00	0.2880E-01
			0.1369E+01	0.5580E-01
			0.2054E+01	0.1026E+00
11	10	0.1653E+02	0.2465E+01	0.1440E+00
			0.2738E+01	0.1800E+00
			0.2465E+01	0.3600E+00
			0.2465E+01	0.5400E+00
			0.2465E+01	0.9000E+00
			0.2465E+01	0.3600E+01
			0.0000E+00	0.0000E+00
12	10	0.2096E+02	0.8292E+00	0.2880E-01
			0.1382E+01	0.5580E-01
			0.2073E+01	0.1026E+00
			0.2487E+01	0.1440E+00
			0.2764E+01	0.1800E+00
			0.2487E+01	0.3600E+00
			0.2487E+01	0.5400E+00
13	10	0.2100E+02	0.2487E+01	0.9000E+00
			0.2487E+01	0.3600E+01
			0.0000E+00	0.0000E+00
			0.1042E+01	0.2880E-01
			0.1736E+01	0.5580E-01
			0.2604E+01	0.1026E+00
			0.3125E+01	0.1440E+00
			0.3472E+01	0.1800E+00
			0.3125E+01	0.3600E+00
			0.3125E+01	0.5400E+00
			0.3125E+01	0.9000E+00
			0.3125E+01	0.3600E+01
			0.0000E+00	0.0000E+00
			0.1042E+01	0.2880E-01

HWY165_18in_Abut_Extreme_Vert.ap6o

			0.0000E+00	0.0000E+00
			0.1104E+01	0.2880E-01
			0.1840E+01	0.5580E-01
			0.2760E+01	0.1026E+00
			0.3312E+01	0.1440E+00
			0.3680E+01	0.1800E+00
			0.3312E+01	0.3600E+00
			0.3312E+01	0.5400E+00
			0.3312E+01	0.9000E+00
			0.3312E+01	0.3600E+01
14	10	0.2353E+02		
			0.0000E+00	0.0000E+00
			0.1099E+01	0.2880E-01
			0.1832E+01	0.5580E-01
			0.2747E+01	0.1026E+00
			0.3297E+01	0.1440E+00
			0.3663E+01	0.1800E+00
			0.3297E+01	0.3600E+00
			0.3297E+01	0.5400E+00
			0.3297E+01	0.9000E+00
			0.3297E+01	0.3600E+01
15	10	0.2596E+02		
			0.0000E+00	0.0000E+00
			0.1149E+01	0.2880E-01
			0.1916E+01	0.5580E-01
			0.2874E+01	0.1026E+00
			0.3448E+01	0.1440E+00
			0.3831E+01	0.1800E+00
			0.3448E+01	0.3600E+00
			0.3448E+01	0.5400E+00
			0.3448E+01	0.9000E+00
			0.3448E+01	0.3600E+01
16	10	0.2600E+02		
			0.0000E+00	0.0000E+00
			0.9588E+00	0.2880E-01
			0.1598E+01	0.5580E-01
			0.2397E+01	0.1026E+00
			0.2876E+01	0.1440E+00
			0.3196E+01	0.1800E+00
			0.2876E+01	0.3600E+00
			0.2876E+01	0.5400E+00
			0.2876E+01	0.9000E+00
			0.2876E+01	0.3600E+01
17	10	0.3178E+02		
			0.0000E+00	0.0000E+00
			0.8343E+00	0.2880E-01
			0.1390E+01	0.5580E-01
			0.2086E+01	0.1026E+00
			0.2503E+01	0.1440E+00
			0.2781E+01	0.1800E+00
			0.2503E+01	0.3600E+00
			0.2503E+01	0.5400E+00
			0.2503E+01	0.9000E+00
			0.2503E+01	0.3600E+01
18	10	0.3746E+02		
			0.0000E+00	0.0000E+00
			0.9027E+00	0.2880E-01
			0.1505E+01	0.5580E-01
			0.2257E+01	0.1026E+00
			0.2708E+01	0.1440E+00
			0.3009E+01	0.1800E+00
			0.2708E+01	0.3600E+00
			0.2708E+01	0.5400E+00

HWY165_18in_Abut_Extreme_Vert.ap6o

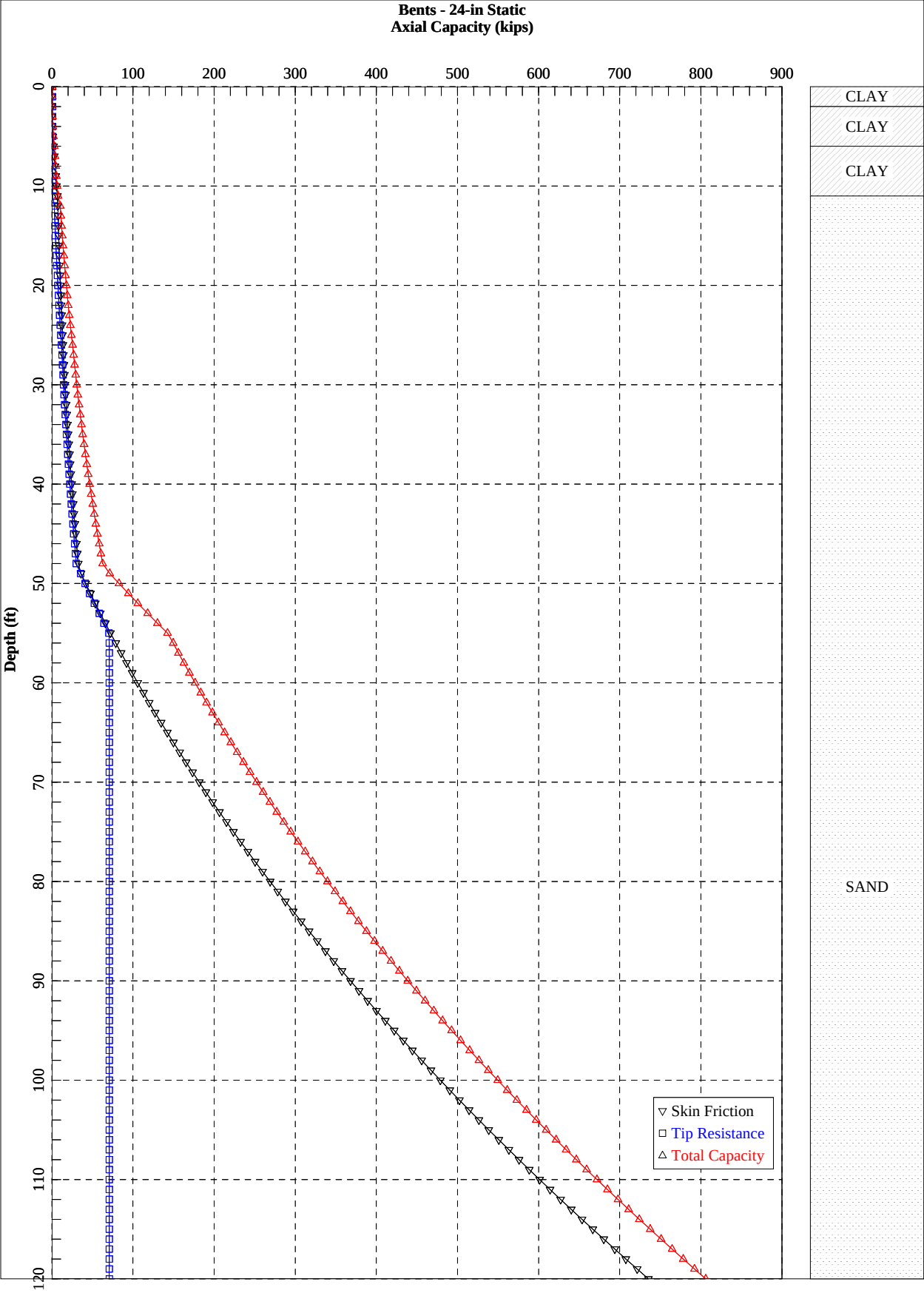
			0.2708E+01	0.9000E+00
			0.2708E+01	0.3600E+01
19	10	0.3750E+02	0.0000E+00	0.0000E+00
			0.3009E+00	0.1000E-01
			0.6018E+00	0.2000E-01
			0.1204E+01	0.4000E-01
			0.1805E+01	0.6000E-01
			0.2407E+01	0.8000E-01
			0.2708E+01	0.9000E-01
			0.3009E+01	0.1000E+00
			0.3009E+01	0.5000E+00
			0.3009E+01	0.2000E+01
20	10	0.6378E+02	0.0000E+00	0.0000E+00
			0.1974E+01	0.1000E-01
			0.3949E+01	0.2000E-01
			0.7898E+01	0.4000E-01
			0.1185E+02	0.6000E-01
			0.1580E+02	0.8000E-01
			0.1777E+02	0.9000E-01
			0.1974E+02	0.1000E+00
			0.1974E+02	0.5000E+00
			0.1974E+02	0.2000E+01
21	10	0.8996E+02	0.0000E+00	0.0000E+00
			0.2386E+01	0.1000E-01
			0.4772E+01	0.2000E-01
			0.9543E+01	0.4000E-01
			0.1431E+02	0.6000E-01
			0.1909E+02	0.8000E-01
			0.2147E+02	0.9000E-01
			0.2386E+02	0.1000E+00
			0.2386E+02	0.5000E+00
			0.2386E+02	0.2000E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.5522E+01	0.9000E-02
0.1104E+02	0.1800E-01
0.2209E+02	0.3600E-01
0.4418E+02	0.2340E+00
0.6627E+02	0.7560E+00
0.7952E+02	0.1314E+01
0.8836E+02	0.1800E+01
0.8836E+02	0.2700E+01
0.8836E+02	0.3600E+01

LOAD VERSUS SETTLEMENT CURVE *****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.6242E+00	0.1558E-03	0.6136E-01	0.1000E-03
0.6242E+01	0.1558E-02	0.6136E+00	0.1000E-02

HWY165_18in_Abut_Extreme_Vert.ap60			
0.3121E+02	0.7789E-02	0.3068E+01	0.5000E-02
0.6242E+02	0.1558E-01	0.6136E+01	0.1000E-01
0.2938E+03	0.7667E-01	0.2365E+02	0.5000E-01
0.5263E+03	0.1485E+00	0.2923E+02	0.1000E+00
0.5555E+03	0.5519E+00	0.5543E+02	0.5000E+00
0.5721E+03	0.1054E+01	0.7206E+02	0.1000E+01
0.5884E+03	0.2056E+01	0.8836E+02	0.2000E+01



HWY165_24in_Bent_Static_Vert.ap6o

APILE for Windows, Version 2014.6.8

Serial Number : 158111698

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 :

U.S. Army Corps of Engineers
Memphis, Tennessee / USA

Path to file locations :
G:\GOSH\~To_Be_GOSHed\BAYOU_METO_HWY165_BRIDGE_DESIGN\05_DESIGN_DOCUMENTS\04_DESIGN_
CALCULATIONS\Vertical Pile Capacity\Bents\
Name of input data file : HWY165_24in_Bent_Static_Vert.ap6d
Name of output file : HWY165_24in_Bent_Static_Vert.ap6o
Name of plot output file : HWY165_24in_Bent_Static_Vert.ap6p

Time and Date of Analysis

Date: November 01, 2015 Time: 16:32:18

1

* INPUT INFORMATION *

Bayou Meto HWY 165 Bents vertical capacities. 24-in diameter. Static.

DESIGNER : Randy Lord

JOB NUMBER :

METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.308E+08 PSI
 - CROSS SECTION AREA = 452.00 IN²

CIRCULAR PILE PROPERTIES :

- OUTSIDE DIAMETER, OD = 24.00 IN.
 - INTERNAL DIAMETER, ID = 23.00 IN.
 - TOTAL PILE LENGTH, TL = 120.00 FT.
 - PILE STICKUP LENGTH, PSL = 0.00 FT.
 - ZERO FRICTION LENGTH, ZFL = 4.00 FT.
 - INCREMENT OF PILE LENGTH
 USED IN COMPUTATION = 1.00 FT.
 - LENGTH OF ENHANCED
 END SECTION = 120.00 FT.
 - INTERNAL DIAMETER OF
 ENHANCED END SECTION = 23.00 IN.

PLUGGED/UNPLUGGED CONDITIONS :

Internal Pile Plug Calculated by Program

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	52.00	0.00	0.00
2.00	CLAY	0.00	52.00	0.00	0.00
2.00	CLAY	0.00	55.00	0.00	0.00
6.00	CLAY	0.00	55.00	0.00	0.00
6.00	CLAY	0.00	71.00	0.00	0.00
11.00	CLAY	0.00	71.00	0.00	0.00
11.00	SAND	0.80	62.00	33.00	20.00
150.00	SAND	0.80	62.00	33.00	20.00

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*	0.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.97	0.00	0.00	0.00	0.00

HWY165_24in_Bent_Static_Vert.ap60

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	0.350	0.350
2.00	0.350	0.350
2.00	0.350	0.350
6.00	0.350	0.350
6.00	0.350	0.350
11.00	0.350	0.350
11.00	0.450	0.450
150.00	0.450	0.450

1

* COMPUTATION RESULT *

* FED. HWY. METHOD *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.6*	0.6
1.00	0.0	0.6*	0.6
2.00	0.0	0.6*	0.6
3.00	0.0	0.8*	0.8
4.00	0.4	0.8*	1.2
5.00	1.3	0.8*	2.1
6.00	2.2	0.8*	3.0
7.00	3.1	0.8*	3.8
8.00	3.9	0.8*	4.7
9.00	4.8	0.8*	5.6
10.00	5.7	0.8*	6.4
11.00	6.8	1.0*	7.8
12.00	7.5	2.9*	10.3
13.00	7.7	3.4*	11.1
14.00	8.1	3.9*	11.9
15.00	8.4	4.4*	12.8
16.00	8.8	5.0*	13.7
17.00	9.1	5.6*	14.7
18.00	9.5	6.2*	15.7
19.00	10.0	6.8*	16.8
20.00	10.4	7.4*	17.9
21.00	10.9	8.1*	19.0
22.00	11.4	8.8*	20.2
23.00	11.9	9.5*	21.5
24.00	12.5	10.3*	22.7

HWY165_24in_Bent_Static_Vert.ap60

25.00	13.0	11.0*	24.1
26.00	13.6	11.8*	25.5
27.00	14.2	12.5*	26.8
28.00	14.9	13.1*	28.0
29.00	15.5	13.8*	29.3
30.00	16.2	14.4*	30.7
31.00	16.9	15.1*	32.0
32.00	17.7	15.8*	33.5
33.00	18.4	16.5*	35.0
34.00	19.2	17.3*	36.5
35.00	20.0	18.0*	38.0
36.00	20.8	18.8*	39.7
37.00	21.7	19.6*	41.3
38.00	22.5	20.5*	43.0
39.00	23.4	21.3*	44.8
40.00	24.4	22.2*	46.6
41.00	25.3	23.1*	48.4
42.00	26.3	24.0*	50.3
43.00	27.2	25.0*	52.2
44.00	28.3	26.0*	54.2
45.00	29.3	26.9*	56.2
46.00	30.3	28.0*	58.3
47.00	31.4	29.0*	60.4
48.00	32.5	30.1*	62.6
49.00	35.9	35.5*	71.4
50.00	41.7	41.0*	82.7
51.00	47.6	46.6*	94.2
52.00	53.6	52.4*	106.0
53.00	59.7	58.3*	118.0
54.00	66.0	64.2*	130.2
55.00	72.3	70.3*	142.6
56.00	78.8	70.7	149.5
57.00	85.4	70.7	156.0
58.00	92.1	70.7	162.7
59.00	98.9	70.7	169.6
60.00	105.8	70.7	176.5
61.00	112.9	70.7	183.6
62.00	120.0	70.7	190.7
63.00	127.3	70.7	198.0
64.00	134.7	70.7	205.4
65.00	142.2	70.7	212.9
66.00	149.9	70.7	220.6
67.00	157.6	70.7	228.3
68.00	165.5	70.7	236.2
69.00	173.5	70.7	244.2
70.00	181.6	70.7	252.3
71.00	189.8	70.7	260.5
72.00	198.1	70.7	268.8
73.00	206.6	70.7	277.3
74.00	215.2	70.7	285.8
75.00	223.8	70.7	294.5
76.00	232.6	70.7	303.3
77.00	241.6	70.7	312.2
78.00	250.6	70.7	321.3
79.00	259.7	70.7	330.4
80.00	269.0	70.7	339.7
81.00	278.4	70.7	349.1
82.00	287.9	70.7	358.6
83.00	297.5	70.7	368.2
84.00	307.3	70.7	377.9
85.00	317.1	70.7	387.8
86.00	327.1	70.7	397.8
87.00	337.2	70.7	407.8

HWY165_24in_Bent_Static_Vert.ap60

88.00	347.4	70.7	418.0
89.00	357.7	70.7	428.4
90.00	368.1	70.7	438.8
91.00	378.7	70.7	449.4
92.00	389.3	70.7	460.0
93.00	400.1	70.7	470.8
94.00	411.0	70.7	481.7
95.00	422.0	70.7	492.7
96.00	433.2	70.7	503.9
97.00	444.4	70.7	515.1
98.00	455.8	70.7	526.5
99.00	467.3	70.7	538.0
100.00	478.9	70.7	549.6
101.00	490.6	70.7	561.3
102.00	502.4	70.7	573.1
103.00	514.4	70.7	585.1
104.00	526.4	70.7	597.1
105.00	538.6	70.7	609.3
106.00	550.9	70.7	621.6
107.00	563.4	70.7	634.0
108.00	575.9	70.7	646.6
109.00	588.5	70.7	659.2
110.00	601.3	70.7	672.0
111.00	614.2	70.7	684.9
112.00	627.2	70.7	697.9
113.00	640.3	70.7	711.0
114.00	653.5	70.7	724.2
115.00	666.9	70.7	737.6
116.00	680.4	70.7	751.0
117.00	693.9	70.7	764.6
118.00	707.6	70.7	778.3
119.00	721.5	70.7	792.2
120.00	735.4	70.7	806.1

 * API RP-2A (1994) *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.6*	0.6
1.00	0.0	0.6*	0.6
2.00	0.0	0.6*	0.6
3.00	0.0	0.8*	0.8
4.00	0.4	0.8*	1.2
5.00	1.1	0.8*	2.0
6.00	2.0	0.8*	2.8
7.00	2.8	0.8*	3.6
8.00	3.7	0.8*	4.4
9.00	4.6	0.8*	5.4
10.00	5.5	0.8*	6.3
11.00	6.7	1.0*	7.7
12.00	7.8	2.5*	10.3
13.00	8.7	3.6*	12.3
14.00	9.7	4.7*	14.4
15.00	10.8	5.8*	16.7
16.00	12.0	7.1*	19.1
17.00	13.2	8.4*	21.6
18.00	14.5	9.8*	24.3
19.00	15.9	11.3*	27.1

HWY165_24in_Bent_Static_Vert.ap60

20.00	17.3	12.8*	30.1
21.00	18.9	14.4*	33.3
22.00	20.5	16.1*	36.5
23.00	22.1	17.8*	39.9
24.00	23.9	19.6*	43.5
25.00	25.7	21.5*	47.2
26.00	27.6	23.5*	51.1
27.00	29.6	25.5*	55.1
28.00	31.6	27.6*	59.2
29.00	33.7	29.8*	63.5
30.00	35.9	32.1*	68.0
31.00	38.2	34.4*	72.6
32.00	40.6	36.8*	77.3
33.00	43.0	39.2*	82.2
34.00	45.5	41.8*	87.2
35.00	48.0	44.4*	92.4
36.00	50.7	47.0*	97.7
37.00	53.4	49.8*	103.2
38.00	56.2	52.6*	108.8
39.00	59.1	55.5*	114.6
40.00	62.0	58.5*	120.5
41.00	65.0	61.5*	126.5
42.00	68.1	64.6*	132.7
43.00	71.3	67.8*	139.0
44.00	74.5	71.0*	145.5
45.00	77.8	74.3*	152.2
46.00	81.2	77.7*	158.9
47.00	84.7	81.2*	165.9
48.00	88.2	84.1	172.3
49.00	91.8	85.8	177.6
50.00	95.5	87.6	183.1
51.00	99.3	89.3	188.6
52.00	103.1	91.1	194.2
53.00	107.0	92.8	199.9
54.00	111.0	94.6	205.6
55.00	115.1	96.3	211.4
56.00	119.2	98.1	217.3
57.00	123.4	99.8	223.3
58.00	127.7	101.6	229.3
59.00	132.1	103.3	235.4
60.00	136.5	105.1	241.6
61.00	141.0	106.8	247.8
62.00	145.6	108.6	254.2
63.00	150.2	110.4	260.6
64.00	155.0	112.1	267.1
65.00	159.8	113.9	273.6
66.00	164.7	115.6	280.3
67.00	169.6	117.4	287.0
68.00	174.6	119.1	293.8
69.00	179.7	120.9	300.6
70.00	184.9	122.6	307.6
71.00	190.2	124.4	314.6
72.00	195.5	126.1	321.6
73.00	200.9	127.9	328.8
74.00	206.4	129.6	336.0
75.00	211.9	131.4	343.3
76.00	217.6	133.1	350.7
77.00	223.3	134.9	358.2
78.00	229.0	136.6	365.7
79.00	234.9	138.4	373.3
80.00	240.8	140.2	381.0
81.00	246.8	141.9	388.7
82.00	252.9	143.7	396.5

HWY165_24in_Bent_Static_Vert.ap60

83.00	259.0	145.4	404.5
84.00	265.3	147.2	412.4
85.00	271.6	148.9	420.5
86.00	277.9	150.7	428.6
87.00	284.4	152.4	436.8
88.00	290.9	154.2	445.1
89.00	297.5	155.9	453.4
90.00	304.2	157.7	461.8
91.00	310.9	159.4	470.3
92.00	317.7	161.2	478.9
93.00	324.6	162.9	487.6
94.00	331.6	164.7	496.3
95.00	338.6	166.5	505.1
96.00	345.7	168.2	514.0
97.00	352.9	170.0	522.9
98.00	360.2	171.7	531.9
99.00	367.5	173.5	541.0
100.00	375.0	175.2	550.2
101.00	382.5	177.0	559.4
102.00	390.0	178.7	568.7
103.00	397.7	180.5	578.1
104.00	405.4	182.2	587.6
105.00	413.2	184.0	597.1
106.00	421.0	185.7	606.8
107.00	429.0	187.5	616.4
108.00	437.0	189.2	626.2
109.00	445.1	191.0	636.1
110.00	453.2	192.7	646.0
111.00	461.5	194.5	656.0
112.00	469.8	196.3	666.0
113.00	478.2	198.0	676.2
114.00	486.6	199.8	686.4
115.00	495.1	201.5	696.7
116.00	503.8	203.3	707.0
117.00	512.4	205.0	717.5
118.00	521.2	206.8	728.0
119.00	530.0	208.5	738.6
120.00	538.9	210.3	749.2

AN ASTERISK WILL BE 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
			0.0000E+00	0.3840E-01
			0.0000E+00	0.7440E-01
			0.0000E+00	0.1368E+00
			0.0000E+00	0.1920E+00
			0.0000E+00	0.2400E+00
			0.0000E+00	0.4800E+00

HWY165_24in_Bent_Static_Vert.ap60

2	10	0.1025E+01	0.0000E+00	0.7200E+00
			0.0000E+00	0.1200E+01
			0.0000E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.0000E+00	0.3840E-01
			0.0000E+00	0.7440E-01
			0.0000E+00	0.1368E+00
			0.0000E+00	0.1920E+00
			0.0000E+00	0.2400E+00
			0.0000E+00	0.4800E+00
3	10	0.1958E+01	0.0000E+00	0.7200E+00
			0.0000E+00	0.1200E+01
			0.0000E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.0000E+00	0.3840E-01
			0.0000E+00	0.7440E-01
			0.0000E+00	0.1368E+00
			0.0000E+00	0.1920E+00
			0.0000E+00	0.2400E+00
			0.0000E+00	0.4800E+00
4	10	0.2000E+01	0.0000E+00	0.7200E+00
			0.0000E+00	0.1200E+01
			0.0000E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.1451E+00	0.3840E-01
			0.2418E+00	0.7440E-01
			0.3628E+00	0.1368E+00
			0.4353E+00	0.1920E+00
			0.4837E+00	0.2400E+00
			0.4353E+00	0.4800E+00
5	10	0.4025E+01	0.4353E+00	0.7200E+00
			0.4353E+00	0.1200E+01
			0.4353E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.2902E+00	0.3840E-01
			0.4837E+00	0.7440E-01
			0.7255E+00	0.1368E+00
			0.8706E+00	0.1920E+00
			0.9674E+00	0.2400E+00
			0.8706E+00	0.4800E+00
6	10	0.5958E+01	0.8706E+00	0.7200E+00
			0.8706E+00	0.1200E+01
			0.8706E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.2893E+00	0.3840E-01
			0.4822E+00	0.7440E-01
			0.7233E+00	0.1368E+00
			0.8679E+00	0.1920E+00
			0.9644E+00	0.2400E+00
			0.8679E+00	0.4800E+00
7	10	0.6000E+01	0.8679E+00	0.7200E+00
			0.8679E+00	0.1200E+01
			0.8679E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.2875E+00	0.3840E-01
			0.4792E+00	0.7440E-01
			0.7188E+00	0.1368E+00

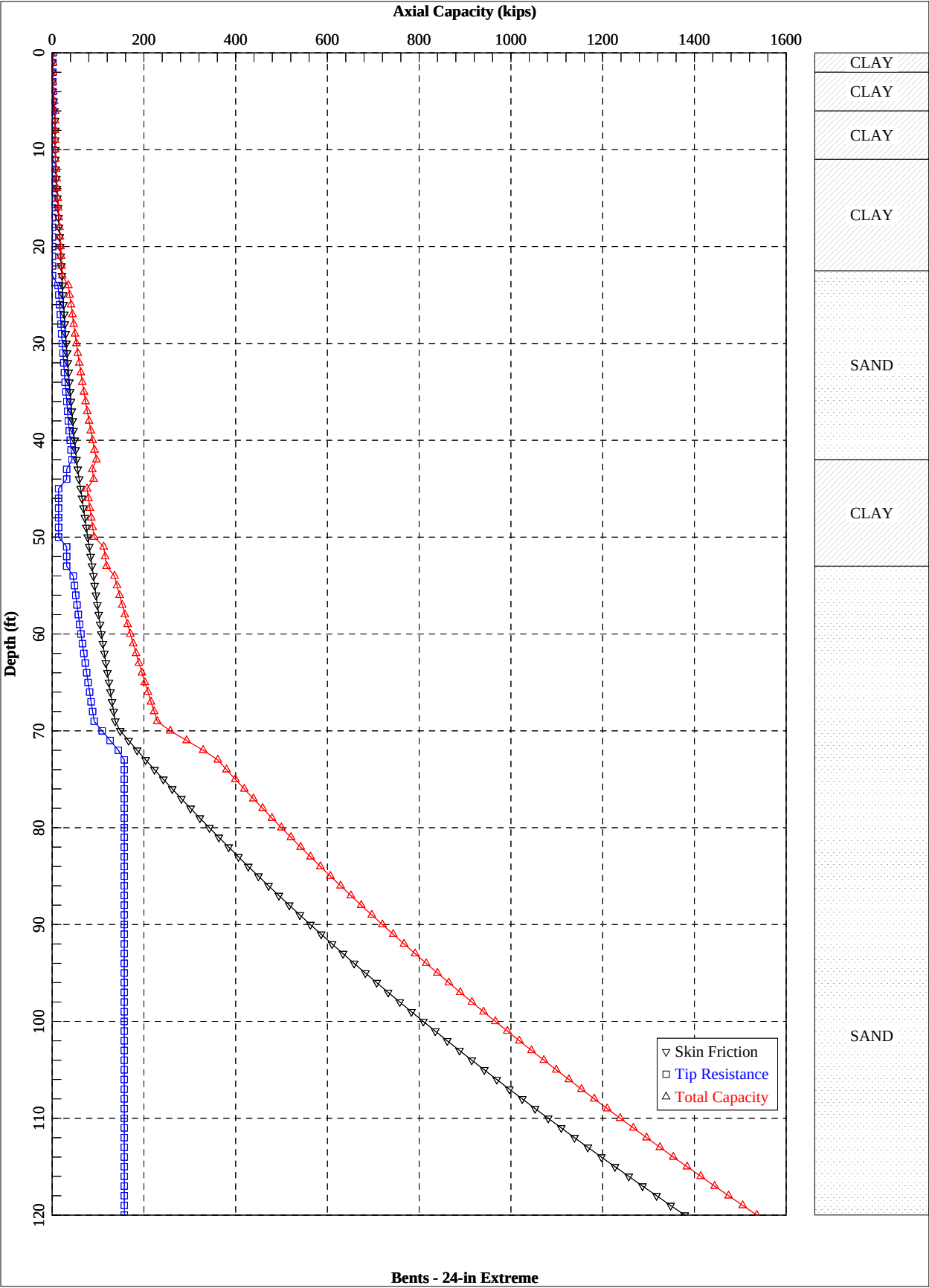
HWY165_24in_Bent_Static_Vert.ap60				
			0.8626E+00	0.1920E+00
			0.9584E+00	0.2400E+00
			0.8626E+00	0.4800E+00
			0.8626E+00	0.7200E+00
			0.8626E+00	0.1200E+01
			0.8626E+00	0.4800E+01
8	10	0.8525E+01		
			0.0000E+00	0.0000E+00
			0.2866E+00	0.3840E-01
			0.4777E+00	0.7440E-01
			0.7166E+00	0.1368E+00
			0.8599E+00	0.1920E+00
			0.9555E+00	0.2400E+00
			0.8599E+00	0.4800E+00
			0.8599E+00	0.7200E+00
			0.8599E+00	0.1200E+01
			0.8599E+00	0.4800E+01
9	10	0.1096E+02		
			0.0000E+00	0.0000E+00
			0.2994E+00	0.3840E-01
			0.4991E+00	0.7440E-01
			0.7486E+00	0.1368E+00
			0.8983E+00	0.1920E+00
			0.9981E+00	0.2400E+00
			0.8983E+00	0.4800E+00
			0.8983E+00	0.7200E+00
			0.8983E+00	0.1200E+01
			0.8983E+00	0.4800E+01
10	10	0.1100E+02		
			0.0000E+00	0.0000E+00
			0.5439E-01	0.1000E-01
			0.1088E+00	0.2000E-01
			0.2176E+00	0.4000E-01
			0.3263E+00	0.6000E-01
			0.4351E+00	0.8000E-01
			0.4895E+00	0.9000E-01
			0.5439E+00	0.1000E+00
			0.5439E+00	0.5000E+00
			0.5439E+00	0.2000E+01
11	10	0.8053E+02		
			0.0000E+00	0.0000E+00
			0.1044E+01	0.1000E-01
			0.2087E+01	0.2000E-01
			0.4175E+01	0.4000E-01
			0.6262E+01	0.6000E-01
			0.8350E+01	0.8000E-01
			0.9393E+01	0.9000E-01
			0.1044E+02	0.1000E+00
			0.1044E+02	0.5000E+00
			0.1044E+02	0.2000E+01
12	10	0.1500E+03		
			0.0000E+00	0.0000E+00
			0.1540E+01	0.1000E-01
			0.3080E+01	0.2000E-01
			0.6160E+01	0.4000E-01
			0.9240E+01	0.6000E-01
			0.1232E+02	0.8000E-01
			0.1386E+02	0.9000E-01
			0.1540E+02	0.1000E+00
			0.1540E+02	0.5000E+00
			0.1540E+02	0.2000E+01

HWY165_24in_Bent_Static_Vert.ap60

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.9817E+01	0.1200E-01
0.1963E+02	0.2400E-01
0.3927E+02	0.4800E-01
0.7854E+02	0.3120E+00
0.1178E+03	0.1008E+01
0.1414E+03	0.1752E+01
0.1571E+03	0.2400E+01
0.1571E+03	0.3600E+01
0.1571E+03	0.4800E+01

LOAD VERSUS SETTLEMENT CURVE *****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.9593E+00	0.1668E-03	0.8181E-01	0.1000E-03
0.9593E+01	0.1668E-02	0.8181E+00	0.1000E-02
0.4796E+02	0.8341E-02	0.4091E+01	0.5000E-02
0.9593E+02	0.1668E-01	0.8181E+01	0.1000E-01
0.4778E+03	0.8328E-01	0.3957E+02	0.5000E-01
0.8214E+03	0.1585E+00	0.4700E+02	0.1000E+00
0.8644E+03	0.5628E+00	0.8915E+02	0.5000E+00
0.8926E+03	0.1066E+01	0.1174E+03	0.1000E+01
0.9226E+03	0.2069E+01	0.1474E+03	0.2000E+01



HWY165_24in_Bent_Extreme_Vert.ap6o

APILE for Windows, Version 2014.6.8

Serial Number : 158111698

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 :

U.S. Army Corps of Engineers
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Path to file locations :
G:\GOSH\~To Be_GOSHed\BAYOU_METO_HWY165_BRIDGE_DESIGN\05_DESIGN_DOCUMENTS\04_DESIGN_CALCULATIONS\Vertical Pile Capacity\Bents\
Name of input data file : HWY165_24in_Bent_Extreme_Vert.ap6d
Name of output file : HWY165_24in_Bent_Extreme_Vert.ap6o
Name of plot output file : HWY165_24in_Bent_Extreme_Vert.ap6p

Time and Date of Analysis

Date: November 01, 2015 Time: 16:41:54

1

* INPUT INFORMATION *

Bayou Meto HWY 165 Bents vertical capacities. 24-in diameter. Extreme.

DESIGNER : Randy Lord

JOB NUMBER :

METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.308E+08 PSI
 - CROSS SECTION AREA = 452.00 IN2

CIRCULAR PILE PROPERTIES :

- OUTSIDE DIAMETER, OD = 24.00 IN.
 - INTERNAL DIAMETER, ID = 23.00 IN.
 - TOTAL PILE LENGTH, TL = 120.00 FT.
 - PILE STICKUP LENGTH, PSL = 0.00 FT.
 - ZERO FRICTION LENGTH, ZFL = 4.00 FT.
 - INCREMENT OF PILE LENGTH
 USED IN COMPUTATION = 1.00 FT.
 - LENGTH OF ENHANCED
 END SECTION = 120.00 FT.
 - INTERNAL DIAMETER OF
 ENHANCED END SECTION = 23.00 IN.

PLUGGED/UNPLUGGED CONDITIONS :

Internal Pile Plug Calculated by Program

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	52.00	0.00	0.00
2.00	CLAY	0.00	52.00	0.00	0.00
2.00	CLAY	0.00	55.00	0.00	0.00
6.00	CLAY	0.00	55.00	0.00	0.00
6.00	CLAY	0.00	71.00	0.00	0.00
11.00	CLAY	0.00	71.00	0.00	0.00
11.00	CLAY	0.00	62.00	0.00	0.00
22.50	CLAY	0.00	62.00	0.00	0.00
22.50	SAND	0.80	62.00	33.00	20.00
42.00	SAND	0.80	62.00	33.00	20.00
42.00	CLAY	0.00	62.00	0.00	0.00
53.00	CLAY	0.00	62.00	0.00	0.00
53.00	SAND	0.80	62.00	33.00	20.00
150.00	SAND	0.80	62.00	33.00	20.00

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

HWY165_24in_Bent_Extreme_Vert.ap60

0.10E+08*	0.10E+08*	0.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.67	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.67	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.06	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.06	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.33	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.33	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*	0.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.50	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
2.00	1.000	1.000
2.00	1.000	1.000
6.00	1.000	1.000
6.00	1.000	1.000
11.00	1.000	1.000
11.00	1.000	1.000
22.50	1.000	1.000
22.50	1.000	1.000
42.00	1.000	1.000
42.00	1.000	1.000
53.00	1.000	1.000
53.00	1.000	1.000
150.00	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	1.7*	1.7
1.00	0.0	1.7*	1.7
2.00	0.0	1.7*	1.7
3.00	0.0	1.5*	1.5
4.00	1.0	1.5*	2.5
5.00	3.0	1.5*	4.5
6.00	5.0	1.5*	6.6

HWY165_24in_Bent_Extreme_Vert.ap60

7.00	6.1	0.1*	6.3
8.00	6.4	0.1*	6.5
9.00	6.6	0.1*	6.8
10.00	6.9	0.1*	7.0
11.00	7.1	0.1*	7.3
12.00	7.9	0.8*	8.6
13.00	9.1	0.8*	9.8
14.00	10.3	0.8*	11.0
15.00	11.5	0.8*	12.2
16.00	12.7	0.8*	13.4
17.00	13.9	0.8*	14.6
18.00	15.1	0.8*	15.8
19.00	16.3	0.8*	17.0
20.00	17.5	0.8*	18.2
21.00	18.7	0.8*	19.4
22.00	19.9	0.8*	20.7
23.00	21.2	0.8*	22.0
24.00	22.5	12.8*	35.2
25.00	23.7	14.5*	38.2
26.00	25.0	16.2*	41.2
27.00	26.4	17.8*	44.2
28.00	27.8	19.1*	46.9
29.00	29.3	20.5*	49.8
30.00	30.8	22.0*	52.8
31.00	32.4	23.5*	55.9
32.00	34.0	25.1*	59.1
33.00	35.7	26.7*	62.4
34.00	37.4	28.3*	65.7
35.00	39.2	30.0*	69.2
36.00	41.0	31.8*	72.8
37.00	42.9	33.6*	76.5
38.00	44.9	35.4*	80.3
39.00	46.8	37.3*	84.2
40.00	48.9	39.3*	88.2
41.00	51.0	41.3*	92.3
42.00	53.1	43.4*	96.5
43.00	55.8	31.7*	87.4
44.00	58.9	31.7*	90.5
45.00	62.0	14.0	76.0
46.00	65.1	14.0	79.1
47.00	68.2	14.0	82.2
48.00	71.3	14.0	85.4
49.00	74.4	14.0	88.5
50.00	77.6	14.0	91.6
51.00	80.7	31.7*	112.4
52.00	83.8	31.7*	115.5
53.00	86.9	31.7*	118.6
54.00	89.9	46.0*	135.9
55.00	92.7	48.7*	141.4
56.00	95.5	51.4*	147.0
57.00	98.5	54.2*	152.7
58.00	101.4	57.1*	158.5
59.00	104.5	60.0*	164.4
60.00	107.5	62.9*	170.4
61.00	110.6	65.9*	176.6
62.00	113.8	69.0*	182.8
63.00	117.1	72.0*	189.1
64.00	120.3	75.2*	195.5
65.00	123.7	78.4*	202.0
66.00	127.0	81.6*	208.7
67.00	130.5	84.9*	215.4
68.00	134.0	88.3*	222.2
69.00	137.5	91.6*	229.1

HWY165_24in_Bent_Extreme_Vert.ap60

70.00	148.3	108.9*	257.2
71.00	166.6	126.4*	293.0
72.00	185.1	144.1*	329.3
73.00	203.9	157.1	361.0
74.00	223.0	157.1	380.0
75.00	242.3	157.1	399.3
76.00	261.8	157.1	418.9
77.00	281.6	157.1	438.7
78.00	301.7	157.1	458.8
79.00	322.0	157.1	479.1
80.00	342.6	157.1	499.7
81.00	363.5	157.1	520.6
82.00	384.6	157.1	541.7
83.00	406.0	157.1	563.1
84.00	427.6	157.1	584.7
85.00	449.5	157.1	606.6
86.00	471.7	157.1	628.7
87.00	494.1	157.1	651.2
88.00	516.7	157.1	673.8
89.00	539.7	157.1	696.8
90.00	562.9	157.1	719.9
91.00	586.3	157.1	743.4
92.00	610.0	157.1	767.1
93.00	634.0	157.1	791.1
94.00	658.2	157.1	815.3
95.00	682.7	157.1	839.8
96.00	707.4	157.1	864.5
97.00	732.4	157.1	889.5
98.00	757.7	157.1	914.8
99.00	783.2	157.1	940.3
100.00	809.0	157.1	966.1
101.00	835.0	157.1	992.1
102.00	861.3	157.1	1018.4
103.00	887.9	157.1	1045.0
104.00	914.7	157.1	1071.8
105.00	941.8	157.1	1098.9
106.00	969.1	157.1	1126.2
107.00	996.7	157.1	1153.8
108.00	1024.6	157.1	1181.7
109.00	1052.7	157.1	1209.8
110.00	1081.1	157.1	1238.1
111.00	1109.7	157.1	1266.8
112.00	1138.6	157.1	1295.7
113.00	1167.7	157.1	1324.8
114.00	1197.2	157.1	1354.2
115.00	1226.8	157.1	1383.9
116.00	1256.7	157.1	1413.8
117.00	1286.9	157.1	1444.0
118.00	1317.4	157.1	1474.5
119.00	1348.1	157.1	1505.2
120.00	1379.1	157.1	1536.1

 * API RP-2A (1994) *

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	1.7*	1.7
1.00	0.0	1.7*	1.7

HWY165_24in_Bent_Extreme_Vert.ap60

2.00	0.0	1.7*	1.7
3.00	0.0	1.5*	1.5
4.00	0.8	1.5*	2.3
5.00	2.4	1.5*	4.0
6.00	4.1	1.5*	5.7
7.00	5.2	0.1*	5.3
8.00	5.6	0.1*	5.7
9.00	5.9	0.1*	6.1
10.00	6.3	0.1*	6.4
11.00	6.7	0.1*	6.8
12.00	7.6	0.8*	8.4
13.00	9.2	0.8*	10.0
14.00	10.9	0.8*	11.6
15.00	12.6	0.8*	13.3
16.00	14.3	0.8*	15.1
17.00	16.1	0.8*	16.9
18.00	18.0	0.8*	18.8
19.00	19.9	0.8*	20.7
20.00	21.9	0.8*	22.7
21.00	24.0	0.8*	24.7
22.00	26.0	0.8*	26.8
23.00	28.1	0.8*	28.8
24.00	31.1	11.3*	42.4
25.00	35.1	15.5*	50.7
26.00	39.4	19.9*	59.3
27.00	43.7	24.4*	68.2
28.00	48.3	29.1*	77.4
29.00	53.0	33.9*	86.9
30.00	57.9	38.9*	96.8
31.00	62.9	44.1*	107.0
32.00	68.2	49.4*	117.5
33.00	73.5	54.9*	128.4
34.00	79.1	60.5*	139.6
35.00	84.8	66.3*	151.1
36.00	90.7	72.2*	162.9
37.00	96.7	78.3*	175.0
38.00	102.9	84.6*	187.5
39.00	109.3	91.0*	200.3
40.00	115.8	97.6*	213.4
41.00	122.5	104.3*	226.9
42.00	129.4	85.8	215.2
43.00	134.4	62.5	196.9
44.00	137.5	38.6	176.1
45.00	140.6	14.0	154.7
46.00	143.8	14.0	157.8
47.00	146.9	14.0	160.9
48.00	150.0	14.0	164.0
49.00	153.1	14.0	167.1
50.00	156.2	14.0	170.3
51.00	159.3	46.4	205.7
52.00	162.5	79.4	241.9
53.00	165.6	99.1*	264.6
54.00	171.6	123.6*	295.2
55.00	180.6	132.5*	313.1
56.00	189.8	141.6*	331.5
57.00	199.2	150.9*	350.1
58.00	208.7	160.4*	369.1
59.00	218.4	170.0*	388.3
60.00	228.2	179.7*	408.0
61.00	238.2	189.6*	427.9
62.00	248.4	199.7*	448.1
63.00	258.8	210.0*	468.7
64.00	269.3	220.3*	489.6

HWY165_24in_Bent_Extreme_Vert.ap60

65.00	280.0	230.9*	510.9
66.00	290.8	241.6*	532.4
67.00	301.8	252.5*	554.3
68.00	313.0	263.5*	576.5
69.00	324.4	268.6	593.0
70.00	335.9	272.5	608.4
71.00	347.5	276.4	623.9
72.00	359.4	280.3	639.7
73.00	371.4	284.2	655.6
74.00	383.6	288.1	671.6
75.00	395.9	292.0	687.9
76.00	408.4	295.9	704.3
77.00	421.1	299.8	720.8
78.00	433.9	303.7	737.6
79.00	446.9	307.6	754.5
80.00	460.1	311.5	771.5
81.00	473.4	315.4	788.7
82.00	486.9	319.2	806.1
83.00	500.5	323.1	823.7
84.00	514.4	327.0	841.4
85.00	528.4	330.9	859.3
86.00	542.5	334.8	877.4
87.00	556.9	338.7	895.6
88.00	571.3	342.6	914.0
89.00	586.0	346.5	932.5
90.00	600.8	350.4	951.2
91.00	615.8	354.3	970.1
92.00	631.0	358.2	989.2
93.00	646.3	362.1	1008.4
94.00	661.8	366.0	1027.8
95.00	677.4	369.9	1047.3
96.00	693.2	373.8	1067.0
97.00	709.2	377.7	1086.9
98.00	725.4	381.6	1107.0
99.00	741.7	385.5	1127.2
100.00	758.2	389.4	1147.5
101.00	774.8	393.3	1168.1
102.00	791.6	397.2	1188.8
103.00	808.6	401.1	1209.7
104.00	825.7	405.0	1230.7
105.00	843.0	408.8	1251.9
106.00	860.5	412.7	1273.3
107.00	878.2	416.6	1294.8
108.00	896.0	420.5	1316.5
109.00	913.9	424.4	1338.4
110.00	932.1	428.3	1360.4
111.00	950.4	432.2	1382.6
112.00	968.8	436.1	1405.0
113.00	987.5	440.0	1427.5
114.00	1006.3	443.9	1450.2
115.00	1025.2	447.8	1473.0
116.00	1044.4	451.7	1496.1
117.00	1063.7	455.6	1519.3
118.00	1083.1	459.5	1542.6
119.00	1102.8	463.4	1566.1
120.00	1122.6	467.3	1589.8

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

HWY165_24in_Bent_Extreme_Vert.ap6o

 * 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 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00	0.0000E+00 0.3840E-01 0.7440E-01 0.1368E+00 0.1920E+00 0.2400E+00 0.4800E+00 0.7200E+00 0.1200E+01 0.4800E+01
2	10	0.1025E+01	0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00	0.0000E+00 0.3840E-01 0.7440E-01 0.1368E+00 0.1920E+00 0.2400E+00 0.4800E+00 0.7200E+00 0.1200E+01 0.4800E+01
3	10	0.1958E+01	0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00	0.0000E+00 0.3840E-01 0.7440E-01 0.1368E+00 0.1920E+00 0.2400E+00 0.4800E+00 0.7200E+00 0.1200E+01 0.4800E+01
4	10	0.2000E+01	0.0000E+00 0.3325E+00 0.5542E+00 0.8313E+00 0.9975E+00 0.1108E+01 0.9975E+00 0.9975E+00 0.9975E+00 0.9975E+00	0.0000E+00 0.3840E-01 0.7440E-01 0.1368E+00 0.1920E+00 0.2400E+00 0.4800E+00 0.7200E+00 0.1200E+01 0.4800E+01
5	10	0.4025E+01	0.0000E+00 0.6650E+00 0.1108E+01 0.1663E+01 0.1995E+01 0.2217E+01 0.1995E+01 0.1995E+01	0.0000E+00 0.3840E-01 0.7440E-01 0.1368E+00 0.1920E+00 0.2400E+00 0.4800E+00 0.7200E+00

HWY165_24in_Bent_Extreme_Vert.ap6o

6	10	0.5958E+01	0.1995E+01	0.1200E+01
			0.1995E+01	0.4800E+01
			0.0000E+00	0.0000E+00
			0.5196E+00	0.3840E-01
			0.8660E+00	0.7440E-01
			0.1299E+01	0.1368E+00
			0.1559E+01	0.1920E+00
			0.1732E+01	0.2400E+00
			0.1559E+01	0.4800E+00
			0.1559E+01	0.7200E+00
7	10	0.6000E+01	0.1559E+01	0.1200E+01
			0.1559E+01	0.4800E+01
			0.0000E+00	0.0000E+00
			0.2288E+00	0.3840E-01
			0.3814E+00	0.7440E-01
			0.5721E+00	0.1368E+00
			0.6865E+00	0.1920E+00
			0.7627E+00	0.2400E+00
			0.6865E+00	0.4800E+00
			0.6865E+00	0.7200E+00
8	10	0.8525E+01	0.6865E+00	0.1200E+01
			0.6865E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.8342E-01	0.3840E-01
			0.1390E+00	0.7440E-01
			0.2085E+00	0.1368E+00
			0.2502E+00	0.1920E+00
			0.2781E+00	0.2400E+00
			0.2502E+00	0.4800E+00
			0.2502E+00	0.7200E+00
9	10	0.1096E+02	0.2502E+00	0.1200E+01
			0.2502E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.1621E+00	0.3840E-01
			0.2702E+00	0.7440E-01
			0.4053E+00	0.1368E+00
			0.4863E+00	0.1920E+00
			0.5403E+00	0.2400E+00
			0.4863E+00	0.4800E+00
			0.4863E+00	0.7200E+00
10	10	0.1100E+02	0.4863E+00	0.1200E+01
			0.4863E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.3195E+00	0.3840E-01
			0.5325E+00	0.7440E-01
			0.7987E+00	0.1368E+00
			0.9584E+00	0.1920E+00
			0.1065E+01	0.2400E+00
			0.9584E+00	0.4800E+00
			0.9584E+00	0.7200E+00
11	10	0.1678E+02	0.9584E+00	0.1200E+01
			0.9584E+00	0.4800E+01
			0.0000E+00	0.0000E+00
			0.3982E+00	0.3840E-01
			0.6636E+00	0.7440E-01
			0.9954E+00	0.1368E+00
			0.1194E+01	0.1920E+00

HWY165_24in_Bent_Extreme_Vert.ap6o

12	10	0.2246E+02	0.1327E+01	0.2400E+00
			0.1194E+01	0.4800E+00
			0.1194E+01	0.7200E+00
			0.1194E+01	0.1200E+01
			0.1194E+01	0.4800E+01
			0.0000E+00	0.0000E+00
			0.4207E+00	0.3840E-01
			0.7012E+00	0.7440E-01
			0.1052E+01	0.1368E+00
			0.1262E+01	0.1920E+00
13	10	0.2250E+02	0.1402E+01	0.2400E+00
			0.1262E+01	0.4800E+00
			0.1262E+01	0.7200E+00
			0.1262E+01	0.1200E+01
			0.1262E+01	0.4800E+01
			0.0000E+00	0.0000E+00
			0.1402E+00	0.1000E-01
			0.2805E+00	0.2000E-01
			0.5610E+00	0.4000E-01
			0.8414E+00	0.6000E-01
14	10	0.3228E+02	0.1122E+01	0.8000E-01
			0.1262E+01	0.9000E-01
			0.1402E+01	0.1000E+00
			0.1402E+01	0.5000E+00
			0.1402E+01	0.2000E+01
			0.0000E+00	0.0000E+00
			0.1882E+00	0.1000E-01
			0.3764E+00	0.2000E-01
			0.7528E+00	0.4000E-01
			0.1129E+01	0.6000E-01
15	10	0.4196E+02	0.1506E+01	0.8000E-01
			0.1694E+01	0.9000E-01
			0.1882E+01	0.1000E+00
			0.1882E+01	0.5000E+00
			0.1882E+01	0.2000E+01
			0.0000E+00	0.0000E+00
			0.2644E+00	0.1000E-01
			0.5287E+00	0.2000E-01
			0.1057E+01	0.4000E-01
			0.1586E+01	0.6000E-01
16	10	0.4200E+02	0.2115E+01	0.8000E-01
			0.2379E+01	0.9000E-01
			0.2644E+01	0.1000E+00
			0.2644E+01	0.5000E+00
			0.2644E+01	0.2000E+01
			0.0000E+00	0.0000E+00
			0.9547E+00	0.3840E-01
			0.1591E+01	0.7440E-01
			0.2387E+01	0.1368E+00
			0.2864E+01	0.1920E+00
17	10	0.4753E+02	0.3182E+01	0.2400E+00
			0.2864E+01	0.4800E+00
			0.2864E+01	0.7200E+00
			0.2864E+01	0.1200E+01
			0.2864E+01	0.4800E+01
			0.0000E+00	0.0000E+00
			0.1033E+01	0.3840E-01

HWY165_24in_Bent_Extreme_Vert.ap6o

			0.1722E+01	0.7440E-01
			0.2583E+01	0.1368E+00
			0.3100E+01	0.1920E+00
			0.3444E+01	0.2400E+00
			0.3100E+01	0.4800E+00
			0.3100E+01	0.7200E+00
			0.3100E+01	0.1200E+01
			0.3100E+01	0.4800E+01
18	10	0.5296E+02		
			0.0000E+00	0.0000E+00
			0.1006E+01	0.3840E-01
			0.1677E+01	0.7440E-01
			0.2515E+01	0.1368E+00
			0.3018E+01	0.1920E+00
			0.3354E+01	0.2400E+00
			0.3018E+01	0.4800E+00
			0.3018E+01	0.7200E+00
			0.3018E+01	0.1200E+01
			0.3018E+01	0.4800E+01
19	10	0.5300E+02		
			0.0000E+00	0.0000E+00
			0.3186E+00	0.1000E-01
			0.6373E+00	0.2000E-01
			0.1275E+01	0.4000E-01
			0.1912E+01	0.6000E-01
			0.2549E+01	0.8000E-01
			0.2868E+01	0.9000E-01
			0.3186E+01	0.1000E+00
			0.3186E+01	0.5000E+00
			0.3186E+01	0.2000E+01
20	10	0.1015E+03		
			0.0000E+00	0.0000E+00
			0.2921E+01	0.1000E-01
			0.5842E+01	0.2000E-01
			0.1168E+02	0.4000E-01
			0.1753E+02	0.6000E-01
			0.2337E+02	0.8000E-01
			0.2629E+02	0.9000E-01
			0.2921E+02	0.1000E+00
			0.2921E+02	0.5000E+00
			0.2921E+02	0.2000E+01
21	10	0.1500E+03		
			0.0000E+00	0.0000E+00
			0.3422E+01	0.1000E-01
			0.6845E+01	0.2000E-01
			0.1369E+02	0.4000E-01
			0.2053E+02	0.6000E-01
			0.2738E+02	0.8000E-01
			0.3080E+02	0.9000E-01
			0.3422E+02	0.1000E+00
			0.3422E+02	0.5000E+00
			0.3422E+02	0.2000E+01
TIP	LOAD	TIP		
	KIP	MOVEMENT		
		IN.		
0.0000E+00		0.0000E+00		
0.9817E+01		0.1200E-01		
0.1963E+02		0.2400E-01		
0.3927E+02		0.4800E-01		
0.7854E+02		0.3120E+00		

	HWY165_24in_Bent_Extreme_Vert.ap60
0.1178E+03	0.1008E+01
0.1414E+03	0.1752E+01
0.1571E+03	0.2400E+01
0.1571E+03	0.3600E+01
0.1571E+03	0.4800E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1578E+01	0.2215E-03	0.8181E-01	0.1000E-03
0.1578E+02	0.2215E-02	0.8181E+00	0.1000E-02
0.7890E+02	0.1107E-01	0.4091E+01	0.5000E-02
0.1578E+03	0.2215E-01	0.8181E+01	0.1000E-01
0.7817E+03	0.1105E+00	0.3957E+02	0.5000E-01
0.1343E+04	0.2067E+00	0.4700E+02	0.1000E+00
0.1389E+04	0.6112E+00	0.8915E+02	0.5000E+00
0.1417E+04	0.1114E+01	0.1174E+03	0.1000E+01
0.1447E+04	0.2117E+01	0.1474E+03	0.2000E+01

APPENDIX D

Lateral Pile Resistance and Lateral Earth Pressure Analysis

Static_Abut1_Cap_Run3_Long.lp7o

LPILE Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LpileRuns_10272015\Abut\Static_long\
Name of input data file: Static_Abut1_Cap_Run3_Long.lp7d
Name of output report file: Static_Abut1_Cap_Run3_Long.lp7o
Name of plot output file: Static_Abut1_Cap_Run3_Long.lp7p
Name of runtime message file: Static_Abut1_Cap_Run3_Long.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 15:01:04

Problem Title

Abutment#1 (Lower): 18-inch Static without p-multipliers Round 1

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 23-BMU-14

Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	80.000000	18.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	18.00000 in
Bottom Width	=	18.00000 in
Top Area	=	254.00000 Sq. in
Bottom Area	=	254.00000 Sq. in
Moment of Inertia at Top	=	1053.00000 in ⁴
Moment of Inertia at Bottom	=	1053.00000 in ⁴
Elastic Modulus	=	30328000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	18.400 degrees
	=	0.321 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 6 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	4.00000 ft
Effective unit weight at top of layer	=	115.00000 pcf
Effective unit weight at bottom of layer	=	115.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer	=	4.00000 ft
Distance from top of pile to bottom of layer	=	10.00000 ft
Effective unit weight at top of layer	=	134.00000 pcf
Effective unit weight at bottom of layer	=	134.00000 pcf
Undrained cohesion at top of layer	=	970.00000 psf

Static_Abut1_Cap_Run3_Long.lp7o

Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	10.00000	ft
Distance from top of pile to bottom of layer	=	12.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 4 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	12.00000	ft
Distance from top of pile to bottom of layer	=	21.00000	ft
Effective unit weight at top of layer	=	55.00000	pcf
Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	1000.00000	psf
Undrained cohesion at bottom of layer	=	1000.00000	psf
Epsilon-50 at top of layer	=	0.00700	
Epsilon-50 at bottom of layer	=	0.00700	
Subgrade k at top of layer	=	500.00000	pci
Subgrade k at bottom of layer	=	500.00000	pci

Layer 5 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	21.00000	ft
Distance from top of pile to bottom of layer	=	26.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 6 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	26.00000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Static_Abut1_Cap_Run3_Long.lp7o

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Criteria) Epsilon 50	Layer Soil Type kpy pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay w/o Free Water	0.01000	0.00	115.000	750.000
--	0.01000	--	4.000	115.000	750.000
2	Stiff Clay w/o Free Water	0.01000	4.000	134.000	970.000
--	0.01000	--	10.000	134.000	970.000
3	Stiff Clay with Free Water	0.01000 100.000	10.000	71.000	970.000
--	0.01000	100.000	12.000	71.000	970.000
4	Stiff Clay with Free Water	0.00700 500.000	12.000	55.000	1000.000
--	0.00700	500.000	21.000	55.000	1000.000
5	Stiff Clay with Free Water	0.01000 100.000	21.000	71.000	970.000
--	0.01000	100.000	26.000	71.000	970.000
6	Sand (Reese, et al.)	0.01000 100.000	26.000	62.000	--
30.000	--	60.000	90.000	62.000	--
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	1.0000	1.0000
2	50.000	1.0000	1.0000

Loading Type

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

Pile-head Loading and Pile-head Fixity Conditions

Static_Abut1_Cap_Run3_Long.lp7o

Number of loads specified = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
Top y vs. Pile Length				
1	1	V = -11500. lbs	M = -138000. in-lbs	85000.
No				

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

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

p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	421.447 lb/in
Pcd	=	843.750 lb/in
Pu	=	421.447 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	23.69969
0.0003600	35.43930
0.0007200	42.14466
0.00360	63.02097
0.00720	74.94499
0.03600	112.06889
0.07200	133.27313
0.18000	167.58208
0.36000	199.28981
0.54000	220.55043
0.72000	236.99686
1.80000	298.00777
3.60000	354.39296
7.20000	421.44663
7.38000	421.44663
7.56000	421.44663

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Equivalent Depth	=	2.000 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter Angle	=	0.000 degrees

Static_Abut1_Cap_Run3_Long.lp7o

Effective Slope = 18.400 degrees
Diameter = 18.000 in
Undrained cohesion, c = 5.20833 psi
Undrained cohesion, c = 750.00000 psf
Average Eff. Unit Weight = 0.06655 pci
Average Eff. Unit Weight = 115.00000 pcf
Epsilon-50 = 0.01000
Pct = 558.183 lb/in
Pcd = 843.750 lb/in
Pu = 558.183 lb/in
y50 = 0.450 in
p-multiplier = 1.00000
y-multiplier = 1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	31.38892
0.0003600	46.93738
0.0007200	55.81826
0.00360	83.46777
0.00720	99.26047
0.03600	148.42902
0.07200	176.51285
0.18000	221.95316
0.36000	263.94828
0.54000	292.10679
0.72000	313.88917
1.80000	394.69473
3.60000	469.37379
7.20000	558.18265
7.38000	558.18265
7.56000	558.18265

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number = 2
Depth below pile head = 4.000 ft
Depth below ground surface = 4.000 ft
Equivalent Depth = 4.972 ft
Ground Slope Angle = 18.400 degrees
Pile Batter Angle = 0.000 degrees
Effective Slope = 18.400 degrees
Diameter = 18.000 in
Undrained cohesion, c = 5.97222 psi
Undrained cohesion, c = 860.00000 psf
Average Eff. Unit Weight = 0.06655 pci
Average Eff. Unit Weight = 115.00000 pcf
Epsilon-50 = 0.01000
Pct = 857.348 lb/in
Pcd = 967.500 lb/in
Pu = 857.348 lb/in
y50 = 0.450 in
p-multiplier = 1.00000
y-multiplier = 1.00000

y, in	p, lb/in
0.0000	0.0000

	Static_Abut1_Cap_Run3_Long.lp7o
0.0000720	48.21223
0.0003600	72.09409
0.0007200	85.73481
0.00360	128.20344
0.00720	152.46045
0.03600	227.98154
0.07200	271.11727
0.18000	340.91192
0.36000	405.41489
0.54000	448.66533
0.72000	482.12227
1.80000	606.23665
3.60000	720.94094
7.20000	857.34810
7.38000	857.34810
7.56000	857.34810

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft
Equivalent Depth	=	6.972 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07022 pci
Average Eff. Unit Weight	=	121.33333 pcf
Epsilon-50	=	0.01000
Pct	=	1125.789 lb/in
Pcd	=	1091.250 lb/in
Pu	=	1091.250 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	61.36550
0.0003600	91.76282
0.0007200	109.12500
0.00360	163.17994
0.00720	194.05474
0.03600	290.17952
0.07200	345.08355
0.18000	433.91959
0.36000	516.02027
0.54000	571.07030
0.72000	613.65497
1.80000	771.63027
3.60000	917.62821
7.20000	1091.25000
7.38000	1091.25000
7.56000	1091.25000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Static_Abut1_Cap_Run3_Long.lp7o

Soil Layer Number	=	2
Depth below pile head	=	8.000 ft
Depth below ground surface	=	8.000 ft
Equivalent Depth	=	8.972 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07205 pci
Average Eff. Unit Weight	=	124.50000 pcf
Epsilon-50	=	0.01000
Pct	=	1297.691 lb/in
Pcd	=	1091.250 lb/in
Pu	=	1091.250 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	61.36550
0.0003600	91.76282
0.0007200	109.12500
0.00360	163.17994
0.00720	194.05474
0.03600	290.17952
0.07200	345.08355
0.18000	433.91959
0.36000	516.02027
0.54000	571.07030
0.72000	613.65497
1.80000	771.63027
3.60000	917.62821
7.20000	1091.25000
7.38000	1091.25000
7.56000	1091.25000

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Equivalent Depth	=	71.746 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07315 pci
Average Eff. Unit Weight	=	126.40000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	26655.847 lb/in
pcd	=	1333.750 lb/in

	Static_Abut1_Cap_Run3_Long.lp7o		
pc	=	1333.750	lb/in
pu	=	116.948	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4	
Depth below pile head	=	12.000	ft
Depth below ground surface	=	12.000	ft
Equivalent Depth	=	72.663	ft
Diameter	=	18.000	in
c (at curve depth)	=	6.840	lb/in**2
Average cohesion, c	=	6.84028	psi
Undrained cohesion, c	=	985.00000	psf
Average Eff. Unit Weight	=	0.06780	pci
Average Eff. Unit Weight	=	117.16667	pcf
k	=	500.000	pci
Epsilon50	=	0.00850	
y50	=	0.153	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	27257.122	lb/in
pcd	=	1354.375	lb/in
pc	=	1354.375	lb/in
pu	=	118.756	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.04590	370.91088
0.09180	524.54719
0.13770	611.11703
0.18360	667.33113
0.22950	705.72579
0.27540	731.37283
0.32130	747.17043

	Static_Abut1_Cap_Run3_Long.lp7o
0.36720	754.98886
0.41310	756.12825
0.45900	751.54057
0.50490	741.95031
0.55080	727.92564
0.91800	525.06857
1.28520	321.91231
1.65240	118.75605
1.74420	118.75605

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Equivalent Depth	=	74.663 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	6.89236 psi
Undrained cohesion, c	=	992.50000 psf
Average Eff. Unit Weight	=	0.06267 pci
Average Eff. Unit Weight	=	108.28571 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.126 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	28073.693 lb/in
pcd	=	1375.000 lb/in
pc	=	1375.000 lb/in
pu	=	120.565 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Equivalent Depth	=	76.663 ft
Diameter	=	18.000 in

Static_Abut1_Cap_Run3_Long.lp7o

c (at curve depth)	=	6.944	lb/in**2
Average cohesion, c	=	12.50935	psi
Undrained cohesion, c	=	1801.34615	psf
Average Eff. Unit Weight	=	0.05881	pci
Average Eff. Unit Weight	=	101.62500	pcf
k	=	500.000	pci
Epsilon50	=	0.00700	
y50	=	0.126	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	50936.492	lb/in
pcd	=	1375.000	lb/in
pc	=	1375.000	lb/in
pu	=	120.565	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4	
Depth below pile head	=	18.000	ft
Depth below ground surface	=	18.000	ft
Equivalent Depth	=	78.663	ft
Diameter	=	18.000	in
c (at curve depth)	=	6.944	lb/in**2
Average cohesion, c	=	17.32292	psi
Undrained cohesion, c	=	2494.50000	psf
Average Eff. Unit Weight	=	0.05581	pci
Average Eff. Unit Weight	=	96.44444	pcf
k	=	500.000	pci
Epsilon50	=	0.00700	
y50	=	0.126	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	71700.000	lb/in
pcd	=	1375.000	lb/in
pc	=	1375.000	lb/in
pu	=	120.565	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in

Static_Abut1_Cap_Run3_Long.lp7o

-----	-----
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	22.000 ft
Depth below ground surface	=	22.000 ft
Equivalent Depth	=	82.820 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05187 pci
Average Eff. Unit Weight	=	89.63636 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	30143.621 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

-----	-----
y, in	p, lb/in
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260

	Static_Abut1_Cap_Run3_Long.lp7o
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth	=	84.820 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05097 pci
Average Eff. Unit Weight	=	88.08333 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	30838.104 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	26.000 ft
Depth below ground surface	=	26.000 ft
Equivalent Depth (see note)	=	12.588 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	86.76923	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	13068.580	lb/in
Psd	=	8106.126	lb/in
Ps = Psd (deep controls)	=	8106.126	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	8427.4004	
$n = Pm/(m Ym)$	=	1.6447	
$m = (Pu-Pm)/(Yu-Ym)$	=	8214.2076	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.8307	in
Pk	=	7528.590	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B ps$	=	4053.063	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A Ps$	=	7133.391	lb/in
Es, lim	=	9063.018	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has a bi-linear shape for a Reese sand p-y curve because $Ym < Yu < Yk$.

y, in	p, lb/in	
0.0000	0.0000	
0.05622	509.52792	*
0.11244	1019.05583	*
0.16866	1528.58375	*
0.22488	2038.11167	*
0.28110	2547.63958	*
0.33732	3057.16750	*
0.39354	3566.69542	*
0.44976	4076.22333	*
0.50599	4585.75125	*
0.56221	5095.27917	*
0.61843	5604.80708	*
0.67465	6114.33500	*
0.73087	6623.86292	*
0.78709	7133.39084	*
0.80677	7133.39084	
0.82644	7133.39084	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	28.000 ft
Depth below ground surface	=	28.000 ft
Equivalent Depth (see note)	=	14.588 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	85.00000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	1700.025	lb/in
Psd	=	8551.675	lb/in
Ps = Pst (shallow controls)	=	1700.025	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	1767.4026	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	1722.6916	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0106	in
Pk	=	111.398	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	850.012	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	1496.022	lb/in
Es, lim	=	10503.018	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.01061	111.39839	*
0.03691	237.79006	
0.06322	329.81397	
0.08953	407.50967	
0.11584	476.60915	
0.14215	539.76355	
0.16846	598.46879	
0.19477	653.67128	
0.22107	706.01664	
0.24738	755.96960	
0.27369	803.87840	
0.30000	850.01232	
0.48750	1173.01700	
0.67500	1496.02167	
0.69188	1496.02167	
0.70875	1496.02167	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	30.000 ft
Depth below ground surface	=	30.000 ft
Equivalent Depth (see note)	=	16.588 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	83.46667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2122.776	lb/in
Psd	=	8997.225	lb/in
Ps = Pst (shallow controls)	=	2122.776	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	2206.9092	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	2151.0797	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0135	in
Pk	=	160.833	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	1061.388	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	1868.043	lb/in
Es, lim	=	11943.018	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.01347	160.83305	*
0.03952	309.46888	
0.06556	421.03258	
0.09161	516.00264	
0.11766	600.79763	
0.14371	678.47667	
0.16976	750.79370	
0.19581	818.86964	
0.22185	883.47451	
0.24790	945.16543	
0.27395	1004.36156	
0.30000	1061.38803	
0.48750	1464.71548	
0.67500	1868.04293	
0.69188	1868.04293	
0.70875	1868.04293	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	32.000 ft
Depth below ground surface	=	32.000 ft
Equivalent Depth (see note)	=	18.588 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	82.12500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2588.061	lb/in
Psd	=	9442.774	lb/in
Ps = Pst (shallow controls)	=	2588.061	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	2690.6354	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	2622.5688	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0167	in
Pk	=	223.491	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	1294.031	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	2277.494	lb/in
Es, lim	=	13383.018	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.01670	223.49108	*
0.04245	394.12186	
0.06821	525.81104	
0.09396	638.87165	
0.11972	740.24528	
0.14547	833.34660	
0.17123	920.16758	
0.19698	1001.99547	
0.22274	1079.72146	
0.24849	1153.99404	
0.27425	1225.30329	
0.30000	1294.03070	
0.48750	1785.76236	
0.67500	2277.49401	
0.69188	2277.49401	
0.70875	2277.49401	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Equivalent Depth (see note)	=	20.588 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	80.94118	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3095.473	lb/in
Psd	=	9888.324	lb/in
Ps = Pst (shallow controls)	=	3095.473	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	3218.1570	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	3136.7455	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0203	in
Pk	=	301.141	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	1547.736	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	2724.016	lb/in
Es, lim	=	14823.018	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.02032	301.14096	*
0.04574	493.26077	
0.07117	645.34852	
0.09659	777.06076	
0.12202	895.68522	
0.14744	1004.92638	
0.17287	1106.98568	
0.19830	1203.30294	
0.22372	1294.88349	
0.24915	1382.46352	
0.27457	1466.60214	
0.30000	1547.73627	
0.48750	2135.87605	
0.67500	2724.01583	
0.69188	2724.01583	
0.70875	2724.01583	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Equivalent Depth (see note)	=	22.588 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	79.88889	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3644.692	lb/in
Psd	=	10333.873	lb/in
Ps = Pst (shallow controls)	=	3644.692	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	3789.1441	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	3693.2880	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0243	in
Pk	=	395.615	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	1822.346	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	3207.329	lb/in
Es, lim	=	16263.018	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.02433	395.61484	*
0.04939	608.49818	
0.07445	780.96188	
0.09951	931.63051	
0.12457	1067.95976	
0.14963	1193.86906	
0.17469	1311.73356	
0.19975	1423.12684	
0.22482	1529.15781	
0.24988	1630.64416	
0.27494	1728.21024	
0.30000	1822.34607	
0.48750	2514.83757	
0.67500	3207.32906	
0.69188	3207.32906	
0.70875	3207.32906	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	38.000 ft
Depth below ground surface	=	38.000 ft
Equivalent Depth (see note)	=	24.588 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	78.94737	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4235.470	lb/in
Psd	=	10779.423	lb/in
Ps = Pst (shallow controls)	=	4235.470	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	4403.3362	
$n = Pm/(m Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	4291.9425	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0287	in
Pk	=	508.808	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B ps$	=	2117.735	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A Ps$	=	3727.213	lb/in
Es, lim	=	17703.018	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.02874	508.80786	*
0.05340	741.53698	
0.07806	934.07560	
0.10272	1103.74956	
0.12738	1258.01301	
0.15204	1400.92043	
0.17670	1534.97944	
0.20136	1661.87434	
0.22602	1782.80386	
0.25068	1898.65855	
0.27534	2010.12240	
0.30000	2117.73480	
0.48750	2922.47401	
0.67500	3727.21323	
0.69188	3727.21323	
0.70875	3727.21323	

* p value(s) computed using $p = k * Eff \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	40.000 ft
Depth below ground surface	=	40.000 ft
Equivalent Depth (see note)	=	26.588 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	78.10000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4867.604	lb/in
Psd	=	11224.972	lb/in
Ps = Pst (shallow controls)	=	4867.604	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	5060.5248	
n = $Pm/(m \cdot Ym)$	=	1.6447	
m = $(Pu - Pm)/(Yu - Ym)$	=	4932.5058	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0336	in
Pk	=	642.677	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	2433.802	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	4283.492	lb/in
Es, lim	=	19143.018	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in
0.0000	0.0000
0.03357	642.67731 *
0.05779	894.16195
0.08201	1106.21311
0.10623	1294.68762
0.13046	1466.88490
0.15468	1626.91353
0.17890	1777.36884
0.20312	1920.01938
0.22734	2056.13715
0.25156	2186.67480
0.27578	2312.36861
0.30000	2433.80223
0.48750	3358.64707
0.67500	4283.49191
0.69188	4283.49191
0.70875	4283.49191

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

 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)

Static_Abut1_Cap_Run3_Long.lp7o

Shear force at pile head = -11500.0 lbs
 Applied moment at pile head = -138000.0 in-lbs
 Axial thrust load on pile head = 85000.0 lbs

Depth Res.	Soil X Es*h feet lb/inch	Deflect. Spr. y Lat. inches lb/inch	Bending Distrib. Load Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil p lb/in
0.00		-0.1009	-138000.	-11500.	0.001600	1514.1328	3.194E+10	
144.9974	4312.9845	0.000	0.000					
1.000		-0.0820	-266875.	-9667.3726	0.001524	2615.6247	3.194E+10	
160.0406	11705.	0.000	0.000					
2.000		-0.0644	-372632.	-7674.3321	0.001403	3519.5355	3.194E+10	
171.6816	15991.	0.000	0.000					
3.000		-0.0485	-453560.	-5564.2847	0.001247	4211.2253	3.194E+10	
179.4832	22218.	0.000	0.000					
4.000		-0.0346	-508508.	-3258.0542	0.001066	4680.8667	3.194E+10	
225.6859	39183.	0.000	0.000					
5.000		-0.0229	-531473.	-340.7143	0.000870	4877.1468	3.194E+10	
247.0139	64628.	0.000	0.000					
6.000		-0.0137	-518735.	2537.1967	0.000672	4768.2813	3.194E+10	
227.9153	99871.	0.000	0.000					
7.000		-0.006782	-473095.	5057.3809	0.000484	4378.1899	3.194E+10	
191.2150	169161.	0.000	0.000					
8.000		-0.001997	-399843.	7067.9993	0.000320	3752.1101	3.194E+10	
140.8942	423253.	0.000	0.000					
9.000		0.000990	-307426.	7729.5789	0.000187	2962.2166	3.194E+10	
-74.9961	454320.	0.000	0.000					
10.000		0.002589	-220800.	6715.8161	8.781E-05	2221.8226	3.194E+10	
-79.9741	185343.	0.000	0.000					
11.000		0.003189	-146235.	5693.8096	1.914E-05	1584.5157	3.194E+10	
-88.7590	167016.	0.000	0.000					
12.000		0.003125	-84311.	4601.9018	-2.387E-05	1055.2491	3.194E+10	
-96.7891	185814.	0.000	0.000					
13.000		0.002678	-36311.	3381.2808	-4.618E-05	645.0001	3.194E+10	
-100.2339	224573.	0.000	0.000					
14.000		0.002063	-2694.3263	2249.6439	-5.319E-05	357.6741	3.194E+10	
-87.9733	255883.	0.000	0.000					
15.000		0.001432	18277.	1280.7402	-4.999E-05	490.8632	3.194E+10	
-73.2982	307130.	0.000	0.000					
16.000		0.000880	28698.	495.5988	-4.094E-05	579.9244	3.194E+10	
-57.4791	391688.	0.000	0.000					
17.000		0.000456	30832.	-97.5106	-2.959E-05	598.1695	3.194E+10	
-41.3721	544252.	0.000	0.000					
18.000		0.000169	26997.	-497.1703	-1.861E-05	565.3924	3.194E+10	
-25.1923	894089.	0.000	0.000					
19.000		2.728E-06	19544.	-675.7471	-9.811E-06	501.6885	3.194E+10	
-1.3040	2867884.	0.000	0.000					
20.000		-7.553E-05	11863.	-551.1522	-3.954E-06	436.0377	3.194E+10	
16.8293	1336863.	0.000	0.000					
21.000		-9.962E-05	6527.7335	-359.5231	-5.617E-07	390.4383	3.194E+10	
9.7810	589102.	0.000	0.000					
22.000		-9.388E-05	2918.2528	-243.3294	1.180E-06	359.5880	3.194E+10	
9.3298	596302.	0.000	0.000					
23.000		-7.460E-05	639.0310	-141.7477	1.819E-06	340.1075	3.194E+10	
7.5031	603502.	0.000	0.000					
24.000		-5.213E-05	-563.0893	-64.8790	1.812E-06	339.4584	3.194E+10	
5.3060	610702.	0.000	0.000					
25.000		-3.199E-05	-999.0948	-13.5386	1.504E-06	343.1849	3.194E+10	

Static_Abut1_Cap_Run3_Long.lp7o

3.2942	617902.	0.000				
26.000	-1.622E-05	-956.5785	11.4064	1.128E-06	342.8216	3.194E+10
0.1470	54378.	0.000				
27.000	-4.753E-06	-811.9979	12.5513	7.958E-07	341.5858	3.194E+10
0.0465	58698.	0.000				
28.000	3.052E-06	-660.2125	12.6211	5.192E-07	340.2885	3.194E+10
-0.0321	63018.	0.000				
29.000	7.878E-06	-512.5892	11.8820	2.991E-07	339.0268	3.194E+10
-0.0884	67338.	0.000				
30.000	1.039E-05	-377.3144	10.5924	1.322E-07	337.8706	3.194E+10
-0.1241	71658.	0.000				
31.000	1.119E-05	-259.6005	8.9850	1.302E-08	336.8645	3.194E+10
-0.1418	75978.	0.000				
32.000	1.082E-05	-162.0686	7.2558	-6.572E-08	336.0309	3.194E+10
-0.1449	80298.	0.000				
33.000	9.716E-06	-85.2348	5.5577	-1.117E-07	335.3742	3.194E+10
-0.1370	84618.	0.000				
34.000	8.218E-06	-28.0329	4.0004	-1.325E-07	334.8853	3.194E+10
-0.1218	88938.	0.000				
35.000	6.589E-06	11.6761	2.6529	-1.352E-07	334.7455	3.194E+10
-0.1024	93258.	0.000				
36.000	5.008E-06	36.6471	1.5494	-1.258E-07	334.9589	3.194E+10
-0.0815	97578.	0.000				
37.000	3.590E-06	49.8705	0.6959	-1.094E-07	335.0719	3.194E+10
-0.0610	101898.	0.000				
38.000	2.394E-06	54.2785	0.0776	-8.961E-08	335.1096	3.194E+10
-0.0424	106218.	0.000				
39.000	1.440E-06	52.5391	-0.3335	-6.942E-08	335.0947	3.194E+10
-0.0265	110538.	0.000				
40.000	7.230E-07	46.9299	-0.5734	-5.067E-08	335.0468	3.194E+10
-0.0138	114858.	0.000				
41.000	2.166E-07	39.2814	-0.6799	-3.444E-08	334.9814	3.194E+10
-0.004302	119178.	0.000				
42.000	-1.128E-07	30.9719	-0.6898	-2.124E-08	334.9104	3.194E+10
0.002322	123498.	0.000				
43.000	-3.025E-07	22.9624	-0.6355	-1.112E-08	334.8419	3.194E+10
0.006444	127818.	0.000				
44.000	-3.883E-07	15.8538	-0.5442	-3.856E-09	334.7812	3.194E+10
0.008552	132138.	0.000				
45.000	-4.024E-07	9.9570	-0.4370	9.632E-10	334.7308	3.194E+10
0.009151	136458.	0.000				
46.000	-3.711E-07	5.3648	-0.3292	3.811E-09	334.6915	3.194E+10
0.008708	140778.	0.000				
47.000	-3.154E-07	2.0188	-0.2309	5.171E-09	334.6629	3.194E+10
0.007626	145098.	0.000				
48.000	-2.502E-07	-0.2327	-0.1476	5.483E-09	334.6477	3.194E+10
0.006230	149418.	0.000				
49.000	-1.858E-07	-1.5877	-0.0817	5.122E-09	334.6592	3.194E+10
0.004760	153738.	0.000				
50.000	-1.283E-07	-2.2558	-0.0330	4.386E-09	334.6649	3.194E+10
0.003381	158058.	0.000				
51.000	-8.094E-08	-2.4344	0.000292	3.496E-09	334.6665	3.194E+10
0.002191	162378.	0.000				
52.000	-4.443E-08	-2.2946	0.0207	2.602E-09	334.6653	3.194E+10
0.001235	166698.	0.000				
53.000	-1.822E-08	-1.9740	0.0310	1.797E-09	334.6625	3.194E+10
0.000519	171018.	0.000				
54.000	-8.916E-10	-1.5758	0.0341	1.129E-09	334.6591	3.194E+10
2.606E-05	175338.	0.000				
55.000	9.335E-09	-1.1715	0.0325	6.134E-10	334.6557	3.194E+10
-0.000280	179658.	0.000				
56.000	1.427E-08	-0.8058	0.0281	2.432E-10	334.6526	3.194E+10
-0.000438	183978.	0.000				

Static_Abut1_Cap_Run3_Long.lp7o						
57.000	1.555E-08	-0.5017	0.0225	0.000	334.6500	3.194E+10
-0.000488	188298.	0.000				
58.000	1.455E-08	-0.2671	0.0167	-1.437E-10	334.6480	3.194E+10
-0.000467	192618.	0.000				
59.000	1.233E-08	-0.0993	0.0114	-2.111E-10	334.6465	3.194E+10
-0.000405	196938.	0.000				
60.000	9.640E-09	0.0104	0.007060	-2.266E-10	334.6458	3.194E+10
-0.000323	201258.	0.000				
61.000	6.986E-09	0.0736	0.003687	-2.098E-10	334.6463	3.194E+10
-0.000239	205578.	0.000				
62.000	4.654E-09	0.1022	0.001282	-1.761E-10	334.6465	3.194E+10
-0.000163	209898.	0.000				
63.000	2.776E-09	0.1072	-0.000279	-1.363E-10	334.6466	3.194E+10
-9.913E-05	214218.	0.000				
64.000	1.378E-09	0.0978	-0.001164	-9.756E-11	334.6465	3.194E+10
-5.020E-05	218538.	0.000				
65.000	4.193E-10	0.0810	-0.001548	-6.385E-11	334.6464	3.194E+10
-1.558E-05	222858.	0.000				
66.000	-1.750E-10	0.0618	-0.001594	-3.701E-11	334.6462	3.194E+10
6.626E-06	227178.	0.000				
67.000	-4.904E-10	0.0434	-0.001434	-1.728E-11	334.6460	3.194E+10
1.892E-05	231498.	0.000				
68.000	-6.091E-10	0.0277	-0.001172	-3.981E-12	334.6459	3.194E+10
2.394E-05	235818.	0.000				
69.000	-6.018E-10	0.0154	-0.000881	4.039E-12	334.6458	3.194E+10
2.408E-05	240138.	0.000				
70.000	-5.241E-10	0.006513	-0.000607	8.079E-12	334.6457	3.194E+10
2.135E-05	244458.	0.000				
71.000	-4.161E-10	0.000683	-0.000375	9.366E-12	334.6457	3.194E+10
1.725E-05	248778.	0.000				
72.000	-3.044E-10	-0.002665	-0.000195	8.942E-12	334.6457	3.194E+10
1.284E-05	253098.	0.000				
73.000	-2.041E-10	-0.004160	-6.541E-05	7.624E-12	334.6457	3.194E+10
8.758E-06	257418.	0.000				
74.000	-1.223E-10	-0.004386	1.858E-05	5.995E-12	334.6457	3.194E+10
5.335E-06	261738.	0.000				
75.000	-6.001E-11	-0.003836	6.600E-05	4.437E-12	334.6457	3.194E+10
2.661E-06	266058.	0.000				
76.000	-1.492E-11	-0.002895	8.554E-05	3.167E-12	334.6457	3.194E+10
6.722E-07	270378.	0.000				
77.000	1.715E-11	-0.001851	8.453E-05	2.276E-12	334.6457	3.194E+10
-7.853E-07	274698.	0.000				
78.000	4.084E-11	-0.000916	6.824E-05	1.761E-12	334.6457	3.194E+10
-1.899E-06	279018.	0.000				
79.000	6.033E-11	-0.000253	3.968E-05	1.549E-12	334.6457	3.194E+10
-2.849E-06	283338.	0.000				
80.000	7.856E-11	0.000	0.000	1.513E-12	334.6457	3.194E+10
-3.766E-06	143829.	0.000				

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	-0.1008564 inches
Computed slope at pile head	=	0.0016004 radians
Maximum bending moment	=	-531473. inch-lbs
Maximum shear force	=	-11500. lbs
Depth of maximum bending moment	=	5.0000000 feet below pile head
Depth of maximum shear force	=	0.0000000 feet below pile head
Number of iterations	=	21
Number of zero deflection points	=	7

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
 Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
 Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
 Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
 Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Condition 1 V(lbs) or y(inches)	Condition 2 Pile-head in-lb, rad., or in-lb/rad. Rotation radians			
1	1	V = -11500.	M = -138000.	85000.	-0.10085644	
-531473.		-11500.	0.00160041			

Computed Pile-head Stiffness Matrix Values
 K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)
 K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
-0.000302	0.00000	1150.000000	19257.	3808377.	63770785.
-0.002431	0.00000	4265.660455	102893.	1754665.	42324664.
-0.004882	0.00000	6088.204986	166898.	1247079.	34186511.
-0.007181	0.00000	7381.320910	216842.	1027966.	30198728.
-0.009273	0.00000	8384.339545	257739.	904181.	27794970.
-0.011182	0.00000	9203.865441	292488.	823064.	26156016.
-0.012958	0.00000	9896.764714	322769.	763783.	24909749.
-0.014585	0.00000	10497.	349580.	719710.	23968420.
-0.016117	0.00000	11026.	373676.	684158.	23185572.
-0.017549	0.00000	11500.	395632.	655296.	22544019.

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The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)

K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
0.00000	0.00000786	362.763125	13800.	46142569.	1755325756.
0.00000	0.00002916	1345.586364	51188.	46142569.	1755325756.
0.00000	0.00004273	1862.430913	73058.	43582457.	1709629690.
0.00000	0.00005347	2173.864499	88576.	40654468.	1656498883.
0.00000	0.00006220	2405.223355	100612.	38667472.	1617485779.
0.00000	0.00006957	2589.175102	110446.	37217722.	1587595548.
0.00000	0.00007593	2735.961430	118761.	36033283.	1564113815.
0.00000	0.00008156	2859.818932	125964.	35063507.	1544409600.
0.00000	0.00008656	2967.992314	132317.	34288254.	1528614519.
0.00000	0.00009112	3063.222734	138000.	33618035.	1514512409.

The analysis ended normally.

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LPILE Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LpileRuns_10272015\Abut\Static_trans\
Name of input data file: Static_Abut1_Cap_Run3_Transv.lp7d
Name of output report file: Static_Abut1_Cap_Run3_Transv.lp7o
Name of plot output file: Static_Abut1_Cap_Run3_Transv.lp7p
Name of runtime message file: Static_Abut1_Cap_Run3_Transv.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 15:08:35

Problem Title

Abutment#1 (Lower): 18-inch Static without p-multipliers Round 1

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 23-BMU-14

Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	80.000000	18.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	18.00000 in
Bottom Width	=	18.00000 in
Top Area	=	254.00000 Sq. in
Bottom Area	=	254.00000 Sq. in
Moment of Inertia at Top	=	1053.00000 in^4
Moment of Inertia at Bottom	=	1053.00000 in^4
Elastic Modulus	=	30328000. lbs/in^2

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 6 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	4.00000 ft
Effective unit weight at top of layer	=	115.00000 pcf
Effective unit weight at bottom of layer	=	115.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer	=	4.00000 ft
Distance from top of pile to bottom of layer	=	10.00000 ft
Effective unit weight at top of layer	=	134.00000 pcf
Effective unit weight at bottom of layer	=	134.00000 pcf
Undrained cohesion at top of layer	=	970.00000 psf

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Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	10.00000	ft
Distance from top of pile to bottom of layer	=	12.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 4 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	12.00000	ft
Distance from top of pile to bottom of layer	=	21.00000	ft
Effective unit weight at top of layer	=	55.00000	pcf
Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	1000.00000	psf
Undrained cohesion at bottom of layer	=	1000.00000	psf
Epsilon-50 at top of layer	=	0.00700	
Epsilon-50 at bottom of layer	=	0.00700	
Subgrade k at top of layer	=	500.00000	pci
Subgrade k at bottom of layer	=	500.00000	pci

Layer 5 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	21.00000	ft
Distance from top of pile to bottom of layer	=	26.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 6 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	26.00000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Static_Abut1_Cap_Run3_Transv.lp7o

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Criteria) Epsilon 50	Layer Soil Type kpy pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay w/o Free Water	0.01000	0.00	115.000	750.000
--	0.01000	--	4.000	115.000	750.000
2	Stiff Clay w/o Free Water	0.01000	4.000	134.000	970.000
--	0.01000	--	10.000	134.000	970.000
3	Stiff Clay with Free Water	0.01000 100.000	10.000	71.000	970.000
--	0.01000	100.000	12.000	71.000	970.000
4	Stiff Clay with Free Water	0.00700 500.000	12.000	55.000	1000.000
--	0.00700	500.000	21.000	55.000	1000.000
5	Stiff Clay with Free Water	0.01000 100.000	21.000	71.000	970.000
--	0.01000	100.000	26.000	71.000	970.000
6	Sand (Reese, et al.)	0.01000 100.000	26.000	62.000	--
30.000	--	60.000	90.000	62.000	--
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	1.0000	1.0000
2	50.000	1.0000	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
Top y	vs. Pile Length			
1	1	V = 9000.00000 lbs	M = 660000. in-lbs	85000.
	No			

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

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

p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	0.000 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	281.250 lb/in
Pcd	=	843.750 lb/in
Pu	=	281.250 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	15.81585
0.0003600	23.65021
0.0007200	28.12500
0.00360	42.05668
0.00720	50.01411
0.03600	74.78854
0.07200	88.93906
0.18000	111.83495
0.36000	132.99491
0.54000	147.18307
0.72000	158.15850
1.80000	198.87378
3.60000	236.50212
7.20000	281.25000
7.38000	281.25000
7.56000	281.25000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Equivalent Depth	=	2.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees

Static_Abut1_Cap_Run3_Transv.lp7o

Effective Slope	=	0.000	degrees
Diameter	=	18.000	in
Undrained cohesion, c	=	5.20833	psi
Undrained cohesion, c	=	750.00000	psf
Average Eff. Unit Weight	=	0.06655	pci
Average Eff. Unit Weight	=	115.00000	pcf
Epsilon-50	=	0.01000	
Pct	=	372.500	lb/in
Pcd	=	843.750	lb/in
Pu	=	372.500	lb/in
y50	=	0.450	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.0000720	20.94721
0.0003600	31.32339
0.0007200	37.25000
0.00360	55.70174
0.00720	66.24091
0.03600	99.05326
0.07200	117.79484
0.18000	148.11917
0.36000	176.14438
0.54000	194.93580
0.72000	209.47214
1.80000	263.39728
3.60000	313.23391
7.20000	372.50000
7.38000	372.50000
7.56000	372.50000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Equivalent Depth	=	3.596 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	0.000 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.97222 psi
Undrained cohesion, c	=	860.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	503.045 lb/in
Pcd	=	967.500 lb/in
Pu	=	503.045 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000

	Static_Abut1_Cap_Run3_Transv.lp7o
0.0000720	28.28831
0.0003600	42.30088
0.0007200	50.30451
0.00360	75.22279
0.00720	89.45548
0.03600	133.76714
0.07200	159.07683
0.18000	200.02853
0.36000	237.87535
0.54000	263.25235
0.72000	282.88306
1.80000	355.70662
3.60000	423.00884
7.20000	503.04512
7.38000	503.04512
7.56000	503.04512

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft
Equivalent Depth	=	5.596 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	0.000 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07022 pci
Average Eff. Unit Weight	=	121.33333 pcf
Epsilon-50	=	0.01000
Pct	=	674.790 lb/in
Pcd	=	1091.250 lb/in
Pu	=	674.790 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.0000720	37.94622
0.0003600	56.74284
0.0007200	67.47899
0.00360	100.90462
0.00720	119.99649
0.03600	179.43660
0.07200	213.38729
0.18000	268.32031
0.36000	319.08842
0.54000	353.12939
0.72000	379.46222
1.80000	477.14848
3.60000	567.42837
7.20000	674.78986
7.38000	674.78986
7.56000	674.78986

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Static_Abut1_Cap_Run3_Transv.lp7o

Soil Layer Number	=	2
Depth below pile head	=	8.000 ft
Depth below ground surface	=	8.000 ft
Equivalent Depth	=	7.596 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	0.000 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07205 pci
Average Eff. Unit Weight	=	124.50000 pcf
Epsilon-50	=	0.01000
Pct	=	788.963 lb/in
Pcd	=	1091.250 lb/in
Pu	=	788.963 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	44.36666
0.0003600	66.34364
0.0007200	78.89632
0.00360	117.97752
0.00720	140.29971
0.03600	209.79700
0.07200	249.49208
0.18000	313.71969
0.36000	373.07768
0.54000	412.87833
0.72000	443.66664
1.80000	557.88126
3.60000	663.43636
7.20000	788.96324
7.38000	788.96324
7.56000	788.96324

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Equivalent Depth	=	52.081 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07315 pci
Average Eff. Unit Weight	=	126.40000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	12979.444 lb/in
pcd	=	1333.750 lb/in

	Static_Abut1_Cap_Run3_Transv.lp7o	
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	12.000 ft
Depth below ground surface	=	12.000 ft
Equivalent Depth	=	53.298 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.840 lb/in**2
Average cohesion, c	=	6.84028 psi
Undrained cohesion, c	=	985.00000 psf
Average Eff. Unit Weight	=	0.06780 pci
Average Eff. Unit Weight	=	117.16667 pcf
k	=	500.000 pci
Epsilon50	=	0.00850
y50	=	0.153 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	13407.784 lb/in
pcd	=	1354.375 lb/in
pc	=	1354.375 lb/in
pu	=	118.756 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.04590	370.91088
0.09180	524.54719
0.13770	611.11703
0.18360	667.33113
0.22950	705.72579
0.27540	731.37283
0.32130	747.17043

	Static_Abut1_Cap_Run3_Transv.lp7o
0.36720	754.98886
0.41310	756.12825
0.45900	751.54057
0.50490	741.95031
0.55080	727.92564
0.91800	525.06857
1.28520	321.91231
1.65240	118.75605
1.74420	118.75605

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Equivalent Depth	=	55.298 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	6.89236 psi
Undrained cohesion, c	=	992.50000 psf
Average Eff. Unit Weight	=	0.06267 pci
Average Eff. Unit Weight	=	108.28571 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.126 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	13939.963 lb/in
pcd	=	1375.000 lb/in
pc	=	1375.000 lb/in
pu	=	120.565 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Equivalent Depth	=	57.298 ft
Diameter	=	18.000 in

Static_Abut1_Cap_Run3_Transv.lp7o

c (at curve depth)	=	6.944	lb/in**2
Average cohesion, c	=	12.50935	psi
Undrained cohesion, c	=	1801.34615	psf
Average Eff. Unit Weight	=	0.05881	pci
Average Eff. Unit Weight	=	101.62500	pcf
k	=	500.000	pci
Epsilon50	=	0.00700	
y50	=	0.126	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	25519.456	lb/in
pcd	=	1375.000	lb/in
pc	=	1375.000	lb/in
pu	=	120.565	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4	
Depth below pile head	=	18.000	ft
Depth below ground surface	=	18.000	ft
Equivalent Depth	=	59.298	ft
Diameter	=	18.000	in
c (at curve depth)	=	6.944	lb/in**2
Average cohesion, c	=	17.32292	psi
Undrained cohesion, c	=	2494.50000	psf
Average Eff. Unit Weight	=	0.05581	pci
Average Eff. Unit Weight	=	96.44444	pcf
k	=	500.000	pci
Epsilon50	=	0.00700	
y50	=	0.126	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	36222.782	lb/in
pcd	=	1375.000	lb/in
pc	=	1375.000	lb/in
pu	=	120.565	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in

Static_Abut1_Cap_Run3_Transv.lp7o

-----	-----
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	22.000 ft
Depth below ground surface	=	22.000 ft
Equivalent Depth	=	63.454 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05187 pci
Average Eff. Unit Weight	=	89.63636 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	15469.218 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

-----	-----
y, in	p, lb/in
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260

	Static_Abut1_Cap_Run3_Transv.lp7o
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth	=	65.454 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05097 pci
Average Eff. Unit Weight	=	88.08333 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	15936.437 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	26.000 ft
Depth below ground surface	=	26.000 ft
Equivalent Depth (see note)	=	11.186 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Transv.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	86.76923	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2053.110	lb/in
Psd	=	8106.126	lb/in
Ps = Pst (shallow controls)	=	2053.110	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	2134.4824	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	2080.4852	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0338	in
Pk	=	272.149	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	1026.555	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	1806.737	lb/in
Es, lim	=	8053.792	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.03379	272.14913	*
0.05799	377.93866	
0.08219	467.20999	
0.10639	546.58489	
0.13059	619.12025	
0.15480	686.53922	
0.17900	749.93130	
0.20320	810.03940	
0.22740	867.39811	
0.25160	922.40790	
0.27580	975.37843	
0.30000	1026.55520	
0.48750	1416.64617	
0.67500	1806.73714	
0.69188	1806.73714	
0.70875	1806.73714	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	28.000 ft
Depth below ground surface	=	28.000 ft
Equivalent Depth (see note)	=	13.186 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Transv.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	85.00000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2727.959	lb/in
Psd	=	8551.675	lb/in
Ps = Pst (shallow controls)	=	2727.959	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	2836.0773	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	2764.3314	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0459	in
Pk	=	435.376	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	1363.979	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	2400.604	lb/in
Es, lim	=	9493.792	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in
0.0000	0.0000
0.04586	435.37557 *
0.06896	557.95034
0.09207	665.10722
0.11517	762.10142
0.13827	851.70284
0.16138	935.59264
0.18448	1014.88578
0.20759	1090.36855
0.23069	1162.62108
0.25379	1232.08652
0.27690	1299.11280
0.30000	1363.97932
0.48750	1882.29145
0.67500	2400.60359
0.69188	2400.60359
0.70875	2400.60359

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	30.000 ft
Depth below ground surface	=	30.000 ft
Equivalent Depth (see note)	=	15.186 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Transv.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	83.46667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3488.907	lb/in
Psd	=	8997.225	lb/in
Ps = Pst (shallow controls)	=	3488.907	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	3627.1842	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	3535.4252	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0599	in
Pk	=	655.117	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B ps$	=	1744.453	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A Ps$	=	3070.238	lb/in
Es, lim	=	10933.792	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.05992	655.11685	*
0.08174	791.29392	
0.10357	913.74987	
0.12539	1026.41224	
0.14722	1131.60002	
0.16905	1230.82350	
0.19087	1325.13409	
0.21270	1415.30000	
0.23452	1501.90364	
0.25635	1585.39952	
0.27817	1666.15079	
0.30000	1744.45327	
0.48750	2407.34550	
0.67500	3070.23773	
0.69188	3070.23773	
0.70875	3070.23773	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	32.000 ft
Depth below ground surface	=	32.000 ft
Equivalent Depth (see note)	=	17.186 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Transv.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	82.12500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4334.626	lb/in
Psd	=	9442.774	lb/in
Ps = Pst (shallow controls)	=	4334.626	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	4506.4226	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	4392.4211	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0760	in
Pk	=	940.685	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	2167.313	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	3814.471	lb/in
Es, lim	=	12373.792	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in
0.0000	0.0000
0.07602	940.68542 *
0.09638	1086.69317
0.11675	1220.99579
0.13711	1346.37044
0.15747	1464.62416
0.17783	1577.01411
0.19819	1684.45839
0.21855	1787.65278
0.23892	1887.14011
0.25928	1983.35397
0.27964	2076.64750
0.30000	2167.31306
0.48750	2990.89201
0.67500	3814.47096
0.69188	3814.47096
0.70875	3814.47096

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Equivalent Depth (see note)	=	19.186 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Transv.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	80.94118	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	5264.102	lb/in
Psd	=	9888.324	lb/in
Ps = Pst (shallow controls)	=	5264.102	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	5472.7368	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	5334.2898	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0942	in
Pk	=	1301.746	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	2632.051	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	4632.410	lb/in
Es, lim	=	13813.792	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.09424	1301.74615	*
0.11294	1453.24445	
0.13165	1595.16818	
0.15035	1729.37255	
0.16906	1857.16945	
0.18776	1979.52878	
0.20647	2097.19263	
0.22518	2210.74441	
0.24388	2320.65308	
0.26259	2427.30259	
0.28129	2531.01220	
0.30000	2632.05093	
0.48750	3632.23028	
0.67500	4632.40962	
0.69188	4632.40962	
0.70875	4632.40962	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Equivalent Depth (see note)	=	21.186 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Transv.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	79.88889	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	6276.544	lb/in
Psd	=	10333.873	lb/in
Ps = Pst (shallow controls)	=	6276.544	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	6525.3055	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	6360.2311	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.1146	in
Pk	=	1748.317	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	3138.272	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	5523.359	lb/in
Es, lim	=	15253.792	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.11462	1748.31726	*
0.13147	1900.39674	
0.14832	2044.99891	
0.16517	2183.28569	
0.18203	2316.13953	
0.19888	2444.25010	
0.21573	2568.16909	
0.23259	2688.34633	
0.24944	2805.15458	
0.26629	2918.90702	
0.28315	3029.86991	
0.30000	3138.27198	
0.48750	4330.81531	
0.67500	5523.35865	
0.69188	5523.35865	
0.70875	5523.35865	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	38.000 ft
Depth below ground surface	=	38.000 ft
Equivalent Depth (see note)	=	23.186 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Transv.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	78.94737	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	7371.329	lb/in
Psd	=	10779.423	lb/in
Ps = Pst (shallow controls)	=	7371.329	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	7663.4806	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	7469.6131	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.1372	in
Pk	=	2290.768	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	3685.664	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	6486.769	lb/in
Es, lim	=	16693.792	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.13722	2290.76837	*
0.15202	2437.93947	
0.16682	2579.59038	
0.18162	2716.39282	
0.19641	2848.88924	
0.21121	2977.52551	
0.22601	3102.67358	
0.24081	3224.64778	
0.25561	3343.71672	
0.27040	3460.11214	
0.28520	3574.03574	
0.30000	3685.66441	
0.48750	5086.21686	
0.67500	6486.76932	
0.69188	6486.76932	
0.70875	6486.76932	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	40.000 ft
Depth below ground surface	=	40.000 ft
Equivalent Depth (see note)	=	25.186 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	18.000 in

Static_Abut1_Cap_Run3_Transv.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	78.10000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	8547.958	lb/in
Psd	=	11224.972	lb/in
Ps = Pst (shallow controls)	=	8547.958	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	8886.7433	
n = $Pm/(m \cdot Ym)$	=	1.6447	
m = $(Pu - Pm)/(Yu - Ym)$	=	8661.9303	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.1621	in
Pk	=	2939.817	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	4273.979	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	7522.203	lb/in
Es, lim	=	18133.792	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.16212	2939.81686	*
0.17465	3075.99392	
0.18719	3208.38938	
0.19972	3337.35170	
0.21226	3463.17753	
0.22479	3586.12206	
0.23733	3706.40672	
0.24986	3824.22526	
0.26240	3939.74835	
0.27493	4053.12732	
0.28747	4164.49714	
0.30000	4273.97880	
0.48750	5898.09072	
0.67500	7522.20264	
0.69188	7522.20264	
0.70875	7522.20264	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

 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)

Static_Abut1_Cap_Run3_Transv.lp7o

Shear force at pile head = 9000.0 lbs
 Applied moment at pile head = 660000.0 in-lbs
 Axial thrust load on pile head = 85000.0 lbs

Depth Res.	Soil X Es*h feet lb/inch	Deflect. Spr. y Lat. inches lb/inch	Bending Distrib. Load Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil p lb/in
0.00		0.2519	660000.	9000.0000	-0.003679	5975.6713	3.194E+10	
-121.6439		1448.5476	0.000					
1.000		0.2093	762613.	7458.6346	-0.003411	6852.7031	3.194E+10	
-134.9800		3868.8951	0.000					
2.000		0.1702	845517.	5770.6402	-0.003109	7561.2851	3.194E+10	
-146.0579		5149.9605	0.000					
3.000		0.1348	907087.	3964.3216	-0.002779	8087.5274	3.194E+10	
-154.6738		6884.2272	0.000					
4.000		0.1035	946062.	2029.7583	-0.002430	8420.6420	3.194E+10	
-174.2050		10096.	0.000					
5.000		0.0765	959360.	-268.4462	-0.002071	8534.3080	3.194E+10	
-198.3533		15554.	0.000					
6.000		0.0538	943766.	-2652.3701	-0.001713	8401.0236	3.194E+10	
-198.4228		22122.	0.000					
7.000		0.0354	899280.	-5009.3621	-0.001366	8020.8025	3.194E+10	
-193.7659		32873.	0.000					
8.000		0.0210	826600.	-7276.6470	-0.001041	7399.6028	3.194E+10	
-183.2846		52462.	0.000					
9.000		0.0103	727283.	-9371.1542	-0.000749	6550.7390	3.194E+10	
-164.4822		96023.	0.000					
10.000		0.002866	604144.	-11016.	-0.000498	5498.2676	3.194E+10	
-84.1700		176219.	0.000					
11.000		-0.001825	468825.	-11150.	-0.000296	4341.6928	3.194E+10	
67.1337		220681.	0.000					
12.000		-0.004400	340934.	-10059.	-0.000145	3248.6120	3.194E+10	
114.8266		156590.	0.000					
13.000		-0.005432	229417.	-8458.2521	-3.794E-05	2295.4737	3.194E+10	
142.7459		157663.	0.000					
14.000		-0.005425	138241.	-6737.8685	3.065E-05	1516.1949	3.194E+10	
142.6480		157778.	0.000					
15.000		-0.004788	67478.	-5072.8927	6.883E-05	911.3802	3.194E+10	
134.0160		167945.	0.000					
16.000		-0.003841	15939.	-3545.4274	8.407E-05	470.8773	3.194E+10	
120.0423		187500.	0.000					
17.000		-0.002818	-18349.	-2206.4412	8.324E-05	491.4755	3.194E+10	
102.8201		218911.	0.000					
18.000		-0.001873	-37840.	-1085.6354	7.237E-05	658.0655	3.194E+10	
83.8354		268493.	0.000					
19.000		-0.001096	-45251.	-197.6128	5.651E-05	721.4055	3.194E+10	
64.1246		351041.	0.000					
20.000		-0.000520	-43412.	452.3697	3.967E-05	705.6898	3.194E+10	
44.1713		509665.	0.000					
21.000		-0.000138	-35205.	819.3721	2.478E-05	635.5447	3.194E+10	
10.3382		449672.	0.000					
22.000		8.580E-05	-24995.	834.9122	1.347E-05	548.2766	3.194E+10	
-6.5331		456872.	0.000					
23.000		0.000197	-15642.	699.4711	5.873E-06	468.3368	3.194E+10	
-15.2039		464072.	0.000					
24.000		0.000236	-8424.6334	493.9158	1.410E-06	406.6511	3.194E+10	
-18.5523		471272.	0.000					
25.000		0.000237	-3849.1609	267.6128	-8.320E-07	367.5445	3.194E+10	

Static_Abut1_Cap_Run3_Transv.lp7o

-18.9066	478472.	0.000				
26.000	0.000220	-1982.0237	94.7404	-1.865E-06	351.5860	3.194E+10
-1.7706	48323.	0.000				
27.000	0.000194	-969.5155	73.8551	-2.414E-06	342.9321	3.194E+10
-1.6987	52643.	0.000				
28.000	0.000163	-200.5190	54.3321	-2.628E-06	336.3595	3.194E+10
-1.5468	56963.	0.000				
29.000	0.000131	346.3113	36.9758	-2.596E-06	337.6056	3.194E+10
-1.3408	61283.	0.000				
30.000	0.000101	700.1992	22.2837	-2.395E-06	340.6303	3.194E+10
-1.1057	65603.	0.000				
31.000	7.410E-05	894.6603	10.4702	-2.092E-06	342.2923	3.194E+10
-0.8635	69923.	0.000				
32.000	5.106E-05	964.3379	1.5114	-1.740E-06	342.8879	3.194E+10
-0.6319	74243.	0.000				
33.000	3.235E-05	942.4464	-4.8004	-1.380E-06	342.7008	3.194E+10
-0.4236	78563.	0.000				
34.000	1.788E-05	858.9048	-8.7982	-1.041E-06	341.9867	3.194E+10
-0.2469	82883.	0.000				
35.000	7.261E-06	739.1556	-10.8861	-7.398E-07	340.9632	3.194E+10
-0.1055	87203.	0.000				
36.000	-2.517E-08	603.6055	-11.4910	-4.874E-07	339.8047	3.194E+10
0.000384	91523.	0.000				
37.000	-4.590E-06	467.5816	-11.0255	-2.862E-07	338.6421	3.194E+10
0.0733	95843.	0.000				
38.000	-7.044E-06	341.6776	-9.8605	-1.345E-07	337.5660	3.194E+10
0.1176	100163.	0.000				
39.000	-7.952E-06	232.3639	-8.3087	-2.711E-08	336.6317	3.194E+10
0.1385	104483.	0.000				
40.000	-7.807E-06	142.7403	-6.6172	4.289E-08	335.8657	3.194E+10
0.1416	108803.	0.000				
41.000	-7.012E-06	73.3348	-4.9672	8.302E-08	335.2725	3.194E+10
0.1322	113123.	0.000				
42.000	-5.881E-06	22.8689	-3.4790	1.007E-07	334.8411	3.194E+10
0.1151	117443.	0.000				
43.000	-4.643E-06	-11.0625	-2.2213	1.025E-07	334.7402	3.194E+10
0.0942	121763.	0.000				
44.000	-3.451E-06	-31.4285	-1.2212	9.427E-08	334.9143	3.194E+10
0.0725	126083.	0.000				
45.000	-2.397E-06	-41.3286	-0.4751	8.039E-08	334.9989	3.194E+10
0.0521	130403.	0.000				
46.000	-1.528E-06	-43.6867	0.0410	6.427E-08	335.0191	3.194E+10
0.0343	134723.	0.000				
47.000	-8.542E-07	-41.0582	0.3631	4.826E-08	334.9966	3.194E+10
0.0198	139043.	0.000				
48.000	-3.648E-07	-35.5326	0.5316	3.382E-08	334.9494	3.194E+10
0.008716	143363.	0.000				
49.000	-3.525E-08	-28.7091	0.5868	2.174E-08	334.8910	3.194E+10
0.000868	147683.	0.000				
50.000	1.649E-07	-21.7243	0.5650	1.227E-08	334.8313	3.194E+10
-0.004177	152003.	0.000				
51.000	2.669E-07	-15.3123	0.4968	5.331E-09	334.7765	3.194E+10
-0.006952	156323.	0.000				
52.000	2.995E-07	-9.8801	0.4059	6.234E-10	334.7301	3.194E+10
-0.008019	160643.	0.000				
53.000	2.873E-07	-5.5882	0.3096	-2.256E-09	334.6934	3.194E+10
-0.007899	164963.	0.000				
54.000	2.496E-07	-2.4250	0.2196	-3.736E-09	334.6664	3.194E+10
-0.007041	169283.	0.000				
55.000	2.006E-07	-0.2715	0.1423	-4.220E-09	334.6480	3.194E+10
-0.005805	173603.	0.000				
56.000	1.502E-07	1.0472	0.0808	-4.057E-09	334.6546	3.194E+10
-0.004454	177923.	0.000				

		Static_Abut1_Cap_Run3_Transv.lp7o				
57.000	1.043E-07	1.7235	0.0351	-3.524E-09	334.6604	3.194E+10
-0.003169	182243.	0.000				
58.000	6.612E-08	1.9412	0.003942	-2.827E-09	334.6623	3.194E+10
-0.002056	186563.	0.000				
59.000	3.656E-08	1.8601	-0.0152	-2.107E-09	334.6616	3.194E+10
-0.001163	190883.	0.000				
60.000	1.534E-08	1.6088	-0.0250	-1.453E-09	334.6594	3.194E+10
-0.000499	195203.	0.000				
61.000	1.362E-09	1.2830	-0.0281	-9.084E-10	334.6566	3.194E+10
-4.529E-05	199523.	0.000				
62.000	-6.838E-09	0.9486	-0.0269	-4.895E-10	334.6538	3.194E+10
0.000232	203843.	0.000				
63.000	-1.075E-08	0.6461	-0.0232	-1.910E-10	334.6512	3.194E+10
0.000373	208163.	0.000				
64.000	-1.173E-08	0.3962	-0.0184	3.479E-12	334.6491	3.194E+10
0.000416	212483.	0.000				
65.000	-1.092E-08	0.2054	-0.0135	1.151E-10	334.6474	3.194E+10
0.000394	216803.	0.000				
66.000	-9.154E-09	0.0709	-0.009071	1.658E-10	334.6463	3.194E+10
0.000337	221123.	0.000				
67.000	-7.060E-09	-0.0151	-0.005450	1.753E-10	334.6458	3.194E+10
0.000265	225443.	0.000				
68.000	-5.022E-09	-0.0629	-0.002708	1.598E-10	334.6462	3.194E+10
0.000192	229763.	0.000				
69.000	-3.260E-09	-0.0829	-0.000799	1.319E-10	334.6464	3.194E+10
0.000127	234083.	0.000				
70.000	-1.867E-09	-0.0844	0.000400	1.001E-10	334.6464	3.194E+10
7.419E-05	238403.	0.000				
71.000	-8.515E-10	-0.0752	0.001042	6.998E-11	334.6463	3.194E+10
3.445E-05	242723.	0.000				
72.000	-1.735E-10	-0.0608	0.001283	4.438E-11	334.6462	3.194E+10
7.142E-06	247043.	0.000				
73.000	2.308E-10	-0.0452	0.001260	2.446E-11	334.6461	3.194E+10
-9.671E-06	251363.	0.000				
74.000	4.307E-10	-0.0310	0.001087	1.018E-11	334.6459	3.194E+10
-1.835E-05	255683.	0.000				
75.000	4.900E-10	-0.0194	0.000846	0.000	334.6458	3.194E+10
-2.123E-05	260003.	0.000				
76.000	4.610E-10	-0.0107	0.000595	-4.806E-12	334.6458	3.194E+10
-2.031E-05	264323.	0.000				
77.000	3.827E-10	-0.005018	0.000369	-7.704E-12	334.6457	3.194E+10
-1.713E-05	268643.	0.000				
78.000	2.811E-10	-0.001743	0.000189	-8.923E-12	334.6457	3.194E+10
-1.279E-05	272963.	0.000				
79.000	1.711E-10	-0.000303	6.429E-05	-9.272E-12	334.6457	3.194E+10
-7.906E-06	277283.	0.000				
80.000	5.940E-11	0.000	0.000	-9.311E-12	334.6457	3.194E+10
-2.788E-06	140801.	0.000				

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.2519294 inches
Computed slope at pile head	=	-0.0036789 radians
Maximum bending moment	=	959360. inch-lbs
Maximum shear force	=	-11310. lbs
Depth of maximum bending moment	=	5.0000000 feet below pile head
Depth of maximum shear force	=	10.5000000 feet below pile head
Number of iterations	=	23
Number of zero deflection points	=	6

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
 Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
 Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
 Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
 Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Condition 1 V(lbs) or y(inches)	Condition 2 Pile-head in-lb, rad., or in-lb/rad. Rotation radians			
1	1	V = 9000.0000	M = 660000.	85000.	0.25192945	
959360.		-11310.	-0.00367890			

Computed Pile-head Stiffness Matrix Values
 K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)
 K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.000315	0.00000	900.000000	16636.	2856233.	52794785.
0.002653	0.00000	3338.342965	90002.	1258148.	33919724.
0.005396	0.00000	4764.682163	146416.	882999.	27134040.
0.007948	0.00000	5776.685930	190355.	726842.	23951097.
0.010264	0.00000	6561.657035	226389.	639263.	22055765.
0.012373	0.00000	7203.025128	256966.	582152.	20768099.
0.014312	0.00000	7745.294124	283534.	541174.	19810875.
0.016111	0.00000	8215.028895	307069.	509896.	19059362.
0.017792	0.00000	8629.364326	328195.	485003.	18445825.
0.019370	0.00000	9000.000000	347398.	464640.	17934979.

Static_Abut1_Cap_Run3_Transv.lp7o

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)

K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
0.00000	0.00003518	1852.712709	66000.	52665864.	1876139256.
0.00000	0.000166	5218.559137	244812.	31403312.	1473184797.
0.00000	0.000258	6816.585938	349410.	26438238.	1355192412.
0.00000	0.000328	7876.286389	423624.	24041460.	1293062514.
0.00000	0.000385	8664.029877	481188.	22522059.	1250843890.
0.00000	0.000433	9287.599010	528222.	21461311.	1220588147.
0.00000	0.000474	9804.348980	567988.	20678582.	1197957260.
0.00000	0.000511	10245.	602435.	20067451.	1180041051.
0.00000	0.000543	10628.	632820.	19568207.	1165163467.
0.00000	0.000573	10966.	660000.	19153202.	1152711935.

The analysis ended normally.

Static_Abut2_Cap_Run3_Long.lp7o

LPILE Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LpileRuns_10272015\Abut\Static_long\
Name of input data file: Static_Abut2_Cap_Run3_Long.lp7d
Name of output report file: Static_Abut2_Cap_Run3_Long.lp7o
Name of plot output file: Static_Abut2_Cap_Run3_Long.lp7p
Name of runtime message file: Static_Abut2_Cap_Run3_Long.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 15:44:00

Problem Title

Abutment#1 (Lower): 18-inch Static without p-multipliers Round 1

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 23-BMU-14

 Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

 Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	80.000000	18.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	18.00000 in
Bottom Width	=	18.00000 in
Top Area	=	254.00000 Sq. in
Bottom Area	=	254.00000 Sq. in
Moment of Inertia at Top	=	1053.00000 in ⁴
Moment of Inertia at Bottom	=	1053.00000 in ⁴
Elastic Modulus	=	30328000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	-18.400 degrees
	=	-0.321 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 6 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	4.00000 ft
Effective unit weight at top of layer	=	115.00000 pcf
Effective unit weight at bottom of layer	=	115.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer	=	4.00000 ft
Distance from top of pile to bottom of layer	=	10.00000 ft
Effective unit weight at top of layer	=	134.00000 pcf
Effective unit weight at bottom of layer	=	134.00000 pcf
Undrained cohesion at top of layer	=	970.00000 psf

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Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	10.00000	ft
Distance from top of pile to bottom of layer	=	12.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 4 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	12.00000	ft
Distance from top of pile to bottom of layer	=	21.00000	ft
Effective unit weight at top of layer	=	55.00000	pcf
Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	1000.00000	psf
Undrained cohesion at bottom of layer	=	1000.00000	psf
Epsilon-50 at top of layer	=	0.00700	
Epsilon-50 at bottom of layer	=	0.00700	
Subgrade k at top of layer	=	500.00000	pci
Subgrade k at bottom of layer	=	500.00000	pci

Layer 5 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	21.00000	ft
Distance from top of pile to bottom of layer	=	26.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 6 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	26.00000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Static_Abut2_Cap_Run3_Long.lp7o

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Criteria) Epsilon 50	Layer Soil Type kpy pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay w/o Free Water	0.01000	0.00	115.000	750.000
--	0.01000	--	4.000	115.000	750.000
2	Stiff Clay w/o Free Water	0.01000	4.000	134.000	970.000
--	0.01000	--	10.000	134.000	970.000
3	Stiff Clay with Free Water	0.01000 100.000	10.000	71.000	970.000
--	0.01000	100.000	12.000	71.000	970.000
4	Stiff Clay with Free Water	0.00700 500.000	12.000	55.000	1000.000
--	0.00700	500.000	21.000	55.000	1000.000
5	Stiff Clay with Free Water	0.01000 100.000	21.000	71.000	970.000
--	0.01000	100.000	26.000	71.000	970.000
6	Sand (Reese, et al.)	0.01000 100.000	26.000	62.000	--
30.000	--	60.000	90.000	62.000	--
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	1.0000	1.0000
2	50.000	1.0000	1.0000

Loading Type

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

Pile-head Loading and Pile-head Fixity Conditions

Static_Abut2_Cap_Run3_Long.lp7o

Number of loads specified = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
Top y vs. Pile Length				
1	1	V = -6000.00000 lbs	M = -295200. in-lbs	88500.
No				

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

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

p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	211.045 lb/in
Pcd	=	843.750 lb/in
Pu	=	211.045 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	11.86792
0.0003600	17.74668
0.0007200	21.10448
0.00360	31.55855
0.00720	37.52965
0.03600	56.11992
0.07200	66.73821
0.18000	83.91886
0.36000	99.79690
0.54000	110.44343
0.72000	118.67919
1.80000	149.23118
3.60000	177.46678
7.20000	211.04475
7.38000	211.04475
7.56000	211.04475

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Equivalent Depth	=	2.000 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter Angle	=	0.000 degrees

Static_Abut2_Cap_Run3_Long.lp7o

Effective Slope	=	-18.400	degrees
Diameter	=	18.000	in
Undrained cohesion, c	=	5.20833	psi
Undrained cohesion, c	=	750.00000	psf
Average Eff. Unit Weight	=	0.06655	pci
Average Eff. Unit Weight	=	115.00000	pcf
Epsilon-50	=	0.01000	
Pct	=	279.517	lb/in
Pcd	=	843.750	lb/in
Pu	=	279.517	lb/in
y50	=	0.450	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.0000720	15.71840
0.0003600	23.50449
0.0007200	27.95171
0.00360	41.79755
0.00720	49.70594
0.03600	74.32772
0.07200	88.39105
0.18000	111.14587
0.36000	132.17545
0.54000	146.27619
0.72000	157.18399
1.80000	197.64840
3.60000	235.04489
7.20000	279.51705
7.38000	279.51705
7.56000	279.51705

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2	
Depth below pile head	=	4.000	ft
Depth below ground surface	=	4.000	ft
Equivalent Depth	=	2.830	ft
Ground Slope Angle	=	-18.400	degrees
Pile Batter Angle	=	0.000	degrees
Effective Slope	=	-18.400	degrees
Diameter	=	18.000	in
Undrained cohesion, c	=	5.97222	psi
Undrained cohesion, c	=	860.00000	psf
Average Eff. Unit Weight	=	0.06655	pci
Average Eff. Unit Weight	=	115.00000	pcf
Epsilon-50	=	0.01000	
Pct	=	348.624	lb/in
Pcd	=	967.500	lb/in
Pu	=	348.624	lb/in
y50	=	0.450	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
-----	-----
0.0000	0.0000

	Static_Abut2_Cap_Run3_Long.lp7o
0.0000720	19.60457
0.0003600	29.31566
0.0007200	34.86240
0.00360	52.13144
0.00720	61.99508
0.03600	92.70427
0.07200	110.24458
0.18000	138.62522
0.36000	164.85410
0.54000	182.44105
0.72000	196.04567
1.80000	246.51438
3.60000	293.15665
7.20000	348.62397
7.38000	348.62397
7.56000	348.62397

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft
Equivalent Depth	=	4.830 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07022 pci
Average Eff. Unit Weight	=	121.33333 pcf
Epsilon-50	=	0.01000
Pct	=	474.409 lb/in
Pcd	=	1091.250 lb/in
Pu	=	474.409 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	26.67800
0.0003600	39.89291
0.0007200	47.44093
0.00360	70.94074
0.00720	84.36324
0.03600	126.15246
0.07200	150.02140
0.18000	188.64193
0.36000	224.33432
0.54000	248.26674
0.72000	266.77997
1.80000	335.45806
3.60000	398.92911
7.20000	474.40933
7.38000	474.40933
7.56000	474.40933

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Static_Abut2_Cap_Run3_Long.lp7o

Soil Layer Number	=	2
Depth below pile head	=	8.000 ft
Depth below ground surface	=	8.000 ft
Equivalent Depth	=	6.830 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07205 pci
Average Eff. Unit Weight	=	124.50000 pcf
Epsilon-50	=	0.01000
Pct	=	559.855 lb/in
Pcd	=	1091.250 lb/in
Pu	=	559.855 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	31.48299
0.0003600	47.07804
0.0007200	55.98554
0.00360	83.71792
0.00720	99.55794
0.03600	148.87385
0.07200	177.04184
0.18000	222.61833
0.36000	264.73930
0.54000	292.98220
0.72000	314.82986
1.80000	395.87758
3.60000	470.78044
7.20000	559.85545
7.38000	559.85545
7.56000	559.85545

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Equivalent Depth	=	37.949 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07315 pci
Average Eff. Unit Weight	=	126.40000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	7146.096 lb/in
pcd	=	1333.750 lb/in

	Static_Abut2_Cap_Run3_Long.lp7o		
pc	=	1333.750	lb/in
pu	=	116.948	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4	
Depth below pile head	=	12.000	ft
Depth below ground surface	=	12.000	ft
Equivalent Depth	=	39.381	ft
Diameter	=	18.000	in
c (at curve depth)	=	6.840	lb/in**2
Average cohesion, c	=	6.84028	psi
Undrained cohesion, c	=	985.00000	psf
Average Eff. Unit Weight	=	0.06780	pci
Average Eff. Unit Weight	=	117.16667	pcf
k	=	500.000	pci
Epsilon50	=	0.00850	
y50	=	0.153	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	7482.119	lb/in
pcd	=	1354.375	lb/in
pc	=	1354.375	lb/in
pu	=	118.756	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.04590	370.91088
0.09180	524.54719
0.13770	611.11703
0.18360	667.33113
0.22950	705.72579
0.27540	731.37283
0.32130	747.17043

	Static_Abut2_Cap_Run3_Long.lp7o
0.36720	754.98886
0.41310	756.12825
0.45900	751.54057
0.50490	741.95031
0.55080	727.92564
0.91800	525.06857
1.28520	321.91231
1.65240	118.75605
1.74420	118.75605

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Equivalent Depth	=	41.381 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	6.89236 psi
Undrained cohesion, c	=	992.50000 psf
Average Eff. Unit Weight	=	0.06267 pci
Average Eff. Unit Weight	=	108.28571 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.126 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	7874.579 lb/in
pcd	=	1375.000 lb/in
pc	=	1375.000 lb/in
pu	=	120.565 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Equivalent Depth	=	43.381 ft
Diameter	=	18.000 in

Static_Abut2_Cap_Run3_Long.lp7o

c (at curve depth)	=	6.944	lb/in**2
Average cohesion, c	=	12.50935	psi
Undrained cohesion, c	=	1801.34615	psf
Average Eff. Unit Weight	=	0.05881	pci
Average Eff. Unit Weight	=	101.62500	pcf
k	=	500.000	pci
Epsilon50	=	0.00700	
y50	=	0.126	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	14580.262	lb/in
pcd	=	1375.000	lb/in
pc	=	1375.000	lb/in
pu	=	120.565	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4	
Depth below pile head	=	18.000	ft
Depth below ground surface	=	18.000	ft
Equivalent Depth	=	45.381	ft
Diameter	=	18.000	in
c (at curve depth)	=	6.944	lb/in**2
Average cohesion, c	=	17.32292	psi
Undrained cohesion, c	=	2494.50000	psf
Average Eff. Unit Weight	=	0.05581	pci
Average Eff. Unit Weight	=	96.44444	pcf
k	=	500.000	pci
Epsilon50	=	0.00700	
y50	=	0.126	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	20911.483	lb/in
pcd	=	1375.000	lb/in
pc	=	1375.000	lb/in
pu	=	120.565	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in

Static_Abut2_Cap_Run3_Long.lp7o

-----	-----
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	22.000 ft
Depth below ground surface	=	22.000 ft
Equivalent Depth	=	49.537 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05187 pci
Average Eff. Unit Weight	=	89.63636 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	9101.861 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

-----	-----
y, in	p, lb/in
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260

	Static_Abut2_Cap_Run3_Long.lp7o
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth	=	51.537 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05097 pci
Average Eff. Unit Weight	=	88.08333 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	9454.481 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	26.000 ft
Depth below ground surface	=	26.000 ft
Equivalent Depth (see note)	=	10.217 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut2_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	86.76923	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	901.203	lb/in
Psd	=	8106.126	lb/in
Ps = Pst (shallow controls)	=	901.203	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	936.9204	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	913.2186	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0052	in
Pk	=	38.339	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	450.601	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	793.058	lb/in
Es, lim	=	7355.919	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in
0.0000	0.0000
0.00521	38.33905 *
0.03201	115.59096
0.05881	167.31242
0.08561	210.21982
0.11241	248.07702
0.13921	282.51906
0.16601	314.43949
0.19280	344.39254
0.21960	372.75123
0.24640	399.78139
0.27320	425.68074
0.30000	450.60127
0.48750	621.82975
0.67500	793.05822
0.69188	793.05822
0.70875	793.05822

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	28.000 ft
Depth below ground surface	=	28.000 ft
Equivalent Depth (see note)	=	12.217 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut2_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	85.00000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	1224.062	lb/in
Psd	=	8551.675	lb/in
Ps = Pst (shallow controls)	=	1224.062	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	1272.5761	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	1240.3830	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0072	in
Pk	=	63.453	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B ps$	=	612.031	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A Ps$	=	1077.175	lb/in
Es, lim	=	8795.919	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in
0.0000	0.0000
0.00721	63.45283 *
0.03383	162.36998
0.06045	231.08025
0.08706	288.47464
0.11368	339.26834
0.14030	385.56003
0.16692	428.51064
0.19353	468.84568
0.22015	507.05590
0.24677	543.49234
0.27338	578.41685
0.30000	612.03112
0.48750	844.60294
0.67500	1077.17476
0.69188	1077.17476
0.70875	1077.17476

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	30.000 ft
Depth below ground surface	=	30.000 ft
Equivalent Depth (see note)	=	14.217 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut2_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	83.46667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	1591.208	lb/in
Psd	=	8997.225	lb/in
Ps = Pst (shallow controls)	=	1591.208	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	1654.2736	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	1612.4245	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0096	in
Pk	=	97.936	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	795.604	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	1400.263	lb/in
Es, lim	=	10235.919	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in
0.0000	0.0000
0.00957	97.93648 *
0.03597	219.09138
0.06237	306.17414
0.08878	379.46616
0.11518	444.55312
0.14158	503.98914
0.16799	559.20684
0.19439	611.10922
0.22079	660.31068
0.24719	707.25266
0.27360	752.26546
0.30000	795.60421
0.48750	1097.93381
0.67500	1400.26341
0.69188	1400.26341
0.70875	1400.26341

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	32.000 ft
Depth below ground surface	=	32.000 ft
Equivalent Depth (see note)	=	16.217 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut2_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	82.12500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2001.879	lb/in
Psd	=	9442.774	lb/in
Ps = Pst (shallow controls)	=	2001.879	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	2081.2204	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	2028.5706	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0123	in
Pk	=	143.432	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	1000.939	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	1761.653	lb/in
Es, lim	=	11675.919	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.01228	143.43189	*
0.03844	286.99148	
0.06460	393.48168	
0.09075	483.83307	
0.11691	564.37528	
0.14306	638.08858	
0.16922	706.67059	
0.19538	771.20173	
0.22153	832.42209	
0.24769	890.86601	
0.27384	946.93482	
0.30000	1000.93946	
0.48750	1381.29645	
0.67500	1761.65344	
0.69188	1761.65344	
0.70875	1761.65344	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Equivalent Depth (see note)	=	18.217 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut2_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	80.94118	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	24981.368	lb/in
Psd	=	9888.324	lb/in
Ps = Psd (deep controls)	=	9888.324	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	10280.2331	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	10020.1681	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.5372	in
Pk	=	7045.496	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	4944.162	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	8701.725	lb/in
Es, lim	=	13115.919	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has a tri-linear shape for a Reese sand p-y curve because $Ym < Yk < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.53717	7045.49574	*
0.54777	7184.55342	*
0.55838	7323.61110	*
0.56898	7462.66878	*
0.57958	7601.72647	*
0.59018	7740.78415	*
0.60078	7879.84183	*
0.61139	8018.89951	*
0.62199	8157.95719	*
0.63259	8276.78144	
0.64319	8383.01733	
0.65380	8489.25322	
0.66440	8595.48910	
0.67500	8701.72499	
0.69188	8701.72499	
0.70875	8701.72499	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Equivalent Depth (see note)	=	20.217 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut2_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	79.88889	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	30219.846	lb/in
Psd	=	10333.873	lb/in
Ps = Psd (deep controls)	=	10333.873	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	10743.4413	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	10471.6582	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.4608	in
Pk	=	6707.639	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	5166.937	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	9093.809	lb/in
Es, lim	=	14555.919	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has a tri-linear shape for a Reese sand p-y curve because $Ym < Yk < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.46082	6707.63896	*
0.47729	6947.45485	*
0.49377	7187.27075	*
0.51025	7368.55160	
0.52672	7541.07729	
0.54320	7713.60298	
0.55967	7886.12868	
0.57615	8058.65437	
0.59262	8231.18006	
0.60910	8403.70576	
0.62557	8576.23145	
0.64205	8748.75714	
0.65852	8921.28284	
0.67500	9093.80853	
0.69188	9093.80853	
0.70875	9093.80853	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	38.000 ft
Depth below ground surface	=	38.000 ft
Equivalent Depth (see note)	=	22.217 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut2_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	78.94737	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	35919.840	lb/in
Psd	=	10779.423	lb/in
Ps = Psd (deep controls)	=	10779.423	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	11206.6494	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	10923.1484	
Yk = [c/(kx)]^(n/(n-1))	=	0.4034	in
Pk	=	6453.440	lb/in
Ym = b/60	=	0.3000	in
Pm = B ps	=	5389.711	lb/in
Yu = 3b/80	=	0.6750	in
Pu = A Ps	=	9485.892	lb/in
Es, lim	=	15995.919	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has a tri-linear shape for a Reese sand p-y curve because $Ym < Yk < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.40344	6453.44043	*
0.42433	6747.80751	
0.44522	6975.98122	
0.46611	7204.15494	
0.48700	7432.32865	
0.50789	7660.50236	
0.52878	7888.67608	
0.54967	8116.84979	
0.57055	8345.02350	
0.59144	8573.19722	
0.61233	8801.37093	
0.63322	9029.54464	
0.65411	9257.71836	
0.67500	9485.89207	
0.69188	9485.89207	
0.70875	9485.89207	

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	40.000 ft
Depth below ground surface	=	40.000 ft
Equivalent Depth (see note)	=	24.217 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter, b	=	18.000 in

Static_Abut2_Cap_Run3_Long.lp7o

Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	78.10000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	42077.910	lb/in
Psd	=	11224.972	lb/in
Ps = Psd (deep controls)	=	11224.972	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	11669.8576	
$n = Pm/(m \cdot Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	11374.6385	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.3590	in
Pk	=	6260.366	lb/in
$Ym = b/60$	=	0.3000	in
$Pm = B \cdot ps$	=	5612.486	lb/in
$Yu = 3b/80$	=	0.6750	in
$Pu = A \cdot Ps$	=	9877.976	lb/in
Es, lim	=	17435.919	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has a tri-linear shape for a Reese sand p-y curve because $Ym < Yk < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.35905	6260.36594	*
0.38335	6560.60549	
0.40766	6837.05300	
0.43196	7113.50051	
0.45627	7389.94802	
0.48057	7666.39553	
0.50487	7942.84304	
0.52918	8219.29055	
0.55348	8495.73806	
0.57778	8772.18557	
0.60209	9048.63308	
0.62639	9325.08059	
0.65070	9601.52810	
0.67500	9877.97561	
0.69188	9877.97561	
0.70875	9877.97561	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

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)

Static_Abut2_Cap_Run3_Long.lp7o

Shear force at pile head = -6000.0 lbs
 Applied moment at pile head = -295200.0 in-lbs
 Axial thrust load on pile head = 88500.0 lbs

Depth Res.	Soil X Es*h feet lb/inch	Deflect. Spr. y Lat. inches lb/inch	Bending Distrib. Load Moment in- lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil p lb/in
	0.00	-0.1291	-295200.	-6000.0000	0.001871	2871.5021	3.194E+10	
77.2311	1794.6999	0.000	-363405.	-5021.2871	0.001747	3454.4548	3.194E+10	
85.7137	4790.8535	0.000	-419137.	-3949.4243	0.001600	3930.7888	3.194E+10	
92.7398	6379.0030	0.000	-461360.	-2802.6964	0.001434	4291.6773	3.194E+10	
98.1734	8536.9417	0.000	-489279.	-1600.5528	0.001255	4530.3006	3.194E+10	
102.0484	11587.	0.000	-501878.	-248.3244	0.001069	4637.9795	3.194E+10	
117.0692	18061.	0.000	-497441.	1161.8864	0.000881	4600.0613	3.194E+10	
117.6248	25949.	0.000	-475895.	2561.3992	0.000697	4415.9073	3.194E+10	
115.2268	38968.	0.000	-437599.	3911.2087	0.000525	4088.5898	3.194E+10	
109.2337	62858.	0.000	-383443.	5160.7543	0.000371	3625.7146	3.194E+10	
98.2467	116029.	0.000	-315067.	6174.0396	0.000239	3041.3089	3.194E+10	
60.0699	247006.	0.000	-238677.	6305.7022	0.000135	2388.3977	3.194E+10	
11.000	0.000744	0.000	-166492.	5621.5186	5.922E-05	1771.4316	3.194E+10	
-34.7713	280434.	0.000	-104979.	4585.5373	8.517E-06	1245.6830	3.194E+10	
12.000	0.001869	0.000	-56539.	3492.8198	-2.152E-05	831.6635	3.194E+10	
-74.8441	240213.	0.000	-20914.	2463.2772	-3.578E-05	527.1748	3.194E+10	
13.000	0.002241	0.000	3010.2008	1551.4769	-3.889E-05	374.1534	3.194E+10	
-91.6855	245456.	0.000	16853.	789.0329	-3.494E-05	492.4708	3.194E+10	
14.000	0.002136	0.000	22520.	192.5177	-2.737E-05	540.9014	3.194E+10	
-89.5088	251445.	0.000	22054.	-229.9076	-1.888E-05	536.9178	3.194E+10	
15.000	0.001772	0.000	17598.	-454.5549	-1.136E-05	498.8366	3.194E+10	
-81.5306	276066.	0.000	12211.	-409.3282	-5.794E-06	452.7968	3.194E+10	
16.000	0.001310	0.000	7672.3819	-339.6159	-2.078E-06	414.0011	3.194E+10	
-70.1162	321024.	0.000	4123.8099	-249.7498	1.124E-07	383.6714	3.194E+10	
17.000	0.000860	0.000	1680.9289	-158.4929	1.177E-06	362.7921	3.194E+10	
-56.7928	396360.	0.000	291.3131	-75.6450	1.524E-06	350.9151	3.194E+10	
18.000	0.000483	0.000						
-42.5543	529027.	0.000						
19.000	0.000205	0.000						
-27.7612	811080.	0.000						
20.000	2.641E-05	0.000						
-7.5079	1705720.	0.000						
21.000	-7.350E-05	0.000						
4.2810	349470.	0.000						
22.000	-0.000118	0.000						
7.0249	356670.	0.000						
23.000	-0.000128	0.000						
7.7607	363870.	0.000						
24.000	-0.000119	0.000						
7.3506	371070.	0.000						
25.000	-0.000102	0.000						

Static_Abut2_Cap_Run3_Long.lp7o

6.4220	378270.	0.000					
26.000	-8.330E-05	-174.8194	-19.1976	1.526E-06	349.9194	3.194E+10	
0.6127	44136.	0.000					
27.000	-6.549E-05	-364.0867	-12.3358	1.423E-06	351.5370	3.194E+10	
0.5289	48456.	0.000					
28.000	-4.931E-05	-477.1470	-6.5545	1.263E-06	352.5034	3.194E+10	
0.4337	52776.	0.000					
29.000	-3.526E-05	-527.5855	-1.9393	1.073E-06	352.9345	3.194E+10	
0.3356	57096.	0.000					
30.000	-2.358E-05	-529.4569	1.5171	8.737E-07	352.9505	3.194E+10	
0.2414	61416.	0.000					
31.000	-1.427E-05	-496.2778	3.8951	6.804E-07	352.6669	3.194E+10	
0.1564	65736.	0.000					
32.000	-7.199E-06	-440.2671	5.3274	5.040E-07	352.1882	3.194E+10	
0.0841	70056.	0.000					
33.000	-2.107E-06	-371.8463	5.9774	3.512E-07	351.6034	3.194E+10	
0.0261	74376.	0.000					
34.000	1.311E-06	-299.3843	6.0201	2.251E-07	350.9840	3.194E+10	
-0.0172	78696.	0.000					
35.000	3.377E-06	-229.1538	5.6268	1.259E-07	350.3838	3.194E+10	
-0.0467	83016.	0.000					
36.000	4.409E-06	-165.4510	4.9532	5.197E-08	349.8393	3.194E+10	
-0.0642	87336.	0.000					
37.000	4.691E-06	-110.8330	4.1315	2.941E-10	349.3725	3.194E+10	
-0.0717	91656.	0.000					
38.000	4.472E-06	-66.4216	3.2675	-3.276E-08	348.9929	3.194E+10	
-0.0715	95976.	0.000					
39.000	3.949E-06	-32.2349	2.4391	-5.107E-08	348.7007	3.194E+10	
-0.0660	100296.	0.000					
40.000	3.279E-06	-7.5115	1.6981	-5.832E-08	348.4894	3.194E+10	
-0.0572	104616.	0.000					
41.000	2.573E-06	8.9966	1.0742	-5.787E-08	348.5021	3.194E+10	
-0.0467	108936.	0.000					
42.000	1.905E-06	18.7780	0.5784	-5.251E-08	348.5857	3.194E+10	
-0.0360	113256.	0.000					
43.000	1.320E-06	23.3685	0.2083	-4.449E-08	348.6249	3.194E+10	
-0.0259	117576.	0.000					
44.000	8.399E-07	24.2128	-0.0482	-3.548E-08	348.6321	3.194E+10	
-0.0171	121896.	0.000					
45.000	4.681E-07	22.5762	-0.2084	-2.664E-08	348.6182	3.194E+10	
-0.009847	126216.	0.000					
46.000	1.977E-07	19.4974	-0.2921	-1.871E-08	348.5918	3.194E+10	
-0.004301	130536.	0.000					
47.000	1.505E-08	15.7773	-0.3188	-1.208E-08	348.5600	3.194E+10	
-0.000338	134856.	0.000					
48.000	-9.647E-08	11.9896	-0.3064	-6.865E-09	348.5277	3.194E+10	
0.002238	139176.	0.000					
49.000	-1.538E-07	8.5091	-0.2702	-3.024E-09	348.4979	3.194E+10	
0.003679	143496.	0.000					
50.000	-1.727E-07	5.5472	-0.2220	-3.966E-10	348.4726	3.194E+10	
0.004254	147816.	0.000					
51.000	-1.664E-07	3.1903	-0.1708	1.230E-09	348.4525	3.194E+10	
0.004218	152136.	0.000					
52.000	-1.455E-07	1.4360	-0.1225	2.086E-09	348.4375	3.194E+10	
0.003793	156456.	0.000					
53.000	-1.180E-07	0.2255	-0.0807	2.386E-09	348.4271	3.194E+10	
0.003161	160776.	0.000					
54.000	-8.929E-08	-0.5306	-0.0470	2.320E-09	348.4297	3.194E+10	
0.002457	165096.	0.000					
55.000	-6.293E-08	-0.9324	-0.0216	2.038E-09	348.4332	3.194E+10	
0.001777	169416.	0.000					
56.000	-4.069E-08	-1.0772	-0.003977	1.655E-09	348.4344	3.194E+10	
0.001178	173736.	0.000					

Static_Abut2_Cap_Run3_Long.lp7o						
57.000	-2.326E-08	-1.0510	0.007146	1.252E-09	348.4342	3.194E+10
0.000690	178056.	0.000				
58.000	-1.055E-08	-0.9238	0.0131	8.793E-10	348.4331	3.194E+10
0.000321	182376.	0.000				
59.000	-1.981E-09	-0.7491	0.0153	5.644E-10	348.4316	3.194E+10
6.164E-05	186696.	0.000				
60.000	3.208E-09	-0.5644	0.0150	3.177E-10	348.4300	3.194E+10
-0.000102	191016.	0.000				
61.000	5.848E-09	-0.3935	0.0132	1.383E-10	348.4286	3.194E+10
-0.000190	195336.	0.000				
62.000	6.705E-09	-0.2494	0.0107	1.818E-11	348.4273	3.194E+10
-0.000223	199656.	0.000				
63.000	6.429E-09	-0.1369	0.008040	-5.364E-11	348.4264	3.194E+10
-0.000219	203976.	0.000				
64.000	5.526E-09	-0.0557	0.005566	-8.914E-11	348.4257	3.194E+10
-0.000192	208296.	0.000				
65.000	4.365E-09	-0.001981	0.003482	-9.939E-11	348.4252	3.194E+10
-0.000155	212616.	0.000				
66.000	3.188E-09	0.0295	0.001863	-9.376E-11	348.4254	3.194E+10
-0.000115	216936.	0.000				
67.000	2.140E-09	0.0443	0.000702	-7.957E-11	348.4256	3.194E+10
-7.891E-05	221256.	0.000				
68.000	1.288E-09	0.0477	-5.695E-05	-6.207E-11	348.4256	3.194E+10
-4.843E-05	225576.	0.000				
69.000	6.495E-10	0.0441	-0.000492	-4.470E-11	348.4256	3.194E+10
-2.489E-05	229896.	0.000				
70.000	2.086E-10	0.0367	-0.000685	-2.947E-11	348.4255	3.194E+10
-8.143E-06	234216.	0.000				
71.000	-6.696E-11	0.0282	-0.000714	-1.726E-11	348.4254	3.194E+10
2.662E-06	238536.	0.000				
72.000	-2.154E-10	0.0199	-0.000642	-8.244E-12	348.4254	3.194E+10
8.718E-06	242856.	0.000				
73.000	-2.735E-10	0.0129	-0.000520	-2.103E-12	348.4253	3.194E+10
1.127E-05	247176.	0.000				
74.000	-2.729E-10	0.007507	-0.000383	1.697E-12	348.4253	3.194E+10
1.144E-05	251496.	0.000				
75.000	-2.380E-10	0.003718	-0.000252	3.769E-12	348.4252	3.194E+10
1.015E-05	255816.	0.000				
76.000	-1.858E-10	0.001381	-0.000143	4.696E-12	348.4252	3.194E+10
8.058E-06	260136.	0.000				
77.000	-1.272E-10	0.000201	-6.054E-05	4.970E-12	348.4252	3.194E+10
5.606E-06	264456.	0.000				
78.000	-6.739E-11	-0.000173	-8.734E-06	4.961E-12	348.4252	3.194E+10
3.019E-06	268776.	0.000				
79.000	-8.251E-12	-0.000114	1.167E-05	4.901E-12	348.4252	3.194E+10
3.755E-07	273096.	0.000				
80.000	5.039E-11	0.000	0.000	4.883E-12	348.4252	3.194E+10
-2.330E-06	138708.	0.000				

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	-0.1290987 inches
Computed slope at pile head	=	0.0018715 radians
Maximum bending moment	=	-501878. inch-lbs
Maximum shear force	=	6382.1327830 lbs
Depth of maximum bending moment	=	5.0000000 feet below pile head
Depth of maximum shear force	=	10.5000000 feet below pile head
Number of iterations	=	22
Number of zero deflection points	=	7

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
 Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
 Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
 Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
 Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Condition 1 V(lbs) or y(inches)	Condition 2 Pile-head in-lb, rad., or in-lb/rad. Rotation radians			
1	1	V = -6000.0000	M = -295200.	88500.	-0.12909869	
-501878.		6382.1328	0.00187147			

Computed Pile-head Stiffness Matrix Values
 K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)
 K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
-0.000258	0.00000	600.000000	11887.	2326211.	46087830.
-0.001801	0.00000	2225.561977	59684.	1235571.	33134809.
-0.003653	0.00000	3176.454775	97310.	869460.	26635754.
-0.005375	0.00000	3851.123953	126675.	716441.	23565875.
-0.006949	0.00000	4374.438023	150779.	629495.	21697533.
-0.008386	0.00000	4802.016752	171262.	572624.	20422460.
-0.009709	0.00000	5163.529416	188996.	531830.	19466090.
-0.010937	0.00000	5476.685930	204750.	500768.	18721538.
-0.012098	0.00000	5752.909551	218898.	475519.	18093485.
-0.013178	0.00000	6000.000000	231731.	455316.	17585099.

Static_Abut2_Cap_Run3_Long.lp7o

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)

K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
0.00000	0.00001430	911.328788	29520.	63722710.	2064122664.
0.00000	0.00005504	3231.112167	109498.	58704221.	1989399883.
0.00000	0.00008363	4287.664397	156282.	51270096.	1868749637.
0.00000	0.000106	4959.740105	189475.	47003830.	1795671665.
0.00000	0.000123	5460.563261	215222.	44307207.	1746321890.
0.00000	0.000138	5863.576656	236259.	42498404.	1712374622.
0.00000	0.000151	6193.304923	254046.	41068490.	1684604799.
0.00000	0.000162	6474.095858	269453.	39946800.	1662592486.
0.00000	0.000172	6718.286599	283043.	39010055.	1643503681.
0.00000	0.000181	6934.530759	295200.	38234386.	1627621405.

The analysis ended normally.

Static_BentsRow1_Run3_long.lp7o

LPILE Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LpileRuns_10272015\Bents\Static_long\
Name of input data file: Static_BentsRow1_Run3_long.lp7d
Name of output report file: Static_BentsRow1_Run3_long.lp7o
Name of plot output file: Static_BentsRow1_Run3_long.lp7p
Name of runtime message file: Static_BentsRow1_Run3_long.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 15:39:30

Problem Title

Bents Row #1: 24-inch Static with p-multipliers Trans

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 22-BMG-14

 Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

 Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	80.000000	24.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	24.00000 in
Bottom Width	=	24.00000 in
Top Area	=	452.00000 Sq. in
Bottom Area	=	452.00000 Sq. in
Moment of Inertia at Top	=	2552.00000 in ⁴
Moment of Inertia at Bottom	=	2552.00000 in ⁴
Elastic Modulus	=	30805000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	2.00000 ft
Effective unit weight at top of layer	=	52.00000 pcf
Effective unit weight at bottom of layer	=	52.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000
Subgrade k at top of layer	=	100.00000 pci
Subgrade k at bottom of layer	=	100.00000 pci

Layer 2 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	2.00000 ft
Distance from top of pile to bottom of layer	=	6.00000 ft
Effective unit weight at top of layer	=	55.00000 pcf

Static_BentsRow1_Run3_long.lp7o

Effective unit weight at bottom of layer = 55.00000 pcf
 Undrained cohesion at top of layer = 1000.00000 psf
 Undrained cohesion at bottom of layer = 1000.00000 psf
 Epsilon-50 at top of layer = 0.00700
 Epsilon-50 at bottom of layer = 0.00700
 Subgrade k at top of layer = 500.00000 pci
 Subgrade k at bottom of layer = 500.00000 pci

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer = 6.00000 ft
 Distance from top of pile to bottom of layer = 11.00000 ft
 Effective unit weight at top of layer = 71.00000 pcf
 Effective unit weight at bottom of layer = 71.00000 pcf
 Undrained cohesion at top of layer = 970.00000 psf
 Undrained cohesion at bottom of layer = 970.00000 psf
 Epsilon-50 at top of layer = 0.01000
 Epsilon-50 at bottom of layer = 0.01000
 Subgrade k at top of layer = 100.00000 pci
 Subgrade k at bottom of layer = 100.00000 pci

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 11.00000 ft
 Distance from top of pile to bottom of layer = 90.00000 ft
 Effective unit weight at top of layer = 62.00000 pcf
 Effective unit weight at bottom of layer = 62.00000 pcf
 Friction angle at top of layer = 30.00000 deg.
 Friction angle at bottom of layer = 30.00000 deg.
 Subgrade k at top of layer = 60.00000 pci
 Subgrade k at bottom of layer = 60.00000 pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor Epsilon 50	Layer Soil Type kpy (p-y Curve Criteria) pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay with Free Water		0.00	52.000	750.000
--	0.01000	100.000	2.000	52.000	750.000
--	0.01000	100.000	2.000	55.000	1000.000
2	Stiff Clay with Free Water		2.000	55.000	1000.000
--	0.00700	500.000	6.000	55.000	1000.000
--	0.00700	500.000	6.000	71.000	970.000
3	Stiff Clay with Free Water		6.000	71.000	970.000
--	0.01000	100.000	11.000	71.000	970.000
--	0.01000	100.000			

Static_BentsRow1_Run3_long.lp7o					
4	Sand (Reese, et al.)		11.000	62.000	--
30.000	--	60.000			
			90.000	62.000	--
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	1.0000	1.0000
2	90.000	1.0000	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
Top y vs. Pile Length				
1	1	V = 3000.00000 lbs	M = 612000. in-lbs	148000.
No				

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
Page 5		

Static_BentsRow1_Run3_long.lp7o

1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

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

p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Diameter	=	24.000 in
c (at curve depth)	=	5.208 lb/in**2
Average cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.235
Ac (not used)	=	0.20000
pct	=	250.000 lb/in
pcd	=	1375.000 lb/in
pc	=	250.000 lb/in

```

Static_BentsRow1_Run3_long.lp7o
pu = 1.553 lb/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

y, in	p, lb/in
0.0000	0.0000
0.02814	0.0000
0.05628	0.0000
0.08442	0.0000
0.11256	0.0000
0.14070	0.0000
0.16884	0.0000
0.19698	0.0000
0.22512	0.0000
0.25326	0.0000
0.28140	0.0000
0.30954	0.0000
0.33768	0.0000
0.56280	0.0000
0.78792	0.0000
1.01304	0.0000
1.06932	0.0000

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

```

Soil Layer Number = 2
Depth below pile head = 2.000 ft
Depth below ground surface = 2.000 ft
Equivalent Depth = 1.736 ft
Diameter = 24.000 in
c (at curve depth) = 6.076 lb/in**2
Average cohesion, c = 6.07639 psi
Undrained cohesion, c = 875.00000 psf
Average Eff. Unit Weight = 0.03009 pci
Average Eff. Unit Weight = 52.00000 pcf
k = 500.000 pci
Epsilon50 = 0.00850
y50 = 0.204 in
As = 0.437
Ac (not used) = 0.28423
pct = 665.036 lb/in
pcd = 1604.167 lb/in
pc = 665.036 lb/in
pu = 47.096 lb/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

y, in	p, lb/in
0.0000	0.0000
0.04454	155.36906
0.08908	219.72503
0.13361	253.72838
0.17815	274.16113
0.22269	286.69714
0.26723	293.57969
0.31176	296.08508
0.35630	295.03600

	Static_BentsRow1_Run3_long.lp7o
0.40084	291.00443
0.44538	284.40943
0.48992	275.57023
0.53445	264.73746
0.89076	192.28817
1.24706	119.69198
1.60336	47.09578
1.69244	47.09578

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Equivalent Depth	=	3.736 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	6.51042 psi
Undrained cohesion, c	=	937.50000 psf
Average Eff. Unit Weight	=	0.03096 pci
Average Eff. Unit Weight	=	53.50000 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.168 in
As	=	0.558
Ac (not used)	=	0.30000
pct	=	1171.919 lb/in
pcd	=	1833.333 lb/in
pc	=	1171.919 lb/in
pu	=	100.045 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.04686	309.47177
0.09372	437.65917
0.14058	508.92062
0.18745	554.48801
0.23431	585.00227
0.28117	604.74599
0.32803	616.16401
0.37489	620.83362
0.42175	619.85134
0.46862	614.02015
0.51548	603.95127
0.56234	590.12420
0.93723	426.93696
1.31212	263.49084
1.68701	100.04473
1.78074	100.04473

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft

Static_BentsRow1_Run3_long.lp7o

Equivalent Depth	=	5.621	ft
Diameter	=	24.000	in
c (at curve depth)	=	6.840	lb/in**2
Average cohesion, c	=	6.84028	psi
Undrained cohesion, c	=	985.00000	psf
Average Eff. Unit Weight	=	0.03125	pci
Average Eff. Unit Weight	=	54.00000	pcf
k	=	100.000	pci
Epsilon50	=	0.00850	
y50	=	0.204	in
As	=	0.598	
Ac (not used)	=	0.30000	
pct	=	1684.554	lb/in
pcd	=	1805.833	lb/in
pc	=	1684.554	lb/in
pu	=	147.587	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.06102	411.57839
0.12205	651.47871
0.18307	758.94049
0.24409	828.67956
0.30511	876.27640
0.36614	908.03304
0.42716	927.55059
0.48818	937.15282
0.54920	938.45519
0.61023	932.64052
0.67125	920.60900
0.73227	903.06663
1.22045	651.48806
1.70863	399.53737
2.19681	147.58669
2.31886	147.58669

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3	
Depth below pile head	=	8.000	ft
Depth below ground surface	=	8.000	ft
Equivalent Depth	=	7.621	ft
Diameter	=	24.000	in
c (at curve depth)	=	6.736	lb/in**2
Average cohesion, c	=	6.78819	psi
Undrained cohesion, c	=	977.50000	psf
Average Eff. Unit Weight	=	0.03371	pci
Average Eff. Unit Weight	=	58.25000	pcf
k	=	100.000	pci
Epsilon50	=	0.01000	
y50	=	0.240	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	2156.565	lb/in
pcd	=	1778.333	lb/in
pc	=	1778.333	lb/in
pu	=	155.930	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

Static_BentsRow1_Run3_long.lp7o

y, in	p, lb/in
0.0000	0.0000
0.07200	487.01665
0.14400	688.74555
0.21600	802.41424
0.28800	876.22497
0.36000	926.63827
0.43200	960.31356
0.50400	981.05627
0.57600	991.32209
0.64800	992.81814
0.72000	986.79439
0.79200	974.20210
0.86400	955.78731
1.44000	689.43013
2.01600	422.68012
2.59200	155.93011
2.73600	155.93011

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Equivalent Depth	=	9.621 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	11.53084 psi
Undrained cohesion, c	=	1660.44118 psf
Average Eff. Unit Weight	=	0.03519 pci
Average Eff. Unit Weight	=	60.80000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	4418.263 lb/in
pcd	=	1778.333 lb/in
pc	=	1778.333 lb/in
pu	=	155.930 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.07200	487.01665
0.14400	688.74555
0.21600	802.41424
0.28800	876.22497
0.36000	926.63827
0.43200	960.31356
0.50400	981.05627
0.57600	991.32209
0.64800	992.81814
0.72000	986.79439
0.79200	974.20210
0.86400	955.78731
1.44000	689.43013
2.01600	422.68012

	Static_BentsRow1_Run3_long.lp7o
2.59200	155.93011
2.73600	155.93011

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	12.000	ft
Depth below ground surface	=	12.000	ft
Equivalent Depth (see note)	=	6.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.75000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	520.674	lb/in
Psd	=	3550.023	lb/in
Ps = Pst (shallow controls)	=	520.674	lb/in
A (static)	=	1.0590	
B (static)	=	0.7088	
C = Pm/(Ym^(1/n))	=	530.1099	
n = Pm/(m Ym)	=	2.5307	
m = (Pu-Pm)/(Yu-Ym)	=	364.6054	
Yk = [c/(kx)]^(n/(n-1))	=	0.0311	in
Pk	=	134.438	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	369.079	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	551.382	lb/in
Es, lim	=	4329.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.03105	134.43766	*
0.06459	179.56081	
0.09813	211.82773	
0.13168	237.92300	
0.16522	260.24215	
0.19876	279.96018	
0.23230	297.75352	
0.26584	314.05235	
0.29938	329.14962	
0.33292	343.25511	
0.36646	356.52494	
0.40000	369.07885	
0.65000	460.23021	
0.90000	551.38157	
0.92250	551.38157	

Static_BentsRow1_Run3_long.lp7o
0.94500 551.38157

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Equivalent Depth (see note)	=	8.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.78571 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	852.004 lb/in
Psd	=	4144.089 lb/in
Ps = Pst (shallow controls)	=	852.004 lb/in
A (static)	=	0.8999
B (static)	=	0.5298
$C = P_m / (Y_m^{(1/n)})$	=	753.2257
$n = P_m / (m Y_m)$	=	1.7896
$m = (P_u - P_m) / (Y_u - Y_m)$	=	630.5924
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0099 in
Pk	=	57.161 lb/in
$Y_m = b / 60$	=	0.4000 in
$P_m = B p_s$	=	451.399 lb/in
$Y_u = 3b / 80$	=	0.9000 in
$P_u = A P_s$	=	766.695 lb/in
Es, lim	=	5769.219 lb/in/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.00991	57.16131	*
0.04537	133.76609	
0.08083	184.71377	
0.11630	226.34650	
0.15176	262.64166	
0.18722	295.34273	
0.22269	325.40333	
0.25815	353.41399	
0.29361	379.77114	
0.32907	404.75650	
0.36454	428.57899	
0.40000	451.39870	
0.65000	609.04681	
0.90000	766.69491	
0.92250	766.69491	

Static_BentsRow1_Run3_long.lp7o
0.94500 766.69491

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	16.000	ft
Depth below ground surface	=	16.000	ft
Equivalent Depth (see note)	=	10.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.81250	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	1262.324	lb/in
Psd	=	4738.155	lb/in
Ps = Pst (shallow controls)	=	1262.324	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	1101.7638	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	959.3665	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0083	in
Pk	=	59.809	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	631.162	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	1110.845	lb/in
Es, lim	=	7209.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.00830	59.80899	*
0.04391	164.71787	
0.07952	236.35332	
0.11512	295.99098	
0.15073	348.69105	
0.18634	396.67915	
0.22195	441.17913	
0.25756	482.95300	
0.29317	522.51490	
0.32878	560.23195	
0.36439	596.37757	
0.40000	631.16217	
0.65000	871.00380	
0.90000	1110.84542	
0.92250	1110.84542	

Static_BentsRow1_Run3_long.lp7o
0.94500 1110.84542

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	18.000	ft
Depth below ground surface	=	18.000	ft
Equivalent Depth (see note)	=	12.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.83333	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	1751.643	lb/in
Psd	=	5332.221	lb/in
Ps = Pst (shallow controls)	=	1751.643	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	1528.8440	
$n = Pm/(m \ Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	1331.2488	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0120	in
Pk	=	104.003	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B \ ps$	=	875.822	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A \ Ps$	=	1541.446	lb/in
Es, lim	=	8649.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.01202	104.00254	*
0.04730	239.13924	
0.08257	335.56506	
0.11784	416.58171	
0.15311	488.47159	
0.18838	554.08976	
0.22365	615.03258	
0.25892	672.30419	
0.29419	726.58696	
0.32946	778.37058	
0.36473	828.02124	
0.40000	875.82160	
0.65000	1208.63380	
0.90000	1541.44600	
0.92250	1541.44600	

Static_BentsRow1_Run3_long.lp7o
0.94500 1541.44600

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	22.000	ft
Depth below ground surface	=	22.000	ft
Equivalent Depth (see note)	=	16.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.86364	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2967.298	lb/in
Psd	=	6520.353	lb/in
Ps = Pst (shallow controls)	=	2967.298	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	2589.8740	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	2255.1461	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0222	in
Pk	=	255.511	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	1483.649	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	2611.222	lb/in
Es, lim	=	11529.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02216	255.51061	*
0.05651	451.41408	
0.09086	602.51622	
0.12521	732.21814	
0.15956	848.50135	
0.19391	955.28919	
0.22826	1054.86943	
0.26260	1148.72009	
0.29695	1237.86422	
0.33130	1323.04619	
0.36565	1404.82845	
0.40000	1483.64880	
0.65000	2047.43533	
0.90000	2611.22187	
0.92250	2611.22187	

Static_BentsRow1_Run3_long.lp7o
0.94500 2611.22187

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	24.000	ft
Depth below ground surface	=	24.000	ft
Equivalent Depth (see note)	=	18.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.87500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3693.639	lb/in
Psd	=	7114.419	lb/in
Ps = Pst (shallow controls)	=	3693.639	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	3223.8288	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	2807.1655	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0287	in
Pk	=	372.148	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	1846.819	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	3250.402	lb/in
Es, lim	=	12969.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02869	372.14760	*
0.06245	597.11017	
0.09620	776.52496	
0.12996	932.32601	
0.16371	1072.84612	
0.19747	1202.36527	
0.23122	1323.44213	
0.26498	1437.75675	
0.29873	1546.48547	
0.33249	1650.49154	
0.36624	1750.43159	
0.40000	1846.81946	
0.65000	2548.61085	
0.90000	3250.40223	
0.92250	3250.40223	

Static_BentsRow1_Run3_long.lp7o
0.94500 3250.40223

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	26.000	ft
Depth below ground surface	=	26.000	ft
Equivalent Depth (see note)	=	20.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.88462	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4498.992	lb/in
Psd	=	7708.485	lb/in
Ps = Pst (shallow controls)	=	4498.992	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	3926.7455	
$n = Pm/(m Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	3419.2339	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0363	in
Pk	=	522.775	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B ps$	=	2249.496	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A Ps$	=	3959.113	lb/in
Es, lim	=	14409.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.03628	522.77489	*
0.06935	775.12854	
0.10241	982.48176	
0.13548	1164.67999	
0.16854	1330.06114	
0.20161	1483.10856	
0.23467	1626.57588	
0.26774	1762.30403	
0.30080	1891.59871	
0.33387	2015.42749	
0.36693	2134.53196	
0.40000	2249.49602	
0.65000	3104.30450	
0.90000	3959.11297	
0.92250	3959.11297	

Static_BentsRow1_Run3_long.lp7o
0.94500 3959.11297

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	28.000	ft
Depth below ground surface	=	28.000	ft
Equivalent Depth (see note)	=	22.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.89286	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	5383.358	lb/in
Psd	=	8302.551	lb/in
Ps = Pst (shallow controls)	=	5383.358	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	4698.6251	
$n = Pm/(m Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	4091.3521	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0450	in
Pk	=	712.811	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B ps$	=	2691.679	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A Ps$	=	4737.355	lb/in
Es, lim	=	15849.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.04497	712.81124	*
0.07725	990.40229	
0.10952	1224.59913	
0.14180	1432.81236	
0.17407	1623.07312	
0.20635	1799.90671	
0.23862	1966.17359	
0.27090	2123.82393	
0.30317	2274.26081	
0.33545	2418.53531	
0.36772	2557.45999	
0.40000	2691.67905	
0.65000	3714.51707	
0.90000	4737.35509	
0.92250	4737.35509	

Static_BentsRow1_Run3_long.lp7o
0.94500 4737.35509

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	30.000	ft
Depth below ground surface	=	30.000	ft
Equivalent Depth (see note)	=	24.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	6346.738	lb/in
Psd	=	8896.617	lb/in
Ps = Pst (shallow controls)	=	6346.738	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	5539.4684	
$n = Pm/(m Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	4823.5208	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0548	in
Pk	=	947.954	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B ps$	=	3173.369	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A Ps$	=	5585.129	lb/in
Es, lim	=	17289.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.05483	947.95435	*
0.08621	1248.19426	
0.11759	1507.46686	
0.14897	1740.62948	
0.18035	1955.15260	
0.21173	2155.44821	
0.24310	2344.39022	
0.27448	2523.97953	
0.30586	2695.67827	
0.33724	2860.59495	
0.36862	3019.59476	
0.40000	3173.36896	
0.65000	4379.24914	
0.90000	5585.12933	
0.92250	5585.12933	

Static_BentsRow1_Run3_long.lp7o
0.94500 5585.12933

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	32.000	ft
Depth below ground surface	=	32.000	ft
Equivalent Depth (see note)	=	26.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90625	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	7389.132	lb/in
Psd	=	9490.683	lb/in
Ps = Pst (shallow controls)	=	7389.132	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	6449.2759	
$n = Pm/(m \ Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	5615.7404	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0659	in
Pk	=	1234.170	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B \ ps$	=	3694.566	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A \ Ps$	=	6502.436	lb/in
Es, lim	=	18729.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.06590	1234.17010	*
0.09627	1554.06644	
0.12664	1836.02109	
0.15701	2092.39152	
0.18739	2329.90371	
0.21776	2552.71921	
0.24813	2763.63401	
0.27851	2964.63841	
0.30888	3157.21128	
0.33925	3342.48855	
0.36963	3521.36613	
0.40000	3694.56607	
0.65000	5098.50115	
0.90000	6502.43624	
0.92250	6502.43624	

Static_BentsRow1_Run3_long.lp7o
0.94500 6502.43624

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	34.000	ft
Depth below ground surface	=	34.000	ft
Equivalent Depth (see note)	=	28.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91176	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	8510.541	lb/in
Psd	=	10084.749	lb/in
Ps = Pst (shallow controls)	=	8510.541	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	7428.0481	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	6468.0113	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0782	in
Pk	=	1577.683	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	4255.271	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	7489.276	lb/in
Es, lim	=	20169.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.07822	1577.68310	*
0.10747	1913.85593	
0.13673	2215.51553	
0.16598	2492.69077	
0.19523	2751.25119	
0.22448	2994.99768	
0.25374	3226.56558	
0.28299	3447.87468	
0.31224	3660.37697	
0.34149	3865.20355	
0.37075	4063.25673	
0.40000	4255.27062	
0.65000	5872.27343	
0.90000	7489.27624	
0.92250	7489.27624	

Static_BentsRow1_Run3_long.lp7o
0.94500 7489.27624

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	36.000	ft
Depth below ground surface	=	36.000	ft
Equivalent Depth (see note)	=	30.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	9710.966	lb/in
Psd	=	10678.815	lb/in
Ps = Pst (shallow controls)	=	9710.966	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	8475.7852	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	7380.3338	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0919	in
Pk	=	1984.968	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B p_s$	=	4855.483	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A P_s$	=	8545.650	lb/in
Es, lim	=	21609.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.09186	1984.96819	*
0.11987	2333.65621	
0.14788	2651.49572	
0.17590	2946.42971	
0.20391	3223.42568	
0.23192	3485.84556	
0.25994	3736.09523	
0.28795	3975.96959	
0.31596	4206.85175	
0.34397	4429.83536	
0.37199	4645.80369	
0.40000	4855.48279	
0.65000	6700.56623	
0.90000	8545.64967	
0.92250	8545.64967	

Static_BentsRow1_Run3_long.lp7o
0.94500 8545.64967

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	38.000	ft
Depth below ground surface	=	38.000	ft
Equivalent Depth (see note)	=	32.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92105	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	10990.405	lb/in
Psd	=	11272.881	lb/in
Ps = Pst (shallow controls)	=	10990.405	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	9592.4875	
$n = Pm/(m Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	8352.7081	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.1068	in
Pk	=	2462.743	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B ps$	=	5495.203	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A Ps$	=	9671.557	lb/in
Es, lim	=	23049.219	lb/in/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.10685	2462.74278	*
0.13350	2819.80247	
0.16015	3149.77658	
0.18680	3458.79983	
0.21345	3750.94804	
0.24010	4029.09915	
0.26675	4295.37856	
0.29340	4551.41097	
0.32005	4798.47283	
0.34670	5037.58959	
0.37335	5269.60040	
0.40000	5495.20274	
0.65000	7583.37976	
0.90000	9671.55677	
0.92250	9671.55677	

Static_BentsRow1_Run3_long.lp7o
0.94500 9671.55677

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	40.000 ft
Depth below ground surface	=	40.000 ft
Equivalent Depth (see note)	=	34.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.92500 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	12348.861 lb/in
Psd	=	11866.947 lb/in
Ps = Psd (deep controls)	=	11866.947 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
$C = Pm/(Ym^{(1/n)})$	=	10357.5377
$n = Pm/(m Ym)$	=	1.6447
$m = (Pu - Pm)/(Yu - Ym)$	=	9018.8795
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.1113 in
Pk	=	2726.539 lb/in
$Ym = b/60$	=	0.4000 in
$Pm = B ps$	=	5933.473 lb/in
$Yu = 3b/80$	=	0.9000 in
$Pu = A Ps$	=	10442.913 lb/in
Es, lim	=	24489.219 lb/in/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.11134	2726.53863	*
0.13758	3100.95283	
0.16382	3448.20103	
0.19006	3774.20871	
0.21630	4082.97653	
0.24255	4377.36246	
0.26879	4659.49587	
0.29503	4931.01583	
0.32127	5193.21731	
0.34752	5447.14545	
0.37376	5693.65882	
0.40000	5933.47343	
0.65000	8188.19330	
0.90000	10443.	
0.92250	10443.	

0.94500

Static_BentsRow1_Run3_long.lp7o
10443.* p value(s) computed using $p = k * \text{Eff} \times y$

 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 = 3000.0 lbs
 Applied moment at pile head = 612000.0 in-lbs
 Axial thrust load on pile head = 148000.0 lbs

Depth Res.	Soil X	Deflect. Spr. y	Bending Distrib. Moment	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil p
feet	Es*h lb/inch	Lat. Load inches lb/inch	in-lbs	lbs	radians	psi*	lb-in^2	lb/in
0.000	0.00	0.0508	612000.	3000.0000	-0.000950	3205.1766	7.861E+10	
0.000	1.000	0.0400	648624.	2692.9819	-0.000853	3377.3919	7.861E+10	
-48.0082	7200.0000	0.000	0.000					
2.000	0.0304	678368.	1785.6789	-0.000752	3517.2538	7.861E+10		
-128.3013	25350.	0.000						
3.000	0.0220	690566.	-102.4042	-0.000647	3574.6102	7.861E+10		
-175.8032	48018.	0.000						
4.000	0.0148	677525.	-2267.4909	-0.000543	3513.2880	7.861E+10		
-182.5714	73866.	0.000						
5.000	0.008930	638177.	-4399.4906	-0.000442	3328.2648	7.861E+10		
-170.3768	114469.	0.000						
6.000	0.004197	574312.	-5935.1500	-0.000349	3027.9613	7.861E+10		
-28.3082	40468.	0.000						
7.000	0.000515	502026.	-6130.7554	-0.000267	2688.0567	7.861E+10		
-4.0937	47668.	0.000						
8.000	-0.002247	429017.	-6031.5344	-0.000196	2344.7566	7.861E+10		
20.5487	54868.	0.000						
9.000	-0.004223	358838.	-5644.4043	-0.000136	2014.7582	7.861E+10		
43.6881	62068.	0.000						
10.000	-0.005541	294826.	-4995.9048	-8.616E-05	1713.7618	7.861E+10		
63.9739	69268.	0.000						
11.000	-0.006319	239912.	-4299.0239	-4.545E-05	1455.5477	7.861E+10		
22.8049	21655.	0.000						
12.000	-0.006656	190129.	-3988.5030	-1.266E-05	1221.4564	7.861E+10		
28.8143	25975.	0.000						
13.000	-0.006644	144431.	-3613.2393	1.283E-05	1006.5785	7.861E+10		
33.5486	30295.	0.000						
14.000	-0.006368	103512.	-3190.3115	3.170E-05	814.1665	7.861E+10		
36.7369	34615.	0.000						
15.000	-0.005901	67839.	-2738.9150	4.473E-05	646.4277	7.861E+10		
38.2926	38935.	0.000						
16.000	-0.005309	37648.	-2278.3762	5.273E-05	504.4637	7.861E+10		
38.2758	43255.	0.000						

Static_BentsRow1_Run3_long.lp7o							
17.000	-0.004648	12946.	-1826.6208	5.654E-05	388.3088	7.861E+10	
36.8551	47575.	0.000					
18.000	-0.003962	-6463.1083	-1399.0886	5.698E-05	357.8244	7.861E+10	
34.2719	51895.	0.000					
19.000	-0.003288	-20943.	-1008.0634	5.485E-05	425.9138	7.861E+10	
30.8071	56215.	0.000					
20.000	-0.002652	-30987.	-662.3688	5.085E-05	473.1418	7.861E+10	
26.7531	60535.	0.000					
21.000	-0.002072	-37173.	-367.3703	4.561E-05	502.2286	7.861E+10	
22.3915	64855.	0.000					
22.000	-0.001559	-40125.	-125.2158	3.968E-05	516.1088	7.861E+10	
17.9752	69175.	0.000					
23.000	-0.001120	-40476.	64.7521	3.351E-05	517.7600	7.861E+10	
13.7176	73495.	0.000					
24.000	-0.000755	-38838.	205.4787	2.744E-05	510.0574	7.861E+10	
9.7862	77815.	0.000					
25.000	-0.000460	-35776.	301.6299	2.173E-05	495.6600	7.861E+10	
6.3003	82135.	0.000					
26.000	-0.000231	-31793.	359.0261	1.657E-05	476.9290	7.861E+10	
3.3334	86455.	0.000					
27.000	-6.062E-05	-27316.	384.1134	1.206E-05	455.8770	7.861E+10	
0.9171	90775.	0.000					
28.000	6.008E-05	-22694.	383.5008	8.238E-06	434.1459	7.861E+10	
-0.9523	95095.	0.000					
29.000	0.000139	-18199.	363.5793	5.120E-06	413.0089	7.861E+10	
-2.3065	99415.	0.000					
30.000	0.000185	-14027.	330.2310	2.664E-06	393.3907	7.861E+10	
-3.1976	103735.	0.000					
31.000	0.000205	-10308.	288.6282	8.113E-07	375.9029	7.861E+10	
-3.6909	108055.	0.000					
32.000	0.000206	-7114.4745	243.1161	-5.132E-07	360.8873	7.861E+10	
-3.8583	112375.	0.000					
33.000	0.000194	-4472.5299	197.1684	-1.392E-06	348.4643	7.861E+10	
-3.7725	116695.	0.000					
34.000	0.000174	-2370.9504	153.4031	-1.910E-06	338.5823	7.861E+10	
-3.5029	121015.	0.000					
35.000	0.000149	-772.0466	113.6440	-2.145E-06	331.0639	7.861E+10	
-3.1121	125335.	0.000					
36.000	0.000123	379.5310	79.0143	-2.171E-06	329.2183	7.861E+10	
-2.6541	129655.	0.000					
37.000	9.732E-05	1149.0224	50.0484	-2.051E-06	332.8366	7.861E+10	
-2.1730	133975.	0.000					
38.000	7.388E-05	1605.1909	26.8120	-1.838E-06	334.9815	7.861E+10	
-1.7029	138295.	0.000					
39.000	5.335E-05	1815.3940	9.0196	-1.575E-06	335.9700	7.861E+10	
-1.2682	142615.	0.000					
40.000	3.613E-05	1842.0257	-3.8558	-1.294E-06	336.0952	7.861E+10	
-0.8848	146935.	0.000					
41.000	2.227E-05	1740.2001	-12.4868	-1.020E-06	335.6164	7.861E+10	
-0.5614	151255.	0.000					
42.000	1.159E-05	1556.4958	-17.6112	-7.677E-07	334.7526	7.861E+10	
-0.3004	155575.	0.000					
43.000	3.749E-06	1328.5619	-19.9695	-5.472E-07	333.6808	7.861E+10	
-0.0999	159895.	0.000					
44.000	-1.656E-06	1085.3819	-20.2581	-3.630E-07	332.5373	7.861E+10	
0.0453	164215.	0.000					
45.000	-5.073E-06	848.0024	-19.0980	-2.155E-07	331.4211	7.861E+10	
0.1425	168535.	0.000					
46.000	-6.934E-06	630.5536	-17.0176	-1.029E-07	330.3986	7.861E+10	
0.1998	172855.	0.000					
47.000	-7.637E-06	441.4170	-14.4453	-2.142E-08	329.5093	7.861E+10	
0.2255	177175.	0.000					
48.000	-7.528E-06	284.4232	-11.7111	3.366E-08	328.7710	7.861E+10	

Static_BentsRow1_Run3_long.lp7o

0.2277	181495.	0.000				
49.000	-6.894E-06	159.9946	-9.0540	6.728E-08	328.1860	7.861E+10
0.2135	185815.	0.000				
50.000	-5.963E-06	66.1724	-6.6336	8.426E-08	327.7448	7.861E+10
0.1890	190135.	0.000				
51.000	-4.908E-06	-0.5059	-4.5431	8.903E-08	327.4360	7.861E+10
0.1591	194455.	0.000				
52.000	-3.851E-06	-44.2936	-2.8232	8.542E-08	327.6419	7.861E+10
0.1276	198775.	0.000				
53.000	-2.873E-06	-69.6865	-1.4758	7.656E-08	327.7613	7.861E+10
0.0973	203095.	0.000				
54.000	-2.022E-06	-81.0282	-0.4756	6.495E-08	327.8146	7.861E+10
0.0699	207415.	0.000				
55.000	-1.317E-06	-82.2479	0.2195	5.241E-08	327.8204	7.861E+10
0.0465	211735.	0.000				
56.000	-7.628E-07	-76.7116	0.6599	4.022E-08	327.7943	7.861E+10
0.0275	216055.	0.000				
57.000	-3.484E-07	-67.1598	0.8983	2.922E-08	327.7494	7.861E+10
0.0128	220375.	0.000				
58.000	-5.671E-08	-55.7113	0.9850	1.983E-08	327.6956	7.861E+10
0.002124	224695.	0.000				
59.000	1.329E-07	-43.9106	0.9649	1.223E-08	327.6401	7.861E+10
-0.005074	229015.	0.000				
60.000	2.420E-07	-32.8028	0.8761	6.383E-09	327.5879	7.861E+10
-0.009413	233335.	0.000				
61.000	2.909E-07	-23.0216	0.7490	2.137E-09	327.5419	7.861E+10
-0.0115	237655.	0.000				
62.000	2.975E-07	-14.8787	0.6069	-7.392E-10	327.5036	7.861E+10
-0.0120	241975.	0.000				
63.000	2.765E-07	-8.4493	0.4661	-2.503E-09	327.4734	7.861E+10
-0.0114	246295.	0.000				
64.000	2.399E-07	-3.6459	0.3375	-3.412E-09	327.4508	7.861E+10
-0.0100	250615.	0.000				
65.000	1.965E-07	-0.2816	0.2271	-3.699E-09	327.4350	7.861E+10
-0.008349	254935.	0.000				
66.000	1.524E-07	1.8813	0.1375	-3.567E-09	327.4425	7.861E+10
-0.006585	259255.	0.000				
67.000	1.117E-07	3.0946	0.0687	-3.179E-09	327.4482	7.861E+10
-0.004905	263575.	0.000				
68.000	7.649E-08	3.5990	0.0190	-2.662E-09	327.4506	7.861E+10
-0.003415	267895.	0.000				
69.000	4.786E-08	3.6085	-0.0144	-2.109E-09	327.4506	7.861E+10
-0.002172	272215.	0.000				
70.000	2.581E-08	3.3018	-0.0343	-1.579E-09	327.4492	7.861E+10
-0.001190	276535.	0.000				
71.000	9.785E-09	2.8208	-0.0440	-1.110E-09	327.4469	7.861E+10
-0.000458	280855.	0.000				
72.000	-1.081E-09	2.2710	-0.0463	-7.216E-10	327.4443	7.861E+10
5.140E-05	285175.	0.000				
73.000	-7.787E-09	1.7263	-0.0436	-4.168E-10	327.4417	7.861E+10
0.000376	289495.	0.000				
74.000	-1.132E-08	1.2339	-0.0380	-1.916E-10	327.4394	7.861E+10
0.000555	293815.	0.000				
75.000	-1.259E-08	0.8201	-0.0308	-3.562E-11	327.4375	7.861E+10
0.000626	298135.	0.000				
76.000	-1.235E-08	0.4955	-0.0233	6.393E-11	327.4360	7.861E+10
0.000623	302455.	0.000				
77.000	-1.119E-08	0.2600	-0.0161	1.208E-10	327.4349	7.861E+10
0.000572	306775.	0.000				
78.000	-9.539E-09	0.1066	-0.009676	1.480E-10	327.4341	7.861E+10
0.000495	311095.	0.000				
79.000	-7.688E-09	0.0242	-0.004277	1.574E-10	327.4337	7.861E+10
0.000404	315415.	0.000				

Static_BentsRow1_Run3_long.lp7o
80.000 -5.786E-09 0.000 0.000 1.587E-10 327.4336 7.861E+10
0.000308 159868. 0.000

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

Output Summary for Load Case No. 1:

File-head deflection = 0.0508340 inches
Computed slope at pile head = -0.0009497 radians
Maximum bending moment = 690566. inch-lbs
Maximum shear force = -6130.7553604 lbs
Depth of maximum bending moment = 3.0000000 feet below pile head
Depth of maximum shear force = 7.0000000 feet below pile head
Number of iterations = 9
Number of zero deflection points = 5

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head Condition		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad. radians			
1	1	V = 3000.0000 -6130.7554	M = 612000. -0.00094970	148000.	0.05083405	

Computed Pile-head Stiffness Matrix Values K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)

Static_BentsRow1_Run3_long.lp7o

K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.000381	0.00000	300.000000	12803.	787205.	33595988.
0.001414	0.00000	1112.780988	47491.	787205.	33595988.
0.002018	0.00000	1588.227388	67782.	787205.	33595988.
0.002446	0.00000	1925.561977	82178.	787205.	33595988.
0.002778	0.00000	2187.219012	93345.	787205.	33595988.
0.003050	0.00000	2401.008376	102469.	787205.	33595988.
0.003280	0.00000	2581.764708	110183.	787205.	33595988.
0.003479	0.00000	2738.342965	116866.	787205.	33595988.
0.003654	0.00000	2876.454775	122760.	787205.	33595988.
0.003811	0.00000	3000.000000	128033.	787205.	33595988.

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)

K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
0.00000	0.00002663	894.501290	61200.	33595988.	2298570705.
0.00000	0.00009876	3317.946764	227007.	33595988.	2298570705.
0.00000	0.000141	4735.571489	323998.	33595988.	2298570705.
0.00000	0.000171	5741.392238	392815.	33595988.	2298570705.
0.00000	0.000195	6502.954202	446193.	33364273.	2289251007.
0.00000	0.000215	7100.326446	489806.	32968521.	2274285527.
0.00000	0.000233	7592.991383	526680.	32589352.	2260526739.
0.00000	0.000248	8014.081630	558622.	32262491.	2248858572.
0.00000	0.000262	8379.323173	586797.	31966151.	2238561952.
0.00000	0.000275	8702.058378	612000.	31701439.	2229504754.

The analysis ended normally.

Static_BentsRow1_Run3_Transverse.lp7o

LPILE Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LpileRuns_10272015\Bents\Static_Trans\
Name of input data file: Static_BentsRow1_Run3_Transverse.lp7d
Name of output report file: Static_BentsRow1_Run3_Transverse.lp7o
Name of plot output file: Static_BentsRow1_Run3_Transverse.lp7p
Name of runtime message file: Static_BentsRow1_Run3_Transverse.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 15:10:23

Problem Title

Bents Row #1: 24-inch Static with p-multipliers Trans

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 22-BMG-14

 Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

 Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	80.000000	24.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	24.00000 in
Bottom Width	=	24.00000 in
Top Area	=	452.00000 Sq. in
Bottom Area	=	452.00000 Sq. in
Moment of Inertia at Top	=	2552.00000 in ⁴
Moment of Inertia at Bottom	=	2552.00000 in ⁴
Elastic Modulus	=	30805000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	2.00000 ft
Effective unit weight at top of layer	=	52.00000 pcf
Effective unit weight at bottom of layer	=	52.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000
Subgrade k at top of layer	=	100.00000 pci
Subgrade k at bottom of layer	=	100.00000 pci

Layer 2 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	2.00000 ft
Distance from top of pile to bottom of layer	=	6.00000 ft
Effective unit weight at top of layer	=	55.00000 pcf

Static_BentsRow1_Run3_Transverse.lp7o

Effective unit weight at bottom of layer = 55.00000 pcf
 Undrained cohesion at top of layer = 1000.00000 psf
 Undrained cohesion at bottom of layer = 1000.00000 psf
 Epsilon-50 at top of layer = 0.00700
 Epsilon-50 at bottom of layer = 0.00700
 Subgrade k at top of layer = 500.00000 pci
 Subgrade k at bottom of layer = 500.00000 pci

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer = 6.00000 ft
 Distance from top of pile to bottom of layer = 11.00000 ft
 Effective unit weight at top of layer = 71.00000 pcf
 Effective unit weight at bottom of layer = 71.00000 pcf
 Undrained cohesion at top of layer = 970.00000 psf
 Undrained cohesion at bottom of layer = 970.00000 psf
 Epsilon-50 at top of layer = 0.01000
 Epsilon-50 at bottom of layer = 0.01000
 Subgrade k at top of layer = 100.00000 pci
 Subgrade k at bottom of layer = 100.00000 pci

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 11.00000 ft
 Distance from top of pile to bottom of layer = 90.00000 ft
 Effective unit weight at top of layer = 62.00000 pcf
 Effective unit weight at bottom of layer = 62.00000 pcf
 Friction angle at top of layer = 30.00000 deg.
 Friction angle at bottom of layer = 30.00000 deg.
 Subgrade k at top of layer = 60.00000 pci
 Subgrade k at bottom of layer = 60.00000 pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor Epsilon 50	Layer Soil Type kpy (p-y Curve Criteria) pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay with Free Water		0.00	52.000	750.000
--	0.01000	100.000	2.000	52.000	750.000
--	0.01000	100.000	2.000	55.000	1000.000
2	Stiff Clay with Free Water		6.000	55.000	1000.000
--	0.00700	500.000	6.000	55.000	1000.000
--	0.00700	500.000	6.000	71.000	970.000
3	Stiff Clay with Free Water		11.000	71.000	970.000
--	0.01000	100.000			
--	0.01000	100.000			

Static_BentsRow1_Run3_Transverse.lp7o					
4	Sand (Reese, et al.)		11.000	62.000	--
30.000	--	60.000			
			90.000	62.000	--
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.9750	1.0000
2	90.000	0.9750	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
Top y vs. Pile Length				
1	1	V = 1000.00000 lbs	M = 247200. in-lbs	137000.
No				

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
Page 5		

Static_BentsRow1_Run3_Transverse.lp7o

1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

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

p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Diameter	=	24.000 in
c (at curve depth)	=	5.208 lb/in**2
Average cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.235
Ac (not used)	=	0.20000
pct	=	250.000 lb/in
pcd	=	1375.000 lb/in
pc	=	250.000 lb/in

Static_BentsRow1_Run3_Transverse.lp70

pu	=	1.553 lb/in
p-multiplier	=	0.97500
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.02814	0.0000
0.05628	0.0000
0.08442	0.0000
0.11256	0.0000
0.14070	0.0000
0.16884	0.0000
0.19698	0.0000
0.22512	0.0000
0.25326	0.0000
0.28140	0.0000
0.30954	0.0000
0.33768	0.0000
0.56280	0.0000
0.78792	0.0000
1.01304	0.0000
1.06932	0.0000

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	2
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Equivalent Depth	=	1.736 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.076 lb/in**2
Average cohesion, c	=	6.07639 psi
Undrained cohesion, c	=	875.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	500.000 pci
Epsilon50	=	0.00850
y50	=	0.204 in
As	=	0.437
Ac (not used)	=	0.28423
pct	=	665.036 lb/in
pcd	=	1604.167 lb/in
pc	=	665.036 lb/in
pu	=	47.096 lb/in
p-multiplier	=	0.97500
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.04454	151.48483
0.08908	214.23190
0.13361	247.38517
0.17815	267.30710
0.22269	279.52972
0.26723	286.24020
0.31176	288.68295
0.35630	287.66010

	Static_BentsRow1_Run3_Transverse.lp7o
0.40084	283.72932
0.44538	277.29919
0.48992	268.68097
0.53445	258.11902
0.89076	187.48097
1.24706	116.69968
1.60336	45.91839
1.69244	45.91839

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Equivalent Depth	=	3.736 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	6.51042 psi
Undrained cohesion, c	=	937.50000 psf
Average Eff. Unit Weight	=	0.03096 pci
Average Eff. Unit Weight	=	53.50000 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.168 in
As	=	0.558
Ac (not used)	=	0.30000
pct	=	1171.919 lb/in
pcd	=	1833.333 lb/in
pc	=	1171.919 lb/in
pu	=	100.045 lb/in
p-multiplier	=	0.97500
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.04686	301.73498
0.09372	426.71770
0.14058	496.19760
0.18745	540.62581
0.23431	570.37721
0.28117	589.62734
0.32803	600.75991
0.37489	605.31278
0.42175	604.35506
0.46862	598.66964
0.51548	588.85249
0.56234	575.37109
0.93723	416.26353
1.31212	256.90357
1.68701	97.54361
1.78074	97.54361

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft

Static_BentsRow1_Run3_Transverse.lp70

Equivalent Depth	=	5.621	ft
Diameter	=	24.000	in
c (at curve depth)	=	6.840	lb/in**2
Average cohesion, c	=	6.84028	psi
Undrained cohesion, c	=	985.00000	psf
Average Eff. Unit Weight	=	0.03125	pci
Average Eff. Unit Weight	=	54.00000	pcf
k	=	100.000	pci
Epsilon50	=	0.00850	
y50	=	0.204	in
As	=	0.598	
Ac (not used)	=	0.30000	
pct	=	1684.554	lb/in
pcd	=	1805.833	lb/in
pc	=	1684.554	lb/in
pu	=	147.587	lb/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.06102	401.28893
0.12205	635.19174
0.18307	739.96697
0.24409	807.96257
0.30511	854.36949
0.36614	885.33222
0.42716	904.36182
0.48818	913.72400
0.54920	914.99381
0.61023	909.32450
0.67125	897.59377
0.73227	880.48997
1.22045	635.20086
1.70863	389.54894
2.19681	143.89702
2.31886	143.89702

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3	
Depth below pile head	=	8.000	ft
Depth below ground surface	=	8.000	ft
Equivalent Depth	=	7.621	ft
Diameter	=	24.000	in
c (at curve depth)	=	6.736	lb/in**2
Average cohesion, c	=	6.78819	psi
Undrained cohesion, c	=	977.50000	psf
Average Eff. Unit Weight	=	0.03371	pci
Average Eff. Unit Weight	=	58.25000	pcf
k	=	100.000	pci
Epsilon50	=	0.01000	
y50	=	0.240	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	2156.565	lb/in
pcd	=	1778.333	lb/in
pc	=	1778.333	lb/in
pu	=	155.930	lb/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

Static_BentsRow1_Run3_Transverse.lp7o

y, in	p, lb/in
0.0000	0.0000
0.07200	474.84123
0.14400	671.52691
0.21600	782.35389
0.28800	854.31934
0.36000	903.47231
0.43200	936.30572
0.50400	956.52987
0.57600	966.53904
0.64800	967.99769
0.72000	962.12453
0.79200	949.84704
0.86400	931.89263
1.44000	672.19438
2.01600	412.11312
2.59200	152.03186
2.73600	152.03186

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Equivalent Depth	=	9.621 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	11.53084 psi
Undrained cohesion, c	=	1660.44118 psf
Average Eff. Unit Weight	=	0.03519 pci
Average Eff. Unit Weight	=	60.80000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	4418.263 lb/in
pcd	=	1778.333 lb/in
pc	=	1778.333 lb/in
pu	=	155.930 lb/in
p-multiplier	=	0.97500
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.07200	474.84123
0.14400	671.52691
0.21600	782.35389
0.28800	854.31934
0.36000	903.47231
0.43200	936.30572
0.50400	956.52987
0.57600	966.53904
0.64800	967.99769
0.72000	962.12453
0.79200	949.84704
0.86400	931.89263
1.44000	672.19438
2.01600	412.11312

	Static_BentsRow1_Run3_Transverse.lp7o
2.59200	152.03186
2.73600	152.03186

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	12.000	ft
Depth below ground surface	=	12.000	ft
Equivalent Depth (see note)	=	6.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.75000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	520.674	lb/in
Psd	=	3550.023	lb/in
Ps = Pst (shallow controls)	=	520.674	lb/in
A (static)	=	1.0590	
B (static)	=	0.7088	
C = $Pm/(Ym^{(1/n)})$	=	530.1099	
n = $Pm/(m Ym)$	=	2.5307	
m = $(Pu-Pm)/(Yu-Ym)$	=	364.6054	
Yk = $[c/(kx)]^{n/(n-1)}$	=	0.0311	in
Pk	=	134.438	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	369.079	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	551.382	lb/in
Es, lim	=	4329.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.03105	131.07672	*
0.06459	175.07179	
0.09813	206.53203	
0.13168	231.97493	
0.16522	253.73610	
0.19876	272.96118	
0.23230	290.30969	
0.26584	306.20104	
0.29938	320.92088	
0.33292	334.67373	
0.36646	347.61182	
0.40000	359.85188	
0.65000	448.72446	
0.90000	537.59703	
0.92250	537.59703	

0.94500 Static_BentsRow1_Run3_Transverse.lp7o
537.59703

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	14.000	ft
Depth below ground surface	=	14.000	ft
Equivalent Depth (see note)	=	8.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.78571	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	852.004	lb/in
Psd	=	4144.089	lb/in
Ps = Pst (shallow controls)	=	852.004	lb/in
A (static)	=	0.8999	
B (static)	=	0.5298	
C = $Pm/(Ym^{(1/n)})$	=	753.2257	
n = $Pm/(m \ Ym)$	=	1.7896	
m = $(Pu - Pm)/(Yu - Ym)$	=	630.5924	
$Yk = [c/(kx)]^{n/(n-1)}$	=	0.0099	in
Pk	=	57.161	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B \ ps$	=	451.399	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A \ Ps$	=	766.695	lb/in
Es, lim	=	5769.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.00991	55.73227	*
0.04537	130.42194	
0.08083	180.09593	
0.11630	220.68783	
0.15176	256.07562	
0.18722	287.95916	
0.22269	317.26825	
0.25815	344.57864	
0.29361	370.27686	
0.32907	394.63759	
0.36454	417.86451	
0.40000	440.11374	
0.65000	593.82064	
0.90000	747.52754	
0.92250	747.52754	

0.94500 Static_BentsRow1_Run3_Transverse.lp7o
747.52754

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Equivalent Depth (see note)	=	10.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.81250 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	1262.324 lb/in
Psd	=	4738.155 lb/in
Ps = Pst (shallow controls)	=	1262.324 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
C = $P_m / (Y_m^{(1/n)})$	=	1101.7638
n = $P_m / (m Y_m)$	=	1.6447
m = $(P_u - P_m) / (Y_u - Y_m)$	=	959.3665
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0083 in
Pk	=	59.809 lb/in
$Y_m = b / 60$	=	0.4000 in
$P_m = B p_s$	=	631.162 lb/in
$Y_u = 3b / 80$	=	0.9000 in
$P_u = A P_s$	=	1110.845 lb/in
Es, lim	=	7209.219 lb/in/in
p-multiplier	=	0.97500
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.00830	58.31377	*
0.04391	160.59993	
0.07952	230.44449	
0.11512	288.59121	
0.15073	339.97377	
0.18634	386.76217	
0.22195	430.14966	
0.25756	470.87918	
0.29317	509.45203	
0.32878	546.22615	
0.36439	581.46813	
0.40000	615.38312	
0.65000	849.22870	
0.90000	1083.07428	
0.92250	1083.07428	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 1083.07428

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	18.000	ft
Depth below ground surface	=	18.000	ft
Equivalent Depth (see note)	=	12.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.83333	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	1751.643	lb/in
Psd	=	5332.221	lb/in
Ps = Pst (shallow controls)	=	1751.643	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	1528.8440	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	1331.2488	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0120	in
Pk	=	104.003	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	875.822	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	1541.446	lb/in
Es, lim	=	8649.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.01202	101.40248	*
0.04730	233.16076	
0.08257	327.17594	
0.11784	406.16717	
0.15311	476.25980	
0.18838	540.23752	
0.22365	599.65676	
0.25892	655.49659	
0.29419	708.42228	
0.32946	758.91132	
0.36473	807.32071	
0.40000	853.92606	
0.65000	1178.41795	
0.90000	1502.90985	
0.92250	1502.90985	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 1502.90985

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	22.000	ft
Depth below ground surface	=	22.000	ft
Equivalent Depth (see note)	=	16.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.86364	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2967.298	lb/in
Psd	=	6520.353	lb/in
Ps = Pst (shallow controls)	=	2967.298	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	2589.8740	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	2255.1461	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0222	in
Pk	=	255.511	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	1483.649	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	2611.222	lb/in
Es, lim	=	11529.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02216	249.12285	*
0.05651	440.12872	
0.09086	587.45332	
0.12521	713.91268	
0.15956	827.28882	
0.19391	931.40696	
0.22826	1028.49769	
0.26260	1120.00208	
0.29695	1206.91762	
0.33130	1289.97004	
0.36565	1369.70774	
0.40000	1446.55758	
0.65000	1996.24945	
0.90000	2545.94132	
0.92250	2545.94132	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 2545.94132

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	24.000	ft
Depth below ground surface	=	24.000	ft
Equivalent Depth (see note)	=	18.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.87500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3693.639	lb/in
Psd	=	7114.419	lb/in
Ps = Pst (shallow controls)	=	3693.639	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	3223.8288	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	2807.1655	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0287	in
Pk	=	372.148	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	1846.819	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	3250.402	lb/in
Es, lim	=	12969.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02869	362.84391	*
0.06245	582.18242	
0.09620	757.11184	
0.12996	909.01786	
0.16371	1046.02496	
0.19747	1172.30613	
0.23122	1290.35607	
0.26498	1401.81283	
0.29873	1507.82334	
0.33249	1609.22925	
0.36624	1706.67080	
0.40000	1800.64897	
0.65000	2484.89558	
0.90000	3169.14218	
0.92250	3169.14218	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 3169.14218

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	26.000	ft
Depth below ground surface	=	26.000	ft
Equivalent Depth (see note)	=	20.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.88462	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4498.992	lb/in
Psd	=	7708.485	lb/in
Ps = Pst (shallow controls)	=	4498.992	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	3926.7455	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	3419.2339	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0363	in
Pk	=	522.775	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	2249.496	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	3959.113	lb/in
Es, lim	=	14409.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.03628	509.70552	*
0.06935	755.75032	
0.10241	957.91971	
0.13548	1135.56299	
0.16854	1296.80961	
0.20161	1446.03084	
0.23467	1585.91148	
0.26774	1718.24643	
0.30080	1844.30874	
0.33387	1965.04180	
0.36693	2081.16866	
0.40000	2193.25862	
0.65000	3026.69688	
0.90000	3860.13515	
0.92250	3860.13515	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 3860.13515

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	28.000	ft
Depth below ground surface	=	28.000	ft
Equivalent Depth (see note)	=	22.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.89286	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	5383.358	lb/in
Psd	=	8302.551	lb/in
Ps = Pst (shallow controls)	=	5383.358	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	4698.6251	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	4091.3521	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0450	in
Pk	=	712.811	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	2691.679	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	4737.355	lb/in
Es, lim	=	15849.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.04497	694.99096	*
0.07725	965.64223	
0.10952	1193.98415	
0.14180	1396.99205	
0.17407	1582.49629	
0.20635	1754.90904	
0.23862	1917.01925	
0.27090	2070.72833	
0.30317	2217.40429	
0.33545	2358.07193	
0.36772	2493.52349	
0.40000	2624.38707	
0.65000	3621.65414	
0.90000	4618.92122	
0.92250	4618.92122	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 4618.92122

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	30.000	ft
Depth below ground surface	=	30.000	ft
Equivalent Depth (see note)	=	24.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	6346.738	lb/in
Psd	=	8896.617	lb/in
Ps = Pst (shallow controls)	=	6346.738	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	5539.4684	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	4823.5208	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0548	in
Pk	=	947.954	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B p_s$	=	3173.369	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A P_s$	=	5585.129	lb/in
Es, lim	=	17289.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.05483	924.25549	*
0.08621	1216.98941	
0.11759	1469.78019	
0.14897	1697.11374	
0.18035	1906.27379	
0.21173	2101.56201	
0.24310	2285.78047	
0.27448	2460.88004	
0.30586	2628.28631	
0.33724	2789.08008	
0.36862	2944.10489	
0.40000	3094.03473	
0.65000	4269.76792	
0.90000	5445.50110	
0.92250	5445.50110	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 5445.50110

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	32.000	ft
Depth below ground surface	=	32.000	ft
Equivalent Depth (see note)	=	26.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90625	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	7389.132	lb/in
Psd	=	9490.683	lb/in
Ps = Pst (shallow controls)	=	7389.132	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	6449.2759	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	5615.7404	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0659	in
Pk	=	1234.170	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	3694.566	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	6502.436	lb/in
Es, lim	=	18729.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.06590	1203.31585	*
0.09627	1515.21478	
0.12664	1790.12056	
0.15701	2040.08173	
0.18739	2271.65612	
0.21776	2488.90123	
0.24813	2694.54316	
0.27851	2890.52245	
0.30888	3078.28099	
0.33925	3258.92633	
0.36963	3433.33198	
0.40000	3602.20191	
0.65000	4971.03863	
0.90000	6339.87534	
0.92250	6339.87534	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 6339.87534

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	34.000	ft
Depth below ground surface	=	34.000	ft
Equivalent Depth (see note)	=	28.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91176	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	8510.541	lb/in
Psd	=	10084.749	lb/in
Ps = Pst (shallow controls)	=	8510.541	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	7428.0481	
$n = Pm/(m \ Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	6468.0113	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0782	in
Pk	=	1577.683	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B \ ps$	=	4255.271	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A \ Ps$	=	7489.276	lb/in
Es, lim	=	20169.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.07822	1538.24102	*
0.10747	1866.00953	
0.13673	2160.12764	
0.16598	2430.37350	
0.19523	2682.46991	
0.22448	2920.12274	
0.25374	3145.90144	
0.28299	3361.67781	
0.31224	3568.86755	
0.34149	3768.57346	
0.37075	3961.67531	
0.40000	4148.88885	
0.65000	5725.46659	
0.90000	7302.04434	
0.92250	7302.04434	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 7302.04434

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	36.000	ft
Depth below ground surface	=	36.000	ft
Equivalent Depth (see note)	=	30.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	9710.966	lb/in
Psd	=	10678.815	lb/in
Ps = Pst (shallow controls)	=	9710.966	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	8475.7852	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	7380.3338	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0919	in
Pk	=	1984.968	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B p_s$	=	4855.483	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A P_s$	=	8545.650	lb/in
Es, lim	=	21609.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.09186	1935.34399	*
0.11987	2275.31480	
0.14788	2585.20833	
0.17590	2872.76897	
0.20391	3142.84004	
0.23192	3398.69942	
0.25994	3642.69285	
0.28795	3876.57035	
0.31596	4101.68046	
0.34397	4319.08948	
0.37199	4529.65860	
0.40000	4734.09572	
0.65000	6533.05207	
0.90000	8332.00843	
0.92250	8332.00843	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 8332.00843

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	38.000	ft
Depth below ground surface	=	38.000	ft
Equivalent Depth (see note)	=	32.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92105	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	10990.405	lb/in
Psd	=	11272.881	lb/in
Ps = Pst (shallow controls)	=	10990.405	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	9592.4875	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	8352.7081	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.1068	in
Pk	=	2462.743	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	5495.203	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	9671.557	lb/in
Es, lim	=	23049.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.10685	2401.17421	*
0.13350	2749.30741	
0.16015	3071.03217	
0.18680	3372.32984	
0.21345	3657.17434	
0.24010	3928.37167	
0.26675	4187.99409	
0.29340	4437.62569	
0.32005	4678.51101	
0.34670	4911.64985	
0.37335	5137.86039	
0.40000	5357.82267	
0.65000	7393.79526	
0.90000	9429.76785	
0.92250	9429.76785	

Static_BentsRow1_Run3_Transverse.lp7o
0.94500 9429.76785

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	40.000	ft
Depth below ground surface	=	40.000	ft
Equivalent Depth (see note)	=	34.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	12348.861	lb/in
Psd	=	11866.947	lb/in
Ps = Psd (deep controls)	=	11866.947	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	10357.5377	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	9018.8795	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.1113	in
Pk	=	2726.539	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	5933.473	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	10442.913	lb/in
Es, lim	=	24489.219	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.11134	2658.37517	*
0.13758	3023.42901	
0.16382	3361.99601	
0.19006	3679.85349	
0.21630	3980.90212	
0.24255	4267.92840	
0.26879	4543.00847	
0.29503	4807.74043	
0.32127	5063.38688	
0.34752	5310.96681	
0.37376	5551.31735	
0.40000	5785.13659	
0.65000	7983.48847	
0.90000	10182.	
0.92250	10182.	

0.94500 Static_BentsRow1_Run3_Transverse.lp7o
10182.

* p value(s) computed using $p = k * \text{Eff} \times y$

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 = 1000.0 lbs
Applied moment at pile head = 247200.0 in-lbs
Axial thrust load on pile head = 137000.0 lbs

Depth Res.	Soil X	Deflect. Spr.	Bending Distrib.	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil p
	Es*h	Lat. Load	Moment					
feet	lb/inch	inches	in-lbs	lbs	radians	psi*	lb-in^2	lb/in
		lb/inch						
0.000	0.00	0.0163	247200.	1000.0000	-0.000343	1465.4798	7.861E+10	
-14.4901	1.000	0.0124	259432.	906.4478	-0.000304	1522.9949	7.861E+10	
-68.0070	2.000	0.008976	269583.	547.1305	-0.000264	1570.7304	7.861E+10	
-90.0235	3.000	0.006060	271044.	-436.2993	-0.000222	1577.5991	7.861E+10	
-79.5507	4.000	0.003639	259635.	-1489.0141	-0.000182	1523.9531	7.861E+10	
-46.9043	5.000	0.001693	236842.	-2256.3340	-0.000144	1416.7758	7.861E+10	
-1.1787	6.000	0.000179	207309.	-2563.2560	-0.000110	1277.9047	7.861E+10	
7.3945	7.000	-0.000955	176774.	-2526.0626	-8.042E-05	1134.3237	7.861E+10	
15.7328	8.000	-0.001765	147257.	-2386.8687	-5.570E-05	995.5304	7.861E+10	
23.2432	9.000	-0.002304	119962.	-2152.2214	-3.533E-05	867.1804	7.861E+10	
29.5394	10.000	-0.002624	95972.	-1834.5118	-1.889E-05	754.3752	7.861E+10	
9.7400	11.000	-0.002768	76198.	-1523.7359	-5.791E-06	661.3967	7.861E+10	
11.6992	12.000	-0.002772	58653.	-1394.7472	4.486E-06	578.8937	7.861E+10	
13.1338	13.000	-0.002668	42772.	-1245.3230	1.221E-05	504.2206	7.861E+10	
13.9808	14.000	-0.002485	28767.	-1082.1862	1.765E-05	438.3650	7.861E+10	
14.2368	15.000	-0.002250	16762.	-912.4479	2.111E-05	381.9168	7.861E+10	
13.9451	16.000	-0.001984	6798.5477	-742.9703	2.289E-05	335.0654	7.861E+10	
		42174.	0.000					

Static_BentsRow1_Run3_Transverse.lp70						
17.000	-0.001705	-1163.0870	-579.8910	2.330E-05	308.5664	7.861E+10
13.1815	46386.	0.000				
18.000	-0.001428	-7229.7093	-428.3050	2.264E-05	337.0928	7.861E+10
12.0424	50598.	0.000				
19.000	-0.001164	-11563.	-292.0868	2.119E-05	357.4682	7.861E+10
10.6336	54810.	0.000				
20.000	-0.000921	-14363.	-173.8359	1.920E-05	370.6367	7.861E+10
9.0608	59022.	0.000				
21.000	-0.000704	-15856.	-74.9211	1.688E-05	377.6560	7.861E+10
7.4226	63234.	0.000				
22.000	-0.000516	-16276.	4.4002	1.442E-05	379.6297	7.861E+10
5.8051	67446.	0.000				
23.000	-0.000358	-15855.	64.8118	1.196E-05	377.6497	7.861E+10
4.2787	71658.	0.000				
24.000	-0.000229	-14812.	107.7393	9.613E-06	372.7477	7.861E+10
2.8966	75870.	0.000				
25.000	-0.000127	-13347.	135.1417	7.461E-06	365.8593	7.861E+10
1.6946	80082.	0.000				
26.000	-4.928E-05	-11633.	149.3095	5.552E-06	357.7993	7.861E+10
0.6923	84294.	0.000				
27.000	7.109E-06	-9814.7069	152.6813	3.915E-06	349.2480	7.861E+10
-0.1049	88506.	0.000				
28.000	4.552E-05	-8006.9817	147.6876	2.555E-06	340.7477	7.861E+10
-0.7034	92718.	0.000				
29.000	6.925E-05	-6296.8796	136.6253	1.465E-06	332.7065	7.861E+10
-1.1187	96930.	0.000				
30.000	8.143E-05	-4744.8319	121.5657	6.239E-07	325.4085	7.861E+10
-1.3726	101142.	0.000				
31.000	8.489E-05	-3388.0195	104.2948	5.210E-09	319.0285	7.861E+10
-1.4906	105354.	0.000				
32.000	8.212E-05	-2244.0172	86.2818	-4.226E-07	313.6492	7.861E+10
-1.4997	109566.	0.000				
33.000	7.522E-05	-1314.6599	68.6731	-6.922E-07	309.2791	7.861E+10
-1.4264	113778.	0.000				
34.000	6.589E-05	-589.8616	52.3057	-8.356E-07	305.8710	7.861E+10
-1.2957	117990.	0.000				
35.000	5.546E-05	-51.1783	37.7354	-8.829E-07	303.3380	7.861E+10
-1.1295	122202.	0.000				
36.000	4.491E-05	325.0301	25.2750	-8.606E-07	304.6257	7.861E+10
-0.9462	126414.	0.000				
37.000	3.494E-05	564.9280	15.0368	-7.915E-07	305.7537	7.861E+10
-0.7607	130626.	0.000				
38.000	2.600E-05	695.0623	6.9775	-6.944E-07	306.3657	7.861E+10
-0.5842	134838.	0.000				
39.000	1.831E-05	740.7453	0.9403	-5.841E-07	306.5805	7.861E+10
-0.4244	139050.	0.000				
40.000	1.198E-05	724.9294	-3.3059	-4.718E-07	306.5061	7.861E+10
-0.2861	143262.	0.000				
41.000	6.974E-06	667.5176	-6.0331	-3.652E-07	306.2361	7.861E+10
-0.1714	147474.	0.000				
42.000	3.186E-06	585.0383	-7.5273	-2.694E-07	305.8483	7.861E+10
-0.0805	151686.	0.000				
43.000	4.675E-07	490.6114	-8.0674	-1.873E-07	305.4043	7.861E+10
-0.0121	155898.	0.000				
44.000	-1.352E-06	394.1304	-7.9096	-1.197E-07	304.9506	7.861E+10
0.0361	160110.	0.000				
45.000	-2.450E-06	302.5919	-7.2788	-6.664E-08	304.5202	7.861E+10
0.0671	164322.	0.000				
46.000	-2.992E-06	220.5119	-6.3627	-2.682E-08	304.1342	7.861E+10
0.0840	168534.	0.000				
47.000	-3.128E-06	150.3794	-5.3110	1.363E-09	303.8045	7.861E+10
0.0901	172746.	0.000				
48.000	-2.988E-06	93.1076	-4.2369	1.982E-08	303.5352	7.861E+10

		Static_BentsRow1_Run3_Transverse.lp7o				
0.0881	176958.	0.000				
49.000	-2.676E-06	48.4549	-3.2201	3.051E-08	303.3252	7.861E+10
0.0808	181170.	0.000				
50.000	-2.274E-06	15.3967	-2.3121	3.528E-08	303.1697	7.861E+10
0.0703	185382.	0.000				
51.000	-1.842E-06	-7.5628	-1.5408	3.579E-08	303.1329	7.861E+10
0.0582	189594.	0.000				
52.000	-1.423E-06	-22.1403	-0.9160	3.345E-08	303.2015	7.861E+10
0.0460	193806.	0.000				
53.000	-1.044E-06	-30.0858	-0.4341	2.941E-08	303.2388	7.861E+10
0.0345	198018.	0.000				
54.000	-7.198E-07	-33.0490	-0.0829	2.455E-08	303.2527	7.861E+10
0.0243	202230.	0.000				
55.000	-4.555E-07	-32.4958	0.1554	1.952E-08	303.2501	7.861E+10
0.0157	206442.	0.000				
56.000	-2.505E-07	-29.6622	0.3009	1.476E-08	303.2368	7.861E+10
0.008793	210654.	0.000				
57.000	-9.961E-08	-25.5399	0.3739	1.054E-08	303.2174	7.861E+10
0.003567	214866.	0.000				
58.000	4.526E-09	-20.8841	0.3933	6.994E-09	303.1955	7.861E+10
-0.000165	219078.	0.000				
59.000	7.040E-08	-16.2354	0.3757	4.163E-09	303.1737	7.861E+10
-0.002620	223290.	0.000				
60.000	1.065E-07	-11.9505	0.3350	2.016E-09	303.1535	7.861E+10
-0.004038	227502.	0.000				
61.000	1.206E-07	-8.2369	0.2823	4.818E-10	303.1361	7.861E+10
-0.004659	231714.	0.000				
62.000	1.196E-07	-5.1870	0.2258	-5.363E-10	303.1217	7.861E+10
-0.004703	235926.	0.000				
63.000	1.090E-07	-2.8095	0.1712	-1.140E-09	303.1106	7.861E+10
-0.004363	240138.	0.000				
64.000	9.319E-08	-1.0576	0.1221	-1.430E-09	303.1023	7.861E+10
-0.003795	244350.	0.000				
65.000	7.536E-08	0.1491	0.0806	-1.494E-09	303.0980	7.861E+10
-0.003122	248562.	0.000				
66.000	5.776E-08	0.9062	0.0473	-1.410E-09	303.1016	7.861E+10
-0.002434	252774.	0.000				
67.000	4.178E-08	1.3123	0.0220	-1.238E-09	303.1035	7.861E+10
-0.001790	256986.	0.000				
68.000	2.818E-08	1.4597	0.003952	-1.024E-09	303.1042	7.861E+10
-0.001227	261198.	0.000				
69.000	1.723E-08	1.4291	-0.007904	-8.024E-10	303.1041	7.861E+10
-0.000762	265410.	0.000				
70.000	8.878E-09	1.2875	-0.0148	-5.943E-10	303.1034	7.861E+10
-0.000399	269622.	0.000				
71.000	2.883E-09	1.0873	-0.0179	-4.127E-10	303.1025	7.861E+10
-0.000132	273834.	0.000				
72.000	-1.123E-09	0.8671	-0.0183	-2.634E-10	303.1014	7.861E+10
5.206E-05	278046.	0.000				
73.000	-3.541E-09	0.6536	-0.0170	-1.475E-10	303.1004	7.861E+10
0.000167	282258.	0.000				
74.000	-4.758E-09	0.4634	-0.0146	-6.258E-11	303.0995	7.861E+10
0.000227	286470.	0.000				
75.000	-5.123E-09	0.3054	-0.0117	-4.238E-12	303.0988	7.861E+10
0.000248	290682.	0.000				
76.000	-4.924E-09	0.1829	-0.008740	3.269E-11	303.0982	7.861E+10
0.000242	294894.	0.000				
77.000	-4.386E-09	0.0950	-0.005967	5.357E-11	303.0978	7.861E+10
0.000219	299106.	0.000				
78.000	-3.671E-09	0.0384	-0.003536	6.348E-11	303.0975	7.861E+10
0.000186	303318.	0.000				
79.000	-2.882E-09	0.008598	-0.001534	6.684E-11	303.0974	7.861E+10
0.000148	307530.	0.000				

Static_BentsRow1_Run3_Transverse.lp70
80.000 -2.075E-09 0.000 0.000 6.732E-11 303.0973 7.861E+10
0.000108 155871. 0.000

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

Output Summary for Load Case No. 1:

File-head deflection = 0.0162682 inches
Computed slope at pile head = -0.0003427 radians
Maximum bending moment = 271850. inch-lbs
Maximum shear force = -2563.2560042 lbs
Depth of maximum bending moment = 2.5000000 feet below pile head
Depth of maximum shear force = 6.0000000 feet below pile head
Number of iterations = 6
Number of zero deflection points = 5

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head Condition		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad. radians			
1	1	V = 1000.0000 271850.	M = 247200. -0.00034273	137000.	0.01626816	

Computed Pile-head Stiffness Matrix Values K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)

Static_BentsRow1_Run3_Transverse.lp70

K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear React. lbs	Pile-Top Mom. React. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.000129	0.000000	100.000000	4285.438217	773992.	33168948.
0.000479	0.000000	370.926996	15896.	773992.	33168948.
0.000684	0.000000	529.409129	22688.	773992.	33168948.
0.000829	0.000000	641.853992	27506.	773992.	33168948.
0.000942	0.000000	729.073004	31244.	773992.	33168948.
0.001034	0.000000	800.336125	34298.	773992.	33168948.
0.001112	0.000000	860.588236	36880.	773992.	33168948.
0.001179	0.000000	912.780988	39117.	773992.	33168948.
0.001239	0.000000	958.818258	41090.	773992.	33168948.
0.001292	0.000000	1000.000000	42854.	773992.	33168948.

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)

K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear React. lbs	Pile-Top Mom. React. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
0.000000	0.00001083	359.256471	24720.	33168948.	2282314890.
0.000000	0.00004018	1332.579237	91693.	33168948.	2282314890.
0.000000	0.00005734	1901.936556	130870.	33168948.	2282314890.
0.000000	0.00006952	2305.902003	158666.	33168948.	2282314890.
0.000000	0.00007897	2619.241946	180227.	33168948.	2282314890.
0.000000	0.00008669	2875.259322	197843.	33168948.	2282314890.
0.000000	0.00009321	3091.718928	212737.	33168948.	2282314890.
0.000000	0.00009886	3279.224768	225639.	33168948.	2282314890.
0.000000	0.000104	3444.616641	237020.	33168948.	2282314890.
0.000000	0.000108	3592.564712	247200.	33168948.	2282314890.

The analysis ended normally.

Static_BentsRow2_Run3_Transverse.lp7o

LPILE Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LpileRuns_10272015\Bents\Static_Trans\
Name of input data file: Static_BentsRow2_Run3_Transverse.lp7d
Name of output report file: Static_BentsRow2_Run3_Transverse.lp7o
Name of plot output file: Static_BentsRow2_Run3_Transverse.lp7p
Name of runtime message file: Static_BentsRow2_Run3_Transverse.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 15:17:50

Problem Title

Bents Row #1: 24-inch Static with p-multipliers Trans

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 22-BMG-14

 Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

 Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	80.000000	24.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	24.00000 in
Bottom Width	=	24.00000 in
Top Area	=	452.00000 Sq. in
Bottom Area	=	452.00000 Sq. in
Moment of Inertia at Top	=	2552.00000 in ⁴
Moment of Inertia at Bottom	=	2552.00000 in ⁴
Elastic Modulus	=	30805000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	2.00000 ft
Effective unit weight at top of layer	=	52.00000 pcf
Effective unit weight at bottom of layer	=	52.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000
Subgrade k at top of layer	=	100.00000 pci
Subgrade k at bottom of layer	=	100.00000 pci

Layer 2 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	2.00000 ft
Distance from top of pile to bottom of layer	=	6.00000 ft
Effective unit weight at top of layer	=	55.00000 pcf

Static_BentsRow2_Run3_Transverse.lp70

Effective unit weight at bottom of layer = 55.00000 pcf
 Undrained cohesion at top of layer = 1000.00000 psf
 Undrained cohesion at bottom of layer = 1000.00000 psf
 Epsilon-50 at top of layer = 0.00700
 Epsilon-50 at bottom of layer = 0.00700
 Subgrade k at top of layer = 500.00000 pci
 Subgrade k at bottom of layer = 500.00000 pci

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer = 6.00000 ft
 Distance from top of pile to bottom of layer = 11.00000 ft
 Effective unit weight at top of layer = 71.00000 pcf
 Effective unit weight at bottom of layer = 71.00000 pcf
 Undrained cohesion at top of layer = 970.00000 psf
 Undrained cohesion at bottom of layer = 970.00000 psf
 Epsilon-50 at top of layer = 0.01000
 Epsilon-50 at bottom of layer = 0.01000
 Subgrade k at top of layer = 100.00000 pci
 Subgrade k at bottom of layer = 100.00000 pci

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 11.00000 ft
 Distance from top of pile to bottom of layer = 90.00000 ft
 Effective unit weight at top of layer = 62.00000 pcf
 Effective unit weight at bottom of layer = 62.00000 pcf
 Friction angle at top of layer = 30.00000 deg.
 Friction angle at bottom of layer = 30.00000 deg.
 Subgrade k at top of layer = 60.00000 pci
 Subgrade k at bottom of layer = 60.00000 pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor Epsilon 50	Layer Soil Type kpy (p-y Curve Criteria) pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay with Free Water		0.00	52.000	750.000
--	0.01000	100.000	2.000	52.000	750.000
--	0.01000	100.000	2.000	55.000	1000.000
2	Stiff Clay with Free Water		2.000	55.000	1000.000
--	0.00700	500.000	6.000	55.000	1000.000
--	0.00700	500.000	6.000	71.000	970.000
3	Stiff Clay with Free Water		6.000	71.000	970.000
--	0.01000	100.000	11.000	71.000	970.000
--	0.01000	100.000			

Static_BentsRow2_Run3_Transverse.lp7o					
4	Sand (Reese, et al.)		11.000	62.000	--
30.000	--	60.000			
			90.000	62.000	--
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7900	1.0000
2	90.000	0.7900	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
Top y vs. Pile Length				
1	1	V = 1000.00000 lbs	M = 247200. in-lbs	137000.
No				

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
Page 5		

Static_BentsRow2_Run3_Transverse.lp7o

1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

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

p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Diameter	=	24.000 in
c (at curve depth)	=	5.208 lb/in**2
Average cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.235
Ac (not used)	=	0.20000
pct	=	250.000 lb/in
pcd	=	1375.000 lb/in
pc	=	250.000 lb/in

Static_BentsRow2_Run3_Transverse.lp70

pu	=	1.553 lb/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.02814	0.0000
0.05628	0.0000
0.08442	0.0000
0.11256	0.0000
0.14070	0.0000
0.16884	0.0000
0.19698	0.0000
0.22512	0.0000
0.25326	0.0000
0.28140	0.0000
0.30954	0.0000
0.33768	0.0000
0.56280	0.0000
0.78792	0.0000
1.01304	0.0000
1.06932	0.0000

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	2
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Equivalent Depth	=	1.736 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.076 lb/in**2
Average cohesion, c	=	6.07639 psi
Undrained cohesion, c	=	875.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	500.000 pci
Epsilon50	=	0.00850
y50	=	0.204 in
As	=	0.437
Ac (not used)	=	0.28423
pct	=	665.036 lb/in
pcd	=	1604.167 lb/in
pc	=	665.036 lb/in
pu	=	47.096 lb/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.04454	122.74156
0.08908	173.58277
0.13361	200.44542
0.17815	216.58729
0.22269	226.49074
0.26723	231.92796
0.31176	233.90721
0.35630	233.07844

	Static_BentsRow2_Run3_Transverse.lp7o
0.40084	229.89350
0.44538	224.68345
0.48992	217.70048
0.53445	209.14259
0.89076	151.90765
1.24706	94.55666
1.60336	37.20567
1.69244	37.20567

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Equivalent Depth	=	3.736 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	6.51042 psi
Undrained cohesion, c	=	937.50000 psf
Average Eff. Unit Weight	=	0.03096 pci
Average Eff. Unit Weight	=	53.50000 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.168 in
As	=	0.558
Ac (not used)	=	0.30000
pct	=	1171.919 lb/in
pcd	=	1833.333 lb/in
pc	=	1171.919 lb/in
pu	=	100.045 lb/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.04686	244.48270
0.09372	345.75075
0.14058	402.04729
0.18745	438.04553
0.23431	462.15179
0.28117	477.74933
0.32803	486.76957
0.37489	490.45856
0.42175	489.68256
0.46862	485.07592
0.51548	477.12150
0.56234	466.19811
0.93723	337.28020
1.31212	208.15776
1.68701	79.03533
1.78074	79.03533

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft

Static_BentsRow2_Run3_Transverse.lp7o

Equivalent Depth	=	5.621	ft
Diameter	=	24.000	in
c (at curve depth)	=	6.840	lb/in**2
Average cohesion, c	=	6.84028	psi
Undrained cohesion, c	=	985.00000	psf
Average Eff. Unit Weight	=	0.03125	pci
Average Eff. Unit Weight	=	54.00000	pcf
k	=	100.000	pci
Epsilon50	=	0.00850	
y50	=	0.204	in
As	=	0.598	
Ac (not used)	=	0.30000	
pct	=	1684.554	lb/in
pcd	=	1805.833	lb/in
pc	=	1684.554	lb/in
pu	=	147.587	lb/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.06102	325.14692
0.12205	514.66818
0.18307	599.56298
0.24409	654.65685
0.30511	692.25835
0.36614	717.34611
0.42716	732.76497
0.48818	740.35073
0.54920	741.37960
0.61023	736.78601
0.67125	727.28111
0.73227	713.42264
1.22045	514.67557
1.70863	315.63452
2.19681	116.59348
2.31886	116.59348

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3	
Depth below pile head	=	8.000	ft
Depth below ground surface	=	8.000	ft
Equivalent Depth	=	7.621	ft
Diameter	=	24.000	in
c (at curve depth)	=	6.736	lb/in**2
Average cohesion, c	=	6.78819	psi
Undrained cohesion, c	=	977.50000	psf
Average Eff. Unit Weight	=	0.03371	pci
Average Eff. Unit Weight	=	58.25000	pcf
k	=	100.000	pci
Epsilon50	=	0.01000	
y50	=	0.240	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	2156.565	lb/in
pcd	=	1778.333	lb/in
pc	=	1778.333	lb/in
pu	=	155.930	lb/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

Static_BentsRow2_Run3_Transverse.lp7o

y, in	p, lb/in
0.0000	0.0000
0.07200	384.74315
0.14400	544.10899
0.21600	633.90725
0.28800	692.21772
0.36000	732.04423
0.43200	758.64771
0.50400	775.03446
0.57600	783.14445
0.64800	784.32633
0.72000	779.56757
0.79200	769.61966
0.86400	755.07197
1.44000	544.64980
2.01600	333.91730
2.59200	123.18479
2.73600	123.18479

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Equivalent Depth	=	9.621 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	11.53084 psi
Undrained cohesion, c	=	1660.44118 psf
Average Eff. Unit Weight	=	0.03519 pci
Average Eff. Unit Weight	=	60.80000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	4418.263 lb/in
pcd	=	1778.333 lb/in
pc	=	1778.333 lb/in
pu	=	155.930 lb/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.07200	384.74315
0.14400	544.10899
0.21600	633.90725
0.28800	692.21772
0.36000	732.04423
0.43200	758.64771
0.50400	775.03446
0.57600	783.14445
0.64800	784.32633
0.72000	779.56757
0.79200	769.61966
0.86400	755.07197
1.44000	544.64980
2.01600	333.91730

	Static_BentsRow2_Run3_Transverse.lp7o
2.59200	123.18479
2.73600	123.18479

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	12.000	ft
Depth below ground surface	=	12.000	ft
Equivalent Depth (see note)	=	6.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.75000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	520.674	lb/in
Psd	=	3550.023	lb/in
Ps = Pst (shallow controls)	=	520.674	lb/in
A (static)	=	1.0590	
B (static)	=	0.7088	
C = $Pm/(Ym^{(1/n)})$	=	530.1099	
n = $Pm/(m Ym)$	=	2.5307	
m = $(Pu-Pm)/(Yu-Ym)$	=	364.6054	
Yk = $[c/(kx)]^{(n/(n-1))}$	=	0.0311	in
Pk	=	134.438	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	369.079	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	551.382	lb/in
Es, lim	=	4329.219	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.03105	106.20575	*
0.06459	141.85304	
0.09813	167.34390	
0.13168	187.95917	
0.16522	205.59130	
0.19876	221.16855	
0.23230	235.22528	
0.26584	248.10135	
0.29938	260.02820	
0.33292	271.17154	
0.36646	281.65470	
0.40000	291.57229	
0.65000	363.58187	
0.90000	435.59144	
0.92250	435.59144	

0.94500 Static_BentsRow2_Run3_Transverse.lp7o
435.59144

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Equivalent Depth (see note)	=	8.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.78571 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	852.004 lb/in
Psd	=	4144.089 lb/in
Ps = Pst (shallow controls)	=	852.004 lb/in
A (static)	=	0.8999
B (static)	=	0.5298
$C = P_m / (Y_m^{(1/n)})$	=	753.2257
$n = P_m / (m Y_m)$	=	1.7896
$m = (P_u - P_m) / (Y_u - Y_m)$	=	630.5924
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0099 in
Pk	=	57.161 lb/in
$Y_m = b / 60$	=	0.4000 in
$P_m = B p_s$	=	451.399 lb/in
$Y_u = 3b / 80$	=	0.9000 in
$P_u = A P_s$	=	766.695 lb/in
Es, lim	=	5769.219 lb/in/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.00991	45.15743	*
0.04537	105.67521	
0.08083	145.92388	
0.11630	178.81373	
0.15176	207.48691	
0.18722	233.32076	
0.22269	257.06863	
0.25815	279.19705	
0.29361	300.01920	
0.32907	319.75764	
0.36454	338.57740	
0.40000	356.60498	
0.65000	481.14698	
0.90000	605.68898	
0.92250	605.68898	

0.94500 Static_BentsRow2_Run3_Transverse.lp7o
605.68898

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Equivalent Depth (see note)	=	10.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.81250 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	1262.324 lb/in
Psd	=	4738.155 lb/in
Ps = Pst (shallow controls)	=	1262.324 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
$C = P_m / (Y_m^{(1/n)})$	=	1101.7638
$n = P_m / (m Y_m)$	=	1.6447
$m = (P_u - P_m) / (Y_u - Y_m)$	=	959.3665
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0083 in
Pk	=	59.809 lb/in
$Y_m = b / 60$	=	0.4000 in
$P_m = B p_s$	=	631.162 lb/in
$Y_u = 3b / 80$	=	0.9000 in
$P_u = A P_s$	=	1110.845 lb/in
Es, lim	=	7209.219 lb/in/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.00830	47.24910	*
0.04391	130.12712	
0.07952	186.71913	
0.11512	233.83288	
0.15073	275.46593	
0.18634	313.37653	
0.22195	348.53152	
0.25756	381.53287	
0.29317	412.78677	
0.32878	442.58324	
0.36439	471.13828	
0.40000	498.61812	
0.65000	688.09300	
0.90000	877.56788	
0.92250	877.56788	

0.94500 Static_BentsRow2_Run3_Transverse.lp7o
877.56788

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	18.000 ft
Depth below ground surface	=	18.000 ft
Equivalent Depth (see note)	=	12.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.83333 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	1751.643 lb/in
Psd	=	5332.221 lb/in
Ps = Pst (shallow controls)	=	1751.643 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
C = $Pm/(Ym^{(1/n)})$	=	1528.8440
n = $Pm/(m \cdot Ym)$	=	1.6447
m = $(Pu - Pm)/(Yu - Ym)$	=	1331.2488
Yk = $[c/(kx)]^{(n/(n-1))}$	=	0.0120 in
Pk	=	104.003 lb/in
Ym = b/60	=	0.4000 in
Pm = B ps	=	875.822 lb/in
Yu = 3b/80	=	0.9000 in
Pu = A Ps	=	1541.446 lb/in
Es, lim	=	8649.219 lb/in/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.01202	82.16201	*
0.04730	188.92000	
0.08257	265.09640	
0.11784	329.09955	
0.15311	385.89255	
0.18838	437.73091	
0.22365	485.87573	
0.25892	531.12031	
0.29419	574.00370	
0.32946	614.91276	
0.36473	654.13678	
0.40000	691.89906	
0.65000	954.82070	
0.90000	1217.74234	
0.92250	1217.74234	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 1217.74234

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	22.000	ft
Depth below ground surface	=	22.000	ft
Equivalent Depth (see note)	=	16.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.86364	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2967.298	lb/in
Psd	=	6520.353	lb/in
Ps = Pst (shallow controls)	=	2967.298	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	2589.8740	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	2255.1461	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0222	in
Pk	=	255.511	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	1483.649	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	2611.222	lb/in
Es, lim	=	11529.219	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02216	201.85339	*
0.05651	356.61712	
0.09086	475.98781	
0.12521	578.45233	
0.15956	670.31607	
0.19391	754.67846	
0.22826	833.34685	
0.26260	907.48887	
0.29695	977.91273	
0.33130	1045.20649	
0.36565	1109.81447	
0.40000	1172.08255	
0.65000	1617.47391	
0.90000	2062.86527	
0.92250	2062.86527	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 2062.86527

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth (see note)	=	18.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.87500 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	3693.639 lb/in
Psd	=	7114.419 lb/in
Ps = Pst (shallow controls)	=	3693.639 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
$C = P_m / (Y_m^{(1/n)})$	=	3223.8288
$n = P_m / (m Y_m)$	=	1.6447
$m = (P_u - P_m) / (Y_u - Y_m)$	=	2807.1655
$Y_k = [c / (kx)]^{(n / (n-1))}$	=	0.0287 in
Pk	=	372.148 lb/in
$Y_m = b / 60$	=	0.4000 in
$P_m = B p_s$	=	1846.819 lb/in
$Y_u = 3b / 80$	=	0.9000 in
$P_u = A P_s$	=	3250.402 lb/in
Es, lim	=	12969.219 lb/in/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02869	293.99661	*
0.06245	471.71704	
0.09620	613.45472	
0.12996	736.53754	
0.16371	847.54843	
0.19747	949.86856	
0.23122	1045.51928	
0.26498	1135.82783	
0.29873	1221.72352	
0.33249	1303.88832	
0.36624	1382.84096	
0.40000	1458.98737	
0.65000	2013.40257	
0.90000	2567.81776	
0.92250	2567.81776	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 2567.81776

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	26.000	ft
Depth below ground surface	=	26.000	ft
Equivalent Depth (see note)	=	20.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.88462	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4498.992	lb/in
Psd	=	7708.485	lb/in
Ps = Pst (shallow controls)	=	4498.992	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	3926.7455	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	3419.2339	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0363	in
Pk	=	522.775	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	2249.496	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	3959.113	lb/in
Es, lim	=	14409.219	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.03628	412.99216	*
0.06935	612.35154	
0.10241	776.16059	
0.13548	920.09719	
0.16854	1050.74830	
0.20161	1171.65576	
0.23467	1284.99495	
0.26774	1392.22018	
0.30080	1494.36298	
0.33387	1592.18772	
0.36693	1686.28025	
0.40000	1777.10186	
0.65000	2452.40055	
0.90000	3127.69925	
0.92250	3127.69925	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 3127.69925

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	28.000	ft
Depth below ground surface	=	28.000	ft
Equivalent Depth (see note)	=	22.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.89286	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	5383.358	lb/in
Psd	=	8302.551	lb/in
Ps = Pst (shallow controls)	=	5383.358	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	4698.6251	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	4091.3521	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0450	in
Pk	=	712.811	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	2691.679	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	4737.355	lb/in
Es, lim	=	15849.219	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.04497	563.12088	*
0.07725	782.41781	
0.10952	967.43331	
0.14180	1131.92176	
0.17407	1282.22776	
0.20635	1421.92630	
0.23862	1553.27714	
0.27090	1677.82091	
0.30317	1796.66604	
0.33545	1910.64290	
0.36772	2020.39339	
0.40000	2126.42645	
0.65000	2934.46849	
0.90000	3742.51052	
0.92250	3742.51052	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 3742.51052

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	30.000	ft
Depth below ground surface	=	30.000	ft
Equivalent Depth (see note)	=	24.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	6346.738	lb/in
Psd	=	8896.617	lb/in
Ps = Pst (shallow controls)	=	6346.738	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	5539.4684	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	4823.5208	
$Y_k = [c / (kx)]^{(n / (n-1))}$	=	0.0548	in
Pk	=	947.954	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	3173.369	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	5585.129	lb/in
Es, lim	=	17289.219	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.05483	748.88394	*
0.08621	986.07347	
0.11759	1190.89882	
0.14897	1375.09729	
0.18035	1544.57056	
0.21173	1702.80409	
0.24310	1852.06828	
0.27448	1993.94383	
0.30586	2129.58583	
0.33724	2259.87001	
0.36862	2385.47986	
0.40000	2506.96148	
0.65000	3459.60682	
0.90000	4412.25217	
0.92250	4412.25217	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 4412.25217

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	32.000	ft
Depth below ground surface	=	32.000	ft
Equivalent Depth (see note)	=	26.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90625	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	7389.132	lb/in
Psd	=	9490.683	lb/in
Ps = Pst (shallow controls)	=	7389.132	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	6449.2759	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	5615.7404	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0659	in
Pk	=	1234.170	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	3694.566	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	6502.436	lb/in
Es, lim	=	18729.219	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.06590	974.99438	*
0.09627	1227.71249	
0.12664	1450.45666	
0.15701	1652.98930	
0.18739	1840.62393	
0.21776	2016.64817	
0.24813	2183.27087	
0.27851	2342.06434	
0.30888	2494.19691	
0.33925	2640.56595	
0.36963	2781.87925	
0.40000	2918.70719	
0.65000	4027.81591	
0.90000	5136.92463	
0.92250	5136.92463	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 5136.92463

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Equivalent Depth (see note)	=	28.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.91176 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	8510.541 lb/in
Psd	=	10084.749 lb/in
Ps = Pst (shallow controls)	=	8510.541 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
$C = P_m / (Y_m^{(1/n)})$	=	7428.0481
$n = P_m / (m Y_m)$	=	1.6447
$m = (P_u - P_m) / (Y_u - Y_m)$	=	6468.0113
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0782 in
Pk	=	1577.683 lb/in
$Y_m = b / 60$	=	0.4000 in
$P_m = B \text{ ps}$	=	4255.271 lb/in
$Y_u = 3b / 80$	=	0.9000 in
$P_u = A \text{ Ps}$	=	7489.276 lb/in
Es, lim	=	20169.219 lb/in/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.07822	1246.36965	*
0.10747	1511.94619	
0.13673	1750.25727	
0.16598	1969.22571	
0.19523	2173.48844	
0.22448	2366.04817	
0.25374	2548.98681	
0.28299	2723.82099	
0.31224	2891.69781	
0.34149	3053.51080	
0.37075	3209.97281	
0.40000	3361.66379	
0.65000	4639.09601	
0.90000	5916.52823	
0.92250	5916.52823	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 5916.52823

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	36.000	ft
Depth below ground surface	=	36.000	ft
Equivalent Depth (see note)	=	30.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	9710.966	lb/in
Psd	=	10678.815	lb/in
Ps = Pst (shallow controls)	=	9710.966	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	8475.7852	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	7380.3338	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0919	in
Pk	=	1984.968	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	4855.483	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	8545.650	lb/in
Es, lim	=	21609.219	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.09186	1568.12487	*
0.11987	1843.58840	
0.14788	2094.68162	
0.17590	2327.67947	
0.20391	2546.50629	
0.23192	2753.81799	
0.25994	2951.51523	
0.28795	3141.01598	
0.31596	3323.41288	
0.34397	3499.56994	
0.37199	3670.18492	
0.40000	3835.83141	
0.65000	5293.44732	
0.90000	6751.06324	
0.92250	6751.06324	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 6751.06324

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	38.000	ft
Depth below ground surface	=	38.000	ft
Equivalent Depth (see note)	=	32.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92105	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	10990.405	lb/in
Psd	=	11272.881	lb/in
Ps = Pst (shallow controls)	=	10990.405	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	9592.4875	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	8352.7081	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.1068	in
Pk	=	2462.743	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	5495.203	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	9671.557	lb/in
Es, lim	=	23049.219	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.10685	1945.56680	*
0.13350	2227.64395	
0.16015	2488.32350	
0.18680	2732.45187	
0.21345	2963.24895	
0.24010	3182.98833	
0.26675	3393.34906	
0.29340	3595.61466	
0.32005	3790.79354	
0.34670	3979.69578	
0.37335	4162.98431	
0.40000	4341.21017	
0.65000	5990.87001	
0.90000	7640.52985	
0.92250	7640.52985	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 7640.52985

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	40.000	ft
Depth below ground surface	=	40.000	ft
Equivalent Depth (see note)	=	34.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	12348.861	lb/in
Psd	=	11866.947	lb/in
Ps = Psd (deep controls)	=	11866.947	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	10357.5377	
$n = Pm/(m \ Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	9018.8795	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.1113	in
Pk	=	2726.539	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B \ ps$	=	5933.473	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A \ Ps$	=	10442.913	lb/in
Es, lim	=	24489.219	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.11134	2153.96552	*
0.13758	2449.75274	
0.16382	2724.07882	
0.19006	2981.62488	
0.21630	3225.55146	
0.24255	3458.11635	
0.26879	3681.00174	
0.29503	3895.50250	
0.32127	4102.64167	
0.34752	4303.24490	
0.37376	4497.99047	
0.40000	4687.44401	
0.65000	6468.67271	
0.90000	8249.90141	
0.92250	8249.90141	

Static_BentsRow2_Run3_Transverse.lp7o
0.94500 8249.90141

* p value(s) computed using $p = k * \text{Eff} \times y$

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 = 1000.0 lbs
Applied moment at pile head = 247200.0 in-lbs
Axial thrust load on pile head = 137000.0 lbs

Depth Res.	Soil X	Deflect. Spr. y	Bending Distrib. Lat. Load	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil p
feet	Es*h	inches	in-lbs	lbs	radians	psi*	lb-in^2	lb/in
lb/inch	lb/inch							
0.000	0.00	0.0181	247200.	1000.0000	-0.000362	1465.4798	7.861E+10	
	1.000	0.0140	259491.	914.9446	-0.000323	1523.2764	7.861E+10	
-13.2284	5688.0000	0.000	0.000					
	2.000	0.0103	269875.	595.0134	-0.000283	1572.1019	7.861E+10	
-59.0774		34364.	0.000					
	3.000	0.007169	272647.	-265.6060	-0.000241	1585.1378	7.861E+10	
-79.3489		66407.	0.000					
	4.000	0.004522	264057.	-1227.5183	-0.000200	1544.7432	7.861E+10	
-79.6521		105690.	0.000					
	5.000	0.002357	244312.	-2032.5296	-0.000161	1451.8982	7.861E+10	
-52.9087		134704.	0.000					
	6.000	0.000638	216961.	-2416.5670	-0.000126	1323.2918	7.861E+10	
-3.4001		31970.	0.000					
	7.000	-0.000683	188036.	-2411.5093	-9.520E-05	1187.2769	7.861E+10	
4.2871		37658.	0.000					
	8.000	-0.001660	159680.	-2313.6207	-6.867E-05	1053.9432	7.861E+10	
11.9906		43346.	0.000					
	9.000	-0.002344	133006.	-2126.1807	-4.635E-05	928.5167	7.861E+10	
19.1540		49034.	0.000					
	10.000	-0.002784	109048.	-1858.1127	-2.791E-05	815.8629	7.861E+10	
25.3895		54722.	0.000					
	11.000	-0.003024	88708.	-1587.6236	-1.285E-05	720.2215	7.861E+10	
8.6216		17108.	0.000					
	12.000	-0.003101	70326.	-1471.9838	-7.282E-07	633.7822	7.861E+10	
10.6058		20520.	0.000					
	13.000	-0.003049	53449.	-1335.0110	8.703E-06	554.4228	7.861E+10	
12.1634		23933.	0.000					
	14.000	-0.002899	38305.	-1182.3451	1.569E-05	483.2147	7.861E+10	
13.2150		27346.	0.000					
	15.000	-0.002679	25050.	-1020.2457	2.051E-05	420.8868	7.861E+10	
13.7354		30759.	0.000					
	16.000	-0.002413	13762.	-855.0074	2.345E-05	367.8078	7.861E+10	
13.7427		34172.	0.000					

Static_BentsRow2_Run3_Transverse.lp70						
17.000	-0.002121	4444.9046	-692.5031	2.482E-05	323.9982	7.861E+10
13.2877	37584.	0.000				
18.000	-0.001821	-2963.1577	-537.8536	2.491E-05	317.0307	7.861E+10
12.4438	40997.	0.000				
19.000	-0.001526	-8581.3311	-395.2158	2.402E-05	343.4484	7.861E+10
11.2970	44410.	0.000				
20.000	-0.001247	-12573.	-267.6770	2.239E-05	362.2157	7.861E+10
9.9387	47823.	0.000				
21.000	-0.000990	-15130.	-157.2386	2.026E-05	374.2438	7.861E+10
8.4578	51236.	0.000				
22.000	-0.000762	-16467.	-64.8725	1.784E-05	380.5290	7.861E+10
6.9362	54648.	0.000				
23.000	-0.000563	-16801.	9.3690	1.529E-05	382.0968	7.861E+10
5.4451	58061.	0.000				
24.000	-0.000395	-16345.	66.2075	1.276E-05	379.9541	7.861E+10
4.0421	61474.	0.000				
25.000	-0.000256	-15302.	106.9733	1.033E-05	375.0496	7.861E+10
2.7708	64887.	0.000				
26.000	-0.000146	-13855.	133.4342	8.107E-06	368.2441	7.861E+10
1.6608	68300.	0.000				
27.000	-6.093E-05	-12163.	147.6319	6.119E-06	360.2901	7.861E+10
0.7282	71712.	0.000				
28.000	1.773E-06	-10362.	151.7320	4.400E-06	351.8210	7.861E+10
-0.0222	75125.	0.000				
29.000	4.549E-05	-8559.7947	147.8967	2.956E-06	343.3472	7.861E+10
-0.5955	78538.	0.000				
30.000	7.353E-05	-6839.8130	138.1807	1.782E-06	335.2595	7.861E+10
-1.0043	81951.	0.000				
31.000	8.902E-05	-5261.4068	124.4541	8.597E-07	327.8375	7.861E+10
-1.2664	85364.	0.000				
32.000	9.484E-05	-3862.9167	108.3500	1.652E-07	321.2615	7.861E+10
-1.4033	88776.	0.000				
33.000	9.358E-05	-2664.6112	91.2353	-3.310E-07	315.6269	7.861E+10
-1.4378	92189.	0.000				
34.000	8.740E-05	-1671.9569	74.2016	-6.601E-07	310.9592	7.861E+10
-1.3926	95602.	0.000				
35.000	7.814E-05	-878.8973	58.0729	-8.529E-07	307.2301	7.861E+10
-1.2895	99015.	0.000				
36.000	6.725E-05	-270.9632	43.4252	-9.390E-07	304.3715	7.861E+10
-1.1481	102428.	0.000				
37.000	5.585E-05	171.9116	30.6156	-9.451E-07	303.9057	7.861E+10
-0.9851	105840.	0.000				
38.000	4.474E-05	472.9542	19.8160	-8.946E-07	305.3213	7.861E+10
-0.8146	109253.	0.000				
39.000	3.448E-05	656.5400	11.0489	-8.074E-07	306.1845	7.861E+10
-0.6475	112666.	0.000				
40.000	2.542E-05	746.6134	4.2236	-6.995E-07	306.6081	7.861E+10
-0.4918	116079.	0.000				
41.000	1.772E-05	765.5256	-0.8306	-5.835E-07	306.6970	7.861E+10
-0.3529	119492.	0.000				
42.000	1.141E-05	733.2518	-4.3350	-4.688E-07	306.5452	7.861E+10
-0.2338	122904.	0.000				
43.000	6.445E-06	666.9403	-6.5360	-3.616E-07	306.2334	7.861E+10
-0.1357	126317.	0.000				
44.000	2.698E-06	580.7346	-7.6851	-2.663E-07	305.8281	7.861E+10
-0.0583	129730.	0.000				
45.000	1.264E-08	485.8097	-8.0229	-1.848E-07	305.3817	7.861E+10
-0.000281	133143.	0.000				
46.000	-1.783E-06	390.5674	-7.7692	-1.180E-07	304.9339	7.861E+10
0.0406	136556.	0.000				
47.000	-2.862E-06	300.9370	-7.1153	-6.529E-08	304.5124	7.861E+10
0.0668	139968.	0.000				
48.000	-3.388E-06	220.7363	-6.2209	-2.557E-08	304.1353	7.861E+10

		Static_BentsRow2_Run3_Transverse.lp7o					
0.0810	143381.	0.000					
	49.000 -3.510E-06	152.0563	-5.2138	2.763E-09	303.8123	7.861E+10	
0.0859	146794.	0.000					
	50.000 -3.351E-06	95.6408	-4.1911	2.155E-08	303.5471	7.861E+10	
0.0839	150207.	0.000					
	51.000 -3.015E-06	51.2385	-3.2217	3.265E-08	303.3383	7.861E+10	
0.0772	153620.	0.000					
	52.000 -2.585E-06	17.9149	-2.3510	3.783E-08	303.1816	7.861E+10	
0.0677	157032.	0.000					
	53.000 -2.120E-06	-5.6837	-1.6043	3.868E-08	303.1241	7.861E+10	
0.0567	160445.	0.000					
	54.000 -1.666E-06	-21.1179	-0.9913	3.656E-08	303.1966	7.861E+10	
0.0455	163858.	0.000					
	55.000 -1.249E-06	-29.9919	-0.5102	3.260E-08	303.2384	7.861E+10	
0.0348	167271.	0.000					
	56.000 -8.859E-07	-33.8366	-0.1511	2.769E-08	303.2565	7.861E+10	
0.0252	170684.	0.000					
	57.000 -5.848E-07	-34.0314	0.1008	2.248E-08	303.2574	7.861E+10	
0.0170	174096.	0.000					
	58.000 -3.457E-07	-31.7609	0.2629	1.744E-08	303.2467	7.861E+10	
0.0102	177509.	0.000					
	59.000 -1.647E-07	-27.9961	0.3529	1.287E-08	303.2290	7.861E+10	
0.004966	180922.	0.000					
	60.000 -3.487E-08	-23.4969	0.3882	8.938E-09	303.2078	7.861E+10	
0.001071	184335.	0.000					
	61.000 5.194E-08	-18.8266	0.3841	5.708E-09	303.1859	7.861E+10	
-0.001625	187748.	0.000					
	62.000 1.042E-07	-14.3767	0.3537	3.178E-09	303.1649	7.861E+10	
-0.003321	191160.	0.000					
	63.000 1.301E-07	-10.3942	0.3079	1.293E-09	303.1462	7.861E+10	
-0.004220	194573.	0.000					
	64.000 1.369E-07	-7.0114	0.2551	-2.984E-11	303.1303	7.861E+10	
-0.004519	197986.	0.000					
	65.000 1.308E-07	-4.2737	0.2014	-8.850E-10	303.1174	7.861E+10	
-0.004392	201399.	0.000					
	66.000 1.168E-07	-2.1649	0.1510	-1.371E-09	303.1075	7.861E+10	
-0.003987	204812.	0.000					
	67.000 9.877E-08	-0.6283	0.1064	-1.579E-09	303.1003	7.861E+10	
-0.003428	208224.	0.000					
	68.000 7.951E-08	0.4154	0.0690	-1.591E-09	303.0993	7.861E+10	
-0.002805	211637.	0.000					
	69.000 6.097E-08	1.0551	0.0391	-1.475E-09	303.1023	7.861E+10	
-0.002185	215050.	0.000					
	70.000 4.433E-08	1.3794	0.0163	-1.287E-09	303.1038	7.861E+10	
-0.001614	218463.	0.000					
	71.000 3.018E-08	1.4703	-1.902E-06	-1.067E-09	303.1043	7.861E+10	
-0.001116	221876.	0.000					
	72.000 1.872E-08	1.3993	-0.0109	-8.470E-10	303.1039	7.861E+10	
-0.000703	225288.	0.000					
	73.000 9.799E-09	1.2260	-0.0172	-6.459E-10	303.1031	7.861E+10	
-0.000373	228701.	0.000					
	74.000 3.121E-09	0.9979	-0.0202	-4.758E-10	303.1020	7.861E+10	
-0.000121	232114.	0.000					
	75.000 -1.731E-09	0.7516	-0.0204	-3.423E-10	303.1009	7.861E+10	
6.797E-05	235527.	0.000					
	76.000 -5.206E-09	0.5145	-0.0188	-2.458E-10	303.0998	7.861E+10	
0.000207	238940.	0.000					
	77.000 -7.734E-09	0.3068	-0.0156	-1.835E-10	303.0988	7.861E+10	
0.000312	242352.	0.000					
	78.000 -9.696E-09	0.1438	-0.0113	-1.496E-10	303.0980	7.861E+10	
0.000397	245765.	0.000					
	79.000 -1.139E-08	0.0378	-0.006121	-1.364E-10	303.0975	7.861E+10	
0.000473	249178.	0.000					

Static_BentsRow2_Run3_Transverse.lp70
80.000 -1.300E-08 0.000 0.000 -1.342E-10 303.0973 7.861E+10
0.000547 126295. 0.000

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

Output Summary for Load Case No. 1:

File-head deflection = 0.0180681 inches
Computed slope at pile head = -0.0003619 radians
Maximum bending moment = 272647. inch-lbs
Maximum shear force = -2425.5690337 lbs
Depth of maximum bending moment = 3.0000000 feet below pile head
Depth of maximum shear force = 6.5000000 feet below pile head
Number of iterations = 6
Number of zero deflection points = 5

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad. radians			
1	1	V = 1000.0000 272647.	M = 247200. -0.00036195	137000.	0.01806806	

Computed Pile-head Stiffness Matrix Values K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)

Static_BentsRow2_Run3_Transverse.lp70

K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear React. lbs	Pile-Top Mom. React. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.000149	0.000000	100.000000	4440.578594	670803.	29787539.
0.000553	0.000000	370.926996	16471.	670803.	29787539.
0.000789	0.000000	529.409129	23509.	670803.	29787539.
0.000957	0.000000	641.853992	28502.	670803.	29787539.
0.001087	0.000000	729.073004	32375.	670803.	29787539.
0.001193	0.000000	800.336125	35540.	670803.	29787539.
0.001283	0.000000	860.588236	38215.	670803.	29787539.
0.001361	0.000000	912.780988	40533.	670803.	29787539.
0.001429	0.000000	958.818258	42577.	670803.	29787539.
0.001491	0.000000	1000.000000	44406.	670803.	29787539.

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)

K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear React. lbs	Pile-Top Mom. React. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
0.000000	0.00001150	342.630560	24720.	29787539.	2149101864.
0.000000	0.00004267	1270.909243	91693.	29787539.	2149101864.
0.000000	0.00006090	1813.917463	130870.	29787539.	2149101864.
0.000000	0.00007383	2199.187926	158666.	29787539.	2149101864.
0.000000	0.00008386	2498.026914	180227.	29787539.	2149101864.
0.000000	0.00009206	2742.196146	197843.	29787539.	2149101864.
0.000000	0.00009899	2948.638290	212737.	29787539.	2149101864.
0.000000	0.000105	3127.466609	225639.	29787539.	2149101864.
0.000000	0.000110	3285.204366	237020.	29787539.	2149101864.
0.000000	0.000115	3426.305597	247200.	29787539.	2149101864.

The analysis ended normally.

Static_BentsRow345_Run3_Transverse.lp7o

LPILE Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LpileRuns_10272015\Bents\Static_Trans\
Name of input data file: Static_BentsRow345_Run3_Transverse.lp7d
Name of output report file: Static_BentsRow345_Run3_Transverse.lp7o
Name of plot output file: Static_BentsRow345_Run3_Transverse.lp7p
Name of runtime message file: Static_BentsRow345_Run3_Transverse.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 15:13:38

Problem Title

Bents Row #1: 24-inch Static with p-multipliers Trans

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 22-BMG-14

Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	80.000000	24.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	24.00000 in
Bottom Width	=	24.00000 in
Top Area	=	452.00000 Sq. in
Bottom Area	=	452.00000 Sq. in
Moment of Inertia at Top	=	2552.00000 in ⁴
Moment of Inertia at Bottom	=	2552.00000 in ⁴
Elastic Modulus	=	30805000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	2.00000 ft
Effective unit weight at top of layer	=	52.00000 pcf
Effective unit weight at bottom of layer	=	52.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000
Subgrade k at top of layer	=	100.00000 pci
Subgrade k at bottom of layer	=	100.00000 pci

Layer 2 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	2.00000 ft
Distance from top of pile to bottom of layer	=	6.00000 ft
Effective unit weight at top of layer	=	55.00000 pcf

Static_BentsRow345_Run3_Transverse.lp7o

Effective unit weight at bottom of layer = 55.00000 pcf
 Undrained cohesion at top of layer = 1000.00000 psf
 Undrained cohesion at bottom of layer = 1000.00000 psf
 Epsilon-50 at top of layer = 0.00700
 Epsilon-50 at bottom of layer = 0.00700
 Subgrade k at top of layer = 500.00000 pci
 Subgrade k at bottom of layer = 500.00000 pci

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer = 6.00000 ft
 Distance from top of pile to bottom of layer = 11.00000 ft
 Effective unit weight at top of layer = 71.00000 pcf
 Effective unit weight at bottom of layer = 71.00000 pcf
 Undrained cohesion at top of layer = 970.00000 psf
 Undrained cohesion at bottom of layer = 970.00000 psf
 Epsilon-50 at top of layer = 0.01000
 Epsilon-50 at bottom of layer = 0.01000
 Subgrade k at top of layer = 100.00000 pci
 Subgrade k at bottom of layer = 100.00000 pci

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 11.00000 ft
 Distance from top of pile to bottom of layer = 90.00000 ft
 Effective unit weight at top of layer = 62.00000 pcf
 Effective unit weight at bottom of layer = 62.00000 pcf
 Friction angle at top of layer = 30.00000 deg.
 Friction angle at bottom of layer = 30.00000 deg.
 Subgrade k at top of layer = 60.00000 pci
 Subgrade k at bottom of layer = 60.00000 pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor Epsilon 50	Layer Soil Type kpy (p-y Curve Criteria) pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay with Free Water	0.01000	0.00	52.000	750.000
--	0.01000	100.000	2.000	52.000	750.000
2	Stiff Clay with Free Water	0.00700	2.000	55.000	1000.000
--	0.00700	500.000	6.000	55.000	1000.000
3	Stiff Clay with Free Water	0.01000	6.000	71.000	970.000
--	0.01000	100.000	11.000	71.000	970.000
--	0.01000	100.000			

Static_BentsRow345_Run3_Transverse.lp70					
4	Sand (Reese, et al.)		11.000	62.000	--
30.000	--	60.000			
			90.000	62.000	--
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.6500	1.0000
2	90.000	0.6500	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
Top y vs. Pile Length				
1	1	V = 1000.00000 lbs	M = 247200. in-lbs	137000.
No				

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft

Page 5

Static_BentsRow345_Run3_Transverse.lp7o

1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

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

p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Diameter	=	24.000 in
c (at curve depth)	=	5.208 lb/in**2
Average cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.235
Ac (not used)	=	0.20000
pct	=	250.000 lb/in
pcd	=	1375.000 lb/in
pc	=	250.000 lb/in

Static_BentsRow345_Run3_Transverse.lp70

pu	=	1.553 lb/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.02814	0.0000
0.05628	0.0000
0.08442	0.0000
0.11256	0.0000
0.14070	0.0000
0.16884	0.0000
0.19698	0.0000
0.22512	0.0000
0.25326	0.0000
0.28140	0.0000
0.30954	0.0000
0.33768	0.0000
0.56280	0.0000
0.78792	0.0000
1.01304	0.0000
1.06932	0.0000

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	2
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Equivalent Depth	=	1.736 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.076 lb/in**2
Average cohesion, c	=	6.07639 psi
Undrained cohesion, c	=	875.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	500.000 pci
Epsilon50	=	0.00850
y50	=	0.204 in
As	=	0.437
Ac (not used)	=	0.28423
pct	=	665.036 lb/in
pcd	=	1604.167 lb/in
pc	=	665.036 lb/in
pu	=	47.096 lb/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.04454	100.98989
0.08908	142.82127
0.13361	164.92344
0.17815	178.20474
0.22269	186.35314
0.26723	190.82680
0.31176	192.45530
0.35630	191.77340

	Static_BentsRow345_Run3_Transverse.lp70
0.40084	189.15288
0.44538	184.86613
0.48992	179.12065
0.53445	172.07935
0.89076	124.98731
1.24706	77.79978
1.60336	30.61226
1.69244	30.61226

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Equivalent Depth	=	3.736 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	6.51042 psi
Undrained cohesion, c	=	937.50000 psf
Average Eff. Unit Weight	=	0.03096 pci
Average Eff. Unit Weight	=	53.50000 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.168 in
As	=	0.558
Ac (not used)	=	0.30000
pct	=	1171.919 lb/in
pcd	=	1833.333 lb/in
pc	=	1171.919 lb/in
pu	=	100.045 lb/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.04686	201.15665
0.09372	284.47846
0.14058	330.79840
0.18745	360.41721
0.23431	380.25147
0.28117	393.08489
0.32803	400.50661
0.37489	403.54185
0.42175	402.90337
0.46862	399.11310
0.51548	392.56833
0.56234	383.58073
0.93723	277.50902
1.31212	171.26905
1.68701	65.02907
1.78074	65.02907

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft

Static_BentsRow345_Run3_Transverse.lp70

Equivalent Depth	=	5.621	ft
Diameter	=	24.000	in
c (at curve depth)	=	6.840	lb/in**2
Average cohesion, c	=	6.84028	psi
Undrained cohesion, c	=	985.00000	psf
Average Eff. Unit Weight	=	0.03125	pci
Average Eff. Unit Weight	=	54.00000	pcf
k	=	100.000	pci
Epsilon50	=	0.00850	
y50	=	0.204	in
As	=	0.598	
Ac (not used)	=	0.30000	
pct	=	1684.554	lb/in
pcd	=	1805.833	lb/in
pc	=	1684.554	lb/in
pu	=	147.587	lb/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.06102	267.52595
0.12205	423.46116
0.18307	493.31132
0.24409	538.64172
0.30511	569.57966
0.36614	590.22148
0.42716	602.90788
0.48818	609.14933
0.54920	609.99587
0.61023	606.21633
0.67125	598.39585
0.73227	586.99331
1.22045	423.46724
1.70863	259.69929
2.19681	95.93135
2.31886	95.93135

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3	
Depth below pile head	=	8.000	ft
Depth below ground surface	=	8.000	ft
Equivalent Depth	=	7.621	ft
Diameter	=	24.000	in
c (at curve depth)	=	6.736	lb/in**2
Average cohesion, c	=	6.78819	psi
Undrained cohesion, c	=	977.50000	psf
Average Eff. Unit Weight	=	0.03371	pci
Average Eff. Unit Weight	=	58.25000	pcf
k	=	100.000	pci
Epsilon50	=	0.01000	
y50	=	0.240	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	2156.565	lb/in
pcd	=	1778.333	lb/in
pc	=	1778.333	lb/in
pu	=	155.930	lb/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

Static_BentsRow345_Run3_Transverse.lp70

y, in	p, lb/in
0.0000	0.0000
0.07200	316.56082
0.14400	447.68461
0.21600	521.56926
0.28800	569.54623
0.36000	602.31487
0.43200	624.20381
0.50400	637.68658
0.57600	644.35936
0.64800	645.33179
0.72000	641.41635
0.79200	633.23136
0.86400	621.26175
1.44000	448.12959
2.01600	274.74208
2.59200	101.35457
2.73600	101.35457

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Equivalent Depth	=	9.621 ft
Diameter	=	24.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	11.53084 psi
Undrained cohesion, c	=	1660.44118 psf
Average Eff. Unit Weight	=	0.03519 pci
Average Eff. Unit Weight	=	60.80000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	4418.263 lb/in
pcd	=	1778.333 lb/in
pc	=	1778.333 lb/in
pu	=	155.930 lb/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.07200	316.56082
0.14400	447.68461
0.21600	521.56926
0.28800	569.54623
0.36000	602.31487
0.43200	624.20381
0.50400	637.68658
0.57600	644.35936
0.64800	645.33179
0.72000	641.41635
0.79200	633.23136
0.86400	621.26175
1.44000	448.12959
2.01600	274.74208

2.59200	Static_BentsRow345_Run3_Transverse.lp70
2.73600	101.35457
	101.35457

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	12.000 ft
Depth below ground surface	=	12.000 ft
Equivalent Depth (see note)	=	6.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.75000 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	520.674 lb/in
Psd	=	3550.023 lb/in
Ps = Pst (shallow controls)	=	520.674 lb/in
A (static)	=	1.0590
B (static)	=	0.7088
C = $Pm/(Ym^{(1/n)})$	=	530.1099
n = $Pm/(m Ym)$	=	2.5307
m = $(Pu-Pm)/(Yu-Ym)$	=	364.6054
Yk = $[c/(kx)]^{(n/(n-1))}$	=	0.0311 in
Pk	=	134.438 lb/in
Ym = b/60	=	0.4000 in
Pm = B ps	=	369.079 lb/in
Yu = 3b/80	=	0.9000 in
Pu = A Ps	=	551.382 lb/in
Es, lim	=	4329.219 lb/in/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.03105	87.38448	*
0.06459	116.71452	
0.09813	137.68802	
0.13168	154.64995	
0.16522	169.15740	
0.19876	181.97412	
0.23230	193.53979	
0.26584	204.13403	
0.29938	213.94725	
0.33292	223.11582	
0.36646	231.74121	
0.40000	239.90125	
0.65000	299.14964	
0.90000	358.39802	
0.92250	358.39802	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
 358.39802

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Equivalent Depth (see note)	=	8.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.78571 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	852.004 lb/in
Psd	=	4144.089 lb/in
Ps = Pst (shallow controls)	=	852.004 lb/in
A (static)	=	0.8999
B (static)	=	0.5298
$C = P_m / (Y_m^{(1/n)})$	=	753.2257
$n = P_m / (m Y_m)$	=	1.7896
$m = (P_u - P_m) / (Y_u - Y_m)$	=	630.5924
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0099 in
Pk	=	57.161 lb/in
$Y_m = b / 60$	=	0.4000 in
$P_m = B p_s$	=	451.399 lb/in
$Y_u = 3b / 80$	=	0.9000 in
$P_u = A P_s$	=	766.695 lb/in
Es, lim	=	5769.219 lb/in/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.00991	37.15485	*
0.04537	86.94796	
0.08083	120.06395	
0.11630	147.12522	
0.15176	170.71708	
0.18722	191.97277	
0.22269	211.51216	
0.25815	229.71909	
0.29361	246.85124	
0.32907	263.09173	
0.36454	278.57634	
0.40000	293.40916	
0.65000	395.88042	
0.90000	498.35169	
0.92250	498.35169	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
498.35169

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Equivalent Depth (see note)	=	10.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.81250 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	1262.324 lb/in
Psd	=	4738.155 lb/in
Ps = Pst (shallow controls)	=	1262.324 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
$C = P_m / (Y_m^{(1/n)})$	=	1101.7638
$n = P_m / (m Y_m)$	=	1.6447
$m = (P_u - P_m) / (Y_u - Y_m)$	=	959.3665
$Y_k = [c / (kx)]^{(n / (n-1))}$	=	0.0083 in
Pk	=	59.809 lb/in
$Y_m = b / 60$	=	0.4000 in
$P_m = B p_s$	=	631.162 lb/in
$Y_u = 3b / 80$	=	0.9000 in
$P_u = A P_s$	=	1110.845 lb/in
Es, lim	=	7209.219 lb/in/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.00830	38.87584	*
0.04391	107.06662	
0.07952	153.62966	
0.11512	192.39414	
0.15073	226.64918	
0.18634	257.84145	
0.22195	286.76644	
0.25756	313.91945	
0.29317	339.63469	
0.32878	364.15076	
0.36439	387.64542	
0.40000	410.25541	
0.65000	566.15247	
0.90000	722.04952	
0.92250	722.04952	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
722.04952

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	18.000 ft
Depth below ground surface	=	18.000 ft
Equivalent Depth (see note)	=	12.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.83333 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	1751.643 lb/in
Psd	=	5332.221 lb/in
Ps = Pst (shallow controls)	=	1751.643 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
C = $P_m / (Y_m^{(1/n)})$	=	1528.8440
n = $P_m / (m Y_m)$	=	1.6447
m = $(P_u - P_m) / (Y_u - Y_m)$	=	1331.2488
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0120 in
Pk	=	104.003 lb/in
$Y_m = b / 60$	=	0.4000 in
$P_m = B p_s$	=	875.822 lb/in
$Y_u = 3b / 80$	=	0.9000 in
$P_u = A P_s$	=	1541.446 lb/in
Es, lim	=	8649.219 lb/in/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.01202	67.60165	*
0.04730	155.44051	
0.08257	218.11729	
0.11784	270.77811	
0.15311	317.50653	
0.18838	360.15835	
0.22365	399.77117	
0.25892	436.99773	
0.29419	472.28152	
0.32946	505.94088	
0.36473	538.21381	
0.40000	569.28404	
0.65000	785.61197	
0.90000	1001.93990	
0.92250	1001.93990	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
1001.93990

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	22.000 ft
Depth below ground surface	=	22.000 ft
Equivalent Depth (see note)	=	16.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.86364 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	2967.298 lb/in
Psd	=	6520.353 lb/in
Ps = Pst (shallow controls)	=	2967.298 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
C = $P_m/(Y_m^{(1/n)})$	=	2589.8740
n = $P_m/(m Y_m)$	=	1.6447
m = $(P_u - P_m)/(Y_u - Y_m)$	=	2255.1461
$Y_k = [c/(kx)]^{n/(n-1)}$	=	0.0222 in
Pk	=	255.511 lb/in
$Y_m = b/60$	=	0.4000 in
$P_m = B p_s$	=	1483.649 lb/in
$Y_u = 3b/80$	=	0.9000 in
$P_u = A P_s$	=	2611.222 lb/in
Es, lim	=	11529.219 lb/in/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02216	166.08190	*
0.05651	293.41915	
0.09086	391.63554	
0.12521	475.94179	
0.15956	551.52588	
0.19391	620.93797	
0.22826	685.66513	
0.26260	746.66806	
0.29695	804.61174	
0.33130	859.98002	
0.36565	913.13849	
0.40000	964.37172	
0.65000	1330.83296	
0.90000	1697.29421	
0.92250	1697.29421	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
1697.29421

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	24.000	ft
Depth below ground surface	=	24.000	ft
Equivalent Depth (see note)	=	18.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.87500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3693.639	lb/in
Psd	=	7114.419	lb/in
Ps = Pst (shallow controls)	=	3693.639	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	3223.8288	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	2807.1655	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0287	in
Pk	=	372.148	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	1846.819	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	3250.402	lb/in
Es, lim	=	12969.219	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02869	241.89594	*
0.06245	388.12161	
0.09620	504.74123	
0.12996	606.01190	
0.16371	697.34998	
0.19747	781.53742	
0.23122	860.23738	
0.26498	934.54189	
0.29873	1005.21556	
0.33249	1072.81950	
0.36624	1137.78054	
0.40000	1200.43265	
0.65000	1656.59705	
0.90000	2112.76145	
0.92250	2112.76145	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
2112.76145

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	26.000	ft
Depth below ground surface	=	26.000	ft
Equivalent Depth (see note)	=	20.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.88462	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4498.992	lb/in
Psd	=	7708.485	lb/in
Ps = Pst (shallow controls)	=	4498.992	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	3926.7455	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	3419.2339	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0363	in
Pk	=	522.775	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	2249.496	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	3959.113	lb/in
Es, lim	=	14409.219	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.03628	339.80368	*
0.06935	503.83355	
0.10241	638.61314	
0.13548	757.04199	
0.16854	864.53974	
0.20161	964.02056	
0.23467	1057.27432	
0.26774	1145.49762	
0.30080	1229.53916	
0.33387	1310.02787	
0.36693	1387.44578	
0.40000	1462.17241	
0.65000	2017.79792	
0.90000	2573.42343	
0.92250	2573.42343	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
2573.42343

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	28.000	ft
Depth below ground surface	=	28.000	ft
Equivalent Depth (see note)	=	22.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.89286	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	5383.358	lb/in
Psd	=	8302.551	lb/in
Ps = Pst (shallow controls)	=	5383.358	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	4698.6251	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	4091.3521	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0450	in
Pk	=	712.811	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B p_s$	=	2691.679	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A P_s$	=	4737.355	lb/in
Es, lim	=	15849.219	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.04497	463.32731	*
0.07725	643.76149	
0.10952	795.98944	
0.14180	931.32803	
0.17407	1054.99753	
0.20635	1169.93936	
0.23862	1278.01283	
0.27090	1380.48555	
0.30317	1478.26953	
0.33545	1572.04795	
0.36772	1662.34899	
0.40000	1749.59138	
0.65000	2414.43610	
0.90000	3079.28081	
0.92250	3079.28081	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
3079.28081

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	30.000	ft
Depth below ground surface	=	30.000	ft
Equivalent Depth (see note)	=	24.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	6346.738	lb/in
Psd	=	8896.617	lb/in
Ps = Pst (shallow controls)	=	6346.738	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	5539.4684	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	4823.5208	
$Y_k = [c / (kx)]^{(n / (n-1))}$	=	0.0548	in
Pk	=	947.954	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B p_s$	=	3173.369	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A P_s$	=	5585.129	lb/in
Es, lim	=	17289.219	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.05483	616.17033	*
0.08621	811.32627	
0.11759	979.85346	
0.14897	1131.40916	
0.18035	1270.84919	
0.21173	1401.04134	
0.24310	1523.85364	
0.27448	1640.58669	
0.30586	1752.19087	
0.33724	1859.38672	
0.36862	1962.73659	
0.40000	2062.68982	
0.65000	2846.51194	
0.90000	3630.33407	
0.92250	3630.33407	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
3630.33407

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	32.000 ft
Depth below ground surface	=	32.000 ft
Equivalent Depth (see note)	=	26.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.90625 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	7389.132 lb/in
Psd	=	9490.683 lb/in
Ps = Pst (shallow controls)	=	7389.132 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
C = $Pm/(Ym^{(1/n)})$	=	6449.2759
n = $Pm/(m Ym)$	=	1.6447
m = $(Pu - Pm)/(Yu - Ym)$	=	5615.7404
Yk = $[c/(kx)]^{n/(n-1)}$	=	0.0659 in
Pk	=	1234.170 lb/in
Ym = b/60	=	0.4000 in
Pm = B ps	=	3694.566 lb/in
Yu = 3b/80	=	0.9000 in
Pu = A Ps	=	6502.436 lb/in
Es, lim	=	18729.219 lb/in/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.06590	802.21056	*
0.09627	1010.14319	
0.12664	1193.41371	
0.15701	1360.05449	
0.18739	1514.43741	
0.21776	1659.26748	
0.24813	1796.36211	
0.27851	1927.01497	
0.30888	2052.18733	
0.33925	2172.61756	
0.36963	2288.88799	
0.40000	2401.46794	
0.65000	3314.02575	
0.90000	4226.58356	
0.92250	4226.58356	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
4226.58356

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Equivalent Depth (see note)	=	28.013 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter, b	=	24.000 in
Angle of Friction	=	30.000 degrees
Avg. Eff. Unit Weight	=	61.91176 pcf
kpy	=	60.000 pci
K active	=	0.333
K passive	=	3.000
K0	=	0.400
Pst	=	8510.541 lb/in
Psd	=	10084.749 lb/in
Ps = Pst (shallow controls)	=	8510.541 lb/in
A (static)	=	0.8800
B (static)	=	0.5000
C = $Pm/(Ym^{(1/n)})$	=	7428.0481
n = $Pm/(m Ym)$	=	1.6447
m = $(Pu - Pm)/(Yu - Ym)$	=	6468.0113
Yk = $[c/(kx)]^{n/(n-1)}$	=	0.0782 in
Pk	=	1577.683 lb/in
Ym = b/60	=	0.4000 in
Pm = B ps	=	4255.271 lb/in
Yu = 3b/80	=	0.9000 in
Pu = A Ps	=	7489.276 lb/in
Es, lim	=	20169.219 lb/in/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.07822	1025.49402	*
0.10747	1244.00636	
0.13673	1440.08509	
0.16598	1620.24900	
0.19523	1788.31327	
0.22448	1946.74849	
0.25374	2097.26763	
0.28299	2241.11854	
0.31224	2379.24503	
0.34149	2512.38230	
0.37075	2641.11687	
0.40000	2765.92590	
0.65000	3816.97773	
0.90000	4868.02956	
0.92250	4868.02956	

Static_BentsRow345_Run3_Transverse.lp70
 0.94500 4868.02956

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	36.000	ft
Depth below ground surface	=	36.000	ft
Equivalent Depth (see note)	=	30.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	9710.966	lb/in
Psd	=	10678.815	lb/in
Ps = Pst (shallow controls)	=	9710.966	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	8475.7852	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	7380.3338	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.0919	in
Pk	=	1984.968	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	4855.483	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	8545.650	lb/in
Es, lim	=	21609.219	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.09186	1290.22932	*
0.11987	1516.87653	
0.14788	1723.47222	
0.17590	1915.17931	
0.20391	2095.22669	
0.23192	2265.79962	
0.25994	2428.46190	
0.28795	2584.38024	
0.31596	2734.45364	
0.34397	2879.39298	
0.37199	3019.77240	
0.40000	3156.06381	
0.65000	4355.36805	
0.90000	5554.67228	
0.92250	5554.67228	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
5554.67228

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	38.000	ft
Depth below ground surface	=	38.000	ft
Equivalent Depth (see note)	=	32.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92105	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	10990.405	lb/in
Psd	=	11272.881	lb/in
Ps = Pst (shallow controls)	=	10990.405	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = P_m / (Y_m^{(1/n)})$	=	9592.4875	
$n = P_m / (m Y_m)$	=	1.6447	
$m = (P_u - P_m) / (Y_u - Y_m)$	=	8352.7081	
$Y_k = [c / (kx)]^{n / (n-1)}$	=	0.1068	in
Pk	=	2462.743	lb/in
$Y_m = b / 60$	=	0.4000	in
$P_m = B \text{ ps}$	=	5495.203	lb/in
$Y_u = 3b / 80$	=	0.9000	in
$P_u = A \text{ Ps}$	=	9671.557	lb/in
Es, lim	=	23049.219	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.10685	1600.78281	*
0.13350	1832.87161	
0.16015	2047.35478	
0.18680	2248.21989	
0.21345	2438.11623	
0.24010	2618.91445	
0.26675	2791.99606	
0.29340	2958.41713	
0.32005	3119.00734	
0.34670	3274.43324	
0.37335	3425.24026	
0.40000	3571.88178	
0.65000	4929.19684	
0.90000	6286.51190	
0.92250	6286.51190	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
6286.51190

* p value(s) computed using $p = k * \text{Eff} \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	40.000	ft
Depth below ground surface	=	40.000	ft
Equivalent Depth (see note)	=	34.013	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	12348.861	lb/in
Psd	=	11866.947	lb/in
Ps = Psd (deep controls)	=	11866.947	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	10357.5377	
n = $Pm/(m \ Ym)$	=	1.6447	
m = $(Pu - Pm)/(Yu - Ym)$	=	9018.8795	
$Yk = [c/(kx)]^{n/(n-1)}$	=	0.1113	in
Pk	=	2726.539	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B \ ps$	=	5933.473	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A \ Ps$	=	10442.913	lb/in
Es, lim	=	24489.219	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.11134	1772.25011	*
0.13758	2015.61934	
0.16382	2241.33067	
0.19006	2453.23566	
0.21630	2653.93475	
0.24255	2845.28560	
0.26879	3028.67231	
0.29503	3205.16029	
0.32127	3375.59125	
0.34752	3540.64454	
0.37376	3700.87823	
0.40000	3856.75773	
0.65000	5322.32565	
0.90000	6787.89357	
0.92250	6787.89357	

0.94500 Static_BentsRow345_Run3_Transverse.lp70
6787.89357

* p value(s) computed using $p = k * \text{Eff} * y$

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 = 1000.0 lbs
Applied moment at pile head = 247200.0 in-lbs
Axial thrust load on pile head = 137000.0 lbs

Depth Res.	Soil X	Deflect. Spr.	Bending Distrib.	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil p
	Es*h	Lat. Load	Moment					
feet	lb/inch	inches	in-lbs	lbs	radians	psi*	lb-in^2	lb/in
		lb/inch						
0.000	0.00	0.0200	247200.	1000.0000	-0.000381	1465.4798	7.861E+10	
0.000	1.000	0.0157	259546.	921.6469	-0.000343	1523.5322	7.861E+10	
-12.2335	4680.0000	0.000	0.000					
2.000	0.0118	270119.	632.8320	-0.000302	1573.2509	7.861E+10		
-52.0112	26422.	0.000	0.000					
3.000	0.008431	273937.	-130.0300	-0.000261	1591.2036	7.861E+10		
-70.7977	50381.	0.000	0.000					
4.000	0.005553	267602.	-996.9765	-0.000219	1561.4158	7.861E+10		
-72.6196	78468.	0.000	0.000					
5.000	0.003163	250818.	-1812.4216	-0.000180	1482.4921	7.861E+10		
-58.4282	110833.	0.000	0.000					
6.000	0.001232	225655.	-2266.4555	-0.000143	1364.1699	7.861E+10		
-5.4002	26304.	0.000	0.000					
7.000	-0.000286	198398.	-2290.3725	-0.000111	1236.0031	7.861E+10		
1.4782	30984.	0.000	0.000					
8.000	-0.001441	171306.	-2230.0572	-8.263E-05	1108.6115	7.861E+10		
8.5645	35664.	0.000	0.000					
9.000	-0.002282	145401.	-2086.2308	-5.847E-05	986.8034	7.861E+10		
15.3411	40344.	0.000	0.000					
10.000	-0.002856	121663.	-1864.9811	-3.812E-05	875.1817	7.861E+10		
21.4288	45024.	0.000	0.000					
11.000	-0.003207	100972.	-1633.3601	-2.116E-05	777.8855	7.861E+10		
7.5225	14076.	0.000	0.000					
12.000	-0.003372	81972.	-1531.0795	-7.205E-06	688.5470	7.861E+10		
9.4897	16884.	0.000	0.000					
13.000	-0.003388	64316.	-1407.1330	3.946E-06	605.5228	7.861E+10		
11.1189	19692.	0.000	0.000					
14.000	-0.003285	48240.	-1266.1559	1.252E-05	529.9332	7.861E+10		
12.3201	22500.	0.000	0.000					
15.000	-0.003094	33923.	-1113.5661	1.877E-05	462.6087	7.861E+10		
13.0519	25308.	0.000	0.000					
16.000	-0.002841	21472.	-955.0331	2.298E-05	404.0616	7.861E+10		
13.3126	28116.	0.000	0.000					

		Static_Bents	Row345_Run3_Transverse.lp7o				
17.000	-0.002548	10928.	-796.0496	2.544E-05	354.4846	7.861E+10	
13.1324	30924.	0.000					
18.000	-0.002235	2269.7585	-641.6034	2.643E-05	313.7702	7.861E+10	
12.5642	33732.	0.000					
19.000	-0.001917	-4583.0778	-495.9492	2.623E-05	324.6479	7.861E+10	
11.6762	36540.	0.000					
20.000	-0.001608	-9755.6044	-362.4694	2.512E-05	348.9701	7.861E+10	
10.5449	39348.	0.000					
21.000	-0.001316	-13409.	-243.6152	2.334E-05	366.1478	7.861E+10	
9.2483	42156.	0.000					
22.000	-0.001049	-15728.	-140.9144	2.111E-05	377.0514	7.861E+10	
7.8617	44964.	0.000					
23.000	-0.000811	-16911.	-55.0318	1.861E-05	382.6141	7.861E+10	
6.4533	47772.	0.000					
24.000	-0.000603	-17160.	14.1312	1.600E-05	383.7858	7.861E+10	
5.0818	50580.	0.000					
25.000	-0.000426	-16672.	67.3124	1.341E-05	381.4927	7.861E+10	
3.7948	53388.	0.000					
26.000	-0.000281	-15633.	105.7499	1.094E-05	376.6052	7.861E+10	
2.6283	56196.	0.000					
27.000	-0.000163	-14210.	131.0424	8.660E-06	369.9136	7.861E+10	
1.6063	59004.	0.000					
28.000	-7.207E-05	-12550.	145.0139	6.616E-06	362.1109	7.861E+10	
0.7425	61812.	0.000					
29.000	-3.775E-06	-10779.	149.5917	4.835E-06	353.7837	7.861E+10	
0.0407	64620.	0.000					
30.000	4.478E-05	-8998.4120	146.7010	3.325E-06	345.4096	7.861E+10	
-0.5032	67428.	0.000					
31.000	7.684E-05	-7286.3900	138.1792	2.084E-06	337.3594	7.861E+10	
-0.8995	70236.	0.000					
32.000	9.554E-05	-5700.8673	125.7107	1.094E-06	329.9039	7.861E+10	
-1.1631	73044.	0.000					
33.000	0.000104	-4280.3644	110.7813	3.337E-07	323.2245	7.861E+10	
-1.3120	75852.	0.000					
34.000	0.000104	-3046.8502	94.6525	-2.237E-07	317.4242	7.861E+10	
-1.3655	78660.	0.000					
35.000	9.893E-05	-2008.5171	78.3504	-6.077E-07	312.5418	7.861E+10	
-1.3433	81468.	0.000					
36.000	9.000E-05	-1162.5965	62.6698	-8.479E-07	308.5641	7.861E+10	
-1.2642	84276.	0.000					
37.000	7.892E-05	-498.0672	48.1881	-9.730E-07	305.4394	7.861E+10	
-1.1455	87084.	0.000					
38.000	6.692E-05	1.8537	35.2868	-1.009E-06	303.1061	7.861E+10	
-1.0025	89892.	0.000					
39.000	5.489E-05	357.5138	24.1787	-9.807E-07	304.7784	7.861E+10	
-0.8481	92700.	0.000					
40.000	4.351E-05	590.9673	14.9368	-9.073E-07	305.8762	7.861E+10	
-0.6926	95508.	0.000					
41.000	3.320E-05	724.4725	7.5244	-8.060E-07	306.5040	7.861E+10	
-0.5440	98316.	0.000					
42.000	2.421E-05	779.3399	1.8229	-6.906E-07	306.7620	7.861E+10	
-0.4080	101124.	0.000					
43.000	1.664E-05	775.1092	-2.3415	-5.715E-07	306.7421	7.861E+10	
-0.2882	103932.	0.000					
44.000	1.048E-05	729.0186	-5.1757	-4.563E-07	306.5253	7.861E+10	
-0.1865	106740.	0.000					
45.000	5.658E-06	655.7250	-6.9006	-3.505E-07	306.1807	7.861E+10	
-0.1033	109548.	0.000					
46.000	2.033E-06	567.2291	-7.7358	-2.570E-07	305.7646	7.861E+10	
-0.0381	112356.	0.000					
47.000	-5.529E-07	472.9588	-7.8889	-1.776E-07	305.3213	7.861E+10	
0.0106	115164.	0.000					
48.000	-2.273E-06	379.9662	-7.5469	-1.126E-07	304.8840	7.861E+10	

		Static_BentsRow345_Run3_Transverse.lp7o					
0.0447	117972.	0.000					
	49.000 -3.296E-06	293.2014	-6.8723	-6.126E-08	304.4760	7.861E+10	
0.0663	120780.	0.000					
	50.000 -3.781E-06	215.8255	-6.0002	-2.251E-08	304.1122	7.861E+10	
0.0779	123588.	0.000					
	51.000 -3.869E-06	149.5387	-5.0387	5.260E-09	303.8005	7.861E+10	
0.0815	126396.	0.000					
	52.000 -3.682E-06	94.8988	-4.0703	2.381E-08	303.5436	7.861E+10	
0.0793	129204.	0.000					
	53.000 -3.320E-06	51.6172	-3.1538	3.488E-08	303.3401	7.861E+10	
0.0731	132012.	0.000					
	54.000 -2.862E-06	18.8197	-2.3282	4.016E-08	303.1858	7.861E+10	
0.0643	134820.	0.000					
	55.000 -2.369E-06	-4.7316	-1.6157	4.116E-08	303.1196	7.861E+10	
0.0543	137628.	0.000					
	56.000 -1.884E-06	-20.4589	-1.0252	3.917E-08	303.1935	7.861E+10	
0.0441	140436.	0.000					
	57.000 -1.435E-06	-29.8286	-0.5557	3.528E-08	303.2376	7.861E+10	
0.0343	143244.	0.000					
	58.000 -1.040E-06	-34.2501	-0.1990	3.034E-08	303.2584	7.861E+10	
0.0253	146052.	0.000					
	59.000 -7.077E-07	-35.0068	0.0572	2.503E-08	303.2620	7.861E+10	
0.0176	148860.	0.000					
	60.000 -4.391E-07	-33.2147	0.2282	1.980E-08	303.2535	7.861E+10	
0.0111	151668.	0.000					
	61.000 -2.312E-07	-29.8043	0.3295	1.498E-08	303.2375	7.861E+10	
0.005951	154476.	0.000					
	62.000 -7.773E-08	-25.5183	0.3766	1.075E-08	303.2173	7.861E+10	
0.002038	157284.	0.000					
	63.000 2.899E-08	-20.9225	0.3834	7.208E-09	303.1957	7.861E+10	
-0.000774	160092.	0.000					
	64.000 9.737E-08	-16.4244	0.3622	4.360E-09	303.1746	7.861E+10	
-0.002644	162900.	0.000					
	65.000 1.356E-07	-12.2960	0.3234	2.173E-09	303.1552	7.861E+10	
-0.003746	165708.	0.000					
	66.000 1.513E-07	-8.6984	0.2750	5.760E-10	303.1382	7.861E+10	
-0.004249	168516.	0.000					
	67.000 1.510E-07	-5.7067	0.2234	-5.174E-10	303.1242	7.861E+10	
-0.004311	171324.	0.000					
	68.000 1.401E-07	-3.3314	0.1730	-1.201E-09	303.1130	7.861E+10	
-0.004066	174132.	0.000					
	69.000 1.231E-07	-1.5392	0.1267	-1.568E-09	303.1046	7.861E+10	
-0.003630	176940.	0.000					
	70.000 1.032E-07	-0.2683	0.0863	-1.701E-09	303.0986	7.861E+10	
-0.003091	179748.	0.000					
	71.000 8.273E-08	0.5579	0.0526	-1.675E-09	303.1000	7.861E+10	
-0.002517	182556.	0.000					
	72.000 6.326E-08	1.0214	0.0258	-1.552E-09	303.1021	7.861E+10	
-0.001954	185364.	0.000					
	73.000 4.563E-08	1.2028	0.005566	-1.380E-09	303.1030	7.861E+10	
-0.001431	188172.	0.000					
	74.000 3.018E-08	1.1774	-0.008743	-1.196E-09	303.1029	7.861E+10	
-0.000961	190980.	0.000					
	75.000 1.687E-08	1.0129	-0.0177	-1.028E-09	303.1021	7.861E+10	
-0.000545	193788.	0.000					
	76.000 5.411E-09	0.7692	-0.0220	-8.916E-10	303.1010	7.861E+10	
-0.000177	196596.	0.000					
	77.000 -4.646E-09	0.4995	-0.0222	-7.947E-10	303.0997	7.861E+10	
0.000154	199404.	0.000					
	78.000 -1.378E-08	0.2516	-0.0184	-7.378E-10	303.0985	7.861E+10	
0.000465	202212.	0.000					
	79.000 -2.245E-08	0.0706	-0.0110	-7.141E-10	303.0977	7.861E+10	
0.000767	205020.	0.000					

Static_BentsRow345_Run3_Transverse.lp70
80.000 -3.098E-08 0.000 0.000 -7.100E-10 303.0973 7.861E+10
0.001073 103914. 0.000

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

Output Summary for Load Case No. 1:

File-head deflection = 0.0200325 inches
Computed slope at pile head = -0.0003815 radians
Maximum bending moment = 273937. inch-lbs
Maximum shear force = -2290.3724676 lbs
Depth of maximum bending moment = 3.0000000 feet below pile head
Depth of maximum shear force = 7.0000000 feet below pile head
Number of iterations = 7
Number of zero deflection points = 5

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head Condition		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad. radians			
1	1	V = 1000.0000 273937.	M = 247200. -0.00038148	137000.	0.02003245	

Computed Pile-head Stiffness Matrix Values K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)

Static_BentsRow345_Run3_Transverse.lp70

K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear React. lbs	Pile-Top Mom. React. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.000171	0.000000	100.000000	4591.691454	586035.	26908916.
0.000633	0.000000	370.926996	17032.	586035.	26908916.
0.000903	0.000000	529.409129	24309.	586035.	26908916.
0.001095	0.000000	641.853992	29472.	586035.	26908916.
0.001244	0.000000	729.073004	33477.	586035.	26908916.
0.001366	0.000000	800.336125	36749.	586035.	26908916.
0.001468	0.000000	860.588236	39516.	586035.	26908916.
0.001558	0.000000	912.780988	41912.	586035.	26908916.
0.001636	0.000000	958.818258	44026.	586035.	26908916.
0.001706	0.000000	1000.000000	45917.	586035.	26908916.

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)

K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear React. lbs	Pile-Top Mom. React. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
0.000000	0.00001217	327.486051	24720.	26908916.	2031196161.
0.000000	0.00004514	1214.734171	91693.	26908916.	2031196161.
0.000000	0.00006443	1733.741050	130870.	26908916.	2031196161.
0.000000	0.00007811	2101.982292	158666.	26908916.	2031196161.
0.000000	0.00008873	2387.612389	180227.	26908916.	2031196161.
0.000000	0.00009740	2620.989171	197843.	26908916.	2031196161.
0.000000	0.000105	2818.306429	212737.	26908916.	2031196161.
0.000000	0.000111	2989.230412	225639.	26908916.	2031196161.
0.000000	0.000117	3139.996050	237020.	26908916.	2031196161.
0.000000	0.000122	3274.860509	247200.	26908916.	2031196161.

The analysis ended normally.

Liq_Abut1_Cap_Run2_Long.lp7o

LPile Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LPileRuns_10272015\Abut\Liq_Long\
Name of input data file: Liq_Abut1_Cap_Run2_Long.lp7d
Name of output report file: Liq_Abut1_Cap_Run2_Long.lp7o
Name of plot output file: Liq_Abut1_Cap_Run2_Long.lp7p
Name of runtime message file: Liq_Abut1_Cap_Run2_Long.lp7r

Date and Time of Analysis

Date: December 1, 2015 Time: 6:46:11

Problem Title

Abutment#1 (Lower): 18-inch Static without p-multipliers Round 1

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 23-BMU-14

Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

Pile Structural Properties and Geometry

Total number of pile sections = 1
Total length of pile = 80.00 ft
Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	80.000000	18.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	18.00000 in
Bottom Width	=	18.00000 in
Top Area	=	254.00000 Sq. in
Bottom Area	=	254.00000 Sq. in
Moment of Inertia at Top	=	1053.00000 in ⁴
Moment of Inertia at Bottom	=	1053.00000 in ⁴
Elastic Modulus	=	30328000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	18.400 degrees
	=	0.321 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 7 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	4.00000 ft
Effective unit weight at top of layer	=	115.00000 pcf
Effective unit weight at bottom of layer	=	115.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer	=	4.00000 ft
Distance from top of pile to bottom of layer	=	10.00000 ft
Effective unit weight at top of layer	=	134.00000 pcf
Effective unit weight at bottom of layer	=	134.00000 pcf
Undrained cohesion at top of layer	=	970.00000 psf

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Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	10.00000	ft
Distance from top of pile to bottom of layer	=	12.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 4 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	12.00000	ft
Distance from top of pile to bottom of layer	=	21.00000	ft
Effective unit weight at top of layer	=	55.00000	pcf
Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	1000.00000	psf
Undrained cohesion at bottom of layer	=	1000.00000	psf
Epsilon-50 at top of layer	=	0.00700	
Epsilon-50 at bottom of layer	=	0.00700	
Subgrade k at top of layer	=	500.00000	pci
Subgrade k at bottom of layer	=	500.00000	pci

Layer 5 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	21.00000	ft
Distance from top of pile to bottom of layer	=	26.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 6 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	26.00000	ft
Distance from top of pile to bottom of layer	=	37.50000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	412.00000	psf
Undrained cohesion at bottom of layer	=	412.00000	psf
Epsilon-50 at top of layer	=	0.02000	
Epsilon-50 at bottom of layer	=	0.02000	

Layer 7 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	37.50000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft

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Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Epsilon 50	Soil Type kpy Criteria) pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay w/o Free Water		0.00	115.000	750.000
--	0.01000	--	4.000	115.000	750.000
--	0.01000	--			
2	Stiff Clay w/o Free Water		4.000	134.000	970.000
--	0.01000	--	10.000	134.000	970.000
--	0.01000	--			
3	Stiff Clay with Free Water		10.000	71.000	970.000
--	0.01000	100.000	12.000	71.000	970.000
--	0.01000	100.000			
4	Stiff Clay with Free Water		12.000	55.000	1000.000
--	0.00700	500.000	21.000	55.000	1000.000
--	0.00700	500.000			
5	Stiff Clay with Free Water		21.000	71.000	970.000
--	0.01000	100.000	26.000	71.000	970.000
--	0.01000	100.000			
6	Soft Clay		26.000	62.000	412.000
--	0.02000	--	37.500	62.000	412.000
--	0.02000	--			
7	Sand (Reese, et al.)		37.500	62.000	--
30.000	--	60.000	90.000	62.000	--
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult

Liq_Abut1_Cap_Run2_Long.lp7o

1	0.000	1.0000	1.0000
2	50.000	1.0000	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V =	M =	
	No	-12000. lbs	-492000. in-lbs	84000.

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000

Liq_Abut1_Cap_Run2_Long.lp7o

15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

 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

 p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	421.447 lb/in
Pcd	=	843.750 lb/in
Pu	=	421.447 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	23.69969
0.0003600	35.43930
0.0007200	42.14466
0.00360	63.02097
0.00720	74.94499
0.03600	112.06889
0.07200	133.27313
0.18000	167.58208
0.36000	199.28981
0.54000	220.55043

Liq_Abut1_Cap_Run2_Long.lp7o

0.72000	236.99686
1.80000	298.00777
3.60000	354.39296
7.20000	421.44663
7.38000	421.44663
7.56000	421.44663

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Equivalent Depth	=	2.000 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	558.183 lb/in
Pcd	=	843.750 lb/in
Pu	=	558.183 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	31.38892
0.0003600	46.93738
0.0007200	55.81826
0.00360	83.46777
0.00720	99.26047
0.03600	148.42902
0.07200	176.51285
0.18000	221.95316
0.36000	263.94828
0.54000	292.10679
0.72000	313.88917
1.80000	394.69473
3.60000	469.37379
7.20000	558.18265
7.38000	558.18265
7.56000	558.18265

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Equivalent Depth	=	4.972 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	18.400 degrees

Liq_Abut1_Cap_Run2_Long.lp7o

Diameter	=	18.000	in
Undrained cohesion, c	=	5.9722	psi
Undrained cohesion, c	=	860.0000	psf
Average Eff. Unit Weight	=	0.0665	pci
Average Eff. Unit Weight	=	115.0000	pcf
Epsilon-50	=	0.0100	
Pct	=	857.348	lb/in
Pcd	=	967.500	lb/in
Pu	=	857.348	lb/in
y50	=	0.450	in
p-multiplier	=	1.0000	
y-multiplier	=	1.0000	

y, in	p, lb/in
0.0000	0.0000
0.0000720	48.21223
0.0003600	72.09409
0.0007200	85.73481
0.00360	128.20344
0.00720	152.46045
0.03600	227.98154
0.07200	271.11727
0.18000	340.91192
0.36000	405.41489
0.54000	448.66533
0.72000	482.12227
1.80000	606.23665
3.60000	720.94094
7.20000	857.34810
7.38000	857.34810
7.56000	857.34810

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft
Equivalent Depth	=	6.972 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07022 pci
Average Eff. Unit Weight	=	121.33333 pcf
Epsilon-50	=	0.01000
Pct	=	1125.789 lb/in
Pcd	=	1091.250 lb/in
Pu	=	1091.250 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	61.36550
0.0003600	91.76282
0.0007200	109.12500
0.00360	163.17994

Liq_Abut1_Cap_Run2_Long.lp7o

0.00720	194.05474
0.03600	290.17952
0.07200	345.08355
0.18000	433.91959
0.36000	516.02027
0.54000	571.07030
0.72000	613.65497
1.80000	771.63027
3.60000	917.62821
7.20000	1091.25000
7.38000	1091.25000
7.56000	1091.25000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	8.000 ft
Depth below ground surface	=	8.000 ft
Equivalent Depth	=	8.972 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07205 pci
Average Eff. Unit Weight	=	124.50000 pcf
Epsilon-50	=	0.01000
Pct	=	1297.691 lb/in
Pcd	=	1091.250 lb/in
Pu	=	1091.250 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	61.36550
0.0003600	91.76282
0.0007200	109.12500
0.00360	163.17994
0.00720	194.05474
0.03600	290.17952
0.07200	345.08355
0.18000	433.91959
0.36000	516.02027
0.54000	571.07030
0.72000	613.65497
1.80000	771.63027
3.60000	917.62821
7.20000	1091.25000
7.38000	1091.25000
7.56000	1091.25000

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3

Liq_Abut1_Cap_Run2_Long.lp7o

Depth below pile head	=	10.000	ft
Depth below ground surface	=	10.000	ft
Equivalent Depth	=	71.746	ft
Diameter	=	18.000	in
c (at curve depth)	=	6.736	lb/in**2
Average cohesion, c	=	6.73611	psi
Undrained cohesion, c	=	970.00000	psf
Average Eff. Unit Weight	=	0.07315	pci
Average Eff. Unit Weight	=	126.40000	pcf
k	=	100.000	pci
Epsilon50	=	0.01000	
y50	=	0.180	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	26655.847	lb/in
pcd	=	1333.750	lb/in
pc	=	1333.750	lb/in
pu	=	116.948	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	12.000 ft
Depth below ground surface	=	12.000 ft
Equivalent Depth	=	72.663 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.840 lb/in**2
Average cohesion, c	=	6.84028 psi
Undrained cohesion, c	=	985.00000 psf
Average Eff. Unit Weight	=	0.06780 pci
Average Eff. Unit Weight	=	117.16667 pcf
k	=	500.000 pci
Epsilon50	=	0.00850
y50	=	0.153 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	27257.122 lb/in

```

                                Liq_Abut1_Cap_Run2_Long.lp7o
pcd                             = 1354.375 lb/in
pc                              = 1354.375 lb/in
pu                              = 118.756 lb/in
p-multiplier                    = 1.00000
y-multiplier                    = 1.00000

```

y, in	p, lb/in
0.0000	0.0000
0.04590	370.91088
0.09180	524.54719
0.13770	611.11703
0.18360	667.33113
0.22950	705.72579
0.27540	731.37283
0.32130	747.17043
0.36720	754.98886
0.41310	756.12825
0.45900	751.54057
0.50490	741.95031
0.55080	727.92564
0.91800	525.06857
1.28520	321.91231
1.65240	118.75605
1.74420	118.75605

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

```

Soil Layer Number              = 4
Depth below pile head          = 14.000 ft
Depth below ground surface     = 14.000 ft
Equivalent Depth               = 74.663 ft
Diameter                       = 18.000 in
c (at curve depth)             = 6.944 lb/in**2
Average cohesion, c            = 6.89236 psi
Undrained cohesion, c          = 992.50000 psf
Average Eff. Unit Weight       = 0.06267 pci
Average Eff. Unit Weight       = 108.28571 pcf
k                               = 500.000 pci
Epsilon50                     = 0.00700
y50                            = 0.126 in
As                              = 0.600
Ac (not used)                  = 0.30000
pct                             = 28073.693 lb/in
pcd                             = 1375.000 lb/in
pc                              = 1375.000 lb/in
pu                              = 120.565 lb/in
p-multiplier                    = 1.00000
y-multiplier                    = 1.00000

```

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290

Liq_Abut1_Cap_Run2_Long.lp7o

0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Equivalent Depth	=	76.663 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	12.50935 psi
Undrained cohesion, c	=	1801.34615 psf
Average Eff. Unit Weight	=	0.05881 pci
Average Eff. Unit Weight	=	101.62500 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.126 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	50936.492 lb/in
pcd	=	1375.000 lb/in
pc	=	1375.000 lb/in
pu	=	120.565 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	18.000 ft
Depth below ground surface	=	18.000 ft
Equivalent Depth	=	78.663 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	17.32292 psi

```

Liq_Abut1_Cap_Run2_Long.lp7o
Undrained cohesion, c = 2494.50000 psf
Average Eff. Unit Weight = 0.05581 pci
Average Eff. Unit Weight = 96.44444 pcf
k = 500.000 pci
Epsilon50 = 0.00700
y50 = 0.126 in
As = 0.600
Ac (not used) = 0.30000
pct = 71700.000 lb/in
pcd = 1375.000 lb/in
pc = 1375.000 lb/in
pu = 120.565 lb/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

```

Soil Layer Number = 5
Depth below pile head = 22.000 ft
Depth below ground surface = 22.000 ft
Equivalent Depth = 82.820 ft
Diameter = 18.000 in
c (at curve depth) = 6.736 lb/in**2
Average cohesion, c = 6.73611 psi
Undrained cohesion, c = 970.00000 psf
Average Eff. Unit Weight = 0.05187 pci
Average Eff. Unit Weight = 89.63636 pcf
k = 100.000 pci
Epsilon50 = 0.01000
y50 = 0.180 in
As = 0.600
Ac (not used) = 0.30000
pct = 30143.621 lb/in
pcd = 1333.750 lb/in
pc = 1333.750 lb/in
pu = 116.948 lb/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

Liq_Abut1_Cap_Run2_Long.lp7o	
y, in	p, lb/in
-----	-----
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth	=	84.820 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05097 pci
Average Eff. Unit Weight	=	88.08333 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	30838.104 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758

2.05200 Liq_Abut1_Cap_Run2_Long.lp7o
116.94758

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	26.000 ft
Depth below ground surface	=	26.000 ft
Transition Depth Xr	=	13.075 ft
Equivalent Depth of p-y curve	=	26.000 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.05021 pci
Avg. Eff. Unit Weight	=	86.76923 pcf
Cohesion, c	=	4.799 psi
Cohesion, c	=	691.000 psf
Epsilon50 parameter	=	0.0150
J (default value)	=	0.5000
Static pu_s for flat ground	=	1289.708 lb/in
Static pu_d for flat ground	=	777.375 lb/in
y_50	=	0.67500 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	0.750
Negative-y Sloping Ground Factor	=	1.498
Sloping Ground Factor	=	1.498
Positive-y, static pu	=	777.375 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00160	51.82500
0.01280	103.65000
0.04320	155.47500
0.10240	207.30001
0.20000	259.12501
0.34560	310.95000
0.54880	362.77500
0.81920	414.60002
1.16640	466.42502
1.60000	518.25002
2.12960	570.07501
2.76480	621.90002
3.51520	673.72503
4.39040	725.55001
5.40000	777.37502
5.73750	777.37500

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	28.000 ft
Depth below ground surface	=	28.000 ft
Transition Depth Xr	=	11.118 ft
Equivalent Depth of p-y curve	=	28.000 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees

Liq_Abut1_Cap_Run2_Long.lp7o

Effective Slope	=	18.400	degrees
Pile Diameter	=	18.000	in
Avg. Eff. Unit Weight	=	0.04919	pci
Avg. Eff. Unit Weight	=	85.00000	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	932.667	lb/in
Static pu_d for flat ground	=	463.500	lb/in
y_50	=	0.90000	in
p-multiplier	=	1.000	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	0.750	
Negative-y Sloping Ground Factor	=	1.498	
Sloping Ground Factor	=	1.498	
Positive-y, static pu	=	463.500	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	30.000 ft
Depth below ground surface	=	30.000 ft
Transition Depth Xr	=	11.196 ft
Equivalent Depth of p-y curve	=	30.000 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.04830 pci
Avg. Eff. Unit Weight	=	83.46667 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	982.500 lb/in
Static pu_d for flat ground	=	463.500 lb/in
y_50	=	0.90000 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	0.750
Negative-y Sloping Ground Factor	=	1.498

Liq_Abut1_Cap_Run2_Long.lp7o

Sloping Ground Factor	=	1.498	
Positive-y, static pu	=	463.500	lb/in

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	32.000 ft
Depth below ground surface	=	32.000 ft
Transition Depth Xr	=	11.264 ft
Equivalent Depth of p-y curve	=	32.000 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.04753 pci
Avg. Eff. Unit Weight	=	82.12500 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	1032.333 lb/in
Static pu_d for flat ground	=	463.500 lb/in
y_50	=	0.90000 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	0.750
Negative-y Sloping Ground Factor	=	1.498
Sloping Ground Factor	=	1.498
Positive-y, static pu	=	463.500 lb/in

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001

	Liq_Abut1_Cap_Run2_Long.lp7o
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Transition Depth Xr	=	11.325 ft
Equivalent Depth of p-y curve	=	34.000 ft
Ground Slope Angle	=	18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	18.400 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.04684 pci
Avg. Eff. Unit Weight	=	80.94118 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	1082.167 lb/in
Static pu_d for flat ground	=	463.500 lb/in
y_50	=	0.90000 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	0.750
Negative-y Sloping Ground Factor	=	1.498
Sloping Ground Factor	=	1.498
Positive-y, static pu	=	463.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Transition Depth Xr	=	11.380 ft

Liq_Abut1_Cap_Run2_Long.lp7o

Equivalent Depth of p-y curve	=	36.000	ft
Ground Slope Angle	=	18.400	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	18.400	degrees
Pile Diameter	=	18.000	in
Avg. Eff. Unit Weight	=	0.04623	pci
Avg. Eff. Unit Weight	=	79.88889	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	1132.000	lb/in
Static pu_d for flat ground	=	463.500	lb/in
y_50	=	0.90000	in
p-multiplier	=	1.000	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	0.750	
Negative-y Sloping Ground Factor	=	1.498	
Sloping Ground Factor	=	1.498	
Positive-y, static pu	=	463.500	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	7	
Depth below pile head	=	38.000	ft
Depth below ground surface	=	38.000	ft
Equivalent Depth (see note)	=	15.583	ft
Ground Slope Angle	=	18.400	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	18.400	degrees
Pile Diameter, b	=	18.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	78.94737	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	17979.451	lb/in
Psd	=	10779.423	lb/in


```

Liq_Abut1_Cap_Run2_Long.lp7o
Ps = Psd (deep controls) = 10779.423 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 11206.6494
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 10923.1484
Yk = [c/(kx)]^(n/(n-1)) = 0.9970 in
Pk = 11185.933 lb/in
Ym = b/60 = 0.3000 in
Pm = B ps = 5389.711 lb/in
Yu = 3b/80 = 0.6750 in
Pu = A Ps = 9485.892 lb/in
Es, lim = 11220.027 lb/in/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has a bi-linear shape for a Reese sand p-y curve because $Y_m < Y_u < Y_k$.

y, in	p, lb/in	
0.0000	0.0000	
0.06039	677.56372	*
0.12078	1355.12744	*
0.18117	2032.69116	*
0.24156	2710.25488	*
0.30194	3387.81860	*
0.36233	4065.38232	*
0.42272	4742.94603	*
0.48311	5420.50975	*
0.54350	6098.07347	*
0.60389	6775.63719	*
0.66428	7453.20091	*
0.72467	8130.76463	*
0.78505	8808.32835	*
0.84544	9485.89207	
0.86658	9485.89207	
0.88772	9485.89207	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```

Soil Layer Number = 7
Depth below pile head = 40.000 ft
Depth below ground surface = 40.000 ft
Equivalent Depth (see note) = 17.583 ft
Ground Slope Angle = 18.400 degrees
Pile Batter = 0.000 degrees
Effective Slope = 18.400 degrees
Pile Diameter, b = 18.000 in
Angle of Friction = 30.000 degrees
Avg. Eff. Unit Weight = 78.10000 pcf
kpy = 60.000 pci
K active = 0.333
K passive = 3.000
K0 = 0.400
Pst = 22497.777 lb/in
Psd = 11224.972 lb/in

```

```

Liq_Abut1_Cap_Run2_Long.lp7o
Ps = Psd (deep controls) = 11224.972 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 11669.8576
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 11374.6385
Yk = [c/(kx)]^(n/(n-1)) = 0.8124 in
Pk = 10285.074 lb/in
Ym = b/60 = 0.3000 in
Pm = B ps = 5612.486 lb/in
Yu = 3b/80 = 0.6750 in
Pu = A Ps = 9877.976 lb/in
Es, lim = 12660.027 lb/in/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has a bi-linear shape for a Reese sand p-y curve because $Y_m < Y_u < Y_k$.

y, in	p, lb/in	
0.0000	0.0000	
0.05573	705.56969	*
0.11146	1411.13937	*
0.16720	2116.70906	*
0.22293	2822.27874	*
0.27866	3527.84843	*
0.33439	4233.41812	*
0.39012	4938.98780	*
0.44586	5644.55749	*
0.50159	6350.12718	*
0.55732	7055.69686	*
0.61305	7761.26655	*
0.66879	8466.83623	*
0.72452	9172.40592	*
0.78025	9877.97561	*
0.79976	9877.97561	
0.81926	9877.97561	

* p value(s) computed using $p = k * \text{Eff} * y$

 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 = -12000.0 lbs
Applied moment at pile head = -492000.0 in-lbs
Axial thrust load on pile head = 84000.0 lbs

```

Depth	Deflect.	Bending	Shear	Slope	Total	Bending	Soil
Res. Soil	Spr. Distrib.	Moment	Force	S	Stress	Stiffness	p
X	y						
Es*h	Lat. Load						

		Liq_Abut1_Cap_Run2_Long.lp7o					
feet	inches	in-lbs	lbs	radians	psi*	lb-in^2	lb/in
lb/inch	lb/inch						

0.00	-0.1803	-492000.	-12000.	0.002917	4535.8369	3.194E+10	
167.6563	2789.6008	0.000					
1.000	-0.1465	-626441.	-9881.4651	0.002706	5684.9047	3.194E+10	
184.9965	7577.0828	0.000					
2.000	-0.1155	-734039.	-7576.6445	0.002450	6604.5449	3.194E+10	
198.6556	10320.	0.000					
3.000	-0.0878	-812790.	-5132.1511	0.002158	7277.6301	3.194E+10	
208.2196	14228.	0.000					
4.000	-0.0638	-861291.	-2450.5105	0.001843	7692.1721	3.194E+10	
263.0279	24746.	0.000					
5.000	-0.0436	-872403.	961.8395	0.001516	7787.1475	3.194E+10	
290.0565	39905.	0.000					
6.000	-0.0274	-841490.	4360.5210	0.001193	7522.9312	3.194E+10	
270.9851	59400.	0.000					
7.000	-0.0149	-771359.	7387.9613	0.000889	6923.5180	3.194E+10	
232.8305	93659.	0.000					
8.000	-0.005928	-667489.	9905.6574	0.000618	6035.7412	3.194E+10	
184.8773	187128.	0.000					
9.000	5.783E-05	-537054.	11335.	0.000392	4920.9153	3.194E+10	
-9.3588	970995.	0.000					
10.000	0.003622	-405038.	10462.	0.000215	3792.5677	3.194E+10	
-94.5856	156706.	0.000					
11.000	0.005355	-286911.	9188.3172	8.519E-05	2782.9364	3.194E+10	
-115.0222	128875.	0.000					
12.000	0.005790	-185102.	7735.7368	-3.093E-06	1912.7770	3.194E+10	
-131.7379	136510.	0.000					
13.000	0.005385	-102231.	6039.2719	-5.659E-05	1204.4761	3.194E+10	
-142.1357	158354.	0.000					
14.000	0.004514	-39728.	4401.7049	-8.279E-05	670.2628	3.194E+10	
-130.1292	172968.	0.000					
15.000	0.003458	4089.6149	2935.1146	-8.908E-05	365.6626	3.194E+10	
-113.8979	197622.	0.000					
16.000	0.002416	31527.	1679.1989	-8.203E-05	600.1661	3.194E+10	
-95.2028	236435.	0.000					
17.000	0.001512	45253.	655.5551	-6.732E-05	717.4871	3.194E+10	
-75.3200	298859.	0.000					
18.000	0.000809	48119.	-127.0377	-4.955E-05	741.9851	3.194E+10	
-55.1047	408522.	0.000					
19.000	0.000321	43033.	-666.3724	-3.227E-05	698.5117	3.194E+10	
-34.7198	648481.	0.000					
20.000	2.578E-05	32952.	-943.3216	-1.792E-05	612.3490	3.194E+10	
-9.8481	2291994.	0.000					
21.000	-0.000121	21844.	-844.7750	-7.673E-06	517.4071	3.194E+10	
11.9293	589102.	0.000					
22.000	-0.000170	12692.	-666.3560	-1.237E-06	439.1869	3.194E+10	
16.8756	596302.	0.000					
23.000	-0.000160	5914.5409	-465.3667	2.202E-06	381.2603	3.194E+10	
16.1127	603502.	0.000					
24.000	-0.000123	1430.3514	-292.1820	3.533E-06	342.9339	3.194E+10	
12.5458	610702.	0.000					
25.000	-7.937E-05	-1254.6525	-167.8207	3.530E-06	341.4322	3.194E+10	
8.1736	617902.	0.000					
26.000	-4.080E-05	-2757.8807	-60.9291	2.756E-06	354.2803	3.194E+10	
15.2564	2243462.	0.000					
27.000	-1.405E-05	-2686.5912	44.7990	1.709E-06	353.6710	3.194E+10	
5.7943	2473978.	0.000					
28.000	8.184E-07	-1906.2913	67.6223	8.428E-07	347.0017	3.194E+10	
-0.1513	1109534.	0.000					
29.000	7.088E-06	-1132.7566	57.9098	2.748E-07	340.3903	3.194E+10	

Liq_Abut1_Cap_Run2_Long.lp7o

-1.3107	1109534.	0.000					
30.000	8.196E-06	-539.0264	40.4457	-3.425E-08	335.3157	3.194E+10	
-1.5157	1109534.	0.000					
31.000	6.813E-06	-159.3002	23.5901	-1.606E-07	332.0702	3.194E+10	
-1.2599	1109534.	0.000					
32.000	4.660E-06	40.2666	10.8352	-1.794E-07	331.0528	3.194E+10	
-0.8618	1109534.	0.000					
33.000	2.654E-06	115.4267	2.7764	-1.479E-07	331.6952	3.194E+10	
-0.4908	1109534.	0.000					
34.000	1.148E-06	119.0100	-1.3649	-1.027E-07	331.7258	3.194E+10	
-0.2123	1109534.	0.000					
35.000	1.704E-07	91.0822	-2.7610	-6.286E-08	331.4871	3.194E+10	
-0.0315	1109534.	0.000					
36.000	-3.978E-07	57.8980	-2.4624	-3.497E-08	331.2035	3.194E+10	
0.0736	1109534.	0.000					
37.000	-7.021E-07	34.8513	-1.2142	-1.790E-08	331.0065	3.194E+10	
0.1298	1109534.	0.000					
38.000	-8.439E-07	25.2756	-0.7448	-6.635E-09	330.9247	3.194E+10	
0.009469	67320.	0.000					
39.000	-8.714E-07	17.0434	-0.6248	1.282E-09	330.8543	3.194E+10	
0.0104	71640.	0.000					
40.000	-8.216E-07	10.2945	-0.4993	6.383E-09	330.7966	3.194E+10	
0.0104	75960.	0.000					
41.000	-7.250E-07	5.0331	-0.3783	9.229E-09	330.7517	3.194E+10	
0.009700	80280.	0.000					
42.000	-6.052E-07	1.1624	-0.2686	1.036E-08	330.7186	3.194E+10	
0.008534	84600.	0.000					
43.000	-4.799E-07	-1.4822	-0.1746	1.028E-08	330.7213	3.194E+10	
0.007112	88920.	0.000					
44.000	-3.610E-07	-3.1027	-0.0983	9.392E-09	330.7352	3.194E+10	
0.005610	93240.	0.000					
45.000	-2.558E-07	-3.9138	-0.0398	8.057E-09	330.7421	3.194E+10	
0.004160	97560.	0.000					
46.000	-1.682E-07	-4.1230	0.002201	6.536E-09	330.7439	3.194E+10	
0.002856	101880.	0.000					
47.000	-9.897E-08	-3.9177	0.0297	5.017E-09	330.7421	3.194E+10	
0.001752	106200.	0.000					
48.000	-4.736E-08	-3.4565	0.0453	3.627E-09	330.7382	3.194E+10	
0.000872	110520.	0.000					
49.000	-1.130E-08	-2.8665	0.0516	2.438E-09	330.7332	3.194E+10	
0.000216	114840.	0.000					
50.000	1.184E-08	-2.2424	0.0514	1.478E-09	330.7278	3.194E+10	
-0.000235	119160.	0.000					
51.000	2.486E-08	-1.6497	0.0468	7.480E-10	330.7228	3.194E+10	
-0.000512	123480.	0.000					
52.000	3.043E-08	-1.1288	0.0397	2.280E-10	330.7183	3.194E+10	
-0.000648	127800.	0.000					
53.000	3.087E-08	-0.6998	0.0317	-1.133E-10	330.7146	3.194E+10	
-0.000680	132120.	0.000					
54.000	2.814E-08	-0.3678	0.0237	-3.116E-10	330.7118	3.194E+10	
-0.000640	136440.	0.000					
55.000	2.371E-08	-0.1275	0.0165	-4.026E-10	330.7098	3.194E+10	
-0.000556	140760.	0.000					
56.000	1.870E-08	0.0330	0.0105	-4.187E-10	330.7089	3.194E+10	
-0.000452	145080.	0.000					
57.000	1.381E-08	0.1285	0.005693	-3.870E-10	330.7098	3.194E+10	
-0.000344	149400.	0.000					
58.000	9.487E-09	0.1742	0.002180	-3.291E-10	330.7102	3.194E+10	
-0.000243	153720.	0.000					
59.000	5.940E-09	0.1848	-0.000205	-2.610E-10	330.7102	3.194E+10	
-0.000156	158040.	0.000					
60.000	3.221E-09	0.1727	-0.001653	-1.934E-10	330.7101	3.194E+10	
-8.716E-05	162360.	0.000					

Liq_Abut1_Cap_Run2_Long.lp7o							
61.000	1.277E-09	0.1477	-0.002376	-1.330E-10	330.7099	3.194E+10	
-3.546E-05	166680.	0.000					
62.000	-3.104E-12	0.1175	-0.002577	-8.311E-11	330.7097	3.194E+10	
8.846E-08	171000.	0.000					
63.000	-7.530E-10	0.0871	-0.002435	-4.472E-11	330.7094	3.194E+10	
2.200E-05	175320.	0.000					
64.000	-1.109E-09	0.0597	-0.002097	-1.724E-11	330.7092	3.194E+10	
3.321E-05	179640.	0.000					
65.000	-1.195E-09	0.0370	-0.001673	0.000	330.7090	3.194E+10	
3.664E-05	183960.	0.000					
66.000	-1.112E-09	0.0196	-0.001241	1.134E-11	330.7088	3.194E+10	
3.490E-05	188280.	0.000					
67.000	-9.397E-10	0.007121	-0.000849	1.625E-11	330.7087	3.194E+10	
3.016E-05	192600.	0.000					
68.000	-7.338E-10	-0.001016	-0.000523	1.730E-11	330.7087	3.194E+10	
2.408E-05	196920.	0.000					
69.000	-5.315E-10	-0.005687	-0.000272	1.597E-11	330.7087	3.194E+10	
1.783E-05	201240.	0.000					
70.000	-3.542E-10	-0.007782	-9.235E-05	1.339E-11	330.7087	3.194E+10	
1.213E-05	205560.	0.000					
71.000	-2.114E-10	-0.008119	2.404E-05	1.037E-11	330.7087	3.194E+10	
7.396E-06	209880.	0.000					
72.000	-1.050E-10	-0.007377	9.009E-05	7.440E-12	330.7087	3.194E+10	
3.749E-06	214200.	0.000					
73.000	-3.167E-11	-0.006084	0.000119	4.903E-12	330.7087	3.194E+10	
1.153E-06	218520.	0.000					
74.000	1.427E-11	-0.004613	0.000122	2.893E-12	330.7087	3.194E+10	
-5.302E-07	222840.	0.000					
75.000	3.940E-11	-0.003211	0.000109	1.426E-12	330.7087	3.194E+10	
-1.492E-06	227160.	0.000					
76.000	4.998E-11	-0.002018	8.844E-05	0.000	330.7087	3.194E+10	
-1.928E-06	231480.	0.000					
77.000	5.139E-11	-0.001099	6.455E-05	0.000	330.7087	3.194E+10	
-2.019E-06	235800.	0.000					
78.000	4.776E-11	-0.000468	4.087E-05	0.000	330.7087	3.194E+10	
-1.911E-06	240120.	0.000					
79.000	4.194E-11	-0.000111	1.911E-05	0.000	330.7087	3.194E+10	
-1.709E-06	244440.	0.000					
80.000	3.555E-11	0.000	0.000	0.000	330.7087	3.194E+10	
-1.474E-06	124380.	0.000					

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	-0.1803014 inches
Computed slope at pile head	=	0.0029165 radians
Maximum bending moment	=	-872403. inch-lbs
Maximum shear force	=	-12000. lbs
Depth of maximum bending moment	=	5.0000000 feet below pile head
Depth of maximum shear force	=	0.0000000 feet below pile head
Number of iterations	=	23
Number of zero deflection points	=	7

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
 Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
 Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
 Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
 Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Condition 1	Condition 2			
		Maximum Shear V(lbs) or y(inches)	Pile-head Rotation or in-lb/rad. radians			
1	1	V = -12000.	M = -492000.	84000.	-0.18030138	
-872403.		-12000.	0.00291653			

Computed Pile-head Stiffness Matrix Values
 K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)
 K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
-0.000315	0.00000	1200.000000	20094.	3808394.	63770792.
-0.002633	0.00000	4451.123953	108968.	1690442.	41383541.
-0.005322	0.00000	6352.909551	176881.	1193819.	33238995.
-0.007814	0.00000	7702.247906	229723.	985654.	29397605.
-0.010097	0.00000	8748.876047	273046.	866500.	27042796.
-0.012190	0.00000	9604.033504	309840.	787883.	25418222.
-0.014109	0.00000	10327.	341939.	731958.	24235852.
-0.015901	0.00000	10953.	370319.	688851.	23289134.
-0.017567	0.00000	11506.	395896.	654982.	22536815.
-0.019122	0.00000	12000.	419076.	627559.	21916238.

The K23 and K33 stiffnesses are computed using the zero displacement and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)
 K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection	Pile-Top Rotation	Pile-Top Shear Reac.	Pile-Top Mom. Reac.	K23 V/rot.	K33 M/rot.

inches	radians	Liq_Abut1_Cap_Run2_Long.lp7o			
		lbs	in-lbs	lb/rad	in-lb/rad
0.00000	0.00002803	1293.323137	49200.	46142576.	1755334524.
0.00000	0.000128	3779.606498	182496.	29477509.	1423304205.
0.00000	0.000199	4932.729373	260469.	24773185.	1308130537.
0.00000	0.000254	5695.621933	315792.	22467913.	1245727138.
0.00000	0.000298	6259.717344	358704.	21015025.	1204235157.
0.00000	0.000335	6709.243377	393765.	20035615.	1175889909.
0.00000	0.000367	7082.044751	423409.	19314984.	1154771853.
0.00000	0.000395	7400.207168	449088.	18757662.	1138325639.
0.00000	0.000419	7677.572604	471739.	18308073.	1124916008.
0.00000	0.000442	7922.754927	492000.	17930909.	1113502474.

The analysis ended normally.

Liq_Abut1_Cap_Run2_Transv.lp7o

LPile Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\lpileRuns_10272015\Abut\Liq_Trans\
Name of input data file: Liq_Abut1_Cap_Run2_Transv.lp7d
Name of output report file: Liq_Abut1_Cap_Run2_Transv.lp7o
Name of plot output file: Liq_Abut1_Cap_Run2_Transv.lp7p
Name of runtime message file: Liq_Abut1_Cap_Run2_Transv.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 17:01:38

Problem Title

Abutment#1 (Lower): 18-inch Static without p-multipliers Round 1

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 23-BMU-14

Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

Pile Structural Properties and Geometry

Total number of pile sections = 1
Total length of pile = 80.00 ft
Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	80.000000	18.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	18.00000 in
Bottom Width	=	18.00000 in
Top Area	=	254.00000 Sq. in
Bottom Area	=	254.00000 Sq. in
Moment of Inertia at Top	=	1053.00000 in ⁴
Moment of Inertia at Bottom	=	1053.00000 in ⁴
Elastic Modulus	=	30328000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 7 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	4.00000 ft
Effective unit weight at top of layer	=	115.00000 pcf
Effective unit weight at bottom of layer	=	115.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer	=	4.00000 ft
Distance from top of pile to bottom of layer	=	10.00000 ft
Effective unit weight at top of layer	=	134.00000 pcf
Effective unit weight at bottom of layer	=	134.00000 pcf
Undrained cohesion at top of layer	=	970.00000 psf

Liq_Abut1_Cap_Run2_Transv.lp7o

Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	10.00000	ft
Distance from top of pile to bottom of layer	=	12.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 4 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	12.00000	ft
Distance from top of pile to bottom of layer	=	21.00000	ft
Effective unit weight at top of layer	=	55.00000	pcf
Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	1000.00000	psf
Undrained cohesion at bottom of layer	=	1000.00000	psf
Epsilon-50 at top of layer	=	0.00700	
Epsilon-50 at bottom of layer	=	0.00700	
Subgrade k at top of layer	=	500.00000	pci
Subgrade k at bottom of layer	=	500.00000	pci

Layer 5 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	21.00000	ft
Distance from top of pile to bottom of layer	=	26.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 6 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	26.00000	ft
Distance from top of pile to bottom of layer	=	37.50000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	412.00000	psf
Undrained cohesion at bottom of layer	=	412.00000	psf
Epsilon-50 at top of layer	=	0.02000	
Epsilon-50 at bottom of layer	=	0.02000	

Layer 7 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	37.50000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft

Liq_Abut1_Cap_Run2_Transv.lp7o

Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Epsilon 50	Layer Soil Type kpy Criteria) pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay w/o	Free Water	0.00	115.000	750.000
--	0.01000	--	4.000	115.000	750.000
--	0.01000	--	4.000	134.000	970.000
2	Stiff Clay w/o	Free Water	10.000	134.000	970.000
--	0.01000	--	10.000	71.000	970.000
3	Stiff Clay with	Free Water	12.000	71.000	970.000
--	0.01000	100.000	12.000	55.000	1000.000
--	0.01000	100.000	21.000	55.000	1000.000
4	Stiff Clay with	Free Water	21.000	71.000	970.000
--	0.00700	500.000	26.000	71.000	970.000
--	0.00700	500.000	26.000	62.000	412.000
5	Stiff Clay with	Free Water	37.500	62.000	412.000
--	0.01000	100.000	37.500	62.000	--
--	0.01000	100.000	90.000	62.000	--
6	Soft Clay				
--	0.02000	--			
--	0.02000	--			
7	Sand (Reese, et al.)				
30.000	--	60.000			
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult

Liq_Abut1_Cap_Run2_Transv.lp7o

1	0.000	1.0000	1.0000
2	50.000	1.0000	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
Top y vs. Pile Length				
1	1	V = 9500.00000 lbs	M = 684000. in-lbs	85000.
No				

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000

Liq_Abut1_Cap_Run2_Transv.lp7o

15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

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

p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	0.000 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	281.250 lb/in
Pcd	=	843.750 lb/in
Pu	=	281.250 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	15.81585
0.0003600	23.65021
0.0007200	28.12500
0.00360	42.05668
0.00720	50.01411
0.03600	74.78854
0.07200	88.93906
0.18000	111.83495
0.36000	132.99491
0.54000	147.18307

Liq_Abut1_Cap_Run2_Transv.lp7o

0.72000	158.15850
1.80000	198.87378
3.60000	236.50212
7.20000	281.25000
7.38000	281.25000
7.56000	281.25000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Equivalent Depth	=	2.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	0.000 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	372.500 lb/in
Pcd	=	843.750 lb/in
Pu	=	372.500 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	20.94721
0.0003600	31.32339
0.0007200	37.25000
0.00360	55.70174
0.00720	66.24091
0.03600	99.05326
0.07200	117.79484
0.18000	148.11917
0.36000	176.14438
0.54000	194.93580
0.72000	209.47214
1.80000	263.39728
3.60000	313.23391
7.20000	372.50000
7.38000	372.50000
7.56000	372.50000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Equivalent Depth	=	3.596 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	0.000 degrees

Liq_Abut1_Cap_Run2_Transv.lp7o

Diameter	=	18.000	in
Undrained cohesion, c	=	5.97222	psi
Undrained cohesion, c	=	860.00000	psf
Average Eff. Unit Weight	=	0.06655	pci
Average Eff. Unit Weight	=	115.00000	pcf
Epsilon-50	=	0.01000	
Pct	=	503.045	lb/in
Pcd	=	967.500	lb/in
Pu	=	503.045	lb/in
y50	=	0.450	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.0000720	28.28831
0.0003600	42.30088
0.0007200	50.30451
0.00360	75.22279
0.00720	89.45548
0.03600	133.76714
0.07200	159.07683
0.18000	200.02853
0.36000	237.87535
0.54000	263.25235
0.72000	282.88306
1.80000	355.70662
3.60000	423.00884
7.20000	503.04512
7.38000	503.04512
7.56000	503.04512

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft
Equivalent Depth	=	5.596 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	0.000 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07022 pci
Average Eff. Unit Weight	=	121.33333 pcf
Epsilon-50	=	0.01000
Pct	=	674.790 lb/in
Pcd	=	1091.250 lb/in
Pu	=	674.790 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	37.94622
0.0003600	56.74284
0.0007200	67.47899
0.00360	100.90462

Liq_Abut1_Cap_Run2_Transv.lp7o

0.00720	119.99649
0.03600	179.43660
0.07200	213.38729
0.18000	268.32031
0.36000	319.08842
0.54000	353.12939
0.72000	379.46222
1.80000	477.14848
3.60000	567.42837
7.20000	674.78986
7.38000	674.78986
7.56000	674.78986

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	8.000 ft
Depth below ground surface	=	8.000 ft
Equivalent Depth	=	7.596 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	0.000 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07205 pci
Average Eff. Unit Weight	=	124.50000 pcf
Epsilon-50	=	0.01000
Pct	=	788.963 lb/in
Pcd	=	1091.250 lb/in
Pu	=	788.963 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	44.36666
0.0003600	66.34364
0.0007200	78.89632
0.00360	117.97752
0.00720	140.29971
0.03600	209.79700
0.07200	249.49208
0.18000	313.71969
0.36000	373.07768
0.54000	412.87833
0.72000	443.66664
1.80000	557.88126
3.60000	663.43636
7.20000	788.96324
7.38000	788.96324
7.56000	788.96324

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3

Liq_Abut1_Cap_Run2_Transv.lp7o

Depth below pile head	=	10.000	ft
Depth below ground surface	=	10.000	ft
Equivalent Depth	=	52.081	ft
Diameter	=	18.000	in
c (at curve depth)	=	6.736	lb/in**2
Average cohesion, c	=	6.73611	psi
Undrained cohesion, c	=	970.00000	psf
Average Eff. Unit Weight	=	0.07315	pci
Average Eff. Unit Weight	=	126.40000	pcf
k	=	100.000	pci
Epsilon50	=	0.01000	
y50	=	0.180	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	12979.444	lb/in
pcd	=	1333.750	lb/in
pc	=	1333.750	lb/in
pu	=	116.948	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4	
Depth below pile head	=	12.000	ft
Depth below ground surface	=	12.000	ft
Equivalent Depth	=	53.298	ft
Diameter	=	18.000	in
c (at curve depth)	=	6.840	lb/in**2
Average cohesion, c	=	6.84028	psi
Undrained cohesion, c	=	985.00000	psf
Average Eff. Unit Weight	=	0.06780	pci
Average Eff. Unit Weight	=	117.16667	pcf
k	=	500.000	pci
Epsilon50	=	0.00850	
y50	=	0.153	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	13407.784	lb/in

Liq_Abut1_Cap_Run2_Transv.lp7o

pcd	=	1354.375	lb/in
pc	=	1354.375	lb/in
pu	=	118.756	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.04590	370.91088
0.09180	524.54719
0.13770	611.11703
0.18360	667.33113
0.22950	705.72579
0.27540	731.37283
0.32130	747.17043
0.36720	754.98886
0.41310	756.12825
0.45900	751.54057
0.50490	741.95031
0.55080	727.92564
0.91800	525.06857
1.28520	321.91231
1.65240	118.75605
1.74420	118.75605

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Equivalent Depth	=	55.298 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	6.89236 psi
Undrained cohesion, c	=	992.50000 psf
Average Eff. Unit Weight	=	0.06267 pci
Average Eff. Unit Weight	=	108.28571 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.126 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	13939.963 lb/in
pcd	=	1375.000 lb/in
pc	=	1375.000 lb/in
pu	=	120.565 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290

Liq_Abut1_Cap_Run2_Transv.lp7o

0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Equivalent Depth	=	57.298 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	12.50935 psi
Undrained cohesion, c	=	1801.34615 psf
Average Eff. Unit Weight	=	0.05881 pci
Average Eff. Unit Weight	=	101.62500 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.126 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	25519.456 lb/in
pcd	=	1375.000 lb/in
pc	=	1375.000 lb/in
pu	=	120.565 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	18.000 ft
Depth below ground surface	=	18.000 ft
Equivalent Depth	=	59.298 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	17.32292 psi

Liq_Abut1_Cap_Run2_Transv.lp7o

Undrained cohesion, c	=	2494.50000	psf
Average Eff. Unit Weight	=	0.05581	pci
Average Eff. Unit Weight	=	96.44444	pcf
k	=	500.000	pci
Epsilon50	=	0.00700	
y50	=	0.126	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	36222.782	lb/in
pcd	=	1375.000	lb/in
pc	=	1375.000	lb/in
pu	=	120.565	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	22.000 ft
Depth below ground surface	=	22.000 ft
Equivalent Depth	=	63.454 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05187 pci
Average Eff. Unit Weight	=	89.63636 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	15469.218 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

Liq_Abut1_Cap_Run2_Transv.lp7o	
y, in	p, lb/in
-----	-----
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth	=	65.454 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05097 pci
Average Eff. Unit Weight	=	88.08333 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	15936.437 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758

2.05200 Liq_Abut1_Cap_Run2_Transv.lp7o
116.94758

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	26.000 ft
Depth below ground surface	=	26.000 ft
Transition Depth Xr	=	13.075 ft
Equivalent Depth of p-y curve	=	26.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.05021 pci
Avg. Eff. Unit Weight	=	86.76923 pcf
Cohesion, c	=	4.799 psi
Cohesion, c	=	691.000 psf
Epsilon50 parameter	=	0.0150
J (default value)	=	0.5000
Static pu_s for flat ground	=	1289.708 lb/in
Static pu_d for flat ground	=	777.375 lb/in
y_50	=	0.67500 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	777.375 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00160	51.82500
0.01280	103.65000
0.04320	155.47500
0.10240	207.30001
0.20000	259.12501
0.34560	310.95000
0.54880	362.77500
0.81920	414.60002
1.16640	466.42502
1.60000	518.25002
2.12960	570.07501
2.76480	621.90002
3.51520	673.72503
4.39040	725.55001
5.40000	777.37502
5.73750	777.37500

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	28.000 ft
Depth below ground surface	=	28.000 ft
Transition Depth Xr	=	11.118 ft
Equivalent Depth of p-y curve	=	28.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees

Liq_Abut1_Cap_Run2_Transv.lp7o

Effective Slope	=	0.000	degrees
Pile Diameter	=	18.000	in
Avg. Eff. Unit Weight	=	0.04919	pci
Avg. Eff. Unit Weight	=	85.00000	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	932.667	lb/in
Static pu_d for flat ground	=	463.500	lb/in
y_50	=	0.90000	in
p-multiplier	=	1.000	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	463.500	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	30.000 ft
Depth below ground surface	=	30.000 ft
Transition Depth Xr	=	11.196 ft
Equivalent Depth of p-y curve	=	30.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.04830 pci
Avg. Eff. Unit Weight	=	83.46667 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	982.500 lb/in
Static pu_d for flat ground	=	463.500 lb/in
y_50	=	0.90000 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000

Liq_Abut1_Cap_Run2_Transv.lp7o

Sloping Ground Factor = 1.000
 Positive-y, static pu = 463.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number = 6
 Depth below pile head = 32.000 ft
 Depth below ground surface = 32.000 ft
 Transition Depth Xr = 11.264 ft
 Equivalent Depth of p-y curve = 32.000 ft
 Ground Slope Angle = 0.000 degrees
 Pile Batter = 0.000 degrees
 Effective Slope = 0.000 degrees
 Pile Diameter = 18.000 in
 Avg. Eff. Unit Weight = 0.04753 pci
 Avg. Eff. Unit Weight = 82.12500 pcf
 Cohesion, c = 2.861 psi
 Cohesion, c = 412.000 psf
 Epsilon50 parameter = 0.0200
 J (default value) = 0.5000
 Static pu_s for flat ground = 1032.333 lb/in
 Static pu_d for flat ground = 463.500 lb/in
 y_50 = 0.90000 in
 p-multiplier = 1.000
 y-multiplier = 1.000
 Positive-y Sloping Ground Factor = 1.000
 Negative-y Sloping Ground Factor = 1.000
 Sloping Ground Factor = 1.000
 Positive-y, static pu = 463.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001

	Liq_Abut1_Cap_Run2_Transv.lp7o
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Transition Depth Xr	=	11.325 ft
Equivalent Depth of p-y curve	=	34.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.04684 pci
Avg. Eff. Unit Weight	=	80.94118 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	1082.167 lb/in
Static pu_d for flat ground	=	463.500 lb/in
y_50	=	0.90000 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	463.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Transition Depth Xr	=	11.380 ft

Liq_Abut1_Cap_Run2_Transv.lp7o

Equivalent Depth of p-y curve	=	36.000	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter	=	18.000	in
Avg. Eff. Unit Weight	=	0.04623	pci
Avg. Eff. Unit Weight	=	79.88889	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	1132.000	lb/in
Static pu_d for flat ground	=	463.500	lb/in
y_50	=	0.90000	in
p-multiplier	=	1.000	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	463.500	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	7	
Depth below pile head	=	38.000	ft
Depth below ground surface	=	38.000	ft
Equivalent Depth (see note)	=	14.524	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	18.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	78.94737	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3035.115	lb/in
Psd	=	10779.423	lb/in

```

Liq_Abut1_Cap_Run2_Transv.lp7o
Ps = Pst (shallow controls) = 3035.115 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 3155.4078
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 3075.5836
Yk = [c/(kx)]^(n/(n-1)) = 0.0471 in
Pk = 492.019 lb/in
Ym = b/60 = 0.3000 in
Pm = B ps = 1517.558 lb/in
Yu = 3b/80 = 0.6750 in
Pu = A Ps = 2670.902 lb/in
Es, lim = 10456.966 lb/in/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.04705	492.01885	*
0.07005	626.68978	
0.09304	744.75494	
0.11604	851.78829	
0.13903	950.76040	
0.16203	1043.48607	
0.18502	1131.17422	
0.20802	1214.68007	
0.23101	1294.63613	
0.25401	1371.52643	
0.27700	1445.73163	
0.30000	1517.55772	
0.48750	2094.22964	
0.67500	2670.90157	
0.69188	2670.90157	
0.70875	2670.90157	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```

Soil Layer Number = 7
Depth below pile head = 40.000 ft
Depth below ground surface = 40.000 ft
Equivalent Depth (see note) = 16.524 ft
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter, b = 18.000 in
Angle of Friction = 30.000 degrees
Avg. Eff. Unit Weight = 78.10000 pcf
kpy = 60.000 pci
K active = 0.333
K passive = 3.000
K0 = 0.400
Pst = 3827.183 lb/in
Psd = 11224.972 lb/in

```

```

Liq_Abut1_Cap_Run2_Transv.lp7o
Ps = Pst (shallow controls) = 3827.183 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 3978.8673
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 3878.2116
Yk = [c/(kx)]^(n/(n-1)) = 0.0612 in
Pk = 727.738 lb/in
Ym = b/60 = 0.3000 in
Pm = B ps = 1913.591 lb/in
Yu = 3b/80 = 0.6750 in
Pu = A Ps = 3367.921 lb/in
Es, lim = 11896.966 lb/in/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.06117	727.73812	*
0.08288	875.35230	
0.10459	1008.36738	
0.12631	1130.89998	
0.14802	1245.40174	
0.16973	1353.47842	
0.19144	1456.25231	
0.21315	1554.54591	
0.23486	1648.98421	
0.25658	1740.05587	
0.27829	1828.15191	
0.30000	1913.59128	
0.48750	2640.75595	
0.67500	3367.92063	
0.69188	3367.92063	
0.70875	3367.92063	

* p value(s) computed using $p = k * \text{Eff} * y$

 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 = 9500.0 lbs
Applied moment at pile head = 684000.0 in-lbs
Axial thrust load on pile head = 85000.0 lbs

```

Depth	Deflect.	Bending	Shear	Slope	Total	Bending	Soil
Res.	Soil Spr.	Distrib.					
X	y	Moment	Force	S	Stress	Stiffness	p
Es*h	Lat. Load						

feet	inches	Liq_Abut1	Cap_Run2	Transv.	lp7o		
lb/inch	lb/inch	in-lbs	lbs	radians	psi*	lb-in^2	lb/in
0.00	0.2738	684000.	9500.0000	-0.003925	6180.7995	3.194E+10	
-124.2068	1360.7194	0.000					
1.000	0.2283	792667.	7925.4591	-0.003647	7109.5773	3.194E+10	
-137.9463	3624.6443	0.000					
2.000	0.1864	881187.	6199.4479	-0.003332	7866.1561	3.194E+10	
-149.4279	4809.3298	0.000					
3.000	0.1485	947874.	4350.2503	-0.002988	8436.1304	3.194E+10	
-158.4510	6403.5697	0.000					
4.000	0.1148	991405.	2366.8094	-0.002623	8808.1941	3.194E+10	
-178.7533	9344.5456	0.000					
5.000	0.0855	1008581.	6.1047	-0.002247	8954.9940	3.194E+10	
-203.9645	14305.	0.000					
6.000	0.0609	996036.	-2448.6177	-0.001869	8847.7730	3.194E+10	
-204.6188	20173.	0.000					
7.000	0.0407	953686.	-4883.9180	-0.001502	8485.8117	3.194E+10	
-200.6374	29610.	0.000					
8.000	0.0247	882130.	-7238.7432	-0.001157	7874.2214	3.194E+10	
-191.0435	46327.	0.000					
9.000	0.0128	782794.	-9434.6580	-0.000843	7025.1928	3.194E+10	
-173.7600	81453.	0.000					
10.000	0.004379	658256.	-11232.	-0.000572	5960.7658	3.194E+10	
-104.0438	142554.	0.000					
11.000	-0.001077	518136.	-11732.	-0.000351	4763.1598	3.194E+10	
51.5537	287080.	0.000					
12.000	-0.004196	382514.	-10734.	-0.000182	3603.9952	3.194E+10	
112.1245	160341.	0.000					
13.000	-0.005585	262823.	-9136.1782	-6.098E-05	2580.9971	3.194E+10	
144.7276	155491.	0.000					
14.000	-0.005783	163727.	-7375.0244	1.867E-05	1734.0206	3.194E+10	
147.2752	152811.	0.000					
15.000	-0.005236	85690.	-5644.8399	6.504E-05	1067.0347	3.194E+10	
140.1494	160586.	0.000					
16.000	-0.004298	27747.	-4038.5438	8.590E-05	571.7960	3.194E+10	
126.9755	177251.	0.000					
17.000	-0.003230	-11956.	-2614.1712	8.846E-05	436.8352	3.194E+10	
110.0675	204485.	0.000					
18.000	-0.002210	-35824.	-1406.3242	7.915E-05	640.8309	3.194E+10	
91.0616	247171.	0.000					
19.000	-0.001349	-46573.	-432.7558	6.339E-05	732.7042	3.194E+10	
71.1444	316378.	0.000					
20.000	-0.000695	-47061.	300.4760	4.559E-05	736.8739	3.194E+10	
51.0651	440808.	0.000					
21.000	-0.000251	-40178.	756.1122	2.906E-05	678.0507	3.194E+10	
18.8135	449672.	0.000					
22.000	1.261E-05	-30180.	854.6858	1.582E-05	592.5951	3.194E+10	
-0.9599	456872.	0.000					
23.000	0.000140	-20219.	777.6215	6.371E-06	507.4600	3.194E+10	
-10.8377	464072.	0.000					
24.000	0.000176	-11750.	625.5512	4.088E-07	435.0688	3.194E+10	
-13.8261	471272.	0.000					
25.000	0.000158	-5228.7944	464.5688	-2.735E-06	379.3362	3.194E+10	
-12.6312	478472.	0.000					
26.000	0.000117	-507.2976	294.6973	-3.775E-06	338.9815	3.194E+10	
-21.6508	1113425.	0.000					
27.000	7.178E-05	1860.9292	134.3966	-3.484E-06	350.5510	3.194E+10	
-9.9757	833823.	0.000					
28.000	3.488E-05	2795.3064	27.2082	-2.579E-06	358.5372	3.194E+10	
-7.8431	1349122.	0.000					
29.000	1.026E-05	2603.1838	-51.7006	-1.542E-06	356.8951	3.194E+10	

Liq_Abut1_Cap_Run2_Transv.lp7o

-5.2175	3049950.	0.000				
30.000	-2.827E-06	1779.5575	-68.5354	-7.171E-07	349.8556	3.194E+10
0.5227	1109534.	0.000				
31.000	-7.872E-06	1017.1615	-55.8031	-1.954E-07	343.3394	3.194E+10
1.4557	1109534.	0.000				
32.000	-8.272E-06	456.3596	-37.4477	7.611E-08	338.5462	3.194E+10
1.5297	1109534.	0.000				
33.000	-6.552E-06	112.2255	-20.8378	1.782E-07	335.6049	3.194E+10
1.2116	1109534.	0.000				
34.000	-4.277E-06	-58.3225	-8.8168	1.849E-07	335.1442	3.194E+10
0.7909	1109534.	0.000				
35.000	-2.233E-06	-114.5192	-1.6544	1.505E-07	335.6245	3.194E+10
0.4129	1109534.	0.000				
36.000	-6.884E-07	-110.3535	1.5137	1.073E-07	335.5889	3.194E+10
0.1273	1109534.	0.000				
37.000	3.637E-07	-86.9867	1.8120	7.020E-08	335.3891	3.194E+10
-0.0673	1109534.	0.000				
38.000	1.021E-06	-67.9876	1.5336	4.111E-08	335.2268	3.194E+10
-0.0107	62742.	0.000				
39.000	1.371E-06	-50.4773	1.3758	1.890E-08	335.0771	3.194E+10
-0.0153	67062.	0.000				
40.000	1.493E-06	-35.1344	1.1758	2.870E-09	334.9460	3.194E+10
-0.0178	71382.	0.000				
41.000	1.456E-06	-22.3192	0.9578	-7.863E-09	334.8364	3.194E+10
-0.0184	75702.	0.000				
42.000	1.317E-06	-12.1280	0.7412	-1.427E-08	334.7493	3.194E+10
-0.0176	80022.	0.000				
43.000	1.123E-06	-4.4531	0.5405	-1.733E-08	334.6837	3.194E+10
-0.0158	84342.	0.000				
44.000	9.087E-07	0.9548	0.3649	-1.794E-08	334.6538	3.194E+10
-0.0134	88662.	0.000				
45.000	6.978E-07	4.4311	0.2194	-1.689E-08	334.6835	3.194E+10
-0.0108	92982.	0.000				
46.000	5.064E-07	6.3484	0.1053	-1.483E-08	334.6999	3.194E+10
-0.008212	97302.	0.000				
47.000	3.433E-07	7.0789	0.0213	-1.228E-08	334.7062	3.194E+10
-0.005814	101622.	0.000				
48.000	2.119E-07	6.9665	-0.0357	-9.628E-09	334.7052	3.194E+10
-0.003741	105942.	0.000				
49.000	1.117E-07	6.3092	-0.0702	-7.124E-09	334.6996	3.194E+10
-0.002054	110262.	0.000				
50.000	3.997E-08	5.3502	-0.0868	-4.929E-09	334.6914	3.194E+10
-0.000763	114582.	0.000				
51.000	-7.716E-09	4.2758	-0.0902	-3.120E-09	334.6822	3.194E+10
0.000153	118902.	0.000				
52.000	-3.612E-08	3.2189	-0.0846	-1.713E-09	334.6732	3.194E+10
0.000742	123222.	0.000				
53.000	-4.997E-08	2.2651	-0.0736	-6.859E-10	334.6650	3.194E+10
0.001062	127542.	0.000				
54.000	-5.357E-08	1.4615	-0.0600	1.046E-11	334.6582	3.194E+10
0.001177	131862.	0.000				
55.000	-5.053E-08	0.8257	-0.0460	4.362E-10	334.6527	3.194E+10
0.001147	136182.	0.000				
56.000	-4.372E-08	0.3538	-0.0329	6.541E-10	334.6487	3.194E+10
0.001024	140502.	0.000				
57.000	-3.528E-08	0.0288	-0.0216	7.228E-10	334.6459	3.194E+10
0.000852	144822.	0.000				
58.000	-2.667E-08	-0.1738	-0.0126	6.930E-10	334.6472	3.194E+10
0.000663	149142.	0.000				
59.000	-1.882E-08	-0.2807	-0.005701	6.057E-10	334.6481	3.194E+10
0.000481	153462.	0.000				
60.000	-1.221E-08	-0.3180	-0.000906	4.919E-10	334.6484	3.194E+10
0.000321	157782.	0.000				

Liq_Abut1_Cap_Run2_Transv.lp7o						
61.000	-7.027E-09	-0.3087	0.002137	3.733E-10	334.6483	3.194E+10
0.000190	162102.	0.000				
62.000	-3.226E-09	-0.2717	0.003790	2.638E-10	334.6480	3.194E+10
8.948E-05	166422.	0.000				
63.000	-6.461E-10	-0.2214	0.004416	1.710E-10	334.6476	3.194E+10
1.838E-05	170742.	0.000				
64.000	9.365E-10	-0.1681	0.004346	9.781E-11	334.6471	3.194E+10
-2.732E-05	175062.	0.000				
65.000	1.760E-09	-0.1185	0.003853	4.410E-11	334.6467	3.194E+10
-5.262E-05	179382.	0.000				
66.000	2.047E-09	-0.0763	0.003151	7.690E-12	334.6463	3.194E+10
-6.267E-05	183702.	0.000				
67.000	1.987E-09	-0.0431	0.002395	-1.453E-11	334.6460	3.194E+10
-6.227E-05	188022.	0.000				
68.000	1.731E-09	-0.0187	0.001685	-2.593E-11	334.6458	3.194E+10
-5.548E-05	192342.	0.000				
69.000	1.388E-09	-0.002253	0.001078	-2.969E-11	334.6457	3.194E+10
-4.548E-05	196662.	0.000				
70.000	1.033E-09	0.007636	0.000598	-2.855E-11	334.6457	3.194E+10
-3.459E-05	200982.	0.000				
71.000	7.107E-10	0.0125	0.000245	-2.466E-11	334.6458	3.194E+10
-2.432E-05	205302.	0.000				
72.000	4.443E-10	0.0139	7.335E-06	-1.962E-11	334.6458	3.194E+10
-1.552E-05	209622.	0.000				
73.000	2.399E-10	0.0130	-0.000136	-1.452E-11	334.6458	3.194E+10
-8.555E-06	213942.	0.000				
74.000	9.402E-11	0.0109	-0.000206	-1.000E-11	334.6458	3.194E+10
-3.420E-06	218262.	0.000				
75.000	-2.857E-12	0.008261	-0.000225	-6.395E-12	334.6457	3.194E+10
1.060E-07	222582.	0.000				
76.000	-6.248E-11	0.005619	-0.000209	-3.791E-12	334.6457	3.194E+10
2.363E-06	226902.	0.000				
77.000	-9.668E-11	0.003306	-0.000172	-2.125E-12	334.6457	3.194E+10
3.726E-06	231222.	0.000				
78.000	-1.158E-10	0.001524	-0.000122	-1.232E-12	334.6457	3.194E+10
4.547E-06	235542.	0.000				
79.000	-1.279E-10	0.000394	-6.437E-05	0.000	334.6457	3.194E+10
5.113E-06	239862.	0.000				
80.000	-1.380E-10	0.000	0.000	0.000	334.6457	3.194E+10
5.616E-06	122091.	0.000				

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.2738406 inches
Computed slope at pile head	=	-0.0039249 radians
Maximum bending moment	=	1008581. inch-lbs
Maximum shear force	=	-11732. lbs
Depth of maximum bending moment	=	5.0000000 feet below pile head
Depth of maximum shear force	=	11.0000000 feet below pile head
Number of iterations	=	24
Number of zero deflection points	=	7

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs

Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians

Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian

Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs

Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head Condition 1		Pile-head Condition 2		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Maximum Shear in Pile lbs	V(lbs) or y(inches) Rotation radians	Pile-head in-lb, rad., or in-lb/rad.	Pile-head in-lb, rad., or in-lb/rad.			
1	1	V = 9500.0000	M = 684000.			85000.	0.27384063	
1008581.		-11732.	-0.00392495					

Computed Pile-head Stiffness Matrix Values
K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

$$K22 = \text{abs}(\text{Shear Reaction/Top } y)$$

$$K32 = \text{abs}(\text{Moment Reaction/Top } y)$$

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.000333	0.000000	950.000000	17560.	2856233.	52794785.
0.002952	0.000000	3523.806463	96896.	1193558.	32819902.
0.006017	0.000000	5029.386728	157597.	835915.	26193523.
0.008859	0.000000	6097.612926	204928.	688316.	23132861.
0.011434	0.000000	6926.193537	243640.	605764.	21308756.
0.013793	0.000000	7603.193191	276507.	551243.	20047154.
0.015955	0.000000	8175.588242	305078.	512413.	19121045.
0.017967	0.000000	8671.419389	330360.	482629.	18387002.
0.019854	0.000000	9108.773456	353064.	458782.	17782764.
0.021659	0.000000	9500.000000	373692.	438623.	17253658.

The K23 and K33 stiffnesses are computed using the zero displacement and moment pile-head condition.

$$K23 = \text{abs}(\text{Shear Reaction/Top Rotation})$$

$$K33 = \text{abs}(\text{Moment Reaction/Top Rotation})$$

Pile-Top Deflection	Pile-Top Rotation	Pile-Top Shear Reac.	Pile-Top Mom. Reac.	K23 V/rot.	K33 M/rot.

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inches	radians	lbs	in-lbs	lb/rad	in-lb/rad
0.00000	0.00003653	1915.746541	68400.	52446661.	1872560664.
0.00000	0.000174	5360.603378	253714.	30867720.	1460950223.
0.00000	0.000269	7001.953872	362116.	25981792.	1343684712.
0.00000	0.000343	8090.789507	439028.	23618859.	1281623199.
0.00000	0.000403	8896.892536	498686.	22102613.	1238888976.
0.00000	0.000453	9538.495869	547430.	21072510.	1209385905.
0.00000	0.000496	10069.	588642.	20305781.	1187083587.
0.00000	0.000534	10521.	624342.	19703634.	1169207746.
0.00000	0.000568	10915.	655832.	19215094.	1154579201.
0.00000	0.000599	11263.	684000.	18807540.	1142220961.

The analysis ended normally.

Liq_Abut2_Cap_Run2_Long.lp7o

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LPILE Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LpileRuns_10272015\Abut\Liq_Long\
Name of input data file: Liq_Abut2_Cap_Run2_Long.lp7d
Name of output report file: Liq_Abut2_Cap_Run2_Long.lp7o
Name of plot output file: Liq_Abut2_Cap_Run2_Long.lp7p
Name of runtime message file: Liq_Abut2_Cap_Run2_Long.lp7r

Date and Time of Analysis

Date: December 1, 2015 Time: 6:37:54

Problem Title

Abutment#1 (Lower): 18-inch Static without p-multipliers Round 1

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 23-BMU-14

Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	80.000000	18.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	18.00000 in
Bottom Width	=	18.00000 in
Top Area	=	254.00000 Sq. in
Bottom Area	=	254.00000 Sq. in
Moment of Inertia at Top	=	1053.00000 in ⁴
Moment of Inertia at Bottom	=	1053.00000 in ⁴
Elastic Modulus	=	30328000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	-18.400 degrees
	=	-0.321 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 7 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	4.00000 ft
Effective unit weight at top of layer	=	115.00000 pcf
Effective unit weight at bottom of layer	=	115.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer	=	4.00000 ft
Distance from top of pile to bottom of layer	=	10.00000 ft
Effective unit weight at top of layer	=	134.00000 pcf
Effective unit weight at bottom of layer	=	134.00000 pcf
Undrained cohesion at top of layer	=	970.00000 psf

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Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	10.00000	ft
Distance from top of pile to bottom of layer	=	12.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 4 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	12.00000	ft
Distance from top of pile to bottom of layer	=	21.00000	ft
Effective unit weight at top of layer	=	55.00000	pcf
Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	1000.00000	psf
Undrained cohesion at bottom of layer	=	1000.00000	psf
Epsilon-50 at top of layer	=	0.00700	
Epsilon-50 at bottom of layer	=	0.00700	
Subgrade k at top of layer	=	500.00000	pci
Subgrade k at bottom of layer	=	500.00000	pci

Layer 5 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	21.00000	ft
Distance from top of pile to bottom of layer	=	26.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	970.00000	psf
Undrained cohesion at bottom of layer	=	970.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	
Subgrade k at top of layer	=	100.00000	pci
Subgrade k at bottom of layer	=	100.00000	pci

Layer 6 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	26.00000	ft
Distance from top of pile to bottom of layer	=	37.50000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	412.00000	psf
Undrained cohesion at bottom of layer	=	412.00000	psf
Epsilon-50 at top of layer	=	0.02000	
Epsilon-50 at bottom of layer	=	0.02000	

Layer 7 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	37.50000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft

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Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Epsilon 50	Soil Type kpy Criteria) pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay w/o Free Water		0.00	115.000	750.000
--	0.01000	--	4.000	115.000	750.000
--	0.01000	--			
2	Stiff Clay w/o Free Water		4.000	134.000	970.000
--	0.01000	--	10.000	134.000	970.000
--	0.01000	--			
3	Stiff Clay with Free Water		10.000	71.000	970.000
--	0.01000	100.000	12.000	71.000	970.000
--	0.01000	100.000			
4	Stiff Clay with Free Water		12.000	55.000	1000.000
--	0.00700	500.000	21.000	55.000	1000.000
--	0.00700	500.000			
5	Stiff Clay with Free Water		21.000	71.000	970.000
--	0.01000	100.000	26.000	71.000	970.000
--	0.01000	100.000			
6	Soft Clay		26.000	62.000	412.000
--	0.02000	--	37.500	62.000	412.000
--	0.02000	--			
7	Sand (Reese, et al.)		37.500	62.000	--
30.000	--	60.000	90.000	62.000	--
30.000	--	60.000			

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult

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1	0.000	1.0000	1.0000
2	50.000	1.0000	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = -7500.00000 lbs	M = -364800. in-lbs	88300.
	No			

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000

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15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000
19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

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

p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	211.045 lb/in
Pcd	=	843.750 lb/in
Pu	=	211.045 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	11.86792
0.0003600	17.74668
0.0007200	21.10448
0.00360	31.55855
0.00720	37.52965
0.03600	56.11992
0.07200	66.73821
0.18000	83.91886
0.36000	99.79690
0.54000	110.44343

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0.72000	118.67919
1.80000	149.23118
3.60000	177.46678
7.20000	211.04475
7.38000	211.04475
7.56000	211.04475

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	1
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Equivalent Depth	=	2.000 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.06655 pci
Average Eff. Unit Weight	=	115.00000 pcf
Epsilon-50	=	0.01000
Pct	=	279.517 lb/in
Pcd	=	843.750 lb/in
Pu	=	279.517 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	15.71840
0.0003600	23.50449
0.0007200	27.95171
0.00360	41.79755
0.00720	49.70594
0.03600	74.32772
0.07200	88.39105
0.18000	111.14587
0.36000	132.17545
0.54000	146.27619
0.72000	157.18399
1.80000	197.64840
3.60000	235.04489
7.20000	279.51705
7.38000	279.51705
7.56000	279.51705

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Equivalent Depth	=	2.830 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	-18.400 degrees

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Diameter	=	18.000	in
Undrained cohesion, c	=	5.97222	psi
Undrained cohesion, c	=	860.00000	psf
Average Eff. Unit Weight	=	0.06655	pci
Average Eff. Unit Weight	=	115.00000	pcf
Epsilon-50	=	0.01000	
Pct	=	348.624	lb/in
Pcd	=	967.500	lb/in
Pu	=	348.624	lb/in
y50	=	0.450	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.0000720	19.60457
0.0003600	29.31566
0.0007200	34.86240
0.00360	52.13144
0.00720	61.99508
0.03600	92.70427
0.07200	110.24458
0.18000	138.62522
0.36000	164.85410
0.54000	182.44105
0.72000	196.04567
1.80000	246.51438
3.60000	293.15665
7.20000	348.62397
7.38000	348.62397
7.56000	348.62397

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft
Equivalent Depth	=	4.830 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07022 pci
Average Eff. Unit Weight	=	121.33333 pcf
Epsilon-50	=	0.01000
Pct	=	474.409 lb/in
Pcd	=	1091.250 lb/in
Pu	=	474.409 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	26.67800
0.0003600	39.89291
0.0007200	47.44093
0.00360	70.94074

Liq_Abut2_Cap_Run2_Long.lp7o

0.00720	84.36324
0.03600	126.15246
0.07200	150.02140
0.18000	188.64193
0.36000	224.33432
0.54000	248.26674
0.72000	266.77997
1.80000	335.45806
3.60000	398.92911
7.20000	474.40933
7.38000	474.40933
7.56000	474.40933

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	8.000 ft
Depth below ground surface	=	8.000 ft
Equivalent Depth	=	6.830 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter Angle	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Diameter	=	18.000 in
Undrained cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.07205 pci
Average Eff. Unit Weight	=	124.50000 pcf
Epsilon-50	=	0.01000
Pct	=	559.855 lb/in
Pcd	=	1091.250 lb/in
Pu	=	559.855 lb/in
y50	=	0.450 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.0000720	31.48299
0.0003600	47.07804
0.0007200	55.98554
0.00360	83.71792
0.00720	99.55794
0.03600	148.87385
0.07200	177.04184
0.18000	222.61833
0.36000	264.73930
0.54000	292.98220
0.72000	314.82986
1.80000	395.87758
3.60000	470.78044
7.20000	559.85545
7.38000	559.85545
7.56000	559.85545

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	3

Liq_Abut2_Cap_Run2_Long.lp7o

Depth below pile head	=	10.000	ft
Depth below ground surface	=	10.000	ft
Equivalent Depth	=	37.949	ft
Diameter	=	18.000	in
c (at curve depth)	=	6.736	lb/in**2
Average cohesion, c	=	6.73611	psi
Undrained cohesion, c	=	970.00000	psf
Average Eff. Unit Weight	=	0.07315	pci
Average Eff. Unit Weight	=	126.40000	pcf
k	=	100.000	pci
Epsilon50	=	0.01000	
y50	=	0.180	in
As	=	0.600	
Ac (not used)	=	0.30000	
pct	=	7146.096	lb/in
pcd	=	1333.750	lb/in
pc	=	1333.750	lb/in
pu	=	116.948	lb/in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lb/in
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	12.000 ft
Depth below ground surface	=	12.000 ft
Equivalent Depth	=	39.381 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.840 lb/in**2
Average cohesion, c	=	6.84028 psi
Undrained cohesion, c	=	985.00000 psf
Average Eff. Unit Weight	=	0.06780 pci
Average Eff. Unit Weight	=	117.16667 pcf
k	=	500.000 pci
Epsilon50	=	0.00850
y50	=	0.153 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	7482.119 lb/in

```

                                Liq_Abut2_Cap_Run2_Long.lp7o
pcd                             =      1354.375 lb/in
pc                              =      1354.375 lb/in
pu                              =      118.756 lb/in
p-multiplier                    =      1.00000
y-multiplier                    =      1.00000

```

y, in	p, lb/in
0.0000	0.0000
0.04590	370.91088
0.09180	524.54719
0.13770	611.11703
0.18360	667.33113
0.22950	705.72579
0.27540	731.37283
0.32130	747.17043
0.36720	754.98886
0.41310	756.12825
0.45900	751.54057
0.50490	741.95031
0.55080	727.92564
0.91800	525.06857
1.28520	321.91231
1.65240	118.75605
1.74420	118.75605

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

```

Soil Layer Number              =      4
Depth below pile head          =      14.000 ft
Depth below ground surface     =      14.000 ft
Equivalent Depth               =      41.381 ft
Diameter                       =      18.000 in
c (at curve depth)             =      6.944 lb/in**2
Average cohesion, c            =      6.89236 psi
Undrained cohesion, c          =      992.50000 psf
Average Eff. Unit Weight       =      0.06267 pci
Average Eff. Unit Weight       =      108.28571 pcf
k                               =      500.000 pci
Epsilon50                     =      0.00700
y50                            =      0.126 in
As                              =      0.600
Ac (not used)                  =      0.30000
pct                             =      7874.579 lb/in
pcd                             =      1375.000 lb/in
pc                              =      1375.000 lb/in
pu                              =      120.565 lb/in
p-multiplier                    =      1.00000
y-multiplier                    =      1.00000

```

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290

Liq_Abut2_Cap_Run2_Long.lp7o

0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Equivalent Depth	=	43.381 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	12.50935 psi
Undrained cohesion, c	=	1801.34615 psf
Average Eff. Unit Weight	=	0.05881 pci
Average Eff. Unit Weight	=	101.62500 pcf
k	=	500.000 pci
Epsilon50	=	0.00700
y50	=	0.126 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	14580.262 lb/in
pcd	=	1375.000 lb/in
pc	=	1375.000 lb/in
pu	=	120.565 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	4
Depth below pile head	=	18.000 ft
Depth below ground surface	=	18.000 ft
Equivalent Depth	=	45.381 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.944 lb/in**2
Average cohesion, c	=	17.32292 psi

```

Liq_Abut2_Cap_Run2_Long.lp7o
Undrained cohesion, c = 2494.50000 psf
Average Eff. Unit Weight = 0.05581 pci
Average Eff. Unit Weight = 96.44444 pcf
k = 500.000 pci
Epsilon50 = 0.00700
y50 = 0.126 in
As = 0.600
Ac (not used) = 0.30000
pct = 20911.483 lb/in
pcd = 1375.000 lb/in
pc = 1375.000 lb/in
pu = 120.565 lb/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

y, in	p, lb/in
0.0000	0.0000
0.03780	376.55927
0.07560	532.53522
0.11340	620.42338
0.15120	677.49353
0.18900	716.47289
0.22680	742.51048
0.26460	758.54866
0.30240	766.48615
0.34020	767.64290
0.37800	762.98535
0.41580	753.24904
0.45360	739.01081
0.75600	533.06453
1.05840	326.81453
1.36080	120.56452
1.43640	120.56452

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

```

Soil Layer Number = 5
Depth below pile head = 22.000 ft
Depth below ground surface = 22.000 ft
Equivalent Depth = 49.537 ft
Diameter = 18.000 in
c (at curve depth) = 6.736 lb/in**2
Average cohesion, c = 6.73611 psi
Undrained cohesion, c = 970.00000 psf
Average Eff. Unit Weight = 0.05187 pci
Average Eff. Unit Weight = 89.63636 pcf
k = 100.000 pci
Epsilon50 = 0.01000
y50 = 0.180 in
As = 0.600
Ac (not used) = 0.30000
pct = 9101.861 lb/in
pcd = 1333.750 lb/in
pc = 1333.750 lb/in
pu = 116.948 lb/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```


Liq_Abut2_Cap_Run2_Long.lp7o	
y, in	p, lb/in
-----	-----
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758
2.05200	116.94758

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth	=	51.537 ft
Diameter	=	18.000 in
c (at curve depth)	=	6.736 lb/in**2
Average cohesion, c	=	6.73611 psi
Undrained cohesion, c	=	970.00000 psf
Average Eff. Unit Weight	=	0.05097 pci
Average Eff. Unit Weight	=	88.08333 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.180 in
As	=	0.600
Ac (not used)	=	0.30000
pct	=	9454.481 lb/in
pcd	=	1333.750 lb/in
pc	=	1333.750 lb/in
pu	=	116.948 lb/in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.05400	365.26249
0.10800	516.55916
0.16200	601.81068
0.21600	657.16873
0.27000	694.97870
0.32400	720.23517
0.37800	735.79220
0.43200	743.49157
0.48600	744.61361
0.54000	740.09579
0.59400	730.65157
0.64800	716.84048
1.08000	517.07260
1.51200	317.01009
1.94400	116.94758

2.05200 Liq_Abut2_Cap_Run2_Long.lp7o
116.94758

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	26.000 ft
Depth below ground surface	=	26.000 ft
Transition Depth Xr	=	13.075 ft
Equivalent Depth of p-y curve	=	26.000 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.05021 pci
Avg. Eff. Unit Weight	=	86.76923 pcf
Cohesion, c	=	4.799 psi
Cohesion, c	=	691.000 psf
Epsilon50 parameter	=	0.0150
J (default value)	=	0.5000
Static pu_s for flat ground	=	1289.708 lb/in
Static pu_d for flat ground	=	777.375 lb/in
y_50	=	0.67500 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.498
Negative-y Sloping Ground Factor	=	0.750
Sloping Ground Factor	=	0.750
Positive-y, static pu	=	777.375 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00160	51.82500
0.01280	103.65000
0.04320	155.47500
0.10240	207.30001
0.20000	259.12501
0.34560	310.95000
0.54880	362.77500
0.81920	414.60002
1.16640	466.42502
1.60000	518.25002
2.12960	570.07501
2.76480	621.90002
3.51520	673.72503
4.39040	725.55001
5.40000	777.37502
5.73750	777.37500

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	28.000 ft
Depth below ground surface	=	28.000 ft
Transition Depth Xr	=	11.118 ft
Equivalent Depth of p-y curve	=	28.000 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees

Liq_Abut2_Cap_Run2_Long.lp7o

Effective Slope	=	-18.400	degrees
Pile Diameter	=	18.000	in
Avg. Eff. Unit Weight	=	0.04919	pci
Avg. Eff. Unit Weight	=	85.00000	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	932.667	lb/in
Static pu_d for flat ground	=	463.500	lb/in
y_50	=	0.90000	in
p-multiplier	=	1.000	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.498	
Negative-y Sloping Ground Factor	=	0.750	
Sloping Ground Factor	=	0.750	
Positive-y, static pu	=	463.500	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	30.000 ft
Depth below ground surface	=	30.000 ft
Transition Depth Xr	=	11.196 ft
Equivalent Depth of p-y curve	=	30.000 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.04830 pci
Avg. Eff. Unit Weight	=	83.46667 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	982.500 lb/in
Static pu_d for flat ground	=	463.500 lb/in
y_50	=	0.90000 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.498
Negative-y Sloping Ground Factor	=	0.750

Liq_Abut2_Cap_Run2_Long.lp7o

Sloping Ground Factor = 0.750
 Positive-y, static pu = 463.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number = 6
 Depth below pile head = 32.000 ft
 Depth below ground surface = 32.000 ft
 Transition Depth Xr = 11.264 ft
 Equivalent Depth of p-y curve = 32.000 ft
 Ground Slope Angle = -18.400 degrees
 Pile Batter = 0.000 degrees
 Effective Slope = -18.400 degrees
 Pile Diameter = 18.000 in
 Avg. Eff. Unit Weight = 0.04753 pci
 Avg. Eff. Unit Weight = 82.12500 pcf
 Cohesion, c = 2.861 psi
 Cohesion, c = 412.000 psf
 Epsilon50 parameter = 0.0200
 J (default value) = 0.5000
 Static pu_s for flat ground = 1032.333 lb/in
 Static pu_d for flat ground = 463.500 lb/in
 y_50 = 0.90000 in
 p-multiplier = 1.000
 y-multiplier = 1.000
 Positive-y Sloping Ground Factor = 1.498
 Negative-y Sloping Ground Factor = 0.750
 Sloping Ground Factor = 0.750
 Positive-y, static pu = 463.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001

	Liq_Abut2_Cap_Run2_Long.lp7o
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Transition Depth Xr	=	11.325 ft
Equivalent Depth of p-y curve	=	34.000 ft
Ground Slope Angle	=	-18.400 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	-18.400 degrees
Pile Diameter	=	18.000 in
Avg. Eff. Unit Weight	=	0.04684 pci
Avg. Eff. Unit Weight	=	80.94118 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	1082.167 lb/in
Static pu_d for flat ground	=	463.500 lb/in
y_50	=	0.90000 in
p-multiplier	=	1.000
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.498
Negative-y Sloping Ground Factor	=	0.750
Sloping Ground Factor	=	0.750
Positive-y, static pu	=	463.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	6
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Transition Depth Xr	=	11.380 ft

Liq_Abut2_Cap_Run2_Long.lp7o

Equivalent Depth of p-y curve	=	36.000	ft
Ground Slope Angle	=	-18.400	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	-18.400	degrees
Pile Diameter	=	18.000	in
Avg. Eff. Unit Weight	=	0.04623	pci
Avg. Eff. Unit Weight	=	79.88889	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	1132.000	lb/in
Static pu_d for flat ground	=	463.500	lb/in
y_50	=	0.90000	in
p-multiplier	=	1.000	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.498	
Negative-y Sloping Ground Factor	=	0.750	
Sloping Ground Factor	=	0.750	
Positive-y, static pu	=	463.500	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00213	30.90000
0.01707	61.80000
0.05760	92.70000
0.13653	123.60000
0.26667	154.50000
0.46080	185.40000
0.73173	216.30000
1.09227	247.20001
1.55520	278.10001
2.13333	309.00001
2.83947	339.90001
3.68640	370.80001
4.68693	401.70002
5.85387	432.60001
7.20000	463.50001
7.65000	463.50000

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	7	
Depth below pile head	=	38.000	ft
Depth below ground surface	=	38.000	ft
Equivalent Depth (see note)	=	13.858	ft
Ground Slope Angle	=	-18.400	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	-18.400	degrees
Pile Diameter, b	=	18.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	78.94737	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	1435.208	lb/in
Psd	=	10779.423	lb/in

```

Liq_Abut2_Cap_Run2_Long.lp7o
Ps = Pst (shallow controls) = 1435.208 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 1492.0907
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 1454.3445
Yk = [c/(kx)]^(n/(n-1)) = 0.0078 in
Pk = 78.317 lb/in
Ym = b/60 = 0.3000 in
Pm = B ps = 717.604 lb/in
Yu = 3b/80 = 0.6750 in
Pu = A Ps = 1262.983 lb/in
Es, lim = 9977.480 lb/in/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.00785	78.31654	*
0.03441	192.34809	
0.06097	272.35518	
0.08753	339.32586	
0.11409	398.65055	
0.14065	452.74638	
0.16720	502.95554	
0.19376	550.11876	
0.22032	594.80563	
0.24688	637.42411	
0.27344	678.27870	
0.30000	717.60418	
0.48750	990.29377	
0.67500	1262.98335	
0.69188	1262.98335	
0.70875	1262.98335	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```

Soil Layer Number = 7
Depth below pile head = 40.000 ft
Depth below ground surface = 40.000 ft
Equivalent Depth (see note) = 15.858 ft
Ground Slope Angle = -18.400 degrees
Pile Batter = 0.000 degrees
Effective Slope = -18.400 degrees
Pile Diameter, b = 18.000 in
Angle of Friction = 30.000 degrees
Avg. Eff. Unit Weight = 78.10000 pcf
kpy = 60.000 pci
K active = 0.333
K passive = 3.000
K0 = 0.400
Pst = 1825.578 lb/in
Psd = 11224.972 lb/in

```

```

Liq_Abut2_Cap_Run2_Long.lp7o
Ps = Pst (shallow controls) = 1825.578 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 1897.9320
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 1849.9189
Yk = [c/(kx)]^(n/(n-1)) = 0.0103 in
Pk = 117.378 lb/in
Ym = b/60 = 0.3000 in
Pm = B ps = 912.789 lb/in
Yu = 3b/80 = 0.6750 in
Pu = A Ps = 1606.509 lb/in
Es, lim = 11417.480 lb/in/in
p-multiplier = 1.00000
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.01028	117.37797	*
0.03662	254.10423	
0.06296	353.26339	
0.08929	436.90135	
0.11563	511.25145	
0.14197	579.18648	
0.16831	642.32443	
0.19465	701.68775	
0.22099	757.97337	
0.24732	811.68263	
0.27366	863.19105	
0.30000	912.78894	
0.48750	1259.64873	
0.67500	1606.50852	
0.69188	1606.50852	
0.70875	1606.50852	

* p value(s) computed using $p = k * \text{Eff} * y$

 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 = -7500.0 lbs
Applied moment at pile head = -364800.0 in-lbs
Axial thrust load on pile head = 88300.0 lbs

```

Depth	Deflect.	Bending	Shear	Slope	Total	Bending	Soil
Res. Soil	Spr. Distrib.	Moment	Force	S	Stress	Stiffness	p
X	y						
Es*h	Lat. Load						

		Liq_Abut2_Cap_Run2_Long.lp7o					
feet	inches	in-lbs	lbs	radians	psi*	lb-in^2	lb/in
lb/inch	lb/inch						
0.00	-0.1933	-364800.	-7500.0000	0.002592	3465.5865	3.194E+10	
85.4275	1326.0488	0.000					
1.000	-0.1630	-451138.	-6415.4678	0.002439	4203.5160	3.194E+10	
95.1516	3501.8462	0.000					
2.000	-0.1348	-523608.	-5222.9831	0.002255	4822.9167	3.194E+10	
103.4040	4601.7116	0.000					
3.000	-0.1090	-580994.	-3940.9789	0.002048	5313.3955	3.194E+10	
110.0547	6059.4560	0.000					
4.000	-0.0857	-622317.	-2588.8861	0.001821	5666.5827	3.194E+10	
115.1715	8059.5618	0.000					
5.000	-0.0653	-646317.	-1056.1926	0.001582	5871.7140	3.194E+10	
133.2627	12243.	0.000					
6.000	-0.0478	-650893.	557.8648	0.001338	5910.8262	3.194E+10	
135.4164	17004.	0.000					
7.000	-0.0332	-635736.	2181.1266	0.001096	5781.2776	3.194E+10	
134.7512	24362.	0.000					
8.000	-0.0215	-600951.	3777.2179	0.000863	5483.9721	3.194E+10	
130.8188	36586.	0.000					
9.000	-0.0124	-547126.	5302.6708	0.000647	5023.9248	3.194E+10	
122.8457	59325.	0.000					
10.000	-0.005857	-475444.	6733.3816	0.000454	4411.2582	3.194E+10	
120.3130	123255.	0.000					
11.000	-0.001428	-387403.	7822.5382	0.000292	3658.7766	3.194E+10	
59.4309	249683.	0.000					
12.000	0.001256	-291810.	7786.9002	0.000164	2841.7389	3.194E+10	
-61.3356	292979.	0.000					
13.000	0.002622	-203874.	6775.7619	7.155E-05	2090.1465	3.194E+10	
-99.1666	226916.	0.000					
14.000	0.003065	-129952.	5526.9242	9.182E-06	1458.3349	3.194E+10	
-107.2185	209901.	0.000					
15.000	0.002917	-71324.	4250.0285	-2.827E-05	957.2429	3.194E+10	
-104.6085	215152.	0.000					
16.000	0.002444	-27676.	3044.2980	-4.653E-05	584.1809	3.194E+10	
-95.7470	235076.	0.000					
17.000	0.001842	2229.9561	1968.9675	-5.101E-05	366.6972	3.194E+10	
-83.1212	270796.	0.000					
18.000	0.001246	20184.	1058.8678	-4.654E-05	520.1522	3.194E+10	
-68.3790	329198.	0.000					
19.000	0.000739	28293.	332.2241	-3.723E-05	589.4548	3.194E+10	
-52.6603	427499.	0.000					
20.000	0.000357	28809.	-203.6074	-2.635E-05	593.8708	3.194E+10	
-36.6195	614867.	0.000					
21.000	0.000104	24046.	-502.2760	-1.632E-05	553.1610	3.194E+10	
-6.0576	349470.	0.000					
22.000	-4.116E-05	17772.	-520.0373	-8.461E-06	499.5359	3.194E+10	
2.4467	356670.	0.000					
23.000	-0.000106	11802.	-463.8874	-2.921E-06	448.5138	3.194E+10	
6.4336	363870.	0.000					
24.000	-0.000118	6726.3432	-379.8003	5.360E-07	405.1279	3.194E+10	
7.2690	371070.	0.000					
25.000	-9.836E-05	2677.1987	-297.9785	2.279E-06	370.5198	3.194E+10	
6.2011	378270.	0.000					
26.000	-6.686E-05	-487.5120	-193.6612	2.673E-06	351.8046	3.194E+10	
17.9840	1613823.	0.000					
27.000	-3.683E-05	-1846.0076	-62.3041	2.204E-06	363.4156	3.194E+10	
7.9869	1301059.	0.000					
28.000	-1.480E-05	-2056.5684	21.2592	1.448E-06	365.2153	3.194E+10	
5.8950	2389503.	0.000					
29.000	-1.806E-06	-1541.9475	48.0190	7.669E-07	360.8168	3.194E+10	

Liq_Abut2_Cap_Run2_Long.lp7o

0.3339	1109534.	0.000				
30.000	4.252E-06	-967.0575	44.5247	2.967E-07	355.9032	3.194E+10
-0.7862	1109534.	0.000				
31.000	5.917E-06	-497.7382	32.7960	2.491E-08	351.8920	3.194E+10
-1.0941	1109534.	0.000				
32.000	5.293E-06	-182.0350	20.1580	-9.920E-08	349.1936	3.194E+10
-0.9788	1109534.	0.000				
33.000	3.809E-06	-5.8351	10.0102	-1.316E-07	347.6877	3.194E+10
-0.7043	1109534.	0.000				
34.000	2.270E-06	68.9903	3.2919	-1.179E-07	348.2275	3.194E+10
-0.4197	1109534.	0.000				
35.000	1.025E-06	82.8330	-0.3124	-8.834E-08	348.3458	3.194E+10
-0.1895	1109534.	0.000				
36.000	1.454E-07	68.7371	-1.5621	-5.952E-08	348.2253	3.194E+10
-0.0269	1109534.	0.000				
37.000	-4.250E-07	50.2265	-1.2150	-3.728E-08	348.0671	3.194E+10
0.0786	1109534.	0.000				
38.000	-7.657E-07	38.7209	-0.9205	-2.059E-08	347.9687	3.194E+10
0.007640	59865.	0.000				
39.000	-9.316E-07	28.2875	-0.8139	-8.030E-09	347.8796	3.194E+10
0.009966	64185.	0.000				
40.000	-9.695E-07	19.2669	-0.6868	8.687E-10	347.8025	3.194E+10
0.0111	68505.	0.000				
41.000	-9.200E-07	11.8234	-0.5527	6.672E-09	347.7388	3.194E+10
0.0112	72825.	0.000				
42.000	-8.168E-07	5.9763	-0.4222	9.979E-09	347.6889	3.194E+10
0.0105	77145.	0.000				
43.000	-6.862E-07	1.6344	-0.3030	1.138E-08	347.6518	3.194E+10
0.009317	81465.	0.000				
44.000	-5.479E-07	-1.3691	-0.2000	1.140E-08	347.6495	3.194E+10
0.007834	85785.	0.000				
45.000	-4.154E-07	-3.2450	-0.1155	1.051E-08	347.6655	3.194E+10
0.006239	90105.	0.000				
46.000	-2.974E-07	-4.2208	-0.0501	9.085E-09	347.6739	3.194E+10
0.004680	94425.	0.000				
47.000	-1.981E-07	-4.5199	-0.002567	7.429E-09	347.6764	3.194E+10
0.003260	98745.	0.000				
48.000	-1.191E-07	-4.3458	0.0291	5.754E-09	347.6749	3.194E+10
0.002046	103065.	0.000				
49.000	-5.961E-08	-3.8732	0.0476	4.205E-09	347.6709	3.194E+10
0.001067	107385.	0.000				
50.000	-1.754E-08	-3.2433	0.0558	2.866E-09	347.6655	3.194E+10
0.000327	111705.	0.000				
51.000	9.917E-09	-2.5631	0.0564	1.775E-09	347.6597	3.194E+10
-0.000192	116025.	0.000				
52.000	2.581E-08	-1.9078	0.0520	9.359E-10	347.6541	3.194E+10
-0.000518	120345.	0.000				
53.000	3.308E-08	-1.3248	0.0447	3.306E-10	347.6491	3.194E+10
-0.000687	124665.	0.000				
54.000	3.435E-08	-0.8392	0.0361	-7.353E-11	347.6450	3.194E+10
-0.000738	128985.	0.000				
55.000	3.180E-08	-0.4589	0.0274	-3.150E-10	347.6417	3.194E+10
-0.000707	133305.	0.000				
56.000	2.716E-08	-0.1797	0.0194	-4.327E-10	347.6393	3.194E+10
-0.000623	137625.	0.000				
57.000	2.168E-08	0.0101	0.0125	-4.626E-10	347.6379	3.194E+10
-0.000513	141945.	0.000				
58.000	1.623E-08	0.1262	0.007079	-4.354E-10	347.6389	3.194E+10
-0.000396	146265.	0.000				
59.000	1.133E-08	0.1851	0.003008	-3.758E-10	347.6394	3.194E+10
-0.000284	150585.	0.000				
60.000	7.250E-09	0.2029	0.000191	-3.021E-10	347.6395	3.194E+10
-0.000187	154905.	0.000				

		Liq_Abut2_Cap_Run2_Long.lp7o				
61.000	4.080E-09	0.1935	-0.001567	-2.271E-10	347.6394	3.194E+10
-0.000108	159225.	0.000				
62.000	1.778E-09	0.1683	-0.002493	-1.589E-10	347.6392	3.194E+10
-4.846E-05	163545.	0.000				
63.000	2.327E-10	0.1358	-0.002811	-1.017E-10	347.6390	3.194E+10
-6.510E-06	167865.	0.000				
64.000	-7.002E-10	0.1023	-0.002719	-5.697E-11	347.6387	3.194E+10
2.009E-05	172185.	0.000				
65.000	-1.171E-09	0.0714	-0.002383	-2.442E-11	347.6384	3.194E+10
3.445E-05	176505.	0.000				
66.000	-1.319E-09	0.0455	-0.001933	-2.585E-12	347.6382	3.194E+10
3.974E-05	180825.	0.000				
67.000	-1.259E-09	0.0251	-0.001457	1.054E-11	347.6380	3.194E+10
3.886E-05	185145.	0.000				
68.000	-1.085E-09	0.0104	-0.001017	1.709E-11	347.6379	3.194E+10
3.427E-05	189465.	0.000				
69.000	-8.630E-10	0.000496	-0.000643	1.902E-11	347.6378	3.194E+10
2.787E-05	193785.	0.000				
70.000	-6.374E-10	-0.005357	-0.000350	1.803E-11	347.6378	3.194E+10
2.105E-05	198105.	0.000				
71.000	-4.351E-10	-0.008173	-0.000136	1.543E-11	347.6379	3.194E+10
1.468E-05	202425.	0.000				
72.000	-2.691E-10	-0.008863	7.031E-06	1.218E-11	347.6379	3.194E+10
9.271E-06	206745.	0.000				
73.000	-1.426E-10	-0.008204	9.187E-05	8.954E-12	347.6379	3.194E+10
5.016E-06	211065.	0.000				
74.000	-5.293E-11	-0.006809	0.000133	6.122E-12	347.6379	3.194E+10
1.900E-06	215385.	0.000				
75.000	6.107E-12	-0.005129	0.000142	3.876E-12	347.6378	3.194E+10
-2.236E-07	219705.	0.000				
76.000	4.201E-11	-0.003472	0.000131	2.264E-12	347.6378	3.194E+10
-1.569E-06	224025.	0.000				
77.000	6.220E-11	-0.002035	0.000107	1.236E-12	347.6378	3.194E+10
-2.367E-06	228345.	0.000				
78.000	7.311E-11	-0.000935	7.537E-05	0.000	347.6378	3.194E+10
-2.835E-06	232665.	0.000				
79.000	7.969E-11	-0.000241	3.941E-05	0.000	347.6378	3.194E+10
-3.148E-06	236985.	0.000				
80.000	8.506E-11	0.000	0.000	0.000	347.6378	3.194E+10
-3.421E-06	120652.	0.000				

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	-0.1932679 inches
Computed slope at pile head	=	0.0025925 radians
Maximum bending moment	=	-651061. inch-lbs
Maximum shear force	=	7985.8689847 lbs
Depth of maximum bending moment	=	5.5000000 feet below pile head
Depth of maximum shear force	=	11.5000000 feet below pile head
Number of iterations	=	22
Number of zero deflection points	=	7

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs

Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians

Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian

Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs

Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head Condition 1		Pile-head Condition 2		Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
		Maximum Shear in Pile lbs	Pile-head V(lbs) or y(inches)	Pile-head Rotation or in-lb/rad. radians	Pile-head in-lb, rad., or in-lb/rad.			
1	1	V = -7500.0000		M = -364800.		88300.	-0.19326789	
-651061.		7985.8690		0.00259248				

Computed Pile-head Stiffness Matrix Values
K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

$$K22 = \text{abs}(\text{Shear Reaction/Top } y)$$

$$K32 = \text{abs}(\text{Moment Reaction/Top } y)$$

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
-0.000322	0.00000	750.000000	14859.	2326213.	46087831.
-0.002802	0.00000	2781.952471	81114.	992936.	28951288.
-0.005724	0.00000	3970.568469	132119.	693718.	23083168.
-0.008427	0.00000	4813.904941	171838.	571232.	20390828.
-0.010901	0.00000	5468.047529	204312.	501596.	18741944.
-0.013189	0.00000	6002.520940	231861.	455114.	17579812.
-0.015352	0.00000	6454.411770	255811.	420438.	16663445.
-0.017352	0.00000	6845.857412	277072.	394535.	15967976.
-0.019207	0.00000	7191.136939	296209.	374393.	15421552.
-0.020934	0.00000	7500.000000	313614.	358269.	14981089.

The K23 and K33 stiffnesses are computed using the zero displacement and moment pile-head condition.

$$K23 = \text{abs}(\text{Shear Reaction/Top Rotation})$$

$$K33 = \text{abs}(\text{Moment Reaction/Top Rotation})$$

Pile-Top Deflection	Pile-Top Rotation	Pile-Top Shear Reac.	Pile-Top Mom. Reac.	K23 V/rot.	K33 M/rot.

inches	radians	Liq_Abut2_Cap_Run2_Long.lp7o			
		lbs	in-lbs	lb/rad	in-lb/rad
0.00000	0.00001767	1126.194150	36480.	63722712.	2064124143.
0.00000	0.00007041	3838.008604	135314.	54507445.	1921733455.
0.00000	0.000108	5031.619105	193128.	46584846.	1788064434.
0.00000	0.000136	5823.994995	234148.	42679279.	1715880973.
0.00000	0.000159	6411.154959	265966.	40197471.	1667586235.
0.00000	0.000179	6877.125406	291963.	38435503.	1631747181.
0.00000	0.000196	7263.694780	313943.	37133809.	1604952382.
0.00000	0.000210	7592.678009	332983.	36089135.	1582715686.
0.00000	0.000224	7879.184434	349777.	35242998.	1564525700.
0.00000	0.000236	8129.366876	364800.	34507376.	1548495840.

The analysis ended normally.

Liq_Bents_Run2_Long.lp7o

LPile Plus for Windows, Version 2013-07.004

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

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USACE-Memphis

Serial Number of Security Device: 158120475

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Files Used for Analysis

Path to file locations: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\lpileRuns_10272015\Bents\Liq_Long\
Name of input data file: Liq_Bents_Run2_Long.lp7d
Name of output report file: Liq_Bents_Run2_Long.lp7o
Name of plot output file: Liq_Bents_Run2_Long.lp7p
Name of runtime message file: Liq_Bents_Run2_Long.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 17:06:35

Problem Title

Bents Row #1: 24-inch Static with p-multipliers Trans

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 22-BMG-14

 Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

 Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	80.000000	24.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	24.00000 in
Bottom Width	=	24.00000 in
Top Area	=	452.00000 Sq. in
Bottom Area	=	452.00000 Sq. in
Moment of Inertia at Top	=	2552.00000 in ⁴
Moment of Inertia at Bottom	=	2552.00000 in ⁴
Elastic Modulus	=	30805000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 7 layers

Layer 1 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	2.00000 ft
Effective unit weight at top of layer	=	52.00000 pcf
Effective unit weight at bottom of layer	=	52.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000
Subgrade k at top of layer	=	100.00000 pci
Subgrade k at bottom of layer	=	100.00000 pci

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	2.00000 ft
Distance from top of pile to bottom of layer	=	6.00000 ft
Effective unit weight at top of layer	=	55.00000 pcf

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Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	667.00000	psf
Undrained cohesion at bottom of layer	=	667.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	6.00000	ft
Distance from top of pile to bottom of layer	=	11.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	59.00000	psf
Undrained cohesion at bottom of layer	=	59.00000	psf
Epsilon-50 at top of layer	=	0.03000	
Epsilon-50 at bottom of layer	=	0.03000	

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	11.00000	ft
Distance from top of pile to bottom of layer	=	22.50000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	412.00000	psf
Undrained cohesion at bottom of layer	=	412.00000	psf
Epsilon-50 at top of layer	=	0.02000	
Epsilon-50 at bottom of layer	=	0.02000	

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	22.50000	ft
Distance from top of pile to bottom of layer	=	42.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

Layer 6 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	42.00000	ft
Distance from top of pile to bottom of layer	=	53.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	627.00000	psf
Undrained cohesion at bottom of layer	=	627.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 7 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	53.00000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.

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Subgrade k at top of layer = 60.00000 pci
 Subgrade k at bottom of layer = 60.00000 pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

 Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Criteria) Epsilon 50	Layer Soil Type kpy pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay with Free Water		0.00	52.000	750.000
--	0.01000	100.000	2.000	52.000	750.000
--	0.01000	100.000	2.000	55.000	667.000
2	Soft Clay	--	6.000	55.000	667.000
--	0.01000	--	6.000	71.000	59.000
3	Soft Clay	--	11.000	71.000	59.000
--	0.03000	--	11.000	62.000	412.000
4	Soft Clay	--	22.500	62.000	412.000
--	0.02000	--	22.500	62.000	--
5	Sand (Reese, et al.)	60.000	42.000	62.000	--
30.000	--	60.000	42.000	62.000	627.000
6	Soft Clay	--	53.000	62.000	627.000
--	0.01000	--	53.000	62.000	--
7	Sand (Reese, et al.)	60.000	90.000	62.000	--
30.000	--	60.000			
30.000	--	60.000			

 p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.9750	1.0000
2	90.000	0.9750	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 1000.00000 lbs	M = 543600. in-lbs	148500.

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000

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19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

 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

 p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Diameter	=	24.000 in
c (at curve depth)	=	5.208 lb/in**2
Average cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.235
Ac (not used)	=	0.20000
pct	=	250.000 lb/in
pcd	=	1375.000 lb/in
pc	=	250.000 lb/in
pu	=	1.553 lb/in
p-multiplier	=	0.97500
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.02814	0.0000
0.05628	0.0000
0.08442	0.0000
0.11256	0.0000
0.14070	0.0000
0.16884	0.0000
0.19698	0.0000
0.22512	0.0000
0.25326	0.0000
0.28140	0.0000
0.30954	0.0000
0.33768	0.0000

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0.56280	0.0000
0.78792	0.0000
1.01304	0.0000
1.06932	0.0000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	2
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Transition Depth Xr	=	18.553 ft
Equivalent Depth of p-y curve	=	0.126 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03009 pci
Avg. Eff. Unit Weight	=	52.00000 pcf
Cohesion, c	=	4.920 psi
Cohesion, c	=	708.500 psf
Epsilon50 parameter	=	0.0100
J (default value)	=	0.5000
Static pu_s for flat ground	=	359.066 lb/in
Static pu_d for flat ground	=	1062.750 lb/in
y_50	=	0.60000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	359.066 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00142	23.33926
0.01138	46.67852
0.03840	70.01778
0.09102	93.35705
0.17778	116.69631
0.30720	140.03557
0.48782	163.37483
0.72818	186.71410
1.03680	210.05336
1.42222	233.39262
1.89298	256.73187
2.45760	280.07114
3.12462	303.41040
3.90258	326.74966
4.80000	350.08892
5.10000	350.08891

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Transition Depth Xr	=	18.170 ft

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Equivalent Depth of p-y curve	=	2.126	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter	=	24.000	in
Avg. Eff. Unit Weight	=	0.03096	pci
Avg. Eff. Unit Weight	=	53.50000	pcf
Cohesion, c	=	4.632	psi
Cohesion, c	=	667.000	psf
Epsilon50 parameter	=	0.0100	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	411.546	lb/in
Static pu_d for flat ground	=	1000.500	lb/in
y_50	=	0.60000	in
p-multiplier	=	0.975	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	411.546	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00142	26.75047
0.01138	53.50094
0.03840	80.25141
0.09102	107.00188
0.17778	133.75235
0.30720	160.50282
0.48782	187.25329
0.72818	214.00377
1.03680	240.75424
1.42222	267.50471
1.89298	294.25517
2.45760	321.00565
3.12462	347.75612
3.90258	374.50659
4.80000	401.25706
5.10000	401.25705

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft
Transition Depth Xr	=	15.047 ft
Equivalent Depth of p-y curve	=	5.800 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03125 pci
Avg. Eff. Unit Weight	=	54.00000 pcf
Cohesion, c	=	2.521 psi
Cohesion, c	=	363.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	321.430 lb/in

```

Liq_Bents_Run2_Long.lp7o
Static pu_d for flat ground = 544.500 lb/in
y_50 = 1.20000 in
p-multiplier = 0.975
y-multiplier = 1.000
Positive-y Sloping Ground Factor = 1.000
Negative-y Sloping Ground Factor = 1.000
Sloping Ground Factor = 1.000
Positive-y, static pu = 321.430 lb/in

```

y, in	p, lb/in
0.0000	0.0000
0.00284	20.89297
0.02276	41.78594
0.07680	62.67891
0.18204	83.57189
0.35556	104.46486
0.61440	125.35782
0.97564	146.25079
1.45636	167.14377
2.07360	188.03674
2.84444	208.92971
3.78596	229.82268
4.91520	250.71565
6.24924	271.60863
7.80516	292.50159
9.60000	313.39456
10.20000	313.39456

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```

Soil Layer Number = 3
Depth below pile head = 8.000 ft
Depth below ground surface = 8.000 ft
Transition Depth Xr = 5.000 ft
Equivalent Depth of p-y curve = 8.000 ft
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter = 24.000 in
Avg. Eff. Unit Weight = 0.03371 pci
Avg. Eff. Unit Weight = 58.25000 pcf
Cohesion, c = 0.410 psi
Cohesion, c = 59.000 psf
Epsilon50 parameter = 0.0300
J (default value) = 0.5000
Static pu_s for flat ground = 126.833 lb/in
Static pu_d for flat ground = 88.500 lb/in
y_50 = 1.80000 in
p-multiplier = 0.975
y-multiplier = 1.000
Positive-y Sloping Ground Factor = 1.000
Negative-y Sloping Ground Factor = 1.000
Sloping Ground Factor = 1.000
Positive-y, static pu = 88.500 lb/in

```

y, in	p, lb/in
0.0000	0.0000
0.00427	5.75250
0.03413	11.50500
0.11520	17.25750

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0.27307	23.01000
0.53333	28.76250
0.92160	34.51500
1.46347	40.26750
2.18453	46.02000
3.11040	51.77250
4.26667	57.52500
5.67893	63.27750
7.37280	69.03000
9.37387	74.78250
11.70773	80.53500
14.40000	86.28750
15.30000	86.28750

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Transition Depth Xr	=	5.000 ft
Equivalent Depth of p-y curve	=	10.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03519 pci
Avg. Eff. Unit Weight	=	60.80000 pcf
Cohesion, c	=	0.410 psi
Cohesion, c	=	59.000 psf
Epsilon50 parameter	=	0.0300
J (default value)	=	0.5000
Static pu_s for flat ground	=	155.417 lb/in
Static pu_d for flat ground	=	88.500 lb/in
y_50	=	1.80000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	88.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00427	5.75250
0.03413	11.50500
0.11520	17.25750
0.27307	23.01000
0.53333	28.76250
0.92160	34.51500
1.46347	40.26750
2.18453	46.02000
3.11040	51.77250
4.26667	57.52500
5.67893	63.27750
7.37280	69.03000
9.37387	74.78250
11.70773	80.53500
14.40000	86.28750
15.30000	86.28750

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	12.000 ft
Depth below ground surface	=	12.000 ft
Transition Depth Xr	=	15.005 ft
Equivalent Depth of p-y curve	=	10.137 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03573 pci
Avg. Eff. Unit Weight	=	61.75000 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	484.356 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	484.356 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	31.48312
0.02276	62.96625
0.07680	94.44937
0.18204	125.93249
0.35556	157.41562
0.61440	188.89874
0.97564	220.38186
1.45636	251.86500
2.07360	283.34811
2.84444	314.83124
3.78596	346.31435
4.91520	377.79748
6.24924	409.28061
7.80516	440.76372
9.60000	472.24685
10.20000	472.24684

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Transition Depth Xr	=	15.001 ft
Equivalent Depth of p-y curve	=	12.137 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03576 pci

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Avg. Eff. Unit Weight = 61.78571 pcf
Cohesion, c = 2.861 psi
Cohesion, c = 412.000 psf
Epsilon50 parameter = 0.0200
J (default value) = 0.5000
Static pu_s for flat ground = 539.345 lb/in
Static pu_d for flat ground = 618.000 lb/in
y_50 = 1.20000 in
p-multiplier = 0.975
y-multiplier = 1.000
Positive-y Sloping Ground Factor = 1.000
Negative-y Sloping Ground Factor = 1.000
Sloping Ground Factor = 1.000
Positive-y, static pu = 539.345 lb/in

```

y, in	p, lb/in
0.0000	0.0000
0.00284	35.05740
0.02276	70.11481
0.07680	105.17220
0.18204	140.22961
0.35556	175.28701
0.61440	210.34441
0.97564	245.40181
1.45636	280.45923
2.07360	315.51663
2.84444	350.57403
3.78596	385.63143
4.91520	420.68883
6.24924	455.74624
7.80516	490.80364
9.60000	525.86104
10.20000	525.86103

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```

Soil Layer Number = 4
Depth below pile head = 16.000 ft
Depth below ground surface = 16.000 ft
Transition Depth Xr = 14.999 ft
Equivalent Depth of p-y curve = 16.000 ft
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter = 24.000 in
Avg. Eff. Unit Weight = 0.03577 pci
Avg. Eff. Unit Weight = 61.81250 pcf
Cohesion, c = 2.861 psi
Cohesion, c = 412.000 psf
Epsilon50 parameter = 0.0200
J (default value) = 0.5000
Static pu_s for flat ground = 645.500 lb/in
Static pu_d for flat ground = 618.000 lb/in
y_50 = 1.20000 in
p-multiplier = 0.975
y-multiplier = 1.000
Positive-y Sloping Ground Factor = 1.000
Negative-y Sloping Ground Factor = 1.000
Sloping Ground Factor = 1.000
Positive-y, static pu = 618.000 lb/in

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Liq_Bents_Run2_Long.lp7o

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.00284	40.17000
0.02276	80.34000
0.07680	120.51000
0.18204	160.68001
0.35556	200.85000
0.61440	241.02000
0.97564	281.19000
1.45636	321.36002
2.07360	361.53001
2.84444	401.70002
3.78596	441.87001
4.91520	482.04001
6.24924	522.21002
7.80516	562.38001
9.60000	602.55001
10.20000	602.55000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	18.000 ft
Depth below ground surface	=	18.000 ft
Transition Depth Xr	=	14.997 ft
Equivalent Depth of p-y curve	=	18.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03578 pci
Avg. Eff. Unit Weight	=	61.83333 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	700.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.00284	40.17000
0.02276	80.34000
0.07680	120.51000
0.18204	160.68001
0.35556	200.85000
0.61440	241.02000
0.97564	281.19000
1.45636	321.36002
2.07360	361.53001
2.84444	401.70002
3.78596	441.87001
4.91520	482.04001

	Liq_Bents_Run2_Long.lp7o
6.24924	522.21002
7.80516	562.38001
9.60000	602.55001
10.20000	602.55000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	22.000 ft
Depth below ground surface	=	22.000 ft
Transition Depth Xr	=	14.994 ft
Equivalent Depth of p-y curve	=	22.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03580 pci
Avg. Eff. Unit Weight	=	61.86364 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	810.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

y, in	p, lb/in
0.00000	0.00000
0.00284	40.17000
0.02276	80.34000
0.07680	120.51000
0.18204	160.68001
0.35556	200.85000
0.61440	241.02000
0.97564	281.19000
1.45636	321.36002
2.07360	361.53001
2.84444	401.70002
3.78596	441.87001
4.91520	482.04001
6.24924	522.21002
7.80516	562.38001
9.60000	602.55001
10.20000	602.55000

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth (see note)	=	13.922 ft

```

Liq_Bents_Run2_Long.lp7o
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter, b = 24.000 in
Angle of Friction = 30.000 degrees
Avg. Eff. Unit Weight = 61.87500 pcf
kpy = 60.000 pci
K active = 0.333
K passive = 3.000
K0 = 0.400
Pst = 2293.304 lb/in
Psd = 7114.419 lb/in
Ps = Pst (shallow controls) = 2293.304 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 2001.6087
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 1742.9111
Yk = [c/(kx)]^(n/(n-1)) = 0.0164 in
Pk = 164.519 lb/in
Ym = b/60 = 0.4000 in
Pm = B ps = 1146.652 lb/in
Yu = 3b/80 = 0.9000 in
Pu = A Ps = 2018.108 lb/in
Es,lim = 10023.604 lb/in/in
p-multiplier = 0.97500
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.01641	160.40599	*
0.05128	320.66852	
0.08616	439.58014	
0.12103	540.47779	
0.15590	630.42440	
0.19077	712.74642	
0.22564	789.33892	
0.26051	861.40810	
0.29539	929.78027	
0.33026	995.05200	
0.36513	1057.67143	
0.40000	1117.98574	
0.65000	1542.82032	
0.90000	1967.65490	
0.92250	1967.65490	
0.94500	1967.65490	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```

Soil Layer Number = 5
Depth below pile head = 26.000 ft
Depth below ground surface = 26.000 ft
Equivalent Depth (see note) = 15.922 ft

```

```

Liq_Bents_Run2_Long.lp7o
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter, b = 24.000 in
Angle of Friction = 30.000 degrees
Avg. Eff. Unit Weight = 61.88462 pcf
kpy = 60.000 pci
K active = 0.333
K passive = 3.000
K0 = 0.400
Pst = 2937.106 lb/in
Psd = 7708.485 lb/in
Ps = Pst (shallow controls) = 2937.106 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 2563.5223
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 2232.2003
Yk = [c/(kx)]^(n/(n-1)) = 0.0219 in
Pk = 251.144 lb/in
Ym = b/60 = 0.4000 in
Pm = B ps = 1468.553 lb/in
Yu = 3b/80 = 0.9000 in
Pu = A Ps = 2584.653 lb/in
Es,lim = 11463.604 lb/in/in
p-multiplier = 0.97500
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in
0.0000	0.0000
0.02191	244.86554 *
0.05628	434.56708
0.09065	580.66690
0.12502	706.01452
0.15940	818.36669
0.19377	921.52936
0.22814	1017.71966
0.26251	1108.36905
0.29688	1194.46787
0.33126	1276.73648
0.36563	1355.71904
0.40000	1431.83900
0.65000	1975.93781
0.90000	2520.03663
0.92250	2520.03663
0.94500	2520.03663

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```

Soil Layer Number = 5
Depth below pile head = 28.000 ft
Depth below ground surface = 28.000 ft
Equivalent Depth (see note) = 17.922 ft

```

```

Liq_Bents_Run2_Long.lp7o
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter, b = 24.000 in
Angle of Friction = 30.000 degrees
Avg. Eff. Unit Weight = 61.89286 pcf
kpy = 60.000 pci
K active = 0.333
K passive = 3.000
K0 = 0.400
Pst = 3659.908 lb/in
Psd = 8302.551 lb/in
Ps = Pst (shallow controls) = 3659.908 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 3194.3884
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 2781.5302
Yk = [c/(kx)]^(n/(n-1)) = 0.0284 in
Pk = 366.411 lb/in
Ym = b/60 = 0.4000 in
Pm = B ps = 1829.954 lb/in
Yu = 3b/80 = 0.9000 in
Pu = A Ps = 3220.719 lb/in
Es,lim = 12903.604 lb/in/in
p-multiplier = 0.97500
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02840	357.25027	*
0.06218	575.33952	
0.09596	749.03857	
0.12974	899.80092	
0.16352	1035.74074	
0.19731	1161.01772	
0.23109	1278.11590	
0.26487	1388.66514	
0.29865	1493.80602	
0.33244	1594.37526	
0.36622	1691.00908	
0.40000	1784.20527	
0.65000	2462.20326	
0.90000	3140.20125	
0.92250	3140.20125	
0.94500	3140.20125	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```

Soil Layer Number = 5
Depth below pile head = 30.000 ft
Depth below ground surface = 30.000 ft
Equivalent Depth (see note) = 19.922 ft

```

Liq_Bents_Run2_Long.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4461.715	lb/in
Psd	=	8896.617	lb/in
Ps = Pst (shallow controls)	=	4461.715	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	3894.2100	
n = $Pm/(m \ Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	3390.9034	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0359	in
Pk	=	515.432	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B \ ps$	=	2230.858	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A \ Ps$	=	3926.309	lb/in
Es,lim	=	14343.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.03593	502.54608	*
0.06903	747.41986	
0.10213	948.38543	
0.13523	1124.88202	
0.16832	1285.04307	
0.20142	1433.23331	
0.23452	1572.13034	
0.26761	1703.52282	
0.30071	1828.67866	
0.33381	1948.53697	
0.36690	2063.81733	
0.40000	2175.08611	
0.65000	3001.61883	
0.90000	3828.15154	
0.92250	3828.15154	
0.94500	3828.15154	

* p value(s) computed using $p = k * Eff \ x \ * \ y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	32.000 ft
Depth below ground surface	=	32.000 ft
Equivalent Depth (see note)	=	21.922 ft


```

Liq_Bents_Run2_Long.lp7o
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter, b = 24.000 in
Angle of Friction = 30.000 degrees
Avg. Eff. Unit Weight = 61.90625 pcf
kpy = 60.000 pci
K active = 0.333
K passive = 3.000
K0 = 0.400
Pst = 5342.529 lb/in
Psd = 9490.683 lb/in
Ps = Pst (shallow controls) = 5342.529 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 4662.9889
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 4060.3217
Yk = [c/(kx)]^(n/(n-1)) = 0.0446 in
Pk = 703.614 lb/in
Ym = b/60 = 0.4000 in
Pm = B ps = 2671.264 lb/in
Yu = 3b/80 = 0.9000 in
Pu = A Ps = 4701.425 lb/in
Es, lim = 15783.604 lb/in/in
p-multiplier = 0.97500
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.04458	686.02338	*
0.07689	955.60230	
0.10920	1182.79736	
0.14151	1384.68507	
0.17382	1569.11218	
0.20613	1740.49117	
0.23844	1901.60772	
0.27076	2054.35931	
0.30307	2200.11028	
0.33538	2339.88219	
0.36769	2474.46444	
0.40000	2604.48271	
0.65000	3594.18613	
0.90000	4583.88955	
0.92250	4583.88955	
0.94500	4583.88955	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```

Soil Layer Number = 5
Depth below pile head = 34.000 ft
Depth below ground surface = 34.000 ft
Equivalent Depth (see note) = 23.922 ft

```

Liq_Bents_Run2_Long.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91176	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	6302.351	lb/in
Psd	=	10084.749	lb/in
Ps = Pst (shallow controls)	=	6302.351	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	5500.7270	
n = $Pm/(m \ Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	4789.7865	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0544	in
Pk	=	936.641	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	3151.175	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	5546.069	lb/in
Es, lim	=	17223.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.05438	913.22506	*
0.08580	1205.00398	
0.11722	1456.73335	
0.14864	1683.00277	
0.18006	1891.12208	
0.21148	2085.39967	
0.24290	2268.63830	
0.27432	2442.78752	
0.30574	2609.27096	
0.33716	2769.16737	
0.36858	2923.31831	
0.40000	3072.39596	
0.65000	4239.90642	
0.90000	5407.41687	
0.92250	5407.41687	
0.94500	5407.41687	

* p value(s) computed using $p = k * Eff \ x \ y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Equivalent Depth (see note)	=	25.922 ft

Liq_Bents_Run2_Long.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	7341.183	lb/in
Psd	=	10678.815	lb/in
Ps = Pst (shallow controls)	=	7341.183	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	6407.4254	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	5579.2988	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0654	in
Pk	=	1220.468	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	3670.591	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	6460.241	lb/in
Es, lim	=	18663.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.06539	1189.95598	*
0.09581	1501.03494	
0.12623	1774.99134	
0.15665	2023.97365	
0.18707	2254.57246	
0.21749	2470.85745	
0.24791	2675.55921	
0.27832	2870.61958	
0.30874	3057.48037	
0.33916	3237.24837	
0.36958	3410.79613	
0.40000	3578.82657	
0.65000	4938.78064	
0.90000	6298.73472	
0.92250	6298.73472	
0.94500	6298.73472	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	38.000 ft
Depth below ground surface	=	38.000 ft
Equivalent Depth (see note)	=	27.922 ft

```

Liq_Bents_Run2_Long.lp7o
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter, b = 24.000 in
Angle of Friction = 30.000 degrees
Avg. Eff. Unit Weight = 61.92105 pcf
kpy = 60.000 pci
K active = 0.333
K passive = 3.000
K0 = 0.400
Pst = 8459.026 lb/in
Psd = 11272.881 lb/in
Ps = Pst (shallow controls) = 8459.026 lb/in
A (static) = 0.8800
B (static) = 0.5000
C = Pm/(Ym^(1/n)) = 7383.0851
n = Pm/(m Ym) = 1.6447
m = (Pu-Pm)/(Yu-Ym) = 6428.8595
Yk = [c/(kx)]^(n/(n-1)) = 0.0777 in
Pk = 1561.306 lb/in
Ym = b/60 = 0.4000 in
Pm = B ps = 4229.513 lb/in
Yu = 3b/80 = 0.9000 in
Pu = A Ps = 7443.943 lb/in
Es,lim = 20103.604 lb/in/in
p-multiplier = 0.97500
y-multiplier = 1.00000

```

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.07766	1522.27368	*
0.10697	1849.37437	
0.13627	2142.68011	
0.16557	2412.06095	
0.19488	2663.27615	
0.22418	2900.04797	
0.25348	3124.95367	
0.28279	3339.86885	
0.31209	3546.21098	
0.34139	3745.08355	
0.37070	3937.36640	
0.40000	4123.77507	
0.65000	5690.80958	
0.90000	7257.84408	
0.92250	7257.84408	
0.94500	7257.84408	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```

Soil Layer Number = 5
Depth below pile head = 40.000 ft
Depth below ground surface = 40.000 ft
Equivalent Depth (see note) = 29.922 ft

```

Liq_Bents_Run2_Long.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	9655.881	lb/in
Psd	=	11866.947	lb/in
Ps = Pst (shallow controls)	=	9655.881	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
$C = Pm/(Ym^{(1/n)})$	=	8427.7069	
$n = Pm/(m Ym)$	=	1.6447	
$m = (Pu - Pm)/(Yu - Ym)$	=	7338.4694	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0912	in
Pk	=	1965.621	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B ps$	=	4827.940	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A Ps$	=	8497.175	lb/in
Es, lim	=	21543.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.09124	1916.48003	*
0.11931	2255.95219	
0.14738	2565.19400	
0.17545	2852.03129	
0.20352	3121.34488	
0.23159	3376.43185	
0.25965	3619.64841	
0.28772	3852.75060	
0.31579	4077.09046	
0.34386	4293.73635	
0.37193	4503.55065	
0.40000	4707.24192	
0.65000	6495.99383	
0.90000	8284.74573	
0.92250	8284.74573	
0.94500	8284.74573	

* p value(s) computed using $p = k * Eff * y$

Liq_Bents_Run2_Long.lp7o

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

Shear force at pile head = 1000.0 lbs
 Applied moment at pile head = 543600.0 in-lbs
 Axial thrust load on pile head = 148500.0 lbs

Depth Res.	Soil X	Deflect. Spr. y	Bending Distrib. Load	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil p
	Es*h feet lb/inch	Lat. inches lb/inch	Moment in-lbs	lbs	radians	psi*	lb-in^2	lb/in
0.000	0.00	0.0589	543600.	1000.0000	-0.000877	2884.6527	7.861E+10	
-57.2191	1.000	0.0489	555956.	639.5366	-0.000793	2942.7513	7.861E+10	
-70.9260	2.000	0.0399	560110.	-211.1044	-0.000708	2962.2876	7.861E+10	
-68.7172	3.000	0.0319	553765.	-1037.3587	-0.000623	2932.4508	7.861E+10	
-69.5196	4.000	0.0249	537384.	-1867.6517	-0.000539	2855.4248	7.861E+10	
-69.1317	5.000	0.0190	510857.	-2700.4735	-0.000459	2730.6898	7.861E+10	
-35.4768	6.000	0.0139	474248.	-3425.1294	-0.000384	2558.5451	7.861E+10	
-7.5752	7.000	0.009732	432200.	-3602.6379	-0.000315	2360.8283	7.861E+10	
-6.5683	8.000	0.006342	388944.	-3687.5459	-0.000252	2157.4316	7.861E+10	
-5.4719	9.000	0.003663	344638.	-3759.8799	-0.000196	1949.0936	7.861E+10	
-4.1692	10.000	0.001616	299451.	-3817.9694	-0.000147	1736.6177	7.861E+10	
-6.4186	11.000	0.000117	253589.	-3869.5795	-0.000105	1520.9646	7.861E+10	
21.5374	12.000	-0.000917	207670.	-3725.2682	-6.948E-05	1305.0460	7.861E+10	
27.2629	13.000	-0.001571	164733.	-3429.9883	-4.109E-05	1103.1453	7.861E+10	
30.7387	14.000	-0.001922	125657.	-3080.8368	-1.897E-05	919.4056	7.861E+10	
32.9747	15.000	-0.002043	90963.	-2697.7936	-2.482E-06	756.2672	7.861E+10	
35.6808	16.000	-0.001997	61063.	-2276.3176	9.072E-06	615.6703	7.861E+10	
34.7114	17.000	-0.001838	36278.	-1853.5208	1.645E-05	499.1257	7.861E+10	
33.2293	18.000	-0.001612	16477.	-1445.5474	2.043E-05	406.0162	7.861E+10	
31.3655	19.000	-0.001355	1452.4103	-1057.7333	2.176E-05	335.3693	7.861E+10	
29.2203	20.000	-0.001096	-9058.1848	-694.0393	2.113E-05	371.1332	7.861E+10	
26.8727	21.000	-0.000852	-15360.	-357.3547	1.923E-05	400.7678	7.861E+10	
24.3803	22.000	-0.000636	-17790.	-49.7429	1.667E-05	412.1931	7.861E+10	
	23.000	-0.000452	-17367.	63.9663	1.398E-05	410.2039	7.861E+10	

Liq_Bents_Run2_Long.lp7o

4.1028	54426.	0.000					
24.000	-0.000300	-16348.	106.1311	1.140E-05	405.4121	7.861E+10	
2.9345	58638.	0.000					
25.000	-0.000178	-14901.	134.8452	9.011E-06	398.6083	7.861E+10	
1.8660	62850.	0.000					
26.000	-8.328E-05	-13180.	151.5168	6.866E-06	390.5162	7.861E+10	
0.9308	67062.	0.000					
27.000	-1.254E-05	-11320.	157.8756	4.995E-06	381.7705	7.861E+10	
0.1490	71274.	0.000					
28.000	3.746E-05	-9434.4720	155.8197	3.411E-06	372.9025	7.861E+10	
-0.4713	75486.	0.000					
29.000	7.018E-05	-7612.4270	147.2816	2.111E-06	364.3349	7.861E+10	
-0.9322	79698.	0.000					
30.000	8.894E-05	-5921.1994	134.1191	1.080E-06	356.3825	7.861E+10	
-1.2438	83910.	0.000					
31.000	9.683E-05	-4406.2607	118.0310	2.932E-07	349.2589	7.861E+10	
-1.4221	88122.	0.000					
32.000	9.662E-05	-3093.8788	100.4998	-2.772E-07	343.0878	7.861E+10	
-1.4869	92334.	0.000					
33.000	9.073E-05	-1993.9413	82.7583	-6.635E-07	337.9157	7.861E+10	
-1.4599	96546.	0.000					
34.000	8.115E-05	-1103.0509	65.7777	-8.979E-07	333.7266	7.861E+10	
-1.3628	100758.	0.000					
35.000	6.954E-05	-407.6621	50.2717	-1.011E-06	330.4567	7.861E+10	
-1.2166	104970.	0.000					
36.000	5.716E-05	112.9233	36.7155	-1.032E-06	329.0708	7.861E+10	
-1.0401	109182.	0.000					
37.000	4.496E-05	483.8304	25.3715	-9.855E-07	330.8149	7.861E+10	
-0.8498	113394.	0.000					
38.000	3.364E-05	732.2367	16.3204	-8.917E-07	331.9829	7.861E+10	
-0.6595	117606.	0.000					
39.000	2.366E-05	885.3799	9.4938	-7.674E-07	332.7031	7.861E+10	
-0.4803	121818.	0.000					
40.000	1.528E-05	968.9440	4.7042	-6.254E-07	333.0960	7.861E+10	
-0.3209	126030.	0.000					
41.000	8.673E-06	1005.7887	1.6711	-4.743E-07	333.2692	7.861E+10	
-0.1883	130242.	0.000					
42.000	3.906E-06	1014.9615	-6.2910	-3.199E-07	333.3124	7.861E+10	
-2.1985	3377076.	0.000					
43.000	9.619E-07	815.7926	-22.0052	-1.784E-07	332.3758	7.861E+10	
-0.5414	3377076.	0.000					
44.000	-4.970E-07	530.8754	-23.0537	-7.559E-08	331.0361	7.861E+10	
0.2797	3377076.	0.000					
45.000	-9.789E-07	281.1703	-17.7621	-1.425E-08	329.8619	7.861E+10	
0.5510	3377076.	0.000					
46.000	-9.366E-07	108.1161	-11.1506	1.469E-08	329.0482	7.861E+10	
0.5272	3377076.	0.000					
47.000	-6.877E-07	9.9417	-5.6260	2.306E-08	328.5866	7.861E+10	
0.3870	3377076.	0.000					
48.000	-4.141E-07	-32.5938	-1.9184	2.091E-08	328.6931	7.861E+10	
0.2331	3377076.	0.000					
49.000	-1.964E-07	-41.2559	0.1125	1.504E-08	328.7338	7.861E+10	
0.1105	3377076.	0.000					
50.000	-5.244E-08	-33.6062	0.9230	9.241E-09	328.6978	7.861E+10	
0.0295	3377076.	0.000					
51.000	3.044E-08	-21.3852	0.9760	5.040E-09	328.6404	7.861E+10	
-0.0171	3377076.	0.000					
52.000	7.388E-08	-11.4274	0.6114	2.579E-09	328.5936	7.861E+10	
-0.0416	3377076.	0.000					
53.000	9.569E-08	-7.3480	0.1876	1.213E-09	328.5744	7.861E+10	
-0.002068	129659.	0.000					
54.000	1.040E-07	-5.2529	0.1611	2.541E-10	328.5645	7.861E+10	
-0.002321	133871.	0.000					

Liq_Bents_Run2_Long.lp7o						
55.000	1.027E-07	-3.4887	0.1328	-4.098E-10	328.5562	7.861E+10
-0.002363	138083.	0.000				
56.000	9.491E-08	-2.0624	0.1050	-8.303E-10	328.5495	7.861E+10
-0.002251	142295.	0.000				
57.000	8.332E-08	-0.9588	0.0793	-1.058E-09	328.5443	7.861E+10
-0.002035	146507.	0.000				
58.000	6.995E-08	-0.1473	0.0565	-1.140E-09	328.5405	7.861E+10
-0.001757	150719.	0.000				
59.000	5.628E-08	0.4114	0.0372	-1.117E-09	328.5418	7.861E+10
-0.001453	154931.	0.000				
60.000	4.334E-08	0.7608	0.0216	-1.026E-09	328.5434	7.861E+10
-0.001150	159143.	0.000				
61.000	3.177E-08	0.9442	0.009535	-8.946E-10	328.5443	7.861E+10
-0.000865	163355.	0.000				
62.000	2.192E-08	1.0025	0.000698	-7.450E-10	328.5445	7.861E+10
-0.000612	167567.	0.000				
63.000	1.390E-08	0.9720	-0.005333	-5.936E-10	328.5444	7.861E+10
-0.000398	171779.	0.000				
64.000	7.647E-09	0.8836	-0.009035	-4.516E-10	328.5440	7.861E+10
-0.000224	175991.	0.000				
65.000	3.010E-09	0.7623	-0.0109	-3.258E-10	328.5434	7.861E+10
-9.041E-05	180203.	0.000				
66.000	-2.311E-10	0.6275	-0.0114	-2.196E-10	328.5428	7.861E+10
7.104E-06	184415.	0.000				
67.000	-2.323E-09	0.4932	-0.0109	-1.342E-10	328.5421	7.861E+10
7.303E-05	188627.	0.000				
68.000	-3.510E-09	0.3691	-0.009734	-6.848E-11	328.5416	7.861E+10
0.000113	192839.	0.000				
69.000	-4.020E-09	0.2609	-0.008251	-2.057E-11	328.5410	7.861E+10
0.000132	197051.	0.000				
70.000	-4.049E-09	0.1715	-0.006634	1.225E-11	328.5406	7.861E+10
0.000136	201263.	0.000				
71.000	-3.762E-09	0.1015	-0.005040	3.290E-11	328.5403	7.861E+10
0.000129	205475.	0.000				
72.000	-3.287E-09	0.0500	-0.003573	4.431E-11	328.5401	7.861E+10
0.000115	209687.	0.000				
73.000	-2.719E-09	0.0150	-0.002300	4.913E-11	328.5399	7.861E+10
9.693E-05	213899.	0.000				
74.000	-2.121E-09	-0.006020	-0.001255	4.970E-11	328.5399	7.861E+10
7.710E-05	218111.	0.000				
75.000	-1.533E-09	-0.0160	-0.000452	4.793E-11	328.5399	7.861E+10
5.681E-05	222323.	0.000				
76.000	-9.734E-10	-0.0178	0.000109	4.529E-11	328.5399	7.861E+10
3.675E-05	226535.	0.000				
77.000	-4.456E-10	-0.0142	0.000432	4.281E-11	328.5399	7.861E+10
1.714E-05	230747.	0.000				
78.000	5.629E-11	-0.008242	0.000522	4.108E-11	328.5399	7.861E+10
-2.204E-06	234959.	0.000				
79.000	5.431E-10	-0.002560	0.000379	4.027E-11	328.5398	7.861E+10
-2.165E-05	239171.	0.000				
80.000	1.025E-09	0.000	0.000	4.012E-11	328.5398	7.861E+10
-4.157E-05	121692.	0.000				

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.0589287 inches
Computed slope at pile head	=	-0.0008770 radians
Maximum bending moment	=	560110. inch-lbs
Maximum shear force	=	-3869.5794615 lbs
Depth of maximum bending moment	=	2.0000000 feet below pile head

Liq_Bents_Run2_Long.lp7o

Depth of maximum shear force = 11.0000000 feet below pile head
 Number of iterations = 15
 Number of zero deflection points = 6

 Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
 Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
 Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
 Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
 Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head Condition 1 Maximum Shear V(lbs) or in Pile y(inches)	Pile-head Condition 2 Pile-head Rotation or in-lb, rad., or in-lb/rad. radians	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
1	1	V = 1000.0000 -3869.5795	M = 543600. -0.00087704	148500.	0.05892867	

 Computed Pile-head Stiffness Matrix Values
 K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)
 K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.00001950	0.000000	100.000000	2580.584745	5128917.	132356041.
0.000139	0.000000	370.926996	11761.	2666178.	84537074.
0.000256	0.000000	529.409129	17822.	2068178.	69622903.
0.000362	0.000000	641.853992	22377.	1773515.	61830397.
0.000457	0.000000	729.073004	26028.	1594463.	56922422.
0.000550	0.000000	800.336125	29174.	1454855.	53031736.
0.000631	0.000000	860.588236	31847.	1362771.	50430367.

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0.000713	0.00000	912.780988	34271.	1279457.	48038023.
0.000784	0.00000	958.818258	36416.	1222642.	46436541.
0.000850	0.00000	1000.000000	38342.	1175783.	45081558.

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)
K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
-----	-----	-----	-----	-----	-----
0.00000	0.00001836	981.240100	54360.	53449824.	2961082009.
0.00000	0.00009646	2655.673615	201636.	27532036.	2090410203.
0.00000	0.000150	3477.642594	287787.	23189784.	1919033809.
0.00000	0.000190	4026.059247	348912.	21177564.	1835318880.
0.00000	0.000222	4436.871559	396324.	19963386.	1783231857.
0.00000	0.000249	4764.746421	435063.	19131190.	1746843742.
0.00000	0.000272	5037.675543	467816.	18517691.	1719616057.
0.00000	0.000292	5270.272703	496188.	18031640.	1697650073.
0.00000	0.000310	5473.475554	521214.	17643967.	1680152826.
0.00000	0.000326	5653.377793	543600.	17315343.	1664955106.

The analysis ended normally.

Liq_BentsRow1_Run2_Transverse.lp7o

LPile Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\lpileRuns_10272015\Bents\Liq_trans\
Name of input data file: Liq_BentsRow1_Run2_Transverse.lp7d
Name of output report file: Liq_BentsRow1_Run2_Transverse.lp7o
Name of plot output file: Liq_BentsRow1_Run2_Transverse.lp7p
Name of runtime message file: Liq_BentsRow1_Run2_Transverse.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 17:12:00

Problem Title

Bents Row #1: 24-inch Static with p-multipliers Trans

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 22-BMG-14

 Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

 Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	80.000000	24.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	24.00000 in
Bottom Width	=	24.00000 in
Top Area	=	452.00000 Sq. in
Bottom Area	=	452.00000 Sq. in
Moment of Inertia at Top	=	2552.00000 in ⁴
Moment of Inertia at Bottom	=	2552.00000 in ⁴
Elastic Modulus	=	30805000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 7 layers

Layer 1 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	2.00000 ft
Effective unit weight at top of layer	=	52.00000 pcf
Effective unit weight at bottom of layer	=	52.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000
Subgrade k at top of layer	=	100.00000 pci
Subgrade k at bottom of layer	=	100.00000 pci

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	2.00000 ft
Distance from top of pile to bottom of layer	=	6.00000 ft
Effective unit weight at top of layer	=	55.00000 pcf

Liq_BentsRow1_Run2_Transverse.lp7o

Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	667.00000	psf
Undrained cohesion at bottom of layer	=	667.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	6.00000	ft
Distance from top of pile to bottom of layer	=	11.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	59.00000	psf
Undrained cohesion at bottom of layer	=	59.00000	psf
Epsilon-50 at top of layer	=	0.03000	
Epsilon-50 at bottom of layer	=	0.03000	

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	11.00000	ft
Distance from top of pile to bottom of layer	=	22.50000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	412.00000	psf
Undrained cohesion at bottom of layer	=	412.00000	psf
Epsilon-50 at top of layer	=	0.02000	
Epsilon-50 at bottom of layer	=	0.02000	

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	22.50000	ft
Distance from top of pile to bottom of layer	=	42.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

Layer 6 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	42.00000	ft
Distance from top of pile to bottom of layer	=	53.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	627.00000	psf
Undrained cohesion at bottom of layer	=	627.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 7 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	53.00000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.

Liq_BentsRow1_Run2_Transverse.lp7o

Subgrade k at top of layer = 60.00000 pci
 Subgrade k at bottom of layer = 60.00000 pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

 Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Criteria) Epsilon 50	Layer Soil Type kpy pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay with Free Water		0.00	52.000	750.000
--	0.01000	100.000	2.000	52.000	750.000
--	0.01000	100.000	2.000	55.000	667.000
2	Soft Clay	--	6.000	55.000	667.000
--	0.01000	--	6.000	71.000	59.000
3	Soft Clay	--	11.000	71.000	59.000
--	0.03000	--	11.000	62.000	412.000
4	Soft Clay	--	22.500	62.000	412.000
--	0.02000	--	22.500	62.000	--
5	Sand (Reese, et al.)	60.000	42.000	62.000	--
30.000	--	60.000	42.000	62.000	627.000
6	Soft Clay	--	53.000	62.000	627.000
--	0.01000	--	53.000	62.000	--
7	Sand (Reese, et al.)	60.000	90.000	62.000	--
30.000	--	60.000			
30.000	--	60.000			

 p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.9750	1.0000
2	90.000	0.9750	1.0000

 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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 1000.00000 lbs	M = 198000. in-lbs	137000.

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

 Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
 (Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000

Liq_BentsRow1_Run2_Transverse.lp7o

19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

 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

 p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Diameter	=	24.000 in
c (at curve depth)	=	5.208 lb/in**2
Average cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.235
Ac (not used)	=	0.20000
pct	=	250.000 lb/in
pcd	=	1375.000 lb/in
pc	=	250.000 lb/in
pu	=	1.553 lb/in
p-multiplier	=	0.97500
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.02814	0.0000
0.05628	0.0000
0.08442	0.0000
0.11256	0.0000
0.14070	0.0000
0.16884	0.0000
0.19698	0.0000
0.22512	0.0000
0.25326	0.0000
0.28140	0.0000
0.30954	0.0000
0.33768	0.0000

	Liq_BentsRow1_Run2_Transverse.lp7o
0.56280	0.0000
0.78792	0.0000
1.01304	0.0000
1.06932	0.0000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	2
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Transition Depth Xr	=	18.553 ft
Equivalent Depth of p-y curve	=	0.126 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03009 pci
Avg. Eff. Unit Weight	=	52.00000 pcf
Cohesion, c	=	4.920 psi
Cohesion, c	=	708.500 psf
Epsilon50 parameter	=	0.0100
J (default value)	=	0.5000
Static pu_s for flat ground	=	359.066 lb/in
Static pu_d for flat ground	=	1062.750 lb/in
y_50	=	0.60000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	359.066 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00142	23.33926
0.01138	46.67852
0.03840	70.01778
0.09102	93.35705
0.17778	116.69631
0.30720	140.03557
0.48782	163.37483
0.72818	186.71410
1.03680	210.05336
1.42222	233.39262
1.89298	256.73187
2.45760	280.07114
3.12462	303.41040
3.90258	326.74966
4.80000	350.08892
5.10000	350.08891

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Transition Depth Xr	=	18.170 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Equivalent Depth of p-y curve	=	2.126	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter	=	24.000	in
Avg. Eff. Unit Weight	=	0.03096	pci
Avg. Eff. Unit Weight	=	53.50000	pcf
Cohesion, c	=	4.632	psi
Cohesion, c	=	667.000	psf
Epsilon50 parameter	=	0.0100	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	411.546	lb/in
Static pu_d for flat ground	=	1000.500	lb/in
y_50	=	0.60000	in
p-multiplier	=	0.975	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	411.546	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00142	26.75047
0.01138	53.50094
0.03840	80.25141
0.09102	107.00188
0.17778	133.75235
0.30720	160.50282
0.48782	187.25329
0.72818	214.00377
1.03680	240.75424
1.42222	267.50471
1.89298	294.25517
2.45760	321.00565
3.12462	347.75612
3.90258	374.50659
4.80000	401.25706
5.10000	401.25705

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3	
Depth below pile head	=	6.000	ft
Depth below ground surface	=	6.000	ft
Transition Depth Xr	=	15.047	ft
Equivalent Depth of p-y curve	=	5.800	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter	=	24.000	in
Avg. Eff. Unit Weight	=	0.03125	pci
Avg. Eff. Unit Weight	=	54.00000	pcf
Cohesion, c	=	2.521	psi
Cohesion, c	=	363.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	321.430	lb/in

Liq_BentsRow1_Run2_Transverse.lp7o

Static pu_d for flat ground = 544.500 lb/in
y_50 = 1.20000 in
p-multiplier = 0.975
y-multiplier = 1.000
Positive-y Sloping Ground Factor = 1.000
Negative-y Sloping Ground Factor = 1.000
Sloping Ground Factor = 1.000
Positive-y, static pu = 321.430 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	20.89297
0.02276	41.78594
0.07680	62.67891
0.18204	83.57189
0.35556	104.46486
0.61440	125.35782
0.97564	146.25079
1.45636	167.14377
2.07360	188.03674
2.84444	208.92971
3.78596	229.82268
4.91520	250.71565
6.24924	271.60863
7.80516	292.50159
9.60000	313.39456
10.20000	313.39456

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number = 3
Depth below pile head = 8.000 ft
Depth below ground surface = 8.000 ft
Transition Depth Xr = 5.000 ft
Equivalent Depth of p-y curve = 8.000 ft
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter = 24.000 in
Avg. Eff. Unit Weight = 0.03371 pci
Avg. Eff. Unit Weight = 58.25000 pcf
Cohesion, c = 0.410 psi
Cohesion, c = 59.000 psf
Epsilon50 parameter = 0.0300
J (default value) = 0.5000
Static pu_s for flat ground = 126.833 lb/in
Static pu_d for flat ground = 88.500 lb/in
y_50 = 1.80000 in
p-multiplier = 0.975
y-multiplier = 1.000
Positive-y Sloping Ground Factor = 1.000
Negative-y Sloping Ground Factor = 1.000
Sloping Ground Factor = 1.000
Positive-y, static pu = 88.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00427	5.75250
0.03413	11.50500
0.11520	17.25750

	Liq_BentsRow1_Run2_Transverse.lp7o
0.27307	23.01000
0.53333	28.76250
0.92160	34.51500
1.46347	40.26750
2.18453	46.02000
3.11040	51.77250
4.26667	57.52500
5.67893	63.27750
7.37280	69.03000
9.37387	74.78250
11.70773	80.53500
14.40000	86.28750
15.30000	86.28750

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Transition Depth Xr	=	5.000 ft
Equivalent Depth of p-y curve	=	10.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03519 pci
Avg. Eff. Unit Weight	=	60.80000 pcf
Cohesion, c	=	0.410 psi
Cohesion, c	=	59.000 psf
Epsilon50 parameter	=	0.0300
J (default value)	=	0.5000
Static pu_s for flat ground	=	155.417 lb/in
Static pu_d for flat ground	=	88.500 lb/in
y_50	=	1.80000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	88.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00427	5.75250
0.03413	11.50500
0.11520	17.25750
0.27307	23.01000
0.53333	28.76250
0.92160	34.51500
1.46347	40.26750
2.18453	46.02000
3.11040	51.77250
4.26667	57.52500
5.67893	63.27750
7.37280	69.03000
9.37387	74.78250
11.70773	80.53500
14.40000	86.28750
15.30000	86.28750

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	12.000 ft
Depth below ground surface	=	12.000 ft
Transition Depth Xr	=	15.005 ft
Equivalent Depth of p-y curve	=	10.137 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03573 pci
Avg. Eff. Unit Weight	=	61.75000 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	484.356 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	484.356 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	31.48312
0.02276	62.96625
0.07680	94.44937
0.18204	125.93249
0.35556	157.41562
0.61440	188.89874
0.97564	220.38186
1.45636	251.86500
2.07360	283.34811
2.84444	314.83124
3.78596	346.31435
4.91520	377.79748
6.24924	409.28061
7.80516	440.76372
9.60000	472.24685
10.20000	472.24684

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Transition Depth Xr	=	15.001 ft
Equivalent Depth of p-y curve	=	12.137 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03576 pci

Liq_BentsRow1_Run2_Transverse.lp7o

Avg. Eff. Unit Weight	=	61.78571	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	539.345	lb/in
Static pu_d for flat ground	=	618.000	lb/in
y_50	=	1.20000	in
p-multiplier	=	0.975	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	539.345	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	35.05740
0.02276	70.11481
0.07680	105.17220
0.18204	140.22961
0.35556	175.28701
0.61440	210.34441
0.97564	245.40181
1.45636	280.45923
2.07360	315.51663
2.84444	350.57403
3.78596	385.63143
4.91520	420.68883
6.24924	455.74624
7.80516	490.80364
9.60000	525.86104
10.20000	525.86103

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Transition Depth Xr	=	14.999 ft
Equivalent Depth of p-y curve	=	16.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03577 pci
Avg. Eff. Unit Weight	=	61.81250 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	645.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

Liq_BentsRow1_Run2_Transverse.lp7o	
y, in	p, lb/in
-----	-----
0.0000	0.0000
0.00284	40.17000
0.02276	80.34000
0.07680	120.51000
0.18204	160.68001
0.35556	200.85000
0.61440	241.02000
0.97564	281.19000
1.45636	321.36002
2.07360	361.53001
2.84444	401.70002
3.78596	441.87001
4.91520	482.04001
6.24924	522.21002
7.80516	562.38001
9.60000	602.55001
10.20000	602.55000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	18.000 ft
Depth below ground surface	=	18.000 ft
Transition Depth Xr	=	14.997 ft
Equivalent Depth of p-y curve	=	18.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03578 pci
Avg. Eff. Unit Weight	=	61.83333 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	700.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.00284	40.17000
0.02276	80.34000
0.07680	120.51000
0.18204	160.68001
0.35556	200.85000
0.61440	241.02000
0.97564	281.19000
1.45636	321.36002
2.07360	361.53001
2.84444	401.70002
3.78596	441.87001
4.91520	482.04001

	Liq_BentsRow1_Run2_Transverse.lp7o
6.24924	522.21002
7.80516	562.38001
9.60000	602.55001
10.20000	602.55000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	22.000 ft
Depth below ground surface	=	22.000 ft
Transition Depth Xr	=	14.994 ft
Equivalent Depth of p-y curve	=	22.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03580 pci
Avg. Eff. Unit Weight	=	61.86364 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	810.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.975
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

y, in	p, lb/in
0.00000	0.00000
0.00284	40.17000
0.02276	80.34000
0.07680	120.51000
0.18204	160.68001
0.35556	200.85000
0.61440	241.02000
0.97564	281.19000
1.45636	321.36002
2.07360	361.53001
2.84444	401.70002
3.78596	441.87001
4.91520	482.04001
6.24924	522.21002
7.80516	562.38001
9.60000	602.55001
10.20000	602.55000

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth (see note)	=	13.922 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.87500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2293.304	lb/in
Psd	=	7114.419	lb/in
Ps = Pst (shallow controls)	=	2293.304	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	2001.6087	
n = $Pm/(m \cdot Ym)$	=	1.6447	
m = $(Pu - Pm)/(Yu - Ym)$	=	1742.9111	
Yk = $[c/(kx)]^{(n/(n-1))}$	=	0.0164	in
Pk	=	164.519	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	1146.652	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	2018.108	lb/in
Es, lim	=	10023.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.01641	160.40599	*
0.05128	320.66852	
0.08616	439.58014	
0.12103	540.47779	
0.15590	630.42440	
0.19077	712.74642	
0.22564	789.33892	
0.26051	861.40810	
0.29539	929.78027	
0.33026	995.05200	
0.36513	1057.67143	
0.40000	1117.98574	
0.65000	1542.82032	
0.90000	1967.65490	
0.92250	1967.65490	
0.94500	1967.65490	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	26.000 ft
Depth below ground surface	=	26.000 ft
Equivalent Depth (see note)	=	15.922 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.88462	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2937.106	lb/in
Psd	=	7708.485	lb/in
Ps = Pst (shallow controls)	=	2937.106	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	2563.5223	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	2232.2003	
Yk = [c/(kx)]^(n/(n-1))	=	0.0219	in
Pk	=	251.144	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	1468.553	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	2584.653	lb/in
Es,lim	=	11463.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02191	244.86554	*
0.05628	434.56708	
0.09065	580.66690	
0.12502	706.01452	
0.15940	818.36669	
0.19377	921.52936	
0.22814	1017.71966	
0.26251	1108.36905	
0.29688	1194.46787	
0.33126	1276.73648	
0.36563	1355.71904	
0.40000	1431.83900	
0.65000	1975.93781	
0.90000	2520.03663	
0.92250	2520.03663	
0.94500	2520.03663	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	28.000 ft
Depth below ground surface	=	28.000 ft
Equivalent Depth (see note)	=	17.922 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.89286	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3659.908	lb/in
Psd	=	8302.551	lb/in
Ps = Pst (shallow controls)	=	3659.908	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	3194.3884	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	2781.5302	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0284	in
Pk	=	366.411	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	1829.954	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	3220.719	lb/in
Es, lim	=	12903.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.02840	357.25027	*
0.06218	575.33952	
0.09596	749.03857	
0.12974	899.80092	
0.16352	1035.74074	
0.19731	1161.01772	
0.23109	1278.11590	
0.26487	1388.66514	
0.29865	1493.80602	
0.33244	1594.37526	
0.36622	1691.00908	
0.40000	1784.20527	
0.65000	2462.20326	
0.90000	3140.20125	
0.92250	3140.20125	
0.94500	3140.20125	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	30.000 ft
Depth below ground surface	=	30.000 ft
Equivalent Depth (see note)	=	19.922 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4461.715	lb/in
Psd	=	8896.617	lb/in
Ps = Pst (shallow controls)	=	4461.715	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	3894.2100	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	3390.9034	
Yk = [c/(kx)]^(n/(n-1))	=	0.0359	in
Pk	=	515.432	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	2230.858	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	3926.309	lb/in
Es,lim	=	14343.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.03593	502.54608	*
0.06903	747.41986	
0.10213	948.38543	
0.13523	1124.88202	
0.16832	1285.04307	
0.20142	1433.23331	
0.23452	1572.13034	
0.26761	1703.52282	
0.30071	1828.67866	
0.33381	1948.53697	
0.36690	2063.81733	
0.40000	2175.08611	
0.65000	3001.61883	
0.90000	3828.15154	
0.92250	3828.15154	
0.94500	3828.15154	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	32.000 ft
Depth below ground surface	=	32.000 ft
Equivalent Depth (see note)	=	21.922 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90625	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	5342.529	lb/in
Psd	=	9490.683	lb/in
Ps = Pst (shallow controls)	=	5342.529	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	4662.9889	
n = $Pm/(m \cdot Ym)$	=	1.6447	
m = $(Pu - Pm)/(Yu - Ym)$	=	4060.3217	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0446	in
Pk	=	703.614	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	2671.264	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	4701.425	lb/in
Es, lim	=	15783.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.04458	686.02338	*
0.07689	955.60230	
0.10920	1182.79736	
0.14151	1384.68507	
0.17382	1569.11218	
0.20613	1740.49117	
0.23844	1901.60772	
0.27076	2054.35931	
0.30307	2200.11028	
0.33538	2339.88219	
0.36769	2474.46444	
0.40000	2604.48271	
0.65000	3594.18613	
0.90000	4583.88955	
0.92250	4583.88955	
0.94500	4583.88955	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Equivalent Depth (see note)	=	23.922 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91176	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	6302.351	lb/in
Psd	=	10084.749	lb/in
Ps = Pst (shallow controls)	=	6302.351	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	5500.7270	
n = $Pm/(m \cdot Ym)$	=	1.6447	
m = $(Pu - Pm)/(Yu - Ym)$	=	4789.7865	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0544	in
Pk	=	936.641	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	3151.175	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	5546.069	lb/in
Es, lim	=	17223.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.05438	913.22506	*
0.08580	1205.00398	
0.11722	1456.73335	
0.14864	1683.00277	
0.18006	1891.12208	
0.21148	2085.39967	
0.24290	2268.63830	
0.27432	2442.78752	
0.30574	2609.27096	
0.33716	2769.16737	
0.36858	2923.31831	
0.40000	3072.39596	
0.65000	4239.90642	
0.90000	5407.41687	
0.92250	5407.41687	
0.94500	5407.41687	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Equivalent Depth (see note)	=	25.922 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	7341.183	lb/in
Psd	=	10678.815	lb/in
Ps = Pst (shallow controls)	=	7341.183	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	6407.4254	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	5579.2988	
Yk = [c/(kx)]^(n/(n-1))	=	0.0654	in
Pk	=	1220.468	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	3670.591	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	6460.241	lb/in
Es, lim	=	18663.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.06539	1189.95598	*
0.09581	1501.03494	
0.12623	1774.99134	
0.15665	2023.97365	
0.18707	2254.57246	
0.21749	2470.85745	
0.24791	2675.55921	
0.27832	2870.61958	
0.30874	3057.48037	
0.33916	3237.24837	
0.36958	3410.79613	
0.40000	3578.82657	
0.65000	4938.78064	
0.90000	6298.73472	
0.92250	6298.73472	
0.94500	6298.73472	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	38.000 ft
Depth below ground surface	=	38.000 ft
Equivalent Depth (see note)	=	27.922 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92105	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	8459.026	lb/in
Psd	=	11272.881	lb/in
Ps = Pst (shallow controls)	=	8459.026	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	7383.0851	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	6428.8595	
Yk = [c/(kx)]^(n/(n-1))	=	0.0777	in
Pk	=	1561.306	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	4229.513	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	7443.943	lb/in
Es, lim	=	20103.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.07766	1522.27368	*
0.10697	1849.37437	
0.13627	2142.68011	
0.16557	2412.06095	
0.19488	2663.27615	
0.22418	2900.04797	
0.25348	3124.95367	
0.28279	3339.86885	
0.31209	3546.21098	
0.34139	3745.08355	
0.37070	3937.36640	
0.40000	4123.77507	
0.65000	5690.80958	
0.90000	7257.84408	
0.92250	7257.84408	
0.94500	7257.84408	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	40.000 ft
Depth below ground surface	=	40.000 ft
Equivalent Depth (see note)	=	29.922 ft

Liq_BentsRow1_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	9655.881	lb/in
Psd	=	11866.947	lb/in
Ps = Pst (shallow controls)	=	9655.881	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	8427.7069	
n = $Pm/(m \ Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	7338.4694	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0912	in
Pk	=	1965.621	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	4827.940	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	8497.175	lb/in
Es, lim	=	21543.604	lb/in/in
p-multiplier	=	0.97500	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.09124	1916.48003	*
0.11931	2255.95219	
0.14738	2565.19400	
0.17545	2852.03129	
0.20352	3121.34488	
0.23159	3376.43185	
0.25965	3619.64841	
0.28772	3852.75060	
0.31579	4077.09046	
0.34386	4293.73635	
0.37193	4503.55065	
0.40000	4707.24192	
0.65000	6495.99383	
0.90000	8284.74573	
0.92250	8284.74573	
0.94500	8284.74573	

* p value(s) computed using $p = k * Eff \times y$

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

Shear force at pile head = 1000.0 lbs
 Applied moment at pile head = 198000.0 in-lbs
 Axial thrust load on pile head = 137000.0 lbs

Depth Res.	Soil X	Deflect. Spr. y	Bending Distrib. Load	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil p
	Es*h feet lb/inch	Lat. inches lb/inch	Moment in-lbs	lbs	radians	psi*	lb-in^2	lb/in
0.000	0.00	0.0200	198000.	1000.0000	-0.000323	1234.1318	7.861E+10	
-19.0390	1.000	0.0163	210125.	879.4587	-0.000291	1291.1443	7.861E+10	
-48.7784	2.000	0.0130	219525.	522.5647	-0.000259	1335.3447	7.861E+10	
-46.7908	3.000	0.0101	222764.	-42.9685	-0.000225	1350.5766	7.861E+10	
-46.7390	4.000	0.007574	219218.	-604.8508	-0.000191	1333.9021	7.861E+10	
-45.7264	5.000	0.005480	208895.	-1160.3819	-0.000158	1285.3622	7.861E+10	
-22.9685	6.000	0.003768	191944.	-1635.5208	-0.000128	1205.6575	7.861E+10	
-4.7603	7.000	0.002408	171492.	-1749.5913	-9.989E-05	1109.4880	7.861E+10	
-3.9397	8.000	0.001361	150312.	-1801.8496	-7.533E-05	1009.8953	7.861E+10	
-2.9891	9.000	0.000590	128528.	-1843.5750	-5.404E-05	907.4627	7.861E+10	
-1.4093	10.000	5.428E-05	106285.	-1871.0705	-3.612E-05	802.8723	7.861E+10	
8.4003	11.000	-0.000287	83894.	-1839.2851	-2.160E-05	697.5809	7.861E+10	
17.2561	12.000	-0.000474	62719.	-1667.5918	-1.043E-05	598.0120	7.861E+10	
19.1376	13.000	-0.000546	43999.	-1448.3705	-2.315E-06	509.9881	7.861E+10	
20.0666	14.000	-0.000538	28015.	-1212.5445	3.155E-06	434.8310	7.861E+10	
20.2728	15.000	-0.000477	14908.	-970.0149	6.403E-06	373.1978	7.861E+10	
20.6522	16.000	-0.000389	4757.3767	-718.6127	7.874E-06	325.4675	7.861E+10	
18.7690	17.000	-0.000292	-2424.4572	-481.7935	8.025E-06	314.4976	7.861E+10	
16.5195	18.000	-0.000200	-6906.2476	-269.7987	7.289E-06	335.5719	7.861E+10	
13.8986	19.000	-0.000119	-9010.7946	-86.9831	6.053E-06	345.4679	7.861E+10	
10.7166	20.000	-5.473E-05	-9116.4153	61.3007	4.652E-06	345.9645	7.861E+10	
1.2931	21.000	-6.993E-06	-7690.2417	149.2143	3.358E-06	339.2584	7.861E+10	
-8.4791	22.000	2.668E-05	-5933.5739	115.0157	2.321E-06	330.9982	7.861E+10	
	23.000	4.934E-05	-4874.0579	86.1826	1.496E-06	326.0161	7.861E+10	

Liq_BentsRow1_Run2_Transverse.lp7o

-0.4475	54426.	0.000				
24.000	6.306E-05	-3877.2598	79.7575	8.292E-07	321.3290	7.861E+10
-0.6163	58638.	0.000				
25.000	6.967E-05	-2967.7351	71.6403	3.077E-07	317.0522	7.861E+10
-0.7298	62850.	0.000				
26.000	7.084E-05	-2162.0943	62.4740	-8.279E-08	313.2639	7.861E+10
-0.7918	67062.	0.000				
27.000	6.803E-05	-1469.5125	52.8431	-3.589E-07	310.0073	7.861E+10
-0.8081	71274.	0.000				
28.000	6.252E-05	-892.5889	43.2498	-5.380E-07	307.2945	7.861E+10
-0.7865	75486.	0.000				
29.000	5.536E-05	-428.4322	34.0999	-6.378E-07	305.1119	7.861E+10
-0.7353	79698.	0.000				
30.000	4.740E-05	-69.8567	25.6983	-6.749E-07	303.4258	7.861E+10
-0.6628	83910.	0.000				
31.000	3.930E-05	193.4064	18.2510	-6.646E-07	304.0068	7.861E+10
-0.5772	88122.	0.000				
32.000	3.155E-05	373.5601	11.8728	-6.206E-07	304.8539	7.861E+10
-0.4855	92334.	0.000				
33.000	2.447E-05	483.7114	6.5993	-5.546E-07	305.3718	7.861E+10
-0.3938	96546.	0.000				
34.000	1.827E-05	536.9960	2.4006	-4.762E-07	305.6224	7.861E+10
-0.3069	100758.	0.000				
35.000	1.306E-05	545.8793	-0.8038	-3.932E-07	305.6642	7.861E+10
-0.2284	104970.	0.000				
36.000	8.834E-06	521.6362	-3.1301	-3.114E-07	305.5502	7.861E+10
-0.1608	109182.	0.000				
37.000	5.565E-06	474.0047	-4.7164	-2.353E-07	305.3262	7.861E+10
-0.1052	113394.	0.000				
38.000	3.162E-06	410.9977	-5.7101	-1.676E-07	305.0299	7.861E+10
-0.0620	117606.	0.000				
39.000	1.511E-06	338.8549	-6.2575	-1.103E-07	304.6907	7.861E+10
-0.0307	121818.	0.000				
40.000	4.806E-07	262.1118	-6.4948	-6.441E-08	304.3298	7.861E+10
-0.0101	126030.	0.000				
41.000	-7.018E-08	183.7683	-6.5402	-3.038E-08	303.9615	7.861E+10
0.001523	130242.	0.000				
42.000	-2.843E-07	105.5369	-6.0277	-8.301E-09	303.5936	7.861E+10
0.1600	3377076.	0.000				
43.000	-3.025E-07	45.2483	-3.9901	2.968E-09	303.3101	7.861E+10
0.1703	3377076.	0.000				
44.000	-2.350E-07	9.0472	-2.1559	6.900E-09	303.1399	7.861E+10
0.1323	3377076.	0.000				
45.000	-1.488E-07	-8.1918	-0.8609	6.817E-09	303.1359	7.861E+10
0.0837	3377076.	0.000				
46.000	-7.616E-08	-13.2944	-0.1105	5.092E-09	303.1599	7.861E+10
0.0429	3377076.	0.000				
47.000	-2.718E-08	-12.0976	0.2283	3.116E-09	303.1542	7.861E+10
0.0153	3377076.	0.000				
48.000	-1.147E-10	-8.5824	0.3124	1.529E-09	303.1377	7.861E+10
6.457E-05	3377076.	0.000				
49.000	1.123E-08	-4.9760	0.2697	4.999E-10	303.1207	7.861E+10
-0.006324	3377076.	0.000				
50.000	1.337E-08	-2.2329	0.1839	-4.013E-11	303.1078	7.861E+10
-0.007523	3377076.	0.000				
51.000	1.128E-08	-0.5517	0.0997	-2.429E-10	303.0999	7.861E+10
-0.006350	3377076.	0.000				
52.000	8.084E-09	0.2203	0.0343	-2.607E-10	303.0984	7.861E+10
-0.004550	3377076.	0.000				
53.000	5.214E-09	0.3350	-0.001907	-2.132E-10	303.0989	7.861E+10
-0.000113	129659.	0.000				
54.000	2.956E-09	0.3052	-0.002972	-1.643E-10	303.0988	7.861E+10
-6.596E-05	133871.	0.000				

Liq_BentsRow1_Run2_Transverse.lp7o							
55.000	1.256E-09	0.2657	-0.003534	-1.206E-10	303.0986	7.861E+10	
-2.891E-05	138083.	0.000					
56.000	4.207E-11	0.2219	-0.003707	-8.338E-11	303.0984	7.861E+10	
-9.977E-07	142295.	0.000					
57.000	-7.654E-10	0.1779	-0.003595	-5.287E-11	303.0982	7.861E+10	
1.869E-05	146507.	0.000					
58.000	-1.247E-09	0.1364	-0.003290	-2.892E-11	303.0980	7.861E+10	
3.132E-05	150719.	0.000					
59.000	-1.478E-09	0.0994	-0.002869	-1.098E-11	303.0978	7.861E+10	
3.815E-05	154931.	0.000					
60.000	-1.526E-09	0.0677	-0.002395	1.724E-12	303.0977	7.861E+10	
4.047E-05	159143.	0.000					
61.000	-1.449E-09	0.0419	-0.001913	1.004E-11	303.0975	7.861E+10	
3.946E-05	163355.	0.000					
62.000	-1.295E-09	0.0217	-0.001458	1.484E-11	303.0974	7.861E+10	
3.618E-05	167567.	0.000					
63.000	-1.101E-09	0.006716	-0.001051	1.696E-11	303.0974	7.861E+10	
3.153E-05	171779.	0.000					
64.000	-8.941E-10	-0.003749	-0.000704	1.715E-11	303.0974	7.861E+10	
2.623E-05	175991.	0.000					
65.000	-6.935E-10	-0.0104	-0.000422	1.604E-11	303.0974	7.861E+10	
2.083E-05	180203.	0.000					
66.000	-5.116E-10	-0.0141	-0.000203	1.414E-11	303.0974	7.861E+10	
1.572E-05	184415.	0.000					
67.000	-3.553E-10	-0.0155	-4.218E-05	1.185E-11	303.0974	7.861E+10	
1.117E-05	188627.	0.000					
68.000	-2.273E-10	-0.0153	6.814E-05	9.487E-12	303.0974	7.861E+10	
7.306E-06	192839.	0.000					
69.000	-1.273E-10	-0.0141	0.000137	7.237E-12	303.0974	7.861E+10	
4.180E-06	197051.	0.000					
70.000	-5.290E-11	-0.0122	0.000172	5.231E-12	303.0974	7.861E+10	
1.774E-06	201263.	0.000					
71.000	0.000	-0.0100	0.000182	3.536E-12	303.0974	7.861E+10	
2.681E-08	205475.	0.000					
72.000	3.297E-11	-0.007866	0.000175	2.172E-12	303.0974	7.861E+10	
-1.152E-06	209687.	0.000					
73.000	5.230E-11	-0.005867	0.000156	1.126E-12	303.0974	7.861E+10	
-1.864E-06	213899.	0.000					
74.000	6.085E-11	-0.004132	0.000132	0.000	303.0974	7.861E+10	
-2.212E-06	218111.	0.000					
75.000	6.179E-11	-0.002712	0.000105	0.000	303.0974	7.861E+10	
-2.290E-06	222323.	0.000					
76.000	5.773E-11	-0.001620	7.769E-05	0.000	303.0974	7.861E+10	
-2.180E-06	226535.	0.000					
77.000	5.067E-11	-0.000840	5.285E-05	0.000	303.0973	7.861E+10	
-1.949E-06	230747.	0.000					
78.000	4.203E-11	-0.000340	3.124E-05	0.000	303.0973	7.861E+10	
-1.646E-06	234959.	0.000					
79.000	3.275E-11	-7.591E-05	1.352E-05	0.000	303.0973	7.861E+10	
-1.305E-06	239171.	0.000					
80.000	2.330E-11	0.000	0.000	0.000	303.0973	7.861E+10	
-9.453E-07	121692.	0.000					

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.0199601 inches
Computed slope at pile head	=	-0.0003226 radians
Maximum bending moment	=	222764. inch-lbs
Maximum shear force	=	-1871.0705001 lbs
Depth of maximum bending moment	=	3.0000000 feet below pile head

Liq_BentsRow1_Run2_Transverse.lp7o

Depth of maximum shear force = 10.0000000 feet below pile head
 Number of iterations = 15
 Number of zero deflection points = 6

 Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
 Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
 Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
 Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
 Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head Condition 1 Maximum Shear V(lbs) or in Pile y(inches)	Pile-head Condition 2 Pile-head Rotation or in-lb, rad., or in-lb/rad. radians	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
1	1	V = 1000.0000	M = 198000.	137000.	0.01996014	
222764.		-1871.0705	-0.00032264			

 Computed Pile-head Stiffness Matrix Values
 K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)
 K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.00001950	0.000000	100.000000	2580.466902	5129225.	132357955.
0.000139	0.000000	370.926996	11760.	2666412.	84538802.
0.000256	0.000000	529.409129	17821.	2068380.	69624451.
0.000362	0.000000	641.853992	22375.	1773702.	61831906.
0.000457	0.000000	729.073004	26026.	1594640.	56923925.
0.000550	0.000000	800.336125	29171.	1455029.	53033361.
0.000631	0.000000	860.588236	31844.	1362941.	50432010.

Liq_BentsRow1_Run2_Transverse.lp7o					
0.000713	0.00000	912.780988	34268.	1279626.	48039774.
0.000784	0.00000	958.818258	36413.	1222808.	46438313.
0.000850	0.00000	1000.000000	38338.	1175947.	45083346.

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

K23 = abs(Shear Reaction/Top Rotation)
K33 = abs(Moment Reaction/Top Rotation)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
0.00000	0.00000505	442.552153	19800.	87673623.	3922560799.
0.00000	0.00002696	1235.944499	73444.	45838093.	2723837573.
0.00000	0.00004243	1619.002393	104823.	38161334.	2470772001.
0.00000	0.00005407	1873.743955	127087.	34652850.	2350337050.
0.00000	0.00006352	2062.148489	144356.	32462486.	2272469391.
0.00000	0.00007138	2213.347502	158467.	31007589.	2220015493.
0.00000	0.00007815	2338.240815	170396.	29919755.	2180365924.
0.00000	0.00008416	2444.026372	180731.	29038806.	2147358969.
0.00000	0.00008949	2536.691648	189846.	28347249.	2121508237.
0.00000	0.00009429	2618.952148	198000.	27774215.	2099807169.

The analysis ended normally.

Liq_BentsRow2_Run2_Transverse.lp7o

LPile Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\lpileRuns_10272015\Bents\Liq_trans\
Name of input data file: Liq_BentsRow2_Run2_Transverse.lp7d
Name of output report file: Liq_BentsRow2_Run2_Transverse.lp7o
Name of plot output file: Liq_BentsRow2_Run2_Transverse.lp7p
Name of runtime message file: Liq_BentsRow2_Run2_Transverse.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 17:12:28

Problem Title

Bents Row #1: 24-inch Static with p-multipliers Trans

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 22-BMG-14

 Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

 Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	80.000000	24.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	24.00000 in
Bottom Width	=	24.00000 in
Top Area	=	452.00000 Sq. in
Bottom Area	=	452.00000 Sq. in
Moment of Inertia at Top	=	2552.00000 in ⁴
Moment of Inertia at Bottom	=	2552.00000 in ⁴
Elastic Modulus	=	30805000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 7 layers

Layer 1 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	2.00000 ft
Effective unit weight at top of layer	=	52.00000 pcf
Effective unit weight at bottom of layer	=	52.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000
Subgrade k at top of layer	=	100.00000 pci
Subgrade k at bottom of layer	=	100.00000 pci

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	2.00000 ft
Distance from top of pile to bottom of layer	=	6.00000 ft
Effective unit weight at top of layer	=	55.00000 pcf

Liq_BentsRow2_Run2_Transverse.lp7o

Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	667.00000	psf
Undrained cohesion at bottom of layer	=	667.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	6.00000	ft
Distance from top of pile to bottom of layer	=	11.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	59.00000	psf
Undrained cohesion at bottom of layer	=	59.00000	psf
Epsilon-50 at top of layer	=	0.03000	
Epsilon-50 at bottom of layer	=	0.03000	

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	11.00000	ft
Distance from top of pile to bottom of layer	=	22.50000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	412.00000	psf
Undrained cohesion at bottom of layer	=	412.00000	psf
Epsilon-50 at top of layer	=	0.02000	
Epsilon-50 at bottom of layer	=	0.02000	

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	22.50000	ft
Distance from top of pile to bottom of layer	=	42.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

Layer 6 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	42.00000	ft
Distance from top of pile to bottom of layer	=	53.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	627.00000	psf
Undrained cohesion at bottom of layer	=	627.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 7 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	53.00000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.

Liq_BentsRow2_Run2_Transverse.lp7o

Subgrade k at top of layer = 60.00000 pci
 Subgrade k at bottom of layer = 60.00000 pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

 Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Criteria) Epsilon 50	Layer Soil Type kpy pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay with Free Water		0.00	52.000	750.000
--	0.01000	100.000	2.000	52.000	750.000
--	0.01000	100.000	2.000	55.000	667.000
2	Soft Clay	--	6.000	55.000	667.000
--	0.01000	--	6.000	71.000	59.000
3	Soft Clay	--	11.000	71.000	59.000
--	0.03000	--	11.000	62.000	412.000
4	Soft Clay	--	22.500	62.000	412.000
--	0.02000	--	22.500	62.000	--
5	Sand (Reese, et al.)	60.000	42.000	62.000	--
30.000	--	60.000	42.000	62.000	627.000
6	Soft Clay	--	53.000	62.000	627.000
--	0.01000	--	53.000	62.000	--
7	Sand (Reese, et al.)	60.000	90.000	62.000	--
30.000	--	60.000			
30.000	--	60.000			

 p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7900	1.0000
2	90.000	0.7900	1.0000

 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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 1000.00000 lbs	M = 198000. in-lbs	137000.

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

 Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
 (Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000

Liq_BentsRow2_Run2_Transverse.lp7o

19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

 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

 p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Diameter	=	24.000 in
c (at curve depth)	=	5.208 lb/in**2
Average cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.235
Ac (not used)	=	0.20000
pct	=	250.000 lb/in
pcd	=	1375.000 lb/in
pc	=	250.000 lb/in
pu	=	1.553 lb/in
p-multiplier	=	0.79000
y-multiplier	=	1.00000

y, in	p, lb/in
0.0000	0.0000
0.02814	0.0000
0.05628	0.0000
0.08442	0.0000
0.11256	0.0000
0.14070	0.0000
0.16884	0.0000
0.19698	0.0000
0.22512	0.0000
0.25326	0.0000
0.28140	0.0000
0.30954	0.0000
0.33768	0.0000

	Liq_BentsRow2_Run2_Transverse.lp7o
0.56280	0.0000
0.78792	0.0000
1.01304	0.0000
1.06932	0.0000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	2
Depth below pile head	=	2.000 ft
Depth below ground surface	=	2.000 ft
Transition Depth Xr	=	18.553 ft
Equivalent Depth of p-y curve	=	0.126 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03009 pci
Avg. Eff. Unit Weight	=	52.00000 pcf
Cohesion, c	=	4.920 psi
Cohesion, c	=	708.500 psf
Epsilon50 parameter	=	0.0100
J (default value)	=	0.5000
Static pu_s for flat ground	=	359.066 lb/in
Static pu_d for flat ground	=	1062.750 lb/in
y_50	=	0.60000 in
p-multiplier	=	0.790
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	359.066 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00142	18.91079
0.01138	37.82157
0.03840	56.73236
0.09102	75.64315
0.17778	94.55393
0.30720	113.46472
0.48782	132.37550
0.72818	151.28629
1.03680	170.19708
1.42222	189.10787
1.89298	208.01865
2.45760	226.92944
3.12462	245.84022
3.90258	264.75101
4.80000	283.66179
5.10000	283.66179

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	2
Depth below pile head	=	4.000 ft
Depth below ground surface	=	4.000 ft
Transition Depth Xr	=	18.170 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Equivalent Depth of p-y curve	=	2.126	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter	=	24.000	in
Avg. Eff. Unit Weight	=	0.03096	pci
Avg. Eff. Unit Weight	=	53.50000	pcf
Cohesion, c	=	4.632	psi
Cohesion, c	=	667.000	psf
Epsilon50 parameter	=	0.0100	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	411.546	lb/in
Static pu_d for flat ground	=	1000.500	lb/in
y_50	=	0.60000	in
p-multiplier	=	0.790	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	411.546	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00142	21.67474
0.01138	43.34948
0.03840	65.02422
0.09102	86.69896
0.17778	108.37370
0.30720	130.04844
0.48782	151.72318
0.72818	173.39793
1.03680	195.07266
1.42222	216.74741
1.89298	238.42214
2.45760	260.09688
3.12462	281.77163
3.90258	303.44636
4.80000	325.12110
5.10000	325.12110

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft
Transition Depth Xr	=	15.047 ft
Equivalent Depth of p-y curve	=	5.800 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03125 pci
Avg. Eff. Unit Weight	=	54.00000 pcf
Cohesion, c	=	2.521 psi
Cohesion, c	=	363.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	321.430 lb/in

Liq_BentsRow2_Run2_Transverse.lp7o

```

Static pu_d for flat ground      =      544.500 lb/in
y_50                             =      1.20000 in
p-multiplier                     =      0.790
y-multiplier                     =      1.000
Positive-y Sloping Ground Factor =      1.000
Negative-y Sloping Ground Factor =      1.000
Sloping Ground Factor           =      1.000
Positive-y, static pu           =      321.430 lb/in

```

y, in	p, lb/in
0.0000	0.0000
0.00284	16.92866
0.02276	33.85733
0.07680	50.78599
0.18204	67.71466
0.35556	84.64332
0.61440	101.57198
0.97564	118.50064
1.45636	135.42931
2.07360	152.35798
2.84444	169.28664
3.78596	186.21530
4.91520	203.14397
6.24924	220.07263
7.80516	237.00129
9.60000	253.92996
10.20000	253.92995

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```

Soil Layer Number                =      3
Depth below pile head            =      8.000 ft
Depth below ground surface       =      8.000 ft
Transition Depth Xr              =      5.000 ft
Equivalent Depth of p-y curve    =      8.000 ft
Ground Slope Angle               =      0.000 degrees
Pile Batter                      =      0.000 degrees
Effective Slope                  =      0.000 degrees
Pile Diameter                    =      24.000 in
Avg. Eff. Unit Weight            =      0.03371 pci
Avg. Eff. Unit Weight            =      58.25000 pcf
Cohesion, c                      =      0.410 psi
Cohesion, c                      =      59.000 psf
Epsilon50 parameter             =      0.0300
J (default value)                =      0.5000
Static pu_s for flat ground      =      126.833 lb/in
Static pu_d for flat ground      =      88.500 lb/in
y_50                             =      1.80000 in
p-multiplier                     =      0.790
y-multiplier                     =      1.000
Positive-y Sloping Ground Factor =      1.000
Negative-y Sloping Ground Factor =      1.000
Sloping Ground Factor           =      1.000
Positive-y, static pu           =      88.500 lb/in

```

y, in	p, lb/in
0.0000	0.0000
0.00427	4.66100
0.03413	9.32200
0.11520	13.98300

	Liq_BentsRow2_Run2_Transverse.lp7o
0.27307	18.64400
0.53333	23.30500
0.92160	27.96600
1.46347	32.62700
2.18453	37.28800
3.11040	41.94900
4.26667	46.61000
5.67893	51.27100
7.37280	55.93200
9.37387	60.59300
11.70773	65.25400
14.40000	69.91500
15.30000	69.91500

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Transition Depth Xr	=	5.000 ft
Equivalent Depth of p-y curve	=	10.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03519 pci
Avg. Eff. Unit Weight	=	60.80000 pcf
Cohesion, c	=	0.410 psi
Cohesion, c	=	59.000 psf
Epsilon50 parameter	=	0.0300
J (default value)	=	0.5000
Static pu_s for flat ground	=	155.417 lb/in
Static pu_d for flat ground	=	88.500 lb/in
y_50	=	1.80000 in
p-multiplier	=	0.790
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	88.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00427	4.66100
0.03413	9.32200
0.11520	13.98300
0.27307	18.64400
0.53333	23.30500
0.92160	27.96600
1.46347	32.62700
2.18453	37.28800
3.11040	41.94900
4.26667	46.61000
5.67893	51.27100
7.37280	55.93200
9.37387	60.59300
11.70773	65.25400
14.40000	69.91500
15.30000	69.91500

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	12.000 ft
Depth below ground surface	=	12.000 ft
Transition Depth Xr	=	15.005 ft
Equivalent Depth of p-y curve	=	10.137 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03573 pci
Avg. Eff. Unit Weight	=	61.75000 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	484.356 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.790
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	484.356 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	25.50940
0.02276	51.01880
0.07680	76.52820
0.18204	102.03761
0.35556	127.54701
0.61440	153.05641
0.97564	178.56581
1.45636	204.07523
2.07360	229.58462
2.84444	255.09403
3.78596	280.60342
4.91520	306.11283
6.24924	331.62224
7.80516	357.13163
9.60000	382.64104
10.20000	382.64103

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	14.000 ft
Depth below ground surface	=	14.000 ft
Transition Depth Xr	=	15.001 ft
Equivalent Depth of p-y curve	=	12.137 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03576 pci

Liq_BentsRow2_Run2_Transverse.lp7o

Avg. Eff. Unit Weight	=	61.78571	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	539.345	lb/in
Static pu_d for flat ground	=	618.000	lb/in
y_50	=	1.20000	in
p-multiplier	=	0.790	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	539.345	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	28.40548
0.02276	56.81097
0.07680	85.21645
0.18204	113.62194
0.35556	142.02743
0.61440	170.43291
0.97564	198.83839
1.45636	227.24389
2.07360	255.64937
2.84444	284.05486
3.78596	312.46034
4.91520	340.86583
6.24924	369.27131
7.80516	397.67679
9.60000	426.08228
10.20000	426.08227

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Transition Depth Xr	=	14.999 ft
Equivalent Depth of p-y curve	=	16.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03577 pci
Avg. Eff. Unit Weight	=	61.81250 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	645.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.790
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

Liq_BentsRow2_Run2_Transverse.lp7o	
y, in	p, lb/in
-----	-----
0.0000	0.0000
0.00284	32.54800
0.02276	65.09600
0.07680	97.64400
0.18204	130.19201
0.35556	162.74000
0.61440	195.28800
0.97564	227.83600
1.45636	260.38402
2.07360	292.93201
2.84444	325.48001
3.78596	358.02801
4.91520	390.57601
6.24924	423.12402
7.80516	455.67201
9.60000	488.22001
10.20000	488.22000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	18.000 ft
Depth below ground surface	=	18.000 ft
Transition Depth Xr	=	14.997 ft
Equivalent Depth of p-y curve	=	18.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03578 pci
Avg. Eff. Unit Weight	=	61.83333 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	700.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.790
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.00284	32.54800
0.02276	65.09600
0.07680	97.64400
0.18204	130.19201
0.35556	162.74000
0.61440	195.28800
0.97564	227.83600
1.45636	260.38402
2.07360	292.93201
2.84444	325.48001
3.78596	358.02801
4.91520	390.57601

	Liq_BentsRow2_Run2_Transverse.lp7o
6.24924	423.12402
7.80516	455.67201
9.60000	488.22001
10.20000	488.22000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	22.000 ft
Depth below ground surface	=	22.000 ft
Transition Depth Xr	=	14.994 ft
Equivalent Depth of p-y curve	=	22.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03580 pci
Avg. Eff. Unit Weight	=	61.86364 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	810.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.790
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	32.54800
0.02276	65.09600
0.07680	97.64400
0.18204	130.19201
0.35556	162.74000
0.61440	195.28800
0.97564	227.83600
1.45636	260.38402
2.07360	292.93201
2.84444	325.48001
3.78596	358.02801
4.91520	390.57601
6.24924	423.12402
7.80516	455.67201
9.60000	488.22001
10.20000	488.22000

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth (see note)	=	13.922 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.87500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2293.304	lb/in
Psd	=	7114.419	lb/in
Ps = Pst (shallow controls)	=	2293.304	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	2001.6087	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	1742.9111	
Yk = [c/(kx)]^(n/(n-1))	=	0.0164	in
Pk	=	164.519	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	1146.652	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	2018.108	lb/in
Es,lim	=	10023.604	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.01641	129.96998	*
0.05128	259.82372	
0.08616	356.17263	
0.12103	437.92559	
0.15590	510.80541	
0.19077	577.50736	
0.22564	639.56692	
0.26051	697.96144	
0.29539	753.36042	
0.33026	806.24726	
0.36513	856.98506	
0.40000	905.85511	
0.65000	1250.08005	
0.90000	1594.30499	
0.92250	1594.30499	
0.94500	1594.30499	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	26.000 ft
Depth below ground surface	=	26.000 ft
Equivalent Depth (see note)	=	15.922 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.88462	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2937.106	lb/in
Psd	=	7708.485	lb/in
Ps = Pst (shallow controls)	=	2937.106	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	2563.5223	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	2232.2003	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0219	in
Pk	=	251.144	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	1468.553	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	2584.653	lb/in
Es,lim	=	11463.604	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.02191	198.40388	*
0.05628	352.11076	
0.09065	470.48908	
0.12502	572.05279	
0.15940	663.08685	
0.19377	746.67507	
0.22814	824.61388	
0.26251	898.06312	
0.29688	967.82525	
0.33126	1034.48392	
0.36563	1098.48004	
0.40000	1160.15673	
0.65000	1601.01628	
0.90000	2041.87583	
0.92250	2041.87583	
0.94500	2041.87583	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	28.000 ft
Depth below ground surface	=	28.000 ft
Equivalent Depth (see note)	=	17.922 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.89286	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3659.908	lb/in
Psd	=	8302.551	lb/in
Ps = Pst (shallow controls)	=	3659.908	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	3194.3884	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	2781.5302	
Yk = [c/(kx)]^(n/(n-1))	=	0.0284	in
Pk	=	366.411	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	1829.954	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	3220.719	lb/in
Es, lim	=	12903.604	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02840	289.46432	*
0.06218	466.17253	
0.09596	606.91330	
0.12974	729.06946	
0.16352	839.21557	
0.19731	940.72205	
0.23109	1035.60160	
0.26487	1125.17483	
0.29865	1210.36590	
0.33244	1291.85277	
0.36622	1370.15095	
0.40000	1445.66376	
0.65000	1995.01598	
0.90000	2544.36820	
0.92250	2544.36820	
0.94500	2544.36820	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	30.000 ft
Depth below ground surface	=	30.000 ft
Equivalent Depth (see note)	=	19.922 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4461.715	lb/in
Psd	=	8896.617	lb/in
Ps = Pst (shallow controls)	=	4461.715	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	3894.2100	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	3390.9034	
Yk = [c/(kx)]^(n/(n-1))	=	0.0359	in
Pk	=	515.432	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	2230.858	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	3926.309	lb/in
Es, lim	=	14343.604	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.03593	407.19119	*
0.06903	605.60173	
0.10213	768.43537	
0.13523	911.44287	
0.16832	1041.21439	
0.20142	1161.28647	
0.23452	1273.82869	
0.26761	1380.29029	
0.30071	1481.69860	
0.33381	1578.81457	
0.36690	1672.22122	
0.40000	1762.37747	
0.65000	2432.08090	
0.90000	3101.78432	
0.92250	3101.78432	
0.94500	3101.78432	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	32.000 ft
Depth below ground surface	=	32.000 ft
Equivalent Depth (see note)	=	21.922 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90625	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	5342.529	lb/in
Psd	=	9490.683	lb/in
Ps = Pst (shallow controls)	=	5342.529	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	4662.9889	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	4060.3217	
Yk = [c/(kx)]^(n/(n-1))	=	0.0446	in
Pk	=	703.614	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	2671.264	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	4701.425	lb/in
Es, lim	=	15783.604	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.04458	555.85484	*
0.07689	774.28289	
0.10920	958.36914	
0.14151	1121.94996	
0.17382	1271.38320	
0.20613	1410.24413	
0.23844	1540.78984	
0.27076	1664.55780	
0.30307	1782.65346	
0.33538	1895.90454	
0.36769	2004.95068	
0.40000	2110.29881	
0.65000	2912.21235	
0.90000	3714.12589	
0.92250	3714.12589	
0.94500	3714.12589	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Equivalent Depth (see note)	=	23.922 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91176	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	6302.351	lb/in
Psd	=	10084.749	lb/in
Ps = Pst (shallow controls)	=	6302.351	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	5500.7270	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	4789.7865	
Yk = [c/(kx)]^(n/(n-1))	=	0.0544	in
Pk	=	936.641	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	3151.175	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	5546.069	lb/in
Es, lim	=	17223.604	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.05438	739.94646	*
0.08580	976.36220	
0.11722	1180.32753	
0.14864	1363.66379	
0.18006	1532.29379	
0.21148	1689.70845	
0.24290	1838.17872	
0.27432	1979.28425	
0.30574	2114.17852	
0.33716	2243.73561	
0.36858	2368.63740	
0.40000	2489.42852	
0.65000	3435.41135	
0.90000	4381.39418	
0.92250	4381.39418	
0.94500	4381.39418	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Equivalent Depth (see note)	=	25.922 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	7341.183	lb/in
Psd	=	10678.815	lb/in
Ps = Pst (shallow controls)	=	7341.183	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	6407.4254	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	5579.2988	
Yk = [c/(kx)]^(n/(n-1))	=	0.0654	in
Pk	=	1220.468	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	3670.591	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	6460.241	lb/in
Es, lim	=	18663.604	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.06539	964.16946	*
0.09581	1216.22318	
0.12623	1438.19811	
0.15665	1639.93763	
0.18707	1826.78179	
0.21749	2002.02808	
0.24791	2167.88900	
0.27832	2325.93792	
0.30874	2477.34307	
0.33916	2623.00124	
0.36958	2763.61943	
0.40000	2899.76717	
0.65000	4001.67868	
0.90000	5103.59018	
0.92250	5103.59018	
0.94500	5103.59018	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	38.000 ft
Depth below ground surface	=	38.000 ft
Equivalent Depth (see note)	=	27.922 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92105	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	8459.026	lb/in
Psd	=	11272.881	lb/in
Ps = Pst (shallow controls)	=	8459.026	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	7383.0851	
n = $Pm/(m \ Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	6428.8595	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0777	in
Pk	=	1561.306	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	4229.513	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	7443.943	lb/in
Es, lim	=	20103.604	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.07766	1233.43201	*
0.10697	1498.46744	
0.13627	1736.12029	
0.16557	1954.38785	
0.19488	2157.93658	
0.22418	2349.78245	
0.25348	2532.01374	
0.28279	2706.15015	
0.31209	2873.34018	
0.34139	3034.47795	
0.37070	3190.27637	
0.40000	3341.31519	
0.65000	4611.01494	
0.90000	5880.71469	
0.92250	5880.71469	
0.94500	5880.71469	

* p value(s) computed using $p = k * Eff \times y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	40.000 ft
Depth below ground surface	=	40.000 ft
Equivalent Depth (see note)	=	29.922 ft

Liq_BentsRow2_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	9655.881	lb/in
Psd	=	11866.947	lb/in
Ps = Pst (shallow controls)	=	9655.881	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	8427.7069	
n = $Pm/(m \ Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	7338.4694	
Yk = $[c/(kx)]^{(n/(n-1))}$	=	0.0912	in
Pk	=	1965.621	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	4827.940	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	8497.175	lb/in
Es, lim	=	21543.604	lb/in/in
p-multiplier	=	0.79000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.09124	1552.84023	*
0.11931	1827.89972	
0.14738	2078.46488	
0.17545	2310.87663	
0.20352	2529.08970	
0.23159	2735.77555	
0.25965	2932.84332	
0.28772	3121.71587	
0.31579	3303.48868	
0.34386	3479.02740	
0.37193	3649.03079	
0.40000	3814.07294	
0.65000	5263.42064	
0.90000	6712.76834	
0.92250	6712.76834	
0.94500	6712.76834	

* p value(s) computed using $p = k * Eff \times y$

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

Shear force at pile head = 1000.0 lbs
 Applied moment at pile head = 198000.0 in-lbs
 Axial thrust load on pile head = 137000.0 lbs

Depth Res.	Soil X	Deflect. Spr.	Bending Distrib.	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil p
	Es*h feet lb/inch	Lat. y inches lb/inch	Load in-lbs	lbs	radians	psi*	lb-in^2	lb/in
0.000	0.00	0.0242	198000.	1000.0000	-0.000354	1234.1318	7.861E+10	
-19.0741	1.000	0.0201	210179.	879.9155	-0.000322	1291.3998	7.861E+10	
-42.7725	2.000	0.0164	219621.	538.8067	-0.000290	1335.7997	7.861E+10	
-41.4569	3.000	0.0132	223522.	40.4253	-0.000256	1354.1391	7.861E+10	
-41.9546	4.000	0.0103	221402.	-460.5684	-0.000222	1344.1730	7.861E+10	
-41.7409	5.000	0.007848	213192.	-963.2830	-0.000189	1305.5682	7.861E+10	
-21.4431	6.000	0.005778	198925.	-1400.9943	-0.000157	1238.4800	7.861E+10	
-4.5894	7.000	0.004072	181399.	-1508.3452	-0.000128	1156.0708	7.861E+10	
-4.0005	8.000	0.002698	163167.	-1559.9046	-0.000102	1070.3409	7.861E+10	
-3.3762	9.000	0.001623	144319.	-1604.2003	-7.820E-05	981.7111	7.861E+10	
-2.6786	10.000	0.000812	124948.	-1640.6097	-5.765E-05	890.6280	7.861E+10	
-6.3483	11.000	0.000230	105162.	-1681.3043	-4.008E-05	797.5917	7.861E+10	
9.8168	12.000	-0.000159	84670.	-1694.4276	-2.559E-05	701.2342	7.861E+10	
13.9696	13.000	-0.000393	65167.	-1549.0244	-1.417E-05	609.5255	7.861E+10	
16.0154	14.000	-0.000508	47643.	-1368.2092	-5.581E-06	527.1217	7.861E+10	
17.1176	15.000	-0.000535	32404.	-1168.8523	5.059E-07	455.4672	7.861E+10	
18.2693	16.000	-0.000502	19657.	-951.4677	4.454E-06	395.5277	7.861E+10	
17.3874	17.000	-0.000433	9531.1928	-737.2145	6.657E-06	347.9149	7.861E+10	
16.1367	18.000	-0.000346	1903.5885	-535.8248	7.507E-06	312.0484	7.861E+10	
14.5857	19.000	-0.000256	-3403.5282	-351.2817	7.371E-06	319.1014	7.861E+10	
12.7605	20.000	-0.000171	-6611.9219	-186.9969	6.588E-06	334.1879	7.861E+10	
10.6192	21.000	-9.863E-05	-7983.9285	-46.4372	5.458E-06	340.6393	7.861E+10	
7.8977	22.000	-4.049E-05	-7829.5308	65.3331	4.238E-06	339.9133	7.861E+10	
	23.000	3.433E-06	-6762.9461	89.6652	3.124E-06	334.8980	7.861E+10	

Liq_BentsRow2_Run2_Transverse.lp7o

-0.0252	44099.	0.000				
24.000	3.497E-05	-5697.8621	87.8138	2.173E-06	329.8898	7.861E+10
-0.2769	47512.	0.000				
25.000	5.607E-05	-4670.7493	83.2565	1.382E-06	325.0601	7.861E+10
-0.4759	50925.	0.000				
26.000	6.861E-05	-3710.5084	76.6336	7.434E-07	320.5449	7.861E+10
-0.6213	54337.	0.000				
27.000	7.433E-05	-2838.3402	68.5761	2.445E-07	316.4438	7.861E+10
-0.7155	57750.	0.000				
28.000	7.485E-05	-2068.0641	59.6724	-1.289E-07	312.8218	7.861E+10
-0.7630	61163.	0.000				
29.000	7.157E-05	-1406.7778	50.4453	-3.931E-07	309.7123	7.861E+10
-0.7702	64576.	0.000				
30.000	6.569E-05	-855.7548	41.3353	-5.647E-07	307.1213	7.861E+10
-0.7444	67989.	0.000				
31.000	5.824E-05	-411.4809	32.6941	-6.604E-07	305.0322	7.861E+10
-0.6931	71401.	0.000				
32.000	5.002E-05	-66.7447	24.7823	-6.960E-07	303.4112	7.861E+10
-0.6237	74814.	0.000				
33.000	4.167E-05	188.2894	17.7740	-6.860E-07	303.9827	7.861E+10
-0.5433	78227.	0.000				
34.000	3.366E-05	365.0821	11.7645	-6.430E-07	304.8140	7.861E+10
-0.4580	81640.	0.000				
35.000	2.631E-05	475.8317	6.7811	-5.783E-07	305.3348	7.861E+10
-0.3729	85053.	0.000				
36.000	1.982E-05	532.7262	2.7952	-5.008E-07	305.6023	7.861E+10
-0.2922	88465.	0.000				
37.000	1.430E-05	547.3432	-0.2654	-4.181E-07	305.6711	7.861E+10
-0.2190	91878.	0.000				
38.000	9.783E-06	530.2021	-2.5038	-3.356E-07	305.5905	7.861E+10
-0.1554	95291.	0.000				
39.000	6.234E-06	490.4571	-4.0430	-2.575E-07	305.4036	7.861E+10
-0.1025	98704.	0.000				
40.000	3.581E-06	435.7209	-5.0155	-1.867E-07	305.1462	7.861E+10
-0.0609	102117.	0.000				
41.000	1.726E-06	371.9995	-5.5553	-1.250E-07	304.8466	7.861E+10
-0.0304	105529.	0.000				
42.000	5.510E-07	303.7219	-6.6905	-7.339E-08	304.5255	7.861E+10
-0.3101	3377076.	0.000				
43.000	-7.235E-08	208.7028	-8.1076	-3.414E-08	304.0787	7.861E+10
0.0407	3377076.	0.000				
44.000	-3.128E-07	117.5586	-6.6826	-9.413E-09	303.6501	7.861E+10
0.1760	3377076.	0.000				
45.000	-3.350E-07	50.6445	-4.4327	3.160E-09	303.3355	7.861E+10
0.1885	3377076.	0.000				
46.000	-2.613E-07	10.3973	-2.3978	7.583E-09	303.1462	7.861E+10
0.1471	3377076.	0.000				
47.000	-1.662E-07	-8.7706	-0.9553	7.543E-09	303.1386	7.861E+10
0.0935	3377076.	0.000				
48.000	-8.554E-08	-14.3880	-0.1152	5.680E-09	303.1650	7.861E+10
0.0481	3377076.	0.000				
49.000	-3.048E-08	-12.9354	0.2656	3.552E-09	303.1582	7.861E+10
0.0172	3377076.	0.000				
50.000	1.171E-09	-8.8895	0.3560	1.877E-09	303.1391	7.861E+10
-0.000659	3377076.	0.000				
51.000	1.653E-08	-4.8537	0.2910	8.362E-10	303.1202	7.861E+10
-0.009302	3377076.	0.000				
52.000	2.284E-08	-2.1112	0.1555	3.204E-10	303.1073	7.861E+10
-0.0129	3377076.	0.000				
53.000	2.507E-08	-1.1997	0.0337	8.651E-11	303.1030	7.861E+10
-0.000439	105057.	0.000				
54.000	2.510E-08	-0.8276	0.0283	-6.761E-11	303.1012	7.861E+10
-0.000454	108470.	0.000				

		Liq_BentsRow2_Run2_Transverse.lp7o				
55.000	2.361E-08	-0.5204	0.0229	-1.699E-10	303.0998	7.861E+10
-0.000440	111883.	0.000				
56.000	2.115E-08	-0.2763	0.0178	-2.301E-10	303.0986	7.861E+10
-0.000406	115296.	0.000				
57.000	1.818E-08	-0.0906	0.0132	-2.576E-10	303.0978	7.861E+10
-0.000360	118708.	0.000				
58.000	1.504E-08	0.0435	0.009217	-2.607E-10	303.0975	7.861E+10
-0.000306	122121.	0.000				
59.000	1.197E-08	0.1335	0.005877	-2.468E-10	303.0980	7.861E+10
-0.000251	125534.	0.000				
60.000	9.149E-09	0.1873	0.003197	-2.220E-10	303.0982	7.861E+10
-0.000197	128947.	0.000				
61.000	6.663E-09	0.2128	0.001139	-1.913E-10	303.0983	7.861E+10
-0.000147	132360.	0.000				
62.000	4.565E-09	0.2170	-0.000358	-1.583E-10	303.0984	7.861E+10
-0.000103	135772.	0.000				
63.000	2.862E-09	0.2062	-0.001371	-1.259E-10	303.0983	7.861E+10
-6.640E-05	139185.	0.000				
64.000	1.536E-09	0.1857	-0.001983	-9.590E-11	303.0982	7.861E+10
-3.651E-05	142598.	0.000				
65.000	5.498E-10	0.1598	-0.002278	-6.950E-11	303.0981	7.861E+10
-1.338E-05	146011.	0.000				
66.000	-1.441E-10	0.1320	-0.002332	-4.722E-11	303.0980	7.861E+10
3.589E-06	149424.	0.000				
67.000	-5.962E-10	0.1045	-0.002216	-2.918E-11	303.0978	7.861E+10
1.519E-05	152836.	0.000				
68.000	-8.566E-10	0.0792	-0.001988	-1.518E-11	303.0977	7.861E+10
2.231E-05	156249.	0.000				
69.000	-9.714E-10	0.0571	-0.001696	-4.808E-12	303.0976	7.861E+10
2.585E-05	159662.	0.000				
70.000	-9.813E-10	0.0386	-0.001379	2.460E-12	303.0975	7.861E+10
2.667E-05	163075.	0.000				
71.000	-9.200E-10	0.0240	-0.001065	7.200E-12	303.0975	7.861E+10
2.553E-05	166488.	0.000				
72.000	-8.144E-10	0.0130	-0.000773	9.985E-12	303.0974	7.861E+10
2.306E-05	169900.	0.000				
73.000	-6.846E-10	0.005281	-0.000515	1.135E-11	303.0974	7.861E+10
1.977E-05	173313.	0.000				
74.000	-5.448E-10	0.000437	-0.000300	1.176E-11	303.0973	7.861E+10
1.605E-05	176726.	0.000				
75.000	-4.040E-10	-0.002098	-0.000131	1.161E-11	303.0974	7.861E+10
1.213E-05	180139.	0.000				
76.000	-2.668E-10	-0.002887	-9.195E-06	1.122E-11	303.0974	7.861E+10
8.163E-06	183552.	0.000				
77.000	-1.348E-10	-0.002499	6.498E-05	1.080E-11	303.0974	7.861E+10
4.200E-06	186964.	0.000				
78.000	-7.271E-12	-0.001505	9.158E-05	1.049E-11	303.0974	7.861E+10
2.307E-07	190377.	0.000				
79.000	1.175E-10	-0.000479	7.026E-05	1.034E-11	303.0973	7.861E+10
-3.795E-06	193790.	0.000				
80.000	2.413E-10	0.000	0.000	1.031E-11	303.0973	7.861E+10
-7.932E-06	98601.	0.000				

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.0241800 inches
Computed slope at pile head	=	-0.0003537 radians
Maximum bending moment	=	223522. inch-lbs
Maximum shear force	=	-1712.1135333 lbs
Depth of maximum bending moment	=	3.0000000 feet below pile head

Depth of maximum shear force = 11.5000000 feet below pile head
 Number of iterations = 14
 Number of zero deflection points = 6

 Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
 Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
 Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
 Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
 Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load	Maximum Load Shear in Pile No.	Pile-head Condition 1 V(lbs) or y(inches) lbs	Pile-head Condition 2 Pile-head Rotation or in-lb/rad. radians	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
Case No.	Type No.	V(lbs) or y(inches) lbs	Pile-head Rotation or in-lb/rad. radians	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
1	1	V = 1000.0000	M = 198000.	137000.	0.02418003	
223522.		-1712.1135	-0.00035366			

 Computed Pile-head Stiffness Matrix Values
 K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)
 K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.00002280	0.000000	100.000000	2695.950505	4385128.	118220894.
0.000175	0.000000	370.926996	12422.	2123709.	71120077.
0.000332	0.000000	529.409129	18920.	1592952.	56927709.
0.000484	0.000000	641.853992	23912.	1327410.	49451222.
0.000624	0.000000	729.073004	28028.	1168288.	44912102.
0.000747	0.000000	800.336125	31469.	1071780.	42142512.
0.000866	0.000000	860.588236	34494.	994272.	39851882.

```

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0.000970      0.00000      912.780988      37104.      941182.      38258135.
0.001067      0.00000      958.818258      39443.      899001.      36982645.
0.001158      0.00000      1000.000000      41593.      863881.      35931805.

```

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

```

K23 = abs(Shear Reaction/Top Rotation)
K33 = abs(Moment Reaction/Top Rotation)

```

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
-----	-----	-----	-----	-----	-----
0.00000	0.00000551	416.001475	19800.	75524704.	3594672709.
0.00000	0.00002937	1145.388952	73444.	38997821.	2500581303.
0.00000	0.00004604	1498.482889	104823.	32544340.	2276566248.
0.00000	0.00005864	1732.223886	127087.	29541162.	2167329708.
0.00000	0.00006870	1907.952302	144356.	27771716.	2101219447.
0.00000	0.00007723	2046.490355	158467.	26499071.	2051911192.
0.00000	0.00008450	2162.194882	170396.	25589014.	2016597924.
0.00000	0.00009088	2261.089841	180731.	24879001.	1988597542.
0.00000	0.00009660	2346.837863	189846.	24294575.	1965294797.
0.00000	0.000102	2421.984984	198000.	23788721.	1944754702.

The analysis ended normally.

Liq_BentsRow345_Run2_Transverse.lp7o

LPILE Plus for Windows, Version 2013-07.004

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: C:\Users\B1ECDTW9\Desktop\165Calcs\Modeling
Data\LpileRuns_10272015\Bents\Liq_trans\
Name of input data file: Liq_BentsRow345_Run2_Transverse.lp7d
Name of output report file: Liq_BentsRow345_Run2_Transverse.lp7o
Name of plot output file: Liq_BentsRow345_Run2_Transverse.lp7p
Name of runtime message file: Liq_BentsRow345_Run2_Transverse.lp7r

Date and Time of Analysis

Date: November 30, 2015 Time: 17:12:50

Problem Title

Bents Row #1: 24-inch Static with p-multipliers Trans

Job Number: HWY 165

Client:

Engineer:

Description: Bor. 22-BMG-14

 Program Options and Settings

Engineering Units of Input Data and Computations:

- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 160

Loading Type and Number of Cycles of Loading:

- Static loading specified

Computational Options:

- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Compute pile-head foundation stiffness matrix
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- p-y curves computed and reported at user-specified depths
- 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) = 2

 Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 80.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values 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.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	80.000000	24.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	80.00000 ft
Top Width	=	24.00000 in
Bottom Width	=	24.00000 in
Top Area	=	452.00000 Sq. in
Bottom Area	=	452.00000 Sq. in
Moment of Inertia at Top	=	2552.00000 in ⁴
Moment of Inertia at Bottom	=	2552.00000 in ⁴
Elastic Modulus	=	30805000. lbs/in ²

Control Data for Pile-head Stiffness Computations

Computation Method 0 - Use loads from Load Case 1
 Number of K-matrix points to generate = 10
 Point distribution method = logarithmic distribution

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 7 layers

Layer 1 is stiff clay with water-induced erosion

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	2.00000 ft
Effective unit weight at top of layer	=	52.00000 pcf
Effective unit weight at bottom of layer	=	52.00000 pcf
Undrained cohesion at top of layer	=	750.00000 psf
Undrained cohesion at bottom of layer	=	750.00000 psf
Epsilon-50 at top of layer	=	0.01000
Epsilon-50 at bottom of layer	=	0.01000
Subgrade k at top of layer	=	100.00000 pci
Subgrade k at bottom of layer	=	100.00000 pci

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	2.00000 ft
Distance from top of pile to bottom of layer	=	6.00000 ft
Effective unit weight at top of layer	=	55.00000 pcf

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Effective unit weight at bottom of layer	=	55.00000	pcf
Undrained cohesion at top of layer	=	667.00000	psf
Undrained cohesion at bottom of layer	=	667.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	6.00000	ft
Distance from top of pile to bottom of layer	=	11.00000	ft
Effective unit weight at top of layer	=	71.00000	pcf
Effective unit weight at bottom of layer	=	71.00000	pcf
Undrained cohesion at top of layer	=	59.00000	psf
Undrained cohesion at bottom of layer	=	59.00000	psf
Epsilon-50 at top of layer	=	0.03000	
Epsilon-50 at bottom of layer	=	0.03000	

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	11.00000	ft
Distance from top of pile to bottom of layer	=	22.50000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	412.00000	psf
Undrained cohesion at bottom of layer	=	412.00000	psf
Epsilon-50 at top of layer	=	0.02000	
Epsilon-50 at bottom of layer	=	0.02000	

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	22.50000	ft
Distance from top of pile to bottom of layer	=	42.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.
Subgrade k at top of layer	=	60.00000	pci
Subgrade k at bottom of layer	=	60.00000	pci

Layer 6 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	42.00000	ft
Distance from top of pile to bottom of layer	=	53.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Undrained cohesion at top of layer	=	627.00000	psf
Undrained cohesion at bottom of layer	=	627.00000	psf
Epsilon-50 at top of layer	=	0.01000	
Epsilon-50 at bottom of layer	=	0.01000	

Layer 7 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	53.00000	ft
Distance from top of pile to bottom of layer	=	90.00000	ft
Effective unit weight at top of layer	=	62.00000	pcf
Effective unit weight at bottom of layer	=	62.00000	pcf
Friction angle at top of layer	=	30.00000	deg.
Friction angle at bottom of layer	=	30.00000	deg.

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Subgrade k at top of layer = 60.00000 pci
 Subgrade k at bottom of layer = 60.00000 pci

(Depth of lowest soil layer extends 10.00 ft below pile tip)

 Summary of Soil Properties

Angle of Layer Friction Num. deg.	Strain Factor (p-y Curve Criteria) Epsilon 50	Layer Soil Type kpy pci	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf
1	Stiff Clay with Free Water		0.00	52.000	750.000
--	0.01000	100.000	2.000	52.000	750.000
--	0.01000	100.000	2.000	55.000	667.000
2	Soft Clay	--	6.000	55.000	667.000
--	0.01000	--	6.000	71.000	59.000
3	Soft Clay	--	11.000	71.000	59.000
--	0.03000	--	11.000	62.000	412.000
4	Soft Clay	--	22.500	62.000	412.000
--	0.02000	--	22.500	62.000	--
5	Sand (Reese, et al.)	60.000	42.000	62.000	--
30.000	--	60.000	42.000	62.000	627.000
6	Soft Clay	--	53.000	62.000	627.000
--	0.01000	--	53.000	62.000	--
7	Sand (Reese, et al.)	60.000	90.000	62.000	--
30.000	--	60.000			
30.000	--	60.000			

 p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.6500	1.0000
2	90.000	0.6500	1.0000

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 = 1

Load No.	Load Compute Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 1000.00000 lbs	M = 198000. in-lbs	137000.

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head

y = lateral deflection relative to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applie to pile head

Axial thrust is assumed to be acting axially for all pile batter angles.

Specified Depths for Output of p-y Curves

Lateral load-transfer (p-y) curves are computed and output at 20 depths.
(Note that these curves are independent from the curves used at nodal point depths)

Depth No.	Depth Below Pile Head ft	Depth Below Ground Surface ft
1	0.000	0.000
2	2.000	2.000
3	4.000	4.000
4	6.000	6.000
5	8.000	8.000
6	10.000	10.000
7	12.000	12.000
8	14.000	14.000
9	16.000	16.000
10	18.000	18.000
11	22.000	22.000
12	24.000	24.000
13	26.000	26.000
14	28.000	28.000
15	30.000	30.000
16	32.000	32.000
17	34.000	34.000
18	36.000	36.000

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19	38.000	38.000
20	40.000	40.000

Depth of ground surface below top of pile = 0.00 ft

 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

 p-y Curves Reported for Specified Depths

p-y Curve Computed Using Static Criteria for Stiff Clay with Free Water

Soil Layer Number	=	1
Depth below pile head	=	0.000 ft
Depth below ground surface	=	0.000 ft
Equivalent Depth	=	0.000 ft
Diameter	=	24.000 in
c (at curve depth)	=	5.208 lb/in**2
Average cohesion, c	=	5.20833 psi
Undrained cohesion, c	=	750.00000 psf
Average Eff. Unit Weight	=	0.03009 pci
Average Eff. Unit Weight	=	52.00000 pcf
k	=	100.000 pci
Epsilon50	=	0.01000
y50	=	0.240 in
As	=	0.235
Ac (not used)	=	0.20000
pct	=	250.000 lb/in
pcd	=	1375.000 lb/in
pc	=	250.000 lb/in
pu	=	1.553 lb/in
p-multiplier	=	0.65000
y-multiplier	=	1.00000

y, in	p, lb/in
-----	-----
0.0000	0.0000
0.02814	0.0000
0.05628	0.0000
0.08442	0.0000
0.11256	0.0000
0.14070	0.0000
0.16884	0.0000
0.19698	0.0000
0.22512	0.0000
0.25326	0.0000
0.28140	0.0000
0.30954	0.0000
0.33768	0.0000

```

                                Liq_BentsRow345_Run2_Transverse.lp7o
0.56280                        0.0000
0.78792                        0.0000
1.01304                        0.0000
1.06932                        0.0000

```

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```

Soil Layer Number              =                2
Depth below pile head          =                2.000 ft
Depth below ground surface     =                2.000 ft
Transition Depth Xr            =            18.553 ft
Equivalent Depth of p-y curve  =                0.126 ft
Ground Slope Angle             =                0.000 degrees
Pile Batter                    =                0.000 degrees
Effective Slope                =                0.000 degrees
Pile Diameter                  =                24.000 in
Avg. Eff. Unit Weight          =                0.03009 pci
Avg. Eff. Unit Weight          =            52.00000 pcf
Cohesion, c                    =                4.920 psi
Cohesion, c                    =            708.500 psf
Epsilon50 parameter           =                0.0100
J (default value)              =                0.5000
Static pu_s for flat ground    =            359.066 lb/in
Static pu_d for flat ground    =            1062.750 lb/in
y_50                           =                0.60000 in
p-multiplier                   =                0.650
y-multiplier                   =                1.000
Positive-y Sloping Ground Factor =                1.000
Negative-y Sloping Ground Factor =                1.000
Sloping Ground Factor          =                1.000
Positive-y, static pu          =            359.066 lb/in

```

y, in	p, lb/in
0.0000	0.0000
0.00142	15.55951
0.01138	31.11902
0.03840	46.67852
0.09102	62.23803
0.17778	77.79754
0.30720	93.35704
0.48782	108.91655
0.72818	124.47607
1.03680	140.03557
1.42222	155.59508
1.89298	171.15458
2.45760	186.71409
3.12462	202.27360
3.90258	217.83311
4.80000	233.39261
5.10000	233.39261

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```

Soil Layer Number              =                2
Depth below pile head          =                4.000 ft
Depth below ground surface     =                4.000 ft
Transition Depth Xr            =            18.170 ft

```

Liq_BentsRow345_Run2_Transverse.lp7o

Equivalent Depth of p-y curve	=	2.126	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter	=	24.000	in
Avg. Eff. Unit Weight	=	0.03096	pci
Avg. Eff. Unit Weight	=	53.50000	pcf
Cohesion, c	=	4.632	psi
Cohesion, c	=	667.000	psf
Epsilon50 parameter	=	0.0100	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	411.546	lb/in
Static pu_d for flat ground	=	1000.500	lb/in
y_50	=	0.60000	in
p-multiplier	=	0.650	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	411.546	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00142	17.83365
0.01138	35.66729
0.03840	53.50094
0.09102	71.33459
0.17778	89.16824
0.30720	107.00188
0.48782	124.83553
0.72818	142.66918
1.03680	160.50283
1.42222	178.33647
1.89298	196.17012
2.45760	214.00377
3.12462	231.83742
3.90258	249.67106
4.80000	267.50470
5.10000	267.50470

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3
Depth below pile head	=	6.000 ft
Depth below ground surface	=	6.000 ft
Transition Depth Xr	=	15.047 ft
Equivalent Depth of p-y curve	=	5.800 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03125 pci
Avg. Eff. Unit Weight	=	54.00000 pcf
Cohesion, c	=	2.521 psi
Cohesion, c	=	363.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	321.430 lb/in

Liq_BentsRow345_Run2_Transverse.lp7o

Static pu_d for flat ground = 544.500 lb/in
y_50 = 1.20000 in
p-multiplier = 0.650
y-multiplier = 1.000
Positive-y Sloping Ground Factor = 1.000
Negative-y Sloping Ground Factor = 1.000
Sloping Ground Factor = 1.000
Positive-y, static pu = 321.430 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	13.92865
0.02276	27.85729
0.07680	41.78594
0.18204	55.71459
0.35556	69.64324
0.61440	83.57188
0.97564	97.50053
1.45636	111.42918
2.07360	125.35783
2.84444	139.28648
3.78596	153.21512
4.91520	167.14377
6.24924	181.07242
7.80516	195.00106
9.60000	208.92971
10.20000	208.92971

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number = 3
Depth below pile head = 8.000 ft
Depth below ground surface = 8.000 ft
Transition Depth Xr = 5.000 ft
Equivalent Depth of p-y curve = 8.000 ft
Ground Slope Angle = 0.000 degrees
Pile Batter = 0.000 degrees
Effective Slope = 0.000 degrees
Pile Diameter = 24.000 in
Avg. Eff. Unit Weight = 0.03371 pci
Avg. Eff. Unit Weight = 58.25000 pcf
Cohesion, c = 0.410 psi
Cohesion, c = 59.000 psf
Epsilon50 parameter = 0.0300
J (default value) = 0.5000
Static pu_s for flat ground = 126.833 lb/in
Static pu_d for flat ground = 88.500 lb/in
y_50 = 1.80000 in
p-multiplier = 0.650
y-multiplier = 1.000
Positive-y Sloping Ground Factor = 1.000
Negative-y Sloping Ground Factor = 1.000
Sloping Ground Factor = 1.000
Positive-y, static pu = 88.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00427	3.83500
0.03413	7.67000
0.11520	11.50500

Liq_BentsRow345_Run2_Transverse.lp7o

0.27307	15.34000
0.53333	19.17500
0.92160	23.01000
1.46347	26.84500
2.18453	30.68000
3.11040	34.51500
4.26667	38.35000
5.67893	42.18500
7.37280	46.02000
9.37387	49.85500
11.70773	53.69000
14.40000	57.52500
15.30000	57.52500

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3
Depth below pile head	=	10.000 ft
Depth below ground surface	=	10.000 ft
Transition Depth Xr	=	5.000 ft
Equivalent Depth of p-y curve	=	10.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03519 pci
Avg. Eff. Unit Weight	=	60.80000 pcf
Cohesion, c	=	0.410 psi
Cohesion, c	=	59.000 psf
Epsilon50 parameter	=	0.0300
J (default value)	=	0.5000
Static pu_s for flat ground	=	155.417 lb/in
Static pu_d for flat ground	=	88.500 lb/in
y_50	=	1.80000 in
p-multiplier	=	0.650
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	88.500 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00427	3.83500
0.03413	7.67000
0.11520	11.50500
0.27307	15.34000
0.53333	19.17500
0.92160	23.01000
1.46347	26.84500
2.18453	30.68000
3.11040	34.51500
4.26667	38.35000
5.67893	42.18500
7.37280	46.02000
9.37387	49.85500
11.70773	53.69000
14.40000	57.52500
15.30000	57.52500

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	12.000	ft
Depth below ground surface	=	12.000	ft
Transition Depth Xr	=	15.005	ft
Equivalent Depth of p-y curve	=	10.137	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter	=	24.000	in
Avg. Eff. Unit Weight	=	0.03573	pci
Avg. Eff. Unit Weight	=	61.75000	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	484.356	lb/in
Static pu_d for flat ground	=	618.000	lb/in
y_50	=	1.20000	in
p-multiplier	=	0.650	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	484.356	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	20.98875
0.02276	41.97750
0.07680	62.96624
0.18204	83.95500
0.35556	104.94374
0.61440	125.93249
0.97564	146.92124
1.45636	167.91000
2.07360	188.89874
2.84444	209.88749
3.78596	230.87624
4.91520	251.86499
6.24924	272.85374
7.80516	293.84248
9.60000	314.83123
10.20000	314.83123

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	14.000	ft
Depth below ground surface	=	14.000	ft
Transition Depth Xr	=	15.001	ft
Equivalent Depth of p-y curve	=	12.137	ft
Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter	=	24.000	in
Avg. Eff. Unit Weight	=	0.03576	pci

Liq_BentsRow345_Run2_Transverse.lp7o

Avg. Eff. Unit Weight	=	61.78571	pcf
Cohesion, c	=	2.861	psi
Cohesion, c	=	412.000	psf
Epsilon50 parameter	=	0.0200	
J (default value)	=	0.5000	
Static pu_s for flat ground	=	539.345	lb/in
Static pu_d for flat ground	=	618.000	lb/in
y_50	=	1.20000	in
p-multiplier	=	0.650	
y-multiplier	=	1.000	
Positive-y Sloping Ground Factor	=	1.000	
Negative-y Sloping Ground Factor	=	1.000	
Sloping Ground Factor	=	1.000	
Positive-y, static pu	=	539.345	lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	23.37160
0.02276	46.74320
0.07680	70.11480
0.18204	93.48641
0.35556	116.85801
0.61440	140.22961
0.97564	163.60121
1.45636	186.97282
2.07360	210.34442
2.84444	233.71602
3.78596	257.08762
4.91520	280.45922
6.24924	303.83083
7.80516	327.20242
9.60000	350.57403
10.20000	350.57402

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	16.000 ft
Depth below ground surface	=	16.000 ft
Transition Depth Xr	=	14.999 ft
Equivalent Depth of p-y curve	=	16.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03577 pci
Avg. Eff. Unit Weight	=	61.81250 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	645.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.650
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

y, in	Liq_BentsRow345_Run2_Transverse.lp7o p, lb/in
0.0000	0.0000
0.00284	26.78000
0.02276	53.56000
0.07680	80.34000
0.18204	107.12000
0.35556	133.90000
0.61440	160.68000
0.97564	187.46000
1.45636	214.24001
2.07360	241.02001
2.84444	267.80001
3.78596	294.58001
4.91520	321.36001
6.24924	348.14001
7.80516	374.92001
9.60000	401.70001
10.20000	401.70000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	18.000 ft
Depth below ground surface	=	18.000 ft
Transition Depth Xr	=	14.997 ft
Equivalent Depth of p-y curve	=	18.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03578 pci
Avg. Eff. Unit Weight	=	61.83333 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	700.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.650
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	26.78000
0.02276	53.56000
0.07680	80.34000
0.18204	107.12000
0.35556	133.90000
0.61440	160.68000
0.97564	187.46000
1.45636	214.24001
2.07360	241.02001
2.84444	267.80001
3.78596	294.58001
4.91520	321.36001

	Liq_BentsRow345_Run2_Transverse.lp7o
6.24924	348.14001
7.80516	374.92001
9.60000	401.70001
10.20000	401.70000

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	4
Depth below pile head	=	22.000 ft
Depth below ground surface	=	22.000 ft
Transition Depth Xr	=	14.994 ft
Equivalent Depth of p-y curve	=	22.000 ft
Ground Slope Angle	=	0.000 degrees
Pile Batter	=	0.000 degrees
Effective Slope	=	0.000 degrees
Pile Diameter	=	24.000 in
Avg. Eff. Unit Weight	=	0.03580 pci
Avg. Eff. Unit Weight	=	61.86364 pcf
Cohesion, c	=	2.861 psi
Cohesion, c	=	412.000 psf
Epsilon50 parameter	=	0.0200
J (default value)	=	0.5000
Static pu_s for flat ground	=	810.500 lb/in
Static pu_d for flat ground	=	618.000 lb/in
y_50	=	1.20000 in
p-multiplier	=	0.650
y-multiplier	=	1.000
Positive-y Sloping Ground Factor	=	1.000
Negative-y Sloping Ground Factor	=	1.000
Sloping Ground Factor	=	1.000
Positive-y, static pu	=	618.000 lb/in

y, in	p, lb/in
0.0000	0.0000
0.00284	26.78000
0.02276	53.56000
0.07680	80.34000
0.18204	107.12000
0.35556	133.90000
0.61440	160.68000
0.97564	187.46000
1.45636	214.24001
2.07360	241.02001
2.84444	267.80001
3.78596	294.58001
4.91520	321.36001
6.24924	348.14001
7.80516	374.92001
9.60000	401.70001
10.20000	401.70000

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	24.000 ft
Depth below ground surface	=	24.000 ft
Equivalent Depth (see note)	=	13.922 ft

Liq_BentsRow345_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.87500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2293.304	lb/in
Psd	=	7114.419	lb/in
Ps = Pst (shallow controls)	=	2293.304	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	2001.6087	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	1742.9111	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0164	in
Pk	=	164.519	lb/in
$Ym = b/60$	=	0.4000	in
$Pm = B ps$	=	1146.652	lb/in
$Yu = 3b/80$	=	0.9000	in
$Pu = A Ps$	=	2018.108	lb/in
Es,lim	=	10023.604	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.01641	106.93733	*
0.05128	213.77901	
0.08616	293.05343	
0.12103	360.31852	
0.15590	420.28293	
0.19077	475.16428	
0.22564	526.22595	
0.26051	574.27207	
0.29539	619.85351	
0.33026	663.36800	
0.36513	705.11429	
0.40000	745.32383	
0.65000	1028.54688	
0.90000	1311.76993	
0.92250	1311.76993	
0.94500	1311.76993	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	26.000 ft
Depth below ground surface	=	26.000 ft
Equivalent Depth (see note)	=	15.922 ft

Liq_BentsRow345_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.88462	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	2937.106	lb/in
Psd	=	7708.485	lb/in
Ps = Pst (shallow controls)	=	2937.106	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	2563.5223	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	2232.2003	
Yk = [c/(kx)]^(n/(n-1))	=	0.0219	in
Pk	=	251.144	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	1468.553	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	2584.653	lb/in
Es,lim	=	11463.604	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.02191	163.24370	*
0.05628	289.71139	
0.09065	387.11127	
0.12502	470.67635	
0.15940	545.57779	
0.19377	614.35290	
0.22814	678.47978	
0.26251	738.91270	
0.29688	796.31192	
0.33126	851.15766	
0.36563	903.81269	
0.40000	954.55933	
0.65000	1317.29188	
0.90000	1680.02442	
0.92250	1680.02442	
0.94500	1680.02442	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	28.000 ft
Depth below ground surface	=	28.000 ft
Equivalent Depth (see note)	=	17.922 ft

Liq_BentsRow345_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.89286	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	3659.908	lb/in
Psd	=	8302.551	lb/in
Ps = Pst (shallow controls)	=	3659.908	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	3194.3884	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	2781.5302	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0284	in
Pk	=	366.411	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	1829.954	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	3220.719	lb/in
Es, lim	=	12903.604	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.02840	238.16685	*
0.06218	383.55968	
0.09596	499.35904	
0.12974	599.86728	
0.16352	690.49382	
0.19731	774.01181	
0.23109	852.07727	
0.26487	925.77676	
0.29865	995.87068	
0.33244	1062.91684	
0.36622	1127.33939	
0.40000	1189.47018	
0.65000	1641.46884	
0.90000	2093.46750	
0.92250	2093.46750	
0.94500	2093.46750	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	30.000 ft
Depth below ground surface	=	30.000 ft
Equivalent Depth (see note)	=	19.922 ft

Liq_BentsRow345_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90000	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	4461.715	lb/in
Psd	=	8896.617	lb/in
Ps = Pst (shallow controls)	=	4461.715	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	3894.2100	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	3390.9034	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0359	in
Pk	=	515.432	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	2230.858	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	3926.309	lb/in
Es, lim	=	14343.604	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.03593	335.03072	*
0.06903	498.27990	
0.10213	632.25695	
0.13523	749.92135	
0.16832	856.69538	
0.20142	955.48887	
0.23452	1048.08690	
0.26761	1135.68188	
0.30071	1219.11910	
0.33381	1299.02465	
0.36690	1375.87822	
0.40000	1450.05741	
0.65000	2001.07922	
0.90000	2552.10103	
0.92250	2552.10103	
0.94500	2552.10103	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	32.000 ft
Depth below ground surface	=	32.000 ft
Equivalent Depth (see note)	=	21.922 ft

Liq_BentsRow345_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.90625	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	5342.529	lb/in
Psd	=	9490.683	lb/in
Ps = Pst (shallow controls)	=	5342.529	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	4662.9889	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	4060.3217	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0446	in
Pk	=	703.614	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	2671.264	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	4701.425	lb/in
Es, lim	=	15783.604	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.04458	457.34892	*
0.07689	637.06820	
0.10920	788.53157	
0.14151	923.12338	
0.17382	1046.07478	
0.20613	1160.32745	
0.23844	1267.73848	
0.27076	1369.57287	
0.30307	1466.74019	
0.33538	1559.92146	
0.36769	1649.64296	
0.40000	1736.32181	
0.65000	2396.12409	
0.90000	3055.92637	
0.92250	3055.92637	
0.94500	3055.92637	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	34.000 ft
Depth below ground surface	=	34.000 ft
Equivalent Depth (see note)	=	23.922 ft

Liq_BentsRow345_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91176	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	6302.351	lb/in
Psd	=	10084.749	lb/in
Ps = Pst (shallow controls)	=	6302.351	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = Pm/(Ym^(1/n))	=	5500.7270	
n = Pm/(m Ym)	=	1.6447	
m = (Pu-Pm)/(Yu-Ym)	=	4789.7865	
Yk = [c/(kx)]^(n/(n-1))	=	0.0544	in
Pk	=	936.641	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	3151.175	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	5546.069	lb/in
Es,lim	=	17223.604	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Y_k < Y_m < Y_u$.

y, in	p, lb/in	
0.0000	0.0000	
0.05438	608.81670	*
0.08580	803.33599	
0.11722	971.15556	
0.14864	1122.00185	
0.18006	1260.74805	
0.21148	1390.26644	
0.24290	1512.42553	
0.27432	1628.52501	
0.30574	1739.51397	
0.33716	1846.11158	
0.36858	1948.87887	
0.40000	2048.26398	
0.65000	2826.60428	
0.90000	3604.94458	
0.92250	3604.94458	
0.94500	3604.94458	

* p value(s) computed using $p = k * \text{Eff} * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	36.000 ft
Depth below ground surface	=	36.000 ft
Equivalent Depth (see note)	=	25.922 ft

Liq_BentsRow345_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.91667	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	7341.183	lb/in
Psd	=	10678.815	lb/in
Ps = Pst (shallow controls)	=	7341.183	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	6407.4254	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	5579.2988	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0654	in
Pk	=	1220.468	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	3670.591	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	6460.241	lb/in
Es, lim	=	18663.604	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.06539	793.30399	*
0.09581	1000.68996	
0.12623	1183.32756	
0.15665	1349.31577	
0.18707	1503.04831	
0.21749	1647.23830	
0.24791	1783.70614	
0.27832	1913.74639	
0.30874	2038.32024	
0.33916	2158.16558	
0.36958	2273.86409	
0.40000	2385.88438	
0.65000	3292.52043	
0.90000	4199.15648	
0.92250	4199.15648	
0.94500	4199.15648	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	38.000 ft
Depth below ground surface	=	38.000 ft
Equivalent Depth (see note)	=	27.922 ft

Liq_BentsRow345_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92105	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	8459.026	lb/in
Psd	=	11272.881	lb/in
Ps = Pst (shallow controls)	=	8459.026	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	7383.0851	
n = $Pm/(m Ym)$	=	1.6447	
m = $(Pu-Pm)/(Yu-Ym)$	=	6428.8595	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0777	in
Pk	=	1561.306	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	4229.513	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	7443.943	lb/in
Es, lim	=	20103.604	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.07766	1014.84912	*
0.10697	1232.91625	
0.13627	1428.45341	
0.16557	1608.04064	
0.19488	1775.51744	
0.22418	1933.36531	
0.25348	2083.30245	
0.28279	2226.57923	
0.31209	2364.14066	
0.34139	2496.72237	
0.37070	2624.91094	
0.40000	2749.18338	
0.65000	3793.87305	
0.90000	4838.56272	
0.92250	4838.56272	
0.94500	4838.56272	

* p value(s) computed using $p = k * Eff * y$

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	5
Depth below pile head	=	40.000 ft
Depth below ground surface	=	40.000 ft
Equivalent Depth (see note)	=	29.922 ft

Liq_BentsRow345_Run2_Transverse.lp7o

Ground Slope Angle	=	0.000	degrees
Pile Batter	=	0.000	degrees
Effective Slope	=	0.000	degrees
Pile Diameter, b	=	24.000	in
Angle of Friction	=	30.000	degrees
Avg. Eff. Unit Weight	=	61.92500	pcf
kpy	=	60.000	pci
K active	=	0.333	
K passive	=	3.000	
K0	=	0.400	
Pst	=	9655.881	lb/in
Psd	=	11866.947	lb/in
Ps = Pst (shallow controls)	=	9655.881	lb/in
A (static)	=	0.8800	
B (static)	=	0.5000	
C = $Pm/(Ym^{(1/n)})$	=	8427.7069	
n = $Pm/(m \cdot Ym)$	=	1.6447	
m = $(Pu - Pm)/(Yu - Ym)$	=	7338.4694	
$Yk = [c/(kx)]^{(n/(n-1))}$	=	0.0912	in
Pk	=	1965.621	lb/in
Ym = b/60	=	0.4000	in
Pm = B ps	=	4827.940	lb/in
Yu = 3b/80	=	0.9000	in
Pu = A Ps	=	8497.175	lb/in
Es, lim	=	21543.604	lb/in/in
p-multiplier	=	0.65000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

This curve has the normal shape for a Reese sand p-y curve where $Yk < Ym < Yu$.

y, in	p, lb/in	
0.0000	0.0000	
0.09124	1277.65335	*
0.11931	1503.96812	
0.14738	1710.12933	
0.17545	1901.35419	
0.20352	2080.89659	
0.23159	2250.95456	
0.25965	2413.09894	
0.28772	2568.50040	
0.31579	2718.06030	
0.34386	2862.49090	
0.37193	3002.36710	
0.40000	3138.16128	
0.65000	4330.66255	
0.90000	5523.16382	
0.92250	5523.16382	
0.94500	5523.16382	

* p value(s) computed using $p = k \cdot \text{Eff} \cdot x \cdot y$

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

Shear force at pile head = 1000.0 lbs
 Applied moment at pile head = 198000.0 in-lbs
 Axial thrust load on pile head = 137000.0 lbs

Depth Res.	Soil X	Deflect. Spr. y	Bending Distrib. Load	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil p
	Es*h feet lb/inch	Lat. inches lb/inch	Moment in-lbs	lbs	radians	psi*	lb-in^2	lb/in
0.000	0.00	0.0289	198000.	1000.0000	-0.000387	1234.1318	7.861E+10	
-19.0544	1.000	0.0244	210237.	880.5679	-0.000356	1291.6730	7.861E+10	
-37.7881	2.000	0.0204	219735.	553.1933	-0.000323	1336.3333	7.861E+10	
-36.9098	3.000	0.0167	224209.	111.2354	-0.000289	1357.3695	7.861E+10	
-37.7019	4.000	0.0134	223316.	-336.8464	-0.000255	1353.1720	7.861E+10	
-37.9369	5.000	0.0106	216943.	-791.1027	-0.000221	1323.2065	7.861E+10	
-19.7646	6.000	0.008115	205058.	-1191.2494	-0.000189	1267.3220	7.861E+10	
-4.3073	7.000	0.006035	190174.	-1290.6567	-0.000159	1197.3315	7.861E+10	
-3.8485	8.000	0.004303	174621.	-1339.6026	-0.000131	1124.2006	7.861E+10	
-3.3711	9.000	0.002890	158471.	-1382.9374	-0.000105	1048.2587	7.861E+10	
-2.8627	10.000	0.001768	141796.	-1420.3708	-8.238E-05	969.8484	7.861E+10	
-8.2953	11.000	0.000906	124673.	-1469.3765	-6.203E-05	889.3349	7.861E+10	
-9.6375	12.000	0.000271	106400.	-1594.6342	-4.438E-05	803.4117	7.861E+10	
8.5932	13.000	-0.000168	86802.	-1627.1353	-2.963E-05	711.2555	7.861E+10	
12.6111	14.000	-0.000449	68021.	-1497.2905	-1.783E-05	622.9462	7.861E+10	
14.6500	15.000	-0.000604	51025.	-1332.9214	-8.761E-06	543.0246	7.861E+10	
16.5080	16.000	-0.000666	36153.	-1141.4747	-2.130E-06	473.0967	7.861E+10	
16.4763	17.000	-0.000662	23645.	-943.2324	2.411E-06	414.2803	7.861E+10	
16.0723	18.000	-0.000614	13500.	-747.7117	5.224E-06	366.5766	7.861E+10	
15.4124	19.000	-0.000541	5663.6324	-558.6453	6.665E-06	329.7288	7.861E+10	
14.5773	20.000	-0.000457	43.7103	-378.6012	7.080E-06	303.3029	7.861E+10	
13.6282	21.000	-0.000373	-3478.1435	-209.3020	6.798E-06	319.4523	7.861E+10	
12.6104	22.000	-0.000295	-5037.3019	-51.8318	6.130E-06	326.7837	7.861E+10	
	23.000	-0.000226	-5160.5164	-0.8640	5.350E-06	327.3631	7.861E+10	

Liq_BentsRow345_Run2_Transverse.lp7o

1.3659	36284.	0.000				
24.000	-0.000166	-5085.7787	13.8329	4.566E-06	327.0117	7.861E+10
1.0840	39092.	0.000				
25.000	-0.000116	-4853.5806	25.1949	3.806E-06	325.9198	7.861E+10
0.8115	41900.	0.000				
26.000	-7.489E-05	-4503.1428	33.3944	3.091E-06	324.2720	7.861E+10
0.5580	44708.	0.000				
27.000	-4.182E-05	-4070.9773	38.7078	2.436E-06	322.2399	7.861E+10
0.3312	47516.	0.000				
28.000	-1.621E-05	-3589.8104	41.4857	1.851E-06	319.9773	7.861E+10
0.1359	50324.	0.000				
29.000	2.836E-06	-3087.8591	42.1245	1.342E-06	317.6171	7.861E+10
-0.0251	53132.	0.000				
30.000	1.622E-05	-2588.4341	41.0403	9.086E-07	315.2687	7.861E+10
-0.1513	55940.	0.000				
31.000	2.487E-05	-2109.8335	38.6472	5.502E-07	313.0182	7.861E+10
-0.2435	58748.	0.000				
32.000	2.964E-05	-1665.4781	35.3392	2.625E-07	310.9287	7.861E+10
-0.3041	61556.	0.000				
33.000	3.136E-05	-1264.2385	31.4764	3.932E-08	309.0420	7.861E+10
-0.3364	64364.	0.000				
34.000	3.076E-05	-910.9038	27.3752	-1.262E-07	307.3806	7.861E+10
-0.3443	67172.	0.000				
35.000	2.848E-05	-606.7436	23.3027	-2.416E-07	305.9504	7.861E+10
-0.3322	69980.	0.000				
36.000	2.509E-05	-350.1234	19.4734	-3.142E-07	304.7437	7.861E+10
-0.3043	72788.	0.000				
37.000	2.105E-05	-137.1385	16.0493	-3.510E-07	303.7422	7.861E+10
-0.2652	75596.	0.000				
38.000	1.675E-05	37.7582	13.1409	-3.582E-07	303.2749	7.861E+10
-0.2189	78404.	0.000				
39.000	1.252E-05	181.1508	10.8095	-3.413E-07	303.9492	7.861E+10
-0.1695	81212.	0.000				
40.000	8.622E-06	300.0843	9.0700	-3.043E-07	304.5084	7.861E+10
-0.1207	84020.	0.000				
41.000	5.269E-06	401.5179	7.8926	-2.506E-07	304.9854	7.861E+10
-0.0763	86828.	0.000				
42.000	2.650E-06	491.8003	2.8483	-1.824E-07	305.4099	7.861E+10
-1.4917	3377076.	0.000				
43.000	9.078E-07	438.7059	-8.7948	-1.101E-07	305.1602	7.861E+10
-0.5109	3377076.	0.000				
44.000	-3.967E-08	307.8588	-11.4350	-5.282E-08	304.5450	7.861E+10
0.0223	3377076.	0.000				
45.000	-4.228E-07	177.2927	-9.6878	-1.602E-08	303.9310	7.861E+10
0.2380	3377076.	0.000				
46.000	-4.773E-07	79.3052	-6.5527	3.198E-09	303.4703	7.861E+10
0.2686	3377076.	0.000				
47.000	-3.821E-07	19.2452	-3.6159	1.038E-08	303.1878	7.861E+10
0.2150	3377076.	0.000				
48.000	-2.481E-07	-10.0321	-1.4869	1.084E-08	303.1445	7.861E+10
0.1396	3377076.	0.000				
49.000	-1.301E-07	-19.1092	-0.2225	8.471E-09	303.1872	7.861E+10
0.0732	3377076.	0.000				
50.000	-4.597E-08	-17.4585	0.3574	5.616E-09	303.1794	7.861E+10
0.0259	3377076.	0.000				
51.000	6.620E-09	-11.9155	0.4788	3.361E-09	303.1534	7.861E+10
-0.003726	3377076.	0.000				
52.000	3.732E-08	-6.7955	0.3234	1.952E-09	303.1293	7.861E+10
-0.0210	3377076.	0.000				
53.000	5.524E-08	-4.6358	0.0976	1.116E-09	303.1191	7.861E+10
-0.000796	86439.	0.000				
54.000	6.464E-08	-3.5263	0.0870	4.942E-10	303.1139	7.861E+10
-0.000962	89247.	0.000				

Liq_BentsRow345_Run2_Transverse.lp7o						
55.000	6.757E-08	-2.5537	0.0750	3.155E-11	303.1094	7.861E+10
-0.001037	92055.	0.000				
56.000	6.581E-08	-1.7290	0.0624	-2.939E-10	303.1055	7.861E+10
-0.001041	94863.	0.000				
57.000	6.087E-08	-1.0533	0.0502	-5.048E-10	303.1023	7.861E+10
-0.000991	97671.	0.000				
58.000	5.397E-08	-0.5196	0.0388	-6.236E-10	303.0998	7.861E+10
-0.000904	100479.	0.000				
59.000	4.611E-08	-0.1158	0.0286	-6.709E-10	303.0979	7.861E+10
-0.000794	103287.	0.000				
60.000	3.803E-08	0.1739	0.0198	-6.655E-10	303.0982	7.861E+10
-0.000672	106095.	0.000				
61.000	3.025E-08	0.3667	0.0125	-6.234E-10	303.0991	7.861E+10
-0.000549	108903.	0.000				
62.000	2.314E-08	0.4803	0.006627	-5.580E-10	303.0996	7.861E+10
-0.000431	111711.	0.000				
63.000	1.690E-08	0.5317	0.002116	-4.803E-10	303.0998	7.861E+10
-0.000322	114519.	0.000				
64.000	1.162E-08	0.5363	-0.001172	-3.984E-10	303.0999	7.861E+10
-0.000227	117327.	0.000				
65.000	7.328E-09	0.5080	-0.003405	-3.184E-10	303.0997	7.861E+10
-0.000147	120135.	0.000				
66.000	3.962E-09	0.4583	-0.004761	-2.445E-10	303.0995	7.861E+10
-8.119E-05	122943.	0.000				
67.000	1.434E-09	0.3967	-0.005418	-1.792E-10	303.0992	7.861E+10
-3.005E-05	125751.	0.000				
68.000	-3.681E-10	0.3305	-0.005542	-1.237E-10	303.0989	7.861E+10
7.886E-06	128559.	0.000				
69.000	-1.565E-09	0.2652	-0.005281	-7.825E-11	303.0986	7.861E+10
3.426E-05	131367.	0.000				
70.000	-2.275E-09	0.2047	-0.004764	-4.244E-11	303.0983	7.861E+10
5.087E-05	134175.	0.000				
71.000	-2.609E-09	0.1515	-0.004096	-1.533E-11	303.0981	7.861E+10
5.957E-05	136983.	0.000				
72.000	-2.665E-09	0.1067	-0.003362	4.293E-12	303.0978	7.861E+10
6.210E-05	139791.	0.000				
73.000	-2.525E-09	0.0708	-0.002626	1.775E-11	303.0977	7.861E+10
6.001E-05	142599.	0.000				
74.000	-2.254E-09	0.0435	-0.001936	2.640E-11	303.0975	7.861E+10
5.462E-05	145407.	0.000				
75.000	-1.902E-09	0.0240	-0.001325	3.147E-11	303.0975	7.861E+10
4.698E-05	148215.	0.000				
76.000	-1.506E-09	0.0113	-0.000815	3.411E-11	303.0974	7.861E+10
3.790E-05	151023.	0.000				
77.000	-1.088E-09	0.003965	-0.000420	3.522E-11	303.0974	7.861E+10
2.789E-05	153831.	0.000				
78.000	-6.626E-10	0.000686	-0.000149	3.555E-11	303.0973	7.861E+10
1.730E-05	156639.	0.000				
79.000	-2.357E-10	-0.000106	-6.862E-06	3.557E-11	303.0973	7.861E+10
6.263E-06	159447.	0.000				
80.000	1.911E-10	0.000	0.000	3.556E-11	303.0973	7.861E+10
-5.169E-06	81128.	0.000				

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

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.0288863 inches
Computed slope at pile head	=	-0.0003868 radians
Maximum bending moment	=	224442. inch-lbs
Maximum shear force	=	-1638.2308378 lbs
Depth of maximum bending moment	=	3.5000000 feet below pile head

Depth of maximum shear force = 12.5000000 feet below pile head
 Number of iterations = 14
 Number of zero deflection points = 6

 Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
 Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
 Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
 Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
 Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Maximum Load Type No.	Pile-head Condition 1 Maximum Shear V(lbs) or in Pile y(inches)	Pile-head Condition 2 Pile-head Rotation or in-lb, rad., or in-lb/rad. radians	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs
1	1	V = 1000.0000	M = 198000.	137000.	0.02888633	
224442.		-1638.2308	-0.00038682			

 Computed Pile-head Stiffness Matrix Values
 K22, K23, K32, K33 for Pile Head

Computation Method Used for Pile-head Stiffnesses

Computations Based on Loads Defined in Load Case 1

The K22 and K32 stiffnesses are computed using the zero rotation and shear pile-head condition.

K22 = abs(Shear Reaction/Top y)
 K32 = abs(Moment Reaction/Top y)

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K22 V/y lb/in.	K32 M/y in-lb/in.
0.00002585	0.000000	100.000000	2822.790880	3869171.	109218615.
0.000222	0.000000	370.926996	13106.	1672334.	59089960.
0.000439	0.000000	529.409129	20205.	1204583.	45972472.
0.000644	0.000000	641.853992	25734.	996386.	39947650.
0.000832	0.000000	729.073004	30232.	876453.	36343253.
0.000997	0.000000	800.336125	33988.	802700.	34088270.
0.001148	0.000000	860.588236	37252.	749592.	32447718.


```

                                Liq_BentsRow345_Run2_Transverse.lp7o
0.001295      0.000000      912.780988      40173.      705025.      31029138.
0.001423      0.000000      958.818258      42744.      673599.      30028674.
0.001545      0.000000      1000.000000      45088.      647103.      29176824.

```

The K23 and K33 stiffnesses are computed using the zero displacment and moment pile-head condition.

```

K23 = abs(Shear Reaction/Top Rotation)
K33 = abs(Moment Reaction/Top Rotation)

```

Pile-Top Deflection inches	Pile-Top Rotation radians	Pile-Top Shear Reac. lbs	Pile-Top Mom. Reac. in-lbs	K23 V/rot. lb/rad	K33 M/rot. in-lb/rad
-----	-----	-----	-----	-----	-----
0.000000	0.00000599	391.003470	19800.	65246684.	3304022731.
0.000000	0.00003178	1064.930379	73444.	33511594.	2311146650.
0.000000	0.00004958	1393.164645	104823.	28101445.	2114378961.
0.000000	0.00006303	1610.990745	127087.	25558014.	2016208784.
0.000000	0.00007381	1774.317963	144356.	24040080.	1955873088.
0.000000	0.00008281	1904.298474	158467.	22996145.	1913628456.
0.000000	0.00009063	2011.364239	170396.	22193626.	1880174370.
0.000000	0.00009744	2103.119342	180731.	21584694.	1854871176.
0.000000	0.000103	2183.355405	189846.	21095484.	1834283842.
0.000000	0.000109	2254.419814	198000.	20687819.	1816958866.

The analysis ended normally.

SUBJECT:

COMPUTED BY: RL

DATE:

FILE NO.

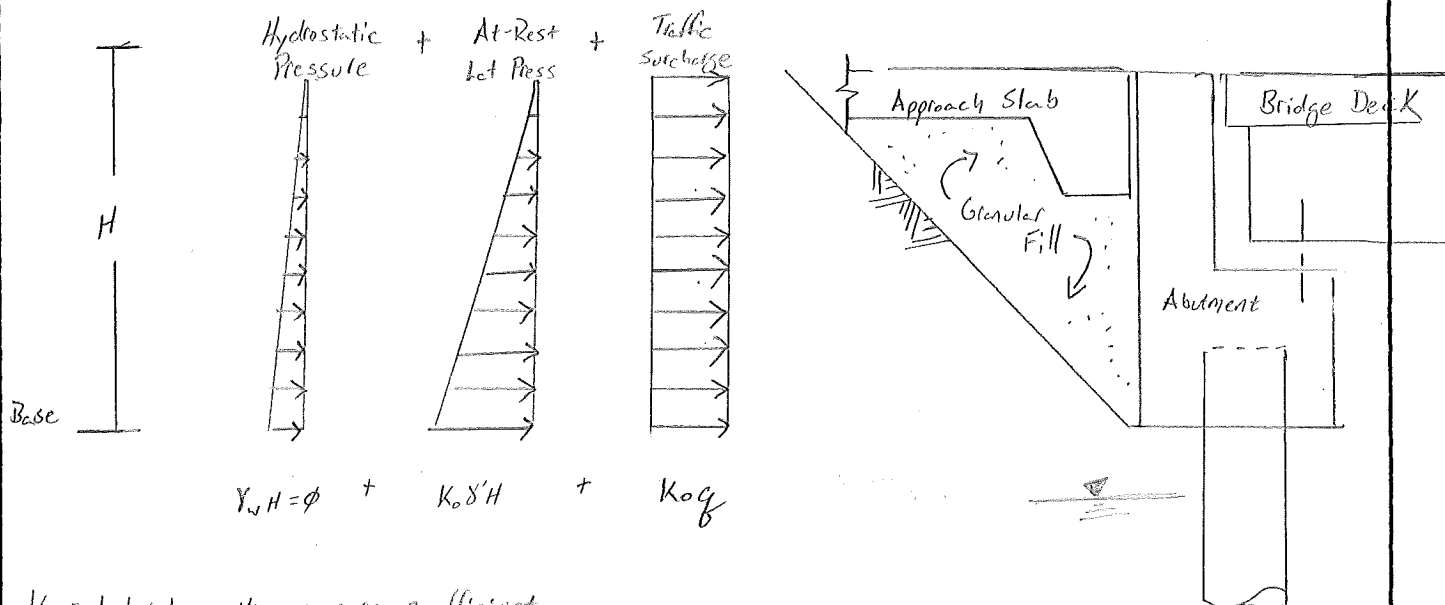
Abutment Lateral Earth Pressures

CHECKED BY:

DATE:

1/2
SHEET NO.

During Static Case Abutments are not expected to move, so "at-rest."



K_o = lateral earth pressure coefficient
 H = height of the wall = 7 ft
 δ' = submerged soil weight = 125 pcf
 γ_w = unit weight of water = 62.4 pcf
 q = surcharge unit weight = 475 pcf

Solve for "At-rest" pressure

- Use Jaky's eq to solve for coefficient of earth pressure at rest,

$$K_o = 1 - \sin \phi = 1 - \sin(30) = 0.50 \quad [\text{this may underestimate results due to compacted fill}]$$

- use $K_o = 0.75$ so $\phi_o' = K_o(\delta' H + q) = 0.75(125 \text{ pcf}(7 \text{ ft}) + 475 \text{ pcf}) = \underline{1 \text{ Ksf}}$

- The total force per unit length of wall

$$P_{\text{soil}} = \frac{1}{2} K_o \delta' H^2 = \frac{1}{2} (0.75)(125 \text{ pcf})(7 \text{ ft})^2 = \underline{2.3 \text{ K/Ft}} \quad @ \quad H/3 \text{ from Base}$$

$$P_{\text{surcharge}} = K_o q H = (0.75)(475 \text{ pcf})(7 \text{ ft}) = \underline{2.5 \text{ K/Ft}} \quad @ \quad H/2 \text{ from Base}$$

SUBJECT:

COMPUTED BY: RL

DATE:

FILE NO.

Abutment Lateral Earth Pressures

CHECKED BY:

DATE:

SHEET NO.

2/2

For Seismic Lateral Earth Pressures assume active & passive conditions

- Use M-O Soln & assumptions
- Assume traffic surcharge is 3.8' of 125pcf fill, so wall idealized as 4' taller.

$$K_h = 0.21$$

$$K_v = 0$$

$$K_A = 0.30 \quad \left\{ \begin{array}{l} \text{Use Coulomb's} \\ \text{coefficients} \end{array} \right.$$

$$K_P = 1.65$$

$$\gamma = 0.125 \text{ kcf}$$

$$\phi' = 30^\circ$$

$$H = 11' = h$$

$$\delta' = 0^\circ$$

$$\beta = 0^\circ$$

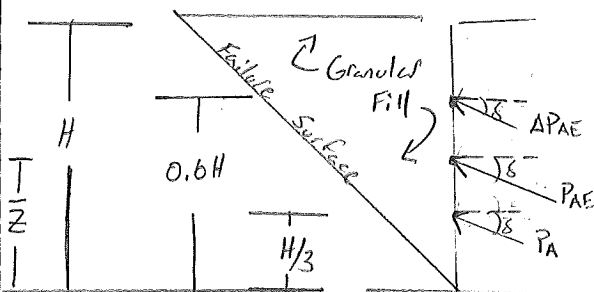
$$\delta = 2/3 \phi' = 20^\circ$$

- For M-O sol based on AASHTO LRFD Appendix II (attached)

$$K_{AE} = 0.52 \quad \& \quad K_{PE} = 4.92$$

$$\text{so } \Delta K_{AE} = 0.22 \quad \& \quad \Delta K_{PE} = 3.27$$

- For Example (Active Condition)



$$P_A = \frac{1}{2} K_A H^2 \gamma$$

$$\Delta P_A = \frac{1}{2} \Delta K_{AE} H^2 \gamma$$

$$\bar{z} = \frac{P_A (H/3) + \Delta P_{AE} (0.6H)}{P_{AE}}$$

$$P_A = \frac{1}{2} (0.30) (11\text{ft})^2 (0.125 \text{ kcf}) = 2.27 \text{ klf}$$

$$\Delta P_{AE} = \frac{1}{2} (0.22) (11\text{ft})^2 (0.125 \text{ kcf}) = 1.66 \text{ klf}$$

$$P_{AE} = 3.93 \text{ klf} \quad \& \quad \bar{z} = 4.91\text{ft} \quad (\text{this may be conserv according to Appendix AII})$$

- AASHTO suggests P_{AE} act through $H/3$ with 0.4H to 0.5H if impact is severe.

Back analysis of full-scale walls in earthquakes, however, indicates earth pressure resultants located higher than $h/3$ will overestimate the force, resulting in a prediction of wall failure when in reality the wall performed well (Clough and Fragaszy, 1977). Recent research indicates the location of the resultant of the total earth pressure (static plus seismic) should be located one-third up from the wall based on centrifuge model tests on gravity walls (Al Atik and Sitar, 2010; Bray et al., 2010; and Lew et al., 2010). However, recent work by others (Nakamura, 2006) also indicates that the resultant location could be slightly higher, depending on the specifics of the ground motion and the wall details.

A reasonable approach is to assume that for routine walls, the combined static/seismic resultant should be located at the same location as static earth pressure resultant but no less than $h/3$. Because there is limited evidence that in some cases the combined static/seismic resultant location could be slightly higher than the static earth pressure resultant, a slightly higher resultant location (e.g., $0.4h$ to $0.5h$) for seismic design of walls for which the impact of wall failure is relatively high should be considered. However, for routine wall designs, a combined static/seismic resultant location equal to that used for static design (e.g., $h/3$) is sufficient.

The effects of abutment inertia are not taken into account in the Mononobe-Okabe analysis. Many current procedures assume that the inertia forces due to the mass of the abutment itself may be neglected in considering seismic behavior and seismic design. This is not a conservative assumption, and for those abutments relying on their mass for stability, it is also an unreasonable assumption in that to neglect the mass is to neglect a major aspect of their behavior. The effects of wall inertia are discussed further by Richards and Elms (1979), who show that wall inertia forces should not be neglected in the design of gravity-retaining walls.

A11.3.2—Modification of Mononobe-Okabe Method to Consider Cohesion

The M-O equation for seismic active earth pressure determination has many limitations, as discussed in Anderson et al. (2008). These limitations include the inability to account for cohesion that occurs in the soil. This limitation has been addressed by rederiving the seismic active earth pressure using a Coulomb-type wedge analysis. Generally, soils with more than 15 percent fines content can be assumed to be undrained during seismic loading. For this loading condition, total stress soil parameters, γ and c , should be used.

Eq. A11.3.2-1 that is provided by Anderson et al. (2008), and Figure A11.3.2-1 shows the terms in the equation. This equation is very simple and practical for the design of the retaining walls and the equation has been calibrated with slope stability computer programs.

$$P_{ae} = \frac{W \left[(1 - k_v) \tan(\alpha - \phi) + k_h \right] - CL \left[\sin \alpha \tan(\alpha - \phi) + \cos \alpha \right] - C_s H \left[\tan(\alpha - \phi) \cos \alpha + \sin \alpha \right]}{\left[1 + \tan(\delta + \phi) \tan(\alpha - \phi) \right] \cos(\delta + \phi)} \quad \text{A11.3.2-1}$$

The only variables in Eq. A11.3.2-1 are the failure plane angle α and the trial wedge surface length L . Values of friction angle (ϕ), seismic horizontal coefficient (k_h), seismic vertical coefficient (k_v), soil cohesion (C), soil wall adhesion (C_a), soil wall friction (δ), and soil wall angle (α) are defined by the designer on the basis of the site conditions and the U.S. Geological Survey seismic hazard maps shown in Section 3.

The recommended approach in this Section is to assume that $k_v = 0$, and k_h is the PGA adjusted for site effects (i.e., A_s , A_{ss} , or k_{hs} or some combination thereof, if the wall is greater than 20.0 ft in height and horizontal wall displacement can occur and is acceptable). A 50 percent reduction in the resulting seismic coefficient is used when defining k_h if 1.0 to 2.0 in. of permanent ground deformation is permitted during the design seismic event. Otherwise, the peak ground acceleration coefficient should be used. Eq. A11.3.2-1 can be easily calculated in a spreadsheet. Using a simple spreadsheet, the user can search for the angle α and calculate maximum value of P_{ae} .

APPENDIX E

Settlement Analysis

Soil Stratigraphy and Material PropertiesBoring 22-BMU-14
GW El (ft) 222.4

Layer	El top (ft)	El bottom (ft)	Model	γ_{dry} (pcf)	w_{nat} (%)	G_s^*	S_u (psf)	LL (%)	PI (%)	PL (%)	e_0
1	243	234	Silt (ML)	110	22	2.65	970	24	5	19	0.50
2	234	224	Clay	95	24	2.75	1000	29	13	16	0.81
3	224	219	Silt (ML)	105	28	2.65	970	25	18	7	0.57
4	219	190	Sand	99	26	2.67				NP	0.68
5	190									0	#DIV/0!
6	0									0	#DIV/0!
7	0									0	#DIV/0!
8	0									0	#DIV/0!
9	0									0	#DIV/0!
10	0									0	#DIV/0!

* Bowles¹ recommends G_s values of 2.65 to 2.68 for SAND, 2.62 to 2.68 for SILT, and 2.68 to 2.75 for inorganic CLAY (table on pg. 29)**Approximate Preconsolidation Stress (σ_c') (cap at 3,500 psf OR NC based on the results of the consolidation tests)**

Layer	Equ. 11.46- Mitchell ² Jamiolkowski, et al. σ_c' (psf)	Equ. 2.60- Bowles Skempton & Henkel σ_c' (psf)	Equ. 2.51- Bowles Nagaraj & S.M σ_c' (psf)	Design Value σ_c' (psf)	Notes
1	3593	7549	3606	3500	
2	3704	6325	3719	3500	
3	3593	5493	3606	3500	
4	0	0	-61		
5	0	0	-61		
6	0	0	-61		
7	0	0	-61		
8	0	0	-61		
9	0	0	-61		
10	0	0	-61		

Approximate Compression Index (C_c)

Layer	Table 2-5 Bowles Terzaghi & Peck $C_c/1+e_0$	Table 2-5 Bowles Azzouz, et al $C_c/1+e_0$	Table 2-5 Bowles Nagaraj & S.M $C_c/1+e_0$	Design Value $C_c/1+e_0$	Notes
1	0.086	0.133	0.100	0.086	Fig. 9.63 has as 0.03
2	0.094	0.139	0.105	0.105	
3	0.089	0.075	0.102	0.089	
4	-0.053	0.149	0.000	0.001	
5	#DIV/0!	0.142	#DIV/0!		
6	#DIV/0!	0.106	#DIV/0!		
7	#DIV/0!	0.126	#DIV/0!		
8	#DIV/0!	0.126	#DIV/0!		
9	#DIV/0!	0.045	#DIV/0!		
10	#DIV/0!	#DIV/0!	#DIV/0!		

Approximate Recompression Index (C_r)

Layer	Table 2-5 Bowles Nakasa, et al. (1) $C_r/1+e_0$	Equ. 11.16 Coduto ³ Kulhawy & Mayne $C_r/1+e_0$	Table 2-5 Bowles Nakasa, et al. (2) ($0.1 \cdot C_c$): $C_r/1+e_0$	Design Value $C_r/1+e_0$	Notes
1	0.000	0.007	0.009	0.007	
2	0.011	0.022	0.011	0.011	
3	0.019	0.032	0.009	0.019	
4	-0.006	0.000	0.000	0.001	
5	#DIV/0!	#DIV/0!	0.000		
6	#DIV/0!	#DIV/0!	0.000		
7	#DIV/0!	#DIV/0!	0.000		
8	#DIV/0!	#DIV/0!	0.000		
9	#DIV/0!	#DIV/0!	0.000		
10	#DIV/0!	#DIV/0!	0.000		

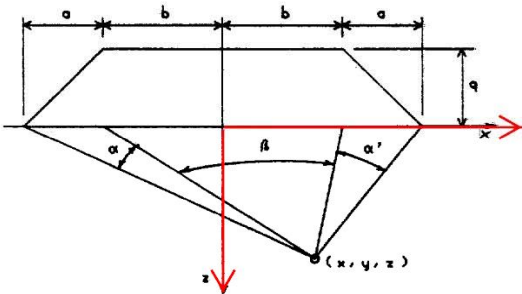
References:

- 1) Bowles, Joseph E. 1996. *Foundation Analysis and Design*, Fifth Edition.
- 2) Mitchell, James K and Kenichi Soga. 2005. *Fundamentals of Soil Behavior*, Third Edition.
- 3) Coduto, Donald P. 1999. *Geotechnical Engineering Principles and Practices*.

TRAPEZOIDAL

$$\frac{q}{\pi a} [a(\alpha+\beta+\alpha') + b(\alpha+\alpha') + x(\alpha-\alpha')]$$

From Table C-1 of EM 1110-1-1904.
September 1990



Embankment Load and Geometry (See Figure above from Table C-1)

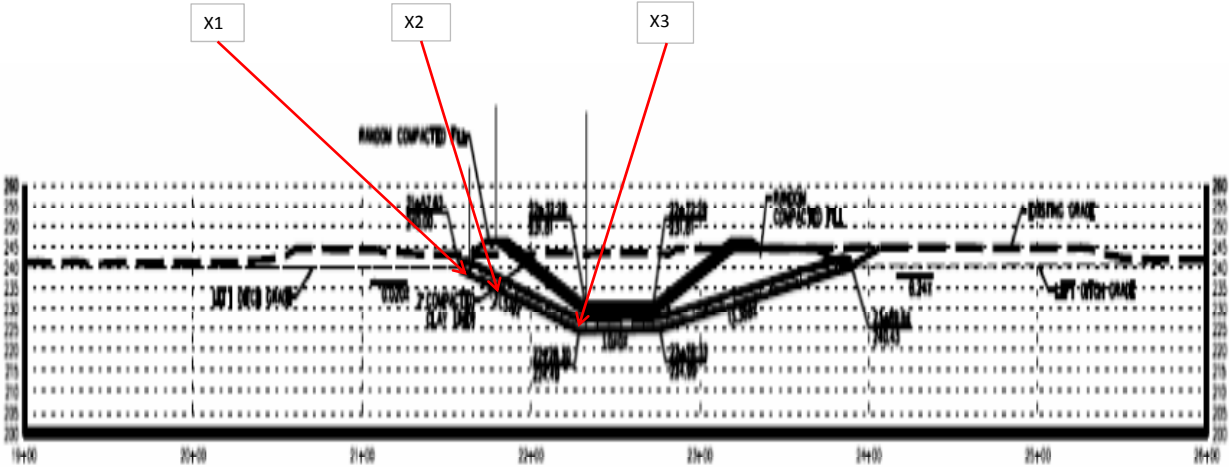
q (psf)	360	x ₁ (ft)	x ₂ (ft)	x ₃ (ft)
a (ft)	9	Value	-16	0
b (ft)	6	Location	LS Toe	Center of Embankment
				RS Edge of Canal Slope

Load Influence Factors (I_o)

Layer	z (ft)	I _o at x ₁	I _o at x ₂	I _o at x ₃
1	4.5	0.101	0.964	0.000
2	14	0.259	0.698	0.005
3	21.5	0.285	0.531	0.014
4	38.5	0.250	0.329	0.044
5	148	0.088	0.090	0.071
6	243	0.054	0.055	0.050
7	243	0.054	0.055	0.050
8	243	0.054	0.055	0.050
9	243	0.054	0.055	0.050
10	243	0.054	0.055	0.050

Embankment Properties

Material	Random
γ (psf)	120
H _{avg} (ft)	3
Slope (#H:1V)	3



Estimate Consolidation Settlement

LS Toe at x1

Layer	h (ft)	Calculated Settlement	σ_{z0}' (psf)	σ_c' (psf)	$I_\sigma * q$ (psf)	σ_{zf}' (psf)	Case ¹	$C_c/(1+e_0)$	$C_r/(1+e_0)$	δ_{ci} (ft)
1	9	yes	604	3500	36	640	OC Case I	0.086	0.007	0.002
2	10	yes	1797	3500	93	1890	OC Case I	0.105	0.011	0.002
3	5	yes	2666	3500	103	2768	OC Case I	0.089	0.019	0.002
4	29	no	3750	0	90	3840	Underconsolidated	0.001	0.001	0.000
5	190	no	-1275	0	32	-1243	OC Case I	0.000	0.000	0.000
6	0	no	-7203	0	20	-7183	OC Case I	0.000	0.000	0.000
7	0	no	-7203	0	20	-7183	OC Case I	0.000	0.000	0.000
8	0	no	-7203	0	20	-7183	OC Case I	0.000	0.000	0.000
9	0	no	-7203	0	20	-7183	OC Case I	0.000	0.000	0.000
10	0	no	-7203	0	20	-7183	OC Case I	0.000	0.000	0.000
									$\sum \delta_c$ (ft)=	0.006
									$\sum \delta_c$ (in)=	0.07

Estimate Consolidation Settlement

Center of Embankment at x2

Layer	h (ft)	Calculated Settlement	σ_{z0}' (psf)	σ_c' (psf)	$I_\sigma * q$ (psf)	σ_{zf}' (psf)	Case ¹	$C_c/(1+e_0)$	$C_r/(1+e_0)$	δ_{ci} (ft)
1	9	no	604	3500	347	951	OC Case I	0.086	0.007	0.000
2	10	yes	1797	3500	251	2048	OC Case I	0.105	0.011	0.006
3	5	yes	2666	3500	191	2857	OC Case I	0.089	0.019	0.003
4	29	no	3750	0	118	3868	Underconsolidated	0.001	0.001	0.000
5	190	no	-1275	0	32	-1242	OC Case I	0.000	0.000	0.000
6	0	no	-7203	0	20	-7183	OC Case I	0.000	0.000	0.000
7	0	no	-7203	0	20	-7183	OC Case I	0.000	0.000	0.000
8	0	no	-7203	0	20	-7183	OC Case I	0.000	0.000	0.000
9	0	no	-7203	0	20	-7183	OC Case I	0.000	0.000	0.000
10	0	no	-7203	0	20	-7183	OC Case I	0.000		
At the CL of the canal levee the pipe will actually be below layer 4. Settlement in layer 4 was accounted for in this analysis to consider variability.									$\sum \delta_c$ (ft)=	0.009
									$\sum \delta_c$ (in)=	0.11

At the CL of the canal levee the pipe will actually be below layer 4. Settlement in layer 4 was accounted for in this analysis to consider variability.

Estimate Consolidation Settlement

RS Edge of Canal Slope at x3

Layer	h (ft)	Calculated Settlement	σ_{z0}' (psf)	σ_c' (psf)	I_0*q (psf)	σ_{zf}' (psf)	Case ¹	$C_c/(1+e_0)$	$C_r/(1+e_0)$	δ_c (ft)
1	9	no	604	3500	0	604	OC Case I	0.086	0.007	0.000
2	10	no	1797	3500	2	1798	OC Case I	0.105	0.011	0.000
3	5	yes	2666	3500	5	2671	OC Case I	0.089	0.019	0.000
4	29	no	3750	0	16	3765	Underconsolidated	0.001	0.001	0.000
5	190	no	-1275	0	26	-1249	OC Case I	0.000	0.000	0.000
6	0	no	-7203	0	18	-7184	OC Case I	0.000	0.000	0.000
7	0	no	-7203	0	18	-7184	OC Case I	0.000	0.000	0.000
8	0	no	-7203	0	18	-7184	OC Case I	0.000	0.000	0.000
9	0	no	-7203	0	18	-7184	OC Case I	0.000	0.000	0.000
10	0	no	-7203	0	18	-7184	OC Case I	0.000		0.000
									$\sum \delta_c$ (ft)=	0.000
									$\sum \delta_c$ (in)=	0.00

NC Case is for normally consolidated soil

$$\delta_c = \sum \frac{C_c}{1+e_0} H \log \left(\frac{\sigma'_{zf}}{\sigma'_{z0}} \right)$$

OC Case I is for overconsolidated soils where $\sigma_{z0}' < \sigma_c' \leq \sigma_{zf}'$

$$\delta_c = \sum \frac{C_r}{1+e_0} H \log \left(\frac{\sigma'_{zf}}{\sigma'_{z0}} \right)$$

OC Case II is for overconsolidated soils where $\sigma_{z0}' < \sigma_c' < \sigma_{zf}'$

$$\delta_c = \sum \left(\frac{C_r}{1+e_0} H \log \left(\frac{\sigma'_c}{\sigma'_{z0}} \right) + \frac{C_c}{1+e_0} H \log \left(\frac{\sigma'_{zf}}{\sigma'_c} \right) \right)$$

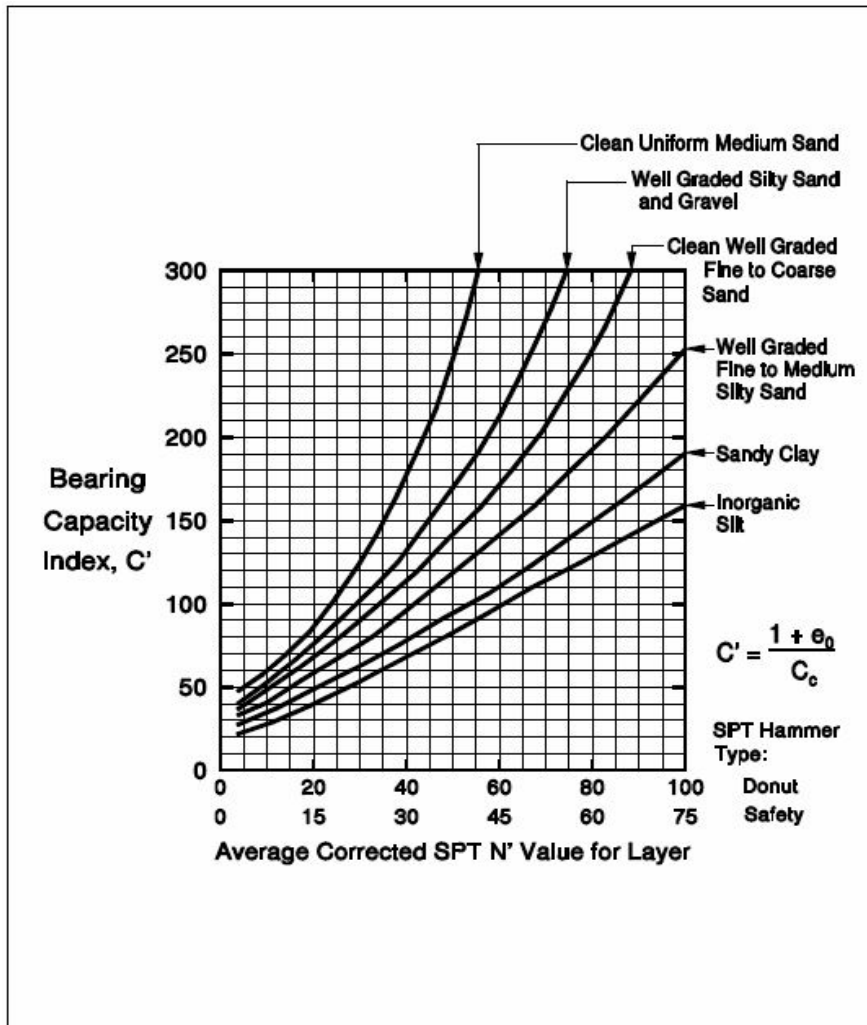


Figure 9.63 Values of the Bearing Capacity Index, C' , for Granular Soil (modified after Cheney and Chassie, 1993)

TABLE 3.3 CONSISTENCY OF COARSE-GRAINED SOILS VARIOUS RELATIVE DENSITIES (Adapted from Lambe and Whitman, 1969)

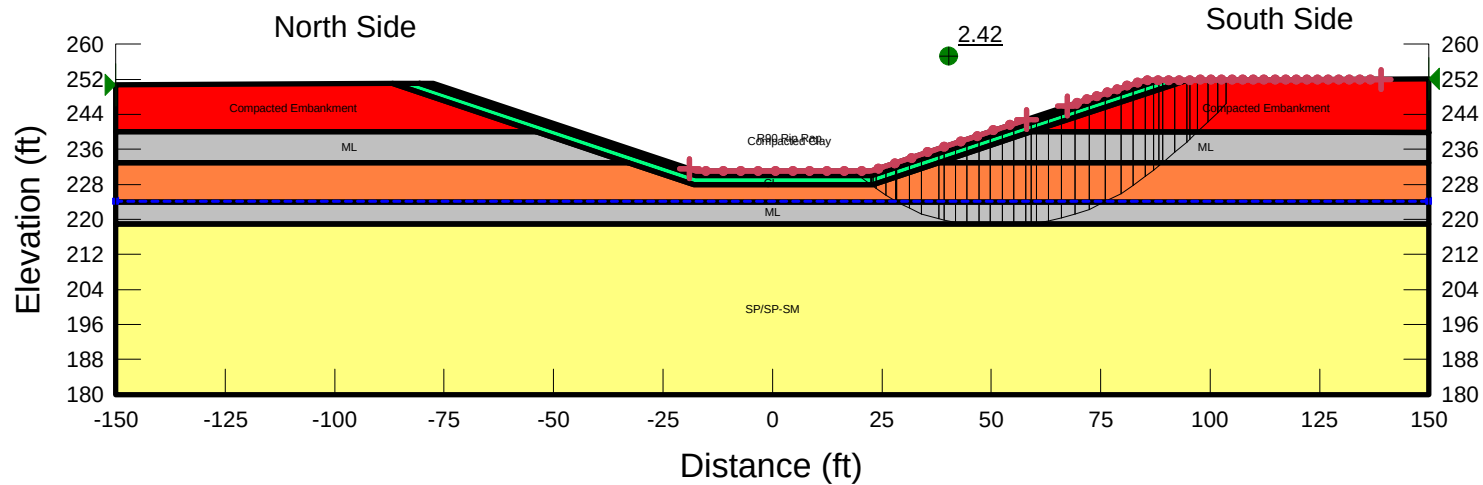
Relative Density, D_r (%)	Classification
0–15	Very loose
15–35	Loose
35–65	Medium dense ^a
65–85	Dense
85–100	Very dense

^aLambe and Whitman used the term "medium," but "medium dense" is better because "medium" usually refers to the grain size distribution.

APPENDIX F

Slope Stability Analysis

Name: HWY 165 - AC
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



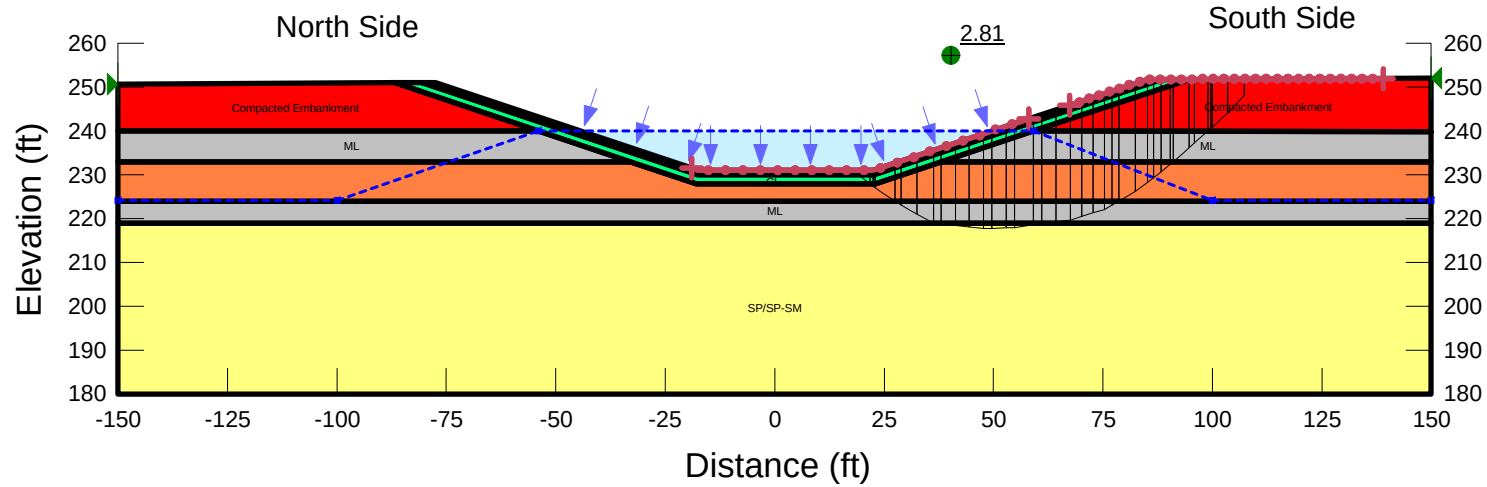
Name: R90 Rip Rap Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 38 ° Piezometric Line: 1
Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 750 psf Phi: 0 ° Piezometric Line: 1
Name: CL Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 134 pcf Cohesion: 970 psf Phi: 0 ° Piezometric Line: 1
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 750 psf Phi: 0 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - FPQ
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



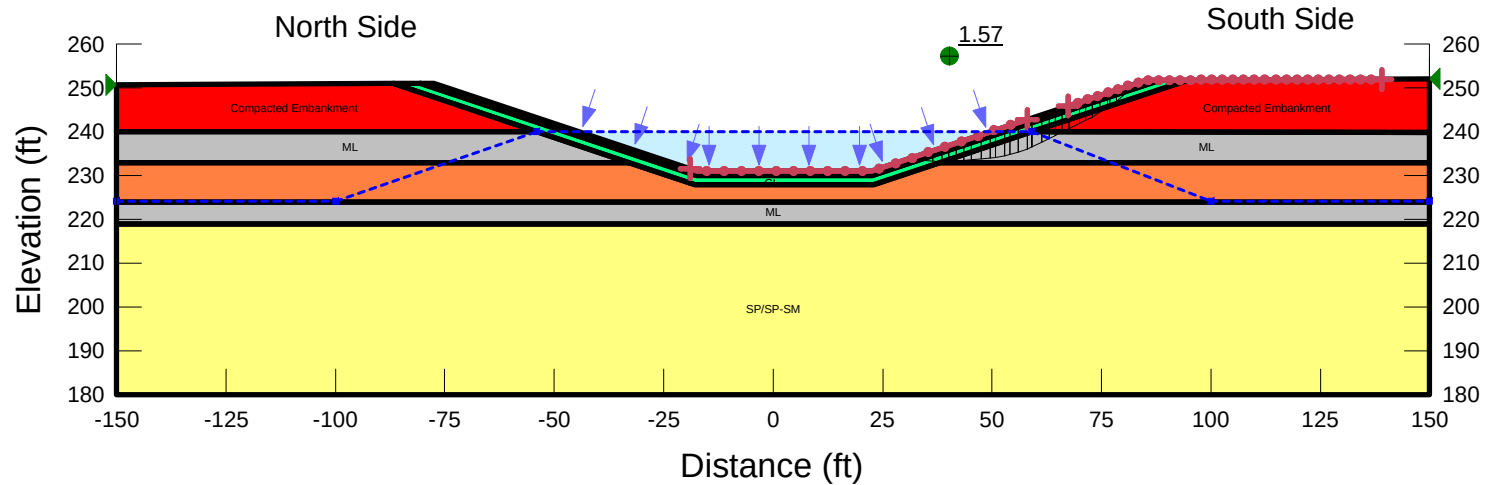
Name: R90 Rip Rap Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 38 ° Piezometric Line: 1
Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 750 psf Phi: 0 ° Piezometric Line: 1
Name: CL Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 134 pcf Cohesion: 970 psf Phi: 0 ° Piezometric Line: 1
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 750 psf Phi: 0 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - FPS
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



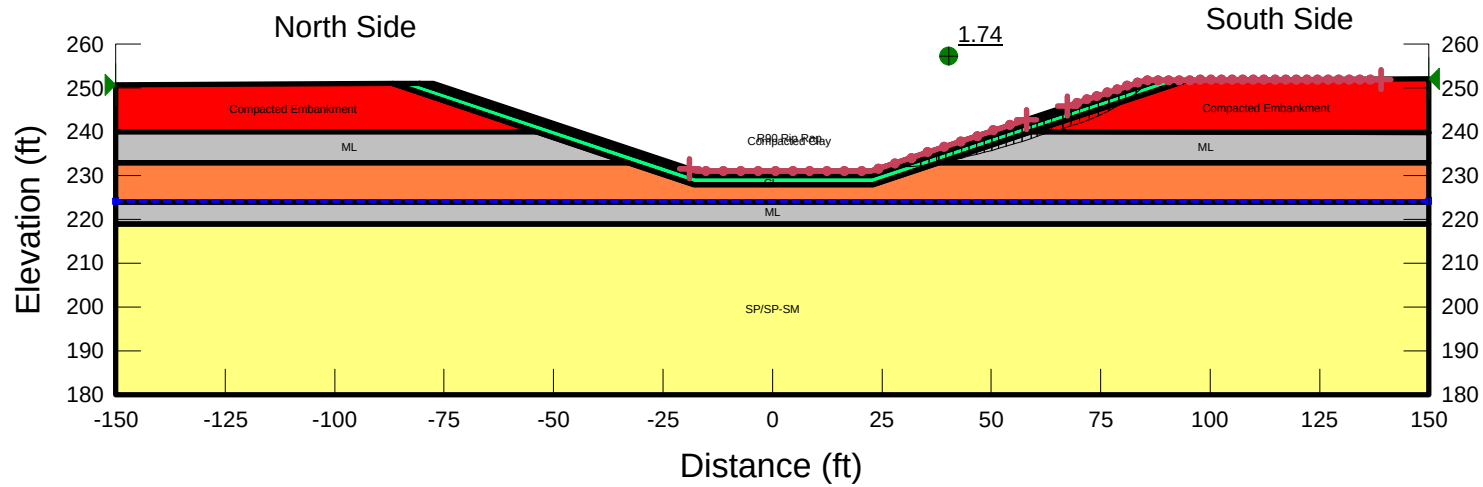
Name: R90 Rip Rap Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 38 ° Piezometric Line: 1
Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1
Name: CL Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 28 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 134 pcf Cohesion: 0 psf Phi: 28 ° Piezometric Line: 1
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - LT
 Method: Spencer
 Slip Surface Option: Entry and Exit
 Minimum Slip Surface Depth: 1.5 ft
 PWP Conditions Source: Piezometric Line
 Horz Seismic Load: 0



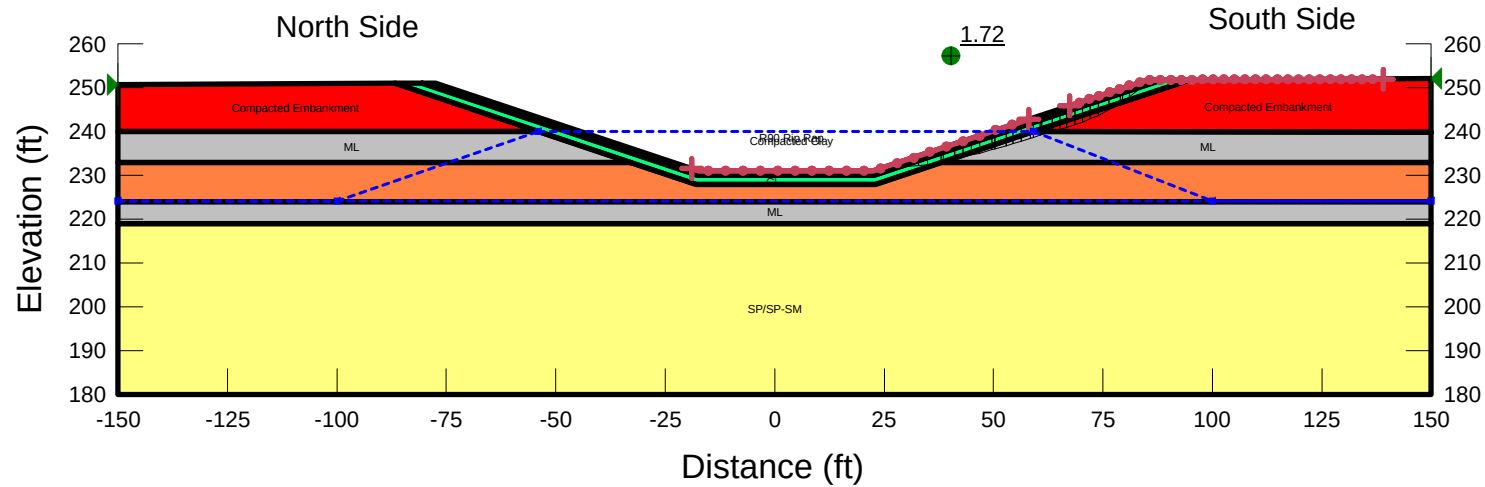
Name: R90 Rip Rap Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 38 ° Piezometric Line: 1
 Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1
 Name: CL Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 28 ° Piezometric Line: 1
 Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
 Name: ML Model: Mohr-Coulomb Unit Weight: 134 pcf Cohesion: 0 psf Phi: 28 ° Piezometric Line: 1
 Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
 HWY 165 BRIDGE
 C1000 CL STATION 106+35
 PULASKI COUNTY, ARKANSAS

Name: HWY 165 - RD
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



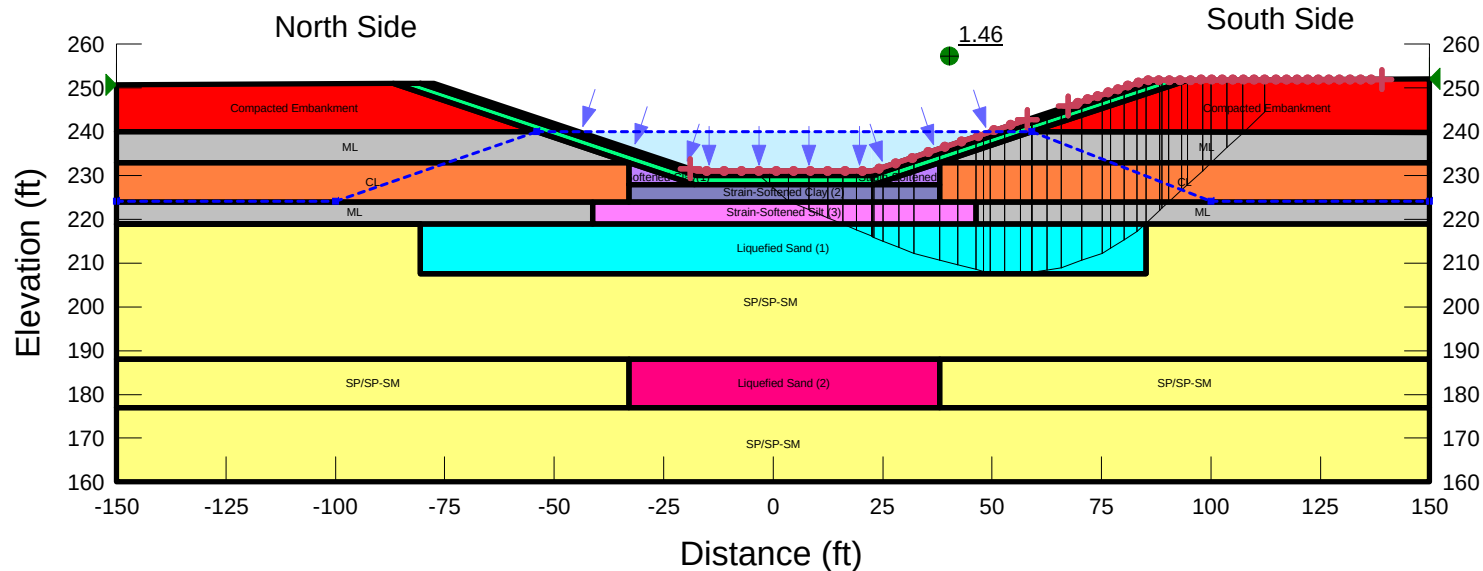
Name: R90 Rip Rap Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 38 ° Drawdown Total Cohesion: 0 psf Drawdown Total Phi: 380 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 23 ° Drawdown Total Cohesion: 350 psf Drawdown Total Phi: 11 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: CL Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 28 ° Drawdown Total Cohesion: 500 psf Drawdown Total Phi: 14 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 ° Drawdown Total Cohesion: 0 psf Drawdown Total Phi: 30 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: ML Model: Mohr-Coulomb Unit Weight: 134 pcf Cohesion: 0 psf Phi: 28 ° Drawdown Total Cohesion: 480 psf Drawdown Total Phi: 14 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 23 ° Drawdown Total Cohesion: 350 psf Drawdown Total Phi: 11 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - Residual Shear
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0



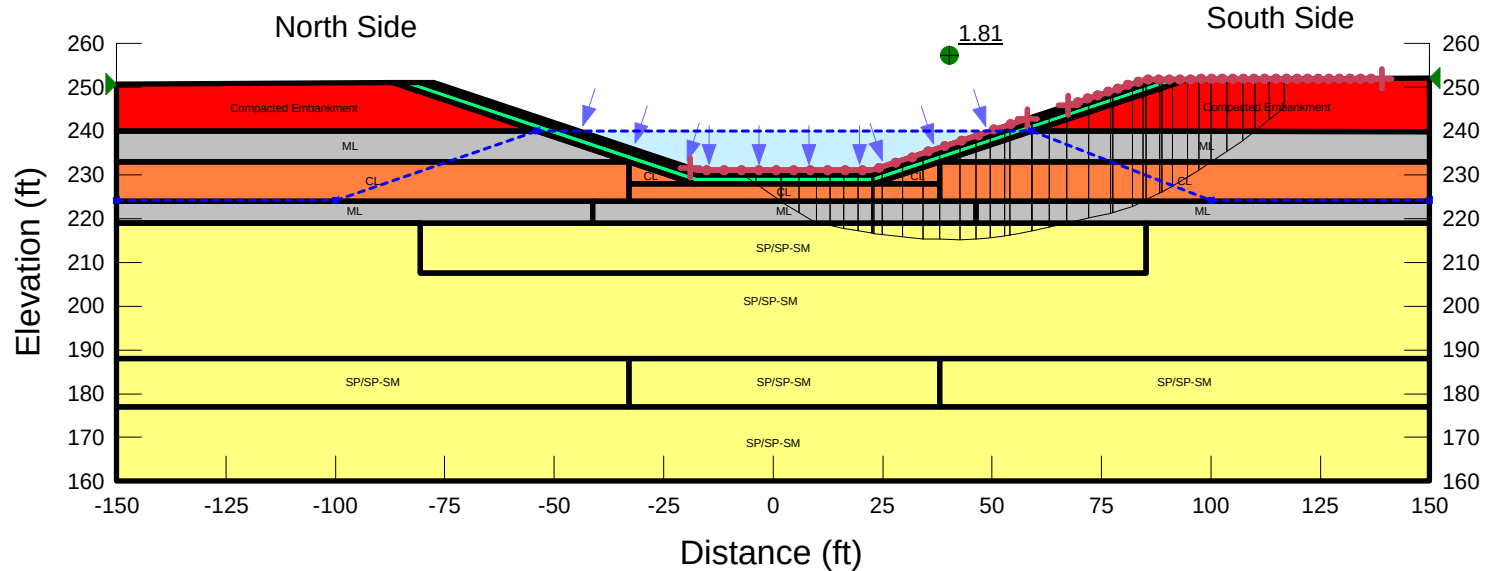
Name: R90 Rip Rap	Model: Mohr-Coulomb	Unit Weight: 122 pcf	Cohesion: 0 psf	Phi: 38 °	Piezometric Line: 1
Name: Compacted Clay	Model: Mohr-Coulomb	Unit Weight: 115 pcf	Cohesion: 750 psf	Phi: 0 °	Piezometric Line: 1
Name: CL	Model: Mohr-Coulomb	Unit Weight: 118 pcf	Cohesion: 1000 psf	Phi: 0 °	Piezometric Line: 1
Name: SP/SP-SM	Model: Mohr-Coulomb	Unit Weight: 125 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: ML	Model: Mohr-Coulomb	Unit Weight: 134 pcf	Cohesion: 970 psf	Phi: 0 °	Piezometric Line: 1
Name: Compacted Embankment	Model: Mohr-Coulomb	Unit Weight: 115 pcf	Cohesion: 750 psf	Phi: 0 °	Piezometric Line: 1
Name: Strain-Softened Clay(1)	Model: Spatial Mohr-Coulomb	Unit Weight: 118 pcf	Cohesion Spatial Fn: Residual Shear Clay (1)	Phi: 0 °	Piezometric Line: 1
Name: Strain-Softened Clay (2)	Model: Spatial Mohr-Coulomb	Unit Weight: 118 pcf	Cohesion Spatial Fn: Residual Shear Clay (2)	Phi: 0 °	Piezometric Line: 1
Name: Strain-Softened Silt (3)	Model: Spatial Mohr-Coulomb	Unit Weight: 134 pcf	Cohesion Spatial Fn: Residual Shear Silt (1)	Phi: 0 °	Piezometric Line: 1
Name: Liquefied Sand (1)	Model: Spatial Mohr-Coulomb	Unit Weight: 125 pcf	Cohesion Spatial Fn: Residual Shear Sand (1)	Phi: 0 °	Piezometric Line: 1
Name: Liquefied Sand (2)	Model: Spatial Mohr-Coulomb	Unit Weight: 125 pcf	Cohesion Spatial Fn: Residual Shear Sand (2)	Phi: 0 °	Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - Seismic Condition
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line
Horz Seismic Load: 0.11



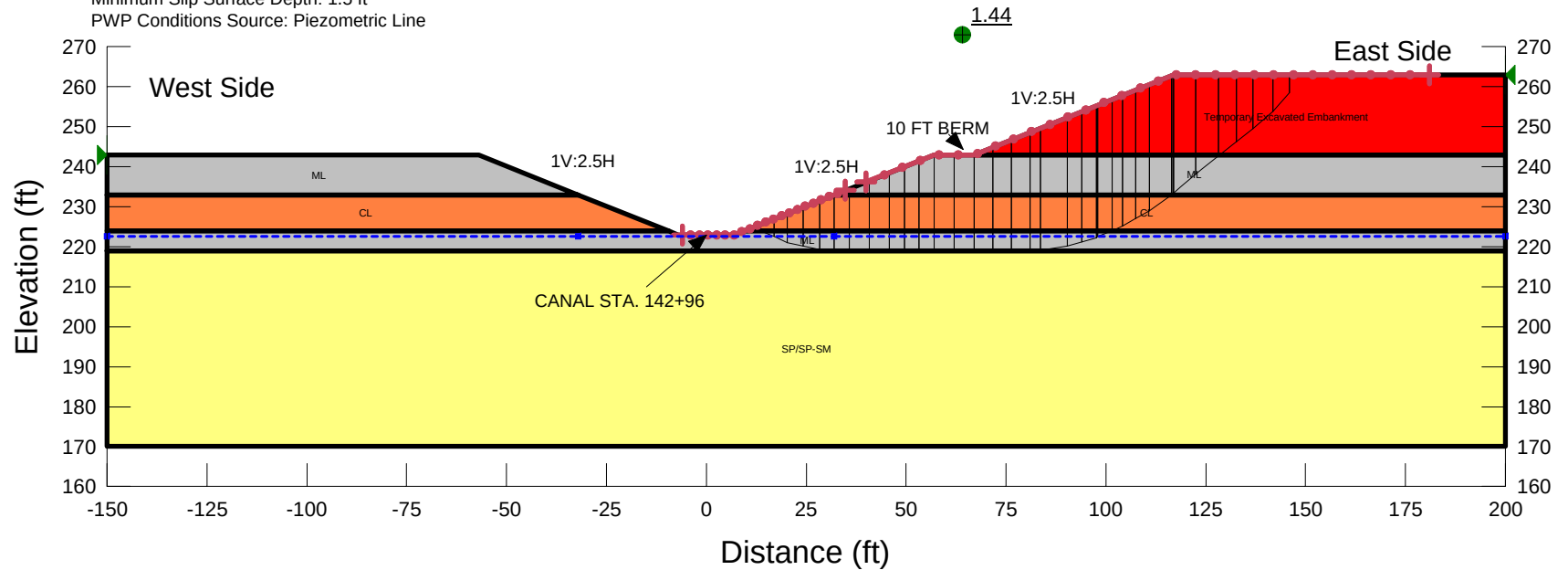
Name: R90 Rip Rap Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 38 ° Piezometric Line: 1
Name: Compacted Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 750 psf Phi: 0 ° Piezometric Line: 1
Name: CL Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 134 pcf Cohesion: 970 psf Phi: 0 ° Piezometric Line: 1
Name: Compacted Embankment Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 750 psf Phi: 0 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
C1000 CL STATION 106+35
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - Temporary Cut
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line



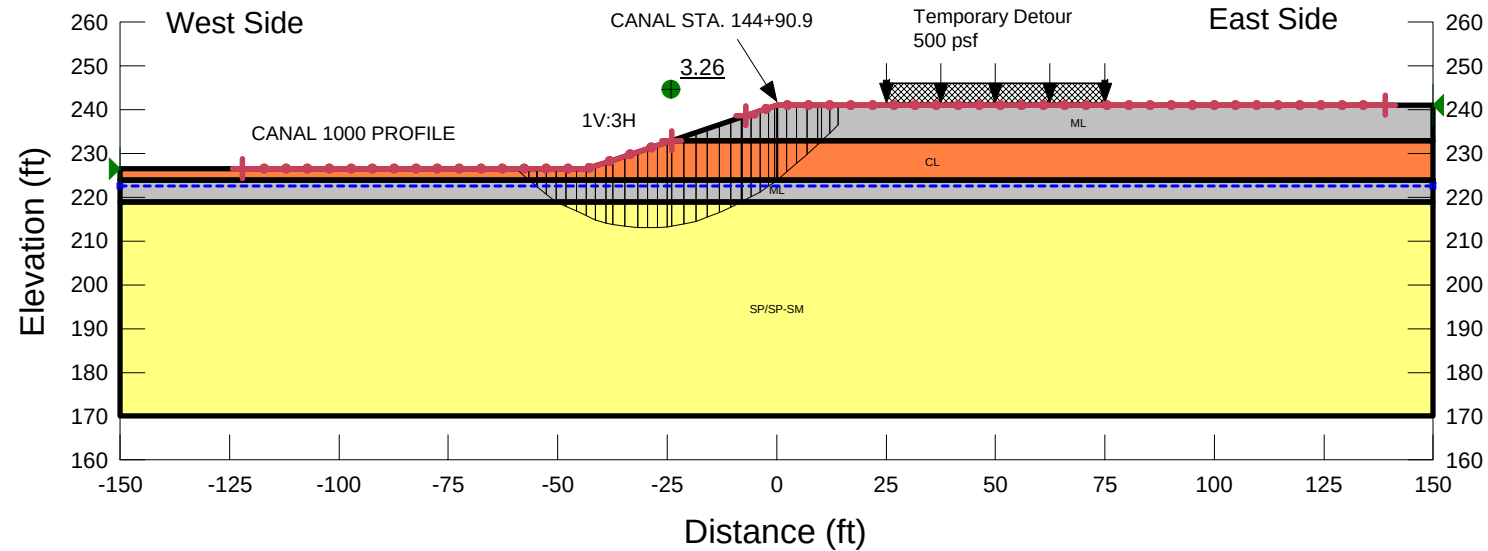
Name: CL Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 134 pcf Cohesion: 970 psf Phi: 0 ° Piezometric Line: 1
Name: Temporary Excavated Embankment Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 500 psf Phi: 0 ° Piezometric Line: 1

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
HWY 165 CL STATION 22+52.53
PULASKI COUNTY, ARKANSAS

Name: HWY 165 - Temporary Cut
Method: Spencer
Slip Surface Option: Entry and Exit
Minimum Slip Surface Depth: 1.5 ft
PWP Conditions Source: Piezometric Line



Name: CL Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 ° Piezometric Line: 1
Name: SP/SP-SM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: ML Model: Mohr-Coulomb Unit Weight: 134 pcf Cohesion: 970 psf Phi: 0 ° Piezometric Line: 1
Surcharge Load: 1 Surcharge (Unit Weight): 100 pcf

GENERAL NOTES:

Classification, stratifications, shear strengths, and unit weights of the soil were based on the results of undisturbed/disturbed data. See Appendix A for boring information. Shear strengths were assumed constant through each layer.

BAYOU METO - CANAL 1000
HWY 165 BRIDGE
HWY 165 CL STATION 22+52.53
PULASKI COUNTY, ARKANSAS

APPENDIX G

Pavement Analysis

INTEROFFICE MEMORANDUM

DATE : 6/24/2015

TO : Mr. Trinity D. Smith, Engineer of Roadway Design

FROM : Martin Cruce, Staff Design Engineer

SUBJECT : Paving Type Recommendation
Job No XXXXXX USACE
Hwy. 165 Over BMB Canal 1000
Route: 165 Section: 8
County Lonoke

The attached pavement design for the subject project is submitted for approval. The following information is a summary of the design.

1. Comparison of alternatives :

<u>Description</u>	<u>Alt. No. 1</u>	<u>Alt. No. 2</u>	<u>Alt. No. 3</u>
ACHM Surface Course (1/2")	2	2	
ACHM Surface Course (1/2")	2	2	2
ACHM Binder Course (1")	3	6	6
ACHM Base Course (1-1/2")	4		
Aggregate Base Course (Class 7)	6	6	12
Total Thickness =	17	16	20
Calculated Structural No.	5.36	5.24	5.20
Required Structural No.	5.18	5.18	5.18
Estimated Cost Per Station	\$34,634	\$32,318	\$33,792
Estimated Cost (Project)	\$478,987	\$446,955	\$467,347

2. Traffic Volume :

2015 ADT	6,000
2035 ADT	7,450
Percent Trucks	10%

3. Recommended Alternate :

District : 2 Roadway : 2

4. Comments :

This project is on a new location vertically and will involve a detour. No FWDs were requested.

Alternative 2 submitted for approval.

Arnette Smith
Engineer of Roadway Design

Date 6/25/15

APPROVED:

Asst. Chief Engineer Design

Date 6/25/15

The Information below is normally required for Pavement Designs. This information was reviewed or provided from the appropriate Divisions prior to submitting the design.

Traffic

SN=4

Total 18K ESAL = 578

$$0.5 * 20 * 365 * 578 = 2,109,700$$

SN=5

Total 18K ESAL = 568

$$0.5 * 20 * 365 * 568 = 2,073,200$$

SN=6

Total 18K ESAL = 571

$$0.5 * 20 * 365 * 571 = 2,084,150$$

Materials

Asphalt Cement%/Mineral Aggregate%

Surface Course - 4.9%/95.1%

Binder Course - 4.2%/95.8%

Base Course - 3.8%/96.2%

Class 7 aggregate is available locally

Resilient Modulus = 2586 psi

Lord, Charles MVM

From: Hou, Zhiqiong "Jacqueline" [Zhiqiong.Hou@ahfd.AR.gov]
Sent: Friday, December 12, 2014 11:54 AM
To: Lord, Charles MVM
Cc: Mayfield-Hart, Elizabeth
Subject: [EXTERNAL] RE: Bayou Meto: Hwy 161 Bridge over Canal 1000 (UNCLASSIFIED)

Follow Up Flag: Follow up
Flag Status: Flagged

Mr. Lord,

Below is the information you requested. Please let me know if you need anything else for this project.

Station	Route	Section	BeginLM	EndLM	2015 ADT	2035 ADT	Annual Growth Factor	Truck%	ESAL_SN4	ESAL_SN5	ESAL_SN6
430070	165	8	27.42	31.48	6000	7450	1.10%	10	578	568	571
600047	161	5	0	6.41	1500	1850	1.10%	5	77	77	78

Jacqueline Hou
Engineer III
Traffic Information Systems Section
System Information and Research Division
Arkansas State Highway and Transportation Department
(501) 569-2110

-----Original Message-----

From: Mayfield-Hart, Elizabeth
Sent: Thursday, December 11, 2014 2:30 PM
To: charles.r.lord@usace.army.mil
Cc: Hou, Zhiqiong "Jacqueline"
Subject: FW: Bayou Meto: Hwy 161 Bridge over Canal 1000 (UNCLASSIFIED)

Mr. Lord-

Chuck indicated that you needed traffic growth rates for this project. Is this correct? Can you give me an idea of where the project is on Highway 161?

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

Job 06XXXX Hwy. 165 Over BMB Canal 1000
SN 5

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	2,073,200
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	85 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	2,586 psi
Stage Construction	1
Calculated Design Structural Number	5.18 in

Job No. XXXXXX USACE
ALT. NO. 1 OPEN SHOULDER

LAYER	MATERIAL DESCRIPTION	STRUCTURAL COEFFICIENT	THICKNESS (INCHES)	CALCULATED SN
1	ACHM SURFACE COURSE (1/2")	0.44	2	0.88
2	ACHM SURFACE COURSE (1/2")	0.44	2	0.88
3	ACHM BINDER COURSE (1")	0.44	3	1.32
4	ACHM BASE COURSE (1-1/2")	0.36	4	1.44
5	AGGREGATE BASE COURSE (CLASS 7)	0.14	6	0.84
TOTAL			17	5.36

SN REQUIRED FOR DESIGN:

5.18

Begin Job 15+66.00

Bridge End 21+85.20

Bridge End 23+21.37

End Job 30+85.00

TOTAL JOB LENGTH = **13.83** STATIONS

COST ESTIMATE FOR ONE STATION

1 Station = 100 FEET

ITEM	WIDTH (FEET)	DEPTH (IN.)	QUANTITY	UNIT	PRICE	COST
MAIN LANES						
ACHM Surface Course (1/2")	28.00	2	34.22	Ton	\$110.00	\$3,764.20
ACHM Surface Course (1/2")	28.25	2	34.53	Ton	\$110.00	\$3,798.30
ACHM Binder Course (1")	28.46	3	52.18	Ton	\$105.00	\$5,478.90
ACHM Base Course (1-1/2")	28.75	4	70.28	Ton	\$100.00	\$7,028.00
Aggregate Base Course (Class 7)	28.00	6	109.00	Ton	\$30.00	\$3,270.00
Tack Coat	85.46	0.03 gal/sq.yd.	28.49	Gallon	\$2.75	\$78.35
SHOULDER						
ACHM Surface Course (1/2")	12.00	2	14.67	Ton	\$110.00	\$1,613.70
Aggregate Base Course (Class 7)	variable	variable	169.50	Ton	\$30.00	\$5,085.00
					SUB-TOTAL:	\$30,116.45
					+15% E & C:	\$4,517.47

TOTAL: **\$34,633.92**

13.83 STATIONS X \$34,633.92 \$478,987.11

Job No. XXXXXX USACE
ALT. NO. 2 OPEN SHOULDER

LAYER	MATERIAL DESCRIPTION	STRUCTURAL	THICKNESS (INCHES)	CALCULATED SN
1	ACHM SURFACE COURSE (1/2")	0.44	2	0.88
2	ACHM SURFACE COURSE (1/2")	0.44	2	0.88
3	ACHM BINDER COURSE (1")	0.44	6	2.64
4	ACHM BASE COURSE (1-1/2")	0.36	0	0.00
5	AGGREGATE BASE COURSE (CLASS 7)	0.14	6	0.84
TOTAL			16	5.24

SN REQUIRED FOR DESIGN: 5.18

Begin Job 15+66.00 Bridge End 21+85.20 Bridge End 23+21.37 End Job 30+85.00

TOTAL JOB LENGTH = 13.83 STATIONS

COST ESTIMATE FOR ONE STATION

1 Station = 100 FEET

ITEM	WIDTH (FEET)	DEPTH (IN.)	QUANTITY	UNIT	PRICE	COST
MAIN LANES						
ACHM Surface Course (1/2")	28.00	2	34.22	Ton	\$110.00	\$3,764.20
ACHM Surface Course (1/2")	28.25	2	34.53	Ton	\$110.00	\$3,798.30
ACHM Binder Course (1")	28.58	6	104.79	Ton	\$105.00	\$11,002.95
ACHM Base Course (1-1/2")	28.83	0	0.00	Ton	\$100.00	\$0.00
Aggregate Base Course (Class 7)	28.00	6	109.00	Ton	\$30.00	\$3,270.00
Tack Coat	85.41	0.03 gal/sq.yd.	28.47	Gallon	\$2.75	\$78.29
SHOULDER						
ACHM Surface Course (1/2")	12.00	2	14.67	Ton	\$110.00	\$1,613.70
Aggregate Base Course (Class 7)	variable	variable	152.50	Ton	\$30.00	\$4,575.00
					SUB-TOTAL:	\$28,102.44
					+15% E & C:	\$4,215.37

TOTAL: \$32,317.81

13.83 STATIONS X \$32,317.81 \$446,955.31

Job No. XXXXXX USACE
ALT. NO. 3 OPEN SHOULDER

LAYER	MATERIAL DESCRIPTION	STRUCTURAL COEFFICIENT	THICKNESS (INCHES)	CALCULATED SN
1	ACHM SURFACE COURSE (1/2")	0.44	2	0.88
2	ACHM SURFACE COURSE (1/2")	0.44	0	0.00
3	ACHM BINDER COURSE (1")	0.44	6	2.64
4	ACHM BASE COURSE (1-1/2")	0.36	0	0.00
5	AGGREGATE BASE COURSE (CLASS 7)	0.14	12	1.68
TOTAL			20	5.20

SN REQUIRED FOR DESIGN:

5.18

Begin Job 15+66.00 Bridge End 21+85.20
 Begin Job 15+66.00

Box Culvert

Bridge End 23+21.37
 +.00

End Job 30+85.00
 End Job 30+85.00

TOTAL JOB LENGTH = **13.83** STATIONS

COST ESTIMATE FOR ONE STATION

1 Station = 100 FEET

ITEM	WIDTH (FEET)	DEPTH (IN.)	QUANTITY	UNIT	PRICE	COST
MAIN LANES						
ACHM Surface Course (1/2")	28.00	2	34.22	Ton	\$110.00	\$3,764.20
ACHM Surface Course (1/2")	28.17	0	0.00	Ton	\$110.00	\$0.00
ACHM Binder Course (1")	28.42	6	104.21	Ton	\$105.00	\$10,942.05
ACHM Base Course (1-1/2")	28.67	0	0.00	Ton	\$100.00	\$0.00
Aggregate Base Course (Class 7)	28.00	12	217.75	Ton	\$30.00	\$6,532.50
Tack Coat	56.84	0.03 gal/sq.yd.	18.95	Gallon	\$2.75	\$52.11
SHOULDERS						
ACHM Surface Course (1/2")	12.00	2	14.67	Ton	\$110.00	\$1,613.70
Aggregate Base Course (Class 7)	variable	variable	216.00	Ton	\$30.00	\$6,480.00
					SUB-TOTAL:	\$29,384.56
					+15% E & C:	\$4,407.68

TOTAL: **\$33,792.24**

13.83 STATIONS X \$33,792.24 \$467,346.68

DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	FEEDBACK DIST. NO.	SALES ADM.	FED. AD PROJ. NO.	SHEET NO.	TOTAL SHEETS
				6	ADM.			
				JOB NO.			1	
① HWY 165 OVER BMB CANAL 1000								

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

CONSTRUCTION PLANS FOR STATE HIGHWAY

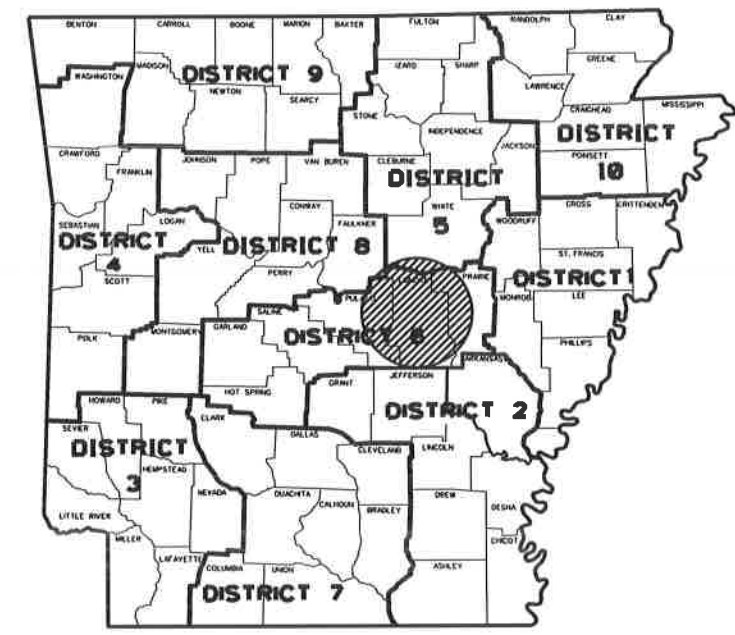
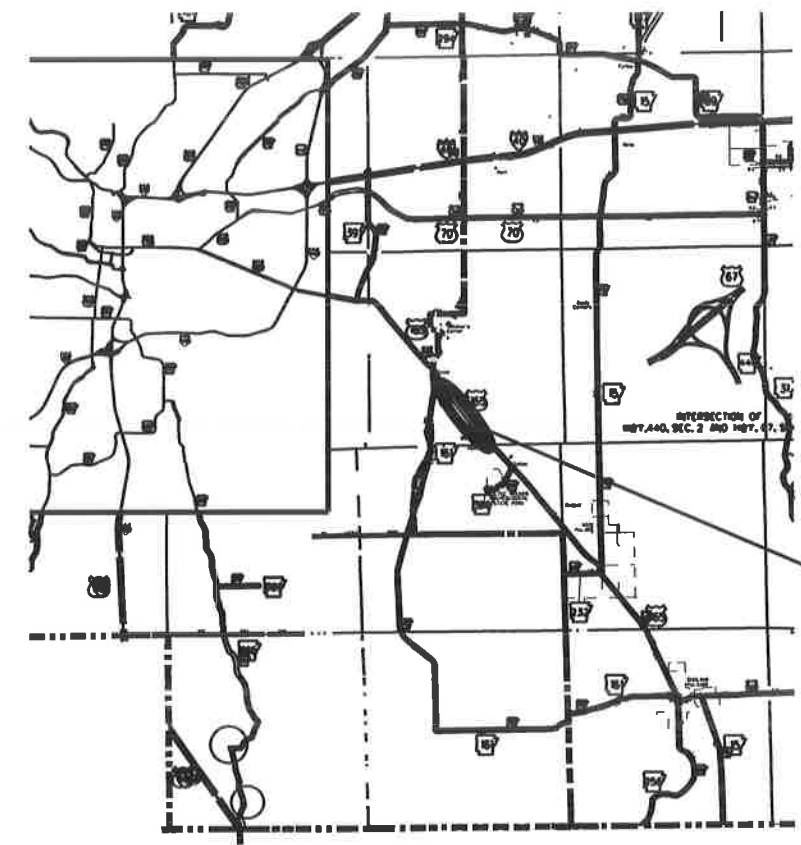
HWY. 165

OVER BMB CANAL 1000

Lenoke County

ROUTE 165 SECTION 8

USACE JOB XXXXXX



ARKANSAS HIGHWAY DIST. 6

LONOKE COUNTY

BRIDGE CONSTRUCTION DATA

- ①

STA. 21+85.20 BRIDGE END

BRIDGE NO. XXXXX

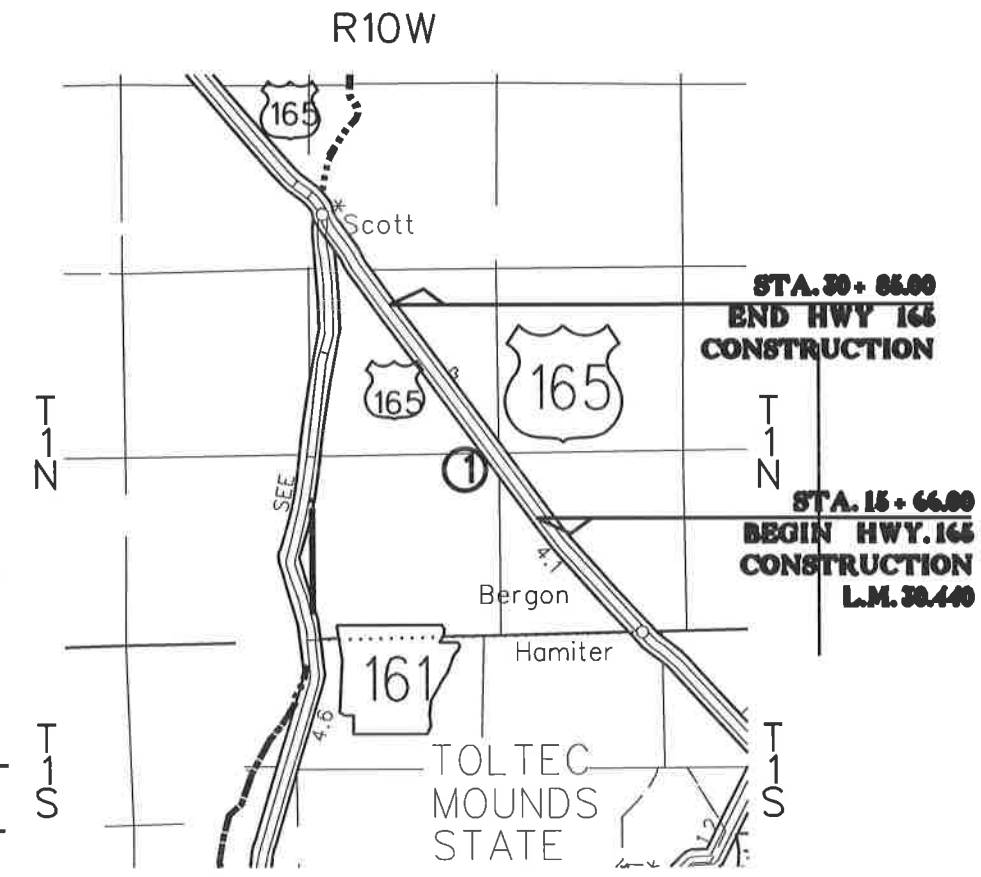
134'-0" COMPOSITE W-BEAM UNIT

40' CLEAR ROADWAY

136'-2" BRIDGE LENGTH

STA. 23+21.37 BRIDGE END

HWY. 165 PROJECT COORDINATES			
	BEGIN	MD-POINT	END
LATITUDE	N 34° 41' 03.46"	N 34° 41' 09.65"	N 34° 41' 15.84"
LONGITUDE	W 92° 05' 12.66"	W 92° 05' 17.82"	W 92° 05' 22.97"
STATION	15+66.00	23+25.50	30+85.00



	JOB XXXXXX				
GROSS LENGTH OF PROJECT	1519.00	FT	OR	0.288	MILES
NET LENGTH OF ROADWAY	1382.83	FT	OR	0.262	MILES
NET LENGTH OF BRIDGE	136.17	FT	OR	0.026	MILES
NET LENGTH OF PROJECT	1519.00	FT	OR	0.288	MILES

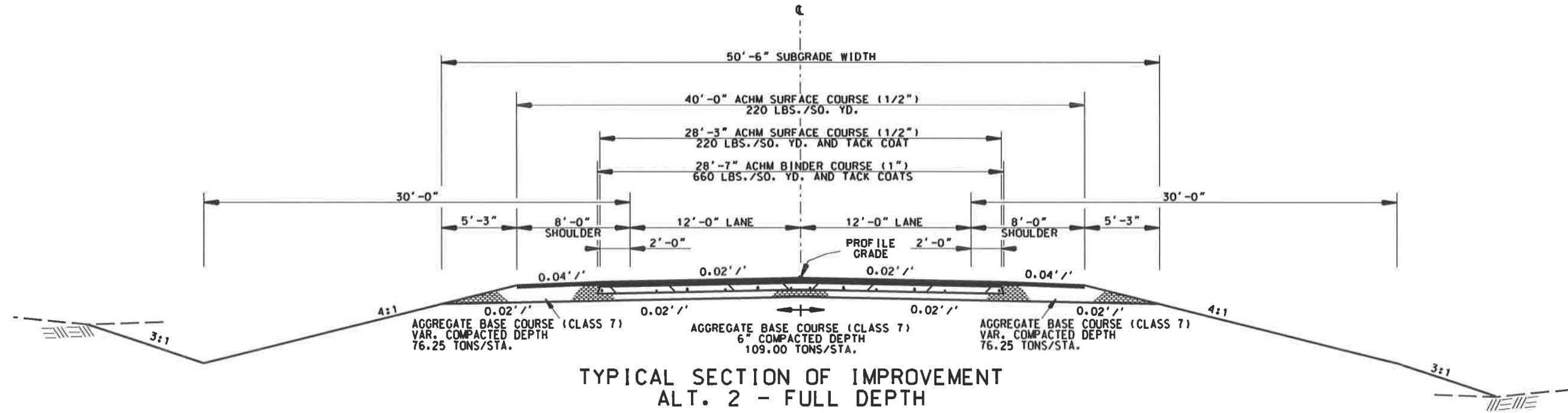
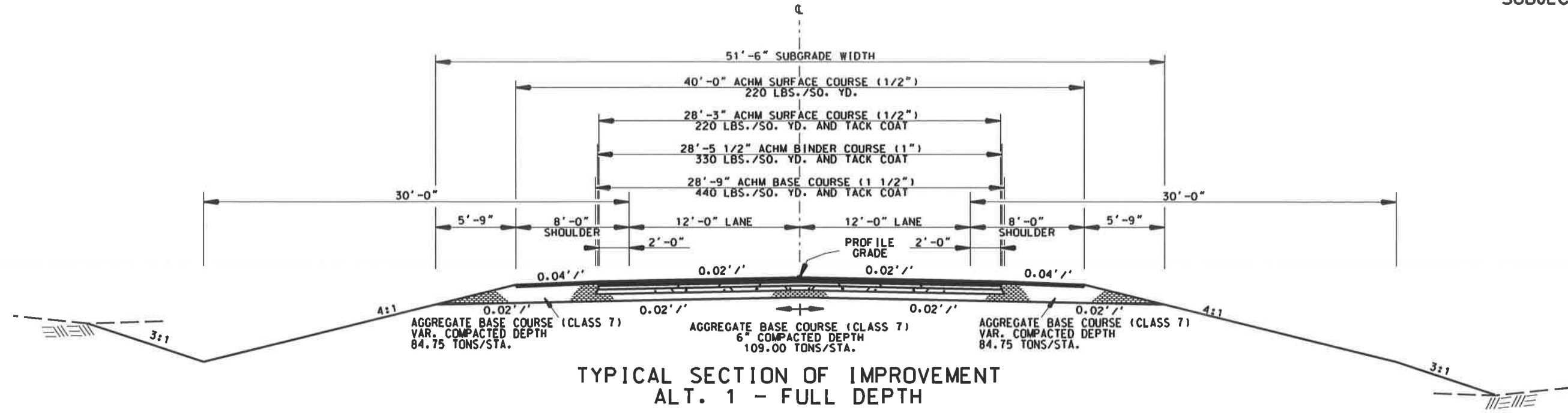
PRELIMINARY
NOT FOR
CONSTRUCTION

DESIGN TRAFFIC DATA	
DESIGN YEAR	2035
2015 ADT	6000
2035 ADT	7450
2035 DHV	830
DIRECTIONAL DISTRIBUTION	60%
TRUCKS	10%
DESIGN SPEED	60 MPH

DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	FED. RD. DIST. NO.	STATE	FED. RD. PROJ. NO.	SHEET NO.	TOTAL SHEETS
				6	ARK.			
				JOB NO.	XXXXXX			

2 TYPICAL SECTIONS OF IMPROVEMENT

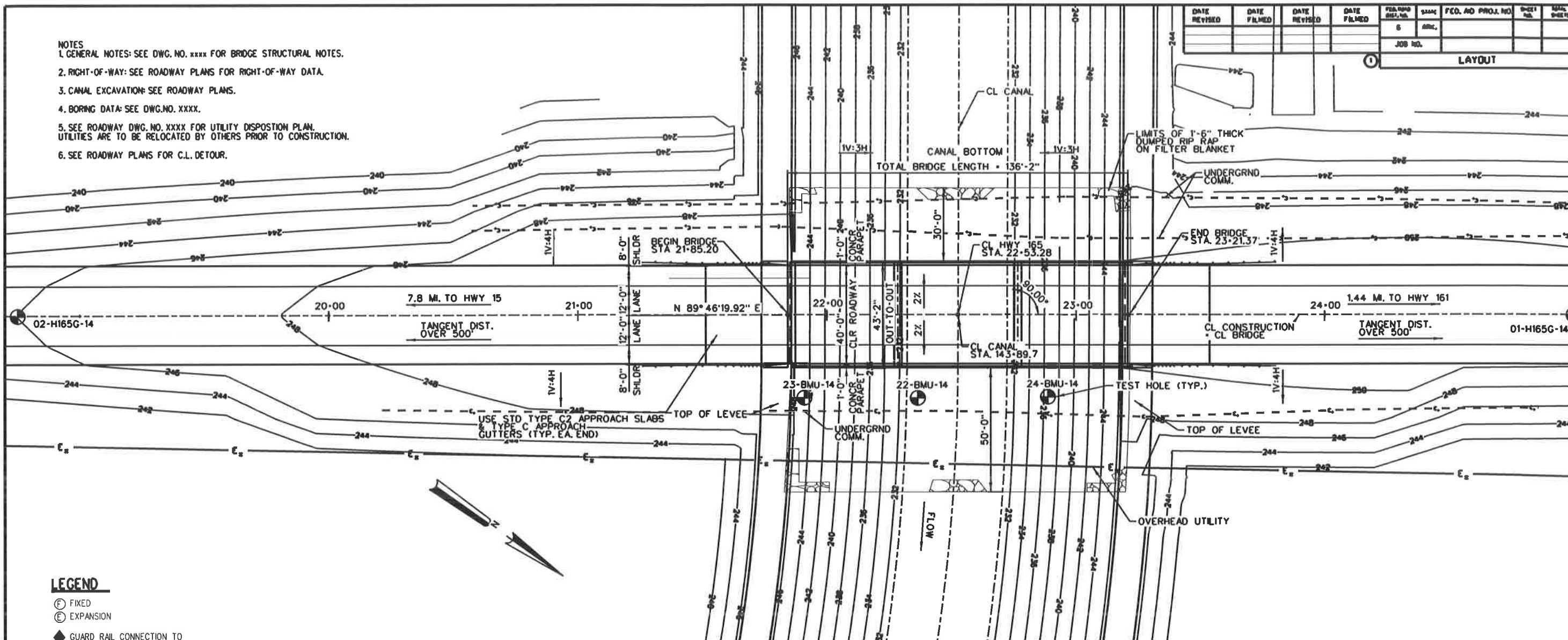
PRELIMINARY
SUBJECT TO REVISION



TYPICAL SECTIONS OF IMPROVEMENT

- NOTES
1. GENERAL NOTES: SEE DWG. NO. XXXX FOR BRIDGE STRUCTURAL NOTES.
 2. RIGHT-OF-WAY: SEE ROADWAY PLANS FOR RIGHT-OF-WAY DATA.
 3. CANAL EXCAVATION: SEE ROADWAY PLANS.
 4. BORING DATA: SEE DWG. NO. XXXX.
 5. SEE ROADWAY DWG. NO. XXXX FOR UTILITY DISPOSITION PLAN. UTILITIES ARE TO BE RELOCATED BY OTHERS PRIOR TO CONSTRUCTION.
 6. SEE ROADWAY PLANS FOR C.L. DETOUR.

DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	FILING NO.	DATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
				6	APR. 2015			
				JOB NO.	LAYOUT			

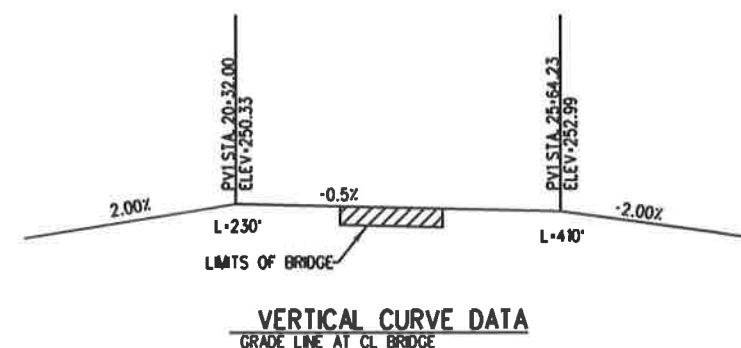
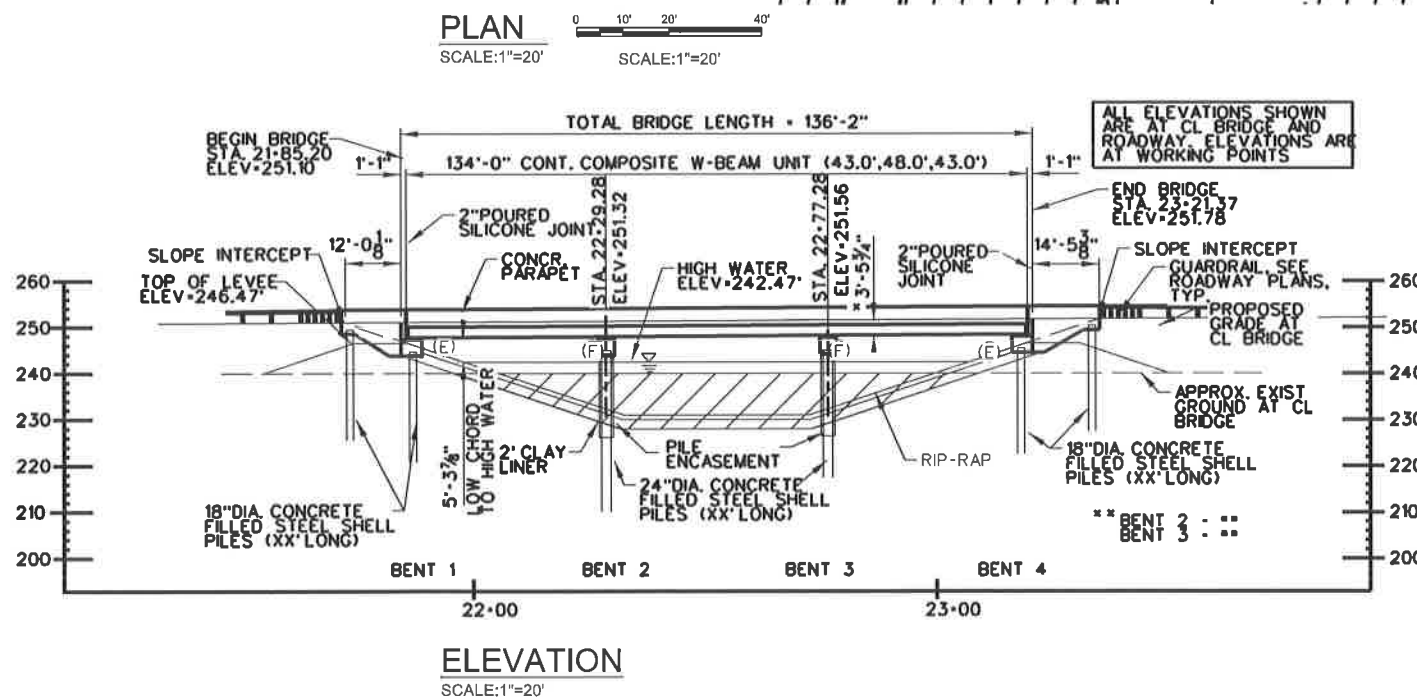


LEGEND

- ⊙ FIXED
- ⊕ EXPANSION
- ◆ GUARD RAIL CONNECTION TO PARAPET TRANSITION
- + CL DECK TO LOW STEEL
- + + CL DECK TO LOW SEAT
- ▨ EXCAVATION LIMITS, SEE ROADWAY FOR QUANTITIES
- ⊙ TEST HOLE

HYDRAULIC DATA

DRAINAGE AREA • 0.07 SQ. MI.
MAIN CANAL LENGTH FOR CANAL 1000 • 7.95 MI.
CANAL FREEBOARD • 5'-3 1/2"
HISTORIC HIGHWATER ELEVATION • N/A
MAXIMUM PUMPED DISCHARGE • 1750 CFS.
FREQUENCY DISCHARGE • N/A
HECRAS STATION • 144+00

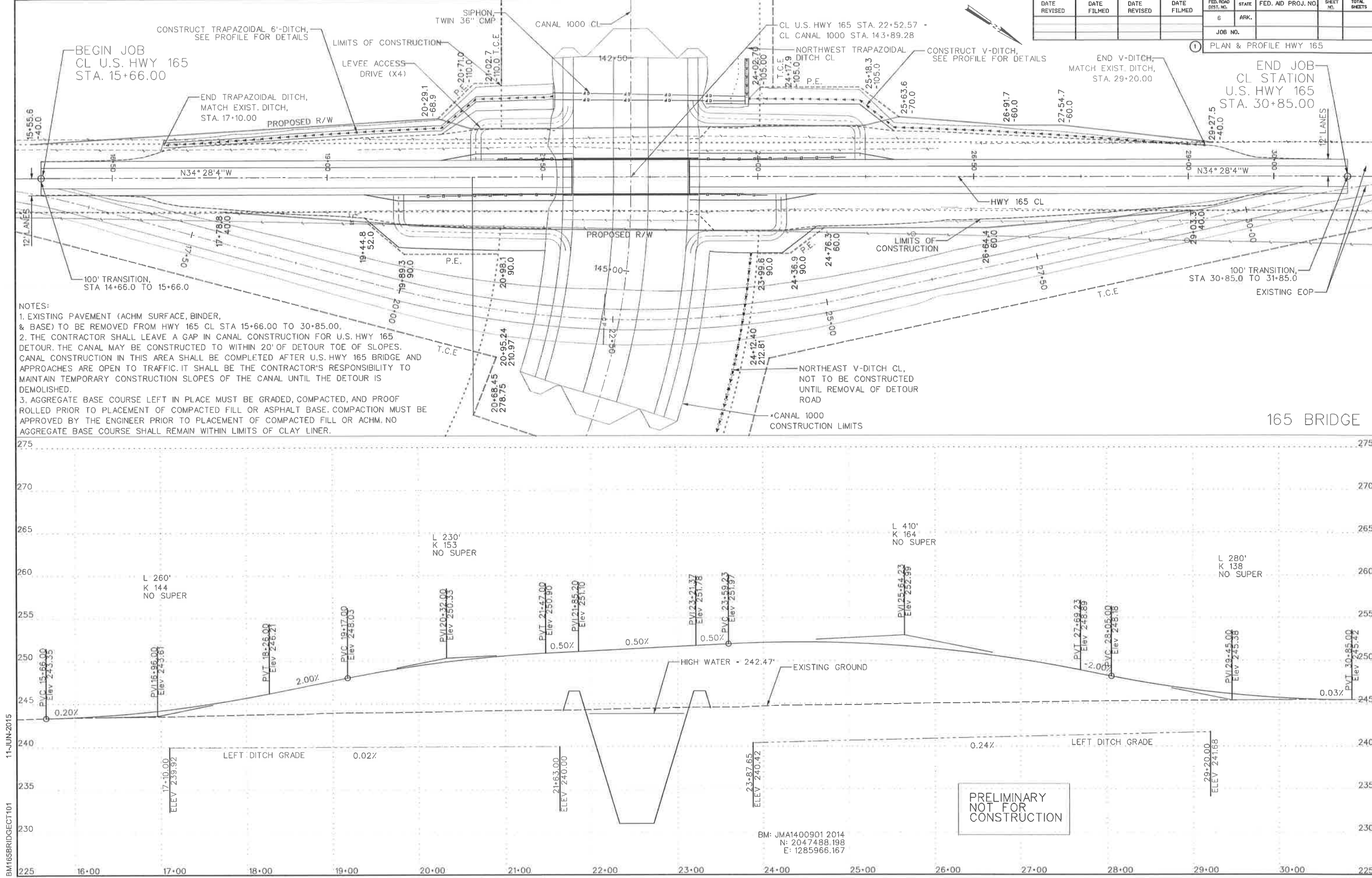


PRELIMINARY
NOT FOR
CONSTRUCTION

SHEET 1 OF ?
LAYOUT OF BRIDGE
HIGHWAY 165 OVER CANAL 1000
LONOKE COUNTIES

ROUTE 165 SEC. 8
ARKANSAS STATE HIGHWAY COMMISSION
LITTLE ROCK, ARK.

DESIGN BY: MJH DATE: APR. 2015
CHECKED BY: DR DATE: APR. 2015
APPROVED BY: TLW DATE: APR. 2015
BRIDGE NO. XXXXX DRAWING NO. 6XXXXX00_11



DATE REVISED	DATE FILMED	DATE REVISED	DATE FILMED	FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
				6	ARK.			

1 PLAN & PROFILE HWY 165

END JOB
CL STATION
U.S. HWY 165
STA. 30+85.00

- NOTES:
1. EXISTING PAVEMENT (ACHM SURFACE, BINDER, & BASE) TO BE REMOVED FROM HWY 165 CL STA 15+66.00 TO 30+85.00.
 2. THE CONTRACTOR SHALL LEAVE A GAP IN CANAL CONSTRUCTION FOR U.S. HWY 165 DETOUR. THE CANAL MAY BE CONSTRUCTED TO WITHIN 20' OF DETOUR TOE OF SLOPES. CANAL CONSTRUCTION IN THIS AREA SHALL BE COMPLETED AFTER U.S. HWY 165 BRIDGE AND APPROACHES ARE OPEN TO TRAFFIC. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO MAINTAIN TEMPORARY CONSTRUCTION SLOPES OF THE CANAL UNTIL THE DETOUR IS DEMOLISHED.
 3. AGGREGATE BASE COURSE LEFT IN PLACE MUST BE GRADED, COMPACTED, AND PROOF ROLLED PRIOR TO PLACEMENT OF COMPACTED FILL OR ASPHALT BASE. COMPACTION MUST BE APPROVED BY THE ENGINEER PRIOR TO PLACEMENT OF COMPACTED FILL OR ACHM. NO AGGREGATE BASE COURSE SHALL REMAIN WITHIN LIMITS OF CLAY LINER.

11-JUN-2015
BM165BRIDGECT101

BM: JMA1400901 2014
N: 2047488.198
E: 1285966.167

PRELIMINARY
NOT FOR
CONSTRUCTION